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April 1, 2013
File No. 09199033.23

Mr. Steven G. Morgan
Florida Department of Environmental Protection
Southwest District Office
13051 North Telecom Parkway
Temple Terrace, Florida 33637-0926

Subject: Hardee County Class I Landfill
Phase II Section II Expansion Construction
Response to Request for Additional Information No. 1
Pending Permit No. 38414-015-SC/01, Hardee County
WACS No. SWD/25/40612

Dear Mr. Morgan:

On behalf of the Hardee County Board of County Commissioners (BOCC), SCS Engineers (SCS) submits the following responses to the Florida Department of Environmental Protection (FDEP) Request for Additional Information (RAI) No. 1 letter dated September 28, 2012. The letter, sent via email, was directed to Ms. Teresa Carver, Director Hardee County Solid Waste Department regarding the Hardee County Class I Landfill Phase II Section II Expansion Application for Construction documents dated August 31, 2012. For ease of review, each FDEP comment is reiterated in bold type followed by SCS's response in normal print.

## GENERAL

1. **The requested information and comments below do not necessarily repeat the information submitted by the applicant. However, every effort has been made to concisely refer to the section, page, drawing detail number, etc. where the information has been presented in the original submittal.**

   **Response:** Comment noted.

2. **Please submit 4 copies of all requested information. Please specify if revised information is intended to supplement, or replace, previously submitted information. Please submit all revised plans and reports as a complete package. For revisions to the narrative reports, deletions may be struckthrough (~~struckthrough~~) and additions may be underlined (underlined) or similar notation method. This format will expedite the review process. Please include revision date on all revised pages.**

   **Response:** Comment noted. SCS has provided revised submittals, or replacement pages to the submittals, hole-punched for a three-ring binder using a strikethrough (~~strikethrough~~), underline (underline) or shaded (shaded) format to facilitate the FDEP review process. SCS included the revision date as part of the footer for all revised submittals, or replacement pages to the submittals, and provided four copies of all revised and additional materials. A list of submitted documents in response to RAI No. 1 is provided at the end of this letter.

3. **Please provide a summary of all revisions to drawings, and indicate the revision on each of the applicable plan sheets. Please use a consistent numbering system for drawings. If new sheets must be added to the original plan set, please use the same numbering system with a prefix or suffix to indicate the sheet was an addition, e.g. Sheet 1A, 1B, P1-A, etc.**

   **Response:** Revisions to the Hardee County Landfill Phase II Section II Expansion Construction Drawings (Drawings) dated August 2012 previously submitted to FDEP consisting of Drawing Numbers 1 through 21 in response to RAI No. 1 have been indicated by SCS on each of the applicable Drawings using revision clouds with labels as necessary and the reason for the revisions have been indicated in the title block. In addition, additional Drawings have been added that were not specifically requested by FDEP but have been included for design component clarification. Also, in response to RAI No. 1, the revisions or clarifications implemented to the Drawings have also been discussed. Please note, for ease of reference, SCS has supplied all of the drawings as a complete set for the Department since several sheets were either added or revised in response to RAI No. 1. Refer to Attachment A for the revised Drawings Number 1 through Drawings Number 37 created by SCS in response to RAI No. 1.

4. **Please be advised that although some comments do not explicitly request additional information, the intent of all comments shall be to request revised calculations, narrative, technical specifications, QA documentation, plan sheets, clarification to the item, and/or other information as appropriate. Please be reminded that all calculations must be signed and sealed by the registered professional engineer (or geologist as appropriate) who prepared them.**

   **Response:** Comment noted. All revised calculations, narrative, technical specifications, QA documentation, Drawings, clarification to items and/or other information as appropriate which has been submitted by SCS in response to RAI No. 1 is signed and sealed by the registered professional engineer who prepared them.

1. **Rule 62-701.320(5)(b), F.A.C. Please address the comments in John Morris' September 21, 2012 memorandum (attached) regarding this application. You may call Mr. Morris at (813) 744-6100, extension 336, to discuss the items in his memorandum.**

   **Response:** SCS has provided responses to the comments in John Morris' September 21, 2012 memorandum relating to the following Parts towards the end of this letter.

   - Part H - Hydrogeological Investigation Requirements
   - Part L - Water Quality And Leachate Monitoring Requirements
   - Part N - Gas Management System Requirements

- Part O - Landfill Final Closure Requirements

2. **Rule 62-701.320(7)(b), F.A.C. Application Form #62-701.900(1): Please provide revised pages to the application form, where appropriate, to address the following comments:**

   a. **Part B.17.: Please verify the number of monitoring wells listed in this section, and revise as appropriate.**

   **Response:** Part B.17 on page 7 of 39 of the State of Florida Department of Environmental Protection Application to Construct, Operate, Modify, or Close a Solid waste Management Facility Form 62-701.900(1) has been revised to indicate the number of monitoring wells will be 10 as opposed to the previously indicated 8 after the Phase II Section II Expansion project has been constructed. Refer to Attachment B for revised Part B.17 (page 7 of 39) of Application Form #62-701.900(1). This quantity of monitoring wells is also consistent with Drawing 4 provided in Attachment A.

   In addition, a new Application Form #62-701.900(1) page 39 has been signed by Shane R. Fischer, P.E. (and sealed) and Teresa Carver as provided in Attachment B.

## SECTION A - GENERAL INFORMATION (RULE 62-701.320(7), F.A.C.

3. **Please note that while the adequacy of the existing design to accommodate the proposed height increase in Phase II Section I will be reviewed as part of this construction permit application, authorization to operate (i.e. filling above the current permit height) will need to be incorporated into the pending operation permit renewal application or a modification of the current operation permit. This comment is provided for informational purposes only and does not necessarily require a response, other than acknowledgement of the comment.**

   **Response:** Comment noted. The Operation Permit renewal application has been completed and was submitted to the Department as the *Hardee County Landfill Operation Permit Renewal Application*, dated March 12, 2013, prepared by SCS. The Operation Permit renewal application included the operation of the Phase II Section II Expansion after approval of the Certification of Construction Completion documents by the Department and the necessary components to incorporate the Phase II Section I height increase as part of the Phase II Section II Expansion construction permit application.

4. **Section A.1: The referenced Attachment A-1 (Figure A-1) does not appear to have been included in the application submittal. Please verify and provide Attachment A-1, as applicable.**

   **Response:** Attachment A-1 (Figure A-1 Regional Map) was inadvertently not included in the original application submittal. Refer to Attachment C for Figure A-1 Regional Map.

## SECTION B - DISPOSAL FACILITY GENERAL INFORMATION (RULE 62-701.320(7), F.A.C.)

5. **Attachment B-1: The certification of county millage, referenced in the letter provided in Attachment B-1 does not appear to have been included in permit application information. Please verify and provide this information, as appropriate.**

   **Response:** Attachment B-1 certification of county millage provided by Janice Williamson, Director of Management and Budget for Hardee County also indicated "Enclosed you will find the certification of the county millage by the Hardee County Property Appraiser's Office." The certification of the county millage by the Property Appraiser's Office was inadvertently not included in the letter provided by Janice Williamson with the original application submittal. Refer to Attachment D for the certification of the county millage by the Hardee County Property Appraiser's Office.

## SECTION D - DISPOSAL FACILITY GENERAL INFORMATION (RULE 62-701.320, F.A.C.)

6. **Section D.9: Attachment E-1 appears to be a copy of the Pickett survey report. Please provide a signed and sealed copy of the topographic survey and survey report.**

   **Response:** Refer to Attachment E for the signed and sealed aerial topographic survey conducted by Pickett and Associates, Inc. (Pickett), dated April 3, 2012 and associated signed and sealed survey report.

7. **Section D.9.b.: The zoning map submitted as Attachment E-3 did not show or identify the location of the landfill relative to the other mapped features. Please verify and revise this figure, as appropriate.**

   **Response:** The approximate location of the Hardee County Landfill has been added to the Hardee County Zoning Map. Refer to Attachment F for the revised Hardee County Zoning Map.

8. **Section D.13: Please publish the attached Notice of Application and provide proof of publication to the Department.**

   **Response:** Refer to Attachment G for the proof of publication of the Notice of Application from The Herald-Advocate which was published on February 28, 2013.

9. **Section D-14: The full state of Florida map at 8-1/2" x 11" submitted as Attachment D-2 was not sufficient to show the relation of the landfill to any nearby airports. Please provide a revised figure that shows the location of the landfill in Hardee County and the nearest airports within Hardee County or a five-mile radius of the landfill.**

   **Response:** Based on project files and the County's knowledge of the area, no licensed and operating airport runways are located within a five-mile radius of the Hardee County

Landfill. The Florida Department of Transportation (FDOT) Aviation Office database was researched by SCS for public, private, and military airports and landing facilities in the vicinity of the landfill. Based on the research, the Wauchula Municipal Airport was determined to be the closest operating airport to the Hardee County Landfill at approximately latitude 27.5149056 longitude -81.8804625. Refer to Attachment H for Figure D-1 Airport Location Map that shows the location of the Hardee County Landfill and the airports within a five-mile radius of the landfill obtained from the FDOT Aviation Office database search.

## SECTION E - LANDFILL PERMIT REQUIREMENTS (RULE 62-701.330, F.A.C.)

10. **Section E.2.b.: The previously provided Figure O-1 referenced in this section does not appear to accurately depict the proposed LFG probe locations. Please verify and revise the reference in this section, as applicable.**

    **Response:** Refer to Attachment I for revised Section E Landfill Permit Requirements of the Engineering Report. Section E.2.b has been revised to reference Figure O-1 Gas Probe Locations which depicts the proposed LFG probe locations. Included at the end of Attachment I is Figure N-1 Gas Probe Locations (previously Figure O-1 Gas Probe Locations). The locations of the existing and six proposed LFG monitoring probes (as well as all of the facility previously existing and abandoned LFG monitoring probes) to be abandoned or installed as part of the project have been included on the Figure. The quantity of LFG monitoring probes is consistent with the probes on revised Drawing 4 proved in Attachment A.

    In addition, the reference to the proposed monitoring wells to be installed with the Phase II Section II Expansion has been revised within Section E. The previously proposed MW-15 has been removed; placement of monitoring points MW-13 and MW-14 were based on Chapter 62-701.510, FAC.

11. **Section E.2.c.: The location of the soil borings do not appear to be included in the drawings in Attachment E-2, as indicated in this section. Please verify and revise the appropriate drawing, if applicable.**

    **Response:** The locations of the soil borings were inadvertently not included in the original application submittal Drawings. Refer to Attachment A for revised Drawing Number 7 for the location of the soil borings as previously indicated.

12. **Section E.3.e.: The cross section disposal lifts do not appear to be included in the drawings in Attachment E-2, as indicated in this section. Please verify and revise the appropriate drawing, if applicable.**

    **Response:** Fill Sequence No. 1 through Fill Sequence No. 6 Plan Drawings has been included on Drawing Number 26 through 31. The cross section disposal lifts has been included on Fill Sequence No. 1 Sections through Fill Sequence No. 6 Sections Drawing

Number 32 through 37. Refer to Attachment A for Drawing Number 26 through 37 for the plan view and cross sections of the disposal lifts.

## ATTACHMENT E-1 - CONSTRUCTION PERMIT APPLICATION DRAWINGS

**Please provide the following additional information and revisions to the Construction Drawings that include all necessary details for the construction of the facility. Due to the difficulty in describing comments related to these drawings, these drawings will be discussed in detail at the meeting requested at the end of this letter. The drawings will be reviewed in their entirety after the responses to this request for information.**

**Response:** Comment noted. Based on the meeting conducted on November 26, 2012 between the following meeting attendees, the following responses are provided. In addition, as previously mentioned, additional Drawings not specifically requested by FDEP have been included for design component clarification in response to RAI No. 1.

- Shane R. Fischer, P.E. - SCS Engineers
- Ed Hilton, Jr., P.E. - SCS Engineers
- Ken Wheeler - Director/County Engineer Hardee County Public Works
- Teresa Carver - Hardee County Solid Waste Director
- Jeff Greenwell - FDEP
- John R. Morris - FDEP
- Steve Morgan - FDEP
- Mike Dunaway - FDEP (via conference call)
- Michele Smith - FDEP (via conference call)

**13. Sheet 11:**

a. **Please identify the location of the anchor trench on the section on this sheet.**

   **Response:** The locations of the anchor trench have been added on the sections as requested. Refer to Attachment A for revised Drawing Number 11 for the locations of the anchor trench.

b. **Section D: Please provide a cross reference to the leachate sump and riser pipe detail.**

   **Response:** A cross reference to the leachate sump and riser pipe detail has been added to Section D located on revised Drawing Number 11. Refer to Attachment A for revised Drawing Number 11 for the cross reference to the leachate sump and riser pipe detail.

**14. Sheet 14:**

a. **Section 2: This section does not appear to be shown on Sheet 9, as indicated. Please verify and revise this sheet or Sheet 9, as appropriate.**

**Response:** Drawing Number 9 has been revised to include Section 2 as identified on Drawing Number 14 Section 2. Refer to Attachment A for revised Drawing Number 9 for the indicated section.

**15. Sheet 15:**

a. **<u>Details 1-5</u>: Please show the limits of the liners at the tie-in and the specific method of tie in, i.e. show the welds.**

**Response:** The limits of the liner at the tie-in locations along the entire eastern side of the Phase II Section II Expansion to the Phase I and Phase II Section I areas is located on Drawing Number 7. Details 1, 2, 3, and 4 on Drawing Number 15 have been revised to indicate the limits of the liner at the tie-in locations. In addition, Detail 8 and Detail 9 have been added to Drawing Number 15 to indicate the tie-in method of construction (showing the welds). Refer to Attachment A for revised Drawing Number 15 for the indicated revisions.

b. **<u>Details 1 & 2</u>: Please verify that the reference to liner on the Phase I side slope is the liner/cap.**

**Response:** The reference to "liner" in Details 1 and 2 on the Phase I sideslope is the liner/cap which was previously installed by the County under Construction Permit No. 38414-012-SF/01 for the closure of the Phase I area. The Phase I liner system along the western sideslope was designed, permitted and constructed according to Rule 62-701.430(1)(c), FAC to be the bottom liner system when the Phase II Section II Expansion "piggy-backs" onto it. Details 1 and 2 have been revised to indicate include a callout to Detail 5 on Sheet 15 which identifies the "Existing Phase I West Sideslope Cover and Liner System Detail." Refer to Attachment A for revised Drawing Number 15 for the indicated revisions.

**16. Sheet 16:**

a. **Please provide the sheet reference numbers for the "Typical liner system" call out shown in both, Details 6 & 7.**

**Response:** Details 6 and 7 on Drawing Number 16 have been revised to indicate the "Bottom Liner System" callout shown on Drawing Number 14 Detail 5 and Detail 6. Refer to Attachment A for revised Drawing Number 16 for the indicated revisions.

b. **Please verify the location of the leakage detection system pipe shown in Detail 5 as in the leachate collection sump.**

**Response:** Detail 5 on Drawing Number 16 has been revised to identify the location of the leachate detection system pipe and the leachate collection system pipe. In addition, Section A, B, and C on Drawing Number 17 has been revised to identify the location of the leachate detection system pipe and the leachate collection system pipe. Also, Detail 1 on Drawing Number 18 has been revised to indicate the location of the leachate detection system pipe and the leachate collection system pipe. Refer to Attachment A for revised Drawing Numbers 16, 17, and 18 for the indicated revisions.

**17. Sheet 17:**

a. **Please verify the location of the leachate detection system pipe shown in the details on this sheet.**

**Response:** Sections A, B, and C on Drawing Number 17 has been revised to identify the location of the leachate detection system pipe. In addition, Detail 1 on Drawing Number 18 has been revised to indicate the leachate collection and leachate detection system riser pipes. Refer to Attachment A for revised Drawing Number 17 for the indicated revisions.

b. **<u>Section B</u>: Please revise this section to show the leachate collection and leak detection portion of the sump, including the location of the components of the liner system.**

**Response:** Section B has been revised to identify the leachate collection and leak detection portion of the sump, including the location of the components of the liner system. An addition, this information has also been added to Section C. Refer to Attachment A for revised Drawing Number 17 for the indicated revisions.

**18. Sheet 18:**

a. **<u>Detail 1</u>: This detail appears to show a pipe running into the cell from the leachate detection system shown in the sump. The leachate Detection System Design Criteria in Section G.2.c.4 of the Engineering Report does not appear to include this pipe as part of the design and it does not appear to be shown or called out in any other drawings. Please verify the location, configuration and function of the leachate detection system piping depicted.**

**Response:** Detail 1 has been revised to remove the pipe running into the cell from the leachate detection system shown in the sump. The Phase II Section II Expansion design does not include the use of leachate detection system piping in the leachate detection system. Refer to Attachment A for revised Drawing Number 18 for the indicated revision.

b. **<u>Detail 1</u>: The call out to Detail 2 on Sheet 12 appears inconsistent with Sheet 12. Please verify this call out and revise the details accordingly.**

**Response:** The callout for Detail 2 on Drawing 12 was previously labeled incorrectly. In addition, additional revisions have been included to Detail 1 as required per additional portions of the responses to this RAI. Refer to Attachment A for revised Drawing Number 18 for the indicated revisions to Detail 1.

**19. Sheet 19: In Details 1 & 2, please clarify the new location for the piping to be removed.**

**Response:** Existing Phase I leachate collection system manholes identified as MH-5, MH-6 and MH-7 are located within the footprint of the Phase II Section II Expansion area along the western sideslope of the existing Phase I area. There is an existing passive landfill gas (LFG) vent system which includes horizontal LFG vent trenches under the sideslope (bottom liner system) of the Phase I sideslope. Each of the existing passive LFG lines within the horizontal vent trenches terminate into the upper portion of existing manholes MH-5, MH-6 and MH-7. The void space within the manholes (rim elevation to invert elevation) is approximately 7 feet, 8 feet and 12 feet, respectively. The proposed final closure elevation of the Phase II Section II Expansion above the existing manholes will be approximately 140 feet, 150 feet and 155 feet, respectively.

Due to the age of the existing manholes and concerns of collapsing in the future due to the additional loading from the anticipated waste, the upper portions of the manholes will be cut off (height reduced) so each is approximately two feet total in height. This will require the existing passive LFG lines within the horizontal vent trenches that terminate in the upper portion of existing manholes to be "lowered" so they discharge into the cut off manholes. In addition, the existing leachate collection system pipes entering/leaving the manholes base will be continued through the cut off manhole using a steel pipe (to ensure a continuous leachate collection system pipeline). The remaining significantly smaller void space in each cut off manhole (approximately 2 feet) will be filled with No. 57 stone.

Details 1 and 2 on Drawing Number 19 have been revised to clarify the existing passive LFG lines termination point is to be lowered for the connection into modified manholes 5, 6, and 7. Refer to Attachment A for revised Drawing Number 19 for the indicated revisions.

## SECTION G - LANDFILL CONSTRUCTION REQUIREMENT (RULE 62-701.400(9), F.A.C.)

**20. Section G.1.a.:**

a. **This section describes filling in the center and northern portion "to the required elevation." Please revise this section to specifically identify the elevation that the center and northern portion will be filled to prior to proceeding to the next area or filling sequence.**

   **Response:** Refer to Attachment I for revised Section G Landfill Construction Requirements. Additional Parts G.1.a.1 through G.1.a.8 have been added to discuss the fill sequencing that the southern, center and northern portions of the Phase II Section II Expansion will be filled to prior to proceeding to the next area or filling sequence. In addition, refer to Attachment A for Drawing Number 26 through 37 for the plan view and cross sections which identify the fill sequence lifts and the elevations which the fill sequences will obtain.

b. **Please revise this section to describe how the design integrity of the drainage sand on the west slope of Phase I will be verified after removal of the sod.**

   **Response:** Refer to Attachment I for revised Section G Landfill Construction

Requirements. Part G.1.a.5 through G.1.a.8 has been added to identify how the design integrity of the drainage sand on the west sideslope of Phase I will be verified after removal of the rain tarp and sod.

Note, that as part of the responses to RAI No. 1, the existing sod along the western sideslope of the Phase I area will now be covered with a rain tarp during the construction of the Phase II Section II Expansion. Parts G.1.a.5 through G.1.a.8 have included provisions to ensure only as much of the rain tarp and sod are removed as needed by the County prior to waste filling.

c. **Both the current operation plan and the Help Models provided with this application appear to assume runoff from intermediate cover areas to stormwater. Therefore leachate recirculation would not appear appropriate in these areas. Please verify and revise this section and Section G.4, as appropriate.**

**Response:** Parts G.1.a.1 through G.1.a.8 have been added to identify the Phase II Section II Expansion southern, center and northern portions filling procedures to prevent runoff from daily or intermediate cover soil to the stormwater management system. Refer to Attachment I for revised Section G Landfill Construction Requirements.

Refer to Attachment J for revised HELP Models for the proposed Scenarios (1 through 11) which indicate no runoff to the stormwater management system will occur during filling. In addition, refer to Attachment J for the calculations and a summary of the revised HELP Model analysis.

Per the meeting conducted on April 3, 2012 between the following meeting attendees, the following responses are provided.

- Shane R. Fischer, P.E. - SCS Engineers
- Ed Hilton, Jr., P.E. - SCS Engineers
- Ken Wheeler - Director/County Engineer Hardee County Public Works
- Teresa Carver - Hardee County Solid Waste Director
- Susan Pelz - FDEP
- Nancy Gaskin - FDEP
- Steve Morgan - FDEP

During the meeting discussions were held regarding the proposal by the County to conduct leachate evaporation, not leachate recirculation, at certain periods of time with the addition of the Phase II Section II Expansion and the Phase II Section I vertical expansion. During waste placement the County will ensure the surface of the waste layer is placed so it is sloped back “into” the landfill cell. Perimeter berms, ditches, or other devices shall be constructed by the County, per the request of FDEP, during filling as needed to control possible leachate runoff if it was to occur during evaporation. Initial and intermediate cover that may receive leachate during the leachate evaporation process shall be graded to shed runoff “into” the leachate collection system to minimize the possibility of mixing leachate and stormwater. Leachate evaporation shall not be conducted during weather conditions or in quantities that may cause runoff outside the solid waste disposal unit or wind-blown spray. In addition, discussions were held regarding any additional calculations that would need to be conducted within the HELP Model to account for leachate evaporation. FDEP indicated since the process would be leachate evaporation and not leachate recirculation no additional input would be required within the HELP Model analysis. Therefore, leachate recirculation has not been included in the revised HELP Models provided in Attachment J to account for leachate recirculation.

The Operation Permit renewal application has been completed and was submitted to the Department as the *Hardee County Landfill Operation Permit Renewal Application*, dated March 12, 2013, prepared by SCS. The Operation Permit renewal application included the operation of the Phase II Section II Expansion after approval of the Certification of Construction Completion documents by the Department and the necessary components to incorporate the Phase II Section I height increase as part of the Phase II Section II Expansion construction permit application. As part of the Operation Permit renewal application, the Operation Plan was updated for the Phase II Section II Expansion and Phase II Section I height increase operation. Refer to the Operation Plan located in Attachment K of the *Hardee County Landfill Operation Permit Renewal Application*, dated March 12, 2013, prepared by SCS.

21. **Section G.2.a.3.: Based on groundwater elevation data collected since 2004 and provided with this application, please revise this section to present the current estimated seasonal high groundwater elevation at the facility.**

**Response:** SCS reviewed the groundwater elevations recorded at the monitor wells and piezometers at the facility during the routine, semi-annual sampling events recorded from June 1999 through June 2012 as provided by the Department in the table "*Summary of Ground Water Elevations, Hardee County Landfill*" and in addition elevations recorded in December 2012 provided by the County. The recorded groundwater elevations provided by the Department and the County are provided in Attachment K. Based on review of the above-mentioned groundwater elevations, Section G.2.a.3 has been revised to present the current estimated seasonal high groundwater elevation within the sump area of the Phase II Section II Expansion to be EL 82.09 feet NGVD.

The bottom liner system in relation to the groundwater table is further addressed in Section I.1.c of the construction permit application. Refer to Attachment I for revised Section G Landfill Construction Requirements.

22. **Section G.2.a.4.:**

    a. **This section discusses hydraulic uplift in the leachate sump area and portions of the leachate collection that will be constructed below the water table, but does not discuss hydrostatic uplift forces under the portions of the liner system that will be constructed below the water table. Please revise this section to discuss this issue and provide supporting buoyancy calculations for the installation of the portion of the liner system below the water table.**

**Response:** As previously indicated, the Technical Specifications will require dewatering equipment be provided to draw down the groundwater table so the bottom lining system is installed "in the dry" without the influence of hydrostatic forces. The lowest proposed elevation of the bottom lining system for the Phase II Section II Expansion area is the leachate collection sump at EL 78.5 feet NGVD. As stated, SCS reviewed the groundwater elevations recorded at the monitor wells and piezometers at the facility during the routine, semi-annual sampling events recorded from June 1999 through June 2012 and in addition elevations recorded in December 2012 provided by the County. Based on review of the groundwater elevations the current estimated seasonal high groundwater elevation was chosen to be EL 82.09 feet NGVD within the sump area of the Phase II Section II Expansion. Therefore, due to the fluctuations of the groundwater table the bottom liner system could be influenced from the area covered from EL 78.5 feet NGVD to EL 82.09 feet NGVD.

Based on the volume of protective cover material and rock within this bottom liner system area (94,692 square feet) it will act as a ballast which is adequate to offset the hydrostatic uplift force and provide a factor of safety of approximately 2.0. Refer to Attachment I for revised Section G Landfill Construction Requirements. Section G.2.a.4 has been revised to discuss hydrostatic uplift forces under the portions of the liner system that will be constructed below the water table. In addition, refer to Attachment L for the supporting buoyancy calculations for the installation of the portion of the liner system below the seasonal high groundwater elevation.

b. **The previously submitted 2004 information and calculations for the groundwater control system referenced in this section appear to have been based on the installation of the system under the western expansion and the available water table elevation information in 2004. Based on currently proposed design of groundwater control system and the groundwater elevation data collected since 2004 and provided with this application, please provide revised supporting information and calculations for the system.**

**Response:** Section G.2.a.4 has been revised based on the currently proposed design of the groundwater control system and the groundwater elevation data collected since 2004 and provided with this application. Refer to Attachment I for revised Section G Landfill Construction Requirements.

The existing groundwater control system piping originally designed with the *Hardee County Landfill Expansion Construction Permit Application*, dated April 2004, prepared by SCS used the entire footprint at that time of 10-acres for pipe sizing calculations. As a conservative estimate, the original design also used a high-water of EL 82.5 feet NGVD within the pipe sizing calculations. The calculated groundwater flow rate at the high-water elevation used for the 10-acres was determined to be 700 gpm. Since the April 2004 submittal the original 10-acre area has been divided and is identified as the Phase II Section II Expansion and the Phase II Section I Expansion. The Phase II Section I Expansion area was constructed with a footprint of approximately 5-acres. The area which the existing groundwater control system piping will be extended under the Phase II

Section II Expansion will be approximately 1.63-acres. Therefore the groundwater control system would be required to handle the flow generated from approximately 6.63-acres as opposed to the original design of 10-acres. In addition, the current estimated high groundwater table of EL 82.09 feet NGVD is below the original system design value of EL 82.5 feet NGVD. Therefore, the existing groundwater control system piping which will be extended under the Phase II Section II Expansion will handle the anticipated groundwater flow.

**23. Section G.2.c.2.2.: Based on your response to comments related to design calculations, please revise this section to identify the peak daily rainfall utilized in design calculations and to describe how that value was determined.**

**Response:** The following rainfall records for the Phase II Section II Expansion were reviewed by SCS.

- National Oceanic and Atmospheric Administration (NOAA) rainfall data obtained from the National Climatic Data Center (NCDC) web site for the NOAA weather station (station index number 08-9401-04) located in Wauchula, Florida at Latitude: 27$^{o}$ 31' North Longitude: 81$^{o}$ 48' West. The NOAA rainfall data is located in Attachment M. Rainfall data information was available for the weather station from January 1954 to April 30, 2012. Based on the NOAA rainfall data for the mentioned time period, the annual average rainfall was documented to be 51.16 inches.

- Site specific rainfall data was obtained from the Hardee County Solid Waste Department. Site specific rainfall data was available from February 1998 through September 1998, calendar years 2003 through 2009, and January 2011 through December 2012. The site specific rainfall data is located in Attachment M. Based on the site specific rainfall data for the mentioned time period, the annual average rainfall was calculated to be 40.88 inches.

- In addition, as a comparison, SCS used the NOAA rainfall data previously mentioned above and included the years where the site specific data was available and calculated the average rainfall from January 1954 to December 31, 2012. The combination of the NOAA rainfall data and the site specific rainfall data is located in Attachment M. Based on the combination of the NOAA rainfall data and the site specific rainfall data, the annual average rainfall was calculated to be 49.82 inches.

- Based on the three above-mentioned rainfall data reviews SCS created a summary table. Refer to Attachment M for a summary table of the rainfall data reviewed. As indicated in the summary tables, the NOAA weather station values are the largest (most conservative) for the annual average rainfall and average monthly rainfall compared to only site specific rainfall and a combination of site specific and NOAA values.

Therefore, the revised HELP Model analyses provided in Attachment J are based on daily site specific rainfall data provided by the County for the following time period:

- February 1998 through September 1998.
- January 2003 through May 2009.
- January 2012 through December 2012.

Daily rainfall data obtained from NOAA was input into the HELP Model analyses and used for the following time period:

- January 1984 through January 1998.
- October 1998 through December 1998 (used to fill-in unavailable County data).
- January 1999 through December 2002 (used to fill-in unavailable County data).
- June 2009 through December 2011 (used to fill-in unavailable County data).

Refer to Attachment I for revised Section G Landfill Construction Requirements.

**24. Section G.2.c.2.4.: The Department suggests that the following comments regarding this section be discussed in further detail during the meeting recommended at the end of this letter.**

**Response:** Comment noted. Based on the meeting conducted on November 26, 2012 between the following meeting attendees, the following responses are provided.

- Shane R. Fischer, P.E. - SCS Engineers
- Ed Hilton, Jr., P.E. - SCS Engineers
- Ken Wheeler - Director/County Engineer Hardee County Public Works
- Teresa Carver - Hardee County Solid Waste Director
- Jeff Greenwell - FDEP
- John R. Morris - FDEP
- Steve Morgan - FDEP
- Mike Dunaway - FDEP (via conference call)
- Michele Smith - FDEP (via conference call)

**a. Please provide filling sequence drawings that support the filling sequence scenarios presented in this section.**

**Response:** Fill Sequence No. 1 through Fill Sequence No. 6 Plan Drawings has been included on Drawing Number 26 through 31. The cross section disposal lifts has been included on Fill Sequence No. 1 Sections through Fill Sequence No. 6 Sections Drawing Number 32 through 37. Refer to Attachment A for Drawing Number 26 through 37 for the plan view and cross sections of the disposal lifts that support the filling sequence scenarios presented in this Section. Refer to Attachment I for revised Section G Landfill Construction Requirements Part G.2.c.2.4 which discusses revised filling Scenarios 1 through 11.

**b. The scenarios described in this section do not appear to include the filling of the southern portion of the phase II Section II expansion, adjacent to the west end of Phase II Section I. Please verify and revise this section to include this filling**

**sequence.**

**Response:** Fill Sequence No. 1 through Fill Sequence No. 6 Plan Drawings have been included on Drawing Number 26 through 31. The cross section disposal lifts have been included on Fill Sequence No. 1 Sections through Fill Sequence No. 6 Sections Drawing Number 32 through 37. Refer to Attachment A for Drawing Number 26 through 37 for the plan view and cross sections of the disposal lifts that support the filling sequence scenarios presented in this Section to include the filling of the southern portion of the Phase II Section II Expansion, adjacent to the west end of Phase II Section I. Refer to Attachment I for revised Section G Landfill Construction Requirements Part G.2.c.2.4 which discusses revised filling Scenarios 1 through 11.

c. **<u>Scenarios 3 through 10</u>: Based on a review of the final closure sections provided on Sheet 13 of the construction drawings, it does not appear that 40 ft or 80 ft of waste will be disposed over the "bottom center and northern portions"; 80 ft of waste will be disposed over the "center and northern bottom slope portions," and 40 ft of waste will be disposed of over the "center and northern top slopes" of the Phase II Section II expansion, west of Phase I. Please verify and revise this section and the HELP Model analyses, as appropriate.**

**Response:** Based on the meeting conducted on November 26, 2012, an agreement was made to use the average waste depth along the Phase I side slope as opposed to the maximum depth over the portions of the side slopes.

Refer to Attachment I for revised Section G Landfill Construction Requirements Part G.2.c.2.4 which discusses revised filling Scenarios 1 through 11.

In addition, refer to Attachment J for the calculations and a summary of the revised HELP Models analysis which indicate the areas and waste depths used.

d. **<u>Scenarios 3-4 and 8-9:</u> These scenarios appear to be based on the assumption that up to 40 ft of waste will be disposed in the bottom of the center and northern portions of Phase II Section II prior to disposal of waste on the side slopes of Phase I. Please verify whether this will be the operational filling sequence at the facility, and if appropriate, provide supporting information to describe stormwater-leachate management in the created valley between this fill sequence and Phase I and provide slope stability analyses for this fill sequence or revise the scenarios in this section and the HELP analyses, if applicable.**

**Response:** Based on the fill sequence Drawings provided in Attachment A waste will be placed across the Phase II Section II Expansion center and northern portions and directly on to the Phase I sideslope. A valley will not be created between the Phase II Section II Expansion areas and Phase I, therefore no additional slope stability analyses were conducted on the condition as requested. After filling the center portion of the Expansion up against the Phase I sideslope to the elevations indicated, filling will then commence in the northern portion of the Expansion.

Fill Sequence No. 1 through Fill Sequence No. 6 Plan Drawings have been included on Drawing Number 26 through 31. The cross section disposal lifts have been included on Fill Sequence No. 1 Sections through Fill Sequence No. 6 Sections Drawing Number 32 through 37. Refer to Attachment A for Drawing Number 26 through 37 for the plan view and cross sections of the disposal lifts that support the filling sequence scenarios.

Refer to Attachment I for revised Section G Landfill Construction Requirements Part G.2.c.2.4 which discusses revised filling Scenarios 1 through 11.

25. **Section G.2.c.2.5.: Based on your response to comments related to the design calculations, please revise this section and/or another appropriate section of the Engineering Report to describe the design of the LCRS pipes in the southern portion of the Phase II Section II expansion and to describe the adequacy of these pipes and the LCRS collection sump in Phase II Section I to handle the conveyed leachate generated from both the Phase II Section I and Phase II Section II expansions.**

**Response:** During Fill Sequence No. 1 through Fill Sequence No. 3, as indicated on Drawing Numbers 26 through 28, stormwater accumulated within the Phase II Section II Expansion sump will be pumped into the adjacent stormwater swale using the leachate collection pump through the use of piping and a bypass valve. Refer to Attachment A for Drawing Numbers 26 through 28 that identify the stormwater bypass piping network.

In addition, during waste filling operations identified as Fill Sequence No. 4 through Fill Sequence No. 6, as indicated on Drawing Numbers 29 through 31, leachate will be pumped from the leachate collection sump (via the leachate collection and leachate detection pumps) through a force main to the three 8-inch diameter HDPE SDR 11 leachate collection sideslope risers located in the south portion of the Phase II Section II Expansion. Valves located at each of the sideslope risers can be manually opened or closed by the County as needed to allow the leachate into any of the sideslope risers individually or to all three at the same time. During normal operations, all valves on the sideslope risers will remain open which will distribute leachate flow into each of the three risers. Refer to Attachment A for Drawing Numbers 29 through 31 that identify the force main piping network.

Based on the revised HELP Model summary provided in Attachment J the worst-case operating Scenario regarding leachate generation from the Phase II Section II Expansion center and northern portions which would be pumped would be Scenario 8. During this scenario approximately 202.93 gpm of leachate is generated from the collection and 0.88 gpm of leachate is generated from the detection (203.81 gpm) which will be pumped from the Phase II Section II Expansion sump through the force main into the south portion leachate collection sideslope risers.

Based on the revised HELP Model summary provided in Attachment J the worst-case operating Scenario regarding leachate generation from the Phase II Section II Expansion center and northern portions and also the leachate generated in the Phase II Section II Expansion south portion would be Scenario 8 and Scenario 3, respectively. During this operating Scenario approximately 202.93 gpm of leachate is generated from the Phase II Section II Expansion north and center collection portion, 0.88 gpm of leachate is generated from the Phase II Section II Expansion north and center detection portion, and 33.20 gpm is generated from the south portion collection system for a total of approximately 237.01 gpm. This amount of leachate will be added to the flow in the existing 8-inch leachate collection pipes within the Phase II Section I area.

Therefore, assuming the worst-case operating Scenario would be if all of the leachate pumped from the Phase II Section II Expansion sump would go into only one of the three leachate collection sideslope risers in the Phase II Section II Expansion south portion and that all of the leachate would be collected in one of the south portion leachate collection laterals. Therefore, the worst case design flow to the leachate collection pipes within the Phase II Section II Expansion south portion would be approximately 237.01 gpm (202.93 gpm + 0.88 gpm + 33.20 gpm). Refer to Attachment N for the 8-inch leachate collection lateral trench capacity calculations for the Phase II Section II south portion.

Additional HELP Models were conducted on the existing conditions of the Phase II Section I area to determine an existing amount of leachate generation from the area. Refer to the HELP Models provided in Attachment J. Based on an existing waste depth of 40 feet within the 5-acre area, peak conditions indicate that approximately 74.71 gpm is generated. In addition, additional HELP Models were conducted on the existing conditions of the Phase I south sideslope area to determine an existing amount of leachate generation from the area which also flows into the Phase II Section I area. Refer to the HELP Models provided in Attachment J. A rain tarp and stormwater outlet pipes divert stormwater away from the active filling area along the sideslope. Based on a waste depth of 10 feet within half of the sideslope area (0.65-acres due to the rain tarp), peak conditions indicate that approximately 23.84 gpm is generated from the sideslope area. Therefore, approximately 98.55 gpm (74.71 gpm + 23.84 gpm) is currently being transported by the existing Phase II Section I leachate collection pipes.

Based on the above-mentioned HELP Model information, the maximum flow to the existing leachate collection pipes within the Phase II Section I area is approximately 335.56 gpm (202.93 gpm + 0.88 gpm + 33.20 gpm + 74.71 gpm + 23.84 gpm).

Therefore, in order to size the 8-inch leachate collection pipes within the Phase II Section II Expansion south portion and also confirm the adequacy of the existing 8-inch leachate collection pipes within the Phase II Section I area, the worst-case flow of 335.56 gpm was utilized. The flow capacity of the LCRS lateral pipe must be greater than the flow entering the pipe from the geocomposite within the area and the flow pumped into the LCRS pipe from the Phase II Section II Expansion. The LCRS lateral pipes are 8-inch diameter HDPE SDR 11 pipe. At the estimated slope after expected settlement, the 8-inch LCRS has a capacity of approximately 587 gpm. Based on the estimated peak flow generated of 335.56 gpm there is a factor of safety of approximately 1.8 for the 8-inch LCRS lateral pipe. Therefore, if one 8-inch diameter HDPE SDR 11 LCRS lateral pipe is sufficient to carry all of the flow as described above, distributing the leachate flow through three 8-inch diameter HDPE SDR 11 LCRS lateral pipes will adequately carry the flow as needed. Refer to Section G.2.c.2.8 for information regarding the force main piping network. Refer to Attachment N for the 8-inch leachate collection lateral trench capacity calculations for the Phase II Section I area.

The existing LCRS collection pump in the Phase II Section I area is a Sligo Series 3-7.5-4 Pump which is sufficient to handle the anticipated flow. The existing LCRS detection pump in the Phase II Section I area is a Sligo Series 1-0.34-2 PSF Pump which is sufficient to handle the anticipated flow.

Refer to Attachment I for revised Section G Landfill Construction Requirements. Sections G.2.c.2.5 and G.2.c.2.8 have been revised to describe the design of the LCRS lateral pipes in the southern portion of the Phase II Section II Expansion and to describe the adequacy of these pipes.

26. **Section G.2.c.2.8.: Please revise this or another appropriate section of the Engineering Report to identify and describe the jet cleaning and video inspection of the Phase II Section I LCRS system conducted in accordance Specific Condition #C.8.g.(3) of Permit #38414-011-SO/01. Based on the findings of the inspection report, please provide an evaluation of the adequacy of the Phase II Section I LCRS to handle the leachate generated from the Phase II Section II expansion.**

**Response:** Per Specific Condition No. C.8.g.(3) of Operation Permit #38414-011-SO/01 the Phase II Section I leachate collection and removal system (LCRS) pipes were jet-cleaned and video-inspected to verify adequate performance by Florida Jetclean (Jetclean) on December 18, 2012. The Phase II Section I LCRS consist of three 8-inch diameter leachate collection lateral pipes identified as south, center and north and one 8-inch diameter leachate detection lateral pipe identified as detection.

The leachate collection lateral pipes were accessed through cleanouts located along the western side of the Phase II Section I Expansion area. The leachate detection lateral pipe was accessed through a cleanout located in the southeast corner of the Phase II Section I Expansion area. The Jetclean video-inspection equipment is capable of recording distances along the LCRS pipes inspected to document the length of LCRS jet-cleaned and video-inspected. The Jetclean video-inspection showed the LCRS pipes viewed with the inspection camera were clean and defect free. In areas where the video quality was obscured by high liquid levels within the LCRS pipes, the fact that both the inspection camera and the high-pressure jetting nozzle were not restricted through those areas would support the contention that those areas of the leachate collection system are also in good working order. A "Jetting Log" summary table was provided in the Jetclean report *Hardee County Landfill 2012 LCS & GCS Pipe Maintenance Phase I LCS & Phase II LCS/GCS* which indicated the LCRS pipes location, achieved inspection distance (pipe length) and results of the inspection.

Refer to Attachment O for the Florida Jetclean report *Hardee County Landfill 2012 LCS & GCS Pipe Maintenance Phase I LCS & Phase II LCS/GCS*. Based on the findings of the Florida Jetclean report, it is SCS's professional opinion that the existing Phase II Section I LCRS is operating as intended and will handle the additional leachate generated from the Phase II Section II and Phase II Section I Expansions.

In addition, as required by Specific Condition No. C.8.i.(3) of Operation Permit #38414-011-SO/01 the Phase II Section I groundwater interceptor system pipes were jet-cleaned and video-inspected by Jetclean on December 18, 2012. The Phase II Section I groundwater interceptor system consist of nine 8-inch diameter groundwater collection pipes identified as CO1 through CO9 and one 12-inch diameter wetwell to header pipe.

The groundwater interceptor system pipes were accessed through cleanouts located along the western side of the Phase II Section I Expansion area. The wetwell to header pipe was accessed through the groundwater wetwell located in the southeast corner of the Phase II Section I Expansion area. The Jetclean video-inspection showed the groundwater interceptor system pipes viewed with the inspection camera were clean and defect free. In areas where the video quality was obscured by high liquid levels within the groundwater interceptor system pipes, the fact that both the inspection camera and the high-pressure jetting nozzle were not restricted through those areas would support the contention that those areas of the groundwater interceptor system are also in good working order. A "Jetting Log" summary table was provided in the Jetclean report *Hardee County Landfill 2012 LCS & GCS Pipe Maintenance Phase I LCS & Phase II LCS/GCS* which indicated the groundwater interceptor system pipes location, achieved inspection distance (pipe length) and results of the inspection.

Refer to Attachment O for the Florida Jetclean report *Hardee County Landfill 2012 LCS & GCS Pipe Maintenance Phase I LCS & Phase II LCS/GCS*. Based on the findings of the Florida Jetclean report, it is SCS's professional opinion that the existing Phase II Section I groundwater interceptor system pipes are operating as intended and will handle the groundwater flow generated from the Phase II Section II and Phase II Section I Expansions.

As indicated in the Departments question "Section G.2.c.2.8.: Please revise this <u>or another</u> appropriate section of the Engineering Report…." SCS revised Section G.2.c.2 Leachate Collection and Removal System as opposed to the Section G.2.c.2.8 to respond to the Department question. Refer to Attachment I for revised Section G Landfill Construction Requirements.

**27. Section G.2.c.2.8.: Please revise the HELP Model analyses, where appropriate, to account for recirculated leachate which will "runoff into the leachate collection system."**

**Response:** Per the meeting conducted on April 3, 2012 between the following meeting attendees, the following responses are provided.

- Shane R. Fischer, P.E. - SCS Engineers
- Ed Hilton, Jr., P.E. - SCS Engineers
- Ken Wheeler - Director/County Engineer Hardee County Public Works
- Teresa Carver - Hardee County Solid Waste Director
- Susan Pelz - FDEP
- Nancy Gaskin - FDEP
- Steve Morgan - FDEP

During the meeting discussions were held regarding the proposal by the County to conduct leachate evaporation, not leachate recirculation, at certain periods of time with the addition of the Phase II Section II Expansion and the Phase II Section I vertical expansion. During waste placement the County will ensure the surface of the waste layer is placed so it is sloped back "into" the landfill cell. Perimeter berms, ditches, or other devices shall be constructed by the County, per the request of FDEP, during filling as needed to control possible leachate runoff if it was to occur during evaporation. Initial and intermediate cover that may receive leachate during the leachate evaporation process shall be graded to shed runoff "into" the leachate collection system to minimize the possibility of mixing leachate and stormwater. Leachate evaporation shall not be conducted during weather conditions or in quantities that may cause runoff outside the solid waste disposal unit or wind-blown spray. In addition, discussions were held regarding any additional calculations that would need to be conducted within the HELP Model to account for leachate evaporation. FDEP indicated since the process would be leachate evaporation and not leachate recirculation no additional input would be required within the HELP Model analysis. Therefore, leachate recirculation has not been included in the revised HELP Models provided in Attachment J to account for leachate recirculation.

## ATTACHMENT G-1 - CONSTRUCTION QUALITY ASURANCE PLAN AND TECHNICAL SPECIFICATIONS (RULES 62-701.400(3), (7), AND (8), F.A.C.)

**Please revise the CQA Plan and/or other referenced application documents, as appropriate, to address the following comments. The CQA Plan may be reviewed in its entirety after receipt of this following information. The Department suggests that some of the following comments may be discussed in further detail during the meeting recommended at the end of this letter.**

**Response:** Comment noted.

**28. Sections 5.3.3 to 5.3.8: Section 5.3 of the CQA Plan indicates that all soil evaluation testing will be conducted in the Soils CQA Laboratory. However these sections and the corresponding sections of Technical Specification 02220 related to testing of the soil component for this project indicate that testing will be conducted by the Contractor's CQC Consultant. The Department does object to the CQA Consultant reviewing testing conducted by the CQC Consultant for general fill, subbase fill, and structural fill. However independent CQA testing should be conducted on the protective soil/drainage sand and leachate trench and groundwater collection system gravels. Please revise the CQA Plan and Specification Section 02220 accordingly or provide additional supporting justification for relying on CQC Consultant testing for all soil testing.**

**Response:** Section 5.3 of the CQA Plan has been revised to indicate that pre-construction materials evaluations shall be performed on samples to identify potential soil borrow sources by the contractors independent CQC Laboratory prior to incorporation of the material into construction to ascertain their acceptability as construction materials. Testing shall be performed by the Soils CQA Laboratory during the course of the work to verify continued material compliance with the Plans and Technical Specifications.

The CQA Plan and Specification Section 02220 - Excavation, Backfill, Fill, and Grading have been revised to indicate that all soil evaluation testing for material which has been incorporated into the work will be conducted in the Soils CQA Laboratory and not the Contractor's CQC Laboratory. The Contractor's CQC Laboratory results will only be used for pre-construction materials evaluations on samples to identify potential soil borrow sources.

Refer to Attachment P for revised Section 5 of the CQA Plan. In addition, Specification Section 02220 - Excavation, Backfill, Fill, and Grading has been revised as required and is also included in Attachment P.

29. **Section 6.1.2.2: It appears that a geomembrane/subbase soil interface is also part of this project. Please either revise this section to include interface friction angle testing for this interface or provide supporting justification for not performing the test.**

    **Response:** Section 6.1.2.2 of the CQA Plan has been revised to include interface friction angle testing for the geomembrane/subbase soil interface. Refer to Attachment P for revised Section 6 of the CQA Plan.

    In addition, Specification Section 02776 - High Density Polyethylene (HDPE) Geomembrane Liner has been revised as required regarding the interface friction angle testing for the geomembrane/subbase soil interface and is also included in Attachment P.

    In addition, the normal loads throughout the CQA Plan as required have been updated to indicate 1,000, 2,000, and 4,000 pounds per square foot.

30. **Section 6.1.9.2: Please verify the testing frequency of "or one test per seam whichever is greater" with Specification Section 02776-3.07.B.1. and revise this section and/or Section 02776, as appropriate.**

    **Response:** Section 6.1.9.2 of the CQA Plan has been revised to indicate "Installed geomembrane shall be tested at a rate of one test per 500 linear feet of welded seam at locations selected by the CQA Consultant." This is consistent with revised Specification Section 02776 - High Density Polyethylene (HDPE) Geomembrane Liner Part 3.07.B.1. Refer to Attachment P for revised Section 6 of the CQA Plan. In addition, Specification Section 02776 - High Density Polyethylene (HDPE) Geomembrane Liner has been revised as required and is also included in Attachment P.

31. **Section 6. 2: This section will be reviewed upon receipt of Technical Specification 02940-Geotextile (See Comment #35 below). This comment is provided for information purposes only and does not require a response other than acknowledgement of the comment.**

    **Response:** Comment noted. Specification Section 02940 - Geotextile was inadvertently not included in the original application submittal. Refer to Attachment P for Specification Section 02940 - Geotextile.

**32. Section 6.3.6.3 & 6.3.7.3: Please verify CQA testing for thickness with Specification Table 02930-3 and Specification Table 02931-3 respectively and revise these section and/or the specification tables, as appropriate. Please also revise Specification Sections 02930-3.02.C. and 02931-3.02.C., as appropriate.**

**Response:** The Specification requirement for thickness testing of the finished geocomposite materials has been removed from Section 6.3.6.3 and Section 6.3.7.3 of the CQA Plan for the tri-planar and bi-planar geocomposites, respectively. In addition Specification Section 02931-3.02.C and Section 02930-3.02.C has been revised to remove the requirement for thickness testing of the finished geocomposite materials for the tri-planar and bi-planar geocomposites, respectively. In addition, miscellaneous American Society for Testing and Materials (ASTM) Standard Test Methods has been updated within the Technical Specifications and CQA Plan to correspond to the current testing standards.

In addition, Specification Section 02930 - Tri-Planar Geocomposite Part 02930-3.10.1 and 2 regarding the normal loads required have been updated to indicate 1,000, 2,000, and 4,000 pounds per square foot. Refer to Attachment P for the revised specification.

In addition, Specification Section 02931 - Bi-Planar Geocomposite Part 02931-3.10.1, 2 and 3 regarding the normal loads required have been updated to indicate 1,000, 2,000, and 4,000 pounds per square foot. Refer to Attachment P for the revised specification.

Also, refer to Attachment P for revised Section 6 of the CQA Plan for the above-mentioned revisions.

**33. Section 6.3.7.3: It appears that a bi-planar geocomposite/leachate drainage soil interface is also part of this project. Please either revise this section to include interface friction angle testing for this interface or provide supporting justification for not performing the test.**

**Response:** Section 6.3.7.3 of the CQA Plan has been revised to include interface friction angle testing for the drainage sand/bi-planar geocomposite interface. Refer to Attachment P for revised Section 6 of the CQA Plan.

In addition, Specification Section 02931 - Bi-Planar Geocomposite has been revised as required and is also included in Attachment P.

**34. Section 6.3.9: Please verify the seaming procedures in this section with specification Tables 02930-4 and 02931-4 and revise this section and/or the tables, as appropriate.**

**Response:** Specification Section 02930 - Tri-Planar Geocomposite has been revised as required and is included in Attachment P.

Specification Section 02931 - Bi-Planar Geocomposite has been revised as required and is included in Attachment P.

## ATTACHMENT G.1, TECHNICAL SPECIFICATIONS (RULES 62-

## 701.400(3), (7), AND (8), F.A.C.)

**Please revise the Technical Specifications and/or other referenced application documents, as appropriate, to address the following comments and/or inconsistencies. The Technical Specifications may be reviewed in their entirety after receipt of this information. The Department suggests that some of the following comments may be discussed in further detail during the meeting recommended at the end of this letter.**

**35. Section 02940 - Geotextile and Section 02941 - Geosynthetic Rain Tarps appear to have been omitted from the application submittal. Please verify and provide these specification sections.**

**Response:** Specification Section 02940 - Geotextile was inadvertently not included in the original application submittal. Refer to Attachment P for Specification Section 02940 - Geotextile.

Specification Section 02941 - Geosynthetic Rain Tarp was inadvertently not included in the original application submittal. Refer to Attachment P for Specification Section 02941 - Geosynthetic Rain Tarp.

**36. Section 02077 - Geosynthetic Clay Liner:**

**a. <u>Table 02077-1</u>: It does not appear that minimum values for the test parameters in this table are specified. Please verify and revise this table or Section 02077, as applicable.**

**Response:** Refer to Attachment P for revised Specification Section 02077 - Geosynthetic Clay Liner. Please note the requirement for GCL Grab Elongation testing has been removed from the Manufacturing Quality Control Testing required. GCL Grab Elongation is no longer an industry standard for finished GCLs and is not required by Method ASTM D5889, Standard Practices For Quality Control of Geosynthetic Clay Liners.

**b. <u>Part 2.01.F</u>: Please verify the finished GCL "permeability with groundwater under 6,000 psf normal load" value specified in this part, and revise this part, as appropriate.**

**Response:** The normal load as required has been updated to indicate 4,000 pounds per square foot. Refer to Attachment P for revised Specification Section 02077 - Geosynthetic Clay Liner.

**37. Section 02140 - Dewatering: Please note that dewatering may require an Industrial Wastewater Permit from the Department. The Department's Industrial Wastewater Section should be contacted to determine if a permit is required prior to conducting any construction dewatering activities. This comment is for information purposes only and does not require a response other than acknowledgement of the comment.**

**Response:** Comment noted.

**38. Section 02220 - Excavating, Backfill, Fill, and Grading:**

a. **<u>Parts 3.10 & 3.11</u>: The adequacy of these sections will be reviewed upon receipt of Specification Section 02940 - Geotextile. This comment is for information purposes only and does not require a response other than acknowledgement of the comment.**

   **Response:** Comment noted. Refer to Attachment P for Specification Section 02940 - Geotextile.

   Refer to Attachment P for revised Specification Section 02220 - Excavating, Backfill, Fill, and Grading.

b. **<u>Part 3.12.H</u>: The adequacy of this section will be reviewed upon receipt of Specification Section 02941 - Geosynthetic Rain Tarp. This comment is for information purposes only and does not require a response other than acknowledgement of the comment.**

   **Response:** Comment noted. Refer to Attachment P for Specification Section 02941 - Geosynthetic Rain Tarp.

   Refer to Attachment P for revised Specification Section 02220 - Excavating, Backfill, Fill, and Grading.

**39. Section 02776 - HDPE Geomembrane Liner:**

a. **<u>Part 1.03.E</u>: Please verify that the CQ laboratory will be independent from the Contractor rather than the Owner and revise this part, as appropriate.**

   **Response:** The CQ laboratory will be independent from the Contractor rather than the Owner. Refer to Attachment P for revised Specification Section 02776 - High Density Polyethylene (HDPE) Geomembrane Liner.

b. **<u>Part 1.05.E</u>: Please verify that the reference in this section should be Part 2.01.E. and revise this part, as appropriate.**

   **Response:** Specification Section 02776 - High Density Polyethylene (HDPE) Geomembrane Liner Part 1.05.A.14 (as opposed to the Departments Part 1.05.E as indicated in the question above) has been revised to reference Part 2.01.E. as opposed to Part 2.02.E as previously indicated. Refer to Attachment P for revised Specification Section 02776 - High Density Polyethylene (HDPE) Geomembrane Liner.

**40. Section 11200 - Leachate Collection and Detection Pumps:**

a. **<u>Part 2.01.C</u>: Based on your response to comments related to the leachate collection and detection system design calculations, please revise this section, if appropriate.**

**Response:** Refer to Attachment P for revised Specification Section 11200 - Leachate Collection and Detection Pumps.

## ATTACHMENT G-2 THROUGH G-22 - DESIGN CALCULATIONS:

**Please address the following comments regarding the design calculations in these Appendices. The Department suggests that these comments be discussed in further detail during the meeting recommended at the end of this letter.**

**Response:** Comment noted. Based on the meeting conducted on November 26, 2012 between the following meeting attendees, the following responses are provided.

- Shane R. Fischer, P.E. - SCS Engineers
- Ed Hilton, Jr., P.E. - SCS Engineers
- Ken Wheeler - Director/County Engineer Hardee County Public Works
- Teresa Carver - Hardee County Solid Waste Director
- Jeff Greenwell - FDEP
- John R. Morris - FDEP
- Steve Morgan - FDEP
- Mike Dunaway - FDEP (via conference call)
- Michele Smith - FDEP (via conference call)

## ATTACHMENT G-2 - LEACHATE COLLECTION SYSTEM SUMP BUOYANCY CALCULATIONS:

**41. The "Known" assumptions and the figure of the leachate collection sump configuration and dimensions provided appear to be inconsistent with the sump details provided on Sheets 17 - 18 of the construction drawings. Please verify and revise these calculations, as appropriate.**

**Response:** The leachate collection sump configuration and dimension has been revised on Sections B and C on Drawing Number 17 and Detail 1 and Sections A and B on Drawing Number 18. Refer to Attachment A for the revised Drawings for the indicated revisions. The calculations for the leachate collection sump have been revised based on the configuration and dimensions of the sump provided on the revised Drawings. Refer to Attachment L for revised leachate collection sump buoyancy calculations.

## ATTACHMENT G-4 - LEACHATE COLLECTION SYSTEM SUMP BUOYANCY CALCULATIONS:

**42. The "Known" assumptions and the figure of the leachate collection sump configuration and dimensions provided appear to be inconsistent with the sump details provided on Sheets 17 - 18 of the construction drawings. Please verify and revise these calculations, as appropriate.**

**Response:** SCS has assumed this question was to refer to Attachment G-3 (not Attachment

G-4 as indicated) Leachate Collection System Pipe (not sump as indicated) Buoyancy Calculations. The leachate collection and detection header pipes configuration and dimensions have been revised on Detail 3, 4, and 5 of Drawing Number 16. Refer to Attachment A for the revised Drawings for the indicated revisions. The calculations for the leachate collection and detection header pipes have been revised based on the configuration and dimensions provided on the revised Drawings. Refer to Attachment L for revised leachate collection and detection header pipes buoyancy calculations.

**43. Please provide similar buoyancy calculations for the leachate lateral collection trenches.**

**Response:** Refer to Attachment L for the 8-inch and the 10-inch leachate lateral collection trenches buoyancy calculations.

## ATTACHMENT G-4 - ANCHOR TRENCH CALCULATIONS:

**44. Please explain why the specified interface friction angle between the liner and soil subgrade for this project [20.5°] was not utilized in this calculation.**

**Response:** The interface friction angle between the liner and soil subgrade has been revised to 20.5º as specified for project. Refer to Attachment Q for revised anchor trench calculations using 20.5º for the interface friction angle between the liner and soil subgrade.

## ATTACHMENT G-9 - BI-PLANAR TRANSMISSIVITY CALCULATIONS:

**45. The "Known" section of this calculation assumes a load of 3,000 psf for Scenario 3. However it appears an interpolated ultimate transmissivity value for a load of 2,500 psf was utilized in the transmissivity/hydraulic conductivity calculations for this scenario. Please explain this apparent discrepancy and revise this calculation, as appropriate. Please also address the same apparent discrepancy in the tri-planar transmissivity calculations in Attachment G-10.**

**Response:** Refer to Attachment R for revised bi-planar transmissivity calculations using 1,000, 2,000, and 4,000 pounds per square foot.

Refer to Attachment R for revised tri-planar transmissivity calculations using 1,000, 2,000, and 4,000 pounds per square foot.

Refer to Attachment R for bi-planar transmissivity calculations for the existing western Phase I sideslope.

## ATTACHMENT G-11 - HELP MODEL/LEACHATE GENERATION RATES CALCULATIONS (Rules 62-701.320(7)(e), 62-701.400(4), F.A.C.):

**Please revise the HELP model evaluation and/or other referenced application documents, as appropriate, to address the following comments and/or inconsistencies. The HELP**

**Model evaluation may be reviewed in their entirety after receipt of the following information.**

**46. HELP Model Output Summary:**

a. **Please revise this summary, as appropriate, based on your response to comments provided above related to the scenarios presented in Section G.2.c.2.4. of the Engineering Report.**

   **Response:** Refer to Attachment J for a revised HELP Model Output Summary based on the responses to comments related to the scenarios presented in revised Section G.2.c.2.4.

   Refer to Attachment I for revised Section G Landfill Construction Requirements Sections G.2.c.2.4.

b. **Please verify the evaluation of a 330 mil bi-planar geocomposite on the Phase I side slopes with the 300 mil geocomposite installed on the Phase I side slopes and assumed in the HELP Model runs, and revise this summary, as appropriate.**

   **Response:** As previously provided to the Department in the *Certification of Construction Completion Report Hardee County Class I Landfill Phase I Closure* (Report), dated June 1, 2011, the bi-planar geocomposite installed on the Phase I western sideslope was a SKAPS TN330-2-8 (330 mil bi-planar geocomposite). Copies of the geocomposite CQA conformance test results were provided within Attachment 7-2 Geocomposite CQA Conformance Test Results of the Report. For ease of reference, SCS has provided a copy of the conformance test results in Attachment R.

   In addition, refer to Attachment R for the SKAPS TN330-2-8 330 mil bi-planar geocomposite transmissivity calculations obtained for the 1,000, 1,500, and 2,000 pounds per square foot (psf). An average CQA testing value of 2.18 $m^2$/sec was obtained for the 800 psf loading and 1.56 $m^2$/sec was obtained for the 5,000 psf. A calculated transmissivity value of 2.15 $m^2$/sec was obtained for the 1,000 psf, 2.07 $m^2$/sec for the 1,500 psf, and 2.00 $m^2$/sec for the 2,000 psf.

   Based on the CQA conformance test results of the installed SKAPS TN330-2-8 330 mil bi-planar geocomposite the following results were used within the revised HELP Model provided in Attachment J for the Phase I western sideslope.

**47. HELP Model Outputs:**

a. **Please explain why root channels are assumed in the vertical percolation layer in HELP Model runs.**

   **Response:** Based on the assumption that no vegetation (very minimal) will be growing on the 24-inch drainage sand layer (bare), a default HELP Model value of 10 inches was chosen for the "evaporative zone depth." In addition, a "maximum leaf area index" was chose as zero which is the value for "bare" ground in the HELP Model which the 24-inch drainage sand layer will be. With these inputs mentioned, root channels are not included in the HELP Model analysis. Refer to Attachment J for revised HELP Model runs without the influence of root channels assumed in the vertical percolation layer. Note that no influence of root channels is only for the areas modeled when the drainage sand layer is exposed with no waste placed.

In addition, when a "6-inch daily cover" soil layer was included into the HELP Model after waste placement an assumption was made that minimal vegetation would be growing on the daily cover layer (bare). A default HELP Model value of 10 inches was chosen for the "evaporative zone depth." In addition, a "maximum leaf area index" was chose as 1.0 which is the value for "poor stand of grass" in the HELP Model. For these revised HELP Model runs influence of root channels are assumed in the vertical percolation layer.

**b. Please explain why the subgrade layer is assumed to have the same properties as the protective soil/leachate drainage layer in the HELP Model runs when the subgrade soils are not specified to have the same properties, including hydraulic conductivity, as the drainage layer in Technical Specification 02220.**

**Response:** The subgrade layer is not required in the HELP Model analysis. Therefore, this subgrade layer has been removed. Refer to Attachment J for revised HELP Model runs without the subgrade layer.

**c. Please explain the basis for the assumed "initial water in layer material."**

**Response:** The initial moisture content of the layers identified in the HELP Model was computed by the HELP Model program based on nearly steady-state values. Therefore, the method of initialization of moisture storage was computed by the HELP Model as a nearly steady-state system, meaning the recently observed behavior of the system would continue into the future. The "initial water in layer materials" under the "general design and evaporative zone data" section of the output was calculated by the HELP Model based on evapotranspiration values input by SCS. The "default evapotranspiration option with location specific guidance" was selected for Tampa, Florida as the location. Based on the assumption that no vegetation (very minimal) will be growing on the 24-inch drainage sand layer (bare), a default HELP Model value of 10 inches was chosen for the "evaporative zone depth." In addition, a "maximum leaf area index" was chose as zero which is the value for "bare" ground in the HELP Model which again the 24-inch drainage sand layer will be. In addition, when a "6-inch daily cover" soil layer was included into the HELP Model after waste placement an assumption was made that minimal vegetation would be growing on the daily cover layer (bare). A default HELP Model value of 10 inches was chosen for the "evaporative zone depth." In addition, a "maximum leaf area index" was chose as 1.0 which is the value for "poor stand of grass" in the HELP Model.

**d. Please explain the basis for the assumed "peak daily rainfall."**

**Response:** The revised HELP Model analyses provided in Attachment J are based on daily site specific rainfall data provided by the County for the following time period:

- February 1998 through September 1998.
- January 2003 through May 2009.
- January 2012 through December 2012.

Daily rainfall data obtained from NOAA was input into the HELP Model analyses and used for the following time period:

- January 1984 through January 1998.
- October 1998 through December 1998 (used to fill-in unavailable County data).
- January 1999 through December 2002 (used to fill-in unavailable County data).
- June 2009 through December 2011 (used to fill-in unavailable County data).

Refer to Attachment I for revised Section G Landfill Construction Requirements.

## ATTACHMENT G-12 - LEACHATE COLLECTION LATERAL TRENCH CAPACITY CALCULATIONS:

**48. Please verify the assumed trench top width with Details 6 and 7 on Sheet 16 of the construction drawing and revise these calculations, as appropriate. Please also address this comment for the calculations in Attachment G-13.**

**Response:** Refer to Attachment N for the 8-inch and 10-inch leachate collection lateral trench capacity calculations.

Refer to Attachment N for the 12-inch leachate collection header trench capacity calculations.

**49. Please explain the basis for the assumed one foot of static head in the calculations. Please also address this comment for the calculations in Attachment G-13.**

**Response:** The calculations included one-inch of static head, not one foot as referenced in the comment by the Department.

**50. Please verify the assumed peak flow for an open cell with no waste with the peak flow reported in the HELP Model Output Summary and revise these calculations, as appropriate.**

**Response:** Based on the HELP Model analyses the worst-case operating Scenario regarding leachate generation from the Phase II Section II Expansion center and northern portions which would be pumped would be Scenario 8. During this scenario approximately 202.93 gpm of leachate is generated from the north and center collection portions and 0.88 gpm of leachate is generated from the north and center detection portions which will be pumped from the Phase II Section II Expansion sump through the force main into the south portion leachate collection sideslope risers for a total of 203.81 gpm.

Refer to Attachment N for the 8-inch and 10-inch leachate collection lateral trench capacity calculations.

Refer to Attachment N for the 12-inch leachate collection header trench capacity calculations.

The calculations are based on the revised HELP Model analyses Summary Table provided in Attachment J.

**51. Please explain how the assumed peak flow for the 10 inch lateral trench was obtained or calculated and revise these calculations, as appropriate. Please also address this comment for the assumed peak flow in Attachment G-13.**

**Response:** Based on the HELP Model analyses the worst-case operating Scenario regarding leachate generation from the Phase II Section II Expansion center and northern portions is approximately 202.93 gpm. There is one 10 inch leachate collection lateral pipe located in the eastern side of the cell adjacent to the Phase I sideslope. The total length of pipe is approximately 951.3 feet. The area of the Phase II Section II Expansion north and center portions is 4.55 acres. The north and center portions from the eastern grade break of the cell bottom area was considered as the contributing area to the 10-inch leachate collection lateral pipe. This area is approximately 1.47 acres. The remaining area, 3.08 acres, was used for sizing of the two Phase II Section II Expansion 8 inch leachate collection lateral pipes within the area. The flow for the 12-inch leachate collection header trench is discussed further in response to question number 52.

The assumed peak flow for the 10-inch leachate collection lateral trench and the peak flow for the 12-inch leachate collection header trench were obtained based on these indicated conditions. Refer to Attachment N for the 10-inch leachate collection lateral trench capacity calculations and the 12-inch leachate collection header trench capacity calculations.

## ATTACHMENT G-13 - LEACHATE COLLECTION HEADER TRENCH CAPACITY CALCULATIONS:

**52. Please provide leachate header trench calculations for the leachate header in the portion of the Phase II Section II expansion west of Phase II Section I and the Phase II Section I header trenches.**

**Response:** A leachate header is not located in the Phase II Section II Expansion west of Phase II Section I (southern portion). Leachate collected from the Phase II Section II Expansion north and center portions will be pumped from the sump into the leachate collection sideslope risers located along the western side of the south portion of the Phase II Section II Expansion. The sideslope risers are extensions of the 8-inch diameter HDPE SDR 11 leachate collection pipes for the Phase II Section II Expansion south portion which will be connected to the existing 8-inch diameter HDPE SDR 11 leachate collection lines located within the Phase II Section I area during construction. The leachate will then flow via gravity to the existing leachate collection sump located within the Phase II Section I area. From the Phase II Section I sump the leachate will be pumped into the existing above ground leachate storage tanks.

Based on the HELP Model analyses the worst-case operating Scenario regarding leachate generation from the Phase II Section II Expansion center and northern portions which would be pumped would be Scenario 8. During this scenario approximately 202.93 gpm of leachate is generated from the north and center collection portions and 0.88 gpm of leachate is generated from the north and center detection portions which will be pumped from the Phase II Section II Expansion sump through the force main into the south portion leachate collection sideslope risers for a total of 203.81 gpm

Based on the HELP Model analyses the worst-case operating Scenario regarding leachate generation from the Phase II Section II Expansion north and center portions and also the leachate generated in the Phase II Section II Expansion south portion would be Scenario 8 and Scenario 3, respectively. During this operating Scenario approximately 202.93 gpm of leachate is generated from the Phase II Section II Expansion north and center collection portions, 0.88 gpm of leachate is generated from the Phase II Section II Expansion north and center detection portions, and 33.20 gpm is generated from the Phase II Section II Expansion south portion collection system for a total of approximately 237.01 gpm. This amount of leachate will be added to the flow in the existing 8-inch leachate collection pipes within the Phase II Section I area.

Therefore, assuming the worst-case operating Scenario would be if all of the leachate pumped from the Phase II Section II Expansion sump would go into only one of the three leachate collection sideslope risers in the Phase II Section II Expansion south portion and that all of the leachate would be collected in one of the south portion leachate collection laterals. Therefore, the worst case design flow to the leachate collection pipes within the Phase II Section II Expansion south portion would be approximately 237.01 gpm (202.93 gpm + 0.88 gpm + 33.20 gpm).

HELP Model analysis were conducted on the existing conditions of the Phase II Section I area to determine an existing amount of leachate generation from the area. Based on an existing waste depth of 40 feet within the 5-acre area, peak conditions indicate that approximately 74.71 gpm is generated. In addition, additional HELP Models were conducted on the existing conditions of the Phase I south sideslope area to determine an existing amount of leachate generation from the area which also flows into the Phase II Section I area. A rain tarp and stormwater outlet pipes divert stormwater away from the active filling area along the sideslope. Based on a waste depth of 10 feet within half of the sideslope area (0.65-acres due to the rain tarp), peak conditions indicate that approximately 23.84 gpm is generated from the sideslope area. Therefore, approximately 98.55 gpm (74.71 gpm + 23.84 gpm) is currently being transported by the existing Phase II Section I leachate collection pipes.

Based on the above-mentioned HELP Model information, the maximum flow to the existing leachate collection pipes within the Phase II Section I area is approximately 335.56 gpm (202.93 gpm + 0.88 gpm + 33.20 gpm + 74.71 gpm + 23.84 gpm).

Therefore, in order to size the 8-inch leachate collection pipes within the Phase II Section II

Expansion south portion and also confirm the adequacy of the existing 8-inch leachate collection pipes within the Phase II Section I area, the worst-case flow of 335.56 gpm was utilized. The flow capacity of the LCRS lateral pipe must be greater than the flow entering the pipe from the geocomposite within the area and the flow pumped into the LCRS pipe from the Phase II Section II Expansion. The LCRS lateral pipes are 8-inch diameter HDPE SDR 11 pipe. At the estimated slope after expected settlement, the 8-inch LCRS has a capacity of approximately 587 gpm. Based on the estimated peak flow generated of 335.56 gpm there is a factor of safety of approximately 1.8 for the 8 inch LCRS lateral pipe. Therefore, if one 8-inch diameter HDPE SDR 11 LCRS lateral pipe is sufficient to carry all of the flow as described above, distributing the leachate flow through three 8-inch diameter HDPE SDR 11 LCRS lateral pipes will adequately carry the flow as needed. Refer to Section G.2.c.2.8 for information regarding the force main piping network located in Attachment I.

The existing LCRS collection pump in the Phase II Section I area is a Sligo Series 3-7.5-4 Pump which is sufficient to handle the anticipated flow. The existing LCRS detection pump in the Phase II Section I area is a Sligo Series 1-0.34-2 PSF Pump which is sufficient to handle the anticipated flow.

Refer to Attachment N for the 8-inch leachate collection lateral trench capacity calculations in the south portion of the Phase II Section II Expansion.

## ATTACHMENT G-15 - LEACHATE COLLECTION/DETECTION PUMP CALCULATIONS:

**53. Please revise these calculations, as appropriate, based on changes to other calculations utilized in support of these calculations that may be made in response to comments provided in this letter.**

**Response:** Refer to Attachment S for the leachate collection/detection pump calculations based on the revised HELP Model analysis.

## ATTACHMENT G-16 - LEACHATE DETECTION SYSTEM LATERAL TRENCH CALCULATIONS:

**54. Please revise these calculations, as appropriate, based on changes to other calculations utilized in support of these calculations that may be made in response to comments provided in this letter.**

**Response:** Refer to Attachment N for the leachate detection system lateral trench capacity calculations.

**55. It is unclear how the value for cross section area was obtained. Please explain.**

**Response:** The value for cross section area (A) was obtained from the width of the tri-planar used for flow (10 feet) times the tri-planar geonet thickness at max waste loading (0.261inches) multiplied by (2 * 0.261 inches = 0.522 inches) because two layer of tri-planar are used within the leachate detection system lateral trench. Therefore, the value of the cross section area was calculated as follows: A = 10 feet * {(2 * 0.261 inches)} * (1 foot / 12 inches) = 0.435 $ft^2$.

## ATTACHMENT G-12 - LEACHATE DETECTION SYSTEM LATERAL TRENCH CALCULATIONS:

**56. Please revise these calculations, as appropriate, based on changes to other calculations utilized in support of these calculations that may be made in response to comments provided in this letter.**

**Response:** Refer to Attachment N for the leachate detection system lateral trench capacity calculations.

## ATTACHMENT G-17 - PIPE CRUSHING SUMMARY TABLE:

**57. Please provide pipe crushing and flow capacity calculations, where applicable, for the leachate collection header pipes in the south portion of Phase II Section II and Phase II Section I; the 10 inch leachate lateral pipes in the center and northern portion of Phase II Section II; and the 8 inch leak detection header pipe in the center and northern portion of Phase II Section II. Please revise the summary table to include the results of these calculations.**

**Response:** Refer to Attachment T for the pipe crushing and flow capacity calculations for the 8 inch leachate collection lateral pipe calculations located in the south portion of the Phase II Section II Expansion. There are three 8 inch leachate collection lateral pipes in the south portion of the Phase II Section II Expansion. The total length of pipe is approximately 539.7 feet. The area of the Phase II Section II Expansion south portion is 1.63 acres. Based on the HELP Model analyses the worst-case operating Scenario regarding leachate generation from the Phase II Section II Expansion center and northern portions and also the leachate generated in the Phase II Section II Expansion south portion would be Scenario 8 and Scenario 3, respectively. During this operating Scenario approximately 202.93 gpm of leachate is generated from the Phase II Section II Expansion north and center collection portions, 0.88 gpm of leachate is generated from the Phase II Section II Expansion north and center detection portions, and 33.20 gpm is generated from the Phase II Section II Expansion south portion collection system for a total of approximately 237.01 gpm. This amount of leachate will be added to the flow in the existing 8 inch leachate collection pipes within the Phase II Section I area.

Refer to Attachment T for the pipe crushing and flow capacity calculations for the 10 inch leachate collection lateral pipes located along the eastern side of the center and northern portions of Phase II Section II. There is one 10 inch leachate collection lateral pipe in the north and center portions of the Phase II Section II Expansion; located in the eastern side of the cell adjacent to the Phase I sideslope. The total length of pipe is approximately 951.3 feet. The area of the Phase II Section II Expansion north and center portions is 4.55 acres. The north and center portions from the eastern grade break of the cell bottom area was considered as the contributing area to the 10-inch leachate collection lateral pipe. This area is approximately 1.47 acres. The remaining area, 3.08 acres, was used for sizing of the two Phase II Section II Expansion 8 inch leachate collection lateral pipes located in the west and center of the cells. The total length of the two 8 inch leachate collection lateral pipes is approximately 1,888 feet.

Refer to Attachment T for the pipe crushing and flow capacity calculations for the 8 inch leak detection header pipe located between the center and northern portions of Phase II Section II. There is one 8-inch leachate detection header pipe located between the north and center portions of the Phase II Section II Expansion. The approximate length of the leachate detection header pipe is 138.8 feet.

Refer to Attachment T for the pipe crushing and flow capacity calculations for the 12 inch leachate collection header pipe located between the center and northern portions of Phase II Section II. There is one 12 inch leachate collection header pipe located between the north and center portions of the Phase II Section II Expansion. The approximate length of the leachate collection header pipe is 138.8 feet.

Refer to Attachment T for the pipe crushing and flow capacity calculations for the 8 inch leachate collection lateral pipe calculations located in the Phase II Section I. There are three 8 inch leachate collection lateral pipes in the Phase I Section I area. The total length of pipe is approximately 2,020 feet. The Phase I Section I area is approximately 5.0 acres. Assuming the worst-case operating Scenario would be if all of the leachate pumped from the Phase II Section II Expansion sump would go into only one of the three leachate collection sideslope risers in the Phase II Section II Expansion south portion and that all of the leachate would be collected in one of the south portion leachate collection laterals. Therefore, the worst case design flow to the leachate collection pipes within the Phase II Section II Expansion south portion would be approximately 237.01 gpm (202.93 gpm + 0.88 gpm + 33.20 gpm). HELP Model analysis were conducted on the existing conditions of the Phase II Section I area to determine an existing amount of leachate generation from the area. Based on an existing waste depth of 40 feet within the 5-acre area, peak conditions indicate that approximately 74.71 gpm is generated. In addition, additional HELP Models were conducted on the existing conditions of the Phase I south sideslope area to determine an existing amount of leachate generation from the area which also flows into the Phase II Section I area. A rain tarp and stormwater outlet pipes divert stormwater away from the active filling area along the sideslope. Based on a waste depth of 10 feet within half of the sideslope area (0.65-acres due to the rain tarp), peak conditions indicate that approximately 23.84 gpm is generated from the sideslope area. Therefore, approximately 98.55 gpm (74.71 gpm + 23.84 gpm) is currently being transported by the existing Phase II Section I leachate collection pipes. Based on the above-mentioned HELP Model information, the maximum flow to the existing leachate collection pipes within the Phase II Section I area is approximately 335.56 gpm (202.93 gpm + 0.88 gpm + 33.20 gpm + 74.71 gpm + 23.84 gpm).

Refer to the beginning of Attachment T for the revised summary table to include the results of the 8 inch leachate collection lateral pipe calculations, 10 inch leachate collection lateral pipes, the 8 inch leachate detection header pipe and the 12 inch leachate collection header pipe calculations. Note there are no leachate collection header pipes or detection header pipes located in the south portion of the Phase II Section II Expansion. Pipe crushing calculations have also taken into account the revised loading for 25 feet and 60 feet of waste as opposed to the previously used 40 feet and 80 feet.

**58. Please revise these calculations, as appropriate, based on changes to other calculations utilized in support of these calculations that may be made in response to comments provided in this letter.**

**Response:** Refer to Attachment T for the pipe crushing and flow capacity calculations for the 8 inch leachate collection lateral pipe calculations located in the north and center portions of the Phase II Section II Expansion.

Refer to Attachment T for the pipe crushing and flow capacity calculations for the 8 inch leachate collection lateral pipe calculations located in the south portion of Phase II Section II and Phase II Section I.

Refer to Attachment T for the pipe crushing and flow capacity calculations for the 10 inch leachate collection lateral pipes located in the center and northern portions of Phase II Section II.

Refer to Attachment T for the pipe crushing and flow capacity calculations for the 8 inch leak detection header pipe located between the center and northern portions of Phase II Section II.

Refer to Attachment T for the pipe crushing and flow capacity calculations for the 12 inch leachate collection header pipe located between the center and northern portions of Phase II Section II.

Refer to Attachment T for the pipe crushing and flow capacity calculations for the 8 inch leachate collection lateral pipe calculations located in the Phase II Section I.

Refer to the beginning of Attachment T for the revised summary table to include the results of the 8 inch leachate collection lateral pipe calculations, 10 inch leachate collection lateral pipes, the 8 inch leachate detection header pipe and the 12 inch leachate collection header pipe calculations. Note, there are no leachate collection header pipes or detection header pipes located in the south portion of the Phase II Section II Expansion

## ATTACHMENT G-18 - PIPE CRUSHING - 12 INCH PERFORATED LEACHATE COLLECTION HEADER PIPE:

**59. Please revise these calculations and the calculations in Attachment G-19, as appropriate, based on changes to other calculations utilized in support of these calculations that may be made in response to comments provided in this letter.**

**Response:** Refer to Attachment T for the pipe crushing and flow capacity calculations for the 12 inch leachate collection header pipe located between the center and northern portions of Phase II Section II.

Refer to the beginning of Attachment T for the revised summary table to include the results of the 12 inch leachate collection header pipe calculations.

**60. Since the LCS header pipe will collect leachate from both the center and northern portion of Phase II Section II, please explain the assumed number of acres of landfill expansion utilized in these calculations.**

**Response:** Based on the HELP Model analyses the worst-case operating Scenario regarding leachate generation from the Phase II Section II Expansion center and northern portions would be from Scenario 8. During this Scenario approximately 202.93 gpm of leachate is generated from the collection system from the Phase II Section II center and northern portions and the Phase I western sideslope portions as indicated below. The flow value calculated for the LCS header pipe accounted for the following areas and conditions:

- Center Bottom Center Portion - 2.22 acres with 60 feet of waste, 6 inches of daily cover, and one foot intermediate cover.
- Bottom Southern Side Slope of Phase I - 0.59 acres with 25 feet of waste and 6 inches of daily cover.
- Bottom Southern Side Slope of Phase I - 0.21 acres covered with rain tarp.
- Top Southern Side Slope of Phase I - 0.33 acres with 25 feet of waste and 6 inches of daily cover.
- Top Southern Side Slope of Phase I - 1.10 acres covered with rain tarp.
- Cell Bottom North - 2.33 acres open cell with waste filling just started.
- Bottom Northern Side Slope of Phase I - 0.19 acres open cell with waste fill ready to start.
- Bottom Northern Side Slope of Phase I - 0.72 acres covered with rain tarp.
- Top Northern Side Slope of Phase I - 1.22 acres covered with rain tarp.
- The Phase II Section II south portion flows directly into the Phase II Section I sump and is not included in the flow calculated for the LCS header pipe.

Sizing of the 12 inch leachate collection header pipe used the above-indicated flow of 202.93 gpm over an area of the Phase II Section II Expansion center and northern portions of 4.55 acres.

**61. Please explain the basis for the assumed number of laterals and length of pipe per lateral when compared to the construction drawings.**

**Response:** There is one 12 inch leachate collection header pipe located between the north and center portions of the Phase II Section II Expansion. The approximate length of the leachate collection header pipe is 138.8 feet.

## ATTACHMENT G-19 - PIPE CRUSHING - 8 INCH PERFORATED LEACHATE COLLECTION PIPE:

**62. Please explain the basis for the assumed total length of pipe per expansion, total number of laterals, and length of pipe per lateral when compared to the construction drawings.**

**Response:** There is one 10 inch leachate collection lateral pipe located in the eastern side of the Phase II Section II Expansion north and center portions adjacent to the Phase I sideslope. The total length of pipe is approximately 951.3 feet. The area of the Phase II Section II Expansion north and center portions is 4.55 acres. The north and center portions from the eastern grade break of the cell bottom area was considered as the contributing area to the 10-inch leachate collection lateral pipe. This area is approximately 1.47 acres. The remaining area, 3.08 acres, was used for sizing of the two Phase II Section II Expansion 8 inch leachate collection lateral pipes located in the west and center of the cells. The total length of the two 8 inch leachate collection lateral pipes is approximately 1,888 feet.

## ATTACHMENT G-21 - PIPE CRUSHING - PHASE I 8 INCH PERFORATED ADS:

**63. Please explain the basis for the assumed height of groundwater above the pipe springline.**

**Response:** The pipe crushing calculations for the Phase I 8 inch perforated ADS pipe has been revised based on the current estimated seasonal high groundwater elevation of the Phase II Section II Expansion to be EL 82.09 feet NGVD. Refer to Attachment T for the revised pipe crushing calculations.

## ATTACHMENT G-22 - GEOTEXTILE CALCULATIONS:

**64. The adequacy of these calculations will be reviewed upon receipt of Specification Section 02940 - Geotextile. This comment is provided for information purposes only and does not require a response other than acknowledgement of the comment.**

**Response:** Specification Section 02940 Geotextile was inadvertently not included in the original application submittal. Refer to Attachment P for Specification Section 02940 Geotextile.

## ATTACHMENTS I-1 THROUGH I-13 - GEOTECHNICAL INVESTIGATION REQUIREMENTS (Rule 62-701.410(2), F.A.C.)

**Please address the following comments regarding the geotechnical analyses in these Appendices. The Department suggests that these comments be discussed in further detail during the meeting recommended at the end of this letter.**

**Response:** Comment noted.

## ATTACHMENTS I-2 FLORIDA GEOLOGY SURVEY'S SINKHOLE DATABASE:

**65. Please provide a map/figure showing the location of the sinkholes in database in relation to the facility.**

**Response:** Refer to Attachment U for a map/figure showing the location of the sinkholes in database in relation to the facility.

## ATTACHMENTS I-6 - SETTLEMENT CALCULATIONS ON EXISTING LFG PIPES AND PHASE I LCS PIPES:

**66. Please provide an evaluation of the settlement of the modified LCS manholes for Phase I.**

**Response:** Refer to Attachment V for settlement calculation for the modified leachate collection system manholes for Phase I.

## ATTACHMENTS I-7 - SLOPE STABILITY SUMMARY TABLE:

**67. Please revise this table based on your response to comments related to Attachment I-8 and I-12.**

**Response:** Refer to Attachment W for a revised slope stability summary table based on the revised slope stability analyses conducted as identified below in response to Item Number 68. Slope stability calculations for the Phase II Section I height increased assumed at the far western end the groundwater would be at the revised EL 82.09 feet NGVD after the installation of the groundwater interceptor system within the south portion of the Phase II Section II Expansion. No changes per RAI No. 1 were conducted on the Phase II Section I center portion based on revised estimated seasonal high groundwater elevation due to existing groundwater interceptor system located within that portion of the Phase II Section I area.

## ATTACHMENTS I-8 THROUGH I-12 - SLOPE STABILITY ANALYSES:

**68. Please verify the assumed piezometric surface elevation used in the slope stability analyses with the groundwater elevation data collected since 2004 provided with this application, and revise the slope stability analyses, as appropriate.**

**Response:** SCS reviewed the groundwater elevations recorded at the monitor wells and piezometers at the facility during the routine, semi-annual sampling events recorded from June 1999 through June 2012 as provided by the Department in the table "*Summary of Ground Water Elevations, Hardee County Landfill*" and in addition elevations recorded in December 2012 provided by the County. The recorded groundwater elevations provided by the Department and the County are provided in Attachment K. Based on review of the above-mentioned groundwater elevations, the assumed piezometric surface elevation used in the revised slope stability analyses has been revised within the sump area of the Phase II Section II Expansion to be EL 82.09 feet NGVD. Based on the revised piezometric surface elevation SCS has determined the Factor of Safety for both the circular and block failure analyses, both with and without equipment loading, meets the required 1.5 Factor of Safety. Refer to Attachment W for revised slope stability analyses using the revised piezometric surface elevation for the following:

- During Construction Phase II Section II Adjacent to Phase I
  Circular Analysis With and Without Equipment Loading
  Block-Type Analysis With and Without Equipment Loading

- During Construction Phase II Section II Adjacent to Phase II Section I
  Circular Analysis With and Without Equipment Loading
  Block-Type Analysis With and Without Equipment Loading

- Phase II Section II Final Buildout
  Circular Analysis With and Without Equipment Loading
  Block-Type Analysis With and Without Equipment Loading

- Phase II Section I East Sideslope
  Circular Analysis With and Without Equipment Loading
  East Sideslope Block-Type Analysis With and Without Equipment Loading

- Phase II Section I South Sideslope
  Circular Analysis With and Without Equipment Loading
  Block-Type Analysis With and Without Equipment Loading

Refer to Attachment I for revised Section I Geotechnical Investigation Requirements Part I.1.d.3 Slope Stability Analysis of the Engineering Report for an updated Table I-6 Slope Stability Evaluations.

## ATTACHMENT R-1 - FINANCIAL RESPONSIBILITY REQUIREMENTS (Rule 62-701.630, F.A.C.):

**69. Please address the comments in Department's September 28, 2012 letter (attached) regarding the financial assurance cost estimates provided in Attachment R-1.**

1. **Based on your response to the comments below and comments provided as part of the above referenced permit application, please provide a revised DEP Form 62-701.900(28), that incorporates all proposed changes to the closure and long-term care cost estimates and is signed by the applicant or signed and sealed by the professional engineer who prepared the estimate.**

   **Response:** Comment noted.

2. **Please note that quantities and unit costs for closure and long-term care items may be added or changed based on comments and revisions to the above referenced permit application and therefore the proposed closure and long-term care costs will need to be revised accordingly.**

**Response:** Comment noted.

3. **<u>Site Specific Costs - Leachate Disposal</u>: Leachate generation and the associated cost of disposal will continue during closure of the facility. The leachate generation rate during closure should be based on the assumed or actual per acre leachate generation rate for the previous year calculated for the total acreage to be closed. Please revise this section to include estimated costs for leachate disposal during closure as a site specific closure cost.**

   **Response:** Based on the revised HELP Model provided in Attachment J, approximately an additional average 10,383 gallons per day or roughly 3,790,119 gallons per year of leachate will be generated due to the Phase II Section II Expansion. Refer to Attachment X for the revised financial assurance cost estimates.

**As indicated in the comments provided above, the Department had some questions about the supporting design information and calculations that were either difficult to describe in writing or are better explained and discussed in person. In order to assist the applicant, the Department feels it would be very beneficial to meet to discuss options for addressing these issues. The Department therefore <u>requests</u> that the applicant contact us to schedule a meeting to discuss the comments in this letter prior to submittal of its response.**

**Response:** Comment noted. Based on the meeting conducted on November 26, 2012 between the following meeting attendees, the following responses are provided.

- Shane R. Fischer, P.E. - SCS Engineers
- Ed Hilton, Jr., P.E. - SCS Engineers
- Ken Wheeler - Director/County Engineer Hardee County Public Works
- Teresa Carver - Hardee County Solid Waste Director
- Jeff Greenwell - FDEP
- John R. Morris - FDEP
- Steve Morgan - FDEP
- Mike Dunaway - FDEP (via conference call)
- Michele Smith - FDEP (via conference call)

**Please respond by the <u>date established in the meeting requested above</u>, responding to all of the information requests and indicating when a response to any unanswered questions will be submitted. If the responses will require longer than the above schedule, you should develop an alternative timetable for the submission of the requested information for Department review and consideration. If the Department does not receive a timely, complete response to this request for information, the Department may issue a final order denying your application. A denial for lack of information or response will be unbiased as to the merits of the application. The applicant may reapply as soon as the requested information is available.**

**Response:** Comment noted.

**Please provide 2 paper and one electronic copy of your response to this letter as one complete package.**

**Response:** Comment noted. SCS has provided two copies of all the revised and additional materials along with one electronic copy of the submittal.

**John Morris' September 21, 2012 memorandum RAI regarding this application.**

**Response:** As previously indicated, SCS has provided responses that address the comments in John Morris' September 21, 2012 memorandum towards the end of this letter.

## PART H - HYDROGEOLOGICAL INVESTIGATION REQUIREMENTS [Rule 62-701.410(1), F.A.C.]

1. **H.1.: Hydrogeological Investigation and Site Report [Rule 62-701.410(1), F.A.C.].**

   a. **Paragraph 1 in this section listed relevant documents previously submitted to the Department that included geological, hydrogeological and geotechnical information in support of the Phase II Section II Expansion. Please submit revisions to the bullet item that described the document titled "Revised Groundwater Monitoring Plan," prepared by SCS, dated March 10, 2008 to indicate that revisions to this document were dated January 18, 2011 [revisions were submitted in support of permit modification #38414-014-SO/MM, issued April 15, 2011].**

      **Response:** Refer to Attachment I for revised part H.1 Hydrogeological Investigation and Site Report paragraph 1 of the Engineering Report.

   b. **Paragraph 2 in this section indicated that the placement of monitor wells was based on the requirements of Rule 62-701.510(1), F.A.C., and the finding of the document titled "Hydrogeological Investigation," prepared by SCS, dated April 2004. This section also indicated that no changes were proposed as part of this pending permit application from what was originally proposed regarding monitor wells and gas probes as submitted to the Department in April 2004. Please note that the <u>attached</u> table ["Summary of Ground Water Elevations, Hardee County Landfill," 2 pages] presents the ground water elevations recorded at the monitor wells and piezometers at the facility during routine, semi-annual sampling events conducted through June 2012. Please submit revisions to all appropriate sections of the Engineering Report, the Site Plan, and the document titled "Revised Groundwater Monitoring Plan," prepared by SCS, dated March 10, 2008, revised January 18, 2011, to provide an updated evaluation of the appropriateness of the well screen intervals [screen length, screen elevation] for the proposed monitor wells [MW-13, MW-14 and MW-15]. Please specifically address the appropriateness of the construction details provided for proposed monitor wells MW-13, MW-14 and MW-15 as presented in Table M-2 of the "Revised Groundwater Monitoring Plan" document based on evaluation of the ground water elevations recorded through June 2012 and submit revisions, as needed.**

**Response:** SCS reviewed the groundwater elevations recorded at the monitor wells and piezometers at the facility during the routine, semi-annual sampling events recorded from June 1999 through June 2012 as provided by the Department in the table "*Summary of Ground Water Elevations, Hardee County Landfill*" and in addition elevations recorded in December 2012 provided by the County. The recorded groundwater elevations provided by the Department and the County are provided in Attachment K. Based on the review of the above-mentioned groundwater elevations, the construction requirements for proposed groundwater monitoring wells MW-13 and MW-14 have been revised. The construction details as provided for proposed groundwater monitoring wells MW-13 and MW-14 will replace the construction details as previously provided in Table M-2 of the *Revised Groundwater Monitoring Plan*, dated March 10, 2008, prepared by SCS and revised by SCS dated January 18, 2011 [revisions were submitted in support of permit modification #38414-014-SO/MM, issued April 15, 2011]. Please note the previously proposed MW-15 has been removed, placement of monitoring points MW-13 and MW-14 were based on Chapter 62-701.510, FAC.

In addition, SCS previously sampled the shallow aquifer formation material at the depth interval where monitoring well screen would be installed to provide grain size data to assist in the design of existing groundwater monitoring wells MW-10R and MW-12R to reduce the level of turbidity in the groundwater samples. Soil samples were submitted to a geotechnical testing laboratory for analysis in accordance with American Society for Testing and Materials (ASTM) D422. The grain size analyses indicated that the aquifer material grain size was similar at the two depths and it also contained a relatively large percentage of silt.

Therefore, to minimize potential turbidity issues in proposed groundwater monitoring wells MW-13 and MW-14, a finer slotted well screen and sand pack will be used as with formerly installed MW-10R and MW-12R. Proposed groundwater monitoring wells MW-13 and MW-14 will be constructed using fifteen feet of 2-inch diameter 0.006-inch factory slotted Schedule 40 polyvinyl chloride (PVC) well screen, five feet of solid PVC riser and an additional three feet of solid PVC for the riser stickup. Following installation of MW-13 and MW-14 well assembly's, the annular space of the screened interval of each well will be packed with 30/65 silica sand from the bottom of the well assembly to approximately three feet above the well screen. The remaining annular space will be sealed to grade with Portland Type I cement and completed with a concrete pad and an aluminum riser-type locking cover. Four bollards, consisting of 4-inch diameter Schedule 40 PVC filled with concrete, will be constructed around MW-13 and MW-14.

The required survey information for groundwater monitoring wells MW-13 and MW-14 will be collected (latitude and longitude coordinates, top of casing and land surface elevations) and provided to FDEP (signed and sealed) within the Certification of Construction Completion Report created for the Expansion project.

Refer to Attachment I for revised part H.1 Hydrogeological Investigation and Site Report paragraph 2 of the Engineering Report.

Refer to Attachment A for revised Drawings that indentify the construction requirements as identified above for proposed groundwater monitoring wells MW-13 and MW-14.

2. **H.1.b.: Direction and rate of ground water and surface water flow including seasonal variations. [Rule 62-701.410(1)(a)(1), F.A.C.]. This section referred to the discussion of the rate and direction of ground water flow presented in the documents titled "Hydrogeological Investigation," prepared by SCS, dated April 2004, and "Groundwater Monitoring Plan Evaluation Report," prepared by SCS, dated January 30, 2008. Please submit revisions to this section to provide an updated evaluation of the rate and direction of ground water flow using the ground water elevations presented on the attached table.**

   **Response:** An updated evaluation of the rate and direction of ground water flow using the ground water elevations presented on the table attached to RAI No. 1 from the Department and provided in Attachment K has been provided. Refer to Attachment I for revised part H.1.b Direction and Rate of Ground Water and Surface Water Flow Including Seasonal Variations of the Engineering Report.

3. **H.1.g.: Inventory of all public and private water wells within a one-mile radius of the landfill…H.1.i." Include a map showing locations of all potable wells…[Rules 62-701.410(1)(b) and 62-701.410(1)(d), F.A.C., respectively].**

   a. **These sections referred to the information presented in Attachment C-1 of the Engineering Report. It appears that Attachment C-1, Figure 1 and Attachment C-1, Table 1 provide information regarding wells located within 1,000 feet of the landfill rather than the required one mile radius. To address the requirements of Rule 62-701.410(1)(b), F.A.C., please submit revisions to Attachment C-1 that provide the results of a query of the Water Use Permit database and of the Well Construction Permitting database maintained by the Southwest Florida Water Management District for the following areas:**

      – **Township 33 south, Range 25 east, Sections 25, 26, 27, 34, 35 and 36; and,**

      – **Township 34 south, Range 25 east, Sections 1, 2, and 3.**

      **Response:** Refer to Attachment Y for revised Figure 1 Potable Wells Inventory and Table 1 SWFWMD Well Construction Permits which provide information regarding potable wells located within a one mile radius of the landfill based on the results of a query of the Water Use Permit database and of the Well Construction Permitting database maintained by the Southwest Florida Water Management District for the areas identified.

   b. **Please submit revisions to these sections to clarify if the wells depicted by Attachment C-1, Figure 1 and if the wells listed in Attachment C-1, Table 1 represent potable wells.**

      **Response:** Refer to Attachment Y for revised Figure 1 Potable Wells Inventory and revised Table 1 SWFWMD Well Construction Permits previously provided in Attachment C-1 to clarify the wells identified represent potable wells.

Refer to Attachment I for revised Part H Hydrogeological Investigation Requirements of the Engineering Report to clarify the wells identified in Figure 1 and Table 1 previously provided in Attachment C-1 represent potable wells.

## PART L - WATER QUALITY AND LEACHATE MONITORING REQUIREMENTS [Rule 62-701.510, F.A.C.]

4. **L.1.: Water quality and leachate monitoring plan shall be submitted describing the proposed…[Rule 62-701.510(1), F.A.C.].**

   a. **Please note that the amendments to Chapter 62-701, F.A.C., that were effective on August 12, 2012 deleted the requirements to sample, analyze and report leachate quality data. Please submit revisions to all sub-sections in Section L of the Engineering Report to delete the references to leachate sampling, analysis and reporting, as appropriate.**

      **Response:** Refer to Attachment I for a revised Section L Water Quality Monitoring Requirements of the Engineering Report to be consistent with the amendments to Chapter 62-701, FAC, that were effective on August 12, 2012 which deleted the requirements to sample, analyze and report leachate quality data.

   b. **Paragraph 1 in this section listed relevant documents previously submitted to the Department that included geological, hydrogeological and geotechnical information in support of the Phase II Section II Expansion. Please submit revisions to all sub-section in Section L of the Engineering Report that reference the document titled "Revised Groundwater Monitoring Plan," prepared by SCS, dated March 10, 2008 to indicate that revisions to this document was revised dated January 18, 2011 [revisions were submitted in support of permit modification #38414-014-SO/MM, issued April 15, 2011].**

      **Response:** Refer to Attachment I for a revised Section L Water Quality Monitoring Requirements paragraph 1 of the Engineering Report to indicate the *Revised Groundwater Monitoring Plan*, dated March 10, 2008, prepared by SCS and revised by SCS dated January 18, 2011 [revisions were submitted in support of permit modification #38414-014-SO/MM, issued April 15, 2011].

5. **L.1.b.: All sampling and analysis performed in accordance…[Rule 62-701.510(2)(b), F.A.C.]. Please submit revisions to last sentence of paragraph 2 to indicate: "Sampling and analysis of groundwater and ~~leachate~~ surface water will be performed in accordance with the requirements of rules ~~62-170~~ 62-160 and 62-701.510(2)(b), F.A.C."**

   **Response:** Refer to Attachment I for a revised Section L Water Quality Monitoring Requirements Part L.1.b Sampling and Analysis Methods of the Engineering Report to indicate "Sampling and analysis of groundwater and surface water will be performed in accordance with the requirements of rules 62-160 and 62-701.510(2)(b), FAC."

6. **L.1.c.: Ground water monitoring requirements…[Rule 62-701.510(3), F.A.C.]. Please submit revisions to the four rule citations presented in the bullet item following paragraph of this section to reflect the amendments to Chapter 62-701, F.A.C., that were effective on August 12, 2012.**

   **Response:** Refer to Attachment I for a revised Section L Water Quality Monitoring Requirements Part L.1.c Groundwater Monitoring Requirements of the Engineering Report to be consistent with the amendments to Chapter 62-701, FAC that were effective on August 12, 2012.

7. **L.1.c.(1): Detection wells located downgradient from…[Rule 62-701.510(3)(a), F.A.C.]. Please submit revisions to this section to describe the anticipated time interval between existing detection well abandonment [MW-5 and MW-8] and proposed detection well installation [MW-13, MW-14 and MW-15]. Please submit additional revisions to this section to indicate if the routine, semi-annual ground water monitoring events can be scheduled around the construction of Phase II Section II so that monitor wells located along the western portion of the landfill will not be omitted from future routine sampling events.**

   **Response:** Please note the previously proposed MW-15 has been removed; placement of monitoring points MW-13 and MW-14 were based on Chapter 62-701.510, FAC. The estimated schedule and anticipated dates for the Hardee County Landfill Phase II Section II Expansion construction is as follows:

   a) Submittal of RAI No. 1 responses to FDEP - April 1, 2013
   b) FDEP review period of RAI No. 1 responses - 30 days (May 1, 2013)
   c) FDEP Notice of Completeness - May 1, 2013
   d) FDEP draft Permit preparation - 45 days (June 15, 2013)
   e) Review and comment on proposed Permit ~ 2 days (June 17, 2013)
   f) FDEP Intent to Issue Permit - 1 day (June 18, 2013)
   g) Notice of proposed Agency Action (Permit advertising period) - 15 days (July 3, 2013)
   h) Notice of Permit Issuance - 1 day (July 8, 2013)
   i) Prepare bid documents ~ 15 days (July 29, 2013)
   j) Bid phase services and BOCC approval of contract ~ 64 days (October 1, 2013)
   k) Notice to Proceed (NTP) ~ Issued October 1, 2013.
   l) Construction phase ~ 180 calendar days (October 1, 2013 - April 1, 2014)
      - The routine, semi-annual groundwater monitoring event for June 2013 can occur on all wells as usual.
      - Existing monitor wells MW-3, MW-5, and MW-8 will be abandoned at the initial stages of construction in approximately mid October 2013.
      - During construction access will be made for the routine, semi-annual groundwater monitoring event for December 2013 for all existing monitor wells with the exception of monitor wells MW-3, MW-5, and MW-8 (which will have been

abandoned by that time).

- Monitor wells MW-13 and MW-14 will be installed at the end of construction in approximately late March 2014.
- The routine, semi-annual groundwater monitoring event for June 2014 will be conducted as usual for all existing monitor wells including new monitor wells MW-13 and MW-14.

8. **L.1.c.(2): Downgradient compliance wells as required [Rule 62-701.510(3)(b), F.A.C.]. Please submit revisions to this section to clarify that none of the existing monitor wells at the Hardee County landfill have been designated as compliance wells. Please submit additional revisions to this section to indicate that compliance wells shall be installed in accordance with the requirements of Rule 62-701.510(6), F.A.C., if needed.**

   **Response:** Refer to Attachment I for a revised Section L Water Quality Monitoring Requirements Part L.1.c.2 Downgradient Compliance Wells of the Engineering Report to clarify that none of the existing monitor wells at the Hardee County Landfill have been designated as compliance wells. In addition, Part L.1.c.2 has been revised to indicate that compliance wells shall be installed if needed in accordance with the requirements of Rule 62-701.510(6), FAC.

9. **L.1.c.(6): Well screen locations properly selected [Rule 62-701.510(3)(d)4, F.A.C.].**

   a. **Please submit revisions to this section regarding the appropriateness of the well screen intervals [screen length, screen elevation] for the proposed monitor wells [MW-13, MW-14 and MW-15] based on review of ground water elevations recorded through June 2012 [refer to Comment #1.b., above.].**

      **Response:** SCS reviewed the groundwater elevations recorded at the monitor wells and piezometers at the facility during the routine, semi-annual sampling events recorded from June 1999 through June 2012 as provided by the Department in the table "*Summary of Ground Water Elevations, Hardee County Landfill*" and in addition elevations recorded in December 2012 provided by the County. The recorded groundwater elevations provided by the Department and the County are provided in Attachment K. Based on the review of the above-mentioned groundwater elevations, the construction requirements for proposed groundwater monitoring wells MW-13 and MW-14 have been revised. The construction details as provided for proposed groundwater monitoring wells MW-13 and MW-14 will replace the construction details as previously provided in Table M-2 of the *Revised Groundwater Monitoring Plan*, dated March 10, 2008, prepared by SCS and revised by SCS dated January 18, 2011 [revisions were submitted in support of permit modification #38414-014-SO/MM, issued April 15, 2011]. Please note the previously proposed MW-15 has been removed, placement of monitoring points MW-13 and MW-14 were based on Chapter 62-701.510, FAC.

      In addition, SCS previously sampled the shallow aquifer formation material at the depth interval where monitoring well screen would be installed to provide grain size data to assist in the design of existing groundwater monitoring wells MW-10R and MW-12R to reduce the level of turbidity in the groundwater samples. Soil samples were submitted to a geotechnical testing laboratory for analysis in accordance with American Society for Testing and Materials (ASTM) D422. The grain size analyses indicated that the aquifer material grain size was similar at the two depths and it also contained a relatively large percentage of silt.

Therefore, to minimize potential turbidity issues in proposed groundwater monitoring wells MW-13 and MW-14, a finer slotted well screen and sand pack will be used as with formerly installed MW-10R and MW-12R. Proposed groundwater monitoring wells MW-13 and MW-14 will be constructed using fifteen feet of 2-inch diameter 0.006-inch factory slotted Schedule 40 polyvinyl chloride (PVC) well screen, five feet of solid PVC riser and an additional three feet of solid PVC for the riser stickup. Following installation of MW-13 and MW-14 well assembly's, the annular space of the screened interval of each well will be packed with 30/65 silica sand from the bottom of the well assembly to approximately three feet above the well screen. The remaining annular space will be sealed to grade with Portland Type I cement and completed with a concrete pad and an aluminum riser-type locking cover. Four bollards, consisting of 4-inch diameter Schedule 40 PVC filled with concrete, will be constructed around MW-13 and MW-14.

Refer to Attachment I for revised Part L.1.c.6 Well Screen Locations of the Engineering Report regarding the appropriateness of the well screen intervals for the proposed monitor wells based on review of ground water elevations recorded through December 2012.

Refer to Attachment A for revised Drawings that indentify the construction requirements as identified above for proposed groundwater monitoring wells MW-13 and MW-14.

b. **The construction details for the proposed monitor wells [MW-13, MW-14 and MW-15] are presented on Figure M-3 of the "Revised Groundwater Monitoring Plan" document. Please note that while wells MW-10 and MW-12 were constructed in accordance with the details provided in Figure M-3 [10-slot well screen, 20/30 graded sand pack], elevated turbidity values were reported following their installation. Please also note that replacement wells MW-10R and MW-12R were subsequently constructed using different materials [6-slot well screen, 30/65 graded sand pack]. Please submit revisions to this section to clarify the materials to be used in the construction of proposed wells MW-13, MW-14 and MW-15.**

**Response:** SCS reviewed the groundwater elevations recorded at the monitor wells and piezometers at the facility during the routine, semi-annual sampling events recorded from June 1999 through June 2012 as provided by the Department in the table "*Summary of Ground Water Elevations, Hardee County Landfill*" and in addition elevations recorded in December 2012 provided by the County. The recorded groundwater elevations provided by the Department and the County are provided in Attachment K. Based on the review of the above-mentioned groundwater elevations, the construction requirements for proposed groundwater monitoring wells MW-13 and MW-14 have been revised. The construction details as provided for proposed groundwater monitoring wells MW-13 and

MW-14 will replace the construction details as previously provided in Table M-2 of the *Revised Groundwater Monitoring Plan*, dated March 10, 2008, prepared by SCS and revised by SCS dated January 18, 2011 [revisions were submitted in support of permit modification #38414-014-SO/MM, issued April 15, 2011]. Please note the previously proposed MW-15 has been removed, placement of monitoring points MW-13 and MW-14 were based on Chapter 62-701.510, FAC.

In addition, SCS previously sampled the shallow aquifer formation material at the depth interval where monitoring well screen would be installed to provide grain size data to assist in the design of existing groundwater monitoring wells MW-10R and MW-12R to reduce the level of turbidity in the groundwater samples. Soil samples were submitted to a geotechnical testing laboratory for analysis in accordance with American Society for Testing and Materials (ASTM) D422. The grain size analyses indicated that the aquifer material grain size was similar at the two depths and it also contained a relatively large percentage of silt.

Therefore, to minimize potential turbidity issues in proposed groundwater monitoring wells MW-13 and MW-14, a finer slotted well screen and sand pack will be used as with formerly installed MW-10R and MW-12R. Proposed groundwater monitoring wells MW-13 and MW-14 will be constructed using fifteen feet of 2-inch diameter 0.006-inch factory slotted Schedule 40 polyvinyl chloride (PVC) well screen, five feet of solid PVC riser and an additional three feet of solid PVC for the riser stickup. Following installation of MW-13 and MW-14 well assembly's, the annular space of the screened interval of each well will be packed with 30/65 silica sand from the bottom of the well assembly to approximately three feet above the well screen. The remaining annular space will be sealed to grade with Portland Type I cement and completed with a concrete pad and an aluminum riser-type locking cover. Four bollards, consisting of 4-inch diameter Schedule 40 PVC filled with concrete, will be constructed around MW-13 and MW-1.

Refer to Attachment I for revised Part L.1.c.6 Well Screen Locations of the Engineering Report to clarify the materials to be used in the construction of proposed groundwater monitor wells MW-13 and MW-14.

Refer to Attachment A for revised Drawings that indentify the construction requirements as identified above for proposed groundwater monitoring wells MW-13 and MW-14.

10. **L.1.c.(8): Procedures for properly abandoning monitoring wells [Rule 62-701.510(3)(d)6, F.A.C.]. Please submit revisions to this section to reference the well abandonment requirements of Rule 62-532.500(5), F.A.C., to reflect the amendments to Chapter 62-532, F.A.C., that were effective on February 16, 2012.**

**Response:** Well abandonment requirements will be according to Rule 62-532.500(5), FAC, per the amendments to Chapter 62-532, FAC that were effective on February 16, 2012. Refer to Attachment I for a revised Section L Water Quality Monitoring Requirements Part L.1.c(8) Procedures for Monitoring Well Abandonment of the Engineering Report has been revised to indicate that properly abandoning monitoring wells will be conducted per Rule 62-701.510(3)(d)6, FAC.

**11. L.1.d.(1): Location of and justification for all proposed surface water monitoring points**

**L.1.d.(2): Each monitoring location to be marked and its position… …[Rules 62-701.510(4)(a) and 62-701.510(4)(c), F.A.C., respectively]. Please submit revisions to these sections to clarify that a single surface water sampling point [location identified as "SW-2"] has been designated for the Hardee County landfill in the "Revised Groundwater Monitoring Plan" document.**

**Response:** Refer to Attachment I for a revised Section L Water Quality Monitoring Requirements Part L.1.d(1) Proposed Surface Water Monitoring Locations of the Engineering Report which clarify that a single surface water sampling point [location identified as "SW-2"] has been designated for the Hardee County landfill in the "Revised Groundwater Monitoring Plan" document.

Refer to Attachment I for a revised Section L Water Quality Monitoring Requirements Part L.1.d(2) Surface Water Monitoring Locations of the Engineering Report which clarify that a single surface water sampling point [location identified as "SW-2"] has been designated for the Hardee County landfill in the "Revised Groundwater Monitoring Plan" document.

**12. L.1.e.: Leachate sampling locations**

**L.1.f.(2): Routine leachate sampling and analysis requirements [formerly Rules 62-701.510(5) and 62-701.510(6)(c), F.A.C.]. Please delete these sections from Section L of the Engineering Report [refer to comment #4.a., above].**

**Response:** Refer to Attachment I for a revised Section L Water Quality Monitoring Requirements Part L.1.f.(2) Routine Leachate Sampling and Analysis Requirements of the Engineering Report which has been removed to be consistent with the amendments to Chapter 62-701, FAC, that were effective on August 12, 2012 which deleted the requirements to sample, analyze and report leachate quality data.

Refer to Attachment I for a revised Section L Water Quality Monitoring Requirements Part L.1.e Leachate Sampling Locations of the Engineering Report which has been removed to be consistent with the amendments to Chapter 62-701, FAC, that were effective on August 12, 2012 which deleted the requirements to sample, analyze and report leachate quality data.

**13. L.1.f.(4): Routine surface water sampling and analysis requirements [Rule 62-701.510(5)(d), F.A.C.]. This section of the Engineering Report referred to the surface water sampling requirements presented in the "Revised Groundwater Monitoring Plan" document. Please note that the list of laboratory parameters for surface water samples presented on page M-10 of the "Revised Groundwater Monitoring Plan" document do not reflect the parameters referenced in Rule 62-701.510(5)(d), F.A.C. Please submit revisions to this section of the Engineering Report to indicate that surface water samples shall be analyzed for the parameters listed in Rule 62-701.510(7)(b), F.A.C.**

**Response:** Refer to Attachment I for a revised Section L Water Quality Monitoring

Requirements Part L.1.f.(4) Routine Surface Water Sampling and Analysis of the Engineering Report which indicate surface water samples shall be analyzed for the parameters listed in Rule 62-701.510(7)(b), FAC.

14. **L.1.g: Describe procedures for implementing evaluation monitoring… [Rule 62-701.510(6), F.A.C.].**

    a. **This section of the Engineering Report referred to "post closure" procedures for evaluation, prevention and corrective actions. Please note that the requirements of Rule 62-701.510(6), F.A.C., apply to both operating and closed facilities. Please submit revisions to this section of the Engineering Report that delete the references to "post closure" procedures.**

       **Response:** Please refer to Attachment I for a revised Section L Water Quality Monitoring Requirements Part L.1.g Procedures for Evaluation, Prevention, Corrective Action of the Engineering Report which deleted the references to "post closure" procedures for evaluation, prevention and corrective actions.

    b. **This section of the Engineering Report referred to the procedures for evaluation, prevention and corrective actions presented in the "Revised Groundwater Monitoring Plan" document. Please note that the information presented on pages M-17 and M-18 of the "Revised Groundwater Monitoring Plan" document do not reflect the current requirements of Rule 62-701.510(6), F.A.C. Please submit revisions to this section of the Engineering Report that reference the requirements of Rule 62-701.510(6), F.A.C.**

       **Response:** Please refer to Attachment I for a revised Section L Water Quality Monitoring Requirements Part L.1.g, Procedures for Evaluation, Prevention, Corrective Action of the Engineering Report which reference the requirements of Rule 62-701.510(6), FAC.

15. **L.1.h.(1): Semi-annual report requirements [Rule 62-701.510(8)(a), F.A.C.]. Please submit revisions to the four rule citations presented in this section of the Engineering Report to reflect the amendments to Chapter 62-701, F.A.C., that were effective on August 12, 2012.**

    **Response:** Please refer to Attachment I for a revised Section L Water Quality Monitoring Requirements Part L.1.h.(1) Semi-annual Report Requirements of the Engineering Report to be consistent with the amendments to Chapter 62-701, FAC that were effective on August 12, 2012.

16. **L.1.h.(3): Two and one-half year report requirements…[Rule 62-701.510(8)(b), F.A.C.]. Please submit revisions to the rule citation presented in this section of the Engineering Report to reflect the amendments to Chapter 62-701, F.A.C., that were effective on August 12, 2012.**

    **Response:** Please refer to Attachment I for a revised Section L Water Quality Monitoring Requirements Part L.1.h.(3) Technical Report Requirements of the Engineering Report to be consistent with the amendments to Chapter 62-701, FAC that were effective on August 12, 2012.

## PART N – GAS MANAGEMENT SYSTEM REQUIREMENTS…[RULE 62-701.530, F.A.C.]

**17. N.1: Provide the design for a gas management system…**

**N.2: Provide documentation that will describe locations, construction details and procedures…[Rule 62-701.530(1) and 62-701.530(2), F.A.C., respectively].**

**a. Section N.1, paragraph 2 and Section N.2, paragraph 3 of the Engineering Report refer to construction details for the proposed landfill gas probes [GP-3R through GP-8R] presented in the Site Plans [Drawing No. 20, inset table "Landfill Gas Monitoring Probe Schedule" and figure "Landfill Gas Monitoring Probe Detail"]. Please note that the attached table ["Summary of Ground Water Elevations, Hardee County Landfill," 2 pages] presents the ground water elevations recorded at the monitor wells and piezometers at the facility during routine, semi-annual sampling events conducted through June 2012. Please specifically address the appropriateness of the construction details provided for proposed landfill gas probes [GP-3R through GP-8R] as presented on Drawing No. 20 of the Site Plans based on evaluation of the seasonal low ground water level using the ground water elevations recorded through June 2012 and submit revisions, as needed.**

**Response:** SCS reviewed the groundwater elevations recorded at the monitor wells and piezometers at the facility during the routine, semi-annual sampling events recorded from June 1999 through June 2012 as provided by the Department in the table "*Summary of Ground Water Elevations, Hardee County Landfill*" and in addition elevations recorded in December 2012 provided by the County. The recorded groundwater elevations provided by the Department and the County are provided in Attachment K.

Based on an evaluation of the seasonal low groundwater level using the above-mentioned groundwater elevations the construction details previously provided for proposed landfill gas probes [GP-3R through GP-8R] as presented on Drawing Number 20 of the Site Plans have been revised. The proposed landfill gas probes are designed to be surface sealed and to provide a greater permeability than the surrounding soils strata's between the waste deposit and the property boundary to act as collector points for any subsurface methane gas, if present. Based on the landfill design, the proposed monitoring probes shall extend from the soil surface to the seasonal low groundwater level to draw gas samples from the permeable layers. The depth of the proposed gas probes and screened interval for each of the monitoring points will vary based on the depth of the seasonal low groundwater level using the groundwater elevations recorded as indicated above. This depth will allow the screened interval to intercept the full cross-section of the landfilled waste to the seasonal low groundwater level that could potentially generate methane.

Refer to Attachment A for revised Drawing Number 20 for the proposed landfill gas probes GP-3R through GP-8R.

b. **Please submit revisions to the "Landfill Gas Monitoring Probe Detail" provided on Drawing No. 20 of the Site Plans to refer to the "Landfill Gas Monitoring Probe Schedule" regarding the "slotted pipe length" determined for the individual proposed gas probes.**

**Response:** Refer to Attachment A for revisions to the "Landfill Gas Monitoring Probe Detail" provided on Drawing Number 20 to refer to the "Landfill Gas Monitoring Probe Schedule" regarding the "slotted pipe length" determined for the individual proposed gas probes.

## PART O - LANDFILL FINAL CLOSURE REQUIREMENTS [RULE 62-701.600, F.A.C.]

18. **O.4.b.: Final survey report [Rule 62-701.600(6)(b), F.A.C.]. Please submit revisions to this section of the Engineering Report to reference Rule 62-701.600(6)(b), F.A.C. [requested revision is underlined].**

    **Response:** Please refer to Attachment I for a revised Section O Part O.4.b Final Survey Report of the Engineering Report to reference Rule 62-701.600(6)(b), FAC as requested by the Department.

19. **O.5.: Declaration to the public [Rule 62-701.600(7), F.A.C.]. Please submit revisions to this section of the Engineering Report to reference Rule 62-701.600(7), F.A.C. [requested revision is underlined].**

    **Response:** Please refer to Attachment I for a revised Section O Part O.5 Declaration To The Public of the Engineering Report to reference Rule 62-701.600(7), FAC as requested by the Department.

20. **O.6.: Official date of closing [Rule 62-701.600(8), F.A.C.]. Please submit revisions to this section of the Engineering Report to reference Rule 62-701.600(8), F.A.C. [requested revision is underlined].**

    **Response:** Please refer to Attachment I for a revised Section O Part O.6 Official Date of Closing of the Engineering Report to reference Rule 62-701.600(8), FAC as requested by the Department.

Please do not hesitate to contact us if you need anything further.

Sincerely,

Shane R. Fischer, P.E.
Project Manager
**SCS ENGINEERS**

C. Ed Hilton, P.E.
Vice President/Solid Waste Division Director
**SCS ENGINEERS**

SRF/CEH:srf
Attachments

cc: Teresa Carver, Hardee County Solid Waste Director, w/ attachments

58026
4/1/13

# LIST OF ATTACHMENTS

- A - Revised Hardee County Landfill Phase II Section II Expansion Construction Drawings
- B - Revised Page 7 and 39 of Application Form #62-701.900(1)
- C - Figure A-1 Regional Map
- D - Certification of County Millage By the Property Appraiser's Office
- E - Signed and Sealed Aerial Topographic Survey Conducted by Pickett and Associates, Inc. (Pickett), Dated April 3, 2012 and Associated Signed and Sealed Survey Report
- F - Revised Hardee County Zoning Map
- G - Proof of Publication from The Herald-Advocate
- H - Figure D-1 Airport Location Map
- I - Revised Section E Landfill Permit Requirements
  - Revised Section G Landfill Construction Requirements
  - Revised Section H Hydrogeological Investigation Requirements
  - Revised Section I Geotechnical Investigation Requirements
  - Revised Section L Water Quality and Leachate Monitoring Requirements
  - Revised Section N Gas Management Systetocm Requirements
  - Revised Section O Landfill Final Closure Requirements
  - Figure O-1 Gas Probe Locations
- J - HELP Model Calculations and HELP Model Summary
- K - Summary Table of Groundwater Elevations
- L - Liner Buoyancy Calculations
  - Leachate Collection Sump Buoyancy Calculations
  - Leachate Collection and Detection Header Pipes Buoyancy Calculations
  - 8-inch Leachate Lateral Collection Trench Buoyancy Calculations
  - 10-inch Leachate Lateral Collection Trench Buoyancy Calculations
- M - Rainfall Data
- N - 8-Inch Leachate Collection Lateral Trench Capacity Calculations
  - 10-Inch Leachate Collection Lateral Trench Capacity Calculations
  - 12-Inch Leachate Collection Header Trench Capacity Calculations
  - 8-Inch Leachate Collection Lateral Trench Capacity Calculations South Portion Phase II Section II Expansion

# LIST OF ATTACHMENTS (CONT'D)

- Leachate Detection System Lateral Trench Capacity Calculations

- O - Rainfall Data Florida Jetclean Report *Hardee County Landfill 2012 LCS & GCS Pipe Maintenance Phase I LCS & Phase II LCS/GCS*

- P - Revised Section 5 of the CQA Plan
  - Revised Section 6 of the CQA Plan
  - Revised Specification Section 02077 - Geosynthetic Clay Liner
  - Revised Specification Section 02220 - Excavation, Backfill, Fill, and Grading
  - Revised Specification Section 02776 - High Density Polyethylene (HDPE) Geomembrane Liner
  - Revised Specification Section 02930 - Tri-Planar Geocomposite
  - Revised Specification Section 02931 - Bi-Planar Geocomposite
  - Specification Section 02940 - Geotextile
  - Specification Section 02941 - Geosynthetic Rain Tarp
  - Revised Specification Section 11200 - Leachate Collection and Detection Pumps

- Q - Revised Anchor Trench Calculations

- R - Revised Bi-Planar Transmissivity Calculations
  - Revised Tri-Planar Transmissivity Calculations
  - SKAPS Bi-Planar Transmissivity Calculations

- S - Revised Leachate Collection and Leachate Detection Pump Calculations

- T - Summary Table for the Below-Listed Collection and Detection Lateral and Header Pipes
  - Summary Table and 8-Inch Leachate Collection Lateral Pipe Crushing and Flow Capacity Calculations North and Center Portions
  - Summary Table and 8-Inch Leachate Collection Lateral Pipe Crushing and Flow Capacity Calculations South Portion
  - Summary Table and 10-Inch Leachate Collection Lateral Pipe Crushing and Flow Capacity Calculations North and Center Portions
  - Summary Table and 8-Inch Leachate Detection Header Pipe Crushing and Flow Capacity Calculations North and Center Portions
  - Summary Table and 12-Inch Leachate Collection Header Pipe Crushing and Flow Capacity Calculations North and Center Portions
  - Summary Table and 8-Inch Leachate Collection Lateral Pipe Crushing and Flow Capacity Calculations Phase II Section I
  - Phase I 8 Inch Perforated ADS Pipe

- U - Sinkhole Database Location and Figure

- V - Settlement Calculation for the Modified LCS Manholes For Phase I

# LIST OF ATTACHMENTS (CONT'D)

- W - Revised Slope Stability Summary Table
  - Slope Stability Analysis during Construction Phase II Section II Adjacent to Phase I Circular Analysis With and Without Equipment Loading
  - Slope Stability Analysis during Construction Phase II Section II Adjacent to Phase I Block-Type Analysis With and Without Equipment Loading
  - Slope Stability Analysis during Construction Phase II Section II Adjacent to Phase II Section I Circular Analysis With and Without Equipment Loading
  - Slope Stability Analysis during Construction Phase II Section II Adjacent to Phase II Section I Block-Type Analysis With and Without Equipment Loading
  - Slope Stability Analysis Phase II Section II Final Buildout Circular Analysis With and Without Equipment Loading
  - Slope Stability Analysis Phase II Section II Final Buildout Block-Type Analysis With and Without Equipment Loading
  - Slope Stability Analysis Phase II Section I East Sideslope Circular Analysis With and Without Equipment Loading
  - Slope Stability Analysis Phase II Section I East Sideslope Block-Type Analysis With and Without Equipment Loading

- X - Revised Financial Assurance

- Y - Revised Figure 1 Potable Wells Inventory and Table 1 SWFWMD Well Construction Permits

# Attachment A

## Revised Hardee County Landfill Phase II Section II Expansion Construction Drawings (Bound Separately)

# Attachment B

## Revised Page 7 and 39
## of Application Form #62-701.900(1)

☐ Air treatment sludge ☐ Industrial sludge
☑ Agricultural ☐ Domestic sludge
☑ Asbestos ☐ Other Describe:
Non-hazardous contaminated soil

9. Salvaging permitted: ☐ Yes ☑ No

10. Attendant: ☑ Yes ☐ No Trained operator: ☑ Yes ☐ No

11. Trained spotters: ☑ Yes ☐ No Number of spotters used: 2

12. Site located in: ☐ Floodplain ☐ Wetlands ☑ Other:
Upland

13. Days of operation: Monday through Saturday - 312 days/year

14. Hours of operation: 7:30 a.m. to 5:00 p.m.

15. Days Working Face covered: Daily for Class I, 312 days/year

16. Elevation of water table: 78.5 ft. Datum Used: NGVD1929

17. Number of monitoring wells: ~~8~~ 10

18. Number of surface monitoring points: 1

19. Gas controls used: ☑ Yes ☐ No Type controls: ☐ Active ☑ Passive

Gas flaring: ☐ Yes ☑ No Gas recovery: ☐ Yes ☑ No

20. Landfill unit liner type:
☑ Natural soils ☑ Double geomembrane
☑ Single clay liner ☑ Geomembrane & composite
☐ Single geomembrane ☐ Double composite
☐ Single composite ☐ None
☐ Slurry wall ☑ Other Describe:
Phase II Section I Expansion was constructed as a double geomembrane. Phase II Section II Expansion will be constructed as a double geomembrane.

**PART S. CERTIFICATION BY APPLICANT AND ENGINEER OR PUBLIC OFFICER**

1. Applicant:

The undersigned applicant or authorized representative of Hardee County Solid Waste Department is aware that statements made in this form and attached information are an application for a Construction Permit from the Florida Department of Environmental Protection and certifies that the information in this application is true, correct and complete to the best of his/her knowledge and belief. Further, the undersigned agrees to comply with the provisions of Chapter 403, Florida Statutes, and all rules and regulations of the Department. It is understood that the Permit is not transferable, and the Department will be notified prior to the sale or legal transfer of the permitted facility.

Teresa Carver

Signature of Applicant or Agent

685 Airport Road

Mailing Address

Teresa Carver, Solid Waste Director

Name and Title (please type)

Wauchula, Florida 33873

City, State, Zip Code

teresa.carver@hardeecounty.net

E-Mail address (if available)

(863 ) 773-5089

Telephone Number

Date: 4/1/13

Attach letter of authorization if agent is not a governmental official, owner, or corporate officer.

2. Professional Engineer registered in Florida (or Public Officer if authorized under Sections 403.707 and 403.7075, Florida Statutes):

This is to certify that the engineering features of this solid waste management facility have been designed/examined by me and found to conform to engineering principles applicable to such facilities. In my professional judgment, this facility, when properly maintained and operated, will comply with all applicable statutes of the State of Florida and rules of the Department. It is agreed that the undersigned will provide the applicant with a set of instructions of proper maintenance and operation of the facility.

Signature

4041 Park Oaks Boulevard , Suite 100

Mailing Address

Shane R. Fischer, PE

Name and Title (please type)

Tampa, Florida 33610

City, State, Zip Code

sfischer@scsengineers.com

E-Mail address (if available)

58026

Florida Registration Number
(please affix seal)

(813 )621-0080

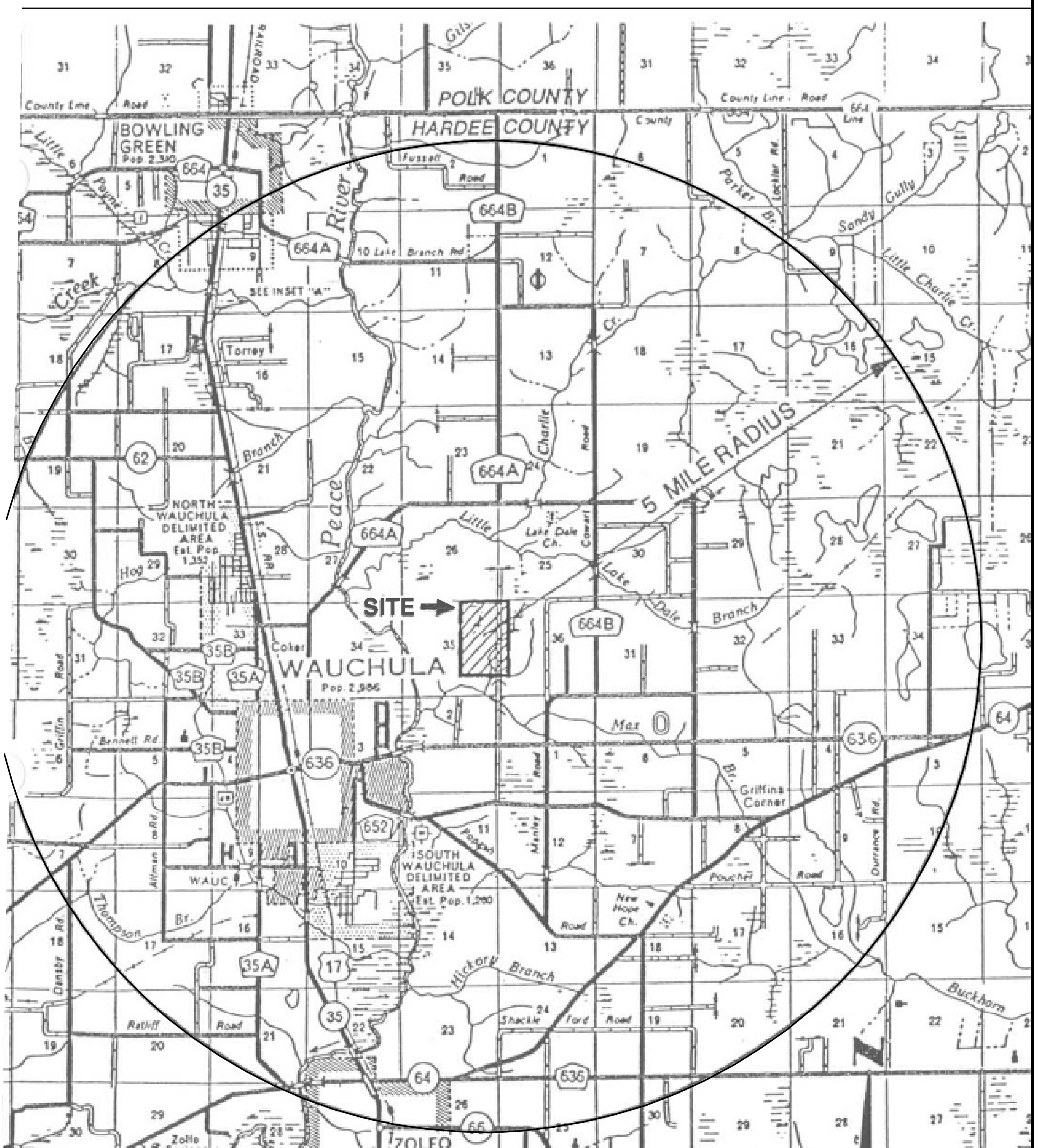
Telephone Number

Date: 4/1/13

# Attachment C

## Figure A-1 Regional Map

C:\Users\2483srf\Documents\Hardee\09199033.23\RAI No. 1\Attachment C – Figure A-1 Regional Map\093323FIGURE A-1.dwg Mar 04, 2013 – 12:54pm Layout Name: Fig A-1 By: 2483srf




SCS ENGINEERS

Figure A–1. Regional Map Hardee County Landfill, Hardee County, Florida.

# Attachment D

# Certification of County Millage By the Property Appraiser's Office

**HARDEE COUNTY**
**BOARD OF COUNTY COMMISSIONERS**
**OFFICE OF MANAGEMENT & BUDGET**
**412 WEST ORANGE STREET – ROOM 204**
**WAUCHULA, FLORIDA 33873**
**(863) 773-3199 * FAX (863) 773-9480**
**Web Page: www.hardeecounty.net**

February 19, 2013

Ms. Susan Pelz
Department of Environmental Protection
13051 North Telecom Parkway
Temple Terrace, Florida 33637

Dear Ms. Pelz:

Pursuant to Florida Statues, Chapter 218.075, Hardee County is eligible for permit fee reduction for the Phase II Section II Expansion construction permit application.

Hardee County is currently at 8.554 mills and Florida law states that millage greater than eight mills would justify a permit fee reduction to be granted on the basis of hardship. Hardee County certifies that the cost of the permit-processing fee is a fiscal hardship due to the fact the ad valorem operation millage is greater than eight mills.

Enclosed please find the certification of the county millage by the Hardee County Property Appraiser's Office.

Sincerely,

Janice Williamson
Director of Management & Budget

DR-403CC
R. 05/89

Hardee County COUNTY SHEET NO. 001

RECAPITULATION OF TAXES AS EXTENDED ON THE 2012 TAX ROLLS; COUNTY COMMISSION, SCHOOL BOARD, AND TAXING DISTRICTS

A.
1.County Commission Levy
2.School Board Levy
3.Independent Special District Levy
4.County Commission Levy for a Dependent Special District
5.MSBU/MSTU

B.
1.County-Wide Levy
2.Less than County-Wide Levy
3.Multi-County District Levying County-Wide
4.Multi-County District Levying Less than County-Wide

C.
1.Operating Millage
2.Debt Service Millage
3.Non-Ad Valorem Assessment Rate/Basis

D.
1.Millage Subject to a Cap
2.Millage Not Subject to a Cap
3.Non-Ad Valorem Assessment

E.
1.Non-Voted Millage
2.Voted Millage
3.Non-Ad Valorem Assessment

The Codes listed above are intended to describe the nature of the taxing authority and the type of millage. Enter the appropriate number in each of the five code columns. Be as descriptive as possible; separately list each taxing authority in your county according to the characteristics above. List all county commission millages first, then, all school district millages, all dependent special district millages, including municipal service taxing unit millages, and all independant special district millages, including water management district millages. Millages with like characteristics, i.e, voted or county-wide or less than county-wide should be listed together within the above categories. Total all taxes levied. All voter approved debt payments should be specified and listed with the appropriate taxing authority or special district. Round all amounts to the nearest whole dollar. List all non-ad valorem assessments that are included on the tax rolls.

| CODES A | B | C | D | E | NAME OF TAXING AUTHORITY AND NATURE OF SPECIAL LEVY, IF APPLICABLE | MILLAGE or other basis of levy | TOTAL TAXABLE VALUE | TAXABLE VALUE EXCLUDED FROM LEVY PURSUANT TO 197.212 F.S. | TOTAL TAXES LEVIED | PENALTIES UNDER 193.072 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 1 | 1 | 1 | COUNTY BCC | .00855400 | 1,534,084,899 | 0 | 13,122,562.08 | 13,126.47 |
| 3 | 1 | 1 | 1 | 1 | HEALTH | .00036010 | 1,542,869,349 | 0 | 555,585.04 | 552.65 |
| 2 | 1 | 1 | 1 | 1 | SCHOOL RLE (STATE) | .00540600 | 1,594,453,478 | 0 | 8,619,615.96 | 8,295.72 |
| 2 | 1 | 1 | 1 | 1 | SCHOOL-DIS | .00224800 | 1,594,453,478 | 0 | 3,584,331.65 | 3,449.61 |
| 3 | 3 | 1 | 1 | 1 | SWFWMD | .00039280 | 1,542,869,349 | 0 | 606,038.90 | 602.76 |
| | | | | | TOTAL DR403CC | | | | 26,488,133.63 | 26,027.21 |
| | | | | | TOTAL BROUGHT FORWARD FOR DR403BM | | | | 986,290.86 | 1,131.40 |
| | | | | | GRAND TOTALS | | | | 27,474,424.49 | 27,158.61 |

DR-403BM
R. 05/89

Hardee County COUNTY SHEET NO. 001

# RECAPITULATION OF TAXES AS EXTENDED ON THE 2012 TAX ROLLS; MUNICIPALITIES

A.
1.Municipal Levy
2.Municipality Levying for a Dependent Special District that is Municipal Wide
3.Municipality Levying for a Dependent Special District that is Less than Municipal Wide
4.Municipal Levy Less Than Municipal Wide
NOTICE: All independent special districts should be reported on DR-403 CC

B.
1.Operating Millage
2.Debt Service Millage
3.Non-Ad Valorem Assessment Rate/Basis

C.
1.Millage Subject to a Cap
2.Millage not Subject to a Cap
3.Non-Ad Valorem Assessment Rate/Basis

D.
1.Non-voted Millage
2.Voted Millage
3.Non-Ad Valorem Assessment Rate/Basis

The codes listed above are intended to describe the nature of the taxing authority and the type of millage. Enter the appropriate number in each of the four code columns. Be as descriptive as possible; separately list the various millages of each municipal taxing authority according to the characteristics coded above. Total the levies for all municipalities included herein. All dependent special districts and voter approved debt payments should be listed with the appropriate municipality. Round all amounts to the nearest whole dollar. List all non-ad valorem assessments included on the tax rolls.

| CODES A | B | C | D | NAME OF MUNICIPALITY OF DISTRICT, AND NATURE OF SPECIAL LEVY, IF APPLICABLE | MILLAGE or other basis of levy | TOTAL TAXABLE VALUE | TAXABLE VALUE EXCLUDED FROM LEVY PURSUANT TO 197.212 F.S. | TOTAL TAXES LEVIED | PENALTIES UNDER 193.072 |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 1 | 1 | BOWLING GR | .00725000 | 29,532,447 | 0 | 214,110.27 | 37.32 |
| 1 | 1 | 1 | 1 | WAUCHULA | .00564850 | 102,221,932 | 0 | 577,400.11 | 744.81 |
| 1 | 1 | 1 | 1 | ZOLFO SPRG | .00855400 | 22,770,697 | 0 | 194,780.48 | 349.27 |
| | | | | TOTALS | | | | 986,290.86 | 1,131.40 |

# Attachment E

## Signed and Sealed Aerial Topographic Survey Conducted by Pickett and Associates, Inc. (Pickett), Dated April 3, 2012 and Associated Signed and Sealed Survey Report

NOTE: THIS REPORT AND ACCOMPANYING MAP TITLED HARDEE COUNTY LANDFILL ARE NOT FULL AND COMPLETE WITHOUT THE OTHER AND ARE NOT VALID WITHOUT THE SIGNATURE AND ORIGINAL RAISED SEAL OF A FLORIDA LICENSED SURVEYOR AND MAPPER

***PICKETT & ASSOCIATES PROJECT NO.: 14198-10***
***TITLE/TYPE OF SURVEY: Topographic Survey***
***DATE OF SURVEY: This Map is based on aerial photography flown 4/03/12***
***SUBJECT: Hardee County Landfill***
***CLIENT: Hardee County***

**ACCURACY STATEMENT:** The following stated plus or minus tolerances encompass a minimum of 90% of the difference between photogrammetrically measured values and any ground truth of all well-identified features. Mapped features meet or exceed the Florida Minimum Technical Standards.

**VERTICAL:** Contours have been measured to an estimated vertical positional accuracy of 0.5'. Spot elevations and well-identified features have been measured to an estimated vertical positional accuracy of 0.25'.

**HORIZONTAL:** Well-identified features have been measured to an estimated horizontal positional accuracy of 1.66'.

**MAP PLOTTING:** This map is intended to be displayed at a scale of 1" = 50' (1:600) or smaller.

**DATUM:**

**HORIZONTAL:** Coordinates are referenced to the West Zone of the Florida State Plane Coordinate System, NAD 83/90. Pickett & Associates provided the horizontal coordinates.

**VERTICAL:** Elevations are to National Geodetic Vertical Datum of 1929. Pickett & Associates provided the vertical elevations.

**Control Points Used:**

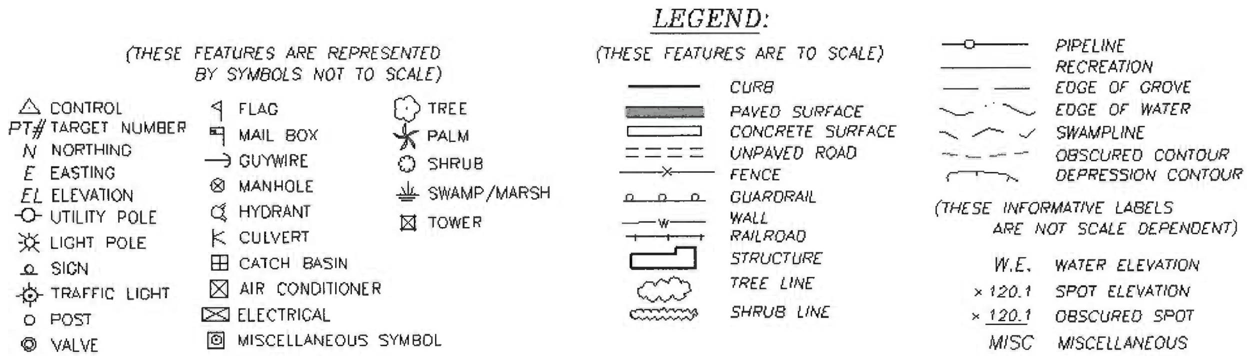
| Pt# | Easting | Northing | Elevation |
|---|---|---|---|
| 101 | 725944.18 | 1177595.96 | 85.05 |
| 102 | 728524.19 | 1177590.85 | 85.66 |
| 103 | 728588.65 | 1174942.96 | 79.09 |
| 104 | 725819.83 | 1174927.58 | 79.24 |
| 105 | 727169.07 | 1176229.17 | 83.18 |

Pickett & Associates, Inc.
475 South First Avenue
Bartow, Florida 33830

Business ~ 863.533.9095
Fax ~ 863.534.1464
email@pickett-inc.com

# PICKETT & ASSOCIATES, INC.

## Feature List




## Measurement Methods:

In areas where vegetation makes the ground difficult to determine contours are shown dashed and do not meet the above stated accuracy. Contours are removed from areas where vegetation completely hides the ground. This map is limited to those features visible on aerial photography. Aerial photography was acquired at a negative scale of 1:3960, scanned at a 15-micron resolution and mapped using softcopy photogrammetric techniques.

## Limitations:

This mapping should be used for preliminary design work only and should not replace an actual field survey where the required accuracy is greater than the accuracy stated in this report. No responsibility is assumed for areas outside the contracted scope.

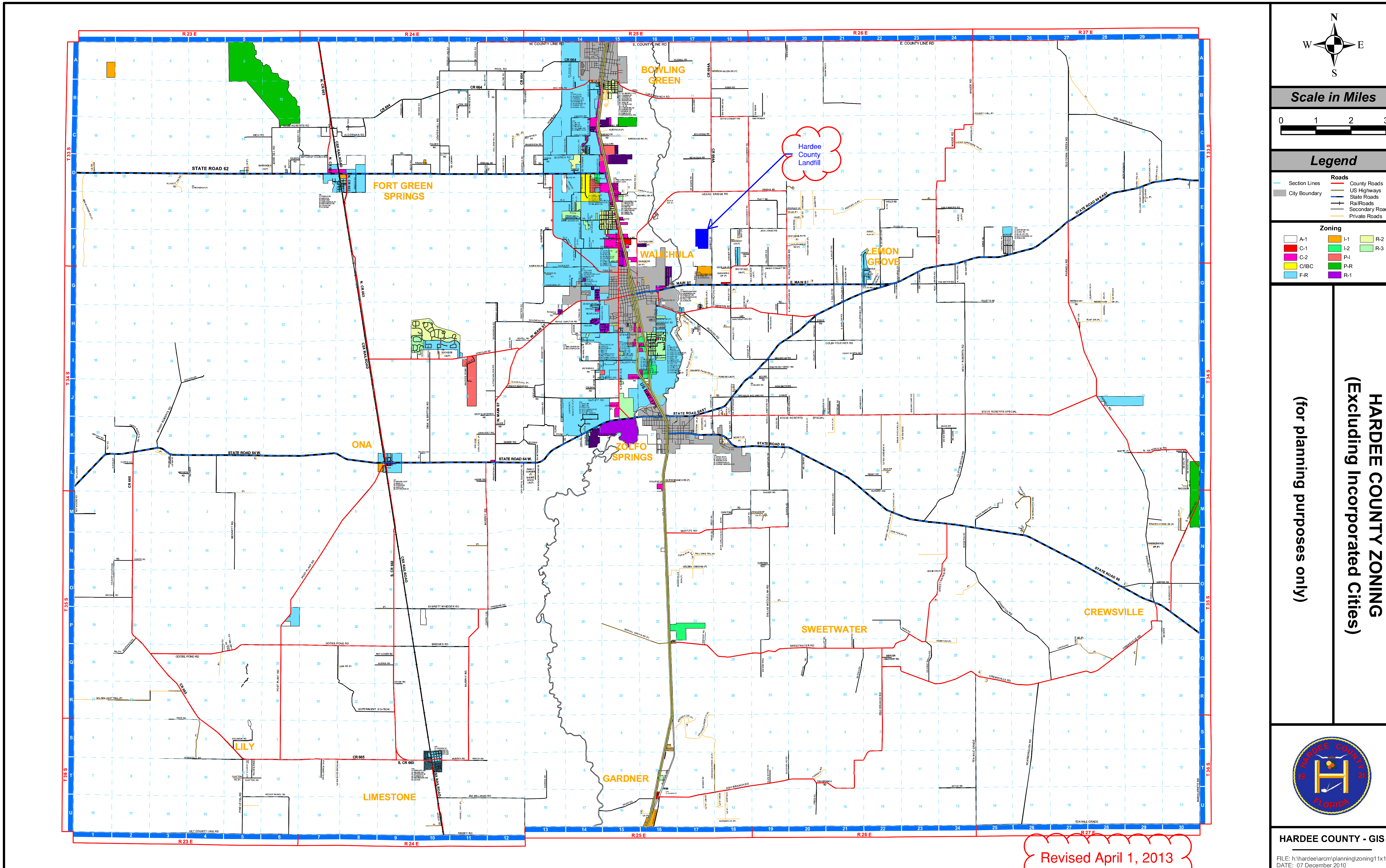
T. Jeffrey Young (signature) 4/3/12

T. JEFFREY YOUNG, PSM, CP
FLORIDA REGISTRATION NO. 5440
PICKETT AND ASSOCIATES, INC.
FLORIDA REGISTRATION NO. 364

SURVEY DATE

# Attachment F

# Revised Hardee County Zoning Map


HARDEE COUNTY ZONING
(Excluding Incorporated Cities)
(for planning purposes only)
Scale in Miles
0 1 2 3
Legend
Roads
Section Lines
City Boundary
County Roads
US Highways
State Roads
RailRoads
Secondary Roads
Private Roads
Zoning
A-1
C-1
C-2
C/IBC
F-R
I-1
I-2
P-I
P-R
R-1
R-2
R-3
N
S
E
W
Hardee County Landfill
BOWLING GREEN
FORT GREEN SPRINGS
WAUCHULA
LEMON GROVE
ONA
ZOLFO SPRINGS
SWEETWATER
CREWSVILLE
LILY
LIMESTONE
GARDNER
STATE ROAD 62
STATE ROAD 64 W.
STATE ROAD 64 EAST
STATE ROAD 66
R 23 E
R 24 E
R 25 E
R 26 E
R 27 E
T 33 S
T 34 S
T 35 S
T 36 S
Revised April 1, 2013
HARDEE COUNTY - GIS
FILE: h:\hardee\arcm\planning\zoning11x17
DATE: 07 December 2010

# Attachment G

## Proof of Publication from The Herald-Advocate

**AFFIDAVIT OF PUBLICATION**

# The Herald-Advocate

**Published Weekly at Wauchula, Florida**

)A,
DEE

ndersigned authority personally appeared Kim Reas
: is the Secretary of The Herald-Advocate, a
d at Wauchula, in Hardee County, Florida; that the attached copy of advertise-
Notice of Application
Environmental Protection - State of Florida
Court, was published in said newspaper in the issues
February 28, 2013

er says that the said Herald-Advocate is a newspaper published at Wauchula, in Florida, and that the said newspaper has heretofore been continuously published ity, Florida, each week and has been entered as second class mail matter at the ula, in said Hardee County, Florida, for a period of one year next preceding the ached copy of advertisement; and affiant further says that he has neither paid nor , firm or corporation any discount, rebate, commission or refund for the purpose rtisement for publication in the said newspaper.

[signature]

subscribed before me this 28th day of February

Nancy P. Davis
Notary Public

ires May 26, 20 16.

NANCY P. DAVIS
Notary Public - State of Florida
My Comm. Expires May 26, 2016
Commission # EE 201632
Bonded Through National Notary Assn.

## State of Florida Department of Environmental Protection Notice of Application

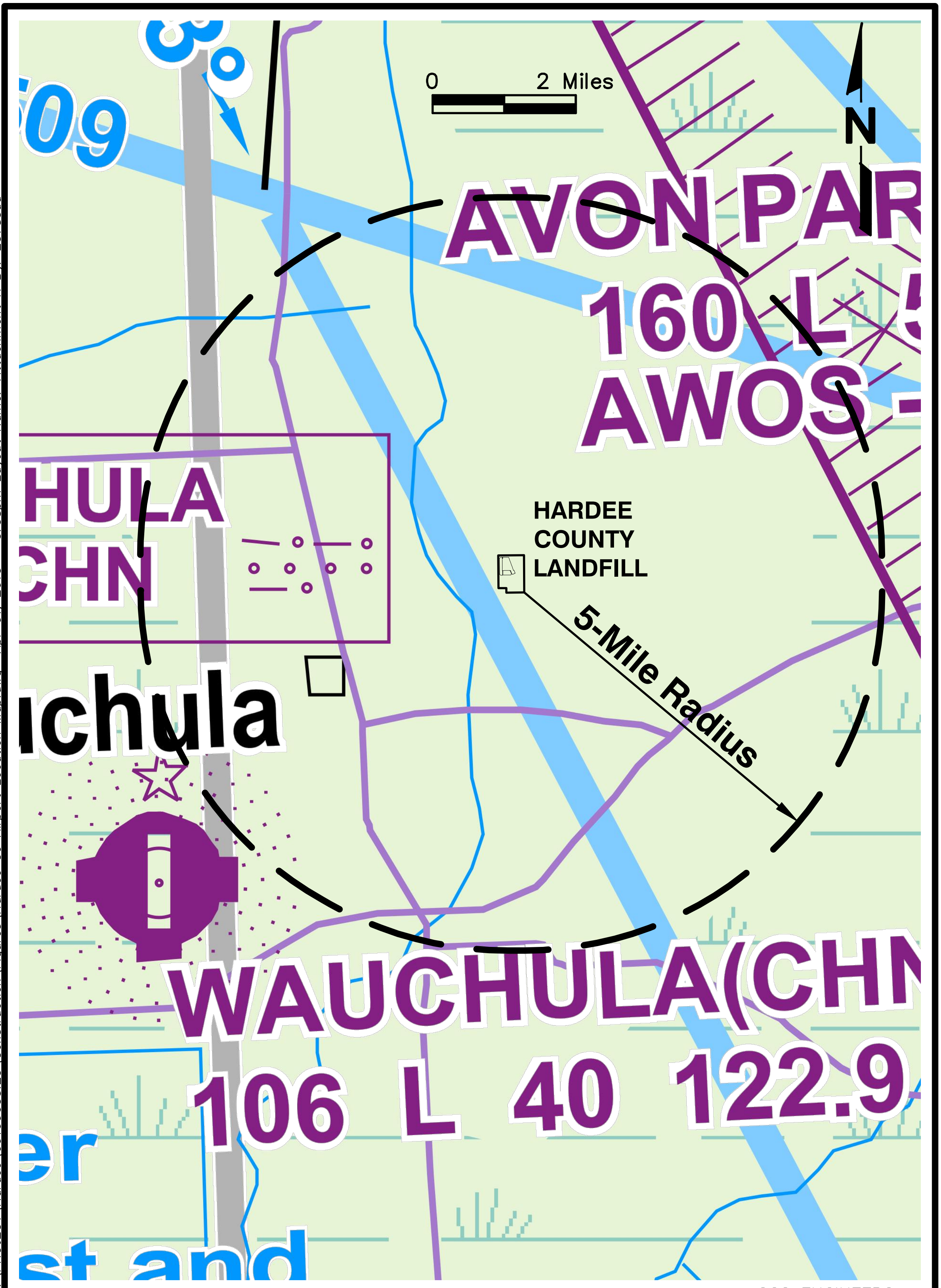
The Department announces receipt of an application for permit from the Hardee County Solid Waste Department for a permit to construct the Phase II Section II expansion of the existing Class I landfill, subject to Department rules, at the Hardee County Regional Landfill located at 685 Airport Road, Wauchula, Hardee County, Florida.

This application is being processed and is available for public inspection during normal business hours, 8:00 a.m. to 5:00 p.m., Monday through Friday, except legal holidays, at the Department of Environmental Protection, Southwest District Office, 13051 North Telecom Parkway, Temple Terrace, Florida 33637-0926.

2:28c

# Attachment H

# Figure D-1 Airport Location Map




G:\PROJECT\Hardee\09199033.23\Construction\Figures\Hardee Co Airport Location Map.dwg Apr 01, 2013 - 3:38pm Layout Name: Attachment H By: 2378sda

Figure D–1. Airport Location Map, Hardee County Landfill, Hardee County, Florida.

# Attachment I

- Revised Section E Landfill Permit Requirements
- Revised Section G Landfill Construction Requirements
- Revised Section H Hydrogeological Investigation Requirements
- Section I Geotechnical Investigation Requirements
- Revised Section L Water Quality and Leachate Monitoring Requirements
- Revised Section N Gas Management System Requirements
- Revised Section O Landfill Final Closure Requirements
- Figure O-1 Gas Probe Locations

# Revised Section E
# Landfill Permit Requirements

# SECTION E

# LANDFILL PERMIT REQUIREMENTS

## E.1 REGIONAL MAP

Per Rule 62-701.330(3)(a), FAC a regional map or aerial photograph no more than 5 years old showing all airports that are located within five miles of the proposed Phase II Section II Expansion is provided in Attachment D-2. Figure D-1 Airport Vicinity Map provided in Attachment D-2 shows the airports within five miles of the Hardee County Landfill. Based on project files and the County's knowledge of the area, there are no licensed and operating airport runways within a five-mile radius of the Hardee County Landfill. In order to confirm this, the Florida Department of Transportation (FDOT) Aviation Office database was searched for public, private and military airports and landing facilities in the vicinity of the landfill. Based on the research, the Wauchula Municipal Airport was determined to be the nearest operating airport to the Hardee County Landfill located at approximately latitude 27.5149056 longitude -81.8804625.

An aerial photograph with a one mile radius around the Hardee County Landfill was obtained from the FDEP Land Boundary Information system (www.LABINS.org) January 2011 and is included on Sheet 3 of the Phase II Section II Expansion construction permit application drawings located in Attachment E-2. In addition, an aerial photograph conducted by Pickett, dated April 3, 2012, is included on Sheet 4 of the Phase II Section II Expansion construction permit application drawings located in Attachment E-2. The aerial photographs on Sheet 3 and Sheet 4 identify the facility site and land use, significant structures, water bodies, roads, and zoning within one mile of the facility as required per Rule 62-701.330(3)(a), FAC.

The proposed Phase II Section II Expansion is approximately 1.6 miles from any permanent residential dwelling or commercial business. The Hardee County Landfill is zoned as Agriculture (A-1) and the land use is designated as Public Institutional. Within approximately a 1-mile radius of the landfill, the metal recycling facility located on Airport Road is zoned "Industrial 1" and the former Wauchula Airport and landfill located at the intersection of Airport Road and SR 636 is zoned "City." Within a 1-mile radius of the landfill, the land use of all surrounding properties is designated as "Agricultural" with the exception of the former Wauchula Airport and landfill that is designated as "City" land use. The Zoning and Land Use Maps obtained from Hardee County for the areas surrounding the landfill are contained in Attachment E-3.

## E.2 PLOT PLANS

Per Rule 62-701.330(3)(b), FAC plot plans with a scale not greater than 200 feet to the inch showing the required information are located in Attachment E-2. This includes drawings that show the proposed dimensions, locations of proposed and existing water quality monitoring wells, locations of soil borings, proposed plan of trenching or disposal areas, cross sections showing original elevations and proposed final contours, previously filled waste disposal areas, proposed Phase II Section II Expansion area, cross sections and proposed final contours, fencing, and other details necessary to support the Phase II Section II Expansion construction permit application.

### E.2.a Dimensions

Per Rule 62-701.330(3)(b), FAC plot plans with a scale not greater than 200 feet to the inch showing the dimensions as required for the Phase II Section II Expansion construction permit application drawings are located in Attachment E-2.

### E.2.b Locations of Proposed and Existing Water Quality Monitoring Wells

Per Rule 62-701.330(3)(b), FAC plot plans with a scale not greater than 200 feet to the inch showing the locations of proposed and existing water quality monitoring wells as required for the Phase II Section II Expansion construction permit application drawings are located in Attachment E-2. In addition, a summary table of the existing groundwater monitoring wells, piezometers and LFG monitoring probes and the proposed groundwater monitoring wells and LFG monitoring probes as discussed below is included on Sheet 4 of the Phase II Section II Expansion construction permit application drawings located in Attachment E-2.

During construction of the Phase II Section I Landfill Expansion per FDEP Construction Permit Number 38414-008-SC/01 monitoring wells MW-10R, MW-11 and MW-12R and piezometers P-17, P-18, P-19, P-20, P-21, P-22 and P-23 were installed and monitoring well MW-9 was abandoned. Copies of the well completion reports, boring logs, well construction and development logs and as-built detail drawings for the installation of the monitoring wells and piezometers were previously provided to the Department with the *Certification of Construction Completion Report Phase II Section I Landfill Expansion*, dated June 4, 2007, prepared by SCS.

Piezometers designated as P-1, P-2 and P-15 were abandoned (by grouting from the top to bottom until surface returns were noted) by Huss Drilling, Inc on November 1, 2010 during construction of the Phase I closure project per FDEP Construction Permit Number 38414-008-SC/01. Documentation of proper abandonment of these piezometers was provided to the Department in the *Certification of Construction Completion Report Phase I Closure*, dated June 1, 2011, prepared by SCS.

The proposed Phase II Section II Expansion will require three existing groundwater monitoring wells (MW-3, MW-5, and MW-8) to be abandoned. The locations of the groundwater monitoring wells to be abandoned are provided on Sheet 4 of the construction permit application drawings located in Attachment E-2.

The proposed Phase II Section II Expansion will require the installation of ~~three~~ two groundwater monitoring wells identified as MW-13~~,~~ and MW-14~~, and MW-15~~. These detection monitoring wells will be located approximately 50 feet from the edge of Phase II Section II Expansion. The locations of the ~~three~~ two groundwater monitoring wells to be installed are provided on Sheet 4 of the construction permit application drawings located in Attachment E-2.

As a note, the proposed Phase II Section II Expansion will require four existing LFG monitoring probes identified as GP-3, GP-4, GP-5, and GP-6 to be abandoned. The locations of the LFG monitoring probes to be abandoned are provided on Sheet 4 of the construction permit application drawings located in Attachment E-2. After abandonment, these LFG monitoring probes will be replaced with the installation of six LFG monitoring probes identified as GP-3R, GP-4R, GP-5R, GP-6R, GP-7R and GP-8R. The locations of the LFG monitoring probes to be installed are provided on Sheet 4 of the construction permit application drawings located in Attachment E-2.

The locations of the existing and proposed groundwater monitoring wells and piezometers (as well as all of the facility previously existing and abandoned groundwater monitoring wells and piezometers) were previously included on Figure M-1 Groundwater, Surface Water and Leachate Monitoring Location Points previously provided to the Department on January 18, 2011 which was updated from the March 10, 2008 submittal for the Hardee County Landfill Expansion construction permit application for the Phase II Section I Landfill Expansion.

The locations of the existing and proposed groundwater monitoring wells to be abandoned or installed as part of the Phase II Section II Expansion were previously included on Figure M-2 Groundwater Monitoring Plan Sampling Locations Map previously provided to the Department with the *Ground Water Monitoring Plan*, dated March 10, 2008, by SCS with the Hardee County Landfill Expansion construction permit application for the Phase II Section I Landfill Expansion.

The locations of the existing and proposed LFG monitoring probes (as well as all of the facility previously existing and abandoned LFG monitoring probes) to be abandoned or installed as part of the Phase II Section II Expansion are~~were previously provided to the Department~~ provided on Figure N~~O~~-1 Gas Probe Locations.

## E.2.c Locations of Soil Borings

Per Rule 62-701.330(3)(b), FAC plot plans with a scale not greater than 200 feet to the inch showing the locations of soil borings as required for the Phase II Section II Expansion construction permit application drawings are located in Attachment E-2. Several previous geotechnical investigations of the site have been performed and the boring locations and soil strata information was previously provided to the Department. SCS previously prepared a site specific geotechnical subsurface investigation for the areas currently designated Phase II Section I and the proposed Phase II Section II Expansion of the Hardee County Landfill. The locations of the soil borings identified on the Phase II Section II Expansion construction permit application drawings were obtained from:

- *Geotechnical Engineering Services Report for the Proposed Landfill Expansion Hardee County Florida*, September 25, 2003, prepared by Professional Services Industries, Inc. (PSI). The PSI investigation was performed for the new (at the time) *Hardee County Landfill Expansion Construction Permit Application*, dated April 2004, prepared by SCS which originally included the Phase II Section I and Phase II Section II areas design at that time. Copies of this report are included in Attachment I-1 of this construction permit application.

### E.2.d Proposed Plan of Trenching or Disposal Areas

Per Rule 62-701.330(3)(b), FAC plot plans with a scale not greater than 200 feet to the inch showing the locations of proposed plan of trenching or disposal areas as required for the Phase II Section II Expansion are provided on the construction permit application drawings located in Attachment E-2.

In accordance with the Operations Plans, a portion of the proposed Phase II Section II Expansion will "piggy-back" along the western sideslope of the existing closed Phase I area in the future. The closure of Phase I was previously completed by the County under Construction Permit No. 38414-012-SF/01. The County received FDEP approval of the Phase I closure construction on January 3, 2012. The Phase I liner system along the western sideslope was designed, permitted and constructed according to Rule 62-701.430(1)(c), FAC to be the bottom liner system when the Phase II Section II Expansion does "piggy-back."

This construction permit application for the Phase II Section II Expansion also includes a request for a height increase for the Phase II Section I area permitted to operate under Permit No. 38414-011-SO-01. The Phase II Section I area and "piggy-back" portion onto the south sideslope of the existing closed Phase I area is currently permitted for filling to a peak of roughly EL 132.1 feet National Geodetic Vertical Datum (NGVD) top of intermediate cover (approximately EL 134.1 feet NGVD top of final closure). With the Phase II Section II Expansion, the height increase will raise the peak to roughly EL 166 feet NGVD top of final closure within the Phase II Section I area with an overall final buildout of the Phase II Section II Expansion to EL 173.2 feet NGVD top of final closure. The request for the height increase will provide sufficient time for the County to continue filling within the area while the Phase II Section II Expansion area is permitted, advertised for bid, constructed, and approval from the Department is received to begin filling within the Phase II Section II Expansion area.

### E.2.e Cross Sections Showing Original Elevations and Proposed Final Contours

Per Rule 62-701.330(3)(b), FAC plot plans with a scale not greater than 200 feet to the inch with cross sections showing original elevations and proposed final contours as required for the Phase II Section II Expansion and the Phase II Section I height increase are provided on the construction permit application drawings located in Attachment E-2.

### E.2.f Previously Filled Waste Disposal Areas

Per Rule 62-701.330(3)(b), FAC plot plans with a scale not greater than 200 feet to the inch showing the Phase II Section II Expansion, the active Phase II Section I Expansion area and the closed Phase I area (previously filled and current waste disposal areas) as required for the Phase II Section II Expansion are provided on the construction permit application drawings located in Attachment E-2.

### E.2.g Fencing or Other Measures to Restrict Access

Per Rule 62-701.330(3)(b), FAC plot plans with a scale not greater than 200 feet to the inch showing fencing to restrict the Hardee County Landfill facility access as required for the Phase II Section II Expansion construction permit application drawings are located in Attachment E-2.

## E.3 TOPOGRAPHIC MAPS

The topographic maps and drawings required by Rule 62-701.330(3)(c), FAC are included on Sheet 5 and Sheet 6 of the construction permit application drawings located in Attachment E-2. This includes drawings that show the existing fill areas, access roads, grades required for proper drainage, cross sections, drainage structures, fencing, and other details necessary to support this construction permit application.

### E.3.a Proposed Fill Areas

The existing conditions topography shown on the Phase II Section II Expansion construction permit application drawings are based on an aerial topographic survey conducted by Pickett and Associates, Inc. (Pickett), dated April 3, 2012. The existing conditions aerial topographic survey conducted by Pickett of the Hardee County Landfill is included on Sheet 5 and Sheet 6 of the construction permit application drawings located in Attachment E-2. In addition, a signed and sealed survey report for the Pickett topographic survey is located in Attachment E-1.

Access roads leading to the Phase II Section II Expansion disposal area are shown on the construction permit application drawings. The grades required for proper drainage of the surface water management system will be constructed during the sequencing of the landfill.

### E.3.b Borrow Areas

There are no active borrow areas at the Hardee County Landfill.

### E.3.c Access Roads

Access roads for the Phase II Section II Expansion areas are shown on the construction permit application drawings located in Attachment E-2.

### E.3.d Grades Required for Proper Drainage

Stormwater management area improvements are shown on the Phase II Section II Expansion construction permit application drawings located in Attachment E-2.

### E.3.e Cross-sections of Lifts

Cross sections of the lifts are shown on the Phase II Section II Expansion construction permit application drawings located in Attachment E-2.

### E.3.f Drainage Devices

Drainage devices are shown on the Phase II Section II Expansion construction permit application drawings located in Attachment E-2.

### E.3.g Fencing

Fencing is shown on the Phase II Section II Expansion construction permit application drawings located in Attachment E-2.

### E.3.h Equipment Facilities

Site equipment facilities are shown on the Phase II Section II Expansion construction permit application drawings located in Attachment E-2.

## E.4 REPORT

### E.4.a Current and Projected Population and Area to be Served

Per Rule 62-701.330(3)(d), FAC current and future population estimates for Hardee County were obtained from the Florida Legislative Office of Economic and Demographic Research (FLOEDR) to estimate the waste quantity disposal rate per capita. Projections were made by FLOEDR to estimate the future population of Hardee County from 2012 through 2030; SCS used the rate of population as constant from 2030 to 2037. Please refer to Attachment E-4 for the planned active life calculations. Included in the site life calculations are the historical and projected population to be served in the future by the Phase II Section II Expansion.

Mandatory collection for the municipalities and rural areas, the Hardee County Landfill service area, was instated for all of Hardee County in 2002. To estimate the landfill capacity remaining, the service area (only Hardee County) was assumed to remain constant throughout the period from 2012 through 2037.

### E.4.b Waste Type, Quantity, and Source

The Hardee County Landfill facility accepts municipal solid wastes (MSW), construction & demolition (C&D) debris, yard waste, and special wastes. Currently, only MSW and C&D debris are disposed of in the Phase II Section I Class I landfill area and will be disposed in the Phase II Section II Landfill Expansion. MSW includes residential wastes, commercial wastes, and agricultural wastes.

Special wastes accepted by the facility include used oil (from residents only), waste tires, white goods, household hazardous wastes, lead-acid batteries, scrap metal, lawn mowers, appliances other than white goods, and electronics. Waste tires are processed and stored on site until a recycling contractor hauls the tires offsite. Yard waste is processed onsite and used for erosion control or distributed to residents. The facility does not accept or dispose of hazardous waste in the Phase II Section I Landfill Expansion nor will it be disposed in the Phase II Section II Landfill Expansion. The facility does not accept biomedical waste with the exception of the collection and offsite disposal of medical sharps. These waste types will continue to be received.

The site life calculations contained in Attachment E-4 show the population and waste generation for the years 2002 through July 2012 obtained from the waste quantities reported by the Hardee

County Solid Waste Department. The 2002 through July 2012 quantities represent the tonnage received since mandatory collection was instated; therefore, the average of 2002 through July 2012 of 0.739 tons per year per capita was used as the representative annual waste tonnage per capita for future disposal estimates, which is representative of current County collection policies. Also, as noted in the calculations, the time period from April 2011 through March 2012 the tons per year per capita was calculated to be reduced to 0.591.

This estimated disposal rate was assumed to remain constant for future filling projections for the Phase II Section I Landfill height increase and the Phase II Section II Expansion. Adjustments for total waste disposed at the landfill were accounted for by variations in population growth for Hardee County (estimated by FLOEDR).

### E.4.c Anticipated Facility Life

For estimating the remaining disposal capacity and life of site the final buildout of EL 173.2 feet NGVD top of final closure was compared to the aerial topographic survey conducted by Pickett and Associates, Inc. (Pickett), dated April 3, 2012, to determine the available airspace. The gross available airspace remaining in the Phase II Section I disposal area to the current permitted EL 132.1 feet NGVD top of intermediate cover was determined to be approximately 84,385 cubic yards (CY) as of the April 3, 2012 topographic survey. The gross available airspace for the Phase II Section II disposal area (less the Phase II Section I disposal area) was determined to be approximately 884,021 CY.

SCS estimated that 5 percent of that airspace would be used for cover material, leaving approximately 80,165 CY of airspace available for waste disposal in the Phase II Section I area and 839,820 CY in the Phase II Section II Expansion area as of the April 3, 2012 topographic survey. SCS used an estimated in-place density for the waste material of approximately 41 pounds per cubic foot (pcf) or approximately 1,100 pounds per CY. The site life calculations identify the available and consumed airspace for the Phase II Section I and Phase II Section II Expansion areas on a yearly basis. The consumed airspace was estimated by converting the annual waste disposal quantity into pounds per year and dividing by the estimated in-place waste density. As shown in the site life calculations, the landfill will use the available airspace within the Phase II Section I disposal area by approximately July 2014 and the Phase II Section II Expansion area by February 2037.

### E.4.d Source and Type of Cover Material

Cover material soils are obtained from either an on-site borrow source or from an off-site County borrow pit. Daily and intermediate cover soil should be well draining sandy soils, typical USCS soils are SW, SP, and SP-SM soil types. Slightly clayey (SC) and low plasticity clays (CL) are only recommended for use as intermediate cover on the outside slopes.

## E.5 APPROVED LABORATORY

Per Rule 62-701.330(3)(g), FAC water quality monitoring will be performed by an approved laboratory in accordance with Rule 62-160, FAC. All water quality sampling and testing shall be conducted in accordance with the Department's Standard Operating Procedures and all sample analyses will be conducted by a firm that is certified by the Florida Department of Health's Environmental Laboratory Certification Program. Currently all sampling for the Hardee County Landfill is conducted by Atkins, (formerly Post, Buckley, Schuh & Jernigan, Inc. (PBS&J)). The laboratory used is certified by the Florida Department of Health's Environmental Laboratory Certification Program. The laboratory is authorized under FDEP CompQAP #880516.

## E.6 FINANCIAL RESPONSIBILITY

Financial responsibility requirements are discussed in Section R of this application in accordance with Rule 62-701.330(3)(h).

# Revised Section G
# Landfill Construction Requirements

# SECTION G

# LANDFILL CONSTRUCTION REQUIREMENTS

## G.1 FILL SEQUENCE PLAN

### G.1.a General

The Operation Permit for the Hardee County Landfill has an expiration date of May 12, 2013. Immediately following the submission of the Phase II Section II Expansion construction permit application the Operation Permit renewal application process will be initiated (well in advance of operation of the Phase II Section II Expansion area). The Operation Permit renewal application will include a request for a modification to the landfill's Operation Permit to include the Phase II Section II Expansion after approval of the Certification of Construction Completion documents by the Department following construction of the Expansion. The Operation Permit renewal application will include the operational fill sequence plans to show a detailed plan for the filling of the Phase II Section II area and the Phase II Section I height increase.

This construction permit application for the Phase II Section II Expansion also includes a request for a height increase for the Phase II Section I area permitted to operate under Permit No. 38414-011-SO-01. The Phase II Section I area and "piggy-back" portion onto the south sideslope of the existing closed Phase I area is currently permitted for filling to a peak of roughly EL 132.1 feet National Geodetic Vertical Datum (NGVD) top of intermediate cover (approximately EL 134.1 feet NGVD top of final closure). With the Phase II Section II Expansion, the height increase will raise the peak to roughly EL 166 feet NGVD top of final closure within the Phase II Section I area with an overall final buildout of the Phase II Section II Expansion to EL 173.2 feet NGVD top of final closure. The request for the height increase will provide sufficient time for the County to continue filling within the area while the Phase II Section II Expansion area is permitted, advertised for bid, constructed, and approval from the Department is received to begin filling within the Phase II Section II Expansion area.

#### G.1.a.1 Phase II Section I Vertical Expansion Filling

The Phase II Section I area will continuing filling in the western portion of the "valley" between the Phase I and Phase II Section I areas to approximately EL 125 feet NGVD. Filling will progress from south to north and west to east. This has been identified as Fill Sequence No. 1 on the construction permit application drawings located in Attachment E-2.

Following, the eastern portion of the "valley" between the Phase I and Phase II Section I areas will be filled while raising the entire Phase II Section I area to a peak of approximately EL 130.6 feet NGVD (132.1 feet NGVD top of intermediate cover). Filling will progress from west to east in the "valley" portion and south to north over the top. This has been identified as Fill Sequence No. 2 on the construction permit application drawings located in Attachment E-2.

Fill Sequences 1 and 2 will bring the Phase II Section I area to the current permitted elevation of EL 130.6 feet NGVD (132.1 feet NGVD top of intermediate cover). By the end of Fill Sequence

No. 2, the Operation Permit renewal application (submitted under a separate cover) should be approved by FDEP. Approval of the Operation Permit will allow the Phase II Section I area to be raised vertically higher and operate to the proposed elevations (i.e. fill above the current permit height).

Following approval of the Operation Permit renewal application, the Phase II Section I area will be raised to approximately EL 166 feet NGVD. Filling will progress from north to south and west to east. This has been identified as Fill Sequence No. 3 on the construction permit application drawings located in Attachment E-2. The filling of Phase II Section I in this manner shall provide sufficient time to allow the construction, creation/submittal of the Certification of Construction Completion Report for the Department and approval by the Department for waste filling in the Phase II Section II Expansion.

The Phase II Section II Expansion area consists of the northern portion, approximately 2.33 acres, the center portion approximately 2.22 acres, and the southern portion approximately 1.63 acres. Waste filling of the Phase II Section II Expansion areas will be generally conducted as follows.

### G.1.a.2 Phase II Section II Expansion Southern Portion Filling

Generally, the filling of the Phase II Section II Expansion area will begin in the southern portion of the disposal area adjacent to the western side of the existing Phase II Section I disposal area. This has been identified as Fill Sequence No. 4 on the construction permit application drawings located in Attachment E-2. The filling will proceed by placing waste along the southern end of this portion and proceeding north and from west to east in theeis area.

An initial lift of select loose municipal solid waste, a minimum of four feet in thickness, will be placed over the protective sand layer. The select waste will be spread out and inspected for large rigid objects that may puncture the liner system when compacted. This waste thickness will bring the southern portion disposal area slightly below the proposed western and southern perimeter road and the interior separation berm along the north side of the area (which separates it from the Phase II Section II Expansion center portion). After the layer of select waste has been placed, additional waste will be placed in order to make Tthe first lift (approximately 10 feet) thick across the entire Phase II Section II Expansion within this area. will bring the disposal area slightly below the proposed perimeter road, The with a limits of waste (as shown on the construction permit application drawings located in Attachment E-2) and surface of the waste layer will be placed so it is sloped back "into" the landfill cell. Also, the limits of waste along the northern portion of this area will be placed approximately 10 feet to the south of the interior separation berm along the north side of the area to ensure waste/leachate runoff does not enter the Phase II Section II Expansion center portion.

In addition, a perimeter berm will be placed around the exterior of the placed waste (southern and western sides) to ensure no runoff of stormwater from the waste will occur outside of the lined cell area. Successive waste layers will be added in this southern portion in 10-foot lifts working from south to north and west to east. Each layer will be placed across the cell bottom and against the existing western sideslope of the Phase II Section I disposal area. Once the Phase II Section

II Expansion southern portion has reached a vertical elevation of approximately EL113.5 feet NGVD top of waste (approximately 25 feet of waste in the deepest section), filling within the portion will be temporarily stopped. Please refer to the construction permit application drawings located in Attachment E-2 for a plan view and section views of Fill Sequence No. 4 within the Phase II Section II Expansion southern portion.

### G.1.a.3 Phase II Section II Expansion Center Portion Filling

Filling will then begin in the center portion of the Phase II Section II Expansion area working from north to south. This has been identified as Fill Sequence No. 5 on the construction permit application drawings located in Attachment E-2. An initial lift of select loose municipal solid waste, a minimum of four feet in thickness, will be placed over the protective sand layer. The select waste will be spread out and inspected for large rigid objects that may puncture the liner system when compacted. After the layer of select waste has been placed, additional waste will be placed in order to make Tthe first lift (approximately 10 feet) thick across the entire Phase II Section II Expansion within this area. This waste thickness will bring the center portion disposal area slightly below the proposed western perimeter road and the interior separation berm along the south side of the area (which separates it from the Phase II Section II Expansion southern portion)., The with a limits of waste (as shown on the construction permit application drawings located in Attachment E-2) and surface of the waste layer will be placed so it is sloped back "into" the landfill cell.

Also, the limits of waste along the northern portion of this area will be placed approximately 50 feet to the south of the east/west main LCS header trench which has been elevated with drainage sand to create an interior separation berm. This interior separation berm will separate the Phase II Section II Expansion center portion from the northern portion to ensure waste/leachate runoff does not enter the Phase II Section II Expansion northern portion (when filling the center portion) which is covered with a rain tarp. In addition, a perimeter berm will be placed around along the exterior of the placed waste (western side) to ensure no runoff of stormwater from the waste will occur outside of the lined cell area.

After the initial 10-foot lift according to the above-mentioned methods, successive waste layers will be added in this center portion in 10-foot lifts. Filling will proceed from north to south and east to west. Each layer will be placed across the cell bottom and against the existing western sideslope of the Phase I disposal area. In addition, while filling from north to south, waste will also be placed against the north sideslope of the Phase II Section II Expansion south portion previously filled in Fill Sequence No. 4. Eventually, waste filling will reach an elevation that waste will also be placed on the western and top portion of the Phase II Section I area previously filled in Fill Sequence No. 3. Filling in this manner will meet the peak elevation obtained in Fill Sequence No. 3 of approximately EL 166 feet NGVD.

Prior to placing waste against the Phase I sideslope, the procedures outlined below in "Waste Placement Against Phase I Sideslope" will be followed by the County. Once Fill Sequence No. 5 has been completed, filling within the portion will be temporarily stopped. Please refer to the construction permit application drawings located in Attachment E-2 for plan views and section views of the proposed fill sequencing within the Phase II Section II Expansion center portion.

Filling will continue within this area until the entire center portion is raised to the required elevation.

#### G.1.a.4 Phase II Section II Expansion Northern Portion Filling

Filling will then begin in the northern portion of the Phase II Section II Expansion working from south to north after removal of the rain tarp within this area. This has been identified as Fill Sequence No. 6. An initial lift of select loose municipal solid waste, a minimum of four feet in thickness, will be placed over the protective sand layer. This will also include the 50 foot offset created during Fill Sequence No. 5 between the north and center portions of the Phase II Section II Expansion. The select waste will be spread out and inspected for large rigid objects that may puncture the liner system when compacted. After the layer of select waste has been placed, additional waste will be placed in order to make Tthe first lift (approximately 10 feet) thick across the entire Phase II Section II Expansion within this area. This waste thickness will bring the northern portion (and the 50 foot offset area) disposal area below the proposed western and northern perimeter road. The, with a limits of waste (as shown on the construction permit application drawings located in Attachment E-2) and surface of the waste layer will be placed so it is sloped back "into" the landfill cell. In addition, a perimeter berm will be placed aroundalong the exterior of the placed waste (western and northern sides) to ensure no runoff of stormwater from the waste will occur outside of the lined cell area.

After the initial 10-foot lift according to the above-mentioned methods, successive waste layers will be added in this northern portion in 10-foot lifts. Filling will proceed from south to north and east to west. Each layer will be placed across the cell bottom and against the existing western sideslope of the Phase I disposal area. In addition, while filling from south to north, waste will also be placed against the north sideslope of the Phase II Section II Expansion center portion previously filled in Fill Sequence No. 5. Prior to placing waste against the Phase I sideslope, the procedures outlined below in "Waste Placement Against Phase I Sideslope" will be followed by the County. Filling will continue within this area until the entire northern portion of the Phase II Section II Expansion area is raised to the required elevation.

#### G.1.a.5 Waste Placement Against Phase I Sideslope

Prior to placement of waste against the western sideslope of the Phase I disposal area (as indicated above during filling of the center and northern portions of the Phase II Section II Expansion), the County will remove only as much of the rain tarp (installed over the existing sod during construction of the Phase II Section II Expansion) and existing sod within an area of the sideslope where waste will be placed as needed. Rain tarp and Ssod within theselect areas will only be removed by the County as needed prior to for waste filling. The remainder of the rain tarp and sod along the western sideslope of the Phase I disposal area will remain in place until further removal is required for additional waste placement to prevent washout of the existing drainage sand material along the sideslope during storm events and stormwater infiltration/runoff into the active waste filling area. As soon as the rain tarp and sod is removed within a select area of the Phase I sideslope prior to waste filling, County personnel will conduct depth checks by hand (on an approximately 25-foot grid) of the remaining sideslope protective cover material to ensure there is 24-inches (measured perpendicular to the slope) of protective material remaining.

If the County depth checks and measurements indicate there is 24-inches of protective material remaining, no other field work will be conducted by the County prior to waste placement along the Phase I sideslope in that area. The County will then notify FDEP according to Part G.1.a.7. prior to waste placement. If the County depth checks indicate less than 24-inches of protective material is remaining after the rain tarp and sod removal the County will place additional protective material within the area prior to waste placement as needed to obtain the required depth. Following material placement to the required depth by the County, the County will notify FDEP according to Part G.1.a.7. prior to waste placement.

### G.1.a.6 Protective Soil/Drainage Sand Material

During construction of the Phase II Section II Expansion, the County will ensure that additional protective soil/drainage sand material, which has met the requirements of the project Technical Specifications (minimum hydraulic conductivity of $1x10^{-3}$ cm/sec, gradation, etc.) and has been approved by the Engineer during construction, is stockpiled onsite for future use. This material would be placed as needed by the County against the Phase I sideslope prior to waste placement in the locations identified from the depth checks that less than 24-inches of the existing protective material was remaining after the rain tarp and sod removal. If the stockpiled protective material has been depleted by the County and additional material is required, the County shall perform material testing as required for protective soil/drainage sand by Specification Section 02220 Excavation, Backfill, Fill, and Grading from a suitable source. After the material has met the requirements of the Specification, the additional material may be utilized by the County.

### G.1.a.7 Confirmation of Protective Soil/Drainage Sand Material Depth

After confirmation by the County that 24-inches of protective material is in place along the Phase I sideslope after removal of the rain tarp and existing sod, through the processes as indicated above in Part G.1.a.5., the County shall provide FDEP a certification statement to the effect prior to waste placement.

### G.1.a.8 Temporary Sideslope Berms

In addition, to reduce the amount of stormwater infiltration and surface water runoff into the Phase II Section II Expansion center and northern portions (and generating additional leachate), the County will ensure the rain tarp (placed during construction of the Phase II Section II Expansion over the existing sod) is maintained as needed along the western sideslope of the Phase I area. In addition, the County will construct temporary sideslope berms along the western Phase I sideslope during operations as needed. The temporary sideslope berms will be active in nature to ensure the rain tarp directs the surface water runoff away from the active filling area. The County will create temporary sideslope berms as needed to accommodate fill sequencing which will be used to control the surface water runoff from the rain tarp and direct it away from the active filling area to reduce surface water runoff into active waste filling to the extent practical.

The temporary sideslope berms will help direct the southern half of the rain-tarped western Phase

I sideslope surface water runoff into the Phase II Section II Expansion northern portion (which will be covered with a rain tarp while waste filling is not occurring) while filling in the center portion. This surface water runoff can then be pumped as needed from the northern portion area into the perimeter stormwater management system.

The temporary sideslope berms created along the northern half of the rain-tarped western Phase I sideslope will help direct the surface water runoff into the northern perimeter stormwater management system swale while filling in the northern portion. This will also reduce the amount of surface water runoff entering the northern portion and generating additional leachate.

In addition, prior to filling, the County will remove the concrete rubble rip rap from within the temporary stormwater downchutes located along the sideslope. After removal of the rip rap, the County will place drainage sand within the area downchute areas to a minimum of two feet. After removal of rain tarp, sod, and rip rap, filling will begin by placing waste against the sideslope of the Phase I disposal area and raising the Phase II Section II Expansion disposal area up. Final filling will achieve the grades shown on the construction permit application drawings located in Attachment E-2.

The County will not recirculate leachate but will conduct leachate evaporation during operation of the Phase II Section II area. Ditches, berms, or other devices shall be constructed to control leachate runoff. Initial and intermediate cover receiving leachate from the leachate evaporation process shall be graded to shed runoff into the leachate collection system and to minimize mixing of leachate runoff and storm water. Initial and intermediate cover shall be permeable to the extent necessary to prevent perched water conditions and gas buildup. Leachate evaporation shall not be conducted during weather conditions or in quantities that may cause runoff outside the solid waste disposal unit, surface seeps, wind-blown spray, or exceedance of the limits of the leachate head on the liner.

As indicated above, the Operation Permit renewal application will include the operational fill sequence plans to show a detailed plan for the filling of the Phase II Section II Expansion area. The fill sequence plans will also indicate the location of temporary sideslope berms to be installed by the County during filling to reduce stormwater runoff from entering into the Phase II Section II Expansion area.

### G.1.b Maximum Waste Height

The maximum final closure elevation of the Phase II Section II Expansion area will be approximately EL 173.2 feet NGVD top of final closure. Please refer to the Phase II Section II Expansion construction permit application drawings located in Attachment E-2 for the proposed final buildout configuration.

### G.1.c Factor of Safety

Per Rule 62-701.400(2), FAC the Phase II Section II Expansion (and the Phase II Section I height increase) has been designed to prevent failures of sideslopes, and designed to prevent deep-seated failures through the waste, along liner systems, and through foundation soils, and achieves a minimum factor of safety of 1.5 using peak strength values. Please refer to Section I of this application for further information regarding the slope stability analysis conducted and the resulting factor of safety for the Phase II Section II Expansion and the Phase II Section I height increase.

## G.2 LANDFILL LINER REQUIREMENTS

The bottom liner system for the Phase II Section II Expansion meets or exceeds the design requirements specified by Rule 62-701.400(3)(c), FAC for a double liner system. The lining system will incorporate an independent leak detection zone. Please refer to the Phase II Section II Expansion construction permit application drawings located in Attachment E-2 for the cross-section of the bottom liner system. The double liner system for the Phase II Section II Expansion will include the following (from bottom to top):

- 12 inch prepared subbase comprised of compacted soil free of sharp materials
- Geosynthetic Clay Liner (GCL) (encapsulated with an additional layer of 60 mil textured High Density Polyethylene (HDPE) geomembrane liner for specific sections of the bottom liner system)
- 60 mil textured HDPE geomembrane liner (secondary liner)
- 300 mil tri-planar geocomposite (secondary geocomposite)
- 60 mil textured HDPE geomembrane liner (primary liner)
- 300 mil bi-planar geocomposite (primary geocomposite)
- 24 inch protective cover soil layer
- Rain tarp (the northern portion of the Phase II Section II Expansion, approximately 2.33 acres)

The Phase I area of the Hardee County Landfill is unlined. In accordance with the Operations Plans, a portion of the proposed Phase II Section II Expansion will "piggy-back" along the western sideslope of the existing closed Phase I area in the future. The closure of Phase I was previously completed by the County under Construction Permit No. 38414-012-SF/01. The County received FDEP approval of the Phase I closure construction on January 3, 2012. The Phase I liner system along the western sideslope was designed, permitted and constructed according to Rule 62-701.430(1)(c), FAC to be the bottom liner system when the Phase II Section II Expansion does "piggy-back." The Phase II Section II Expansion "piggy-back" area along the western Phase I sideslope will be approximately 4.36 acres in size divided into the northern portion (approximately 2.13 acres) and the southern portion (approximately 2.23 acres). The sideslope (bottom liner system) in the Phase I area along the western sideslope where the Phase II Section II Expansion will "piggy-back" consist of the following (from bottom to top):

- In place waste

- 24 inch thick protective bedding soil layer (as required by Rule 62-701.430(1)(c)3, FAC)
- 60 mil textured HDPE geomembrane liner (as required by Rule 62-701.430(1)(c)2, FAC)
- 300 mil bi-planar geocomposite (as required by Rule 62-701.430(1)(c)1, FAC)
- 24 inch thick protective cover soil drainage sand layer (as required by Rule 62-701.430(1)(c)3, FAC)
- Vegetative layer (to be covered by a rain tarp during the construction of the Phase II Section II Expansion which the sod and rain tarp will be removed by the County prior to waste filling within the area)

The existing closed Phase I area along the southern sideslope where the Phase II Section I height increase will "piggy-back" consists of the following (from bottom to top):

- In place waste
- 24 inch thick protective bedding soil layer (as required by Rule 62-701.430(1)(c)3, FAC)
- 60 mil textured HDPE geomembrane liner (as required by Rule 62-701.430(1)(c)2, FAC)
- 300 mil bi-planar geocomposite (as required by Rule 62-701.430(1)(c)1, FAC)
- 24 inch thick protective cover soil drainage sand layer (as required by Rule 62-701.430(1)(c)3, FAC)
- Rain tarp (which will be removed by the County prior to waste filling within the area)

### G.2.a.1 Test Information and Documentation

The bottom liner for the Phase II Section II Expansion area will meet the liner design requirements specified by Rule 62-701.400(3)(c)1, FAC for double liner systems. The requirements for geomembrane liner testing and documentation are included in the Technical Specifications contained in the Construction Quality Assurance (CQA) Plan for the Phase II Section II Expansion located in Attachment G-1. The Technical Specifications include manufacturer's quality control testing performance and field construction testing.

- Liner Resin Specifications - The Technical Specifications for the geomembrane liner will include recommendations from the Geosynthetic Research Institute (GRI) and requirements from the American Society for Testing and Materials (ASTM) for meeting resin material formulation and testing criteria to ensure satisfactory performance.
- Liner Construction Quality Assurance (CQA) Controls - Hardee County will retain qualified personnel who will be responsible for conducting Construction Quality Assurance (CQA) measures and inspections for the materials, installation, seaming and testing of the HDPE geomembrane liner.

- Direct Shear Test - The Technical Specifications for the geomembrane liner will include test requirements for the interface direct shear testing to ensure satisfactory performance.

Testing and documentation of the bottom liner system for the Phase II Section II Expansion area will be performed during construction and will be provided to FDEP upon construction completion. The construction certification report submitted for FDEP approval will include:

- CQA monitoring of subbase preparation, placement, testing, and final survey.
- Geosynthetic Clay Liner (GCL) MQC certificates, CQA direct shear test results (interface and internal), GCL installation plan, repair log, and record drawings.
- Geomembrane Manufacturer's Quality Control (MQC) certificates, CQA monitoring data, seam test results, geomembrane panel layout plan, repair logs, and record drawings.
- Construction of the leachate collection and removal system (LCRS), including MQC certificates from the pipe manufacturer(s), permeability tests of the protective drainage sand, MQC certificates from the geocomposite manufacturer(s), CQA test results for the geocomposites, and depth measurements for the protective drainage sand layer.
- The test information, which will be provided to FDEP, will verify that the materials used are in accordance with the Technical Specifications provided by ASTM and GRI.
- Record documents reflecting as-built conditions.

The test information, which will be provided to FDEP, for the HDPE geomembrane liner will verify the materials were constructed in accordance with the Technical Specifications contained in the CQA Plan located in Attachment G-1. Geomembrane liner MQC tests will include:

- Density.
- Sheet thickness.
- Sheet tensile properties.
- High Density Polyethylene (HDPE) content.
- Carbon black content.
- Carbon black dispersion.
- Seam strength.

#### G.2.a.2 Foundation

The estimated bearing capacity of the Phase II Section II Expansion area foundation is discussed in Section I of this application. Per Rule 62-701.400(3)(a)2, FAC the Phase II Section II

Expansion area will be installed upon a base and in a geologic setting capable of providing structural support to prevent overstressing of the liner due to settlements and applied stresses.

### G.2.a.3 Bottom Liner Location Relative to Seasonal High Groundwater

To estimate the seasonal high groundwater table, SCS previously had the County dig test holes in five locations several feet below existing grade, surrounding the facility borrow pit area. Soil staining observations made in accordance with the Southwest Florida Water Management District (SWFWMD) district guidelines were used to estimate the groundwater elevations. Pit numbers 1 and 5 were used to estimate the seasonal high groundwater table as previously submitted to the Department with the *Hardee County Landfill Expansion Construction Permit Application*, dated April 2004, prepared by SCS. In pit number 2, 3, and 4 no distinct soil staining layers were observed possibly due to the close proximity to the adjoining former borrow pit. The County surveyed in the stained soil layer in pit numbers 1 and 5. Based upon the survey the seasonal high groundwater elevation was estimated to be at approximately EL 78.53 feet NGVD.

In addition, SCS reviewed the groundwater elevations recorded at the monitor wells and piezometers at the facility during the routine, semi-annual sampling events recorded from June 1999 through June 2012 and in addition elevations recorded in December 2012 provided by the County. Based on review of the above-mentioned groundwater elevations the current estimated seasonal high groundwater elevation was chosen to be EL 82.09 feet NGVD within the sump area of the Phase II Section II Expansion. The bottom liner system in relation to the groundwater table is further addressed in Section I.1.c of this construction permit application.

The lowest proposed elevation of the bottom lining system for the Phase II Section II Expansion area is the leachate collection sump at EL 78.5 feet NGVD. Due to the fluctuations of the groundwater table within the area of the sump and a portion of the cell bottom, as further discussed in Section I of this construction permit application, an additional layer of 60 mil textured HDPE geomembrane liner will be placed under the GCL and welded to the secondary 60 mil textured HDPE geomembrane liner. This additional layer of 60 mil textured HDPE geomembrane liner will help prevent the “wet-dry” cycles of the GCL due to the fluctuations of the groundwater table. Requirements for the additional layer of liner below the GCL has been included within the Technical Specifications located in Attachment G-1 and the construction permit application drawings located in Attachment E-2. The bottom liner system in relation to the groundwater table is further addressed in Section I of this construction permit application.

### G.2.a.4 Hydrostatic Uplift

The double lined bottom of the leachate sump is placed at EL 78.5 feet NGVD in order to facilitate good drainage flow off the leachate collection system and provide adequate temporary storage for the proper operation of the automatic leachate pumps. An additional layer of 60 mil textured HDPE geomembrane liner will be placed under the GCL and welded to the secondary 60 mil textured HDPE geomembrane liner. This additional layer of 60 mil textured HDPE geomembrane liner will help prevent the “wet-dry” cycles of the GCL due to the fluctuations of the groundwater table. Provisions have been made in the design and construction of the sump and the leachate collection and leachate detection header trench to reduce the potential for hydrostatic uplift that could damage the bottom lining system. The Technical Specifications will require dewatering equipment be provided to draw down the groundwater table so the lining systems are installed “in the dry” without hydrostatic uplift forces. Following the lining installation the rock fill will be placed in the sump and leachate collection and leachate detection header trench to the prescribed height as indicated on the construction permit application drawings located in Attachment E-2 to act as ballast. The bottom liner system in relation to the groundwater table is addressed in Section I of this construction permit application.

Once the dewatering system is shut off, should the water table rise, the weight of the rock within these areas will act as a ballast which is adequate to offset the hydrostatic uplift force and provide a factor of safety of approximately 1.75. Please refer to Attachment G-2 for buoyancy calculations for the leachate collection system sump.

The weight of the rock in the leachate collection and detection header trench acting is adequate to offset the hydrostatic uplift force and will provide a factor of safety of approximately 1.91. Please refer to Attachment G-3 for buoyancy calculations for the leachate collection system header pipe and detection header pipe leading to the leachate collection system sump.

As previously indicated, the Technical Specifications will require dewatering equipment be provided to draw down the groundwater table so the bottom lining system is installed “in the dry” without the influence of hydrostatic forces. The lowest proposed elevation of the bottom lining system for the Phase II Section II Expansion area is the leachate collection sump at EL 78.5 feet NGVD. SCS reviewed the groundwater elevations recorded at the monitor wells and piezometers at the facility during the routine, semi-annual sampling events recorded from June 1999 through June 2012 and in addition elevations recorded in December 2012 provided by the County. Based on review of the groundwater elevations the current estimated seasonal high groundwater elevation was chosen to be EL 82.09 feet NGVD within the sump area of the Phase II Section II Expansion. Therefore, due to the fluctuations of the groundwater table the bottom liner system could be influenced from the area covered from EL 78.5 feet NGVD to EL 82.09 feet NGVD. Based on the volume of protective cover material and rock within this area it will act as a ballast which is adequate to offset the hydrostatic uplift force and provide a factor of safety of approximately 2.0.

The existing nine 8-inch diameter HDPE groundwater control system pipes located under the Phase II Section I area will be extended and continued to the west under the southern portion of the Phase II Section II Expansion area as shown on the construction permit application drawings located in Attachment E-2. Trenches for each of the groundwater control system pipes will be excavated in the existing subgrade to the grades as shown on the construction permit application drawings (similar in nature to the construction of the original groundwater control system pipes during construction of the Phase II Section I area). A separate cleanout will be constructed for each of the groundwater control system pipes along the western side of the Phase II Section II Expansion for access.

The groundwater control system pipes, sloped from west to east, will all be connected to an existing 12-inch diameter HDPE header pipe located on the eastern end of the Phase II Section I area. The 12-inch diameter HDPE header pipe is connected to an existing groundwater control system pump station located to the southeast of the Phase II Section I cell. The capacity of the 8-inch diameter HDPE groundwater control system pipes, 12-inch diameter HDPE header pipe, groundwater pump station and pumps were originally sized for collection of the groundwater previously submitted to the Department with the *Hardee County Landfill Expansion Construction Permit Application*, dated April 2004, prepared by SCS.

Jet cleaning and tracked video camera equipment will be able to travel from west to east through the groundwater control system pipes to the point they are connected to the existing 12-inch diameter HDPE header within the Phase II Section I area. Access within these pipes will be available from west to east in the Phase II Section II Expansion and also from the east to west in the Phase II Section I area.

The existing groundwater control system piping originally designed with the *Hardee County Landfill Expansion Construction Permit Application*, dated April 2004, prepared by SCS used the entire footprint at that time of 10-acres for pipe sizing calculations. As a conservative estimate, the original design also used a high-water of EL 82.5 feet NGVD within the pipe sizing calculations. The calculated groundwater flow rate at the high-water elevation used for the 10-acres was determined to be 700 gpm. Since the April 2004 submittal the original 10-acre area has been divided and is identified as the Phase II Section II Expansion and the Phase II Section I Expansion. The Phase II Section I Expansion area was constructed with a footprint of approximately 5-acres. The area which the existing groundwater control system piping will be extended under the Phase II Section II Expansion will be approximately 1.63-acres. Therefore the groundwater control system would be required to handle the flow generated from approximately 6.63-acres as opposed to the original design of 10-acres. In addition, the current estimated high groundwater table of EL 82.09 feet NGVD is below the original system design value of EL 82.5 feet NGVD. Therefore, the existing groundwater control system piping which will be extended under the Phase II Section II Expansion will handle the anticipated groundwater flow.

### G.2.a.5 Limits of Liner

Solid waste will not be placed beyond the horizontal extent of the liner for the Phase II Section II Expansion area. The limits of the lining system will be easily visible in the field at all leading edges including the anchor trenches along the north, west and south sides. Anchor trench markers will be placed along the north, west and south sides of the Phase II Section II Expansion area. Maintaining the waste within the limits of liner prevents municipal solid waste and leachate from coming into contact with any exposed soil.

The peripheral geomembrane anchor trench was designed to restrain the geomembrane from movement under anticipated loads but to pull out of the anchor trench before the geomembrane tears. The geometry of the anchor trench was designed so that the resistance capacity of the trench was lower than the ultimate yield strength of the geomembrane but still high enough to restrain the geomembrane against typical loads. Refer to Attachment G-4 for the anchor trench calculations.

## G.2.b Composite Liner

This Section of the application is not applicable. The proposed facility will have a full double liner system. Please refer to Section G.2.c below for the double liner system description.

## G.2.c Double Liners

### G.2.c.1 Geomembrane Thickness and Properties

The bottom liner for the Phase II Section II Expansion area will meet the liner design requirements specified by Rule 62-701.400(3)(c)1, FAC for double liner systems. The requirements and properties for the primary and secondary HDPE liners are described in the Technical Specifications for the liner system, which are presented in the CQA Plan located in Attachment G-1. The HDPE geomembrane liners will be nominal 60 mils thick and textured.

The proposed double liner system of the Phase II Section II Expansion will include the following (from bottom to top). Please refer to the Phase II Section II Expansion construction permit application drawings located in Attachment E-2 for the cross-section of the bottom liner system.

- 12 inch prepared subbase comprised of compacted soil free of sharp materials
- Geosynthetic Clay Liner (GCL) (encapsulated with an additional layer of 60 mil textured High Density Polyethylene (HDPE) geomembrane liner for specific sections of the bottom liner system)
- 60 mil textured HDPE geomembrane liner (secondary liner)
- 300 mil tri-planar geocomposite (secondary geocomposite)
- 60 mil textured HDPE geomembrane liner (primary liner)
- 300 mil bi-planar geocomposite (primary geocomposite)
- 24 inch protective cover soil layer
- Rain tarp (the northern portion of the Phase II Section II Expansion, approximately 2.33 acres)

The GCL below the secondary liner is intended for use as a substitute, but equal material for the 6-inch thick prepared subbase required by Rule 62-701.400(3)(c)1, FAC. The use of GCL is allowed in accordance with Rule 62-701.400(3)(c)(1), FAC.

The geosynthetic components of the bottom liner for the Phase II Section II Expansion area will meet the requirements specified by Rule 62-701.400(3)(d), FAC for double liner systems. The properties for the GCL, 60 mil primary and secondary HDPE textured geomembrane liners, primary and secondary geocomposite drainage layer materials, rain tarp, and protective cover soil are described in the Technical Specifications that are presented in the CQA Plan located in

Attachment G-1.

A geosynthetic rain tarp will be placed over portions of the Phase II Section II Expansion that will not receive waste initially to reduce the flow of rainwater to the leachate collection system. The northern portion of the Phase II Section II Expansion, approximately 2.13 acres, will receive the rain tarp. The location for the rain tarp is identified on the construction permit application drawings located in Attachment E-2.

### G.2.c.2 Leachate Collection and Removal System

The leachate collection and removal system (LCRS) is designed to meet the FDEP requirements to limit the leachate head above the primary geomembrane liner to less than one foot during routine landfill operations after placement of the initial cover as per Rule 62-701.400(3)(c)(1), FAC.

The LCRS, as shown on the Phase II Section II Expansion construction permit application drawings located in Attachment E-2, includes the 24-inch thick sloping sand drainage layer, a sloped bi-planar geocomposite (i.e., the geonet or drainage net) and a piping network. The bi-planar geocomposite and the drainage layer are installed at a slope across the Phase II Section II Expansion as indicated on the construction permit application drawings. A series of sloped 8-inch diameter HDPE perforated pipes are placed in rock-filled trenches wrapped with a geotextile that are spaced at regular, predetermined intervals across the geocomposite lining. Together the piping and geocomposite collect leachate flowing through the drainage layer and transport it to the leachate collection header trench which in turn transports the leachate via gravity to the leachate collection sump. The leachate sump is equipped with submersible pumps that discharge the leachate out of the sump through a pipeline and out of the cell.

From that point the leachate will travel in a pressure pipeline (i.e., a force main) from the cell to the leachate collection sideslope risers located along the western side of the south portion of the Phase II Section II Expansion. The leachate force main is sized to serve the flow from the leachate collection and detection pumps. The sideslope risers are extensions of the leachate collection pipes for the Phase II Section II Expansion which will be connected to the existing leachate collection lines located within the Phase II Section I area during construction. Leachate will then flow via gravity to the existing leachate collection sump and pumps located within the Phase II Section I area. From the Phase II Section I sump the leachate will be pumped into the existing above ground leachate storage tanks.

Per Specific Condition No. C.8.g.(3) of Operation Permit #38414-011-SO/01 the Phase II Section I leachate collection and removal system (LCRS) pipes were jet-cleaned and video-inspected to verify adequate performance by Florida Jetclean (Jetclean) on December 18, 2012. The Phase II Section I LCRS consist of three 8-inch diameter leachate collection lateral pipes identified as south, center and north and one 8-inch diameter leachate detection lateral pipe identified as detection.

The leachate collection lateral pipes were accessed through cleanouts located along the western side of the Phase II Section I Expansion area. The leachate detection lateral pipe was accessed through a cleanout located in the southeast corner of the Phase II Section I Expansion area. The Jetclean video-inspection equipment is capable of recording distances along the LCRS pipes inspected to document the length of LCRS jet-cleaned and video-inspected. The Jetclean video-inspection showed the LCRS pipes viewed with the inspection camera were clean and defect free. In areas where the video quality was obscured by high liquid levels within the LCRS pipes, the fact that both the inspection camera and the high-pressure jetting nozzle were not restricted through those areas would support the contention that those areas of the leachate collection system are also in good working order. A "Jetting Log" summary table was provided in the Jetclean report *Hardee County Landfill 2012 LCS & GCS Pipe Maintenance Phase I LCS & Phase II LCS/GCS* which indicated the LCRS pipes location, achieved inspection distance (pipe length) and results of the inspection.

The Florida Jetclean report *Hardee County Landfill 2012 LCS & GCS Pipe Maintenance Phase I LCS & Phase II LCS/GCS*. Based on the findings of the Florida Jetclean report, it is SCS's professional opinion that the existing Phase II Section I LCRS is operating as intended and will handle the additional leachate generated from the Phase II Section II and Phase II Section I Expansions.

In addition, as required by Specific Condition No. C.8.i.(3) of Operation Permit #38414-011-SO/01 the Phase II Section I groundwater interceptor system pipes were jet-cleaned and video-inspected by Jetclean on December 18, 2012. The Phase II Section I groundwater interceptor system consist of nine 8-inch diameter groundwater collection pipes identified as CO1 through CO9 and one 12-inch diameter wetwell to header pipe.

The groundwater interceptor system pipes were accessed through cleanouts located along the western side of the Phase II Section I Expansion area. The wetwell to header pipe was accessed through the groundwater wetwell located in the southeast corner of the Phase II Section I Expansion area. The Jetclean video-inspection showed the groundwater interceptor system pipes viewed with the inspection camera were clean and defect free. In areas where the video quality was obscured by high liquid levels within the groundwater interceptor system pipes, the fact that both the inspection camera and the high-pressure jetting nozzle were not restricted through those areas would support the contention that those areas of the groundwater interceptor system are also in good working order. A "Jetting Log" summary table was provided in the Jetclean report *Hardee County Landfill 2012 LCS & GCS Pipe Maintenance Phase I LCS & Phase II LCS/GCS* which indicated the groundwater interceptor system pipes location, achieved inspection distance (pipe length) and results of the inspection.

The Florida Jetclean report *Hardee County Landfill 2012 LCS & GCS Pipe Maintenance Phase I LCS & Phase II LCS/GCS*. Based on the findings of the Florida Jetclean report, it is SCS's professional opinion that the existing Phase II Section I groundwater interceptor system pipes are operating as intended and will handle the groundwater flow generated from the Phase II Section II and Phase II Section I Expansions.

#### G.2.c.2.1 Leachate Generation Modeling

To calculate the anticipated rate of leachate generation and in turn determine the capacity of the leachate pumping equipment, a water balance was performed using the United States Environmental Protection Agency's (U.S. EPA) Hydrological Evaluation of Landfill Performance (HELP) model version 3.07, 1994. Precipitation falling on a landfill surface will run off, evaporate, evapotranspirate, or infiltrate. The percentage of precipitation falling on a landfill surface that will travel each of these paths can be estimated by use of water balance methods.

The HELP model uses various formulas based upon fundamentals of soil mechanics to simulate water percolation in a vertical and horizontal direction under many climatological, soil and topographic conditions. The HELP model estimates how much leachate and surface drainage is likely to occur after a certain period of time within a specific landfill profile. Parameters pertinent to the design of the geonet component of the geocomposite drainage layer include hydraulic transmissivity, hydraulic conductivity and hydraulic gradient. The hydraulic transmissivity and hydraulic conductivity of the geonet drainage layer is primarily a function of overburden compressive stress and boundary conditions. The model provides an estimation of how much leachate will be generated within a landfill profile and how the LCRS will perform on a daily basis using daily climatological data.

The HELP model calculates flow through the geonet with McEnroe's equation. This equation is based on unconfined flow principles. McEnroe's equation assumes that the geonet drainage layer is infinite in thickness. When the head exceeds the geonet thickness, the HELP model assumes that the leachate can continue to stage up past the geonet layer thickness, yet still have the associated hydraulic conductivity of the geonet. In actuality, the leachate is moving at the hydraulic conductivity of the geonet and drainage sand. When the head over the liner exceeds the geonet thickness, the Model does not account for this change in conductivity.

#### G.2.c.2.2 Rainfall Records and Design Storm

The following rainfall records for the Phase II Section II Expansion were reviewed by SCS.

- ~~Information was reviewed~~ National Oceanic and Atmospheric Administration (NOAA) rainfall data ~~was~~ obtained from the National Climatic Data Center (NCDC) web site for the NOAA weather station (station index number 08-9401-04) located in Wauchula, Florida at Latitude: 27° 31' North Longitude: 81° 48' West. The NOAA rainfall data is located in Attachment G-5. Rainfall data information was available for the weather station from January 1954 to April 30, 2012. Based on the NOAA rainfall data for the mentioned time period, the annual average rainfall was documented to be 51.16 inches.

- Site specific rainfall data was also obtained from the Hardee County Solid Waste Department. Site specific rainfall data was available from February 1998 through September 1998, calendar years 2003 through 2009, and January 2011 through ~~June~~December 2012. The site specific rainfall data is located in Attachment G-6. Based on the site specific rainfall data for the mentioned time period, the annual average rainfall was calculated to be 40.26 inches.

- In addition, as a comparison, SCS used the NOAA rainfall data previously mentioned above and included the years where the site specific data was available and calculated the average rainfall from January 1954 to ~~April~~ December 31~~0~~, 2012. The combination of the NOAA rainfall data and the site specific rainfall data is located in Attachment G-7. Based on the combination of the NOAA rainfall data and the site specific rainfall data, the annual average rainfall was calculated to be 48.70 inches.

The HELP Model analyses are based on daily site specific rainfall data provided by the County for the following time period:

- February 1998 through September 1998.
- January 2003 through May 2009.
- January 2012 through December 2012.

Daily rainfall data obtained from NOAA was input into the HELP Model analyses and used for the following time period:

- January 1984 through January 1998.
- October 1998 through December 1998 (used to fill-in unavailable County data).
- January 1999 through December 2002 (used to fill-in unavailable County data).
- June 2009 through December 2011 (used to fill-in unavailable County data).

Based on the three above-mentioned rainfall data reviews SCS created a summary table. Please refer to Attachment G-8 for a summary table of the rainfall data reviewed. As indicated in the summary tables, the NOAA weather station values are the largest (most conservative) for the annual average rainfall and average monthly rainfall compared to only site specific rainfall and a combination of site specific and NOAA values. ~~Therefore, the average monthly rainfall data for the NOAA weather station was used within the HELP model analysis.~~

### G.2.c.2.3 Geonet Design Properties

Under dry conditions (i.e., no active rainfall) the maximum depth of leachate on the primary geomembrane liner is normally designed to be maintained within the thickness provided by the geonet. Thus precise physical parameters are required to be designated for the geonet including the minimum transmissivity (i.e., a flow rate per unit area). The transmissivity calculations for the bi-planar and tri-planar geocomposites are located in Attachment G-9 and Attachment G-10, respectively. Appropriate reduction factors have been applied to the transmissivity values calculated for the geocomposites. These reduction factors represent chemical clogging ($RF_{CC}$), biological clogging ($RF_{BC}$), geotextile intrusion ($RF_{IN}$), creep reduction ($RF_{CR}$) and a factor of safety.

- Chemical and biological reduction factors account for the particles that fill the voids in the geotextile over time. The chemical and biological clogging reduces the transmissivity of the geocomposite. The chemical and biological reduction factors have been obtained from the Geosynthetic Research Institute (GRI) Standard-GC8. The primary and secondary systems have differing chemical and biological clogging factors.

- Geotextile intrusion accounts for the geotextile encroaching on the geonet under a constant load. A 100-hour transmissivity test factors into intrusion. After the 100-hour seat time the geotextile has already begun to intrude into the geonet; therefore, the transmissivity value has already been affected by the intrusion factor. The intrusion factor used in the calculations is 1.0 because the transmissivity values were based on the 100-hour seat time.

- Creep reduction represents the elongation of the geonet under constant load for an extended period of time. Typical creep reduction factors have been supplied by the bi-planar and tri-planar geocomposite manufacturers.

- The transmissivity is also divided by a factor of safety of two.

The HELP model requires a hydraulic conductivity input for each of the geocomposite layers (primary and secondary). Hydraulic conductivity for each geocomposite is determined by dividing the transmissivity by the thickness of the geocomposite. The transmissivity and hydraulic conductivity calculations for the bi-planar and tri-planar geocomposites are located in Attachment G-9 and Attachment G-10, respectively.

The leachate collection system (LCS) drainage layer consists of 24 inches of soil cover placed over a 300 mil (0.300-inch) bi-planar geocomposite (primary geocomposite). In accordance with Rule 62-701.400(3)(c)1, FAC the hydraulic head on the upper liner must not exceed one foot during normal facility operations. According to the HELP model results located in Attachment G-11, the maximum hydraulic head on the primary liner is 0.~~179~~283 inches (i.e., worst-case operating scenario for production of leachate), which is significantly less than the one foot required by Rule 62-701.400(3)(c)1, FAC. Therefore, a bi-planar geocomposite can be used for the primary leachate collection system. Refer to Section G.2.c.2.4 for the design of the LCRS collection layer.

Per 62-701.400(3)(c)(2), FAC the leak detection and secondary leachate collection system shall have a minimum hydraulic conductivity of ten centimeters per second (cm/sec), shall be designed to limit the maximum hydraulic head on the lower liner to one inch, and shall not allow leachate head to exceed the thickness of the drainage layer. The hydraulic conductivity of the leak detection and secondary collection system material shall be derived from transmissivity and thickness measurements. According to the HELP model results located in Attachment G-11, the maximum hydraulic head on the secondary liner is 0.00~~1~~2 inches (i.e., worst-case operating scenario for production of leachate), which is less than the thickness of the drainage layer tri-planar geocomposite. Therefore, a tri-planar geocomposite can be used for the secondary leachate collection system. A tri-planar geocomposite can achieve this hydraulic conductivity after accounting for all the reduction factors and while keeping the maximum head within the geocomposite thickness in the secondary system. Refer to Section G.2.c.2.4 for the design of the LCRS collection layer.

#### G.2.c.2.4 Design of LCRS Collection Layer

The leachate collection and removal system (LCRS) is designed to limit the hydraulic head on the liner to the thickness of the geocomposite layer. The primary leachate collection system is composed of double-sided, bi-planar geocomposite (geonet between two layers of geotextile) placed over the primary 60 mil textured HDPE geomembrane liner along the bottom and sides of the cell. The geocomposite is designed to maintain a high flow rate under the pressure exerted by the solid waste under final buildout height conditions. The maximum final closure elevation of the Phase II Section II Expansion area will be approximately EL 173.2 feet NGVD top of final closure. Refer to the Phase II Section II Expansion construction permit application drawings located in Attachment E-2 for the proposed final buildout configuration.

For the proposed Phase II Section II Expansion the final buildout height pressure is estimated to be approximately ~~4~~5,~~2~~000 pounds per square foot (psf) at a waste thickness of approximately ~~8~~60 feet and an average density of 60 pounds per cubic foot or 1,640 pounds per cubic yard. A cross section detail of the leachate collection system is provided in the Phase II Section II Expansion construction permit application drawings located in Attachment E-2.

The HELP model was used to determine leachate quantities generated for several anticipated operating (waste filling) Scenarios within the Phase II Section II Expansion area and when it "piggy-backs" onto the western sideslope of the Phase I area. The following ~~ten~~ eleven Scenarios (Scenario 1 through Scenario 11~~0~~) represent the varying operating conditions analyzed. The maximum hydraulic head and geonet thickness for the respective Scenarios is summarized in Table G-1 below. Refer to the HELP model runs located in Attachment G-11.

In addition, Drawing 1 has been provided in Attachment G-11 which identifies the areas indicated below for the Scenarios analyzed.

- Phase II Section II Expansion divided into north, center and south portions = 6.18 acres.
- Northern portion of Expansion bottom area = 2.33 acres
- Center portion of Expansion bottom area = 2.22 acres
- Southern portion of Expansion bottom area = 1.63 acres
- Expansion center and north bottom area = 4.55 acres
- Total Phase I western sideslope area = 4.36 acres
- Entire southern sideslope of Phase I adjacent to center portion of Expansion bottom area = 2.23 acres
  - Bottom southern sideslope of Phase I adjacent to center portion of Expansion bottom area = 0.80 acres
  - Top southern sideslope of Phase I adjacent to center portion of Expansion bottom area = 1.43 acres
- Entire northern sideslope of Phase I adjacent to northern portion of Expansion bottom

area = 2.13 acres

- Bottom northern sideslope of Phase I adjacent to northern portion of Expansion bottom area = 0.91 acres

- Top northern sideslope of Phase I adjacent to northern portion of Expansion bottom area = 1.22 acres

## SCENARIO 1

- The northern portion of the Phase II Section II Expansion, approximately 2.33 acres, is covered with a rain tarp.

- The bottom northern sideslope portion of the Phase I sideslope adjacent to the area, approximately 0.91~~2.13~~ acres, remains intact with a rain tarp over the existing sod. Stormwater runoff from the rain-tarped sideslope enters the rain-tarped northern portion of the Expansion which is pumped to the stormwater swale adjacent to the Expansion.

- The top northern sideslope portion of the Phase I sideslope adjacent to the area, approximately 1.22 acres, remains intact with a rain tarp over the existing sod.

- The center portion of the Expansion, approximately 2.22 acres, is completely open with no waste placement. Stormwater which enters the area is pumped to the swale adjacent to the Expansion using the leachate collection pump located within the sump through bypass piping.

- The bottom southern sideslope portion of the Phase I sideslope adjacent to the area, approximately 0.80 acres, remains intact with a rain tarp over the existing sod.

- The top southern sideslope portion of the Phase I sideslope adjacent to the area, approximately 1.43 acres, remains intact with a rain tarp over the existing sod.

- ~~For an additional design factor of safety and to consider the worse case conditions possible, the Scenario included the entire sideslope of the Phase I area adjacent to the center portion of the Expansion has been stripped of sod, approximately 2.23 acres. Due to erosion control, actual filling will only remove a minimal quantity of sod along the Phase I area sideslope as needed prior to filling. Therefore, the flow estimated is very conservative.~~

- The southern portion of the Expansion, approximately 1.63 acres, is completely open and waste placement has just started.

- The leachate generated will flow to the 8-inch diameter leachate collection pipes within the area for which will be connected to the existing 8-inch diameter leachate collection lines located within the Phase II Section I area during construction of the Phase II Section II Expansion south portion. The leachate will flow via gravity to the existing leachate collection sump and pumps located within the Phase II Section I area. From the Phase II

Section I sump the leachate will be pumped into the existing above ground leachate storage tanks.

## SCENARIO 2

- The northern portion of the Phase II Section II Expansion, approximately 2.33 acres, is covered with a rain tarp.

- The bottom northern sideslope portion of the Phase I sideslope adjacent to the area, approximately 0.912.13 acres, remains intact with a rain tarp over the existing sod. Stormwater runoff from the rain-tarped sideslope enters the rain-tarped northern portion of the Expansion which is pumped to the stormwater swale adjacent to the Expansion.

- The top northern sideslope portion of the Phase I sideslope adjacent to the area, approximately 1.22 acres, remains intact with a rain tarp over the existing sod.

- The center portion of the Expansion, approximately 2.22 acres, is completely open with no waste placement. Stormwater which enters the area is pumped to the swale adjacent to the Expansion using the leachate collection pump located within the sump through bypass piping.

- The bottom southern sideslope portion of the Phase I sideslope adjacent to the area, approximately 0.80 acres, remains intact with a rain tarp over the existing sod.

- The top southern sideslope portion of the Phase I sideslope adjacent to the area, approximately 1.43 acres, remains intact with a rain tarp over the existing sod.

- ~~The waste height is approximately 10 feet across the bottom of the center portion of the Expansion, approximately 2.22 acres. For an additional design factor of safety and to consider the worse case conditions possible, the Scenario included the entire sideslope of the Phase I area adjacent to the center portion of the Expansion has been stripped of sod, approximately 2.23 acres. Due to erosion control, actual filling will only remove a minimal quantity of sod along the Phase I area sideslope as needed prior to filling. Therefore, the flow estimated is very conservative.~~

- The southern portion of the Expansion, approximately 1.63 acres, has had an initial four foot lift of select loose municipal solid waste placed over the drainage sand layer. The waste will be offset 10 feet to the south of the interior separation berm along the north side of the area (which separates it from the Phase II Section II Expansion center portion). This waste thickness will bring the southern portion disposal area slightly below the western and southern perimeter berm. A temporary working face berm will be placed along the western and southern perimeters of the area to prevent stormwater runoff from the active filling area entering the adjacent stormwater swale. Additional waste will then be placed to make the first lift approximately 10 feet thick across the area and up against the Phase II Section I western sideslope within this area. During waste placement, the surface of the waste layer will be placed so it is sloped back "into" the landfill cell.

- The leachate generated will flow to the 8-inch diameter leachate collection pipes within the area for which will be connected to the existing 8-inch diameter leachate collection lines located within the Phase II Section I area during construction of the Phase II Section II Expansion south portion. The leachate will flow via gravity to the existing leachate collection sump and pumps located within the Phase II Section I area. From the Phase II Section I sump the leachate will be pumped into the existing above ground leachate storage tanks.

## SCENARIO 3

- The northern portion of the Phase II Section II Expansion, approximately 2.33 acres, is covered with a rain tarp.
- The bottom northern sideslope portion of the Phase I sideslope adjacent to the area, approximately 0.91~~2.13~~ acres, remains intact with a rain tarp over the existing sod. Stormwater runoff from the rain-tarped sideslope enters the rain-tarped northern portion of the Expansion which is pumped to the stormwater swale adjacent to the Expansion.
- The top northern sideslope portion of the Phase I sideslope adjacent to the area, approximately 1.22 acres, remains intact with a rain tarp over the existing sod.
- The center portion of the Expansion, approximately 2.22 acres, is completely open with no waste placement. Stormwater which enters the area is pumped to the swale adjacent to the Expansion using the leachate collection pump located within the sump through bypass piping.
- The bottom southern sideslope portion of the Phase I sideslope adjacent to the area, approximately 0.80 acres, remains intact with a rain tarp over the existing sod.
- The top southern sideslope portion of the Phase I sideslope adjacent to the area, approximately 1.43 acres, remains intact with a rain tarp over the existing sod.
- ~~The waste height is approximately 40 feet across the bottom of the center portion of the Expansion, approximately 2.22 acres. For an additional design factor of safety and to consider the worse case conditions possible, the Scenario included the entire sideslope of the Phase I area adjacent to the center portion of the Expansion has been stripped of sod, approximately 2.23 acres. Due to erosion control, actual filling will only remove a minimal quantity of sod along the Phase I area sideslope as needed prior to filling. Therefore, the flow estimated is very conservative.~~
- The southern portion of the Expansion, approximately 1.63 acres, has waste placed in ten foot lifts (beginning with the offset 10 feet to the south of the interior separation berm along the north side of the area which separates it from the Phase II Section II Expansion center portion) and up against the Phase II Section I western sideslope to a depth of approximately 25 feet thick in the deepest portion identified as Fill Sequence No. 4. A temporary working face berm will be placed along the western and southern perimeters of

the area to prevent stormwater runoff from the active filling area entering the adjacent stormwater swale. During waste placement, the surface of the waste layers will be placed so they are sloped back "into" the landfill cell.

- The leachate generated will flow to the 8-inch diameter leachate collection pipes within the area for which will be connected to the existing 8-inch diameter leachate collection lines located within the Phase II Section I area during construction of the Phase II Section II Expansion south portion. The leachate will flow via gravity to the existing leachate collection sump and pumps located within the Phase II Section I area. From the Phase II Section I sump the leachate will be pumped into the existing above ground leachate storage tanks.

SCENARIO 4

- The northern portion of the Phase II Section II Expansion, approximately 2.33 acres, is covered with a rain tarp.
- The bottom northern sideslope portion of the Phase I sideslope adjacent to the area, approximately 0.912.13 acres, remains intact with a rain tarp over the existing sod. Stormwater runoff from the rain-tarped sideslope enters the rain-tarped northern portion of the Expansion which is pumped to the stormwater swale adjacent to the Expansion.
- The top northern sideslope portion of the Phase I sideslope adjacent to the area, approximately 1.22 acres, remains intact with a rain tarp over the existing sod.
- The center portion of the Expansion, approximately 2.22 acres, is completely open and waste placement has just started. Prior to filling in the center portion the bypass piping used for Scenarios 1, 2, and 3 for this area to discharge the stormwater to the swale adjacent to the Expansion using the leachate collection pump within the sump will be capped. All liquid generated within this area from this point on will be considered leachate.
- The bottom southern sideslope portion of the Phase I sideslope adjacent to the area, approximately 0.18 acres, has had the rain tarp and sod removed, the County has constructed a temporary sideslope berm as needed, and the area is ready for waste placement. The temporary sideslope berm will direct the surface water runoff from the above sideslope area into the Expansion northern portion (which will be covered with a rain tarp while waste filling is not occurring). This surface water runoff will then be pumped by the County from the northern portion area into the adjacent stormwater swale. Approximately 0.62 acres of the bottom southern sideslope portion remains intact with a rain tarp over the existing sod.
- The top southern sideslope portion of the Phase I sideslope adjacent to the area, approximately 1.43 acres, remains intact with a rain tarp over the existing sod.
- ~~The waste height is approximately 40 feet across the bottom of the center portion of the~~

~~Expansion, approximately 2.22 acres. The waste height is approximately 10 feet placed against the bottom sideslope area of the Phase I area, approximately 0.8 acres. For an additional design factor of safety and to consider the worse case conditions possible, the Scenario included the remainder of the sideslope of the Phase I area adjacent to the center portion of the Expansion has been stripped of sod, approximately 1.43 acres. Due to erosion control, actual filling will only remove a minimal quantity of sod along the Phase I area sideslope as needed prior to filling. Therefore, the flow estimated is very conservative.~~

- The leachate generated will be pumped from the Phase II Section II Expansion sump, through the forcemain and into the leachate collection sideslope risers located along the western side of the south portion of the Expansion. The sideslope risers are extensions of the 8-inch diameter leachate collection pipes for the Phase II Section II Expansion south portion which will be connected to the existing 8-inch diameter leachate collection lines located within the Phase II Section I area during construction. The leachate will flow via gravity to the existing leachate collection sump and pumps located within the Phase II Section I area. From the Phase II Section I sump the leachate will be pumped into the existing above ground leachate storage tanks.

- The southern portion of the Expansion, approximately 1.63 acres, previously had waste placed to a depth of approximately 25 feet thick in the deepest portion across the Expansion and up against the Phase II Section I western sideslope within the area. No additional waste filling within the area has occurred vertically during this scenario. The temporary berms placed along the western and southern perimeters have been maintained to prevent stormwater runoff from the area entering the adjacent stormwater swale.

## SCENARIO 5

- The northern portion of the Phase II Section II Expansion, approximately 2.33 acres, is covered with a rain tarp.

- The bottom northern sideslope portion of the Phase I sideslope adjacent to the area, approximately 0.91~~2.13~~ acres, remains intact with a rain tarp over the existing sod. Stormwater runoff from the rain-tarped sideslope enters the rain-tarped northern portion of the Expansion which is pumped to the stormwater swale adjacent to the Expansion.

- The top northern sideslope portion of the Phase I sideslope adjacent to the area, approximately 1.22 acres, remains intact with a rain tarp over the existing sod.

- The center portion of the Expansion, approximately 2.22 acres, has had an initial four foot lift of select loose municipal solid waste placed over the drainage sand layer. The waste will be offset 50 feet to the south of the interior separation berm along the north side of the area (which separates it from the Phase II Section II Expansion north portion). This waste thickness will bring the center portion disposal area slightly below the western perimeter berm. A temporary working face berm will be placed along the western side of the area to prevent stormwater runoff from the active filling area entering the adjacent stormwater swale. Additional waste will then be placed to make the first lift approximately 10 feet thick at the deepest section within the area and up against the bottom southern portion of the Phase I sideslope adjacent to the area. During waste placement, the surface of the waste layer will be placed so it is sloped back "into" the landfill cell. Prior to waste placement against the bottom southern portion of the Phase I sideslope, the County will construct a temporary sideslope berm as needed and will remove the rain tarp and existing sod from approximately 0.34 acres which will be open and ready for waste placement. The temporary sideslope berm will direct the surface water runoff from the above sideslope area into the Expansion northern portion (which will be covered with a rain tarp while waste filling is not occurring). This surface water runoff will then be pumped by the County from the northern portion area into the adjacent stormwater swale. The remainder of the bottom southern portion of the Phase I sideslope in this area of roughly 0.46 acres will remain intact with a rain tarp over the existing sod.

- The top southern sideslope portion of the Phase I sideslope adjacent to the area, approximately 1.43 acres, remains intact with a rain tarp over the existing sod.

- ~~The waste height is approximately 80 feet across the bottom of the center portion of the Expansion, approximately 2.22 acres. The waste height is approximately 80 feet placed against the bottom sideslope area of the Phase I area, approximately 0.8 acres. The waste height has been raised against the Phase I sideslope and an average of 40 feet has been used for the top portion of the sideslope, approximately 1.43 acres.~~

- The leachate generated will be pumped from the Phase II Section II Expansion sump, through the forcemain and into the leachate collection sideslope risers located along the western side of the south portion of the Expansion. The sideslope risers are extensions of the 8-inch diameter leachate collection pipes for the Phase II Section II Expansion south portion which will be connected to the existing 8-inch diameter leachate collection lines located within the Phase II Section I area during construction. The leachate will flow via gravity to the existing leachate collection sump and pumps located within the Phase II Section I area. From the Phase II Section I sump the leachate will be pumped into the existing above ground leachate storage tanks.

- The southern portion of the Expansion, approximately 1.63 acres, previously had waste placed to a depth of approximately 25 feet thick in the deepest portion across the Expansion and up against the Phase II Section I western sideslope within the area. No additional waste filling within the area has occurred vertically during this scenario. The temporary berms placed along the western and southern perimeters have been maintained to prevent stormwater runoff from the area entering the adjacent stormwater swale.

SCENARIO 6

- The northern portion of the Phase II Section II Expansion, approximately 2.33 acres, is covered with a rain tarp.

- The bottom northern sideslope portion of the Phase I sideslope adjacent to the area, approximately 0.91 acres, remains intact with a rain tarp over the existing sod. Stormwater runoff from the rain-tarped sideslope enters the rain-tarped northern portion of the Expansion which is pumped to the stormwater swale adjacent to the Expansion.

- The top northern sideslope portion of the Phase I sideslope adjacent to the area, approximately 1.22 acres, remains intact with a rain tarp over the existing sod.

- The center portion of the Expansion, approximately 2.22 acres, has had a ten foot thick lift of waste placed across the bottom and up against the bottom southern sideslope portion of the Phase I sideslope adjacent to the area for approximately 0.34 acres. The center portion of the Expansion will continue to have waste placed in ten foot lifts across the bottom to a depth of approximately 25 feet thick at the deepest section. Waste will also be placed up against the north sideslope of the south portion which will fill in the 10 foot offset south of the east west interior separation berm created during Fill Sequence No. 4. During waste placement, the surface of the waste layer will be placed so it is sloped back "into" the landfill cell. Waste will also be placed up against the bottom southern sideslope portion of the Phase I sideslope adjacent to the area for approximately 0.56 acres for an average depth of 10 feet over the sideslope. Prior to waste placement against the bottom southern portion of the Phase I sideslope, the County will construct a temporary sideslope berm as needed and will remove the rain tarp and existing sod within the area. The temporary sideslope berm will direct the surface water runoff from the above sideslope area into the Expansion northern portion (which will be covered with a rain tarp while waste filling is not occurring). This surface water runoff will then be pumped by the County from the northern portion area into the adjacent stormwater swale. The remainder of the bottom southern portion of the Phase I sideslope in this area of roughly 0.24 acres will remain intact with a rain tarp over the existing sod.

- The top southern sideslope portion of the Phase I sideslope adjacent to the area, approximately 1.43 acres, remains intact with a rain tarp over the existing sod.

- The leachate generated will be pumped from the Phase II Section II Expansion sump, through the forcemain and into the leachate collection sideslope risers located along the western side of the south portion of the Expansion. The sideslope risers are extensions of the 8-inch diameter leachate collection pipes for the Phase II Section II Expansion south portion which will be connected to the existing 8-inch diameter leachate collection lines located within the Phase II Section I area during construction. The leachate will flow via gravity to the existing leachate collection sump and pumps located within the Phase II Section I area. From the Phase II Section I sump the leachate will be pumped into the existing above ground leachate storage tanks.

- The southern portion of the Expansion, approximately 1.63 acres, previously had waste placed to a depth of approximately 25 feet thick in the deepest portion across the Expansion and up against the Phase II Section I western sideslope within the area. No additional waste filling within the area has occurred vertically during this scenario. The temporary berms placed along the western and southern perimeters have been maintained to prevent stormwater runoff from the area entering the adjacent stormwater swale.

- ~~The rain tarp on the northern portion of the Phase II Section II Expansion, approximately 2.33 acres, has been removed and is completely open with no waste placement. For an additional design factor of safety and to consider the worse case conditions possible, the Scenario included the entire sideslope of the Phase I area adjacent to the northern portion of the Expansion has been stripped of sod, approximately 2.13 acres. Due to erosion control, actual filling will only remove a minimal quantity of sod along the Phase I area sideslope as needed prior to filling. Therefore, the flow estimated is very conservative.~~

- ~~The waste height is approximately 80 feet across the bottom of the center portion of the Expansion, approximately 2.22 acres. The waste height is approximately 80 feet placed against the bottom sideslope area of the Phase I area, approximately 0.8 acres. The waste height has been raised against the Phase I sideslope and an average of 40 feet has been used for the top portion of the sideslope, approximately 1.43 acres.~~

## SCENARIO 7

- The northern portion of the Phase II Section II Expansion, approximately 2.33 acres, is covered with a rain tarp.

- The bottom northern sideslope portion of the Phase I sideslope adjacent to the area, approximately 0.91 acres, remains intact with a rain tarp over the existing sod. Stormwater runoff from the rain-tarped sideslope enters the rain-tarped northern portion of the Expansion which is pumped to the stormwater swale adjacent to the Expansion.

- The top northern sideslope portion of the Phase I sideslope adjacent to the area, approximately 1.22 acres, remains intact with a rain tarp over the existing sod.

- The center portion of the Expansion, approximately 2.22 acres, has had waste placed in ten foot lifts across the bottom and up against the northern sideslope of the south portion adjacent to the area and up against the bottom southern portion of the Phase I sideslope adjacent to the area for an average depth of 10 feet over the sideslope. The center portion of the Expansion, approximately 2.22 acres, will continue to have waste placed in ten foot lifts across the bottom to a depth of approximately 60 feet thick at the deepest section. Waste will also be placed up against the north sideslope of the south portion created during Fill Sequence No. 4. During waste placement, the surface of the waste layer will be placed so it is sloped back "into" the landfill cell. Waste will also be placed up against the bottom southern sideslope portion of the Phase I sideslope adjacent to the area for approximately 0.59 acres for an average depth of 25 feet over the sideslope. Prior to waste placement against the bottom southern portion of the Phase I sideslope, the County will construct a temporary sideslope berm as needed and will remove the rain tarp and existing sod. The temporary sideslope berm will direct the surface water runoff from the above sideslope area into the Expansion northern portion (which will be covered with a rain tarp while waste filling is not occurring). This surface water runoff will then be pumped by the County from the northern portion area into the adjacent stormwater swale. The remainder of the bottom southern portion of the Phase I sideslope in this area of roughly 0.21 acres will remain intact with a rain tarp over the existing sod.

- The County has constructed a temporary sideslope berm as needed and removed the rain tarp and existing sod within the area from approximately 0.33 acres within the top southern portion of the Phase I sideslope. Waste has been placed within this area for an average depth of approximately 25 feet. The remainder of the top southern portion of the Phase I sideslope in this area of roughly 1.10 acres will remain intact with a rain tarp over the existing sod.

- The leachate generated will be pumped from the Phase II Section II Expansion sump, through the forcemain and into the leachate collection sideslope risers located along the western side of the south portion of the Expansion. The sideslope risers are extensions of the 8-inch diameter leachate collection pipes for the Phase II Section II Expansion south portion which will be connected to the existing 8-inch diameter leachate collection lines located within the Phase II Section I area during construction. The leachate will flow via gravity to the existing leachate collection sump and pumps located within the Phase II Section I area. From the Phase II Section I sump the leachate will be pumped into the existing above ground leachate storage tanks.

- The southern portion of the Expansion, approximately 1.63 acres, previously had waste placed to a depth of approximately 25 feet thick in the deepest portion across the Expansion and up against the Phase II Section I western sideslope within the area. Waste has been placed up against the north sideslope of the area in the original 10 foot offset area created during Fill Sequence No. 4. Eventually, waste filling from the center portion will reach an elevation that waste will also be placed on the top of the south portion and the western and top portion of the Phase II Section I area previously filled in Fill Sequence No. 3 to a depth of approximately 60 feet thick at the deepest section. Filling in this manner from the center portion into the southern portion will meet the peak elevation previously obtained in Fill Sequence No. 3 of approximately EL 166 feet NGVD. The temporary berms placed have been maintained to prevent stormwater runoff from the area entering the adjacent stormwater swale.

- ~~The waste height is approximately 10 feet across the bottom of the northern portion of the Phase II Section II Expansion, approximately 2.33 acres. For an additional design factor of safety and to consider the worse case conditions possible, the Scenario included the entire sideslope of the Phase I area adjacent to the northern portion of the Expansion has been stripped of sod, approximately 2.13 acres. Due to erosion control, actual filling will only remove a minimal quantity of sod along the Phase I area sideslope as needed prior to filling. Therefore, the flow estimated is very conservative.~~

- ~~The waste height is approximately 80 feet across the bottom of the center portion of the Expansion, approximately 2.22 acres. The waste height is approximately 80 feet placed against the bottom sideslope area of the Phase I area, approximately 0.8 acres. The waste height has been raised against the Phase I sideslope and an average of 40 feet has been used for the top portion of the sideslope, approximately 1.43 acres.~~

SCENARIO 8

- The rain tarp on the northern portion of the Phase II Section II Expansion, approximately 2.33 acres, has been removed and is completely open and waste placement has just started.

- The bottom northern sideslope portion of the Phase I sideslope adjacent to the area, approximately 0.19 acres, has had the rain tarp and sod removed, the County has constructed a temporary sideslope berm as needed, and the area is ready for waste placement. The temporary sideslope berm will direct the surface water runoff from the above sideslope area into the adjacent stormwater swale. Approximately 0.72 acres of the bottom northern sideslope portion remains intact with a rain tarp over the existing sod.

- The top northern sideslope portion of the Phase I sideslope adjacent to the area, approximately 1.22 acres, remains intact with a rain tarp over the existing sod.

- The center portion of the Expansion, approximately 2.22 acres, has had waste placed in ten foot lifts across the bottom to a depth of approximately 60 feet thick at the deepest section. Waste has also been placed up against the north sideslope of the south portion created during Fill Sequence No. 4. During waste placement, the surface of the waste layer was placed so it was sloped back "into" the landfill cell. Waste was also placed up against the bottom southern sideslope portion of the Phase I sideslope adjacent to the area for approximately 0.59 acres for an average depth of 25 feet over the sideslope. Prior to waste placement against the bottom southern portion of the Phase I sideslope, the County constructed a temporary sideslope berm as needed and removed the rain tarp and existing sod within the area. The remainder of the bottom southern portion of the Phase I sideslope in this area of roughly 0.21 acres will remain intact with a rain tarp over the existing sod.

- The County has constructed a temporary sideslope berm as needed and removed the rain tarp and existing sod within the area from approximately 0.33 acres within the top southern portion of the Phase I sideslope. Waste has been placed within this area for an average depth of approximately 25 feet. The remainder of the top southern portion of the Phase I sideslope in this area of roughly 1.10 acres will remain intact with a rain tarp over the existing sod.

- The leachate generated will be pumped from the Phase II Section II Expansion sump, through the forcemain and into the leachate collection sideslope risers located along the western side of the south portion of the Expansion. The sideslope risers are extensions of the 8-inch diameter leachate collection pipes for the Phase II Section II Expansion south portion which will be connected to the existing 8-inch diameter leachate collection lines located within the Phase II Section I area during construction. The leachate will flow via gravity to the existing leachate collection sump and pumps located within the Phase II Section I area. From the Phase II Section I sump the leachate will be pumped into the existing above ground leachate storage tanks.

- The southern portion of the Expansion, approximately 1.63 acres, has had waste placed up against the north sideslope of the area in the original 10 foot offset area created during

Fill Sequence No. 4. Waste filling from the center portion reached an elevation that waste was also placed on the top of the south portion and the western and top portion of the Phase II Section I area previously filled in Fill Sequence No. 3 to a depth of approximately 60 feet thick at the deepest section. Filling in this manner from the center portion into the southern portion has met the peak elevation previously obtained in Fill Sequence No. 3 of approximately EL 166 feet NGVD. The temporary berms placed have been maintained to prevent stormwater runoff from the area entering the adjacent stormwater swale.

- ~~The waste height is approximately 40 feet across the bottom of the northern portion of the Phase II Section II Expansion, approximately 2.33 acres. For an additional design factor of safety and to consider the worse case conditions possible, the Scenario included the entire sideslope of the Phase I area adjacent to the northern portion of the Expansion has been stripped of sod, approximately 2.13 acres. Due to erosion control, actual filling will only remove a minimal quantity of sod along the Phase I area sideslope as needed prior to filling. Therefore, the flow estimated is very conservative.~~

- ~~The waste height is approximately 80 feet across the bottom of the center portion of the Expansion, approximately 2.22 acres. The waste height is approximately 80 feet placed against the bottom sideslope area of the Phase I area, approximately 0.8 acres. The waste height has been raised against the Phase I sideslope and an average of 40 feet has been used for the top portion of the sideslope, approximately 1.43 acres.~~

SCENARIO 9

- The northern portion of the Expansion, approximately 2.33 acres, has had an initial four foot lift of select loose municipal solid waste placed over the drainage sand layer to include the 50 foot offset to the south of the interior separation berm along the south side of the area (which originally separated it from the Phase II Section II Expansion center portion). This waste thickness will bring the northern portion disposal area slightly below the northern and western perimeter berm. A temporary working face berm will be placed along the northern and western sides of the area to prevent stormwater runoff from the active filling area entering the adjacent stormwater swale. Additional waste will then be placed to make the first lift approximately 10 feet thick at the deepest section within the area and up against the north side of the center portion of the Expansion created in Fill Sequence No. 5 in the original fifty foot offset space when the center portion had been filled. During waste placement, the surface of the waste layer will be placed so it is sloped back "into" the landfill cell.

- The bottom northern sideslope portion of the Phase I sideslope adjacent to the area, approximately 0.19 acres, has had the rain tarp and sod removed, the County has constructed a temporary sideslope berm as needed, and the area is ready for waste placement. The temporary sideslope berm will direct the surface water runoff from the above sideslope area into the adjacent stormwater swale. Approximately 0.72 acres of the bottom northern sideslope portion remains intact with a rain tarp over the existing sod.

- The top northern sideslope portion of the Phase I sideslope adjacent to the area, approximately 1.22 acres, remains intact with a rain tarp over the existing sod.

- The center portion of the Expansion, approximately 2.22 acres, has had waste placed in ten foot lifts across the bottom to a depth of approximately 60 feet thick at the deepest section. Waste has also been placed up against the north sideslope of the south portion created during Fill Sequence No. 4. During waste placement, the surface of the waste layer was placed so it was sloped back "into" the landfill cell. Waste was also placed up against the bottom southern sideslope portion of the Phase I sideslope adjacent to the area for approximately 0.65 acres for an average depth of 25 feet over the sideslope. Prior to waste placement against the bottom southern portion of the Phase I sideslope, the County constructed a temporary sideslope berm as needed and removed the rain tarp and existing sod within the area. The remainder of the bottom southern portion of the Phase I sideslope in this area of roughly 0.15 acres will remain intact with a rain tarp over the existing sod.

- The County has constructed a temporary sideslope berm as needed and removed the rain tarp and existing sod within the area from approximately 0.33 acres within the top southern portion of the Phase I sideslope. Waste has been placed within this area for an average depth of approximately 25 feet. The remainder of the top southern portion of the Phase I sideslope in this area of roughly 1.10 acres will remain intact with a rain tarp over the existing sod.

- The leachate generated will be pumped from the Phase II Section II Expansion sump, through the forcemain and into the leachate collection sideslope risers located along the western side of the south portion of the Expansion. The sideslope risers are extensions of the 8-inch diameter leachate collection pipes for the Phase II Section II Expansion south portion which will be connected to the existing 8-inch diameter leachate collection lines located within the Phase II Section I area during construction. The leachate will flow via gravity to the existing leachate collection sump and pumps located within the Phase II Section I area. From the Phase II Section I sump the leachate will be pumped into the existing above ground leachate storage tanks.

- The southern portion of the Expansion, approximately 1.63 acres, has had waste placed up against the north sideslope of the area in the original 10 foot offset area created during Fill Sequence No. 4. Waste filling from the center portion reached an elevation that waste was also placed on the top of the south portion and the western and top portion of the Phase II Section I area previously filled in Fill Sequence No. 3 to a depth of approximately 60 feet thick at the deepest section. Filling in this manner from the center portion into the southern portion has met the peak elevation previously obtained in Fill Sequence No. 3 of approximately EL 166 feet NGVD. The temporary berms placed have been maintained to prevent stormwater runoff from the area entering the adjacent stormwater swale.

- ~~The waste height is approximately 40 feet across the bottom of the northern portion of the Expansion, approximately 2.33 acres. The waste height is approximately 10 feet placed~~

~~against the bottom sideslope area of the Phase I area, approximately 0.91 acres. For an additional design factor of safety and to consider the worse case conditions possible, the Scenario included the remainder of the sideslope of the Phase I area adjacent to the northern portion of the Expansion has been stripped of sod, approximately 1.22 acres. Due to erosion control, actual filling will only remove a minimal quantity of sod along the Phase I area sideslope as needed prior to filling. Therefore, the flow estimated is very conservative.~~

- ~~The waste height is approximately 80 feet across the bottom of the center portion of the Expansion, approximately 2.22 acres. The waste height is approximately 80 feet placed against the bottom sideslope area of the Phase I area, approximately 0.8 acres. The waste height has been raised against the Phase I sideslope and an average of 40 feet has been used for the top portion of the sideslope, approximately 1.43 acres.~~

SCENARIO 10

- The northern portion of the Expansion, approximately 2.23 acres, has had a ten foot thick lift of waste placed across the bottom and up against the bottom northern sideslope portion of the Phase I sideslope adjacent to the area for approximately 0.85 acres. The northern portion of the Expansion will continue to have waste placed in ten foot lifts across the bottom to a depth of approximately 25 feet thick at the deepest section. Waste will also be placed up against the north sideslope of the south portion created during Fill Sequence No. 4. During waste placement, the surface of the waste layer will be placed so it is sloped back "into" the landfill cell. Waste will also be placed up against the bottom northern sideslope portion of the Phase I sideslope adjacent to the area for approximately 0.85 acres for an average depth of 10 feet over the sideslope. Prior to waste placement against the bottom northern portion of the Phase I sideslope, the County will construct a temporary sideslope berm as needed and will remove the rain tarp and existing sod within the area. The temporary sideslope berm will direct the surface water runoff from the above sideslope area into the adjacent stormwater swale. The remainder of the bottom northern portion of the Phase I sideslope in this area of roughly 0.06 acres will remain intact with a rain tarp over the existing sod. This will roughly complete the filling up against the bottom northern portion of the Phase I sideslope in this area.

- The top northern sideslope portion of the Phase I sideslope adjacent to the area, approximately 1.22 acres, remains intact with a rain tarp over the existing sod.

- The center portion of the Expansion, approximately 2.22 acres, has had waste placed in ten foot lifts across the bottom to a depth of approximately 60 feet thick at the deepest section. Waste has also been placed up against the north sideslope of the south portion created during Fill Sequence No. 4. During waste placement, the surface of the waste layer was placed so it was sloped back "into" the landfill cell. Waste was also placed up against the bottom southern sideslope portion of the Phase I sideslope adjacent to the area for approximately 0.80 acres for an average depth of 25 feet over the sideslope. Prior to waste placement against the bottom southern portion of the Phase I sideslope, the County constructed a temporary sideslope berm as needed and removed the rain tarp and existing sod within the area from approximately 0.80 acres.

- The County has constructed a temporary sideslope berm as needed and removed the rain tarp and existing sod within the area from approximately 0.33 acres within the top southern portion of the Phase I sideslope. Waste has been placed within this area for an average depth of approximately 25 feet. The remainder of the top southern portion of the Phase I sideslope in this area of roughly 1.10 acres will remain intact with a rain tarp over the existing sod.

- The leachate generated will be pumped from the Phase II Section II Expansion sump, through the forcemain and into the leachate collection sideslope risers located along the western side of the south portion of the Expansion. The sideslope risers are extensions of the 8-inch diameter leachate collection pipes for the Phase II Section II Expansion south portion which will be connected to the existing 8-inch diameter leachate collection lines located within the Phase II Section I area during construction. The leachate will flow via gravity to the existing leachate collection sump and pumps located within the Phase II Section I area. From the Phase II Section I sump the leachate will be pumped into the existing above ground leachate storage tanks.

- The southern portion of the Expansion, approximately 1.63 acres, has had waste placed up against the north sideslope of the area in the original 10 foot offset area created during Fill Sequence No. 4. Waste filling from the center portion reached an elevation that waste was also placed on the top of the south portion and the western and top portion of the Phase II Section I area previously filled in Fill Sequence No. 3 to a depth of approximately 60 feet thick at the deepest section. Filling in this manner from the center portion into the southern portion has met the peak elevation previously obtained in Fill Sequence No. 3 of approximately EL 166 feet NGVD. The temporary berms placed have been maintained to prevent stormwater runoff from the area entering the adjacent stormwater swale.

- ~~The waste height is approximately 80 feet across the bottom of the northern portion of the Expansion, approximately 2.33 acres. The waste height is approximately 80 feet placed against the bottom sideslope area of the Phase I area, approximately 0.91 acres. The waste height has been raised against the Phase I north sideslope and an average of 40 feet has been used for the top portion of the sideslope, approximately 1.22 acres.~~

- ~~The waste height is approximately 80 feet across the bottom of the center portion of the Expansion, approximately 2.22 acres. The waste height is approximately 80 feet placed against the bottom sideslope area of the Phase I area, approximately 0.8 acres. The waste height has been raised against the Phase I sideslope and an average of 40 feet has been used for the top portion of the sideslope, approximately 1.43 acres.~~

SCENARIO 11

- The northern portion of the Expansion has had waste placed to final grades.

- The bottom northern portion of the Phase I sideslope has had waste placed to final grades.
- The top northern portion of the Phase I sideslope has had waste placed to final grades.
- The center portion of the Expansion has had waste placed to final grades.
- The bottom southern portion of the Phase I sideslope has had waste placed to final grades.
- The top southern portion of the Phase I sideslope has had waste placed to final grades.
- The southern portion of the Expansion has had waste placed to final grades.

## HELP MODEL INPUTS

The HELP model allows the user to input soil, waste, or material types in order to simulate the leachate percolation through the landfill. The HELP model user's guide suggests using 0.5 to 1.0 pinholes per acre should account for manufacturers and construction defects for the HDPE geomembrane liner. To be conservative, one pinhole per acre was used within the HELP model.

The HELP model also ranks geomembrane installation on a scale of 1 to 5, with 1 being perfect installation and 5 being the worst-case scenario for installation. The worst-case scenario assumes that the contact between the geomembrane and adjacent soil does not limit the drainage rate, resulting in a leakage rate controlled only by the pinhole. An installation ranking of 3 was used, which represents good field installation with well-prepared, smooth soil surface and good geomembrane wrinkle control to insure good contact between geomembrane and adjacent soil that limits drainage rate. Input data is summarized below in Table G-1 for each of the above-mentioned Scenarios 1 through 11~~0~~. Refer to the HELP model runs located in Attachment G-11.

Table G-1 HELP Model Input Data

| | Thickness (inches) | Soil Texture Number | USCS Description | Hydraulic Conductivity (cm/sec) | Comments |
|---|---|---|---|---|---|
| ~~Expansion~~ South, Center and North Portions **Bottom**<br>**Waste Depth = 0 ft** | | | | | |
| Protective Sand Layer | 24 | 5 | SM | 1.0x10$^{-3}$ | |
| Bi-planar Geocomposite | 0.30 | | | 11.9 | |
| 60 mil Textured Liner | 0.06 | 35 | HDPE Membrane | 2.0x10$^{-13}$ | 1 pinhole/acre (per EPA HELP Model Guide) |
| Tri-planar Geocomposite | 0.30 | | | 40.7~~32.5~~ | |
| 60 mil Textured Liner | 0.06 | 35 | HDPE Membrane | 2.0x10$^{-13}$ | 1 pinhole/acre (per EPA HELP Model Guide) |
| GCL | 0.25 | 17 | GCL | 3.0x10$^{-9}$ | |
| ~~Subbase~~ | ~~24~~ | ~~5~~ | ~~SM~~ | ~~1.0x10$^{-3}$~~ | |
| ~~Expansion~~ South, Center and North Portions **Bottom**<br>**Waste Depth = 10 ft** | | | | | |
| Daily Cover | 6 | 5 | SM | 1.0x10$^{-3}$ | |

| | Thickness (inches) | Soil Texture Number | USCS Description | Hydraulic Conductivity (cm/sec) | Comments |
|---|---|---|---|---|---|
| Waste Layer | 12~~6~~0 | 19 | Municipal Waste w/ Channeling | $1.0 \times 10^{-3}$ | |
| ~~Waste Layer~~ | ~~60~~ | ~~19~~ | ~~Municipal Waste w/ Channeling~~ | ~~$1.0 \times 10^{-3}$~~ | |
| Protective Sand Layer | 24 | 5 | SM | $1.0 \times 10^{-3}$ | |
| Bi-planar Geocomposite | 0.30 | | | 11.9 | Transmissivity/hydraulic conductivity |
| 60 mil Textured Liner | 0.06 | 35 | HDPE Membrane | $2.0 \times 10^{-13}$ | 1 pinhole/acre (per EPA HELP Model Guide) |
| Tri-planar Geocomposite | 0.30 | | | 40.7~~32.5~~ | Transmissivity/hydraulic conductivity |
| 60 mil Textured Liner | 0.06 | 35 | HDPE Membrane | $2.0 \times 10^{-13}$ | 1 pinhole/acre (per EPA HELP Model Guide) |
| GCL | 0.25 | 17 | GCL | $3.0 \times 10^{-9}$ | |
| ~~Subbase~~ | ~~24~~ | ~~5~~ | ~~SM~~ | ~~$1.0 \times 10^{-3}$~~ | |
| **~~Expansion~~ South, Center and North Portions Bottom Waste Depth = 25~~40~~ ft** | | | | | |
| Daily Cover | 6 | 5 | SM | $1.0 \times 10^{-3}$ | |
| Waste Layer | 60~~120~~ | 19 | Municipal Waste w/ Channeling | $1.0 \times 10^{-3}$ | |
| Waste Layer | 120 | 19 | Municipal Waste w/ Channeling | $1.0 \times 10^{-3}$ | |
| Waste Layer | 120 | 19 | Municipal Waste w/ Channeling | $1.0 \times 10^{-3}$ | |
| ~~Waste Layer~~ | ~~120~~ | ~~19~~ | ~~Municipal Waste w/ Channeling~~ | ~~$1.0 \times 10^{-3}$~~ | |
| Protective Sand Layer | 24 | 5 | SM | $1.0 \times 10^{-3}$ | |
| Bi-planar Geocomposite | 0.273 | | | 7.2~~8.2~~ | Reduced transmissivity/hydraulic conductivity |
| 60 mil Textured Liner | 0.06 | 35 | HDPE Membrane | $2.0 \times 10^{-13}$ | 1 pinhole/acre (per EPA HELP Model Guide) |
| Tri-planar Geocomposite | 0.273 | | | 29.4~~23.7~~ | Reduced transmissivity/hydraulic conductivity |
| 60 mil Textured Liner | 0.06 | 35 | HDPE Membrane | $2.0 \times 10^{-13}$ | 1 pinhole/acre (per EPA HELP Model Guide) |
| GCL | 0.25 | 17 | GCL | $3.0 \times 10^{-9}$ | |
| ~~Subbase~~ | ~~24~~ | ~~5~~ | ~~SM~~ | ~~$1.0 \times 10^{-3}$~~ | |
| **~~Expansion~~ South, Center and North Portions Bottom Waste Depth = 6~~8~~0 ft** | | | | | |

| | Thickness (inches) | Soil Texture Number | USCS Description | Hydraulic Conductivity (cm/sec) | Comments |
|---|---|---|---|---|---|
| Intermediate Cover | 18 | 5 | SM | $1.0x10^{-3}$ | |
| Waste Layer | 120 | 19 | Municipal Waste w/ Channeling | $1.0x10^{-3}$ | |
| Waste Layer | 120 | 19 | Municipal Waste w/ Channeling | $1.0x10^{-3}$ | |
| Waste Layer | 120 | 19 | Municipal Waste w/ Channeling | $1.0x10^{-3}$ | |
| Waste Layer | 120 | 19 | Municipal Waste w/ Channeling | $1.0x10^{-3}$ | |
| Waste Layer | 120 | 19 | Municipal Waste w/ Channeling | $1.0x10^{-3}$ | |
| Waste Layer | 120 | 19 | Municipal Waste w/ Channeling | $1.0x10^{-3}$ | |
| ~~Waste Layer~~ | ~~120~~ | ~~19~~ | ~~Municipal Waste w/ Channeling~~ | ~~$1.0x10^{-3}$~~ | |
| ~~Waste Layer~~ | ~~120~~ | ~~19~~ | ~~Municipal Waste w/ Channeling~~ | ~~$1.0x10^{-3}$~~ | |
| Protective Sand Layer | 24 | 5 | SM | $1.0x10^{-3}$ | |
| Bi-planar Geocomposite | 0.261 | | | 5.3~~4.8~~ | Reduced transmissivity/hydraulic conductivity |
| 60 mil Textured Liner | 0.06 | 35 | HDPE Membrane | $2.0x10^{-13}$ | 1 pinhole/acre (per EPA HELP Model Guide) |
| Tri-planar Geocomposite | 0.261 | | | 21.8~~17.4~~ | Reduced transmissivity/hydraulic conductivity |
| 60 mil Textured Liner | 0.06 | 35 | HDPE Membrane | $2.0x10^{-13}$ | 1 pinhole/acre (per EPA HELP Model Guide) |
| GCL | 0.25 | 17 | GCL | $3.0x10^{-9}$ | |
| ~~Subbase~~ | ~~24~~ | ~~5~~ | ~~SM~~ | ~~$1.0x10^{-3}$~~ | |

**Bottom Southern Sideslope Phase I~~Phase I Sideslope~~, Top Southern Sideslope Phase I, Bottom Northern Sideslope Phase I and Top Northern Sideslope Phase I**
**(With Sod)**
**Waste Depth = 0 ft**

| | | | | | |
|---|---|---|---|---|---|
| Protective Sand Layer | 24 | 5 | SM | $1.0x10^{-3}$ | |
| Bi-planar Geocomposite | 0.33 | | | 7.8~~10.5~~ | |
| 60 mil Textured Liner | 0.06 | 35 | HDPE Membrane | $2.0x10^{-13}$ | 1 pinhole/acre (per EPA HELP Model Guide) |

| | Thickness (inches) | Soil Texture Number | USCS Description | Hydraulic Conductivity (cm/sec) | Comments |
|---|---|---|---|---|---|
| Subbase | 24 | 5 | SM | 1.0x10$^{-3}$ | |
| **Bottom Southern Sideslope Phase I~~Phase I Sideslope~~ and Bottom Northern Sideslope Phase I (No Sod) Waste Depth = 0 ft** | | | | | |
| Protective Sand Layer | 24 | 5 | SM | 1.0x10$^{-3}$ | |
| Bi-planar Geocomposite | 0.33 | | | 7.8~~10.5~~ | |
| 60 mil Textured Liner | 0.06 | 35 | HDPE Membrane | 2.0x10$^{-13}$ | 1 pinhole/acre (per EPA HELP Model Guide) |
| Subbase | 24 | 5 | SM | 1.0x10$^{-3}$ | |
| **Bottom Southern Sideslope Phase I~~Phase I Sideslope~~ and Bottom Northern Sideslope Phase I Waste Depth = 10 ft** | | | | | |
| Daily Cover | 6 | 5 | SM | 1.0x10$^{-3}$ | |
| ~~Waste Layer~~ | ~~60~~ | ~~19~~ | ~~Municipal Waste w/ Channeling~~ | ~~1.0x10$^{-3}$~~ | |
| Waste Layer | 120~~60~~ | 19 | Municipal Waste w/ Channeling | 1.0x10$^{-3}$ | |
| Protective Sand Layer | 24 | 5 | SM | 1.0x10$^{-3}$ | |
| Bi-planar Geocomposite | 0.33 | | | 7.8~~10.5~~ | Transmissivity/hydraulic conductivity |
| 60 mil Textured Liner | 0.06 | 35 | HDPE Membrane | 2.0x10$^{-13}$ | 1 pinhole/acre (per EPA HELP Model Guide) |
| Subbase | 24 | 5 | SM | 1.0x10$^{-3}$ | |
| **Bottom Southern Sideslope Phase I~~Phase I Sideslope~~, Top Southern Sideslope Phase I and Bottom Northern Sideslope Phase I Waste Depth = 25~~40~~ ft** | | | | | |
| Daily Cover | 6 | 5 | SM | 1.0x10$^{-3}$ | |
| Waste Layer | 60~~120~~ | 19 | Municipal Waste w/ Channeling | 1.0x10$^{-3}$ | |
| Waste Layer | 120 | 19 | Municipal Waste w/ Channeling | 1.0x10$^{-3}$ | |
| Waste Layer | 120 | 19 | Municipal Waste w/ Channeling | 1.0x10$^{-3}$ | |
| ~~Waste Layer~~ | ~~120~~ | ~~19~~ | ~~Municipal Waste w/ Channeling~~ | ~~1.0x10$^{-3}$~~ | |
| Protective Sand Layer | 24 | 5 | SM | 1.0x10$^{-3}$ | |
| Bi-planar Geocomposite | 0.30 | | | 5.7~~7.3~~ | Reduced transmissivity/hydraulic conductivity |
| 60 mil Textured Liner | 0.06 | 35 | HDPE Membrane | 2.0x10$^{-13}$ | 1 pinhole/acre (per EPA HELP Model Guide) |

| | Thickness (inches) | Soil Texture Number | USCS Description | Hydraulic Conductivity (cm/sec) | Comments |
|---|---|---|---|---|---|
| Subbase | 24 | 5 | SM | $1.0x10^{-3}$ | |
| ~~Phase I Sideslope Waste Depth = 80 ft~~ | | | | | |
| ~~Intermediate Cover~~ | ~~18~~ | ~~5~~ | ~~SM~~ | ~~$1.0x10^{-3}$~~ | |
| ~~Waste Layer~~ | ~~120~~ | ~~19~~ | ~~Municipal Waste w/ Channeling~~ | ~~$1.0x10^{-3}$~~ | |
| ~~Waste Layer~~ | ~~120~~ | ~~19~~ | ~~Municipal Waste w/ Channeling~~ | ~~$1.0x10^{-3}$~~ | |
| ~~Waste Layer~~ | ~~120~~ | ~~19~~ | ~~Municipal Waste w/ Channeling~~ | ~~$1.0x10^{-3}$~~ | |
| ~~Waste Layer~~ | ~~120~~ | ~~19~~ | ~~Municipal Waste w/ Channeling~~ | ~~$1.0x10^{-3}$~~ | |
| ~~Waste Layer~~ | ~~120~~ | ~~19~~ | ~~Municipal Waste w/ Channeling~~ | ~~$1.0x10^{-3}$~~ | |
| ~~Waste Layer~~ | ~~120~~ | ~~19~~ | ~~Municipal Waste w/ Channeling~~ | ~~$1.0x10^{-3}$~~ | |
| ~~Waste Layer~~ | ~~120~~ | ~~19~~ | ~~Municipal Waste w/ Channeling~~ | ~~$1.0x10^{-3}$~~ | |
| ~~Waste Layer~~ | ~~120~~ | ~~19~~ | ~~Municipal Waste w/ Channeling~~ | ~~$1.0x10^{-3}$~~ | |
| ~~Protective Sand Layer~~ | ~~24~~ | ~~5~~ | ~~SM~~ | ~~$1.0x10^{-3}$~~ | |
| ~~Bi-planar Geocomposite~~ | ~~0.287~~ | | | ~~4.0~~ | ~~Reduced transmissivity/hydraulic conductivity~~ |
| ~~60 mil Textured Liner~~ | ~~0.06~~ | ~~35~~ | ~~HDPE Membrane~~ | ~~$2.0x10^{-13}$~~ | ~~1 pinhole/acre (per EPA HELP Model Guide)~~ |
| ~~Subbase~~ | ~~24~~ | ~~5~~ | ~~SM~~ | ~~$1.0x10^{-3}$~~ | |

Provided below are summary Tables G-2 through G-25~~10~~ identifying the results of the HELP model analysis for the above-mentioned Scenarios. Please refer to Attachment G-11 for the HELP model runs and a summary table of the results provided below. In addition, the anticipated leachate volume generated from the leachate collection system and leachate detection system is provided for each Scenario.

Table G-2 Expansion South Portion Bottom Waste Depth = 0 Feet (Peak Values)

| | Collection System | Detection System |
|---|---|---|

| | Maximum Head on Liner (inch) | Leachate Collected (ft³/day)* | Leachate Collected (gal/min)* | Maximum Head on Liner (inch) | Leachate Collected (ft³/day)* | Leachate Collected (gal/min)* |
|---|---|---|---|---|---|---|
| Length = ~~46~~53.10 ft<br>Slope = 2.20% | 0.280~~179~~ | 12,611.95 ~~11,015~~ | 65.52~~57.22~~ | 0.000 | 46.67~~40.326~~ | 0.24~~0.21~~ |

Note: *Leachate collected is on a per acre basis.

Table G-3 Expansion South Portion Bottom Waste Depth = 10 Feet (Peak Values)

| | Collection System | | | Detection System | | |
|---|---|---|---|---|---|---|
| | Maximum Head on Liner (inch) | Leachate Collected (ft³/day)* | Leachate Collected (gal/min)* | Maximum Head on Liner (inch) | Leachate Collected (ft³/day)* | Leachate Collected (gal/min)* |
| Length = ~~46~~53.10 ft<br>Slope = 2.20% | 0.134~~0.012~~ | 7,045.82~~7,305~~ | 36.60~~37.95~~ | 0.00~~0~~1 | 34.62~~32.745~~ | 0.18~~0.17~~ |

Note: *Leachate collected is on a per acre basis.

Table G-4 Expansion South Portion Bottom Waste Depth = 25~~40~~ Feet (Peak Values)

| | Collection System | | | Detection System | | |
|---|---|---|---|---|---|---|
| | Maximum Head on Liner (inch) | Leachate Collected (ft³/day)* | Leachate Collected (gal/min)* | Maximum Head on Liner (inch) | Leachate Collected (ft³/day)* | Leachate Collected (gal/min)* |
| Length = ~~46~~53.10 ft<br>Slope = 2.20% | 0.123~~0.079~~ | 3,921.42~~3,288~~ | 20.37~~17.08~~ | 0.0000~~1~~ | 33.34~~26.486~~ | 0.17~~0.14~~ |

Note: *Leachate collected is on a per acre basis.

Table G-5 Expansion South Portion Bottom Waste Depth = 60~~80~~ Feet (Peak Values)

| | Collection System | | | Detection System | | |
|---|---|---|---|---|---|---|
| | Maximum Head on Liner (inch) | Leachate Collected (ft³/day)* | Leachate Collected (gal/min)* | Maximum Head on Liner (inch) | Leachate Collected (ft³/day)* | Leachate Collected (gal/min)* |
| Length = ~~46~~53.10 ft<br>Slope = 2.20% | 0.0836 | 1,925.07~~2,080~~ | 10.~~81~~00 | 0.00~~0~~1 | 27.08~~611~~ | 0.14 |

Note: *Leachate collected is on a per acre basis.

Table G-6 Expansion Center Portion Bottom Waste Depth = 0 Feet (Peak Values)

| | Collection System | | | Detection System | | |
|---|---|---|---|---|---|---|

| | Maximum Head on Liner (inch) | Leachate Collected ($ft^3$/day)* | Leachate Collected (gal/min)* | Maximum Head on Liner (inch) | Leachate Collected ($ft^3$/day)* | Leachate Collected (gal/min)* |
|---|---|---|---|---|---|---|
| Length = 53.10 ft<br>Slope = 2.20% | 0.280 | 12,611.95 | 65.52 | 0.000 | 46.67 | 0.24 |

Note: *Leachate collected is on a per acre basis.

Table G-7 Expansion Center Portion Bottom Waste Depth = 10 Feet (Peak Values)

| | Collection System | | | Detection System | | |
|---|---|---|---|---|---|---|
| | Maximum Head on Liner (inch) | Leachate Collected ($ft^3$/day)* | Leachate Collected (gal/min)* | Maximum Head on Liner (inch) | Leachate Collected ($ft^3$/day)* | Leachate Collected (gal/min)* |
| Length = 53.10 ft<br>Slope = 2.20% | 0.134 | 7,045.82 | 36.60 | 0.001 | 34.64 | 0.18 |

Note: *Leachate collected is on a per acre basis.

Table G-8 Expansion Center Portion Bottom Waste Depth = 25 Feet (Peak Values)

| | Collection System | | | Detection System | | |
|---|---|---|---|---|---|---|
| | Maximum Head on Liner (inch) | Leachate Collected ($ft^3$/day)* | Leachate Collected (gal/min)* | Maximum Head on Liner (inch) | Leachate Collected ($ft^3$/day)* | Leachate Collected (gal/min)* |
| Length = 53.10 ft<br>Slope = 2.20% | 0.123 | 3,921.42 | 20.37 | 0.000 | 33.34 | 0.17 |

Note: *Leachate collected is on a per acre basis.

Table G-9 Expansion Center Portion Bottom Waste Depth = 60 Feet (Peak Values)

| | Collection System | | | Detection System | | |
|---|---|---|---|---|---|---|
| | Maximum Head on Liner (inch) | Leachate Collected ($ft^3$/day)* | Leachate Collected (gal/min)* | Maximum Head on Liner (inch) | Leachate Collected ($ft^3$/day)* | Leachate Collected (gal/min)* |
| Length = 53.10 ft<br>Slope = 2.20% | 0.261 | 1,925.07 | 10.00 | 0.001 | 27.08 | 0.14 |

Note: *Leachate collected is on a per acre basis.

Table G-10 Expansion North Portion Bottom Waste Depth = 0 Feet (Peak Values)

| | Collection System | | | Detection System | | |
|---|---|---|---|---|---|---|
| | Maximum Head on Liner (inch) | Leachate Collected ($ft^3$/day)* | Leachate Collected (gal/min)* | Maximum Head on Liner (inch) | Leachate Collected ($ft^3$/day)* | Leachate Collected (gal/min)* |

| | | | | | | |
|---|---|---|---|---|---|---|
| Length = 53.5 ft<br>Slope = 2.20% | 0.283 | 12,617.35 | 65.54 | 0.000 | 46.82 | 0.24 |

Note: *Leachate collected is on a per acre basis.

Table G-11 Expansion North Portion Bottom Waste Depth = 10 Feet (Peak Values)

| | Collection System | | | Detection System | | |
|---|---|---|---|---|---|---|
| | Maximum Head on Liner (inch) | Leachate Collected (ft³/day)* | Leachate Collected (gal/min)* | Maximum Head on Liner (inch) | Leachate Collected (ft³/day)* | Leachate Collected (gal/min)* |
| Length = 53.5 ft<br>Slope = 2.20% | 0.135 | 7,046.71 | 36.61 | 0.001 | 34.75 | 0.18 |

Note: *Leachate collected is on a per acre basis.

Table G-12 Expansion North Portion Bottom Waste Depth = 25 Feet (Peak Values)

| | Collection System | | | Detection System | | |
|---|---|---|---|---|---|---|
| | Maximum Head on Liner (inch) | Leachate Collected (ft³/day)* | Leachate Collected (gal/min)* | Maximum Head on Liner (inch) | Leachate Collected (ft³/day)* | Leachate Collected (gal/min)* |
| Length = 53.5 ft<br>Slope = 2.20% | 0.273 | 3,935.12 | 20.44 | 0.002 | 33.53 | 0.17 |

Note: *Leachate collected is on a per acre basis.

Table G-13 Expansion North Portion Bottom Waste Depth = 60 Feet (Peak Values)

| | Collection System | | | Detection System | | |
|---|---|---|---|---|---|---|
| | Maximum Head on Liner (inch) | Leachate Collected (ft³/day)* | Leachate Collected (gal/min)* | Maximum Head on Liner (inch) | Leachate Collected (ft³/day)* | Leachate Collected (gal/min)* |
| Length = 53.5 ft<br>Slope = 2.20% | 0.261 | 1,925.07 | 10.00 | 0.000 | 27.18 | 0.14 |

Note: *Leachate collected is on a per acre basis.

Table G-14~~6~~ Phase I Sideslope Bottom Southern Sideslope (With Sod) Waste Depth = 0 Feet (Peak Values)

| | Collection System | | |
|---|---|---|---|
| | Maximum Head on Liner (inch) | Leachate Collected (ft³/day)* | Leachate Collected (gal/min)* |
| Length = ~~10~~75 ft<br>Slope = 33.33% | 0.030~~17~~ | ~~5,683~~9,546.75 | ~~29.25~~49.59 |

Note: *Leachate collected is on a per acre basis.

Table G-157 Phase I Bottom Southern Sideslope (No Sod) Waste Depth = 10 Feet (Peak Values)

| | Collection System | | |
|---|---|---|---|
| | Maximum Head on Liner (inch) | Leachate Collected (ft³/day)* | Leachate Collected (gal/min)* |
| Length = 1075 ft<br>Slope = 33.33% | 0.0386 | 11,1087,083.94 | 57.7036.80 |

Note: *Leachate collected is on a per acre basis.

Table G-16 Phase I Bottom Southern Sideslope Waste Depth = Open Cell, 0 Feet (Peak Values)

| | Collection System | | |
|---|---|---|---|
| | Maximum Head on Liner (inch) | Leachate Collected (ft³/day)* | Leachate Collected (gal/min)* |
| Length = 75 ft<br>Slope = 33.33% | 0.022 | 9,601.70 | 49.88 |

Note: *Leachate collected is on a per acre basis.

Table G-817 Phase I Bottom Southern Sideslope Waste Depth = 1025 Feet (Peak Values)

| | Collection System | | |
|---|---|---|---|
| | Maximum Head on Liner (inch) | Leachate Collected (ft³/day)* | Leachate Collected (gal/min)* |
| Length = 1075 ft<br>Slope = 33.33% | 0.01542 | 7,0573,880.14 | 36.6620.16 |

Note: *Leachate collected is on a per acre basis.

Table G-189 Phase I Top Southern Sideslope With Sod Waste Depth = 40 Feet (Peak Values)

| | Collection System |
|---|---|

| | Maximum Head on Liner (inch) | Leachate Collected (ft³/day)* | Leachate Collected (gal/min)* |
|---|---|---|---|
| Length = 105 ft<br>Slope = 33.33% | 0.04518 | 4,2889,494.95 | 22.7749.32 |

Note: *Leachate collected is on a per acre basis.

Table G-190 Phase I Top Southern Sideslope Waste Depth = 2580 Feet (Peak Values)

| | Collection System | | |
|---|---|---|---|
| | Maximum Head on Liner (inch) | Leachate Collected (ft³/day)* | Leachate Collected (gal/min)* |
| Length = 105 ft<br>Slope = 33.33% | 0.0495 | 2,6913,872.44 | 13.9820.12 |

Note: *Leachate collected is on a per acre basis.

Table G-20 Phase I Sideslope Bottom Northern Sideslope (With Sod) Waste Depth = 0 Feet (Peak Values)

| | Collection System | | |
|---|---|---|---|
| | Maximum Head on Liner (inch) | Leachate Collected (ft³/day)* | Leachate Collected (gal/min)* |
| Length = 75 ft<br>Slope = 33.33% | 0.030 | 9,546.75 | 49.59 |

Note: *Leachate collected is on a per acre basis.

Table G-21 Phase I Bottom Northern Sideslope Waste Depth = Open Cell, 0 Feet (Peak Values)

| | Collection System | | |
|---|---|---|---|
| | Maximum Head on Liner (inch) | Leachate Collected (ft³/day)* | Leachate Collected (gal/min)* |
| Length = 75 ft<br>Slope = 33.33% | 0.022 | 9,601.70 | 49.88 |

Note: *Leachate collected is on a per acre basis.

## Table G-22 Phase I Bottom Northern Sideslope Waste Depth = 10 Feet (Peak Values)

| | Collection System | | |
|---|---|---|---|
| | Maximum Head on Liner (inch) | Leachate Collected ($ft^3$/day)* | Leachate Collected (gal/min)* |
| Length = 75 ft<br>Slope = 33.33% | 0.038 | 7,083.94 | 36.80 |

Note: *Leachate collected is on a per acre basis.

## Table G-23 Phase I Bottom Northern Sideslope Waste Depth = 25 Feet (Peak Values)

| | Collection System | | |
|---|---|---|---|
| | Maximum Head on Liner (inch) | Leachate Collected ($ft^3$/day)* | Leachate Collected (gal/min)* |
| Length = 75 ft<br>Slope = 33.33% | 0.015 | 3,880.14 | 20.16 |

Note: *Leachate collected is on a per acre basis.

## Table G-24 Phase I Sideslope Top Northern Sideslope (With Sod) Waste Depth = 0 Feet (Peak Values)

| | Collection System | | |
|---|---|---|---|
| | Maximum Head on Liner (inch) | Leachate Collected ($ft^3$/day)* | Leachate Collected (gal/min)* |
| Length = 105 ft<br>Slope = 33.33% | 0.045 | 9,494.95 | 49.32 |

Note: *Leachate collected is on a per acre basis.

## Table G-25 Phase I Top Northern Sideslope Waste Depth = 15 Feet (Peak Values)

| | Collection System | | |
|---|---|---|---|
| | Maximum Head on Liner (inch) | Leachate Collected ($ft^3$/day)* | Leachate Collected (gal/min)* |
| Length = 105 ft<br>Slope = 33.33% | 0.037 | 5,313.60 | 27.60 |

Note: *Leachate collected is on a per acre basis.

As shown in the above Tables G-2 through G-25~~10~~, the addition of waste decreases the amount of leachate produced. In all HELP model runs, the head in the primary and secondary LCRS is less than the thickness of the bi-planar geocomposite and secondary tri-planar geocomposites as identified in Table G-26~~11~~ below. In addition, please refer to Attachment G-11 for the HELP model runs and a summary table of the results.

Table G-26~~11~~ Leachate Depth in LCRS

| | Depth of Waste (Feet) | Thickness of Primary Geocomposite (Inches) | Maximum Leachate Head (Inches) | Thickness of Secondary Geocomposite (Inches) | Maximum Leachate Head (Inches) |
|---|---|---|---|---|---|
| Expansion Bottom South | 0 | 0.300 | 0.280~~179~~ | 0.300 | 0.000 |
| Expansion Bottom South | 10 | 0.300 | 0.134~~012~~ | 0.300 | 0.001~~0~~ |
| Expansion Bottom South | 25~~40~~ | 0.273 | 0.123~~079~~ | 0.273 | 0.000~~1~~ |
| Expansion Bottom South | 6~~8~~0 | 0.261 | 0.083~~6~~ | 0.261 | 0.001~~0~~ |
| Expansion Bottom Center | 0 | 0.300 | 0.280 | 0.300 | 0.000 |
| Expansion Bottom Center | 10 | 0.300 | 0.134 | 0.300 | 0.001 |
| Expansion Bottom Center | 25 | 0.273 | 0.123 | 0.273 | 0.000 |
| Expansion Bottom Center | 60 | 0.261 | 0.083 | 0.261 | 0.001 |
| Expansion Bottom North | 0 | 0.300 | 0.283 | 0.300 | 0.000 |
| Expansion Bottom North | 10 | 0.300 | 0.135 | 0.300 | 0.001 |
| Expansion Bottom North | 25 | 0.273 | 0.125 | 0.273 | 0.002 |
| Expansion Bottom North | 60 | 0.261 | 0.000 | 0.261 | 0.000 |
| Phase I Bottom South Sideslope (With Existing Sod) | 0 | 0.330 | 0.030~~17~~ | N/A* | N/A* |
| Phase I Bottom South Sideslope (No Sod) | 0 | 0.330 | 0.022~~6~~ | N/A* | N/A* |
| Phase I Bottom South Sideslope | 10 | 0.330 | 0.038~~42~~ | N/A* | N/A* |
| Phase I Bottom South Sideslope | 25~~40~~ | 0.300 | 0.015~~8~~ | N/A* | N/A* |

| | | | | | |
|---|---|---|---|---|---|
| Phase I Top South Sideslope (With Existing Sod) | ~~8~~0 | 0.330~~287~~ | 0.045 | N/A* | N/A* |
| Phase I Top South Sideslope | 25 | 0.300 | 0.049 | N/A* | N/A* |
| Phase I Bottom North Sideslope (With Existing Sod) | 0 | 0.330 | 0.030 | N/A* | N/A* |
| Phase I Bottom North Sideslope (No Sod) | 0 | 0.330 | 0.022 | N/A* | N/A* |
| Phase I Bottom North Sideslope | 10 | 0.330 | 0.038 | N/A* | N/A* |
| Phase I Bottom North Sideslope | 25 | 0.300 | 0.015 | N/A* | N/A* |
| Phase I Top North Sideslope (With Existing Sod) | 0 | 0.330 | 0.045 | N/A* | N/A* |
| Phase I Top North Sideslope | 15 | 0.300 | 0.037 | N/A* | N/A* |

Note: *Phase I sideslope only has a primary geocomposite, no secondary geocomposite installed.

### G.2.c.2.5 Design of LCRS Pipes

The leachate collection and removal system is designed to limit the hydraulic head on the liner to the thickness of the geocomposite layer. The primary leachate collection system is composed of double-sided bi-planar geocomposite laid over the primary HDPE liner along the bottom and sides of the cell. The geocomposite is designed to maintain a high flow rate under the load exerted by the full height of the landfill waste.

~~Using Scenario 1, as described above with the conservative estimate regarding the open areas during filling, the estimated peak flow is approximately 317.3 gpm or roughly 61,086 cubic feet/day.~~ The flow capacity of the LCRS lateral pipes must be greater than the flow entering the pipes from the geocomposite. The LCRS lateral pipes are 8-inch diameter HDPE SDR 11 pipe except for the LCRS lateral pipes at the toe of slope where the Phase II Section II Expansion joins the Phase I area where the LCRS lateral pipes will be 10-inch diameter HDPE SDR 11 pipe. ~~At a slope of approximately 1.1 percent after expected settlement, the 8-inch LCRS has a capacity of approximately 582 gpm and the 10-inch LCRS at a slope of approximately 0.86 percent has a capacity of approximately 914 gpm. Therefore, based on the entire estimated peak flow generated of 317.3 gpm there is a factor of safety of approximately 1.8 for the 8-inch LCRS lateral pipes and 2.9 for the 10-inch LCRS lateral pipes.~~ Please refer to Attachment G-12 for the LCRS lateral trench and pipe capacity calculations.

The LCRS lateral pipes transport the leachate to a 12-inch diameter HDPE SDR 11 header pipe, which in turn transports the leachate to the leachate collection sump. The flow capacity of the LCRS header pipe must be greater than the flow entering the header pipe from the LCRS lateral pipes. At a slope of approximately 0.93 percent after expected settlement, the LCRS has a capacity of approximately 1,498 gpm. The maximum flow with the conservative estimate regarding the open areas during filling is approximately 317.3 gpm; therefore, there is a factor of safety of approximately 4.7. Please refer to Attachment G-13 for the LCRS header pipe capacity calculations.

During Fill Sequence No. 1 through Fill Sequence No. 3, as indicated on the Drawings, stormwater accumulated within the Phase II Section II Expansion sump will be pumped into the adjacent stormwater swale using the leachate collection pump through the use of piping and a bypass valve.

In addition, during waste filling operations identified as Fill Sequence No. 4 through Fill Sequence No. 6, as indicated on Drawings, leachate will be pumped from the leachate collection sump (via the leachate collection and leachate detection pumps) through a force main to the three 8-inch diameter HDPE SDR 11 leachate collection sideslope risers located in the south portion of the Phase II Section II Expansion. Valves located at each of the sideslope risers can be manually opened or closed by the County as needed to allow the leachate into any of the sideslope risers individually or to all three at the same time. During normal operations, all valves on the sideslope risers will remain open which will distribute leachate flow into each of the three risers.

Based on the HELP Model analyses the worst-case operating Scenario regarding leachate generation from the Phase II Section II Expansion center and northern portions which would be pumped would be Scenario 8. During this scenario approximately 202.93 gpm of leachate is generated from the north and center collection portions and 0.88 gpm of leachate is generated from the north and center detection portions which will be pumped from the Phase II Section II Expansion sump through the force main into the south portion leachate collection sideslope risers for a total of 203.81 gpm.

Based on the HELP Model analyses the worst-case operating Scenario regarding leachate generation from the Phase II Section II Expansion center and northern portions and also the leachate generated in the Phase II Section II Expansion south portion would be Scenario 8 and Scenario 3, respectively. During this operating Scenario approximately 202.93 gpm of leachate is generated from the Phase II Section II Expansion north and center collection portions, 0.88 gpm of leachate is generated from the Phase II Section II Expansion north and center detection portions, and 33.20 gpm is generated from the Phase II Section II Expansion south portion collection system for a total of approximately 237.01 gpm. This amount of leachate will be added to the flow in the existing 8-inch leachate collection pipes within the Phase II Section I area.

Therefore, assuming the worst-case operating Scenario would be if all of the leachate pumped from the Phase II Section II Expansion sump would go into only one of the three leachate collection sideslope risers in the Phase II Section II Expansion south portion and that all of the leachate would be collected in one of the south portion leachate collection laterals. Therefore, the worst case design flow to the leachate collection pipes within the Phase II Section II

Expansion south portion would be approximately 237.01 gpm (202.93 gpm + 0.88 gpm + 33.20 gpm).

HELP Model analysis were conducted on the existing conditions of the Phase II Section I area to determine an existing amount of leachate generation from the area. Based on an existing waste depth of 40 feet within the 5-acre area, peak conditions indicate that approximately 74.71 gpm is generated. In addition, additional HELP Models were conducted on the existing conditions of the Phase I south sideslope area to determine an existing amount of leachate generation from the area which also flows into the Phase II Section I area. A rain tarp and stormwater outlet pipes divert stormwater away from the active filling area along the sideslope. Based on a waste depth of 10 feet within half of the sideslope area (0.65-acres due to the rain tarp), peak conditions indicate that approximately 23.84 gpm is generated from the sideslope area. Therefore, approximately 98.55 gpm (74.71 gpm + 23.84 gpm) is currently being transported by the existing Phase II Section I leachate collection pipes.

Based on the above-mentioned HELP Model information, the maximum flow to the existing leachate collection pipes within the Phase II Section I area is approximately 335.56 gpm (202.93 gpm + 0.88 gpm + 33.20 gpm + 74.71 gpm + 23.84 gpm).

Therefore, in order to size the 8-inch leachate collection pipes within the Phase II Section II Expansion south portion and also confirm the adequacy of the existing 8-inch leachate collection pipes within the Phase II Section I area, the worst-case flow of 335.56 gpm was utilized. The flow capacity of the LCRS lateral pipe must be greater than the flow entering the pipe from the geocomposite within the area and the flow pumped into the LCRS pipe from the Phase II Section II Expansion. The LCRS lateral pipes are 8-inch diameter HDPE SDR 11 pipe. At the estimated slope after expected settlement, the 8-inch LCRS has a capacity of approximately 587 gpm. Based on the estimated peak flow generated of 335.56 gpm there is a factor of safety of approximately 1.8 for the 8-inch LCRS lateral pipe. Therefore, if one 8-inch diameter HDPE SDR 11 LCRS lateral pipe is sufficient to carry all of the flow as described above, distributing the leachate flow through three 8-inch diameter HDPE SDR 11 LCRS lateral pipes will adequately carry the flow as needed. Refer to Section G.2.c.2.8 for information regarding the force main piping network.

The existing LCRS collection pump in the Phase II Section I area is a Sligo Series 3-7.5-4 Pump which is sufficient to handle the anticipated flow. The existing LCRS detection pump in the Phase II Section I area is a Sligo Series 1-0.34-2 PSF Pump which is sufficient to handle the anticipated flow.

#### G.2.c.2.6 Design of LCRS Pumps

Peak daily leachate flows indicated from the HELP model were used to assess the appropriate size of the leachate pumps. SCS also considered a special design case (Scenario 1) for the pumps recognizing that solid waste operations can be substantially affected by a 24-hour 25-year storm event, especially early in the filling operation. The Southwest Florida Water Management District (SWFWMD) Twenty Four Hour Twenty Five Year Return Period Rainfall Map for the Hardee County Landfill indicates that the total rainfall amount that occurs during a 24-hour 25-year storm event is 8.2 inches. In effect, periodically generated leachate flows are erratic and can be greater over a short period of time than with the assumption of constant hydraulic conductivity. Thus, the leachate pumping system should be designed with a greater capacity to absorb these periodic higher flow discharges. This special case will consider major short-circuiting of rainfall into the collection system caused by virtually no attenuation offered by in-place waste. Essentially this is a flooded condition in the cell. Thus, in order to account for these irregularities in leachate flow, the leachate pump design also included considerations for the 24-hour 25-year design storm event totaling 8.2 inches in the cell which would be pumped down by the leachate pump to normal conditions within approximately 72 hours.

To reduce the head on the liner to 12 inches within three days of the 24-hour 25-year storm event of 8.2 inches as required, the sump will be required to pump at a rate of approximately 171 gallons per minute (gpm). The leachate sump will consist of one leachate pump for handling flow from the primary leachate collection system and one leachate detection pump for handling flow from the secondary leachate detection system. The leachate pumps will be located within a sideslope riser pipe at the low point in the sump to allow easy access. The leachate collection pump is rated at 320 gpm and the leachate detection pump is rated at 60 gpm. Please refer to Attachment G-14 for the leachate collection and leachate detection pump sizing calculations.

#### G.2.c.2.7 Size of Leachate Sump

The leachate sump is sized to provide an adequate temporary storage volume for leachate to prevent the leachate pumps from cycling on and off excessively. The proposed sump provides a net storage capacity of approximately 1,346 gallons. Leachate pump manufacturers recommend no more than 15 cycles per hour, or approximately once every four minutes. The volume of the sump was sized such that the volume provided will allow the pump cycle times to be less than the cycle time recommended by the manufacturer (thus extending the life of the pumps by not excessively starting and stopping). Please refer to Attachment G-15 for the leachate sump sizing calculations. As cell waste volume increases and leachate flows begin to drop, the County may decide to change to smaller pumps that are better matched to the lower flows so that adequate running time for the pumps is provided.

#### G.2.c.2.8 Leachate Force Main

The leachate sump is equipped with submersible pumps that discharge the leachate out of the sump through a pipeline and out of the cell. From that point the leachate will travel in a pressure pipeline (i.e., a force main) to any or all three ~~the~~ leachate collection sideslope risers located along the western side of the south portion of the Phase II Section II Expansion through a series of valves. The leachate force main is sized to serve the flow from the leachate collection and detection pumps. The sideslope risers are extensions of the 8-inch diameter HDPE SDR 11 leachate collection pipes for the Phase II Section II Expansion south portion which will be connected to the existing 8-inch diameter HDPE SDR 11 leachate collection lines located within the Phase II Section I area during construction. Leachate flow to the three leachate collection sideslope risers will be directed by the County through valves located at each of the risers as needed. During normal operations all valves will remain open which will distribute leachate flow into each of the risers. Please refer to the Drawings which identify the force main piping network.

Leachate will then flow via gravity to the existing leachate collection sump and pumps located within the Phase II Section I area. From the Phase II Section I sump the leachate will be pumped into the existing above ground leachate storage tanks.

These two leachate storage tanks can hold 79,000 gallons each. The County has secured interlocal agreements with the three surrounding wastewater treatment plants (WWTPs) for leachate disposal. The WWTPs and their respective leachate disposal quantities are as follows:

- City of Wauchula WWTP - 35,000 gal/day
- Wauchula Hills WWTP - 63,000 gal/day
- Vandolah WWTP - 25,000 gal/day

### G.2.c.3 Subbase Design

Rule 62-701.400(3)(c)1, FAC requires that the subbase below the lower geomembrane be a minimum of 6-inches thick, free of sharp materials or any materials larger than one-half inch, and have a saturated hydraulic conductivity equal to or less than $1x10^{-5}$ cm/sec. The subbase for the liner system will be constructed of existing native soil and fill placed over native soil and graded as shown on the construction permit applications drawings located in Attachment E-2. The subbase will be prepared as described in the Technical Specifications included in the CQA Plan provided in Attachment G-1.

A GCL with a hydraulic conductivity (k) equal to or less than $1x10^{-7}$cm/sec will be used as an equivalent substitute for the 6-inch thick prepared soil subbase required by Rule 62-701.400(3)(c)1, FAC. The GCL will be installed in accordance with Technical Specification 02077 - Geosynthetic Clay Liner included in the CQA Plan provided in Attachment G-1.

The lowest proposed elevation of the bottom lining system for the Phase II Section II Expansion area is the leachate collection sump at EL 78.5 feet NGVD. Due to the fluctuations of the groundwater table within the area of the sump and a portion of the cell bottom, as further discussed in Section I of this construction permit application, an additional layer of 60 mil textured HDPE geomembrane liner will be placed under the GCL and welded to the secondary 60 mil textured HDPE geomembrane liner. This additional layer of 60 mil textured HDPE geomembrane liner will help prevent the “wet-dry” cycles of the GCL due to the fluctuations of the groundwater table. Requirements for the additional layer of liner below the GCL has been included within the Technical Specifications located in Attachment G-1 and the construction permit application drawings located in Attachment E-2. The bottom liner system in relation to the groundwater table is further addressed in Section I of this construction permit application.

### G.2.c.4 Leak Detection System Design Criteria

The leak detection system (LDS) is designed to limit the hydraulic head on the lower liner to less than the thickness of the leak detection system geonet. The LDS consists of the LDS drainage layer, trenches, headers, and pumps. The secondary leachate collection system is composed of double-sided, tri-planar geocomposite placed over the secondary HDPE liner along the bottom and sides of the cell. The geocomposite is designed to maintain a high flow rate under the load exerted by the full height of the landfill waste.

Per 62-701.400(3)(c)(2), FAC the leak detection and secondary leachate collection system shall have a minimum hydraulic conductivity of ten centimeters per second (cm/sec), shall be designed to limit the maximum hydraulic head on the lower liner to one inch, and shall not allow the leachate head to exceed the thickness of the drainage layer. The hydraulic conductivity of the leak detection and secondary collection system material shall be derived from transmissivity and thickness measurements.

According to the HELP model results located in Attachment G-11 and summarized above in Tables G-2 through G-25~~5~~, the maximum hydraulic head on the Expansion secondary liner is 0.00~~1~~2 inches, which is less than the thickness of the drainage layer tri-planar geocomposite. Therefore, a tri-planar geocomposite can be used for the secondary leachate collection system. A tri-planar geocomposite can achieve this hydraulic conductivity after accounting for all the reduction factors and while keeping the maximum head within the geocomposite thickness in the secondary system throughout the range of expected loadings.

The HELP model was also used to estimate flow into the leak detection system. Using Scenario 8~~1~~, as described above, the estimated peak flow through the primary liner into the secondary collection system is approximately 0.88~~1.3~~ gpm. The flow capacity of the LDS swales must be greater than the rate of flow entering them. Each LDS swale includes one additional layer of 300 mil tri-planar geocomposite to transport the anticipated flow. Refer to Attachment G-16 for the flow capacity calculations of the LDS trenches using one additional layer of 300 mil tri-planar geocomposite. For the maximum anticipated loading condition, the calculated flow capacity of the LDS trench with one additional layer of tri-planar geocomposite is greater than the calculated rate of flow entering the LDS trench. Therefore, the flow capacity of the LDS trench is adequate.

The LDS trenches transport the leachate to a center header trench which has an 8-inch diameter HDPE SDR 11 header pipe for a portion of the trench, which in turn transports the leachate to the leachate collection sump. The flow capacity of the LDS header pipe must be greater than the flow entering the header pipe from the LDS trenches. At a slope of 0.93 percent after expected settlement, the LDS header pipe has a capacity of approximately 520 gpm flowing full. The maximum flow according to the HELP model is 202.93~~242.85~~ cubic feet/day or approximately 0.88~~1.3~~ gpm. The pipe capacity is more than the flow entering from the LDS trenches.

## G.2.d Standards for Geosynthetic Components

The geosynthetic components of the bottom liner for the Phase II Section II Expansion area will meet the requirements specified by Rule 62-701.400(3)(d), FAC for double liner systems. The properties for the GCL, 60 mil primary and secondary HDPE geomembrane liners, primary and secondary geocomposite drainage layer materials, rain tarp, and soil cover are described in the Technical Specifications that are presented in the CQA Plan located in Attachment G-1.

### G.2.d.1 Geomembrane Seams

Geomembrane seam strength will be tested as required by Rule 62-701.400(3)(d)(1), FAC. All field seams will be visually inspected and tested for seam continuity using suitable non-destructive techniques as described in the Technical Specifications and the CQA Plan presented in Attachment G-1. The Technical Specifications and CQA Plan for the geomembrane including seams are presented in Attachment G-1.

### G.2.d.2 Spark Test

Rule 62-701.400(3)(d)2, FAC requires liners used in landfills to be subjected to continuous spark testing by the manufacturer at the factory, with no defects found. The manufacturer of the HDPE geomembrane will be required to test the geomembrane using a continuous spark test. Only HDPE geomembranes found to have no defects will be used at the proposed Phase II Section II Expansion. The Technical Specifications and CQA Plan requiring continuous spark testing for the geomembrane are presented in Attachment G-1.

### G.2.d.3 Protective Layers over Upper Liner

A 24-inch thick protective sand layer will be placed on top of the double-sided primary geocomposite material. The sand layer will be installed across the entire bottom and sideslopes of the cell prior to the placement of the first lift of waste. All materials in direct contact with the liner shall be free of sharp materials or any materials larger than one half inch. The Technical Specifications and CQA Plan for the protective sand layer are presented in Attachment G-1.

### G.2.d.4 First Layer of Waste

Hardee County Landfill personnel will take care when placing the first layer of waste over the 24-inch protective sand layer. This first layer of waste will consist of selected wastes containing no large, rigid objects that might damage the liner or leachate collection system and will be a minimum of four feet in compacted thickness. In order to minimize disturbance of the protective layer, traffic will be prohibited from traveling directly on top of the sand drainage layer. The first lift of waste will be deposited from the top of an adjacent working face, if possible, or otherwise from the end of a temporary dirt haul road.

### G.2.d.5 HDPE Geomembrane Specification

The Technical Specifications are presented with the CQA Plan in Attachment G-1. The Technical Specifications include definitions and requirements for the manufacture, handling, installation and quality control for geomembranes and other geosynthetics. HDPE geomembranes will be required to meet the specifications of GRI GM13.

### G.2.d.6 PVC Geomembranes

PVC geomembranes will not be used for the Hardee County Landfill Phase II Section II Expansion. Therefore, this requirement is not applicable to this project.

### G.2.d.7 Interface Shear Strength Testing

Per Rule 62-701.400(3)(d)7, laboratory interface shear strength testing will be conducted on representative samples of the actual lining system components proposed for use in accordance with the following testing parameters. The required interface shear strength properties and testing parameters are included in the Technical Specifications presented with the CQA Plan in Attachment G-1. The results of this testing will be submitted to the FDEP prior to or during construction.

- Interface Friction Angle (ASTM D5321) testing configuration of protective soil material and the bi-planar geocomposite material. The testing criteria will be as follows. The proposed protective soil material shall be prepared and molded to a minimum of 90% of the standard proctor (ASTM D698). The direct shear box shall be a minimum of 12 inches by 12 inches. Each normal load shall be preloaded at the specified normal load for a minimum of 1 hour. Fully saturate soil prior to testing for each normal load. The specified testing normal stresses are 1,000, 2~~3~~,000, and 4~~6~~,000 psf. The strain rate is 1 mm/min (0.04 in/min). The minimum peak interface friction angle shall be 20.5 degrees. The interface friction angle shall be the result of a linear regression line drawn continuously through the three shear strength results obtained for the normal loads specified following the procedures outlined in ASTM D5321. The results of peak and residual values shall be provided, the adhesion value may be considered in determining the effective interface friction angle.

- Interface Friction Angle (ASTM D5321) testing configuration of bi-planar geocomposite and the 60 mil textured HDPE geomembrane material. The testing criteria will be as follows. The direct shear box shall be a minimum of 12 inches by 12 inches. Each normal load shall be preloaded at the specified normal load for a minimum of 1 hour. Fully saturate soil prior to testing for each normal load. The specified testing normal stresses are 1,000, 2~~3~~,000, and 4~~6~~,000 psf. The strain rate is 1 mm/min (0.04 in/min). The minimum peak interface friction angle shall be 20.5 degrees. The interface friction angle shall be the result of a linear regression line drawn continuously through the three shear strength results obtained for the normal loads specified following the procedures outlined in ASTM D5321. The results of peak and residual values shall be provided, the adhesion value may be considered in determining the effective interface friction angle.

- Interface Friction Angle (ASTM D5321) testing configuration of tri-planar geocomposite and the 60 mil textured HDPE geomembrane material. The testing criteria will be as follows. The direct shear box shall be a minimum of 12 inches by 12 inches. Each normal load shall be preloaded at the specified normal load for a minimum of 1 hour. Fully saturate soil prior to testing for each normal load. The specified testing normal stresses are 1,000, 2~~3~~,000, and 4~~6~~,000 psf. The strain rate is 1 mm/min (0.04 in/min). The minimum peak interface friction angle shall be 20.5 degrees. The interface friction angle shall be the result of a linear regression line drawn continuously through the three shear strength results obtained for the normal loads specified following the procedures outlined in ASTM D5321. The results of peak and residual values shall be provided, the adhesion value may be considered in determining the effective interface friction angle.

- Interface Friction Angle (ASTM D6243) testing configuration of GCL and the 60 mil textured HDPE geomembrane material. The testing criteria will be as follows. The shear box shall be a minimum of 12 inches by 12 inches. Each normal load shall be preloaded at the specified normal load for a minimum of 24 hours. Fully saturate interface prior to testing for each normal load. The specified testing normal stresses are 1,000, 2~~3~~,000, and 4~~6~~,000 psf. The strain rate is 1 mm/min (0.04 in/min). The minimum peak interface friction angle shall be 20.5 degrees. The interface friction angle shall be the result of a linear regression line drawn continuously through the three shear strength results obtained for the normal loads specified following the procedures outlined in ASTM D6243. The results of peak and residual values shall be provided, the adhesion value may be considered in determining the effective interface friction angle.

- Interface Friction Angle (ASTM D6243) testing configuration of GCL and the subbase material. The testing criteria will be as follows. The shear box shall be a minimum of 12 inches by 12 inches. Each normal load shall be preloaded at the specified normal load for a minimum of 24 hours. Fully saturate interface prior to testing for each normal load. The specified testing normal stresses are 1,000, 2~~3~~,000, and 4~~6~~,000 psf. The strain rate is 1 mm/min (0.04 in/min). The minimum peak interface friction angle shall be 20.5 degrees. The interface friction angle shall be the result of a linear regression line drawn continuously through the three shear strength results obtained for the normal loads specified following the procedures outlined in ASTM D6243. The results of peak and residual values shall be provided, the adhesion value may be considered in determining the effective interface friction angle.

- Interface Friction Angle (ASTM D6243) testing configuration of the 60 mil textured HDPE geomembrane material and the subbase. The testing criteria will be as follows. The shear box shall be a minimum of 12 inches by 12 inches. Each normal load shall be preloaded at the specified normal load for a minimum of 24 hours. Fully saturate interface prior to testing for each normal load. The specified testing normal stresses are 1,000, 2,000, and 4,000 psf. The strain rate is 1 mm/min (0.04 in/min). The minimum peak interface friction angle shall be 20.5 degrees. The interface friction angle shall be the result of a linear regression line drawn continuously through the three shear strength results obtained for the normal loads specified following the procedures outlined in ASTM D6243. The results of peak and residual values shall be provided, the adhesion value may be considered in determining the effective interface friction angle.

- Internal Shear Resistance (ASTM D6243) GCL material. The testing criteria will be as follows. The shear box shall be a minimum of 12 inches by 12 inches. Each normal load shall be preloaded at the specified normal load for a minimum of 24 hours. Fully saturate interface prior to testing for each normal load. The specified testing normal stresses are 1,000, 2~~3~~,000, and 4~~6~~,000 psf. The strain rate is 1 mm/min (0.04 in/min). The minimum peak internal shear friction angle shall be 20.5 degrees. The internal shear friction angle shall be the result of a linear regression line drawn continuously through the three shear strength results obtained for the normal loads specified following the procedures outlined in ASTM D6243. The results of peak and residual values shall be provided, the adhesion value may be considered in determining the effective internal shear friction angle.

### G.2.d.8 Transmissivity Testing

Per Rule 62-701.400(3)(d)8, the transmissivity of the geonets shall be tested with method ASTM D4716, or an equivalent test method, to demonstrate that the design transmissivity will be maintained for the design period of the facility. The testing for the geonet in the liner system shall be conducted using actual boundary materials intended for the geonet at the maximum design normal load for the landfill. At the maximum design normal load, testing shall be conducted for a minimum period of 100 hours unless data equivalent to the 100-hour period is provided in which case the test shall be conducted for a minimum period of one hour.

Laboratory transmissivity testing will be performed on the bi-planar and tri-planar geocomposites and the results of this testing will be submitted to FDEP with the Construction Certification Report. The required transmissivity properties are included in the Technical Specifications presented in Attachment G-1.

- Per ASTM D4716 with a normal stress of 4~~6~~,000 psf; water at 20$^{o}$C (68$^{o}$F); with a gradient of 0.02; testing configuration of Ottawa sand/bi-planar geocomposite/60 mil textured HDPE geomembrane material; and a test time period of 100 hours. Apply normal stress, under saturated conditions, for 1 hour minimum prior to start of test. Test data shall indicate that transmissivity values when tested in excess of 100 hours do not fall below the minimum value specified. Report shall provide hydraulic conductivity and transmissivity values.

- Per ASTM D4716 with a normal stress of 4~~6~~,000 psf; water at 20$^{o}$C (68$^{o}$F); with a gradient of 0.02; testing configuration of 60 mil textured HDPE geomembrane material /tri-planar geocomposite/60 mil textured HDPE geomembrane material; and a test time period of 100 hours. Apply normal stress, under saturated conditions, for 1 hour minimum prior to start of test. Test data shall indicate that transmissivity values when tested in excess of 100 hours do not fall below the minimum value specified. Report shall provide hydraulic conductivity and transmissivity values.

### G.2.d.9 Hydraulic Conductivity Testing of Geosynthetic Clay Liners

Per Rule 62-701.400(3)(d)9, FAC hydraulic conductivity testing will be performed on the GCL and the results of this testing will be submitted to the FDEP with the Construction Certification Report. The required hydraulic conductivity properties are included in the Technical Specification 02077 - Geosynthetic Clay Liner presented in Attachment G-1.

The hydraulic conductivity of the GCL shall be tested with method ASTM D5887, or ASTM D6766-06a, or an equivalent test method and EPA 9100. First, the GCL test specimen shall be hydrated with using leachate and groundwater from the existing Hardee County Landfill for a minimum of 48 hours using sufficient backpressure to achieve a minimum B coefficient of 0.9 and using a confined effective consolidation stress not exceeding five pounds per square inch. Then, the hydraulic conductivity test on the GCL specimen shall be conducted, using the appropriate permeant fluid, at a confined effective consolidation stress not exceeding five pounds per square inch. The hydraulic conductivity test shall continue until steady state conditions are reached or a minimum of two pore volumes of permeant fluid have passed through the test specimen. The permeant fluid shall be a representative leachate sample obtained from the Hardee County Landfill.

### G.2.e Geosynthetic Specifications

Per Rule 62-701.400(3)(e), FAC the CQA Plan and/or the Technical Specifications presented in Attachment G-1 include the following requirements.

#### G.2.e.1 Definitions and Qualifications

The definitions and qualifications of the designer, manufacturer, installer, QA consultant and laboratory, and QA program are identified.

#### G.2.e.2 Material Specifications

The material specifications for geomembranes, geocomposites and geotextiles are identified.

#### G.2.e.3 Manufacturing and Fabrication Specifications

The manufacturing and fabrication specifications including geomembrane raw material and roll QA, fabrication personnel qualifications, seaming equipment and procedures, overlaps, trial seams, destructive and nondestructive seam testing, seam testing location, frequency, procedure, sample size and geomembrane repairs are identified.

#### G.2.e.4 Geomembrane Installation Specifications

The Technical Specification 02776 - High Density Polyethylene (HDPE) Geomembrane Liner installation specifications including earthwork, conformance testing, geomembrane placement, installation personnel qualifications, field seaming and testing, overlapping and repairs, materials in contact with geomembrane and procedures for lining system acceptance are identified.

#### G.2.e.5 Geotextile and Geogrid Specifications

Technical Specification 02940 - Geotextile includes handling and placement, conformance testing, seams and overlaps, repair, and placement of soil materials and any overlying materials are identified.

#### G.2.e.6 Geonet and Geocomposite Specifications

Technical Specifications 02930 Tri-Planar Geocomposite and 02931 Bi-Planar Geocomposite include handling and placement, conformance testing, stacking and joining, repair, and placement of soil materials and any overlying materials are identified.

#### G.2.e.7 GCL Specifications

The Technical Specification 02077 - Geosynthetic Clay Liner includes handling and placement, conformance testing, seams and overlaps, repair, and placement of soil material and any overlying materials are identified.

### G.2.f Soil Component Standards

Technical Specification Section 02220 - Excavation, Backfill, Fill, and Grading presented in Attachment G-1describes construction procedures including over-excavation and backfilling to preclude structural inconsistencies and procedures for placing and compacting soil components in layers for the soil components are.

#### G.2.f.1 Construction Procedures

A GCL with a hydraulic conductivity (k) equal to or less than $1x10^{-7}$ cm/sec will be used as an equivalent substitute for the 6-inch thick prepared soil sub-base required by Rule 62-701.400(3)(c)1, FAC. The use of GCL is allowed in accordance with Rule 62-701.400(3)(c)1, FAC. The GCL will be installed in accordance with Technical Specification 02077 - Geosynthetic Clay Liner included in Attachment G-1. Therefore, this subsection is "Not Applicable" for the liner system and has been so designated on the State of Florida Department of Environmental Protection Application for a Permit to Construct, Operate, Modify or Close a Solid Waste Management Facility Application Form 62-701.900(1), which is attached at the beginning of this permit application report.

#### G.2.f.2 Compatibility of the Soil Component

A GCL with a hydraulic conductivity (k) equal to or less than $1x10^{-7}$ cm/sec will be used as an equivalent substitute for the 6-inch thick prepared soil sub-base required by Rule 62-701.400(3)(c)1, FAC. The use of GCL is allowed in accordance with Rule 62-701.400(3)(c)1, FAC. The GCL will be installed in accordance with Technical Specification 02077 - Geosynthetic Clay Liner included in Attachment G-1. Therefore, this subsection is "Not Applicable" for the liner system and has been so designated on the State of Florida Department of Environmental Protection Application for a Permit to Construct, Operate, Modify or Close a Solid Waste Management Facility Application Form 62-701.900(1), which is attached at the beginning of this permit application report.

#### G.2.f.3 Procedures for Testing In-Situ Soils

Rule 62-701.400(3)(c)1, FAC requires that the sub-base below the lower geomembrane be a minimum of 6-inches thick, free of sharp materials or any materials larger than one-half inch, and have a saturated hydraulic conductivity equal to or less than $1x10^{-5}$ cm/sec. The subbase for the liner system will be placed over prepared native soil graded to the grades shown on the construction permit applications drawings located in Attachment E-1. The subbase will be prepared as described in the Technical Specifications included in Attachment G-1. A GCL with a hydraulic conductivity (k) equal to or less than $1x10^{-7}$ cm/sec will be used as an equivalent substitute for the 6-inch thick prepared soil sub-base required by Rule 62-701.400(3)(c)1, FAC. The use of GCL is allowed in accordance with Rule 62-701.400(3)(c)1, FAC. The GCL will be installed in accordance with Technical Specification 02077 - Geosynthetic Clay Liner included in Attachment G-1.

#### G.2.f.4 Specifications for Soil Component of Liner

A GCL with a hydraulic conductivity (k) equal to or less than $1x10^{-7}$ cm/sec will be used as an equivalent substitute for the 6-inch thick prepared soil sub-base required by Rule 62-701.400(3)(c)1, FAC. The use of GCL is allowed in accordance with Rule 62-701.400(3)(c)1, FAC. The GCL will be installed in accordance with Technical Specification 02077 - Geosynthetic Clay Liner included in Attachment G-1. Therefore, this subsection is "Not Applicable" for the liner system and has been so designated on the State of Florida Department of Environmental Protection Application for a Permit to Construct, Operate, Modify or Close a Solid Waste Management Facility Application Form 62-701.900(1), which is attached at the beginning of this permit application report.

#### G.2.f.5 Field Test Section

A GCL with a hydraulic conductivity (k) equal to or less than $1x10^{-7}$ cm/sec will be used as an equivalent substitute for the 6-inch thick prepared soil sub-base required by Rule 62-701.400(3)(c)1, FAC. The use of GCL is allowed in accordance with Rule 62-701.400(3)(c)1, FAC. The GCL will be installed in accordance with Technical Specification 02077 - Geosynthetic Clay Liner included in Attachment G-1. Therefore, this subsection is "Not Applicable" for the liner system and has been so designated on the State of Florida Department of Environmental Protection Application for a Permit to Construct, Operate, Modify or Close a Solid Waste Management Facility Application Form 62-701.900(1), which is attached at the beginning of this permit application report.

### G.2.g Class III Landfills

The Hardee County Landfill Phase II Section II Expansion will be a Class I Landfill. Therefore, this subsection is "Not Applicable" for the liner system and has been so designated on the State of Florida Department of Environmental Protection Application for a Permit to Construct, Operate, Modify or Close a Solid Waste Management Facility Application Form 62-701.900(1), which is attached at the beginning of this permit application report.

## G.3 LEACHATE COLLECTION AND REMOVAL SYSTEM

The leachate collection and removal system (LCRS) for the proposed Phase II Section II Expansion includes the primary leachate collection system (LCS) and a secondary leak detection system (LDS).

### G.3.a Primary and Secondary LCRS Requirements

#### G.3.a.1 Chemical Compatibility

The LCRS components, including non-calcareous quartz or granite gravel, drainage sand, bi-planar and tri-planar geocomposites, geotextile, leachate collection pipe, leachate pump riser pipes, force main, and geomembranes, will be constructed of materials which are known to be chemically resistant to the leachate anticipated to be generated from the municipal solid waste placed in the Phase II Section II Expansion. Aggregates for use in the LCRS will be rounded to well-rounded non-calcareous quartz or granite gravel which is inert to the leachate and does not form calcium carbonate deposits.

- Geotextile: Polypropylene or polyester.
- Geomembrane: High-Density Polyethylene (HDPE).
- Geocomposite (Geonet): Polyethylene core, polypropylene or polyester geotextile facing (both sides).
- Collection Header Pipe: High-Density Polyethylene (HDPE).
- Pump Intake and Riser Access Pipes: High-Density Polyethylene (HDPE).
- Force Main: High-Density Polyethylene (HDPE).

The leachate collection and removal system consists of:

- The LCRS is overlain by a 2 foot thick protective cover layer consisting of granular material.
- LCRS geocomposite drainage layer covering the entire cell area; and
- LCRS collection pipe including an 8-inch nominal diameter perforated HDPE pipe embedded in pipe bedding material (non-calcareous quartz or granite gravel).

### G.3.a.2 Mechanical Properties

#### G.3.a.2.1 LCRS and LDS Pipes

To verify the LCRS and LDS pipes have sufficient mechanical properties to prevent collapse under pressures exerted by overlying wastes, cover materials, and by equipment used at the landfill pipe crushing calculations were conducted. The pipes proposed for use in the leachate collection system and the leak detection system is smooth wall, HDPE pipes, minimum SDR 11.

The LCRS leachate collection pipe and the LCRS and LDS leachate riser pipes were evaluated to determine if each has sufficient mechanical properties to prevent collapse under pressure exerted by the overlying landfilled material, cover materials, and equipment. The buried leachate pipe must be designed to resist the three pipe structural failure mechanisms referred to as wall crushing, wall buckling and excessive ring deflection. The three pipe structural failure mechanisms have been evaluated for the Phase II Section II Expansion construction permit application using methods recommended by the pipe manufacturer and all exceed the minimum standards recommended by the pipe manufacturer. Please refer to the following locations for pipe structural calculations for wall crushing, wall buckling, and excessive ring deflection based on the loads anticipated on the pipe during construction, operation and post-closure. A summary table of the pipe structural calculations for wall crushing, wall buckling, and excessive ring deflection based on the loads anticipated on the pipe is provided prior to the calculations in Attachment G-17.

- Phase II Section II Expansion

    - Attachment G-18 - 12-inch diameter perforated HDPE leachate collection header pipe during construction. In addition during operations with a CAT 826G Series II Compactor and a CAT D7R Series II track-type bulldozer. The analysis during operations was performed at different waste filling scenarios of no waste, 10 feet, 25~~40~~ feet and 60~~80~~ feet (final buildout).

    - Attachment G-19 - 8-inch diameter perforated HDPE leachate collection pipe during construction. In addition during operations with a CAT 826G Series II Compactor and a CAT D7R Series II track-type bulldozer. The analysis during operations was performed at different waste filling scenarios of no waste, 10 feet, 25~~40~~ feet and 60~~80~~ feet (final buildout).

- Phase II Section I Vertical Expansion

    - The Phase II Section I vertical expansion area also has existing 8-inch diameter perforated HDPE leachate collection pipe. Pipe crushing calculations were not conducted on these existing pipes. This is due to the fact that the Phase II Section II Expansion pipe crushing analysis which was conducted on 8-inch diameter perforated HDPE leachate collection pipe is representative of the existing pipes within this area. The final loading on the existing 8-inch diameter perforated HDPE leachate collection pipe will be less in this area than in the proposed Phase II Section II Expansion area.

- Phase I Area

    - Attachment G-20 - Existing 4-inch diameter perforated HDPE SDR 17 LFG pipe during operations with a CAT 826G Series II Compactor and a CAT D7R Series II track-type bulldozer. The analysis during operations was performed at different waste filling scenarios of no waste, 10 feet, 25~~40~~ feet and 60~~80~~ feet (final buildout). The existing 10-inch diameter perforated HDPE leachate collection pipe during operations with a CAT 826G Series II Compactor and a CAT D7R Series II track-type bulldozer. The analysis during operations was performed at different waste filling scenarios of no waste, 10 feet, 25~~40~~ feet and 60~~80~~ feet (final buildout). The existing HDPE leachate collection pipe connects MH-7 and MH-9.

    - Attachment G-21 - Existing 8-inch diameter perforated ADS leachate collection pipe during operations with a CAT 826G Series II Compactor and a CAT D7R Series II track-type bulldozer. The analysis during operations was performed at 60~~80~~ feet (final buildout). The existing ADS leachate collection pipe connects MH-4, MH-5 and MH-6.

The pipes with the respective SDR rating have been calculated to be of sufficient strength to withstand the pressures exerted during construction, operations and under the maximum permitted depth of municipal solid waste. Perforation diameter, spacing, and location will be as shown on the Phase II Section II Expansion construction permit drawings located in Attachment E-1.

#### G.3.a.2.2 Bi-planar and Tri-planar Geocomposites

Geocomposite loading is identified for the bi-planar geocomposite in Attachment G-9 and for the tri-planar geocomposite in Attachment G-10. The transmissivity values in the HELP model analysis provided in Attachment G-11 estimate the long-term performance of the geocomposite materials after the reduction factors for geotextile intrusion, creep deformation, chemical degradation, particulate clogging, biological clogging, and chemical clogging. The geocomposite transmissivity values determined in were selected to account for reduction in flow capacity due to high overburden pressures expected to be exerted by the landfilled material. The flow characteristics of the geocomposite materials were also selected based on the long-term slopes after predicted settlement. As the HELP model summary provided at the beginning of Attachment G-11 demonstrates, even with the estimated reductions, it still maintains the head over the liner with the design limits. Therefore, the geocomposite materials are stable under loading.

### G.3.a.3 Reduction of Clog Potential

The LCRS has been designed to maintain proper leachate flow and to maximize resistance to clogging. The LCRS consists of 24-inches of protective sand placed on top of a bi-planar geocomposite drainage layer (geonet with a non-woven geotextile on both sides). The bi-planar geocomposite drainage material has a geotextile on both sides to prevent sand particles from passing into the geonet and collection pipes. Clogging is reduced within the geonet by bonding the non-woven geotextile on both sides of the geonet core. To account for possible reductions in flow rates due to biological and chemical clogging, reduction factors were considered in the transmissivity calculations when determining the anticipated leachate flow.

The LCRS pipes (header and lateral pipes) will be encased in a non-calcareous quartz or granite gravel backfilled trench that will be wrapped with a 6-oz woven geotextile which will also be covered by the 24-inch drainage sand layer. The geotextile and aggregate have been designed to effectively filter out solids in the leachate and also to minimize sites or conditions at the rock and protective sand interface where growth of organisms can accumulate and prevent normal flow of leachate into the collection system. Refer to Attachment G-22 and Attachment G-23 for the leachate collection pipes and geocomposite geotextile calculations, respectively. The leachate collection sump will be encased in non-calcareous quartz or granite gravel that will resist clogging and promote adequate flow to the pumps.

### G.3.a.4 System Cleanouts

The design of the LCRS piping (header and lateral pipes) has also taken into consideration the need to periodically test and clean the system and to provide contingent design for unexpected problems that affect normal leachate flow. All of the LCRS piping was sized and configured to allow for jet cleaning and tracked video camera equipment access through the piping. The geocomposite is proposed to cover the entire bottom and sideslopes of the Phase II Section II Expansion and if a section becomes clogged, leachate can flow around the area and eventually will either discharge into the leachate collection header pipe or the leachate sump. Should the main leachate collection header pipe become blocked, leachate can still flow directly to the sump through the non-calcareous quartz or granite gravel placed around the header pipe. Refer to Attachment G-13 for the LCRS header trench conveyance calculations.

For the northern portion of the Phase II Section II Expansion, the center and eastern 8-inch and 10-inch diameter leachate collection lateral pipes will be accessed through cleanouts for each line located at the northern end of the Expansion area. Jet cleaning and tracked video camera equipment will travel south the approximately 920 feet through the pipes to the interior east/west berm located in the southern portion of the Expansion area (where the pipes begin).

For the northern portion of the Phase II Section II Expansion the western 8-inch diameter leachate collection lateral pipe located at the toe of slope will be accessed through a cleanout located at the northern end of the Expansion area. Jet cleaning and tracked video camera equipment will travel south the approximately 460 feet through the pipe to the leachate collection sump (where the pipe discharges).

For the center portion of the Phase II Section II Expansion the western 8-inch diameter leachate collection lateral pipe located at the toe of slope will be accessed through a cleanout located along the western side of the Expansion area. Jet cleaning and tracked video camera equipment will travel north the approximately 460 feet through the pipe to the leachate collection sump (where the pipe discharges).

The 12-inch diameter leachate collection header pipe will be located approximately in the center of the northern and center portions of the Phase II Section II Expansion and will be sloped from east to west into the leachate collection sump located on the western side of the Expansion area. The leachate collection header pipe will be extended with a riser pipe through the leachate collection sump, along the sideslope of the Expansion area to the top of slope and terminated at the surface with a cleanout for access. Jet cleaning and tracked video camera equipment will travel east the approximately 160 feet through the entire pipe to the end.

The three 8-inch diameter leachate collection lateral pipes located in the southern portion of the Phase II Section II Expansion will be connected to the existing 8-inch diameter leachate collection lateral pipes within the Phase II Section I area. The leachate collection lateral pipes within this area will continue from east to west from the existing leachate collection pipes and will be accessed through cleanouts located along the western side of the Phase II Section II Expansion. Jet cleaning and tracked video camera equipment will travel east the approximately 160 feet through the pipes to the point they are connected to the existing leachate collection lateral pipes within the Phase II Section I area. Access within these leachate collection lateral pipes will then be available from west to east in the Phase II Section II Expansion and also from the east to west in the Phase II Section I area.

The leachate detection system for the northern portion of the Phase II Section II Expansion will convey liquid in the tri-planar geocomposite located within the LCS trench to an 8-inch diameter detection header pipe located within the same trench as the 12-inch diameter leachate collection header pipe. The leachate detection header pipe will be extended with a riser pipe through the leachate collection sump, along the sideslope of the Expansion area to the top of slope and terminated at the surface with a cleanout for access. Jet cleaning and tracked video camera equipment will travel east the approximately 80 feet through the entire pipe to the end.

The leachate detection system for the southern portion of the Phase II Section II Expansion area will convey liquid in the tri-planar geocomposite located within the LCS swale, to an existing tri-planar geocomposite located within the LCS trench of the Phase II Section I area to an existing 8-inch diameter header pipe located along the toe of slope of the Phase II Section I area. The existing 8-inch diameter header pipe drains to the existing leachate collection sump located in the northeast corner of the Phase II Section I area. The existing leachate detection header pipe is extended with a riser pipe through the leachate collection sump, along the sideslope to the top of slope and terminated at the surface with a cleanout for access. The existing leachate pump riser pipe is accessible from the surface and is equipped so that the existing pump and discharge piping can be completely removed for repairs or replacement. In addition, with the pumps removed, the portion of the pipe forming the intake section in the sump can have jet cleaning and tracked video camera equipment inserted to travel through the entire pipe to the end.

## G.3.b Primary LCRS Requirements

### G.3.b.1 Bottom Twelve Inches

The primary leachate collection layer will consist of a 60 mil textured HDPE geomembrane liner overlain by a double-sided bi-planar geocomposite overlain by a protective cover soil drainage layer a minimum of 12 inches thick. The 12 inch thick protective cover soil drainage layer above the primary geomembrane liner and bi-planar geocomposite will consist of a non-carbonate sand with a minimum hydraulic conductivity of $1x10^{-3}$ cm/sec.

Laboratory tests will be conducted during construction to demonstrate the geocomposite will maintain the required hydraulic conductivity under full design load. The bi-planar geocomposite includes a geonet core with a 6-oz non-woven geotextile on both sides that will provide equal or better protection to the HDPE geomembrane liner than a granular material.

### G.3.b.2 Total Thickness Resistant to Waste and Leachate

The 12 inch thick protective cover soil drainage layer will be overlain by a minimum of 12 inches of additional non-carbonate protective soil, for a total drainage layer thickness of 24 inches above the bi-planar geocomposite. The non-carbonate protective soil will be chemically resistant to the waste and leachate.

### G.3.b.3 Bottom Slope Design to Accommodate for Predicted Settlement

The Phase II Section II Expansion cell bottom drains to the LCRS piping (header and lateral pipes) and LDS header pipe at a minimum slope of 2.2 percent after the anticipated settlement. The LCS lateral pipes drain to the header pipe at a minimum slope of 0.47 percent after the predicted maximum settlement. The header pipes drain to the leachate collection sump at a minimum slope of 0.93 percent after the predicted maximum settlement.

The bottom slope of the LCRS has been designed to achieve the required leachate head after the predicted settlement determined by the foundation analysis. Refer to Section J for the settlement calculations.

#### G.3.b.4 Equivalent to Granular Material

The primary leachate collection layer will consist of a 60 mil textured HDPE geomembrane liner overlain by a double-sided bi-planar geocomposite overlain by a protective sand layer a minimum of 24 inches thick. The protective sand layer above the primary geomembrane liner and bi-planar geocomposite will have a minimum hydraulic conductivity of $1 \times 10^{-3}$ cm/sec. The bi-planar geocomposite will maintain the head over the geomembrane to within the thickness of the geocomposite. The calculations presented in Attachment G-9 for the bi-planar geocomposite and Attachment G-10 for the tri-planar geocomposite show that the hydraulic conductivity of the geocomposites under the anticipated design load is greater than the hydraulic conductivity of the drainage layer.

## G.4 LEACHATE RECIRCULATION

Leachate will be stored on-site in the leachate tanks until being hauled to local wastewater treatment facilities that have disposal agreements with the County. The County is not exploring the option of leachate recirculation at this time. Therefore, this subsection for G.5.b.1 through G.5.b.6 is "Not Applicable" for the liner system and has been so designated on the State of Florida Department of Environmental Protection Application for a Permit to Construct, Operate, Modify or Close a Solid Waste Management Facility Application Form 62-701.900(1), which is attached at the beginning of this permit application report.

The County will not recirculate leachate but will conduct leachate evaporation during operation of the Phase II Section II area. Ditches, berms, or other devices shall be constructed to control leachate runoff. Initial and intermediate cover receiving leachate from the leachate evaporation process shall be graded to shed runoff into the leachate collection system and to minimize mixing of leachate runoff and storm water. Initial and intermediate cover shall be permeable to the extent necessary to prevent perched water conditions and gas buildup. Leachate evaporation shall not be conducted during weather conditions or in quantities that may cause runoff outside the solid waste disposal unit, surface seeps, wind-blown spray, or exceedance of the limits of the leachate head on the liner.

The Operations Permit for the Hardee County Landfill has an expiration date of May 12, 2013. Immediately following the submission of the Phase II Section II Expansion construction permit application the Operations Permit renewal application process will be initiated (well in advance of operation of the Phase II Section II Expansion area). The Operations Permit renewal application will include a request for a modification to the landfill's Operation Permit to include the Phase II Section II Expansion after approval of the Certification of Construction Completion documents by the Department following construction of the Expansion. The Operation Permit renewal application will include an explanation of the leachate evaporation procedures proposed by the County during operations of the Phase II Section II area.

## G.5 LEACHATE STORAGE TANKS AND SURFACE IMPOUNDMENTS

The Hardee County Landfill currently stores leachate in two steel tanks with a capacity of 79,000 gallons each. The Phase II Section II Expansion will produce additional amounts of leachate resulting in more frequent hauling events to the wastewater treatment facility.

### G.5.a Surface Impoundment Requirements

A leachate surface impoundment will not be used for the Hardee County Landfill Phase II Section II Expansion. Therefore, this subsection for G.5.a.1 through G.5.a.6 is "Not Applicable" for the liner system and has been so designated on the State of Florida Department of Environmental Protection Application for a Permit to Construct, Operate, Modify or Close a Solid Waste Management Facility Application Form 62-701.900(1), which is attached at the beginning of this permit application report.

### G.5.b Above-ground Leachate Storage Tanks

The previously permitted aboveground leachate storage tanks will be used for storing leachate for the Phase II Section II Expansion. Therefore, this subsection for G.5.b.1 through G.5.b.7 have been identified as "No Change" and has been so designated on the State of Florida Department of Environmental Protection Application for a Permit to Construct, Operate, Modify or Close a Solid Waste Management Facility Application Form 62-701.900(1), which is attached at the beginning of this permit application report.

### G.5.c Underground Leachate Storage Tanks

An underground leachate storage tank will not be used for the Hardee County Landfill Phase II Section II Expansion. Therefore, this subsection for G.5.c.1 through G.5.c.4 is "Not Applicable" and has been so designated on the State of Florida Department of Environmental Protection Application for a Permit to Construct, Operate, Modify or Close a Solid Waste Management Facility Application Form 62-701.900(1), which is attached at the beginning of this permit application report.

### G.5.d Routine Maintenance Schedule

The LCRS includes leachate collection pipes and cleanout riser pipes. The leachate collection pipes will be cleaned and maintained, as necessary, through the sideslope cleanout riser pipes. The LCRS collection pipes will be cleaned by flushing or be inspected by video recording in accordance with Rule 62-701.500(8)(h), FAC. Flushing will be accomplished by inserting a self-propelled nozzle attached to the end of a hose into the cleanout riser and the LCRS pipe. The nozzle is used to flush the pipes with pressurized water. The leachate pump manufacturer will supply an operation manual presenting the manufacturer's recommended maintenance.

# G.6 GEOMEMBRANE CONSTRUCTION QUALITY ASSURANCE PLAN

## G.6.a CQA Plan

The installation of the geosynthetic components (i.e., geomembrane, geocomposite, and geotextile) of the bottom liner system will be monitored in accordance with the CQA Plan, included as Attachment G-1. The CQA Plan describes procedures to be followed to certify the integrity of the geosynthetics. Technical Specifications for the components of the bottom liner system are also contained in Attachment G-1. The CQA Plan includes a description of quality control testing procedures and frequencies, identification of key personnel (i.e., supervising professional, laboratory), and the forms used in the field for documenting the construction activities.

### G.6.a.1 Specifications and Construction Requirements for Liner System

The CQA Plan describes procedures to be followed to certify the integrity of the geosynthetics. The CQA Plan will provide personnel with adequate information to achieve continuous compliance with the liner construction requirements.

### G.6.a.2 Quality Control Testing Procedures and Frequencies

The CQA Plan describes procedures to be followed to certify the integrity of the geosynthetics. Refer to Attachment G-1 for the CQA Plan.

### G.6.a.3 Supervising Professional Engineer

The CQA Plan describes the supervising professional engineer responsible for the project. Sampling and testing shall be conducted in the field by trained personnel during construction and after construction completion. Such personnel will be under the direction of the construction quality assurance professional engineer, to assure the liner system will comply with the standards. The construction quality assurance professional engineer or his designee shall be on-site at all times during construction to monitor construction activities and shall be on-site to monitor off-loading of the geosynthetics to be used in the liner system. Refer to Attachment G-1 for the CQA Plan.

### G.6.a.4 Responsibility and Authority

The CQA Plan describes the responsibility and authority of the personnel for the project. Refer to Attachment G-1 for the CQA Plan.

### G.6.a.5 Qualifications of Personnel

The CQA Plan describes the qualifications of the personnel for the project. Refer to Attachment G-1 for the CQA Plan.

#### G.6.a.6 CQA Reporting Forms and Documents

The CQA Plan provides the required reporting forms and documents to be followed. Refer to Attachment G-1 for the CQA Plan.

#### G.6.a.7 Independent Laboratory Testing of Geosynthetics

The CQA Plan describes procedures to be followed for testing of the geosynthetic materials. A laboratory experienced in the testing of geosynthetics, independent of the liner manufacturer and installer, shall perform the required testing which will include conformance testing for all geosynthetics and geocomposites, and testing of seam shear and peel strength for geomembranes. Refer to Attachment G-1 for the CQA Plan.

## G.7 SOIL CONSTRUCTION QUALITY ASSURANCE PLAN

A GCL with a hydraulic conductivity (k) equal to or less than $1x10^{-7}$ cm/sec will be used as a substitute for the 6-inch thick prepared sub-base required by Rule 62-701.400(3)(c)1, FAC. The use of GCL is allowed in accordance with Rule 62-701.400(3)(c)1, FAC. The GCL will be installed in accordance with Technical Specification 02077 - Geosynthetic Clay Liner included in Attachment G-1. Therefore, this subsection for G.7.a through G.7.c is "Not Applicable" for the liner system and has been so designated on the State of Florida Department of Environmental Protection Application for a Permit to Construct, Operate, Modify or Close a Solid Waste Management Facility Application Form 62-701.900(1), which is attached at the beginning of this permit application report. The CQA Plan included in Attachment G-1 contains the soils testing requirements for general soils backfill.

## G.8 SURFACE WATER MANAGEMENT SYSTEM

### G.8.a Department Permit for Stormwater Control

The County currently has or has had the following stormwater permits for the site.

- Management and Storage of Surface Water (MSSW) Permit (Number 407767.00) from the SWFWMD for the Solid Waste Recycling Center located on-site.

- Environmental Resource Permit (Number 25-0124892-001) from the Florida Department of Environmental Protection (FDEP) for the Leachate Storage Tank Facility located on-site.

- MSSW Permit (Number 477767.01) from the Southwest Florida Water Management District (SWFWMD) for the Animal Control Facility located on-site.

- Environmental Resource Permit (Number 25-0124892-002) from the Florida Department of Environmental Protection (FDEP) for the Phase II Section I Expansion.

- Environmental Resource Permit (Number 25-0124892-003) from the Florida Department of Environmental Protection (FDEP) for the Phase II Section I Expansion.

ERP Number 25-0124892-002, dated July 10, 2006, with an expiration date of July 10, 2011, was previously issued by FDEP for a proposed 10-acre expansion which included both the Phase II Section I and Phase II Section II Expansions. A FDEP solid waste construction permit was only approved and issued for the Phase II Section I Expansion (approximately 5-acres). Therefore, the ERP was modified during construction of the Phase II Section I Expansion to remove the Phase II Section II Expansion construction requirements. FDEP issued a modified ERP which was only for the construction of the Phase II Section I Expansion under FDEP ERP Number 25-0124892-003. An application for a new ERP is currently being made under a separate cover for the proposed remaining portions of the Phase II Section II Expansion stormwater management system.

### G.8.b Surface Water Management System Design

The only remaining stormwater management feature remaining for construction during the Phase II Section II Expansion from the original 10-acre ERP will be a stormwater swale system along the north, west, and south sides of the Expansion area. The northern swale will connect to an existing swale system that will transfer the stormwater to an existing wet detention pond located in the northeast corner of the facility. The western and southern swales will connect to an existing swale located in the southeast corner of the Phase II Section I area which will transport the surface water to the east and then south to the existing wet detention pond located on the southern end of the site.

Stormwater runoff from the upper portion of the landfill travels via sheet flow into collection terraces located along the sideslopes of the landfill. Stormwater runoff flows within the collection terraces and is conveyed, via stormwater structures, down the landfill and into ditches that are located on the perimeter of the landfill.

The perimeter ditches convey stormwater runoff to an existing stormwater detention pond located in the northeast corner of the facility. As the stormwater runoff in the pond rises, an overflow structure located on the southern end of the pond allows water to be discharged into the heavily vegetative area located on the east side of the facility. Two culverts, located beneath the main access road allow stormwater to flow from the east side of the site under the road and along a channel to the existing stormwater management area on the southern end of the site. This stormwater area is a wet detention pond that treats the first one-inch of stormwater runoff from the entire site. An existing overflow structure discharges the stormwater offsite. Once offsite the runoff flows overland and via naturally occurring channels until the flows eventually discharges into the Peach River.

### G.8.c Stormwater Control Details

Details of the stormwater controls design, including collection channels, and downchutes, are provided on the Phase II Section II Expansion construction permit application drawings located in Attachment E-2.

The disposal area was designed and will be graded to keep stormwater runoff separate from runoff (leachate) that has come in contact with waste material. Isolation berms will be used to minimize erosion and separate stormwater from waste disposal areas. The unused portion of the disposal (northern portion of the Phase II Section II Expansion area approximately 2.33 acres) will be covered with a rain tarp to keep stormwater runoff from entering the leachate collection system. Stormwater will be removed from the cell that has accumulated on the rain tarp via pumps that will discharge stormwater to the perimeter ditches that convey water to the stormwater management system. Runoff that has not come in contact with waste material will be allowed to discharge into the stormwater management system.

The Operations Permit for the Hardee County Landfill has an expiration date of May 12, 2013. Immediately following the submission of the Phase II Section II Expansion construction permit application the Operations Permit renewal application process will be initiated (well in advance of operation of the Phase II Section II Expansion area). The Operations Permit renewal application will include a request for a modification to the landfill's Operation Permit to include the Phase II Section II Expansion after approval of the Certification of Construction Completion documents by the Department following construction of the Expansion. The Operation Permit renewal application will include the operational fill sequence plans to show a detailed plan for the filling of the Phase II Section II area and the Phase II Section I height increase.

## G.9 GAS CONTROL SYSTEMS

See Section N of this document for the landfill gas control system for the Hardee County landfill.

## G.10 GROUND WATER GRADIENT

See Section I of this document for the discussion regarding the bottom liner system in relation to the groundwater table.

# Revised Section H
# Hydrogeological Investigation Requirements

# SECTION H

# HYDROGEOLOGICAL INVESTIGATION REQUIREMENTS

## H.1 HYDROGEOLOGICAL INVESTIGATION AND SITE REPORT

The Hardee County Landfill has had numerous geological, hydrogeological and geotechnical investigations conducted over as part of the design, permitting, and on-going monitoring of waste disposal cells at the facility. Some of the relevant documents previously provided to the Department in support of the Phase II Section II Expansion construction permit application are as follows.

- *Hydrogeological Investigation*, dated April 2004, prepared by SCS.
- *Revised Hydrogeological Investigation*, dated November 15, 2004, prepared by SCS.
- *Revised Ground Water Monitoring Plan*, dated November 15, 2004, prepared by SCS.
- *Biennial Groundwater Monitoring Plan Evaluation Report*, dated January 30, 2008, prepared by SCS.
- *Operation Permit Modification to Include Phase II Section I Landfill Expansion*, dated March 10, 2008, prepared by SCS.
- *Revised Groundwater Monitoring Plan*, dated March 10, 2008, prepared by SCS~~.~~ and revised by SCS dated January 18, 2011 [revisions were submitted in support of permit modification #38414-014-SO/MM, issued April 15, 2011].
- *Figure M-2 Hardee County Solid Waste Groundwater Monitoring Plan Sampling Locations Map*, dated March 10, 2008, prepared by SCS.
- *Groundwater Flow Evaluation*, dated June 1, 2009, prepared by SCS.

The *Hydrogeological Investigation,* dated April 2004, was previously prepared by SCS and submitted to the Department for the original submittal of the Hardee County Landfill Expansion which included the Phase II Section I and current Phase II Section II areas. The placement of the monitoring points was based on Rule 62-701.510, FAC and the findings of the *Hydrogeological Investigation* submitted concurrently with the Hardee County Landfill Expansion construction permit application. ~~No changes are being proposed as part of this construction permit application for the current Phase II Section II Expansion design from what was originally proposed regarding abandonment of existing monitoring wells, the quantity of additional monitoring wells and LFG monitoring probes as was previously submitted to the Department in April 2004 as discussed below.~~

SCS reviewed the groundwater elevations recorded at the monitor wells and piezometers at the facility during the routine, semi-annual sampling events recorded from June 1999 through June 2012 and in addition elevations recorded in December 2012 provided by the County. Based on the review of the above-mentioned groundwater elevations, the construction requirements for proposed groundwater monitoring wells MW-13 and MW-14 have been revised. The construction details as provided for proposed groundwater monitoring wells MW-13 and MW-14 will replace the construction details as previously provided in Table M-2 of the *Revised Groundwater Monitoring Plan*, dated March 10, 2008, prepared by SCS and revised by SCS dated January 18, 2011 [revisions were submitted in support of permit modification #38414-014-SO/MM, issued April 15, 2011]. Placement of monitoring points MW-13 and MW-14 were based on Chapter 62-701.510, FAC.

In addition, SCS previously sampled the shallow aquifer formation material at the depth interval where monitoring well screen would be installed to provide grain size data to assist in the design of existing groundwater monitoring wells MW-10R and MW-12R to reduce the level of turbidity in the groundwater samples. Soil samples were submitted to a geotechnical testing laboratory for analysis in accordance with American Society for Testing and Materials (ASTM) D422. The grain size analyses indicated that the aquifer material grain size was similar at the two depths and it also contained a relatively large percentage of silt.

Therefore, to minimize potential turbidity issues in proposed groundwater monitoring wells MW-13 and MW-14, a finer slotted well screen and sand pack will be used as with formerly installed MW-10R and MW-12R. Proposed groundwater monitoring wells MW-13 and MW-14 will be constructed using fifteen feet of 2-inch diameter 0.006-inch factory slotted Schedule 40 polyvinyl chloride (PVC) well screen, five feet of solid PVC riser and an additional three feet of solid PVC for the riser stickup. Following installation of MW-13 and MW-14 well assembly's, the annular space of the screened interval of each well will be packed with 30/65 silica sand from the bottom of the well assembly to approximately three feet above the well screen. The remaining annular space will be sealed to grade with Portland Type I cement and completed with a concrete pad and an aluminum riser-type locking cover. Four bollards, consisting of 4-inch diameter Schedule 40 PVC filled with concrete, will be constructed around MW-13 and MW-14.

The required survey information for groundwater monitoring wells MW-13 and MW-14 will be collected (latitude and longitude coordinates, top of casing and land surface elevations) and provided to FDEP (signed and sealed) within the Certification of Construction Completion Report created for the Expansion project.

Refer to the Phase II Section II Expansion construction permit application drawings located in Attachment E-2 that indentify the construction requirements as identified above for proposed groundwater monitoring wells MW-13 and MW-14.

### H.1.a Regional and Site Specific Geology and Hydrogeology

The *Revised Hydrogeological Investigation Report,* dated November 15, 2004, included as Attachment I-1 in the Hardee County Landfill Expansion construction permit application prepared by SCS discussed the site geology and hydrogeology. In addition, information regarding site specific geology and hydrogeology was provided to the Department by SCS within the *Groundwater Flow Evaluation,* dated June 1, 2009, as required by FDEP Operation Permit Number 38414-011-SO/01 Specific Condition Number E.11.

### H.1.b Direction and Rate of Ground Water and Surface Water Flow Including Seasonal Variations

The *Revised Hydrogeological Investigation Report,* dated November 15, 2004, included as Attachment I-1 in the Hardee County Landfill Expansion construction permit application prepared by SCS discussed the direction and rate of groundwater flow. In addition, the *Biennial Groundwater Monitoring Plan Evaluation Report,* dated January 30, 2008, prepared by SCS discussed the direction and rate of groundwater flow.

A hydrogeological investigation, dated March 17, 1993 was performed by Mevers and Associates. This report indicated that the HCL site is underlain by a 10 to 15- foot thick surficial aquifer consisting mainly of fine sand to clayey fine sand. These results were consistent with the site soil conditions reported be Envisors, Inc. in 1982. The lithologic logs as prepared by Envisors, Inc., 1982 were previously provided to the Department. According to Envisors, Inc (1982), the surficial aquifer is separated from the deeper Floridan Aquifer by a continuous confining clay layer that varies in thickness from 14 feet to 35 feet with an average thickness of approximately 25 feet thick. Based on field permeability testing, Mevers found the surficial aquifer to have an average horizontal permeability of about 5 feet per day, the porosity of the upper sands was estimated to be 0.20.

On May 15, 1995 PBS&J performed slug tests at MW-6, MW-7 and MW-3, located down gradient from the extent of waste. Based on these tests the average hydraulic conductivity of the surficial across the site is 1.4 X $10^{-4}$ feet per minute (ft/min) (0.0230 feet per day). The hydraulic gradient (I) was based on groundwater flow maps generated for the period of record.

On June 6, 2003 SCS performed a slug test on monitoring wells MW-8 and MW-4. The results of the test were provided in Attachment I-3 of the *Hardee County Landfill Expansion Construction Permit Application*, dated April 2004, prepared by SCS. Slug test data for the two onsite wells indicate a hydraulic conductivity of 4.9 ft/day at MW-4, located in the northern portion of the site and 9.0 ft/day at MW-8, south of the landfill, in the Phase II Section II Expansion area.

The groundwater flow velocity was calculated using the following aquifer values and Darcy's Law ($V=KI/\eta$),

$V=$ groundwater velocity in feet per day (ft/day)
$K=$ hydraulic conductivity of the surficial aquifer (0.0230-9.00 utilized for calculation)
$I$ = gradient of the surficial aquifer (varies, see below)
$\eta=$ effective porosity of the surficial aquifer (0.20 utilized for calculation)

For the purposes of the evaluation the most conservative hydraulic conductivity of 9.0 ft/day was utilized to calculate surficial groundwater flow velocity. The hydraulic gradient of the surficial aquifer was calculated from the June 2012 groundwater elevation measurements. Three different hydraulic gradients were used for the site. The first hydraulic gradient (0.002 feet per foot (ft/ft)) was calculated from the west side of the landfill (area between MW-5 and MW-8), the second hydraulic gradient (0.001 ft/ft) was calculated from the east side of the landfill (area between P-11 and MW-2), and the third hydraulic gradient was calculated from the east side of the landfill (0.002 ft/ft) area between MW-10R and MW-11). The effective porosity of the sands of the surficial aquifer was estimated at 0.20. Based on the aquifer characteristics discussed above, the groundwater flow velocity in the surficial aquifer ranges from 16.4 to 32.9 feet per year (ft/year) or 8.1 feet/180 days to 16.2 feet/180 days. However, it should be noted that 32.9 ft/year is a liberal estimate of the groundwater flow velocity onsite and is not representative of the groundwater velocity at all locations across the site.

### H.1.c Background Quality of Ground Water and Surface Water

The *Revised Hydrogeological Investigation Report,* dated November 15, 2004, included as Attachment I-1 in the Hardee County Landfill Expansion construction permit application prepared by SCS discussed the background water quality and surface water. In addition, the *Biennial Groundwater Monitoring Plan Evaluation Report,* dated January 30, 2008, prepared by SCS discussed the background water quality and surface water.

### H.1.d On-Site Hydraulic Connections Between Aquifers

The *Revised Hydrogeological Investigation Report,* dated November 15, 2004, included as Attachment I-1 in the Hardee County Landfill Expansion construction permit application prepared by SCS identified there is no on-site connection between the surficial aquifer and the Floridian aquifer. In addition, the *Biennial Groundwater Monitoring Plan Evaluation Report,* dated January 30, 2008, prepared by SCS included information regarding the on-site aquifer hydraulic connections.

### H.1.e Site Stratigraphy and Aquifer Characteristics

The *Revised Hydrogeological Investigation Report,* dated November 15, 2004, included as Attachment I-1 in the Hardee County Landfill Expansion construction permit application prepared by SCS discussed the site stratigraphy and aquifer characteristics. In addition, the *Biennial Groundwater Monitoring Plan Evaluation Report,* dated January 30, 2008, prepared by SCS included information regarding the site stratigraphy and aquifer characteristics.

### H.1.f Topography, Soil Types and Surface Water Drainage Systems

Information regarding the topography, soil types and surface water drainage systems was included in the *Revised Hydrogeological Investigation Report,* dated November 15, 2004, included as Attachment I-1 in the Hardee County Landfill Expansion construction permit application prepared by SCS.

### H.1.g Well Inventory

SCS has obtained from the Southwest Florida Water Management District (SWFWMD) Water Use Permit (WUP) and Well Construction Permit (WCP) database an updated printout of the inventory of public and private potable water wells within a one-mile radius of the Hardee County Landfill. The query search included all publically available information on public and private potable water wells within one-mile of the landfill. A listing of potable water wells obtained from the District (Table 1 SWFWMD Potable Water Well Construction Permits) has been included in Attachment C-1. In addition Figure 1 Potable Well Inventory, Hardee County Landfill, Hardee County, Florida has been provided in Attachment C-1.

### H.1.h Existing Contaminated Areas

Based on the information presented in the *Revised Hydrogeological Investigation Report,* dated November 15, 2004, included as Attachment I-1 in the Hardee County Landfill Expansion construction permit application prepared by SCS and the information submitted by SCS in the *Biennial Groundwater Monitoring Plan Evaluation Report,* dated January 30, 2008, there is no reason to believe that there are contaminated areas at the site.

### H.1.i Map of Potable Wells and Community Water Supply Wells

A map of the potable wells within 500 feet of the site was included in the *Revised Hydrogeological Investigation Report,* dated November 15, 2004, included as Attachment I-1 in the Hardee County Landfill Expansion construction permit application prepared by SCS. The only potable wells within the 500 foot radius of the landfill are two onsite wells used for water to supply the facility toilets, operations within the Materials Recycling Facility (MRF) and a fire hydrant. The two wells are not used for drinking water (bottled water is for drinking water). There are no community supply wells within 1,000 feet of the waste storage and disposal areas.

SCS has obtained from the SWFWMD WUP and WCP database an updated printout of the inventory of public and private water wells within a one-mile radius of the Hardee County Landfill. The query search included all publically available information on public and private wells within one-mile of the landfill. A listing of potable water wells obtained from the District (Table 1 SWFWMD Potable Water Well Construction Permits) has been included in Attachment C-1. In addition Figure 1 Potable Well Inventory, Hardee County Landfill, Hardee County, Florida has been provided in Attachment C-1.

## H.2 PROFESSIONAL ENGINEER OR GEOLOGIST SIGNATURE

The information previously provided to the Department were signed, sealed, and dated by the professional engineer and/or professional geologist.

# Revised Section I
# Geotechnical Investigation Requirements

# SECTION I

# GEOTECHNICAL INVESTIGATION REQUIREMENTS

## I.1 GEOTECHNICAL SITE INVESTIGATION REPORT

Several previous geotechnical investigations of the site have been performed and the boring locations and soil strata information previously provided to the Department. SCS previously prepared a site specific geotechnical subsurface investigation for the areas currently designated as the Phase II Section II Expansion and Phase II Section I of the Hardee County Landfill. SCS previously subcontracted the drilling and laboratory sampling as part of a geotechnical investigation to Professional Services, Incorporated (PSI) of Tampa, Florida. For the geotechnical investigation, SCS selected the locations for seven geotechnical borings. The location for the seven geotechnical borings were established to obtain subsurface information directly within the Phase II Section II Expansion and Phase II Section I footprint (at the time) as well as to estimate the perimeter subsurface soil strata conditions that may influence the design.

SCS prepared a drilling and testing plan to classify the soils, estimate the relative density of the subsurface soil layers using Standard Penetration Tests (SPT), estimate the insitu permeability of the soils, and retrieving samples of the sandy clay and stiff clay layers for shear strength estimations and consolidation properties. The soil investigation testing methods are outlined below:

- Subsurface Soil Classification - Field classification, SPT N-values, grain size analysis, and Atterberg Limits. Based upon field classification, grain size and Atterberg Limits the soils were classified using the Unified Soil Classification System (USCS). Blow counts from the SPT N-values were used to estimate the insitu density of the soil layers.

- Soil borings were conducted by PSI using a CME-45 drill rig capable of conducting SPT and retrieving both spilt spoon samples and undisturbed Shelby Tube soil samples. Spilt spoon samples were used to field classify the soils and Shelby Tubes were used to recover undisturbed samples for the laboratory sampling.

- Permeability - A flexible wall permeameter was used to test the soil samples retrieved from the Shelby Tubes.

- Tri-Axial Consolidated Undrained (CU) Testing - Samples retrieved from the Shelby Tubes were consolidated under various loads and then loaded until the samples sheared under undrained conditions. The shear strength parameters, cohesion and phi angle were estimated over a range of loading conditions to estimate the soils strength.

- Consolidation Testing - The consolidation test conducted was to estimate the amount of consolidation (settlement) in the soil layer that could be expected due to the additional loading and stresses induced by the overlying landfill waste material.

The locations of the soil borings identified on the Phase II Section II Expansion construction permit application drawings were obtained from:

- *Geotechnical Engineering Services Report for the Proposed Landfill Expansion Hardee County Florida*, September 25, 2003, prepared by Professional Services Industries, Inc. (PSI). The PSI investigation was performed for the new (at the time) proposed Hardee County Landfill Expansion previously submitted to the Department, dated April 2004, which originally included the Phase II Section I and Phase II Section II areas design at that time. Copies of this report are included in Attachment I-1 of this construction permit application.

In addition, SCS reviewed previous geotechnical information that had been collected at the facility. The previous geotechnical information reviewed by SCS included the following reports, drawings or boring logs. Copies of the reports were previously provided to the Department with the Hardee County Landfill Expansion construction permit application, dated April 2004.

- *Hardee County Landfill*, November 1982, prepared by Envisors, Incorporated.

- *Report Geotechnical Engineering Services, Hardee County Sanitary Landfill*, March 1997, prepared by PSI Report No. 757-75054.

Based on the review of the previously collected subsurface information, SCS estimated that the upper soil strata consisted of approximately 15 feet of silty and poorly graded sands. The next soil strata was a clayey sand, approximately 5 to 10 feet thick, above a stiff low plasticity clay. Below the stiff clay layer, the previous investigations indicate a dense to very dense sand with phosphate particles.

Based on the review of the investigations, it has been concluded that the subsurface soils will provide adequate support for the Phase II Section II Expansion.

### I.1.a Description of Subsurface Conditions Including Soil Stratigraphy and Ground Water Table Conditions

A description of subsurface conditions including soil stratigraphy and groundwater table conditions was previously included in the geotechnical investigation report prepared by PSI submitted by SCS as Attachment J-1 with the Hardee County Landfill Expansion construction permit application, dated April 2004, which included the Phase II Section II Expansion area design at that time. Copies of this report are included in Attachment I-1 of this construction permit application.

### I.1.b Investigation for the Presence of Muck, Previously Filled Areas, Soft Ground, Lineaments and Sinkholes

A description of subsurface conditions including soil stratigraphy and groundwater table conditions was previously included in the geotechnical investigation report prepared by PSI submitted by SCS as Attachment J-1 with the Hardee County Landfill Expansion construction permit application, dated April 2004, which included the Phase II Section II Expansion area design at that time. Copies of this report are included in Attachment I-1 of this construction permit application. A review of the soil borings contained in the PSI report indicated no muck or high organic soils layers are present within or adjacent to the Phase II Section II Expansion area or existing landfill disposal areas. The area within the proposed Phase II Section II Expansion has remained undisturbed since operations began in 1983. During the subsurface investigation conducted by PSI, SCS field personnel examined the spilt spoon samples retrieved from the borings. The split spoon samples did not have multiple soils types or colors that are generally found in filled areas. This indicates that the area has not been disturbed or previously filled. No soft ground depressions or weak subsurface soil layers were noted in the borings.

In addition, SCS reviewed the sinkhole activity information that is currently available for Hardee County on the Florida Department of Environmental Protection/Florida Geology Survey's Sinkhole Database. A copy of the sinkhole activity available for Hardee County is contained in Attachment I-2. No active sinkhole information near the vicinity of the Hardee County Landfill is identified in the Sinkhole Database.

### I.1.c Average and Maximum High Water Table

The following rainfall records for the Phase II Section II Expansion were reviewed by SCS.

- Information was reviewed National Oceanic and Atmospheric Administration (NOAA) rainfall data was obtained from the National Climatic Data Center (NCDC) web site for the NOAA weather station (station index number 08-9401-04) located in Wauchula, Florida at Latitude: 27° 31' North Longitude: 81° 48' West. The NOAA rainfall data is located in Attachment G-5. Rainfall data information was available for the weather station from January 1954 to April 30, 2012. Based on the NOAA rainfall data for the mentioned time period, the annual average rainfall was documented to be 51.16 inches.

- Site specific rainfall data was also obtained from the Hardee County Solid Waste Department. Site specific rainfall data was available from February 1998 through September 1998, calendar years 2003 through 2009, and January 2011 through ~~June~~ December 2012. The site specific rainfall data is located in Attachment G-6. Based on the site specific rainfall data for the mentioned time period, the annual average rainfall was calculated to be 40.26 inches.

- In addition, as a comparison, SCS used the NOAA rainfall data previously mentioned above and included the years where the site specific data was available and calculated the average rainfall from January 1954 to ~~April~~ December 3~~0~~1, 2012. The combination of the NOAA rainfall data and the site specific rainfall data is located in Attachment G-7. Based on the combination of the NOAA rainfall data and the site specific rainfall data, the annual average rainfall was calculated to be 48.70 inches.

The HELP Model analyses are based on daily site specific rainfall data provided by the County for the following time period:

- February 1998 through September 1998.

- January 2003 through May 2009.
- January 2012 through December 2012.

Daily rainfall data obtained from NOAA was input into the HELP Model analyses and used for the following time period:

- January 1984 through January 1998.
- October 1998 through December 1998 (used to fill-in unavailable County data).
- January 1999 through December 2002 (used to fill-in unavailable County data).
- June 2009 through December 2011 (used to fill-in unavailable County data).

- Based on the three above-mentioned rainfall data reviews SCS created a summary table. Please refer to Attachment G-8 for a summary table of the rainfall data reviewed. As indicated in the summary tables, the NOAA weather station values are the largest (most conservative) for the annual average rainfall and average monthly rainfall compared to only site specific rainfall and a combination of site specific and NOAA values. ~~Therefore, the average monthly rainfall data for the NOAA weather station was used within the HELP model.~~

To estimate the average and high groundwater table elevations across the site, SCS reviewed the groundwater elevation data collected for the piezometers and groundwater monitoring wells on-site. The period reviewed was from June 1999 to December 2011. The facility had a leachate spray irrigation system in operation prior to and until April of 1999. Consequently, groundwater elevation data prior to April of 1999 may have been influenced to some extent by the underdrain system or spray field operations. The estimated average groundwater elevations across the site range from approximately EL 81.7 feet NGVD at MW-1 located on the north side of the site to approximately EL 80.1 feet NGVD in MW-12R located south of the existing Phase II Section I disposal area. The high groundwater elevations across the site range from approximately EL 84.1 feet NGVD at MW-1 located on the north side of the site to approximately EL 83.10 feet NGVD in MW-12R located south of the existing Phase II Section I disposal area.

In addition, to estimate the seasonal high groundwater table, SCS previously had the County dig test holes in five locations several feet below existing grade, surrounding the facility borrow pit area. Soil staining observations made in accordance with the Southwest Florida Water Management District (SWFWMD) district guidelines were used to estimate the groundwater elevations. Pit numbers 1 and 5 were used to estimate the seasonal high groundwater table as previously submitted to the Department with the Hardee County Landfill Expansion construction permit application, April 2004. In pit number 2, 3, and 4 no distinct soil staining layers were observed possibly due to the close proximity to the adjoining former borrow pit. The County surveyed in the stained soil layer in pit numbers 1 and 5. Based upon the survey the seasonal high groundwater elevation was estimated and set to be approximately EL 78.53 feet NGVD.

SCS plotted the groundwater elevations within the proposed Phase II Section II Expansion area using MW-3, MW-5 and MW-8 groundwater data obtained from the County and checked the GCL placement in regards to the subbase in relation to the average estimated groundwater elevation. The average groundwater elevations and the expansion cell elevations at certain locations are shown below in Table I-1.

Table I-1 Monitoring Points, Groundwater Elevations, and Cell Elevations

| Monitoring Point | Average Elevation of Groundwater | Elevation of GCL at Monitoring Point |
|---|---|---|
| MW-3 | 80.41 | 84.3 |
| MW-5 | 79.35 | 83.1 |
| MW-8 | 78.97 | 82.9 |

The lowest proposed elevation of the bottom lining system for the Phase II Section II Expansion area is the leachate collection sump at EL 78.5 feet NGVD. Based on the groundwater elevation readings observed within MW-5 (monitoring well closest to sump) groundwater elevations fluctuated between a minimum of EL 76.46 feet NGVD to a maximum of EL 82.09 feet NGVD. Due to the fluctuations of the groundwater table within the area of the sump and a portion of the cell bottom, an additional layer of 60 mil textured HDPE geomembrane liner will be placed under the GCL and welded to the secondary 60 mil textured HDPE geomembrane liner. This additional layer of 60 mil textured HDPE geomembrane liner will help prevent the “wet-dry” cycles of the GCL due to the fluctuations of the groundwater table. The additional layer of 60 mil textured HDPE geomembrane liner will be placed under the GCL throughout the sump and cell bottom to cover the area up to EL 82.5 feet NGVD (approximately 0.41 feet higher than the highest reading observed).

Requirements for the additional layer of liner below the GCL has been included within the Technical Specifications located in Attachment G-1 and the construction permit application drawings located in Attachment E-2. Please refer to Attachment I-3 for the estimated average and high groundwater table elevation, groundwater data, and rainfall information.

## I.1.d Foundation Analysis

In accordance with Rule 62-701.410(2)(e), FAC, the foundation analyses included foundation bearing capacity, maximum total and differential settlements, and slope stability (including waste and subgrade). These evaluations are conservatively based on subsurface soil engineering properties established from field and laboratory investigations and literature data. Subsurface conditions in the area of the Phase II Section II Expansion are generalized into profiles for foundation analysis.

### I.1.d.1 Foundation Bearing Capacity Analysis

Bearing capacity is the ability of the foundation soil to safely carry a structure without undergoing a shear failure. The ultimate bearing capacity of the soil is calculated to evaluate the adequacy of the foundation to support the proposed loads. Typical bearing capacity calculations based on Terzaghi’s equations are applicable to small footings or mat foundations for buildings, although these equations have been modified for modeling large embankment loads. Such equations are, however, typically not applicable to large area loadings such as stockpiling or landfilling. A more accurate analysis for the foundation bearing capacity of a large embankment (as in the case of a landfill at final grade) is an evaluation of deep rotational foundation failure. SCS performed a slope stability analysis with the Phase II Section II Expansion at final grade and the rotational failure plane through the waste and foundation soils. This model is comparable to a bearing capacity failure.

The bearing capacity analysis included one west-to-east critical cross-section, through the peak Phase II Section II Expansion EL 173.2 ft NGVD and bottom liner system. The results of the bearing capacity analysis shows a minimum factor of safety against failure of 1.6, which exceeds the minimum factor of safety requirements of 1.5 for landfill slopes per Rule 62-701.400(2), FAC. The results of the slope stability analysis and the maximum anticipated settlements indicate that the design of the Phase II Section II Expansion area meets regulatory requirements. Therefore, the foundation soils have sufficient bearing capacity to support the proposed final buildout plans presented.

#### I.1.d.2 Total and Differential Settlement Analysis

Total settlement of the foundation soils was calculated based on determining the changes in stress imposed on the foundation due to excavation of the soil and construction of the Phase II Section II Expansion. The settlement analysis included calculating the total settlement at representative soil borings. The settlement calculations were then used to evaluate settlement along the leachate collection system lateral trenches, header trench and critical sections perpendicular to the leachate collection trenches (cross slope) to determine the final slope of the bottom liner system and thus the effectiveness of the leachate collection system for long-term operation.

Two conditions were analyzed for the leachate collection and detection systems in the Phase II Section II Landfill Expansion area. Settlement, due to the proposed waste loading, will influence the conveyance of leachate to the leachate collection and detection pumps. The two bottom cell conditions analyzed are as follows:

- Leachate Collection/Detection Trenches - The leachate collection/detection trenches were designed to convey the leachate collected from the geocomposite drainage layer to the leachate sump. The slope of the trenches were designed to convey the high flow rates during the initial open cell condition as well as retain sufficient slope after settlement to convey the estimated flow rates as filling occurs in the expansion area.

- Cross Slope of the Cell - The design of the bottom of the expansion area included a typical “saw-tooth” pattern or a series of peaks (ridgelines) and valleys (leachate collection/detection trenches). This pattern, and the spacing of the trenches, was designed to limit the potential hydrostatic head above the primary and secondary containment geomembrane. The flow rate and transmissivity of the geocomposite drainage layer and cross slope between the peaks and valleys was used in the USEPA’s HELP model to estimate the potential head above the various geomembrane layers. As the expansion area is loaded, settlement will decrease the initial cross slopes. Settlement of several cross slopes were computed, the resultant slopes estimated, and the long-term slopes were then used in the USEPA's HELP model to estimate the head of the geomembrane layers.

The estimated settlement of the subsurface soil layers in the Phase II Section II Landfill Expansion area was computed at several points, specifically along the length of each segment of pipeline and at points in the trenches and ridgeline. The locations of the points were selected in areas of maximum anticipated loading (stress). At these locations the deflection of the pipes in the trenches and the cross slope of the cell was computed.

At each selected point, the pre-existing (prior to excavation for the expansion) stress in the various subsurface layers was estimated based upon the effective (buoyant) overburden stress at the mid-point of each soil type. Soil layers were grouped together based upon similar soil classification and blow counts. Settlement estimates were terminated in very dense layers since these layers are at or near the maximum anticipated density for that layer. SCS estimated the unit weight of each soil type over a range of relative densities that are representative of SPT N-values that were recorded in the field. The unit weight of the clay soils was tested in the laboratory. The soil stratification at each point was estimated using the nearest borehole. Groundwater levels were estimated from the nearest monitoring well and the lowest water elevations taken to maximize the overburden stress in the soil layers.

Next SCS estimated the unit weight of the waste material to be placed in the expansion cell. To conservatively estimate the anticipated settlement, SCS maximized the unit weight of the waste material. In the settlement calculations, the waste material and daily cover soils were assumed to be fully saturated. In addition, the drainage sand and cover soils were computed using saturated soil weights. A composite unit weight of 60 pcf was estimated for fully saturated waste materials and daily cover soil for settlement calculations.

SCS computed the maximum anticipated settlement for the leachate collection trenches and cross slopes based upon the procedures outlined. Refer to Attachment I-4 for the Phase II Section II Expansion settlement calculations. The locations of the settlement points are shown on Figures 1 and 2 contained within Attachment I-4. The results of the settlement estimates are summarized below in Tables I-2 and I-3.

Table I-2 Estimated Settlement and Slopes Leachate Collection/Detection Trenches

| Points | Initial Conditions | | | | Final Conditions | | | |
|---|---|---|---|---|---|---|---|---|
| | Initial Elevation (ft NGVD) | Difference (ft) | Distance (ft) | Slope (%) | Settlement (ft) | Elevation (ft NGVD) | Difference (ft) | Slope (%) |
| G | 84.37 | | | | 0.22 | 84.15 | | |
| | | 5.87 | 472.05 | 1.24 | | | 5.72 | 1.21 |
| D | 78.50 | | | | 0.08 | 78.42 | | |
| | | 4.79 | 419.01 | 1.14 | | | 4.62 | 1.10 |
| A | 83.29 | | | | 0.25 | 83.04 | | |

| Points | Initial Conditions | | | | Final Conditions | | | |
|---|---|---|---|---|---|---|---|---|
| | Initial Elevation (ft NGVD) | Difference (ft) | Distance (ft) | Slope (%) | Settlement (ft) | Elevation (ft NGVD) | Difference (ft) | Slope (%) |
| H | 84.57 | | | | 0.34 | 84.23 | | |
| | | 5.49 | 479.61 | 1.14 | | | 5.26 | 1.10 |
| E | 79.08 | | | | 0.11 | 78.97 | | |
| | | 5.45 | 476.34 | 1.14 | | | 5.31 | 1.11 |
| B | 84.53 | | | | 0.26 | 84.27 | | |

| Points | Initial Conditions | | | | Final Conditions | | | |
|---|---|---|---|---|---|---|---|---|
| | Initial Elevation (ft NGVD) | Difference (ft) | Distance (ft) | Slope (%) | Settlement (ft) | Elevation (ft NGVD) | Difference (ft) | Slope (%) |
| I | 83.99 | | | | 0.42 | 83.57 | | |
| | | 4.13 | 476.78 | 0.87 | | | 3.87 | 0.81 |
| F | 79.86 | | | | 0.17 | 79.69 | | |
| | | 4.09 | 475.40 | 0.86 | | | 4.07 | 0.86 |
| C | 83.95 | | | | 0.18 | 83.77 | | |

| Points | Initial Conditions | | | | Final Conditions | | | |
|---|---|---|---|---|---|---|---|---|
| | Initial Elevation (ft NGVD) | Difference (ft) | Distance (ft) | Slope (%) | Settlement (ft) | Elevation (ft NGVD) | Difference (ft) | Slope (%) |
| J | 83.00 | | | | 0.13 | 82.87 | | |
| | | 0.50 | 99.7 | 0.50 | | | 0.57 | 0.57 |
| K | 82.50 | | | | 0.20 | 82.30 | | |
| | | 0.47 | 99.7 | 0.47 | | | 0.45 | 0.45 |
| L | 82.03 | | | | 0.18 | 81.85 | | |

| Points | Initial Conditions | | | | Final Conditions | | | |
|---|---|---|---|---|---|---|---|---|
| | Initial Elevation (ft NGVD) | Difference (ft) | Distance (ft) | Slope (%) | Settlement (ft) | Elevation (ft NGVD) | Difference (ft) | Slope (%) |
| M | 84.23 | | | | 0.16 | 84.07 | | |
| | | 0.51 | 98.3 | 0.52 | | | 0.60 | 0.62 |
| N | 83.72 | | | | 0.25 | 83.47 | | |
| | | 0.51 | 98.3 | 0.52 | | | 0.50 | 0.51 |
| O | 83.21 | | | | 0.25 | 82.96 | | |

| Points | Initial Conditions | | | | Final Conditions | | | |
|---|---|---|---|---|---|---|---|---|
| | Initial Elevation (ft NGVD) | Difference (ft) | Distance (ft) | Slope (%) | Settlement (ft) | Elevation (ft NGVD) | Difference (ft) | Slope (%) |
| P | 83.89 | | | | 0.14 | 83.75 | | |
| | | 0.26 | 50.20 | 0.52 | | | 0.24 | 0.49 |
| Q | 83.63 | | | | 0.12 | 83.51 | | |
| | | 0.49 | 94.90 | 0.52 | | | 0.52 | 0.55 |
| R | 83.14 | | | | 0.15 | 82.99 | | |

Table I-3 Estimated Settlement and Slopes Cross (Perpendicular) to Trenches

| Points | Initial Conditions | | | | Final Conditions | | | |
|---|---|---|---|---|---|---|---|---|
| | Initial Elevation (ft NGVD) | Difference (ft) | Distance (ft) | Slope (%) | Settlement (ft) | Elevation (ft NGVD) | Difference (ft) | Slope (%) |
| 3 | 81.14 | | | | 0.19 | 80.95 | | |
| | | 1.53 | 44.80 | 3.42 | | | 1.47 | 3.28 |
| 4 | 82.67 | | | | 0.25 | 82.42 | | |
| | | 0.86 | 34.80 | 2.49 | | | 0.86 | 2.48 |
| 5 | 81.81 | | | | 0.25 | 81.56 | | |
| | | 1.24 | 34.10 | 3.62 | | | 1.18 | 3.46 |
| 6 | 83.04 | | | | 0.30 | 82.74 | | |
| | | 1.09 | 45.00 | 2.42 | | | 1.06 | 2.35 |
| 7 | 81.95 | | | | 0.27 | 81.68 | | |

| Points | Initial Conditions | | | | Final Conditions | | | |
|---|---|---|---|---|---|---|---|---|
| | Initial Elevation (ft NGVD) | Difference (ft) | Distance (ft) | Slope (%) | Settlement (ft) | Elevation (ft NGVD) | Difference (ft) | Slope (%) |
| 8 | 81.39 | | | | 0.07 | 81.32 | | |
| | | 1.36 | 38.90 | 3.50 | | | 1.31 | 3.37 |
| 9 | 82.75 | | | | 0.12 | 82.63 | | |
| | | 0.92 | 36.10 | 2.55 | | | 0.92 | 2.55 |
| 10 | 81.83 | | | | 0.12 | 81.71 | | |
| | | 1.20 | 34.90 | 3.44 | | | 1.16 | 3.32 |
| 11 | 83.03 | | | | 0.16 | 82.87 | | |
| | | 1.07 | 41.10 | 2.60 | | | 1.07 | 2.61 |
| 12 | 81.96 | | | | 0.16 | 81.80 | | |

| Points | Initial Conditions | | | | Final Conditions | | | |
|---|---|---|---|---|---|---|---|---|
| | Initial Elevation (ft NGVD) | Difference (ft) | Distance (ft) | Slope (%) | Settlement (ft) | Elevation (ft NGVD) | Difference (ft) | Slope (%) |
| Q | 83.63 | | | | 0.12 | 83.51 | | |
| | | 1.65 | 55.20 | 2.99 | | | 1.48 | 2.68 |
| 14 | 85.28 | | | | 0.29 | 84.99 | | |
| | | 1.56 | 61.10 | 2.55 | | | 1.52 | 2.49 |
| N | 83.72 | | | | 0.25 | 83.47 | | |
| | | 1.05 | 46.10 | 2.28 | | | 1.01 | 2.20 |
| 13 | 84.77 | | | | 0.29 | 84.48 | | |
| | | 2.27 | 64.50 | 3.52 | | | 2.18 | 3.38 |
| K | 82.50 | | | | 0.20 | 82.30 | | |

Results: Based upon the maximum anticipated settlements in the Phase II Section II Expansion area, the designed leachate collection system and cross slopes are adequate to maintain the flow within the trenches and pipelines and minimize the head over the liner.

## EFFECT OF HEIGHT INCREASE ON THE EXISTING PHASE II SECTION I LEACHATE COLLECTION SYSTEM

The Phase II Section I area and “piggy-back” portion onto the south sideslope of the existing closed Phase I area is currently permitted for filling to a peak of roughly EL 132.1 feet National Geodetic Vertical Datum (NGVD) top of intermediate cover (approximately EL 134.1 feet NGVD top of final closure). With the Phase II Section II Expansion, the height increase will raise the peak to roughly EL 166 feet NGVD top of final closure within the Phase II Section I area with an overall final buildout of the Phase II Section II Expansion to EL 173.2 feet NGVD top of final closure. The request for the height increase will provide sufficient time for the County to continue filling within the area while the Phase II Section II Expansion area is permitted, advertised for bid, constructed, and approval from the Department is received to begin filling within the Phase II Section II Expansion area.

To estimate the effects of adding additional waste placement on top of the existing Phase II Section I area leachate collection system, SCS computed the anticipated settlement along the leachate collection system pipes. Using the estimated settlement at points along the leachate collection system, the anticipated long-term slope of the pipelines was computed. Refer to Attachment I-5 for the results of the Phase II Section I vertical expansion settlement calculations on the existing leachate collection system pipes. The locations of the settlement points are shown on Figure 1 contained within Attachment I-5. The results of the settlement estimates are summarized below in Table I-4.

Table I-4 Estimated Settlement and Slopes Leachate Collection/Detection Trenches
Phase II Section I

| Points | Initial Conditions | | | | Final Conditions | | | |
|---|---|---|---|---|---|---|---|---|
| | Initial Elevation (ft NGVD) | Difference (ft) | Distance (ft) | Slope (%) | Settlement (ft) | Elevation (ft NGVD) | Difference (ft) | Slope (%) |
| R | 83.14 | | | | 0.09 | 83.05 | | |
| | | 0.76 | 260.00 | 0.29 | | | 0.79 | 0.30 |
| S | 82.38 | | | | 0.11 | 82.27 | | |
| | | 2.31 | 360.00 | 0.64 | | | 2.28 | 0.63 |
| T | 80.07 | | | | 0.08 | 79.99 | | |

| Points | Initial Conditions | | | | Final Conditions | | | |
|---|---|---|---|---|---|---|---|---|
| | Initial Elevation (ft NGVD) | Difference (ft) | Distance (ft) | Slope (%) | Settlement (ft) | Elevation (ft NGVD) | Difference (ft) | Slope (%) |
| O | 83.21 | | | | 0.25 | 82.96 | | |
| | | 2.41 | 280.0 | 0.86 | | | 2.43 | 0.87 |
| U | 80.80 | | | | 0.27 | 80.53 | | |
| | | 1.00 | 320.0 | 0.31 | | | 0.81 | 0.25 |
| V | 79.80 | | | | 0.08 | 79.72 | | |

| Points | Initial Conditions | | | | Final Conditions | | | |
|---|---|---|---|---|---|---|---|---|
| | Initial Elevation (ft NGVD) | Difference (ft) | Distance (ft) | Slope (%) | Settlement (ft) | Elevation (ft NGVD) | Difference (ft) | Slope (%) |
| L | 82.03 | | | | 0.38 | 81.65 | | |
| | | 2.23 | 300.0 | 0.74 | | | 2.13 | 0.71 |
| W | 79.80 | | | | 0.28 | 79.52 | | |
| | | 0.55 | 300.0 | 0.18 | | | 0.33 | 0.11 |
| X | 79.25 | | | | 0.06 | 79.19 | | |

Results: Based upon the maximum anticipated settlements in the Phase II Section I area, the existing leachate collection system are adequate to maintain the flow within the swales and pipelines and minimize the head over the liner.

## EFFECT OF PHASE II SECTION II EXPANSION AND HEIGHT INCREASE ON THE EXISTING PHASE I LEACHATE COLLECTION SYSTEM AND LFG SYSTEM

To estimate the effects of adding additional waste on top of the existing Phase I area leachate collection system and LFG system due to the "piggy-back" of the Phase II Section II Expansion and the height increase of the Phase II Section I area, SCS computed the anticipated settlement along the western and southern sides of the Phase I area. Using the estimated settlement at points along the existing leachate collection system and LFG system, the anticipated long-term slope of the pipelines were computed. Refer to Attachment I-6 for the results of the settlement calculations on the existing LFG system pipes and the leachate collection system. The locations of the settlement points are shown on Figure 1 contained within Attachment I-10. The results of the settlement estimates are summarized below in Table I-5.

### Table I-5 Estimated Settlement and Slopes Existing LFG Pipes/Leachate Collection Pipes Phase I

| Points | Initial Conditions | | | | Final Conditions | | | |
|---|---|---|---|---|---|---|---|---|
| | Initial Elevation (ft NGVD) | Difference (ft) | Distance (ft) | Slope (%) | Settlement (ft) | Elevation (ft NGVD) | Difference (ft) | Slope (%) |
| 6 LFG | 81.33 | | | | 0.43 | 80.90 | | |
| | | 26.63 | 300.00 | 8.88 | | | 26.49 | 8.83 |
| 5 LFG | 107.96 | | | | 0.56 | 107.40 | | |
| | | 52.15 | 380.00 | 13.72 | | | 52.51 | 13.82 |
| 4 LFG | 160.11 | | | | 0.20 | 159.91 | | |

| Points | Initial Conditions | | | | Final Conditions | | | |
|---|---|---|---|---|---|---|---|---|
| | Initial Elevation (ft NGVD) | Difference (ft) | Distance (ft) | Slope (%) | Settlement (ft) | Elevation (ft NGVD) | Difference (ft) | Slope (%) |
| 10 LFG | 87.67 | | | | 0.54 | 87.13 | | |
| | | 20.92 | 300.00 | 6.97 | | | 20.94 | 6.98 |
| 9 LFG | 108.59 | | | | 0.52 | 108.07 | | |
| | | 33.14 | 303.00 | 10.94 | | | 33.24 | 10.97 |
| 8 LFG | 141.73 | | | | 0.42 | 141.31 | | |
| | | 17.40 | 303.00 | 5.74 | | | 17.62 | 5.82 |
| 7 LFG | 159.13 | | | | 0.20 | 158.93 | | |

| Points | Initial Conditions | | | | Final Conditions | | | |
|---|---|---|---|---|---|---|---|---|
| | Initial Elevation (ft NGVD) | Difference (ft) | Distance (ft) | Slope (%) | Settlement (ft) | Elevation (ft NGVD) | Difference (ft) | Slope (%) |
| 13 LFG | 86.68 | | | | 0.52 | 86.16 | | |
| | | 17.90 | 378.00 | 4.74 | | | 18.00 | 4.76 |
| 12 LFG | 104.58 | | | | 0.42 | 104.16 | | |
| | | 40.40 | 302.00 | 13.38 | | | 40.62 | 13.45 |
| 11 LFG | 144.98 | | | | 0.20 | 144.78 | | |

| Points | Initial Conditions | | | | Final Conditions | | | |
|---|---|---|---|---|---|---|---|---|
| | Initial Elevation (ft NGVD) | Difference (ft) | Distance (ft) | Slope (%) | Settlement (ft) | Elevation (ft NGVD) | Difference (ft) | Slope (%) |
| 16 LFG | 80.34 | | | | 0.15 | 80.19 | | |
| | | 27.68 | 366.00 | 7.56 | | | 27.67 | 7.56 |
| 15 LFG | 108.02 | | | | 0.16 | 107.86 | | |
| | | 21.89 | 299.00 | 7.32 | | | 21.87 | 7.31 |
| 14 LFG | 129.91 | | | | 0.18 | 129.73 | | |

| Points | Initial Conditions | | | | Final Conditions | | | |
|---|---|---|---|---|---|---|---|---|
| | Initial Elevation (ft NGVD) | Difference (ft) | Distance (ft) | Slope (%) | Settlement (ft) | Elevation (ft NGVD) | Difference (ft) | Slope (%) |
| A-MH4 | 84.00 | | | | 0.54 | 83.46 | | |
| | | 4.58 | 396.00 | 1.16 | | | 4.56 | 1.15 |
| B-MH5 | 79.42 | | | | 0.52 | 78.90 | | |
| | | 1.14 | 399.00 | 0.29 | | | 1.04 | 0.26 |
| C-MH6 | 78.28 | | | | 0.42 | 77.86 | | |
| | | 2.78 | 160.00 | 1.74 | | | 2.56 | 1.60 |
| D-MH7 | 75.50 | | | | 0.20 | 75.30 | | |

| Points | Initial Conditions | | | | Final Conditions | | | |
|---|---|---|---|---|---|---|---|---|
| | Initial Elevation (ft NGVD) | Difference (ft) | Distance (ft) | Slope (%) | Settlement (ft) | Elevation (ft NGVD) | Difference (ft) | Slope (%) |
| D-MH7 | 75.50 | | | | 0.52 | 74.98 | | |
| | | 1.80 | 378.00 | 0.48 | | | 1.70 | 0.45 |
| E | 73.70 | | | | 0.42 | 73.28 | | |
| | | 1.03 | 368.00 | 0.28 | | | 0.81 | 0.22 |
| F-MH8 | 72.67 | | | | 0.20 | 72.47 | | |

Results: Based upon the maximum anticipated settlements in the Phase I area, the existing leachate collection system pipeline is adequate to maintain the flow. In addition, the anticipated settlement should not be detrimental to the existing LFG system pipelines.

### I.1.d.3 Slope Stability Analysis

The potential for deep seated rotational or translational failures through the waste and the final cover system was analyzed. A global slope stability analysis was performed for the steepest typical final slopes and worst case site conditions which occur using the computer program PCSTABL5M. Slope stability analysis involves the calculation of the minimum (critical) safety factor for assumed failure surfaces through representative slope cross-sections. The safety factor is defined as the ratio of the forces that act to preserve stability in a slope (resisting forces) to the forces acting to make the slope unstable (driving forces). A safety factor of 1.0 (unity) indicates a condition of impending slope failure.

The PCSTABL5M computer program uses two-dimensional limit equilibrium methods to calculate a factor of safety against shear failure for slope sections analyzed. This program is able to use an automatic search routine to generate multiple shear failure surfaces for both circular failures and block or wedge-type failure modes until the surface with the lowest factor of safety value is found. The analytical methods used for the circular and sliding block failure modes in the slope stability analysis are the Modified Bishop and Modified Janbu methods.

A critical failure surface is automatically determined for selected cross-sections by the PCSTABL5M program. The calculated critical failure surface defines a slope mass with the lowest static safety factor. Two scenarios were analyzed for each section for potential failure through the waste mass and through the foundation soils:

- Static analysis using circular-type failure surfaces. The analysis was conducted from outside the toe of slope to the upper surface. All failure planes passed through the foundation soils and waste mass.

- Static analysis using wedge/block-type failure surfaces along the weakest interface. The models analyzed potential deep failure planes extending through the waste and extending horizontally along potential failure planes.

Please refer to the following locations for the slope stability analysis conducted based on the loads anticipated during construction and operation. A summary table of the slope stability analysis is provided prior to the calculations in Attachment I-7. The results of the slope stability analysis are summarized below in Table I-6.

- Phase II Section II Expansion

    - Attachment I-8 - At a location during construction when the cell has been excavated to subbase elevations to the lowest depth with the adjacent Phase I area at its current configuration. Both circular and block-type failure surfaces were analyzed, with and without the anticipated operating equipment loading on the adjacent Phase I area. Equipment loading from a CAT D7R Series II track-type bulldozer was conservatively used within the analysis on the Phase I area even though the area is closed and this type of operating equipment should no longer be present.

    - Attachment I-9 - At a location during construction when the cell has been excavated to subbase elevations to the lowest depth and the adjacent Phase II Section I area has been filled to its anticipated highest elevation (during fill sequencing prior to needing to move into the Phase II Section II Expansion area). Both circular and block-type failure surfaces were analyzed, with and without the anticipated operating equipment loading on the adjacent Phase II Section I area. Equipment loading from a CAT D7R Series II track-type bulldozer was used within the analysis.

    - Attachment I-10 - At a location at the final buildout elevation and the “piggy-back” of waste has been performed along the western sideslope of the Phase I area. Both circular and block-type failure surfaces were analyzed, with and without the anticipated operating equipment loading. Equipment loading from a CAT D7R Series II track-type bulldozer was used within the analysis.

- Phase II Section I Vertical Expansion
  - Attachment I-11 - At a location along the eastern sideslope at the final buildout elevation of the area. Both circular and block-type failure surfaces were analyzed, with and without the anticipated operating equipment loading. Equipment loading from a CAT D7R Series II track-type bulldozer was used within the analysis.
  - Attachment I-12 - At a location at the final buildout elevation and the "piggy-back" of waste has been performed along the southern sideslope of the Phase I area. Both circular and block-type failure surfaces were analyzed, with and without the anticipated operating equipment loading. Equipment loading from a CAT D7R Series II track-type bulldozer was used within the analysis.

Table I-6 Slope Stability Evaluations

| Slope Stability Analysis Location | Calculation Location | Circular Mode No Load | Block Mode No Load | Circular Mode With Load | Block Mode With Load |
|---|---|---|---|---|---|
| | | Factor of Safety | | | |
| Phase II Section II - East/West Section During Construction Phase I to Final Buildout | Attachment I-8 | 1.6 | ~~1.7~~ 1.6 | 1.6 | ~~1.7~~ 1.6 |
| Phase II Section II - East/West Section During Construction Phase II Section I to Highest Sequence Buildout | Attachment I-9 | ~~2.1~~ 1.9 | ~~2.6~~ 2.5 | ~~2.0~~ 1.8 | 2.1 |
| Phase II Section II - East/West Section Final Buildout Phase I to Final Buildout | Attachment I-10 | 1.7 | 1.7 | ~~1.7~~ 1.6 | ~~1.7~~ 1.6 |
| Phase II Section I - East/West Section Height Increase Phase II Section I to Final Buildout | Attachment I-11 | 1.7 | 2.3 | 1.7 | 2.2 |
| Phase II Section I - North/South Section Height Increase Phase II Section I to Final Buildout | Attachment I-12 | 1.7 | 2.6 | 1.7 | 2.6 |

Based upon the results of the slope stability analysis the following recommendations are proposed for excavation, equipment loading, and geosynthetic interface friction properties.

- Excavation of the Phase II Section II Expansion - Prior to excavation, the contractor should provide dewatering activities as needed and remove ponded surface water. This will keep the excavation area dry as well as improve the stability of the sideslopes.
- Geosynthetic interface friction requirements.
  - As required by FDEP regulations and SCS, the interface friction angle testing will be

conducted and approved prior to construction in accordance with ASTM D5321 and ASTM D6243 as indicated by the Technical Specifications located in Attachment G-1.

Based upon the above recommendations, the estimated shear strength properties of the waste materials, the foundation soil test results, the proposed geosynthetic materials, and the slope stability model results, the design of the expansion cell will meet the regulatory requirements.

### I.1.e Description of Methods Used In the Investigation

Several previous geotechnical investigations of the site have been performed and the boring locations and soil strata information previously provided to the Department. SCS previously prepared a site specific geotechnical subsurface investigation for the areas currently designated Phase II Section I and Phase II Section II of the Hardee County Landfill. The locations of the soil borings identified on the Phase II Section II Expansion construction permit application drawings were obtained from:

- *Geotechnical Engineering Services Report for the Proposed Landfill Expansion Hardee County Florida*, September 25, 2003, prepared by Professional Services Industries, Inc. (PSI). The PSI investigation was performed for the new (at the time) proposed Hardee County Landfill Expansion previously submitted to the Department, dated April 2004, which originally included the Phase II Section I and Phase II Section II areas design at that time. Copies of this report are included in Attachment I-1 of this construction permit application.

The methods used in the foundation analysis and a description of the water tables across the site were included in the above-mentioned geotechnical investigation report submitted by SCS. Soil borings were conducted as indicated during the investigation performed from April 22 through 24, 2003. Seven geotechnical boreholes were designated as Test Hole Numbers 1 through 7 (TH-1 through TH-7). SCS has summarized the boring log information for each borehole below.

- TH-1: From ground surface to approximately eighteen feet below land surface (bls) the soils consist of poorly graded and silty sands. SPT N-values range from 8 to 13 with an average of about 10. Based on N-values, this sand layer would be classified as loose to medium dense soil layers. Groundwater was estimated to be approximately seven feet bls. The next major soil stratum, from eighteen to twenty-eight feet bls, encountered was a low plasticity clay. The upper five feet had a blow count of approximately 7 (a medium stiff layer) over a very stiff lower five feet of clay with a blow count of 19. A Shelby Tube, Undisturbed Sample No.1 (US-1) was collected in the upper clay layer for tri-axial testing since the upper layer had a lower density and anticipated shear strength. A Shelby Tube was also taken in the lower stiffer clay (US-2) to estimate consolidation however the sample in the tube had too much silty sand, probably from miscellaneous drill cuttings, and was not representative of the in-situ stiff clay layer and was disregarded. The soils strata below the clay layer were generally sandy clays and clays with sand and phosphates. The blow counts from approximately twenty-eight feet bls to seventy feet bls (the end of the boring) had blow counts ranging from 19 to 50 blows per inch with the majority of the blow county above 50. Below twenty-eight feet bls the soils would be classified as dense to very dense soils. Very high shear strengths and little settlement would be anticipated in these layers due to the high density of the soils. Upon completion of the boring the borehole was grouted with portland cement and bentonite from boring terminus to ground surface.

- TH-2: From ground surface to approximately eight feet bls the soils consist of poorly graded and silty sands. SPT N-values range from 6 to 11 with an average of about 11. Based on N-values, this sand layer would be classified as a medium dense soil layer. Groundwater was estimated to be approximately six and half feet bls. A five-foot clayey sand layer was encounter next. From thirteen to twenty-three feet bls, poorly graded to silty sands with SPT N-values ranging from 12 to 28 were encountered. From twenty three to thirty three feet bls, a very stiff to hard low plasticity clay layer was encountered. From thirty-three to forty-five feet bls, the soils were generally sandy clays and clays with sand and phosphates. The blow counts ranging from approximately 47 to 50 blows per 5-inches with the majority of the blow county above 50. The soils would be classified as dense to very dense soils. Very high shear strengths and little settlement would be anticipated in these layers due to the high density of the soils. Upon completion of the boring the borehole was grouted with portland cement and bentonite from boring terminus to ground surface.

- TH-3: From ground surface to approximately eighteen feet bls the soils consist of poorly graded and silty sands. SPT N-values range from 5 to 20 with an average of about 10. Based on N-values, this sand layer would be classified as loose to medium dense layer soil layers. Groundwater was not measured in this borehole. A five- foot highly weather fragmented limestone layer was encountered next. From thirteen to twenty-three feet bls, low plasticity clay layer with SPT N-values ranging from 38 to 69 were encountered. This is would be classified as a hard to very hard clay layer. From thirty-three to forty-five feet bls, a sand clay to clayey soils were encountered with blow counts ranging from approximately 32 to 50 blows per 6-inches. These soils would be classified as dense to very dense soils. Very high shear strengths and little settlement would be anticipated in these layers due to the high density of the soils. Upon completion of the boring the borehole was grouted with portland cement and bentonite from boring terminus to ground surface.

- TH-4: From ground surface to approximately thirteen feet bls the soils consist of poorly graded and silty sands. SPT N-values range from 6 to 21. Based on N-values, this sand layer would be classified as loose to medium dense soil layers. Groundwater was measured approximately five and half feet bls in this borehole. A five-foot sandy clay layer with a blow count of 19 was encountered next. From eighteen to twenty-four feet bls, low plasticity clay layer with SPT N-values of 10 was encountered. This would be classified as a stiff clay layer. A Shelby Tube (US-3) sample was collected from this layer however insufficient sample material was retrieved to accurately test. From twenty four to twenty eight feet bls, the clay transitioned to a more sandy clay material with a blow county of 24. A Shelby Tube (US-4) was collected from the lower more stiff clays and this sample was tested for shear strength. From twenty eight to forty five feet bls, clayey sands were encountered with blow counts ranging from approximately 24 to 45 blows per 6-inches. These soils would be classified as dense to very dense soils. Very high shear strengths and little settlement would be anticipated in these layers due to the high density of the soils. Upon completion of the boring the borehole was grouted with portland cement and bentonite from boring terminus to ground surface.

- TH-5: From ground surface to approximately thirteen feet bls the soils consist of poorly graded and silty sands. SPT N-values range from 8 to 27. Based on N-values, this sand layer would be classified as loose to medium dense soil layers. Groundwater was measured approximately five and half feet bls in this borehole. From thirteen to twenty-three feet bls, a low plasticity clay layer with SPT N-values ranging from 8 to 18 was encountered. This is would be classified as a stiff to very stiff clay layer. A Shelby Tube (US-5) was collected from the upper stiff clay for shear strength testing. From twenty-three to forty five feet bls, a clayey sands were encountered with blow counts ranging from approximately 21 to 51 blows. These soils would be classified as medium to very dense soils. Very high shear strengths and little settlement would be anticipated in these layers due to the high density of the soils. Upon completion of the boring the borehole was grouted with portland cement and bentonite from boring terminus to ground surface.

- TH-6: From ground surface to approximately eighteen feet bls the soils consist of poorly graded and silty sands. SPT N-values range from 10 to 50 blows for 6 inches. Based on N-values, this sand layer would be classified as a medium to very dense soil layers. From thirteen to twenty-three feet bls, a low plasticity clay layer with SPT N-values of 5 was encountered. This is would be classified medium stiff clay layer. A Shelby Tube (US-6) was collected from the upper stiff clay for shear strength testing. From twenty three to thirty five feet bls, clayey sands were encountered with blow counts ranging from approximately 51 to 51 blows for 4 inches. These soils would be classified very dense soils. Very high shear strengths and little settlement would be anticipated in these layers due to the high density of the soils. Upon completion of the boring the borehole was grouted with portland cement and bentonite from boring terminus to ground surface.

- TH-7: From ground surface to approximately thirteen feet bls the soils consist of poorly graded and silty sands. SPT N-values range from 7 to 28 blows. Based on N-values, this sand layer would be classified as a loose to medium dense soil layers. Groundwater was measured approximately six and half feet bls in this borehole. From thirteen to twenty-three feet bls, a low plasticity clay layer with SPT N-values ranging from 7 to 9 was encountered. This is would be classified medium stiff clay layer. A Shelby Tube (US-7) was collected from the upper stiff clay for permeability and shear strength testing. In the upper portion of the Shelby Tube a sandy clay sample was identified for permeability testing as well as a clay sample for permeability testing. The sandy clay transition was present at all the transition zones of the borings so the permeability would transition from a clayey sand to a clay. A consolidation sample was also retrieved from the tube estimate the amount of settlement could be anticipated in the medium stiff clays. From twenty three to thirty five feet bls, clayey sands and low plasticity clays were encountered with blow counts ranging from approximately 22 to 50 blow for 5 inches. These soils would be classified very stiff to hard, very dense soils. Very high shear strengths and little settlement would be anticipated in these layers due to the high density of the soils. Upon completion of the boring the borehole was grouted with portland cement and bentonite from boring terminus to ground surface.

### I.1.f Fault Areas, Seismic Impact Zones, and Unstable Areas Investigation

The United States Geological Survey (USGS) Seismic Hazard Map for Florida indicates that Hardee County is within an area of low expected seismic activity. A review of the database indicates there are no known faults in the vicinity of the Hardee County Landfill. A copy of the Seismic Impact Zone Map is contained in Attachment I-13.

A review of the subsurface information contained in the PSI investigation *Geotechnical Engineering Services Report for the Proposed Landfill Expansion Hardee County Florida*, September 25, 2003, included in Attachment I-1 of this construction permit application indicates no unstable subsurface soil layers were present within the proposed expansion area.

## I.2 PROFESSIONAL ENGINEER OR GEOLOGIST

The geotechnical subsurface investigation report prepared by PSI was signed and sealed by the registered professional engineer performing the investigation. Original signed and sealed reports were previously supplied to the Department with the April 2004 submittal.

# Revised Section L
# Water Quality and Leachate Monitoring Requirements

# SECTION L

# WATER QUALITY AND LEACHATE MONITORING REQUIREMENTS

## L.1 WATER QUALITY AND LEACHATE MONITORING PLAN

The water quality and leachate monitoring requirements and locations of the existing groundwater monitoring wells for the Hardee County Landfill were previously provided to the Department in the following documents.

- *Hydrogeological Investigation*, dated April 2004, prepared by SCS.
- *Revised Hydrogeological Investigation*, dated November 15, 2004, prepared by SCS.
- *Revised Ground Water Monitoring Plan*, dated November 15, 2004, prepared by SCS.
- *Biennial Groundwater Monitoring Plan Evaluation Report*, dated January 30, 2008, prepared by SCS.
- *Operation Permit Modification to Include Phase II Section I Landfill Expansion*, dated March 10, 2008, prepared by SCS.
- *Revised Groundwater Monitoring Plan*, dated March 10, 2008, prepared by SCS, and revised by SCS dated January 18, 2011 [revisions were submitted in support of permit modification #38414-014-SO/MM, issued April 15, 2011].
- *Figure M-2 Hardee County Solid Waste Groundwater Monitoring Plan Sampling Locations Map*, dated March 10, 2008, prepared by SCS.
- *Groundwater Flow Evaluation*, dated June 1, 2009, prepared by SCS
- The locations of the existing groundwater monitoring wells for the Hardee County Landfill were also provided by SCS on Sheet 3 of 26 Aerial Photograph June 2006 of the *Operation Permit Modification to Include Phase II Section I Landfill Expansion*.

### L.1.a Hydrogeological Investigation Information Signed, Dated and Sealed

The *Revised Hydrogeological Investigation Report,* dated November 15, 2004, included as Attachment I-1 in the Hardee County Landfill Expansion construction permit application prepared by SCS discussed the hydrogeological investigation information. In addition, the *Revised Groundwater Monitoring Plan,* dated March 10, 2008, prepared by SCS and revised by SCS dated January 18, 2011 [revisions were submitted in support of permit modification #38414-014-SO/MM, issued April 15, 2011] discussed the hydrogeological investigation information.

### L.1.b Sampling and Analysis Methods

All water quality sampling and analysis is performed in accordance with Chapter 62-160, FAC and with the latest revision of FDEP Standard Operating Procedures for Field Activities. The analyses of environmental samples collected at the Hardee County Landfill are conducted by a firm that is certified by the Florida Department of Health, Environmental Laboratory Certification Program. Currently Atkins [formerly known as Post, Buckley, Schuh & Jernigan, Inc. (PBS&J)] provides groundwater and surface water sampling activities as required by the County's Operations Permit.

All sampling activities are conducted in accordance with Chapter 62-160, FAC procedures and requirements. The frequency of sampling and monitoring for analysis is in accordance with applicable FDEP Permits. Proper analytical procedures by specified methods, with trip blanks and controls, are performed. Results and reports are generated in the FDEP required format and are provided to the County for review. The County reviews and compiles the reports for submittal to FDEP. Sampling and analysis of groundwater~~,~~ and ~~leachate~~ surface water will be performed in accordance with the requirements of Rules 62-16~~7~~0 and 62-701.510(2)(b) FAC.

### L.1.c Groundwater Monitoring Requirements

Groundwater monitoring requirements were discussed in the *Revised Hydrogeological Investigation Report,* dated November 15, 2004, included as Attachment I-1 in the Hardee County Landfill Expansion construction permit application prepared by SCS and the *Biennial Groundwater Monitoring Plan Evaluation Report,* dated January 30, 2008, prepared by SCS. The groundwater monitoring requirements were also updated in the *Revised Groundwater Monitoring Plan,* dated March 10, 2008, prepared by SCS and revised by SCS dated January 18, 2011 [revisions were submitted in support of permit modification #38414-014-SO/MM, issued April 15, 2011].

The groundwater monitoring program includes analysis of groundwater samples for field and laboratory parameters described in Chapter 62-701.510, FAC. The monitoring program is divided into two parts: (i) initial monitoring (collection of background data); and (ii) semiannual routine monitoring. The sampling frequency and protocol are discussed below.

- After construction, each monitoring well is sampled and analyzed for field and laboratory parameters as described in Rules 62-701.510(7~~8~~)(a) and (c~~d~~), FAC (in accordance with Rule 62-701.510(5~~6~~)(b)2, FAC). After this initial sampling event, groundwater samples will be collected semiannually from all wells identified as background and detection wells and analyzed for the groundwater indicator parameters listed in Rule 62-701.510(7~~8~~)(a), FAC (in accordance with Rule 62-701.510(5~~6~~)(c~~d~~), FAC).

#### L.1.c.1 Detection Wells Located Downgradient Within 50 Feet of Disposal Units

Information regarding the detection well locations was submitted in the *Revised Hydrogeological Investigation Report,* dated November 15, 2004, included as Attachment I-1 in the Hardee County Landfill Expansion construction permit application prepared by SCS and the *Biennial Groundwater Monitoring Plan Evaluation Report,* dated January 30, 2008, prepared by SCS.

The detection well locations were also updated in the *Revised Groundwater Monitoring Plan,* dated March 10, 2008, prepared by SCS and revised by SCS dated January 18, 2011 [revisions were submitted in support of permit modification #38414-014-SO/MM, issued April 15, 2011]. The location of the existing and proposed detection wells is identified on the construction permit application drawings located in Attachment E-2.

The estimated schedule for the Hardee County Landfill Phase II Section II Expansion construction is as follows:

a) FDEP Notice of Completeness - May 1, 2013
b) FDEP draft Permit preparation - 45 days (June 15, 2013)
c) Review and comment on proposed Permit ~ 2 days (June 17, 2013)
d) FDEP Intent to Issue Permit - 1 day (June 18, 2013)
e) Notice of proposed Agency Action (Permit advertising period) - 15 days (July 3, 2013)
f) Notice of Permit Issuance - 1 day (July 8, 2013)
g) Prepare bid documents ~ 15 days (July 29, 2013)
h) Bid phase services and BOCC approval of contract ~ 64 days (October 1, 2013)
i) Notice to Proceed (NTP) ~ Issued October 1, 2013.
j) Construction phase ~ 180 calendar days (October 1, 2013 - April 1, 2014)
    - The routine, semi-annual groundwater monitoring event for June 2013 can occur on all wells as usual.
    - Existing monitor wells MW-3, MW-5, and MW-8 will be abandoned at the initial stages of construction in approximately mid October 2013.
    - During construction access will be made for the routine, semi-annual groundwater monitoring event for December 2013 for all existing monitor wells with the exception of monitor wells MW-3, MW-5, and MW-8 (which will have been abandoned by that time).
    - Monitor wells MW-13 and MW-14 will be installed at the end of construction in approximately late March 2014.
k) The routine, semi-annual groundwater monitoring event for June 2014 will be conducted as usual for all existing monitor wells including new monitor wells MW-13 and MW-14.

### L.1.c.2 Downgradient Compliance Wells

Information regarding the downgradient compliance wells locations was submitted in the *Revised Hydrogeological Investigation Report,* dated November 15, 2004, included as Attachment I-1 in the Hardee County Landfill Expansion construction permit application prepared by SCS and the *Biennial Groundwater Monitoring Plan Evaluation Report,* dated January 30, 2008, prepared by SCS. The compliance wells ~~locations~~ information was~~ere~~ also updated in the *Revised Groundwater Monitoring Plan,* dated March 10, 2008, prepared by SCS and revised by SCS dated January 18, 2011 [revisions were submitted in support of permit modification #38414-014-SO/MM, issued April 15, 2011]. ~~The location of the existing compliance wells is identified on the construction permit application drawings located in Attachment E-2.~~ Currently, none of the existing monitor wells at the Hardee County Landfill have been designated as compliance wells. Compliance wells shall be installed if needed in accordance with the requirements of Rule 62-701.510(6), FAC.

### L.1.c.3 Background Wells

Information regarding the background wells locations was submitted in the *Revised Hydrogeological Investigation Report,* dated November 15, 2004, included as Attachment I-1 in the Hardee County Landfill Expansion construction permit application prepared by SCS and the *Biennial Groundwater Monitoring Plan Evaluation Report,* dated January 30, 2008, prepared by SCS. The background wells locations were also updated in the *Revised Groundwater Monitoring Plan,* dated March 10, 2008, prepared by SCS and revised by SCS dated January 18, 2011 [revisions were submitted in support of permit modification #38414-014-SO/MM, issued April 15, 2011]. The location of the existing background wells is identified on the construction permit application drawings located in Attachment E-2.

### L.1.c.4 Location Information for Monitoring Wells

Location information for monitoring wells was submitted in the *Revised Hydrogeological Investigation Report,* dated November 15, 2004, included as Attachment I-1 in the Hardee County Landfill Expansion construction permit application prepared by SCS and the *Biennial Groundwater Monitoring Plan Evaluation Report,* dated January 30, 2008, prepared by SCS. The monitoring wells locations were also updated in the *Revised Groundwater Monitoring Plan,* dated March 10, 2008, prepared by SCS and revised by SCS dated January 18, 2011 [revisions were submitted in support of permit modification #38414-014-SO/MM, issued April 15, 2011]. The location of the existing monitoring wells is identified on the construction permit application drawings located in Attachment E-2.

### L.1.c.5 Well Spacing

Well spacing information was discussed in the *Revised Hydrogeological Investigation Report,* dated November 15, 2004, included as Attachment I-1 in the Hardee County Landfill Expansion construction permit application prepared by SCS and the *Biennial Groundwater Monitoring Plan Evaluation Report,* dated January 30, 2008, prepared by SCS. The monitoring wells locations were also updated in the *Revised Groundwater Monitoring Plan,* dated March 10, 2008, prepared by SCS and revised by SCS dated January 18, 2011 [revisions were submitted in support of permit modification #38414-014-SO/MM, issued April 15, 2011]. The location of the existing monitoring wells is identified on the construction permit application drawings located in Attachment E-2. The location of the existing wells is identified on the construction permit application drawings located in Attachment E-2. Well spacing will be completed and accomplished with appropriate intervals to satisfy the FDEP requirements of 1,500 feet upgradient and 500 feet downgradient.

### L.1.c.6 Well Screen Locations

Well screen intervals information was discussed in the "*Revised Hydrogeological Investigation Report,* dated November 15, 2004, included as Attachment I-1 in the Hardee County Landfill Expansion construction permit application prepared by SCS and the *Biennial Groundwater Monitoring Plan Evaluation Report,* dated January 30, 2008, prepared by SCS. The monitoring wells locations were also updated in the *Revised Groundwater Monitoring Plan,* dated March 10, 2008, prepared by SCS and revised by SCS dated January 18, 2011 [revisions were submitted in support of permit modification #38414-014-SO/MM, issued April 15, 2011]. The proposed monitor wells (MW-13 and MW-14) locations and screen intervals (screen length, screen elevation) have been updated for the Phase II Section II Expansion. The location of the existing monitoring wells is identified on the construction permit application drawings located in Attachment E-2. The location of the existing wells is identified on the construction permit application drawings located in Attachment E-2.

SCS reviewed the groundwater elevations recorded at the monitor wells and piezometers at the facility during the routine, semi-annual sampling events recorded from June 1999 through June 2012 and in addition elevations recorded in December 2012 provided by the County. Based on the review of the above-mentioned groundwater elevations, the construction requirements for proposed groundwater monitoring wells MW-13 and MW-14 have been revised. The construction details as provided for proposed groundwater monitoring wells MW-13 and MW-14 will replace the construction details as previously provided in Table M-2 of the *Revised Groundwater Monitoring Plan*, dated March 10, 2008, prepared by SCS and revised by SCS dated January 18, 2011 [revisions were submitted in support of permit modification #38414-014-SO/MM, issued April 15, 2011]. Placement of monitoring points MW-13 and MW-14 were based on Chapter 62-701.510, FAC.

In addition, SCS previously sampled the shallow aquifer formation material at the depth interval where monitoring well screen would be installed to provide grain size data to assist in the design of existing groundwater monitoring wells MW-10R and MW-12R to reduce the level of turbidity in the groundwater samples. Soil samples were submitted to a geotechnical testing laboratory for analysis in accordance with American Society for Testing and Materials (ASTM) D422. The grain size analyses indicated that the aquifer material grain size was similar at the two depths and it also contained a relatively large percentage of silt.

Therefore, to minimize potential turbidity issues in proposed groundwater monitoring wells MW-13 and MW-14, a finer slotted well screen and sand pack will be used as with formerly installed MW-10R and MW-12R. Proposed groundwater monitoring wells MW-13 and MW-14 will be constructed using fifteen feet of 2-inch diameter 0.006-inch factory slotted Schedule 40 polyvinyl chloride (PVC) well screen, five feet of solid PVC riser and an additional three feet of solid PVC for the riser stickup. Following installation of MW-13 and MW-14 well assembly's, the annular space of the screened interval of each well will be packed with 30/65 silica sand from the bottom of the well assembly to approximately three feet above the well screen. The remaining annular space will be sealed to grade with Portland Type I cement and completed with a concrete pad and an aluminum riser-type locking cover. Four bollards, consisting of 4-inch diameter Schedule 40 PVC filled with concrete, will be constructed around MW-13 and MW-14.

Refer to the Phase II Section II Expansion construction permit application drawings located in Attachment E-2 that indentify the construction requirements as identified above for proposed groundwater monitoring wells MW-13 and MW-14.

### L.1.c.7 Monitoring Well Representative Groundwater Samples

Monitoring wells representative groundwater samples were discussed in the *Biennial Groundwater Monitoring Plan Evaluation Report,* dated January 30, 2008, prepared by SCS.

### L.1.c.8 Procedures for Monitoring Well Abandonment

Post closure procedures for abandonment of monitoring wells are proposed to be the same as the current requirements. Procedures for monitoring wells which are abandoned due to the Phase II Section II Expansion where discussed in the *Revised Hydrogeological Investigation Report,* dated November 15, 2004, included as Attachment I-1 in the Hardee County Landfill Expansion construction permit application prepared by SCS. The procedures for abandonment of monitoring wells was updated in the *Revised Groundwater Monitoring Plan,* dated March 10, 2008, prepared by SCS and revised by SCS dated January 18, 2011 [revisions were submitted in support of permit modification #38414-014-SO/MM, issued April 15, 2011]. ~~Abandonment~~ ~~p~~Procedures for properly abandoning monitoring wells will be conducted per Rule 62-701.510(3)(d)6, FAC. Well abandonment requirements will be according to Rule 62-532.500(5), FAC, per the amendments to Chapter 62-532, FAC, that were effective on February 16, 2012~~will be in conformance with Rule 62-532.440, FAC~~ and SWFWMD.

### L.1.c.9 Detailed Description of Detection Sensors

The County does not use detection sensors capable of detecting changes in ground water that may indicate leachate releases.

## L.1.d Surface Water Monitoring Locations

### L.1.d.1 Proposed Surface Water Monitoring Locations

Surface water monitoring locations were discussed in the "*Revised Hydrogeological Investigation Report,* dated November 15, 2004, included as Attachment I-1 in the Hardee County Landfill Expansion construction permit application prepared by SCS and the *Biennial Groundwater Monitoring Plan Evaluation Report,* dated January 30, 2008, prepared by SCS. The surface water monitoring locations were updated in the *Revised Groundwater Monitoring Plan,* dated March 10, 2008, prepared by SCS and revised by SCS dated January 18, 2011 [revisions were submitted in support of permit modification #38414-014-SO/MM, issued April 15, 2011]. A single surface water sampling point [location identified as "SW-2"] has been designated for the Hardee County Landfill in the "Revised Groundwater Monitoring Plan" document. The location of the existing single surface water monitoring location~~s~~ remains unchanged with regard to location and designation and is identified on the construction permit application drawings located in Attachment E-2.

### L.1.d.2 Surface Water Monitoring Locations

Surface water monitoring locations were discussed in the "*Revised Hydrogeological Investigation Report,* dated November 15, 2004, included as Attachment I-1 in the Hardee County Landfill Expansion construction permit application prepared by SCS and the *Biennial Groundwater Monitoring Plan Evaluation Report,* dated January 30, 2008, prepared by SCS. The surface water monitoring locations were updated in the *Revised Groundwater Monitoring*

*Plan,* dated March 10, 2008, prepared by SCS and revised by SCS dated January 18, 2011 [revisions were submitted in support of permit modification #38414-014-SO/MM, issued April 15, 2011]. A single surface water sampling point [location identified as “SW-2”] has been designated for the Hardee County Landfill in the “Revised Groundwater Monitoring Plan” document. The location of the existing surface water monitoring location~~s~~ is identified on the construction permit application drawings located in Attachment E-2. The ~~All~~ existing single surface water monitoring location~~s~~ remains unchanged with regard to location and designation. No additional surface water monitoring locations are proposed.

### L.1.e Leachate Sampling Locations

~~Leachate sampling locations were discussed in the “*Revised Hydrogeological Investigation Report,* dated November 15, 2004, included as Attachment I-1 in the Hardee County Landfill Expansion construction permit application prepared by SCS and the *Biennial Groundwater Monitoring Plan Evaluation Report,* dated January 30, 2008, prepared by SCS. The leachate sampling locations were updated in the *Revised Groundwater Monitoring Plan,* dated March 10, 2008, prepared by SCS. Leachate sampling is conducted from Manhole 9 for Phase I and from the Phase II Section I leachate collection/detection riser. The locations of the existing leachate sampling locations were provided on Figure M-2 Hardee County Solid Waste, Groundwater Monitoring Plan Sampling Locations Map provided in the *Revised Groundwater Monitoring Plan,* dated March 10, 2008, prepared by SCS. All existing leachate sampling locations remain unchanged with regard to location and designation. Post closure leachate sampling locations and procedures are proposed to be the same as the current requirements~~. This Part of the Engineering Report is not applicable (has been removed) to be consistent with the amendments to Chapter 62-701, FAC, that were effective on August 12, 2012 which deleted the requirements to sample, analyze and report leachate quality data.

### L.1.f Initial and Routine Sampling Frequency and Requirements

Post closure initial and routine sampling frequency and requirements are proposed to be the same as the current requirements within the Operations Permit. Sampling frequency and requirements were discussed in the “*Revised Hydrogeological Investigation Report,* dated November 15, 2004, included as Attachment I-1 in the Hardee County Landfill Expansion construction permit application prepared by SCS and the *Biennial Groundwater Monitoring Plan Evaluation Report,* dated January 30, 2008, prepared by SCS. The initial and routine sampling frequency and requirements were updated in the *Revised Groundwater Monitoring Plan,* dated March 10, 2008, prepared by SCS and revised by SCS dated January 18, 2011 [revisions were submitted in support of permit modification #38414-014-SO/MM, issued April 15, 2011].

#### L.1.f.1 Initial Background Groundwater and Surface Water Sampling

Initial background groundwater and surface water sampling requirements remains unchanged as described in the “*Revised Hydrogeological Investigation Report,* dated November 15, 2004, included as Attachment I-1 in the Hardee County Landfill Expansion construction permit application prepared by SCS and the *Biennial Groundwater Monitoring Plan Evaluation Report,* dated January 30, 2008, prepared by SCS. The initial background groundwater and surface water sampling requirements were updated in the *Revised Groundwater Monitoring Plan,* dated March 10, 2008, prepared by SCS and revised by SCS dated January 18, 2011 [revisions were submitted in support of permit modification #38414-014-SO/MM, issued April 15, 2011].

### L.1.f.2 Routine Leachate Sampling and Analysis

~~Routine leachate sampling and analysis remains unchanged as described in the "*Revised Hydrogeological Investigation Report,* dated November 15, 2004, included as Attachment I-1 in the Hardee County Landfill Expansion construction permit application prepared by SCS and the *Biennial Groundwater Monitoring Plan Evaluation Report,* dated January 30, 2008, prepared by SCS. The initial background groundwater and surface water sampling requirements were updated in the *Revised Groundwater Monitoring Plan,* dated March 10, 2008, prepared by SCS. Leachate samples are collected annually and analyzed for the parameters described in Rule 62-701.510(8)(c) and (d), FAC. Leachate concentrations are evaluated to assess if relevant constituents are detected in excess of the toxicity characteristics for hazardous waste, as described in 40 CFR 261.24. If the regulatory level is exceeded, then the requirements of Rule 62-701.510(6)(c)2 are implemented.~~ This Part of the Engineering Report is not applicable (has been removed) to be consistent with the amendments to Chapter 62-701, FAC, that were effective on August 12, 2012 which deleted the requirements to sample, analyze and report leachate quality data.

### L.1.f.3 Routine Monitor Well Sampling and Analysis

Routine monitor well sampling and analysis remains unchanged as described in the "*Revised Hydrogeological Investigation Report,* dated November 15, 2004, included as Attachment I-1 in the Hardee County Landfill Expansion construction permit application prepared by SCS and the *Biennial Groundwater Monitoring Plan Evaluation Report,* dated January 30, 2008, prepared by SCS. The routine monitor well sampling and analysis requirements were updated in the *Revised Groundwater Monitoring Plan,* dated March 10, 2008, prepared by SCS and revised by SCS dated January 18, 2011 [revisions were submitted in support of permit modification #38414-014-SO/MM, issued April 15, 2011]. Groundwater sampling is performed in general accordance with FDEP standard operating procedures (SOPs) FS 2200 for the purpose of field measurement and sampling activities as mandated by FAC 62-160 (Quality Assurance) and DEP-SOP-001-01.

### L.1.f.4 Routine Surface Water Sampling and Analysis

Routine surface water sampling and analysis remains unchanged as described in the *Biennial Groundwater Monitoring Plan Evaluation Report,* dated January 30, 2008, prepared by SCS. The routine surface water sampling and analysis requirements were updated in the *Revised Groundwater Monitoring Plan,* dated March 10, 2008, prepared by SCS and revised by SCS dated January 18, 2011 [revisions were submitted in support of permit modification #38414-014-SO/MM, issued April 15, 2011]. Surface water samples shall be analyzed for the parameters listed in Rule 62-701.510(7)(b), FAC.

## L.1.g Procedures for Evaluation, Prevention, Corrective Action

~~Post closure p~~Procedures for evaluation, prevention and corrective actions remains unchanged as described in the "*Biennial Groundwater Monitoring Plan Evaluation Report,* dated January 30, 2008, prepared by SCS per the requirements of Rule 62-701.510(6), FAC. The ~~post closure~~ procedures for evaluation, prevention and corrective actions were updated in the *Revised Groundwater Monitoring Plan,* dated March 10, 2008, prepared by SCS and revised by SCS dated January 18, 2011 [revisions were submitted in support of permit modification #38414-014-SO/MM, issued April 15, 2011].

### L.1.h Water Quality Monitoring Report Requirements

Water quality monitoring report requirements were discussed in the "*Revised Hydrogeological Investigation Report,* dated November 15, 2004, included as Attachment I-1 in the Hardee County Landfill Expansion construction permit application prepared by SCS and the *Biennial Groundwater Monitoring Plan Evaluation Report,* dated January 30, 2008, prepared by SCS. The water quality monitoring report requirements were updated in the *Revised Groundwater Monitoring Plan,* dated March 10, 2008, prepared by SCS and revised by SCS dated January 18, 2011 [revisions were submitted in support of permit modification #38414-014-SO/MM, issued April 15, 2011].

#### L.1.h.1 Semi-annual Report Requirements

The County will continue to prepare and submit monitoring reports to FDEP every two and a half years regarding monitoring at the Hardee County Landfill. Procedures for the Technical ~~semi-annual r~~Report~~ing~~ requirements ~~remains unchanged~~ will be as described in the *Revised Groundwater Monitoring Plan,* dated March 10, 2008, prepared by SCS and revised by SCS dated January 18, 2011 [revisions were submitted in support of permit modification #38414-014-SO/MM, issued April 15, 2011]. Monitoring wells will be sampled and analyzed for field and laboratory parameters as described in Rules 62-701.510(~~8~~7)(a) and (~~d~~c), FAC (in accordance with Rule 62-701.510(~~6~~5)(b)2, FAC). After an initial sampling event, groundwater samples will be collected semi-annually from all wells identified as background and detection wells and analyzed for the groundwater indicator parameters listed in Rule 62-701.510(~~8~~7)(a), FAC (in accordance with Rule 62-701.510(~~6~~5)(~~d~~c), FAC).

#### L.1.h.2 Water Quality Data Electronic Format Submittal to the Department

Monitoring wells will be sampled and analyzed for field and laboratory parameters as described in the Rules.

#### L.1.h.3 Technical Report Requirements

The County will continue to prepare and submit monitoring reports to FDEP every two and a half years regarding monitoring at the Hardee County Landfill. Procedures for the Technical ~~bi-annual r~~Report~~ing~~ requirements ~~remains unchanged~~ will be as described in the *Revised Groundwater Monitoring Plan,* dated March 10, 2008, prepared by SCS and revised by SCS dated January 18, 2011 [revisions were submitted in support of permit modification #38414-014-SO/MM, issued April 15, 2011]. Every two and a half years, a technical report (prepared, signed, and sealed by a professional geologist or professional engineer with experience in hydrogeologic investigations) will be submitted to the FDEP. The report will be updated at the time of permit renewal. The report will summarize and interpret the water quality data, leachate monitoring results, and water level measurements collected during the past two and a half years. The report will contain the following, as required by Rule 62-701.510(98)(b) to be consistent with the amendments to Chapter 62-701, FAC, that were effective on August 12, 2012:

- Tabular and/or graphical displays of the data, including hydrographs for all monitoring wells.
- Trend analyses of any monitoring parameters consistently detected.
- Comparisons among shallow, middle, and deep wells (if applicable).
- Comparisons between background water quality and the water quality in detection and compliance wells.
- Correlations between related parameters such as total dissolved solids and specific conductance.
- Discussion of erratic and/or poorly correlated data.
- An interpretation of the groundwater contour maps and an evaluation of groundwater flow rates.
- An evaluation of the adequacy of the water quality monitoring frequency and sampling locations.

All field and laboratory records will be made available to the FDEP and be retained for the design period of the storage facility.

# Revised Section N
# Gas Management System Requirements

# SECTION N

# GAS MANAGEMENT SYSTEM REQUIREMENTS

## N.1 GAS MANAGEMENT SYSTEM DESIGN

Landfill gas (LFG) that is generated by the anaerobic decomposition of the waste buried within the landfill is allowed to vent to the atmosphere. The current LFG management system in place at the Hardee County Landfill consists of 11 LFG monitoring probes located around the perimeter of the existing landfill footprint and at the property boundary. The existing LFG monitoring plan includes quarterly monitoring of these probes, as well as on-site structures in order to demonstrate compliance with Rule 62-701.530(1), FAC.

Because the proposed landfill expansion will be to the west and south of the existing landfill, it will be necessary to relocate several of the existing LFG monitoring probes outside of the expansion area. Hardee County proposes to abandon and replace existing LFG monitoring probes GP-3, GP-4, GP-5, GP-6, GP-7, and GP-8, and install replacement LFG monitoring wells designated as GP-3R, GP-4R, GP-5R, GP-6R, GP-7R, and GP-8R, as shown on the construction permit application drawings located in Attachment E-2. The replacement LFG monitoring wells are located along the west side and northwest corner of the property. LFG monitoring well, GP-1, GP-2, and GP-3R, will be used to detect possible subsurface migration of LFG toward the north side of the property. A typical detail for construction of the probes is included in these drawings.

SCS reviewed the groundwater elevations recorded at the monitor wells and piezometers at the facility during the routine, semi-annual sampling events recorded from June 1999 through June 2012 as provided by the Department in the table "*Summary of Ground Water Elevations, Hardee County Landfill*" and in addition elevations recorded in December 2012 provided by the County.

The proposed landfill gas probes are designed to be surface sealed and to provide a greater permeability than the surrounding soils strata's between the waste deposit and the property boundary to act as collector points for any subsurface methane gas, if present. Based on the landfill design, the proposed monitoring probes shall extend from the soil surface to the seasonal low groundwater level to draw gas samples from the permeable layers. The depth of the proposed gas probes and screened interval for each of the monitoring points will vary based on the depth of the seasonal low groundwater level using the groundwater elevations recorded as indicated above. This depth will allow the screened interval to intercept the full cross-section of the landfilled waste to the seasonal low groundwater level that could potentially generate methane.

### N.1.a Preventing High Combustible Gas Concentrations

The Hardee County Landfill does not currently have a LFG management system. LFG that is generated is allowed to vent to the atmosphere. A passive LFG vent system was incorporated into the Phase I closure project. In accordance with the current Operations Permit, the County conducts LFG monitoring in onsite structures on a quarterly basis as required by Rule 62-701.530(2)(c), FAC and submits the results to FDEP. The monitoring program is conducted to ensure that concentrations of combustible gases do not exceed 25% of the lower explosive limit (LEL) in structures and 100% of the LEL at the property boundary. Please refer to Attachment L-1, Section L-9, of the "Operation Permit Modification to Include Phase II Section I Landfill Expansion" for the site landfill gas monitoring program. Monitoring will continue to be conducted on a quarterly basis as required by Rule 62-701.530(2)(c), FAC with the results submitted to FDEP, consistent with the existing landfill gas monitoring program and Operations Permit.

### N.1.b Design for Site Specific Conditions

The design of the replacement LFG monitoring probes are consistent with industry standards and include considerations for site-specific conditions. The replacement LFG monitoring probes were designed based on the landfill configuration, base grades, and groundwater conditions at the site.

The landfill cover has been effective for controlling disease, vectors, objectionable odors, and litter onsite. No objectionable odors have been detected or reported by adjacent property owners. On a quarterly basis, qualified personnel from the County assess the presence of ambient objectionable odors at the location of the perimeter monitoring wells. If objectionable odors are detected at the property line, the County will implement an odor monitoring program as required by Rule 62-701.530(3)(b), FAC.

The following eleven LFG monitoring probes are currently located at the Hardee County Landfill facility. The location of the existing LFG monitoring probes are identified on the Phase II Section II Expansion construction permit application drawings located in Attachment E-2.

- GP-1
- GP-2
- GP-3
- GP-4
- GP-5
- GP-6
- GP-9
- GP-10
- GP-11
- GP-12
- GP-13

### N.1.c Reduction of Gas Pressures Within the Interior of the Landfill

A passive landfill gas (LFG) venting system was constructed during the Phase I closure project. Along the western sideslope of the Phase I area where the Phase II Section II Expansion will "piggy-back" there is an existing passive LFG vent system which includes horizontal LFG vent trenches under the sideslope (bottom liner system). The horizontal LFG vent trenches are identified as HC-2, HC-3, and HC-4. The horizontal LFG vent trenches also contain a vertical LFG vent under the sideslope (bottom liner system) to collect LFG from the uppermost 2/3 of the waste in accordance with Rule 62-701.530 (1)(a)(3) (vertical component of the horizontal LFG vent trenches). The vertical components of the horizontal LFG vent trenches, 4 within the area, are identified as HC-2.1, HC-2.2, HC-3.1 and HC-4.1. In addition, the horizontal LFG vent trenches (connected to the vertical components) are also connected to a horizontal LFG vent gooseneck located at the crest of the Phase I area. The horizontal LFG vent goosenecks, 3 total, are identified as HC-2, HC-3, and HC-4.

An "Existing Horizontal LFG Trench Vent Schedule" is located on the Phase II Section II Expansion construction permit application drawings located in Attachment E-2. The Schedule identifies the northings, eastings, approximate existing ground surface elevations (top of 24 inch thick protective cover soil drainage sand layer), solid pipe length, perforated pipe length and invert elevation (termination point into an existing manhole) for each of the existing horizontal LFG vent trenches. The Schedule also identifies the vertical component of the horizontal LFG vent trenches northings, eastings, approximate existing ground surface elevations (top of 24 inch thick protective cover soil drainage sand layer), well depth (termination point into the waste), rock backfill and slotted pipe length. In addition, the Schedule identifies the horizontal LFG vent gooseneck northings and eastings locations.

The existing passive LFG venting system under the western sideslope of the Phase I area will still be permitted to vent freely to the atmosphere due to the proposed Phase II Section II Expansion "piggy-back". LFG will be vented from the interface between the existing Phase I landfill western sideslope (bottom liner system) and the vertical expansion slopes above to prevent accumulation of gas under the existing liner system. The horizontal vent trenches and vertical component of the horizontal LFG vent trenches will convey LFG to the existing vertical vents (goosenecks) at the western crest of the Phase I area outside of the limits of where the Phase II Section II Expansion will "piggy-back".

The LFG gas venting system for the Phase II Section II Expansion will be designed and permitted upon submittal of the closure application for the area. LFG will be permitted to vent freely to the atmosphere through a proposed passive LFG vent system, vertical vents and horizontal vent trenches, thereby limiting the pressure within the landfill and reducing the potential for lateral migration of LFG through the surrounding subsurface. Surface water and groundwater contact with the wastes will be prevented as demonstrated by the facility design.

### N.1.d Non-Interference with the Liner, Leachate Control System, or Final Cover

The LFG gas venting system for the Phase II Section II Expansion will be designed and permitted upon submittal of the closure application for the area. The LFG management system will be designed to not impact the bottom of the landfill nor the LCRS. The vent boreholes will be designed to terminate above the bottom of the landfill. Any future vents/wells that will be installed will have a buffer between the bottom of the boreholes and the liner and LCRS components. The LFG vent system will be designed to maintain the integrity of the final cover system by minimizing the gas pressure internal to the landfill.

## N.2 LANDFILL GAS MONITORING

As previously mentioned eleven LFG monitoring probes are currently located at the Hardee County Landfill facility as part of the currently permitted landfill operations. The existing LFG monitoring probes are located around the perimeter of the existing landfill as shown on the construction permit application drawings located in Attachment E-2. These LFG monitoring probes are sampled on a quarterly basis, with the results reported to the FDEP. In addition, the County also monitors the following structures for landfill gas.

- Maintenance Building
- Materials Recovery Facility (MRF)
- Scalehouse/Administrative Offices
- Kennel

The enclosed structures and gas monitoring points will continue to be sampled and inspected quarterly for the LEL of methane in accordance with the Operation Permit with the results reported to FDEP.

Because the proposed landfill expansion will be to the west and south of the existing landfill, it will be necessary to relocate several of the existing LFG monitoring probes outside of the expansion area. Hardee County proposes to abandon and replace existing LFG monitoring probes GP-3, GP-4, GP-5, GP-6, GP-7, and GP-8, and install replacement LFG monitoring wells designated as GP-3R, GP-4R, GP-5R, GP-6R, GP-7R, and GP-8R, as shown on the construction permit application drawings located in Attachment E-2. The replacement LFG monitoring wells are located along the west side of the property. The new probes will be constructed similar to the existing probes, taking into consideration site-specific conditions such as soil characteristics, hydrogeologic conditions surrounding the facility, hydraulic conditions surrounding the facility, and location of facility structures and property boundaries.

SCS reviewed the groundwater elevations recorded at the monitor wells and piezometers at the facility during the routine, semi-annual sampling events recorded from June 1999 through June 2012 as provided by the Department in the table "*Summary of Ground Water Elevations, Hardee County Landfill*" and in addition elevations recorded in December 2012 provided by the County.

The proposed landfill gas probes are designed to be surface sealed and to provide a greater permeability than the surrounding soils strata's between the waste deposit and the property boundary to act as collector points for any subsurface methane gas, if present. Based on the landfill design, the proposed monitoring probes shall extend from the soil surface to the seasonal low groundwater level to draw gas samples from the permeable layers. The depth of the proposed gas probes and screened interval for each of the monitoring points will vary based on the depth of the seasonal low groundwater level using the groundwater elevations recorded as indicated above. This depth will allow the screened interval to intercept the full cross-section of the landfilled waste to the seasonal low groundwater level that could potentially generate methane.

## N.3 GAS AND ODOR REMEDIATION PLANS

On a quarterly basis, qualified personnel from the County assess the presence of ambient objectionable odors at the location of the perimeter monitoring wells. If objectionable odors are detected at the property line, the County will immediately take corrective actions and implement an odor-monitoring program as required by Rule 62-701.530(3)(b), FAC.

If the results of gas monitoring show that combustible gas concentration exceeds 100 percent of the LEL at the property boundary or 25 percent of the LEL in the structures previously mentioned, the County will notify FDEP and take all necessary steps to ensure protection of human health. Within 7 days of detection, the County will submit a gas remediation plan to FDEP for approval. The gas remediation plan will describe the nature and extent of the problem and the proposed remedy. The remedy may include installation of additional passive LFG gas vents, active LFG vents, cut-off trenches or other methods appropriate to the situation. The remedy will be completed within 60 days of detection unless otherwise approved by the FDEP.

As per Rule 62-701.530(a), FAC a LFG remediation plan will be instituted if:

- The monitoring results from the probes demonstrate that combustible gas concentrations exceed the LEL of 5% methane.
- The onsite structures contain gas concentrations that exceed 25% of the LEL, which is equivalent to 1.25% methane.

If LFG concentrations cause objectionable odors at or beyond the landfill property boundary, per Rule 62-701.530(3)(b), FAC the County will implement a routine odor monitoring program to determine the timing and extent of any off-site odors. If the monitoring program confirms the existence of objectionable odors, the initial action may include equipping the LFG vents with passive flares. If additional remedies are required the County will prepare and submit to the FDEP an odor remediation plan for the gas releases. The odor remediation plan will describe the nature and extent of the problem and the proposed remedy. The remedy will be initiated within 30 days of approval.

## N.4 LANDFILL GAS RECOVERY FACILITIES

The Hardee County Landfill does not have a LFG recovery facility. A LFG recovery facility for purposes of energy recovery or similar end uses is not proposed at this time. No changes are proposed as part of the Phase II Section II Expansion. Therefore, the State of Florida Department of Environmental Protection Application for a Permit to Construct, Operate, Modify or Close a Solid Waste Management Facility Application Form 62-701.900(1) attached at the beginning of this construction permit application has been designated as "Not Applicable."

# Revised Section O
# Landfill Final Closure Requirements

# SECTION O

# LANDFILL FINAL CLOSURE REQUIREMENTS

## O.1 CLOSURE PERMIT REQUIREMENTS

In accordance with Rule 62-701.600(2), FAC at least 90 days prior to the projected date when wastes will no longer be accepted at the proposed facility, the County will submit to FDEP an application for final closure of the storage facility. The closure plan submitted with the closure permit application will include the following:

- Closure design plan;
- Closure operation plan;
- Plan for long-term care; and
- A demonstration of proof of financial responsibility for long-term care.

### O.1.a Application Submitted to Department

In accordance with Rule 62-701.600(2), FAC at least 90 days prior to the projected date when wastes will no longer be accepted at the proposed facility, Hardee County will submit to FDEP an application for final closure of the storage facility. The application will include a Closure Plan consisting of the items listed in Item O.1.b Closure Plan below.

### O.1.b Closure Plan

The Closure Plan submitted with the Closure Permit Application will include the following:

(1) Closure design plan;

(2) Closure operation plan;

(3) Plan for long-term care; and

(4) A demonstration of proof of financial responsibility for long-term care.

## O.2 CLOSURE DESIGN PLAN REQUIREMENTS

A closure design plan consisting of engineering plans and a report on closing procedures that apply to the final closing of the waste disposal units will be submitted at least 90 days before the date when wastes will no longer be accepted. The design will include the information listed below.

a. Plan drawing showing phases of site closing.

b. Drawings showing existing topography as proposed final grades.

c. Provisions to close units when they reach approved final dimensions.

d. Final elevations before settlement.

e. Final sideslope design.

f. Final cover installation plan to including:

(1) CQA plan for installing and testing final cover.

(2) Schedule for installing final cover after final receipt of waste.

(3) Description of drought-resistant species to be used in the vegetative cover.

(4) Top gradient design to maximize runoff and minimize erosion.

(5) Provisions for cover material to be used for final cover maintenance.

g. Final Cover Design - the final cover design will comply with Rule 62-701.600(3)(g). The design will address:

(1) Protective soil layer design.

(2) Barrier soil layer design.

(3) Erosion control vegetation.

(4) Geomembrane/soil barrier layer design.

(5) Geosynthetic clay liner design if used.

(6) Stability analysis of the cover system and the disposed waste.

h. Proposed method of storm water control.

i. Proposed method of access control.

j. Description of the proposed or existing gas management system.

## O.3 CLOSURE OPERATION PLAN

The closure operation plan will include the following:

a. Detailed description of actions that will be taken to close the facility.

b. Time schedule for completion of closing and long term care.

c. Description of method for demonstrating financial responsibility.

d. Operation of the water quality monitoring plan required.

e. Development and implementation of gas management system.

## O.4 CERTIFICATION OF CONSTRUCTION COMPLETION

Certification of closure construction will include survey monuments and a final survey report. A certification of closure construction completion, consistent with the requirements of the CQA Plan for the project, signed, dated and sealed by a Professional Engineer in the State of Florida will be provided to FDEP upon completion of closure in accordance with Rule 62-701.600(6), FAC.

### O.4.a Survey Monuments

Survey monuments already exist at the Hardee County Landfill. The existing survey monuments are shown on the construction permit application drawings located in Attachment E-2. The survey monuments shall be preserved and maintained.

### O.4.b Final Survey Report

A final topographic survey will be performed as part of the construction completion certification in accordance with Rule 62-701.600(~~7~~6)(b), FAC to confirm that the final contours and elevations of the facility are in accordance with the plans as approved in the closure permit. The topographic map will be prepared by a registered land surveyor in the State of Florida or by aerial mapping with equivalent accuracy.

## O.5 DECLARATION TO THE PUBLIC

The Declaration to the Public required by Rule 62-701.600(7), FAC will be prepared and filed in the deed records of the Hardee County Clerk's office.

## O.6 OFFICIAL DATE OF CLOSING

The official date of closing will be determined in accordance with Rule 62-701.600(8), FAC.

## O.7 TEMPORARY CLOSURE

It is not anticipated that temporary closure of the facility will be required. If temporary closure is proposed, the closure will be conducted in accordance with the requirements of Rule 62-701.600(9), FAC.

# Figure O-1 Gas Probe Locations

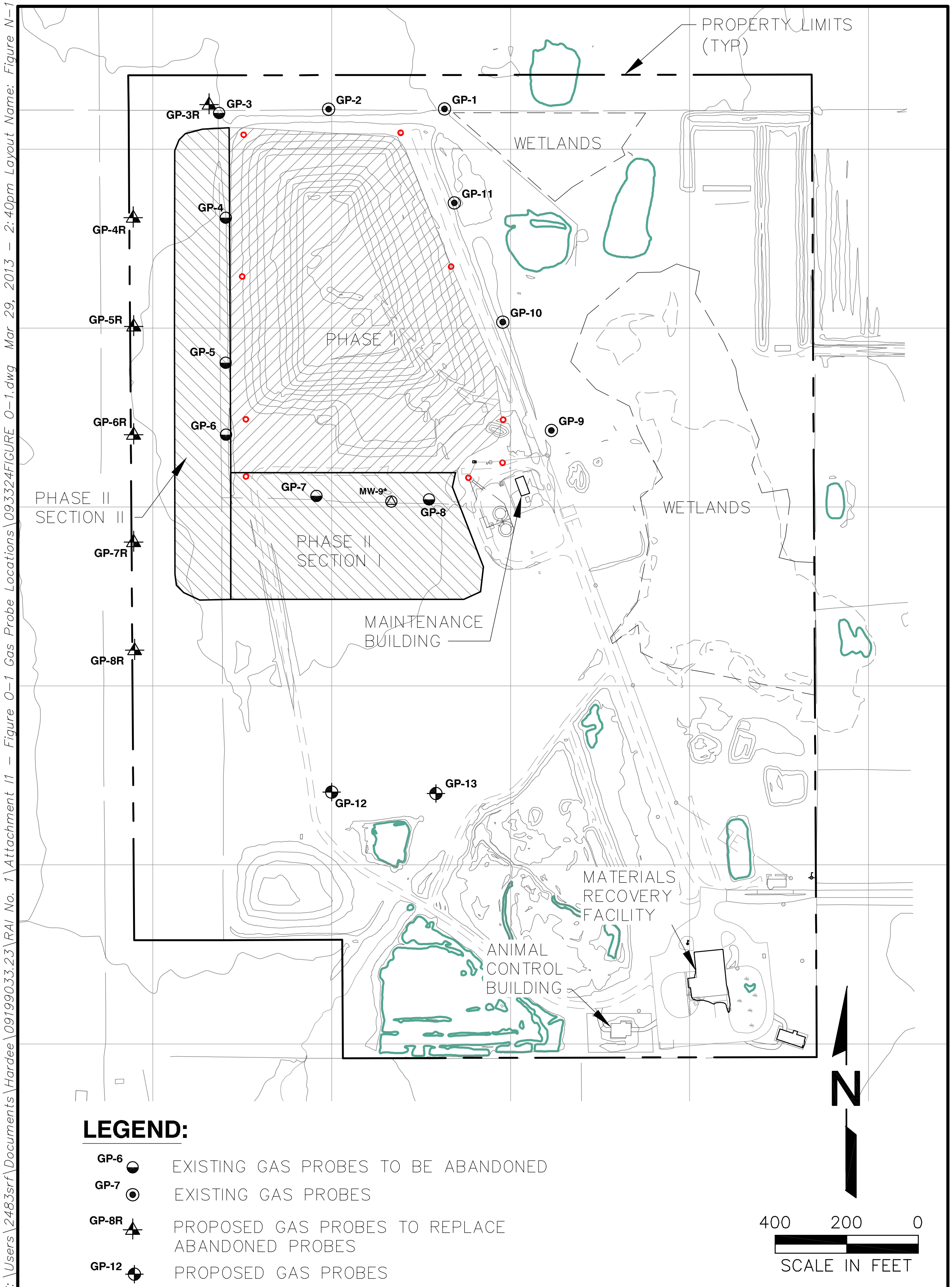



Figure O-1. Gas Probe Locations, Hardee County Landfill Expansion, Hardee County, Florida

# Attachment J

# HELP Model Calculations
# and
# HELP Model Summary

SCS ENGINEERS

SHEET 1 OF 40

| CLIENT | PROJECT | JOB NO. | |
|---|---|---|---|
| Hardee County | Phase II Section II Expansion | 09199033.23 | |
| SUBJECT | | BY | DATE |
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| **Peak Daily Values**<br>300-mil Bi-planar with 300-mil Tri-planar Geocomposite | | CHECKED | DATE |

**Case 1 - Cell Bottom South - open cell, 0 ft waste**

| | Collection System, K = 11.9 cm/sec | | | | Detection System, K = 40.7 cm/sec | | | |
|---|---|---|---|---|---|---|---|---|
| | Thickness at 100 hr (inches) | Max. Head on Liner (inches) | Leachate Collected ($ft^3$/day) | Leachate Collected (gal/min) | Thickness at 100 hr (inches) | Max. Head on Liner (inches) | Leachate Collected ($ft^3$/day) | Leachate Collected (gal/min) |
| $L_{total}$ = 53.1 ft<br>S = 2.20% | 0.300(1) | 0.280 | 12,611.95 | 65.52 | 0.300(2) | 0.000 | 46.67 | 0.24 |

**Case 2 - Cell Bottom South - 10 ft waste + 6-inch daily cover**

| | Collection System, K = 11.9 cm/sec | | | | Detection System, K = 40.7 cm/sec | | | |
|---|---|---|---|---|---|---|---|---|
| | Thickness at 100 hr (inches) | Max. Head on Liner (inches) | Leachate Collected ($ft^3$/day) | Leachate Collected (gal/min) | Thickness at 100 hr (inches) | Max. Head on Liner (inches) | Leachate Collected ($ft^3$/day) | Leachate Collected (gal/min) |
| $L_{total}$ = 53.1 ft<br>S = 2.20% | 0.300(1) | 0.134 | 7,045.82 | 36.60 | 0.300(2) | 0.001 | 34.62 | 0.18 |

**Case 3 - Cell Bottom South - 25 ft waste + 6-inch daily cover**

| | Collection System, K = 7.2 cm/sec | | | | Detection System, K = 29.4 cm/sec | | | |
|---|---|---|---|---|---|---|---|---|
| | Thickness at 100 hr (inches) | Max. Head on Liner (inches) | Leachate Collected ($ft^3$/day) | Leachate Collected (gal/min) | Thickness at 100 hr (inches) | Max. Head on Liner (inches) | Leachate Collected ($ft^3$/day) | Leachate Collected (gal/min) |
| $L_{total}$ = 53.1 ft<br>S = 2.20% | 0.273(1) | 0.123 | 3,921.42 | 20.37 | 0.273(2) | 0.000 | 33.34 | 0.17 |

**Case 4 - Cell Bottom South - 60 ft waste + 6-inch daily cover + 1 ft int cover**

| | Collection System, K = 5.3 cm/sec | | | | Detection System, K = 21.8 cm/sec | | | |
|---|---|---|---|---|---|---|---|---|
| | Thickness at 100 hr (inches) | Max. Head on Liner (inches) | Leachate Collected ($ft^3$/day) | Leachate Collected (gal/min) | Thickness at 100 hr (inches) | Max. Head on Liner (inches) | Leachate Collected ($ft^3$/day) | Leachate Collected (gal/min) |
| $L_{total}$ = 53.1 ft<br>S = 2.20% | 0.261(1) | 0.083 | 1,925.07 | 10.00 | 0.261(2) | 0.001 | 27.08 | 0.14 |

NOTES:

1. Thickness of 300-mil bi-planar geocomposite at 100 hrs & loaded.
2. Thickness of 300-mil tri-planar geocomposite at 100 hrs & loaded.

All flow rates are based on a per acre basis.

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| **Peak Daily Values** | CHECKED | DATE |
| 300-mil Bi-planar with 300-mil Tri-planar Geocomposite | | |

**Case 5 - Cell Bottom Center - open cell, 0 ft waste**

| | Collection System, K = 11.9 cm/sec | | | | Detection System, K = 40.7 cm/sec | | | |
|---|---|---|---|---|---|---|---|---|
| | Thickness at 100 hr (inches) | Max. Head on Liner (inches) | Leachate Collected ($ft^3$/day) | Leachate Collected (gal/min) | Thickness at 100 hr (inches) | Max. Head on Liner (inches) | Leachate Collected ($ft^3$/day) | Leachate Collected (gal/min) |
| $L_{total}$ = 53.1 ft<br>S = 2.20% | 0.300(1) | 0.280 | 12,611.95 | 65.52 | 0.300(2) | 0.000 | 46.67 | 0.24 |

**Case 6 - Cell Bottom Center - 10 ft waste + 6-inch daily cover**

| | Collection System, K = 11.9 cm/sec | | | | Detection System, K = 40.7 cm/sec | | | |
|---|---|---|---|---|---|---|---|---|
| | Thickness at 100 hr (inches) | Max. Head on Liner (inches) | Leachate Collected ($ft^3$/day) | Leachate Collected (gal/min) | Thickness at 100 hr (inches) | Max. Head on Liner (inches) | Leachate Collected ($ft^3$/day) | Leachate Collected (gal/min) |
| $L_{total}$ = 53.1 ft<br>S = 2.20% | 0.300(1) | 0.134 | 7,045.82 | 36.60 | 0.300(2) | 0.001 | 34.62 | 0.18 |

**Case 7 - Cell Bottom Center - 25 ft waste + 6-inch daily cover**

| | Collection System, K = 7.2 cm/sec | | | | Detection System, K = 29.4 cm/sec | | | |
|---|---|---|---|---|---|---|---|---|
| | Thickness at 100 hr (inches) | Max. Head on Liner (inches) | Leachate Collected ($ft^3$/day) | Leachate Collected (gal/min) | Thickness at 100 hr (inches) | Max. Head on Liner (inches) | Leachate Collected ($ft^3$/day) | Leachate Collected (gal/min) |
| $L_{total}$ = 53.1 ft<br>S = 2.20% | 0.273(1) | 0.123 | 3,921.42 | 20.37 | 0.273(2) | 0.000 | 33.34 | 0.17 |

**Case 8 - Cell Bottom Center - 60 ft waste + 6-inch daily cover + 1 ft int cover**

| | Collection System, K = 5.3 cm/sec | | | | Detection System, K = 21.8 cm/sec | | | |
|---|---|---|---|---|---|---|---|---|
| | Thickness at 100 hr (inches) | Max. Head on Liner (inches) | Leachate Collected ($ft^3$/day) | Leachate Collected (gal/min) | Thickness at 100 hr (inches) | Max. Head on Liner (inches) | Leachate Collected ($ft^3$/day) | Leachate Collected (gal/min) |
| $L_{total}$ = 53.1 ft<br>S = 2.20% | 0.261(1) | 0.083 | 1,925.07 | 10.00 | 0.261(2) | 0.001 | 27.08 | 0.14 |

NOTES:

1. Thickness of 300-mil bi-planar geocomposite at 100 hrs & loaded.
2. Thickness of 300-mil tri-planar geocomposite at 100 hrs & loaded.

All flow rates are based on a per acre basis.

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| 300-mil Bi-planar with 300-mil Tri-planar Geocomposite | | |

**Case 9 - Cell Bottom North - open cell, 0 ft waste**

| | Collection System, K = 11.9 cm/sec | | | | Detection System, K = 40.7 cm/sec | | | |
|---|---|---|---|---|---|---|---|---|
| | Thickness at 100 hr (inches) | Max. Head on Liner (inches) | Leachate Collected ($ft^3$/day) | Leachate Collected (gal/min) | Thickness at 100 hr (inches) | Max. Head on Liner (inches) | Leachate Collected ($ft^3$/day) | Leachate Collected (gal/min) |
| $L_{total}$ = 53.5 ft<br>S = 2.20% | 0.300(1) | 0.283 | 12,617.35 | 65.54 | 0.300(2) | 0.000 | 46.82 | 0.24 |

**Case 10 - Cell Bottom North - 10 ft waste + 6-inch daily cover**

| | Collection System, K = 11.9 cm/sec | | | | Detection System, K = 40.7 cm/sec | | | |
|---|---|---|---|---|---|---|---|---|
| | Thickness at 100 hr (inches) | Max. Head on Liner (inches) | Leachate Collected ($ft^3$/day) | Leachate Collected (gal/min) | Thickness at 100 hr (inches) | Max. Head on Liner (inches) | Leachate Collected ($ft^3$/day) | Leachate Collected (gal/min) |
| $L_{total}$ = 53.5 ft<br>S = 2.20% | 0.300(1) | 0.135 | 7,046.71 | 36.61 | 0.300(2) | 0.001 | 34.75 | 0.18 |

**Case 11 - Cell Bottom North - 25 ft waste + 6-inch daily cover**

| | Collection System, K = 7.2 cm/sec | | | | Detection System, K = 29.4 cm/sec | | | |
|---|---|---|---|---|---|---|---|---|
| | Thickness at 100 hr (inches) | Max. Head on Liner (inches) | Leachate Collected ($ft^3$/day) | Leachate Collected (gal/min) | Thickness at 100 hr (inches) | Max. Head on Liner (inches) | Leachate Collected ($ft^3$/day) | Leachate Collected (gal/min) |
| $L_{total}$ = 53.5 ft<br>S = 2.20% | 0.273(1) | 0.125 | 3,935.12 | 20.44 | 0.273(2) | 0.002 | 33.53 | 0.17 |

**Case 12 - Cell Bottom North - 60 ft waste + 6-inch daily cover + 1 ft int cover**

| | Collection System, K = 5.3 cm/sec | | | | Detection System, K = 21.8 cm/sec | | | |
|---|---|---|---|---|---|---|---|---|
| | Thickness at 100 hr (inches) | Max. Head on Liner (inches) | Leachate Collected ($ft^3$/day) | Leachate Collected (gal/min) | Thickness at 100 hr (inches) | Max. Head on Liner (inches) | Leachate Collected ($ft^3$/day) | Leachate Collected (gal/min) |
| $L_{total}$ = 53.5 ft<br>S = 2.20% | 0.261(1) | 0.000 | 1,925.10 | 10.00 | 0.261(2) | 0.000 | 27.18 | 0.14 |

NOTES:

1. Thickness of 300-mil bi-planar geocomposite at 100 hrs & loaded.
2. Thickness of 300-mil tri-planar geocomposite at 100 hrs & loaded.

All flow rates are based on a per acre basis.

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| 330-mil Bi-planar Geocomposite | | |

**Case 13 - Bottom Southern Side Slope of Phase I - with sod, 0 ft waste**

| | | Collection System, K = 7.8 cm/sec | | |
|---|---|---|---|---|
| | Thickness at 100 hr (inches) | Max. Head on Liner (inches) | Leachate Collected ($ft^3$/day) | Leachate Collected (gal/min) |
| $L_{total}$ = 75 ft<br>S = 33.33% | 0.330^(1)^ | 0.030 | 9,546.75 | 49.59 |

**Case 14 - Bottom Southern Side Slope of Phase I - open cell, no sod, 0 ft waste**

| | | Collection System, K = 7.8 cm/sec | | |
|---|---|---|---|---|
| | Thickness at 100 hr (inches) | Max. Head on Liner (inches) | Leachate Collected ($ft^3$/day) | Leachate Collected (gal/min) |
| $L_{total}$ = 75 ft<br>S = 33.33% | 0.330^(1)^ | 0.022 | 9,601.70 | 49.88 |

**Case 15 - Bottom Southern Side Slope of Phase I - 10 ft waste + 6-inch daily cover**

| | | Collection System, K = 7.8 cm/sec | | |
|---|---|---|---|---|
| | Thickness at 100 hr (inches) | Max. Head on Liner (inches) | Leachate Collected ($ft^3$/day) | Leachate Collected (gal/min) |
| $L_{total}$ = 75 ft<br>S = 33.33% | 0.330^(1)^ | 0.038 | 7,083.94 | 36.80 |

**Case 16 - Bottom Southern Side Slope of Phase I - 25 ft waste + 6-inch daily cover**

| | | Collection System, K = 5.7 cm/sec | | |
|---|---|---|---|---|
| | Thickness at 100 hr (inches) | Max. Head on Liner (inches) | Leachate Collected ($ft^3$/day) | Leachate Collected (gal/min) |
| $L_{total}$ = 75 ft<br>S = 33.33% | 0.300^(1)^ | 0.015 | 3,880.14 | 20.16 |

NOTES:

1. Thickness of 330-mil bi-planar geocomposite at 100 hrs & loaded.
2. Phase I side slope has a primary bi-planar geocomposite collection layer only, no detection layer.

All flow rates are based on a per acre basis.

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| **Peak Daily Values** | CHECKED | DATE |
| 330-mil Bi-planar Geocomposite | | |

**Case 17 - Top Southern Side Slope of Phase I - with sod, 0 ft waste**

| | | Collection System, K = 7.8 cm/sec | | |
|---|---|---|---|---|
| | Thickness at 100 hr (inches) | Max. Head on Liner (inches) | Leachate Collected ($ft^3$/day) | Leachate Collected (gal/min) |
| $L_{total}$ = 105 ft<br>S = 33.33% | 0.330(1) | 0.045 | 9,494.95 | 49.32 |

**Case 18 - Top Southern Side Slope of Phase I - 25 ft waste + 6-inch daily cover**

| | | Collection System, K = 5.7 cm/sec | | |
|---|---|---|---|---|
| | Thickness at 100 hr (inches) | Max. Head on Liner (inches) | Leachate Collected ($ft^3$/day) | Leachate Collected (gal/min) |
| $L_{total}$ = 105 ft<br>S = 33.33% | 0.300(1) | 0.049 | 3,872.44 | 20.12 |

NOTES:

1. Thickness of 330-mil bi-planar geocomposite at 100 hrs & loaded.
2. Phase I side slope has a primary bi-planar geocomposite collection layer only, no detection layer.

All flow rates are based on a per acre basis.

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| **Peak Daily Values** | CHECKED | DATE |
| 330-mil Bi-planar Geocomposite | | |

**Case 19 - Bottom Northern Side Slope of Phase I - with sod, 0 ft waste**

| | | Collection System, K = 7.8 cm/sec | | |
|---|---|---|---|---|
| | Thickness at 100 hr (inches) | Max. Head on Liner (inches) | Leachate Collected ($ft^3$/day) | Leachate Collected (gal/min) |
| $L_{total}$ = 75 ft<br>S = 33.33% | 0.330(1) | 0.030 | 9,546.75 | 49.59 |

**Case 20 - Bottom Northern Side Slope of Phase I - open cell, no sod, 0 ft waste**

| | | Collection System, K = 7.8 cm/sec | | |
|---|---|---|---|---|
| | Thickness at 100 hr (inches) | Max. Head on Liner (inches) | Leachate Collected ($ft^3$/day) | Leachate Collected (gal/min) |
| $L_{total}$ = 75 ft<br>S = 33.33% | 0.330(1) | 0.022 | 9,601.70 | 49.88 |

**Case 21 - Bottom Northern Side Slope of Phase I - 10 ft waste + 6-inch daily cover**

| | | Collection System, K = 7.8 cm/sec | | |
|---|---|---|---|---|
| | Thickness at 100 hr (inches) | Max. Head on Liner (inches) | Leachate Collected ($ft^3$/day) | Leachate Collected (gal/min) |
| $L_{total}$ = 75 ft<br>S = 33.33% | 0.330(1) | 0.038 | 7,083.94 | 36.80 |

**Case 22 - Bottom Northern Side Slope of Phase I - 25 ft waste + 6-inch daily cover**

| | | Collection System, K = 5.7 cm/sec | | |
|---|---|---|---|---|
| | Thickness at 100 hr (inches) | Max. Head on Liner (inches) | Leachate Collected ($ft^3$/day) | Leachate Collected (gal/min) |
| $L_{total}$ = 75 ft<br>S = 33.33% | 0.300(1) | 0.015 | 3,880.14 | 20.16 |

NOTES:

1. Thickness of 330-mil bi-planar geocomposite at 100 hrs & loaded.
2. Phase I side slope has a primary bi-planar geocomposite collection layer only, no detection layer.

All flow rates are based on a per acre basis.

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| **Peak Daily Values** | CHECKED | DATE |
| 330-mil Bi-planar Geocomposite | | |

**Case 23 - Top Northern Side Slope of Phase I - with sod, 0 ft waste**

| | | Collection System, K = 7.8 cm/sec | | |
|---|---|---|---|---|
| | Thickness at 100 hr (inches) | Max. Head on Liner (inches) | Leachate Collected ($ft^3$/day) | Leachate Collected (gal/min) |
| $L_{total}$ = 105 ft<br>S = 33.33% | 0.330(1) | 0.045 | 9,494.95 | 49.32 |

**Case 24 - Top Northern Side Slope of Phase I - 15 ft waste + 6-inch daily cover**

| | | Collection System, K = 5.7 cm/sec | | |
|---|---|---|---|---|
| | Thickness at 100 hr (inches) | Max. Head on Liner (inches) | Leachate Collected ($ft^3$/day) | Leachate Collected (gal/min) |
| $L_{total}$ = 105 ft<br>S = 33.33% | 0.300(1) | 0.037 | 5,313.60 | 27.60 |

NOTES:

1. Thickness of 330-mil bi-planar geocomposite at 100 hrs & loaded.
2. Phase I side slope has a primary bi-planar geocomposite collection layer only, no detection layer.

All flow rates are based on a per acre basis.

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**Case 1 - Cell Bottom South - open cell, 0 ft waste**

| | Collection System, K = 11.9 cm/sec | | | | Detection System, K = 40.7 cm/sec | | | |
|---|---|---|---|---|---|---|---|---|
| | Thickness at 100 hr (inches) | Ave. Head on Liner (inches) | Leachate Collected ($ft^3/yr$) | Leachate Collected (gal/min) | Thickness at 100 hr (inches) | Ave. Head on Liner (inches) | Leachate Collected ($ft^3/yr$) | Leachate Collected (gal/min) |
| $L_{total}$ = 53.1 ft<br>S = 2.20% | 0.300(1) | 0.002 | 74,092.20 | 1.05 | 0.300(2) | 0.000 | 1,502.23 | 0.02 |

**Case 2 - Cell Bottom South - 10 ft waste + 6-inch daily cover**

| | Collection System, K = 11.9 cm/sec | | | | Detection System, K = 40.7 cm/sec | | | |
|---|---|---|---|---|---|---|---|---|
| | Thickness at 100 hr (inches) | Ave. Head on Liner (inches) | Leachate Collected ($ft^3/yr$) | Leachate Collected (gal/min) | Thickness at 100 hr (inches) | Ave. Head on Liner (inches) | Leachate Collected ($ft^3/yr$) | Leachate Collected (gal/min) |
| $L_{total}$ = 53.1 ft<br>S = 2.20% | 0.300(1) | 0.002 | 63,717.25 | 0.91 | 0.300(2) | 0.000 | 1,462.09 | 0.02 |

**Case 3 - Cell Bottom South - 25 ft waste + 6-inch daily cover**

| | Collection System, K = 7.2 cm/sec | | | | Detection System, K = 29.4 cm/sec | | | |
|---|---|---|---|---|---|---|---|---|
| | Thickness at 100 hr (inches) | Ave. Head on Liner (inches) | Leachate Collected ($ft^3/yr$) | Leachate Collected (gal/min) | Thickness at 100 hr (inches) | Ave. Head on Liner (inches) | Leachate Collected ($ft^3/yr$) | Leachate Collected (gal/min) |
| $L_{total}$ = 53.1 ft<br>S = 2.20% | 0.273(1) | 0.003 | 63,634.77 | 0.91 | 0.273(2) | 0.000 | 1,879.81 | 0.03 |

**Case 4 - Cell Bottom South - 60 ft waste + 6-inch daily cover + 1 ft int cover**

| | Collection System, K = 5.3 cm/sec | | | | Detection System, K = 21.8 cm/sec | | | |
|---|---|---|---|---|---|---|---|---|
| | Thickness at 100 hr (inches) | Ave. Head on Liner (inches) | Leachate Collected ($ft^3/yr$) | Leachate Collected (gal/min) | Thickness at 100 hr (inches) | Ave. Head on Liner (inches) | Leachate Collected ($ft^3/yr$) | Leachate Collected (gal/min) |
| $L_{total}$ = 53.1 ft<br>S = 2.20% | 0.261(1) | 0.000 | 58,269.54 | 0.83 | 0.261(2) | 0.000 | 2,139.78 | 0.03 |

NOTES:

1. Thickness of 300-mil bi-planar geocomposite at 100 hrs & loaded.
2. Thickness of 300-mil tri-planar geocomposite at 100 hrs & loaded.

All flow rates are based on a per acre basis.

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**Case 5 - Cell Bottom Center - open cell, 0 ft waste**

| | Collection System, K = 11.9 cm/sec | | | | Detection System, K = 40.7 cm/sec | | | |
|---|---|---|---|---|---|---|---|---|
| | Thickness at 100 hr (inches) | Ave. Head on Liner (inches) | Leachate Collected ($ft^3/yr$) | Leachate Collected (gal/min) | Thickness at 100 hr (inches) | Ave. Head on Liner (inches) | Leachate Collected ($ft^3/yr$) | Leachate Collected (gal/min) |
| $L_{total}$ = 53.1 ft<br>S = 2.20% | 0.300(1) | 0.002 | 74,092.20 | 1.05 | 0.300(2) | 0.000 | 1,502.23 | 0.02 |

**Case 6 - Cell Bottom Center - 10 ft waste + 6-inch daily cover**

| | Collection System, K = 11.9 cm/sec | | | | Detection System, K = 40.7 cm/sec | | | |
|---|---|---|---|---|---|---|---|---|
| | Thickness at 100 hr (inches) | Ave. Head on Liner (inches) | Leachate Collected ($ft^3/yr$) | Leachate Collected (gal/min) | Thickness at 100 hr (inches) | Ave. Head on Liner (inches) | Leachate Collected ($ft^3/yr$) | Leachate Collected (gal/min) |
| $L_{total}$ = 53.1 ft<br>S = 2.20% | 0.300(1) | 0.002 | 63,717.25 | 0.91 | 0.300(2) | 0.000 | 1,462.09 | 0.02 |

**Case 7 - Cell Bottom Center - 25 ft waste + 6-inch daily cover**

| | Collection System, K = 7.2 cm/sec | | | | Detection System, K = 29.4 cm/sec | | | |
|---|---|---|---|---|---|---|---|---|
| | Thickness at 100 hr (inches) | Ave. Head on Liner (inches) | Leachate Collected ($ft^3/yr$) | Leachate Collected (gal/min) | Thickness at 100 hr (inches) | Ave. Head on Liner (inches) | Leachate Collected ($ft^3/yr$) | Leachate Collected (gal/min) |
| $L_{total}$ = 53.1 ft<br>S = 2.20% | 0.273(1) | 0.003 | 63,634.77 | 0.91 | 0.273(2) | 0.000 | 1,879.81 | 0.03 |

**Case 8 - Cell Bottom Center - 60 ft waste + 6-inch daily cover + 1 ft int cover**

| | Collection System, K = 5.3 cm/sec | | | | Detection System, K = 21.8 cm/sec | | | |
|---|---|---|---|---|---|---|---|---|
| | Thickness at 100 hr (inches) | Ave. Head on Liner (inches) | Leachate Collected ($ft^3/yr$) | Leachate Collected (gal/min) | Thickness at 100 hr (inches) | Ave. Head on Liner (inches) | Leachate Collected ($ft^3/yr$) | Leachate Collected (gal/min) |
| $L_{total}$ = 53.1 ft<br>S = 2.20% | 0.261(1) | 0.004 | 58,269.54 | 0.83 | 0.261(2) | 0.000 | 2,139.78 | 0.03 |

NOTES:

1. Thickness of 300-mil bi-planar geocomposite at 100 hrs & loaded.
2. Thickness of 300-mil tri-planar geocomposite at 100 hrs & loaded.

All flow rates are based on a per acre basis.

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**Case 9 - Cell Bottom North - open cell, 0 ft waste**

| | Collection System, K = 11.9 cm/sec | | | | Detection System, K = 40.7 cm/sec | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| | Thickness at 100 hr (inches) | Ave. Head on Liner (inches) | Leachate Collected ($ft^3$/yr) | Leachate Collected (gal/min) | Thickness at 100 hr (inches) | Ave. Head on Liner (inches) | Leachate Collected ($ft^3$/yr) | Leachate Collected (gal/min) |
| $L_{total}$ = 53.5 ft S = 2.20% | 0.300(1) | 0.002 | 74,086.28 | 1.05 | 0.300(2) | 0.000 | 1,508.13 | 0.02 |

**Case 10 - Cell Bottom North - 10 ft waste + 6-inch daily cover**

| | Collection System, K = 11.9 cm/sec | | | | Detection System, K = 40.7 cm/sec | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| | Thickness at 100 hr (inches) | Ave. Head on Liner (inches) | Leachate Collected ($ft^3$/yr) | Leachate Collected (gal/min) | Thickness at 100 hr (inches) | Ave. Head on Liner (inches) | Leachate Collected ($ft^3$/yr) | Leachate Collected (gal/min) |
| $L_{total}$ = 53.5 ft S = 2.20% | 0.300(1) | 0.002 | 63,711.76 | 0.91 | 0.300(2) | 0.000 | 1,467.59 | 0.02 |

**Case 11 - Cell Bottom North - 25 ft waste + 6-inch daily cover**

| | Collection System, K = 7.2 cm/sec | | | | Detection System, K = 29.4 cm/sec | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| | Thickness at 100 hr (inches) | Ave. Head on Liner (inches) | Leachate Collected ($ft^3$/yr) | Leachate Collected (gal/min) | Thickness at 100 hr (inches) | Ave. Head on Liner (inches) | Leachate Collected ($ft^3$/yr) | Leachate Collected (gal/min) |
| $L_{total}$ = 53.5 ft S = 2.20% | 0.273(1) | 0.003 | 63,782.34 | 0.91 | 0.273(2) | 0.000 | 1,887.34 | 0.03 |

**Case 12 - Cell Bottom North - 60 ft waste + 6-inch daily cover + 1 ft int cover**

| | Collection System, K = 5.3 cm/sec | | | | Detection System, K = 21.8 cm/sec | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| | Thickness at 100 hr (inches) | Ave. Head on Liner (inches) | Leachate Collected ($ft^3$/yr) | Leachate Collected (gal/min) | Thickness at 100 hr (inches) | Ave. Head on Liner (inches) | Leachate Collected ($ft^3$/yr) | Leachate Collected (gal/min) |
| $L_{total}$ = 53.5 ft S = 2.20% | 0.261(1) | 0.004 | 58,261.15 | 0.83 | 0.261(2) | 0.000 | 2,148.19 | 0.03 |

NOTES:

1. Thickness of 300-mil bi-planar geocomposite at 100 hrs & loaded.
2. Thickness of 300-mil tri-planar geocomposite at 100 hrs & loaded.

All flow rates are based on a per acre basis.

SCS ENGINEERS

SHEET 11 OF 40

| CLIENT | PROJECT | JOB NO. |
|---|---|---|
| Hardee County | Phase II Section II Expansion | 09199033.23 |

| SUBJECT | BY | DATE |
|---|---|---|
| HELP Model Summary | SRF | 4/1/13 |
| **Average Daily Values** | CHECKED | DATE |
| 330-mil Bi-planar Geocomposite | | |

**Case 13 - Bottom Southern Side Slope of Phase I - with sod, 0 ft waste**

| | | Collection System, K = 7.8 cm/sec | | |
|---|---|---|---|---|
| | Thickness at 100 hr (inches) | Ave. Head on Liner (inches) | Leachate Collected ($ft^3$/yr) | Leachate Collected (gal/min) |
| $L_{total}$ = 75 ft<br>S = 33.33% | 0.330(1) | 0.000 | 92,232.06 | 1.31 |

**Case 14 - Bottom Southern Side Slope of Phase I - open cell, no sod, 0 ft waste**

| | | Collection System, K = 7.8 cm/sec | | |
|---|---|---|---|---|
| | Thickness at 100 hr (inches) | Ave. Head on Liner (inches) | Leachate Collected ($ft^3$/yr) | Leachate Collected (gal/min) |
| $L_{total}$ = 75 ft<br>S = 33.33% | 0.330(1) | 0.000 | 97,719.06 | 1.39 |

**Case 15 - Bottom Southern Side Slope of Phase I - 10 ft waste + 6-inch daily cover**

| | | Collection System, K = 7.8 cm/sec | | |
|---|---|---|---|---|
| | Thickness at 100 hr (inches) | Ave. Head on Liner (inches) | Leachate Collected ($ft^3$/yr) | Leachate Collected (gal/min) |
| $L_{total}$ = 75 ft<br>S = 33.33% | 0.330(1) | 0.000 | 75,452.12 | 1.07 |

**Case 16 - Bottom Southern Side Slope of Phase I - 25 ft waste + 6-inch daily cover**

| | | Collection System, K = 5.7 cm/sec | | |
|---|---|---|---|---|
| | Thickness at 100 hr (inches) | Ave. Head on Liner (inches) | Leachate Collected ($ft^3$/yr) | Leachate Collected (gal/min) |
| $L_{total}$ = 75 ft<br>S = 33.33% | 0.300(1) | 0.000 | 78,252.99 | 1.11 |

NOTES:

1. Thickness of 330-mil bi-planar geocomposite at 100 hrs & loaded.
2. Phase I side slope has a primary bi-planar geocomposite collection layer only, no detection layer.

All flow rates are based on a per acre basis.

| CLIENT | PROJECT | JOB NO. |
|---|---|---|
| Hardee County | Phase II Section II Expansion | 09199033.23 |

| SUBJECT | BY | DATE |
|---|---|---|
| HELP Model Summary | SRF | 4/1/13 |
| **Average Daily Values** | CHECKED | DATE |
| 330-mil Bi-planar Geocomposite | | |

**Case 17 - Top Southern Side Slope of Phase I - with sod, 0 ft waste**

| | | Collection System, K = 7.8 cm/sec | | |
|---|---|---|---|---|
| | Thickness at 100 hr (inches) | Ave. Head on Liner (inches) | Leachate Collected ($ft^3$/yr) | Leachate Collected (gal/min) |
| $L_{total}$ = 105 ft<br>S = 33.33% | 0.330[(1)] | 0.001 | 92,231.66 | 1.31 |

**Case 18 - Top Southern Side Slope of Phase I - 25 ft waste + 6-inch daily cover**

| | | Collection System, K = 5.7 cm/sec | | |
|---|---|---|---|---|
| | Thickness at 100 hr (inches) | Ave. Head on Liner (inches) | Leachate Collected ($ft^3$/yr) | Leachate Collected (gal/min) |
| $L_{total}$ = 105 ft<br>S = 33.33% | 0.300[(1)] | 0.001 | 75,449.13 | 1.07 |

NOTES:

1. Thickness of 330-mil bi-planar geocomposite at 100 hrs & loaded.
2. Phase I side slope has a primary bi-planar geocomposite collection layer only, no detection layer.

All flow rates are based on a per acre basis.

SCS ENGINEERS

SHEET 13 OF 40

| CLIENT | PROJECT | JOB NO. |
|---|---|---|
| Hardee County | Phase II Section II Expansion | 09199033.23 |

| SUBJECT | BY | DATE |
|---|---|---|
| HELP Model Summary | SRF | 4/1/13 |
| **Average Daily Values** | CHECKED | DATE |
| 330-mil Bi-planar Geocomposite | | |

**Case 19 - Bottom Northern Side Slope of Phase I - with sod, 0 ft waste**

| | | Collection System, K = 7.8 cm/sec | | |
|---|---|---|---|---|
| | Thickness at 100 hr (inches) | Ave. Head on Liner (inches) | Leachate Collected ($ft^3$/yr) | Leachate Collected (gal/min) |
| $L_{total}$ = 75 ft<br>S = 33.33% | 0.330(1) | 0.000 | 92,232.06 | 1.31 |

**Case 20 - Bottom Northern Side Slope of Phase I - open cell, no sod, 0 ft waste**

| | | Collection System, K = 7.8 cm/sec | | |
|---|---|---|---|---|
| | Thickness at 100 hr (inches) | Ave. Head on Liner (inches) | Leachate Collected ($ft^3$/yr) | Leachate Collected (gal/min) |
| $L_{total}$ = 75 ft<br>S = 33.33% | 0.330(1) | 0.000 | 97,719.06 | 1.39 |

**Case 21 - Bottom Northern Side Slope of Phase I - 10 ft waste + 6-inch daily cover**

| | | Collection System, K = 7.8 cm/sec | | |
|---|---|---|---|---|
| | Thickness at 100 hr (inches) | Ave. Head on Liner (inches) | Leachate Collected ($ft^3$/yr) | Leachate Collected (gal/min) |
| $L_{total}$ = 75 ft<br>S = 33.33% | 0.330(1) | 0.000 | 75,452.12 | 1.07 |

**Case 22 - Bottom Northern Side Slope of Phase I - 25 ft waste + 6-inch daily cover**

| | | Collection System, K = 5.7 cm/sec | | |
|---|---|---|---|---|
| | Thickness at 100 hr (inches) | Ave. Head on Liner (inches) | Leachate Collected ($ft^3$/yr) | Leachate Collected (gal/min) |
| $L_{total}$ = 75 ft<br>S = 33.33% | 0.300(1) | 0.000 | 78,252.99 | 1.11 |

NOTES:

1. Thickness of 330-mil bi-planar geocomposite at 100 hrs & loaded.
2. Phase I side slope has a primary bi-planar geocomposite collection layer only, no detection layer.

All flow rates are based on a per acre basis.

| CLIENT | PROJECT | JOB NO. |
|---|---|---|
| Hardee County | Phase II Section II Expansion | 09199033.23 |

| SUBJECT | BY | DATE |
|---|---|---|
| HELP Model Summary | SRF | 4/1/13 |
| **Average Daily Values** | CHECKED | DATE |
| 330-mil Bi-planar Geocomposite | | |

**Case 23 - Top Northern Side Slope of Phase I - with sod, 0 ft waste**

| | | Collection System, K = 7.8 cm/sec | | |
|---|---|---|---|---|
| | Thickness at 100 hr (inches) | Ave. Head on Liner (inches) | Leachate Collected ($ft^3/yr$) | Leachate Collected (gal/min) |
| $L_{total}$ = 105 ft<br>S = 33.33% | 0.330(1) | 0.001 | 92,231.66 | 1.31 |

**Case 24 - Top Northern Side Slope of Phase I - 15 ft waste + 6-inch daily cover**

| | | Collection System, K = 5.7 cm/sec | | |
|---|---|---|---|---|
| | Thickness at 100 hr (inches) | Ave. Head on Liner (inches) | Leachate Collected ($ft^3/yr$) | Leachate Collected (gal/min) |
| $L_{total}$ = 105 ft<br>S = 33.33% | 0.300(1) | 0.001 | 75,450.94 | 1.07 |

NOTES:

1. Thickness of 330-mil bi-planar geocomposite at 100 hrs & loaded.
2. Phase I side slope has a primary bi-planar geocomposite collection layer only, no detection layer.

All flow rates are based on a per acre basis.

SCS ENGINEERS



| CLIENT | PROJECT | JOB NO. |
|---|---|---|
| Hardee County | Phase II Section II Expansion | 09199033.23 |

| SUBJECT | BY | DATE |
|---|---|---|
| HELP Model Summary | SRF | 4/1/13 |
| **Peak Daily and Average Annual Values** | CHECKED | DATE |
| 300-mil Bi-planar and 300-mil Tri-planar Bottom, 330-mil Bi-planar Geocomposite Slope | | |

**Case 1 Phase II Section I Bottom - 40 ft waste + 6-inch daily cover**

| | Collection System, K = 6.9 cm/sec | | | | Detection System, K = 26.6 cm/sec | | | |
|---|---|---|---|---|---|---|---|---|
| | Thickness at 100 hr (inches) | Max. Head on Liner (inches) | Leachate Collected ($ft^3$/day) | Leachate Collected (gal/min) | Thickness at 100 hr (inches) | Max. Head on Liner (inches) | Leachate Collected ($ft^3$/day) | Leachate Collected (gal/min) |
| $L_{total}$ = 77.3 ft<br>S = 2.14% | 0.273(1) | 0.142 | 2,876.27 | 14.94 | 0.273(2) | 0.001 | 35.71 | 0.19 |

**Case 1 Phase II Section I Bottom - 40 ft waste + 6-inch daily cover**

| | Collection System, K = 6.9 cm/sec | | | | Detection System, K = 26.6 cm/sec | | | |
|---|---|---|---|---|---|---|---|---|
| | Thickness at 100 hr (inches) | Ave. Head on Liner (inches) | Leachate Collected ($ft^3$/yr) | Leachate Collected (gal/min) | Thickness at 100 hr (inches) | Ave. Head on Liner (inches) | Leachate Collected ($ft^3$/yr) | Leachate Collected (gal/min) |
| $L_{total}$ = 77.3 ft<br>S = 2.14% | 0.273(1) | 0.004 | 63,629.36 | 0.91 | 0.273(2) | 0.000 | 2,343.85 | 0.03 |

**Case 2 Phase I South Side Slope - 10 ft waste + 6-inch daily cover**

| | | Collection System, K = 7.8 cm/sec | | |
|---|---|---|---|---|
| | Thickness at 100 hr (inches) | Max. Head on Liner (inches) | Leachate Collected ($ft^3$/day) | Leachate Collected (gal/min) |
| $L_{total}$ = 75 ft<br>S = 33.33% | 0.330(3) | 0.04 | 7,115.32 | 36.96 |

**Case 2 Phase I South Side Slope - 10 ft waste + 6-inch daily cover**

| | | Collection System, K = 7.8 cm/sec | | |
|---|---|---|---|---|
| | Thickness at 100 hr (inches) | Ave. Head on Liner (inches) | Leachate Collected ($ft^3$/yr) | Leachate Collected (gal/min) |
| $L_{total}$ = 75 ft<br>S = 33.33% | 0.330(3) | 0.000 | 85,650.74 | 1.22 |

NOTES:

1. Thickness of 300-mil bi-planar geocomposite at 100 hrs & loaded.
2. Thickness of 300-mil tri-planar geocomposite at 100 hrs & loaded.
3. Thickness of 330-mil bi-planar geocomposite at 100 hrs & loaded.

All flow rates are based on a per acre basis.

| CLIENT | PROJECT | JOB NO. | |
|---|---|---|---|
| Hardee County | Phase II Section II Expansion | 09199033.23 | |
| SUBJECT | | BY | DATE |
| Leachate Generation Estimates | | SRF | 4/1/13 |
| **Collection System Phase II Section II and Phase I Side Slope** | | CHECKED | DATE |

| Summary Collection Per Acre Flow Values | $Q_{PEAK}$ | | $Q_{AVERAGE}$ | |
|---|---|---|---|---|
| **SOUTH PORTION** | | | | |
| Cell Bottom South - open cell, 0 ft waste | 65.52 | gal/min | 1.05 | gal/min |
| Cell Bottom South - 10 ft waste + 6-inch daily cover | 36.60 | gal/min | 0.91 | gal/min |
| Cell Bottom South - 25 ft waste + 6-inch daily cover | 20.37 | gal/min | 0.91 | gal/min |
| Cell Bottom South - 60 ft waste + 6-inch daily cover + 1 ft int cover | 10.00 | gal/min | 0.83 | gal/min |
| **CENTER PORTION** | | | | |
| Cell Bottom Center - open cell, 0 ft waste | 65.52 | gal/min | 1.05 | gal/min |
| Cell Bottom Center - 10 ft waste + 6-inch daily cover | 36.60 | gal/min | 0.91 | gal/min |
| Cell Bottom Center - 25 ft waste + 6-inch daily cover | 20.37 | gal/min | 0.91 | gal/min |
| Cell Bottom Center - 60 ft waste + 6-inch daily cover + 1 ft int cover | 10.00 | gal/min | 0.83 | gal/min |
| **NORTH PORTION** | | | | |
| Cell Bottom North - Rain Tarp | 0.00 | gal/min | 0.00 | gal/min |
| Cell Bottom North - open cell, 0 ft waste | 65.54 | gal/min | 1.05 | gal/min |
| Cell Bottom North - 10 ft waste + 6-inch daily cover | 36.61 | gal/min | 0.91 | gal/min |
| Cell Bottom North - 25 ft waste + 6-inch daily cover | 20.44 | gal/min | 0.91 | gal/min |
| Cell Bottom North - 60 ft waste + 6-inch daily cover + 1 ft int cover | 10.00 | gal/min | 0.83 | gal/min |
| **PHASE I WEST SIDE SLOPE** | | | | |
| Bottom Southern Side Slope of Phase I - with rain tarp | 0.00 | gal/min | 0.00 | gal/min |
| Bottom Southern Side Slope of Phase I - with sod, 0 ft waste | 49.59 | gal/min | 1.31 | gal/min |
| Bottom Southern Side Slope of Phase I - open cell, no sod, 0 ft waste | 49.88 | gal/min | 1.39 | gal/min |
| Bottom Southern Side Slope of Phase I - 10 ft waste + 6-inch daily cover | 36.80 | gal/min | 1.07 | gal/min |
| Bottom Southern Side Slope of Phase I - 25 ft waste + 6-inch daily cover | 20.16 | gal/min | 1.11 | gal/min |
| Top Southern Side Slope of Phase I - with rain tarp | 0.00 | gal/min | 0.00 | gal/min |
| Top Southern Side Slope of Phase I - with sod, 0 ft waste | 49.32 | gal/min | 1.31 | gal/min |
| Top Southern Side Slope of Phase I - 25 ft waste + 6-inch daily cover | 20.12 | gal/min | 1.07 | gal/min |
| Bottom Northern Side Slope of Phase I - with rain tarp | 0.00 | gal/min | 0.00 | gal/min |
| Bottom Northern Side Slope of Phase I - with sod, 0 ft waste | 49.59 | gal/min | 1.31 | gal/min |
| Bottom Northern Side Slope of Phase I - open cell, no sod, 0 ft waste | 49.88 | gal/min | 1.39 | gal/min |
| Bottom Northern Side Slope of Phase I - 10 ft waste + 6-inch daily cover | 36.80 | gal/min | 1.07 | gal/min |
| Bottom Northern Side Slope of Phase I - 25 ft waste + 6-inch daily cover | 20.16 | gal/min | 1.11 | gal/min |
| Top Northern Side Slope of Phase I - with rain tarp | 0.00 | gal/min | 0.00 | gal/min |
| Top Northern Side Slope of Phase I - with sod, 0 ft waste | 49.32 | gal/min | 1.31 | gal/min |
| Top Northern Side Slope of Phase I - 15 ft waste + 6-inch daily cover | 27.60 | gal/min | 1.07 | gal/min |

Note: Used average depth of waste on side slope

| Assumptions | Area | | Area | |
|---|---|---|---|---|
| Total No. of Acres Landfill Expansion South, Center and and North | 269,135.53 | $ft^2$ | 6.18 | ac |
| Southern Portion of Landfill Bottom = | 70,987.38 | $ft^2$ | 1.63 | ac |
| Center Portion of Landfill Bottom = | 96,629.66 | $ft^2$ | 2.22 | ac |
| Northern Portion of Landfill Bottom = | 101,306.05 | $ft^2$ | 2.33 | ac |
| Total No. of Acres Landfill Expansion Center and North Bottom | 198,049.25 | $ft^2$ | 4.55 | ac |
| Total No. of Acres Phase I Western Side Slope | 189,881.67 | $ft^2$ | 4.36 | ac |
| Entire Southern Side Slope of Phase I | 97,063.58 | $ft^2$ | 2.23 | ac |
| Bottom Southern Side Slope of Phase I = | 34,942.52 | $ft^2$ | 0.80 | ac |
| Top Southern Side Slope of Phase I = | 62,121.06 | $ft^2$ | 1.43 | ac |
| Entire Northern Side Slope of Phase I | 92,818.09 | $ft^2$ | 2.13 | ac |
| Bottom Northern Side Slope of Phase I = | 39,650.12 | $ft^2$ | 0.91 | ac |
| Top Northern Side Slope of Phase I = | 53,167.97 | $ft^2$ | 1.22 | ac |

| | | | | | |
|---|---|---|---|---|---|
| **Scenario 1 =** Cell Bottom South - open cell, 0 ft waste | 1.63 | ac | 0 | ft of waste | Open cell, start waste filling |
| Cell Bottom Center - open cell, 0 ft waste | 2.22 | ac | 0 | ft of waste | Open cell, no waste filling |
| Bottom Southern Side Slope of Phase I - with rain tarp | 0.80 | ac | 0 | ft of waste | Rain tarp |
| Top Southern Side Slope of Phase I - with rain tarp | 1.43 | ac | 0 | ft of waste | Rain tarp |
| Cell Bottom North - Rain Tarp | 2.33 | ac | 0 | ft of waste | Rain tarp |
| Bottom Northern Side Slope of Phase I - with rain tarp | 0.91 | ac | 0 | ft of waste | Rain tarp |
| Top Northern Side Slope of Phase I - with rain tarp | 1.22 | ac | 0 | ft of waste | Rain tarp |
| | 10.54 | | | | |

| **Scenario 1 Generation =** | | | | | |
|---|---|---|---|---|---|
| Waste filling just started in south portion | 106.79 | gal/min | 1.72 | gal/min | leachate, flow to Phase II Section I |
| Rainwater falling on open cell, no waste filling | 145.45 | gal/min | 2.34 | gal/min | stormwater, pumped to swale |
| No Infiltration through bottom southern side slope rain tarp | 0.00 | gal/min | 0.00 | gal/min | stormwater runoff, pumped to swale |
| No Infiltration through top southern side slope rain tarp | 0.00 | gal/min | 0.00 | gal/min | stormwater runoff, pumped to swale |
| No Infiltration through northern cell bottom rain tarp | 0.00 | gal/min | 0.00 | gal/min | stormwater, pumped to swale |
| No Infiltration through bottom northern side slope rain tarp | 0.00 | gal/min | 0.00 | gal/min | stormwater runoff, pumped to swale |
| No Infiltration through top northern side slope rain tarp | 0.00 | gal/min | 0.00 | gal/min | stormwater runoff, pumped to swale |
| PEAK LEACHATE | 106.79 | gal/min | 1.72 | gal/min | AVG LEACHATE |

| CLIENT | PROJECT | JOB NO. | |
|---|---|---|---|
| Hardee County | Phase II Section II Expansion | 09199033.23 | |
| SUBJECT | | BY | DATE |
| Leachate Generation Estimates | | SRF | 4/1/13 |
| **Detection System Phase II Section II** | | CHECKED | DATE |

Summary Collection Per Acre Flow Values

| | $Q_{PEAK}$ | | $Q_{AVERAGE}$ | |
|---|---|---|---|---|
| **SOUTH PORTION** | | | | |
| Cell Bottom South - open cell, 0 ft waste | 0.24 | gal/min | 0.02 | gal/min |
| Cell Bottom South - 10 ft waste + 6-inch daily cover | 0.18 | gal/min | 0.02 | gal/min |
| Cell Bottom South - 25 ft waste + 6-inch daily cover | 0.17 | gal/min | 0.03 | gal/min |
| Cell Bottom South - 60 ft waste + 6-inch daily cover + 1 ft int cover | 0.14 | gal/min | 0.03 | gal/min |
| **CENTER PORTION** | | | | |
| Cell Bottom Center - open cell, 0 ft waste | 0.24 | gal/min | 0.02 | gal/min |
| Cell Bottom Center - 10 ft waste + 6-inch daily cover | 0.18 | gal/min | 0.02 | gal/min |
| Cell Bottom Center - 25 ft waste + 6-inch daily cover | 0.17 | gal/min | 0.03 | gal/min |
| Cell Bottom Center - 60 ft waste + 6-inch daily cover + 1 ft int cover | 0.14 | gal/min | 0.03 | gal/min |
| **NORTH PORTION** | | | | |
| Cell Bottom North - Rain Tarp | 0.00 | gal/min | 0.00 | gal/min |
| Cell Bottom North - open cell, 0 ft waste | 0.24 | gal/min | 0.02 | gal/min |
| Cell Bottom North - 10 ft waste + 6-inch daily cover | 0.18 | gal/min | 0.02 | gal/min |
| Cell Bottom North - 25 ft waste + 6-inch daily cover | 0.17 | gal/min | 0.03 | gal/min |
| Cell Bottom North - 60 ft waste + 6-inch daily cover + 1 ft int cover | 0.14 | gal/min | 0.03 | gal/min |
| **PHASE I WEST SIDE SLOPE** | | | | |
| Bottom Southern Side Slope of Phase I - with rain tarp | 0.00 | gal/min | 0.00 | gal/min |
| Bottom Southern Side Slope of Phase I - with sod, 0 ft waste | 0.00 | gal/min | 0.00 | gal/min |
| Bottom Southern Side Slope of Phase I - open cell, no sod, 0 ft waste | 0.00 | gal/min | 0.00 | gal/min |
| Bottom Southern Side Slope of Phase I - 10 ft waste + 6-inch daily cover | 0.00 | gal/min | 0.00 | gal/min |
| Bottom Southern Side Slope of Phase I - 25 ft waste + 6-inch daily cover | 0.00 | gal/min | 0.00 | gal/min |
| Top Southern Side Slope of Phase I - with rain tarp | 0.00 | gal/min | 0.00 | gal/min |
| Top Southern Side Slope of Phase I - with sod, 0 ft waste | 0.00 | gal/min | 0.00 | gal/min |
| Top Southern Side Slope of Phase I - 25 ft waste + 6-inch daily cover | 0.00 | gal/min | 0.00 | gal/min |
| Bottom Northern Side Slope of Phase I - with rain tarp | 0.00 | gal/min | 0.00 | gal/min |
| Bottom Northern Side Slope of Phase I - with sod, 0 ft waste | 0.00 | gal/min | 0.00 | gal/min |
| Bottom Northern Side Slope of Phase I - open cell, no sod, 0 ft waste | 0.00 | gal/min | 0.00 | gal/min |
| Bottom Northern Side Slope of Phase I - 10 ft waste + 6-inch daily cover | 0.00 | gal/min | 0.00 | gal/min |
| Bottom Northern Side Slope of Phase I - 25 ft waste + 6-inch daily cover | 0.00 | gal/min | 0.00 | gal/min |
| Top Northern Side Slope of Phase I - with rain tarp | 0.00 | gal/min | 0.00 | gal/min |
| Top Northern Side Slope of Phase I - with sod, 0 ft waste | 0.00 | gal/min | 0.00 | gal/min |
| Top Northern Side Slope of Phase I - 15 ft waste + 6-inch daily cover | 0.00 | gal/min | 0.00 | gal/min |

Note: Used average depth of waste on side slope

| Assumptions | Area | | Area | |
|---|---|---|---|---|
| Total No. of Acres Landfill Expansion South, Center and and North | 269,135.53 | $ft^2$ | 6.18 | ac |
| Southern Portion of Landfill Bottom = | 70,987.38 | $ft^2$ | 1.63 | ac |
| Center Portion of Landfill Bottom = | 96,629.66 | $ft^2$ | 2.22 | ac |
| Northern Portion of Landfill Bottom = | 101,306.05 | $ft^2$ | 2.33 | ac |
| Total No. of Acres Landfill Expansion Center and North Bottom | 198,049.25 | $ft^2$ | 4.55 | ac |
| Total No. of Acres Phase I Western Side Slope | 189,881.67 | $ft^2$ | 4.36 | ac |
| Entire Southern Side Slope of Phase I | 97,063.58 | $ft^2$ | 2.23 | ac |
| Bottom Southern Side Slope of Phase I = | 34,942.52 | $ft^2$ | 0.80 | ac |
| Top Southern Side Slope of Phase I = | 62,121.06 | $ft^2$ | 1.43 | ac |
| Entire Northern Side Slope of Phase I | 92,818.09 | $ft^2$ | 2.13 | ac |
| Bottom Northern Side Slope of Phase I = | 39,650.12 | $ft^2$ | 0.91 | ac |
| Top Northern Side Slope of Phase I = | 53,167.97 | $ft^2$ | 1.22 | ac |

| | | | | | |
|---|---|---|---|---|---|
| **Scenario 1 =** Cell Bottom South - open cell, 0 ft waste | 1.63 | ac | 0 | ft of waste | Open cell, start waste filling |
| Cell Bottom Center - open cell, 0 ft waste | 2.22 | ac | 0 | ft of waste | Open cell, no waste filling |
| Bottom Southern Side Slope of Phase I - with rain tarp | 0.80 | ac | 0 | ft of waste | Rain tarp |
| Top Southern Side Slope of Phase I - with rain tarp | 1.43 | ac | 0 | ft of waste | Rain tarp |
| Cell Bottom North - Rain Tarp | 2.33 | ac | 0 | ft of waste | Rain tarp |
| Bottom Northern Side Slope of Phase I - with rain tarp | 0.91 | ac | 0 | ft of waste | Rain tarp |
| Top Northern Side Slope of Phase I - with rain tarp | 1.22 | ac | 0 | ft of waste | Rain tarp |
| | 10.54 | | | | |

| **Scenario 1 Generation =** | | | | | |
|---|---|---|---|---|---|
| Waste filling just started in south portion | 0.40 | gal/min | 0.03 | gal/min | leachate, flow to Phase II Section I |
| Rainwater falling on open cell, no waste filling | 0.54 | gal/min | 0.05 | gal/min | stormwater, pumped to swale |
| No Infiltration through bottom southern side slope rain tarp | 0.00 | gal/min | 0.00 | gal/min | stormwater runoff, pumped to swale |
| No Infiltration through top southern side slope rain tarp | 0.00 | gal/min | 0.00 | gal/min | stormwater runoff, pumped to swale |
| No Infiltration through northern cell bottom rain tarp | 0.00 | gal/min | 0.00 | gal/min | stormwater, pumped to swale |
| No Infiltration through bottom northern side slope rain tarp | 0.00 | gal/min | 0.00 | gal/min | stormwater runoff, pumped to swale |
| No Infiltration through top northern side slope rain tarp | 0.00 | gal/min | 0.00 | gal/min | stormwater runoff, pumped to swale |
| PEAK LEACHATE | 0.40 | gal/min | 0.03 | gal/min | AVG LEACHATE |

| | | | |
|---|---|---|---|
| CLIENT<br>Hardee County | PROJECT<br>Phase II Section II Expansion | JOB NO.<br>09199033.23 | |
| SUBJECT<br>Leachate Generation Estimates<br>**Collection System Phase II Section II and Phase I Side Slope** | | BY<br>SRF | DATE<br>4/1/13 |
| | | CHECKED | DATE |

Summary Collection Per Acre Flow Values

| | $Q_{PEAK}$ | | $Q_{AVERAGE}$ | |
|---|---|---|---|---|
| **SOUTH PORTION** | | | | |
| Cell Bottom South - open cell, 0 ft waste | 65.52 | gal/min | 1.05 | gal/min |
| Cell Bottom South - 10 ft waste + 6-inch daily cover | 36.60 | gal/min | 0.91 | gal/min |
| Cell Bottom South - 25 ft waste + 6-inch daily cover | 20.37 | gal/min | 0.91 | gal/min |
| Cell Bottom South - 60 ft waste + 6-inch daily cover + 1 ft int cover | 10.00 | gal/min | 0.83 | gal/min |
| **CENTER PORTION** | | | | |
| Cell Bottom Center - open cell, 0 ft waste | 65.52 | gal/min | 1.05 | gal/min |
| Cell Bottom Center - 10 ft waste + 6-inch daily cover | 36.60 | gal/min | 0.91 | gal/min |
| Cell Bottom Center - 25 ft waste + 6-inch daily cover | 20.37 | gal/min | 0.91 | gal/min |
| Cell Bottom Center - 60 ft waste + 6-inch daily cover + 1 ft int cover | 10.00 | gal/min | 0.83 | gal/min |
| **NORTH PORTION** | | | | |
| Cell Bottom North - Rain Tarp | 0.00 | gal/min | 0.00 | gal/min |
| Cell Bottom North - open cell, 0 ft waste | 65.54 | gal/min | 1.05 | gal/min |
| Cell Bottom North - 10 ft waste + 6-inch daily cover | 36.61 | gal/min | 0.91 | gal/min |
| Cell Bottom North - 25 ft waste + 6-inch daily cover | 20.44 | gal/min | 0.91 | gal/min |
| Cell Bottom North - 60 ft waste + 6-inch daily cover + 1 ft int cover | 10.00 | gal/min | 0.83 | gal/min |
| **PHASE I WEST SIDE SLOPE** | | | | |
| Bottom Southern Side Slope of Phase I - with rain tarp | 0.00 | gal/min | 0.00 | gal/min |
| Bottom Southern Side Slope of Phase I - with sod, 0 ft waste | 49.59 | gal/min | 1.31 | gal/min |
| Bottom Southern Side Slope of Phase I - open cell, no sod, 0 ft waste | 49.88 | gal/min | 1.39 | gal/min |
| Bottom Southern Side Slope of Phase I - 10 ft waste + 6-inch daily cover | 36.80 | gal/min | 1.07 | gal/min |
| Bottom Southern Side Slope of Phase I - 25 ft waste + 6-inch daily cover | 20.16 | gal/min | 1.11 | gal/min |
| Top Southern Side Slope of Phase I - with rain tarp | 0.00 | gal/min | 0.00 | gal/min |
| Top Southern Side Slope of Phase I - with sod, 0 ft waste | 49.32 | gal/min | 1.31 | gal/min |
| Top Southern Side Slope of Phase I - 25 ft waste + 6-inch daily cover | 20.12 | gal/min | 1.07 | gal/min |
| Bottom Northern Side Slope of Phase I - with rain tarp | 0.00 | gal/min | 0.00 | gal/min |
| Bottom Northern Side Slope of Phase I - with sod, 0 ft waste | 49.59 | gal/min | 1.31 | gal/min |
| Bottom Northern Side Slope of Phase I - open cell, no sod, 0 ft waste | 49.88 | gal/min | 1.39 | gal/min |
| Bottom Northern Side Slope of Phase I - 10 ft waste + 6-inch daily cover | 36.80 | gal/min | 1.07 | gal/min |
| Bottom Northern Side Slope of Phase I - 25 ft waste + 6-inch daily cover | 20.16 | gal/min | 1.11 | gal/min |
| Top Northern Side Slope of Phase I - with rain tarp | 0.00 | gal/min | 0.00 | gal/min |
| Top Northern Side Slope of Phase I - with sod, 0 ft waste | 49.32 | gal/min | 1.31 | gal/min |
| Top Northern Side Slope of Phase I - 15 ft waste + 6-inch daily cover | 27.60 | gal/min | 1.07 | gal/min |

Note: Used average depth of waste on side slope

| Assumptions | Area | | Area | |
|---|---|---|---|---|
| Total No. of Acres Landfill Expansion South, Center and and North | 269,135.53 | $ft^2$ | 6.18 | ac |
| Southern Portion of Landfill Bottom = | 70,987.38 | $ft^2$ | 1.63 | ac |
| Center Portion of Landfill Bottom = | 96,629.66 | $ft^2$ | 2.22 | ac |
| Northern Portion of Landfill Bottom = | 101,306.05 | $ft^2$ | 2.33 | ac |
| Total No. of Acres Landfill Expansion Center and North Bottom | 198,049.25 | $ft^2$ | 4.55 | ac |
| Total No. of Acres Phase I Western Side Slope | 189,881.67 | $ft^2$ | 4.36 | ac |
| Entire Southern Side Slope of Phase I | 97,063.58 | $ft^2$ | 2.23 | ac |
| Bottom Southern Side Slope of Phase I = | 34,942.52 | $ft^2$ | 0.80 | ac |
| Top Southern Side Slope of Phase I = | 62,121.06 | $ft^2$ | 1.43 | ac |
| Entire Northern Side Slope of Phase I | 92,818.09 | $ft^2$ | 2.13 | ac |
| Bottom Northern Side Slope of Phase I = | 39,650.12 | $ft^2$ | 0.91 | ac |
| Top Northern Side Slope of Phase I = | 53,167.97 | $ft^2$ | 1.22 | ac |

| | | | | | |
|---|---|---|---|---|---|
| **Scenario 2 =** Cell Bottom South - 10 ft waste + 6-inch daily cover | 1.63 | ac | 10 | ft of waste | Waste |
| Cell Bottom Center - open cell, 0 ft waste | 2.22 | ac | 0 | ft of waste | Open cell, no waste filling |
| Bottom Southern Side Slope of Phase I - with rain tarp | 0.80 | ac | 0 | ft of waste | Rain tarp |
| Top Southern Side Slope of Phase I - with rain tarp | 1.43 | ac | 0 | ft of waste | Rain tarp |
| Cell Bottom North - Rain Tarp | 2.33 | ac | 0 | ft of waste | Rain tarp |
| Bottom Northern Side Slope of Phase I - with rain tarp | 0.91 | ac | 0 | ft of waste | Rain tarp |
| Top Northern Side Slope of Phase I - with rain tarp | 1.22 | ac | 0 | ft of waste | Rain tarp |
| | 10.54 | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| **Scenario 2 Generation =** | Waste filling in south portion | 59.66 | gal/min | 1.48 | gal/min | leachate, flow to Phase II Section I |
| | Rainwater falling on open cell, no waste filling | 145.45 | gal/min | 2.34 | gal/min | stormwater, pumped to swale |
| | No Infiltration through bottom southern side slope rain tarp | 0.00 | gal/min | 0.00 | gal/min | stormwater runoff, pumped to swale |
| | No Infiltration through top southern side slope rain tarp | 0.00 | gal/min | 0.00 | gal/min | stormwater runoff, pumped to swale |
| | No Infiltration through northern cell bottom rain tarp | 0.00 | gal/min | 0.00 | gal/min | stormwater, pumped to swale |
| | No Infiltration through bottom northern side slope rain tarp | 0.00 | gal/min | 0.00 | gal/min | stormwater runoff, pumped to swale |
| | No Infiltration through top northern side slope rain tarp | 0.00 | gal/min | 0.00 | gal/min | stormwater runoff, pumped to swale |
| | PEAK LEACHATE | 59.66 | gal/min | 1.48 | gal/min | AVG LEACHATE |

| CLIENT | PROJECT | JOB NO. | |
|---|---|---|---|
| Hardee County | Phase II Section II Expansion | 09199033.23 | |
| SUBJECT | | BY | DATE |
| Leachate Generation Estimates | | SRF | 4/1/13 |
| **Detection System Phase II Section II** | | CHECKED | DATE |

Summary Collection Per Acre Flow Values

| | $Q_{PEAK}$ | | $Q_{AVERAGE}$ | |
|---|---|---|---|---|
| **SOUTH PORTION** | | | | |
| Cell Bottom South - open cell, 0 ft waste | 0.24 | gal/min | 0.02 | gal/min |
| Cell Bottom South - 10 ft waste + 6-inch daily cover | 0.18 | gal/min | 0.02 | gal/min |
| Cell Bottom South - 25 ft waste + 6-inch daily cover | 0.17 | gal/min | 0.03 | gal/min |
| Cell Bottom South - 60 ft waste + 6-inch daily cover + 1 ft int cover | 0.14 | gal/min | 0.03 | gal/min |
| **CENTER PORTION** | | | | |
| Cell Bottom Center - open cell, 0 ft waste | 0.24 | gal/min | 0.02 | gal/min |
| Cell Bottom Center - 10 ft waste + 6-inch daily cover | 0.18 | gal/min | 0.02 | gal/min |
| Cell Bottom Center - 25 ft waste + 6-inch daily cover | 0.17 | gal/min | 0.03 | gal/min |
| Cell Bottom Center - 60 ft waste + 6-inch daily cover + 1 ft int cover | 0.14 | gal/min | 0.03 | gal/min |
| **NORTH PORTION** | | | | |
| Cell Bottom North - Rain Tarp | 0.00 | gal/min | 0.00 | gal/min |
| Cell Bottom North - open cell, 0 ft waste | 0.24 | gal/min | 0.02 | gal/min |
| Cell Bottom North - 10 ft waste + 6-inch daily cover | 0.18 | gal/min | 0.02 | gal/min |
| Cell Bottom North - 25 ft waste + 6-inch daily cover | 0.17 | gal/min | 0.03 | gal/min |
| Cell Bottom North - 60 ft waste + 6-inch daily cover + 1 ft int cover | 0.14 | gal/min | 0.03 | gal/min |
| **PHASE I WEST SIDE SLOPE** | | | | |
| Bottom Southern Side Slope of Phase I - with rain tarp | 0.00 | gal/min | 0.00 | gal/min |
| Bottom Southern Side Slope of Phase I - with sod, 0 ft waste | 0.00 | gal/min | 0.00 | gal/min |
| Bottom Southern Side Slope of Phase I - open cell, no sod, 0 ft waste | 0.00 | gal/min | 0.00 | gal/min |
| Bottom Southern Side Slope of Phase I - 10 ft waste + 6-inch daily cover | 0.00 | gal/min | 0.00 | gal/min |
| Bottom Southern Side Slope of Phase I - 25 ft waste + 6-inch daily cover | 0.00 | gal/min | 0.00 | gal/min |
| Top Southern Side Slope of Phase I - with rain tarp | 0.00 | gal/min | 0.00 | gal/min |
| Top Southern Side Slope of Phase I - with sod, 0 ft waste | 0.00 | gal/min | 0.00 | gal/min |
| Top Southern Side Slope of Phase I - 25 ft waste + 6-inch daily cover | 0.00 | gal/min | 0.00 | gal/min |
| Bottom Northern Side Slope of Phase I - with rain tarp | 0.00 | gal/min | 0.00 | gal/min |
| Bottom Northern Side Slope of Phase I - with sod, 0 ft waste | 0.00 | gal/min | 0.00 | gal/min |
| Bottom Northern Side Slope of Phase I - open cell, no sod, 0 ft waste | 0.00 | gal/min | 0.00 | gal/min |
| Bottom Northern Side Slope of Phase I - 10 ft waste + 6-inch daily cover | 0.00 | gal/min | 0.00 | gal/min |
| Bottom Northern Side Slope of Phase I - 25 ft waste + 6-inch daily cover | 0.00 | gal/min | 0.00 | gal/min |
| Top Northern Side Slope of Phase I - with rain tarp | 0.00 | gal/min | 0.00 | gal/min |
| Top Northern Side Slope of Phase I - with sod, 0 ft waste | 0.00 | gal/min | 0.00 | gal/min |
| Top Northern Side Slope of Phase I - 15 ft waste + 6-inch daily cover | 0.00 | gal/min | 0.00 | gal/min |

Note: Used average depth of waste on side slope

| Assumptions | Area | | Area | |
|---|---|---|---|---|
| Total No. of Acres Landfill Expansion South, Center and and North | 269,135.53 | $ft^2$ | 6.18 | ac |
| Southern Portion of Landfill Bottom = | 70,987.38 | $ft^2$ | 1.63 | ac |
| Center Portion of Landfill Bottom = | 96,629.66 | $ft^2$ | 2.22 | ac |
| Northern Portion of Landfill Bottom = | 101,306.05 | $ft^2$ | 2.33 | ac |
| Total No. of Acres Landfill Expansion Center and North Bottom | 198,049.25 | $ft^2$ | 4.55 | ac |
| Total No. of Acres Phase I Western Side Slope | 189,881.67 | $ft^2$ | 4.36 | ac |
| Entire Southern Side Slope of Phase I | 97,063.58 | $ft^2$ | 2.23 | ac |
| Bottom Southern Side Slope of Phase I = | 34,942.52 | $ft^2$ | 0.80 | ac |
| Top Southern Side Slope of Phase I = | 62,121.06 | $ft^2$ | 1.43 | ac |
| Entire Northern Side Slope of Phase I | 92,818.09 | $ft^2$ | 2.13 | ac |
| Bottom Northern Side Slope of Phase I = | 39,650.12 | $ft^2$ | 0.91 | ac |
| Top Northern Side Slope of Phase I = | 53,167.97 | $ft^2$ | 1.22 | ac |

| | | | | | |
|---|---|---|---|---|---|
| **Scenario 2 =** Cell Bottom South - 10 ft waste + 6-inch daily cover | 1.63 | ac | 10 | ft of waste | Waste |
| Cell Bottom Center - open cell, 0 ft waste | 2.22 | ac | 0 | ft of waste | Open cell, no waste filling |
| Bottom Southern Side Slope of Phase I - with rain tarp | 0.80 | ac | 0 | ft of waste | Rain tarp |
| Top Southern Side Slope of Phase I - with rain tarp | 1.43 | ac | 0 | ft of waste | Rain tarp |
| Cell Bottom North - Rain Tarp | 2.33 | ac | 0 | ft of waste | Rain tarp |
| Bottom Northern Side Slope of Phase I - with rain tarp | 0.91 | ac | 0 | ft of waste | Rain tarp |
| Top Northern Side Slope of Phase I - with rain tarp | 1.22 | ac | 0 | ft of waste | Rain tarp |
| | 10.54 | | | | |

| **Scenario 2 Generation =** | | | | | |
|---|---|---|---|---|---|
| Waste filling in south portion | 0.29 | gal/min | 0.03 | gal/min | leachate, flow to Phase II Section I |
| Rainwater falling on open cell, no waste filling | 0.54 | gal/min | 0.05 | gal/min | stormwater, pumped to swale |
| No Infiltration through bottom southern side slope rain tarp | 0.00 | gal/min | 0.00 | gal/min | stormwater runoff, pumped to swale |
| No Infiltration through top southern side slope rain tarp | 0.00 | gal/min | 0.00 | gal/min | stormwater runoff, pumped to swale |
| No Infiltration through northern cell bottom rain tarp | 0.00 | gal/min | 0.00 | gal/min | stormwater, pumped to swale |
| No Infiltration through bottom northern side slope rain tarp | 0.00 | gal/min | 0.00 | gal/min | stormwater runoff, pumped to swale |
| No Infiltration through top northern side slope rain tarp | 0.00 | gal/min | 0.00 | gal/min | stormwater runoff, pumped to swale |
| PEAK LEACHATE | 0.29 | gal/min | 0.03 | gal/min | AVG LEACHATE |

| | | | |
|---|---|---|---|
| CLIENT<br>Hardee County | PROJECT<br>Phase II Section II Expansion | JOB NO.<br>09199033.23 | |
| SUBJECT<br>Leachate Generation Estimates | | BY<br>SRF | DATE<br>4/1/13 |
| **Collection System Phase II Section II and Phase I Side Slope** | | CHECKED | DATE |

| Summary Collection Per Acre Flow Values | $Q_{PEAK}$ | | $Q_{AVERAGE}$ | |
|---|---|---|---|---|
| **SOUTH PORTION** | | | | |
| Cell Bottom South - open cell, 0 ft waste | 65.52 | gal/min | 1.05 | gal/min |
| Cell Bottom South - 10 ft waste + 6-inch daily cover | 36.60 | gal/min | 0.91 | gal/min |
| Cell Bottom South - 25 ft waste + 6-inch daily cover | 20.37 | gal/min | 0.91 | gal/min |
| Cell Bottom South - 60 ft waste + 6-inch daily cover + 1 ft int cover | 10.00 | gal/min | 0.83 | gal/min |
| **CENTER PORTION** | | | | |
| Cell Bottom Center - open cell, 0 ft waste | 65.52 | gal/min | 1.05 | gal/min |
| Cell Bottom Center - 10 ft waste + 6-inch daily cover | 36.60 | gal/min | 0.91 | gal/min |
| Cell Bottom Center - 25 ft waste + 6-inch daily cover | 20.37 | gal/min | 0.91 | gal/min |
| Cell Bottom Center - 60 ft waste + 6-inch daily cover + 1 ft int cover | 10.00 | gal/min | 0.83 | gal/min |
| **NORTH PORTION** | | | | |
| Cell Bottom North - Rain Tarp | 0.00 | gal/min | 0.00 | gal/min |
| Cell Bottom North - open cell, 0 ft waste | 65.54 | gal/min | 1.05 | gal/min |
| Cell Bottom North - 10 ft waste + 6-inch daily cover | 36.61 | gal/min | 0.91 | gal/min |
| Cell Bottom North - 25 ft waste + 6-inch daily cover | 20.44 | gal/min | 0.91 | gal/min |
| Cell Bottom North - 60 ft waste + 6-inch daily cover + 1 ft int cover | 10.00 | gal/min | 0.83 | gal/min |
| **PHASE I WEST SIDE SLOPE** | | | | |
| Bottom Southern Side Slope of Phase I - with rain tarp | 0.00 | gal/min | 0.00 | gal/min |
| Bottom Southern Side Slope of Phase I - with sod, 0 ft waste | 49.59 | gal/min | 1.31 | gal/min |
| Bottom Southern Side Slope of Phase I - open cell, no sod, 0 ft waste | 49.88 | gal/min | 1.39 | gal/min |
| Bottom Southern Side Slope of Phase I - 10 ft waste + 6-inch daily cover | 36.80 | gal/min | 1.07 | gal/min |
| Bottom Southern Side Slope of Phase I - 25 ft waste + 6-inch daily cover | 20.16 | gal/min | 1.11 | gal/min |
| Top Southern Side Slope of Phase I - with rain tarp | 0.00 | gal/min | 0.00 | gal/min |
| Top Southern Side Slope of Phase I - with sod, 0 ft waste | 49.32 | gal/min | 1.31 | gal/min |
| Top Southern Side Slope of Phase I - 25 ft waste + 6-inch daily cover | 20.12 | gal/min | 1.07 | gal/min |
| Bottom Northern Side Slope of Phase I - with rain tarp | 0.00 | gal/min | 0.00 | gal/min |
| Bottom Northern Side Slope of Phase I - with sod, 0 ft waste | 49.59 | gal/min | 1.31 | gal/min |
| Bottom Northern Side Slope of Phase I - open cell, no sod, 0 ft waste | 49.88 | gal/min | 1.39 | gal/min |
| Bottom Northern Side Slope of Phase I - 10 ft waste + 6-inch daily cover | 36.80 | gal/min | 1.07 | gal/min |
| Bottom Northern Side Slope of Phase I - 25 ft waste + 6-inch daily cover | 20.16 | gal/min | 1.11 | gal/min |
| Top Northern Side Slope of Phase I - with rain tarp | 0.00 | gal/min | 0.00 | gal/min |
| Top Northern Side Slope of Phase I - with sod, 0 ft waste | 49.32 | gal/min | 1.31 | gal/min |
| Top Northern Side Slope of Phase I - 15 ft waste + 6-inch daily cover | 27.60 | gal/min | 1.07 | gal/min |

Note: Used average depth of waste on side slope

| Assumptions | Area | | Area | |
|---|---|---|---|---|
| Total No. of Acres Landfill Expansion South, Center and and North | 269,135.53 | $ft^2$ | 6.18 | ac |
| Southern Portion of Landfill Bottom = | 70,987.38 | $ft^2$ | 1.63 | ac |
| Center Portion of Landfill Bottom = | 96,629.66 | $ft^2$ | 2.22 | ac |
| Northern Portion of Landfill Bottom = | 101,306.05 | $ft^2$ | 2.33 | ac |
| Total No. of Acres Landfill Expansion Center and North Bottom | 198,049.25 | $ft^2$ | 4.55 | ac |
| Total No. of Acres Phase I Western Side Slope | 189,881.67 | $ft^2$ | 4.36 | ac |
| Entire Southern Side Slope of Phase I | 97,063.58 | $ft^2$ | 2.23 | ac |
| Bottom Southern Side Slope of Phase I = | 34,942.52 | $ft^2$ | 0.80 | ac |
| Top Southern Side Slope of Phase I = | 62,121.06 | $ft^2$ | 1.43 | ac |
| Entire Northern Side Slope of Phase I | 92,818.09 | $ft^2$ | 2.13 | ac |
| Bottom Northern Side Slope of Phase I = | 39,650.12 | $ft^2$ | 0.91 | ac |
| Top Northern Side Slope of Phase I = | 53,167.97 | $ft^2$ | 1.22 | ac |

| | | | | | |
|---|---|---|---|---|---|
| **Scenario 3 =** Cell Bottom South - 25 ft waste + 6-inch daily cover | 1.63 | ac | 25 | ft of waste | Waste |
| Cell Bottom Center - open cell, 0 ft waste | 2.22 | ac | 0 | ft of waste | Open cell, no waste filling |
| Bottom Southern Side Slope of Phase I - with rain tarp | 0.80 | ac | 0 | ft of waste | Rain tarp |
| Top Southern Side Slope of Phase I - with rain tarp | 1.43 | ac | 0 | ft of waste | Rain tarp |
| Cell Bottom North - Rain Tarp | 2.33 | ac | 0 | ft of waste | Rain tarp |
| Bottom Northern Side Slope of Phase I - with rain tarp | 0.91 | ac | 0 | ft of waste | Rain tarp |
| Top Northern Side Slope of Phase I - with rain tarp | 1.22 | ac | 0 | ft of waste | Rain tarp |
| | 10.54 | | | | |

| **Scenario 3 Generation =** | | | | | | |
|---|---|---|---|---|---|---|
| | Waste filling in south portion | 33.20 | gal/min | 1.48 | gal/min | leachate, flow to Phase II Section I |
| | Rainwater falling on open cell, no waste filling | 145.45 | gal/min | 2.34 | gal/min | stormwater, pumped to swale |
| | No Infiltration through bottom southern side slope rain tarp | 0.00 | gal/min | 0.00 | gal/min | stormwater runoff, pumped to swale |
| | No Infiltration through top southern side slope rain tarp | 0.00 | gal/min | 0.00 | gal/min | stormwater runoff, pumped to swale |
| | No Infiltration through northern cell bottom rain tarp | 0.00 | gal/min | 0.00 | gal/min | stormwater, pumped to swale |
| | No Infiltration through bottom northern side slope rain tarp | 0.00 | gal/min | 0.00 | gal/min | stormwater runoff, pumped to swale |
| | No Infiltration through top northern side slope rain tarp | 0.00 | gal/min | 0.00 | gal/min | stormwater runoff, pumped to swale |
| | PEAK LEACHATE | 33.20 | gal/min | 1.48 | gal/min | AVG LEACHATE |

| CLIENT | PROJECT | JOB NO. | |
|---|---|---|---|
| Hardee County | Phase II Section II Expansion | 09199033.23 | |
| SUBJECT | | BY | DATE |
| Leachate Generation Estimates | | SRF | 4/1/13 |
| **Detection System Phase II Section II** | | CHECKED | DATE |

Summary Collection Per Acre Flow Values

| | $Q_{PEAK}$ | | $Q_{AVERAGE}$ | |
|---|---|---|---|---|
| **SOUTH PORTION** | | | | |
| Cell Bottom South - open cell, 0 ft waste | 0.24 | gal/min | 0.02 | gal/min |
| Cell Bottom South - 10 ft waste + 6-inch daily cover | 0.18 | gal/min | 0.02 | gal/min |
| Cell Bottom South - 25 ft waste + 6-inch daily cover | 0.17 | gal/min | 0.03 | gal/min |
| Cell Bottom South - 60 ft waste + 6-inch daily cover + 1 ft int cover | 0.14 | gal/min | 0.03 | gal/min |
| **CENTER PORTION** | | | | |
| Cell Bottom Center - open cell, 0 ft waste | 0.24 | gal/min | 0.02 | gal/min |
| Cell Bottom Center - 10 ft waste + 6-inch daily cover | 0.18 | gal/min | 0.02 | gal/min |
| Cell Bottom Center - 25 ft waste + 6-inch daily cover | 0.17 | gal/min | 0.03 | gal/min |
| Cell Bottom Center - 60 ft waste + 6-inch daily cover + 1 ft int cover | 0.14 | gal/min | 0.03 | gal/min |
| **NORTH PORTION** | | | | |
| Cell Bottom North - Rain Tarp | 0.00 | gal/min | 0.00 | gal/min |
| Cell Bottom North - open cell, 0 ft waste | 0.24 | gal/min | 0.02 | gal/min |
| Cell Bottom North - 10 ft waste + 6-inch daily cover | 0.18 | gal/min | 0.02 | gal/min |
| Cell Bottom North - 25 ft waste + 6-inch daily cover | 0.17 | gal/min | 0.03 | gal/min |
| Cell Bottom North - 60 ft waste + 6-inch daily cover + 1 ft int cover | 0.14 | gal/min | 0.03 | gal/min |
| **PHASE I WEST SIDE SLOPE** | | | | |
| Bottom Southern Side Slope of Phase I - with rain tarp | 0.00 | gal/min | 0.00 | gal/min |
| Bottom Southern Side Slope of Phase I - with sod, 0 ft waste | 0.00 | gal/min | 0.00 | gal/min |
| Bottom Southern Side Slope of Phase I - open cell, no sod, 0 ft waste | 0.00 | gal/min | 0.00 | gal/min |
| Bottom Southern Side Slope of Phase I - 10 ft waste + 6-inch daily cover | 0.00 | gal/min | 0.00 | gal/min |
| Bottom Southern Side Slope of Phase I - 25 ft waste + 6-inch daily cover | 0.00 | gal/min | 0.00 | gal/min |
| Top Southern Side Slope of Phase I - with rain tarp | 0.00 | gal/min | 0.00 | gal/min |
| Top Southern Side Slope of Phase I - with sod, 0 ft waste | 0.00 | gal/min | 0.00 | gal/min |
| Top Southern Side Slope of Phase I - 25 ft waste + 6-inch daily cover | 0.00 | gal/min | 0.00 | gal/min |
| Bottom Northern Side Slope of Phase I - with rain tarp | 0.00 | gal/min | 0.00 | gal/min |
| Bottom Northern Side Slope of Phase I - with sod, 0 ft waste | 0.00 | gal/min | 0.00 | gal/min |
| Bottom Northern Side Slope of Phase I - open cell, no sod, 0 ft waste | 0.00 | gal/min | 0.00 | gal/min |
| Bottom Northern Side Slope of Phase I - 10 ft waste + 6-inch daily cover | 0.00 | gal/min | 0.00 | gal/min |
| Bottom Northern Side Slope of Phase I - 25 ft waste + 6-inch daily cover | 0.00 | gal/min | 0.00 | gal/min |
| Top Northern Side Slope of Phase I - with rain tarp | 0.00 | gal/min | 0.00 | gal/min |
| Top Northern Side Slope of Phase I - with sod, 0 ft waste | 0.00 | gal/min | 0.00 | gal/min |
| Top Northern Side Slope of Phase I - 15 ft waste + 6-inch daily cover | 0.00 | gal/min | 0.00 | gal/min |

Note: Used average depth of waste on side slope

Assumptions

| | Area | | Area | |
|---|---|---|---|---|
| Total No. of Acres Landfill Expansion South, Center and and North | 269,135.53 | $ft^2$ | 6.18 | ac |
| Southern Portion of Landfill Bottom = | 70,987.38 | $ft^2$ | 1.63 | ac |
| Center Portion of Landfill Bottom = | 96,629.66 | $ft^2$ | 2.22 | ac |
| Northern Portion of Landfill Bottom = | 101,306.05 | $ft^2$ | 2.33 | ac |
| Total No. of Acres Landfill Expansion Center and North Bottom | 198,049.25 | $ft^2$ | 4.55 | ac |
| Total No. of Acres Phase I Western Side Slope | 189,881.67 | $ft^2$ | 4.36 | ac |
| Entire Southern Side Slope of Phase I | 97,063.58 | $ft^2$ | 2.23 | ac |
| Bottom Southern Side Slope of Phase I = | 34,942.52 | $ft^2$ | 0.80 | ac |
| Top Southern Side Slope of Phase I = | 62,121.06 | $ft^2$ | 1.43 | ac |
| Entire Northern Side Slope of Phase I | 92,818.09 | $ft^2$ | 2.13 | ac |
| Bottom Northern Side Slope of Phase I = | 39,650.12 | $ft^2$ | 0.91 | ac |
| Top Northern Side Slope of Phase I = | 53,167.97 | $ft^2$ | 1.22 | ac |

| | | | | | |
|---|---|---|---|---|---|
| Scenario 3 = Cell Bottom South - 25 ft waste + 6-inch daily cover | 1.63 | ac | 25 | ft of waste | Waste |
| Cell Bottom Center - open cell, 0 ft waste | 2.22 | ac | 0 | ft of waste | Open cell, no waste filling |
| Bottom Southern Side Slope of Phase I - with rain tarp | 0.80 | ac | 0 | ft of waste | Rain tarp |
| Top Southern Side Slope of Phase I - with rain tarp | 1.43 | ac | 0 | ft of waste | Rain tarp |
| Cell Bottom North - Rain Tarp | 2.33 | ac | 0 | ft of waste | Rain tarp |
| Bottom Northern Side Slope of Phase I - with rain tarp | 0.91 | ac | 0 | ft of waste | Rain tarp |
| Top Northern Side Slope of Phase I - with rain tarp | 1.22 | ac | 0 | ft of waste | Rain tarp |
| | 10.54 | | | | |

| Scenario 3 Generation = | | | | | |
|---|---|---|---|---|---|
| Waste filling in south portion | 0.28 | gal/min | 0.04 | gal/min | leachate, flow to Phase II Section I |
| Rainwater falling on open cell, no waste filling | 0.54 | gal/min | 0.05 | gal/min | stormwater, pumped to swale |
| No Infiltration through bottom southern side slope rain tarp | 0.00 | gal/min | 0.00 | gal/min | stormwater runoff, pumped to swale |
| No Infiltration through top southern side slope rain tarp | 0.00 | gal/min | 0.00 | gal/min | stormwater runoff, pumped to swale |
| No Infiltration through northern cell bottom rain tarp | 0.00 | gal/min | 0.00 | gal/min | stormwater, pumped to swale |
| No Infiltration through bottom northern side slope rain tarp | 0.00 | gal/min | 0.00 | gal/min | stormwater runoff, pumped to swale |
| No Infiltration through top northern side slope rain tarp | 0.00 | gal/min | 0.00 | gal/min | stormwater runoff, pumped to swale |
| PEAK LEACHATE | 0.28 | gal/min | 0.04 | gal/min | AVG LEACHATE |

| CLIENT | PROJECT | JOB NO. | |
|---|---|---|---|
| Hardee County | Phase II Section II Expansion | 09199033.23 | |
| SUBJECT | | BY | DATE |
| Leachate Generation Estimates | | SRF | 4/1/13 |
| **Collection System Phase II Section II and Phase I Side Slope** | | CHECKED | DATE |

| Summary Collection Per Acre Flow Values | $Q_{PEAK}$ | | $Q_{AVERAGE}$ | |
|---|---|---|---|---|
| **SOUTH PORTION** | | | | |
| Cell Bottom South - open cell, 0 ft waste | 65.52 | gal/min | 1.05 | gal/min |
| Cell Bottom South - 10 ft waste + 6-inch daily cover | 36.60 | gal/min | 0.91 | gal/min |
| Cell Bottom South - 25 ft waste + 6-inch daily cover | 20.37 | gal/min | 0.91 | gal/min |
| Cell Bottom South - 60 ft waste + 6-inch daily cover + 1 ft int cover | 10.00 | gal/min | 0.83 | gal/min |
| **CENTER PORTION** | | | | |
| Cell Bottom Center - open cell, 0 ft waste | 65.52 | gal/min | 1.05 | gal/min |
| Cell Bottom Center - 10 ft waste + 6-inch daily cover | 36.60 | gal/min | 0.91 | gal/min |
| Cell Bottom Center - 25 ft waste + 6-inch daily cover | 20.37 | gal/min | 0.91 | gal/min |
| Cell Bottom Center - 60 ft waste + 6-inch daily cover + 1 ft int cover | 10.00 | gal/min | 0.83 | gal/min |
| **NORTH PORTION** | | | | |
| Cell Bottom North - Rain Tarp | 0.00 | gal/min | 0.00 | gal/min |
| Cell Bottom North - open cell, 0 ft waste | 65.54 | gal/min | 1.05 | gal/min |
| Cell Bottom North - 10 ft waste + 6-inch daily cover | 36.61 | gal/min | 0.91 | gal/min |
| Cell Bottom North - 25 ft waste + 6-inch daily cover | 20.44 | gal/min | 0.91 | gal/min |
| Cell Bottom North - 60 ft waste + 6-inch daily cover + 1 ft int cover | 10.00 | gal/min | 0.83 | gal/min |
| **PHASE I WEST SIDE SLOPE** | | | | |
| Bottom Southern Side Slope of Phase I - with rain tarp | 0.00 | gal/min | 0.00 | gal/min |
| Bottom Southern Side Slope of Phase I - with sod, 0 ft waste | 49.59 | gal/min | 1.31 | gal/min |
| Bottom Southern Side Slope of Phase I - open cell, no sod, 0 ft waste | 49.88 | gal/min | 1.39 | gal/min |
| Bottom Southern Side Slope of Phase I - 10 ft waste + 6-inch daily cover | 36.80 | gal/min | 1.07 | gal/min |
| Bottom Southern Side Slope of Phase I - 25 ft waste + 6-inch daily cover | 20.16 | gal/min | 1.11 | gal/min |
| Top Southern Side Slope of Phase I - with rain tarp | 0.00 | gal/min | 0.00 | gal/min |
| Top Southern Side Slope of Phase I - with sod, 0 ft waste | 49.32 | gal/min | 1.31 | gal/min |
| Top Southern Side Slope of Phase I - 25 ft waste + 6-inch daily cover | 20.12 | gal/min | 1.07 | gal/min |
| Bottom Northern Side Slope of Phase I - with rain tarp | 0.00 | gal/min | 0.00 | gal/min |
| Bottom Northern Side Slope of Phase I - with sod, 0 ft waste | 49.59 | gal/min | 1.31 | gal/min |
| Bottom Northern Side Slope of Phase I - open cell, no sod, 0 ft waste | 49.88 | gal/min | 1.39 | gal/min |
| Bottom Northern Side Slope of Phase I - 10 ft waste + 6-inch daily cover | 36.80 | gal/min | 1.07 | gal/min |
| Bottom Northern Side Slope of Phase I - 25 ft waste + 6-inch daily cover | 20.16 | gal/min | 1.11 | gal/min |
| Top Northern Side Slope of Phase I - with rain tarp | 0.00 | gal/min | 0.00 | gal/min |
| Top Northern Side Slope of Phase I - with sod, 0 ft waste | 49.32 | gal/min | 1.31 | gal/min |
| Top Northern Side Slope of Phase I - 15 ft waste + 6-inch daily cover | 27.60 | gal/min | 1.07 | gal/min |
| Note: Used average depth of waste on side slope | | | | |

| Assumptions | Area | | Area | |
|---|---|---|---|---|
| Total No. of Acres Landfill Expansion South, Center and and North | 269,135.53 | $ft^2$ | 6.18 | ac |
| Southern Portion of Landfill Bottom = | 70,987.38 | $ft^2$ | 1.63 | ac |
| Center Portion of Landfill Bottom = | 96,629.66 | $ft^2$ | 2.22 | ac |
| Northern Portion of Landfill Bottom = | 101,306.05 | $ft^2$ | 2.33 | ac |
| Total No. of Acres Landfill Expansion Center and North Bottom | 198,049.25 | $ft^2$ | 4.55 | ac |
| Total No. of Acres Phase I Western Side Slope | 189,881.67 | $ft^2$ | 4.36 | ac |
| Entire Southern Side Slope of Phase I | 97,063.58 | $ft^2$ | 2.23 | ac |
| Bottom Southern Side Slope of Phase I = | 34,942.52 | $ft^2$ | 0.80 | ac |
| Top Southern Side Slope of Phase I = | 62,121.06 | $ft^2$ | 1.43 | ac |
| Entire Northern Side Slope of Phase I | 92,818.09 | $ft^2$ | 2.13 | ac |
| Bottom Northern Side Slope of Phase I = | 39,650.12 | $ft^2$ | 0.91 | ac |
| Top Northern Side Slope of Phase I = | 53,167.97 | $ft^2$ | 1.22 | ac |

| | | | | | |
|---|---|---|---|---|---|
| **Scenario 4 =** Cell Bottom Center - open cell, 0 ft waste | 2.22 | ac | 0 | ft of waste | Open cell, start waste filling |
| Bottom Southern Side Slope of Phase I - open cell, no sod, 0 ft waste | 0.18 | ac | 0 | ft of waste | Open cell Sideslope berm to |
| Bottom Southern Side Slope of Phase I - with rain tarp | 0.62 | ac | 0 | ft of waste | Rain tarp divert runoff from cell |
| Top Southern Side Slope of Phase I - with rain tarp | 1.43 | ac | 0 | ft of waste | Rain tarp |
| Cell Bottom North - Rain Tarp | 2.33 | ac | 0 | ft of waste | Rain tarp |
| Bottom Northern Side Slope of Phase I - with rain tarp | 0.91 | ac | 0 | ft of waste | Rain tarp |
| Top Northern Side Slope of Phase I - with rain tarp | 1.22 | ac | 0 | ft of waste | Rain tarp |
| Cell Bottom South - 25 ft waste + 6-inch daily cover | 1.63 | ac | 25 | ft of waste | Waste |
| | 10.54 | | | | |

| **Scenario 4 Generation =** | | | | | |
|---|---|---|---|---|---|
| Waste filling just started in center portion | 145.45 | gal/min | 2.34 | gal/min | leachate, pumped to sideslope risers |
| Infiltration into Phase I sideslope, into geocomposite, flow to sump | 8.89 | gal/min | 0.25 | gal/min | leachate, pumped to sideslope risers |
| No Infiltration through remainder of bottom southern side slope with rain tarp | 0.00 | gal/min | 0.00 | gal/min | stormwater runoff, pumped to swale |
| No Infiltration through top southern side slope rain tarp | 0.00 | gal/min | 0.00 | gal/min | stormwater runoff, pumped to swale |
| No Infiltration through northern cell bottom rain tarp | 0.00 | gal/min | 0.00 | gal/min | stormwater, pumped to swale |
| No Infiltration through bottom northern side slope rain tarp | 0.00 | gal/min | 0.00 | gal/min | stormwater, pumped to swale |
| No Infiltration through top northern side slope rain tarp | 0.00 | gal/min | 0.00 | gal/min | stormwater, pumped to swale |
| Waste filling in south portion | 33.20 | gal/min | 1.48 | gal/min | leachate, flow to Phase II Section I |
| PEAK LEACHATE | 187.54 | gal/min | 4.07 | gal/min | AVG LEACHATE |

| CLIENT | PROJECT | JOB NO. | |
|---|---|---|---|
| Hardee County | Phase II Section II Expansion | 09199033.23 | |
| SUBJECT | | BY | DATE |
| Leachate Generation Estimates | | SRF | 4/1/13 |
| **Detection System Phase II Section II** | | CHECKED | DATE |

| Summary Collection Per Acre Flow Values | $Q_{PEAK}$ | | $Q_{AVERAGE}$ | |
|---|---|---|---|---|
| **SOUTH PORTION** | | | | |
| Cell Bottom South - open cell, 0 ft waste | 0.24 | gal/min | 0.02 | gal/min |
| Cell Bottom South - 10 ft waste + 6-inch daily cover | 0.18 | gal/min | 0.02 | gal/min |
| Cell Bottom South - 25 ft waste + 6-inch daily cover | 0.17 | gal/min | 0.03 | gal/min |
| Cell Bottom South - 60 ft waste + 6-inch daily cover + 1 ft int cover | 0.14 | gal/min | 0.03 | gal/min |
| **CENTER PORTION** | | | | |
| Cell Bottom Center - open cell, 0 ft waste | 0.24 | gal/min | 0.02 | gal/min |
| Cell Bottom Center - 10 ft waste + 6-inch daily cover | 0.18 | gal/min | 0.02 | gal/min |
| Cell Bottom Center - 25 ft waste + 6-inch daily cover | 0.17 | gal/min | 0.03 | gal/min |
| Cell Bottom Center - 60 ft waste + 6-inch daily cover + 1 ft int cover | 0.14 | gal/min | 0.03 | gal/min |
| **NORTH PORTION** | | | | |
| Cell Bottom North - Rain Tarp | 0.00 | gal/min | 0.00 | gal/min |
| Cell Bottom North - open cell, 0 ft waste | 0.24 | gal/min | 0.02 | gal/min |
| Cell Bottom North - 10 ft waste + 6-inch daily cover | 0.18 | gal/min | 0.02 | gal/min |
| Cell Bottom North - 25 ft waste + 6-inch daily cover | 0.17 | gal/min | 0.03 | gal/min |
| Cell Bottom North - 60 ft waste + 6-inch daily cover + 1 ft int cover | 0.14 | gal/min | 0.03 | gal/min |
| **PHASE I WEST SIDE SLOPE** | | | | |
| Bottom Southern Side Slope of Phase I - with rain tarp | 0.00 | gal/min | 0.00 | gal/min |
| Bottom Southern Side Slope of Phase I - with sod, 0 ft waste | 0.00 | gal/min | 0.00 | gal/min |
| Bottom Southern Side Slope of Phase I - open cell, no sod, 0 ft waste | 0.00 | gal/min | 0.00 | gal/min |
| Bottom Southern Side Slope of Phase I - 10 ft waste + 6-inch daily cover | 0.00 | gal/min | 0.00 | gal/min |
| Bottom Southern Side Slope of Phase I - 25 ft waste + 6-inch daily cover | 0.00 | gal/min | 0.00 | gal/min |
| Top Southern Side Slope of Phase I - with rain tarp | 0.00 | gal/min | 0.00 | gal/min |
| Top Southern Side Slope of Phase I - with sod, 0 ft waste | 0.00 | gal/min | 0.00 | gal/min |
| Top Southern Side Slope of Phase I - 25 ft waste + 6-inch daily cover | 0.00 | gal/min | 0.00 | gal/min |
| Bottom Northern Side Slope of Phase I - with rain tarp | 0.00 | gal/min | 0.00 | gal/min |
| Bottom Northern Side Slope of Phase I - with sod, 0 ft waste | 0.00 | gal/min | 0.00 | gal/min |
| Bottom Northern Side Slope of Phase I - open cell, no sod, 0 ft waste | 0.00 | gal/min | 0.00 | gal/min |
| Bottom Northern Side Slope of Phase I - 10 ft waste + 6-inch daily cover | 0.00 | gal/min | 0.00 | gal/min |
| Bottom Northern Side Slope of Phase I - 25 ft waste + 6-inch daily cover | 0.00 | gal/min | 0.00 | gal/min |
| Top Northern Side Slope of Phase I - with rain tarp | 0.00 | gal/min | 0.00 | gal/min |
| Top Northern Side Slope of Phase I - with sod, 0 ft waste | 0.00 | gal/min | 0.00 | gal/min |
| Top Northern Side Slope of Phase I - 15 ft waste + 6-inch daily cover | 0.00 | gal/min | 0.00 | gal/min |

Note: Used average depth of waste on side slope

| Assumptions | Area | | Area | |
|---|---|---|---|---|
| Total No. of Acres Landfill Expansion South, Center and and North | 269,135.53 | $ft^2$ | 6.18 | ac |
| Southern Portion of Landfill Bottom = | 70,987.38 | $ft^2$ | 1.63 | ac |
| Center Portion of Landfill Bottom = | 96,629.66 | $ft^2$ | 2.22 | ac |
| Northern Portion of Landfill Bottom = | 101,306.05 | $ft^2$ | 2.33 | ac |
| Total No. of Acres Landfill Expansion Center and North Bottom | 198,049.25 | $ft^2$ | 4.55 | ac |
| Total No. of Acres Phase I Western Side Slope | 189,881.67 | $ft^2$ | 4.36 | ac |
| Entire Southern Side Slope of Phase I | 97,063.58 | $ft^2$ | 2.23 | ac |
| Bottom Southern Side Slope of Phase I = | 34,942.52 | $ft^2$ | 0.80 | ac |
| Top Southern Side Slope of Phase I = | 62,121.06 | $ft^2$ | 1.43 | ac |
| Entire Northern Side Slope of Phase I | 92,818.09 | $ft^2$ | 2.13 | ac |
| Bottom Northern Side Slope of Phase I = | 39,650.12 | $ft^2$ | 0.91 | ac |
| Top Northern Side Slope of Phase I = | 53,167.97 | $ft^2$ | 1.22 | ac |

| | | | | | |
|---|---|---|---|---|---|
| **Scenario 4 =** Cell Bottom Center - open cell, 0 ft waste | 2.22 | ac | 0 | ft of waste | Open cell, start waste filling |
| Bottom Southern Side Slope of Phase I - open cell, no sod, 0 ft waste | 0.18 | ac | 0 | ft of waste | Open cell Sideslope berm to |
| Bottom Southern Side Slope of Phase I - with rain tarp | 0.62 | ac | 0 | ft of waste | Rain tarp divert runoff from cell |
| Top Southern Side Slope of Phase I - with rain tarp | 1.43 | ac | 0 | ft of waste | Rain tarp |
| Cell Bottom North - Rain Tarp | 2.33 | ac | 0 | ft of waste | Rain tarp |
| Bottom Northern Side Slope of Phase I - with rain tarp | 0.91 | ac | 0 | ft of waste | Rain tarp |
| Top Northern Side Slope of Phase I - with rain tarp | 1.22 | ac | 0 | ft of waste | Rain tarp |
| Cell Bottom South - 25 ft waste + 6-inch daily cover | 1.63 | ac | 25 | ft of waste | Waste |
| | 10.54 | | | | |

| **Scenario 4 Generation =** | | | | | |
|---|---|---|---|---|---|
| Waste filling just started in center portion | 0.54 | gal/min | 0.05 | gal/min | leachate, pumped to sideslope risers |
| Infiltration into Phase I sideslope, into geocomposite, flow to sump | 0.00 | gal/min | 0.00 | gal/min | leachate, pumped to sideslope risers |
| No Infiltration through remainder of bottom southern side slope with rain tarp | 0.00 | gal/min | 0.00 | gal/min | stormwater runoff, pumped to swale |
| No Infiltration through top southern side slope rain tarp | 0.00 | gal/min | 0.00 | gal/min | stormwater runoff, pumped to swale |
| No Infiltration through northern cell bottom rain tarp | 0.00 | gal/min | 0.00 | gal/min | stormwater, pumped to swale |
| No Infiltration through bottom northern side slope rain tarp | 0.00 | gal/min | 0.00 | gal/min | stormwater runoff, pumped to swale |
| No Infiltration through top northern side slope rain tarp | 0.00 | gal/min | 0.00 | gal/min | stormwater runoff, pumped to swale |
| Waste filling in south portion | 0.28 | gal/min | 0.04 | gal/min | leachate, flow to Phase II Section I |
| PEAK LEACHATE | 0.82 | gal/min | 0.09 | gal/min | AVG LEACHATE |

SCS ENGINEERS



| CLIENT | PROJECT | JOB NO. | |
|---|---|---|---|
| Hardee County | Phase II Section II Expansion | 09199033.23 | |
| SUBJECT | | BY | DATE |
| Leachate Generation Estimates | | SRF | 4/1/13 |
| **Collection System Phase II Section II and Phase I Side Slope** | | CHECKED | DATE |

| Summary Collection Per Acre Flow Values | $Q_{PEAK}$ | | $Q_{AVERAGE}$ | |
|---|---|---|---|---|
| **SOUTH PORTION** | | | | |
| Cell Bottom South - open cell, 0 ft waste | 65.52 | gal/min | 1.05 | gal/min |
| Cell Bottom South - 10 ft waste + 6-inch daily cover | 36.60 | gal/min | 0.91 | gal/min |
| Cell Bottom South - 25 ft waste + 6-inch daily cover | 20.37 | gal/min | 0.91 | gal/min |
| Cell Bottom South - 60 ft waste + 6-inch daily cover + 1 ft int cover | 10.00 | gal/min | 0.83 | gal/min |
| **CENTER PORTION** | | | | |
| Cell Bottom Center - open cell, 0 ft waste | 65.52 | gal/min | 1.05 | gal/min |
| Cell Bottom Center - 10 ft waste + 6-inch daily cover | 36.60 | gal/min | 0.91 | gal/min |
| Cell Bottom Center - 25 ft waste + 6-inch daily cover | 20.37 | gal/min | 0.91 | gal/min |
| Cell Bottom Center - 60 ft waste + 6-inch daily cover + 1 ft int cover | 10.00 | gal/min | 0.83 | gal/min |
| **NORTH PORTION** | | | | |
| Cell Bottom North - Rain Tarp | 0.00 | gal/min | 0.00 | gal/min |
| Cell Bottom North - open cell, 0 ft waste | 65.54 | gal/min | 1.05 | gal/min |
| Cell Bottom North - 10 ft waste + 6-inch daily cover | 36.61 | gal/min | 0.91 | gal/min |
| Cell Bottom North - 25 ft waste + 6-inch daily cover | 20.44 | gal/min | 0.91 | gal/min |
| Cell Bottom North - 60 ft waste + 6-inch daily cover + 1 ft int cover | 10.00 | gal/min | 0.83 | gal/min |
| **PHASE I WEST SIDE SLOPE** | | | | |
| Bottom Southern Side Slope of Phase I - with rain tarp | 0.00 | gal/min | 0.00 | gal/min |
| Bottom Southern Side Slope of Phase I - with sod, 0 ft waste | 49.59 | gal/min | 1.31 | gal/min |
| Bottom Southern Side Slope of Phase I - open cell, no sod, 0 ft waste | 49.88 | gal/min | 1.39 | gal/min |
| Bottom Southern Side Slope of Phase I - 10 ft waste + 6-inch daily cover | 36.80 | gal/min | 1.07 | gal/min |
| Bottom Southern Side Slope of Phase I - 25 ft waste + 6-inch daily cover | 20.16 | gal/min | 1.11 | gal/min |
| Top Southern Side Slope of Phase I - with rain tarp | 0.00 | gal/min | 0.00 | gal/min |
| Top Southern Side Slope of Phase I - with sod, 0 ft waste | 49.32 | gal/min | 1.31 | gal/min |
| Top Southern Side Slope of Phase I - 25 ft waste + 6-inch daily cover | 20.12 | gal/min | 1.07 | gal/min |
| Bottom Northern Side Slope of Phase I - with rain tarp | 0.00 | gal/min | 0.00 | gal/min |
| Bottom Northern Side Slope of Phase I - with sod, 0 ft waste | 49.59 | gal/min | 1.31 | gal/min |
| Bottom Northern Side Slope of Phase I - open cell, no sod, 0 ft waste | 49.88 | gal/min | 1.39 | gal/min |
| Bottom Northern Side Slope of Phase I - 10 ft waste + 6-inch daily cover | 36.80 | gal/min | 1.07 | gal/min |
| Bottom Northern Side Slope of Phase I - 25 ft waste + 6-inch daily cover | 20.16 | gal/min | 1.11 | gal/min |
| Top Northern Side Slope of Phase I - with rain tarp | 0.00 | gal/min | 0.00 | gal/min |
| Top Northern Side Slope of Phase I - with sod, 0 ft waste | 49.32 | gal/min | 1.31 | gal/min |
| Top Northern Side Slope of Phase I - 15 ft waste + 6-inch daily cover | 27.60 | gal/min | 1.07 | gal/min |

Note: Used average depth of waste on side slope

| Assumptions | Area | | Area | |
|---|---|---|---|---|
| Total No. of Acres Landfill Expansion South, Center and and North | 269,135.53 | $ft^2$ | 6.18 | ac |
| Southern Portion of Landfill Bottom = | 70,987.38 | $ft^2$ | 1.63 | ac |
| Center Portion of Landfill Bottom = | 96,629.66 | $ft^2$ | 2.22 | ac |
| Northern Portion of Landfill Bottom = | 101,306.05 | $ft^2$ | 2.33 | ac |
| Total No. of Acres Landfill Expansion Center and North Bottom | 198,049.25 | $ft^2$ | 4.55 | ac |
| Total No. of Acres Phase I Western Side Slope | 189,881.67 | $ft^2$ | 4.36 | ac |
| Entire Southern Side Slope of Phase I | 97,063.58 | $ft^2$ | 2.23 | ac |
| Bottom Southern Side Slope of Phase I = | 34,942.52 | $ft^2$ | 0.80 | ac |
| Top Southern Side Slope of Phase I = | 62,121.06 | $ft^2$ | 1.43 | ac |
| Entire Northern Side Slope of Phase I | 92,818.09 | $ft^2$ | 2.13 | ac |
| Bottom Northern Side Slope of Phase I = | 39,650.12 | $ft^2$ | 0.91 | ac |
| Top Northern Side Slope of Phase I = | 53,167.97 | $ft^2$ | 1.22 | ac |

| | | | | | | |
|---|---|---|---|---|---|---|
| **Scenario 5 =** Cell Bottom Center - 10 ft waste + 6-inch daily cover | 2.22 | ac | 10 | ft of waste | Waste | |
| Bottom Southern Side Slope of Phase I - open cell, no sod, 0 ft waste | 0.34 | ac | 0 | ft of waste | Open cell | Sideslope berm to |
| Bottom Southern Side Slope of Phase I - with rain tarp | 0.46 | ac | 0 | ft of waste | Rain tarp | divert runoff from cell |
| Top Southern Side Slope of Phase I - with rain tarp | 1.43 | ac | 0 | ft of waste | Rain tarp | |
| Cell Bottom North - Rain Tarp | 2.33 | ac | 0 | ft of waste | Rain tarp | |
| Bottom Northern Side Slope of Phase I - with rain tarp | 0.91 | ac | 0 | ft of waste | Rain tarp | |
| Top Northern Side Slope of Phase I - with rain tarp | 1.22 | ac | 0 | ft of waste | Rain tarp | |
| Cell Bottom South - 25 ft waste + 6-inch daily cover | 1.63 | ac | 25 | ft of waste | Waste | |
| | 10.54 | | | | | |

| | | | | | |
|---|---|---|---|---|---|
| **Scenario 5 Generation =** Waste filling in center portion | 81.26 | gal/min | 2.01 | gal/min | leachate, pumped to sideslope risers |
| Infiltration into Phase I sideslope, into geocomposite, flow to sump | 17.03 | gal/min | 0.47 | gal/min | leachate, pumped to sideslope risers |
| No Infiltration through remainder of bottom southern side slope with rain tarp | 0.00 | gal/min | 0.00 | gal/min | stormwater runoff, pumped to swale |
| No Infiltration through top southern side slope rain tarp | 0.00 | gal/min | 0.00 | gal/min | stormwater runoff, pumped to swale |
| No Infiltration through northern cell bottom rain tarp | 0.00 | gal/min | 0.00 | gal/min | stormwater, pumped to swale |
| No Infiltration through bottom northern side slope rain tarp | 0.00 | gal/min | 0.00 | gal/min | stormwater runoff, pumped to swale |
| No Infiltration through top northern side slope rain tarp | 0.00 | gal/min | 0.00 | gal/min | stormwater runoff, pumped to swale |
| Waste filling in south portion | 33.20 | gal/min | 1.48 | gal/min | leachate, flow to Phase II Section I |
| PEAK LEACHATE | 131.49 | gal/min | 3.96 | gal/min | AVG LEACHATE |

SCS ENGINEERS

SHEET 25 OF 40

| CLIENT | PROJECT | JOB NO. | |
|---|---|---|---|
| Hardee County | Phase II Section II Expansion | 09199033.23 | |
| SUBJECT | | BY | DATE |
| Leachate Generation Estimates | | SRF | 4/1/13 |
| **Detection System Phase II Section II** | | CHECKED | DATE |

Summary Collection Per Acre Flow Values

| | $Q_{PEAK}$ | | $Q_{AVERAGE}$ | |
|---|---|---|---|---|
| **SOUTH PORTION** | | | | |
| Cell Bottom South - open cell, 0 ft waste | 0.24 | gal/min | 0.02 | gal/min |
| Cell Bottom South - 10 ft waste + 6-inch daily cover | 0.18 | gal/min | 0.02 | gal/min |
| Cell Bottom South - 25 ft waste + 6-inch daily cover | 0.17 | gal/min | 0.03 | gal/min |
| Cell Bottom South - 60 ft waste + 6-inch daily cover + 1 ft int cover | 0.14 | gal/min | 0.03 | gal/min |
| **CENTER PORTION** | | | | |
| Cell Bottom Center - open cell, 0 ft waste | 0.24 | gal/min | 0.02 | gal/min |
| Cell Bottom Center - 10 ft waste + 6-inch daily cover | 0.18 | gal/min | 0.02 | gal/min |
| Cell Bottom Center - 25 ft waste + 6-inch daily cover | 0.17 | gal/min | 0.03 | gal/min |
| Cell Bottom Center - 60 ft waste + 6-inch daily cover + 1 ft int cover | 0.14 | gal/min | 0.03 | gal/min |
| **NORTH PORTION** | | | | |
| Cell Bottom North - Rain Tarp | 0.00 | gal/min | 0.00 | gal/min |
| Cell Bottom North - open cell, 0 ft waste | 0.24 | gal/min | 0.02 | gal/min |
| Cell Bottom North - 10 ft waste + 6-inch daily cover | 0.18 | gal/min | 0.02 | gal/min |
| Cell Bottom North - 25 ft waste + 6-inch daily cover | 0.17 | gal/min | 0.03 | gal/min |
| Cell Bottom North - 60 ft waste + 6-inch daily cover + 1 ft int cover | 0.14 | gal/min | 0.03 | gal/min |
| **PHASE I WEST SIDE SLOPE** | | | | |
| Bottom Southern Side Slope of Phase I - with rain tarp | 0.00 | gal/min | 0.00 | gal/min |
| Bottom Southern Side Slope of Phase I - with sod, 0 ft waste | 0.00 | gal/min | 0.00 | gal/min |
| Bottom Southern Side Slope of Phase I - open cell, no sod, 0 ft waste | 0.00 | gal/min | 0.00 | gal/min |
| Bottom Southern Side Slope of Phase I - 10 ft waste + 6-inch daily cover | 0.00 | gal/min | 0.00 | gal/min |
| Bottom Southern Side Slope of Phase I - 25 ft waste + 6-inch daily cover | 0.00 | gal/min | 0.00 | gal/min |
| Top Southern Side Slope of Phase I - with rain tarp | 0.00 | gal/min | 0.00 | gal/min |
| Top Southern Side Slope of Phase I - with sod, 0 ft waste | 0.00 | gal/min | 0.00 | gal/min |
| Top Southern Side Slope of Phase I - 25 ft waste + 6-inch daily cover | 0.00 | gal/min | 0.00 | gal/min |
| Bottom Northern Side Slope of Phase I - with rain tarp | 0.00 | gal/min | 0.00 | gal/min |
| Bottom Northern Side Slope of Phase I - with sod, 0 ft waste | 0.00 | gal/min | 0.00 | gal/min |
| Bottom Northern Side Slope of Phase I - open cell, no sod, 0 ft waste | 0.00 | gal/min | 0.00 | gal/min |
| Bottom Northern Side Slope of Phase I - 10 ft waste + 6-inch daily cover | 0.00 | gal/min | 0.00 | gal/min |
| Bottom Northern Side Slope of Phase I - 25 ft waste + 6-inch daily cover | 0.00 | gal/min | 0.00 | gal/min |
| Top Northern Side Slope of Phase I - with rain tarp | 0.00 | gal/min | 0.00 | gal/min |
| Top Northern Side Slope of Phase I - with sod, 0 ft waste | 0.00 | gal/min | 0.00 | gal/min |
| Top Northern Side Slope of Phase I - 15 ft waste + 6-inch daily cover | 0.00 | gal/min | 0.00 | gal/min |

Note: Used average depth of waste on side slope

| Assumptions | Area | | Area | |
|---|---|---|---|---|
| Total No. of Acres Landfill Expansion South, Center and and North | 269,135.53 | $ft^2$ | 6.18 | ac |
| Southern Portion of Landfill Bottom = | 70,987.38 | $ft^2$ | 1.63 | ac |
| Center Portion of Landfill Bottom = | 96,629.66 | $ft^2$ | 2.22 | ac |
| Northern Portion of Landfill Bottom = | 101,306.05 | $ft^2$ | 2.33 | ac |
| Total No. of Acres Landfill Expansion Center and North Bottom | 198,049.25 | $ft^2$ | 4.55 | ac |
| Total No. of Acres Phase I Western Side Slope | 189,881.67 | $ft^2$ | 4.36 | ac |
| Entire Southern Side Slope of Phase I | 97,063.58 | $ft^2$ | 2.23 | ac |
| Bottom Southern Side Slope of Phase I = | 34,942.52 | $ft^2$ | 0.80 | ac |
| Top Southern Side Slope of Phase I = | 62,121.06 | $ft^2$ | 1.43 | ac |
| Entire Northern Side Slope of Phase I | 92,818.09 | $ft^2$ | 2.13 | ac |
| Bottom Northern Side Slope of Phase I = | 39,650.12 | $ft^2$ | 0.91 | ac |
| Top Northern Side Slope of Phase I = | 53,167.97 | $ft^2$ | 1.22 | ac |

| | | | | | | |
|---|---|---|---|---|---|---|
| Scenario 5 = Cell Bottom Center - 10 ft waste + 6-inch daily cover | 2.22 | ac | 10 | ft of waste | Waste | |
| Bottom Southern Side Slope of Phase I - open cell, no sod, 0 ft waste | 0.34 | ac | 0 | ft of waste | Open cell | Sideslope berm to |
| Bottom Southern Side Slope of Phase I - with rain tarp | 0.46 | ac | 0 | ft of waste | Rain tarp | divert runoff from cell |
| Top Southern Side Slope of Phase I - with rain tarp | 1.43 | ac | 0 | ft of waste | Rain tarp | |
| Cell Bottom North - Rain Tarp | 2.33 | ac | 0 | ft of waste | Rain tarp | |
| Bottom Northern Side Slope of Phase I - with rain tarp | 0.91 | ac | 0 | ft of waste | Rain tarp | |
| Top Northern Side Slope of Phase I - with rain tarp | 1.22 | ac | 0 | ft of waste | Rain tarp | |
| Cell Bottom South - 25 ft waste + 6-inch daily cover | 1.63 | ac | 25 | ft of waste | Waste | |
| | 10.54 | | | | | |

| Scenario 5 Generation = | | | | | |
|---|---|---|---|---|---|
| Waste filling in center portion | 0.40 | gal/min | 0.05 | gal/min | leachate, pumped to sideslope risers |
| Infiltration into Phase I sideslope, into geocomposite, flow to sump | 0.00 | gal/min | 0.00 | gal/min | leachate, pumped to sideslope risers |
| No Infiltration through remainder of bottom southern side slope with rain tarp | 0.00 | gal/min | 0.00 | gal/min | stormwater runoff, pumped to swale |
| No Infiltration through top southern side slope rain tarp | 0.00 | gal/min | 0.00 | gal/min | stormwater runoff, pumped to swale |
| No Infiltration through northern cell bottom rain tarp | 0.00 | gal/min | 0.00 | gal/min | stormwater, pumped to swale |
| No Infiltration through bottom northern side slope rain tarp | 0.00 | gal/min | 0.00 | gal/min | stormwater runoff, pumped to swale |
| No Infiltration through top northern side slope rain tarp | 0.00 | gal/min | 0.00 | gal/min | stormwater runoff, pumped to swale |
| Waste filling in south portion | 0.28 | gal/min | 0.04 | gal/min | leachate, flow to Phase II Section I |
| PEAK LEACHATE | 0.68 | gal/min | 0.09 | gal/min | AVG LEACHATE |

| CLIENT | PROJECT | JOB NO. | |
|---|---|---|---|
| Hardee County | Phase II Section II Expansion | 09199033.23 | |
| SUBJECT | | BY | DATE |
| Leachate Generation Estimates | | SRF | 4/1/13 |
| **Collection System Phase II Section II and Phase I Side Slope** | | CHECKED | DATE |

| Summary Collection Per Acre Flow Values | $Q_{PEAK}$ | | $Q_{AVERAGE}$ | |
|---|---|---|---|---|
| **SOUTH PORTION** | | | | |
| Cell Bottom South - open cell, 0 ft waste | 65.52 | gal/min | 1.05 | gal/min |
| Cell Bottom South - 10 ft waste + 6-inch daily cover | 36.60 | gal/min | 0.91 | gal/min |
| Cell Bottom South - 25 ft waste + 6-inch daily cover | 20.37 | gal/min | 0.91 | gal/min |
| Cell Bottom South - 60 ft waste + 6-inch daily cover + 1 ft int cover | 10.00 | gal/min | 0.83 | gal/min |
| **CENTER PORTION** | | | | |
| Cell Bottom Center - open cell, 0 ft waste | 65.52 | gal/min | 1.05 | gal/min |
| Cell Bottom Center - 10 ft waste + 6-inch daily cover | 36.60 | gal/min | 0.91 | gal/min |
| Cell Bottom Center - 25 ft waste + 6-inch daily cover | 20.37 | gal/min | 0.91 | gal/min |
| Cell Bottom Center - 60 ft waste + 6-inch daily cover + 1 ft int cover | 10.00 | gal/min | 0.83 | gal/min |
| **NORTH PORTION** | | | | |
| Cell Bottom North - Rain Tarp | 0.00 | gal/min | 0.00 | gal/min |
| Cell Bottom North - open cell, 0 ft waste | 65.54 | gal/min | 1.05 | gal/min |
| Cell Bottom North - 10 ft waste + 6-inch daily cover | 36.61 | gal/min | 0.91 | gal/min |
| Cell Bottom North - 25 ft waste + 6-inch daily cover | 20.44 | gal/min | 0.91 | gal/min |
| Cell Bottom North - 60 ft waste + 6-inch daily cover + 1 ft int cover | 10.00 | gal/min | 0.83 | gal/min |
| **PHASE I WEST SIDE SLOPE** | | | | |
| Bottom Southern Side Slope of Phase I - with rain tarp | 0.00 | gal/min | 0.00 | gal/min |
| Bottom Southern Side Slope of Phase I - with sod, 0 ft waste | 49.59 | gal/min | 1.31 | gal/min |
| Bottom Southern Side Slope of Phase I - open cell, no sod, 0 ft waste | 49.88 | gal/min | 1.39 | gal/min |
| Bottom Southern Side Slope of Phase I - 10 ft waste + 6-inch daily cover | 36.80 | gal/min | 1.07 | gal/min |
| Bottom Southern Side Slope of Phase I - 25 ft waste + 6-inch daily cover | 20.16 | gal/min | 1.11 | gal/min |
| Top Southern Side Slope of Phase I - with rain tarp | 0.00 | gal/min | 0.00 | gal/min |
| Top Southern Side Slope of Phase I - with sod, 0 ft waste | 49.32 | gal/min | 1.31 | gal/min |
| Top Southern Side Slope of Phase I - 25 ft waste + 6-inch daily cover | 20.12 | gal/min | 1.07 | gal/min |
| Bottom Northern Side Slope of Phase I - with rain tarp | 0.00 | gal/min | 0.00 | gal/min |
| Bottom Northern Side Slope of Phase I - with sod, 0 ft waste | 49.59 | gal/min | 1.31 | gal/min |
| Bottom Northern Side Slope of Phase I - open cell, no sod, 0 ft waste | 49.88 | gal/min | 1.39 | gal/min |
| Bottom Northern Side Slope of Phase I - 10 ft waste + 6-inch daily cover | 36.80 | gal/min | 1.07 | gal/min |
| Bottom Northern Side Slope of Phase I - 25 ft waste + 6-inch daily cover | 20.16 | gal/min | 1.11 | gal/min |
| Top Northern Side Slope of Phase I - with rain tarp | 0.00 | gal/min | 0.00 | gal/min |
| Top Northern Side Slope of Phase I - with sod, 0 ft waste | 49.32 | gal/min | 1.31 | gal/min |
| Top Northern Side Slope of Phase I - 15 ft waste + 6-inch daily cover | 27.60 | gal/min | 1.07 | gal/min |

Note: Used average depth of waste on side slope

| Assumptions | Area | | Area | |
|---|---|---|---|---|
| Total No. of Acres Landfill Expansion South, Center and and North | 269,135.53 | $ft^2$ | 6.18 | ac |
| Southern Portion of Landfill Bottom = | 70,987.38 | $ft^2$ | 1.63 | ac |
| Center Portion of Landfill Bottom = | 96,629.66 | $ft^2$ | 2.22 | ac |
| Northern Portion of Landfill Bottom = | 101,306.05 | $ft^2$ | 2.33 | ac |
| Total No. of Acres Landfill Expansion Center and North Bottom | 198,049.25 | $ft^2$ | 4.55 | ac |
| Total No. of Acres Phase I Western Side Slope | 189,881.67 | $ft^2$ | 4.36 | ac |
| Entire Southern Side Slope of Phase I | 97,063.58 | $ft^2$ | 2.23 | ac |
| Bottom Southern Side Slope of Phase I = | 34,942.52 | $ft^2$ | 0.80 | ac |
| Top Southern Side Slope of Phase I = | 62,121.06 | $ft^2$ | 1.43 | ac |
| Entire Northern Side Slope of Phase I | 92,818.09 | $ft^2$ | 2.13 | ac |
| Bottom Northern Side Slope of Phase I = | 39,650.12 | $ft^2$ | 0.91 | ac |
| Top Northern Side Slope of Phase I = | 53,167.97 | $ft^2$ | 1.22 | ac |

| | | | | | | |
|---|---|---|---|---|---|---|
| **Scenario 6 =** Cell Bottom Center - 25 ft waste + 6-inch daily cover | 2.22 | ac | 25 | ft of waste | Waste | |
| Bottom Southern Side Slope of Phase I - 10 ft waste + 6-inch daily cover | 0.56 | ac | 10 | ft of waste | Waste | Sideslope berm to |
| Bottom Southern Side Slope of Phase I - with rain tarp | 0.24 | ac | 0 | ft of waste | Rain tarp | divert runoff from cell |
| Top Southern Side Slope of Phase I - with rain tarp | 1.43 | ac | 0 | ft of waste | Rain tarp | |
| Cell Bottom North - Rain Tarp | 2.33 | ac | 0 | ft of waste | Rain tarp | |
| Bottom Northern Side Slope of Phase I - with rain tarp | 0.91 | ac | 0 | ft of waste | Rain tarp | |
| Top Northern Side Slope of Phase I - with rain tarp | 1.22 | ac | 0 | ft of waste | Rain tarp | |
| Cell Bottom South - 25 ft waste + 6-inch daily cover | 1.63 | ac | 25 | ft of waste | Waste | |
| | 10.54 | | | | | |

| **Scenario 6 Generation =** | | | | | |
|---|---|---|---|---|---|
| Waste filling in center portion | 45.22 | gal/min | 2.01 | gal/min | leachate, pumped to sideslope risers |
| Waste filling against Phase I sideslope (portion of the sideslope) | 20.76 | gal/min | 0.61 | gal/min | leachate, pumped to sideslope risers |
| No Infiltration through remainder of bottom southern side slope with rain tarp | 0.00 | gal/min | 0.00 | gal/min | stormwater runoff, pumped to swale |
| No Infiltration through top southern side slope rain tarp | 0.00 | gal/min | 0.00 | gal/min | stormwater runoff, pumped to swale |
| No Infiltration through northern cell bottom rain tarp | 0.00 | gal/min | 0.00 | gal/min | stormwater, pumped to swale |
| No Infiltration through bottom northern side slope rain tarp | 0.00 | gal/min | 0.00 | gal/min | stormwater runoff, pumped to swale |
| No Infiltration through top northern side slope rain tarp | 0.00 | gal/min | 0.00 | gal/min | stormwater runoff, pumped to swale |
| Waste filling in south portion | 33.20 | gal/min | 1.48 | gal/min | leachate, flow to Phase II Section I |
| PEAK LEACHATE | 99.19 | gal/min | 4.09 | gal/min | AVG LEACHATE |

| CLIENT | PROJECT | JOB NO. | |
|---|---|---|---|
| Hardee County | Phase II Section II Expansion | 09199033.23 | |
| SUBJECT | | BY | DATE |
| Leachate Generation Estimates | | SRF | 4/1/13 |
| **Detection System Phase II Section II** | | CHECKED | DATE |

Summary Collection Per Acre Flow Values

| | $Q_{PEAK}$ | | $Q_{AVERAGE}$ | |
|---|---|---|---|---|
| **SOUTH PORTION** | | | | |
| Cell Bottom South - open cell, 0 ft waste | 0.24 | gal/min | 0.02 | gal/min |
| Cell Bottom South - 10 ft waste + 6-inch daily cover | 0.18 | gal/min | 0.02 | gal/min |
| Cell Bottom South - 25 ft waste + 6-inch daily cover | 0.17 | gal/min | 0.03 | gal/min |
| Cell Bottom South - 60 ft waste + 6-inch daily cover + 1 ft int cover | 0.14 | gal/min | 0.03 | gal/min |
| **CENTER PORTION** | | | | |
| Cell Bottom Center - open cell, 0 ft waste | 0.24 | gal/min | 0.02 | gal/min |
| Cell Bottom Center - 10 ft waste + 6-inch daily cover | 0.18 | gal/min | 0.02 | gal/min |
| Cell Bottom Center - 25 ft waste + 6-inch daily cover | 0.17 | gal/min | 0.03 | gal/min |
| Cell Bottom Center - 60 ft waste + 6-inch daily cover + 1 ft int cover | 0.14 | gal/min | 0.03 | gal/min |
| **NORTH PORTION** | | | | |
| Cell Bottom North - Rain Tarp | 0.00 | gal/min | 0.00 | gal/min |
| Cell Bottom North - open cell, 0 ft waste | 0.24 | gal/min | 0.02 | gal/min |
| Cell Bottom North - 10 ft waste + 6-inch daily cover | 0.18 | gal/min | 0.02 | gal/min |
| Cell Bottom North - 25 ft waste + 6-inch daily cover | 0.17 | gal/min | 0.03 | gal/min |
| Cell Bottom North - 60 ft waste + 6-inch daily cover + 1 ft int cover | 0.14 | gal/min | 0.03 | gal/min |
| **PHASE I WEST SIDE SLOPE** | | | | |
| Bottom Southern Side Slope of Phase I - with rain tarp | 0.00 | gal/min | 0.00 | gal/min |
| Bottom Southern Side Slope of Phase I - with sod, 0 ft waste | 0.00 | gal/min | 0.00 | gal/min |
| Bottom Southern Side Slope of Phase I - open cell, no sod, 0 ft waste | 0.00 | gal/min | 0.00 | gal/min |
| Bottom Southern Side Slope of Phase I - 10 ft waste + 6-inch daily cover | 0.00 | gal/min | 0.00 | gal/min |
| Bottom Southern Side Slope of Phase I - 25 ft waste + 6-inch daily cover | 0.00 | gal/min | 0.00 | gal/min |
| Top Southern Side Slope of Phase I - with rain tarp | 0.00 | gal/min | 0.00 | gal/min |
| Top Southern Side Slope of Phase I - with sod, 0 ft waste | 0.00 | gal/min | 0.00 | gal/min |
| Top Southern Side Slope of Phase I - 25 ft waste + 6-inch daily cover | 0.00 | gal/min | 0.00 | gal/min |
| Bottom Northern Side Slope of Phase I - with rain tarp | 0.00 | gal/min | 0.00 | gal/min |
| Bottom Northern Side Slope of Phase I - with sod, 0 ft waste | 0.00 | gal/min | 0.00 | gal/min |
| Bottom Northern Side Slope of Phase I - open cell, no sod, 0 ft waste | 0.00 | gal/min | 0.00 | gal/min |
| Bottom Northern Side Slope of Phase I - 10 ft waste + 6-inch daily cover | 0.00 | gal/min | 0.00 | gal/min |
| Bottom Northern Side Slope of Phase I - 25 ft waste + 6-inch daily cover | 0.00 | gal/min | 0.00 | gal/min |
| Top Northern Side Slope of Phase I - with rain tarp | 0.00 | gal/min | 0.00 | gal/min |
| Top Northern Side Slope of Phase I - with sod, 0 ft waste | 0.00 | gal/min | 0.00 | gal/min |
| Top Northern Side Slope of Phase I - 15 ft waste + 6-inch daily cover | 0.00 | gal/min | 0.00 | gal/min |

Note: Used average depth of waste on side slope

Assumptions

| | Area | | Area | |
|---|---|---|---|---|
| Total No. of Acres Landfill Expansion South, Center and and North | 269,135.53 | $ft^2$ | 6.18 | ac |
| Southern Portion of Landfill Bottom = | 70,987.38 | $ft^2$ | 1.63 | ac |
| Center Portion of Landfill Bottom = | 96,629.66 | $ft^2$ | 2.22 | ac |
| Northern Portion of Landfill Bottom = | 101,306.05 | $ft^2$ | 2.33 | ac |
| Total No. of Acres Landfill Expansion Center and North Bottom | 198,049.25 | $ft^2$ | 4.55 | ac |
| Total No. of Acres Phase I Western Side Slope | 189,881.67 | $ft^2$ | 4.36 | ac |
| Entire Southern Side Slope of Phase I | 97,063.58 | $ft^2$ | 2.23 | ac |
| Bottom Southern Side Slope of Phase I = | 34,942.52 | $ft^2$ | 0.80 | ac |
| Top Southern Side Slope of Phase I = | 62,121.06 | $ft^2$ | 1.43 | ac |
| Entire Northern Side Slope of Phase I | 92,818.09 | $ft^2$ | 2.13 | ac |
| Bottom Northern Side Slope of Phase I = | 39,650.12 | $ft^2$ | 0.91 | ac |
| Top Northern Side Slope of Phase I = | 53,167.97 | $ft^2$ | 1.22 | ac |

| | | | | | | |
|---|---|---|---|---|---|---|
| **Scenario 6 =** Cell Bottom Center - 25 ft waste + 6-inch daily cover | 2.22 | ac | 25 | ft of waste | Waste | |
| Bottom Southern Side Slope of Phase I - 10 ft waste + 6-inch daily cover | 0.56 | ac | 10 | ft of waste | Waste | Sideslope berm to |
| Bottom Southern Side Slope of Phase I - with rain tarp | 0.24 | ac | 0 | ft of waste | Rain tarp | divert runoff from cell |
| Top Southern Side Slope of Phase I - with rain tarp | 1.43 | ac | 0 | ft of waste | Rain tarp | |
| Cell Bottom North - Rain Tarp | 2.33 | ac | 0 | ft of waste | Rain tarp | |
| Bottom Northern Side Slope of Phase I - with rain tarp | 0.91 | ac | 0 | ft of waste | Rain tarp | |
| Top Northern Side Slope of Phase I - with rain tarp | 1.22 | ac | 0 | ft of waste | Rain tarp | |
| Cell Bottom South - 25 ft waste + 6-inch daily cover | 1.63 | ac | 25 | ft of waste | Waste | |
| | 10.54 | | | | | |

| **Scenario 6 Generation =** | | | | | |
|---|---|---|---|---|---|
| Waste filling in center portion | 0.38 | gal/min | 0.06 | gal/min | leachate, pumped to sideslope risers |
| Waste filling against Phase I sideslope (portion of the sideslope) | 0.00 | gal/min | 0.00 | gal/min | leachate, pumped to sideslope risers |
| No Infiltration through remainder of bottom southern side slope with rain tarp | 0.00 | gal/min | 0.00 | gal/min | stormwater runoff, pumped to swale |
| No Infiltration through top southern side slope rain tarp | 0.00 | gal/min | 0.00 | gal/min | stormwater runoff, pumped to swale |
| No Infiltration through northern cell bottom rain tarp | 0.00 | gal/min | 0.00 | gal/min | stormwater, pumped to swale |
| No Infiltration through bottom northern side slope rain tarp | 0.00 | gal/min | 0.00 | gal/min | stormwater runoff, pumped to swale |
| No Infiltration through top northern side slope rain tarp | 0.00 | gal/min | 0.00 | gal/min | stormwater runoff, pumped to swale |
| Waste filling in south portion | 0.28 | gal/min | 0.04 | gal/min | leachate, flow to Phase II Section I |
| PEAK LEACHATE | 0.67 | gal/min | 0.10 | gal/min | AVG LEACHATE |

SCS ENGINEERS



| CLIENT | PROJECT | JOB NO. | |
|---|---|---|---|
| Hardee County | Phase II Section II Expansion | 09199033.23 | |
| SUBJECT | | BY | DATE |
| Leachate Generation Estimates | | SRF | 4/1/13 |
| **Collection System Phase II Section II and Phase I Side Slope** | | CHECKED | DATE |

Summary Collection Per Acre Flow Values

| | $Q_{PEAK}$ | | $Q_{AVERAGE}$ | |
|---|---|---|---|---|
| **SOUTH PORTION** | | | | |
| Cell Bottom South - open cell, 0 ft waste | 65.52 | gal/min | 1.05 | gal/min |
| Cell Bottom South - 10 ft waste + 6-inch daily cover | 36.60 | gal/min | 0.91 | gal/min |
| Cell Bottom South - 25 ft waste + 6-inch daily cover | 20.37 | gal/min | 0.91 | gal/min |
| Cell Bottom South - 60 ft waste + 6-inch daily cover + 1 ft int cover | 10.00 | gal/min | 0.83 | gal/min |
| **CENTER PORTION** | | | | |
| Cell Bottom Center - open cell, 0 ft waste | 65.52 | gal/min | 1.05 | gal/min |
| Cell Bottom Center - 10 ft waste + 6-inch daily cover | 36.60 | gal/min | 0.91 | gal/min |
| Cell Bottom Center - 25 ft waste + 6-inch daily cover | 20.37 | gal/min | 0.91 | gal/min |
| Cell Bottom Center - 60 ft waste + 6-inch daily cover + 1 ft int cover | 10.00 | gal/min | 0.83 | gal/min |
| **NORTH PORTION** | | | | |
| Cell Bottom North - Rain Tarp | 0.00 | gal/min | 0.00 | gal/min |
| Cell Bottom North - open cell, 0 ft waste | 65.54 | gal/min | 1.05 | gal/min |
| Cell Bottom North - 10 ft waste + 6-inch daily cover | 36.61 | gal/min | 0.91 | gal/min |
| Cell Bottom North - 25 ft waste + 6-inch daily cover | 20.44 | gal/min | 0.91 | gal/min |
| Cell Bottom North - 60 ft waste + 6-inch daily cover + 1 ft int cover | 10.00 | gal/min | 0.83 | gal/min |
| **PHASE I WEST SIDE SLOPE** | | | | |
| Bottom Southern Side Slope of Phase I - with rain tarp | 0.00 | gal/min | 0.00 | gal/min |
| Bottom Southern Side Slope of Phase I - with sod, 0 ft waste | 49.59 | gal/min | 1.31 | gal/min |
| Bottom Southern Side Slope of Phase I - open cell, no sod, 0 ft waste | 49.88 | gal/min | 1.39 | gal/min |
| Bottom Southern Side Slope of Phase I - 10 ft waste + 6-inch daily cover | 36.80 | gal/min | 1.07 | gal/min |
| Bottom Southern Side Slope of Phase I - 25 ft waste + 6-inch daily cover | 20.16 | gal/min | 1.11 | gal/min |
| Top Southern Side Slope of Phase I - with rain tarp | 0.00 | gal/min | 0.00 | gal/min |
| Top Southern Side Slope of Phase I - with sod, 0 ft waste | 49.32 | gal/min | 1.31 | gal/min |
| Top Southern Side Slope of Phase I - 25 ft waste + 6-inch daily cover | 20.12 | gal/min | 1.07 | gal/min |
| Bottom Northern Side Slope of Phase I - with rain tarp | 0.00 | gal/min | 0.00 | gal/min |
| Bottom Northern Side Slope of Phase I - with sod, 0 ft waste | 49.59 | gal/min | 1.31 | gal/min |
| Bottom Northern Side Slope of Phase I - open cell, no sod, 0 ft waste | 49.88 | gal/min | 1.39 | gal/min |
| Bottom Northern Side Slope of Phase I - 10 ft waste + 6-inch daily cover | 36.80 | gal/min | 1.07 | gal/min |
| Bottom Northern Side Slope of Phase I - 25 ft waste + 6-inch daily cover | 20.16 | gal/min | 1.11 | gal/min |
| Top Northern Side Slope of Phase I - with rain tarp | 0.00 | gal/min | 0.00 | gal/min |
| Top Northern Side Slope of Phase I - with sod, 0 ft waste | 49.32 | gal/min | 1.31 | gal/min |
| Top Northern Side Slope of Phase I - 15 ft waste + 6-inch daily cover | 27.60 | gal/min | 1.07 | gal/min |

Note: Used average depth of waste on side slope

| Assumptions | Area | | Area | |
|---|---|---|---|---|
| Total No. of Acres Landfill Expansion South, Center and and North | 269,135.53 | $ft^2$ | 6.18 | ac |
| Southern Portion of Landfill Bottom = | 70,987.38 | $ft^2$ | 1.63 | ac |
| Center Portion of Landfill Bottom = | 96,629.66 | $ft^2$ | 2.22 | ac |
| Northern Portion of Landfill Bottom = | 101,306.05 | $ft^2$ | 2.33 | ac |
| Total No. of Acres Landfill Expansion Center and North Bottom | 198,049.25 | $ft^2$ | 4.55 | ac |
| Total No. of Acres Phase I Western Side Slope | 189,881.67 | $ft^2$ | 4.36 | ac |
| Entire Southern Side Slope of Phase I | 97,063.58 | $ft^2$ | 2.23 | ac |
| Bottom Southern Side Slope of Phase I = | 34,942.52 | $ft^2$ | 0.80 | ac |
| Top Southern Side Slope of Phase I = | 62,121.06 | $ft^2$ | 1.43 | ac |
| Entire Northern Side Slope of Phase I | 92,818.09 | $ft^2$ | 2.13 | ac |
| Bottom Northern Side Slope of Phase I = | 39,650.12 | $ft^2$ | 0.91 | ac |
| Top Northern Side Slope of Phase I = | 53,167.97 | $ft^2$ | 1.22 | ac |

| | | | | | | |
|---|---|---|---|---|---|---|
| Scenario 7 = Cell Bottom Center - 60 ft waste + 6-inch daily cover + 1 ft int cover | 2.22 | ac | 60 | ft of waste | Waste | |
| Bottom Southern Side Slope of Phase I - 25 ft waste + 6-inch daily cover | 0.59 | ac | 25 | ft of waste | Waste | Sideslope berm to |
| Bottom Southern Side Slope of Phase I - with rain tarp | 0.21 | ac | 0 | ft of waste | Rain tarp | divert runoff from cell |
| Top Southern Side Slope of Phase I - 25 ft waste + 6-inch daily cover | 0.33 | ac | 25 | ft of waste | Waste | |
| Top Southern Side Slope of Phase I - with rain tarp | 1.10 | ac | 0 | ft of waste | Rain tarp | |
| Cell Bottom North - Rain Tarp | 2.33 | ac | 0 | ft of waste | Rain tarp | |
| Bottom Northern Side Slope of Phase I - with rain tarp | 0.91 | ac | 0 | ft of waste | Rain tarp | |
| Top Northern Side Slope of Phase I - with rain tarp | 1.22 | ac | 0 | ft of waste | Rain tarp | |
| Cell Bottom South - 60 ft waste + 6-inch daily cover + 1 ft int cover | 1.63 | ac | 60 | ft of waste | Waste | |
| | 10.54 | | | | | |

| Scenario 7 Generation = | | | | | |
|---|---|---|---|---|---|
| Waste filling in center portion | 22.20 | gal/min | 1.84 | gal/min | leachate, pumped to sideslope risers |
| Waste filling against Phase I sideslope (portion of the sideslope) | 11.89 | gal/min | 0.66 | gal/min | leachate, pumped to sideslope risers |
| No Infiltration through remainder of bottom southern side slope with rain tarp | 0.00 | gal/min | 0.00 | gal/min | stormwater runoff, pumped to swale |
| Waste filling against Phase I sideslope (portion of the sideslope) | 6.64 | gal/min | 0.35 | gal/min | leachate, pumped to sideslope risers |
| No Infiltration through top southern side slope rain tarp | 0.00 | gal/min | 0.00 | gal/min | stormwater runoff, pumped to swale |
| No Infiltration through northern cell bottom rain tarp | 0.00 | gal/min | 0.00 | gal/min | stormwater, pumped to swale |
| No Infiltration through bottom northern side slope rain tarp | 0.00 | gal/min | 0.00 | gal/min | stormwater runoff, pumped to swale |
| No Infiltration through top northern side slope rain tarp | 0.00 | gal/min | 0.00 | gal/min | stormwater runoff, pumped to swale |
| Waste filling in south portion | 16.30 | gal/min | 1.35 | gal/min | leachate, flow to Phase II Section I |
| PEAK LEACHATE | 57.03 | gal/min | 4.20 | gal/min | AVG LEACHATE |

SCS ENGINEERS



| CLIENT | PROJECT | JOB NO. | |
|---|---|---|---|
| Hardee County | Phase II Section II Expansion | 09199033.23 | |
| SUBJECT | | BY | DATE |
| Leachate Generation Estimates | | SRF | 4/1/13 |
| **Detection System Phase II Section II** | | CHECKED | DATE |

Summary Collection Per Acre Flow Values

| | $Q_{PEAK}$ | | $Q_{AVERAGE}$ | |
|---|---|---|---|---|
| **SOUTH PORTION** | | | | |
| Cell Bottom South - open cell, 0 ft waste | 0.24 | gal/min | 0.02 | gal/min |
| Cell Bottom South - 10 ft waste + 6-inch daily cover | 0.18 | gal/min | 0.02 | gal/min |
| Cell Bottom South - 25 ft waste + 6-inch daily cover | 0.17 | gal/min | 0.03 | gal/min |
| Cell Bottom South - 60 ft waste + 6-inch daily cover + 1 ft int cover | 0.14 | gal/min | 0.03 | gal/min |
| **CENTER PORTION** | | | | |
| Cell Bottom Center - open cell, 0 ft waste | 0.24 | gal/min | 0.02 | gal/min |
| Cell Bottom Center - 10 ft waste + 6-inch daily cover | 0.18 | gal/min | 0.02 | gal/min |
| Cell Bottom Center - 25 ft waste + 6-inch daily cover | 0.17 | gal/min | 0.03 | gal/min |
| Cell Bottom Center - 60 ft waste + 6-inch daily cover + 1 ft int cover | 0.14 | gal/min | 0.03 | gal/min |
| **NORTH PORTION** | | | | |
| Cell Bottom North - Rain Tarp | 0.00 | gal/min | 0.00 | gal/min |
| Cell Bottom North - open cell, 0 ft waste | 0.24 | gal/min | 0.02 | gal/min |
| Cell Bottom North - 10 ft waste + 6-inch daily cover | 0.18 | gal/min | 0.02 | gal/min |
| Cell Bottom North - 25 ft waste + 6-inch daily cover | 0.17 | gal/min | 0.03 | gal/min |
| Cell Bottom North - 60 ft waste + 6-inch daily cover + 1 ft int cover | 0.14 | gal/min | 0.03 | gal/min |
| **PHASE I WEST SIDE SLOPE** | | | | |
| Bottom Southern Side Slope of Phase I - with rain tarp | 0.00 | gal/min | 0.00 | gal/min |
| Bottom Southern Side Slope of Phase I - with sod, 0 ft waste | 0.00 | gal/min | 0.00 | gal/min |
| Bottom Southern Side Slope of Phase I - open cell, no sod, 0 ft waste | 0.00 | gal/min | 0.00 | gal/min |
| Bottom Southern Side Slope of Phase I - 10 ft waste + 6-inch daily cover | 0.00 | gal/min | 0.00 | gal/min |
| Bottom Southern Side Slope of Phase I - 25 ft waste + 6-inch daily cover | 0.00 | gal/min | 0.00 | gal/min |
| Top Southern Side Slope of Phase I - with rain tarp | 0.00 | gal/min | 0.00 | gal/min |
| Top Southern Side Slope of Phase I - with sod, 0 ft waste | 0.00 | gal/min | 0.00 | gal/min |
| Top Southern Side Slope of Phase I - 25 ft waste + 6-inch daily cover | 0.00 | gal/min | 0.00 | gal/min |
| Bottom Northern Side Slope of Phase I - with rain tarp | 0.00 | gal/min | 0.00 | gal/min |
| Bottom Northern Side Slope of Phase I - with sod, 0 ft waste | 0.00 | gal/min | 0.00 | gal/min |
| Bottom Northern Side Slope of Phase I - open cell, no sod, 0 ft waste | 0.00 | gal/min | 0.00 | gal/min |
| Bottom Northern Side Slope of Phase I - 10 ft waste + 6-inch daily cover | 0.00 | gal/min | 0.00 | gal/min |
| Bottom Northern Side Slope of Phase I - 25 ft waste + 6-inch daily cover | 0.00 | gal/min | 0.00 | gal/min |
| Top Northern Side Slope of Phase I - with rain tarp | 0.00 | gal/min | 0.00 | gal/min |
| Top Northern Side Slope of Phase I - with sod, 0 ft waste | 0.00 | gal/min | 0.00 | gal/min |
| Top Northern Side Slope of Phase I - 15 ft waste + 6-inch daily cover | 0.00 | gal/min | 0.00 | gal/min |

Note: Used average depth of waste on side slope

| Assumptions | Area | | Area | |
|---|---|---|---|---|
| Total No. of Acres Landfill Expansion South, Center and and North | 269,135.53 | $ft^2$ | 6.18 | ac |
| Southern Portion of Landfill Bottom = | 70,987.38 | $ft^2$ | 1.63 | ac |
| Center Portion of Landfill Bottom = | 96,629.66 | $ft^2$ | 2.22 | ac |
| Northern Portion of Landfill Bottom = | 101,306.05 | $ft^2$ | 2.33 | ac |
| Total No. of Acres Landfill Expansion Center and North Bottom | 198,049.25 | $ft^2$ | 4.55 | ac |
| Total No. of Acres Phase I Western Side Slope | 189,881.67 | $ft^2$ | 4.36 | ac |
| Entire Southern Side Slope of Phase I | 97,063.58 | $ft^2$ | 2.23 | ac |
| Bottom Southern Side Slope of Phase I = | 34,942.52 | $ft^2$ | 0.80 | ac |
| Top Southern Side Slope of Phase I = | 62,121.06 | $ft^2$ | 1.43 | ac |
| Entire Northern Side Slope of Phase I | 92,818.09 | $ft^2$ | 2.13 | ac |
| Bottom Northern Side Slope of Phase I = | 39,650.12 | $ft^2$ | 0.91 | ac |
| Top Northern Side Slope of Phase I = | 53,167.97 | $ft^2$ | 1.22 | ac |

| | | | | | | |
|---|---|---|---|---|---|---|
| Scenario 7 = Cell Bottom Center - 60 ft waste + 6-inch daily cover + 1 ft int cover | 2.22 | ac | 60 | ft of waste | Waste | |
| Bottom Southern Side Slope of Phase I - 25 ft waste + 6-inch daily cover | 0.59 | ac | 25 | ft of waste | Waste | Sideslope berm to |
| Bottom Southern Side Slope of Phase I - with rain tarp | 0.21 | ac | 0 | ft of waste | Rain tarp | divert runoff from cell |
| Top Southern Side Slope of Phase I - 25 ft waste + 6-inch daily cover | 0.33 | ac | 25 | ft of waste | Waste | |
| Top Southern Side Slope of Phase I - with rain tarp | 1.10 | ac | 0 | ft of waste | Rain tarp | |
| Cell Bottom North - Rain Tarp | 2.33 | ac | 0 | ft of waste | Rain tarp | |
| Bottom Northern Side Slope of Phase I - with rain tarp | 0.91 | ac | 0 | ft of waste | Rain tarp | |
| Top Northern Side Slope of Phase I - with rain tarp | 1.22 | ac | 0 | ft of waste | Rain tarp | |
| Cell Bottom South - 60 ft waste + 6-inch daily cover + 1 ft int cover | 1.63 | ac | 60 | ft of waste | Waste | |
| | 10.54 | | | | | |

| Scenario 7 Generation = | | | | | |
|---|---|---|---|---|---|
| Waste filling in center portion | 0.31 | gal/min | 0.07 | gal/min | leachate, pumped to sideslope risers |
| Waste filling against Phase I sideslope (portion of the sideslope) | 0.00 | gal/min | 0.00 | gal/min | leachate, pumped to sideslope risers |
| No Infiltration through remainder of bottom southern side slope with rain tarp | 0.00 | gal/min | 0.00 | gal/min | stormwater runoff, pumped to swale |
| Waste filling against Phase I sideslope (portion of the sideslope) | 0.00 | gal/min | 0.00 | gal/min | leachate, pumped to sideslope risers |
| No Infiltration through top southern side slope rain tarp | 0.00 | gal/min | 0.00 | gal/min | stormwater runoff, pumped to swale |
| No Infiltration through northern cell bottom rain tarp | 0.00 | gal/min | 0.00 | gal/min | stormwater, pumped to swale |
| No Infiltration through bottom northern side slope rain tarp | 0.00 | gal/min | 0.00 | gal/min | stormwater runoff, pumped to swale |
| No Infiltration through top northern side slope rain tarp | 0.00 | gal/min | 0.00 | gal/min | stormwater runoff, pumped to swale |
| Waste filling in south portion | 0.23 | gal/min | 0.05 | gal/min | leachate, flow to Phase II Section I |
| PEAK LEACHATE | 0.54 | gal/min | 0.12 | gal/min | AVG LEACHATE |

SCS ENGINEERS



| CLIENT | PROJECT | JOB NO. | |
|---|---|---|---|
| Hardee County | Phase II Section II Expansion | 09199033.23 | |
| SUBJECT | | BY | DATE |
| Leachate Generation Estimates | | SRF | 4/1/13 |
| **Collection System Phase II Section II and Phase I Side Slope** | | CHECKED | DATE |

| Summary Collection Per Acre Flow Values | $Q_{PEAK}$ | | $Q_{AVERAGE}$ | |
|---|---|---|---|---|
| **SOUTH PORTION** | | | | |
| Cell Bottom South - open cell, 0 ft waste | 65.52 | gal/min | 1.05 | gal/min |
| Cell Bottom South - 10 ft waste + 6-inch daily cover | 36.60 | gal/min | 0.91 | gal/min |
| Cell Bottom South - 25 ft waste + 6-inch daily cover | 20.37 | gal/min | 0.91 | gal/min |
| Cell Bottom South - 60 ft waste + 6-inch daily cover + 1 ft int cover | 10.00 | gal/min | 0.83 | gal/min |
| **CENTER PORTION** | | | | |
| Cell Bottom Center - open cell, 0 ft waste | 65.52 | gal/min | 1.05 | gal/min |
| Cell Bottom Center - 10 ft waste + 6-inch daily cover | 36.60 | gal/min | 0.91 | gal/min |
| Cell Bottom Center - 25 ft waste + 6-inch daily cover | 20.37 | gal/min | 0.91 | gal/min |
| Cell Bottom Center - 60 ft waste + 6-inch daily cover + 1 ft int cover | 10.00 | gal/min | 0.83 | gal/min |
| **NORTH PORTION** | | | | |
| Cell Bottom North - Rain Tarp | 0.00 | gal/min | 0.00 | gal/min |
| Cell Bottom North - open cell, 0 ft waste | 65.54 | gal/min | 1.05 | gal/min |
| Cell Bottom North - 10 ft waste + 6-inch daily cover | 36.61 | gal/min | 0.91 | gal/min |
| Cell Bottom North - 25 ft waste + 6-inch daily cover | 20.44 | gal/min | 0.91 | gal/min |
| Cell Bottom North - 60 ft waste + 6-inch daily cover + 1 ft int cover | 10.00 | gal/min | 0.83 | gal/min |
| **PHASE I WEST SIDE SLOPE** | | | | |
| Bottom Southern Side Slope of Phase I - with rain tarp | 0.00 | gal/min | 0.00 | gal/min |
| Bottom Southern Side Slope of Phase I - with sod, 0 ft waste | 49.59 | gal/min | 1.31 | gal/min |
| Bottom Southern Side Slope of Phase I - open cell, no sod, 0 ft waste | 49.88 | gal/min | 1.39 | gal/min |
| Bottom Southern Side Slope of Phase I - 10 ft waste + 6-inch daily cover | 36.80 | gal/min | 1.07 | gal/min |
| Bottom Southern Side Slope of Phase I - 25 ft waste + 6-inch daily cover | 20.16 | gal/min | 1.11 | gal/min |
| Top Southern Side Slope of Phase I - with rain tarp | 0.00 | gal/min | 0.00 | gal/min |
| Top Southern Side Slope of Phase I - with sod, 0 ft waste | 49.32 | gal/min | 1.31 | gal/min |
| Top Southern Side Slope of Phase I - 25 ft waste + 6-inch daily cover | 20.12 | gal/min | 1.07 | gal/min |
| Bottom Northern Side Slope of Phase I - with rain tarp | 0.00 | gal/min | 0.00 | gal/min |
| Bottom Northern Side Slope of Phase I - with sod, 0 ft waste | 49.59 | gal/min | 1.31 | gal/min |
| Bottom Northern Side Slope of Phase I - open cell, no sod, 0 ft waste | 49.88 | gal/min | 1.39 | gal/min |
| Bottom Northern Side Slope of Phase I - 10 ft waste + 6-inch daily cover | 36.80 | gal/min | 1.07 | gal/min |
| Bottom Northern Side Slope of Phase I - 25 ft waste + 6-inch daily cover | 20.16 | gal/min | 1.11 | gal/min |
| Top Northern Side Slope of Phase I - with rain tarp | 0.00 | gal/min | 0.00 | gal/min |
| Top Northern Side Slope of Phase I - with sod, 0 ft waste | 49.32 | gal/min | 1.31 | gal/min |
| Top Northern Side Slope of Phase I - 15 ft waste + 6-inch daily cover | 27.60 | gal/min | 1.07 | gal/min |

Note: Used average depth of waste on side slope

| Assumptions | Area | | Area | |
|---|---|---|---|---|
| Total No. of Acres Landfill Expansion South, Center and and North | 269,135.53 | $ft^2$ | 6.18 | ac |
| Southern Portion of Landfill Bottom = | 70,987.38 | $ft^2$ | 1.63 | ac |
| Center Portion of Landfill Bottom = | 96,629.66 | $ft^2$ | 2.22 | ac |
| Northern Portion of Landfill Bottom = | 101,306.05 | $ft^2$ | 2.33 | ac |
| Total No. of Acres Landfill Expansion Center and North Bottom | 198,049.25 | $ft^2$ | 4.55 | ac |
| Total No. of Acres Phase I Western Side Slope | 189,881.67 | $ft^2$ | 4.36 | ac |
| Entire Southern Side Slope of Phase I | 97,063.58 | $ft^2$ | 2.23 | ac |
| Bottom Southern Side Slope of Phase I = | 34,942.52 | $ft^2$ | 0.80 | ac |
| Top Southern Side Slope of Phase I = | 62,121.06 | $ft^2$ | 1.43 | ac |
| Entire Northern Side Slope of Phase I | 92,818.09 | $ft^2$ | 2.13 | ac |
| Bottom Northern Side Slope of Phase I = | 39,650.12 | $ft^2$ | 0.91 | ac |
| Top Northern Side Slope of Phase I = | 53,167.97 | $ft^2$ | 1.22 | ac |

| | | | | | | |
|---|---|---|---|---|---|---|
| **Scenario 8 =** Cell Bottom Center - 60 ft waste + 6-inch daily cover + 1 ft int cover | 2.22 | ac | 60 | ft of waste | Waste | |
| Bottom Southern Side Slope of Phase I - 25 ft waste + 6-inch daily cover | 0.59 | ac | 25 | ft of waste | Waste | Sideslope berm to |
| Bottom Southern Side Slope of Phase I - with rain tarp | 0.21 | ac | 0 | ft of waste | Rain tarp | divert runoff from cell |
| Top Southern Side Slope of Phase I - 25 ft waste + 6-inch daily cover | 0.33 | ac | 25 | ft of waste | Waste | |
| Top Southern Side Slope of Phase I - with rain tarp | 1.10 | ac | 0 | ft of waste | Rain tarp | |
| Cell Bottom North - open cell, 0 ft waste | 2.33 | ac | 0 | ft of waste | Open cell, start waste filling | |
| Bottom Northern Side Slope of Phase I - open cell, no sod, 0 ft waste | 0.19 | ac | 0 | ft of waste | Open cell | Sideslope berm to |
| Bottom Northern Side Slope of Phase I - with rain tarp | 0.72 | ac | 0 | ft of waste | Rain tarp | divert runoff from cell |
| Top Northern Side Slope of Phase I - with rain tarp | 1.22 | ac | 0 | ft of waste | Rain tarp | |
| Cell Bottom South - 60 ft waste + 6-inch daily cover + 1 ft int cover | 1.63 | ac | 60 | ft of waste | Waste | |
| | 10.54 | | | | | |

| **Scenario 8 Generation =** | | | | | |
|---|---|---|---|---|---|
| Waste filling in center portion | 22.20 | gal/min | 1.84 | gal/min | leachate, pumped to sideslope risers |
| Waste filling against Phase I sideslope (portion of the sideslope) | 11.89 | gal/min | 0.66 | gal/min | leachate, pumped to sideslope risers |
| No Infiltration through remainder of bottom southern side slope with rain tarp | 0.00 | gal/min | 0.00 | gal/min | stormwater runoff, pumped to swale |
| Waste filling against Phase I sideslope (portion of the sideslope) | 6.64 | gal/min | 0.35 | gal/min | leachate, pumped to sideslope risers |
| No Infiltration through top southern side slope rain tarp | 0.00 | gal/min | 0.00 | gal/min | stormwater runoff, pumped to swale |
| Waste filling just started in northern portion | 152.72 | gal/min | 2.46 | gal/min | leachate, pumped to sideslope risers |
| Infiltration into Phase I sideslope, into geocomposite, flow to sump | 9.48 | gal/min | 0.26 | gal/min | leachate, pumped to sideslope risers |
| No Infiltration through bottom northern side slope rain tarp | 0.00 | gal/min | 0.00 | gal/min | stormwater runoff, pumped to swale |
| No Infiltration through top northern side slope rain tarp | 0.00 | gal/min | 0.00 | gal/min | stormwater runoff, pumped to swale |
| Waste filling in south portion | 16.30 | gal/min | 1.35 | gal/min | leachate, flow to Phase II Section I |
| PEAK LEACHATE | 219.23 | gal/min | 6.93 | gal/min | AVG LEACHATE |

SCS ENGINEERS



| CLIENT | PROJECT | JOB NO. | |
|---|---|---|---|
| Hardee County | Phase II Section II Expansion | 09199033.23 | |
| SUBJECT | | BY | DATE |
| Leachate Generation Estimates | | SRF | 4/1/13 |
| **Detection System Phase II Section II** | | CHECKED | DATE |

| Summary Collection Per Acre Flow Values | $Q_{PEAK}$ | | $Q_{AVERAGE}$ | |
|---|---|---|---|---|
| **SOUTH PORTION** | | | | |
| Cell Bottom South - open cell, 0 ft waste | 0.24 | gal/min | 0.02 | gal/min |
| Cell Bottom South - 10 ft waste + 6-inch daily cover | 0.18 | gal/min | 0.02 | gal/min |
| Cell Bottom South - 25 ft waste + 6-inch daily cover | 0.17 | gal/min | 0.03 | gal/min |
| Cell Bottom South - 60 ft waste + 6-inch daily cover + 1 ft int cover | 0.14 | gal/min | 0.03 | gal/min |
| **CENTER PORTION** | | | | |
| Cell Bottom Center - open cell, 0 ft waste | 0.24 | gal/min | 0.02 | gal/min |
| Cell Bottom Center - 10 ft waste + 6-inch daily cover | 0.18 | gal/min | 0.02 | gal/min |
| Cell Bottom Center - 25 ft waste + 6-inch daily cover | 0.17 | gal/min | 0.03 | gal/min |
| Cell Bottom Center - 60 ft waste + 6-inch daily cover + 1 ft int cover | 0.14 | gal/min | 0.03 | gal/min |
| **NORTH PORTION** | | | | |
| Cell Bottom North - Rain Tarp | 0.00 | gal/min | 0.00 | gal/min |
| Cell Bottom North - open cell, 0 ft waste | 0.24 | gal/min | 0.02 | gal/min |
| Cell Bottom North - 10 ft waste + 6-inch daily cover | 0.18 | gal/min | 0.02 | gal/min |
| Cell Bottom North - 25 ft waste + 6-inch daily cover | 0.17 | gal/min | 0.03 | gal/min |
| Cell Bottom North - 60 ft waste + 6-inch daily cover + 1 ft int cover | 0.14 | gal/min | 0.03 | gal/min |
| **PHASE I WEST SIDE SLOPE** | | | | |
| Bottom Southern Side Slope of Phase I - with rain tarp | 0.00 | gal/min | 0.00 | gal/min |
| Bottom Southern Side Slope of Phase I - with sod, 0 ft waste | 0.00 | gal/min | 0.00 | gal/min |
| Bottom Southern Side Slope of Phase I - open cell, no sod, 0 ft waste | 0.00 | gal/min | 0.00 | gal/min |
| Bottom Southern Side Slope of Phase I - 10 ft waste + 6-inch daily cover | 0.00 | gal/min | 0.00 | gal/min |
| Bottom Southern Side Slope of Phase I - 25 ft waste + 6-inch daily cover | 0.00 | gal/min | 0.00 | gal/min |
| Top Southern Side Slope of Phase I - with rain tarp | 0.00 | gal/min | 0.00 | gal/min |
| Top Southern Side Slope of Phase I - with sod, 0 ft waste | 0.00 | gal/min | 0.00 | gal/min |
| Top Southern Side Slope of Phase I - 25 ft waste + 6-inch daily cover | 0.00 | gal/min | 0.00 | gal/min |
| Bottom Northern Side Slope of Phase I - with rain tarp | 0.00 | gal/min | 0.00 | gal/min |
| Bottom Northern Side Slope of Phase I - with sod, 0 ft waste | 0.00 | gal/min | 0.00 | gal/min |
| Bottom Northern Side Slope of Phase I - open cell, no sod, 0 ft waste | 0.00 | gal/min | 0.00 | gal/min |
| Bottom Northern Side Slope of Phase I - 10 ft waste + 6-inch daily cover | 0.00 | gal/min | 0.00 | gal/min |
| Bottom Northern Side Slope of Phase I - 25 ft waste + 6-inch daily cover | 0.00 | gal/min | 0.00 | gal/min |
| Top Northern Side Slope of Phase I - with rain tarp | 0.00 | gal/min | 0.00 | gal/min |
| Top Northern Side Slope of Phase I - with sod, 0 ft waste | 0.00 | gal/min | 0.00 | gal/min |
| Top Northern Side Slope of Phase I - 15 ft waste + 6-inch daily cover | 0.00 | gal/min | 0.00 | gal/min |

Note: Used average depth of waste on side slope

| Assumptions | Area | | Area | |
|---|---|---|---|---|
| Total No. of Acres Landfill Expansion South, Center and and North | 269,135.53 | $ft^2$ | 6.18 | ac |
| Southern Portion of Landfill Bottom = | 70,987.38 | $ft^2$ | 1.63 | ac |
| Center Portion of Landfill Bottom = | 96,629.66 | $ft^2$ | 2.22 | ac |
| Northern Portion of Landfill Bottom = | 101,306.05 | $ft^2$ | 2.33 | ac |
| Total No. of Acres Landfill Expansion Center and North Bottom | 198,049.25 | $ft^2$ | 4.55 | ac |
| Total No. of Acres Phase I Western Side Slope | 189,881.67 | $ft^2$ | 4.36 | ac |
| Entire Southern Side Slope of Phase I | 97,063.58 | $ft^2$ | 2.23 | ac |
| Bottom Southern Side Slope of Phase I = | 34,942.52 | $ft^2$ | 0.80 | ac |
| Top Southern Side Slope of Phase I = | 62,121.06 | $ft^2$ | 1.43 | ac |
| Entire Northern Side Slope of Phase I | 92,818.09 | $ft^2$ | 2.13 | ac |
| Bottom Northern Side Slope of Phase I = | 39,650.12 | $ft^2$ | 0.91 | ac |
| Top Northern Side Slope of Phase I = | 53,167.97 | $ft^2$ | 1.22 | ac |

| | | | | | | |
|---|---|---|---|---|---|---|
| **Scenario 8 =** Cell Bottom Center - 60 ft waste + 6-inch daily cover + 1 ft int cover | 2.22 | ac | 60 | ft of waste | Waste | |
| Bottom Southern Side Slope of Phase I - 25 ft waste + 6-inch daily cover | 0.59 | ac | 25 | ft of waste | Waste | Sideslope berm to |
| Bottom Southern Side Slope of Phase I - with rain tarp | 0.21 | ac | 0 | ft of waste | Rain tarp | divert runoff from cell |
| Top Southern Side Slope of Phase I - 25 ft waste + 6-inch daily cover | 0.33 | ac | 25 | ft of waste | Waste | |
| Top Southern Side Slope of Phase I - with rain tarp | 1.10 | ac | 0 | ft of waste | Rain tarp | |
| Cell Bottom North - open cell, 0 ft waste | 2.33 | ac | 0 | ft of waste | Open cell, start waste filling | |
| Bottom Northern Side Slope of Phase I - open cell, no sod, 0 ft waste | 0.19 | ac | 0 | ft of waste | Open cell | Sideslope berm to |
| Bottom Northern Side Slope of Phase I - with rain tarp | 0.72 | ac | 0 | ft of waste | Rain tarp | divert runoff from cell |
| Top Northern Side Slope of Phase I - with rain tarp | 1.22 | ac | 0 | ft of waste | Rain tarp | |
| Cell Bottom South - 60 ft waste + 6-inch daily cover + 1 ft int cover | 1.63 | ac | 60 | ft of waste | Waste | |
| | 10.54 | | | | | |

| **Scenario 8 Generation =** | | | | | |
|---|---|---|---|---|---|
| Waste filling in center portion | 0.31 | gal/min | 0.07 | gal/min | leachate, pumped to sideslope risers |
| Waste filling against Phase I sideslope (portion of the sideslope) | 0.00 | gal/min | 0.00 | gal/min | leachate, pumped to sideslope risers |
| No Infiltration through remainder of bottom southern side slope with rain tarp | 0.00 | gal/min | 0.00 | gal/min | stormwater runoff, pumped to swale |
| Waste filling against Phase I sideslope (portion of the sideslope) | 0.00 | gal/min | 0.00 | gal/min | leachate, pumped to sideslope risers |
| No Infiltration through top southern side slope rain tarp | 0.00 | gal/min | 0.00 | gal/min | stormwater runoff, pumped to swale |
| Waste filling just started in northern portion | 0.57 | gal/min | 0.05 | gal/min | leachate, pumped to sideslope risers |
| Infiltration into Phase I sideslope, into geocomposite, flow to sump | 0.00 | gal/min | 0.00 | gal/min | leachate, pumped to sideslope risers |
| No Infiltration through bottom northern side slope rain tarp | 0.00 | gal/min | 0.00 | gal/min | stormwater runoff, pumped to swale |
| No Infiltration through top northern side slope rain tarp | 0.00 | gal/min | 0.00 | gal/min | stormwater runoff, pumped to swale |
| Waste filling in south portion | 0.23 | gal/min | 0.05 | gal/min | leachate, flow to Phase II Section I |
| PEAK LEACHATE | 1.11 | gal/min | 0.17 | gal/min | AVG LEACHATE |

SCS ENGINEERS

SHEET 32 OF 40

| CLIENT | PROJECT | JOB NO. | |
|---|---|---|---|
| Hardee County | Phase II Section II Expansion | 09199033.23 | |
| SUBJECT | | BY | DATE |
| Leachate Generation Estimates | | SRF | 4/1/13 |
| **Collection System Phase II Section II and Phase I Side Slope** | | CHECKED | DATE |

| Summary Collection Per Acre Flow Values | $Q_{PEAK}$ | | $Q_{AVERAGE}$ | |
|---|---|---|---|---|
| **SOUTH PORTION** | | | | |
| Cell Bottom South - open cell, 0 ft waste | 65.52 | gal/min | 1.05 | gal/min |
| Cell Bottom South - 10 ft waste + 6-inch daily cover | 36.60 | gal/min | 0.91 | gal/min |
| Cell Bottom South - 25 ft waste + 6-inch daily cover | 20.37 | gal/min | 0.91 | gal/min |
| Cell Bottom South - 60 ft waste + 6-inch daily cover + 1 ft int cover | 10.00 | gal/min | 0.83 | gal/min |
| **CENTER PORTION** | | | | |
| Cell Bottom Center - open cell, 0 ft waste | 65.52 | gal/min | 1.05 | gal/min |
| Cell Bottom Center - 10 ft waste + 6-inch daily cover | 36.60 | gal/min | 0.91 | gal/min |
| Cell Bottom Center - 25 ft waste + 6-inch daily cover | 20.37 | gal/min | 0.91 | gal/min |
| Cell Bottom Center - 60 ft waste + 6-inch daily cover + 1 ft int cover | 10.00 | gal/min | 0.83 | gal/min |
| **NORTH PORTION** | | | | |
| Cell Bottom North - Rain Tarp | 0.00 | gal/min | 0.00 | gal/min |
| Cell Bottom North - open cell, 0 ft waste | 65.54 | gal/min | 1.05 | gal/min |
| Cell Bottom North - 10 ft waste + 6-inch daily cover | 36.61 | gal/min | 0.91 | gal/min |
| Cell Bottom North - 25 ft waste + 6-inch daily cover | 20.44 | gal/min | 0.91 | gal/min |
| Cell Bottom North - 60 ft waste + 6-inch daily cover + 1 ft int cover | 10.00 | gal/min | 0.83 | gal/min |
| **PHASE I WEST SIDE SLOPE** | | | | |
| Bottom Southern Side Slope of Phase I - with rain tarp | 0.00 | gal/min | 0.00 | gal/min |
| Bottom Southern Side Slope of Phase I - with sod, 0 ft waste | 49.59 | gal/min | 1.31 | gal/min |
| Bottom Southern Side Slope of Phase I - open cell, no sod, 0 ft waste | 49.88 | gal/min | 1.39 | gal/min |
| Bottom Southern Side Slope of Phase I - 10 ft waste + 6-inch daily cover | 36.80 | gal/min | 1.07 | gal/min |
| Bottom Southern Side Slope of Phase I - 25 ft waste + 6-inch daily cover | 20.16 | gal/min | 1.11 | gal/min |
| Top Southern Side Slope of Phase I - with rain tarp | 0.00 | gal/min | 0.00 | gal/min |
| Top Southern Side Slope of Phase I - with sod, 0 ft waste | 49.32 | gal/min | 1.31 | gal/min |
| Top Southern Side Slope of Phase I - 25 ft waste + 6-inch daily cover | 20.12 | gal/min | 1.07 | gal/min |
| Bottom Northern Side Slope of Phase I - with rain tarp | 0.00 | gal/min | 0.00 | gal/min |
| Bottom Northern Side Slope of Phase I - with sod, 0 ft waste | 49.59 | gal/min | 1.31 | gal/min |
| Bottom Northern Side Slope of Phase I - open cell, no sod, 0 ft waste | 49.88 | gal/min | 1.39 | gal/min |
| Bottom Northern Side Slope of Phase I - 10 ft waste + 6-inch daily cover | 36.80 | gal/min | 1.07 | gal/min |
| Bottom Northern Side Slope of Phase I - 25 ft waste + 6-inch daily cover | 20.16 | gal/min | 1.11 | gal/min |
| Top Northern Side Slope of Phase I - with rain tarp | 0.00 | gal/min | 0.00 | gal/min |
| Top Northern Side Slope of Phase I - with sod, 0 ft waste | 49.32 | gal/min | 1.31 | gal/min |
| Top Northern Side Slope of Phase I - 15 ft waste + 6-inch daily cover | 27.60 | gal/min | 1.07 | gal/min |

Note: Used average depth of waste on side slope

| Assumptions | Area | | Area | |
|---|---|---|---|---|
| Total No. of Acres Landfill Expansion South, Center and and North | 269,135.53 | $ft^2$ | 6.18 | ac |
| Southern Portion of Landfill Bottom = | 70,987.38 | $ft^2$ | 1.63 | ac |
| Center Portion of Landfill Bottom = | 96,629.66 | $ft^2$ | 2.22 | ac |
| Northern Portion of Landfill Bottom = | 101,306.05 | $ft^2$ | 2.33 | ac |
| Total No. of Acres Landfill Expansion Center and North Bottom | 198,049.25 | $ft^2$ | 4.55 | ac |
| Total No. of Acres Phase I Western Side Slope | 189,881.67 | $ft^2$ | 4.36 | ac |
| Entire Southern Side Slope of Phase I | 97,063.58 | $ft^2$ | 2.23 | ac |
| Bottom Southern Side Slope of Phase I = | 34,942.52 | $ft^2$ | 0.80 | ac |
| Top Southern Side Slope of Phase I = | 62,121.06 | $ft^2$ | 1.43 | ac |
| Entire Northern Side Slope of Phase I | 92,818.09 | $ft^2$ | 2.13 | ac |
| Bottom Northern Side Slope of Phase I = | 39,650.12 | $ft^2$ | 0.91 | ac |
| Top Northern Side Slope of Phase I = | 53,167.97 | $ft^2$ | 1.22 | ac |

| | | | | | | |
|---|---|---|---|---|---|---|
| **Scenario 9 =** Cell Bottom Center - 60 ft waste + 6-inch daily cover + 1 ft int cover | 2.22 | ac | 60 | ft of waste | Waste | |
| Bottom Southern Side Slope of Phase I - 25 ft waste + 6-inch daily cover | 0.65 | ac | 25 | ft of waste | Waste | Sideslope berm to |
| Bottom Southern Side Slope of Phase I - with rain tarp | 0.15 | ac | 0 | ft of waste | Rain tarp | divert runoff from cell |
| Top Southern Side Slope of Phase I - 25 ft waste + 6-inch daily cover | 0.33 | ac | 25 | ft of waste | Waste | |
| Top Southern Side Slope of Phase I - with rain tarp | 1.10 | ac | 0 | ft of waste | Rain tarp | |
| Cell Bottom North - 10 ft waste + 6-inch daily cover | 2.33 | ac | 10 | ft of waste | Waste | |
| Bottom Northern Side Slope of Phase I - open cell, no sod, 0 ft waste | 0.19 | ac | 0 | ft of waste | Open cell | Sideslope berm to |
| Bottom Northern Side Slope of Phase I - with rain tarp | 0.72 | ac | 0 | ft of waste | Rain tarp | divert runoff from cell |
| Top Northern Side Slope of Phase I - with rain tarp | 1.22 | ac | 0 | ft of waste | Rain tarp | |
| Cell Bottom South - 60 ft waste + 6-inch daily cover + 1 ft int cover | 1.63 | ac | 60 | ft of waste | Waste | |
| | 10.54 | | | | | |

| Scenario 9 Generation = | | | | | |
|---|---|---|---|---|---|
| Waste filling in center portion | 22.20 | gal/min | 1.84 | gal/min | leachate, pumped to sideslope risers |
| Waste filling against Phase I sideslope (portion of the sideslope) | 13.10 | gal/min | 0.72 | gal/min | leachate, pumped to sideslope risers |
| No Infiltration through remainder of bottom southern side slope with rain tarp | 0.00 | gal/min | 0.00 | gal/min | stormwater runoff, pumped to swale |
| Waste filling against Phase I sideslope (portion of the sideslope) | 6.64 | gal/min | 0.35 | gal/min | leachate, pumped to sideslope risers |
| No Infiltration through top southern side slope rain tarp | 0.00 | gal/min | 0.00 | gal/min | stormwater runoff, pumped to swale |
| Waste filling in north portion | 85.28 | gal/min | 2.11 | gal/min | leachate, pumped to sideslope risers |
| Infiltration into Phase I sideslope, into geocomposite, flow to sump | 9.48 | gal/min | 0.26 | gal/min | leachate, pumped to sideslope risers |
| No Infiltration through bottom northern side slope rain tarp | 0.00 | gal/min | 0.00 | gal/min | stormwater runoff, pumped to swale |
| No Infiltration through top northern side slope rain tarp | 0.00 | gal/min | 0.00 | gal/min | stormwater runoff, pumped to swale |
| Waste filling in south portion | 16.30 | gal/min | 1.35 | gal/min | leachate, flow to Phase II Section I |
| PEAK LEACHATE | 153.00 | gal/min | 6.65 | gal/min | AVG LEACHATE |

SCS ENGINEERS



| CLIENT | PROJECT | JOB NO. | |
|---|---|---|---|
| Hardee County | Phase II Section II Expansion | 09199033.23 | |
| SUBJECT | | BY | DATE |
| Leachate Generation Estimates<br>**Detection System Phase II Section II** | | SRF | 4/1/13 |
| | | CHECKED | DATE |

| Summary Collection Per Acre Flow Values | $Q_{PEAK}$ | | $Q_{AVERAGE}$ | |
|---|---|---|---|---|
| **SOUTH PORTION** | | | | |
| Cell Bottom South - open cell, 0 ft waste | 0.24 | gal/min | 0.02 | gal/min |
| Cell Bottom South - 10 ft waste + 6-inch daily cover | 0.18 | gal/min | 0.02 | gal/min |
| Cell Bottom South - 25 ft waste + 6-inch daily cover | 0.17 | gal/min | 0.03 | gal/min |
| Cell Bottom South - 60 ft waste + 6-inch daily cover + 1 ft int cover | 0.14 | gal/min | 0.03 | gal/min |
| **CENTER PORTION** | | | | |
| Cell Bottom Center - open cell, 0 ft waste | 0.24 | gal/min | 0.02 | gal/min |
| Cell Bottom Center - 10 ft waste + 6-inch daily cover | 0.18 | gal/min | 0.02 | gal/min |
| Cell Bottom Center - 25 ft waste + 6-inch daily cover | 0.17 | gal/min | 0.03 | gal/min |
| Cell Bottom Center - 60 ft waste + 6-inch daily cover + 1 ft int cover | 0.14 | gal/min | 0.03 | gal/min |
| **NORTH PORTION** | | | | |
| Cell Bottom North - Rain Tarp | 0.00 | gal/min | 0.00 | gal/min |
| Cell Bottom North - open cell, 0 ft waste | 0.24 | gal/min | 0.02 | gal/min |
| Cell Bottom North - 10 ft waste + 6-inch daily cover | 0.18 | gal/min | 0.02 | gal/min |
| Cell Bottom North - 25 ft waste + 6-inch daily cover | 0.17 | gal/min | 0.03 | gal/min |
| Cell Bottom North - 60 ft waste + 6-inch daily cover + 1 ft int cover | 0.14 | gal/min | 0.03 | gal/min |
| **PHASE I WEST SIDE SLOPE** | | | | |
| Bottom Southern Side Slope of Phase I - with rain tarp | 0.00 | gal/min | 0.00 | gal/min |
| Bottom Southern Side Slope of Phase I - with sod, 0 ft waste | 0.00 | gal/min | 0.00 | gal/min |
| Bottom Southern Side Slope of Phase I - open cell, no sod, 0 ft waste | 0.00 | gal/min | 0.00 | gal/min |
| Bottom Southern Side Slope of Phase I - 10 ft waste + 6-inch daily cover | 0.00 | gal/min | 0.00 | gal/min |
| Bottom Southern Side Slope of Phase I - 25 ft waste + 6-inch daily cover | 0.00 | gal/min | 0.00 | gal/min |
| Top Southern Side Slope of Phase I - with rain tarp | 0.00 | gal/min | 0.00 | gal/min |
| Top Southern Side Slope of Phase I - with sod, 0 ft waste | 0.00 | gal/min | 0.00 | gal/min |
| Top Southern Side Slope of Phase I - 25 ft waste + 6-inch daily cover | 0.00 | gal/min | 0.00 | gal/min |
| Bottom Northern Side Slope of Phase I - with rain tarp | 0.00 | gal/min | 0.00 | gal/min |
| Bottom Northern Side Slope of Phase I - with sod, 0 ft waste | 0.00 | gal/min | 0.00 | gal/min |
| Bottom Northern Side Slope of Phase I - open cell, no sod, 0 ft waste | 0.00 | gal/min | 0.00 | gal/min |
| Bottom Northern Side Slope of Phase I - 10 ft waste + 6-inch daily cover | 0.00 | gal/min | 0.00 | gal/min |
| Bottom Northern Side Slope of Phase I - 25 ft waste + 6-inch daily cover | 0.00 | gal/min | 0.00 | gal/min |
| Top Northern Side Slope of Phase I - with rain tarp | 0.00 | gal/min | 0.00 | gal/min |
| Top Northern Side Slope of Phase I - with sod, 0 ft waste | 0.00 | gal/min | 0.00 | gal/min |
| Top Northern Side Slope of Phase I - 15 ft waste + 6-inch daily cover | 0.00 | gal/min | 0.00 | gal/min |

Note: Used average depth of waste on side slope

| Assumptions | Area | | Area | |
|---|---|---|---|---|
| Total No. of Acres Landfill Expansion South, Center and and North | 269,135.53 | $ft^2$ | 6.18 | ac |
| Southern Portion of Landfill Bottom = | 70,987.38 | $ft^2$ | 1.63 | ac |
| Center Portion of Landfill Bottom = | 96,629.66 | $ft^2$ | 2.22 | ac |
| Northern Portion of Landfill Bottom = | 101,306.05 | $ft^2$ | 2.33 | ac |
| Total No. of Acres Landfill Expansion Center and North Bottom | 198,049.25 | $ft^2$ | 4.55 | ac |
| Total No. of Acres Phase I Western Side Slope | 189,881.67 | $ft^2$ | 4.36 | ac |
| Entire Southern Side Slope of Phase I | 97,063.58 | $ft^2$ | 2.23 | ac |
| Bottom Southern Side Slope of Phase I = | 34,942.52 | $ft^2$ | 0.80 | ac |
| Top Southern Side Slope of Phase I = | 62,121.06 | $ft^2$ | 1.43 | ac |
| Entire Northern Side Slope of Phase I | 92,818.09 | $ft^2$ | 2.13 | ac |
| Bottom Northern Side Slope of Phase I = | 39,650.12 | $ft^2$ | 0.91 | ac |
| Top Northern Side Slope of Phase I = | 53,167.97 | $ft^2$ | 1.22 | ac |

| | | | | | | |
|---|---|---|---|---|---|---|
| **Scenario 9 =** Cell Bottom Center - 60 ft waste + 6-inch daily cover + 1 ft int cover | 2.22 | ac | 60 | ft of waste | Waste | |
| Bottom Southern Side Slope of Phase I - 25 ft waste + 6-inch daily cover | 0.65 | ac | 25 | ft of waste | Waste | Sideslope berm to |
| Bottom Southern Side Slope of Phase I - with rain tarp | 0.15 | ac | 0 | ft of waste | Rain tarp | divert runoff from cell |
| Top Southern Side Slope of Phase I - 25 ft waste + 6-inch daily cover | 0.33 | ac | 25 | ft of waste | Waste | |
| Top Southern Side Slope of Phase I - with rain tarp | 1.10 | ac | 0 | ft of waste | Rain tarp | |
| Cell Bottom North - 10 ft waste + 6-inch daily cover | 2.33 | ac | 10 | ft of waste | Waste | |
| Bottom Northern Side Slope of Phase I - open cell, no sod, 0 ft waste | 0.19 | ac | 0 | ft of waste | Open cell | Sideslope berm to |
| Bottom Northern Side Slope of Phase I - with rain tarp | 0.72 | ac | 0 | ft of waste | Rain tarp | divert runoff from cell |
| Top Northern Side Slope of Phase I - with rain tarp | 1.22 | ac | 0 | ft of waste | Rain tarp | |
| Cell Bottom South - 60 ft waste + 6-inch daily cover + 1 ft int cover | 1.63 | ac | 60 | ft of waste | Waste | |
| | 10.54 | | | | | |

| **Scenario 9 Generation =** | | | | | |
|---|---|---|---|---|---|
| Waste filling in center portion | 0.31 | gal/min | 0.07 | gal/min | leachate, pumped to sideslope risers |
| Waste filling against Phase I sideslope (portion of the sideslope) | 0.00 | gal/min | 0.00 | gal/min | leachate, pumped to sideslope risers |
| No Infiltration through remainder of bottom southern side slope with rain tarp | 0.00 | gal/min | 0.00 | gal/min | stormwater runoff, pumped to swale |
| Waste filling against Phase I sideslope (portion of the sideslope) | 0.00 | gal/min | 0.00 | gal/min | leachate, pumped to sideslope risers |
| No Infiltration through top southern side slope rain tarp | 0.00 | gal/min | 0.00 | gal/min | stormwater runoff, pumped to swale |
| Waste filling in north portion | 0.42 | gal/min | 0.05 | gal/min | leachate, pumped to sideslope risers |
| Infiltration into Phase I sideslope, into geocomposite, flow to sump | 0.00 | gal/min | 0.00 | gal/min | leachate, pumped to sideslope risers |
| No Infiltration through bottom northern side slope rain tarp | 0.00 | gal/min | 0.00 | gal/min | stormwater runoff, pumped to swale |
| No Infiltration through top northern side slope rain tarp | 0.00 | gal/min | 0.00 | gal/min | stormwater runoff, pumped to swale |
| Waste filling in south portion | 0.23 | gal/min | 0.05 | gal/min | leachate, flow to Phase II Section I |
| PEAK LEACHATE | 0.96 | gal/min | 0.17 | gal/min | AVG LEACHATE |

| CLIENT | PROJECT | JOB NO. | |
|---|---|---|---|
| Hardee County | Phase II Section II Expansion | 09199033.23 | |
| SUBJECT | | BY | DATE |
| Leachate Generation Estimates | | SRF | 4/1/13 |
| **Collection System Phase II Section II and Phase I Side Slope** | | CHECKED | DATE |

Summary Collection Per Acre Flow Values

| | $Q_{PEAK}$ | | $Q_{AVERAGE}$ | |
|---|---|---|---|---|
| **SOUTH PORTION** | | | | |
| Cell Bottom South - open cell, 0 ft waste | 65.52 | gal/min | 1.05 | gal/min |
| Cell Bottom South - 10 ft waste + 6-inch daily cover | 36.60 | gal/min | 0.91 | gal/min |
| Cell Bottom South - 25 ft waste + 6-inch daily cover | 20.37 | gal/min | 0.91 | gal/min |
| Cell Bottom South - 60 ft waste + 6-inch daily cover + 1 ft int cover | 10.00 | gal/min | 0.83 | gal/min |
| **CENTER PORTION** | | | | |
| Cell Bottom Center - open cell, 0 ft waste | 65.52 | gal/min | 1.05 | gal/min |
| Cell Bottom Center - 10 ft waste + 6-inch daily cover | 36.60 | gal/min | 0.91 | gal/min |
| Cell Bottom Center - 25 ft waste + 6-inch daily cover | 20.37 | gal/min | 0.91 | gal/min |
| Cell Bottom Center - 60 ft waste + 6-inch daily cover + 1 ft int cover | 10.00 | gal/min | 0.83 | gal/min |
| **NORTH PORTION** | | | | |
| Cell Bottom North - Rain Tarp | 0.00 | gal/min | 0.00 | gal/min |
| Cell Bottom North - open cell, 0 ft waste | 65.54 | gal/min | 1.05 | gal/min |
| Cell Bottom North - 10 ft waste + 6-inch daily cover | 36.61 | gal/min | 0.91 | gal/min |
| Cell Bottom North - 25 ft waste + 6-inch daily cover | 20.44 | gal/min | 0.91 | gal/min |
| Cell Bottom North - 60 ft waste + 6-inch daily cover + 1 ft int cover | 10.00 | gal/min | 0.83 | gal/min |
| **PHASE I WEST SIDE SLOPE** | | | | |
| Bottom Southern Side Slope of Phase I - with rain tarp | 0.00 | gal/min | 0.00 | gal/min |
| Bottom Southern Side Slope of Phase I - with sod, 0 ft waste | 49.59 | gal/min | 1.31 | gal/min |
| Bottom Southern Side Slope of Phase I - open cell, no sod, 0 ft waste | 49.88 | gal/min | 1.39 | gal/min |
| Bottom Southern Side Slope of Phase I - 10 ft waste + 6-inch daily cover | 36.80 | gal/min | 1.07 | gal/min |
| Bottom Southern Side Slope of Phase I - 25 ft waste + 6-inch daily cover | 20.16 | gal/min | 1.11 | gal/min |
| Top Southern Side Slope of Phase I - with rain tarp | 0.00 | gal/min | 0.00 | gal/min |
| Top Southern Side Slope of Phase I - with sod, 0 ft waste | 49.32 | gal/min | 1.31 | gal/min |
| Top Southern Side Slope of Phase I - 25 ft waste + 6-inch daily cover | 20.12 | gal/min | 1.07 | gal/min |
| Bottom Northern Side Slope of Phase I - with rain tarp | 0.00 | gal/min | 0.00 | gal/min |
| Bottom Northern Side Slope of Phase I - with sod, 0 ft waste | 49.59 | gal/min | 1.31 | gal/min |
| Bottom Northern Side Slope of Phase I - open cell, no sod, 0 ft waste | 49.88 | gal/min | 1.39 | gal/min |
| Bottom Northern Side Slope of Phase I - 10 ft waste + 6-inch daily cover | 36.80 | gal/min | 1.07 | gal/min |
| Bottom Northern Side Slope of Phase I - 25 ft waste + 6-inch daily cover | 20.16 | gal/min | 1.11 | gal/min |
| Top Northern Side Slope of Phase I - with rain tarp | 0.00 | gal/min | 0.00 | gal/min |
| Top Northern Side Slope of Phase I - with sod, 0 ft waste | 49.32 | gal/min | 1.31 | gal/min |
| Top Northern Side Slope of Phase I - 15 ft waste + 6-inch daily cover | 27.60 | gal/min | 1.07 | gal/min |

Note: Used average depth of waste on side slope

| Assumptions | Area | | Area | |
|---|---|---|---|---|
| Total No. of Acres Landfill Expansion South, Center and and North | 269,135.53 | $ft^2$ | 6.18 | ac |
| Southern Portion of Landfill Bottom = | 70,987.38 | $ft^2$ | 1.63 | ac |
| Center Portion of Landfill Bottom = | 96,629.66 | $ft^2$ | 2.22 | ac |
| Northern Portion of Landfill Bottom = | 101,306.05 | $ft^2$ | 2.33 | ac |
| Total No. of Acres Landfill Expansion Center and North Bottom | 198,049.25 | $ft^2$ | 4.55 | ac |
| Total No. of Acres Phase I Western Side Slope | 189,881.67 | $ft^2$ | 4.36 | ac |
| Entire Southern Side Slope of Phase I | 97,063.58 | $ft^2$ | 2.23 | ac |
| Bottom Southern Side Slope of Phase I = | 34,942.52 | $ft^2$ | 0.80 | ac |
| Top Southern Side Slope of Phase I = | 62,121.06 | $ft^2$ | 1.43 | ac |
| Entire Northern Side Slope of Phase I | 92,818.09 | $ft^2$ | 2.13 | ac |
| Bottom Northern Side Slope of Phase I = | 39,650.12 | $ft^2$ | 0.91 | ac |
| Top Northern Side Slope of Phase I = | 53,167.97 | $ft^2$ | 1.22 | ac |

| | | | | | | |
|---|---|---|---|---|---|---|
| **Scenario 10 =** Cell Bottom Center - 60 ft waste + 6-inch daily cover + 1 ft int cover | 2.22 | ac | 60 | ft of waste | Waste | |
| Bottom Southern Side Slope of Phase I - 25 ft waste + 6-inch daily cover | 0.80 | ac | 25 | ft of waste | Waste | Sideslope berm to |
| Top Southern Side Slope of Phase I - 25 ft waste + 6-inch daily cover | 0.33 | ac | 25 | ft of waste | Waste | divert runoff from cell |
| Top Southern Side Slope of Phase I - with rain tarp | 1.10 | ac | 0 | ft of waste | Rain tarp | |
| Cell Bottom North - 25 ft waste + 6-inch daily cover | 2.33 | ac | 25 | ft of waste | Waste | |
| Bottom Northern Side Slope of Phase I - 10 ft waste + 6-inch daily cover | 0.85 | ac | 10 | ft of waste | Waste | Sideslope berm to |
| Bottom Northern Side Slope of Phase I - with rain tarp | 0.06 | ac | 0 | ft of waste | Rain tarp | divert runoff from cell |
| Top Northern Side Slope of Phase I - with rain tarp | 1.22 | ac | 0 | ft of waste | Rain tarp | |
| Cell Bottom South - 60 ft waste + 6-inch daily cover + 1 ft int cover | 1.63 | ac | 60 | ft of waste | Waste | |
| | 10.54 | | | | | |

| **Scenario 10 Generation =** | | | | | |
|---|---|---|---|---|---|
| Waste filling in center portion | 22.20 | gal/min | 1.84 | gal/min | leachate, pumped to sideslope risers |
| Waste filling against Phase I sideslope (portion of the sideslope) | 16.13 | gal/min | 0.89 | gal/min | leachate, pumped to sideslope risers |
| Waste filling against Phase I sideslope (portion of the sideslope) | 6.64 | gal/min | 0.35 | gal/min | leachate, pumped to sideslope risers |
| No Infiltration through top southern side slope rain tarp | 0.00 | gal/min | 0.00 | gal/min | stormwater runoff, pumped to swale |
| Waste filling in north portion | 85.28 | gal/min | 2.11 | gal/min | leachate, pumped to sideslope risers |
| Waste filling against Phase I sideslope (portion of the sideslope) | 31.28 | gal/min | 0.91 | gal/min | leachate, pumped to sideslope risers |
| No Infiltration through bottom northern side slope rain tarp | 0.00 | gal/min | 0.00 | gal/min | stormwater runoff, pumped to swale |
| No Infiltration through top northern side slope rain tarp | 0.00 | gal/min | 0.00 | gal/min | stormwater runoff, pumped to swale |
| Waste filling in south portion | 16.30 | gal/min | 1.35 | gal/min | leachate, flow to Phase II Section I |
| PEAK LEACHATE | 177.83 | gal/min | 7.46 | gal/min | AVG LEACHATE |

SCS ENGINEERS



| CLIENT | PROJECT | JOB NO. | |
|---|---|---|---|
| Hardee County | Phase II Section II Expansion | 09199033.23 | |
| SUBJECT | | BY | DATE |
| Leachate Generation Estimates | | SRF | 4/1/13 |
| **Detection System Phase II Section II** | | CHECKED | DATE |

Summary Collection Per Acre Flow Values

| | $Q_{PEAK}$ | | $Q_{AVERAGE}$ | |
|---|---|---|---|---|
| **SOUTH PORTION** | | | | |
| Cell Bottom South - open cell, 0 ft waste | 0.24 | gal/min | 0.02 | gal/min |
| Cell Bottom South - 10 ft waste + 6-inch daily cover | 0.18 | gal/min | 0.02 | gal/min |
| Cell Bottom South - 25 ft waste + 6-inch daily cover | 0.17 | gal/min | 0.03 | gal/min |
| Cell Bottom South - 60 ft waste + 6-inch daily cover + 1 ft int cover | 0.14 | gal/min | 0.03 | gal/min |
| **CENTER PORTION** | | | | |
| Cell Bottom Center - open cell, 0 ft waste | 0.24 | gal/min | 0.02 | gal/min |
| Cell Bottom Center - 10 ft waste + 6-inch daily cover | 0.18 | gal/min | 0.02 | gal/min |
| Cell Bottom Center - 25 ft waste + 6-inch daily cover | 0.17 | gal/min | 0.03 | gal/min |
| Cell Bottom Center - 60 ft waste + 6-inch daily cover + 1 ft int cover | 0.14 | gal/min | 0.03 | gal/min |
| **NORTH PORTION** | | | | |
| Cell Bottom North - Rain Tarp | 0.00 | gal/min | 0.00 | gal/min |
| Cell Bottom North - open cell, 0 ft waste | 0.24 | gal/min | 0.02 | gal/min |
| Cell Bottom North - 10 ft waste + 6-inch daily cover | 0.18 | gal/min | 0.02 | gal/min |
| Cell Bottom North - 25 ft waste + 6-inch daily cover | 0.17 | gal/min | 0.03 | gal/min |
| Cell Bottom North - 60 ft waste + 6-inch daily cover + 1 ft int cover | 0.14 | gal/min | 0.03 | gal/min |
| **PHASE I WEST SIDE SLOPE** | | | | |
| Bottom Southern Side Slope of Phase I - with rain tarp | 0.00 | gal/min | 0.00 | gal/min |
| Bottom Southern Side Slope of Phase I - with sod, 0 ft waste | 0.00 | gal/min | 0.00 | gal/min |
| Bottom Southern Side Slope of Phase I - open cell, no sod, 0 ft waste | 0.00 | gal/min | 0.00 | gal/min |
| Bottom Southern Side Slope of Phase I - 10 ft waste + 6-inch daily cover | 0.00 | gal/min | 0.00 | gal/min |
| Bottom Southern Side Slope of Phase I - 25 ft waste + 6-inch daily cover | 0.00 | gal/min | 0.00 | gal/min |
| Top Southern Side Slope of Phase I - with rain tarp | 0.00 | gal/min | 0.00 | gal/min |
| Top Southern Side Slope of Phase I - with sod, 0 ft waste | 0.00 | gal/min | 0.00 | gal/min |
| Top Southern Side Slope of Phase I - 25 ft waste + 6-inch daily cover | 0.00 | gal/min | 0.00 | gal/min |
| Bottom Northern Side Slope of Phase I - with rain tarp | 0.00 | gal/min | 0.00 | gal/min |
| Bottom Northern Side Slope of Phase I - with sod, 0 ft waste | 0.00 | gal/min | 0.00 | gal/min |
| Bottom Northern Side Slope of Phase I - open cell, no sod, 0 ft waste | 0.00 | gal/min | 0.00 | gal/min |
| Bottom Northern Side Slope of Phase I - 10 ft waste + 6-inch daily cover | 0.00 | gal/min | 0.00 | gal/min |
| Bottom Northern Side Slope of Phase I - 25 ft waste + 6-inch daily cover | 0.00 | gal/min | 0.00 | gal/min |
| Top Northern Side Slope of Phase I - with rain tarp | 0.00 | gal/min | 0.00 | gal/min |
| Top Northern Side Slope of Phase I - with sod, 0 ft waste | 0.00 | gal/min | 0.00 | gal/min |
| Top Northern Side Slope of Phase I - 15 ft waste + 6-inch daily cover | 0.00 | gal/min | 0.00 | gal/min |

Note: Used average depth of waste on side slope

| Assumptions | Area | | Area | |
|---|---|---|---|---|
| Total No. of Acres Landfill Expansion South, Center and and North | 269,135.53 | $ft^2$ | 6.18 | ac |
| Southern Portion of Landfill Bottom = | 70,987.38 | $ft^2$ | 1.63 | ac |
| Center Portion of Landfill Bottom = | 96,629.66 | $ft^2$ | 2.22 | ac |
| Northern Portion of Landfill Bottom = | 101,306.05 | $ft^2$ | 2.33 | ac |
| Total No. of Acres Landfill Expansion Center and North Bottom | 198,049.25 | $ft^2$ | 4.55 | ac |
| Total No. of Acres Phase I Western Side Slope | 189,881.67 | $ft^2$ | 4.36 | ac |
| Entire Southern Side Slope of Phase I | 97,063.58 | $ft^2$ | 2.23 | ac |
| Bottom Southern Side Slope of Phase I = | 34,942.52 | $ft^2$ | 0.80 | ac |
| Top Southern Side Slope of Phase I = | 62,121.06 | $ft^2$ | 1.43 | ac |
| Entire Northern Side Slope of Phase I | 92,818.09 | $ft^2$ | 2.13 | ac |
| Bottom Northern Side Slope of Phase I = | 39,650.12 | $ft^2$ | 0.91 | ac |
| Top Northern Side Slope of Phase I = | 53,167.97 | $ft^2$ | 1.22 | ac |

| | | | | | | |
|---|---|---|---|---|---|---|
| **Scenario 10 =** Cell Bottom Center - 60 ft waste + 6-inch daily cover + 1 ft int cover | 2.22 | ac | 60 | ft of waste | Waste | |
| Bottom Southern Side Slope of Phase I - 25 ft waste + 6-inch daily cover | 0.80 | ac | 25 | ft of waste | Waste | Sideslope berm to |
| Top Southern Side Slope of Phase I - 25 ft waste + 6-inch daily cover | 0.33 | ac | 25 | ft of waste | Waste | divert runoff from cell |
| Top Southern Side Slope of Phase I - with rain tarp | 1.10 | ac | 0 | ft of waste | Rain tarp | |
| Cell Bottom North - 25 ft waste + 6-inch daily cover | 2.33 | ac | 25 | ft of waste | Waste | |
| Bottom Northern Side Slope of Phase I - 10 ft waste + 6-inch daily cover | 0.85 | ac | 10 | ft of waste | Waste | Sideslope berm to |
| Bottom Northern Side Slope of Phase I - with rain tarp | 0.06 | ac | 0 | ft of waste | Rain tarp | divert runoff from cell |
| Top Northern Side Slope of Phase I - with rain tarp | 1.22 | ac | 0 | ft of waste | Rain tarp | |
| Cell Bottom South - 60 ft waste + 6-inch daily cover + 1 ft int cover | 1.63 | ac | 60 | ft of waste | Waste | |
| | 10.54 | | | | | |

| | | | | | |
|---|---|---|---|---|---|
| **Scenario 10 Generation =** Waste filling in center portion | 0.31 | gal/min | 0.07 | gal/min | leachate, pumped to sideslope risers |
| Waste filling against Phase I sideslope (portion of the sideslope) | 0.00 | gal/min | 0.00 | gal/min | leachate, pumped to sideslope risers |
| Waste filling against Phase I sideslope (portion of the sideslope) | 0.00 | gal/min | 0.00 | gal/min | leachate, pumped to sideslope risers |
| No Infiltration through top southern side slope rain tarp | 0.00 | gal/min | 0.00 | gal/min | stormwater runoff, pumped to swale |
| Waste filling in north portion | 0.42 | gal/min | 0.05 | gal/min | leachate, pumped to sideslope risers |
| Waste filling against Phase I sideslope (portion of the sideslope) | 0.00 | gal/min | 0.00 | gal/min | leachate, pumped to sideslope risers |
| No Infiltration through bottom northern side slope rain tarp | 0.00 | gal/min | 0.00 | gal/min | stormwater runoff, pumped to swale |
| No Infiltration through top northern side slope rain tarp | 0.00 | gal/min | 0.00 | gal/min | stormwater runoff, pumped to swale |
| Waste filling in south portion | 0.23 | gal/min | 0.05 | gal/min | leachate, flow to Phase II Section I |
| PEAK LEACHATE | 0.96 | gal/min | 0.17 | gal/min | AVG LEACHATE |

| CLIENT | PROJECT | JOB NO. | |
|---|---|---|---|
| Hardee County | Phase II Section II Expansion | 09199033.23 | |
| SUBJECT | | BY | DATE |
| Leachate Generation Estimates | | SRF | 4/1/13 |
| **Collection System Phase II Section II and Phase I Side Slope** | | CHECKED | DATE |

Summary Collection Per Acre Flow Values

| | $Q_{PEAK}$ | | $Q_{AVERAGE}$ | |
|---|---|---|---|---|
| **SOUTH PORTION** | | | | |
| Cell Bottom South - open cell, 0 ft waste | 65.52 | gal/min | 1.05 | gal/min |
| Cell Bottom South - 10 ft waste + 6-inch daily cover | 36.60 | gal/min | 0.91 | gal/min |
| Cell Bottom South - 25 ft waste + 6-inch daily cover | 20.37 | gal/min | 0.91 | gal/min |
| Cell Bottom South - 60 ft waste + 6-inch daily cover + 1 ft int cover | 10.00 | gal/min | 0.83 | gal/min |
| **CENTER PORTION** | | | | |
| Cell Bottom Center - open cell, 0 ft waste | 65.52 | gal/min | 1.05 | gal/min |
| Cell Bottom Center - 10 ft waste + 6-inch daily cover | 36.60 | gal/min | 0.91 | gal/min |
| Cell Bottom Center - 25 ft waste + 6-inch daily cover | 20.37 | gal/min | 0.91 | gal/min |
| Cell Bottom Center - 60 ft waste + 6-inch daily cover + 1 ft int cover | 10.00 | gal/min | 0.83 | gal/min |
| **NORTH PORTION** | | | | |
| Cell Bottom North - Rain Tarp | 0.00 | gal/min | 0.00 | gal/min |
| Cell Bottom North - open cell, 0 ft waste | 65.54 | gal/min | 1.05 | gal/min |
| Cell Bottom North - 10 ft waste + 6-inch daily cover | 36.61 | gal/min | 0.91 | gal/min |
| Cell Bottom North - 25 ft waste + 6-inch daily cover | 20.44 | gal/min | 0.91 | gal/min |
| Cell Bottom North - 60 ft waste + 6-inch daily cover + 1 ft int cover | 10.00 | gal/min | 0.83 | gal/min |
| **PHASE I WEST SIDE SLOPE** | | | | |
| Bottom Southern Side Slope of Phase I - with rain tarp | 0.00 | gal/min | 0.00 | gal/min |
| Bottom Southern Side Slope of Phase I - with sod, 0 ft waste | 49.59 | gal/min | 1.31 | gal/min |
| Bottom Southern Side Slope of Phase I - open cell, no sod, 0 ft waste | 49.88 | gal/min | 1.39 | gal/min |
| Bottom Southern Side Slope of Phase I - 10 ft waste + 6-inch daily cover | 36.80 | gal/min | 1.07 | gal/min |
| Bottom Southern Side Slope of Phase I - 25 ft waste + 6-inch daily cover | 20.16 | gal/min | 1.11 | gal/min |
| Top Southern Side Slope of Phase I - with rain tarp | 0.00 | gal/min | 0.00 | gal/min |
| Top Southern Side Slope of Phase I - with sod, 0 ft waste | 49.32 | gal/min | 1.31 | gal/min |
| Top Southern Side Slope of Phase I - 25 ft waste + 6-inch daily cover | 20.12 | gal/min | 1.07 | gal/min |
| Bottom Northern Side Slope of Phase I - with rain tarp | 0.00 | gal/min | 0.00 | gal/min |
| Bottom Northern Side Slope of Phase I - with sod, 0 ft waste | 49.59 | gal/min | 1.31 | gal/min |
| Bottom Northern Side Slope of Phase I - open cell, no sod, 0 ft waste | 49.88 | gal/min | 1.39 | gal/min |
| Bottom Northern Side Slope of Phase I - 10 ft waste + 6-inch daily cover | 36.80 | gal/min | 1.07 | gal/min |
| Bottom Northern Side Slope of Phase I - 25 ft waste + 6-inch daily cover | 20.16 | gal/min | 1.11 | gal/min |
| Top Northern Side Slope of Phase I - with rain tarp | 0.00 | gal/min | 0.00 | gal/min |
| Top Northern Side Slope of Phase I - with sod, 0 ft waste | 49.32 | gal/min | 1.31 | gal/min |
| Top Northern Side Slope of Phase I - 15 ft waste + 6-inch daily cover | 27.60 | gal/min | 1.07 | gal/min |

Note: Used average depth of waste on side slope

Assumptions

| | Area | | Area | |
|---|---|---|---|---|
| Total No. of Acres Landfill Expansion South, Center and and North | 269,135.53 | $ft^2$ | 6.18 | ac |
| Southern Portion of Landfill Bottom = | 70,987.38 | $ft^2$ | 1.63 | ac |
| Center Portion of Landfill Bottom = | 96,629.66 | $ft^2$ | 2.22 | ac |
| Northern Portion of Landfill Bottom = | 101,306.05 | $ft^2$ | 2.33 | ac |
| Total No. of Acres Landfill Expansion Center and North Bottom | 198,049.25 | $ft^2$ | 4.55 | ac |
| Total No. of Acres Phase I Western Side Slope | 189,881.67 | $ft^2$ | 4.36 | ac |
| Entire Southern Side Slope of Phase I | 97,063.58 | $ft^2$ | 2.23 | ac |
| Bottom Southern Side Slope of Phase I = | 34,942.52 | $ft^2$ | 0.80 | ac |
| Top Southern Side Slope of Phase I = | 62,121.06 | $ft^2$ | 1.43 | ac |
| Entire Northern Side Slope of Phase I | 92,818.09 | $ft^2$ | 2.13 | ac |
| Bottom Northern Side Slope of Phase I = | 39,650.12 | $ft^2$ | 0.91 | ac |
| Top Northern Side Slope of Phase I = | 53,167.97 | $ft^2$ | 1.22 | ac |

| | | | | | |
|---|---|---|---|---|---|
| **Scenario 11 =** Cell Bottom Center - 60 ft waste + 6-inch daily cover + 1 ft int cover | 2.22 | ac | 60 | ft of waste | Waste |
| Bottom Southern Side Slope of Phase I - 25 ft waste + 6-inch daily cover | 0.80 | ac | 25 | ft of waste | Waste |
| Top Southern Side Slope of Phase I - 25 ft waste + 6-inch daily cover | 1.43 | ac | 25 | ft of waste | Waste |
| Cell Bottom North - 60 ft waste + 6-inch daily cover + 1 ft int cover | 2.33 | ac | 60 | ft of waste | Waste |
| Bottom Northern Side Slope of Phase I - 25 ft waste + 6-inch daily cover | 0.91 | ac | 25 | ft of waste | Waste |
| Top Northern Side Slope of Phase I - 15 ft waste + 6-inch daily cover | 1.22 | ac | 15 | ft of waste | Waste |
| Cell Bottom South - 60 ft waste + 6-inch daily cover + 1 ft int cover | 1.63 | ac | 60 | ft of waste | Waste |
| | 10.54 | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| **Scenario 11 Generation =** | Waste filling in center portion | 22.20 | gal/min | 1.84 | gal/min | leachate, pumped to sideslope risers |
| | Waste filling against Phase I sideslope | 16.13 | gal/min | 0.89 | gal/min | leachate, pumped to sideslope risers |
| | Waste filling against Phase I sideslope | 28.77 | gal/min | 1.54 | gal/min | leachate, pumped to sideslope risers |
| | Waste filling in north portion | 23.30 | gal/min | 1.93 | gal/min | leachate, pumped to sideslope risers |
| | Waste filling against Phase I sideslope | 18.34 | gal/min | 1.01 | gal/min | leachate, pumped to sideslope risers |
| | Waste filling against Phase I sideslope | 33.68 | gal/min | 1.31 | gal/min | leachate, pumped to sideslope risers |
| | Waste filling in south portion | 16.30 | gal/min | 1.35 | gal/min | leachate, flow to Phase II Section I |
| | PEAK LEACHATE | 158.71 | gal/min | 9.87 | gal/min | AVG LEACHATE |

SCS ENGINEERS

SHEET 37 OF 40

| CLIENT | PROJECT | JOB NO. | |
|---|---|---|---|
| Hardee County | Phase II Section II Expansion | 09199033.23 | |
| SUBJECT | | BY | DATE |
| Leachate Generation Estimates | | SRF | 4/1/13 |
| **Detection System Phase II Section II** | | CHECKED | DATE |

| Summary Collection Per Acre Flow Values | $Q_{PEAK}$ | | $Q_{AVERAGE}$ | |
|---|---|---|---|---|
| **SOUTH PORTION** | | | | |
| Cell Bottom South - open cell, 0 ft waste | 0.24 | gal/min | 0.02 | gal/min |
| Cell Bottom South - 10 ft waste + 6-inch daily cover | 0.18 | gal/min | 0.02 | gal/min |
| Cell Bottom South - 25 ft waste + 6-inch daily cover | 0.17 | gal/min | 0.03 | gal/min |
| Cell Bottom South - 60 ft waste + 6-inch daily cover + 1 ft int cover | 0.14 | gal/min | 0.03 | gal/min |
| **CENTER PORTION** | | | | |
| Cell Bottom Center - open cell, 0 ft waste | 0.24 | gal/min | 0.02 | gal/min |
| Cell Bottom Center - 10 ft waste + 6-inch daily cover | 0.18 | gal/min | 0.02 | gal/min |
| Cell Bottom Center - 25 ft waste + 6-inch daily cover | 0.17 | gal/min | 0.03 | gal/min |
| Cell Bottom Center - 60 ft waste + 6-inch daily cover + 1 ft int cover | 0.14 | gal/min | 0.03 | gal/min |
| **NORTH PORTION** | | | | |
| Cell Bottom North - Rain Tarp | 0.00 | gal/min | 0.00 | gal/min |
| Cell Bottom North - open cell, 0 ft waste | 0.24 | gal/min | 0.02 | gal/min |
| Cell Bottom North - 10 ft waste + 6-inch daily cover | 0.18 | gal/min | 0.02 | gal/min |
| Cell Bottom North - 25 ft waste + 6-inch daily cover | 0.17 | gal/min | 0.03 | gal/min |
| Cell Bottom North - 60 ft waste + 6-inch daily cover + 1 ft int cover | 0.14 | gal/min | 0.03 | gal/min |
| **PHASE I WEST SIDE SLOPE** | | | | |
| Bottom Southern Side Slope of Phase I - with rain tarp | 0.00 | gal/min | 0.00 | gal/min |
| Bottom Southern Side Slope of Phase I - with sod, 0 ft waste | 0.00 | gal/min | 0.00 | gal/min |
| Bottom Southern Side Slope of Phase I - open cell, no sod, 0 ft waste | 0.00 | gal/min | 0.00 | gal/min |
| Bottom Southern Side Slope of Phase I - 10 ft waste + 6-inch daily cover | 0.00 | gal/min | 0.00 | gal/min |
| Bottom Southern Side Slope of Phase I - 25 ft waste + 6-inch daily cover | 0.00 | gal/min | 0.00 | gal/min |
| Top Southern Side Slope of Phase I - with rain tarp | 0.00 | gal/min | 0.00 | gal/min |
| Top Southern Side Slope of Phase I - with sod, 0 ft waste | 0.00 | gal/min | 0.00 | gal/min |
| Top Southern Side Slope of Phase I - 25 ft waste + 6-inch daily cover | 0.00 | gal/min | 0.00 | gal/min |
| Bottom Northern Side Slope of Phase I - with rain tarp | 0.00 | gal/min | 0.00 | gal/min |
| Bottom Northern Side Slope of Phase I - with sod, 0 ft waste | 0.00 | gal/min | 0.00 | gal/min |
| Bottom Northern Side Slope of Phase I - open cell, no sod, 0 ft waste | 0.00 | gal/min | 0.00 | gal/min |
| Bottom Northern Side Slope of Phase I - 10 ft waste + 6-inch daily cover | 0.00 | gal/min | 0.00 | gal/min |
| Bottom Northern Side Slope of Phase I - 25 ft waste + 6-inch daily cover | 0.00 | gal/min | 0.00 | gal/min |
| Top Northern Side Slope of Phase I - with rain tarp | 0.00 | gal/min | 0.00 | gal/min |
| Top Northern Side Slope of Phase I - with sod, 0 ft waste | 0.00 | gal/min | 0.00 | gal/min |
| Top Northern Side Slope of Phase I - 15 ft waste + 6-inch daily cover | 0.00 | gal/min | 0.00 | gal/min |

Note: Used average depth of waste on side slope

| Assumptions | Area | | Area | |
|---|---|---|---|---|
| Total No. of Acres Landfill Expansion South, Center and and North | 269,135.53 | $ft^2$ | 6.18 | ac |
| Southern Portion of Landfill Bottom = | 70,987.38 | $ft^2$ | 1.63 | ac |
| Center Portion of Landfill Bottom = | 96,629.66 | $ft^2$ | 2.22 | ac |
| Northern Portion of Landfill Bottom = | 101,306.05 | $ft^2$ | 2.33 | ac |
| Total No. of Acres Landfill Expansion Center and North Bottom | 198,049.25 | $ft^2$ | 4.55 | ac |
| Total No. of Acres Phase I Western Side Slope | 189,881.67 | $ft^2$ | 4.36 | ac |
| Entire Southern Side Slope of Phase I | 97,063.58 | $ft^2$ | 2.23 | ac |
| Bottom Southern Side Slope of Phase I = | 34,942.52 | $ft^2$ | 0.80 | ac |
| Top Southern Side Slope of Phase I = | 62,121.06 | $ft^2$ | 1.43 | ac |
| Entire Northern Side Slope of Phase I | 92,818.09 | $ft^2$ | 2.13 | ac |
| Bottom Northern Side Slope of Phase I = | 39,650.12 | $ft^2$ | 0.91 | ac |
| Top Northern Side Slope of Phase I = | 53,167.97 | $ft^2$ | 1.22 | ac |

| | | | | | |
|---|---|---|---|---|---|
| **Scenario 11 =** Cell Bottom Center - 60 ft waste + 6-inch daily cover + 1 ft int cover | 2.22 | ac | 60 | ft of waste | Waste |
| Bottom Southern Side Slope of Phase I - 25 ft waste + 6-inch daily cover | 0.80 | ac | 25 | ft of waste | Waste |
| Top Southern Side Slope of Phase I - 25 ft waste + 6-inch daily cover | 1.43 | ac | 25 | ft of waste | Waste |
| Cell Bottom North - 60 ft waste + 6-inch daily cover + 1 ft int cover | 2.33 | ac | 60 | ft of waste | Waste |
| Bottom Northern Side Slope of Phase I - 25 ft waste + 6-inch daily cover | 0.91 | ac | 25 | ft of waste | Waste |
| Top Northern Side Slope of Phase I - 15 ft waste + 6-inch daily cover | 1.22 | ac | 15 | ft of waste | Waste |
| Cell Bottom South - 60 ft waste + 6-inch daily cover + 1 ft int cover | 1.63 | ac | 60 | ft of waste | Waste |
| | 10.54 | | | | |

| **Scenario 11 Generation =** | | | | | | |
|---|---|---|---|---|---|---|
| | Waste filling in center portion | 0.31 | gal/min | 0.07 | gal/min | leachate, pumped to sideslope risers |
| | Waste filling against Phase I sideslope | 0.00 | gal/min | 0.00 | gal/min | leachate, pumped to sideslope risers |
| | Waste filling against Phase I sideslope | 0.00 | gal/min | 0.00 | gal/min | leachate, pumped to sideslope risers |
| | Waste filling in north portion | 0.33 | gal/min | 0.07 | gal/min | leachate, pumped to sideslope risers |
| | Waste filling against Phase I sideslope | 0.00 | gal/min | 0.00 | gal/min | leachate, pumped to sideslope risers |
| | Waste filling against Phase I sideslope | 0.00 | gal/min | 0.00 | gal/min | leachate, pumped to sideslope risers |
| | Waste filling in south portion | 0.23 | gal/min | 0.05 | gal/min | leachate, flow to Phase II Section I |
| | PEAK LEACHATE | 0.87 | gal/min | 0.19 | gal/min | AVG LEACHATE |

| CLIENT | PROJECT | JOB NO. |
|---|---|---|
| Hardee County | Phase II Section II Expansion | 09199033.23 |

| SUBJECT | BY | DATE |
|---|---|---|
| Leachate Generation Estimates | SRF | 4/1/13 |
| **Collection System Phase II Section II and Phase I Side Slope** | CHECKED | DATE |

**Leachate Pumped From North and Center Portions to Three Phase II Section II South Portion LCS Risers**

| | Collection | | | Detection | | | |
|---|---|---|---|---|---|---|---|
| From Scenario 1 | PEAK | NA | gal/min (See note 1) | PEAK | NA | gal/min (See note 1) | |
| From Scenario 1 | AVG | NA | gal/min (See note 1) | AVG | NA | gal/min (See note 1) | |
| From Scenario 2 | PEAK | NA | gal/min (See note 1) | PEAK | NA | gal/min (See note 1) | |
| From Scenario 2 | AVG | NA | gal/min (See note 1) | AVG | NA | gal/min (See note 1) | |
| From Scenario 3 | PEAK | NA | gal/min (See note 1) | PEAK | NA | gal/min (See note 1) | |
| From Scenario 3 | AVG | NA | gal/min (See note 1) | AVG | NA | gal/min (See note 1) | |
| From Scenario 4 | PEAK | 154.34 | gal/min | PEAK | 0.54 | gal/min | |
| From Scenario 4 | AVG | 2.59 | gal/min | AVG | 0.05 | gal/min | |
| From Scenario 5 | PEAK | 98.28 | gal/min | PEAK | 0.40 | gal/min | |
| From Scenario 5 | AVG | 2.49 | gal/min | AVG | 0.05 | gal/min | |
| From Scenario 6 | PEAK | 65.99 | gal/min | PEAK | 0.38 | gal/min | |
| From Scenario 6 | AVG | 2.62 | gal/min | AVG | 0.06 | gal/min | |
| From Scenario 7 | PEAK | 40.73 | gal/min | PEAK | 0.31 | gal/min | |
| From Scenario 7 | AVG | 2.85 | gal/min | AVG | 0.07 | gal/min | |
| From Scenario 8 | PEAK | 202.93 | gal/min | PEAK | 0.88 | gal/min | Used for sizing the leachate |
| From Scenario 8 | AVG | 5.57 | gal/min | AVG | 0.12 | gal/min | collection and detection pumps |
| From Scenario 9 | PEAK | 136.70 | gal/min | PEAK | 0.73 | gal/min | |
| From Scenario 9 | AVG | 5.30 | gal/min | AVG | 0.12 | gal/min | |
| From Scenario 10 | PEAK | 161.53 | gal/min | PEAK | 0.73 | gal/min | |
| From Scenario 10 | AVG | 6.11 | gal/min | AVG | 0.12 | gal/min | |
| From Scenario 11 | PEAK | 142.41 | gal/min | PEAK | 0.64 | gal/min | |
| From Scenario 11 | AVG | 8.52 | gal/min | AVG | 0.14 | gal/min | |

**Leachate Collection System Center and North Portions (4.55 acres)**

| | | | | |
|---|---|---|---|---|
| Worst case Peak Flow = | 202.93 | gal/min | 39,063.50 | cf/day |
| | 44.60 | gal/min/acre | 292,215.25 | gal/day |
| Worst case Average Flow = | 8.52 | gal/min | 1,640.71 | cf/day |
| | 1.87 | gal/min/acre | 12,273.39 | gal/day |

**Leachate Detection System Center and North Portions (4.55 acres)**

| | | | | |
|---|---|---|---|---|
| Worst case Peak Flow = | 0.88 | gal/min | 169.21 | cf/day |
| | 0.19 | gal/min/acre | 1,265.80 | gal/day |
| Worst case Average Flow = | 0.14 | gal/min | 26.73 | cf/day |
| | 0.03 | gal/min/acre | 199.94 | gal/day |

| | | | | | | |
|---|---|---|---|---|---|---|
| Worst case Peak Flow Pumped = | 202.93 | gal/min | + | 0.88 | gal/min | Leachate from the collection and detection |
| = | 203.81 | gal/min | | | | system is pumped to the sideslope risers |
| = | 44.79 | gal/min/acre | | | | |

NOTES:

1.) Leachated generated in Scenarios 1, 2, and 3 in south portion flow directly into the Phase II Section I LCS pipes, no pumping is required.

2.) Northern portion of landfill bottom will have a rain tarp untill filling begins within the area.

3.) Western side slope of the Phase I area will have a rain tarp over the existing sod untill filling begins. The County will remove the rain tarp only within the areas as needed for filling.

| CLIENT | PROJECT | JOB NO. |
|---|---|---|
| Hardee County | Phase II Section II Expansion | 09199033.23 |

| SUBJECT | BY | DATE |
|---|---|---|
| Leachate Generation Estimates | SRF | 4/1/13 |
| **Collection System Phase II Section II and Phase I Side Slope** | CHECKED | DATE |

**Leachate Pumped and Gravity Flow From Phase II Section II Expansion To Phase II Section I Sump**

| Collection | | | | Detection | | | |
|---|---|---|---|---|---|---|---|
| From Scenario 1 | PEAK | 106.79 | gal/min | PEAK | 0.40 | gal/min | |
| From Scenario 1 | AVG | 1.72 | gal/min | AVG | 0.03 | gal/min | |
| From Scenario 2 | PEAK | 59.66 | gal/min | PEAK | 0.29 | gal/min | |
| From Scenario 2 | AVG | 1.48 | gal/min | AVG | 0.03 | gal/min | |
| From Scenario 3 | PEAK | 33.20 | gal/min | PEAK | 0.28 | gal/min | Waste at 25 feet in south |
| From Scenario 3 | AVG | 1.48 | gal/min | AVG | 0.04 | gal/min | portion |
| From Scenario 4 | PEAK | 154.34 | gal/min | PEAK | 0.54 | gal/min | Open cell, just started filling |
| From Scenario 4 | AVG | 2.59 | gal/min | AVG | 0.05 | gal/min | in center portion |
| From Scenario 5 | PEAK | 98.28 | gal/min | PEAK | 0.40 | gal/min | |
| From Scenario 5 | AVG | 2.49 | gal/min | AVG | 0.05 | gal/min | |
| From Scenario 6 | PEAK | 65.99 | gal/min | PEAK | 0.38 | gal/min | |
| From Scenario 6 | AVG | 2.62 | gal/min | AVG | 0.06 | gal/min | |
| From Scenario 7 | PEAK | 40.73 | gal/min | PEAK | 0.31 | gal/min | |
| From Scenario 7 | AVG | 2.85 | gal/min | AVG | 0.07 | gal/min | |
| From Scenario 8 | PEAK | 202.93 | gal/min | PEAK | 0.88 | gal/min | Used for sizing the leachate |
| From Scenario 8 | AVG | 5.57 | gal/min | AVG | 0.12 | gal/min | collection and detection pumps |
| From Scenario 9 | PEAK | 136.70 | gal/min | PEAK | 0.73 | gal/min | |
| From Scenario 9 | AVG | 5.30 | gal/min | AVG | 0.12 | gal/min | |
| From Scenario 10 | PEAK | 161.53 | gal/min | PEAK | 0.73 | gal/min | |
| From Scenario 10 | AVG | 6.11 | gal/min | AVG | 0.12 | gal/min | |
| From Scenario 11 | PEAK | 142.41 | gal/min | PEAK | 0.64 | gal/min | |
| From Scenario 11 | AVG | 8.52 | gal/min | AVG | 0.14 | gal/min | |

**Leachate Collection System and Detection System Center and North Portions (4.55 acres)**

| | | | | | | |
|---|---|---|---|---|---|---|
| Worst case Peak Flow = | 202.93 | gal/min | + | 0.88 | gal/min | Worst case from Scenario 8 leachate |
| = | 203.81 | gal/min | | 39,232.71 | cf/day | pumped to LCS side slope risers |
| = | 44.79 | gal/min/acre | | 293,481.05 | gal/day | which is added to leachate generated |
| | | | | | | from Scenario 3 in south portion |
| Worst case Average Flow = | 5.57 | gal/min | | 1,072.91 | cf/day | (Leachate from the collection and detection |
| | 1.22 | gal/min/acre | | 8,025.93 | gal/day | system is pumped to the sideslope risers) |

**Leachate Collection System South Portion (1.63 acres)**

| | | | | |
|---|---|---|---|---|
| Worst case Peak Flow = | 33.20 | gal/min | | |
| = | 33.20 | gal/min | 6,391.89 | cf/day |
| = | 20.37 | gal/min/acre | 47,814.69 | gal/day |
| Worst case Average Flow = | 1.48 | gal/min | 284.18 | cf/day |
| = | 0.91 | gal/min/acre | 2,125.79 | gal/day |

| | | |
|---|---|---|
| Peak Flow to Phase II Section I = | 237.01 | gal/min |
| Average Flow to Phase II Section I = | 7.05 | gal/min |

NOTES:

1.) Leachated generated in Scenarios 1, 2, and 3 in south portion flow directly into the Phase II Section I LCS pipes, no pumping is required.

2.) Northern portion of landfill bottom will have a rain tarp untill filling begins within the area.

3.) Western side slope of the Phase I area will have a rain tarp over the existing sod untill filling begins. The County will remove the rain tarp only within the areas as needed for filling.

| CLIENT | PROJECT | | JOB NO. |
|---|---|---|---|
| Hardee County | Phase II Section II Expansion | | 09199033.23 |
| SUBJECT | | BY | DATE |
| Leachate Generation Estimates | | SRF | 4/1/13 |
| **Collection System Phase II Section II and Phase I Side Slope** | | CHECKED | DATE |

**Leachate From Phase II Section I To Phase II Section I Sump**

Phase II Section I Area = 5 acres With 40 feet of waste (approximate existing conditions)

| **Collection** | | | | **Detection** | | |
|---|---|---|---|---|---|---|
| From Phase II Section I | PEAK | 74.71 | gal/min | PEAK | 0.93 | gal/min |
| From Phase II Section I | AVG | 4.53 | gal/min | AVG | 0.17 | gal/min |

Phase I South Side Slope Area = 0.65 acres 10 feet of waste

| **Collection** | | | |
|---|---|---|---|
| From Phase I South Slope | PEAK | 23.84 | gal/min |
| From Phase I South Slope | AVG | 0.79 | gal/min |

**Phase II Section I and Phase I South Slope Leachate Collection System**

| | | | | | |
|---|---|---|---|---|---|
| Worst case Peak Flow = | 74.71 | gal/min | + | 23.84 | gal/min |
| = | 98.55 | gal/min | | 18,970.70 | cf/day |
| = | 17.46 | gal/min/acre | | 141,910.68 | gal/day |
| Worst case Average Flow = | 4.53 | gal/min | + | 0.79 | gal/min |
| = | 5.31 | gal/min | | 1,023.06 | cf/day |
| = | 0.94 | gal/min/acre | | 7,652.48 | gal/day |

**Phase II Section I Leachate Detection System**

| | | | | |
|---|---|---|---|---|
| Worst case Peak Flow = | 0.93 | gal/min | 178.56 | cf/day |
| = | 0.19 | gal/min/acre | 1,335.70 | gal/day |
| Worst case Average Flow = | 0.17 | gal/min | 32.11 | cf/day |
| = | 0.03 | gal/min/acre | 240.18 | gal/day |

**Total Leachate Flow From Phase II Section II (North, Center and South Portions), South Side Slope of Phase I, and Phase II Section I To the Existing Phase II Section I Sump**

**Leachate Collection and Detection System North and Center (and Leachate Collection System South Portion) and Leachate Collection System South Side Slope of Phase I and Phase II Section I**

| | | | | | |
|---|---|---|---|---|---|
| Worst case Peak Flow = | 237.01 | gal/min | + | 98.55 | gal/min |
| = | 335.56 | gal/min | | 64,595.30 | cf/day |
| = | 26.91 | gal/min/acre | | 483,206.40 | gal/day |
| Worst case Average Flow = | 7.05 | gal/min | + | 5.31 | gal/min |
| = | 12.36 | gal/min | | 2,380.08 | cf/day |
| = | 0.99 | gal/min/acre | | 17,804.20 | gal/day |

**Leachate Detection System South Portion and Phase II Section I**

| | | | | | |
|---|---|---|---|---|---|
| Worst case Peak Flow = | 0.28 | gal/min | + | 0.93 | gal/min |
| = | 1.21 | gal/min | | 232.90 | cf/day |
| = | 0.18 | gal/min/acre | | 1,742.22 | gal/day |
| Worst case Average Flow = | 0.04 | gal/min | + | 0.17 | gal/min |
| = | 0.21 | gal/min | | 40.50 | cf/day |
| = | 0.03 | gal/min/acre | | 302.98 | gal/day |

NOTES:
1.) Leachated generated in Scenarios 1, 2, and 3 in south portion flow directly into the Phase II Section I LCS pipes, no pumping is required.
2.) Northern portion of landfill bottom will have a rain tarp untill filling begins within the area.
3.) Western side slope of the Phase I area will have a rain tarp over the existing sod untill filling begins. The County will remove the rain tarp only within the areas as needed for filling.

```
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**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**             HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                   **
**              DEVELOPED BY ENVIRONMENTAL LABORATORY                       **
**                 USAE WATERWAYS EXPERIMENT STATION                        **
**           FOR USEPA RISK REDUCTION ENGINEERING LABORATORY                **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************

PRECIPITATION DATA FILE:    C:\HELP\hardee\bottoms\hardrai1.D4
TEMPERATURE DATA FILE:      C:\HELP\hardee\bottoms\hardrai1.D7
SOLAR RADIATION DATA FILE:  C:\HELP\hardee\bottoms\hardrai1.D13
EVAPOTRANSPIRATION DATA:    C:\HELP\hardee\bottoms\hardrai1.D11
SOIL AND DESIGN DATA FILE:  C:\HELP\hardee\bottoms\hardeeop.D10
OUTPUT DATA FILE:           C:\HELP\hardee\bottoms\hardrai1.OUT

TIME:  19:24     DATE:   3/ 5/2013

******************************************************************************
TITLE:  Hardee County Phase II Section II Expansion RAI No. 1
```
**Bottom South Portion (Open Cell - No Waste)**
```
******************************************************************************

     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.

                    LAYER  1 (Drainage Sand 24-inches)
                    --------
                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER   5
           THICKNESS                   =     24.00   INCHES
           POROSITY                    =      0.4570 VOL/VOL
           FIELD CAPACITY              =      0.1310 VOL/VOL
           WILTING POINT               =      0.0580 VOL/VOL
           INITIAL SOIL WATER CONTENT  =      0.1837 VOL/VOL
           EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC

          LAYER  2 (300-mil Bi-planar Geocomposite FabriNet UF)
           --------
                       TYPE 2 - LATERAL DRAINAGE LAYER
                         MATERIAL TEXTURE NUMBER   0
           THICKNESS                   =      0.30   INCHES
           POROSITY                    =      0.8500 VOL/VOL
           FIELD CAPACITY              =      0.0100 VOL/VOL
           WILTING POINT               =      0.0050 VOL/VOL
           INITIAL SOIL WATER CONTENT  =      0.0102 VOL/VOL
           EFFECTIVE SAT. HYD. COND.   =   11.8999996000     CM/SEC
           SLOPE                       =      2.20   PERCENT
           DRAINAGE LENGTH             =     53.1    FEET
```

```
          LAYER  3 (60-mil HDPE geomembrane)
          --------
             TYPE 4 - FLEXIBLE MEMBRANE LINER
               MATERIAL TEXTURE NUMBER  35
THICKNESS                    =      0.06   INCHES
POROSITY                     =      0.0000 VOL/VOL
FIELD CAPACITY               =      0.0000 VOL/VOL
WILTING POINT                =      0.0000 VOL/VOL
INITIAL SOIL WATER CONTENT   =      0.0000 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.199999996000E-12 CM/SEC
FML PINHOLE DENSITY          =      1.00   HOLES/ACRE
FML INSTALLATION DEFECTS     =      1.00   HOLES/ACRE
FML PLACEMENT QUALITY        =  3 - GOOD

LAYER  4 (300-mil Tri-planar Geocomposite TENDRAIN 770-2)
--------
             TYPE 2 - LATERAL DRAINAGE LAYER
               MATERIAL TEXTURE NUMBER   0
THICKNESS                    =      0.30   INCHES
POROSITY                     =      0.8500 VOL/VOL
FIELD CAPACITY               =      0.0100 VOL/VOL
WILTING POINT                =      0.0050 VOL/VOL
INITIAL SOIL WATER CONTENT   =      0.0100 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =   40.7000008000     CM/SEC
SLOPE                        =      2.20   PERCENT
DRAINAGE LENGTH              =     53.1    FEET

          LAYER  5 (60-mil HDPE geomembrane)
          --------
             TYPE 4 - FLEXIBLE MEMBRANE LINER
               MATERIAL TEXTURE NUMBER  35
THICKNESS                    =      0.06   INCHES
POROSITY                     =      0.0000 VOL/VOL
FIELD CAPACITY               =      0.0000 VOL/VOL
WILTING POINT                =      0.0000 VOL/VOL
INITIAL SOIL WATER CONTENT   =      0.0000 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.199999996000E-12 CM/SEC
FML PINHOLE DENSITY          =      1.00   HOLES/ACRE
FML INSTALLATION DEFECTS     =      1.00   HOLES/ACRE
FML PLACEMENT QUALITY        =  3 - GOOD

                    LAYER  6 (GCL)
                    --------
               TYPE 3 - BARRIER SOIL LINER
               MATERIAL TEXTURE NUMBER  17
THICKNESS                    =      0.25   INCHES
POROSITY                     =      0.7500 VOL/VOL
FIELD CAPACITY               =      0.7470 VOL/VOL
WILTING POINT                =      0.4000 VOL/VOL
INITIAL SOIL WATER CONTENT   =      0.7500 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.300000003000E-08 CM/SEC
```

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

---

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE # 5 WITH BARE GROUND CONDITIONS, A SURFACE SLOPE OF 2.% AND A SLOPE LENGTH OF 53. FEET.

| | | | |
|---|---|---|---|
| SCS RUNOFF CURVE NUMBER | = | 85.00 | |
| FRACTION OF AREA ALLOWING RUNOFF | = | 0.0 | PERCENT |
| AREA PROJECTED ON HORIZONTAL PLANE | = | 1.000 | ACRES |
| EVAPORATIVE ZONE DEPTH | = | 10.0 | INCHES |
| INITIAL WATER IN EVAPORATIVE ZONE | = | 1.827 | INCHES |
| UPPER LIMIT OF EVAPORATIVE STORAGE | = | 4.570 | INCHES |
| LOWER LIMIT OF EVAPORATIVE STORAGE | = | 0.580 | INCHES |
| INITIAL SNOW WATER | = | 0.000 | INCHES |
| INITIAL WATER IN LAYER MATERIALS | = | 4.603 | INCHES |
| TOTAL INITIAL WATER | = | 4.603 | INCHES |
| TOTAL SUBSURFACE INFLOW | = | 0.00 | INCHES/YEAR |

EVAPOTRANSPIRATION AND WEATHER DATA

---

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM TAMPA FLORIDA

| | | | |
|---|---|---|---|
| STATION LATITUDE | = | 27.58 | DEGREES |
| MAXIMUM LEAF AREA INDEX | = | 0.00 | |
| START OF GROWING SEASON (JULIAN DATE) | = | 0 | |
| END OF GROWING SEASON (JULIAN DATE) | = | 367 | |
| EVAPORATIVE ZONE DEPTH | = | 10.0 | INCHES |
| AVERAGE ANNUAL WIND SPEED | = | 8.60 | MPH |
| AVERAGE 1ST QUARTER RELATIVE HUMIDITY | = | 74.00 | % |
| AVERAGE 2ND QUARTER RELATIVE HUMIDITY | = | 72.00 | % |
| AVERAGE 3RD QUARTER RELATIVE HUMIDITY | = | 78.00 | % |
| AVERAGE 4TH QUARTER RELATIVE HUMIDITY | = | 76.00 | % |

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR TAMPA FLORIDA

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

| JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|
| 1.85 | 2.58 | 3.39 | 2.95 | 2.52 | 8.31 |
| 7.83 | 7.98 | 5.61 | 2.86 | 1.94 | 1.84 |

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR TAMPA FLORIDA

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL FEB/AUG MAR/SEP APR/OCT MAY/NOV JUN/DEC

| ------- | ------- | ------- | ------- | ------- | ------- |
|---|---|---|---|---|---|
| 59.80 | 60.80 | 66.20 | 71.60 | 77.10 | 80.90 |
| 82.20 | 82.20 | 80.90 | 74.50 | 66.70 | 61.30 |

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR TAMPA FLORIDA
AND STATION LATITUDE = 27.58 DEGREES

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 28

| | JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|---|
| **PRECIPITATION** | | | | | | |
| TOTALS | 1.82 | 2.13 | 3.38 | 2.54 | 3.05 | 7.89 |
| | 8.50 | 7.72 | 5.34 | 2.65 | 1.83 | 1.84 |
| STD. DEVIATIONS | 1.56 | 2.17 | 2.92 | 1.84 | 2.10 | 3.63 |
| | 3.41 | 2.59 | 2.44 | 2.42 | 2.77 | 2.09 |
| **RUNOFF** | | | | | | |
| TOTALS | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| STD. DEVIATIONS | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| **EVAPOTRANSPIRATION** | | | | | | |
| TOTALS | 1.276 | 1.223 | 1.852 | 1.713 | 1.833 | 3.929 |
| | 4.656 | 4.317 | 3.272 | 1.710 | 1.100 | 1.005 |
| STD. DEVIATIONS | 0.796 | 0.858 | 1.176 | 0.904 | 1.054 | 1.195 |
| | 1.041 | 1.068 | 0.990 | 0.929 | 0.781 | 0.763 |
| **LATERAL DRAINAGE COLLECTED FROM LAYER 2** | | | | | | |
| TOTALS | 0.5047 | 0.7189 | 1.2996 | 0.7604 | 1.0604 | 2.8942 |
| | 3.9592 | 3.4038 | 2.3643 | 1.5467 | 1.1053 | 0.7936 |
| STD. DEVIATIONS | 0.5272 | 1.2821 | 1.9427 | 0.6624 | 0.9583 | 2.4216 |
| | 2.4743 | 1.7575 | 1.7561 | 1.5039 | 1.8846 | 1.3141 |
| **PERCOLATION/LEAKAGE THROUGH LAYER 3** | | | | | | |
| TOTALS | 0.0206 | 0.0212 | 0.0293 | 0.0252 | 0.0292 | 0.0429 |
| | 0.0578 | 0.0567 | 0.0450 | 0.0363 | 0.0272 | 0.0225 |
| STD. DEVIATIONS | 0.0086 | 0.0115 | 0.0180 | 0.0108 | 0.0111 | 0.0205 |
| | 0.0197 | 0.0146 | 0.0139 | 0.0138 | 0.0156 | 0.0141 |

LATERAL DRAINAGE COLLECTED FROM LAYER 4

| | | | | | | |
|---|---|---|---|---|---|---|
| TOTALS | 0.0206 | 0.0212 | 0.0293 | 0.0252 | 0.0292 | 0.0429 |
| | 0.0578 | 0.0567 | 0.0450 | 0.0363 | 0.0272 | 0.0225 |
| STD. DEVIATIONS | 0.0086 | 0.0115 | 0.0180 | 0.0108 | 0.0111 | 0.0205 |
| | 0.0197 | 0.0146 | 0.0139 | 0.0138 | 0.0156 | 0.0141 |

PERCOLATION/LEAKAGE THROUGH LAYER 6

| | | | | | | |
|---|---|---|---|---|---|---|
| TOTALS | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| STD. DEVIATIONS | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

---

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

---

DAILY AVERAGE HEAD ON TOP OF LAYER 3

| | | | | | | |
|---|---|---|---|---|---|---|
| AVERAGES | 0.0006 | 0.0009 | 0.0015 | 0.0009 | 0.0012 | 0.0035 |
| | 0.0049 | 0.0039 | 0.0028 | 0.0018 | 0.0013 | 0.0009 |
| STD. DEVIATIONS | 0.0006 | 0.0016 | 0.0022 | 0.0008 | 0.0011 | 0.0029 |
| | 0.0038 | 0.0020 | 0.0021 | 0.0017 | 0.0022 | 0.0015 |

DAILY AVERAGE HEAD ON TOP OF LAYER 5

| | | | | | | |
|---|---|---|---|---|---|---|
| AVERAGES | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0002 |
| | 0.0003 | 0.0003 | 0.0002 | 0.0002 | 0.0001 | 0.0001 |
| STD. DEVIATIONS | 0.0000 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 |
| | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 |

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 28

| | INCHES | CU. FEET | PERCENT |
|---|---|---|---|
| PRECIPITATION | 48.67 ( 9.518) | 176683.8 | 100.00 |
| RUNOFF | 0.000 ( 0.0000) | 0.00 | 0.000 |
| EVAPOTRANSPIRATION | 27.888 ( 4.3435) | 101231.80 | 57.295 |
| LATERAL DRAINAGE COLLECTED FROM LAYER 2 | 20.41107 ( 6.21105) | 74092.195 | 41.93492 |
| PERCOLATION/LEAKAGE THROUGH LAYER 3 | 0.41384 ( 0.05952) | 1502.230 | 0.85024 |

```
 AVERAGE HEAD ON TOP             0.002 (    0.001)
  OF LAYER  3

LATERAL DRAINAGE COLLECTED    0.41384 (  0.05952)      1502.230    0.85024
  FROM LAYER  4

PERCOLATION/LEAKAGE THROUGH  0.00000 (  0.00000)         0.000    0.00000
  LAYER  6

AVERAGE HEAD ON TOP             0.000 (    0.000)
  OF LAYER  5

CHANGE IN WATER STORAGE       -0.039   (  0.8487)       -142.42     -0.081

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              PEAK DAILY VALUES FOR YEARS    1 THROUGH   28
    --------------------------------------------------------------------------
                                                (INCHES)      (CU. FT.)
                                               ----------   -------------
      PRECIPITATION                               7.60         27588.000

      RUNOFF                                      0.000            0.0000

      DRAINAGE COLLECTED FROM LAYER  2          3.47436      12611.94530

      PERCOLATION/LEAKAGE THROUGH LAYER  3      0.012856        46.66630

      AVERAGE HEAD ON TOP OF LAYER  3            0.360

      MAXIMUM HEAD ON TOP OF LAYER  3            0.280

      LOCATION OF MAXIMUM HEAD IN LAYER  2
            (DISTANCE FROM DRAIN)                3.3 FEET

      DRAINAGE COLLECTED FROM LAYER  4          0.01286         46.66630

      PERCOLATION/LEAKAGE THROUGH LAYER  6      0.000000         0.00000

      AVERAGE HEAD ON TOP OF LAYER  5            0.002

      MAXIMUM HEAD ON TOP OF LAYER  5            0.000

      LOCATION OF MAXIMUM HEAD IN LAYER  4
            (DISTANCE FROM DRAIN)                0.0 FEET

      SNOW WATER                                 0.00              0.0000

      MAXIMUM VEG. SOIL WATER (VOL/VOL)                  0.4570

      MINIMUM VEG. SOIL WATER (VOL/VOL)                  0.0580

       ***  Maximum heads are computed using McEnroe's equations.  ***

            Reference:  Maximum Saturated Depth over Landfill Liner
                        by Bruce M. McEnroe, University of Kansas
                        ASCE Journal of Environmental Engineering
                        Vol. 119, No. 2, March 1993, pp. 262-270.

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FINAL WATER STORAGE AT END OF YEAR 28

| LAYER | (INCHES) | (VOL/VOL) |
|---|---|---|
| 1 | 3.3109 | 0.1380 |
| 2 | 0.0031 | 0.0104 |
| 3 | 0.0000 | 0.0000 |
| 4 | 0.0030 | 0.0100 |
| 5 | 0.0000 | 0.0000 |
| 6 | 0.1875 | 0.7500 |
| SNOW WATER | 0.000 | |

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**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************

PRECIPITATION DATA FILE:    C:\HELP\hardee\bots10\hardrai1.D4
TEMPERATURE DATA FILE:      C:\HELP\hardee\bots10\hardrai1.D7
SOLAR RADIATION DATA FILE:  C:\HELP\hardee\bots10\hardrai1.D13
EVAPOTRANSPIRATION DATA:    C:\HELP\hardee\bots10\hardrai1.D11
SOIL AND DESIGN DATA FILE:  C:\HELP\hardee\bots10\hardee10.D10
OUTPUT DATA FILE:           C:\HELP\hardee\bots10\hardee10.OUT

TIME:   6: 0     DATE:   3/ 6/2013

*****************************************************************************
TITLE:  Hardee County Phase II Section II Expansion RAI No. 1
Bottom South Portion (10 Feet Waste)
*****************************************************************************

     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.

                      LAYER  1 (Daily Cover 6-inches)
                      --------
                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER   5
           THICKNESS                   =      6.00    INCHES
           POROSITY                    =      0.4570 VOL/VOL
           FIELD CAPACITY              =      0.1310 VOL/VOL
           WILTING POINT               =      0.0580 VOL/VOL
           INITIAL SOIL WATER CONTENT  =      0.1989 VOL/VOL
           EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC
         NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  1.80
                  FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.

                      LAYER  2 (10 Feet Waste)
                      --------
                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER  19
           THICKNESS                   =    120.00    INCHES
           POROSITY                    =      0.1680 VOL/VOL
           FIELD CAPACITY              =      0.0730 VOL/VOL
           WILTING POINT               =      0.0190 VOL/VOL
           INITIAL SOIL WATER CONTENT  =      0.0724 VOL/VOL
           EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC
```

```
          LAYER  3 (Drainage Sand 24-inches)
          --------
           TYPE 1 - VERTICAL PERCOLATION LAYER
               MATERIAL TEXTURE NUMBER   5
 THICKNESS                     =    24.00   INCHES
 POROSITY                      =     0.4570 VOL/VOL
 FIELD CAPACITY                =     0.1310 VOL/VOL
 WILTING POINT                 =     0.0580 VOL/VOL
 INITIAL SOIL WATER CONTENT    =     0.1794 VOL/VOL
 EFFECTIVE SAT. HYD. COND.     =  0.100000005000E-02 CM/SEC

 LAYER  4 (300-mil Bi-planar Geocomposite FabriNet UF)
 --------
             TYPE 2 - LATERAL DRAINAGE LAYER
               MATERIAL TEXTURE NUMBER   0
 THICKNESS                     =     0.30   INCHES
 POROSITY                      =     0.8500 VOL/VOL
 FIELD CAPACITY                =     0.0100 VOL/VOL
 WILTING POINT                 =     0.0050 VOL/VOL
 INITIAL SOIL WATER CONTENT    =     0.0106 VOL/VOL
 EFFECTIVE SAT. HYD. COND.     =   11.8999996000     CM/SEC
 SLOPE                         =     2.20   PERCENT
 DRAINAGE LENGTH               =    53.1    FEET

          LAYER  5 (60-mil HDPE geomembrane)
          --------
             TYPE 4 - FLEXIBLE MEMBRANE LINER
               MATERIAL TEXTURE NUMBER  35
 THICKNESS                     =     0.06   INCHES
 POROSITY                      =     0.0000 VOL/VOL
 FIELD CAPACITY                =     0.0000 VOL/VOL
 WILTING POINT                 =     0.0000 VOL/VOL
 INITIAL SOIL WATER CONTENT    =     0.0000 VOL/VOL
 EFFECTIVE SAT. HYD. COND.     =  0.199999996000E-12 CM/SEC
 FML PINHOLE DENSITY           =     1.00   HOLES/ACRE
 FML INSTALLATION DEFECTS      =     1.00   HOLES/ACRE
 FML PLACEMENT QUALITY         =  3 - GOOD

LAYER  6 (300-mil Tri-planar Geocomposite TENDRAIN 770-2)
--------
             TYPE 2 - LATERAL DRAINAGE LAYER
               MATERIAL TEXTURE NUMBER   0
 THICKNESS                     =     0.30   INCHES
 POROSITY                      =     0.8500 VOL/VOL
 FIELD CAPACITY                =     0.0100 VOL/VOL
 WILTING POINT                 =     0.0050 VOL/VOL
 INITIAL SOIL WATER CONTENT    =     0.0100 VOL/VOL
 EFFECTIVE SAT. HYD. COND.     =   40.7000008000     CM/SEC
 SLOPE                         =     2.20   PERCENT
 DRAINAGE LENGTH               =    53.1    FEET
```

```
            LAYER  7 (60-mil HDPE geomembrane)
            --------
               TYPE 4 - FLEXIBLE MEMBRANE LINER
                 MATERIAL TEXTURE NUMBER  35
   THICKNESS                  =     0.06   INCHES
   POROSITY                   =     0.0000 VOL/VOL
   FIELD CAPACITY             =     0.0000 VOL/VOL
   WILTING POINT              =     0.0000 VOL/VOL
   INITIAL SOIL WATER CONTENT  =     0.0000 VOL/VOL
   EFFECTIVE SAT. HYD. COND.   =  0.199999996000E-12 CM/SEC
   FML PINHOLE DENSITY        =     1.00   HOLES/ACRE
   FML INSTALLATION DEFECTS    =     1.00   HOLES/ACRE
   FML PLACEMENT QUALITY       =  3 - GOOD

                      LAYER  8 (GCL)
                      --------
                 TYPE 3 - BARRIER SOIL LINER
                 MATERIAL TEXTURE NUMBER  17
   THICKNESS                  =     0.25   INCHES
   POROSITY                   =     0.7500 VOL/VOL
   FIELD CAPACITY             =     0.7470 VOL/VOL
   WILTING POINT              =     0.4000 VOL/VOL
   INITIAL SOIL WATER CONTENT  =     0.7500 VOL/VOL
   EFFECTIVE SAT. HYD. COND.   =  0.300000003000E-08 CM/SEC

           GENERAL DESIGN AND EVAPORATIVE ZONE DATA
           ----------------------------------------

  NOTE:  SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
           SOIL DATA BASE USING SOIL TEXTURE # 5 WITH A
           POOR STAND OF GRASS, A SURFACE SLOPE OF  2.%
           AND A SLOPE LENGTH OF   53. FEET.

SCS RUNOFF CURVE NUMBER             =    79.20
FRACTION OF AREA ALLOWING RUNOFF    =     0.0    PERCENT
AREA PROJECTED ON HORIZONTAL PLANE  =     1.000  ACRES
EVAPORATIVE ZONE DEPTH              =    10.0    INCHES
INITIAL WATER IN EVAPORATIVE ZONE   =     1.411  INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE  =     3.414  INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE  =     0.424  INCHES
INITIAL SNOW WATER                  =     0.000  INCHES
INITIAL WATER IN LAYER MATERIALS    =    14.380  INCHES
TOTAL INITIAL WATER                 =    14.380  INCHES
TOTAL SUBSURFACE INFLOW             =     0.00   INCHES/YEAR

            EVAPOTRANSPIRATION AND WEATHER DATA
            -----------------------------------

  NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
           TAMPA                 FLORIDA

     STATION LATITUDE                        =  27.58 DEGREES
     MAXIMUM LEAF AREA INDEX                 =   1.00
```

```
START OF GROWING SEASON (JULIAN DATE)  =      0
END OF GROWING SEASON (JULIAN DATE)    =    367
EVAPORATIVE ZONE DEPTH                 =  10.0  INCHES
AVERAGE ANNUAL WIND SPEED              =   8.60 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY  =  74.00 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY  =  72.00 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY  =  78.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY  =  76.00 %
```

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR TAMPA FLORIDA

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

| JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|
| 1.85 | 2.58 | 3.39 | 2.95 | 2.52 | 8.31 |
| 7.83 | 7.98 | 5.61 | 2.86 | 1.94 | 1.84 |

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR TAMPA FLORIDA

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

| JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|
| 59.80 | 60.80 | 66.20 | 71.60 | 77.10 | 80.90 |
| 82.20 | 82.20 | 80.90 | 74.50 | 66.70 | 61.30 |

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR TAMPA FLORIDA
AND STATION LATITUDE = 27.58 DEGREES

***************************************************************************

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 28

---------------------------------------------------------------------------

| | JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|---|
| **PRECIPITATION** | | | | | | |
| TOTALS | 1.82 | 2.13 | 3.38 | 2.54 | 3.05 | 7.89 |
| | 8.50 | 7.72 | 5.34 | 2.65 | 1.83 | 1.84 |
| STD. DEVIATIONS | 1.56 | 2.17 | 2.92 | 1.84 | 2.10 | 3.63 |
| | 3.41 | 2.59 | 2.44 | 2.42 | 2.77 | 2.09 |
| **RUNOFF** | | | | | | |
| TOTALS | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| STD. DEVIATIONS | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |

```
                     0.000    0.000    0.000    0.000    0.000    0.000

 EVAPOTRANSPIRATION
 ------------------
   TOTALS            1.216    1.352    2.074    1.895    2.105    4.555
                     5.287    4.925    3.558    1.760    1.081    0.950

   STD. DEVIATIONS   0.833    0.924    1.337    1.090    1.206    1.257
                     1.181    1.120    1.176    1.131    0.820    0.785

 LATERAL DRAINAGE COLLECTED FROM LAYER  4
 ----------------------------------------
   TOTALS           0.5119   0.6473   1.1193   0.7043   0.8136   1.9390
                    3.1396   2.9737   2.3195   1.4989   1.0473   0.8388

   STD. DEVIATIONS  0.4830   1.2514   1.8061   0.8392   0.8675   1.9381
                    2.1590   1.5598   1.7735   1.3749   1.5792   1.3799

 PERCOLATION/LEAKAGE THROUGH LAYER  5
 ------------------------------------
   TOTALS           0.0215   0.0220   0.0286   0.0248   0.0262   0.0369
                    0.0519   0.0539   0.0464   0.0375   0.0287   0.0245

   STD. DEVIATIONS  0.0103   0.0139   0.0189   0.0129   0.0112   0.0200
                    0.0214   0.0154   0.0166   0.0144   0.0149   0.0168

 LATERAL DRAINAGE COLLECTED FROM LAYER  6
 ----------------------------------------
   TOTALS           0.0215   0.0220   0.0286   0.0248   0.0262   0.0369
                    0.0519   0.0539   0.0464   0.0375   0.0287   0.0245

   STD. DEVIATIONS  0.0103   0.0139   0.0189   0.0129   0.0112   0.0200
                    0.0214   0.0154   0.0166   0.0144   0.0149   0.0168

 PERCOLATION/LEAKAGE THROUGH LAYER  8
 ------------------------------------
   TOTALS           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                    0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

   STD. DEVIATIONS  0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                    0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

-----------------------------------------------------------------------------
             AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)
----------------------------------------------------------------------------

 DAILY AVERAGE HEAD ON TOP OF LAYER  5
 -------------------------------------
   AVERAGES         0.0006   0.0008   0.0013   0.0008   0.0009   0.0023
                    0.0036   0.0034   0.0028   0.0017   0.0012   0.0010

   STD. DEVIATIONS  0.0006   0.0016   0.0021   0.0010   0.0010   0.0023
                    0.0025   0.0018   0.0021   0.0016   0.0019   0.0016
```

DAILY AVERAGE HEAD ON TOP OF LAYER 7

| | | | | | | |
|---|---|---|---|---|---|---|
| AVERAGES | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0002 |
| | 0.0002 | 0.0003 | 0.0002 | 0.0002 | 0.0001 | 0.0001 |
| STD. DEVIATIONS | 0.0000 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 |
| | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 |

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 28

| | INCHES | | CU. FEET | PERCENT |
|---|---|---|---|---|
| PRECIPITATION | 48.67 | ( 9.518) | 176683.8 | 100.00 |
| RUNOFF | 0.000 | ( 0.0000) | 0.00 | 0.000 |
| EVAPOTRANSPIRATION | 30.757 | ( 4.7107) | 111647.02 | 63.190 |
| LATERAL DRAINAGE COLLECTED FROM LAYER 4 | 17.55296 | (5.94249) | 63717.250 | 36.06288 |
| PERCOLATION/LEAKAGE THROUGH LAYER 5 | 0.40278 | (0.06896) | 1462.094 | 0.82752 |
| AVERAGE HEAD ON TOP OF LAYER 5 | 0.002 | ( 0.001) | | |
| LATERAL DRAINAGE COLLECTED FROM LAYER 6 | 0.40278 | (0.06896) | 1462.093 | 0.82752 |
| PERCOLATION/LEAKAGE THROUGH LAYER 8 | 0.00000 | ( 0.00000) | 0.000 | 0.00000 |
| AVERAGE HEAD ON TOP OF LAYER 7 | 0.000 | ( 0.000) | | |
| CHANGE IN WATER STORAGE | -0.039 | ( 1.1827) | -142.59 | -0.081 |

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                PEAK DAILY VALUES FOR YEARS    1 THROUGH   28
    ---------------------------------------------------------------------------
                                                     (INCHES)      (CU. FT.)
                                                    ----------   -------------
       PRECIPITATION                                  7.60         27588.000

       RUNOFF                                         0.000            0.0000

       DRAINAGE COLLECTED FROM LAYER  4              1.94100       7045.81982

       PERCOLATION/LEAKAGE THROUGH LAYER  5          0.009537        34.61891

       AVERAGE HEAD ON TOP OF LAYER  5                0.069

       MAXIMUM HEAD ON TOP OF LAYER  5                0.134

       LOCATION OF MAXIMUM HEAD IN LAYER  4
             (DISTANCE FROM DRAIN)                    1.9 FEET

       DRAINAGE COLLECTED FROM LAYER  6              0.00954         34.61891

       PERCOLATION/LEAKAGE THROUGH LAYER  8          0.000000         0.00000

       AVERAGE HEAD ON TOP OF LAYER  7                0.001

       MAXIMUM HEAD ON TOP OF LAYER  7                0.001

       LOCATION OF MAXIMUM HEAD IN LAYER  6
             (DISTANCE FROM DRAIN)                    0.0 FEET

       SNOW WATER                                     0.00             0.0000

       MAXIMUM VEG. SOIL WATER (VOL/VOL)                      0.3182

       MINIMUM VEG. SOIL WATER (VOL/VOL)                      0.0424

        ***  Maximum heads are computed using McEnroe's equations.  ***

             Reference:  Maximum Saturated Depth over Landfill Liner
                         by Bruce M. McEnroe, University of Kansas
                         ASCE Journal of Environmental Engineering
                         Vol. 119, No. 2, March 1993, pp. 262-270.

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FINAL WATER STORAGE AT END OF YEAR 28

| LAYER | (INCHES) | (VOL/VOL) |
|---|---|---|
| 1 | 0.3324 | 0.0554 |
| 2 | 8.5597 | 0.0713 |
| 3 | 4.1939 | 0.1747 |
| 4 | 0.0031 | 0.0104 |
| 5 | 0.0000 | 0.0000 |
| 6 | 0.0030 | 0.0100 |
| 7 | 0.0000 | 0.0000 |
| 8 | 0.1875 | 0.7500 |
| SNOW WATER | 0.000 | |

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**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
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PRECIPITATION DATA FILE:     C:\HELP\hardee\bots25\hardrai1.D4
TEMPERATURE DATA FILE:       C:\HELP\hardee\bots25\hardrai1.D7
SOLAR RADIATION DATA FILE:   C:\HELP\hardee\bots25\hardrai1.D13
EVAPOTRANSPIRATION DATA:     C:\HELP\hardee\bots25\hardrai1.D11
SOIL AND DESIGN DATA FILE:   C:\HELP\hardee\bots25\hardee25.D10
OUTPUT DATA FILE:            C:\HELP\hardee\bots25\hardee25.OUT

TIME:   5:53     DATE:   3/ 6/2013

****************************************************************************
TITLE:  Hardee County Phase II Section II Expansion RAI No. 1
Bottom South Portion (25 Feet Waste)
****************************************************************************

     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
            COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.

                      LAYER  1 (Daily Cover 6-inches)
                      --------
                    TYPE 1 - VERTICAL PERCOLATION LAYER
                        MATERIAL TEXTURE NUMBER   5
          THICKNESS                  =      6.00   INCHES
          POROSITY                   =      0.4570 VOL/VOL
          FIELD CAPACITY             =      0.1310 VOL/VOL
          WILTING POINT              =      0.0580 VOL/VOL
          INITIAL SOIL WATER CONTENT =      0.1982 VOL/VOL
          EFFECTIVE SAT. HYD. COND.  =  0.100000005000E-02 CM/SEC
        NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  1.80
                 FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.

                      LAYER  2 (5 Feet Waste)
                      --------
                    TYPE 1 - VERTICAL PERCOLATION LAYER
                        MATERIAL TEXTURE NUMBER  19
          THICKNESS                  =     60.00   INCHES
          POROSITY                   =      0.1680 VOL/VOL
          FIELD CAPACITY             =      0.0730 VOL/VOL
          WILTING POINT              =      0.0190 VOL/VOL
          INITIAL SOIL WATER CONTENT =      0.0718 VOL/VOL
          EFFECTIVE SAT. HYD. COND.  =  0.100000005000E-02 CM/SEC
```

```
            LAYER  3 (10 Feet Waste)
            --------
          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  19
THICKNESS                   =    120.00   INCHES
POROSITY                    =      0.1680 VOL/VOL
FIELD CAPACITY              =      0.0730 VOL/VOL
WILTING POINT               =      0.0190 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.0730 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC

            LAYER  4 (10 Feet Waste)
            --------
          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  19
THICKNESS                   =    120.00   INCHES
POROSITY                    =      0.1680 VOL/VOL
FIELD CAPACITY              =      0.0730 VOL/VOL
WILTING POINT               =      0.0190 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.0730 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC

          LAYER  5 (Drainage Sand 24-inches)
          --------
          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER   5
THICKNESS                   =     24.00   INCHES
POROSITY                    =      0.4570 VOL/VOL
FIELD CAPACITY              =      0.1310 VOL/VOL
WILTING POINT               =      0.0580 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.1800 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC

LAYER  6 (300-mil Bi-planar Geocomposite FabriNet UF)
--------
            TYPE 2 - LATERAL DRAINAGE LAYER
              MATERIAL TEXTURE NUMBER   0
THICKNESS                   =      0.27   INCHES
POROSITY                    =      0.8500 VOL/VOL
FIELD CAPACITY              =      0.0100 VOL/VOL
WILTING POINT               =      0.0050 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.0110 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =   7.19999981000     CM/SEC
SLOPE                       =      2.20   PERCENT
DRAINAGE LENGTH             =     53.1    FEET

          LAYER  7 (60-mil HDPE geomembrane)
          --------
            TYPE 4 - FLEXIBLE MEMBRANE LINER
              MATERIAL TEXTURE NUMBER  35
THICKNESS                   =      0.06   INCHES
POROSITY                    =      0.0000 VOL/VOL
FIELD CAPACITY              =      0.0000 VOL/VOL
```

```
   WILTING POINT                =      0.0000 VOL/VOL
   INITIAL SOIL WATER CONTENT   =      0.0000 VOL/VOL
   EFFECTIVE SAT. HYD. COND.    =  0.199999996000E-12 CM/SEC
   FML PINHOLE DENSITY          =      1.00   HOLES/ACRE
   FML INSTALLATION DEFECTS     =      1.00   HOLES/ACRE
   FML PLACEMENT QUALITY        =  3 - GOOD

LAYER  8 (300-mil Tri-planar Geocomposite TENDRAIN 770-2)
--------
              TYPE 2 - LATERAL DRAINAGE LAYER
                MATERIAL TEXTURE NUMBER   0
   THICKNESS                    =      0.27   INCHES
   POROSITY                     =      0.8500 VOL/VOL
   FIELD CAPACITY               =      0.0100 VOL/VOL
   WILTING POINT                =      0.0050 VOL/VOL
   INITIAL SOIL WATER CONTENT   =      0.0100 VOL/VOL
   EFFECTIVE SAT. HYD. COND.    =   29.3999996000     CM/SEC
   SLOPE                        =      2.20   PERCENT
   DRAINAGE LENGTH              =     53.1    FEET

           LAYER  9 (60-mil HDPE geomembrane)
           --------
              TYPE 4 - FLEXIBLE MEMBRANE LINER
                MATERIAL TEXTURE NUMBER  35
   THICKNESS                    =      0.06   INCHES
   POROSITY                     =      0.0000 VOL/VOL
   FIELD CAPACITY               =      0.0000 VOL/VOL
   WILTING POINT                =      0.0000 VOL/VOL
   INITIAL SOIL WATER CONTENT   =      0.0000 VOL/VOL
   EFFECTIVE SAT. HYD. COND.    =  0.199999996000E-12 CM/SEC
   FML PINHOLE DENSITY          =      1.00   HOLES/ACRE
   FML INSTALLATION DEFECTS     =      1.00   HOLES/ACRE
   FML PLACEMENT QUALITY        =  3 - GOOD

                     LAYER  10 (GCL)
                      --------
                TYPE 3 - BARRIER SOIL LINER
                MATERIAL TEXTURE NUMBER  17
   THICKNESS                    =      0.25   INCHES
   POROSITY                     =      0.7500 VOL/VOL
   FIELD CAPACITY               =      0.7470 VOL/VOL
   WILTING POINT                =      0.4000 VOL/VOL
   INITIAL SOIL WATER CONTENT   =      0.7500 VOL/VOL
   EFFECTIVE SAT. HYD. COND.    =  0.300000003000E-08 CM/SEC

          GENERAL DESIGN AND EVAPORATIVE ZONE DATA
          ----------------------------------------

 NOTE:  SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
          SOIL DATA BASE USING SOIL TEXTURE # 5 WITH A
          POOR STAND OF GRASS, A SURFACE SLOPE OF  2.%
          AND A SLOPE LENGTH OF   53. FEET.
```

```
SCS RUNOFF CURVE NUMBER              =     79.20
FRACTION OF AREA ALLOWING RUNOFF     =      0.0    PERCENT
AREA PROJECTED ON HORIZONTAL PLANE   =      1.000  ACRES
EVAPORATIVE ZONE DEPTH               =     10.0    INCHES
INITIAL WATER IN EVAPORATIVE ZONE    =      1.410  INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE   =      3.414  INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE   =      0.424  INCHES
INITIAL SNOW WATER                   =      0.000  INCHES
INITIAL WATER IN LAYER MATERIALS     =     27.530  INCHES
TOTAL INITIAL WATER                  =     27.530  INCHES
TOTAL SUBSURFACE INFLOW              =      0.00   INCHES/YEAR
```

EVAPOTRANSPIRATION AND WEATHER DATA

```
NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
         TAMPA                FLORIDA

     STATION LATITUDE                         =  27.58 DEGREES
     MAXIMUM LEAF AREA INDEX                  =   1.00
     START OF GROWING SEASON (JULIAN DATE)    =      0
     END OF GROWING SEASON (JULIAN DATE)      =    367
     EVAPORATIVE ZONE DEPTH                   =  10.0  INCHES
     AVERAGE ANNUAL WIND SPEED                =   8.60 MPH
     AVERAGE 1ST QUARTER RELATIVE HUMIDITY    =  74.00 %
     AVERAGE 2ND QUARTER RELATIVE HUMIDITY    =  72.00 %
     AVERAGE 3RD QUARTER RELATIVE HUMIDITY    =  78.00 %
     AVERAGE 4TH QUARTER RELATIVE HUMIDITY    =  76.00 %

NOTE:  PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
         COEFFICIENTS FOR    TAMPA              FLORIDA
```

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

| JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|
| 1.85 | 2.58 | 3.39 | 2.95 | 2.52 | 8.31 |
| 7.83 | 7.98 | 5.61 | 2.86 | 1.94 | 1.84 |

```
NOTE:  TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
         COEFFICIENTS FOR    TAMPA              FLORIDA
```

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

| JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|
| 59.80 | 60.80 | 66.20 | 71.60 | 77.10 | 80.90 |
| 82.20 | 82.20 | 80.90 | 74.50 | 66.70 | 61.30 |

```
NOTE:  SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
         COEFFICIENTS FOR    TAMPA              FLORIDA
           AND STATION LATITUDE  =  27.58 DEGREES
```

```
*******************************************************************************
        AVERAGE MONTHLY VALUES IN INCHES FOR YEARS    1 THROUGH   28
-------------------------------------------------------------------------------

                          JAN/JUL  FEB/AUG  MAR/SEP  APR/OCT  MAY/NOV  JUN/DEC
                          -------  -------  -------  -------  -------  -------
   PRECIPITATION
   -------------
     TOTALS                 1.82     2.13     3.38     2.54     3.05     7.89
                            8.50     7.72     5.34     2.65     1.83     1.84

     STD. DEVIATIONS        1.56     2.17     2.92     1.84     2.10     3.63
                            3.41     2.59     2.44     2.42     2.77     2.09

   RUNOFF
   ------
     TOTALS                0.000    0.000    0.000    0.000    0.000    0.000
                           0.000    0.000    0.000    0.000    0.000    0.000

     STD. DEVIATIONS       0.000    0.000    0.000    0.000    0.000    0.000
                           0.000    0.000    0.000    0.000    0.000    0.000

   EVAPOTRANSPIRATION
   ------------------
     TOTALS                1.207    1.348    2.064    1.894    2.091    4.556
                           5.277    4.915    3.535    1.753    1.077    0.947

     STD. DEVIATIONS       0.828    0.919    1.337    1.086    1.194    1.234
                           1.176    1.115    1.154    1.120    0.817    0.785

   LATERAL DRAINAGE COLLECTED FROM LAYER  6
   ----------------------------------------
     TOTALS               0.5369   0.6154   1.0739   0.8121   0.6770   1.4669
                          3.2209   3.2043   2.4266   1.5772   1.0444   0.8748

     STD. DEVIATIONS      0.6549   1.2064   1.7443   0.9340   0.6987   1.6776
                          2.1310   1.8537   1.7823   1.4643   1.4963   1.6016

   PERCOLATION/LEAKAGE THROUGH LAYER  7
   ------------------------------------
     TOTALS               0.0280   0.0280   0.0357   0.0334   0.0318   0.0414
                          0.0674   0.0712   0.0612   0.0500   0.0374   0.0324

     STD. DEVIATIONS      0.0156   0.0176   0.0236   0.0181   0.0132   0.0231
                          0.0284   0.0238   0.0212   0.0197   0.0189   0.0241

   LATERAL DRAINAGE COLLECTED FROM LAYER  8
   ----------------------------------------
     TOTALS               0.0280   0.0280   0.0357   0.0334   0.0318   0.0414
                          0.0674   0.0712   0.0612   0.0500   0.0374   0.0324

     STD. DEVIATIONS      0.0156   0.0176   0.0236   0.0181   0.0132   0.0231
                          0.0284   0.0238   0.0212   0.0197   0.0189   0.0241
```

PERCOLATION/LEAKAGE THROUGH LAYER 10

| | | | | | | |
|---|---|---|---|---|---|---|
| TOTALS | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| STD. DEVIATIONS | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 7

| | | | | | | |
|---|---|---|---|---|---|---|
| AVERAGES | 0.0010 | 0.0013 | 0.0020 | 0.0016 | 0.0013 | 0.0029 |
| | 0.0061 | 0.0061 | 0.0048 | 0.0030 | 0.0021 | 0.0017 |
| STD. DEVIATIONS | 0.0012 | 0.0025 | 0.0033 | 0.0018 | 0.0013 | 0.0033 |
| | 0.0041 | 0.0035 | 0.0035 | 0.0028 | 0.0030 | 0.0031 |

DAILY AVERAGE HEAD ON TOP OF LAYER 9

| | | | | | | |
|---|---|---|---|---|---|---|
| AVERAGES | 0.0001 | 0.0001 | 0.0002 | 0.0002 | 0.0002 | 0.0002 |
| | 0.0003 | 0.0003 | 0.0003 | 0.0002 | 0.0002 | 0.0002 |
| STD. DEVIATIONS | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 |
| | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 |

******************************************************************************
******************************************************************************

AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 28

| | INCHES | CU. FEET | PERCENT |
|---|---|---|---|
| PRECIPITATION | 48.67 ( 9.518) | 176683.8 | 100.00 |
| RUNOFF | 0.000 ( 0.0000) | 0.00 | 0.000 |
| EVAPOTRANSPIRATION | 30.664 ( 4.6860) | 111311.69 | 63.001 |
| LATERAL DRAINAGE COLLECTED FROM LAYER 6 | 17.53024 (5.92711) | 63634.770 | 36.01619 |
| PERCOLATION/LEAKAGE THROUGH LAYER 7 | 0.51785 ( 0.08969) | 1879.808 | 1.06394 |
| AVERAGE HEAD ON TOP OF LAYER 7 | 0.003 ( 0.001) | | |
| LATERAL DRAINAGE COLLECTED FROM LAYER 8 | 0.51785 (0.08969) | 1879.807 | 1.06394 |
| PERCOLATION/LEAKAGE THROUGH | 0.00000 ( 0.00000) | 0.000 | 0.00000 |

```
    LAYER 10

  AVERAGE HEAD ON TOP              0.000 (    0.000)
    OF LAYER  9

  CHANGE IN WATER STORAGE       -0.039   (  1.5043)       -142.51     -0.081

*****************************************************************************
```

```
*******************************************************************************
             PEAK DAILY VALUES FOR YEARS    1 THROUGH   28
    ------------------------------------------------------------------------
                                                  (INCHES)      (CU. FT.)
                                                 ----------   -------------
      PRECIPITATION                                7.60         27588.000

      RUNOFF                                       0.000            0.0000

      DRAINAGE COLLECTED FROM LAYER  6            1.08028       3921.41748

      PERCOLATION/LEAKAGE THROUGH LAYER  7        0.009184        33.33931

      AVERAGE HEAD ON TOP OF LAYER  7              0.064

      MAXIMUM HEAD ON TOP OF LAYER  7              0.123

      LOCATION OF MAXIMUM HEAD IN LAYER  6
            (DISTANCE FROM DRAIN)                  1.8 FEET

      DRAINAGE COLLECTED FROM LAYER  8            0.00918         33.33931

      PERCOLATION/LEAKAGE THROUGH LAYER 10        0.000000         0.00000

      AVERAGE HEAD ON TOP OF LAYER  9              0.001

      MAXIMUM HEAD ON TOP OF LAYER  9              0.000

      LOCATION OF MAXIMUM HEAD IN LAYER  8
            (DISTANCE FROM DRAIN)                  0.0 FEET

      SNOW WATER                                   0.00             0.0000

      MAXIMUM VEG. SOIL WATER (VOL/VOL)                    0.3312

      MINIMUM VEG. SOIL WATER (VOL/VOL)                    0.0424

       ***  Maximum heads are computed using McEnroe's equations.  ***

            Reference:  Maximum Saturated Depth over Landfill Liner
                        by Bruce M. McEnroe, University of Kansas
                        ASCE Journal of Environmental Engineering
                        Vol. 119, No. 2, March 1993, pp. 262-270.

*******************************************************************************
```

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FINAL WATER STORAGE AT END OF YEAR 28

| LAYER | (INCHES) | (VOL/VOL) |
| --- | --- | --- |
| 1 | 0.3324 | 0.0554 |
| 2 | 4.1797 | 0.0697 |
| 3 | 8.7600 | 0.0730 |
| 4 | 8.7600 | 0.0730 |
| 5 | 4.2058 | 0.1752 |
| 6 | 0.0029 | 0.0107 |
| 7 | 0.0000 | 0.0000 |
| 8 | 0.0027 | 0.0100 |
| 9 | 0.0000 | 0.0000 |
| 10 | 0.1875 | 0.7500 |
| SNOW WATER | 0.000 | |

******************************************************************************
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******************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************

PRECIPITATION DATA FILE:     C:\HELP\hardee\bots60\hardrai1.D4
TEMPERATURE DATA FILE:       C:\HELP\hardee\bots60\hardrai1.D7
SOLAR RADIATION DATA FILE:   C:\HELP\hardee\bots60\hardrai1.D13
EVAPOTRANSPIRATION DATA:     C:\HELP\hardee\bots60\hardrai1.D11
SOIL AND DESIGN DATA FILE:   C:\HELP\hardee\bots60\hardee60.D10
OUTPUT DATA FILE:            C:\HELP\hardee\bots60\hardee60.OUT

TIME:   5:46     DATE:   3/ 6/2013

******************************************************************************
TITLE:  Hardee County Phase II Section II Expansion RAI No. 1
Bottom South Portion (60 Feet Waste)
******************************************************************************

     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
            COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.

                     LAYER  1 (Daily Cover 18-inches)
                      --------
                    TYPE 1 - VERTICAL PERCOLATION LAYER
                        MATERIAL TEXTURE NUMBER   5
          THICKNESS                   =    18.00   INCHES
          POROSITY                    =     0.4570 VOL/VOL
          FIELD CAPACITY              =     0.1310 VOL/VOL
          WILTING POINT               =     0.0580 VOL/VOL
          INITIAL SOIL WATER CONTENT  =     0.1524 VOL/VOL
          EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC
        NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  1.80
               FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.

                     LAYER  2 (10 Feet Waste)
                      --------
                    TYPE 1 - VERTICAL PERCOLATION LAYER
                        MATERIAL TEXTURE NUMBER  19
          THICKNESS                   =   120.00   INCHES
          POROSITY                    =     0.1680 VOL/VOL
          FIELD CAPACITY              =     0.0730 VOL/VOL
          WILTING POINT               =     0.0190 VOL/VOL
          INITIAL SOIL WATER CONTENT  =     0.0730 VOL/VOL
          EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC
```

```
            LAYER  3 (10 Feet Waste)
            --------
          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  19
THICKNESS                    =    120.00   INCHES
POROSITY                     =      0.1680 VOL/VOL
FIELD CAPACITY               =      0.0730 VOL/VOL
WILTING POINT                =      0.0190 VOL/VOL
INITIAL SOIL WATER CONTENT   =      0.0730 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.100000005000E-02 CM/SEC

            LAYER  4 (10 Feet Waste)
            --------
          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  19
THICKNESS                    =    120.00   INCHES
POROSITY                     =      0.1680 VOL/VOL
FIELD CAPACITY               =      0.0730 VOL/VOL
WILTING POINT                =      0.0190 VOL/VOL
INITIAL SOIL WATER CONTENT   =      0.0730 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.100000005000E-02 CM/SEC

            LAYER  5 (10 Feet Waste)
            --------
          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  19
THICKNESS                    =    120.00   INCHES
POROSITY                     =      0.1680 VOL/VOL
FIELD CAPACITY               =      0.0730 VOL/VOL
WILTING POINT                =      0.0190 VOL/VOL
INITIAL SOIL WATER CONTENT   =      0.0730 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.100000005000E-02 CM/SEC

            LAYER  6 (10 Feet Waste)
            --------
          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  19
THICKNESS                    =    120.00   INCHES
POROSITY                     =      0.1680 VOL/VOL
FIELD CAPACITY               =      0.0730 VOL/VOL
WILTING POINT                =      0.0190 VOL/VOL
INITIAL SOIL WATER CONTENT   =      0.0730 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.100000005000E-02 CM/SEC

            LAYER  7 (10 Feet Waste)
            --------
          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  19
THICKNESS                    =    120.00   INCHES
POROSITY                     =      0.1680 VOL/VOL
FIELD CAPACITY               =      0.0730 VOL/VOL
WILTING POINT                =      0.0190 VOL/VOL
INITIAL SOIL WATER CONTENT   =      0.0730 VOL/VOL
```

```
   EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC

            LAYER  8 (Drainage Sand 24-inches)
            --------
             TYPE 1 - VERTICAL PERCOLATION LAYER
                 MATERIAL TEXTURE NUMBER   5
   THICKNESS                   =     24.00   INCHES
   POROSITY                    =      0.4570 VOL/VOL
   FIELD CAPACITY              =      0.1310 VOL/VOL
   WILTING POINT               =      0.0580 VOL/VOL
   INITIAL SOIL WATER CONTENT  =      0.1964 VOL/VOL
   EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC

  LAYER  9 (300-mil Bi-planar Geocomposite FabriNet UF)
   --------
               TYPE 2 - LATERAL DRAINAGE LAYER
                 MATERIAL TEXTURE NUMBER   0
   THICKNESS                   =      0.26   INCHES
   POROSITY                    =      0.8500 VOL/VOL
   FIELD CAPACITY              =      0.0100 VOL/VOL
   WILTING POINT               =      0.0050 VOL/VOL
   INITIAL SOIL WATER CONTENT  =      0.0118 VOL/VOL
   EFFECTIVE SAT. HYD. COND.   =   5.30000019000     CM/SEC
   SLOPE                       =      2.20   PERCENT
   DRAINAGE LENGTH             =     53.1    FEET

           LAYER  10 (60-mil HDPE geomembrane)
            --------
               TYPE 4 - FLEXIBLE MEMBRANE LINER
                 MATERIAL TEXTURE NUMBER  35
   THICKNESS                   =      0.06   INCHES
   POROSITY                    =      0.0000 VOL/VOL
   FIELD CAPACITY              =      0.0000 VOL/VOL
   WILTING POINT               =      0.0000 VOL/VOL
   INITIAL SOIL WATER CONTENT  =      0.0000 VOL/VOL
   EFFECTIVE SAT. HYD. COND.   =  0.199999996000E-12 CM/SEC
   FML PINHOLE DENSITY         =      1.00   HOLES/ACRE
   FML INSTALLATION DEFECTS    =      1.00   HOLES/ACRE
   FML PLACEMENT QUALITY       =  3 - GOOD

LAYER  11 (300-mil Tri-planar Geocomposite TENDRAIN 770-2)
 --------
               TYPE 2 - LATERAL DRAINAGE LAYER
                 MATERIAL TEXTURE NUMBER   0
   THICKNESS                   =      0.26   INCHES
   POROSITY                    =      0.8500 VOL/VOL
   FIELD CAPACITY              =      0.0100 VOL/VOL
   WILTING POINT               =      0.0050 VOL/VOL
   INITIAL SOIL WATER CONTENT  =      0.0100 VOL/VOL
   EFFECTIVE SAT. HYD. COND.   =   21.7999992000     CM/SEC
   SLOPE                       =      2.20   PERCENT
   DRAINAGE LENGTH             =     53.1    FEET
```

```
            LAYER  12 (60-mil HDPE geomembrane)
             --------
                TYPE 4 - FLEXIBLE MEMBRANE LINER
                  MATERIAL TEXTURE NUMBER  35
   THICKNESS                  =     0.06   INCHES
   POROSITY                   =     0.0000 VOL/VOL
   FIELD CAPACITY             =     0.0000 VOL/VOL
   WILTING POINT              =     0.0000 VOL/VOL
   INITIAL SOIL WATER CONTENT  =     0.0000 VOL/VOL
   EFFECTIVE SAT. HYD. COND.   =  0.199999996000E-12 CM/SEC
   FML PINHOLE DENSITY        =     1.00   HOLES/ACRE
   FML INSTALLATION DEFECTS    =     1.00   HOLES/ACRE
   FML PLACEMENT QUALITY       =  3 - GOOD

                      LAYER  13 (GCL)
                       --------
                  TYPE 3 - BARRIER SOIL LINER
                  MATERIAL TEXTURE NUMBER  17
   THICKNESS                  =     0.25   INCHES
   POROSITY                   =     0.7500 VOL/VOL
   FIELD CAPACITY             =     0.7470 VOL/VOL
   WILTING POINT              =     0.4000 VOL/VOL
   INITIAL SOIL WATER CONTENT  =     0.7500 VOL/VOL
   EFFECTIVE SAT. HYD. COND.   =  0.300000003000E-08 CM/SEC

           GENERAL DESIGN AND EVAPORATIVE ZONE DATA
           ----------------------------------------

 NOTE:  SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
         SOIL DATA BASE USING SOIL TEXTURE # 5 WITH A
         POOR STAND OF GRASS, A SURFACE SLOPE OF  2.%
         AND A SLOPE LENGTH OF   53. FEET.

SCS RUNOFF CURVE NUMBER            =    79.20
FRACTION OF AREA ALLOWING RUNOFF    =     0.0    PERCENT
AREA PROJECTED ON HORIZONTAL PLANE  =     1.000  ACRES
EVAPORATIVE ZONE DEPTH             =    10.0    INCHES
INITIAL WATER IN EVAPORATIVE ZONE   =     1.295  INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE  =     4.570  INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE  =     0.580  INCHES
INITIAL SNOW WATER                 =     0.000  INCHES
INITIAL WATER IN LAYER MATERIALS    =    60.210  INCHES
TOTAL INITIAL WATER                =    60.210  INCHES
TOTAL SUBSURFACE INFLOW            =     0.00   INCHES/YEAR

            EVAPOTRANSPIRATION AND WEATHER DATA
            -----------------------------------

 NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
         TAMPA                 FLORIDA

     STATION LATITUDE                     =  27.58 DEGREES
     MAXIMUM LEAF AREA INDEX              =   1.00
```

```
START OF GROWING SEASON (JULIAN DATE)  =      0
END OF GROWING SEASON (JULIAN DATE)    =    367
EVAPORATIVE ZONE DEPTH                 =  10.0  INCHES
AVERAGE ANNUAL WIND SPEED              =   8.60 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY  =  74.00 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY  =  72.00 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY  =  78.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY  =  76.00 %
```

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR TAMPA FLORIDA

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

| JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|
| 1.85 | 2.58 | 3.39 | 2.95 | 2.52 | 8.31 |
| 7.83 | 7.98 | 5.61 | 2.86 | 1.94 | 1.84 |

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR TAMPA FLORIDA

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

| JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|
| 59.80 | 60.80 | 66.20 | 71.60 | 77.10 | 80.90 |
| 82.20 | 82.20 | 80.90 | 74.50 | 66.70 | 61.30 |

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR TAMPA FLORIDA AND STATION LATITUDE = 27.58 DEGREES

*****************************************************************************

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 28

-----------------------------------------------------------------------------

| | JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|---|
| PRECIPITATION | | | | | | |
| TOTALS | 1.82 | 2.13 | 3.38 | 2.54 | 3.05 | 7.89 |
| | 8.50 | 7.72 | 5.34 | 2.65 | 1.83 | 1.84 |
| STD. DEVIATIONS | 1.56 | 2.17 | 2.92 | 1.84 | 2.10 | 3.63 |
| | 3.41 | 2.59 | 2.44 | 2.42 | 2.77 | 2.09 |
| RUNOFF | | | | | | |
| TOTALS | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| STD. DEVIATIONS | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |

```
                      0.000    0.000    0.000    0.000    0.000    0.000

  EVAPOTRANSPIRATION
  ------------------
    TOTALS            1.216    1.501    2.156    1.980    2.227    4.650
                      5.436    5.190    3.751    1.916    1.110    0.935

    STD. DEVIATIONS   0.729    0.948    1.396    1.152    1.298    1.280
                      1.238    1.030    1.168    1.184    0.865    0.760

  LATERAL DRAINAGE COLLECTED FROM LAYER  9
  ----------------------------------------
    TOTALS           0.7888   0.4086   0.7408   1.0360   0.6187   0.7786
                     2.3822   2.9889   2.5000   1.8109   1.0575   0.9413

    STD. DEVIATIONS  1.3022   0.4646   1.2413   1.7064   0.5269   0.8317
                     2.0626   1.9496   1.5195   1.3027   1.1920   1.6296

  PERCOLATION/LEAKAGE THROUGH LAYER 10
  ------------------------------------
    TOTALS           0.0368   0.0280   0.0362   0.0412   0.0365   0.0372
                     0.0653   0.0811   0.0746   0.0640   0.0467   0.0418

    STD. DEVIATIONS  0.0256   0.0124   0.0218   0.0298   0.0157   0.0169
                     0.0352   0.0304   0.0242   0.0224   0.0209   0.0257

  LATERAL DRAINAGE COLLECTED FROM LAYER 11
  ----------------------------------------
    TOTALS           0.0368   0.0280   0.0362   0.0412   0.0365   0.0372
                     0.0653   0.0811   0.0746   0.0640   0.0467   0.0418

    STD. DEVIATIONS  0.0256   0.0124   0.0218   0.0298   0.0157   0.0169
                     0.0352   0.0304   0.0242   0.0224   0.0209   0.0257

  PERCOLATION/LEAKAGE THROUGH LAYER 13
  ------------------------------------
    TOTALS           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                     0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

    STD. DEVIATIONS  0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                     0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

-----------------------------------------------------------------------------
             AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)
-----------------------------------------------------------------------------

   DAILY AVERAGE HEAD ON TOP OF LAYER 10
  -------------------------------------
    AVERAGES         0.0020   0.0012   0.0019   0.0028   0.0016   0.0021
                     0.0062   0.0077   0.0067   0.0047   0.0028   0.0024

    STD. DEVIATIONS  0.0034   0.0013   0.0032   0.0046   0.0014   0.0022
                     0.0053   0.0051   0.0041   0.0034   0.0032   0.0042
```

```
   DAILY AVERAGE HEAD ON TOP OF LAYER 12
  -------------------------------------
    AVERAGES            0.0002   0.0001   0.0002   0.0002   0.0002   0.0002
                        0.0003   0.0004   0.0004   0.0003   0.0002   0.0002

    STD. DEVIATIONS     0.0001   0.0001   0.0001   0.0001   0.0001   0.0001
                        0.0002   0.0001   0.0001   0.0001   0.0001   0.0001

***************************************************************************
***************************************************************************
      AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS    1 THROUGH   28
---------------------------------------------------------------------------
                                      INCHES            CU. FEET      PERCENT
                               -------------------   -------------   ---------
  PRECIPITATION                    48.67    (   9.518)    176683.8     100.00

  RUNOFF                           0.000   (  0.0000)        0.00      0.000

  EVAPOTRANSPIRATION              32.067   (  4.7749)    116402.73     65.882

  LATERAL DRAINAGE COLLECTED       16.05222 (5.71713)    58269.543   32.97957
    FROM LAYER  9

  PERCOLATION/LEAKAGE THROUGH  0.58947 (  0.10990)      2139.779     1.21108
    LAYER 10

  AVERAGE HEAD ON TOP               0.004 (    0.001)
    OF LAYER 10

  LATERAL DRAINAGE COLLECTED        0.58947 (0.10990)      2139.779    1.21108
    FROM LAYER 11

  PERCOLATION/LEAKAGE THROUGH  0.00000 (  0.00000)         0.001     0.00000
    LAYER 13

  AVERAGE HEAD ON TOP               0.000 (    0.000)
    OF LAYER 12

  CHANGE IN WATER STORAGE         -0.035   (  2.6191)      -128.28     -0.073

 ***************************************************************************
```

```
*******************************************************************************
            PEAK DAILY VALUES FOR YEARS    1 THROUGH   28
    ---------------------------------------------------------------------------
                                                (INCHES)      (CU. FT.)
                                               ----------    -------------
       PRECIPITATION                             7.60          27588.000

       RUNOFF                                    0.000             0.0000

       DRAINAGE COLLECTED FROM LAYER  9         0.53032        1925.07129

       PERCOLATION/LEAKAGE THROUGH LAYER 10     0.007460         27.07832

       AVERAGE HEAD ON TOP OF LAYER 10           0.043

       MAXIMUM HEAD ON TOP OF LAYER 10           0.083

       LOCATION OF MAXIMUM HEAD IN LAYER  9
             (DISTANCE FROM DRAIN)               1.3 FEET

       DRAINAGE COLLECTED FROM LAYER 11         0.00746          27.07832

       PERCOLATION/LEAKAGE THROUGH LAYER 13     0.000000          0.00000

       AVERAGE HEAD ON TOP OF LAYER 12           0.001

       MAXIMUM HEAD ON TOP OF LAYER 12           0.001

       LOCATION OF MAXIMUM HEAD IN LAYER 11
             (DISTANCE FROM DRAIN)               0.0 FEET

       SNOW WATER                                0.00              0.0000

       MAXIMUM VEG. SOIL WATER (VOL/VOL)                 0.4570

       MINIMUM VEG. SOIL WATER (VOL/VOL)                 0.0580

        ***  Maximum heads are computed using McEnroe's equations.  ***

             Reference:  Maximum Saturated Depth over Landfill Liner
                         by Bruce M. McEnroe, University of Kansas
                         ASCE Journal of Environmental Engineering
                         Vol. 119, No. 2, March 1993, pp. 262-270.

*******************************************************************************
```

******************************************************************************

FINAL WATER STORAGE AT END OF YEAR 28

| LAYER | (INCHES) | (VOL/VOL) |
|---|---|---|
| 1 | 1.9705 | 0.1095 |
| 2 | 8.7600 | 0.0730 |
| 3 | 8.7600 | 0.0730 |
| 4 | 8.7600 | 0.0730 |
| 5 | 8.7600 | 0.0730 |
| 6 | 8.7600 | 0.0730 |
| 7 | 8.7600 | 0.0730 |
| 8 | 4.4972 | 0.1874 |
| 9 | 0.0030 | 0.0114 |
| 10 | 0.0000 | 0.0000 |
| 11 | 0.0026 | 0.0100 |
| 12 | 0.0000 | 0.0000 |
| 13 | 0.1875 | 0.7500 |
| SNOW WATER | 0.000 | |

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******************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************

PRECIPITATION DATA FILE:    C:\HELP\hardee\bottomc\hardrai1.D4
TEMPERATURE DATA FILE:      C:\HELP\hardee\bottomc\hardrai1.D7
SOLAR RADIATION DATA FILE:  C:\HELP\hardee\bottomc\hardrai1.D13
EVAPOTRANSPIRATION DATA:    C:\HELP\hardee\bottomc\hardrai1.D11
SOIL AND DESIGN DATA FILE:  C:\HELP\hardee\bottomc\hardeeop.D10
OUTPUT DATA FILE:           C:\HELP\hardee\bottomc\hardrai1.OUT

TIME:   5: 5     DATE:   3/ 6/2013

*****************************************************************************
TITLE:  Hardee County Phase II Section II Expansion RAI No. 1
Bottom Center Portion (Open Cell - No Waste)
*****************************************************************************

     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.

                    LAYER  1 (Drainage Sand 24-inches)
                    --------
                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER   5
           THICKNESS                    =      24.00   INCHES
           POROSITY                     =      0.4570 VOL/VOL
           FIELD CAPACITY               =      0.1310 VOL/VOL
           WILTING POINT                =      0.0580 VOL/VOL
           INITIAL SOIL WATER CONTENT   =      0.1837 VOL/VOL
           EFFECTIVE SAT. HYD. COND.    =  0.100000005000E-02 CM/SEC

          LAYER  2 (300-mil Bi-planar Geocomposite FabriNet UF)
           --------
                       TYPE 2 - LATERAL DRAINAGE LAYER
                         MATERIAL TEXTURE NUMBER   0
           THICKNESS                    =      0.30   INCHES
           POROSITY                     =      0.8500 VOL/VOL
           FIELD CAPACITY               =      0.0100 VOL/VOL
           WILTING POINT                =      0.0050 VOL/VOL
           INITIAL SOIL WATER CONTENT   =      0.0102 VOL/VOL
           EFFECTIVE SAT. HYD. COND.    =   11.8999996000     CM/SEC
           SLOPE                        =      2.20    PERCENT
           DRAINAGE LENGTH              =     53.1     FEET
```

```
           LAYER  3 (60-mil HDPE geomembrane)
           --------
              TYPE 4 - FLEXIBLE MEMBRANE LINER
                MATERIAL TEXTURE NUMBER  35
  THICKNESS                  =     0.06   INCHES
  POROSITY                   =     0.0000 VOL/VOL
  FIELD CAPACITY             =     0.0000 VOL/VOL
  WILTING POINT              =     0.0000 VOL/VOL
  INITIAL SOIL WATER CONTENT =     0.0000 VOL/VOL
  EFFECTIVE SAT. HYD. COND.  =  0.199999996000E-12 CM/SEC
  FML PINHOLE DENSITY        =     1.00   HOLES/ACRE
  FML INSTALLATION DEFECTS   =     1.00   HOLES/ACRE
  FML PLACEMENT QUALITY      =  3 - GOOD

LAYER  4 (300-mil Tri-planar Geocomposite TENDRAIN 770-2)
--------
              TYPE 2 - LATERAL DRAINAGE LAYER
                MATERIAL TEXTURE NUMBER   0
  THICKNESS                  =     0.30   INCHES
  POROSITY                   =     0.8500 VOL/VOL
  FIELD CAPACITY             =     0.0100 VOL/VOL
  WILTING POINT              =     0.0050 VOL/VOL
  INITIAL SOIL WATER CONTENT =     0.0100 VOL/VOL
  EFFECTIVE SAT. HYD. COND.  =   40.7000008000     CM/SEC
  SLOPE                      =     2.20   PERCENT
  DRAINAGE LENGTH            =    53.1    FEET

           LAYER  5 (60-mil HDPE geomembrane)
           --------
              TYPE 4 - FLEXIBLE MEMBRANE LINER
                MATERIAL TEXTURE NUMBER  35
  THICKNESS                  =     0.06   INCHES
  POROSITY                   =     0.0000 VOL/VOL
  FIELD CAPACITY             =     0.0000 VOL/VOL
  WILTING POINT              =     0.0000 VOL/VOL
  INITIAL SOIL WATER CONTENT =     0.0000 VOL/VOL
  EFFECTIVE SAT. HYD. COND.  =  0.199999996000E-12 CM/SEC
  FML PINHOLE DENSITY        =     1.00   HOLES/ACRE
  FML INSTALLATION DEFECTS   =     1.00   HOLES/ACRE
  FML PLACEMENT QUALITY      =  3 - GOOD

                     LAYER  6 (GCL)
                     --------
                TYPE 3 - BARRIER SOIL LINER
                MATERIAL TEXTURE NUMBER  17
  THICKNESS                  =     0.25   INCHES
  POROSITY                   =     0.7500 VOL/VOL
  FIELD CAPACITY             =     0.7470 VOL/VOL
  WILTING POINT              =     0.4000 VOL/VOL
  INITIAL SOIL WATER CONTENT =     0.7500 VOL/VOL
  EFFECTIVE SAT. HYD. COND.  =  0.300000003000E-08 CM/SEC

          GENERAL DESIGN AND EVAPORATIVE ZONE DATA
```

```
                ----------------------------------------

     NOTE:  SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
              SOIL DATA BASE USING SOIL TEXTURE # 5 WITH BARE
              GROUND CONDITIONS, A SURFACE SLOPE OF  2.% AND
              A SLOPE LENGTH OF   53. FEET.

    SCS RUNOFF CURVE NUMBER              =    85.00
    FRACTION OF AREA ALLOWING RUNOFF     =     0.0    PERCENT
    AREA PROJECTED ON HORIZONTAL PLANE   =     1.000  ACRES
    EVAPORATIVE ZONE DEPTH               =    10.0    INCHES
    INITIAL WATER IN EVAPORATIVE ZONE    =     1.827  INCHES
    UPPER LIMIT OF EVAPORATIVE STORAGE   =     4.570  INCHES
    LOWER LIMIT OF EVAPORATIVE STORAGE   =     0.580  INCHES
    INITIAL SNOW WATER                   =     0.000  INCHES
    INITIAL WATER IN LAYER MATERIALS     =     4.603  INCHES
    TOTAL INITIAL WATER                  =     4.603  INCHES
    TOTAL SUBSURFACE INFLOW              =     0.00   INCHES/YEAR

               EVAPOTRANSPIRATION AND WEATHER DATA
               -----------------------------------

     NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
              TAMPA                 FLORIDA

         STATION LATITUDE                           =  27.58 DEGREES
         MAXIMUM LEAF AREA INDEX                    =   0.00
         START OF GROWING SEASON (JULIAN DATE)      =      0
         END OF GROWING SEASON (JULIAN DATE)        =    367
         EVAPORATIVE ZONE DEPTH                     =  10.0  INCHES
         AVERAGE ANNUAL WIND SPEED                  =   8.60 MPH
         AVERAGE 1ST QUARTER RELATIVE HUMIDITY      =  74.00 %
         AVERAGE 2ND QUARTER RELATIVE HUMIDITY      =  72.00 %
         AVERAGE 3RD QUARTER RELATIVE HUMIDITY      =  78.00 %
         AVERAGE 4TH QUARTER RELATIVE HUMIDITY      =  76.00 %

     NOTE:  PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
              COEFFICIENTS FOR    TAMPA              FLORIDA

              NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

 JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
 -------     -------     -------     -------     -------     -------
   1.85        2.58        3.39        2.95        2.52        8.31
   7.83        7.98        5.61        2.86        1.94        1.84

     NOTE:  TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
              COEFFICIENTS FOR    TAMPA              FLORIDA

         NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)
 JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
 -------     -------     -------     -------     -------     -------
  59.80       60.80       66.20       71.60       77.10       80.90
```

| | | | | | |
|---|---|---|---|---|---|
| 82.20 | 82.20 | 80.90 | 74.50 | 66.70 | 61.30 |

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR TAMPA FLORIDA
AND STATION LATITUDE = 27.58 DEGREES

*****************************************************************************

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 28

| | JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|---|
| **PRECIPITATION** | | | | | | |
| TOTALS | 1.82 | 2.13 | 3.38 | 2.54 | 3.05 | 7.89 |
| | 8.50 | 7.72 | 5.34 | 2.65 | 1.83 | 1.84 |
| STD. DEVIATIONS | 1.56 | 2.17 | 2.92 | 1.84 | 2.10 | 3.63 |
| | 3.41 | 2.59 | 2.44 | 2.42 | 2.77 | 2.09 |
| **RUNOFF** | | | | | | |
| TOTALS | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| STD. DEVIATIONS | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| **EVAPOTRANSPIRATION** | | | | | | |
| TOTALS | 1.276 | 1.223 | 1.852 | 1.713 | 1.833 | 3.929 |
| | 4.656 | 4.317 | 3.272 | 1.710 | 1.100 | 1.005 |
| STD. DEVIATIONS | 0.796 | 0.858 | 1.176 | 0.904 | 1.054 | 1.195 |
| | 1.041 | 1.068 | 0.990 | 0.929 | 0.781 | 0.763 |
| **LATERAL DRAINAGE COLLECTED FROM LAYER 2** | | | | | | |
| TOTALS | 0.5047 | 0.7189 | 1.2996 | 0.7604 | 1.0604 | 2.8942 |
| | 3.9592 | 3.4038 | 2.3643 | 1.5467 | 1.1053 | 0.7936 |
| STD. DEVIATIONS | 0.5272 | 1.2821 | 1.9427 | 0.6624 | 0.9583 | 2.4216 |
| | 2.4743 | 1.7575 | 1.7561 | 1.5039 | 1.8846 | 1.3141 |
| **PERCOLATION/LEAKAGE THROUGH LAYER 3** | | | | | | |
| TOTALS | 0.0206 | 0.0212 | 0.0293 | 0.0252 | 0.0292 | 0.0429 |
| | 0.0578 | 0.0567 | 0.0450 | 0.0363 | 0.0272 | 0.0225 |
| STD. DEVIATIONS | 0.0086 | 0.0115 | 0.0180 | 0.0108 | 0.0111 | 0.0205 |
| | 0.0197 | 0.0146 | 0.0139 | 0.0138 | 0.0156 | 0.0141 |

LATERAL DRAINAGE COLLECTED FROM LAYER 4

| | | | | | | |
|---|---|---|---|---|---|---|
| TOTALS | 0.0206 | 0.0212 | 0.0293 | 0.0252 | 0.0292 | 0.0429 |
| | 0.0578 | 0.0567 | 0.0450 | 0.0363 | 0.0272 | 0.0225 |
| STD. DEVIATIONS | 0.0086 | 0.0115 | 0.0180 | 0.0108 | 0.0111 | 0.0205 |
| | 0.0197 | 0.0146 | 0.0139 | 0.0138 | 0.0156 | 0.0141 |

PERCOLATION/LEAKAGE THROUGH LAYER 6

| | | | | | | |
|---|---|---|---|---|---|---|
| TOTALS | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| STD. DEVIATIONS | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

---

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

---

DAILY AVERAGE HEAD ON TOP OF LAYER 3

| | | | | | | |
|---|---|---|---|---|---|---|
| AVERAGES | 0.0006 | 0.0009 | 0.0015 | 0.0009 | 0.0012 | 0.0035 |
| | 0.0049 | 0.0039 | 0.0028 | 0.0018 | 0.0013 | 0.0009 |
| STD. DEVIATIONS | 0.0006 | 0.0016 | 0.0022 | 0.0008 | 0.0011 | 0.0029 |
| | 0.0038 | 0.0020 | 0.0021 | 0.0017 | 0.0022 | 0.0015 |

DAILY AVERAGE HEAD ON TOP OF LAYER 5

| | | | | | | |
|---|---|---|---|---|---|---|
| AVERAGES | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0002 |
| | 0.0003 | 0.0003 | 0.0002 | 0.0002 | 0.0001 | 0.0001 |
| STD. DEVIATIONS | 0.0000 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 |
| | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 |

*****************************************************************************
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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 28

| | INCHES | CU. FEET | PERCENT |
|---|---|---|---|
| PRECIPITATION | 48.67 ( 9.518) | 176683.8 | 100.00 |
| RUNOFF | 0.000 ( 0.0000) | 0.00 | 0.000 |
| EVAPOTRANSPIRATION | 27.888 ( 4.3435) | 101231.80 | 57.295 |
| LATERAL DRAINAGE COLLECTED FROM LAYER 2 | 20.41107 ( 6.21105) | 74092.195 | 41.93492 |
| PERCOLATION/LEAKAGE THROUGH LAYER 3 | 0.41384 ( 0.05952) | 1502.230 | 0.85024 |
| AVERAGE HEAD ON TOP OF LAYER 3 | 0.002 ( 0.001) | | |

| | | | | |
|---|---|---|---|---|
| LATERAL DRAINAGE COLLECTED FROM LAYER 4 | 0.41384 ( | 0.05952) | 1502.230 | 0.85024 |
| PERCOLATION/LEAKAGE THROUGH LAYER 6 | 0.00000 ( | 0.00000) | 0.000 | 0.00000 |
| AVERAGE HEAD ON TOP OF LAYER 5 | 0.000 ( | 0.000) | | |
| CHANGE IN WATER STORAGE | -0.039 ( | 0.8487) | -142.42 | -0.081 |

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******************************************************************************
              PEAK DAILY VALUES FOR YEARS    1 THROUGH   28
    --------------------------------------------------------------------------
                                                   (INCHES)      (CU. FT.)
                                                  ----------   -------------
       PRECIPITATION                                 7.60         27588.000

       RUNOFF                                        0.000            0.0000

       DRAINAGE COLLECTED FROM LAYER  2             3.47436      12611.94530

       PERCOLATION/LEAKAGE THROUGH LAYER  3         0.012856        46.66630

       AVERAGE HEAD ON TOP OF LAYER  3               0.360

       MAXIMUM HEAD ON TOP OF LAYER  3               0.280

       LOCATION OF MAXIMUM HEAD IN LAYER  2
             (DISTANCE FROM DRAIN)                   3.3 FEET

       DRAINAGE COLLECTED FROM LAYER  4             0.01286         46.66630

       PERCOLATION/LEAKAGE THROUGH LAYER  6         0.000000         0.00000

       AVERAGE HEAD ON TOP OF LAYER  5               0.002

       MAXIMUM HEAD ON TOP OF LAYER  5               0.000

       LOCATION OF MAXIMUM HEAD IN LAYER  4
             (DISTANCE FROM DRAIN)                   0.0 FEET

       SNOW WATER                                    0.00             0.0000


       MAXIMUM VEG. SOIL WATER (VOL/VOL)                     0.4570

       MINIMUM VEG. SOIL WATER (VOL/VOL)                     0.0580


        ***  Maximum heads are computed using McEnroe's equations.  ***

             Reference:  Maximum Saturated Depth over Landfill Liner
                         by Bruce M. McEnroe, University of Kansas
                         ASCE Journal of Environmental Engineering
                         Vol. 119, No. 2, March 1993, pp. 262-270.

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******************************************************************************
                    FINAL WATER STORAGE AT END OF YEAR   28
     ----------------------------------------------------------------------
                     LAYER        (INCHES)        (VOL/VOL)
                     -----        --------        ---------
                       1           3.3109           0.1380

                       2           0.0031           0.0104

                       3           0.0000           0.0000

                       4           0.0030           0.0100

                       5           0.0000           0.0000

                       6           0.1875           0.7500

                   SNOW WATER      0.000

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******************************************************************************
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***************************************************************************
***************************************************************************
**                                                                       **
**                                                                       **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE            **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)             **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                **
**                    USAE WATERWAYS EXPERIMENT STATION                  **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY           **
**                                                                       **
**                                                                       **
***************************************************************************
***************************************************************************

PRECIPITATION DATA FILE:    C:\HELP\hardee\botc10\hardrai1.D4
TEMPERATURE DATA FILE:      C:\HELP\hardee\botc10\hardrai1.D7
SOLAR RADIATION DATA FILE:  C:\HELP\hardee\botc10\hardrai1.D13
EVAPOTRANSPIRATION DATA:    C:\HELP\hardee\botc10\hardrai1.D11
SOIL AND DESIGN DATA FILE:  C:\HELP\hardee\botc10\hardee10.D10
OUTPUT DATA FILE:           C:\HELP\hardee\botc10\hardee10.OUT

TIME:  10:35     DATE:   3/19/2013

**************************************************************************
TITLE:  Hardee County Phase II Section II Expansion RAI No. 1
```
**Bottom Center Portion (10 Feet Waste)**
```
**************************************************************************

     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.

                      LAYER  1 (Daily Cover 6-inches)
                      --------
                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER   5
           THICKNESS                   =      6.00   INCHES
           POROSITY                    =      0.4570 VOL/VOL
           FIELD CAPACITY              =      0.1310 VOL/VOL
           WILTING POINT               =      0.0580 VOL/VOL
           INITIAL SOIL WATER CONTENT  =      0.1989 VOL/VOL
           EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC
         NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  1.80
                  FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.

                      LAYER  2 (10 Feet Waste)
                      --------
                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER  19
           THICKNESS                   =    120.00   INCHES
           POROSITY                    =      0.1680 VOL/VOL
           FIELD CAPACITY              =      0.0730 VOL/VOL
           WILTING POINT               =      0.0190 VOL/VOL
           INITIAL SOIL WATER CONTENT  =      0.0724 VOL/VOL
           EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC
```

```
          LAYER  3 (Drainage Sand 24-inches)
          --------
           TYPE 1 - VERTICAL PERCOLATION LAYER
               MATERIAL TEXTURE NUMBER   5
 THICKNESS                   =     24.00   INCHES
 POROSITY                    =      0.4570 VOL/VOL
 FIELD CAPACITY              =      0.1310 VOL/VOL
 WILTING POINT               =      0.0580 VOL/VOL
 INITIAL SOIL WATER CONTENT  =      0.1794 VOL/VOL
 EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC

LAYER  4 (300-mil Bi-planar Geocomposite FabriNet UF)
--------
             TYPE 2 - LATERAL DRAINAGE LAYER
               MATERIAL TEXTURE NUMBER   0
 THICKNESS                   =      0.30   INCHES
 POROSITY                    =      0.8500 VOL/VOL
 FIELD CAPACITY              =      0.0100 VOL/VOL
 WILTING POINT               =      0.0050 VOL/VOL
 INITIAL SOIL WATER CONTENT  =      0.0106 VOL/VOL
 EFFECTIVE SAT. HYD. COND.   =   11.8999996000     CM/SEC
 SLOPE                       =      2.20   PERCENT
 DRAINAGE LENGTH             =     53.1    FEET

          LAYER  5 (60-mil HDPE geomembrane)
          --------
             TYPE 4 - FLEXIBLE MEMBRANE LINER
               MATERIAL TEXTURE NUMBER  35
 THICKNESS                   =      0.06   INCHES
 POROSITY                    =      0.0000 VOL/VOL
 FIELD CAPACITY              =      0.0000 VOL/VOL
 WILTING POINT               =      0.0000 VOL/VOL
 INITIAL SOIL WATER CONTENT  =      0.0000 VOL/VOL
 EFFECTIVE SAT. HYD. COND.   =  0.199999996000E-12 CM/SEC
 FML PINHOLE DENSITY         =      1.00   HOLES/ACRE
 FML INSTALLATION DEFECTS    =      1.00   HOLES/ACRE
 FML PLACEMENT QUALITY       =  3 - GOOD

LAYER  6 (300-mil Tri-planar Geocomposite TENDRAIN 770-2)
--------
             TYPE 2 - LATERAL DRAINAGE LAYER
               MATERIAL TEXTURE NUMBER   0
 THICKNESS                   =      0.30   INCHES
 POROSITY                    =      0.8500 VOL/VOL
 FIELD CAPACITY              =      0.0100 VOL/VOL
 WILTING POINT               =      0.0050 VOL/VOL
 INITIAL SOIL WATER CONTENT  =      0.0100 VOL/VOL
 EFFECTIVE SAT. HYD. COND.   =   40.7000008000     CM/SEC
 SLOPE                       =      2.20   PERCENT
 DRAINAGE LENGTH             =     53.1    FEET

          LAYER  7 (60-mil HDPE geomembrane)
          --------
```

```
              TYPE 4 - FLEXIBLE MEMBRANE LINER
                MATERIAL TEXTURE NUMBER  35
   THICKNESS                  =     0.06   INCHES
   POROSITY                   =     0.0000 VOL/VOL
   FIELD CAPACITY             =     0.0000 VOL/VOL
   WILTING POINT              =     0.0000 VOL/VOL
   INITIAL SOIL WATER CONTENT =     0.0000 VOL/VOL
   EFFECTIVE SAT. HYD. COND.  =  0.199999996000E-12 CM/SEC
   FML PINHOLE DENSITY        =     1.00   HOLES/ACRE
   FML INSTALLATION DEFECTS   =     1.00   HOLES/ACRE
   FML PLACEMENT QUALITY      =  3 - GOOD

                     LAYER  8 (GCL)
                     --------
                TYPE 3 - BARRIER SOIL LINER
                MATERIAL TEXTURE NUMBER  17
   THICKNESS                  =     0.25   INCHES
   POROSITY                   =     0.7500 VOL/VOL
   FIELD CAPACITY             =     0.7470 VOL/VOL
   WILTING POINT              =     0.4000 VOL/VOL
   INITIAL SOIL WATER CONTENT =     0.7500 VOL/VOL
   EFFECTIVE SAT. HYD. COND.  =  0.300000003000E-08 CM/SEC

           GENERAL DESIGN AND EVAPORATIVE ZONE DATA
           ----------------------------------------

  NOTE:  SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
           SOIL DATA BASE USING SOIL TEXTURE # 5 WITH A
           POOR STAND OF GRASS, A SURFACE SLOPE OF  2.%
           AND A SLOPE LENGTH OF   53. FEET.

 SCS RUNOFF CURVE NUMBER             =    79.20
 FRACTION OF AREA ALLOWING RUNOFF    =     0.0    PERCENT
 AREA PROJECTED ON HORIZONTAL PLANE  =     1.000  ACRES
 EVAPORATIVE ZONE DEPTH              =    10.0    INCHES
 INITIAL WATER IN EVAPORATIVE ZONE   =     1.411  INCHES
 UPPER LIMIT OF EVAPORATIVE STORAGE  =     3.414  INCHES
 LOWER LIMIT OF EVAPORATIVE STORAGE  =     0.424  INCHES
 INITIAL SNOW WATER                  =     0.000  INCHES
 INITIAL WATER IN LAYER MATERIALS    =    14.380  INCHES
 TOTAL INITIAL WATER                 =    14.380  INCHES
 TOTAL SUBSURFACE INFLOW             =     0.00   INCHES/YEAR

            EVAPOTRANSPIRATION AND WEATHER DATA
            -----------------------------------

  NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
           TAMPA                FLORIDA

      STATION LATITUDE                        =  27.58 DEGREES
      MAXIMUM LEAF AREA INDEX                 =   1.00
      START OF GROWING SEASON (JULIAN DATE)   =      0
      END OF GROWING SEASON (JULIAN DATE)     =    367
```

```
        EVAPORATIVE ZONE DEPTH                  =  10.0  INCHES
        AVERAGE ANNUAL WIND SPEED               =   8.60 MPH
        AVERAGE 1ST QUARTER RELATIVE HUMIDITY  =  74.00 %
        AVERAGE 2ND QUARTER RELATIVE HUMIDITY  =  72.00 %
        AVERAGE 3RD QUARTER RELATIVE HUMIDITY  =  78.00 %
        AVERAGE 4TH QUARTER RELATIVE HUMIDITY  =  76.00 %

    NOTE:  PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
             COEFFICIENTS FOR    TAMPA              FLORIDA

             NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

  JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
  -------     -------     -------     -------     -------     -------
    1.85        2.58        3.39        2.95        2.52        8.31
    7.83        7.98        5.61        2.86        1.94        1.84

    NOTE:  TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
             COEFFICIENTS FOR    TAMPA              FLORIDA

        NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

  JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
  -------     -------     -------     -------     -------     -------
   59.80       60.80       66.20       71.60       77.10       80.90
   82.20       82.20       80.90       74.50       66.70       61.30

    NOTE:  SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
             COEFFICIENTS FOR    TAMPA              FLORIDA
               AND STATION LATITUDE  =  27.58 DEGREES

*****************************************************************************
     AVERAGE MONTHLY VALUES IN INCHES FOR YEARS    1 THROUGH   28
 ----------------------------------------------------------------------------
                        JAN/JUL  FEB/AUG  MAR/SEP  APR/OCT  MAY/NOV  JUN/DEC
                        -------  -------  -------  -------  -------  -------
  PRECIPITATION
  -------------
  TOTALS                  1.82     2.13     3.38     2.54     3.05     7.89
                          8.50     7.72     5.34     2.65     1.83     1.84

  STD. DEVIATIONS         1.56     2.17     2.92     1.84     2.10     3.63
                          3.41     2.59     2.44     2.42     2.77     2.09

  RUNOFF
  ------
  TOTALS                  0.000    0.000    0.000    0.000    0.000    0.000
                          0.000    0.000    0.000    0.000    0.000    0.000

  STD. DEVIATIONS         0.000    0.000    0.000    0.000    0.000    0.000
                          0.000    0.000    0.000    0.000    0.000    0.000
  EVAPOTRANSPIRATION
  ------------------
```

| | | | | | | |
|---|---|---|---|---|---|---|
| TOTALS | 1.216 | 1.352 | 2.074 | 1.895 | 2.105 | 4.555 |
| | 5.287 | 4.925 | 3.558 | 1.760 | 1.081 | 0.950 |
| STD. DEVIATIONS | 0.833 | 0.924 | 1.337 | 1.090 | 1.206 | 1.257 |
| | 1.181 | 1.120 | 1.176 | 1.131 | 0.820 | 0.785 |

LATERAL DRAINAGE COLLECTED FROM LAYER 4

| | | | | | | |
|---|---|---|---|---|---|---|
| TOTALS | 0.5119 | 0.6473 | 1.1193 | 0.7043 | 0.8136 | 1.9390 |
| | 3.1396 | 2.9737 | 2.3195 | 1.4989 | 1.0473 | 0.8388 |
| STD. DEVIATIONS | 0.4830 | 1.2514 | 1.8061 | 0.8392 | 0.8675 | 1.9381 |
| | 2.1590 | 1.5598 | 1.7735 | 1.3749 | 1.5792 | 1.3799 |

PERCOLATION/LEAKAGE THROUGH LAYER 5

| | | | | | | |
|---|---|---|---|---|---|---|
| TOTALS | 0.0215 | 0.0220 | 0.0286 | 0.0248 | 0.0262 | 0.0369 |
| | 0.0519 | 0.0539 | 0.0464 | 0.0375 | 0.0287 | 0.0245 |
| STD. DEVIATIONS | 0.0103 | 0.0139 | 0.0189 | 0.0129 | 0.0112 | 0.0200 |
| | 0.0214 | 0.0154 | 0.0166 | 0.0144 | 0.0149 | 0.0168 |

LATERAL DRAINAGE COLLECTED FROM LAYER 6

| | | | | | | |
|---|---|---|---|---|---|---|
| TOTALS | 0.0215 | 0.0220 | 0.0286 | 0.0248 | 0.0262 | 0.0369 |
| | 0.0519 | 0.0539 | 0.0464 | 0.0375 | 0.0287 | 0.0245 |
| STD. DEVIATIONS | 0.0103 | 0.0139 | 0.0189 | 0.0129 | 0.0112 | 0.0200 |
| | 0.0214 | 0.0154 | 0.0166 | 0.0144 | 0.0149 | 0.0168 |

PERCOLATION/LEAKAGE THROUGH LAYER 8

| | | | | | | |
|---|---|---|---|---|---|---|
| TOTALS | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| STD. DEVIATIONS | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

---

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

---

DAILY AVERAGE HEAD ON TOP OF LAYER 5

| | | | | | | |
|---|---|---|---|---|---|---|
| AVERAGES | 0.0006 | 0.0008 | 0.0013 | 0.0008 | 0.0009 | 0.0023 |
| | 0.0036 | 0.0034 | 0.0028 | 0.0017 | 0.0012 | 0.0010 |
| STD. DEVIATIONS | 0.0006 | 0.0016 | 0.0021 | 0.0010 | 0.0010 | 0.0023 |
| | 0.0025 | 0.0018 | 0.0021 | 0.0016 | 0.0019 | 0.0016 |

DAILY AVERAGE HEAD ON TOP OF LAYER 7

| | | | | | | |
|---|---|---|---|---|---|---|
| AVERAGES | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0002 |
| | 0.0002 | 0.0003 | 0.0002 | 0.0002 | 0.0001 | 0.0001 |

```
  STD. DEVIATIONS        0.0000   0.0001   0.0001   0.0001   0.0001   0.0001
                         0.0001   0.0001   0.0001   0.0001   0.0001   0.0001

*****************************************************************************
*****************************************************************************
      AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS    1 THROUGH   28
 ----------------------------------------------------------------------------
                                      INCHES           CU. FEET      PERCENT
                            -------------------   -------------   ---------
PRECIPITATION                  48.67    (   9.518)     176683.8     100.00

RUNOFF                         0.000   (  0.0000)         0.00      0.000

EVAPOTRANSPIRATION            30.757   (  4.7107)    111647.02     63.190

LATERAL DRAINAGE COLLECTED    17.55296 (  5.94249)     63717.250   36.06288
FROM LAYER  4

PERCOLATION/LEAKAGE THROUGH   0.40278 (  0.06896)      1462.094    0.82752
LAYER  5

AVERAGE HEAD ON TOP           0.002 (    0.001)
OF LAYER  5

LATERAL DRAINAGE COLLECTED     0.40278 (  0.06896)      1462.093    0.82752
FROM LAYER  6

PERCOLATION/LEAKAGE THROUGH   0.00000 (  0.00000)         0.000    0.00000
LAYER  8

AVERAGE HEAD ON TOP            0.000 (    0.000)
OF LAYER  7

CHANGE IN WATER STORAGE       -0.039   (  1.1827)      -142.59     -0.081

*****************************************************************************
```

```
******************************************************************************
              PEAK DAILY VALUES FOR YEARS    1 THROUGH   28
    --------------------------------------------------------------------------
                                                 (INCHES)      (CU. FT.)
                                                ----------   -------------
       PRECIPITATION                              7.60         27588.000

       RUNOFF                                     0.000            0.0000

       DRAINAGE COLLECTED FROM LAYER  4          1.94100       7045.81982

       PERCOLATION/LEAKAGE THROUGH LAYER  5      0.009537        34.61891

       AVERAGE HEAD ON TOP OF LAYER  5            0.069

       MAXIMUM HEAD ON TOP OF LAYER  5            0.134

       LOCATION OF MAXIMUM HEAD IN LAYER  4
             (DISTANCE FROM DRAIN)                1.9 FEET

       DRAINAGE COLLECTED FROM LAYER  6          0.00954         34.61891

       PERCOLATION/LEAKAGE THROUGH LAYER  8      0.000000         0.00000

       AVERAGE HEAD ON TOP OF LAYER  7            0.001

       MAXIMUM HEAD ON TOP OF LAYER  7            0.001

       LOCATION OF MAXIMUM HEAD IN LAYER  6
             (DISTANCE FROM DRAIN)                0.0 FEET

       SNOW WATER                                 0.00             0.0000


       MAXIMUM VEG. SOIL WATER (VOL/VOL)                  0.3182

       MINIMUM VEG. SOIL WATER (VOL/VOL)                  0.0424


        ***  Maximum heads are computed using McEnroe's equations.  ***

             Reference:  Maximum Saturated Depth over Landfill Liner
                         by Bruce M. McEnroe, University of Kansas
                         ASCE Journal of Environmental Engineering
                         Vol. 119, No. 2, March 1993, pp. 262-270.

******************************************************************************
```

******************************************************************************

FINAL WATER STORAGE AT END OF YEAR 28

| LAYER | (INCHES) | (VOL/VOL) |
|---|---|---|
| 1 | 0.3324 | 0.0554 |
| 2 | 8.5597 | 0.0713 |
| 3 | 4.1939 | 0.1747 |
| 4 | 0.0031 | 0.0104 |
| 5 | 0.0000 | 0.0000 |
| 6 | 0.0030 | 0.0100 |
| 7 | 0.0000 | 0.0000 |
| 8 | 0.1875 | 0.7500 |
| SNOW WATER | 0.000 | |

******************************************************************************
******************************************************************************

```
******************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**              FOR USEPA RISK REDUCTION ENGINEERING LABORATORY             **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************

PRECIPITATION DATA FILE:    C:\HELP\hardee\botc25\hardrai1.D4
TEMPERATURE DATA FILE:      C:\HELP\hardee\botc25\hardrai1.D7
SOLAR RADIATION DATA FILE:  C:\HELP\hardee\botc25\hardrai1.D13
EVAPOTRANSPIRATION DATA:    C:\HELP\hardee\botc25\hardrai1.D11
SOIL AND DESIGN DATA FILE:  C:\HELP\hardee\botc25\hardee25.D10
OUTPUT DATA FILE:           C:\HELP\hardee\botc25\hardee25.OUT

TIME:  11: 0     DATE:   3/19/2013

******************************************************************************
TITLE:  Hardee County Phase II Section II Expansion RAI No. 1
```
**Bottom Center Portion (25 Feet Waste)**
```
******************************************************************************

     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.

                      LAYER  1 (Daily Cover 6-inches)
                      --------
                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER   5
           THICKNESS                   =      6.00   INCHES
           POROSITY                    =      0.4570 VOL/VOL
           FIELD CAPACITY              =      0.1310 VOL/VOL
           WILTING POINT               =      0.0580 VOL/VOL
           INITIAL SOIL WATER CONTENT  =      0.1982 VOL/VOL
           EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC
         NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  1.80
                  FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.

                      LAYER  2 (5 Feet Waste)
                      --------
                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER  19
           THICKNESS                   =     60.00   INCHES
           POROSITY                    =      0.1680 VOL/VOL
           FIELD CAPACITY              =      0.0730 VOL/VOL
           WILTING POINT               =      0.0190 VOL/VOL
           INITIAL SOIL WATER CONTENT  =      0.0718 VOL/VOL
           EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC
```

```
            LAYER  3 (10 Feet Waste)
            --------
          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  19
THICKNESS                  =    120.00   INCHES
POROSITY                   =      0.1680 VOL/VOL
FIELD CAPACITY             =      0.0730 VOL/VOL
WILTING POINT              =      0.0190 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.0730 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  0.100000005000E-02 CM/SEC

            LAYER  4 (10 Feet Waste)
            --------
          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  19
THICKNESS                  =    120.00   INCHES
POROSITY                   =      0.1680 VOL/VOL
FIELD CAPACITY             =      0.0730 VOL/VOL
WILTING POINT              =      0.0190 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.0730 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  0.100000005000E-02 CM/SEC

          LAYER  5 (Drainage Sand 24-inches)
          --------
          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER   5
THICKNESS                  =     24.00   INCHES
POROSITY                   =      0.4570 VOL/VOL
FIELD CAPACITY             =      0.1310 VOL/VOL
WILTING POINT              =      0.0580 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.1800 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  0.100000005000E-02 CM/SEC

LAYER  6 (300-mil Bi-planar Geocomposite FabriNet UF)
--------
            TYPE 2 - LATERAL DRAINAGE LAYER
              MATERIAL TEXTURE NUMBER   0
THICKNESS                  =      0.27   INCHES
POROSITY                   =      0.8500 VOL/VOL
FIELD CAPACITY             =      0.0100 VOL/VOL
WILTING POINT              =      0.0050 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.0110 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =   7.19999981000     CM/SEC
SLOPE                      =      2.20   PERCENT
DRAINAGE LENGTH            =     53.1    FEET

          LAYER  7 (60-mil HDPE geomembrane)
          --------
            TYPE 4 - FLEXIBLE MEMBRANE LINER
              MATERIAL TEXTURE NUMBER  35
THICKNESS                  =      0.06   INCHES
POROSITY                   =      0.0000 VOL/VOL
FIELD CAPACITY             =      0.0000 VOL/VOL
```

```
  WILTING POINT               =     0.0000 VOL/VOL
  INITIAL SOIL WATER CONTENT  =     0.0000 VOL/VOL
  EFFECTIVE SAT. HYD. COND.   =  0.199999996000E-12 CM/SEC
  FML PINHOLE DENSITY         =     1.00   HOLES/ACRE
  FML INSTALLATION DEFECTS    =     1.00   HOLES/ACRE
  FML PLACEMENT QUALITY       =  3 - GOOD

LAYER  8 (300-mil Tri-planar Geocomposite TENDRAIN 770-2)
--------
              TYPE 2 - LATERAL DRAINAGE LAYER
                MATERIAL TEXTURE NUMBER   0
  THICKNESS                   =     0.27   INCHES
  POROSITY                    =     0.8500 VOL/VOL
  FIELD CAPACITY              =     0.0100 VOL/VOL
  WILTING POINT               =     0.0050 VOL/VOL
  INITIAL SOIL WATER CONTENT  =     0.0100 VOL/VOL
  EFFECTIVE SAT. HYD. COND.   =   29.3999996000     CM/SEC
  SLOPE                       =     2.20   PERCENT
  DRAINAGE LENGTH             =    53.1    FEET

           LAYER  9 (60-mil HDPE geomembrane)
           --------
              TYPE 4 - FLEXIBLE MEMBRANE LINER
                MATERIAL TEXTURE NUMBER  35
  THICKNESS                   =     0.06   INCHES
  POROSITY                    =     0.0000 VOL/VOL
  FIELD CAPACITY              =     0.0000 VOL/VOL
  WILTING POINT               =     0.0000 VOL/VOL
  INITIAL SOIL WATER CONTENT  =     0.0000 VOL/VOL
  EFFECTIVE SAT. HYD. COND.   =  0.199999996000E-12 CM/SEC
  FML PINHOLE DENSITY         =     1.00   HOLES/ACRE
  FML INSTALLATION DEFECTS    =     1.00   HOLES/ACRE
  FML PLACEMENT QUALITY       =  3 - GOOD

                    LAYER  10 (GCL)
                     --------
                TYPE 3 - BARRIER SOIL LINER
                MATERIAL TEXTURE NUMBER  17
  THICKNESS                   =     0.25   INCHES
  POROSITY                    =     0.7500 VOL/VOL
  FIELD CAPACITY              =     0.7470 VOL/VOL
  WILTING POINT               =     0.4000 VOL/VOL
  INITIAL SOIL WATER CONTENT  =     0.7500 VOL/VOL
  EFFECTIVE SAT. HYD. COND.   =  0.300000003000E-08 CM/SEC

          GENERAL DESIGN AND EVAPORATIVE ZONE DATA
          ----------------------------------------

NOTE:  SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
         SOIL DATA BASE USING SOIL TEXTURE # 5 WITH A
         POOR STAND OF GRASS, A SURFACE SLOPE OF  2.%
         AND A SLOPE LENGTH OF   53. FEET.
```

```
SCS RUNOFF CURVE NUMBER              =     79.20
FRACTION OF AREA ALLOWING RUNOFF     =      0.0    PERCENT
AREA PROJECTED ON HORIZONTAL PLANE   =      1.000  ACRES
EVAPORATIVE ZONE DEPTH               =     10.0    INCHES
INITIAL WATER IN EVAPORATIVE ZONE    =      1.410  INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE   =      3.414  INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE   =      0.424  INCHES
INITIAL SNOW WATER                   =      0.000  INCHES
INITIAL WATER IN LAYER MATERIALS     =     27.530  INCHES
TOTAL INITIAL WATER                  =     27.530  INCHES
TOTAL SUBSURFACE INFLOW              =      0.00   INCHES/YEAR
```

EVAPOTRANSPIRATION AND WEATHER DATA

```
NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
       TAMPA                 FLORIDA

    STATION LATITUDE                        =  27.58 DEGREES
    MAXIMUM LEAF AREA INDEX                 =   1.00
    START OF GROWING SEASON (JULIAN DATE)   =      0
    END OF GROWING SEASON (JULIAN DATE)     =    367
    EVAPORATIVE ZONE DEPTH                  =  10.0  INCHES
    AVERAGE ANNUAL WIND SPEED               =   8.60 MPH
    AVERAGE 1ST QUARTER RELATIVE HUMIDITY   =  74.00 %
    AVERAGE 2ND QUARTER RELATIVE HUMIDITY   =  72.00 %
    AVERAGE 3RD QUARTER RELATIVE HUMIDITY   =  78.00 %
    AVERAGE 4TH QUARTER RELATIVE HUMIDITY   =  76.00 %

NOTE:  PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
       COEFFICIENTS FOR    TAMPA               FLORIDA
```

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

| JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|
| 1.85 | 2.58 | 3.39 | 2.95 | 2.52 | 8.31 |
| 7.83 | 7.98 | 5.61 | 2.86 | 1.94 | 1.84 |

```
NOTE:  TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
       COEFFICIENTS FOR    TAMPA               FLORIDA
```

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

| JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|
| 59.80 | 60.80 | 66.20 | 71.60 | 77.10 | 80.90 |
| 82.20 | 82.20 | 80.90 | 74.50 | 66.70 | 61.30 |

```
NOTE:  SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
       COEFFICIENTS FOR    TAMPA               FLORIDA
         AND STATION LATITUDE  =  27.58 DEGREES
```

```
*******************************************************************************
         AVERAGE MONTHLY VALUES IN INCHES FOR YEARS    1 THROUGH   28
 ------------------------------------------------------------------------------

                          JAN/JUL  FEB/AUG  MAR/SEP  APR/OCT  MAY/NOV
JUN/DEC
                        -------  -------  -------  -------  -------  -------
PRECIPITATION
-------------
TOTALS                      1.82     2.13     3.38     2.54     3.05     7.89
                            8.50     7.72     5.34     2.65     1.83     1.84

STD. DEVIATIONS             1.56     2.17     2.92     1.84     2.10     3.63
                            3.41     2.59     2.44     2.42     2.77     2.09

RUNOFF
------
TOTALS                     0.000    0.000    0.000    0.000    0.000    0.000
                           0.000    0.000    0.000    0.000    0.000    0.000

STD. DEVIATIONS            0.000    0.000    0.000    0.000    0.000    0.000
                           0.000    0.000    0.000    0.000    0.000    0.000

EVAPOTRANSPIRATION
------------------
TOTALS                     1.207    1.348    2.064    1.894    2.091    4.556
                           5.277    4.915    3.535    1.753    1.077    0.947

STD. DEVIATIONS            0.828    0.919    1.337    1.086    1.194    1.234
                           1.176    1.115    1.154    1.120    0.817    0.785

LATERAL DRAINAGE COLLECTED FROM LAYER  6
----------------------------------------
TOTALS                    0.5369   0.6154   1.0739   0.8121   0.6770   1.4669
                          3.2209   3.2043   2.4266   1.5772   1.0444   0.8748

STD. DEVIATIONS           0.6549   1.2064   1.7443   0.9340   0.6987   1.6776
                          2.1310   1.8537   1.7823   1.4643   1.4963   1.6016

PERCOLATION/LEAKAGE THROUGH LAYER  7
------------------------------------
TOTALS                  0.0280   0.0280   0.0357   0.0334   0.0318   0.0414
                        0.0674   0.0712   0.0612   0.0500   0.0374   0.0324

STD. DEVIATIONS         0.0156   0.0176   0.0236   0.0181   0.0132   0.0231
                        0.0284   0.0238   0.0212   0.0197   0.0189   0.0241

LATERAL DRAINAGE COLLECTED FROM LAYER  8
----------------------------------------
TOTALS                  0.0280   0.0280   0.0357   0.0334   0.0318   0.0414
                        0.0674   0.0712   0.0612   0.0500   0.0374   0.0324

STD. DEVIATIONS         0.0156   0.0176   0.0236   0.0181   0.0132   0.0231
```

```
                         0.0284   0.0238   0.0212   0.0197   0.0189   0.0241

PERCOLATION/LEAKAGE THROUGH LAYER 10
------------------------------------
TOTALS                 0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                       0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

STD. DEVIATIONS        0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                       0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

----------------------------------------------------------------------------
                AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)
 ---------------------------------------------------------------------------

DAILY AVERAGE HEAD ON TOP OF LAYER  7
-------------------------------------
AVERAGES               0.0010   0.0013   0.0020   0.0016   0.0013   0.0029
                       0.0061   0.0061   0.0048   0.0030   0.0021   0.0017

STD. DEVIATIONS        0.0012   0.0025   0.0033   0.0018   0.0013   0.0033
                       0.0041   0.0035   0.0035   0.0028   0.0030   0.0031

   DAILY AVERAGE HEAD ON TOP OF LAYER  9
   -------------------------------------
AVERAGES               0.0001   0.0001   0.0002   0.0002   0.0002   0.0002
                       0.0003   0.0003   0.0003   0.0002   0.0002   0.0002

STD. DEVIATIONS        0.0001   0.0001   0.0001   0.0001   0.0001   0.0001
                       0.0001   0.0001   0.0001   0.0001   0.0001   0.0001

****************************************************************************
****************************************************************************
      AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS    1 THROUGH   28
 ---------------------------------------------------------------------------
                                     INCHES            CU. FEET      PERCENT
                               -------------------  -------------   ---------
PRECIPITATION                     48.67    (   9.518)     176683.8     100.00

RUNOFF                            0.000   (  0.0000)         0.00      0.000

EVAPOTRANSPIRATION               30.664   (  4.6860)    111311.69     63.001

LATERAL DRAINAGE COLLECTED       17.53024 (  5.92711)     63634.770   36.01619
FROM LAYER  6

PERCOLATION/LEAKAGE THROUGH      0.51785 (  0.08969)      1879.808     1.06394
LAYER  7

AVERAGE HEAD ON TOP              0.003 (    0.001)
OF LAYER  7

LATERAL DRAINAGE COLLECTED        0.51785 (  0.08969)      1879.807    1.06394
FROM LAYER  8
```

```
PERCOLATION/LEAKAGE THROUGH    0.00000 (  0.00000)         0.000     0.00000
LAYER 10

AVERAGE HEAD ON TOP             0.000 (    0.000)
OF LAYER  9

CHANGE IN WATER STORAGE        -0.039   (  1.5043)       -142.51     -0.081

****************************************************************************
```

```
*******************************************************************************
                 PEAK DAILY VALUES FOR YEARS    1 THROUGH   28
    ---------------------------------------------------------------------------
                                                 (INCHES)      (CU. FT.)
                                                ----------    -------------
      PRECIPITATION                               7.60          27588.000

      RUNOFF                                      0.000             0.0000

      DRAINAGE COLLECTED FROM LAYER  6           1.08028        3921.41748

      PERCOLATION/LEAKAGE THROUGH LAYER  7       0.009184         33.33931

      AVERAGE HEAD ON TOP OF LAYER  7             0.064

      MAXIMUM HEAD ON TOP OF LAYER  7             0.123

      LOCATION OF MAXIMUM HEAD IN LAYER  6
            (DISTANCE FROM DRAIN)                 1.8 FEET

      DRAINAGE COLLECTED FROM LAYER  8           0.00918          33.33931

      PERCOLATION/LEAKAGE THROUGH LAYER 10       0.000000          0.00000

      AVERAGE HEAD ON TOP OF LAYER  9             0.001

      MAXIMUM HEAD ON TOP OF LAYER  9             0.000

      LOCATION OF MAXIMUM HEAD IN LAYER  8
            (DISTANCE FROM DRAIN)                 0.0 FEET

      SNOW WATER                                  0.00              0.0000


      MAXIMUM VEG. SOIL WATER (VOL/VOL)                   0.3312

      MINIMUM VEG. SOIL WATER (VOL/VOL)                   0.0424


       ***  Maximum heads are computed using McEnroe's equations.  ***

            Reference:  Maximum Saturated Depth over Landfill Liner
                        by Bruce M. McEnroe, University of Kansas
                        ASCE Journal of Environmental Engineering
                        Vol. 119, No. 2, March 1993, pp. 262-270.

*******************************************************************************
```

******************************************************************************

FINAL WATER STORAGE AT END OF YEAR 28

| LAYER | (INCHES) | (VOL/VOL) |
|---|---|---|
| 1 | 0.3324 | 0.0554 |
| 2 | 4.1797 | 0.0697 |
| 3 | 8.7600 | 0.0730 |
| 4 | 8.7600 | 0.0730 |
| 5 | 4.2058 | 0.1752 |
| 6 | 0.0029 | 0.0107 |
| 7 | 0.0000 | 0.0000 |
| 8 | 0.0027 | 0.0100 |
| 9 | 0.0000 | 0.0000 |
| 10 | 0.1875 | 0.7500 |
| SNOW WATER | 0.000 | |

******************************************************************************
******************************************************************************

```
******************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************

PRECIPITATION DATA FILE:    C:\HELP\hardee\botc60\hardrai1.D4
TEMPERATURE DATA FILE:      C:\HELP\hardee\botc60\hardrai1.D7
SOLAR RADIATION DATA FILE:  C:\HELP\hardee\botc60\hardrai1.D13
EVAPOTRANSPIRATION DATA:    C:\HELP\hardee\botc60\hardrai1.D11
SOIL AND DESIGN DATA FILE:  C:\HELP\hardee\botc60\hardee60.D10
OUTPUT DATA FILE:           C:\HELP\hardee\botc60\hardee60.OUT

TIME:  11:11     DATE:   3/19/2013

******************************************************************************
TITLE:  Hardee County Phase II Section II Expansion RAI No. 1
Bottom Center Portion (60 Feet Waste)
******************************************************************************

     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
            COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.

                     LAYER  1 (Daily Cover 18-inches)
                     --------
                     TYPE 1 - VERTICAL PERCOLATION LAYER
                        MATERIAL TEXTURE NUMBER   5
          THICKNESS                  =     18.00   INCHES
          POROSITY                   =      0.4570 VOL/VOL
          FIELD CAPACITY             =      0.1310 VOL/VOL
          WILTING POINT              =      0.0580 VOL/VOL
          INITIAL SOIL WATER CONTENT =      0.1524 VOL/VOL
          EFFECTIVE SAT. HYD. COND.  =  0.100000005000E-02 CM/SEC
        NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  1.80
               FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.

                     LAYER  2 (10 Feet Waste)
                     --------
                     TYPE 1 - VERTICAL PERCOLATION LAYER
                        MATERIAL TEXTURE NUMBER  19
          THICKNESS                  =    120.00   INCHES
          POROSITY                   =      0.1680 VOL/VOL
          FIELD CAPACITY             =      0.0730 VOL/VOL
          WILTING POINT              =      0.0190 VOL/VOL
          INITIAL SOIL WATER CONTENT =      0.0730 VOL/VOL
          EFFECTIVE SAT. HYD. COND.  =  0.100000005000E-02 CM/SEC
```

```
            LAYER  3 (10 Feet Waste)
            --------
          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  19
THICKNESS                  =    120.00   INCHES
POROSITY                   =      0.1680 VOL/VOL
FIELD CAPACITY             =      0.0730 VOL/VOL
WILTING POINT              =      0.0190 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.0730 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  0.100000005000E-02 CM/SEC

            LAYER  4 (10 Feet Waste)
            --------
          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  19
THICKNESS                  =    120.00   INCHES
POROSITY                   =      0.1680 VOL/VOL
FIELD CAPACITY             =      0.0730 VOL/VOL
WILTING POINT              =      0.0190 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.0730 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  0.100000005000E-02 CM/SEC

            LAYER  5 (10 Feet Waste)
            --------
          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  19
THICKNESS                  =    120.00   INCHES
POROSITY                   =      0.1680 VOL/VOL
FIELD CAPACITY             =      0.0730 VOL/VOL
WILTING POINT              =      0.0190 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.0730 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  0.100000005000E-02 CM/SEC

            LAYER  6 (10 Feet Waste)
            --------
          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  19
THICKNESS                  =    120.00   INCHES
POROSITY                   =      0.1680 VOL/VOL
FIELD CAPACITY             =      0.0730 VOL/VOL
WILTING POINT              =      0.0190 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.0730 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  0.100000005000E-02 CM/SEC

            LAYER  7 (10 Feet Waste)
            --------
          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  19
THICKNESS                  =    120.00   INCHES
POROSITY                   =      0.1680 VOL/VOL
FIELD CAPACITY             =      0.0730 VOL/VOL
WILTING POINT              =      0.0190 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.0730 VOL/VOL
```

```
   EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC

            LAYER  8 (Drainage Sand 24-inches)
            --------
             TYPE 1 - VERTICAL PERCOLATION LAYER
                 MATERIAL TEXTURE NUMBER   5
   THICKNESS                   =     24.00   INCHES
   POROSITY                    =      0.4570 VOL/VOL
   FIELD CAPACITY              =      0.1310 VOL/VOL
   WILTING POINT               =      0.0580 VOL/VOL
   INITIAL SOIL WATER CONTENT  =      0.1964 VOL/VOL
   EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC

   LAYER  9 (300-mil Bi-planar Geocomposite FabriNet UF)
   --------
               TYPE 2 - LATERAL DRAINAGE LAYER
                 MATERIAL TEXTURE NUMBER   0
   THICKNESS                   =      0.26   INCHES
   POROSITY                    =      0.8500 VOL/VOL
   FIELD CAPACITY              =      0.0100 VOL/VOL
   WILTING POINT               =      0.0050 VOL/VOL
   INITIAL SOIL WATER CONTENT  =      0.0118 VOL/VOL
   EFFECTIVE SAT. HYD. COND.   =   5.30000019000     CM/SEC
   SLOPE                       =      2.20   PERCENT
   DRAINAGE LENGTH             =     53.1    FEET

            LAYER  10 (60-mil HDPE geomembrane)
            --------
               TYPE 4 - FLEXIBLE MEMBRANE LINER
                 MATERIAL TEXTURE NUMBER  35
   THICKNESS                   =      0.06   INCHES
   POROSITY                    =      0.0000 VOL/VOL
   FIELD CAPACITY              =      0.0000 VOL/VOL
   WILTING POINT               =      0.0000 VOL/VOL
   INITIAL SOIL WATER CONTENT  =      0.0000 VOL/VOL
   EFFECTIVE SAT. HYD. COND.   =  0.199999996000E-12 CM/SEC
   FML PINHOLE DENSITY         =      1.00   HOLES/ACRE
   FML INSTALLATION DEFECTS    =      1.00   HOLES/ACRE
   FML PLACEMENT QUALITY       =  3 - GOOD

LAYER  11 (300-mil Tri-planar Geocomposite TENDRAIN 770-2)
 --------
               TYPE 2 - LATERAL DRAINAGE LAYER
                 MATERIAL TEXTURE NUMBER   0
   THICKNESS                   =      0.26   INCHES
   POROSITY                    =      0.8500 VOL/VOL
   FIELD CAPACITY              =      0.0100 VOL/VOL
   WILTING POINT               =      0.0050 VOL/VOL
   INITIAL SOIL WATER CONTENT  =      0.0100 VOL/VOL
   EFFECTIVE SAT. HYD. COND.   =   21.7999992000     CM/SEC
   SLOPE                       =      2.20   PERCENT
   DRAINAGE LENGTH             =     53.1    FEET
```

```
            LAYER  12 (60-mil HDPE geomembrane)
             --------
               TYPE 4 - FLEXIBLE MEMBRANE LINER
                 MATERIAL TEXTURE NUMBER  35
   THICKNESS                  =     0.06   INCHES
   POROSITY                   =     0.0000 VOL/VOL
   FIELD CAPACITY             =     0.0000 VOL/VOL
   WILTING POINT              =     0.0000 VOL/VOL
   INITIAL SOIL WATER CONTENT =     0.0000 VOL/VOL
   EFFECTIVE SAT. HYD. COND.  =  0.199999996000E-12 CM/SEC
   FML PINHOLE DENSITY        =     1.00   HOLES/ACRE
   FML INSTALLATION DEFECTS   =     1.00   HOLES/ACRE
   FML PLACEMENT QUALITY      =  3 - GOOD

                      LAYER  13 (GCL)
                       --------
                 TYPE 3 - BARRIER SOIL LINER
                 MATERIAL TEXTURE NUMBER  17
   THICKNESS                  =     0.25   INCHES
   POROSITY                   =     0.7500 VOL/VOL
   FIELD CAPACITY             =     0.7470 VOL/VOL
   WILTING POINT              =     0.4000 VOL/VOL
   INITIAL SOIL WATER CONTENT =     0.7500 VOL/VOL
   EFFECTIVE SAT. HYD. COND.  =  0.300000003000E-08 CM/SEC

           GENERAL DESIGN AND EVAPORATIVE ZONE DATA
           ----------------------------------------

  NOTE:  SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
           SOIL DATA BASE USING SOIL TEXTURE # 5 WITH A
           POOR STAND OF GRASS, A SURFACE SLOPE OF  2.%
           AND A SLOPE LENGTH OF   53. FEET.

   SCS RUNOFF CURVE NUMBER            =    79.20
   FRACTION OF AREA ALLOWING RUNOFF   =     0.0    PERCENT
   AREA PROJECTED ON HORIZONTAL PLANE =     1.000  ACRES
   EVAPORATIVE ZONE DEPTH             =    10.0    INCHES
   INITIAL WATER IN EVAPORATIVE ZONE  =     1.295  INCHES
   UPPER LIMIT OF EVAPORATIVE STORAGE =     4.570  INCHES
   LOWER LIMIT OF EVAPORATIVE STORAGE =     0.580  INCHES
   INITIAL SNOW WATER                 =     0.000  INCHES
   INITIAL WATER IN LAYER MATERIALS   =    60.210  INCHES
   TOTAL INITIAL WATER                =    60.210  INCHES
   TOTAL SUBSURFACE INFLOW            =     0.00   INCHES/YEAR

             EVAPOTRANSPIRATION AND WEATHER DATA
             -----------------------------------

  NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
           TAMPA                  FLORIDA

        STATION LATITUDE                       =  27.58 DEGREES
        MAXIMUM LEAF AREA INDEX                =   1.00
```

```
START OF GROWING SEASON (JULIAN DATE)  =      0
END OF GROWING SEASON (JULIAN DATE)    =    367
EVAPORATIVE ZONE DEPTH                 =  10.0  INCHES
AVERAGE ANNUAL WIND SPEED              =   8.60 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY  =  74.00 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY  =  72.00 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY  =  78.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY  =  76.00 %
```

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR TAMPA FLORIDA

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

| JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|
| 1.85 | 2.58 | 3.39 | 2.95 | 2.52 | 8.31 |
| 7.83 | 7.98 | 5.61 | 2.86 | 1.94 | 1.84 |

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR TAMPA FLORIDA

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

| JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|
| 59.80 | 60.80 | 66.20 | 71.60 | 77.10 | 80.90 |
| 82.20 | 82.20 | 80.90 | 74.50 | 66.70 | 61.30 |

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR TAMPA FLORIDA AND STATION LATITUDE = 27.58 DEGREES

*****************************************************************************

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 28

| | JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|---|
| PRECIPITATION | | | | | | |
| TOTALS | 1.82 | 2.13 | 3.38 | 2.54 | 3.05 | 7.89 |
| | 8.50 | 7.72 | 5.34 | 2.65 | 1.83 | 1.84 |
| STD. DEVIATIONS | 1.56 | 2.17 | 2.92 | 1.84 | 2.10 | 3.63 |
| | 3.41 | 2.59 | 2.44 | 2.42 | 2.77 | 2.09 |
| RUNOFF | | | | | | |
| TOTALS | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| STD. DEVIATIONS | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |

```
                      0.000    0.000    0.000    0.000    0.000    0.000

EVAPOTRANSPIRATION
------------------
TOTALS                1.216    1.501    2.156    1.980    2.227    4.650
                      5.436    5.190    3.751    1.916    1.110    0.935

STD. DEVIATIONS       0.729    0.948    1.396    1.152    1.298    1.280
                      1.238    1.030    1.168    1.184    0.865    0.760

LATERAL DRAINAGE COLLECTED FROM LAYER  9
----------------------------------------
TOTALS                0.7888   0.4086   0.7408   1.0360   0.6187   0.7786
                      2.3822   2.9889   2.5000   1.8109   1.0575   0.9413

STD. DEVIATIONS       1.3022   0.4646   1.2413   1.7064   0.5269   0.8317
                      2.0626   1.9496   1.5195   1.3027   1.1920   1.6296

PERCOLATION/LEAKAGE THROUGH LAYER 10
------------------------------------
TOTALS                0.0368   0.0280   0.0362   0.0412   0.0365   0.0372
                      0.0653   0.0811   0.0746   0.0640   0.0467   0.0418

STD. DEVIATIONS       0.0256   0.0124   0.0218   0.0298   0.0157   0.0169
                      0.0352   0.0304   0.0242   0.0224   0.0209   0.0257

LATERAL DRAINAGE COLLECTED FROM LAYER 11
----------------------------------------
TOTALS                0.0368   0.0280   0.0362   0.0412   0.0365   0.0372
                      0.0653   0.0811   0.0746   0.0640   0.0467   0.0418

STD. DEVIATIONS       0.0256   0.0124   0.0218   0.0298   0.0157   0.0169
                      0.0352   0.0304   0.0242   0.0224   0.0209   0.0257

PERCOLATION/LEAKAGE THROUGH LAYER 13
------------------------------------
TOTALS                0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                      0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

STD. DEVIATIONS       0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                      0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

-----------------------------------------------------------------------------
                AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)
-----------------------------------------------------------------------------

DAILY AVERAGE HEAD ON TOP OF LAYER 10
-------------------------------------
AVERAGES              0.0020   0.0012   0.0019   0.0028   0.0016   0.0021
                      0.0062   0.0077   0.0067   0.0047   0.0028   0.0024

STD. DEVIATIONS       0.0034   0.0013   0.0032   0.0046   0.0014   0.0022
                      0.0053   0.0051   0.0041   0.0034   0.0032   0.0042
```

DAILY AVERAGE HEAD ON TOP OF LAYER 12

| | | | | | | |
|---|---|---|---|---|---|---|
| AVERAGES | 0.0002 | 0.0001 | 0.0002 | 0.0002 | 0.0002 | 0.0002 |
| | 0.0003 | 0.0004 | 0.0004 | 0.0003 | 0.0002 | 0.0002 |
| STD. DEVIATIONS | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 |
| | 0.0002 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 |

AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 28

| | INCHES | | CU. FEET | PERCENT |
|---|---|---|---|---|
| PRECIPITATION | 48.67 | ( 9.518) | 176683.8 | 100.00 |
| RUNOFF | 0.000 | ( 0.0000) | 0.00 | 0.000 |
| EVAPOTRANSPIRATION | 32.067 | ( 4.7749) | 116402.73 | 65.882 |
| LATERAL DRAINAGE COLLECTED FROM LAYER 9 | 16.05222 | ( 5.71713) | 58269.543 | 32.97957 |
| PERCOLATION/LEAKAGE THROUGH LAYER 10 | 0.58947 | ( 0.10990) | 2139.779 | 1.21108 |
| AVERAGE HEAD ON TOP OF LAYER 10 | 0.004 | ( 0.001) | | |
| LATERAL DRAINAGE COLLECTED FROM LAYER 11 | 0.58947 | ( 0.10990) | 2139.779 | 1.21108 |
| PERCOLATION/LEAKAGE THROUGH LAYER 13 | 0.00000 | ( 0.00000) | 0.001 | 0.00000 |
| AVERAGE HEAD ON TOP OF LAYER 12 | 0.000 | ( 0.000) | | |
| CHANGE IN WATER STORAGE | -0.035 | ( 2.6191) | -128.28 | -0.073 |

```
*******************************************************************************
            PEAK DAILY VALUES FOR YEARS    1 THROUGH   28
    ---------------------------------------------------------------------------
                                                (INCHES)      (CU. FT.)
                                               ----------   -------------
      PRECIPITATION                              7.60         27588.000

      RUNOFF                                     0.000            0.0000

      DRAINAGE COLLECTED FROM LAYER  9          0.53032       1925.07129

      PERCOLATION/LEAKAGE THROUGH LAYER 10      0.007460        27.07832

      AVERAGE HEAD ON TOP OF LAYER 10            0.043

      MAXIMUM HEAD ON TOP OF LAYER 10            0.083

      LOCATION OF MAXIMUM HEAD IN LAYER  9
            (DISTANCE FROM DRAIN)                1.3 FEET

      DRAINAGE COLLECTED FROM LAYER 11          0.00746         27.07832

      PERCOLATION/LEAKAGE THROUGH LAYER 13      0.000000         0.00000

      AVERAGE HEAD ON TOP OF LAYER 12            0.001

      MAXIMUM HEAD ON TOP OF LAYER 12            0.001

      LOCATION OF MAXIMUM HEAD IN LAYER 11
            (DISTANCE FROM DRAIN)                0.0 FEET

      SNOW WATER                                 0.00             0.0000


      MAXIMUM VEG. SOIL WATER (VOL/VOL)                  0.4570

      MINIMUM VEG. SOIL WATER (VOL/VOL)                  0.0580


       ***  Maximum heads are computed using McEnroe's equations.  ***

            Reference:  Maximum Saturated Depth over Landfill Liner
                        by Bruce M. McEnroe, University of Kansas
                        ASCE Journal of Environmental Engineering
                        Vol. 119, No. 2, March 1993, pp. 262-270.

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FINAL WATER STORAGE AT END OF YEAR 28

| LAYER | (INCHES) | (VOL/VOL) |
|---|---|---|
| 1 | 1.9705 | 0.1095 |
| 2 | 8.7600 | 0.0730 |
| 3 | 8.7600 | 0.0730 |
| 4 | 8.7600 | 0.0730 |
| 5 | 8.7600 | 0.0730 |
| 6 | 8.7600 | 0.0730 |
| 7 | 8.7600 | 0.0730 |
| 8 | 4.4972 | 0.1874 |
| 9 | 0.0030 | 0.0114 |
| 10 | 0.0000 | 0.0000 |
| 11 | 0.0026 | 0.0100 |
| 12 | 0.0000 | 0.0000 |
| 13 | 0.1875 | 0.7500 |
| SNOW WATER | 0.000 | |

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**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY             **
**                                                                          **
**                                                                          **
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PRECIPITATION DATA FILE:    C:\HELP\hardee\bottomn\hardrai1.D4
TEMPERATURE DATA FILE:      C:\HELP\hardee\bottomn\hardrai1.D7
SOLAR RADIATION DATA FILE:  C:\HELP\hardee\bottomn\hardrai1.D13
EVAPOTRANSPIRATION DATA:    C:\HELP\hardee\bottomn\hardrai1.D11
SOIL AND DESIGN DATA FILE:  C:\HELP\hardee\bottomn\hardeeop.D10
OUTPUT DATA FILE:           C:\HELP\hardee\bottomn\hardrai1.OUT

TIME:   3:57     DATE:   3/ 6/2013

****************************************************************************
TITLE:  Hardee County Phase II Section II Expansion RAI No. 1
```
**Bottom North Portion (Open Cell – No Waste)**
```
****************************************************************************

     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.

                    LAYER  1 (Drainage Sand 24-inches)
                    --------
                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER   5
           THICKNESS                    =     24.00   INCHES
           POROSITY                     =      0.4570 VOL/VOL
           FIELD CAPACITY               =      0.1310 VOL/VOL
           WILTING POINT                =      0.0580 VOL/VOL
           INITIAL SOIL WATER CONTENT   =      0.1837 VOL/VOL
           EFFECTIVE SAT. HYD. COND.    =  0.100000005000E-02 CM/SEC

          LAYER  2 (300-mil Bi-planar Geocomposite FabriNet UF)
           --------
                       TYPE 2 - LATERAL DRAINAGE LAYER
                         MATERIAL TEXTURE NUMBER   0
           THICKNESS                    =      0.30   INCHES
           POROSITY                     =      0.8500 VOL/VOL
           FIELD CAPACITY               =      0.0100 VOL/VOL
           WILTING POINT                =      0.0050 VOL/VOL
           INITIAL SOIL WATER CONTENT   =      0.0102 VOL/VOL
           EFFECTIVE SAT. HYD. COND.    =   11.8999996000     CM/SEC
           SLOPE                        =      2.20   PERCENT
           DRAINAGE LENGTH              =     53.5    FEET
```

```
            LAYER  3 (60-mil HDPE geomembrane)
            --------
               TYPE 4 - FLEXIBLE MEMBRANE LINER
                 MATERIAL TEXTURE NUMBER  35
   THICKNESS                  =     0.06   INCHES
   POROSITY                   =     0.0000 VOL/VOL
   FIELD CAPACITY             =     0.0000 VOL/VOL
   WILTING POINT              =     0.0000 VOL/VOL
   INITIAL SOIL WATER CONTENT =     0.0000 VOL/VOL
   EFFECTIVE SAT. HYD. COND.  =  0.199999996000E-12 CM/SEC
   FML PINHOLE DENSITY        =     1.00   HOLES/ACRE
   FML INSTALLATION DEFECTS   =     1.00   HOLES/ACRE
   FML PLACEMENT QUALITY      =  3 - GOOD

LAYER  4 (300-mil Tri-planar Geocomposite TENDRAIN 770-2)
--------
               TYPE 2 - LATERAL DRAINAGE LAYER
                 MATERIAL TEXTURE NUMBER   0
   THICKNESS                  =     0.30   INCHES
   POROSITY                   =     0.8500 VOL/VOL
   FIELD CAPACITY             =     0.0100 VOL/VOL
   WILTING POINT              =     0.0050 VOL/VOL
   INITIAL SOIL WATER CONTENT =     0.0100 VOL/VOL
   EFFECTIVE SAT. HYD. COND.  =   40.7000008000     CM/SEC
   SLOPE                      =     2.20   PERCENT
   DRAINAGE LENGTH            =    53.5    FEET

            LAYER  5 (60-mil HDPE geomembrane)
            --------
               TYPE 4 - FLEXIBLE MEMBRANE LINER
                 MATERIAL TEXTURE NUMBER  35
   THICKNESS                  =     0.06   INCHES
   POROSITY                   =     0.0000 VOL/VOL
   FIELD CAPACITY             =     0.0000 VOL/VOL
   WILTING POINT              =     0.0000 VOL/VOL
   INITIAL SOIL WATER CONTENT =     0.0000 VOL/VOL
   EFFECTIVE SAT. HYD. COND.  =  0.199999996000E-12 CM/SEC
   FML PINHOLE DENSITY        =     1.00   HOLES/ACRE
   FML INSTALLATION DEFECTS   =     1.00   HOLES/ACRE
   FML PLACEMENT QUALITY      =  3 - GOOD

                      LAYER  6 (GCL)
                      --------
                 TYPE 3 - BARRIER SOIL LINER
                 MATERIAL TEXTURE NUMBER  17
   THICKNESS                  =     0.25   INCHES
   POROSITY                   =     0.7500 VOL/VOL
   FIELD CAPACITY             =     0.7470 VOL/VOL
   WILTING POINT              =     0.4000 VOL/VOL
   INITIAL SOIL WATER CONTENT =     0.7500 VOL/VOL
   EFFECTIVE SAT. HYD. COND.  =  0.300000003000E-08 CM/SEC

           GENERAL DESIGN AND EVAPORATIVE ZONE DATA
```

```
            ----------------------------------------

    NOTE:  SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
             SOIL DATA BASE USING SOIL TEXTURE # 5 WITH BARE
             GROUND CONDITIONS, A SURFACE SLOPE OF  2.% AND
             A SLOPE LENGTH OF   53. FEET.

   SCS RUNOFF CURVE NUMBER            =    85.00
   FRACTION OF AREA ALLOWING RUNOFF   =     0.0    PERCENT
   AREA PROJECTED ON HORIZONTAL PLANE =     1.000  ACRES
   EVAPORATIVE ZONE DEPTH             =    10.0    INCHES
   INITIAL WATER IN EVAPORATIVE ZONE  =     1.827  INCHES
   UPPER LIMIT OF EVAPORATIVE STORAGE =     4.570  INCHES
   LOWER LIMIT OF EVAPORATIVE STORAGE =     0.580  INCHES
   INITIAL SNOW WATER                 =     0.000  INCHES
   INITIAL WATER IN LAYER MATERIALS   =     4.603  INCHES
   TOTAL INITIAL WATER                =     4.603  INCHES
   TOTAL SUBSURFACE INFLOW            =     0.00   INCHES/YEAR

             EVAPOTRANSPIRATION AND WEATHER DATA
             -----------------------------------

    NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
             TAMPA                FLORIDA

        STATION LATITUDE                         =  27.58 DEGREES
        MAXIMUM LEAF AREA INDEX                  =   0.00
        START OF GROWING SEASON (JULIAN DATE)    =      0
        END OF GROWING SEASON (JULIAN DATE)      =    367
        EVAPORATIVE ZONE DEPTH                   =  10.0  INCHES
        AVERAGE ANNUAL WIND SPEED                =   8.60 MPH
        AVERAGE 1ST QUARTER RELATIVE HUMIDITY    =  74.00 %
        AVERAGE 2ND QUARTER RELATIVE HUMIDITY    =  72.00 %
        AVERAGE 3RD QUARTER RELATIVE HUMIDITY    =  78.00 %
        AVERAGE 4TH QUARTER RELATIVE HUMIDITY    =  76.00 %

    NOTE:  PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
             COEFFICIENTS FOR    TAMPA              FLORIDA

             NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
-------     -------     -------     -------     -------     -------
  1.85        2.58        3.39        2.95        2.52        8.31
  7.83        7.98        5.61        2.86        1.94        1.84

    NOTE:  TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
             COEFFICIENTS FOR    TAMPA              FLORIDA

        NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
-------     -------     -------     -------     -------     -------
```

| | | | | | |
|---|---|---|---|---|---|
| 59.80 | 60.80 | 66.20 | 71.60 | 77.10 | 80.90 |
| 82.20 | 82.20 | 80.90 | 74.50 | 66.70 | 61.30 |

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR TAMPA FLORIDA AND STATION LATITUDE = 27.58 DEGREES

*******************************************************************************

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 28

| | JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|---|
| **PRECIPITATION** | | | | | | |
| TOTALS | 1.82 | 2.13 | 3.38 | 2.54 | 3.05 | 7.89 |
| | 8.50 | 7.72 | 5.34 | 2.65 | 1.83 | 1.84 |
| STD. DEVIATIONS | 1.56 | 2.17 | 2.92 | 1.84 | 2.10 | 3.63 |
| | 3.41 | 2.59 | 2.44 | 2.42 | 2.77 | 2.09 |
| **RUNOFF** | | | | | | |
| TOTALS | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| STD. DEVIATIONS | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| **EVAPOTRANSPIRATION** | | | | | | |
| TOTALS | 1.276 | 1.223 | 1.852 | 1.713 | 1.833 | 3.929 |
| | 4.656 | 4.317 | 3.272 | 1.710 | 1.100 | 1.005 |
| STD. DEVIATIONS | 0.796 | 0.858 | 1.176 | 0.904 | 1.054 | 1.195 |
| | 1.041 | 1.068 | 0.990 | 0.929 | 0.781 | 0.763 |
| **LATERAL DRAINAGE COLLECTED FROM LAYER 2** | | | | | | |
| TOTALS | 0.5046 | 0.7188 | 1.2995 | 0.7603 | 1.0602 | 2.8939 |
| | 3.9590 | 3.4036 | 2.3641 | 1.5466 | 1.1052 | 0.7935 |
| STD. DEVIATIONS | 0.5272 | 1.2820 | 1.9426 | 0.6624 | 0.9583 | 2.4215 |
| | 2.4742 | 1.7575 | 1.7560 | 1.5038 | 1.8845 | 1.3141 |
| **PERCOLATION/LEAKAGE THROUGH LAYER 3** | | | | | | |
| TOTALS | 0.0207 | 0.0213 | 0.0294 | 0.0253 | 0.0293 | 0.0431 |
| | 0.0580 | 0.0569 | 0.0452 | 0.0364 | 0.0273 | 0.0226 |
| STD. DEVIATIONS | 0.0086 | 0.0115 | 0.0180 | 0.0108 | 0.0111 | 0.0206 |
| | 0.0198 | 0.0147 | 0.0140 | 0.0139 | 0.0156 | 0.0142 |

```
LATERAL DRAINAGE COLLECTED FROM LAYER  4
----------------------------------------
TOTALS                  0.0207   0.0213   0.0294   0.0253   0.0293   0.0431
                        0.0580   0.0569   0.0452   0.0364   0.0273   0.0226

STD. DEVIATIONS         0.0086   0.0115   0.0180   0.0108   0.0111   0.0206
                        0.0198   0.0147   0.0140   0.0139   0.0156   0.0142

PERCOLATION/LEAKAGE THROUGH LAYER  6
------------------------------------
TOTALS                  0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                        0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

STD. DEVIATIONS         0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                        0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

-------------------------------------------------------------------------
                AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)
 ------------------------------------------------------------------------

DAILY AVERAGE HEAD ON TOP OF LAYER  3
-------------------------------------
AVERAGES                0.0006   0.0009   0.0015   0.0009   0.0012   0.0035
                        0.0049   0.0040   0.0028   0.0018   0.0013   0.0009

STD. DEVIATIONS          0.0006   0.0017   0.0023   0.0008   0.0011   0.0029
                         0.0038   0.0020   0.0021   0.0017   0.0023   0.0015

DAILY AVERAGE HEAD ON TOP OF LAYER  5
-------------------------------------
AVERAGES                 0.0001   0.0001   0.0001   0.0001   0.0001   0.0002
                         0.0003   0.0003   0.0002   0.0002   0.0001   0.0001

STD. DEVIATIONS          0.0000   0.0001   0.0001   0.0001   0.0001   0.0001
                         0.0001   0.0001   0.0001   0.0001   0.0001   0.0001

*************************************************************************
*************************************************************************

AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS    1 THROUGH   28
 ------------------------------------------------------------------------
                                   INCHES            CU. FEET       PERCENT
                            -------------------   -------------   ---------
PRECIPITATION                  48.67    (   9.518)     176683.8     100.00

RUNOFF                         0.000   (  0.0000)         0.00      0.000

EVAPOTRANSPIRATION            27.888   (  4.3435)    101231.80     57.295

LATERAL DRAINAGE COLLECTED  20.40944 (  6.21082)    74086.281   41.93158
FROM LAYER  2

PERCOLATION/LEAKAGE THROUGH 0.41546 (  0.05977)      1508.129    0.85358
```

```
LAYER  3

AVERAGE HEAD ON TOP           0.002 (    0.001)
OF LAYER  3

LATERAL DRAINAGE COLLECTED   0.41546 (  0.05977)      1508.128    0.85357
FROM LAYER  4

PERCOLATION/LEAKAGE THROUGH 0.00000 (  0.00000)         0.000     0.00000
LAYER  6

AVERAGE HEAD ON TOP             0.000 (    0.000)
OF LAYER  5

CHANGE IN WATER STORAGE        -0.039   (  0.8487)       -142.42     -0.081

***************************************************************************
```

```
**************************************************************************
               PEAK DAILY VALUES FOR YEARS    1 THROUGH   28
    --------------------------------------------------------------------------
                                                 (INCHES)      (CU. FT.)
                                                ----------    -------------
       PRECIPITATION                              7.60          27588.000

       RUNOFF                                     0.000             0.0000

       DRAINAGE COLLECTED FROM LAYER  2          3.47585      12617.35160

       PERCOLATION/LEAKAGE THROUGH LAYER  3      0.012899        46.82414

       AVERAGE HEAD ON TOP OF LAYER  3            0.361

       MAXIMUM HEAD ON TOP OF LAYER  3            0.283

       LOCATION OF MAXIMUM HEAD IN LAYER  2
       DISTANCE FROM DRAIN)                      3.3 FEET

       DRAINAGE COLLECTED FROM LAYER  4          0.01290         46.82414

       PERCOLATION/LEAKAGE THROUGH LAYER  6      0.000000         0.00000

       AVERAGE HEAD ON TOP OF LAYER  5            0.002

       MAXIMUM HEAD ON TOP OF LAYER  5            0.000

       LOCATION OF MAXIMUM HEAD IN LAYER  4
       DISTANCE FROM DRAIN)                     0.0 FEET

       SNOW WATER                               0.00            0.0000

       MAXIMUM VEG. SOIL WATER (VOL/VOL)                  0.4570

       MINIMUM VEG. SOIL WATER (VOL/VOL)                  0.0580

        ***  Maximum heads are computed using McEnroe's equations.  ***

             Reference:  Maximum Saturated Depth over Landfill Liner
                         by Bruce M. McEnroe, University of Kansas
                         ASCE Journal of Environmental Engineering
                         Vol. 119, No. 2, March 1993, pp. 262-270.

**************************************************************************
```

```
*************************************************************************
                    FINAL WATER STORAGE AT END OF YEAR   28
----------------------------------------------------------------------
                     LAYER        (INCHES)       (VOL/VOL)
                     -----        --------       ---------
                       1           3.3109          0.1380

                       2           0.0031          0.0104

                       3           0.0000          0.0000

                       4           0.0030          0.0100

                       5           0.0000          0.0000

                       6           0.1875          0.7500

                    SNOW WATER     0.000

*************************************************************************
*************************************************************************
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******************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**              FOR USEPA RISK REDUCTION ENGINEERING LABORATORY             **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************

PRECIPITATION DATA FILE:    C:\HELP\hardee\botn10\hardrai1.D4
TEMPERATURE DATA FILE:      C:\HELP\hardee\botn10\hardrai1.D7
SOLAR RADIATION DATA FILE:  C:\HELP\hardee\botn10\hardrai1.D13
EVAPOTRANSPIRATION DATA:    C:\HELP\hardee\botn10\hardrai1.D11
SOIL AND DESIGN DATA FILE:  C:\HELP\hardee\botn10\hardee10.D10
OUTPUT DATA FILE:           C:\HELP\hardee\botn10\hardee10.OUT

TIME:  11:26     DATE:   3/19/2013
```

```
****************************************************************************
TITLE:  Hardee County Phase II Section II Expansion RAI No. 1
```
**Bottom North Portion (10 Feet Waste)**
```
****************************************************************************

     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.

                      LAYER  1 (Daily Cover 6-inches)
                      --------
                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER   5
           THICKNESS                   =      6.00   INCHES
           POROSITY                    =      0.4570 VOL/VOL
           FIELD CAPACITY              =      0.1310 VOL/VOL
           WILTING POINT               =      0.0580 VOL/VOL
           INITIAL SOIL WATER CONTENT  =      0.1989 VOL/VOL
           EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC
         NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  1.80
                  FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.

                      LAYER  2 (10 Feet Waste)
                      --------
                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER  19
           THICKNESS                   =    120.00   INCHES
           POROSITY                    =      0.1680 VOL/VOL
           FIELD CAPACITY              =      0.0730 VOL/VOL
           WILTING POINT               =      0.0190 VOL/VOL
           INITIAL SOIL WATER CONTENT  =      0.0724 VOL/VOL
           EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC
```

```
          LAYER  3 (Drainage Sand 24-inches)
          --------
           TYPE 1 - VERTICAL PERCOLATION LAYER
               MATERIAL TEXTURE NUMBER   5
 THICKNESS                  =     24.00   INCHES
 POROSITY                   =      0.4570 VOL/VOL
 FIELD CAPACITY             =      0.1310 VOL/VOL
 WILTING POINT              =      0.0580 VOL/VOL
 INITIAL SOIL WATER CONTENT =      0.1794 VOL/VOL
 EFFECTIVE SAT. HYD. COND.  =  0.100000005000E-02 CM/SEC

LAYER  4 (300-mil Bi-planar Geocomposite FabriNet UF)
--------
             TYPE 2 - LATERAL DRAINAGE LAYER
               MATERIAL TEXTURE NUMBER   0
 THICKNESS                  =      0.30   INCHES
 POROSITY                   =      0.8500 VOL/VOL
 FIELD CAPACITY             =      0.0100 VOL/VOL
 WILTING POINT              =      0.0050 VOL/VOL
 INITIAL SOIL WATER CONTENT =      0.0106 VOL/VOL
 EFFECTIVE SAT. HYD. COND.  =   11.8999996000     CM/SEC
 SLOPE                      =      2.20   PERCENT
 DRAINAGE LENGTH            =     53.5    FEET

          LAYER  5 (60-mil HDPE geomembrane)
          --------
             TYPE 4 - FLEXIBLE MEMBRANE LINER
               MATERIAL TEXTURE NUMBER  35
 THICKNESS                  =      0.06   INCHES
 POROSITY                   =      0.0000 VOL/VOL
 FIELD CAPACITY             =      0.0000 VOL/VOL
 WILTING POINT              =      0.0000 VOL/VOL
 INITIAL SOIL WATER CONTENT =      0.0000 VOL/VOL
 EFFECTIVE SAT. HYD. COND.  =  0.199999996000E-12 CM/SEC
 FML PINHOLE DENSITY        =      1.00   HOLES/ACRE
 FML INSTALLATION DEFECTS   =      1.00   HOLES/ACRE
 FML PLACEMENT QUALITY      =  3 - GOOD

LAYER  6 (300-mil Tri-planar Geocomposite TENDRAIN 770-2)
--------
             TYPE 2 - LATERAL DRAINAGE LAYER
               MATERIAL TEXTURE NUMBER   0
 THICKNESS                  =      0.30   INCHES
 POROSITY                   =      0.8500 VOL/VOL
 FIELD CAPACITY             =      0.0100 VOL/VOL
 WILTING POINT              =      0.0050 VOL/VOL
 INITIAL SOIL WATER CONTENT =      0.0100 VOL/VOL
 EFFECTIVE SAT. HYD. COND.  =   40.7000008000     CM/SEC
 SLOPE                      =      2.20   PERCENT
 DRAINAGE LENGTH            =     53.5    FEET
```

```
            LAYER  7 (60-mil HDPE geomembrane)
            --------
               TYPE 4 - FLEXIBLE MEMBRANE LINER
                 MATERIAL TEXTURE NUMBER  35
   THICKNESS                  =     0.06   INCHES
   POROSITY                   =     0.0000 VOL/VOL
   FIELD CAPACITY             =     0.0000 VOL/VOL
   WILTING POINT              =     0.0000 VOL/VOL
   INITIAL SOIL WATER CONTENT =     0.0000 VOL/VOL
   EFFECTIVE SAT. HYD. COND.  =  0.199999996000E-12 CM/SEC
   FML PINHOLE DENSITY        =     1.00   HOLES/ACRE
   FML INSTALLATION DEFECTS   =     1.00   HOLES/ACRE
   FML PLACEMENT QUALITY      =  3 - GOOD

                      LAYER  8 (GCL)
                      --------
                 TYPE 3 - BARRIER SOIL LINER
                 MATERIAL TEXTURE NUMBER  17
   THICKNESS                  =     0.25   INCHES
   POROSITY                   =     0.7500 VOL/VOL
   FIELD CAPACITY             =     0.7470 VOL/VOL
   WILTING POINT              =     0.4000 VOL/VOL
   INITIAL SOIL WATER CONTENT =     0.7500 VOL/VOL
   EFFECTIVE SAT. HYD. COND.  =  0.300000003000E-08 CM/SEC

           GENERAL DESIGN AND EVAPORATIVE ZONE DATA
           ----------------------------------------

  NOTE:  SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
           SOIL DATA BASE USING SOIL TEXTURE # 5 WITH A
           POOR STAND OF GRASS, A SURFACE SLOPE OF  2.%
           AND A SLOPE LENGTH OF   53. FEET.

 SCS RUNOFF CURVE NUMBER            =    79.20
 FRACTION OF AREA ALLOWING RUNOFF   =     0.0    PERCENT
 AREA PROJECTED ON HORIZONTAL PLANE =     1.000  ACRES
 EVAPORATIVE ZONE DEPTH             =    10.0    INCHES
 INITIAL WATER IN EVAPORATIVE ZONE  =     1.411  INCHES
 UPPER LIMIT OF EVAPORATIVE STORAGE =     3.414  INCHES
 LOWER LIMIT OF EVAPORATIVE STORAGE =     0.424  INCHES
 INITIAL SNOW WATER                 =     0.000  INCHES
 INITIAL WATER IN LAYER MATERIALS   =    14.380  INCHES
 TOTAL INITIAL WATER                =    14.380  INCHES
 TOTAL SUBSURFACE INFLOW            =     0.00   INCHES/YEAR

            EVAPOTRANSPIRATION AND WEATHER DATA
            -----------------------------------

  NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
           TAMPA                  FLORIDA

      STATION LATITUDE                        =  27.58 DEGREES
      MAXIMUM LEAF AREA INDEX                 =   1.00
```

```
START OF GROWING SEASON (JULIAN DATE)  =      0
END OF GROWING SEASON (JULIAN DATE)    =    367
EVAPORATIVE ZONE DEPTH                 =  10.0  INCHES
AVERAGE ANNUAL WIND SPEED              =   8.60 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY  =  74.00 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY  =  72.00 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY  =  78.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY  =  76.00 %
```

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR TAMPA FLORIDA

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

| JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|
| 1.85 | 2.58 | 3.39 | 2.95 | 2.52 | 8.31 |
| 7.83 | 7.98 | 5.61 | 2.86 | 1.94 | 1.84 |

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR TAMPA FLORIDA

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

| JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|
| 59.80 | 60.80 | 66.20 | 71.60 | 77.10 | 80.90 |
| 82.20 | 82.20 | 80.90 | 74.50 | 66.70 | 61.30 |

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR TAMPA FLORIDA AND STATION LATITUDE = 27.58 DEGREES

*****************************************************************************

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 28

-----------------------------------------------------------------------------

| | JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|---|
| **PRECIPITATION** | | | | | | |
| TOTALS | 1.82 | 2.13 | 3.38 | 2.54 | 3.05 | 7.89 |
| | 8.50 | 7.72 | 5.34 | 2.65 | 1.83 | 1.84 |
| STD. DEVIATIONS | 1.56 | 2.17 | 2.92 | 1.84 | 2.10 | 3.63 |
| | 3.41 | 2.59 | 2.44 | 2.42 | 2.77 | 2.09 |
| **RUNOFF** | | | | | | |
| TOTALS | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| STD. DEVIATIONS | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |

```
                      0.000    0.000    0.000    0.000    0.000    0.000

EVAPOTRANSPIRATION
------------------
TOTALS                1.216    1.352    2.074    1.895    2.105    4.555
                      5.287    4.925    3.558    1.760    1.081    0.950

STD. DEVIATIONS       0.833    0.924    1.337    1.090    1.206    1.257
                      1.181    1.120    1.176    1.131    0.820    0.785

LATERAL DRAINAGE COLLECTED FROM LAYER  4
----------------------------------------
TOTALS                0.5118   0.6472   1.1192   0.7042   0.8135   1.9388
                      3.1394   2.9735   2.3193   1.4988   1.0472   0.8387

STD. DEVIATIONS       0.4829   1.2514   1.8061   0.8392   0.8675   1.9380
                      2.1589   1.5597   1.7734   1.3748   1.5791   1.3798

PERCOLATION/LEAKAGE THROUGH LAYER  5
------------------------------------
TOTALS                0.0215   0.0220   0.0287   0.0249   0.0263   0.0371
                      0.0521   0.0541   0.0465   0.0376   0.0288   0.0246

STD. DEVIATIONS       0.0103   0.0139   0.0189   0.0129   0.0112   0.0201
                      0.0215   0.0155   0.0167   0.0145   0.0149   0.0168

LATERAL DRAINAGE COLLECTED FROM LAYER  6
----------------------------------------
TOTALS                0.0215   0.0220   0.0287   0.0249   0.0263   0.0371
                      0.0521   0.0541   0.0465   0.0376   0.0288   0.0246

STD. DEVIATIONS       0.0103   0.0139   0.0189   0.0129   0.0112   0.0201
                      0.0215   0.0155   0.0167   0.0145   0.0149   0.0168

PERCOLATION/LEAKAGE THROUGH LAYER  8
------------------------------------
TOTALS                0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                      0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

STD. DEVIATIONS       0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                      0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

----------------------------------------------------------------------------
                AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)
----------------------------------------------------------------------------

   DAILY AVERAGE HEAD ON TOP OF LAYER  5
   -------------------------------------
   AVERAGES             0.0006   0.0008   0.0013   0.0008   0.0009   0.0023
                        0.0037   0.0035   0.0028   0.0017   0.0013   0.0010

     STD. DEVIATIONS    0.0006   0.0016   0.0021   0.0010   0.0010   0.0023
                        0.0025   0.0018   0.0021   0.0016   0.0019   0.0016
```

DAILY AVERAGE HEAD ON TOP OF LAYER 7

| | | | | | | |
|---|---|---|---|---|---|---|
| AVERAGES | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0002 |
| | 0.0003 | 0.0003 | 0.0002 | 0.0002 | 0.0001 | 0.0001 |
| STD. DEVIATIONS | 0.0000 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 |
| | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 |

*************************************************************************
*************************************************************************

AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 28

| | INCHES | | CU. FEET | PERCENT |
|---|---|---|---|---|
| PRECIPITATION | 48.67 | ( 9.518) | 176683.8 | 100.00 |
| RUNOFF | 0.000 | ( 0.0000) | 0.00 | 0.000 |
| EVAPOTRANSPIRATION | 30.757 | ( 4.7107) | 111647.02 | 63.190 |
| LATERAL DRAINAGE COLLECTED FROM LAYER 4 | 17.55145 | ( 5.94224) | 63711.758 | 36.05977 |
| PERCOLATION/LEAKAGE THROUGH LAYER 5 | 0.40429 | ( 0.06922) | 1467.588 | 0.83063 |
| AVERAGE HEAD ON TOP OF LAYER 5 | 0.002 | ( 0.001) | | |
| LATERAL DRAINAGE COLLECTED FROM LAYER 6 | 0.40429 | ( 0.06922) | 1467.588 | 0.83063 |
| PERCOLATION/LEAKAGE THROUGH LAYER 8 | 0.00000 | ( 0.00000) | 0.000 | 0.00000 |
| AVERAGE HEAD ON TOP OF LAYER 7 | 0.000 | ( 0.000) | | |
| CHANGE IN WATER STORAGE | -0.039 | ( 1.1828) | -142.59 | -0.081 |

************************************************************************

```
*******************************************************************************
             PEAK DAILY VALUES FOR YEARS    1 THROUGH   28
    ---------------------------------------------------------------------------
                                                  (INCHES)      (CU. FT.)
                                                 ----------   -------------
       PRECIPITATION                               7.60         27588.000

       RUNOFF                                      0.000            0.0000

       DRAINAGE COLLECTED FROM LAYER  4           1.94124       7046.71338

       PERCOLATION/LEAKAGE THROUGH LAYER  5       0.009574        34.75416

       AVERAGE HEAD ON TOP OF LAYER  5             0.070

       MAXIMUM HEAD ON TOP OF LAYER  5             0.135

       LOCATION OF MAXIMUM HEAD IN LAYER  4
             (DISTANCE FROM DRAIN)                 1.9 FEET

       DRAINAGE COLLECTED FROM LAYER  6           0.00957         34.75416

       PERCOLATION/LEAKAGE THROUGH LAYER  8       0.000000         0.00000

       AVERAGE HEAD ON TOP OF LAYER  7             0.001

       MAXIMUM HEAD ON TOP OF LAYER  7             0.001

       LOCATION OF MAXIMUM HEAD IN LAYER  6
             (DISTANCE FROM DRAIN)                 0.0 FEET

       SNOW WATER                                  0.00             0.0000

       MAXIMUM VEG. SOIL WATER (VOL/VOL)                   0.3182

       MINIMUM VEG. SOIL WATER (VOL/VOL)                   0.0424


        ***  Maximum heads are computed using McEnroe's equations.  ***

             Reference:  Maximum Saturated Depth over Landfill Liner
                         by Bruce M. McEnroe, University of Kansas
                         ASCE Journal of Environmental Engineering
                         Vol. 119, No. 2, March 1993, pp. 262-270.

*******************************************************************************
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FINAL WATER STORAGE AT END OF YEAR 28

| LAYER | (INCHES) | (VOL/VOL) |
|---|---|---|
| 1 | 0.3324 | 0.0554 |
| 2 | 8.5597 | 0.0713 |
| 3 | 4.1939 | 0.1747 |
| 4 | 0.0031 | 0.0104 |
| 5 | 0.0000 | 0.0000 |
| 6 | 0.0030 | 0.0100 |
| 7 | 0.0000 | 0.0000 |
| 8 | 0.1875 | 0.7500 |
| SNOW WATER | 0.000 | |

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```
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 *****************************************************************************
 **                                                                         **
 **                                                                         **
 **              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE              **
 **                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)               **
 **                  DEVELOPED BY ENVIRONMENTAL LABORATORY                  **
 **                    USAE WATERWAYS EXPERIMENT STATION                    **
 **             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY             **
 **                                                                         **
 **                                                                         **
 *****************************************************************************
 *****************************************************************************


 PRECIPITATION DATA FILE:    C:\HELP\hardee\botn25\hardrai1.D4
 TEMPERATURE DATA FILE:      C:\HELP\hardee\botn25\hardrai1.D7
 SOLAR RADIATION DATA FILE:  C:\HELP\hardee\botn25\hardrai1.D13
 EVAPOTRANSPIRATION DATA:    C:\HELP\hardee\botn25\hardrai1.D11
 SOIL AND DESIGN DATA FILE:  C:\HELP\hardee\botn25\hardee25.D10
 OUTPUT DATA FILE:           C:\HELP\hardee\botn25\hardee25.OUT

 TIME:  11:34     DATE:   3/19/2013

****************************************************************************
TITLE:  Hardee County Phase II Section II Expansion RAI No. 1
Bottom North Portion (25 Feet Waste)
****************************************************************************

      NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
               COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.

                       LAYER  1 (Daily Cover 6-inches)
                        --------
                      TYPE 1 - VERTICAL PERCOLATION LAYER
                          MATERIAL TEXTURE NUMBER   5
            THICKNESS                   =      6.00   INCHES
            POROSITY                    =      0.4570 VOL/VOL
            FIELD CAPACITY              =      0.1310 VOL/VOL
            WILTING POINT               =      0.0580 VOL/VOL
            INITIAL SOIL WATER CONTENT  =      0.1977 VOL/VOL
            EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC
          NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  1.80
                   FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.

                       LAYER  2 (5 Feet Waste)
                        --------
                      TYPE 1 - VERTICAL PERCOLATION LAYER
                          MATERIAL TEXTURE NUMBER  19
            THICKNESS                   =     60.00   INCHES
            POROSITY                    =      0.1680 VOL/VOL
            FIELD CAPACITY              =      0.0730 VOL/VOL
            WILTING POINT               =      0.0190 VOL/VOL
            INITIAL SOIL WATER CONTENT  =      0.0719 VOL/VOL
            EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC
```

```
            LAYER  3 (10 Feet Waste)
            --------
          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  19
THICKNESS                  =    120.00   INCHES
POROSITY                   =      0.1680 VOL/VOL
FIELD CAPACITY             =      0.0730 VOL/VOL
WILTING POINT              =      0.0190 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.0730 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  0.100000005000E-02 CM/SEC

            LAYER  4 (10 Feet Waste)
            --------
          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  19
THICKNESS                  =    120.00   INCHES
POROSITY                   =      0.1680 VOL/VOL
FIELD CAPACITY             =      0.0730 VOL/VOL
WILTING POINT              =      0.0190 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.0730 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  0.100000005000E-02 CM/SEC

          LAYER  5 (Drainage Sand 24-inches)
          --------
          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER   5
THICKNESS                  =     24.00   INCHES
POROSITY                   =      0.4570 VOL/VOL
FIELD CAPACITY             =      0.1310 VOL/VOL
WILTING POINT              =      0.0580 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.1800 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  0.100000005000E-02 CM/SEC

LAYER  6 (300-mil Bi-planar Geocomposite FabriNet UF)
--------
            TYPE 2 - LATERAL DRAINAGE LAYER
              MATERIAL TEXTURE NUMBER   0
THICKNESS                  =      0.27   INCHES
POROSITY                   =      0.8500 VOL/VOL
FIELD CAPACITY             =      0.0100 VOL/VOL
WILTING POINT              =      0.0050 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.0110 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =   7.19999981000     CM/SEC
SLOPE                      =      2.20   PERCENT
DRAINAGE LENGTH            =     53.5    FEET

          LAYER  7 (60-mil HDPE geomembrane)
          --------
            TYPE 4 - FLEXIBLE MEMBRANE LINER
              MATERIAL TEXTURE NUMBER  35
THICKNESS                  =      0.06   INCHES
POROSITY                   =      0.0000 VOL/VOL
FIELD CAPACITY             =      0.0000 VOL/VOL
```

```
   WILTING POINT                =      0.0000 VOL/VOL
   INITIAL SOIL WATER CONTENT  =      0.0000 VOL/VOL
   EFFECTIVE SAT. HYD. COND.   =  0.199999996000E-12 CM/SEC
   FML PINHOLE DENSITY          =      1.00   HOLES/ACRE
   FML INSTALLATION DEFECTS     =      1.00   HOLES/ACRE
   FML PLACEMENT QUALITY        =  3 - GOOD

 LAYER  8 (300-mil Tri-planar Geocomposite TENDRAIN 770-2)
 --------
              TYPE 2 - LATERAL DRAINAGE LAYER
                MATERIAL TEXTURE NUMBER   0
   THICKNESS                    =      0.27   INCHES
   POROSITY                     =      0.8500 VOL/VOL
   FIELD CAPACITY               =      0.0100 VOL/VOL
   WILTING POINT                =      0.0050 VOL/VOL
   INITIAL SOIL WATER CONTENT  =      0.0100 VOL/VOL
   EFFECTIVE SAT. HYD. COND.   =   29.3999996000     CM/SEC
   SLOPE                        =      2.20   PERCENT
   DRAINAGE LENGTH              =     53.5    FEET

           LAYER  9 (60-mil HDPE geomembrane)
           --------
              TYPE 4 - FLEXIBLE MEMBRANE LINER
                MATERIAL TEXTURE NUMBER  35
   THICKNESS                    =      0.06   INCHES
   POROSITY                     =      0.0000 VOL/VOL
   FIELD CAPACITY               =      0.0000 VOL/VOL
   WILTING POINT                =      0.0000 VOL/VOL
   INITIAL SOIL WATER CONTENT  =      0.0000 VOL/VOL
   EFFECTIVE SAT. HYD. COND.   =  0.199999996000E-12 CM/SEC
   FML PINHOLE DENSITY          =      1.00   HOLES/ACRE
   FML INSTALLATION DEFECTS     =      1.00   HOLES/ACRE
   FML PLACEMENT QUALITY        =  3 - GOOD

                     LAYER  10 (GCL)
                      --------
                TYPE 3 - BARRIER SOIL LINER
                MATERIAL TEXTURE NUMBER  17
   THICKNESS                    =      0.25   INCHES
   POROSITY                     =      0.7500 VOL/VOL
   FIELD CAPACITY               =      0.7470 VOL/VOL
   WILTING POINT                =      0.4000 VOL/VOL
   INITIAL SOIL WATER CONTENT  =      0.7500 VOL/VOL
   EFFECTIVE SAT. HYD. COND.   =  0.300000003000E-08 CM/SEC

          GENERAL DESIGN AND EVAPORATIVE ZONE DATA
          ----------------------------------------

 NOTE:  SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
         SOIL DATA BASE USING SOIL TEXTURE # 5 WITH A
         POOR STAND OF GRASS, A SURFACE SLOPE OF  2.%
         AND A SLOPE LENGTH OF   53. FEET.
SCS RUNOFF CURVE NUMBER            =     79.20
```

```
FRACTION OF AREA ALLOWING RUNOFF    =      0.0    PERCENT
AREA PROJECTED ON HORIZONTAL PLANE  =      1.000  ACRES
EVAPORATIVE ZONE DEPTH              =     10.0    INCHES
INITIAL WATER IN EVAPORATIVE ZONE   =      1.413  INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE  =      3.414  INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE  =      0.424  INCHES
INITIAL SNOW WATER                  =      0.000  INCHES
INITIAL WATER IN LAYER MATERIALS    =     27.534  INCHES
TOTAL INITIAL WATER                 =     27.534  INCHES
TOTAL SUBSURFACE INFLOW             =      0.00   INCHES/YEAR
```

EVAPOTRANSPIRATION AND WEATHER DATA
-----------------------------------

```
NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
         TAMPA                 FLORIDA

     STATION LATITUDE                          =  27.58 DEGREES
     MAXIMUM LEAF AREA INDEX                   =   1.00
     START OF GROWING SEASON (JULIAN DATE)     =      0
     END OF GROWING SEASON (JULIAN DATE)       =    367
     EVAPORATIVE ZONE DEPTH                    =  10.0  INCHES
     AVERAGE ANNUAL WIND SPEED                 =   8.60 MPH
     AVERAGE 1ST QUARTER RELATIVE HUMIDITY     =  74.00 %
     AVERAGE 2ND QUARTER RELATIVE HUMIDITY     =  72.00 %
     AVERAGE 3RD QUARTER RELATIVE HUMIDITY     =  78.00 %
     AVERAGE 4TH QUARTER RELATIVE HUMIDITY     =  76.00 %

NOTE:  PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
         COEFFICIENTS FOR    TAMPA              FLORIDA
```

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

| JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|
| 1.85 | 2.58 | 3.39 | 2.95 | 2.52 | 8.31 |
| 7.83 | 7.98 | 5.61 | 2.86 | 1.94 | 1.84 |

```
NOTE:  TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
         COEFFICIENTS FOR    TAMPA              FLORIDA
```

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

| JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|
| 59.80 | 60.80 | 66.20 | 71.60 | 77.10 | 80.90 |
| 82.20 | 82.20 | 80.90 | 74.50 | 66.70 | 61.30 |

```
NOTE:  SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
         COEFFICIENTS FOR    TAMPA              FLORIDA
           AND STATION LATITUDE  =  27.58 DEGREES
```

******************************************************************************

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 28

| | | JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|---|---|
| **PRECIPITATION** | | | | | | | |
| | TOTALS | 1.82 | 2.13 | 3.38 | 2.54 | 3.05 | 7.89 |
| | | 8.50 | 7.72 | 5.34 | 2.65 | 1.83 | 1.84 |
| | STD. DEVIATIONS | 1.56 | 2.17 | 2.92 | 1.84 | 2.10 | 3.63 |
| | | 3.41 | 2.59 | 2.44 | 2.42 | 2.77 | 2.09 |
| **RUNOFF** | | | | | | | |
| | TOTALS | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| | STD. DEVIATIONS | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| **EVAPOTRANSPIRATION** | | | | | | | |
| | TOTALS | 1.206 | 1.344 | 2.064 | 1.893 | 2.089 | 4.540 |
| | | 5.270 | 4.912 | 3.531 | 1.751 | 1.073 | 0.950 |
| | STD. DEVIATIONS | 0.832 | 0.920 | 1.338 | 1.083 | 1.194 | 1.254 |
| | | 1.175 | 1.114 | 1.153 | 1.120 | 0.816 | 0.784 |
| **LATERAL DRAINAGE COLLECTED FROM LAYER 6** | | | | | | | |
| | TOTALS | 0.5387 | 0.6174 | 1.0761 | 0.8115 | 0.6789 | 1.4732 |
| | | 3.2385 | 3.2083 | 2.4294 | 1.5781 | 1.0464 | 0.8744 |
| | STD. DEVIATIONS | 0.6576 | 1.2069 | 1.7452 | 0.9323 | 0.7011 | 1.6841 |
| | | 2.1265 | 1.8517 | 1.7840 | 1.4642 | 1.4997 | 1.6025 |
| **PERCOLATION/LEAKAGE THROUGH LAYER 7** | | | | | | | |
| | TOTALS | 0.0281 | 0.0282 | 0.0359 | 0.0336 | 0.0319 | 0.0416 |
| | | 0.0679 | 0.0714 | 0.0613 | 0.0501 | 0.0375 | 0.0324 |
| | STD. DEVIATIONS | 0.0156 | 0.0176 | 0.0236 | 0.0181 | 0.0132 | 0.0235 |
| | | 0.0284 | 0.0238 | 0.0213 | 0.0198 | 0.0189 | 0.0242 |
| **LATERAL DRAINAGE COLLECTED FROM LAYER 8** | | | | | | | |
| | TOTALS | 0.0281 | 0.0282 | 0.0359 | 0.0336 | 0.0319 | 0.0416 |
| | | 0.0679 | 0.0714 | 0.0613 | 0.0501 | 0.0375 | 0.0324 |
| | STD. DEVIATIONS | 0.0156 | 0.0176 | 0.0236 | 0.0181 | 0.0132 | 0.0235 |
| | | 0.0284 | 0.0238 | 0.0213 | 0.0198 | 0.0189 | 0.0242 |

```
    PERCOLATION/LEAKAGE THROUGH LAYER 10
   ------------------------------------
     TOTALS               0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                          0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

     STD. DEVIATIONS      0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                          0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

-------------------------------------------------------------------------
                AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)
---------------------------------------------------------------------------

   DAILY AVERAGE HEAD ON TOP OF LAYER  7
   -------------------------------------
     AVERAGES             0.0010   0.0013   0.0021   0.0016   0.0013   0.0029
                          0.0062   0.0062   0.0048   0.0030   0.0021   0.0017

     STD. DEVIATIONS      0.0013   0.0026   0.0034   0.0019   0.0013   0.0033
                          0.0041   0.0036   0.0035   0.0028   0.0030   0.0031

   DAILY AVERAGE HEAD ON TOP OF LAYER  9
   -------------------------------------
     AVERAGES             0.0001   0.0001   0.0002   0.0002   0.0002   0.0002
                          0.0003   0.0003   0.0003   0.0002   0.0002   0.0002

     STD. DEVIATIONS      0.0001   0.0001   0.0001   0.0001   0.0001   0.0001
                          0.0001   0.0001   0.0001   0.0001   0.0001   0.0001

***************************************************************************
***************************************************************************
      AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS    1 THROUGH   28
---------------------------------------------------------------------------
                                     INCHES          CU. FEET      PERCENT
                               -------------------  -------------  ---------
  PRECIPITATION                  48.67    (   9.518)     176683.8     100.00

  RUNOFF                          0.000   (  0.0000)         0.00      0.000

  EVAPOTRANSPIRATION             30.622   (  4.7088)    111157.37     62.913

  LATERAL DRAINAGE COLLECTED   17.57089 (  5.90936)     63782.340   36.09972
    FROM LAYER  6

  PERCOLATION/LEAKAGE THROUGH  0.51993 (  0.08981)     1887.339     1.06820
    LAYER  7

  AVERAGE HEAD ON TOP             0.003 (    0.001)
    OF LAYER  7

  LATERAL DRAINAGE COLLECTED    0.51993 (  0.08981)      1887.339    1.06820
    FROM LAYER  8

  PERCOLATION/LEAKAGE THROUGH  0.00000 (  0.00000)        0.000     0.00000
```

```
   LAYER 10

 AVERAGE HEAD ON TOP              0.000 (    0.000)
   OF LAYER  9

 CHANGE IN WATER STORAGE       -0.039   (  1.5072)       -143.27     -0.081

***************************************************************************
```

```
*******************************************************************************
            PEAK DAILY VALUES FOR YEARS    1 THROUGH   28
    ---------------------------------------------------------------------------
                                                  (INCHES)      (CU. FT.)
                                                 ----------   -------------
       PRECIPITATION                               7.60         27588.000

       RUNOFF                                      0.000            0.0000

       DRAINAGE COLLECTED FROM LAYER  6           1.08406       3935.12280

       PERCOLATION/LEAKAGE THROUGH LAYER  7       0.009236        33.52502

       AVERAGE HEAD ON TOP OF LAYER  7             0.065

       MAXIMUM HEAD ON TOP OF LAYER  7             0.125

       LOCATION OF MAXIMUM HEAD IN LAYER  6
             (DISTANCE FROM DRAIN)                 1.8 FEET

       DRAINAGE COLLECTED FROM LAYER  8           0.00924         33.52502

       PERCOLATION/LEAKAGE THROUGH LAYER 10       0.000000         0.00000

       AVERAGE HEAD ON TOP OF LAYER  9             0.001

       MAXIMUM HEAD ON TOP OF LAYER  9             0.002

       LOCATION OF MAXIMUM HEAD IN LAYER  8
             (DISTANCE FROM DRAIN)                 0.0 FEET

       SNOW WATER                                  0.00             0.0000

       MAXIMUM VEG. SOIL WATER (VOL/VOL)                   0.3315

       MINIMUM VEG. SOIL WATER (VOL/VOL)                   0.0424

        ***  Maximum heads are computed using McEnroe's equations.  ***

             Reference:  Maximum Saturated Depth over Landfill Liner
                         by Bruce M. McEnroe, University of Kansas
                         ASCE Journal of Environmental Engineering
                         Vol. 119, No. 2, March 1993, pp. 262-270.

*******************************************************************************
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FINAL WATER STORAGE AT END OF YEAR 28

| LAYER | (INCHES) | (VOL/VOL) |
|---|---|---|
| 1 | 0.3324 | 0.0554 |
| 2 | 4.1797 | 0.0697 |
| 3 | 8.7600 | 0.0730 |
| 4 | 8.7600 | 0.0730 |
| 5 | 4.2034 | 0.1751 |
| 6 | 0.0029 | 0.0107 |
| 7 | 0.0000 | 0.0000 |
| 8 | 0.0027 | 0.0100 |
| 9 | 0.0000 | 0.0000 |
| 10 | 0.1875 | 0.7500 |
| SNOW WATER | 0.000 | |

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 **                                                                        **
 **                                                                        **
 **              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE             **
 **                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)              **
 **                  DEVELOPED BY ENVIRONMENTAL LABORATORY                 **
 **                    USAE WATERWAYS EXPERIMENT STATION                   **
 **             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY            **
 **                                                                        **
 **                                                                        **
 ****************************************************************************
 ****************************************************************************

 PRECIPITATION DATA FILE:     C:\HELP\hardee\botn60\hardrai1.D4
 TEMPERATURE DATA FILE:       C:\HELP\hardee\botn60\hardrai1.D7
 SOLAR RADIATION DATA FILE:   C:\HELP\hardee\botn60\hardrai1.D13
 EVAPOTRANSPIRATION DATA:     C:\HELP\hardee\botn60\hardrai1.D11
 SOIL AND DESIGN DATA FILE:   C:\HELP\hardee\botn60\hardee60.D10
 OUTPUT DATA FILE:            C:\HELP\hardee\botn60\hardee60.OUT

 TIME:  11:42     DATE:   3/19/2013

**************************************************************************
TITLE:  Hardee County Phase II Section II Expansion RAI No. 1
Bottom North Portion (60 Feet Waste)
**************************************************************************

      NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
               COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.

                      LAYER  1 (Daily Cover 18-inches)
                      --------
                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER   5
            THICKNESS                  =     18.00   INCHES
            POROSITY                   =      0.4570 VOL/VOL
            FIELD CAPACITY             =      0.1310 VOL/VOL
            WILTING POINT              =      0.0580 VOL/VOL
            INITIAL SOIL WATER CONTENT =      0.1524 VOL/VOL
            EFFECTIVE SAT. HYD. COND.  =  0.100000005000E-02 CM/SEC
          NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  1.80
                   FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.

                      LAYER  2 (10 Feet Waste)
                      --------
                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER  19
            THICKNESS                  =    120.00   INCHES
            POROSITY                   =      0.1680 VOL/VOL
            FIELD CAPACITY             =      0.0730 VOL/VOL
            WILTING POINT              =      0.0190 VOL/VOL
            INITIAL SOIL WATER CONTENT =      0.0730 VOL/VOL
            EFFECTIVE SAT. HYD. COND.  =  0.100000005000E-02 CM/SEC
```

```
            LAYER  3 (10 Feet Waste)
            --------
           TYPE 1 - VERTICAL PERCOLATION LAYER
               MATERIAL TEXTURE NUMBER  19
THICKNESS                  =    120.00   INCHES
POROSITY                   =     0.1680 VOL/VOL
FIELD CAPACITY             =     0.0730 VOL/VOL
WILTING POINT              =     0.0190 VOL/VOL
INITIAL SOIL WATER CONTENT =     0.0730 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  0.100000005000E-02 CM/SEC

            LAYER  4 (10 Feet Waste)
            --------
           TYPE 1 - VERTICAL PERCOLATION LAYER
               MATERIAL TEXTURE NUMBER  19
THICKNESS                  =    120.00   INCHES
POROSITY                   =     0.1680 VOL/VOL
FIELD CAPACITY             =     0.0730 VOL/VOL
WILTING POINT              =     0.0190 VOL/VOL
INITIAL SOIL WATER CONTENT =     0.0730 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  0.100000005000E-02 CM/SEC

            LAYER  5 (10 Feet Waste)
            --------
           TYPE 1 - VERTICAL PERCOLATION LAYER
               MATERIAL TEXTURE NUMBER  19
THICKNESS                  =    120.00   INCHES
POROSITY                   =     0.1680 VOL/VOL
FIELD CAPACITY             =     0.0730 VOL/VOL
WILTING POINT              =     0.0190 VOL/VOL
INITIAL SOIL WATER CONTENT =     0.0730 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  0.100000005000E-02 CM/SEC

            LAYER  6 (10 Feet Waste)
            --------
           TYPE 1 - VERTICAL PERCOLATION LAYER
               MATERIAL TEXTURE NUMBER  19
THICKNESS                  =    120.00   INCHES
POROSITY                   =     0.1680 VOL/VOL
FIELD CAPACITY             =     0.0730 VOL/VOL
WILTING POINT              =     0.0190 VOL/VOL
INITIAL SOIL WATER CONTENT =     0.0730 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  0.100000005000E-02 CM/SEC

            LAYER  7 (10 Feet Waste)
            --------
           TYPE 1 - VERTICAL PERCOLATION LAYER
               MATERIAL TEXTURE NUMBER  19
THICKNESS                  =    120.00   INCHES
POROSITY                   =     0.1680 VOL/VOL
FIELD CAPACITY             =     0.0730 VOL/VOL
WILTING POINT              =     0.0190 VOL/VOL
INITIAL SOIL WATER CONTENT =     0.0730 VOL/VOL
```

```
   EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC

            LAYER  8 (Drainage Sand 24-inches)
            --------
             TYPE 1 - VERTICAL PERCOLATION LAYER
                 MATERIAL TEXTURE NUMBER   5
   THICKNESS                   =     24.00   INCHES
   POROSITY                    =      0.4570 VOL/VOL
   FIELD CAPACITY              =      0.1310 VOL/VOL
   WILTING POINT               =      0.0580 VOL/VOL
   INITIAL SOIL WATER CONTENT  =      0.1964 VOL/VOL
   EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC

   LAYER  9 (300-mil Bi-planar Geocomposite FabriNet UF)
   --------
               TYPE 2 - LATERAL DRAINAGE LAYER
                 MATERIAL TEXTURE NUMBER   0
   THICKNESS                   =      0.26   INCHES
   POROSITY                    =      0.8500 VOL/VOL
   FIELD CAPACITY              =      0.0100 VOL/VOL
   WILTING POINT               =      0.0050 VOL/VOL
   INITIAL SOIL WATER CONTENT  =      0.0118 VOL/VOL
   EFFECTIVE SAT. HYD. COND.   =   5.30000019000     CM/SEC
   SLOPE                       =      2.20   PERCENT
   DRAINAGE LENGTH             =     53.5    FEET

            LAYER  10 (60-mil HDPE geomembrane)
            --------
               TYPE 4 - FLEXIBLE MEMBRANE LINER
                 MATERIAL TEXTURE NUMBER  35
   THICKNESS                   =      0.06   INCHES
   POROSITY                    =      0.0000 VOL/VOL
   FIELD CAPACITY              =      0.0000 VOL/VOL
   WILTING POINT               =      0.0000 VOL/VOL
   INITIAL SOIL WATER CONTENT  =      0.0000 VOL/VOL
   EFFECTIVE SAT. HYD. COND.   =  0.199999996000E-12 CM/SEC
   FML PINHOLE DENSITY         =      1.00   HOLES/ACRE
   FML INSTALLATION DEFECTS    =      1.00   HOLES/ACRE
   FML PLACEMENT QUALITY       =  3 - GOOD

LAYER  11 (300-mil Tri-planar Geocomposite TENDRAIN 770-2)
 --------
               TYPE 2 - LATERAL DRAINAGE LAYER
                 MATERIAL TEXTURE NUMBER   0
   THICKNESS                   =      0.26   INCHES
   POROSITY                    =      0.8500 VOL/VOL
   FIELD CAPACITY              =      0.0100 VOL/VOL
   WILTING POINT               =      0.0050 VOL/VOL
   INITIAL SOIL WATER CONTENT  =      0.0100 VOL/VOL
   EFFECTIVE SAT. HYD. COND.   =   21.7999992000     CM/SEC
   SLOPE                       =      2.20   PERCENT
   DRAINAGE LENGTH             =     53.5    FEET
```

```
            LAYER  12 (60-mil HDPE geomembrane)
             --------
               TYPE 4 - FLEXIBLE MEMBRANE LINER
                 MATERIAL TEXTURE NUMBER  35
   THICKNESS                   =     0.06   INCHES
   POROSITY                    =     0.0000 VOL/VOL
   FIELD CAPACITY              =     0.0000 VOL/VOL
   WILTING POINT               =     0.0000 VOL/VOL
   INITIAL SOIL WATER CONTENT  =     0.0000 VOL/VOL
   EFFECTIVE SAT. HYD. COND.   =  0.199999996000E-12 CM/SEC
   FML PINHOLE DENSITY         =     1.00   HOLES/ACRE
   FML INSTALLATION DEFECTS    =     1.00   HOLES/ACRE
   FML PLACEMENT QUALITY       =  3 - GOOD

                      LAYER  13 (GCL)
                       --------
                 TYPE 3 - BARRIER SOIL LINER
                 MATERIAL TEXTURE NUMBER  17
   THICKNESS                   =     0.25   INCHES
   POROSITY                    =     0.7500 VOL/VOL
   FIELD CAPACITY              =     0.7470 VOL/VOL
   WILTING POINT               =     0.4000 VOL/VOL
   INITIAL SOIL WATER CONTENT  =     0.7500 VOL/VOL
   EFFECTIVE SAT. HYD. COND.   =  0.300000003000E-08 CM/SEC

            GENERAL DESIGN AND EVAPORATIVE ZONE DATA
            ----------------------------------------

  NOTE:  SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
           SOIL DATA BASE USING SOIL TEXTURE # 5 WITH A
           POOR STAND OF GRASS, A SURFACE SLOPE OF  2.%
           AND A SLOPE LENGTH OF   53. FEET.

SCS RUNOFF CURVE NUMBER            =    79.20
FRACTION OF AREA ALLOWING RUNOFF   =     0.0    PERCENT
AREA PROJECTED ON HORIZONTAL PLANE =     1.000  ACRES
EVAPORATIVE ZONE DEPTH             =    10.0    INCHES
INITIAL WATER IN EVAPORATIVE ZONE  =     1.295  INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE =     4.570  INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE =     0.580  INCHES
INITIAL SNOW WATER                 =     0.000  INCHES
INITIAL WATER IN LAYER MATERIALS   =    60.210  INCHES
TOTAL INITIAL WATER                =    60.210  INCHES
TOTAL SUBSURFACE INFLOW            =     0.00   INCHES/YEAR

             EVAPOTRANSPIRATION AND WEATHER DATA
             -----------------------------------

  NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
           TAMPA                 FLORIDA

     STATION LATITUDE                       =  27.58 DEGREES
     MAXIMUM LEAF AREA INDEX                =   1.00
```

```
          START OF GROWING SEASON (JULIAN DATE)  =      0
          END OF GROWING SEASON (JULIAN DATE)    =    367
          EVAPORATIVE ZONE DEPTH                 =  10.0  INCHES
          AVERAGE ANNUAL WIND SPEED              =   8.60 MPH
          AVERAGE 1ST QUARTER RELATIVE HUMIDITY  =  74.00 %
          AVERAGE 2ND QUARTER RELATIVE HUMIDITY  =  72.00 %
          AVERAGE 3RD QUARTER RELATIVE HUMIDITY  =  78.00 %
          AVERAGE 4TH QUARTER RELATIVE HUMIDITY  =  76.00 %

      NOTE:  PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
               COEFFICIENTS FOR    TAMPA              FLORIDA

               NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

  JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
  -------     -------     -------     -------     -------     -------
    1.85        2.58        3.39        2.95        2.52        8.31
    7.83        7.98        5.61        2.86        1.94        1.84

      NOTE:  TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
               COEFFICIENTS FOR    TAMPA              FLORIDA

          NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

  JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
  -------     -------     -------     -------     -------     -------
   59.80       60.80       66.20       71.60       77.10       80.90
   82.20       82.20       80.90       74.50       66.70       61.30

      NOTE:  SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
               COEFFICIENTS FOR    TAMPA              FLORIDA
                 AND STATION LATITUDE  =  27.58 DEGREES

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      AVERAGE MONTHLY VALUES IN INCHES FOR YEARS    1 THROUGH   28
-----------------------------------------------------------------------------

                        JAN/JUL  FEB/AUG  MAR/SEP  APR/OCT  MAY/NOV  JUN/DEC
                        -------  -------  -------  -------  -------  -------
   PRECIPITATION
   -------------
     TOTALS                1.82     2.13     3.38     2.54     3.05     7.89
                           8.50     7.72     5.34     2.65     1.83     1.84

     STD. DEVIATIONS       1.56     2.17     2.92     1.84     2.10     3.63
                           3.41     2.59     2.44     2.42     2.77     2.09

   RUNOFF
   ------
     TOTALS               0.000    0.000    0.000    0.000    0.000    0.000
                          0.000    0.000    0.000    0.000    0.000    0.000

     STD. DEVIATIONS      0.000    0.000    0.000    0.000    0.000    0.000
```

```
                    0.000    0.000    0.000    0.000    0.000    0.000

  EVAPOTRANSPIRATION
  ------------------
    TOTALS          1.216    1.501    2.156    1.980    2.227    4.650
                    5.436    5.190    3.751    1.916    1.110    0.935

    STD. DEVIATIONS 0.729    0.948    1.396    1.152    1.298    1.280
                    1.238    1.030    1.168    1.184    0.865    0.760

  LATERAL DRAINAGE COLLECTED FROM LAYER  9
  ----------------------------------------
    TOTALS          0.7887   0.4085   0.7406   1.0358   0.6185   0.7784
                    2.3819   2.9886   2.4997   1.8106   1.0574   0.9411

    STD. DEVIATIONS 1.3021   0.4646   1.2412   1.7062   0.5269   0.8316
                    2.0625   1.9494   1.5194   1.3026   1.1919   1.6295

  PERCOLATION/LEAKAGE THROUGH LAYER 10
  ------------------------------------
    TOTALS          0.0369   0.0282   0.0364   0.0413   0.0366   0.0373
                    0.0656   0.0815   0.0749   0.0643   0.0469   0.0419

    STD. DEVIATIONS 0.0257   0.0125   0.0219   0.0299   0.0157   0.0170
                    0.0354   0.0305   0.0243   0.0225   0.0210   0.0258

  LATERAL DRAINAGE COLLECTED FROM LAYER 11
  ----------------------------------------
    TOTALS          0.0369   0.0282   0.0364   0.0413   0.0366   0.0373
                    0.0656   0.0815   0.0749   0.0643   0.0469   0.0419

    STD. DEVIATIONS 0.0257   0.0125   0.0219   0.0299   0.0157   0.0170
                    0.0354   0.0305   0.0243   0.0225   0.0210   0.0258

  PERCOLATION/LEAKAGE THROUGH LAYER 13
  ------------------------------------
    TOTALS          0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                    0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

    STD. DEVIATIONS 0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                    0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

-----------------------------------------------------------------------------
             AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)
-----------------------------------------------------------------------------

  DAILY AVERAGE HEAD ON TOP OF LAYER 10
  -------------------------------------
    AVERAGES        0.0021   0.0012   0.0019   0.0028   0.0016   0.0021
                    0.0062   0.0078   0.0067   0.0047   0.0029   0.0025

    STD. DEVIATIONS 0.0034   0.0013   0.0032   0.0046   0.0014   0.0022
                    0.0054   0.0051   0.0041   0.0034   0.0032   0.0043
```

DAILY AVERAGE HEAD ON TOP OF LAYER 12

| | | | | | | |
|---|---|---|---|---|---|---|
| AVERAGES | 0.0002 | 0.0001 | 0.0002 | 0.0002 | 0.0002 | 0.0002 |
| | 0.0003 | 0.0004 | 0.0004 | 0.0003 | 0.0002 | 0.0002 |
| STD. DEVIATIONS | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 |
| | 0.0002 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 |

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 28

| | INCHES | CU. FEET | PERCENT |
|---|---|---|---|
| PRECIPITATION | 48.67 ( 9.518) | 176683.8 | 100.00 |
| RUNOFF | 0.000 ( 0.0000) | 0.00 | 0.000 |
| EVAPOTRANSPIRATION | 32.067 ( 4.7749) | 116402.73 | 65.882 |
| LATERAL DRAINAGE COLLECTED FROM LAYER 9 | 16.04990 ( 5.71668) | 58261.145 | 32.97482 |
| PERCOLATION/LEAKAGE THROUGH LAYER 10 | 0.59179 ( 0.11034) | 2148.193 | 1.21584 |
| AVERAGE HEAD ON TOP OF LAYER 10 | 0.004 ( 0.001) | | |
| LATERAL DRAINAGE COLLECTED FROM LAYER 11 | 0.59179 ( 0.11034) | 2148.192 | 1.21584 |
| PERCOLATION/LEAKAGE THROUGH LAYER 13 | 0.00000 ( 0.00000) | 0.001 | 0.00000 |
| AVERAGE HEAD ON TOP OF LAYER 12 | 0.000 ( 0.000) | | |
| CHANGE IN WATER STORAGE | -0.035 ( 2.6191) | -128.28 | -0.073 |

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              PEAK DAILY VALUES FOR YEARS    1 THROUGH   28
    ------------------------------------------------------------------------
                                                    (INCHES)      (CU. FT.)
                                                   ----------    -------------
       PRECIPITATION                                 7.60         27588.000

       RUNOFF                                        0.000            0.0000

       DRAINAGE COLLECTED FROM LAYER  9             0.53033       1925.09534

       PERCOLATION/LEAKAGE THROUGH LAYER 10         0.007488        27.18223

       AVERAGE HEAD ON TOP OF LAYER 10               0.043

       MAXIMUM HEAD ON TOP OF LAYER 10               0.084

       LOCATION OF MAXIMUM HEAD IN LAYER  9
             (DISTANCE FROM DRAIN)                   1.3 FEET

       DRAINAGE COLLECTED FROM LAYER 11             0.00749         27.18223

       PERCOLATION/LEAKAGE THROUGH LAYER 13         0.000000         0.00000

       AVERAGE HEAD ON TOP OF LAYER 12               0.001

       MAXIMUM HEAD ON TOP OF LAYER 12               0.000

       LOCATION OF MAXIMUM HEAD IN LAYER 11
             (DISTANCE FROM DRAIN)                   0.0 FEET

       SNOW WATER                                    0.00             0.0000

       MAXIMUM VEG. SOIL WATER (VOL/VOL)                     0.4570

       MINIMUM VEG. SOIL WATER (VOL/VOL)                     0.0580

        ***  Maximum heads are computed using McEnroe's equations.  ***

             Reference:  Maximum Saturated Depth over Landfill Liner
                         by Bruce M. McEnroe, University of Kansas
                         ASCE Journal of Environmental Engineering
                         Vol. 119, No. 2, March 1993, pp. 262-270.

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FINAL WATER STORAGE AT END OF YEAR 28

| LAYER | (INCHES) | (VOL/VOL) |
|---|---|---|
| 1 | 1.9705 | 0.1095 |
| 2 | 8.7600 | 0.0730 |
| 3 | 8.7600 | 0.0730 |
| 4 | 8.7600 | 0.0730 |
| 5 | 8.7600 | 0.0730 |
| 6 | 8.7600 | 0.0730 |
| 7 | 8.7600 | 0.0730 |
| 8 | 4.4972 | 0.1874 |
| 9 | 0.0030 | 0.0115 |
| 10 | 0.0000 | 0.0000 |
| 11 | 0.0026 | 0.0100 |
| 12 | 0.0000 | 0.0000 |
| 13 | 0.1875 | 0.7500 |
| SNOW WATER | 0.000 | |

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 **                                                                          **
 **              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
 **                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                **
 **                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
 **                    USAE WATERWAYS EXPERIMENT STATION                     **
 **              FOR USEPA RISK REDUCTION ENGINEERING LABORATORY             **
 **                                                                          **
 **                                                                          **
 ******************************************************************************
 ******************************************************************************

 PRECIPITATION DATA FILE:    C:\HELP\hardee\ssbotsod\hardrai1.D4
 TEMPERATURE DATA FILE:      C:\HELP\hardee\ssbotsod\hardrai1.D7
 SOLAR RADIATION DATA FILE:  C:\HELP\hardee\ssbotsod\hardrai1.D13
 EVAPOTRANSPIRATION DATA:    C:\HELP\hardee\ssbotsod\hardrai1.D11
 SOIL AND DESIGN DATA FILE:  C:\HELP\hardee\ssbotsod\existsod.D10
 OUTPUT DATA FILE:           C:\HELP\hardee\ssbotsod\existsod.OUT

 TIME:  12:15     DATE:   3/19/2013

******************************************************************************
 TITLE:  Hardee County Phase II Section II Expansion RAI No. 1
 Phase I Sideslope South Bottom (Existing Sod)
 *****************************************************************************

      NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
               COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.

                    LAYER  1 (Drainage Sand 24-inches)
                    --------
                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER   5
           THICKNESS                   =     24.00   INCHES
           POROSITY                    =      0.4570 VOL/VOL
           FIELD CAPACITY              =      0.1310 VOL/VOL
           WILTING POINT               =      0.0580 VOL/VOL
           INITIAL SOIL WATER CONTENT  =      0.1653 VOL/VOL
           EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC
         NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  1.80
                  FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.

              LAYER  2 (330-mil Bi-planar Geocomposite SKAPS)
           --------
                       TYPE 2 - LATERAL DRAINAGE LAYER
                         MATERIAL TEXTURE NUMBER   0
           THICKNESS                   =      0.33   INCHES
           POROSITY                    =      0.8500 VOL/VOL
           FIELD CAPACITY              =      0.0100 VOL/VOL
           WILTING POINT               =      0.0050 VOL/VOL
           INITIAL SOIL WATER CONTENT  =      0.0112 VOL/VOL
           EFFECTIVE SAT. HYD. COND.   =   7.80000019000     CM/SEC
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   SLOPE                          =     33.33   PERCENT
   DRAINAGE LENGTH                =     75.0    FEET

            LAYER  3 (60-mil HDPE geomembrane)
            --------
               TYPE 4 - FLEXIBLE MEMBRANE LINER
                 MATERIAL TEXTURE NUMBER  35
   THICKNESS                      =      0.06   INCHES
   POROSITY                       =      0.0000 VOL/VOL
   FIELD CAPACITY                 =      0.0000 VOL/VOL
   WILTING POINT                  =      0.0000 VOL/VOL
   INITIAL SOIL WATER CONTENT     =      0.0000 VOL/VOL
   EFFECTIVE SAT. HYD. COND.      =  0.199999996000E-12 CM/SEC
   FML PINHOLE DENSITY            =      1.00   HOLES/ACRE
   FML INSTALLATION DEFECTS       =      1.00   HOLES/ACRE
   FML PLACEMENT QUALITY          =  3 - GOOD

            LAYER  4 (Drainage Sand 24-inches)
            --------
             TYPE 1 - VERTICAL PERCOLATION LAYER
                 MATERIAL TEXTURE NUMBER   5
   THICKNESS                      =     24.00   INCHES
   POROSITY                       =      0.4570 VOL/VOL
   FIELD CAPACITY                 =      0.1310 VOL/VOL
   WILTING POINT                  =      0.0580 VOL/VOL
   INITIAL SOIL WATER CONTENT     =      0.1310 VOL/VOL
   EFFECTIVE SAT. HYD. COND.      =  0.100000005000E-02 CM/SEC

           GENERAL DESIGN AND EVAPORATIVE ZONE DATA
           ----------------------------------------

 NOTE:  SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
          SOIL DATA BASE USING SOIL TEXTURE # 5 WITH A
          GOOD STAND OF GRASS, A SURFACE SLOPE OF 33.%
          AND A SLOPE LENGTH OF   75. FEET.

SCS RUNOFF CURVE NUMBER                =     63.60
FRACTION OF AREA ALLOWING RUNOFF       =      0.0    PERCENT
AREA PROJECTED ON HORIZONTAL PLANE     =      1.000  ACRES
EVAPORATIVE ZONE DEPTH                 =     10.0    INCHES
INITIAL WATER IN EVAPORATIVE ZONE      =      0.600  INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE     =      4.570  INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE     =      0.580  INCHES
INITIAL SNOW WATER                     =      0.000  INCHES
INITIAL WATER IN LAYER MATERIALS       =      7.115  INCHES
TOTAL INITIAL WATER                    =      7.115  INCHES
TOTAL SUBSURFACE INFLOW                =      0.00   INCHES/YEAR

            EVAPOTRANSPIRATION AND WEATHER DATA
            -----------------------------------

 NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
          TAMPA                  FLORIDA
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```
STATION LATITUDE                        =  27.58 DEGREES
MAXIMUM LEAF AREA INDEX                 =   1.00
START OF GROWING SEASON (JULIAN DATE)   =      0
END OF GROWING SEASON (JULIAN DATE)     =    367
EVAPORATIVE ZONE DEPTH                  =  10.0  INCHES
AVERAGE ANNUAL WIND SPEED               =   8.60 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY   =  74.00 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY   =  72.00 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY   =  78.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY   =  76.00 %
```

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR TAMPA FLORIDA

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

| JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|
| 1.85 | 2.58 | 3.39 | 2.95 | 2.52 | 8.31 |
| 7.83 | 7.98 | 5.61 | 2.86 | 1.94 | 1.84 |

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR TAMPA FLORIDA

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

| JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|
| 59.80 | 60.80 | 66.20 | 71.60 | 77.10 | 80.90 |
| 82.20 | 82.20 | 80.90 | 74.50 | 66.70 | 61.30 |

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR TAMPA FLORIDA AND STATION LATITUDE = 27.58 DEGREES

***************************************************************************

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 28

---------------------------------------------------------------------------

| | JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|---|
| PRECIPITATION | | | | | | |
| TOTALS | 1.82 | 2.13 | 3.38 | 2.54 | 3.05 | 7.89 |
| | 8.50 | 7.72 | 5.34 | 2.65 | 1.83 | 1.84 |
| STD. DEVIATIONS | 1.56 | 2.17 | 2.92 | 1.84 | 2.10 | 3.63 |
| | 3.41 | 2.59 | 2.44 | 2.42 | 2.77 | 2.09 |
| RUNOFF | | | | | | |
| TOTALS | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |

```
    STD. DEVIATIONS     0.000    0.000    0.000    0.000    0.000    0.000
                        0.000    0.000    0.000    0.000    0.000    0.000

  EVAPOTRANSPIRATION
  ------------------
    TOTALS              0.871    0.839    1.443    1.207    1.503    3.499
                        4.311    4.235    2.815    1.217    0.717    0.634

    STD. DEVIATIONS     0.685    0.756    1.247    0.958    1.158    1.431
                        1.692    1.421    1.330    1.034    0.824    0.766

  LATERAL DRAINAGE COLECTED FROM LAYER  2
  ----------------------------------------
    TOTALS             0.9632   1.1720   1.8027   1.3339   1.4496   3.4789
                       4.2947   3.6554   2.8928   1.9249   1.3546   1.0857

    STD. DEVIATIONS    0.7416   1.2167   1.8725   0.6713   0.9488   2.0325
                       1.7842   1.2451   1.4201   1.3535   1.8175   1.3006

  PERCOLATION/LEAKAGETHROUGH LAYER  3
  ------------------------------------
    TOTALS             0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                       0.0001   0.0000   0.0000   0.0000   0.0000   0.0000

    STD. DEVIATIONS    0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                       0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

  PERCOLATION/LEAKAGE THROUGH LAYER  4
  ------------------------------------
    TOTALS             0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                       0.0001   0.0000   0.0000   0.0000   0.0000   0.0000

    STD. DEVIATIONS    0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                       0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

-----------------------------------------------------------------------------
                AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)
-----------------------------------------------------------------------------

  DAILY AVERAGE HEAD ON TOP OF LAYER  3
  -------------------------------------
    AVERAGES           0.0002   0.0002   0.0003   0.0003   0.0003   0.0007
                       0.0008   0.0007   0.0006   0.0004   0.0003   0.0002

    STD. DEVIATIONS    0.0001   0.0003   0.0003   0.0001   0.0002   0.0004
                       0.0003   0.0002   0.0003   0.0003   0.0003   0.0002

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 28

| | INCHES | | CU. FEET | PERCENT |
|---|---|---|---|---|
| PRECIPITATION | 48.67 | ( 9.518) | 176683.8 | 100.00 |
| RUNOFF | 0.000 | ( 0.0000) | 0.00 | 0.000 |
| EVAPOTRANSPIRATION | 23.290 | ( 3.9876) | 84543.12 | 47.850 |
| LATERAL DRAINAGE COLLECTED FROM LAYER 2 | 25.40828 | ( 6.11293) | 92232.055 | 52.20177 |
| PERCOLATION/LEAKAGE THROUGH LAYER 3 | 0.00036 | ( 0.00006) | 1.295 | 0.00073 |
| AVERAGE HEAD ON TOP OF LAYER 3 | 0.000 | ( 0.000) | | |
| PERCOLATION/LEAKAGE THROUGH LAYER 4 | 0.00037 | ( 0.00007) | 1.342 | 0.00076 |
| CHANGE IN WATER STORAGE | -0.026 | ( 0.8809) | -92.73 | -0.052 |

*******************************************************************************

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*******************************************************************************
              PEAK DAILY VALUES FOR YEARS    1 THROUGH   28
-------------------------------------------------------------------------------
                                               (INCHES)     (CU. FT.)
                                              ----------   -------------
   PRECIPITATION                                 7.60        27588.000

   RUNOFF                                        0.000          0.0000

   DRAINAGE COLLECTED FROM LAYER  2              2.62996      9546.74707

   PERCOLATION/LEAKAGE THROUGH LAYER  3          0.000017        0.06090

   AVERAGE HEAD ON TOP OF LAYER  3               0.016

   MAXIMUM HEAD ON TOP OF LAYER  3               0.030

   LOCATION OF MAXIMUM HEAD IN LAYER  2
         (DISTANCE FROM DRAIN)                   0.0 FEET

   PERCOLATION/LEAKAGE THROUGH LAYER  4          0.000042        0.15065

   SNOW WATER                                    0.00            0.0000

   MAXIMUM VEG. SOIL WATER (VOL/VOL)                     0.3665

   MINIMUM VEG. SOIL WATER (VOL/VOL)                     0.0580

    ***  Maximum heads are computed using McEnroe's equations.  ***

         Reference:  Maximum Saturated Depth over Landfill Liner
                     by Bruce M. McEnroe, University of Kansas
                     ASCE Journal of Environmental Engineering
                     Vol. 119, No. 2, March 1993, pp. 262-270.

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FINAL WATER STORAGE AT END OF YEAR 28

| LAYER | (INCHES) | (VOL/VOL) |
|---|---|---|
| 1 | 3.2528 | 0.1355 |
| 2 | 0.0033 | 0.0101 |
| 3 | 0.0000 | 0.0000 |
| 4 | 3.1436 | 0.1310 |
| SNOW WATER | 0.000 | |

*****************************************************************************
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 ****************************************************************************
 **                                                                        **
 **                                                                        **
 **              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE             **
 **                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)              **
 **                  DEVELOPED BY ENVIRONMENTAL LABORATORY                 **
 **                    USAE WATERWAYS EXPERIMENT STATION                   **
 **             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY            **
 **                                                                        **
 **                                                                        **
 ****************************************************************************
 ****************************************************************************

 PRECIPITATION DATA FILE:    C:\HELP\hardee\ssbot\hardrai1.D4
 TEMPERATURE DATA FILE:      C:\HELP\hardee\ssbot\hardrai1.D7
 SOLAR RADIATION DATA FILE:  C:\HELP\hardee\ssbot\hardrai1.D13
 EVAPOTRANSPIRATION DATA:    C:\HELP\hardee\ssbot\hardrai1.D11
 SOIL AND DESIGN DATA FILE:  C:\HELP\hardee\ssbot\ssopen.D10
 OUTPUT DATA FILE:           C:\HELP\hardee\ssbot\ssopen.OUT

 TIME:  12: 3     DATE:   3/19/2013

****************************************************************************
 TITLE:  Hardee County Phase II Section II Expansion RAI No. 1
 Phase I Sideslope South Bottom (Open Cell – No Waste)
 ****************************************************************************

      NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
               COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.

                     LAYER  1 (Drainage Sand 24-inches)
                     --------
                      TYPE 1 - VERTICAL PERCOLATION LAYER
                          MATERIAL TEXTURE NUMBER   5
            THICKNESS                    =     24.00   INCHES
            POROSITY                     =      0.4570 VOL/VOL
            FIELD CAPACITY               =      0.1310 VOL/VOL
            WILTING POINT                =      0.0580 VOL/VOL
            INITIAL SOIL WATER CONTENT   =      0.1663 VOL/VOL
            EFFECTIVE SAT. HYD. COND.    =  0.100000005000E-02 CM/SEC

              LAYER  2 (330-mil Bi-planar Geocomposite SKAPS)
            --------
                        TYPE 2 - LATERAL DRAINAGE LAYER
                          MATERIAL TEXTURE NUMBER   0
            THICKNESS                    =      0.33   INCHES
            POROSITY                     =      0.8500 VOL/VOL
            FIELD CAPACITY               =      0.0100 VOL/VOL
            WILTING POINT                =      0.0050 VOL/VOL
            INITIAL SOIL WATER CONTENT   =      0.0122 VOL/VOL
            EFFECTIVE SAT. HYD. COND.    =   7.80000019000     CM/SEC
            SLOPE                        =     33.33   PERCENT
            DRAINAGE LENGTH              =     75.0    FEET
```

```
          LAYER  3 (60-mil HDPE geomembrane)
          --------
             TYPE 4 - FLEXIBLE MEMBRANE LINER
               MATERIAL TEXTURE NUMBER  35
 THICKNESS                  =     0.06   INCHES
 POROSITY                   =     0.0000 VOL/VOL
 FIELD CAPACITY             =     0.0000 VOL/VOL
 WILTING POINT              =     0.0000 VOL/VOL
 INITIAL SOIL WATER CONTENT =     0.0000 VOL/VOL
 EFFECTIVE SAT. HYD. COND.  =  0.199999996000E-12 CM/SEC
 FML PINHOLE DENSITY        =     1.00   HOLES/ACRE
 FML INSTALLATION DEFECTS   =     1.00   HOLES/ACRE
 FML PLACEMENT QUALITY      =  3 - GOOD

          LAYER  4 (Drainage Sand 24-inches)
          --------
           TYPE 1 - VERTICAL PERCOLATION LAYER
               MATERIAL TEXTURE NUMBER   5
 THICKNESS                  =    24.00   INCHES
 POROSITY                   =     0.4570 VOL/VOL
 FIELD CAPACITY             =     0.1310 VOL/VOL
 WILTING POINT              =     0.0580 VOL/VOL
 INITIAL SOIL WATER CONTENT =     0.1310 VOL/VOL
 EFFECTIVE SAT. HYD. COND.  =  0.100000005000E-02 CM/SEC

         GENERAL DESIGN AND EVAPORATIVE ZONE DATA
         ----------------------------------------

NOTE:  SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
         SOIL DATA BASE USING SOIL TEXTURE # 5 WITH BARE
         GROUND CONDITIONS, A SURFACE SLOPE OF 33.% AND
         A SLOPE LENGTH OF   75. FEET.

SCS RUNOFF CURVE NUMBER            =    85.80
FRACTION OF AREA ALLOWING RUNOFF   =     0.0    PERCENT
AREA PROJECTED ON HORIZONTAL PLANE =     1.000  ACRES
EVAPORATIVE ZONE DEPTH             =    10.0    INCHES
INITIAL WATER IN EVAPORATIVE ZONE  =     0.602  INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE =     4.570  INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE =     0.580  INCHES
INITIAL SNOW WATER                 =     0.000  INCHES
INITIAL WATER IN LAYER MATERIALS   =     7.139  INCHES
TOTAL INITIAL WATER                =     7.139  INCHES
TOTAL SUBSURFACE INFLOW            =     0.00   INCHES/YEAR

          EVAPOTRANSPIRATION AND WEATHER DATA
          -----------------------------------

NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
         TAMPA                 FLORIDA

    STATION LATITUDE                         =  27.58 DEGREES
    MAXIMUM LEAF AREA INDEX                  =   0.00
```

START OF GROWING SEASON (JULIAN DATE)  =      0
END OF GROWING SEASON (JULIAN DATE)    =    367
EVAPORATIVE ZONE DEPTH                 =  10.0  INCHES
AVERAGE ANNUAL WIND SPEED              =   8.60 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY  =  74.00 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY  =  72.00 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY  =  78.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY  =  76.00 %

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR TAMPA FLORIDA

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

| JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|
| 1.85 | 2.58 | 3.39 | 2.95 | 2.52 | 8.31 |
| 7.83 | 7.98 | 5.61 | 2.86 | 1.94 | 1.84 |

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR TAMPA FLORIDA

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

| JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|
| 59.80 | 60.80 | 66.20 | 71.60 | 77.10 | 80.90 |
| 82.20 | 82.20 | 80.90 | 74.50 | 66.70 | 61.30 |

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR TAMPA FLORIDA AND STATION LATITUDE = 27.58 DEGREES

***************************************************************************

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 28

| | JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|---|
| PRECIPITATION | | | | | | |
| TOTALS | 1.82 | 2.13 | 3.38 | 2.54 | 3.05 | 7.89 |
| | 8.50 | 7.72 | 5.34 | 2.65 | 1.83 | 1.84 |
| STD. DEVIATIONS | 1.56 | 2.17 | 2.92 | 1.84 | 2.10 | 3.63 |
| | 3.41 | 2.59 | 2.44 | 2.42 | 2.77 | 2.09 |
| RUNOFF | | | | | | |
| TOTALS | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| STD. DEVIATIONS | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |

```
 EVAPOTRANSPIRATION
------------------
  TOTALS               0.825     0.752     1.222     1.181     1.420     3.108
                       4.041     3.938     2.726     1.248     0.698     0.618

  STD. DEVIATIONS      0.667     0.734     1.049     0.952     1.035     1.452
                       1.463     1.317     1.200     0.851     0.829     0.799

LATERAL DRAINAGE COLLECTED FROM LAYER  2
----------------------------------------
  TOTALS              1.0096    1.2287    1.9054    1.3467    1.4913    3.8582
                      4.5743    3.7890    3.1095    1.9664    1.4701    1.1707

  STD. DEVIATIONS     0.7468    1.2717    1.9026    0.7239    0.9329    1.9959
                      1.9215    1.5082    1.5134    1.2952    1.7934    1.3093

PERCOLATION/LEAKAGE THROUGH LAYER  3
------------------------------------
  TOTALS              0.0000    0.0000    0.0000    0.0000    0.0000    0.0000
                      0.0001    0.0000    0.0000    0.0000    0.0000    0.0000

  STD. DEVIATIONS     0.0000    0.0000    0.0000    0.0000    0.0000    0.0000
                      0.0000    0.0000    0.0000    0.0000    0.0000    0.0000

PERCOLATION/LEAKAGE THROUGH LAYER  4
------------------------------------
  TOTALS              0.0000    0.0000    0.0000    0.0000    0.0000    0.0000
                      0.0001    0.0000    0.0000    0.0000    0.0000    0.0000

  STD. DEVIATIONS     0.0000    0.0000    0.0000    0.0000    0.0000    0.0000
                      0.0000    0.0000    0.0000    0.0000    0.0000    0.0000

-----------------------------------------------------------------------------
               AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)
-----------------------------------------------------------------------------
DAILY AVERAGE HEAD ON TOP OF LAYER  3
-------------------------------------
  AVERAGES            0.0002    0.0003    0.0004    0.0003    0.0003    0.0008
                      0.0009    0.0007    0.0006    0.0004    0.0003    0.0002

  STD. DEVIATIONS     0.0001    0.0003    0.0003    0.0001    0.0002    0.0004
                      0.0004    0.0003    0.0003    0.0002    0.0003    0.0002

*****************************************************************************
*****************************************************************************
      AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS    1 THROUGH   28
-----------------------------------------------------------------------------
                                   INCHES           CU. FEET       PERCENT
                             -------------------  -------------   ---------
 PRECIPITATION                   48.67    (   9.518)     176683.8     100.00

 RUNOFF                          0.000   (  0.0000)          0.00      0.000
```

| | | | | |
|---|---|---|---|---|
| EVAPOTRANSPIRATION | 21.778 | ( 4.0902) | 79053.69 | 44.743 |
| LATERAL DRAINAGE COLLECTED FROM LAYER 2 | 26.91985 | ( 6.00087) | 97719.062 | 55.30732 |
| PERCOLATION/LEAKAGE THROUGH LAYER 3 | 0.00037 | ( 0.00006) | 1.351 | 0.00076 |
| AVERAGE HEAD ON TOP OF LAYER 3 | 0.000 | ( 0.000) | | |
| PERCOLATION/LEAKAGE THROUGH LAYER 4 | 0.00038 | ( 0.00007) | 1.391 | 0.00079 |
| CHANGE IN WATER STORAGE | -0.025 | ( 0.8439) | -90.36 | -0.051 |

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******************************************************************************
              PEAK DAILY VALUES FOR YEARS    1 THROUGH   28
    ------------------------------------------------------------------------
                                                (INCHES)      (CU. FT.)
                                               ----------   -------------
       PRECIPITATION                             7.60        27588.000

       RUNOFF                                    0.000           0.0000

       DRAINAGE COLLECTED FROM LAYER  2         2.64510       9601.69629

       PERCOLATION/LEAKAGE THROUGH LAYER  3     0.000017         0.06135

       AVERAGE HEAD ON TOP OF LAYER  3           0.017

       MAXIMUM HEAD ON TOP OF LAYER  3           0.022

       LOCATION OF MAXIMUM HEAD IN LAYER  2
             (DISTANCE FROM DRAIN)              12.7 FEET

       PERCOLATION/LEAKAGE THROUGH LAYER  4     0.000041         0.14851

       SNOW WATER                                0.00            0.0000

       MAXIMUM VEG. SOIL WATER (VOL/VOL)                 0.3774

       MINIMUM VEG. SOIL WATER (VOL/VOL)                 0.0580

        ***  Maximum heads are computed using McEnroe's equations.  ***

             Reference:  Maximum Saturated Depth over Landfill Liner
                         by Bruce M. McEnroe, University of Kansas
                         ASCE Journal of Environmental Engineering
                         Vol. 119, No. 2, March 1993, pp. 262-270.

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FINAL WATER STORAGE AT END OF YEAR 28

| LAYER | (INCHES) | (VOL/VOL) |
|---|---|---|
| 1 | 3.2946 | 0.1373 |
| 2 | 0.0034 | 0.0102 |
| 3 | 0.0000 | 0.0000 |
| 4 | 3.1437 | 0.1310 |
| SNOW WATER | 0.000 | |

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**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************

PRECIPITATION DATA FILE:    C:\HELP\hardee\ssbotsod\hardrai1.D4
PRECIPITATION DATA FILE:    C:\HELP\hardee\ssbot10\hardrai1.D4
TEMPERATURE DATA FILE:      C:\HELP\hardee\ssbot10\hardrai1.D7
SOLAR RADIATION DATA FILE:  C:\HELP\hardee\ssbot10\hardrai1.D13
EVAPOTRANSPIRATION DATA:    C:\HELP\hardee\ssbot10\hardrai1.D11
SOIL AND DESIGN DATA FILE:  C:\HELP\hardee\ssbot10\ssbot10.D10
OUTPUT DATA FILE:           C:\HELP\hardee\ssbot10\ssbot10.OUT

TIME:  12:48     DATE:   3/19/2013

*****************************************************************************
TITLE:  Hardee County Phase II Section II Expansion RAI No. 1
Phase I Sideslope South Bottom (10 Feet Waste)
*****************************************************************************

     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.

                      LAYER  1 (Daily Cover 6-inches)
                      --------
                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER   5
           THICKNESS                  =      6.00   INCHES
           POROSITY                   =      0.4570 VOL/VOL
           FIELD CAPACITY             =      0.1310 VOL/VOL
           WILTING POINT              =      0.0580 VOL/VOL
           INITIAL SOIL WATER CONTENT =      0.0643 VOL/VOL
           EFFECTIVE SAT. HYD. COND.  =  0.100000005000E-02 CM/SEC
         NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  1.80
                  FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.

                      LAYER  2 (5 Feet Waste)
                      --------
                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER  19
           THICKNESS                  =     60.00   INCHES
           POROSITY                   =      0.1680 VOL/VOL
           FIELD CAPACITY             =      0.0730 VOL/VOL
           WILTING POINT              =      0.0190 VOL/VOL
           INITIAL SOIL WATER CONTENT =      0.0756 VOL/VOL
```

```
EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC

           LAYER  3 (5 Feet Waste)
           --------
          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  19
THICKNESS                   =     60.00   INCHES
POROSITY                    =      0.1680 VOL/VOL
FIELD CAPACITY              =      0.0730 VOL/VOL
WILTING POINT               =      0.0190 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.0743 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC

         LAYER  4 (Drainage Sand 24-inches)
         --------
          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER   5
THICKNESS                   =     24.00   INCHES
POROSITY                    =      0.4570 VOL/VOL
FIELD CAPACITY              =      0.1310 VOL/VOL
WILTING POINT               =      0.0580 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.1969 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC

  LAYER  5 (330-mil Bi-planar Geocomposite SKAPS)
--------
            TYPE 2 - LATERAL DRAINAGE LAYER
              MATERIAL TEXTURE NUMBER   0
THICKNESS                   =      0.33   INCHES
POROSITY                    =      0.8500 VOL/VOL
FIELD CAPACITY              =      0.0100 VOL/VOL
WILTING POINT               =      0.0050 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.0102 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =   7.80000019000     CM/SEC
SLOPE                       =     33.33   PERCENT
DRAINAGE LENGTH             =     75.0    FEET

         LAYER  6 (60-mil HDPE geomembrane)
         --------
            TYPE 4 - FLEXIBLE MEMBRANE LINER
              MATERIAL TEXTURE NUMBER  35
THICKNESS                   =      0.06   INCHES
POROSITY                    =      0.0000 VOL/VOL
FIELD CAPACITY              =      0.0000 VOL/VOL
WILTING POINT               =      0.0000 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.0000 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.199999996000E-12 CM/SEC
FML PINHOLE DENSITY         =      1.00   HOLES/ACRE
FML INSTALLATION DEFECTS    =      1.00   HOLES/ACRE
FML PLACEMENT QUALITY       =  3 - GOOD
```

```
            LAYER  7 (Drainage Sand 24-inches)
            --------
             TYPE 1 - VERTICAL PERCOLATION LAYER
                 MATERIAL TEXTURE NUMBER   5
   THICKNESS                  =    24.00   INCHES
   POROSITY                   =     0.4570 VOL/VOL
   FIELD CAPACITY             =     0.1310 VOL/VOL
   WILTING POINT              =     0.0580 VOL/VOL
   INITIAL SOIL WATER CONTENT =     0.1310 VOL/VOL
   EFFECTIVE SAT. HYD. COND.  =  0.100000005000E-02 CM/SEC

           GENERAL DESIGN AND EVAPORATIVE ZONE DATA
           ----------------------------------------

 NOTE:  SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
          SOIL DATA BASE USING SOIL TEXTURE # 5 WITH A
          POOR STAND OF GRASS, A SURFACE SLOPE OF 33.%
          AND A SLOPE LENGTH OF   75. FEET.

SCS RUNOFF CURVE NUMBER              =    80.30
FRACTION OF AREA ALLOWING RUNOFF     =     0.0    PERCENT
AREA PROJECTED ON HORIZONTAL PLANE   =     1.000  ACRES
EVAPORATIVE ZONE DEPTH               =    10.0    INCHES
INITIAL WATER IN EVAPORATIVE ZONE    =     0.664  INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE   =     3.414  INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE   =     0.424  INCHES
INITIAL SNOW WATER                   =     0.000  INCHES
INITIAL WATER IN LAYER MATERIALS     =    17.252  INCHES
TOTAL INITIAL WATER                  =    17.252  INCHES
TOTAL SUBSURFACE INFLOW              =     0.00   INCHES/YEAR

            EVAPOTRANSPIRATION AND WEATHER DATA
            -----------------------------------

 NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
          TAMPA                 FLORIDA

     STATION LATITUDE                         =  27.58 DEGREES
     MAXIMUM LEAF AREA INDEX                  =   1.00
     START OF GROWING SEASON (JULIAN DATE)    =      0
     END OF GROWING SEASON (JULIAN DATE)      =    367
     EVAPORATIVE ZONE DEPTH                   =  10.0  INCHES
     AVERAGE ANNUAL WIND SPEED                =   8.60 MPH
     AVERAGE 1ST QUARTER RELATIVE HUMIDITY    =  74.00 %
     AVERAGE 2ND QUARTER RELATIVE HUMIDITY    =  72.00 %
     AVERAGE 3RD QUARTER RELATIVE HUMIDITY    =  78.00 %
     AVERAGE 4TH QUARTER RELATIVE HUMIDITY    =  76.00 %

 NOTE:  PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
          COEFFICIENTS FOR    TAMPA              FLORIDA

          NORMAL MEAN MONTHLY PRECIPITATION (INCHES)
```

| JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|
| 1.85 | 2.58 | 3.39 | 2.95 | 2.52 | 8.31 |
| 7.83 | 7.98 | 5.61 | 2.86 | 1.94 | 1.84 |

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR TAMPA FLORIDA

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

| JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|
| 59.80 | 60.80 | 66.20 | 71.60 | 77.10 | 80.90 |
| 82.20 | 82.20 | 80.90 | 74.50 | 66.70 | 61.30 |

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR TAMPA FLORIDA
AND STATION LATITUDE = 27.58 DEGREES

*****************************************************************************

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 28

| | JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|---|
| PRECIPITATION | | | | | | |
| TOTALS | 1.82 | 2.13 | 3.38 | 2.54 | 3.05 | 7.89 |
| | 8.50 | 7.72 | 5.34 | 2.65 | 1.83 | 1.84 |
| STD. DEVIATIONS | 1.56 | 2.17 | 2.92 | 1.84 | 2.10 | 3.63 |
| | 3.41 | 2.59 | 2.44 | 2.42 | 2.77 | 2.09 |
| RUNOFF | | | | | | |
| TOTALS | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| STD. DEVIATIONS | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| EVAPOTRANSPIRATION | | | | | | |
| TOTALS | 1.097 | 1.095 | 1.776 | 1.613 | 1.877 | 4.279 |
| | 4.949 | 4.621 | 3.243 | 1.569 | 0.930 | 0.860 |
| STD. DEVIATIONS | 0.774 | 0.771 | 1.174 | 1.038 | 1.064 | 1.248 |
| | 1.284 | 1.148 | 1.173 | 1.007 | 0.784 | 0.758 |
| LATERAL DRAINAGE COLLECTED FROM LAYER 5 | | | | | | |
| TOTALS | 0.6773 | 0.8110 | 1.4077 | 0.9751 | 1.0736 | 2.2790 |
| | 3.5413 | 3.3877 | 2.6720 | 1.7781 | 1.2187 | 0.9643 |

```
    STD. DEVIATIONS     0.5326   1.2296   1.9182   0.9291   0.9414   1.9798
                        2.0589   1.4914   1.6578   1.4845   1.5683   1.3994

  PERCOLATION/LEAKAGE THROUGH LAYER  6
  ------------------------------------
    TOTALS              0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                        0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

    STD. DEVIATIONS     0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                        0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

  PERCOLATION/LEAKAGE THROUGH LAYER  7
  ------------------------------------
    TOTALS              0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                        0.0001   0.0000   0.0000   0.0000   0.0000   0.0000

    STD. DEVIATIONS     0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                        0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

-----------------------------------------------------------------------------
               AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)
-----------------------------------------------------------------------------

  DAILY AVERAGE HEAD ON TOP OF LAYER  6
  -------------------------------------
    AVERAGES            0.0001   0.0002   0.0003   0.0002   0.0002   0.0004
                        0.0006   0.0006   0.0005   0.0003   0.0002   0.0002

    STD. DEVIATIONS     0.0001   0.0002   0.0004   0.0002   0.0002   0.0004
                        0.0004   0.0003   0.0003   0.0003   0.0003   0.0003

*****************************************************************************
*****************************************************************************
      AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS    1 THROUGH   28
-----------------------------------------------------------------------------
                                   INCHES           CU. FEET       PERCENT
                             -------------------  -------------   ---------
 PRECIPITATION                   48.67    (   9.518)     176683.8     100.00

 RUNOFF                          0.000   (  0.0000)         0.00      0.000

 EVAPOTRANSPIRATION             27.908   (  4.3401)    101305.65     57.337

 LATERAL DRAINAGE COLLECTED   20.78571 (  5.96986)    75452.117   42.70461
   FROM LAYER  5

 PERCOLATION/LEAKAGE THROUGH  0.00031 (  0.00006)        1.110     0.00063
   LAYER  6

 AVERAGE HEAD ON TOP             0.000 (    0.000)
   OF LAYER  6

 PERCOLATION/LEAKAGE THROUGH  0.00032 (  0.00008)        1.150     0.00065
```

LAYER 7

| | | | | |
|---|---|---|---|---|
| CHANGE IN WATER STORAGE | -0.021 | ( 1.0810) | -75.13 | -0.043 |

***************************************************************************

```
*******************************************************************************
              PEAK DAILY VALUES FOR YEARS    1 THROUGH   28
    ---------------------------------------------------------------------------
                                                   (INCHES)     (CU. FT.)
                                                  ----------  -------------
      PRECIPITATION                                  7.60       27588.000

      RUNOFF                                         0.000          0.0000

      DRAINAGE COLLECTED FROM LAYER  5              1.95150      7083.93652

      PERCOLATION/LEAKAGE THROUGH LAYER  6          0.000015        0.05284

      AVERAGE HEAD ON TOP OF LAYER  6                0.011

      MAXIMUM HEAD ON TOP OF LAYER  6                0.038

      LOCATION OF MAXIMUM HEAD IN LAYER  5
            (DISTANCE FROM DRAIN)                    0.0 FEET

      PERCOLATION/LEAKAGE THROUGH LAYER  7          0.000041        0.14744

      SNOW WATER                                     0.00           0.0000

      MAXIMUM VEG. SOIL WATER (VOL/VOL)                      0.2611

      MINIMUM VEG. SOIL WATER (VOL/VOL)                      0.0424

       ***  Maximum heads are computed using McEnroe's equations.  ***

            Reference:  Maximum Saturated Depth over Landfill Liner
                        by Bruce M. McEnroe, University of Kansas
                        ASCE Journal of Environmental Engineering
                        Vol. 119, No. 2, March 1993, pp. 262-270.

*******************************************************************************
```

******************************************************************************

FINAL WATER STORAGE AT END OF YEAR 28

| LAYER | (INCHES) | (VOL/VOL) |
|---|---|---|
| 1 | 0.3324 | 0.0554 |
| 2 | 4.1796 | 0.0697 |
| 3 | 4.3800 | 0.0730 |
| 4 | 4.6339 | 0.1931 |
| 5 | 0.0034 | 0.0102 |
| 6 | 0.0000 | 0.0000 |
| 7 | 3.1437 | 0.1310 |
| SNOW WATER | 0.000 | |

******************************************************************************

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***************************************************************************
 ***************************************************************************
 **                                                                       **
 **                                                                       **
 **             HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE             **
 **               HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)              **
 **                 DEVELOPED BY ENVIRONMENTAL LABORATORY                 **
 **                   USAE WATERWAYS EXPERIMENT STATION                   **
 **           FOR USEPA RISK REDUCTION ENGINEERING LABORATORY             **
 **                                                                       **
 **                                                                       **
 ***************************************************************************
 ***************************************************************************

 PRECIPITATION DATA FILE:    C:\HELP\hardee\ssbot25\hardrai1.D4
 TEMPERATURE DATA FILE:      C:\HELP\hardee\ssbot25\hardrai1.D7
 SOLAR RADIATION DATA FILE:  C:\HELP\hardee\ssbot25\hardrai1.D13
 EVAPOTRANSPIRATION DATA:    C:\HELP\hardee\ssbot25\hardrai1.D11
 SOIL AND DESIGN DATA FILE:  C:\HELP\hardee\ssbot25\ssbot25.D10
 OUTPUT DATA FILE:           C:\HELP\hardee\ssbot25\ssbot25.OUT

 TIME:   5:25     DATE:   3/23/2013

*****************************************************************************
 TITLE:  Hardee County Phase II Section II Expansion RAI No. 1
 Phase I Sideslope South Bottom (25 Feet Waste)
 ****************************************************************************

      NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
               COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.

                      LAYER  1 (Daily Cover 6-inches)
                      --------
                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER   5
           THICKNESS                  =      6.00   INCHES
           POROSITY                   =      0.4570 VOL/VOL
           FIELD CAPACITY             =      0.1310 VOL/VOL
           WILTING POINT              =      0.0580 VOL/VOL
           INITIAL SOIL WATER CONTENT =      0.0612 VOL/VOL
           EFFECTIVE SAT. HYD. COND.  =  0.100000005000E-02 CM/SEC
         NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  1.80
                  FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.

                      LAYER  2 (5 Feet Waste)
                      --------
                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER  19
           THICKNESS                  =     60.00   INCHES
           POROSITY                   =      0.1680 VOL/VOL
           FIELD CAPACITY             =      0.0730 VOL/VOL
           WILTING POINT              =      0.0190 VOL/VOL
           INITIAL SOIL WATER CONTENT =      0.0761 VOL/VOL
           EFFECTIVE SAT. HYD. COND.  =  0.100000005000E-02 CM/SEC
```

```
             LAYER  3 (10 Feet Waste)
             --------
            TYPE 1 - VERTICAL PERCOLATION LAYER
                MATERIAL TEXTURE NUMBER  19
THICKNESS                    =    120.00   INCHES
POROSITY                     =      0.1680 VOL/VOL
FIELD CAPACITY               =      0.0730 VOL/VOL
WILTING POINT                =      0.0190 VOL/VOL
INITIAL SOIL WATER CONTENT   =      0.0736 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.100000005000E-02 CM/SEC

             LAYER  4 (10 Feet Waste)
             --------
            TYPE 1 - VERTICAL PERCOLATION LAYER
                MATERIAL TEXTURE NUMBER  19
THICKNESS                    =    120.00   INCHES
POROSITY                     =      0.1680 VOL/VOL
FIELD CAPACITY               =      0.0730 VOL/VOL
WILTING POINT                =      0.0190 VOL/VOL
INITIAL SOIL WATER CONTENT   =      0.0730 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.100000005000E-02 CM/SEC

           LAYER  5 (Drainage Sand 24-inches)
           --------
            TYPE 1 - VERTICAL PERCOLATION LAYER
                MATERIAL TEXTURE NUMBER   5
THICKNESS                    =     24.00   INCHES
POROSITY                     =      0.4570 VOL/VOL
FIELD CAPACITY               =      0.1310 VOL/VOL
WILTING POINT                =      0.0580 VOL/VOL
INITIAL SOIL WATER CONTENT   =      0.1990 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.100000005000E-02 CM/SEC

  LAYER  6 (330-mil Bi-planar Geocomposite SKAPS)
--------
              TYPE 2 - LATERAL DRAINAGE LAYER
                MATERIAL TEXTURE NUMBER   0
THICKNESS                    =      0.30   INCHES
POROSITY                     =      0.8500 VOL/VOL
FIELD CAPACITY               =      0.0100 VOL/VOL
WILTING POINT                =      0.0050 VOL/VOL
INITIAL SOIL WATER CONTENT   =      0.0103 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =   5.69999981000     CM/SEC
SLOPE                        =     33.33   PERCENT
DRAINAGE LENGTH              =     75.0    FEET

           LAYER  7 (60-mil HDPE geomembrane)
           --------
              TYPE 4 - FLEXIBLE MEMBRANE LINER
                MATERIAL TEXTURE NUMBER  35
THICKNESS                    =      0.06   INCHES
POROSITY                     =      0.0000 VOL/VOL
FIELD CAPACITY               =      0.0000 VOL/VOL
```

```
   WILTING POINT                =     0.0000 VOL/VOL
   INITIAL SOIL WATER CONTENT  =     0.0000 VOL/VOL
   EFFECTIVE SAT. HYD. COND.   =  0.199999996000E-12 CM/SEC
   FML PINHOLE DENSITY          =     1.00   HOLES/ACRE
   FML INSTALLATION DEFECTS     =     1.00   HOLES/ACRE
   FML PLACEMENT QUALITY        =  3 - GOOD

            LAYER  8 (Drainage Sand 24-inches)
            --------
             TYPE 1 - VERTICAL PERCOLATION LAYER
                 MATERIAL TEXTURE NUMBER   5
   THICKNESS                    =    24.00   INCHES
   POROSITY                     =     0.4570 VOL/VOL
   FIELD CAPACITY               =     0.1310 VOL/VOL
   WILTING POINT                =     0.0580 VOL/VOL
   INITIAL SOIL WATER CONTENT  =     0.1310 VOL/VOL
   EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC

           GENERAL DESIGN AND EVAPORATIVE ZONE DATA
           ----------------------------------------

 NOTE:  SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
          SOIL DATA BASE USING SOIL TEXTURE # 5 WITH A
          POOR STAND OF GRASS, A SURFACE SLOPE OF 33.%
          AND A SLOPE LENGTH OF   75. FEET.

SCS RUNOFF CURVE NUMBER              =    80.30
FRACTION OF AREA ALLOWING RUNOFF     =     0.0    PERCENT
AREA PROJECTED ON HORIZONTAL PLANE  =     1.000  ACRES
EVAPORATIVE ZONE DEPTH               =    10.0    INCHES
INITIAL WATER IN EVAPORATIVE ZONE   =     0.637  INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE  =     3.414  INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE  =     0.424  INCHES
INITIAL SNOW WATER                   =     0.000  INCHES
INITIAL WATER IN LAYER MATERIALS    =    30.447  INCHES
TOTAL INITIAL WATER                  =    30.447  INCHES
TOTAL SUBSURFACE INFLOW              =     0.00   INCHES/YEAR

            EVAPOTRANSPIRATION AND WEATHER DATA
            -----------------------------------

 NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
          TAMPA                  FLORIDA

     STATION LATITUDE                          =  27.58 DEGREES
     MAXIMUM LEAF AREA INDEX                   =   1.00
     START OF GROWING SEASON (JULIAN DATE)    =      0
     END OF GROWING SEASON (JULIAN DATE)      =    367
     EVAPORATIVE ZONE DEPTH                    =  10.0  INCHES
     AVERAGE ANNUAL WIND SPEED                 =   8.60 MPH
     AVERAGE 1ST QUARTER RELATIVE HUMIDITY    =  74.00 %
     AVERAGE 2ND QUARTER RELATIVE HUMIDITY    =  72.00 %
     AVERAGE 3RD QUARTER RELATIVE HUMIDITY    =  78.00 %
```

AVERAGE 4TH QUARTER RELATIVE HUMIDITY = 76.00 %

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR TAMPA FLORIDA

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

| JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|
| 1.85 | 2.58 | 3.39 | 2.95 | 2.52 | 8.31 |
| 7.83 | 7.98 | 5.61 | 2.86 | 1.94 | 1.84 |

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR TAMPA FLORIDA

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

| JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|
| 59.80 | 60.80 | 66.20 | 71.60 | 77.10 | 80.90 |
| 82.20 | 82.20 | 80.90 | 74.50 | 66.70 | 61.30 |

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR TAMPA FLORIDA AND STATION LATITUDE = 27.58 DEGREES

***************************************************************************

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 28

---------------------------------------------------------------------------

| | JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|---|
| PRECIPITATION | | | | | | |
| TOTALS | 1.82 | 2.13 | 3.38 | 2.54 | 3.05 | 7.89 |
| | 8.50 | 7.72 | 5.34 | 2.65 | 1.83 | 1.84 |
| STD. DEVIATIONS | 1.56 | 2.17 | 2.92 | 1.84 | 2.10 | 3.63 |
| | 3.41 | 2.59 | 2.44 | 2.42 | 2.77 | 2.09 |
| RUNOFF | | | | | | |
| TOTALS | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| STD. DEVIATIONS | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| EVAPOTRANSPIRATION | | | | | | |
| TOTALS | 1.070 | 1.045 | 1.703 | 1.575 | 1.874 | 4.168 |
| | 4.868 | 4.550 | 3.153 | 1.457 | 0.900 | 0.779 |

```
    STD. DEVIATIONS      0.780    0.764    1.231    1.058    1.122    1.145
                         1.234    1.177    1.133    0.996    0.753    0.722

  LATERAL DRAINAGE COLLECTED FROM LAYER  6
  ----------------------------------------
    TOTALS              0.7239   0.8431   1.4121   1.1366   0.9572   1.8536
                        3.7667   3.7332   2.8249   1.9746   1.2999   1.0314

    STD. DEVIATIONS     0.6672   1.1698   1.8344   0.9688   0.7260   1.6220
                        2.0334   1.7585   1.6500   1.5187   1.5135   1.6326

  PERCOLATION/LEAKAGE THROUGH LAYER  7
  ------------------------------------
    TOTALS              0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                        0.0001   0.0001   0.0000   0.0000   0.0000   0.0000

    STD. DEVIATIONS     0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                        0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

  PERCOLATION/LEAKAGE THROUGH LAYER  8
  ------------------------------------
    TOTALS              0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                        0.0001   0.0001   0.0000   0.0000   0.0000   0.0000

    STD. DEVIATIONS     0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                        0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

-----------------------------------------------------------------------------
               AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)
-----------------------------------------------------------------------------
  DAILY AVERAGE HEAD ON TOP OF LAYER  7
  -------------------------------------
    AVERAGES            0.0002   0.0002   0.0004   0.0003   0.0002   0.0005
                        0.0009   0.0009   0.0007   0.0005   0.0003   0.0003

    STD. DEVIATIONS     0.0002   0.0003   0.0005   0.0002   0.0002   0.0004
                        0.0005   0.0004   0.0004   0.0004   0.0004   0.0004

*****************************************************************************
*****************************************************************************
      AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS    1 THROUGH   28
-----------------------------------------------------------------------------
                                     INCHES          CU. FEET       PERCENT
                              -------------------   -------------  ---------
 PRECIPITATION                    48.67    (   9.518)     176683.8     100.00

 RUNOFF                           0.000   (  0.0000)          0.00      0.000

 EVAPOTRANSPIRATION              27.142   (  4.4607)      98525.24     55.764

 LATERAL DRAINAGE COLLECTED   21.55730 (  5.59219)     78252.992   44.28986
   FROM LAYER  6
```

```
  PERCOLATION/LEAKAGE THROUGH  0.00040 (  0.00008)          1.470     0.00083
    LAYER  7

  AVERAGE HEAD ON TOP             0.000 (    0.000)
    OF LAYER  7

  PERCOLATION/LEAKAGE THROUGH  0.00042 (  0.00009)          1.525     0.00086
    LAYER  8

  CHANGE IN WATER STORAGE      -0.026   (  1.4548)        -96.01     -0.054

*****************************************************************************
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PEAK DAILY VALUES FOR YEARS 1 THROUGH 28

| | (INCHES) | (CU. FT.) |
|---|---|---|
| PRECIPITATION | 7.60 | 27588.000 |
| RUNOFF | 0.000 | 0.0000 |
| DRAINAGE COLLECTED FROM LAYER 6 | 1.06891 | 3880.13940 |
| PERCOLATION/LEAKAGE THROUGH LAYER 7 | 0.000012 | 0.04259 |
| AVERAGE HEAD ON TOP OF LAYER 7 | 0.008 | |
| MAXIMUM HEAD ON TOP OF LAYER 7 | 0.015 | |
| LOCATION OF MAXIMUM HEAD IN LAYER 6 (DISTANCE FROM DRAIN) | 0.0 FEET | |
| PERCOLATION/LEAKAGE THROUGH LAYER 8 | 0.000040 | 0.14471 |
| SNOW WATER | 0.00 | 0.0000 |
| MAXIMUM VEG. SOIL WATER (VOL/VOL) | 0.2612 | |
| MINIMUM VEG. SOIL WATER (VOL/VOL) | 0.0424 | |

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner
by Bruce M. McEnroe, University of Kansas
ASCE Journal of Environmental Engineering
Vol. 119, No. 2, March 1993, pp. 262-270.

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```
******************************************************************************
                  FINAL WATER STORAGE AT END OF YEAR   28
     ----------------------------------------------------------------------
                   LAYER        (INCHES)       (VOL/VOL)
                   -----        --------       ---------
                     1           0.3324          0.0554

                     2           4.1796          0.0697

                     3           8.7600          0.0730

                     4           8.7600          0.0730

                     5           4.5276          0.1886

                     6           0.0031          0.0102

                     7           0.0000          0.0000

                     8           3.1436          0.1310

                 SNOW WATER      0.000

******************************************************************************
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 **                                                                          **
 **                                                                          **
 **              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
 **                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                **
 **                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
 **                    USAE WATERWAYS EXPERIMENT STATION                     **
 **             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
 **                                                                          **
 **                                                                          **
 ******************************************************************************
 ******************************************************************************

 PRECIPITATION DATA FILE:    C:\HELP\hardee\sstopsod\hardrai1.D4
 TEMPERATURE DATA FILE:      C:\HELP\hardee\sstopsod\hardrai1.D7
 SOLAR RADIATION DATA FILE:  C:\HELP\hardee\sstopsod\hardrai1.D13
 EVAPOTRANSPIRATION DATA:    C:\HELP\hardee\sstopsod\hardrai1.D11
 SOIL AND DESIGN DATA FILE:  C:\HELP\hardee\sstopsod\existsod.D10
 OUTPUT DATA FILE:           C:\HELP\hardee\sstopsod\existsod.OUT

 TIME:  16:27     DATE:   3/19/2013

******************************************************************************
 TITLE:  Hardee County Phase II Section II Expansion RAI No. 1
 Phase I Sideslope South Top (Existing Sod)
 ******************************************************************************

      NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
               COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.

                     LAYER  1 (Drainage Sand 24-inches)
                     --------
                      TYPE 1 - VERTICAL PERCOLATION LAYER
                          MATERIAL TEXTURE NUMBER   5
           THICKNESS                   =     24.00    INCHES
           POROSITY                    =      0.4570 VOL/VOL
           FIELD CAPACITY              =      0.1310 VOL/VOL
           WILTING POINT               =      0.0580 VOL/VOL
           INITIAL SOIL WATER CONTENT  =      0.1653 VOL/VOL
           EFFECTIVE SAT. HYD. COND.   =   0.100000005000E-02 CM/SEC
         NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  1.80
                  FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.

              LAYER  2 (330-mil Bi-planar Geocomposite SKAPS)
           --------
                        TYPE 2 - LATERAL DRAINAGE LAYER
                          MATERIAL TEXTURE NUMBER   0
           THICKNESS                   =      0.33    INCHES
           POROSITY                    =      0.8500 VOL/VOL
           FIELD CAPACITY              =      0.0100 VOL/VOL
           WILTING POINT               =      0.0050 VOL/VOL
           INITIAL SOIL WATER CONTENT  =      0.0119 VOL/VOL
           EFFECTIVE SAT. HYD. COND.   =   7.80000019000     CM/SEC
```

```
   SLOPE                         =     33.33   PERCENT
   DRAINAGE LENGTH               =    105.0    FEET

            LAYER  3 (60-mil HDPE geomembrane)
            --------
               TYPE 4 - FLEXIBLE MEMBRANE LINER
                 MATERIAL TEXTURE NUMBER  35
   THICKNESS                     =      0.06   INCHES
   POROSITY                      =      0.0000 VOL/VOL
   FIELD CAPACITY                =      0.0000 VOL/VOL
   WILTING POINT                 =      0.0000 VOL/VOL
   INITIAL SOIL WATER CONTENT    =      0.0000 VOL/VOL
   EFFECTIVE SAT. HYD. COND.     =  0.199999996000E-12 CM/SEC
   FML PINHOLE DENSITY           =      1.00   HOLES/ACRE
   FML INSTALLATION DEFECTS      =      1.00   HOLES/ACRE
   FML PLACEMENT QUALITY         =  3 - GOOD

            LAYER  4 (Drainage Sand 24-inches)
            --------
             TYPE 1 - VERTICAL PERCOLATION LAYER
                 MATERIAL TEXTURE NUMBER   5
   THICKNESS                     =     24.00   INCHES
   POROSITY                      =      0.4570 VOL/VOL
   FIELD CAPACITY                =      0.1310 VOL/VOL
   WILTING POINT                 =      0.0580 VOL/VOL
   INITIAL SOIL WATER CONTENT    =      0.1310 VOL/VOL
   EFFECTIVE SAT. HYD. COND.     =  0.100000005000E-02 CM/SEC

           GENERAL DESIGN AND EVAPORATIVE ZONE DATA
           ----------------------------------------

 NOTE:  SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
          SOIL DATA BASE USING SOIL TEXTURE # 5 WITH A
          GOOD STAND OF GRASS, A SURFACE SLOPE OF 33.%
          AND A SLOPE LENGTH OF  105. FEET.

SCS RUNOFF CURVE NUMBER            =     62.60
FRACTION OF AREA ALLOWING RUNOFF   =      0.0    PERCENT
AREA PROJECTED ON HORIZONTAL PLANE =      1.000  ACRES
EVAPORATIVE ZONE DEPTH             =     10.0    INCHES
INITIAL WATER IN EVAPORATIVE ZONE  =      0.600  INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE =      4.570  INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE =      0.580  INCHES
INITIAL SNOW WATER                 =      0.000  INCHES
INITIAL WATER IN LAYER MATERIALS   =      7.115  INCHES
TOTAL INITIAL WATER                =      7.115  INCHES
TOTAL SUBSURFACE INFLOW            =      0.00   INCHES/YEAR

            EVAPOTRANSPIRATION AND WEATHER DATA
            -----------------------------------

 NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
          TAMPA                  FLORIDA
```

| | | |
|---|---|---|
| STATION LATITUDE | = | 27.58 DEGREES |
| MAXIMUM LEAF AREA INDEX | = | 1.00 |
| START OF GROWING SEASON (JULIAN DATE) | = | 0 |
| END OF GROWING SEASON (JULIAN DATE) | = | 367 |
| EVAPORATIVE ZONE DEPTH | = | 10.0 INCHES |
| AVERAGE ANNUAL WIND SPEED | = | 8.60 MPH |
| AVERAGE 1ST QUARTER RELATIVE HUMIDITY | = | 74.00 % |
| AVERAGE 2ND QUARTER RELATIVE HUMIDITY | = | 72.00 % |
| AVERAGE 3RD QUARTER RELATIVE HUMIDITY | = | 78.00 % |
| AVERAGE 4TH QUARTER RELATIVE HUMIDITY | = | 76.00 % |

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR TAMPA FLORIDA

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

| JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|
| 1.85 | 2.58 | 3.39 | 2.95 | 2.52 | 8.31 |
| 7.83 | 7.98 | 5.61 | 2.86 | 1.94 | 1.84 |

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR TAMPA FLORIDA

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

| JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|
| 59.80 | 60.80 | 66.20 | 71.60 | 77.10 | 80.90 |
| 82.20 | 82.20 | 80.90 | 74.50 | 66.70 | 61.30 |

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR TAMPA FLORIDA AND STATION LATITUDE = 27.58 DEGREES

***************************************************************************

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 28

---------------------------------------------------------------------------

| | JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|---|
| **PRECIPITATION** | | | | | | |
| TOTALS | 1.82 | 2.13 | 3.38 | 2.54 | 3.05 | 7.89 |
| | 8.50 | 7.72 | 5.34 | 2.65 | 1.83 | 1.84 |
| STD. DEVIATIONS | 1.56 | 2.17 | 2.92 | 1.84 | 2.10 | 3.63 |
| | 3.41 | 2.59 | 2.44 | 2.42 | 2.77 | 2.09 |
| **RUNOFF** | | | | | | |
| TOTALS | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |

```
     STD. DEVIATIONS     0.000    0.000    0.000    0.000    0.000    0.000
                         0.000    0.000    0.000    0.000    0.000    0.000

  EVAPOTRANSPIRATION
  ------------------
    TOTALS              0.871    0.839    1.443    1.207    1.503    3.499
                        4.311    4.235    2.815    1.217    0.717    0.634

    STD. DEVIATIONS     0.685    0.756    1.247    0.958    1.158    1.431
                        1.692    1.421    1.330    1.034    0.824    0.766

  LATERAL DRAINAGE COLLECTED FROM LAYER  2
  ----------------------------------------
    TOTALS              0.9632   1.1719   1.8027   1.3338   1.4497   3.4782
                        4.2951   3.6555   2.8928   1.9250   1.3546   1.0857

    STD. DEVIATIONS     0.7416   1.2167   1.8724   0.6712   0.9489   2.0324
                        1.7844   1.2451   1.4201   1.3534   1.8174   1.3006

  PERCOLATION/LEAKAGE THROUGH LAYER  3
  ------------------------------------
    TOTALS              0.0000   0.0000   0.0000   0.0000   0.0000   0.0001
                        0.0001   0.0001   0.0001   0.0000   0.0000   0.0000

    STD. DEVIATIONS     0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                        0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

  PERCOLATION/LEAKAGE THROUGH LAYER  4
  ------------------------------------
    TOTALS              0.0000   0.0000   0.0000   0.0000   0.0000   0.0001
                        0.0001   0.0001   0.0001   0.0000   0.0000   0.0000

    STD. DEVIATIONS     0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                        0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

-----------------------------------------------------------------------------
                AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)
-----------------------------------------------------------------------------

  DAILY AVERAGE HEAD ON TOP OF LAYER  3
  -------------------------------------
    AVERAGES            0.0002   0.0003   0.0005   0.0004   0.0004   0.0009
                        0.0011   0.0009   0.0008   0.0005   0.0004   0.0003

    STD. DEVIATIONS     0.0002   0.0003   0.0005   0.0002   0.0002   0.0005
                        0.0005   0.0003   0.0004   0.0003   0.0005   0.0003

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*****************************************************************************

     AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS    1 THROUGH   28
-----------------------------------------------------------------------------
                                    INCHES          CU. FEET       PERCENT
```

| | | | |
|---|---|---|---|
| PRECIPITATION | 48.67 ( 9.518) | 176683.8 | 100.00 |
| RUNOFF | 0.000 ( 0.0000) | 0.00 | 0.000 |
| EVAPOTRANSPIRATION | 23.290 ( 3.9876) | 84543.12 | 47.850 |
| LATERAL DRAINAGE COLLECTED FROM LAYER 2 | 25.40817 ( 6.11293) | 92231.664 | 52.20155 |
| PERCOLATION/LEAKAGE THROUGH LAYER 3 | 0.00046 ( 0.00008) | 1.685 | 0.00095 |
| AVERAGE HEAD ON TOP OF LAYER 3 | 0.001 ( 0.000) | | |
| PERCOLATION/LEAKAGE THROUGH LAYER 4 | 0.00048 ( 0.00009) | 1.754 | 0.00099 |
| CHANGE IN WATER STORAGE | -0.026 ( 0.8810) | -92.78 | -0.053 |

***************************************************************************

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*************************************************************************
              PEAK DAILY VALUES FOR YEARS    1 THROUGH   28
------------------------------------------------------------------------
                                              (INCHES)      (CU. FT.)
                                             ----------   -------------
       PRECIPITATION                            7.60         27588.000

       RUNOFF                                   0.000            0.0000

       DRAINAGE COLLECTED FROM LAYER  2        2.61569      9494.95410

       PERCOLATION/LEAKAGE THROUGH LAYER  3    0.000022         0.07896

       AVERAGE HEAD ON TOP OF LAYER  3          0.021

       MAXIMUM HEAD ON TOP OF LAYER  3          0.045

       LOCATION OF MAXIMUM HEAD IN LAYER  2
             (DISTANCE FROM DRAIN)              0.0 FEET

       PERCOLATION/LEAKAGE THROUGH LAYER  4    0.000043         0.15480

       SNOW WATER                               0.00             0.0000

       MAXIMUM VEG. SOIL WATER (VOL/VOL)                0.3665

       MINIMUM VEG. SOIL WATER (VOL/VOL)                0.0580

        ***  Maximum heads are computed using McEnroe's equations.  ***

             Reference:  Maximum Saturated Depth over Landfill Liner
                         by Bruce M. McEnroe, University of Kansas
                         ASCE Journal of Environmental Engineering
                         Vol. 119, No. 2, March 1993, pp. 262-270.

*************************************************************************
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***************************************************************************

FINAL WATER STORAGE AT END OF YEAR 28

| LAYER | (INCHES) | (VOL/VOL) |
|---|---|---|
| 1 | 3.2528 | 0.1355 |
| 2 | 0.0034 | 0.0102 |
| 3 | 0.0000 | 0.0000 |
| 4 | 3.1434 | 0.1310 |
| SNOW WATER | 0.000 | |

*************************************************************************
*************************************************************************

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******************************************************************************
 ******************************************************************************
 **                                                                          **
 **                                                                          **
 **              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
 **                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                **
 **                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
 **                    USAE WATERWAYS EXPERIMENT STATION                     **
 **             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
 **                                                                          **
 **                                                                          **
 ******************************************************************************
 ******************************************************************************

 PRECIPITATION DATA FILE:    C:\HELP\hardee\sstop\hardrai1.D4
 TEMPERATURE DATA FILE:      C:\HELP\hardee\sstop\hardrai1.D7
 SOLAR RADIATION DATA FILE:  C:\HELP\hardee\sstop\hardrai1.D13
 EVAPOTRANSPIRATION DATA:    C:\HELP\hardee\sstop\hardrai1.D11
 SOIL AND DESIGN DATA FILE:  C:\HELP\hardee\sstop\sstopo.D10
 OUTPUT DATA FILE:           C:\HELP\hardee\sstop\sstopo.OUT

 TIME:  16:17     DATE:   3/19/2013

******************************************************************************
 TITLE:  Hardee County Phase II Section II Expansion RAI No. 1
 Phase I Sideslope South Top (Open Cell - No Waste)
 ******************************************************************************

      NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
               COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.

                    LAYER  1 (Drainage Sand 24-inches)
                    --------
                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER   5
           THICKNESS                   =     24.00   INCHES
           POROSITY                    =      0.4570 VOL/VOL
           FIELD CAPACITY              =      0.1310 VOL/VOL
           WILTING POINT               =      0.0580 VOL/VOL
           INITIAL SOIL WATER CONTENT  =      0.1646 VOL/VOL
           EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC

              LAYER  2 (330-mil Bi-planar Geocomposite SKAPS)
           --------
                       TYPE 2 - LATERAL DRAINAGE LAYER
                         MATERIAL TEXTURE NUMBER   0
           THICKNESS                   =      0.33   INCHES
           POROSITY                    =      0.8500 VOL/VOL
           FIELD CAPACITY              =      0.0100 VOL/VOL
           WILTING POINT               =      0.0050 VOL/VOL
           INITIAL SOIL WATER CONTENT  =      0.0107 VOL/VOL
           EFFECTIVE SAT. HYD. COND.   =   7.80000019000     CM/SEC
           SLOPE                       =     33.33   PERCENT
           DRAINAGE LENGTH             =    150.0    FEET
```

```
           LAYER  3 (60-mil HDPE geomembrane)
           --------
              TYPE 4 - FLEXIBLE MEMBRANE LINER
                MATERIAL TEXTURE NUMBER  35
  THICKNESS                  =     0.06   INCHES
  POROSITY                   =     0.0000 VOL/VOL
  FIELD CAPACITY             =     0.0000 VOL/VOL
  WILTING POINT              =     0.0000 VOL/VOL
  INITIAL SOIL WATER CONTENT =     0.0000 VOL/VOL
  EFFECTIVE SAT. HYD. COND.  =  0.199999996000E-12 CM/SEC
  FML PINHOLE DENSITY        =     1.00   HOLES/ACRE
  FML INSTALLATION DEFECTS   =     1.00   HOLES/ACRE
  FML PLACEMENT QUALITY      =  3 - GOOD

           LAYER  4 (Drainage Sand 24-inches)
           --------
            TYPE 1 - VERTICAL PERCOLATION LAYER
                MATERIAL TEXTURE NUMBER   5
  THICKNESS                  =    24.00   INCHES
  POROSITY                   =     0.4570 VOL/VOL
  FIELD CAPACITY             =     0.1310 VOL/VOL
  WILTING POINT              =     0.0580 VOL/VOL
  INITIAL SOIL WATER CONTENT =     0.1310 VOL/VOL
  EFFECTIVE SAT. HYD. COND.  =  0.100000005000E-02 CM/SEC

          GENERAL DESIGN AND EVAPORATIVE ZONE DATA
          ----------------------------------------

 NOTE:  SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
         SOIL DATA BASE USING SOIL TEXTURE # 5 WITH BARE
         GROUND CONDITIONS, A SURFACE SLOPE OF 33.% AND
         A SLOPE LENGTH OF  150. FEET.

SCS RUNOFF CURVE NUMBER              =    85.20
FRACTION OF AREA ALLOWING RUNOFF     =     0.0    PERCENT
AREA PROJECTED ON HORIZONTAL PLANE   =     1.000  ACRES
EVAPORATIVE ZONE DEPTH               =    10.0    INCHES
INITIAL WATER IN EVAPORATIVE ZONE    =     1.029  INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE   =     4.570  INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE   =     0.580  INCHES
INITIAL SNOW WATER                   =     0.000  INCHES
INITIAL WATER IN LAYER MATERIALS     =     7.097  INCHES
TOTAL INITIAL WATER                  =     7.097  INCHES
TOTAL SUBSURFACE INFLOW              =     0.00   INCHES/YEAR

           EVAPOTRANSPIRATION AND WEATHER DATA
           -----------------------------------

 NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
         TAMPA                 FLORIDA

     STATION LATITUDE                        =  27.58 DEGREES
     MAXIMUM LEAF AREA INDEX                 =   0.00
```

START OF GROWING SEASON (JULIAN DATE) = 0
END OF GROWING SEASON (JULIAN DATE) = 367
EVAPORATIVE ZONE DEPTH = 10.0 INCHES
AVERAGE ANNUAL WIND SPEED = 8.60 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY = 74.00 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY = 72.00 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY = 78.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY = 76.00 %

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR TAMPA FLORIDA

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

| JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|
| 1.85 | 2.58 | 3.39 | 2.95 | 2.52 | 8.31 |
| 7.83 | 7.98 | 5.61 | 2.86 | 1.94 | 1.84 |

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR TAMPA FLORIDA

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

| JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|
| 59.80 | 60.80 | 66.20 | 71.60 | 77.10 | 80.90 |
| 82.20 | 82.20 | 80.90 | 74.50 | 66.70 | 61.30 |

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR TAMPA FLORIDA AND STATION LATITUDE = 27.58 DEGREES

*****************************************************************************

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 28

-----------------------------------------------------------------------------

| | JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|---|
| PRECIPITATION | | | | | | |
| TOTALS | 1.82 | 2.13 | 3.38 | 2.54 | 3.05 | 7.89 |
| | 8.50 | 7.72 | 5.34 | 2.65 | 1.83 | 1.84 |
| STD. DEVIATIONS | 1.56 | 2.17 | 2.92 | 1.84 | 2.10 | 3.63 |
| | 3.41 | 2.59 | 2.44 | 2.42 | 2.77 | 2.09 |
| RUNOFF | | | | | | |
| TOTALS | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| STD. DEVIATIONS | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |

```
                      0.000    0.000    0.000    0.000    0.000    0.000

   EVAPOTRANSPIRATION
   ------------------
     TOTALS             0.866    0.671    1.339    1.218    1.510    3.291
                        4.159    3.963    2.673    1.290    0.693    0.656

     STD. DEVIATIONS    0.720    0.685    1.126    0.997    1.017    1.388
                        1.425    1.245    1.214    0.926    0.805    0.834

   LATERAL DRAINAGE COLLECTED FROM LAYER  2
   ----------------------------------------
     TOTALS            0.9917   1.2708   1.8026   1.3258   1.4025   3.6050
                       4.4520   3.8804   3.1431   1.9212   1.4617   1.1098

     STD. DEVIATIONS   0.6813   1.2621   1.9097   0.6390   0.9770   2.1057
                       2.0047   1.5194   1.5020   1.3374   1.8346   1.3076

   PERCOLATION/LEAKAGE THROUGH LAYER  3
   ------------------------------------
     TOTALS            0.0000   0.0000   0.0000   0.0000   0.0000   0.0001
                       0.0001   0.0001   0.0001   0.0000   0.0000   0.0000

     STD. DEVIATIONS   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                       0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

   PERCOLATION/LEAKAGE THROUGH LAYER  4
   ------------------------------------
     TOTALS            0.0000   0.0000   0.0001   0.0000   0.0000   0.0001
                       0.0001   0.0001   0.0001   0.0001   0.0000   0.0000

     STD. DEVIATIONS   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                       0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

-----------------------------------------------------------------------------
                AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)
-----------------------------------------------------------------------------
   DAILY AVERAGE HEAD ON TOP OF LAYER  3
   -------------------------------------
     AVERAGES          0.0004   0.0005   0.0007   0.0005   0.0005   0.0014
                       0.0016   0.0014   0.0012   0.0007   0.0006   0.0004

     STD. DEVIATIONS   0.0002   0.0005   0.0007   0.0002   0.0004   0.0008
                       0.0007   0.0006   0.0006   0.0005   0.0007   0.0005

*****************************************************************************
*****************************************************************************
      AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS    1 THROUGH   28
-----------------------------------------------------------------------------
                                      INCHES            CU. FEET      PERCENT
                             -------------------  -------------   ---------
  PRECIPITATION                  48.67    (   9.518)     176683.8     100.00
```

| | | | | |
|---|---|---|---|---|
| RUNOFF | 0.000 | ( 0.0000) | 0.00 | 0.000 |
| EVAPOTRANSPIRATION | 22.330 | ( 4.3277) | 81058.22 | 45.878 |
| LATERAL DRAINAGE COLLECTED FROM LAYER 2 | 26.36665 | ( 5.73353) | 95710.930 | 54.17076 |
| PERCOLATION/LEAKAGE THROUGH LAYER 3 | 0.00063 | ( 0.00010) | 2.275 | 0.00129 |
| AVERAGE HEAD ON TOP OF LAYER 3 | 0.001 | ( 0.000) | | |
| PERCOLATION/LEAKAGE THROUGH LAYER 4 | 0.00067 | ( 0.00012) | 2.419 | 0.00137 |
| CHANGE IN WATER STORAGE | -0.024 | ( 0.8475) | -87.77 | -0.050 |

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 28

| | (INCHES) | (CU. FT.) |
|---|---|---|
| PRECIPITATION | 7.60 | 27588.000 |
| RUNOFF | 0.000 | 0.0000 |
| DRAINAGE COLLECTED FROM LAYER 2 | 2.62133 | 9515.43555 |
| PERCOLATION/LEAKAGE THROUGH LAYER 3 | 0.000029 | 0.10460 |
| AVERAGE HEAD ON TOP OF LAYER 3 | 0.030 | |
| MAXIMUM HEAD ON TOP OF LAYER 3 | 0.051 | |
| LOCATION OF MAXIMUM HEAD IN LAYER 2 (DISTANCE FROM DRAIN) | 5.9 FEET | |
| PERCOLATION/LEAKAGE THROUGH LAYER 4 | 0.000051 | 0.18469 |
| SNOW WATER | 0.00 | 0.0000 |
| MAXIMUM VEG. SOIL WATER (VOL/VOL) | 0.3764 | |
| MINIMUM VEG. SOIL WATER (VOL/VOL) | 0.0580 | |

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner
by Bruce M. McEnroe, University of Kansas
ASCE Journal of Environmental Engineering
Vol. 119, No. 2, March 1993, pp. 262-270.

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******************************************************************************
                  FINAL WATER STORAGE AT END OF YEAR   28
     ----------------------------------------------------------------------
                   LAYER        (INCHES)       (VOL/VOL)
                   -----        --------       ---------
                     1           3.2737          0.1364

                     2           0.0034          0.0103

                     3           0.0000          0.0000

                     4           3.1428          0.1310

                 SNOW WATER      0.000

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******************************************************************************
**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************

PRECIPITATION DATA FILE:    C:\HELP\hardee\sstop25\hardrai1.D4
TEMPERATURE DATA FILE:      C:\HELP\hardee\sstop25\hardrai1.D7
SOLAR RADIATION DATA FILE:  C:\HELP\hardee\sstop25\hardrai1.D13
EVAPOTRANSPIRATION DATA:    C:\HELP\hardee\sstop25\hardrai1.D11
SOIL AND DESIGN DATA FILE:  C:\HELP\hardee\sstop25\sstop25.D10
OUTPUT DATA FILE:           C:\HELP\hardee\sstop25\sstop25.OUT

TIME:   5:14     DATE:   3/23/2013

******************************************************************************
TITLE:  Hardee County Phase II Section II Expansion RAI No. 1
```
**Phase I Sideslope South Top (25 Feet Waste)**
```
******************************************************************************

     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.

                      LAYER  1 (Daily Cover 6-inches)
                      --------
                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER   5
           THICKNESS                     =     6.00   INCHES
           POROSITY                      =     0.4570 VOL/VOL
           FIELD CAPACITY                =     0.1310 VOL/VOL
           WILTING POINT                 =     0.0580 VOL/VOL
           INITIAL SOIL WATER CONTENT    =     0.0643 VOL/VOL
           EFFECTIVE SAT. HYD. COND.     =  0.100000005000E-02 CM/SEC
         NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  1.80
                  FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.

                      LAYER  2 (5 Feet Waste)
                      --------
                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER  19
           THICKNESS                     =    60.00   INCHES
           POROSITY                      =     0.1680 VOL/VOL
           FIELD CAPACITY                =     0.0730 VOL/VOL
           WILTING POINT                 =     0.0190 VOL/VOL
           INITIAL SOIL WATER CONTENT    =     0.0756 VOL/VOL
           EFFECTIVE SAT. HYD. COND.     =  0.100000005000E-02 CM/SEC
```

```
            LAYER  3 (10 Feet Waste)
            --------
         TYPE 1 - VERTICAL PERCOLATION LAYER
             MATERIAL TEXTURE NUMBER  19
THICKNESS                  =    120.00   INCHES
POROSITY                   =      0.1680 VOL/VOL
FIELD CAPACITY             =      0.0730 VOL/VOL
WILTING POINT              =      0.0190 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.0736 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  0.100000005000E-02 CM/SEC

            LAYER  4 (10 Feet Waste)
            --------
         TYPE 1 - VERTICAL PERCOLATION LAYER
             MATERIAL TEXTURE NUMBER  19
THICKNESS                  =    120.00   INCHES
POROSITY                   =      0.1680 VOL/VOL
FIELD CAPACITY             =      0.0730 VOL/VOL
WILTING POINT              =      0.0190 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.0730 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  0.100000005000E-02 CM/SEC

          LAYER  5 (Drainage Sand 24-inches)
          --------
         TYPE 1 - VERTICAL PERCOLATION LAYER
             MATERIAL TEXTURE NUMBER   5
THICKNESS                  =     24.00   INCHES
POROSITY                   =      0.4570 VOL/VOL
FIELD CAPACITY             =      0.1310 VOL/VOL
WILTING POINT              =      0.0580 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.1971 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  0.100000005000E-02 CM/SEC

   LAYER  6 (330-mil Bi-planar Geocomposite SKAPS)
--------
           TYPE 2 - LATERAL DRAINAGE LAYER
             MATERIAL TEXTURE NUMBER   0
THICKNESS                  =      0.30   INCHES
POROSITY                   =      0.8500 VOL/VOL
FIELD CAPACITY             =      0.0100 VOL/VOL
WILTING POINT              =      0.0050 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.0104 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =   5.69999981000     CM/SEC
SLOPE                      =     33.33   PERCENT
DRAINAGE LENGTH            =    105.0    FEET

          LAYER  7 (60-mil HDPE geomembrane)
          --------
           TYPE 4 - FLEXIBLE MEMBRANE LINER
             MATERIAL TEXTURE NUMBER  35
THICKNESS                  =      0.06   INCHES
POROSITY                   =      0.0000 VOL/VOL
FIELD CAPACITY             =      0.0000 VOL/VOL
```

```
   WILTING POINT                 =      0.0000 VOL/VOL
   INITIAL SOIL WATER CONTENT    =      0.0000 VOL/VOL
   EFFECTIVE SAT. HYD. COND.     =  0.199999996000E-12 CM/SEC
   FML PINHOLE DENSITY           =      1.00   HOLES/ACRE
   FML INSTALLATION DEFECTS      =      1.00   HOLES/ACRE
   FML PLACEMENT QUALITY         =  3 - GOOD

            LAYER  8 (Drainage Sand 24-inches)
            --------
             TYPE 1 - VERTICAL PERCOLATION LAYER
                 MATERIAL TEXTURE NUMBER   5
   THICKNESS                     =     24.00   INCHES
   POROSITY                      =      0.4570 VOL/VOL
   FIELD CAPACITY                =      0.1310 VOL/VOL
   WILTING POINT                 =      0.0580 VOL/VOL
   INITIAL SOIL WATER CONTENT    =      0.1310 VOL/VOL
   EFFECTIVE SAT. HYD. COND.     =  0.100000005000E-02 CM/SEC

           GENERAL DESIGN AND EVAPORATIVE ZONE DATA
           ----------------------------------------

 NOTE:  SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
          SOIL DATA BASE USING SOIL TEXTURE # 5 WITH A
          POOR STAND OF GRASS, A SURFACE SLOPE OF 33.%
          AND A SLOPE LENGTH OF  105. FEET.

SCS RUNOFF CURVE NUMBER             =     80.00
FRACTION OF AREA ALLOWING RUNOFF    =      0.0    PERCENT
AREA PROJECTED ON HORIZONTAL PLANE  =      1.000  ACRES
EVAPORATIVE ZONE DEPTH              =     10.0    INCHES
INITIAL WATER IN EVAPORATIVE ZONE   =      0.664  INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE  =      3.414  INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE  =      0.424  INCHES
INITIAL SNOW WATER                  =      0.000  INCHES
INITIAL WATER IN LAYER MATERIALS    =     30.401  INCHES
TOTAL INITIAL WATER                 =     30.401  INCHES
TOTAL SUBSURFACE INFLOW             =      0.00   INCHES/YEAR

            EVAPOTRANSPIRATION AND WEATHER DATA
            -----------------------------------

 NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
          TAMPA                 FLORIDA

     STATION LATITUDE                        =  27.58 DEGREES
     MAXIMUM LEAF AREA INDEX                 =   1.00
     START OF GROWING SEASON (JULIAN DATE)   =      0
     END OF GROWING SEASON (JULIAN DATE)     =    367
     EVAPORATIVE ZONE DEPTH                  =  10.0  INCHES
     AVERAGE ANNUAL WIND SPEED               =   8.60 MPH
     AVERAGE 1ST QUARTER RELATIVE HUMIDITY   =  74.00 %
     AVERAGE 2ND QUARTER RELATIVE HUMIDITY   =  72.00 %
     AVERAGE 3RD QUARTER RELATIVE HUMIDITY   =  78.00 %
```

AVERAGE 4TH QUARTER RELATIVE HUMIDITY = 76.00 %

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR TAMPA FLORIDA

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

| JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|
| 1.85 | 2.58 | 3.39 | 2.95 | 2.52 | 8.31 |
| 7.83 | 7.98 | 5.61 | 2.86 | 1.94 | 1.84 |

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR TAMPA FLORIDA

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

| JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|
| 59.80 | 60.80 | 66.20 | 71.60 | 77.10 | 80.90 |
| 82.20 | 82.20 | 80.90 | 74.50 | 66.70 | 61.30 |

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR TAMPA FLORIDA AND STATION LATITUDE = 27.58 DEGREES

***************************************************************************

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 28

---------------------------------------------------------------------------

| | JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|---|
| PRECIPITATION | | | | | | |
| TOTALS | 1.82 | 2.13 | 3.38 | 2.54 | 3.05 | 7.89 |
| | 8.50 | 7.72 | 5.34 | 2.65 | 1.83 | 1.84 |
| STD. DEVIATIONS | 1.56 | 2.17 | 2.92 | 1.84 | 2.10 | 3.63 |
| | 3.41 | 2.59 | 2.44 | 2.42 | 2.77 | 2.09 |
| RUNOFF | | | | | | |
| TOTALS | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| STD. DEVIATIONS | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| EVAPOTRANSPIRATION | | | | | | |
| TOTALS | 1.097 | 1.095 | 1.776 | 1.613 | 1.877 | 4.279 |
| | 4.949 | 4.621 | 3.243 | 1.569 | 0.930 | 0.860 |

```
    STD. DEVIATIONS      0.774    0.771    1.174    1.038    1.064    1.248
                         1.284    1.148    1.173    1.007    0.784    0.758

  LATERAL DRAINAGE COLLECTED FROM LAYER  6
  ----------------------------------------
    TOTALS              0.7049   0.7578   1.3591   1.1140   0.9034   1.7762
                        3.6888   3.6302   2.7603   1.8726   1.2090   1.0085

    STD. DEVIATIONS     0.6950   1.1538   1.8416   1.0107   0.7218   1.6364
                        1.9972   1.7854   1.6637   1.5559   1.4762   1.6450

  PERCOLATION/LEAKAGE THROUGH LAYER  7
  ------------------------------------
    TOTALS              0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                        0.0001   0.0001   0.0001   0.0000   0.0000   0.0000

    STD. DEVIATIONS     0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                        0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

  PERCOLATION/LEAKAGE THROUGH LAYER  8
  ------------------------------------
    TOTALS              0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                        0.0001   0.0001   0.0001   0.0001   0.0000   0.0000

    STD. DEVIATIONS     0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                        0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

-----------------------------------------------------------------------------
               AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)
-----------------------------------------------------------------------------

  DAILY AVERAGE HEAD ON TOP OF LAYER  7
  -------------------------------------
    AVERAGES            0.0002   0.0003   0.0005   0.0004   0.0003   0.0006
                        0.0013   0.0013   0.0010   0.0007   0.0004   0.0004

    STD. DEVIATIONS     0.0002   0.0004   0.0006   0.0004   0.0003   0.0006
                        0.0007   0.0006   0.0006   0.0005   0.0005   0.0006

*****************************************************************************
*****************************************************************************
     AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS    1 THROUGH   28
-----------------------------------------------------------------------------
                                     INCHES            CU. FEET      PERCENT
                              -------------------   -------------   ---------
 PRECIPITATION                    48.67    (   9.518)     176683.8     100.00

 RUNOFF                            0.000   (  0.0000)         0.00      0.000

 EVAPOTRANSPIRATION               27.908   (  4.3401)    101305.65     57.337

 LATERAL DRAINAGE COLLECTED     20.78488 (  5.91835)     75449.125   42.70292
    FROM LAYER  6
```

```
 PERCOLATION/LEAKAGE THROUGH 0.00050 (  0.00011)        1.833     0.00104
  LAYER  7

AVERAGE HEAD ON TOP             0.001 (    0.000)
  OF LAYER  7

PERCOLATION/LEAKAGE THROUGH  0.00053 (  0.00012)        1.919     0.00109
  LAYER  8

CHANGE IN WATER STORAGE       -0.020   (  1.4483)       -72.92    -0.041

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******************************************************************************
                PEAK DAILY VALUES FOR YEARS    1 THROUGH   28
    --------------------------------------------------------------------------
                                                (INCHES)      (CU. FT.)
                                               ----------   -------------
       PRECIPITATION                              7.60        27588.000

       RUNOFF                                     0.000           0.0000

       DRAINAGE COLLECTED FROM LAYER  6          1.06679      3872.44165

       PERCOLATION/LEAKAGE THROUGH LAYER  7      0.000015        0.05491

       AVERAGE HEAD ON TOP OF LAYER  7            0.012

       MAXIMUM HEAD ON TOP OF LAYER  7            0.049

       LOCATION OF MAXIMUM HEAD IN LAYER  6
             (DISTANCE FROM DRAIN)                0.0 FEET

       PERCOLATION/LEAKAGE THROUGH LAYER  8      0.000041        0.14725

       SNOW WATER                                 0.00            0.0000

       MAXIMUM VEG. SOIL WATER (VOL/VOL)                  0.2611

       MINIMUM VEG. SOIL WATER (VOL/VOL)                  0.0424

        ***  Maximum heads are computed using McEnroe's equations.  ***

             Reference:  Maximum Saturated Depth over Landfill Liner
                         by Bruce M. McEnroe, University of Kansas
                         ASCE Journal of Environmental Engineering
                         Vol. 119, No. 2, March 1993, pp. 262-270.

******************************************************************************
```

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FINAL WATER STORAGE AT END OF YEAR 28

| LAYER | (INCHES) | (VOL/VOL) |
|---|---|---|
| 1 | 0.3324 | 0.0554 |
| 2 | 4.1796 | 0.0697 |
| 3 | 8.7600 | 0.0730 |
| 4 | 8.7600 | 0.0730 |
| 5 | 4.6603 | 0.1942 |
| 6 | 0.0031 | 0.0104 |
| 7 | 0.0000 | 0.0000 |
| 8 | 3.1433 | 0.1310 |
| SNOW WATER | 0.000 | |

*****************************************************************************
*****************************************************************************

```
*****************************************************************************
 ****************************************************************************
 **                                                                        **
 **                                                                        **
 **              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE             **
 **                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)              **
 **                  DEVELOPED BY ENVIRONMENTAL LABORATORY                 **
 **                    USAE WATERWAYS EXPERIMENT STATION                   **
 **             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY            **
 **                                                                        **
 **                                                                        **
 ****************************************************************************
 ****************************************************************************

 PRECIPITATION DATA FILE:    C:\HELP\hardee\snbotsod\hardrai1.D4
 TEMPERATURE DATA FILE:      C:\HELP\hardee\snbotsod\hardrai1.D7
 SOLAR RADIATION DATA FILE:  C:\HELP\hardee\snbotsod\hardrai1.D13
 EVAPOTRANSPIRATION DATA:    C:\HELP\hardee\snbotsod\hardrai1.D11
 SOIL AND DESIGN DATA FILE:  C:\HELP\hardee\snbotsod\existsod.D10
 OUTPUT DATA FILE:           C:\HELP\hardee\snbotsod\existsod.OUT

 TIME:  14:32     DATE:   3/19/2013

****************************************************************************
 TITLE:  Hardee County Phase II Section II Expansion RAI No. 1
 Phase I Sideslope North Bottom (Existing Sod)
 ****************************************************************************

      NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.

                    LAYER  1 (Drainage Sand 24-inches)
                    --------
                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER   5
           THICKNESS                  =     24.00   INCHES
           POROSITY                   =      0.4570 VOL/VOL
           FIELD CAPACITY             =      0.1310 VOL/VOL
           WILTING POINT              =      0.0580 VOL/VOL
           INITIAL SOIL WATER CONTENT =      0.1653 VOL/VOL
           EFFECTIVE SAT. HYD. COND.  =  0.100000005000E-02 CM/SEC
         NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  1.80
                  FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.

              LAYER  2 (330-mil Bi-planar Geocomposite SKAPS)
              --------
                       TYPE 2 - LATERAL DRAINAGE LAYER
                         MATERIAL TEXTURE NUMBER   0
           THICKNESS                  =      0.33   INCHES
           POROSITY                   =      0.8500 VOL/VOL
           FIELD CAPACITY             =      0.0100 VOL/VOL
           WILTING POINT              =      0.0050 VOL/VOL
           INITIAL SOIL WATER CONTENT =      0.0112 VOL/VOL
           EFFECTIVE SAT. HYD. COND.  =   7.80000019000     CM/SEC
```

```
   SLOPE                         =     33.33   PERCENT
   DRAINAGE LENGTH               =     75.0    FEET

            LAYER  3 (60-mil HDPE geomembrane)
            --------
               TYPE 4 - FLEXIBLE MEMBRANE LINER
                 MATERIAL TEXTURE NUMBER  35
   THICKNESS                     =      0.06   INCHES
   POROSITY                      =      0.0000 VOL/VOL
   FIELD CAPACITY                =      0.0000 VOL/VOL
   WILTING POINT                 =      0.0000 VOL/VOL
   INITIAL SOIL WATER CONTENT    =      0.0000 VOL/VOL
   EFFECTIVE SAT. HYD. COND.     =  0.199999996000E-12 CM/SEC
   FML PINHOLE DENSITY           =      1.00   HOLES/ACRE
   FML INSTALLATION DEFECTS      =      1.00   HOLES/ACRE
   FML PLACEMENT QUALITY         =  3 - GOOD

            LAYER  4 (Drainage Sand 24-inches)
            --------
             TYPE 1 - VERTICAL PERCOLATION LAYER
                 MATERIAL TEXTURE NUMBER   5
   THICKNESS                     =     24.00   INCHES
   POROSITY                      =      0.4570 VOL/VOL
   FIELD CAPACITY                =      0.1310 VOL/VOL
   WILTING POINT                 =      0.0580 VOL/VOL
   INITIAL SOIL WATER CONTENT    =      0.1310 VOL/VOL
   EFFECTIVE SAT. HYD. COND.     =  0.100000005000E-02 CM/SEC

           GENERAL DESIGN AND EVAPORATIVE ZONE DATA
           ----------------------------------------

 NOTE:  SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
          SOIL DATA BASE USING SOIL TEXTURE # 5 WITH A
          GOOD STAND OF GRASS, A SURFACE SLOPE OF 33.%
          AND A SLOPE LENGTH OF   75. FEET.

SCS RUNOFF CURVE NUMBER             =     63.60
FRACTION OF AREA ALLOWING RUNOFF    =      0.0    PERCENT
AREA PROJECTED ON HORIZONTAL PLANE  =      1.000  ACRES
EVAPORATIVE ZONE DEPTH              =     10.0    INCHES
INITIAL WATER IN EVAPORATIVE ZONE   =      0.600  INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE  =      4.570  INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE  =      0.580  INCHES
INITIAL SNOW WATER                  =      0.000  INCHES
INITIAL WATER IN LAYER MATERIALS    =      7.115  INCHES
TOTAL INITIAL WATER                 =      7.115  INCHES
TOTAL SUBSURFACE INFLOW             =      0.00   INCHES/YEAR

            EVAPOTRANSPIRATION AND WEATHER DATA
            -----------------------------------

 NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
          TAMPA                  FLORIDA
```

```
STATION LATITUDE                           =  27.58 DEGREES
MAXIMUM LEAF AREA INDEX                    =   1.00
START OF GROWING SEASON (JULIAN DATE)      =      0
END OF GROWING SEASON (JULIAN DATE)        =    367
EVAPORATIVE ZONE DEPTH                     =  10.0  INCHES
AVERAGE ANNUAL WIND SPEED                  =   8.60 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY      =  74.00 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY      =  72.00 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY      =  78.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY      =  76.00 %
```

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR TAMPA FLORIDA

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

| JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|
| 1.85 | 2.58 | 3.39 | 2.95 | 2.52 | 8.31 |
| 7.83 | 7.98 | 5.61 | 2.86 | 1.94 | 1.84 |

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR TAMPA FLORIDA

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

| JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|
| 59.80 | 60.80 | 66.20 | 71.60 | 77.10 | 80.90 |
| 82.20 | 82.20 | 80.90 | 74.50 | 66.70 | 61.30 |

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR TAMPA FLORIDA AND STATION LATITUDE = 27.58 DEGREES

*****************************************************************************

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 28

| | JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|---|
| PRECIPITATION | | | | | | |
| TOTALS | 1.82 | 2.13 | 3.38 | 2.54 | 3.05 | 7.89 |
| | 8.50 | 7.72 | 5.34 | 2.65 | 1.83 | 1.84 |
| STD. DEVIATIONS | 1.56 | 2.17 | 2.92 | 1.84 | 2.10 | 3.63 |
| | 3.41 | 2.59 | 2.44 | 2.42 | 2.77 | 2.09 |
| RUNOFF | | | | | | |
| TOTALS | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |

```
     STD. DEVIATIONS     0.000    0.000    0.000    0.000    0.000    0.000
                         0.000    0.000    0.000    0.000    0.000    0.000

  EVAPOTRANSPIRATION
  ------------------
    TOTALS               0.871    0.839    1.443    1.207    1.503    3.499
                         4.311    4.235    2.815    1.217    0.717    0.634

    STD. DEVIATIONS      0.685    0.756    1.247    0.958    1.158    1.431
                         1.692    1.421    1.330    1.034    0.824    0.766

  LATERAL DRAINAGE COLECTED FROM LAYER  2
  ----------------------------------------
    TOTALS              0.9632   1.1720   1.8027   1.3339   1.4496   3.4789
                        4.2947   3.6554   2.8928   1.9249   1.3546   1.0857

    STD. DEVIATIONS     0.7416   1.2167   1.8725   0.6713   0.9488   2.0325
                        1.7842   1.2451   1.4201   1.3535   1.8175   1.3006

  PERCOLATION/LEAKAGE TROUGH LAYER  3
  ------------------------------------
    TOTALS              0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                        0.0001   0.0000   0.0000   0.0000   0.0000   0.0000

    STD. DEVIATIONS     0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                        0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

  PERCOLATION/LEAKAGE THROUGH LAYER  4
  ------------------------------------
    TOTALS              0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                        0.0001   0.0000   0.0000   0.0000   0.0000   0.0000

    STD. DEVIATINS      0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                        0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

-----------------------------------------------------------------------------
             AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)
 ----------------------------------------------------------------------------

  DAILY AVERAGE HEAD ON TOP OF LAYER  3
  -------------------------------------
    AVERAGES            0.0002   0.0002   0.0003   0.0003   0.0003   0.0007
                        0.0008   0.0007   0.0006   0.0004   0.0003   0.0002

    STD. DEVIATIONS     0.0001   0.0003   0.0003   0.0001   0.0002   0.0004
                        0.0003   0.0002   0.0003   0.0003   0.0003   0.0002

*****************************************************************************
*****************************************************************************

   AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS    1 THROUGH   28
-----------------------------------------------------------------------------
                                  INCHES          CU. FEET       PERCENT
```

| | | | | |
|---|---|---|---|---|
| | ------------------ | ------------- | --------- |
| PRECIPITATION | 48.67 ( 9.518) | 176683.8 | 100.00 |
| RUNOFF | 0.000 ( 0.0000) | 0.00 | 0.000 |
| EVAPOTRANSPIRATION | 23.290 ( 3.9876) | 84543.12 | 47.850 |
| LATERAL DRAINAGE COLLECTED FROM LAYER 2 | 25.40828 ( 6.11293) | 92232.055 | 52.20177 |
| PERCOLATION/LEAKAGE THROUGH LAYER 3 | 0.00036 ( 0.00006) | 1.295 | 0.00073 |
| AVERAGE HEAD ON TOP OF LAYER 3 | 0.000 ( 0.000) | | |
| PERCOLATION/LEAKAGE THROUGH LAYER 4 | 0.00037 ( 0.00007) | 1.342 | 0.00076 |
| CHANGE IN WATER STORAGE | -0.026 ( 0.8809) | -92.73 | -0.052 |

*****************************************************************************

```
*******************************************************************************
              PEAK DAILY VALUES FOR YEARS    1 THROUGH   28
    ---------------------------------------------------------------------------
                                                  (INCHES)      (CU. FT.)
                                                 ----------   -------------
      PRECIPITATION                                 7.60        27588.000

      RUNOFF                                        0.000           0.0000

      DRAINAGE COLLECTED FROM LAYER  2              2.62996       9546.74707

      PERCOLATION/LEAKAGE THROUGH LAYER  3          0.000017         0.06090

      AVERAGE HEAD ON TOP OF LAYER  3               0.016

      MAXIMUM HEAD ON TOP OF LAYER  3               0.030

      LOCATION OF MAXIMUM HEAD IN LAYER  2
            (DISTANCE FROM DRAIN)                   0.0 FEET

      PERCOLATION/LEAKAGE THROUGH LAYER  4          0.000042         0.15065

      SNOW WATER                                    0.00             0.0000

      MAXIMUM VEG. SOIL WATER (VOL/VOL)                     0.3665

      MINIMUM VEG. SOIL WATER (VOL/VOL)                     0.0580

       ***  Maximum heads are computed using McEnroe's equations.  ***

            Reference:  Maximum Saturated Depth over Landfill Liner
                        by Bruce M. McEnroe, University of Kansas
                        ASCE Journal of Environmental Engineering
                        Vol. 119, No. 2, March 1993, pp. 262-270.

*******************************************************************************
```

```
******************************************************************************
                 FINAL WATER STORAGE AT END OF YEAR   28
     ----------------------------------------------------------------------
                  LAYER         (INCHES)       (VOL/VOL)
                  -----         --------       ---------
                    1             3.2528         0.1355

                    2             0.0033         0.0101

                    3             0.0000         0.0000

                    4             3.1436         0.1310

                SNOW WATER        0.000

******************************************************************************
******************************************************************************
```

```
******************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                **
**                 DEVELOPED BY ENVIRONMENTAL LABORATORY                    **
**                   USAE WATERWAYS EXPERIMENT STATION                      **
**              FOR USEPA RISK REDUCTION ENGINEERING LABORATORY             **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************

PRECIPITATION DATA FILE:    C:\HELP\hardee\snbot\hardrai1.D4
TEMPERATURE DATA FILE:      C:\HELP\hardee\snbot\hardrai1.D7
SOLAR RADIATION DATA FILE:  C:\HELP\hardee\snbot\hardrai1.D13
EVAPOTRANSPIRATION DATA:    C:\HELP\hardee\snbot\hardrai1.D11
SOIL AND DESIGN DATA FILE:  C:\HELP\hardee\snbot\snopen.D10
OUTPUT DATA FILE:           C:\HELP\hardee\snbot\snopen.OUT

TIME:  14:24     DATE:   3/19/2013

******************************************************************************
TITLE:  Hardee County Phase II Section II Expansion RAI No. 1
```
**Phase I Sideslope North Bottom (Open Cell – No Waste)**
```
******************************************************************************

     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.

                    LAYER  1 (Drainage Sand 24-inches)
                    --------
                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER   5
           THICKNESS                   =     24.00   INCHES
           POROSITY                    =      0.4570 VOL/VOL
           FIELD CAPACITY              =      0.1310 VOL/VOL
           WILTING POINT               =      0.0580 VOL/VOL
           INITIAL SOIL WATER CONTENT  =      0.1663 VOL/VOL
           EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC

              LAYER  2 (330-mil Bi-planar Geocomposite SKAPS)
              --------
                       TYPE 2 - LATERAL DRAINAGE LAYER
                         MATERIAL TEXTURE NUMBER   0
           THICKNESS                   =      0.33   INCHES
           POROSITY                    =      0.8500 VOL/VOL
           FIELD CAPACITY              =      0.0100 VOL/VOL
           WILTING POINT               =      0.0050 VOL/VOL
           INITIAL SOIL WATER CONTENT  =      0.0122 VOL/VOL
           EFFECTIVE SAT. HYD. COND.   =   7.80000019000     CM/SEC
           SLOPE                       =     33.33   PERCENT
           DRAINAGE LENGTH             =     75.0    FEET
```

```
            LAYER  3 (60-mil HDPE geomembrane)
            --------
               TYPE 4 - FLEXIBLE MEMBRANE LINER
                 MATERIAL TEXTURE NUMBER  35
   THICKNESS                     =     0.06   INCHES
   POROSITY                      =     0.0000 VOL/VOL
   FIELD CAPACITY                =     0.0000 VOL/VOL
   WILTING POINT                 =     0.0000 VOL/VOL
   INITIAL SOIL WATER CONTENT    =     0.0000 VOL/VOL
   EFFECTIVE SAT. HYD. COND.     =  0.199999996000E-12 CM/SEC
   FML PINHOLE DENSITY           =     1.00   HOLES/ACRE
   FML INSTALLATION DEFECTS      =     1.00   HOLES/ACRE
   FML PLACEMENT QUALITY         =  3 - GOOD

            LAYER  4 (Drainage Sand 24-inches)
            --------
             TYPE 1 - VERTICAL PERCOLATION LAYER
                 MATERIAL TEXTURE NUMBER   5
   THICKNESS                     =    24.00   INCHES
   POROSITY                      =     0.4570 VOL/VOL
   FIELD CAPACITY                =     0.1310 VOL/VOL
   WILTING POINT                 =     0.0580 VOL/VOL
   INITIAL SOIL WATER CONTENT    =     0.1310 VOL/VOL
   EFFECTIVE SAT. HYD. COND.     =  0.100000005000E-02 CM/SEC

           GENERAL DESIGN AND EVAPORATIVE ZONE DATA
           ----------------------------------------

  NOTE:  SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
           SOIL DATA BASE USING SOIL TEXTURE # 5 WITH BARE
           GROUND CONDITIONS, A SURFACE SLOPE OF 33.% AND
           A SLOPE LENGTH OF   75. FEET.

 SCS RUNOFF CURVE NUMBER              =     85.80
 FRACTION OF AREA ALLOWING RUNOFF     =      0.0    PERCENT
 AREA PROJECTED ON HORIZONTAL PLANE   =      1.000  ACRES
 EVAPORATIVE ZONE DEPTH               =     10.0    INCHES
 INITIAL WATER IN EVAPORATIVE ZONE    =      0.602  INCHES
 UPPER LIMIT OF EVAPORATIVE STORAGE   =      4.570  INCHES
 LOWER LIMIT OF EVAPORATIVE STORAGE   =      0.580  INCHES
 INITIAL SNOW WATER                   =      0.000  INCHES
 INITIAL WATER IN LAYER MATERIALS     =      7.139  INCHES
 TOTAL INITIAL WATER                  =      7.139  INCHES
 TOTAL SUBSURFACE INFLOW              =      0.00   INCHES/YEAR

            EVAPOTRANSPIRATION AND WEATHER DATA
            -----------------------------------

  NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
           TAMPA                 FLORIDA

      STATION LATITUDE                          =  27.58 DEGREES
      MAXIMUM LEAF AREA INDEX                   =   0.00
```

```
START OF GROWING SEASON (JULIAN DATE)  =      0
END OF GROWING SEASON (JULIAN DATE)    =    367
EVAPORATIVE ZONE DEPTH                 =  10.0  INCHES
AVERAGE ANNUAL WIND SPEED              =   8.60 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY  =  74.00 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY  =  72.00 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY  =  78.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY  =  76.00 %
```

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR TAMPA FLORIDA

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

| JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|
| 1.85 | 2.58 | 3.39 | 2.95 | 2.52 | 8.31 |
| 7.83 | 7.98 | 5.61 | 2.86 | 1.94 | 1.84 |

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR TAMPA FLORIDA

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

| JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|
| 59.80 | 60.80 | 66.20 | 71.60 | 77.10 | 80.90 |
| 82.20 | 82.20 | 80.90 | 74.50 | 66.70 | 61.30 |

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR TAMPA FLORIDA AND STATION LATITUDE = 27.58 DEGREES

***************************************************************************

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 28

---------------------------------------------------------------------------

| | JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|---|
| **PRECIPITATION** | | | | | | |
| TOTALS | 1.82 | 2.13 | 3.38 | 2.54 | 3.05 | 7.89 |
| | 8.50 | 7.72 | 5.34 | 2.65 | 1.83 | 1.84 |
| STD. DEVIATIONS | 1.56 | 2.17 | 2.92 | 1.84 | 2.10 | 3.63 |
| | 3.41 | 2.59 | 2.44 | 2.42 | 2.77 | 2.09 |
| **RUNOFF** | | | | | | |
| TOTALS | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| STD. DEVIATIONS | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |

```
                          0.000    0.000    0.000    0.000    0.000    0.000

   EVAPOTRANSPIRATION
   ------------------
     TOTALS               0.825    0.752    1.222    1.181    1.420    3.108
                          4.041    3.938    2.726    1.248    0.698    0.618

     STD. DEVIATIONS      0.667    0.734    1.049    0.952    1.035    1.452
                          1.463    1.317    1.200    0.851    0.829    0.799

   LATERAL DRAINAGE COLLECTED FROM LAYER  2
   ----------------------------------------
     TOTALS              1.0096   1.2287   1.9054   1.3467   1.4913   3.8582
                         4.5743   3.7890   3.1095   1.9664   1.4701   1.1707

     STD. DEVIATIONS     0.7468   1.2717   1.9026   0.7239   0.9329   1.9959
                         1.9215   1.5082   1.5134   1.2952   1.7934   1.3093

   PERCOLATION/LEAKAGE THROUGH LAYER  3
   ------------------------------------
     TOTALS              0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                         0.0001   0.0000   0.0000   0.0000   0.0000   0.0000

     STD. DEVIATIONS     0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                         0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

   PERCOLATION/LEAKAGE THROUGH LAYER  4
   ------------------------------------
     TOTALS              0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                         0.0001   0.0000   0.0000   0.0000   0.0000   0.0000

     STD. DEVIATIONS     0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                         0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

-----------------------------------------------------------------------------
             AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)
-----------------------------------------------------------------------------

   DAILY AVERAGE HEAD ON TOP OF LAYER  3
   -------------------------------------
     AVERAGES            0.0002   0.0003   0.0004   0.0003   0.0003   0.0008
                         0.0009   0.0007   0.0006   0.0004   0.0003   0.0002

     STD. DEVIATIONS     0.0001   0.0003   0.0003   0.0001   0.0002   0.0004
                         0.0004   0.0003   0.0003   0.0002   0.0003   0.0002

*****************************************************************************
*****************************************************************************
      AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS    1 THROUGH   28
-----------------------------------------------------------------------------
                                         INCHES            CU. FEET      PERCENT
                                     -------------------  -------------  ------
  PRECIPITATION                        48.67     (   9.518)     176683.8     100.00
```

```
 RUNOFF                          0.000    (  0.0000)         0.00      0.000

EVAPOTRANSPIRATION              21.778    (  4.0902)     79053.69     44.743

LATERAL DRAINAGE COLLECTED   26.91985 (  6.00087)    97719.062   55.30732
  FROM LAYER  2

PERCOLATION/LEAKAGE THROUGH  0.00037 (  0.00006)        1.351    0.00076
  LAYER  3

AVERAGE HEAD ON TOP             0.000 (    0.000)
  OF LAYER  3

PERCOLATION/LEAKAGE THROUGH  0.00038 (  0.00007)        1.391    0.00079
  LAYER  4

CHANGE IN WATER STORAGE        -0.025    (  0.8439)       -90.36     -0.051

*****************************************************************************
```

```
******************************************************************************
                PEAK DAILY VALUES FOR YEARS    1 THROUGH   28
    --------------------------------------------------------------------------
                                                (INCHES)      (CU. FT.)
                                               ----------    -------------
       PRECIPITATION                             7.60         27588.000

       RUNOFF                                    0.000            0.0000

       DRAINAGE COLLECTED FROM LAYER  2          2.64510       9601.69629

       PERCOLATION/LEAKAGE THROUGH LAYER  3      0.000017         0.06135

       AVERAGE HEAD ON TOP OF LAYER  3           0.017

       MAXIMUM HEAD ON TOP OF LAYER  3           0.022

       LOCATION OF MAXIMUM HEAD IN LAYER  2
             (DISTANCE FROM DRAIN)              12.7 FEET

       PERCOLATION/LEAKAGE THROUGH LAYER  4      0.000041         0.14851

       SNOW WATER                                0.00             0.0000

       MAXIMUM VEG. SOIL WATER (VOL/VOL)                 0.3774

       MINIMUM VEG. SOIL WATER (VOL/VOL)                 0.0580

        ***  Maximum heads are computed using McEnroe's equations.  ***

             Reference:  Maximum Saturated Depth over Landfill Liner
                         by Bruce M. McEnroe, University of Kansas
                         ASCE Journal of Environmental Engineering
                         Vol. 119, No. 2, March 1993, pp. 262-270.

******************************************************************************
```

```
******************************************************************************
                FINAL WATER STORAGE AT END OF YEAR   28
     ----------------------------------------------------------------------
                 LAYER        (INCHES)       (VOL/VOL)
                 -----        --------       ---------
                   1           3.2946          0.1373

                   2           0.0034          0.0102

                   3           0.0000          0.0000

                   4           3.1437          0.1310

               SNOW WATER      0.000

******************************************************************************
******************************************************************************
```

```
******************************************************************************
 ******************************************************************************
 **                                                                          **
 **                                                                          **
 **              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE              **
 **              HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                 **
 **              DEVELOPED BY ENVIRONMENTAL LABORATORY                      **
 **              USAE WATERWAYS EXPERIMENT STATION                          **
 **              FOR USEPA RISK REDUCTION ENGINEERING LABORATORY            **
 **                                                                          **
 **                                                                          **
 ******************************************************************************
 ******************************************************************************

 PRECIPITATION DATA FILE:    C:\HELP\hardee\snbot10\hardrai1.D4
 TEMPERATURE DATA FILE:      C:\HELP\hardee\snbot10\hardrai1.D7
 SOLAR RADIATION DATA FILE:  C:\HELP\hardee\snbot10\hardrai1.D13
 EVAPOTRANSPIRATION DATA:    C:\HELP\hardee\snbot10\hardrai1.D11
 SOIL AND DESIGN DATA FILE:  C:\HELP\hardee\snbot10\snbot10.D10
 OUTPUT DATA FILE:           C:\HELP\hardee\snbot10\snbot10.OUT

 TIME:  14:41     DATE:   3/19/2013

******************************************************************************
 TITLE:  Hardee County Phase II Section II Expansion RAI No. 1
 Phase I Sideslope North Bottom (10 Feet Waste)
 ******************************************************************************

      NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
             COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.

                      LAYER  1 (Daily Cover 6-inches)
                      --------
                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER   5
            THICKNESS                   =      6.00   INCHES
            POROSITY                    =      0.4570 VOL/VOL
            FIELD CAPACITY              =      0.1310 VOL/VOL
            WILTING POINT               =      0.0580 VOL/VOL
            INITIAL SOIL WATER CONTENT  =      0.0643 VOL/VOL
            EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC
          NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  1.80
                 FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.

                      LAYER  2 (5 Feet Waste)
                      --------
                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER  19
            THICKNESS                   =     60.00   INCHES
            POROSITY                    =      0.1680 VOL/VOL
            FIELD CAPACITY              =      0.0730 VOL/VOL
            WILTING POINT               =      0.0190 VOL/VOL
            INITIAL SOIL WATER CONTENT  =      0.0756 VOL/VOL
            EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC
```

```
           LAYER  3 (5 Feet Waste)
           --------
          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  19
THICKNESS                  =    60.00   INCHES
POROSITY                   =     0.1680 VOL/VOL
FIELD CAPACITY             =     0.0730 VOL/VOL
WILTING POINT              =     0.0190 VOL/VOL
INITIAL SOIL WATER CONTENT =     0.0743 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  0.100000005000E-02 CM/SEC

         LAYER  4 (Drainage Sand 24-inches)
         --------
          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER   5
THICKNESS                  =    24.00   INCHES
POROSITY                   =     0.4570 VOL/VOL
FIELD CAPACITY             =     0.1310 VOL/VOL
WILTING POINT              =     0.0580 VOL/VOL
INITIAL SOIL WATER CONTENT =     0.1969 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  0.100000005000E-02 CM/SEC

   LAYER  5 (330-mil Bi-planar Geocomposite SKAPS)
--------
            TYPE 2 - LATERAL DRAINAGE LAYER
              MATERIAL TEXTURE NUMBER   0
THICKNESS                  =     0.33   INCHES
POROSITY                   =     0.8500 VOL/VOL
FIELD CAPACITY             =     0.0100 VOL/VOL
WILTING POINT              =     0.0050 VOL/VOL
INITIAL SOIL WATER CONTENT =     0.0102 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =   7.80000019000     CM/SEC
SLOPE                      =    33.33   PERCENT
DRAINAGE LENGTH            =    75.0    FEET

         LAYER  6 (60-mil HDPE geomembrane)
         --------
            TYPE 4 - FLEXIBLE MEMBRANE LINER
              MATERIAL TEXTURE NUMBER  35
THICKNESS                  =     0.06   INCHES
POROSITY                   =     0.0000 VOL/VOL
FIELD CAPACITY             =     0.0000 VOL/VOL
WILTING POINT              =     0.0000 VOL/VOL
INITIAL SOIL WATER CONTENT =     0.0000 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  0.199999996000E-12 CM/SEC
FML PINHOLE DENSITY        =     1.00   HOLES/ACRE
FML INSTALLATION DEFECTS   =     1.00   HOLES/ACRE
FML PLACEMENT QUALITY      =  3 - GOOD

         LAYER  7 (Drainage Sand 24-inches)
         --------
          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER   5
```

```
          THICKNESS                    =     24.00   INCHES
          POROSITY                     =      0.4570 VOL/VOL
          FIELD CAPACITY               =      0.1310 VOL/VOL
          WILTING POINT                =      0.0580 VOL/VOL
          INITIAL SOIL WATER CONTENT   =      0.1310 VOL/VOL
          EFFECTIVE SAT. HYD. COND.    =  0.100000005000E-02 CM/SEC

                  GENERAL DESIGN AND EVAPORATIVE ZONE DATA
                  ----------------------------------------

        NOTE:  SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
                 SOIL DATA BASE USING SOIL TEXTURE # 5 WITH A
                 POOR STAND OF GRASS, A SURFACE SLOPE OF 33.%
                 AND A SLOPE LENGTH OF   75. FEET.

       SCS RUNOFF CURVE NUMBER              =     80.30
       FRACTION OF AREA ALLOWING RUNOFF     =      0.0    PERCENT
       AREA PROJECTED ON HORIZONTAL PLANE   =      1.000  ACRES
       EVAPORATIVE ZONE DEPTH               =     10.0    INCHES
       INITIAL WATER IN EVAPORATIVE ZONE    =      0.664  INCHES
       UPPER LIMIT OF EVAPORATIVE STORAGE   =      3.414  INCHES
       LOWER LIMIT OF EVAPORATIVE STORAGE   =      0.424  INCHES
       INITIAL SNOW WATER                   =      0.000  INCHES
       INITIAL WATER IN LAYER MATERIALS     =     17.252  INCHES
       TOTAL INITIAL WATER                  =     17.252  INCHES
       TOTAL SUBSURFACE INFLOW              =      0.00   INCHES/YEAR

                   EVAPOTRANSPIRATION AND WEATHER DATA
                   -----------------------------------

        NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
                 TAMPA                 FLORIDA

            STATION LATITUDE                         =  27.58 DEGREES
            MAXIMUM LEAF AREA INDEX                  =   1.00
            START OF GROWING SEASON (JULIAN DATE)    =      0
            END OF GROWING SEASON (JULIAN DATE)      =    367
            EVAPORATIVE ZONE DEPTH                   =  10.0  INCHES
            AVERAGE ANNUAL WIND SPEED                =   8.60 MPH
            AVERAGE 1ST QUARTER RELATIVE HUMIDITY    =  74.00 %
            AVERAGE 2ND QUARTER RELATIVE HUMIDITY    =  72.00 %
            AVERAGE 3RD QUARTER RELATIVE HUMIDITY    =  78.00 %
            AVERAGE 4TH QUARTER RELATIVE HUMIDITY    =  76.00 %

        NOTE:  PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
                 COEFFICIENTS FOR    TAMPA               FLORIDA

                 NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

    JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
    -------     -------     -------     -------     -------     -------
      1.85        2.58        3.39        2.95        2.52        8.31
      7.83        7.98        5.61        2.86        1.94        1.84
```

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR TAMPA FLORIDA

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

| JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|
| 59.80 | 60.80 | 66.20 | 71.60 | 77.10 | 80.90 |
| 82.20 | 82.20 | 80.90 | 74.50 | 66.70 | 61.30 |

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR TAMPA FLORIDA AND STATION LATITUDE = 27.58 DEGREES

******************************************************************************

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 28

------------------------------------------------------------------------------

| | JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|---|
| **PRECIPITATION** | | | | | | |
| TOTALS | 1.82 | 2.13 | 3.38 | 2.54 | 3.05 | 7.89 |
| | 8.50 | 7.72 | 5.34 | 2.65 | 1.83 | 1.84 |
| STD. DEVIATIONS | 1.56 | 2.17 | 2.92 | 1.84 | 2.10 | 3.63 |
| | 3.41 | 2.59 | 2.44 | 2.42 | 2.77 | 2.09 |
| **RUNOFF** | | | | | | |
| TOTALS | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| STD. DEVIATIONS | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| **EVAPOTRANSPIRATION** | | | | | | |
| TOTALS | 1.097 | 1.095 | 1.776 | 1.613 | 1.877 | 4.279 |
| | 4.949 | 4.621 | 3.243 | 1.569 | 0.930 | 0.860 |
| STD. DEVIATIONS | 0.774 | 0.771 | 1.174 | 1.038 | 1.064 | 1.248 |
| | 1.284 | 1.148 | 1.173 | 1.007 | 0.784 | 0.758 |
| **LATERAL DRAINAGE COLLECTED FROM LAYER 5** | | | | | | |
| TOTALS | 0.6773 | 0.8110 | 1.4077 | 0.9751 | 1.0736 | 2.2790 |
| | 3.5413 | 3.3877 | 2.6720 | 1.7781 | 1.2187 | 0.9643 |
| STD. DEVIATIONS | 0.5326 | 1.2296 | 1.9182 | 0.9291 | 0.9414 | 1.9798 |
| | 2.0589 | 1.4914 | 1.6578 | 1.4845 | 1.5683 | 1.3994 |

```
   PERCOLATION/LEAKAGE THROUGH LAYER  6
   ------------------------------------
     TOTALS               0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                          0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

     STD. DEVIATIONS      0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                          0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

   PERCOLATION/LEAKAGE THROUGH LAYER  7
   ------------------------------------
     TOTALS               0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                          0.0001   0.0000   0.0000   0.0000   0.0000   0.0000

     STD. DEVIATIONS      0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                          0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

-----------------------------------------------------------------------------
                AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)
-----------------------------------------------------------------------------
   DAILY AVERAGE HEAD ON TOP OF LAYER  6
   -------------------------------------
     AVERAGES             0.0001   0.0002   0.0003   0.0002   0.0002   0.0004
                          0.0006   0.0006   0.0005   0.0003   0.0002   0.0002

     STD. DEVIATIONS      0.0001   0.0002   0.0004   0.0002   0.0002   0.0004
                          0.0004   0.0003   0.0003   0.0003   0.0003   0.0003

*****************************************************************************
*****************************************************************************
      AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS    1 THROUGH   28
-----------------------------------------------------------------------------
                                    INCHES           CU. FEET       PERCENT
                             -------------------   -------------   ---------
  PRECIPITATION                 48.67    (   9.518)     176683.8     100.00

  RUNOFF                         0.000   (  0.0000)         0.00       0.000

  EVAPOTRANSPIRATION            27.908   (  4.3401)    101305.65      57.337

  LATERAL DRAINAGE COLLECTED   20.78571 (  5.96986)    75452.117   42.70461
    FROM LAYER  5

  PERCOLATION/LEAKAGE THROUGH  0.00031 (  0.00006)        1.110     0.00063
    LAYER  6

  AVERAGE HEAD ON TOP            0.000 (    0.000)
    OF LAYER  6

  PERCOLATION/LEAKAGE THROUGH  0.00032 (  0.00008)        1.150     0.00065
    LAYER  7

  CHANGE IN WATER STORAGE       -0.021   (  1.0810)       -75.13      -0.043
*****************************************************************************
```

```
*******************************************************************************
               PEAK DAILY VALUES FOR YEARS    1 THROUGH   28
    ---------------------------------------------------------------------------
                                                  (INCHES)      (CU. FT.)
                                                 ----------   -------------
      PRECIPITATION                                 7.60         27588.000

      RUNOFF                                       0.000            0.0000

      DRAINAGE COLLECTED FROM LAYER  5            1.95150       7083.93652

      PERCOLATION/LEAKAGE THROUGH LAYER  6        0.000015         0.05284

      AVERAGE HEAD ON TOP OF LAYER  6             0.011

      MAXIMUM HEAD ON TOP OF LAYER  6             0.038

      LOCATION OF MAXIMUM HEAD IN LAYER  5
            (DISTANCE FROM DRAIN)                 0.0 FEET

      PERCOLATION/LEAKAGE THROUGH LAYER  7        0.000041         0.14744

      SNOW WATER                                  0.00             0.0000

      MAXIMUM VEG. SOIL WATER (VOL/VOL)                   0.2611

      MINIMUM VEG. SOIL WATER (VOL/VOL)                   0.0424

       ***  Maximum heads are computed using McEnroe's equations.  ***

            Reference:  Maximum Saturated Depth over Landfill Liner
                        by Bruce M. McEnroe, University of Kansas
                        ASCE Journal of Environmental Engineering
                        Vol. 119, No. 2, March 1993, pp. 262-270.

*******************************************************************************
```

******************************************************************************

FINAL WATER STORAGE AT END OF YEAR 28

| LAYER | (INCHES) | (VOL/VOL) |
|---|---|---|
| 1 | 0.3324 | 0.0554 |
| 2 | 4.1796 | 0.0697 |
| 3 | 4.3800 | 0.0730 |
| 4 | 4.6339 | 0.1931 |
| 5 | 0.0034 | 0.0102 |
| 6 | 0.0000 | 0.0000 |
| 7 | 3.1437 | 0.1310 |
| SNOW WATER | 0.000 | |

******************************************************************************
******************************************************************************

```
*****************************************************************************
*****************************************************************************
**                                                                         **
**                                                                         **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE              **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)               **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                  **
**                    USAE WATERWAYS EXPERIMENT STATION                    **
**              FOR USEPA RISK REDUCTION ENGINEERING LABORATORY            **
**                                                                         **
**                                                                         **
*****************************************************************************
*****************************************************************************

PRECIPITATION DATA FILE:    C:\HELP\hardee\snbot25\hardrai1.D4
TEMPERATURE DATA FILE:      C:\HELP\hardee\snbot25\hardrai1.D7
SOLAR RADIATION DATA FILE:  C:\HELP\hardee\snbot25\hardrai1.D13
EVAPOTRANSPIRATION DATA:    C:\HELP\hardee\snbot25\hardrai1.D11
SOIL AND DESIGN DATA FILE:  C:\HELP\hardee\snbot25\snbot25.D10
OUTPUT DATA FILE:           C:\HELP\hardee\snbot25\snbot25.OUT

TIME:   5:49     DATE:   3/23/2013
****************************************************************************
TITLE:  Hardee County Phase II Section II Expansion RAI No. 1
Phase I Sideslope North Bottom (25 Feet Waste)
****************************************************************************

     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.

                      LAYER  1 (Daily Cover 6-inches)
                      --------
                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER   5
           THICKNESS                  =      6.00   INCHES
           POROSITY                   =      0.4570 VOL/VOL
           FIELD CAPACITY             =      0.1310 VOL/VOL
           WILTING POINT              =      0.0580 VOL/VOL
           INITIAL SOIL WATER CONTENT =      0.0612 VOL/VOL
           EFFECTIVE SAT. HYD. COND.  =  0.100000005000E-02 CM/SEC
         NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  1.80
                  FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.

                      LAYER  2 (5 Feet Waste)
                      --------
                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER  19
           THICKNESS                  =     60.00   INCHES
           POROSITY                   =      0.1680 VOL/VOL
           FIELD CAPACITY             =      0.0730 VOL/VOL
           WILTING POINT              =      0.0190 VOL/VOL
           INITIAL SOIL WATER CONTENT =      0.0761 VOL/VOL
           EFFECTIVE SAT. HYD. COND.  =  0.100000005000E-02 CM/SEC
```

```
          LAYER  3 (10 Feet Waste)
          --------
         TYPE 1 - VERTICAL PERCOLATION LAYER
             MATERIAL TEXTURE NUMBER  19
THICKNESS                  =    120.00   INCHES
POROSITY                   =      0.1680 VOL/VOL
FIELD CAPACITY             =      0.0730 VOL/VOL
WILTING POINT              =      0.0190 VOL/VOL
INITIAL SOIL WATER CONTENT  =     0.0736 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC

          LAYER  4 (10 Feet Waste)
          --------
         TYPE 1 - VERTICAL PERCOLATION LAYER
             MATERIAL TEXTURE NUMBER  19
THICKNESS                  =    120.00   INCHES
POROSITY                   =      0.1680 VOL/VOL
FIELD CAPACITY             =      0.0730 VOL/VOL
WILTING POINT              =      0.0190 VOL/VOL
INITIAL SOIL WATER CONTENT  =     0.0730 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC

         LAYER  5 (Drainage Sand 24-inches)
         --------
         TYPE 1 - VERTICAL PERCOLATION LAYER
             MATERIAL TEXTURE NUMBER   5
THICKNESS                  =     24.00   INCHES
POROSITY                   =      0.4570 VOL/VOL
FIELD CAPACITY             =      0.1310 VOL/VOL
WILTING POINT              =      0.0580 VOL/VOL
INITIAL SOIL WATER CONTENT  =     0.1990 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC

  LAYER  6 (330-mil Bi-planar Geocomposite SKAPS)
--------
           TYPE 2 - LATERAL DRAINAGE LAYER
             MATERIAL TEXTURE NUMBER   0
THICKNESS                  =      0.30   INCHES
POROSITY                   =      0.8500 VOL/VOL
FIELD CAPACITY             =      0.0100 VOL/VOL
WILTING POINT              =      0.0050 VOL/VOL
INITIAL SOIL WATER CONTENT  =     0.0103 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =   5.69999981000     CM/SEC
SLOPE                      =     33.33   PERCENT
DRAINAGE LENGTH            =     75.0    FEET

         LAYER  7 (60-mil HDPE geomembrane)
         --------
           TYPE 4 - FLEXIBLE MEMBRANE LINER
             MATERIAL TEXTURE NUMBER  35
THICKNESS                  =      0.06   INCHES
POROSITY                   =      0.0000 VOL/VOL
FIELD CAPACITY             =      0.0000 VOL/VOL
```

```
   WILTING POINT                  =      0.0000 VOL/VOL
   INITIAL SOIL WATER CONTENT  =      0.0000 VOL/VOL
   EFFECTIVE SAT. HYD. COND.   =  0.199999996000E-12 CM/SEC
   FML PINHOLE DENSITY         =      1.00   HOLES/ACRE
   FML INSTALLATION DEFECTS    =      1.00   HOLES/ACRE
   FML PLACEMENT QUALITY       =  3 - GOOD

            LAYER  8 (Drainage Sand 24-inches)
            --------
             TYPE 1 - VERTICAL PERCOLATION LAYER
                 MATERIAL TEXTURE NUMBER   5
   THICKNESS                   =     24.00   INCHES
   POROSITY                    =      0.4570 VOL/VOL
   FIELD CAPACITY              =      0.1310 VOL/VOL
   WILTING POINT               =      0.0580 VOL/VOL
   INITIAL SOIL WATER CONTENT  =      0.1310 VOL/VOL
   EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC

           GENERAL DESIGN AND EVAPORATIVE ZONE DATA
           ----------------------------------------

 NOTE:  SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
          SOIL DATA BASE USING SOIL TEXTURE # 5 WITH A
          POOR STAND OF GRASS, A SURFACE SLOPE OF 33.%
          AND A SLOPE LENGTH OF   75. FEET.

SCS RUNOFF CURVE NUMBER             =     80.30
FRACTION OF AREA ALLOWING RUNOFF    =      0.0    PERCENT
AREA PROJECTED ON HORIZONTAL PLANE  =      1.000  ACRES
EVAPORATIVE ZONE DEPTH              =     10.0    INCHES
INITIAL WATER IN EVAPORATIVE ZONE   =      0.637  INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE  =      3.414  INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE  =      0.424  INCHES
INITIAL SNOW WATER                  =      0.000  INCHES
INITIAL WATER IN LAYER MATERIALS    =     30.447  INCHES
TOTAL INITIAL WATER                 =     30.447  INCHES
TOTAL SUBSURFACE INFLOW             =      0.00   INCHES/YEAR

            EVAPOTRANSPIRATION AND WEATHER DATA
            -----------------------------------

 NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
          TAMPA                FLORIDA

     STATION LATITUDE                        =  27.58 DEGREES
     MAXIMUM LEAF AREA INDEX                 =   1.00
     START OF GROWING SEASON (JULIAN DATE)  =      0
     END OF GROWING SEASON (JULIAN DATE)    =    367
     EVAPORATIVE ZONE DEPTH                  =  10.0  INCHES
     AVERAGE ANNUAL WIND SPEED               =   8.60 MPH
     AVERAGE 1ST QUARTER RELATIVE HUMIDITY  =  74.00 %
     AVERAGE 2ND QUARTER RELATIVE HUMIDITY  =  72.00 %
     AVERAGE 3RD QUARTER RELATIVE HUMIDITY  =  78.00 %
```

AVERAGE 4TH QUARTER RELATIVE HUMIDITY = 76.00 %

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR TAMPA FLORIDA

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

| JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
| --- | --- | --- | --- | --- | --- |
| 1.85 | 2.58 | 3.39 | 2.95 | 2.52 | 8.31 |
| 7.83 | 7.98 | 5.61 | 2.86 | 1.94 | 1.84 |

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR TAMPA FLORIDA

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

| JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
| --- | --- | --- | --- | --- | --- |
| 59.80 | 60.80 | 66.20 | 71.60 | 77.10 | 80.90 |
| 82.20 | 82.20 | 80.90 | 74.50 | 66.70 | 61.30 |

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR TAMPA FLORIDA AND STATION LATITUDE = 27.58 DEGREES

*****************************************************************************

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 28

| | JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
| --- | --- | --- | --- | --- | --- | --- |
| **PRECIPITATION** | | | | | | |
| TOTALS | 1.82 | 2.13 | 3.38 | 2.54 | 3.05 | 7.89 |
| | 8.50 | 7.72 | 5.34 | 2.65 | 1.83 | 1.84 |
| STD. DEVIATIONS | 1.56 | 2.17 | 2.92 | 1.84 | 2.10 | 3.63 |
| | 3.41 | 2.59 | 2.44 | 2.42 | 2.77 | 2.09 |
| **RUNOFF** | | | | | | |
| TOTALS | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| STD. DEVIATIONS | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| **EVAPOTRANSPIRATION** | | | | | | |
| TOTALS | 1.070 | 1.045 | 1.703 | 1.575 | 1.874 | 4.168 |
| | 4.868 | 4.550 | 3.153 | 1.457 | 0.900 | 0.779 |

| | | | | | | |
|---|---|---|---|---|---|---|
| STD. DEVIATIONS | 0.780 | 0.764 | 1.231 | 1.058 | 1.122 | 1.145 |
| | 1.234 | 1.177 | 1.133 | 0.996 | 0.753 | 0.722 |

LATERAL DRAINAGE COLLECTED FROM LAYER 6

| | | | | | | |
|---|---|---|---|---|---|---|
| TOTALS | 0.7239 | 0.8431 | 1.4121 | 1.1366 | 0.9572 | 1.8536 |
| | 3.7667 | 3.7332 | 2.8249 | 1.9746 | 1.2999 | 1.0314 |
| STD. DEVIATIONS | 0.6672 | 1.1698 | 1.8344 | 0.9688 | 0.7260 | 1.6220 |
| | 2.0334 | 1.7585 | 1.6500 | 1.5187 | 1.5135 | 1.6326 |

PERCOLATION/LEAKAGE THROUGH LAYER 7

| | | | | | | |
|---|---|---|---|---|---|---|
| TOTALS | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| | 0.0001 | 0.0001 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| STD. DEVIATIONS | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

PERCOLATION/LEAKAGE THROUGH LAYER 8

| | | | | | | |
|---|---|---|---|---|---|---|
| TOTALS | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| | 0.0001 | 0.0001 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| STD. DEVIATIONS | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 7

| | | | | | | |
|---|---|---|---|---|---|---|
| AVERAGES | 0.0002 | 0.0002 | 0.0004 | 0.0003 | 0.0002 | 0.0005 |
| | 0.0009 | 0.0009 | 0.0007 | 0.0005 | 0.0003 | 0.0003 |
| STD. DEVIATIONS | 0.0002 | 0.0003 | 0.0005 | 0.0002 | 0.0002 | 0.0004 |
| | 0.0005 | 0.0004 | 0.0004 | 0.0004 | 0.0004 | 0.0004 |

***************************************************************************
***************************************************************************

AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 28

| | INCHES | CU. FEET | PERCENT |
|---|---|---|---|
| PRECIPITATION | 48.67 ( 9.518) | 176683.8 | 100.00 |
| RUNOFF | 0.000 ( 0.0000) | 0.00 | 0.000 |
| EVAPOTRANSPIRATION | 27.142 ( 4.4607) | 98525.24 | 55.764 |
| LATERAL DRAINAGE COLLECTED | 21.55730 ( 5.59219) | 78252.992 | 44.28986 |

```
     FROM LAYER  6

   PERCOLATION/LEAKAGE THROUGH  0.00040 (  0.00008)         1.470     0.00083
     LAYER  7

   AVERAGE HEAD ON TOP             0.000 (    0.000)
     OF LAYER  7

   PERCOLATION/LEAKAGE THROUGH  0.00042 (  0.00009)         1.525     0.00086
     LAYER  8

   CHANGE IN WATER STORAGE      -0.026   (  1.4548)       -96.01     -0.054

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```

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******************************************************************************
              PEAK DAILY VALUES FOR YEARS    1 THROUGH   28
    --------------------------------------------------------------------------
                                                  (INCHES)      (CU. FT.)
                                                 ----------   -------------
       PRECIPITATION                               7.60          27588.000

       RUNOFF                                      0.000             0.0000

       DRAINAGE COLLECTED FROM LAYER  6          1.06891         3880.13940

       PERCOLATION/LEAKAGE THROUGH LAYER  7        0.000012          0.04259

       AVERAGE HEAD ON TOP OF LAYER  7             0.008

       MAXIMUM HEAD ON TOP OF LAYER  7             0.015

       LOCATION OF MAXIMUM HEAD IN LAYER  6
             (DISTANCE FROM DRAIN)                 0.0 FEET

       PERCOLATION/LEAKAGE THROUGH LAYER  8        0.000040          0.14471

       SNOW WATER                                  0.00              0.0000

       MAXIMUM VEG. SOIL WATER (VOL/VOL)                   0.2612

       MINIMUM VEG. SOIL WATER (VOL/VOL)                   0.0424

        ***  Maximum heads are computed using McEnroe's equations.  ***

             Reference:  Maximum Saturated Depth over Landfill Liner
                         by Bruce M. McEnroe, University of Kansas
                         ASCE Journal of Environmental Engineering
                         Vol. 119, No. 2, March 1993, pp. 262-270.

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FINAL WATER STORAGE AT END OF YEAR 28

| LAYER | (INCHES) | (VOL/VOL) |
|---|---|---|
| 1 | 0.3324 | 0.0554 |
| 2 | 4.1796 | 0.0697 |
| 3 | 8.7600 | 0.0730 |
| 4 | 8.7600 | 0.0730 |
| 5 | 4.5276 | 0.1886 |
| 6 | 0.0031 | 0.0102 |
| 7 | 0.0000 | 0.0000 |
| 8 | 3.1436 | 0.1310 |
| SNOW WATER | 0.000 | |

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******************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************

PRECIPITATION DATA FILE:    C:\HELP\hardee\sntopsod\hardrai1.D4
TEMPERATURE DATA FILE:      C:\HELP\hardee\sntopsod\hardrai1.D7
SOLAR RADIATION DATA FILE:  C:\HELP\hardee\sntopsod\hardrai1.D13
EVAPOTRANSPIRATION DATA:    C:\HELP\hardee\sntopsod\hardrai1.D11
SOIL AND DESIGN DATA FILE:  C:\HELP\hardee\sntopsod\existsod.D10
OUTPUT DATA FILE:           C:\HELP\hardee\sntopsod\existsod.OUT

TIME:   6:39     DATE:   3/23/2013

*****************************************************************************
TITLE:  Hardee County Phase II Section II Expansion RAI No. 1
Phase I Sideslope North Top (Existing Sod)
*****************************************************************************

     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.

                    LAYER  1 (Drainage Sand 24-inches)
                    --------
                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER   5
           THICKNESS                   =    24.00   INCHES
           POROSITY                    =     0.4570 VOL/VOL
           FIELD CAPACITY              =     0.1310 VOL/VOL
           WILTING POINT               =     0.0580 VOL/VOL
           INITIAL SOIL WATER CONTENT  =     0.1653 VOL/VOL
           EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC
         NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  1.80
                  FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.

              LAYER  2 (330-mil Bi-planar Geocomposite SKAPS)
           --------
                       TYPE 2 - LATERAL DRAINAGE LAYER
                         MATERIAL TEXTURE NUMBER   0
           THICKNESS                   =     0.33   INCHES
           POROSITY                    =     0.8500 VOL/VOL
           FIELD CAPACITY              =     0.0100 VOL/VOL
           WILTING POINT               =     0.0050 VOL/VOL
           INITIAL SOIL WATER CONTENT  =     0.0119 VOL/VOL
           EFFECTIVE SAT. HYD. COND.   =   7.80000019000     CM/SEC
```

```
   SLOPE                         =     33.33   PERCENT
   DRAINAGE LENGTH               =    105.0    FEET

            LAYER  3 (60-mil HDPE geomembrane)
            --------
               TYPE 4 - FLEXIBLE MEMBRANE LINER
                 MATERIAL TEXTURE NUMBER  35
   THICKNESS                     =      0.06   INCHES
   POROSITY                      =      0.0000 VOL/VOL
   FIELD CAPACITY                =      0.0000 VOL/VOL
   WILTING POINT                 =      0.0000 VOL/VOL
   INITIAL SOIL WATER CONTENT    =      0.0000 VOL/VOL
   EFFECTIVE SAT. HYD. COND.     =  0.199999996000E-12 CM/SEC
   FML PINHOLE DENSITY           =      1.00   HOLES/ACRE
   FML INSTALLATION DEFECTS      =      1.00   HOLES/ACRE
   FML PLACEMENT QUALITY         =  3 - GOOD

            LAYER  4 (Drainage Sand 24-inches)
            --------
             TYPE 1 - VERTICAL PERCOLATION LAYER
                 MATERIAL TEXTURE NUMBER   5
   THICKNESS                     =     24.00   INCHES
   POROSITY                      =      0.4570 VOL/VOL
   FIELD CAPACITY                =      0.1310 VOL/VOL
   WILTING POINT                 =      0.0580 VOL/VOL
   INITIAL SOIL WATER CONTENT    =      0.1310 VOL/VOL
   EFFECTIVE SAT. HYD. COND.     =  0.100000005000E-02 CM/SEC

           GENERAL DESIGN AND EVAPORATIVE ZONE DATA
           ----------------------------------------

 NOTE:  SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
          SOIL DATA BASE USING SOIL TEXTURE # 5 WITH A
          GOOD STAND OF GRASS, A SURFACE SLOPE OF 33.%
          AND A SLOPE LENGTH OF  105. FEET.

SCS RUNOFF CURVE NUMBER              =     62.60
FRACTION OF AREA ALLOWING RUNOFF     =      0.0    PERCENT
AREA PROJECTED ON HORIZONTAL PLANE   =      1.000  ACRES
EVAPORATIVE ZONE DEPTH               =     10.0    INCHES
INITIAL WATER IN EVAPORATIVE ZONE    =      0.600  INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE   =      4.570  INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE   =      0.580  INCHES
INITIAL SNOW WATER                   =      0.000  INCHES
INITIAL WATER IN LAYER MATERIALS     =      7.115  INCHES
TOTAL INITIAL WATER                  =      7.115  INCHES
TOTAL SUBSURFACE INFLOW              =      0.00   INCHES/YEAR

            EVAPOTRANSPIRATION AND WEATHER DATA
            -----------------------------------

 NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
          TAMPA                 FLORIDA
```

```
STATION LATITUDE                          =  27.58 DEGREES
MAXIMUM LEAF AREA INDEX                   =   1.00
START OF GROWING SEASON (JULIAN DATE)     =      0
END OF GROWING SEASON (JULIAN DATE)       =    367
EVAPORATIVE ZONE DEPTH                    =  10.0  INCHES
AVERAGE ANNUAL WIND SPEED                 =   8.60 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY     =  74.00 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY     =  72.00 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY     =  78.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY     =  76.00 %
```

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR TAMPA FLORIDA

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

| JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|
| 1.85 | 2.58 | 3.39 | 2.95 | 2.52 | 8.31 |
| 7.83 | 7.98 | 5.61 | 2.86 | 1.94 | 1.84 |

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR TAMPA FLORIDA

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

| JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|
| 59.80 | 60.80 | 66.20 | 71.60 | 77.10 | 80.90 |
| 82.20 | 82.20 | 80.90 | 74.50 | 66.70 | 61.30 |

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR TAMPA FLORIDA AND STATION LATITUDE = 27.58 DEGREES

*******************************************************************************

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 28

| | JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|---|
| PRECIPITATION | | | | | | |
| TOTALS | 1.82 | 2.13 | 3.38 | 2.54 | 3.05 | 7.89 |
| | 8.50 | 7.72 | 5.34 | 2.65 | 1.83 | 1.84 |
| STD. DEVIATIONS | 1.56 | 2.17 | 2.92 | 1.84 | 2.10 | 3.63 |
| | 3.41 | 2.59 | 2.44 | 2.42 | 2.77 | 2.09 |
| RUNOFF | | | | | | |
| TOTALS | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |

```
    STD. DEVIATIONS     0.000    0.000    0.000    0.000    0.000    0.000
                        0.000    0.000    0.000    0.000    0.000    0.000

  EVAPOTRANSPIRATION
  ------------------
    TOTALS              0.871    0.839    1.443    1.207    1.503    3.499
                        4.311    4.235    2.815    1.217    0.717    0.634

    STD. DEVIATIONS     0.685    0.756    1.247    0.958    1.158    1.431
                        1.692    1.421    1.330    1.034    0.824    0.766

  LATERAL DRAINAGE COLLECTED FROM LAYER  2
  ----------------------------------------
    TOTALS             0.9632   1.1719   1.8027   1.3338   1.4497   3.4782
                       4.2951   3.6555   2.8928   1.9250   1.3546   1.0857

    STD. DEVIATIONS    0.7416   1.2167   1.8724   0.6712   0.9489   2.0324
                       1.7844   1.2451   1.4201   1.3534   1.8174   1.3006

  PERCOLATION/LEAKAGE THROUGH LAYER  3
  ------------------------------------
    TOTALS             0.0000   0.0000   0.0000   0.0000   0.0000   0.0001
                       0.0001   0.0001   0.0001   0.0000   0.0000   0.0000

    STD. DEVIATIONS    0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                       0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

  PERCOLATION/LEAKAGE THROUGH LAYER  4
  ------------------------------------
    TOTALS             0.0000   0.0000   0.0000   0.0000   0.0000   0.0001
                       0.0001   0.0001   0.0001   0.0000   0.0000   0.0000

    STD. DEVIATIONS    0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                       0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

-----------------------------------------------------------------------------
                AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)
-----------------------------------------------------------------------------

  DAILY AVERAGE HEAD ON TOP OF LAYER  3
  -------------------------------------
    AVERAGES           0.0002   0.0003   0.0005   0.0004   0.0004   0.0009
                       0.0011   0.0009   0.0008   0.0005   0.0004   0.0003

    STD. DEVIATIONS    0.0002   0.0003   0.0005   0.0002   0.0002   0.0005
                       0.0005   0.0003   0.0004   0.0003   0.0005   0.0003

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*****************************************************************************

    AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS    1 THROUGH   28
-----------------------------------------------------------------------------
                                    INCHES          CU. FEET      PERCENT
```

| | | | |
|---|---|---|---|
| PRECIPITATION | 48.67 ( 9.518) | 176683.8 | 100.00 |
| RUNOFF | 0.000 ( 0.0000) | 0.00 | 0.000 |
| EVAPOTRANSPIRATION | 23.290 ( 3.9876) | 84543.12 | 47.850 |
| LATERAL DRAINAGE COLLECTED FROM LAYER 2 | 25.40817 ( 6.11293) | 92231.664 | 52.20155 |
| PERCOLATION/LEAKAGE THROUGH LAYER 3 | 0.00046 ( 0.00008) | 1.685 | 0.00095 |
| AVERAGE HEAD ON TOP OF LAYER 3 | 0.001 ( 0.000) | | |
| PERCOLATION/LEAKAGE THROUGH LAYER 4 | 0.00048 ( 0.00009) | 1.754 | 0.00099 |
| CHANGE IN WATER STORAGE | -0.026 ( 0.8810) | -92.78 | -0.053 |

***************************************************************************

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*******************************************************************************
            PEAK DAILY VALUES FOR YEARS    1 THROUGH   28
    ---------------------------------------------------------------------------
                                                (INCHES)      (CU. FT.)
                                               ----------    -------------
    PRECIPITATION                                7.60          27588.000

    RUNOFF                                       0.000             0.0000

    DRAINAGE COLLECTED FROM LAYER  2             2.61569        9494.95410

    PERCOLATION/LEAKAGE THROUGH LAYER  3         0.000022          0.07896

    AVERAGE HEAD ON TOP OF LAYER  3              0.021

    MAXIMUM HEAD ON TOP OF LAYER  3              0.045

    LOCATION OF MAXIMUM HEAD IN LAYER  2
          (DISTANCE FROM DRAIN)                  0.0 FEET

    PERCOLATION/LEAKAGE THROUGH LAYER  4         0.000043          0.15480

    SNOW WATER                                   0.00              0.0000

    MAXIMUM VEG. SOIL WATER (VOL/VOL)                    0.3665

    MINIMUM VEG. SOIL WATER (VOL/VOL)                    0.0580

     ***  Maximum heads are computed using McEnroe's equations.  ***

          Reference:  Maximum Saturated Depth over Landfill Liner
                      by Bruce M. McEnroe, University of Kansas
                      ASCE Journal of Environmental Engineering
                      Vol. 119, No. 2, March 1993, pp. 262-270.

*******************************************************************************
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FINAL WATER STORAGE AT END OF YEAR 28

| LAYER | (INCHES) | (VOL/VOL) |
| --- | --- | --- |
| 1 | 3.2528 | 0.1355 |
| 2 | 0.0034 | 0.0102 |
| 3 | 0.0000 | 0.0000 |
| 4 | 3.1434 | 0.1310 |
| SNOW WATER | 0.000 | |

*****************************************************************************
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```
******************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**               FOR USEPA RISK REDUCTION ENGINEERING LABORATORY            **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************

PRECIPITATION DATA FILE:     C:\HELP\hardee\sntop15\hardrai1.D4
TEMPERATURE DATA FILE:       C:\HELP\hardee\sntop15\hardrai1.D7
SOLAR RADIATION DATA FILE:   C:\HELP\hardee\sntop15\hardrai1.D13
EVAPOTRANSPIRATION DATA:     C:\HELP\hardee\sntop15\hardrai1.D11
SOIL AND DESIGN DATA FILE:   C:\HELP\hardee\sntop15\sntop15.D10
OUTPUT DATA FILE:            C:\HELP\hardee\sntop15\sntop15.OUT

TIME:   7: 9     DATE:   3/23/2013

*****************************************************************************
TITLE:  Hardee County Phase II Section II Expansion RAI No. 1
Phase I Sideslope North Top (15 Feet Waste)
*****************************************************************************

     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.

                      LAYER  1 (Daily Cover 6-inches)
                      --------
                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER   5
           THICKNESS                  =      6.00   INCHES
           POROSITY                   =      0.4570 VOL/VOL
           FIELD CAPACITY             =      0.1310 VOL/VOL
           WILTING POINT              =      0.0580 VOL/VOL
           INITIAL SOIL WATER CONTENT =      0.0643 VOL/VOL
           EFFECTIVE SAT. HYD. COND.  =  0.100000005000E-02 CM/SEC
         NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  1.80
                  FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.

                      LAYER  2 (5 Feet Waste)
                      --------
                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER  19
           THICKNESS                  =     60.00   INCHES
           POROSITY                   =      0.1680 VOL/VOL
           FIELD CAPACITY             =      0.0730 VOL/VOL
           WILTING POINT              =      0.0190 VOL/VOL
           INITIAL SOIL WATER CONTENT =      0.0756 VOL/VOL
           EFFECTIVE SAT. HYD. COND.  =  0.100000005000E-02 CM/SEC
```

```
             LAYER  3 (10 Feet Waste)
             --------
            TYPE 1 - VERTICAL PERCOLATION LAYER
                MATERIAL TEXTURE NUMBER  19
THICKNESS                    =    120.00   INCHES
POROSITY                     =      0.1680 VOL/VOL
FIELD CAPACITY               =      0.0730 VOL/VOL
WILTING POINT                =      0.0190 VOL/VOL
INITIAL SOIL WATER CONTENT   =      0.0736 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.100000005000E-02 CM/SEC

           LAYER  4 (Drainage Sand 24-inches)
           --------
            TYPE 1 - VERTICAL PERCOLATION LAYER
                MATERIAL TEXTURE NUMBER   5
THICKNESS                    =     24.00   INCHES
POROSITY                     =      0.4570 VOL/VOL
FIELD CAPACITY               =      0.1310 VOL/VOL
WILTING POINT                =      0.0580 VOL/VOL
INITIAL SOIL WATER CONTENT   =      0.1970 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.100000005000E-02 CM/SEC

   LAYER  5 (330-mil Bi-planar Geocomposite SKAPS)
--------
              TYPE 2 - LATERAL DRAINAGE LAYER
                MATERIAL TEXTURE NUMBER   0
THICKNESS                    =      0.30   INCHES
POROSITY                     =      0.8500 VOL/VOL
FIELD CAPACITY               =      0.0100 VOL/VOL
WILTING POINT                =      0.0050 VOL/VOL
INITIAL SOIL WATER CONTENT   =      0.0104 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =   5.69999981000     CM/SEC
SLOPE                        =     33.33   PERCENT
DRAINAGE LENGTH              =    105.0    FEET

           LAYER  6 (60-mil HDPE geomembrane)
           --------
              TYPE 4 - FLEXIBLE MEMBRANE LINER
                MATERIAL TEXTURE NUMBER  35
THICKNESS                    =      0.06   INCHES
POROSITY                     =      0.0000 VOL/VOL
FIELD CAPACITY               =      0.0000 VOL/VOL
WILTING POINT                =      0.0000 VOL/VOL
INITIAL SOIL WATER CONTENT   =      0.0000 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.199999996000E-12 CM/SEC
FML PINHOLE DENSITY          =      1.00   HOLES/ACRE
FML INSTALLATION DEFECTS     =      1.00   HOLES/ACRE
FML PLACEMENT QUALITY        =  3 - GOOD

           LAYER  7 (Drainage Sand 24-inches)
           --------
            TYPE 1 - VERTICAL PERCOLATION LAYER
                MATERIAL TEXTURE NUMBER   5
```

```
THICKNESS                       =     24.00   INCHES
POROSITY                        =      0.4570 VOL/VOL
FIELD CAPACITY                  =      0.1310 VOL/VOL
WILTING POINT                   =      0.0580 VOL/VOL
INITIAL SOIL WATER CONTENT      =      0.1310 VOL/VOL
EFFECTIVE SAT. HYD. COND.       =  0.100000005000E-02 CM/SEC
```

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

```
NOTE:  SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
         SOIL DATA BASE USING SOIL TEXTURE # 5 WITH A
         POOR STAND OF GRASS, A SURFACE SLOPE OF 33.%
         AND A SLOPE LENGTH OF  105. FEET.

SCS RUNOFF CURVE NUMBER              =     80.00
FRACTION OF AREA ALLOWING RUNOFF     =      0.0    PERCENT
AREA PROJECTED ON HORIZONTAL PLANE   =      1.000  ACRES
EVAPORATIVE ZONE DEPTH               =     10.0    INCHES
INITIAL WATER IN EVAPORATIVE ZONE    =      0.664  INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE   =      3.414  INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE   =      0.424  INCHES
INITIAL SNOW WATER                   =      0.000  INCHES
INITIAL WATER IN LAYER MATERIALS     =     21.634  INCHES
TOTAL INITIAL WATER                  =     21.634  INCHES
TOTAL SUBSURFACE INFLOW              =      0.00   INCHES/YEAR
```

EVAPOTRANSPIRATION AND WEATHER DATA

```
NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
         TAMPA                 FLORIDA

     STATION LATITUDE                          =  27.58 DEGREES
     MAXIMUM LEAF AREA INDEX                   =   1.00
     START OF GROWING SEASON (JULIAN DATE)     =      0
     END OF GROWING SEASON (JULIAN DATE)       =    367
     EVAPORATIVE ZONE DEPTH                    =  10.0  INCHES
     AVERAGE ANNUAL WIND SPEED                 =   8.60 MPH
     AVERAGE 1ST QUARTER RELATIVE HUMIDITY     =  74.00 %
     AVERAGE 2ND QUARTER RELATIVE HUMIDITY     =  72.00 %
     AVERAGE 3RD QUARTER RELATIVE HUMIDITY     =  78.00 %
     AVERAGE 4TH QUARTER RELATIVE HUMIDITY     =  76.00 %

NOTE:  PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
         COEFFICIENTS FOR    TAMPA              FLORIDA
```

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

| JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|
| 1.85 | 2.58 | 3.39 | 2.95 | 2.52 | 8.31 |
| 7.83 | 7.98 | 5.61 | 2.86 | 1.94 | 1.84 |

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR TAMPA FLORIDA

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

| JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|
| 59.80 | 60.80 | 66.20 | 71.60 | 77.10 | 80.90 |
| 82.20 | 82.20 | 80.90 | 74.50 | 66.70 | 61.30 |

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR TAMPA FLORIDA AND STATION LATITUDE = 27.58 DEGREES

*****************************************************************************

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 28

| | JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|---|
| PRECIPITATION | | | | | | |
| TOTALS | 1.82 | 2.13 | 3.38 | 2.54 | 3.05 | 7.89 |
| | 8.50 | 7.72 | 5.34 | 2.65 | 1.83 | 1.84 |
| STD. DEVIATIONS | 1.56 | 2.17 | 2.92 | 1.84 | 2.10 | 3.63 |
| | 3.41 | 2.59 | 2.44 | 2.42 | 2.77 | 2.09 |
| RUNOFF | | | | | | |
| TOTALS | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| STD. DEVIATIONS | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| EVAPOTRANSPIRATION | | | | | | |
| TOTALS | 1.097 | 1.095 | 1.776 | 1.613 | 1.877 | 4.279 |
| | 4.949 | 4.621 | 3.243 | 1.569 | 0.930 | 0.860 |
| STD. DEVIATIONS | 0.774 | 0.771 | 1.174 | 1.038 | 1.064 | 1.248 |
| | 1.284 | 1.148 | 1.173 | 1.007 | 0.784 | 0.758 |
| LATERAL DRAINAGE COLLECTED FROM LAYER 5 | | | | | | |
| TOTALS | 0.6853 | 0.7937 | 1.4251 | 0.9948 | 1.0182 | 2.0981 |
| | 3.6176 | 3.4566 | 2.6950 | 1.8163 | 1.2356 | 0.9492 |
| STD. DEVIATIONS | 0.5898 | 1.3033 | 1.9348 | 0.9278 | 0.8773 | 1.8788 |
| | 2.0452 | 1.5476 | 1.7272 | 1.5356 | 1.5502 | 1.4387 |

PERCOLATION/LEAKAGE THROUGH LAYER 6

| | | | | | | |
|---|---|---|---|---|---|---|
| TOTALS | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| | 0.0001 | 0.0001 | 0.0001 | 0.0000 | 0.0000 | 0.0000 |
| STD. DEVIATIONS | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

PERCOLATION/LEAKAGE THROUGH LAYER 7

| | | | | | | |
|---|---|---|---|---|---|---|
| TOTALS | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| | 0.0001 | 0.0001 | 0.0001 | 0.0000 | 0.0000 | 0.0000 |
| STD. DEVIATIONS | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

---

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

---

DAILY AVERAGE HEAD ON TOP OF LAYER 6

| | | | | | | |
|---|---|---|---|---|---|---|
| AVERAGES | 0.0002 | 0.0003 | 0.0005 | 0.0004 | 0.0004 | 0.0008 |
| | 0.0013 | 0.0012 | 0.0010 | 0.0006 | 0.0004 | 0.0003 |
| STD. DEVIATIONS | 0.0002 | 0.0005 | 0.0007 | 0.0003 | 0.0003 | 0.0007 |
| | 0.0007 | 0.0005 | 0.0006 | 0.0005 | 0.0006 | 0.0005 |

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 28

| | INCHES | | CU. FEET | PERCENT |
|---|---|---|---|---|
| PRECIPITATION | 48.67 | ( 9.518) | 176683.8 | 100.00 |
| RUNOFF | 0.000 | ( 0.0000) | 0.00 | 0.000 |
| EVAPOTRANSPIRATION | 27.908 | ( 4.3401) | 101305.65 | 57.337 |
| LATERAL DRAINAGE COLLECTED FROM LAYER 5 | 20.78538 | ( 5.96203) | 75450.937 | 42.70394 |
| PERCOLATION/LEAKAGE THROUGH LAYER 6 | 0.00050 | ( 0.00011) | 1.828 | 0.00103 |
| AVERAGE HEAD ON TOP OF LAYER 6 | 0.001 | ( 0.000) | | |
| PERCOLATION/LEAKAGE THROUGH LAYER 7 | 0.00053 | ( 0.00012) | 1.914 | 0.00108 |
| CHANGE IN WATER STORAGE | -0.021 | ( 1.2691) | -74.71 | -0.042 |

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******************************************************************************
                PEAK DAILY VALUES FOR YEARS     1 THROUGH   28
    --------------------------------------------------------------------------
                                                  (INCHES)      (CU. FT.)
                                                 ----------   -------------
      PRECIPITATION                                 7.60         27588.000

      RUNOFF                                        0.000            0.0000

      DRAINAGE COLLECTED FROM LAYER  5             1.46380       5313.59619

      PERCOLATION/LEAKAGE THROUGH LAYER  6         0.000019         0.06976

      AVERAGE HEAD ON TOP OF LAYER  6              0.016

      MAXIMUM HEAD ON TOP OF LAYER  6              0.037

      LOCATION OF MAXIMUM HEAD IN LAYER  5
            (DISTANCE FROM DRAIN)                  0.0 FEET

      PERCOLATION/LEAKAGE THROUGH LAYER  7         0.000043         0.15450

      SNOW WATER                                   0.00             0.0000


      MAXIMUM VEG. SOIL WATER (VOL/VOL)                    0.2611

      MINIMUM VEG. SOIL WATER (VOL/VOL)                    0.0424

       ***  Maximum heads are computed using McEnroe's equations.  ***

            Reference:  Maximum Saturated Depth over Landfill Liner
                        by Bruce M. McEnroe, University of Kansas
                        ASCE Journal of Environmental Engineering
                        Vol. 119, No. 2, March 1993, pp. 262-270.

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******************************************************************************
                 FINAL WATER STORAGE AT END OF YEAR   28
      ----------------------------------------------------------------------
                    LAYER       (INCHES)       (VOL/VOL)
                    -----       --------       ---------
                      1          0.3324          0.0554

                      2          4.1796          0.0697

                      3          8.7600          0.0730

                      4          4.6393          0.1933

                      5          0.0031          0.0104

                      6          0.0000          0.0000

                      7          3.1433          0.1310

                  SNOW WATER     0.000

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**                                                                           **
**                                                                           **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE                **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                 **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                    **
**                    USAE WATERWAYS EXPERIMENT STATION                      **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY               **
**                                                                           **
**                                                                           **
*******************************************************************************
*******************************************************************************

PRECIPITATION DATA FILE:    C:\HELP\hardee\botp2s1\hardrai1.D4
TEMPERATURE DATA FILE:      C:\HELP\hardee\botp2s1\hardrai1.D7
SOLAR RADIATION DATA FILE:  C:\HELP\hardee\botp2s1\hardrai1.D13
EVAPOTRANSPIRATION DATA:    C:\HELP\hardee\botp2s1\hardrai1.D11
SOIL AND DESIGN DATA FILE:  C:\HELP\hardee\botp2s1\hardee40.D10
OUTPUT DATA FILE:           C:\HELP\hardee\botp2s1\hardee40.OUT

TIME:  11:45     DATE:   3/25/2013
******************************************************************************
TITLE:  Hardee County Phase II Section I Expansion RAI No. 1
Phase II Section I (40 Feet Waste)
******************************************************************************

     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.

                      LAYER  1 (Daily Cover 6-inches)
                       --------
                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER   5
          THICKNESS                    =      6.00   INCHES
          POROSITY                     =      0.4570 VOL/VOL
          FIELD CAPACITY               =      0.1310 VOL/VOL
          WILTING POINT                =      0.0580 VOL/VOL
          INITIAL SOIL WATER CONTENT   =      0.1970 VOL/VOL
          EFFECTIVE SAT. HYD. COND.    =  0.100000005000E-02 CM/SEC
        NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  1.80
                 FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.

                      LAYER  2 (10 Feet Waste)
                       --------
                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER  19
          THICKNESS                    =    120.00   INCHES
          POROSITY                     =      0.1680 VOL/VOL
          FIELD CAPACITY               =      0.0730 VOL/VOL
          WILTING POINT                =      0.0190 VOL/VOL
          INITIAL SOIL WATER CONTENT   =      0.0731 VOL/VOL
          EFFECTIVE SAT. HYD. COND.    =  0.100000005000E-02 CM/SEC
```

```
            LAYER  3 (10 Feet Waste)
            --------
           TYPE 1 - VERTICAL PERCOLATION LAYER
               MATERIAL TEXTURE NUMBER  19
THICKNESS                  =    120.00   INCHES
POROSITY                   =      0.1680 VOL/VOL
FIELD CAPACITY             =      0.0730 VOL/VOL
WILTING POINT              =      0.0190 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.0730 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC

            LAYER  4 (10 Feet Waste)
            --------
           TYPE 1 - VERTICAL PERCOLATION LAYER
               MATERIAL TEXTURE NUMBER  19
THICKNESS                  =    120.00   INCHES
POROSITY                   =      0.1680 VOL/VOL
FIELD CAPACITY             =      0.0730 VOL/VOL
WILTING POINT              =      0.0190 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.0730 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC

            LAYER  5 (10 Feet Waste)
            --------
           TYPE 1 - VERTICAL PERCOLATION LAYER
               MATERIAL TEXTURE NUMBER  19
THICKNESS                  =    120.00   INCHES
POROSITY                   =      0.1680 VOL/VOL
FIELD CAPACITY             =      0.0730 VOL/VOL
WILTING POINT              =      0.0190 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.0730 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC

          LAYER  6 (Drainage Sand 24-inches)
          --------
           TYPE 1 - VERTICAL PERCOLATION LAYER
               MATERIAL TEXTURE NUMBER   5
THICKNESS                  =     24.00   INCHES
POROSITY                   =      0.4570 VOL/VOL
FIELD CAPACITY             =      0.1310 VOL/VOL
WILTING POINT              =      0.0580 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.1805 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC

LAYER  7 (300-mil Bi-planar Geocomposite FabriNet UF)
--------
             TYPE 2 - LATERAL DRAINAGE LAYER
               MATERIAL TEXTURE NUMBER   0
THICKNESS                  =      0.27   INCHES
POROSITY                   =      0.8500 VOL/VOL
FIELD CAPACITY             =      0.0100 VOL/VOL
WILTING POINT              =      0.0050 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.0116 VOL/VOL
```

```
   EFFECTIVE SAT. HYD. COND.   =   6.90000010000     CM/SEC
   SLOPE                       =      2.14   PERCENT
   DRAINAGE LENGTH             =     77.3    FEET

            LAYER  8 (60-mil HDPE geomembrane)
            --------
               TYPE 4 - FLEXIBLE MEMBRANE LINER
                 MATERIAL TEXTURE NUMBER  35
   THICKNESS                   =      0.06   INCHES
   POROSITY                    =      0.0000 VOL/VOL
   FIELD CAPACITY              =      0.0000 VOL/VOL
   WILTING POINT               =      0.0000 VOL/VOL
   INITIAL SOIL WATER CONTENT  =      0.0000 VOL/VOL
   EFFECTIVE SAT. HYD. COND.   =  0.199999996000E-12 CM/SEC
   FML PINHOLE DENSITY         =      1.00   HOLES/ACRE
   FML INSTALLATION DEFECTS    =      1.00   HOLES/ACRE
   FML PLACEMENT QUALITY       =  3 - GOOD

 LAYER  9 (300-mil Tri-planar Geocomposite TENDRAIN 770-2)
 --------
               TYPE 2 - LATERAL DRAINAGE LAYER
                 MATERIAL TEXTURE NUMBER   0
   THICKNESS                   =      0.27   INCHES
   POROSITY                    =      0.8500 VOL/VOL
   FIELD CAPACITY              =      0.0100 VOL/VOL
   WILTING POINT               =      0.0050 VOL/VOL
   INITIAL SOIL WATER CONTENT  =      0.0100 VOL/VOL
   EFFECTIVE SAT. HYD. COND.   =   26.6000004000     CM/SEC
   SLOPE                       =      2.14   PERCENT
   DRAINAGE LENGTH             =     77.3    FEET

           LAYER  10 (60-mil HDPE geomembrane)
            --------
               TYPE 4 - FLEXIBLE MEMBRANE LINER
                 MATERIAL TEXTURE NUMBER  35
   THICKNESS                   =      0.06   INCHES
   POROSITY                    =      0.0000 VOL/VOL
   FIELD CAPACITY              =      0.0000 VOL/VOL
   WILTING POINT               =      0.0000 VOL/VOL
   INITIAL SOIL WATER CONTENT  =      0.0000 VOL/VOL
   EFFECTIVE SAT. HYD. COND.   =  0.199999996000E-12 CM/SEC
   FML PINHOLE DENSITY         =      1.00   HOLES/ACRE
   FML INSTALLATION DEFECTS    =      1.00   HOLES/ACRE
   FML PLACEMENT QUALITY       =  3 - GOOD

                     LAYER  11 (GCL)
                      --------
                 TYPE 3 - BARRIER SOIL LINER
                 MATERIAL TEXTURE NUMBER  17
   THICKNESS                   =      0.25   INCHES
   POROSITY                    =      0.7500 VOL/VOL
   FIELD CAPACITY              =      0.7470 VOL/VOL
   WILTING POINT               =      0.4000 VOL/VOL
```

```
   INITIAL SOIL WATER CONTENT  =      0.7500 VOL/VOL
   EFFECTIVE SAT. HYD. CONDUCT.   =  0.300000003000E-08 CM/SEC
```

GENERAL DESIGN AND EVAPORATIVE ZONE DATA
----------------------------------------

```
NOTE:  SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
         SOIL DATA BASE USING SOIL TEXTURE # 5 WITH A
         POOR STAND OF GRASS, A SURFACE SLOPE OF  2.%
         AND A SLOPE LENGTH OF   77. FEET.

SCS RUNOFF CURVE NUMBER              =     78.70
FRACTION OF AREA ALLOWING RUNOFF     =      0.0    PERCENT
AREA PROJECTED ON HORIZONTAL PLANE   =      1.000  ACRES
EVAPORATIVE ZONE DEPTH               =     10.0    INCHES
INITIAL WATER IN EVAPORATIVE ZONE    =      1.487  INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE   =      3.414  INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE   =      0.424  INCHES
INITIAL SNOW WATER                   =      0.000  INCHES
INITIAL WATER IN LAYER MATERIALS     =     40.761  INCHES
TOTAL INITIAL WATER                  =     40.761  INCHES
TOTAL SUBSURFACE INFLOW              =      0.00   INCHES/YEAR
```

EVAPOTRANSPIRATION AND WEATHER DATA
-----------------------------------

```
NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
         TAMPA                  FLORIDA

     STATION LATITUDE                        =  27.58 DEGREES
     MAXIMUM LEAF AREA INDEX                 =   1.00
     START OF GROWING SEASON (JULIAN DATE)   =      0
     END OF GROWING SEASON (JULIAN DATE)     =    367
     EVAPORATIVE ZONE DEPTH                  =  10.0  INCHES
     AVERAGE ANNUAL WIND SPEED               =   8.60 MPH
     AVERAGE 1ST QUARTER RELATIVE HUMIDITY   =  74.00 %
     AVERAGE 2ND QUARTER RELATIVE HUMIDITY   =  72.00 %
     AVERAGE 3RD QUARTER RELATIVE HUMIDITY   =  78.00 %
     AVERAGE 4TH QUARTER RELATIVE HUMIDITY   =  76.00 %

NOTE:  PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
         COEFFICIENTS FOR    TAMPA                FLORIDA
```

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

| JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|
| 1.85 | 2.58 | 3.39 | 2.95 | 2.52 | 8.31 |
| 7.83 | 7.98 | 5.61 | 2.86 | 1.94 | 1.84 |

```
NOTE:  TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
         COEFFICIENTS FOR    TAMPA                FLORIDA
```

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

| JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|
| 59.80 | 60.80 | 66.20 | 71.60 | 77.10 | 80.90 |
| 82.20 | 82.20 | 80.90 | 74.50 | 66.70 | 61.30 |

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR TAMPA FLORIDA
AND STATION LATITUDE = 27.58 DEGREES

*******************************************************************************

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 28

| | JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|---|
| **PRECIPITATION** | | | | | | |
| TOTALS | 1.82 | 2.13 | 3.38 | 2.54 | 3.05 | 7.89 |
| | 8.50 | 7.72 | 5.34 | 2.65 | 1.83 | 1.84 |
| STD. DEVIATIONS | 1.56 | 2.17 | 2.92 | 1.84 | 2.10 | 3.63 |
| | 3.41 | 2.59 | 2.44 | 2.42 | 2.77 | 2.09 |
| **RUNOFF** | | | | | | |
| TOTALS | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| STD. DEVIATIONS | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| **EVAPOTRANSPIRATION** | | | | | | |
| TOTALS | 1.203 | 1.344 | 2.059 | 1.885 | 2.082 | 4.529 |
| | 5.260 | 4.901 | 3.519 | 1.745 | 1.069 | 0.945 |
| STD. DEVIATIONS | 0.828 | 0.916 | 1.334 | 1.077 | 1.189 | 1.251 |
| | 1.170 | 1.118 | 1.151 | 1.116 | 0.815 | 0.784 |
| **LATERAL DRAINAGE COLLECTED FROM LAYER 7** | | | | | | |
| TOTALS | 0.6323 | 0.5178 | 0.9212 | 1.0574 | 0.6301 | 1.1921 |
| | 3.1021 | 3.3364 | 2.4803 | 1.7707 | 0.9523 | 0.9359 |
| STD. DEVIATIONS | 0.8854 | 0.6753 | 1.5791 | 1.4297 | 0.6474 | 1.3880 |
| | 2.0451 | 2.0808 | 1.6819 | 1.4914 | 1.1537 | 1.7179 |
| **PERCOLATION/LEAKAGE THROUGH LAYER 8** | | | | | | |
| TOTALS | 0.0361 | 0.0335 | 0.0418 | 0.0450 | 0.0388 | 0.0463 |
| | 0.0825 | 0.0906 | 0.0774 | 0.0657 | 0.0466 | 0.0415 |

```
     STD. DEVIATIONS    0.0233   0.0167   0.0275   0.0283   0.0159   0.0254
                        0.0354   0.0342   0.0261   0.0245   0.0204   0.0306

  LATERAL DRAINAGE COLLECTED FROM LAYER  9
  ----------------------------------------
    TOTALS              0.0361   0.0335   0.0418   0.0450   0.0388   0.0463
                        0.0825   0.0906   0.0774   0.0657   0.0466   0.0415
     STD. DEVIATIONS    0.0233   0.0167   0.0275   0.0283   0.0159   0.0254
                        0.0354   0.0342   0.0261   0.0245   0.0204   0.0306

  PERCOLATION/LEAKAGE THROUGH LAYER 11
  ------------------------------------
    TOTALS              0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                        0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

    STD. DEVIATIONS     0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                        0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
-----------------------------------------------------------------------------
             AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)
-----------------------------------------------------------------------------
  DAILY AVERAGE HEAD ON TOP OF LAYER  8
  -------------------------------------
    AVERAGES            0.0019   0.0017   0.0027   0.0033   0.0019   0.0037
                        0.0092   0.0099   0.0076   0.0053   0.0029   0.0028

    STD. DEVIATIONS     0.0026   0.0022   0.0047   0.0044   0.0019   0.0043
                        0.0061   0.0062   0.0052   0.0044   0.0036   0.0051

  DAILY AVERAGE HEAD ON TOP OF LAYER 10
  ------------------------------------
    AVERAGES            0.0002   0.0002   0.0002   0.0002   0.0002   0.0002
                        0.0004   0.0004   0.0004   0.0003   0.0002   0.0002

    STD. DEVIATIONS     0.0001   0.0001   0.0001   0.0001   0.0001   0.0001
                        0.0002   0.0002   0.0001   0.0001   0.0001   0.0001

*****************************************************************************
*****************************************************************************
     AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS    1 THROUGH   28
-----------------------------------------------------------------------------
                                   INCHES          CU. FEET      PERCENT
                             -------------------  -------------  ---------
 PRECIPITATION                   48.67    (   9.518)     176683.8     100.00

 RUNOFF                           0.000   (  0.0000)          0.00      0.000

 EVAPOTRANSPIRATION              30.541   (  4.6932)     110864.10     62.747

 LATERAL DRAINAGE COLLECTED   17.52875 (  5.75987)     63629.359   36.01313
   FROM LAYER  7

  PERCOLATION/LEAKAGE THROUGH 0.64569 (  0.11219)      2343.851    1.32658
   LAYER  8
```

```
  AVERAGE HEAD ON TOP             0.004 (    0.001)
   OF LAYER  8

 LATERAL DRAINAGE COLLECTED    0.64569 (  0.11219)      2343.850    1.32658
   FROM LAYER  9

 PERCOLATION/LEAKAGE THROUGH  0.00000 (  0.00000)         0.001    0.00000
   LAYER 11

 AVERAGE HEAD ON TOP             0.000 (    0.000)
   OF LAYER 10

 CHANGE IN WATER STORAGE       -0.042   (  1.8222)       -153.55     -0.087

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```
******************************************************************************
              PEAK DAILY VALUES FOR YEARS    1 THROUGH   28
    --------------------------------------------------------------------------
                                                    (INCHES)      (CU. FT.)
                                                   ----------   -------------
       PRECIPITATION                                 7.60        27588.000

       RUNOFF                                        0.000           0.0000

       DRAINAGE COLLECTED FROM LAYER  7              0.79236      2876.27368

       PERCOLATION/LEAKAGE THROUGH LAYER  8          0.009838       35.71165

       AVERAGE HEAD ON TOP OF LAYER  8               0.073

       MAXIMUM HEAD ON TOP OF LAYER  8               0.142

       LOCATION OF MAXIMUM HEAD IN LAYER  7
             (DISTANCE FROM DRAIN)                   2.2 FEET

       DRAINAGE COLLECTED FROM LAYER  9              0.00984        35.71164

       PERCOLATION/LEAKAGE THROUGH LAYER 11          0.000000        0.00000

       AVERAGE HEAD ON TOP OF LAYER 10               0.001

       MAXIMUM HEAD ON TOP OF LAYER 10               0.000

       LOCATION OF MAXIMUM HEAD IN LAYER  9
             (DISTANCE FROM DRAIN)                   0.0 FEET

       SNOW WATER                                    0.00            0.0000

       MAXIMUM VEG. SOIL WATER (VOL/VOL)                     0.3324

       MINIMUM VEG. SOIL WATER (VOL/VOL)                     0.0424

        ***  Maximum heads are computed using McEnroe's equations.  ***

             Reference:  Maximum Saturated Depth over Landfill Liner
                         by Bruce M. McEnroe, University of Kansas
                         ASCE Journal of Environmental Engineering
                         Vol. 119, No. 2, March 1993, pp. 262-270.

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FINAL WATER STORAGE AT END OF YEAR 28

| LAYER | (INCHES) | (VOL/VOL) |
|---|---|---|
| 1 | 0.3324 | 0.0554 |
| 2 | 8.5597 | 0.0713 |
| 3 | 8.7600 | 0.0730 |
| 4 | 8.7600 | 0.0730 |
| 5 | 8.7600 | 0.0730 |
| 6 | 4.2113 | 0.1755 |
| 7 | 0.0030 | 0.0111 |
| 8 | 0.0000 | 0.0000 |
| 9 | 0.0027 | 0.0100 |
| 10 | 0.0000 | 0.0000 |
| 11 | 0.1875 | 0.7500 |
| SNOW WATER | 0.000 | |

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# Attachment K

# Summary Table of Groundwater Elevations

SCS ENGINEERS



| CLIENT | PROJECT | JOB NO. |
|---|---|---|
| Hardee County | Phase II Section II Expansion | 09199033.23 |

| SUBJECT | BY | DATE |
|---|---|---|
| Responses to RAI No. 1<br>Phase II Section II Expansion Area<br>Site Groundwater Data | SRF | 8/31/12 |
| | CHECKED | DATE |

| Monitoring | Site Groundwater Data | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Point | Jun-99 | Dec-99 | Jun-00 | Dec-00 | Jun-01 | Dec-01 | Mar-02 | Jun-02 | Dec-02 | Jun-03 | Dec-03 | May-04 | Dec-04 | May-05 | Nov-05 |
| MW-1 | 79.97 | 82.17 | 78.27 | 81.77 | 81.67 | 81.17 | | 79.97 | 84.12 | 83.72 | | 81.42 | 80.87 | 81.67 | 81.97 |
| MW-2 | 76.86 | 78.76 | 75.56 | 77.56 | 77.06 | 78.16 | | 76.36 | 82.46 | 80.26 | | 77.91 | 78.26 | 79.06 | 79.41 |
| MW-3 | | | | | 76.45 | | | | | | | | | | |
| MW-4 | 77.71 | 79.96 | 76.56 | 78.66 | 77.86 | 79.96 | | 77.56 | 83.06 | 81.36 | | 79.26 | 79.61 | 80.14 | 80.71 |
| MW-5 | 77.71 | 79.76 | 76.46 | 77.96 | 76.56 | 79.51 | | 77.46 | 81.56 | 79.81 | | 78.76 | 79.76 | 80.46 | 80.06 |
| MW-6 | 75.59 | | 74.54 | 75.54 | 74.64 | 77.44 | | 74.54 | 83.44 | 75.69 | | 77.44 | | | |
| MW-7 | 75.86 | | 74.36 | 75.51 | 74.41 | 75.91 | | 74.91 | 83.26 | 76.46 | | 75.91 | | | |
| MW-8 | | | 76.18 | 77.58 | 75.58 | 80.28 | 78.38 | 76.38 | 83.18 | 78.38 | | 77.88 | 79.98 | 80.48 | 80.13 |
| MW-9 | | | 75.51 | 76.91 | 75.31 | 78.71 | | 76.21 | 83.11 | 77.11 | | 77.31 | 79.46 | 80.11 | 80.01 |
| MW-10R | | | | | | | | | | | | | | | |
| MW-11 | | | | | | | | | | | | | | | |
| MW-12R | | | | | | | | | | | | | | | |
| P-7 | | | | | | | | | | | | | | | |
| P-8 | | | | | | | | | | | | | | | |
| P-11 | 76.01 | 78.16 | 75.86 | 76.36 | 76.06 | 77.76 | | 72.96 | 78.06 | 78.06 | | 77.16 | | | |
| P-13 | | | | | | | | | | | | | | | |
| P-14 | | | | | | | | | | | | | | | |
| P-16 | | | 72.65 | 76.33 | | 75.75 | | 70.33 | 79.63 | 75.73 | | 76.33 | | | |
| P-17 | | | | | | | | | | | | | | | |
| P-18 | | | | | | | | | | | | | | | |
| P-19 | | | | | | | | | | | | | | | |
| P-20 | | | | | | | | | | | | | | | |
| P-21 | | | | | | | | | | | | | | | |
| P-22 | | | | | | | | | | | | | | | |
| P-23 | | | | | | | | | | | | | | | |

| | | |
|---|---|---|
| MW-3 | = High groundwater elevation used for Phase II Section II south design = | 82.63 |
| MW-5 | = High groundwater elevation used for Phase II Section II sump design = | 82.09 |
| MW-8 | = High groundwater elevation used for Phase II Section II south design = | 83.18 |
| Average Groundwater table In the area of the Phase II Section II sump EL = | | 79.40 |

**Revised April 1, 2013**

SCS ENGINEERS

SHEET 2 OF 2

| CLIENT | PROJECT | JOB NO. |
|---|---|---|
| Hardee County | Phase II Section II Expansion | 09199033.23 |

| SUBJECT | BY | DATE |
|---|---|---|
| Responses to RAI No. 1 | SRF | 8/31/12 |
| Phase II Section II Expansion Area | CHECKED | DATE |
| Site Groundwater Data | | |

| Monitoring | Site Groundwater Data | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Point | Jun-06 | Nov-06 | Jun-07 | Dec-07 | Jun-08 | Nov-08 | Jun-09 | Dec-09 | Jun-10 | Nov-10 | Jun-11 | Dec-11 | Jun-12 | Dec-12 | Average | Minimum | Maximum |
| MW-1 | | 81.14 | | 81.10 | 81.89 | 81.62 | 84.17 | 83.86 | 82.70 | 82.14 | 81.27 | 81.44 | 84.37 | 81.20 | 81.83 | 78.27 | 84.37 |
| MW-2 | 76.26 | 77.84 | 77.74 | 77.96 | 77.23 | 78.90 | 81.24 | 81.52 | 79.70 | 79.52 | 78.21 | 78.86 | 82.62 | 78.50 | 78.66 | 75.56 | 82.62 |
| MW-3 | | | | | 77.62 | 80.47 | 81.73 | 81.28 | 81.10 | 81.00 | 79.48 | 80.61 | 82.63 | 80.27 | 80.24 | 76.45 | 82.63 |
| MW-4 | 77.61 | 79.46 | | 79.48 | 78.23 | 80.34 | 82.01 | 81.87 | 81.00 | 80.63 | 79.37 | 80.28 | 82.39 | 79.90 | 79.81 | 76.56 | 83.06 |
| MW-5 | 77.60 | 80.36 | 77.94 | 79.01 | 77.50 | 80.16 | 81.14 | 82.09 | 80.50 | 80.46 | 79.37 | 80.40 | 81.93 | 79.50 | 79.40 | 76.46 | 82.09 |
| MW-6 | | | | | 77.16 | 79.11 | 81.59 | 81.93 | 80.00 | 79.46 | 78.53 | 78.80 | Abandoned | | 77.97 | 74.54 | 83.44 |
| MW-7 | | | | | 76.94 | 79.16 | 81.81 | 81.62 | 79.75 | 79.75 | 78.63 | 79.04 | 82.19 | 78.87 | 78.12 | 74.36 | 83.26 |
| MW-8 | 76.98 | 78.50 | 76.91 | 76.91 | 76.61 | 79.48 | 80.59 | 81.76 | 80.30 | 79.72 | 78.88 | 79.73 | 83.08 | 78.40 | 78.93 | 75.58 | 83.18 |
| MW-9 | | | | | | | | | | | | | | | 78.16 | 75.31 | 83.11 |
| MW-10R | | | | | 77.34 | 79.39 | 80.95 | 81.64 | 79.90 | 79.63 | 78.98 | 79.72 | 80.68 | 78.90 | 79.71 | 77.34 | 81.64 |
| MW-11 | | | | | 77.04 | 79.22 | 81.02 | 81.98 | 79.90 | 79.53 | 78.64 | 78.86 | 81.08 | 78.60 | 79.59 | 77.04 | 81.98 |
| MW-12R | | | | | 77.10 | 79.40 | 81.30 | 82.12 | 83.10 | 79.83 | 78.82 | 79.11 | 82.38 | 78.80 | 80.20 | 77.10 | 83.10 |
| P-7 | | | | | 77.36 | 79.02 | 81.45 | 81.53 | 80.17 | 79.10 | 78.33 | 78.63 | Abandoned | | 79.45 | 77.36 | 81.53 |
| P-8 | | | | | 77.09 | 78.73 | 80.87 | 79.50 | 79.53 | 79.12 | 78.37 | 78.74 | 81.62 | 78.73 | 79.23 | 77.09 | 81.62 |
| P-11 | | | | | 77.99 | 80.01 | 81.74 | 81.74 | 80.67 | 80.40 | 79.50 | 80.21 | 82.91 | 80.44 | 78.60 | 72.96 | 82.91 |
| P-13 | | | | | 77.08 | 79.21 | 81.75 | 81.92 | 80.07 | 79.68 | 78.65 | 78.94 | 82.17 | 78.81 | 79.83 | 77.08 | 82.17 |
| P-14 | | | | | 77.22 | 78.93 | 81.83 | 81.78 | 79.98 | 79.42 | 78.53 | 78.83 | 82.36 | 78.77 | 79.77 | 77.22 | 82.36 |
| P-16 | | | | | | | | | | | | | | | 75.25 | 70.33 | 79.63 |
| P-17 | | | | | 78.86 | 81.98 | 84.15 | 84.15 | 82.57 | 82.58 | 80.97 | 81.86 | 84.80 | 81.97 | 82.39 | 78.86 | 84.80 |
| P-18 | | | | | 78.72 | 80.67 | 83.63 | 83.53 | 82.12 | 81.49 | 78.89 | 80.42 | 84.24 | 80.53 | 81.42 | 78.72 | 84.24 |
| P-19 | | | | | 78.30 | 80.52 | 84.21 | 82.92 | 84.25 | 81.15 | 79.71 | 80.63 | 84.45 | 80.66 | 81.68 | 78.30 | 84.45 |
| P-20 | | | | | 78.57 | 80.46 | 83.21 | 82.70 | 82.74 | 80.99 | 79.66 | 80.59 | 83.00 | 80.62 | 81.25 | 78.57 | 83.21 |
| P-21 | | | | | 76.74 | 79.18 | 81.51 | 81.18 | 79.62 | 79.45 | 78.43 | 79.27 | 82.09 | 79.38 | 79.69 | 76.74 | 82.09 |
| P-22 | | | | | 76.38 | 79.17 | 81.52 | 81.40 | 79.38 | 79.81 | 78.40 | 79.14 | 82.48 | 78.86 | 79.65 | 76.38 | 82.48 |
| P-23 | | | | | 76.01 | 78.57 | 81.40 | 80.78 | 81.40 | 81.40 | 81.40 | 78.52 | 81.80 | 78.38 | 79.97 | 76.01 | 81.80 |

| | | |
|---|---|---|
| MW-3 | = High groundwater elevation used for Phase II Section II south design = | 82.63 |
| MW-5 | = High groundwater elevation used for Phase II Section II sump design = | 82.09 |
| MW-8 | = High groundwater elevation used for Phase II Section II south design = | 83.18 |
| Average Groundwater table In the area of the Phase II Section II sump EL = | | 79.40 |

Notes:

The Facility had a leachate spray irrigation system in operation until April of 1999. Consequently, groundwater elevation data prior to April of 1999 may have been influenced to some extent by the underdrain system or spray field operations.

**Revised April 1, 2013**

# Attachment L

- Liner Buoyancy Calculations
- Leachate Collection Sump Buoyancy Calculations
- Leachate Collection and Detection Header Pipes Buoyancy Calculations
- 8-inch Leachate Lateral Collection Trench Buoyancy Calculations
- 10-inch Leachate Lateral Collection Trench Buoyancy Calculations

# Liner Buoyancy Calculations

SCS ENGINEERS

SHEET 1 OF 1

| CLIENT | PROJECT | JOB NO. |
|---|---|---|
| Hardee County | Phase II Section II Expansion | 09199033.23 |

| SUBJECT | BY | DATE |
|---|---|---|
| | SRF | 4/1/13 |
| Buoyancy Calculations<br>Bottom Liner System | CHECKED | DATE |

OBJECTIVE: Verify the pressure acting down resists the bouyant forces of the water.

KNOWN:

| | | | |
|---|---|---|---|
| Drainage sand layer thickness = | 2.0 | ft | Conservatively did not include the additional weight of the mounding in the leachate trenches or sump |
| Stone thickness = | 0.0 | ft | Conservatively did not include the weight of the stone within the leachate trenches or sump, assumed weight of drainage sand |
| Base liner elevation = | 78.50 | ft NGVD | |
| High water elevation = | 82.09 | ft NGVD | |
| Bottom liner system area, $A_{Liner}$ = | 94,692.0 | $ft^2$ | From AutoCAD the area between EL 82.09 feet NGVD to EL 78.5 feet NGVD. |
| Density of water $\gamma_{water}$ = | 62.4 | $lb/ft^3$ | |
| Density of sand $\gamma_{sand}$ = | 115.0 | $lb/ft^3$ | Refer to Attachment 1 |
| Density of stone $\gamma_{stone}$ = | 0.0 | $lb/ft^3$ | Conservatively did not include the weight of the stone within the leachate trenches, assumed weight of drainage sand |
| Bouyant force = | 10,606,261.5 | lbs | |
| Resisting force (sand) = | 21,779,160.00 | lbs | |

$$FS = \frac{21,779,160.00}{10,606,261.54}$$

FS = 2.05

# Leachate Collection Sump Buoyancy Calculations

SCS ENGINEERS

SHEET 1 OF 1

| CLIENT | PROJECT | JOB NO. |
|---|---|---|
| Hardee County | Phase II Section II Expansion | 09199033.23 |

| SUBJECT | BY | DATE |
|---|---|---|
| Buoyancy Calculations<br>Leachate Collection Sump | SRF | 8/31/12 |
| | CHECKED | DATE |

OBJECTIVE: Verify the pressure acting down resists the bouyant forces of the water.

KNOWN:

| | | | | | |
|---|---|---|---|---|---|
| Drainage sand layer thickness (1) = | 2.0 | ft | | | |
| Stone thickness (2) = | 3.0 | ft | | | |
| Nominal pipe diameter (3) = | 24.0 | in | SDR 11 | | |
| Pipe OD = | 2.00 | ft | 24.000 | in | Refer to Attachment 1 |
| Pipe area (ID) = | 2.05 | $ft^2$ | 19.374 | in | Refer to Attachment 1 |
| Pipe area (OD) = | 3.14 | $ft^2$ | 65.58 | lbs/ft | Refer to Attachment 1 |

| | | | | | |
|---|---|---|---|---|---|
| Sump depth ($h_b$) = | 1.0 | ft | | | |
| Sump bottom width (4) = | 20.0 | ft | Sump bottom length = | 20.0 | ft |
| W = Sump top width = | 24.0 | ft | Sump top length = | 24.0 | ft |

| | | | | | |
|---|---|---|---|---|---|
| Sump depth ($h_t$) = | 2.0 | ft | | | |
| a = Sump bottom width = | 24.0 | ft | Sump bottom length = | 24.0 | ft |
| W = Sump top width (5) = | 16.0 | ft | Sump top length = | 16.0 | ft |

| | | |
|---|---|---|
| Sump side slope left = | 2.0 | :1 |
| Sump side slope right = | 2.0 | :1 |
| Sump bottom area, $A_{sump}$ = | 22.00 | $ft^2$ |

| | | | |
|---|---|---|---|
| Volume of pipe per foot (OD) = | 6.28 | $ft^3$ | With two 24 inch riser pipes in sump |
| Volume of pipe = | 125.66 | $ft^3$ | |
| Weight of pipe = | 2,623.20 | lbs | |

| | | | |
|---|---|---|---|
| Volume of stone lower portion of sump = | 485.33 | $ft^3$ | |
| Volume of stone upper portion of sump = | 917.33 | $ft^3$ | |
| Total volume of stone = | 1,277.00 | $ft^3$ | Less volume of pipes |
| Weight stone in sump = | 178,780.41 | lbs | |

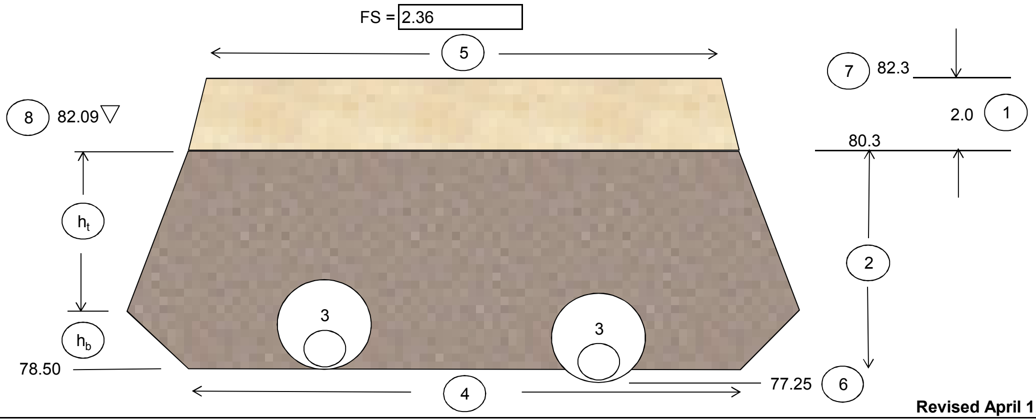
| | | |
|---|---|---|
| Volume of sand above sump = | 1152.00 | $ft^3$ |
| Weight of sand above sump = | 132,480.00 | lbs |

| | | | |
|---|---|---|---|
| Base liner elevation (6) = | 77.25 | ft | Sump bottom EL 78.5, lowest elevation uner leachate detection |
| Finish grade elevation (7) = | 82.3 | ft | riser pipe is 77.25. Conservatively used lowest elevation for buoyancy. |
| High Water elevation (8) = | 82.09 | ft | |
| Density of sand $\gamma_{sand}$ = | 115.0 | $lb/ft^3$ | Refer to Attachment 2 |
| Density of water $\gamma_{water}$ = | 62.4 | $lb/ft^3$ | |
| Density of stone $\gamma_{stone}$ = | 140.0 | $lb/ft^3$ | Refer to Attachment 2 |

| | | |
|---|---|---|
| Bouyant force = | 132,887.04 | lbs |
| Resisting force (sand + stone + pipe) = | 313,883.61 | lbs |

$$FS = \frac{313{,}883.61}{132{,}887.04}$$

FS = 2.36




Revised April 1, 2013

# Leachate Collection and Detection Header Pipes Buoyancy Calculations

SCS ENGINEERS

SHEET 1 OF 1

| CLIENT | PROJECT | JOB NO. |
|---|---|---|
| Hardee County | Phase II Section II Expansion | 09199033.23 |

| SUBJECT | BY | DATE |
|---|---|---|
| RAI No. 1<br>Buoyancy Calculations<br>8-inch Leachate Collection Lateral Pipe | SRF | 4/1/13 |
| | CHECKED | DATE |

OBJECTIVE: Verify the pressure acting down resists the bouyant forces of the water.

KNOWN:

| | | | | | |
|---|---|---|---|---|---|
| Drainage sand layer thickness = | 2.00 | ft | Drainage sand layer thickness = | 4.60 | ft |
| Stone thickness = | 3.00 | ft | Stone thickness = | 0.54 | ft |
| Trench depth = | 5.00 | ft | Trench depth = | 5.14 | ft |
| Nominal pipe diameter = | 12.0 | in | Nominal pipe diameter = | 8.0 | in |
| Pipe OD = | 1.06 | ft | Pipe OD = | 0.72 | ft |
| Pipe area (ID) = | 0.58 | $ft^2$ | Pipe area (ID) = | 0.26 | $ft^2$ |
| Pipe area (OD) = | 0.89 | $ft^2$ | Pipe area (OD) = | 0.41 | $ft^2$ |

| | | | | |
|---|---|---|---|---|
| SDR 11 | | | SDR 11 | |
| 12.750 | in OD | Refer to Attachment 1 | 8.625 | in OD |
| 10.293 | in ID | | 6.963 | in ID |
| 18.51 | lbs/ft | | 8.47 | lbs/ft |

| | | | | | |
|---|---|---|---|---|---|
| Trench bottom width = | 6.0 | ft | Trench bottom width = | 1.58 | ft |
| Trench top width = | 2.0 | ft | Trench top width = | 0.79 | ft |
| Trench area per foot (trapezoid), $A_{trench}$ = | 12.00 | $ft^2$ | Trench area per foot (trapezoid), $A_{trench}$ = | 0.64 | $ft^2$ |
| Trench bottom area per foot, $A_{trench\ bottom}$ = | 6.00 | $ft^2$ | Trench bottom area per foot, $A_{trench\ bottom}$ = | 1.58 | $ft^2$ |

| | | | |
|---|---|---|---|
| Base liner elevation = | 79.5 | ft | Refer to construction drawings |
| Finish grade elevation = | 84.5 | ft | |
| High Water elevation = | 82.09 | ft | Refer to construction drawings |
| Density of sand $\gamma_{sand}$ = | 115.0 | $lb/ft^3$ | Refer to Attachment 2 |
| Density of water $\gamma_{water}$ = | 62.4 | $lb/ft^3$ | |
| Density of stone $\gamma_{stone}$ = | 140.0 | $lb/ft^3$ | Refer to Attachment 2 |

| | | | | | |
|---|---|---|---|---|---|
| Volume of pipe per foot (OD) = | 0.89 | $ft^3$ | Volume of pipe per foot (OD) = | 0.41 | $ft^3$ |
| Volume of stone per foot (less pipe) = | 11.11 | $ft^3$ | Volume of stone per foot (less pipe) = | 0.64 | $ft^3$ |
| Weight of stone per foot (less pipe) = | 1,555.87 | lbs | Weight of stone per foot (less pipe) = | 89.40 | lbs |

| | | | |
|---|---|---|---|
| Volume of sand per foot = | 40.23 | $ft^3$ | Per AutoCAD |
| Weight of sand per foot = | 4,626.68 | lbs | |

Resisting force per foot (sand + stone + pipe) = 6,290.46 lbs

Bouyant force = 1,225.05 lbs

$$FS = \frac{6,290.46}{1,225.05}$$

FS = 5.13

**Revised April 1, 2013**

# 8-inch Leachate Lateral Collection Trench Buoyancy Calculations

SCS ENGINEERS

SHEET 1 OF 1

| CLIENT | PROJECT | JOB NO. |
|---|---|---|
| Hardee County | Phase II Section II Expansion | 09199033.23 |

| SUBJECT | BY | DATE |
|---|---|---|
| RAI No. 1 | SRF | 4/1/13 |
| Buoyancy Calculations | CHECKED | DATE |
| 8-inch Leachate Collection Lateral Pipe | | |

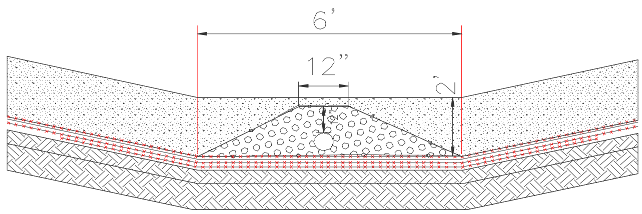
OBJECTIVE: Verify the pressure acting down resists the bouyant forces of the water.

KNOWN:

| | | | |
|---|---|---|---|
| Drainage sand layer thickness = | 0.28 | ft | Refer to construction drawings |
| Stone thickness = | 1.72 | ft | Refer to construction drawings |
| Trench depth = | 2.00 | ft | |
| Nominal pipe diameter = | 8.0 | in | SDR 11 Leachate collection lateral pipe |
| Pipe OD = | 0.72 | ft | 8.625 in OD Refer to Attachment 1 |
| Pipe area (ID) = | 0.26 | $ft^2$ | 6.963 in ID Refer to Attachment 1 |
| Pipe area (OD) = | 0.41 | $ft^2$ | 8.47 lbs/ft Refer to Attachment 1 |
| Trench bottom width = | 6.0 | ft | Refer to construction drawings |
| Trench top width = | 1.0 | ft | Refer to construction drawings |
| Trench area per foot (trapezoid), $A_{trench}$ = | 6.02 | $ft^2$ | |
| Trench bottom area per foot, $A_{trench\ bottom}$ = | 6.00 | $ft^2$ | |
| Base liner elevation = | 79.5 | ft | Refer to construction drawings |
| Finish grade elevation = | 81.5 | ft | |
| High Water elevation = | 82.09 | ft | Refer to construction drawings |
| Density of sand $\gamma_{sand}$ = | 115.0 | $lb/ft^3$ | Refer to Attachment 2 |
| Density of water $\gamma_{water}$ = | 62.4 | $lb/ft^3$ | |
| Density of stone $\gamma_{stone}$ = | 140.0 | $lb/ft^3$ | Refer to Attachment 2 |
| Volume of pipe per foot (OD) = | 0.41 | $ft^3$ | |
| Volume of stone per foot (less pipe) = | 5.61 | $ft^3$ | |
| Weight of stone per foot (less pipe) = | 786.00 | lbs | |
| Volume of sand per foot = | 5.98 | $ft^3$ | Per AutoCAD |
| Weight of sand per foot = | 687.70 | lbs | |
| Resisting force per foot (sand + stone + pipe) = | 1,482.17 | lbs | |
| Bouyant force = | 969.70 | lbs | |

$$FS = \frac{1,482.17}{969.70}$$

FS = 1.53



# 10-inch Leachate Lateral Collection Trench Buoyancy Calculations

SCS ENGINEERS

SHEET 1 OF 1

| CLIENT | PROJECT | JOB NO. |
|---|---|---|
| Hardee County | Phase II Section II Expansion | 09199033.23 |

| SUBJECT | BY | DATE |
|---|---|---|
| RAI No. 1 | SRF | 4/1/13 |
| Buoyancy Calculations | CHECKED | DATE |
| 10-inch Leachate Collection Lateral Pipe | | |

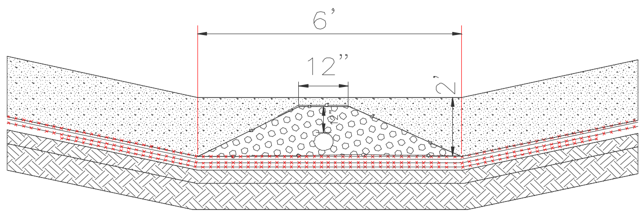
OBJECTIVE: Verify the pressure acting down resists the bouyant forces of the water.

KNOWN:

| | | | |
|---|---|---|---|
| Drainage sand layer thickness = | 0.28 | ft | Refer to construction drawings |
| Stone thickness = | 1.72 | ft | Refer to construction drawings |
| Trench depth = | 2.00 | ft | |
| Nominal pipe diameter = | 10.0 | in | SDR 11 Leachate collection lateral pipe |
| Pipe OD = | 0.90 | ft | 10.750 in OD Refer to Attachment 1 |
| Pipe area (ID) = | 0.41 | $ft^2$ | 8.679 in ID Refer to Attachment 1 |
| Pipe area (OD) = | 0.63 | $ft^2$ | 13.16 lbs/ft Refer to Attachment 1 |
| Trench bottom width = | 6.0 | ft | Refer to construction drawings |
| Trench top width = | 1.0 | ft | Refer to construction drawings |
| Trench area per foot (trapezoid), $A_{trench}$ = | 6.02 | $ft^2$ | |
| Trench bottom area per foot, $A_{trench\ bottom}$ = | 6.00 | $ft^2$ | |
| Base liner elevation = | 80.0 | ft | Refer to construction drawings |
| Finish grade elevation = | 82.0 | ft | |
| High Water elevation = | 82.09 | ft | Refer to construction drawings |
| Density of sand $\gamma_{sand}$ = | 115.0 | $lb/ft^3$ | Refer to Attachment 2 |
| Density of water $\gamma_{water}$ = | 62.4 | $lb/ft^3$ | |
| Density of stone $\gamma_{stone}$ = | 140.0 | $lb/ft^3$ | Refer to Attachment 2 |
| Volume of pipe per foot (OD) = | 0.63 | $ft^3$ | |
| Volume of stone per foot (less pipe) = | 5.39 | $ft^3$ | |
| Weight of stone per foot (less pipe) = | 754.56 | lbs | |
| Volume of sand per foot = | 5.98 | $ft^3$ | Per AutoCAD |
| Weight of sand per foot = | 687.70 | lbs | |
| Resisting force per foot (sand + stone + pipe) = | 1,455.42 | lbs | |
| Bouyant force = | 782.50 | lbs | |

$$FS = \frac{1,455.42}{782.50}$$

FS = 1.86



# Attachment M

# Rainfall Data

SCS ENGINEERS

SHEET 1 OF 1

| CLIENT | PROJECT | JOB NO. |
|---|---|---|
| Hardee County | Phase II Section II Expansion | 09199033.23 |

| SUBJECT | BY | DATE |
|---|---|---|
| | SRF | 8/31/12 |
| Monthly Rainfall Data<br>Site Specific | CHECKED | DATE |

| Month | Rainfall (inches) |
|---|---|
| Jan-98 | ND |
| Feb-98 | 10.10 |
| Mar-98 | 10.70 |
| Apr-98 | 3.10 |
| May-98 | 2.00 |
| Jun-98 | 4.10 |
| Jul-98 | 5.10 |
| Aug-98 | 8.20 |
| Sep-98 | 11.10 |
| Oct-98 | ND |
| Nov-98 | ND |
| Dec-98 | ND |
| 1998 Total: | 54.40 |

| Month | Rainfall (inches) |
|---|---|
| Jan-03 | 0.00 |
| Feb-03 | 1.30 |
| Mar-03 | 2.40 |
| Apr-03 | 3.45 |
| May-03 | 5.07 |
| Jun-03 | 11.90 |
| Jul-03 | 7.64 |
| Aug-03 | 12.28 |
| Sep-03 | 8.00 |
| Oct-03 | 1.70 |
| Nov-03 | 1.10 |
| Dec-03 | 1.80 |
| 2003 Total: | 56.64 |

| Month | Rainfall (inches) |
|---|---|
| Jan-04 | 0.57 |
| Feb-04 | 4.40 |
| Mar-04 | 1.94 |
| Apr-04 | 1.50 |
| May-04 | 3.70 |
| Jun-04 | 9.63 |
| Jul-04 | 6.47 |
| Aug-04 | 8.73 |
| Sep-04 | 6.37 |
| Oct-04 | 1.44 |
| Nov-04 | 0.73 |
| Dec-04 | 0.65 |
| 2004 Total: | 46.13 |

| Month | Rainfall (inches) |
|---|---|
| Jan-05 | 2.60 |
| Feb-05 | 2.60 |
| Mar-05 | 9.29 |
| Apr-05 | 3.38 |
| May-05 | 2.96 |
| Jun-05 | 16.20 |
| Jul-05 | 9.46 |
| Aug-05 | 3.62 |
| Sep-05 | 1.90 |
| Oct-05 | 5.50 |
| Nov-05 | 0.52 |
| Dec-05 | 0.70 |
| 2005 Total: | 58.73 |

| Month | Rainfall (inches) |
|---|---|
| Jan-06 | 0.00 |
| Feb-06 | 2.50 |
| Mar-06 | 0.00 |
| Apr-06 | 0.00 |
| May-06 | 0.00 |
| Jun-06 | 7.92 |
| Jul-06 | 7.53 |
| Aug-06 | 8.35 |
| Sep-06 | 3.78 |
| Oct-06 | 0.00 |
| Nov-06 | 0.00 |
| Dec-06 | 1.50 |
| 2006 Total: | 31.58 |

| Month | Rainfall (inches) |
|---|---|
| Jan-07 | 1.25 |
| Feb-07 | 0.50 |
| Mar-07 | 0.75 |
| Apr-07 | 1.30 |
| May-07 | 0.00 |
| Jun-07 | 4.82 |
| Jul-07 | 7.69 |
| Aug-07 | 5.07 |
| Sep-07 | 3.40 |
| Oct-07 | 4.25 |
| Nov-07 | 0.33 |
| Dec-07 | 0.91 |
| 2007 Total: | 30.27 |

| Month | Rainfall (inches) |
|---|---|
| Jan-08 | 2.80 |
| Feb-08 | 4.00 |
| Mar-08 | 2.70 |
| Apr-08 | 1.60 |
| May-08 | 0.90 |
| Jun-08 | 10.00 |
| Jul-08 | 17.20 |
| Aug-08 | 6.20 |
| Sep-08 | 2.20 |
| Oct-08 | 0.10 |
| Nov-08 | 0.00 |
| Dec-08 | 0.00 |
| 2008 Total: | 47.70 |

| Month | Rainfall (inches) |
|---|---|
| Jan-09 | 2.00 |
| Feb-09 | 0.20 |
| Mar-09 | 1.20 |
| Apr-09 | 2.10 |
| May-09 | 6.20 |
| Jun-09 | 12.50 |
| Jul-09 | 12.30 |
| Aug-09 | 0.00 |
| Sep-09 | 5.80 |
| Oct-09 | 1.70 |
| Nov-09 | 0.20 |
| Dec-09 | 0.10 |
| 2009 Total: | 44.30 |

| Month | Rainfall (inches) |
|---|---|
| Jan-11 | 0.00 |
| Feb-11 | 0.00 |
| Mar-11 | 0.00 |
| Apr-11 | 0.10 |
| May-11 | 3.60 |
| Jun-11 | 3.10 |
| Jul-11 | 7.60 |
| Aug-11 | 5.80 |
| Sep-11 | 6.90 |
| Oct-11 | 0.70 |
| Nov-11 | 0.20 |
| Dec-11 | 0.10 |
| 2011 Total: | 28.10 |

| Month | Rainfall (inches) |
|---|---|
| Jan-12 | 0.20 |
| Feb-12 | 1.20 |
| Mar-12 | 0.20 |
| Apr-12 | 6.00 |
| May-12 | 0.50 |
| Jun-12 | 6.70 |
| Jul-12 | 4.66 |
| Aug-12 | 10.27 |
| Sep-12 | 6.34 |
| Oct-12 | 4.85 |
| Nov-12 | 0.19 |
| Dec-12 | 1.66 |
| 2012 Total: | 42.77 |

**Site Only Average**

| Month | Rainfall |
|---|---|
| Jan | 0.99 |
| Feb | 2.57 |
| Mar | 2.93 |
| Apr | 2.05 |
| May | 2.27 |
| Jun | 7.90 |
| Jul | 7.79 |
| Aug | 6.23 |
| Sep | 5.07 |
| Oct | 2.02 |
| Nov | 0.33 |
| Dec | 0.74 |
| **Average** | **40.88** |

Notes:

Site specific data obtained from the Hardee County Solid Waste Department.

**Revised April 1, 2013**

SCS ENGINEERS

SHEET 1 OF 1

| CLIENT | PROJECT | JOB NO. |
|---|---|---|
| Hardee County | Phase II Section II Expansion | 09199033.23 |

| SUBJECT | BY | DATE |
|---|---|---|
| NOAA Weather Station CoopID # 089401 Located at<br>Latitude: 27° 31' North Longitude 81° 48' West in Wauchula Period of Record 1/1/1954 to 4/30/2012<br>With Site Specific Data When Available | SRF | 8/31/12 |
| | CHECKED | DATE |

| YEAR(S) | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC | ANN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1954 | 1.62 | 2.77 | 1.19 | 4.14 | 11.32 | 11.87 | 6.61 | 8.08 | 6.00 | 2.87 | 2.23 | 2.10 | 60.80 |
| 1955 | 2.57 | 1.32 | 2.10 | 2.14 | 1.49 | 10.62 | 7.35 | 8.64 | 6.87 | 1.39 | 0.83 | 1.11 | 46.43 |
| 1956 | 0.54 | 1.25 | 0.94 | 4.25 | 5.65 | 3.69 | 5.63 | 12.11 | 6.99 | 2.79 | 0.24 | 0.12 | 44.20 |
| 1957 | 3.42 | 4.47 | 5.28 | 4.14 | 11.31 | 5.39 | 7.83 | 3.75 | 0.00 | 0.00 | 1.71 | 2.70 | 50.00 |
| 1958 | 7.20 | 4.26 | 7.72 | 2.95 | 5.11 | 3.48 | 7.87 | 3.30 | 7.09 | 2.82 | 2.99 | 4.77 | 59.56 |
| 1959 | 2.33 | 2.54 | 9.22 | 2.49 | 3.43 | 13.97 | 12.12 | 8.08 | 8.97 | 3.86 | 0.80 | 1.32 | 69.13 |
| 1960 | 0.62 | 5.46 | 4.47 | 3.39 | 2.86 | 3.72 | 14.60 | 8.40 | 13.83 | 5.11 | 0.08 | 1.37 | 63.91 |
| 1961 | 2.19 | 3.35 | 2.21 | 1.96 | 5.30 | 4.27 | 5.57 | 8.20 | 1.19 | 0.57 | 0.36 | 1.76 | 36.93 |
| 1962 | 1.07 | 0.58 | 3.77 | 6.94 | 6.27 | 14.77 | 2.80 | 7.93 | 11.41 | 0.96 | 2.30 | 0.43 | 59.23 |
| 1963 | 2.24 | 7.37 | 0.90 | 0.03 | 10.61 | 9.91 | 7.29 | 5.86 | 8.62 | 0.27 | 5.89 | 2.58 | 61.57 |
| 1964 | 3.13 | 5.04 | 4.34 | 3.39 | 2.68 | 3.26 | 6.20 | 4.84 | 8.17 | 2.78 | 0.86 | 1.16 | 45.85 |
| 1965 | 1.51 | 3.86 | 6.85 | 0.96 | 0.01 | 8.92 | 13.76 | 4.17 | 6.03 | 3.96 | 1.20 | 2.77 | 54.00 |
| 1966 | 6.49 | 4.95 | 0.84 | 2.52 | 1.82 | 5.37 | 7.16 | 5.48 | 6.70 | 1.33 | 0.24 | 0.76 | 43.66 |
| 1967 | 0.52 | 2.98 | 0.08 | 0.00 | 0.77 | 11.87 | 10.91 | 7.51 | 3.79 | 0.93 | 0.03 | 2.67 | 42.06 |
| 1968 | 0.73 | 1.79 | 1.16 | 0.65 | 7.82 | 15.85 | 10.18 | 6.50 | 5.01 | 3.43 | 2.32 | 0.37 | 55.81 |
| 1969 | 2.91 | 2.05 | 6.53 | 2.05 | 1.65 | 7.88 | 6.40 | 8.67 | 9.77 | 5.14 | 1.97 | 2.70 | 57.72 |
| 1970 | 2.89 | 2.60 | 5.80 | 0.13 | 5.01 | 5.91 | 12.31 | 4.24 | 5.96 | 2.16 | 0.84 | 0.89 | 48.74 |
| 1971 | 0.35 | 4.01 | 1.46 | 0.05 | 5.80 | 5.65 | 8.24 | 7.86 | 7.09 | 4.08 | 1.23 | 0.94 | 46.76 |
| 1972 | 0.67 | 4.70 | 4.41 | 2.11 | 7.42 | 9.05 | 5.40 | 8.83 | 1.44 | 1.65 | 4.75 | 2.68 | 53.11 |
| 1973 | 7.26 | 2.64 | 5.09 | 3.49 | 1.27 | 4.81 | 10.91 | 4.76 | 8.44 | 0.59 | 0.76 | 1.78 | 51.80 |
| 1974 | 0.03 | 1.12 | 0.30 | 1.56 | 2.74 | 14.97 | 10.05 | 7.92 | 3.58 | 0.10 | 0.16 | 2.32 | 44.85 |
| 1975 | 0.50 | 1.62 | 0.88 | 0.23 | 6.87 | 0.00 | 8.45 | 5.41 | 9.41 | 10.36 | 0.36 | 0.60 | 44.69 |
| 1976 | 1.04 | 0.69 | 0.35 | 1.60 | 8.39 | 10.74 | 9.09 | 6.33 | 3.26 | 1.57 | 1.26 | 2.56 | 46.88 |
| 1977 | 2.41 | 1.77 | 0.84 | 0.28 | 4.05 | 8.06 | 12.46 | 5.34 | 5.38 | 1.55 | 0.00 | 4.83 | 46.97 |
| 1978 | 2.93 | 3.59 | 2.09 | 0.00 | 5.68 | 7.25 | 10.40 | 6.41 | 2.70 | 1.43 | 0.97 | 2.90 | 46.35 |
| 1979 | 7.84 | 1.41 | 1.52 | 1.72 | 7.08 | 8.00 | 7.16 | 8.62 | 11.56 | 0.45 | 0.72 | 1.91 | 57.99 |
| 1980 | 2.25 | 2.37 | 1.70 | 4.66 | 6.39 | 10.05 | 4.17 | 6.02 | 2.00 | 1.24 | 3.08 | 0.78 | 44.71 |
| 1981 | 0.58 | 4.37 | 1.35 | 0.08 | 2.91 | 8.09 | 2.21 | 6.91 | 8.12 | 0.22 | 0.44 | 1.38 | 36.66 |
| 1982 | 1.13 | 3.08 | 5.35 | 4.32 | 6.50 | 15.96 | 9.08 | 2.66 | 10.95 | 1.73 | 0.82 | 0.98 | 62.56 |
| 1983 | 4.29 | 7.99 | 7.45 | 2.75 | 1.79 | 8.25 | 9.66 | 9.49 | 7.42 | 3.14 | 2.22 | 3.79 | 68.24 |
| 1984 | 0.72 | 0.00 | 3.45 | 1.73 | 6.13 | 3.82 | 7.70 | 6.85 | 5.10 | 0.36 | 1.30 | 0.47 | 37.63 |
| 1985 | 0.96 | 0.84 | 2.08 | 2.63 | 4.95 | 7.33 | 3.63 | 10.27 | 7.51 | 2.81 | 1.25 | 0.75 | 45.01 |
| 1986 | 2.66 | 1.88 | 5.78 | 0.73 | 2.22 | 11.65 | 9.08 | 7.06 | 4.79 | 3.84 | 0.82 | 5.51 | 56.02 |
| 1987 | 2.96 | 1.99 | 7.03 | 0.16 | 3.02 | 4.47 | 8.56 | 5.16 | 3.35 | 4.51 | 11.18 | 0.74 | 53.13 |
| 1988 | 1.77 | 2.56 | 5.55 | 0.70 | 3.24 | 4.48 | 12.45 | 8.06 | 7.16 | 0.65 | 3.44 | 1.17 | 51.23 |
| 1989 | 1.48 | 0.22 | 2.77 | 3.38 | 1.76 | 7.20 | 5.32 | 4.76 | 7.11 | 0.91 | 1.23 | 4.11 | 40.25 |
| 1990 | 0.14 | 4.96 | 0.68 | 2.71 | 2.05 | 5.34 | 10.76 | 10.80 | 5.65 | 1.43 | 0.45 | 1.03 | 46.00 |
| 1991 | 2.59 | 1.31 | 4.35 | 4.18 | 4.05 | 12.94 | 10.25 | 7.37 | 2.21 | 3.47 | 0.12 | 0.28 | 53.12 |
| 1992 | 0.30 | 5.21 | 2.07 | 6.44 | 1.61 | 12.75 | 2.91 | 12.76 | 4.95 | 2.95 | 1.55 | 0.69 | 54.19 |
| 1993 | 5.93 | 2.15 | 5.52 | 4.34 | 2.42 | 7.62 | 7.47 | 6.24 | 5.23 | 5.16 | 0.72 | 1.27 | 54.07 |
| 1994 | 3.20 | 1.58 | 3.34 | 1.45 | 2.71 | 13.04 | 7.29 | 7.44 | ND | ND | ND | ND | 40.05 |
| 1995 | ND | ND | ND | 6.60 | 0.65 | 8.56 | 11.41 | 9.99 | 5.58 | 8.64 | 1.45 | 0.33 | 53.21 |
| 1996 | 2.67 | 1.38 | 3.79 | 0.76 | 4.25 | 4.24 | 3.71 | 8.56 | 7.83 | 3.49 | 0.74 | 2.51 | 43.93 |
| 1997 | 0.44 | 0.30 | 2.60 | 5.95 | 2.85 | 7.42 | 12.26 | 8.66 | 5.38 | 3.24 | 10.38 | 6.29 | 57.11 |
| 1998 | ND | 10.10 | 10.70 | 3.10 | 2.00 | 4.10 | 5.10 | 8.20 | 11.10 | ND | ND | ND | NC |
| 1998 | 6.09 | 8.82 | 12.14 | 2.53 | 3.57 | 1.69 | 6.78 | 7.58 | 10.19 | 1.76 | 3.34 | 1.56 | 66.05 |
| 1999 | 3.73 | 0.80 | 0.87 | 2.65 | 2.47 | 4.08 | 2.90 | 7.26 | 5.50 | 5.61 | 2.00 | 2.40 | 40.27 |
| 2000 | 0.00 | 0.00 | 0.85 | 1.40 | 0.00 | 3.18 | 5.80 | 5.62 | 10.47 | 0.00 | 0.79 | 1.45 | 29.56 |
| 2001 | 0.00 | 0.00 | 6.98 | 0.00 | 5.37 | 9.16 | 13.31 | 6.15 | 7.03 | 0.67 | 0.80 | 0.00 | 49.47 |
| 2002 | 2.02 | 6.03 | 0.00 | 4.28 | 1.77 | 9.02 | 7.17 | 7.24 | 3.46 | 0.00 | 4.41 | 7.89 | 53.29 |
| 2003 | 0.00 | 1.30 | 2.40 | 3.45 | 5.07 | 11.90 | 7.64 | 12.28 | 8.00 | 1.70 | 1.10 | 1.80 | 56.64 |
| 2003 | 1.28 | 2.05 | 2.02 | 3.45 | 5.07 | 11.90 | 4.40 | 12.28 | 4.55 | 1.27 | 0.76 | 2.61 | 50.88 |
| 2004 | 0.57 | 4.40 | 1.94 | 1.50 | 3.70 | 9.63 | 6.47 | 8.73 | 6.37 | 1.44 | 0.73 | 0.65 | 46.13 |
| 2004 | 1.94 | 3.40 | 0.57 | 1.13 | 0.70 | 9.64 | 6.42 | 8.73 | 6.82 | 1.44 | 0.73 | 0.65 | 33.44 |
| 2005 | 2.60 | 2.60 | 9.29 | 3.38 | 2.96 | 16.20 | 9.46 | 3.62 | 1.90 | 5.50 | 0.52 | 0.70 | 58.73 |
| 2005 | 2.15 | 2.60 | 3.09 | 3.38 | 2.80 | 16.20 | 9.49 | 3.67 | 3.68 | 5.55 | 1.91 | 1.08 | 55.60 |
| 2006 | 0.00 | 2.50 | 0.00 | 0.00 | 0.00 | 7.92 | 7.53 | 8.35 | 3.78 | 0.00 | 0.00 | 1.50 | 31.58 |
| 2006 | 0.33 | 3.83 | 0.30 | 0.60 | 1.00 | 6.97 | 5.80 | 10.70 | 6.93 | 0.53 | 1.04 | 3.36 | 41.39 |
| 2007 | 1.25 | 0.50 | 0.75 | 1.30 | 0.00 | 4.82 | 7.69 | 5.07 | 3.40 | 4.25 | 0.33 | 0.91 | 30.27 |
| 2007 | 1.53 | 2.12 | 0.85 | 2.19 | 2.53 | 6.11 | 7.21 | 4.98 | 3.78 | 4.05 | 0.33 | 0.91 | 36.59 |
| 2008 | 2.80 | 4.00 | 2.70 | 1.60 | 0.90 | 10.00 | 17.20 | 6.20 | 2.20 | 0.10 | 0.00 | 0.00 | 47.70 |
| 2008 | 1.31 | 2.61 | 2.69 | 4.09 | 0.48 | 8.58 | 13.72 | 6.23 | 1.91 | 2.32 | 0.69 | 1.11 | 45.74 |
| 2009 | 2.00 | 0.20 | 1.20 | 2.10 | 6.20 | 12.50 | 12.30 | 0.00 | 5.80 | 1.70 | 0.20 | 0.10 | 44.30 |
| 2009 | 1.99 | 0.45 | 1.21 | 1.53 | 9.37 | 7.37 | 13.43 | 4.48 | 6.20 | 2.22 | 1.30 | 5.57 | 55.12 |
| 2010 | 3.09 | 2.99 | 2.39 | 1.05 | 4.49 | 3.53 | 7.94 | 14.17 | 5.26 | 1.15 | 3.93 | 1.66 | 48.21 |
| 2011 | 0.00 | 0.00 | 0.00 | 0.10 | 3.60 | 3.10 | 7.60 | 5.80 | 6.90 | 0.70 | 0.20 | 0.10 | 28.10 |
| 2011 | 3.24 | 0.68 | 3.58 | 2.07 | 5.28 | 10.06 | 7.88 | 5.36 | 4.95 | 8.27 | 0.26 | 0.20 | 51.83 |
| 2012 | 0.20 | 1.20 | 0.20 | 6.00 | 0.50 | 6.70 | 4.66 | 10.27 | 6.34 | 4.85 | 0.19 | 1.66 | 42.77 |
| 2012 | 0.44 | 1.26 | 0.22 | 3.82 | ND | ND | ND | ND | ND | ND | ND | ND | 5.74 |
| | | | | | | | | | | | | | |
| **NOAA Average 1/1/1954 to 4/30/2012** | **2.29** | **2.84** | **3.22** | **2.36** | **4.14** | **8.21** | **8.23** | **7.26** | **6.34** | **2.53** | **1.79** | **1.96** | **51.16** |
| | | | | | | | | | | | | | |
| **NOAA Average W/ Site Specific Data When Available** | **2.11** | **2.68** | **3.24** | **2.36** | **3.93** | **8.14** | **8.30** | **7.08** | **6.16** | **2.42** | **1.59** | **1.81** | **49.82** |

Site specific data highlighted, obtained from the Hardee County Solid Waste Department.

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SHEET 1 OF 1

| CLIENT | PROJECT | JOB NO. |
|---|---|---|
| Hardee County | Phase II Section II Expansion | 09199033.23 |

| SUBJECT | BY | DATE |
|---|---|---|
| | SRF | 8/31/12 |
| Monthly Rainfall Data Summary<br>Site Specific and NOAA Weather Station | CHECKED | DATE |

**NOAA Average**
**1/1/1954 to 4/30/2012**

| Month | Rainfall (inches) |
|---|---|
| Jan | 2.29 |
| Feb | 2.84 |
| Mar | 3.22 |
| Apr | 2.36 |
| May | 4.14 |
| Jun | 8.21 |
| Jul | 8.23 |
| Aug | 7.26 |
| Sep | 6.34 |
| Oct | 2.53 |
| Nov | 1.79 |
| Dec | 1.96 |
| **Annual Average** | **51.16** |

**Site Only Average**
**Site Specific Data**

| Month | Rainfall (inches) |
|---|---|
| Jan | 0.99 |
| Feb | 2.57 |
| Mar | 2.93 |
| Apr | 2.05 |
| May | 2.27 |
| Jun | 7.90 |
| Jul | 7.79 |
| Aug | 6.23 |
| Sep | 5.07 |
| Oct | 2.02 |
| Nov | 0.33 |
| Dec | 0.74 |
| **Annual Average** | **40.88** |

**NOAA Average**
**W/ Site Specific Data**
**When Available**

| Month | Rainfall (inches) |
|---|---|
| Jan | 2.11 |
| Feb | 2.68 |
| Mar | 3.24 |
| Apr | 2.36 |
| May | 3.93 |
| Jun | 8.14 |
| Jul | 8.30 |
| Aug | 7.08 |
| Sep | 6.16 |
| Oct | 2.42 |
| Nov | 1.59 |
| Dec | 1.81 |
| **Annual Average** | **49.82** |

Notes:

Site specific data obtained from the Hardee County Solid Waste Department.

NOAA Weather Station CoopID # 089401 located at Latitude: 27$^{o}$ 31' North Longitude: 81$^{o}$ 48' West in Wauchula

**Revised April 1, 2013**

# Attachment N

- 8-Inch Leachate Collection Lateral Trench Capacity Calculations
- 10-Inch Leachate Collection Lateral Trench Capacity Calculations
- 12-Inch Leachate Collection Header Trench Capacity Calculations
- 8-Inch Leachate Collection Lateral Trench Capacity Calculations South Portion Phase II Section II Expansion
- 8-Inch Leachate Detection Header Trench Capacity Calculations
- Leachate Detection System Lateral Trench Capacity Calculations

# 8-Inch Leachate Collection Lateral Trench Capacity Calculations

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| CLIENT | PROJECT | JOB NO. |
|---|---|---|
| Hardee County | Phase II Section II Expansion | 09199033.23 |

| SUBJECT | BY | DATE |
|---|---|---|
| | SRF | 8/31/12 |
| Leachate Collection & Removal System<br>8-inch Leachate Collection Lateral Trench Capacity Calculations | CHECKED | DATE |

OBJECTIVE: Verify that the stone lined leachate collection lateral trench can convey the estimated leachate quantities predicted from the HELP model analysis.

KNOWN: Leachate collection lateral trench cross section.

| | | | | | |
|---|---|---|---|---|---|
| Trench bottom width = | 6.0 | feet | | | |
| Trench top width = | 1.0 | feet | | | |
| Trench side slope left = | 1.0 | :1 | | | |
| Trench side slope right = | 1.0 | :1 | | | |
| Trench depth = | 2.0 | feet | | | |
| Trench gravel depth (above pipe) = | 1.28 | feet | | | |
| Trench bottom area per foot, $A_{trench\ bottom}$ = | 6.00 | $ft^2$ | | | |
| Nominal pipe diameter = | 8.0 | inches | SDR 11 | | |
| Pipe area (ID) = | 0.26 | $ft^2$ | 6.963 | inches | Refer to Attachment 1 |
| Pipe area (OD) = | 0.41 | $ft^2$ | 8.625 | inches | Refer to Attachment 1 |

CALCULATIONS: Determine the hydraulic capacity of the leachate collection lateral trench by calculating the flow through the trench gravel, geocomposite, and leachate collection lateral pipe. Then, determine the hydraulic capacity of the trench if the leachate collection lateral pipe was crushed or 50% blocked. Compare results to peak leachate generation predicted by the HELP model.

$Q_{LCS}$ = Gravel Flow + Geocomposite Flow + Pipe Flow = $Q_{gravel} + Q_{geocomposite} + Q_{pipe}$
$Q_{LCS}$ = total flow through leachate collection system trench
$Q_{gravel}$ = flow through gravel
$Q_{geocomposite}$ = flow through geocomposite
$Q_{pipe}$ = flow through pipe

1. Determine flow through gravel using Darcy's Law.
$Q_{gravel} = KiA$

| | | | |
|---|---|---|---|
| K = horizontal hydraulic conductivity = | 10.0 | cm/sec | Refer to Attachment 2 Table 14.1 |
| i = hydraulic gradient = | 1.13% | | Slope of trench after waste placement, including settlement |
| A = cross section area = ($A_{trench} - A_{pipeOD}$) = | 5.59 | $ft^2$ | |
| $Q_{gravel}$ = flow through gravel = | 2.07E-02 | $ft^3$/sec | |
| = | 1.24 | $ft^3$/min | |
| $Q_{gravel}$ = | 9.31 | gal/min | |

2. Determine flow through geocomposite using Darcy's Law.
$Q_{geocomposite} = KiA = Ki(tW) = TiW$

| | | | |
|---|---|---|---|
| K = horizontal hydraulic conductivity = | 5.3 | cm/sec | Refer to Attachment 3 for bi-planar geocomposite hydraulic conductivity calculations based on max waste loading |
| i = hydraulic gradient = | 1.13% | | Slope of trench after waste placement, including settlement |
| t = geonet thickness = | 0.261 | inches | Refer to Attachment 3 for bi-planar geocomposite hydraulic thickness calculations based on max waste loading |
| W = width of trench bottom = | 6.0 | feet | |
| T = transmissivity = Kt = | 0.00035 | $m^2$/sec | Refer to Attachment 3 for bi-planar geocomposite hydraulic conductivity calculations based on max waste loading |
| A = cross section area = Wt = | 0.1305 | $ft^2$ | |
| $Q_{geocomposite}$ = | 7.27E-06 | $m^3$/sec | |
| = | 2.56E-04 | $ft^3$/sec | |
| $Q_{geocomposite}$ = | 0.11 | gal/min | |

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| SUBJECT | BY | DATE |
|---|---|---|
| Leachate Collection & Removal System<br>8-inch Leachate Collection Lateral Trench Capacity Calculations | SRF | 8/31/12 |
| | CHECKED | DATE |

3. Determine flow in/through leachate collection lateral pipe. Verify the perforations in the LCRS are adequate for the peak leachate flow anticipated based on worst-case conditions from the HELP model.
Discharge equation, orifice flow rate = $Q_{orifice} = (C_d)(A_o)(2gh)^{0.5}$

| | | | | |
|---|---|---|---|---|
| $C_d$ = coefficient of discharge = | 0.82 | | | |
| $D_o$ = diameter of orifice = | 0.375 | inch | 0.031 | feet |
| $A_o$ = area of orifice = $(\pi)(D_o)^2$ = | 0.110 | $in^2$ | 0.00077 | $ft^2$ |
| g = gravitational acceleration = | 32.2 | $ft/sec^2$ | | |
| h = static head = | 1.0 | inch | 0.083 | feet |
| $Q_{orifice}$ = | 0.0015 | $ft^3$/s/orifice | 0.65 | gpm/orifice |

| | | | | |
|---|---|---|---|---|
| Total length of lateral pipe = | 481.2 | feet | | |
| Number of perforations per row per foot of pipe= | 3 | | | |
| Number of row perforations = | 2 | | | |
| Number of perforations per foot of pipe = | 6 | | | |
| Max leachate flow per foot of pipe = | 0.009 | $ft^3$/sec/ft | 3.92 | gpm/ft |
| Total flow into pipe through orifices = | 4.21 | $ft^3$/sec | 1,887.77 | gal/min |

4. Determine the flow through the leachate collection lateral pipe using the Manning's equation and assuming a full flowing pipe.
$Q = 1.49/n * R^{2/3} * S^{1/2} * A$

| | | | |
|---|---|---|---|
| n = Manning's roughness coefficient = | 0.009 | | Refer to Attachment 4 |
| A = cross section area of flow (inside) = | 0.26 | $ft^2$ | |
| $P_w$ = wetted perimeter = ID*$\pi$ = | 1.82 | feet | |
| R = Hydraulic radius = A/$P_w$ = | 0.15 | feet | |
| S = slope of pipe = | 1.13% | | Slope of trench after waste placement, including settlement |

| | | | | |
|---|---|---|---|---|
| $Q_{pipe}$ = flow through pipe = | 1.28 | $ft^3$/sec | 576.66 | gal/min |

$Q_{LCS}$ = Gravel Flow + Geocomposite Flow + Pipe Flow = $Q_{gravel} + Q_{geocomposite} + Q_{pipe}$

= 9.31 + 0.11 + 576.66

$Q_{LCS}$ = 586.09 gal/min

5. Determine flow through a damaged leachate collection pipe using the Mannings equation and assuming a 50% loss of volume.
$Q_{damaged} = 1.49/n * R_{damaged}^{2/3} * S^{1/2} * A$

| | | | |
|---|---|---|---|
| n = Manning's roughness coefficient = | 0.009 | | Refer to Attachment 4 |
| $A_{damaged}$ = 50% less cross section area of flow = | 0.13 | $ft^2$ | |
| $P_{damaged}$ = damaged wetted perimeter = ID*$\pi$ = | 0.91 | feet | |
| $R_{damaged}$ = damaged hydraulic radius = A/$P_w$ = | 0.073 | feet | |
| S = slope of pipe = | 1.13% | | Slope of trench after waste placement, including settlement |

| | | | | |
|---|---|---|---|---|
| $Q_{damaged}$ = flow through damaged pipe = | 0.40 | $ft^3$/sec | 181.64 | gal/min |

$Q_{LCS\ damaged}$ = Gravel Flow + Geocomposite Flow + Pipe Flow = $Q_{gravel} + Q_{geocomposite} + Q_{damaged}$

= 9.31 + 0.11 + 181.64

$Q_{LCS\ damaged}$ = 191.06 gal/min

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| Leachate Collection & Removal System<br>8-inch Leachate Collection Lateral Trench Capacity Calculations | CHECKED | DATE |

HELP model results from leachate balance summary report (peak-worst case) filling conditions.

Peak flow = $Q_{max}$ = 202.93 gal/min    From the HELP Model

$Q_{LCS}$ = 586.09 gal/min > $Q_{HELP}$ = 202.93 gal/min    FS = 2.9

$Q_{LCS\ damaged}$ = 241.06 gal/min > $Q_{HELP}$ = 202.93 gal/min    FS = 1.2

CONCLUSION:

Compared to the peak drainage collected from the leachate collection system as predicted in the HELP model analyses, the gravel trench, leachate collection lateral pipe and geocomposite provide adequate flow for the leachate collection system. Furthermore, in accordance with Rule 62-701.400(4)(a)4, the LCRS has sufficient capacity to convey the leachate past a collapse or clog.

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# 10-Inch Leachate Collection Lateral Trench Capacity Calculations

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| Hardee County | Phase II Section II Expansion | 09199033.23 |

| SUBJECT | BY | DATE |
|---|---|---|
| | SRF | 8/31/12 |
| Leachate Collection & Removal System<br>10-inch Leachate Collection Lateral Trench Capacity Calculations | CHECKED | DATE |

OBJECTIVE: Verify that the stone lined leachate collection lateral trench can convey the estimated leachate quantities predicted from the HELP model analysis.

KNOWN: Leachate collection lateral trench cross section.

| | | | | | |
|---|---|---|---|---|---|
| Trench bottom width = | 6.0 | feet | | | |
| Trench top width = | 1.0 | feet | | | |
| Trench side slope left = | 1.0 | :1 | | | |
| Trench side slope right = | 1.0 | :1 | | | |
| Trench depth = | 2.0 | feet | | | |
| Trench gravel depth (above pipe) = | 1.10 | feet | | | |
| Trench bottom area per foot, $A_{trench\ bottom}$ = | 6.00 | $ft^2$ | | | |
| Nominal pipe diameter = | 10.0 | inches | SDR 11 | | |
| Pipe area (ID) = | 0.41 | $ft^2$ | 8.679 | inches | Refer to Attachment 1 |
| Pipe area (OD) = | 0.63 | $ft^2$ | 10.750 | inches | Refer to Attachment 1 |

CALCULATIONS: Determine the hydraulic capacity of the leachate collection lateral trench by calculating the flow through the trench gravel, geocomposite, and leachate collection lateral pipe. Then, determine the hydraulic capacity of the trench if the leachate collection lateral pipe was crushed or 50% blocked. Compare results to peak leachate generation predicted by the HELP model.

$Q_{LCS}$ = Gravel Flow + Geocomposite Flow + Pipe Flow = $Q_{gravel} + Q_{geocomposite} + Q_{pipe}$
$Q_{LCS}$ = total flow through leachate collection system trench
$Q_{gravel}$ = flow through gravel
$Q_{geocomposite}$ = flow through geocomposite
$Q_{pipe}$ = flow through pipe

1. Determine flow through gravel using Darcy's Law.
$Q_{gravel} = KiA$

| | | | |
|---|---|---|---|
| K = horizontal hydraulic conductivity = | 10.0 | cm/sec | Refer to Attachment 2 Table 14.1 |
| i = hydraulic gradient = | 0.86% | | Slope of trench after waste placement, including settlement |
| A = cross section area = ($A_{trench} - A_{pipeOD}$) = | 5.37 | $ft^2$ | |
| $Q_{gravel}$ = flow through gravel = | 1.52E-02 | $ft^3$/sec | |
| = | 0.91 | $ft^3$/min | |
| $Q_{gravel}$ = | 6.80 | gal/min | |

2. Determine flow through geocomposite using Darcy's Law.
$Q_{geocomposite} = KiA = Ki(tW) = TiW$

| | | | |
|---|---|---|---|
| K = horizontal hydraulic conductivity = | 5.3 | cm/sec | Refer to Attachment 3 for bi-planar geocomposite hydraulic conductivity calculations based on max waste loading |
| i = hydraulic gradient = | 0.86% | | Slope of trench after waste placement, including settlement |
| t = geonet thickness = | 0.261 | inches | Refer to Attachment 3 for bi-planar geocomposite hydraulic thickness calculations based on max waste loading |
| W = width of trench bottom = | 6.0 | feet | |
| T = transmissivity = Kt = | 0.00035 | $m^2$/sec | Refer to Attachment 3 for bi-planar geocomposite hydraulic conductivity calculations based on max waste loading |
| A = cross section area = Wt = | 0.1305 | $ft^2$ | |
| $Q_{geocomposite}$ = | 5.53E-06 | $m^3$/sec | |
| = | 1.95E-04 | $ft^3$/sec | |
| $Q_{geocomposite}$ = | 0.09 | gal/min | |

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| | SRF | 8/31/12 |
| Leachate Collection & Removal System | CHECKED | DATE |
| 10-inch Leachate Collection Lateral Trench Capacity Calculations | | |

3. Determine flow in/through leachate collection lateral pipe. Verify the perforations in the LCRS are adequate for the peak leachate flow anticipated based on worst-case conditions from the HELP model.

Discharge equation, orifice flow rate = $Q_{orifice} = (C_d)(A_o)(2gh)^{0.5}$

| | | | | |
|---|---|---|---|---|
| $C_d$ = coefficient of discharge = | 0.82 | | | |
| $D_o$ = diameter of orifice = | 0.375 | inch | 0.031 | feet |
| $A_o$ = area of orifice = $(\pi)(D_o)^2$ = | 0.110 | $in^2$ | 0.00077 | $ft^2$ |
| g = gravitational acceleration = | 32.2 | $ft/sec^2$ | | |
| h = static head = | 1.0 | inch | 0.083 | feet |
| $Q_{orifice}$ = | 0.0015 | $ft^3$/s/orifice | 0.65 | gpm/orifice |

| | | | | |
|---|---|---|---|---|
| Total length of lateral pipe = | 475.4 | feet | | |
| Number of perforations per row per foot of pipe= | 3 | | | |
| Number of row perforations = | 2 | | | |
| Number of perforations per foot of pipe = | 6 | | | |
| Max leachate flow per foot of pipe = | 0.009 | $ft^3$/sec/ft | 3.92 | gpm/ft |
| Total flow into pipe through orifices = | 4.16 | $ft^3$/sec | 1,865.17 | gal/min |

4. Determine the flow through the leachate collection lateral pipe using the Manning's equation and assuming a full flowing pipe.

$Q = 1.49/n * R^{2/3} * S^{1/2} * A$

| | | | |
|---|---|---|---|
| n = Manning's roughness coefficient = | 0.009 | | Refer to Attachment 4 |
| A = cross section area of flow (inside) = | 0.41 | $ft^2$ | |
| $P_w$ = wetted perimeter = ID*$\pi$ = | 2.27 | feet | |
| R = Hydraulic radius = A/$P_w$ = | 0.18 | feet | |
| S = slope of pipe = | 0.86% | | Slope of trench after waste placement, including settlement |

| | | | | |
|---|---|---|---|---|
| $Q_{pipe}$ = flow through pipe = | 2.02 | $ft^3$/sec | 905.23 | gal/min |

$Q_{LCS}$ = Gravel Flow + Geocomposite Flow + Pipe Flow = $Q_{gravel} + Q_{geocomposite} + Q_{pipe}$

= 6.80 + 0.09 + 905.23

$Q_{LCS}$ = 912.12 gal/min

5. Determine flow through a damaged leachate collection pipe using the Mannings equation and assuming a 50% loss of volume.

$Q_{damaged} = 1.49/n * R_{damaged}^{2/3} * S^{1/2} * A$

| | | | |
|---|---|---|---|
| n = Manning's roughness coefficient = | 0.009 | | Refer to Attachment 4 |
| $A_{damaged}$ = 50% less cross section area of flow = | 0.21 | $ft^2$ | |
| $P_{damaged}$ = damaged wetted perimeter = ID*$\pi$ = | 1.14 | feet | |
| $R_{damaged}$ = damaged hydraulic radius = A/$P_w$ = | 0.090 | feet | |
| S = slope of pipe = | 0.86% | | Slope of trench after waste placement, including settlement |

| | | | | |
|---|---|---|---|---|
| $Q_{damaged}$ = flow through damaged pipe = | 0.64 | $ft^3$/sec | 285.13 | gal/min |

$Q_{LCS\ damaged}$ = Gravel Flow + Geocomposite Flow + Pipe Flow = $Q_{gravel} + Q_{geocomposite} + Q_{damaged}$

= 6.80 + 0.09 + 285.13

$Q_{LCS\ damaged}$ = 292.02 gal/min

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| Hardee County | Phase II Section II Expansion | 09199033.23 |

| SUBJECT | BY | DATE |
|---|---|---|
| | SRF | 8/31/12 |
| Leachate Collection & Removal System | CHECKED | DATE |
| 10-inch Leachate Collection Lateral Trench Capacity Calculations | | |

HELP model results from leachate balance summary report (peak-worst case) filling conditions.

Peak flow = $Q_{max}$ = 202.93 gal/min    From the HELP Model

$Q_{LCS}$ = 912.12 gal/min > $Q_{HELP}$ = 202.93 gal/min    FS = 4.5

$Q_{LCS\ damaged}$ = 292.02 gal/min > $Q_{HELP}$ = 202.93 gal/min    FS = 1.4

CONCLUSION:

Compared to the peak drainage collected from the leachate collection system as predicted in the HELP model analyses, the gravel trench, leachate collection lateral pipe and geocomposite provide adequate flow for the leachate collection system. Furthermore, in accordance with Rule 62-701.400(4)(a)4, the LCRS has sufficient capacity to convey the leachate past a collapse or clog.

**Revised April 1, 2013**

# 12-Inch Leachate Collection Header Trench Capacity Calculations

| CLIENT | PROJECT | JOB NO. |
|---|---|---|
| Hardee County | Phase II Section II Expansion | 09199033.23 |

| SUBJECT | BY | DATE |
|---|---|---|
| | SRF | 8/31/12 |
| Leachate Collection & Removal System<br>Leachate Collection Header Trench Capacity Calculations | CHECKED | DATE |

OBJECTIVE: Verify that the stone lined leachate collection header trench can convey the estimated leachate quantities predicted from the HELP model analysis.

KNOWN: Leachate collection header trench cross section.

| | | | | | |
|---|---|---|---|---|---|
| Trench bottom width = | 6.0 | feet | | | |
| Trench top width = | 2.0 | feet | | | |
| Trench side slope left = | 1.0 | :1 | | | |
| Trench side slope right = | 1.0 | :1 | | | |
| Trench depth = | 3.0 | feet | | | |
| Trench gravel depth (above pipe) = | 1.94 | feet | | | |
| Trench area (trapezoid), $A_{trench}$ = | 12.00 | $ft^2$ | | | |
| Nominal pipe diameter = | 12.0 | inches | SDR 11 | | |
| Pipe area (ID) = | 0.58 | $ft^2$ | 10.293 | inches | Refer to Attachment 1 |
| Pipe area (OD) = | 0.89 | $ft^2$ | 12.750 | inches | Refer to Attachment 1 |

CALCULATIONS: Determine the hydraulic capacity of the leachate collection header trench by calculating the flow through the trench gravel, geocomposite, and leachate collection header pipe. Then, determine the hydraulic capacity of the trench if the leachate collection header pipe was crushed or 50% blocked. Compare results to peak leachate generation predicted by the HELP model.

$Q_{LCS}$ = Gravel Flow + Geocomposite Flow + Pipe Flow = $Q_{gravel} + Q_{geocomposite} + Q_{pipe}$

$Q_{LCS}$ = total flow through leachate collection system trench

$Q_{gravel}$ = flow through gravel

$Q_{geocomposite}$ = flow through geocomposite

$Q_{pipe}$ = flow through pipe

1. Determine flow through gravel using Darcy's Law.

$Q_{gravel} = KiA$

| | | | |
|---|---|---|---|
| K = horizontal hydraulic conductivity = | 10.0 | cm/sec | Refer to Attachment 2 Table 14.1 |
| i = hydraulic gradient = | 0.93% | | Slope of trench after waste placement, including settlement |
| A = cross section area = ($A_{trench}$ - $A_{pipeOD}$) = | 11.11 | $ft^2$ | |
| $Q_{gravel}$ = flow through gravel = | 3.39E-02 | $ft^3$/sec | |
| = | 2.03 | $ft^3$/min | |
| $Q_{gravel}$ = | 15.22 | gal/min | |

2. Determine flow through geocomposite using Darcy's Law.

$Q_{geocomposite}$ = KiA = Ki(tW) = TiW

| | | | |
|---|---|---|---|
| K = horizontal hydraulic conductivity = | 5.3 | cm/sec | Refer to Attachment 3 for bi-planar geocomposite hydraulic conductivity calculations based on max waste loading |
| i = hydraulic gradient = | 0.93% | | Slope of trench after waste placement, including settlement |
| t = geonet thickness = | 0.261 | inches | Refer to Attachment 3 for bi-planar geocomposite hydraulic thickness calculations based on max waste loading |
| W = width of trench bottom = | 6.0 | feet | |
| T = transmissivity = Kt = | 0.00035 | $m^2$/sec | Refer to Attachment 3 for bi-planar geocomposite hydraulic conductivity calculations based on max waste loading |
| A = cross section area = Wt = | 0.1305 | $ft^2$ | |
| $Q_{geocomposite}$ = | 5.98E-06 | $m^3$/sec | |
| = | 2.11E-04 | $ft^3$/sec | |
| $Q_{geocomposite}$ = | 0.09 | gal/min | |

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| | SRF | 8/31/12 |
| Leachate Collection & Removal System<br>Leachate Collection Header Trench Capacity Calculations | CHECKED | DATE |

3. Determine flow in/through leachate collection header pipe. Verify the perforations in the LCRS are adequate for the peak leachate flow anticipated based on worst-case conditions from the HELP model.

Discharge equation, orifice flow rate = $Q_{orifice} = (C_d)(A_o)(2gh)^{0.5}$

| | | | | |
|---|---|---|---|---|
| $C_d$ = coefficient of discharge = | 0.82 | | | |
| $D_o$ = diameter of orifice = | 0.375 | inch | 0.031 | feet |
| $A_o$ = area of orifice = $(\pi)(D_o)^2$ = | 0.110 | $in^2$ | 0.00077 | $ft^2$ |
| g = gravitational acceleration = | 32.2 | $ft/sec^2$ | | |
| h = static head = | 1.0 | inch | 0.083 | feet |
| $Q_{orifice}$ = | 0.0015 | $ft^3$/s/orifice | 0.65 | gpm/orifice |

| | | | | |
|---|---|---|---|---|
| Total length of header pipe = | 138.8 | feet | | |
| Number of perforations per row per foot of pipe= | 3 | | | |
| Number of row perforations = | 2 | | | |
| Number of perforations per foot of pipe = | 6 | | | |
| Max leachate flow per foot of pipe = | 0.009 | $ft^3$/sec/ft | 3.92 | gpm/ft |
| Total flow into pipe through orifices = | 1.21 | $ft^3$/sec | 544.56 | gal/min |

4. Determine the flow through the leachate collection header pipe using the Manning's equation and assuming a full flowing pipe.

$Q = 1.49/n * R^{2/3} * S^{1/2} * A$

| | | | |
|---|---|---|---|
| n = Manning's roughness coefficient = | 0.009 | | Refer to Attachment 4 |
| A = cross section area of flow (inside) = | 0.58 | $ft^2$ | |
| $P_w$ = wetted perimeter = ID*$\pi$ = | 2.69 | feet | |
| R = Hydraulic radius = A/$P_w$ = | 0.21 | feet | |
| S = slope of pipe = | 0.93% | | Slope of trench after waste placement, including settlement |

| | | | | |
|---|---|---|---|---|
| $Q_{pipe}$ = flow through pipe = | 3.31 | $ft^3$/sec | 1483.47 | gal/min |

$Q_{LCS}$ = Gravel Flow + Geocomposite Flow + Pipe Flow = $Q_{gravel} + Q_{geocomposite} + Q_{pipe}$

= 15.22 + 0.09 + 1,483.47

$Q_{LCS}$ = 1,498.78 gal/min

5. Determine flow through a damaged leachate collection pipe using the Mannings equation and assuming a 50% loss of volume.

$Q_{damaged} = 1.49/n * R_{damaged}^{2/3} * S^{1/2} * A$

| | | | |
|---|---|---|---|
| n = Manning's roughness coefficient = | 0.009 | | Refer to Attachment 4 |
| $A_{damaged}$ = 50% less cross section area of flow = | 0.29 | $ft^2$ | |
| $P_{damaged}$ = damaged wetted perimeter = ID*$\pi$ = | 1.35 | feet | |
| $R_{damaged}$ = damaged hydraulic radius = A/$P_w$ = | 0.107 | feet | |
| S = slope of pipe = | 0.93% | | Slope of trench after waste placement, including settlement |

| | | | | |
|---|---|---|---|---|
| $Q_{damaged}$ = flow through damaged pipe = | 1.04 | $ft^3$/sec | 467.26 | gal/min |

$Q_{LCS\ damaged}$ = Gravel Flow + Geocomposite Flow + Pipe Flow = $Q_{gravel} + Q_{geocomposite} + Q_{damaged}$

= 15.22 + 0.09 + 467.26

$Q_{LCS\ damaged}$ = 482.58 gal/min

SCS ENGINEERS



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| Leachate Collection & Removal System<br>Leachate Collection Header Trench Capacity Calculations | CHECKED | DATE |

HELP model results from leachate balance summary report (peak-worst case) filling conditions.

Peak flow = $Q_{max}$ = 202.93 gal/min    From the HELP Model

$Q_{LCS}$ = 1,498.78 gal/min > $Q_{HELP}$ = 202.93 gal/min    FS = 7.4

$Q_{LCS\ damaged}$ = 482.58 gal/min > $Q_{HELP}$ = 202.93 gal/min    FS = 2.4

CONCLUSION:

Compared to the peak drainage collected from the leachate collection system as predicted in the HELP model analyses, the gravel trench, leachate collection header pipe and geocomposite provide adequate flow for the leachate collection system. Furthermore, in accordance with Rule 62-701.400(4)(a)4, the LCRS has sufficient capacity to convey the leachate past a collapse or clog.

**Revised April 1, 2013**

# 8-Inch Leachate Collection Lateral Trench Capacity Calculations South Portion Phase II Section II Expansion

| CLIENT | PROJECT | JOB NO. |
|---|---|---|
| Hardee County | Phase II Section II Expansion | 09199033.23 |

| SUBJECT | BY | DATE |
|---|---|---|
| Phase II Section II South Portion<br>Leachate Collection & Removal System<br>8-inch Leachate Collection Lateral Trench Capacity Calculations | SRF<br>CHECKED | 4/1/13<br>DATE |

OBJECTIVE: Verify that the stone lined leachate collection lateral trench can convey the estimated leachate quantities predicted from the HELP model analysis.

KNOWN: Leachate collection lateral trench cross section.

| | | | | | |
|---|---|---|---|---|---|
| Trench bottom width = | 6.0 | feet | | | |
| Trench top width = | 1.0 | feet | | | |
| Trench side slope left = | 1.0 | :1 | | | |
| Trench side slope right = | 1.0 | :1 | | | |
| Trench depth = | 2.0 | feet | | | |
| Trench gravel depth (above pipe) = | 1.28 | feet | | | |
| Trench bottom area per foot, $A_{trench\ bottom}$ = | 6.00 | $ft^2$ | | | |
| Nominal pipe diameter = | 8.0 | inches | SDR 11 | | |
| Pipe area (ID) = | 0.26 | $ft^2$ | 6.963 | inches | Refer to Attachment 1 |
| Pipe area (OD) = | 0.41 | $ft^2$ | 8.625 | inches | Refer to Attachment 1 |

CALCULATIONS: Determine the hydraulic capacity of the leachate collection lateral trench by calculating the flow through the trench gravel, geocomposite, and leachate collection lateral pipe. Then, determine the hydraulic capacity of the trench if the leachate collection lateral pipe was crushed or 30% blocked. Compare results to peak leachate generation predicted by the HELP model.

$Q_{LCS}$ = Gravel Flow + Geocomposite Flow + Pipe Flow = $Q_{gravel} + Q_{geocomposite} + Q_{pipe}$
$Q_{LCS}$ = total flow through leachate collection system trench
$Q_{gravel}$ = flow through gravel
$Q_{geocomposite}$ = flow through geocomposite
$Q_{pipe}$ = flow through pipe

1. Determine flow through gravel using Darcy's Law.
$Q_{gravel} = KiA$

| | | | |
|---|---|---|---|
| K = horizontal hydraulic conductivity = | 10.0 | cm/sec | Refer to Attachment 2 Table 14.1 |
| i = hydraulic gradient = | 1.13% | | Slope of trench after waste placement, including settlement |
| A = cross section area = $(A_{trench} - A_{pipeOD})$ = | 5.59 | $ft^2$ | |
| $Q_{gravel}$ = flow through gravel = | 2.07E-02 | $ft^3/sec$ | |
| = | 1.24 | $ft^3/min$ | |
| $Q_{gravel}$ = | 9.31 | gal/min | |

2. Determine flow through geocomposite using Darcy's Law.
$Q_{geocomposite} = KiA = Ki(tW) = TiW$

| | | | |
|---|---|---|---|
| K = horizontal hydraulic conductivity = | 5.3 | cm/sec | Refer to Attachment 3 for bi-planar geocomposite hydraulic conductivity calculations based on max waste loading |
| i = hydraulic gradient = | 1.13% | | Slope of trench after waste placement, including settlement |
| t = geonet thickness = | 0.261 | inches | Refer to Attachment 3 for bi-planar geocomposite hydraulic thickness calculations based on max waste loading |
| W = width of trench bottom = | 6.0 | feet | |
| T = transmissivity = Kt = | 0.00035 | $m^2/sec$ | Refer to Attachment 3 for bi-planar geocomposite hydraulic conductivity calculations based on max waste loading |
| A = cross section area = Wt = | 0.1305 | $ft^2$ | |
| $Q_{geocomposite}$ = | 7.27E-06 | $m^3/sec$ | |
| = | 2.56E-04 | $ft^3/sec$ | |
| $Q_{geocomposite}$ = | 0.11 | gal/min | |

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| Phase II Section II South Portion | SRF | 4/1/13 |
| Leachate Collection & Removal System | CHECKED | DATE |
| 8-inch Leachate Collection Lateral Trench Capacity Calculations | | |

3. Determine flow in/through leachate collection lateral pipe. Verify the perforations in the LCRS are adequate for the peak leachate flow anticipated based on worst-case conditions from the HELP model.

Discharge equation, orifice flow rate = $Q_{orifice} = (C_d)(A_o)(2gh)^{0.5}$

| | | | | |
|---|---|---|---|---|
| $C_d$ = coefficient of discharge = | 0.82 | | | |
| $D_o$ = diameter of orifice = | 0.375 | inch | 0.031 | feet |
| $A_o$ = area of orifice = $(\pi)(D_o)^2$ = | 0.110 | $in^2$ | 0.00077 | $ft^2$ |
| g = gravitational acceleration = | 32.2 | $ft/sec^2$ | | |
| h = static head = | 1.0 | inch | 0.083 | feet |
| $Q_{orifice}$ = | 0.0015 | $ft^3$/s/orifice | 0.65 | gpm/orifice |

| | | | | |
|---|---|---|---|---|
| Total length of lateral pipe = | 196.0 | feet | | |
| Number of perforations per row per foot of pipe= | 3 | | | |
| Number of row perforations = | 2 | | | |
| Number of perforations per foot of pipe = | 6 | | | |
| Max leachate flow per foot of pipe = | 0.009 | $ft^3$/sec/ft | 3.92 | gpm/ft |
| Total flow into pipe through orifices = | 1.71 | $ft^3$/sec | 768.98 | gal/min |

4. Determine the flow through the leachate collection lateral pipe using the Manning's equation and assuming a full flowing pipe.

$Q = 1.49/n * R^{2/3} * S^{1/2} * A$

| | | | |
|---|---|---|---|
| n = Manning's roughness coefficient = | 0.009 | | Refer to Attachment 4 |
| A = cross section area of flow (inside) = | 0.26 | $ft^2$ | |
| $P_w$ = wetted perimeter = ID*$\pi$ = | 1.82 | feet | |
| R = Hydraulic radius = A/$P_w$ = | 0.15 | feet | |
| S = slope of pipe = | 1.13% | | Slope of trench after waste placement, including settlement |

$Q_{pipe}$ = flow through pipe = 1.28 $ft^3$/sec | 576.66 gal/min

$Q_{LCS}$ = Gravel Flow + Geocomposite Flow + Pipe Flow = $Q_{gravel} + Q_{geocomposite} + Q_{pipe}$

= 9.31 + 0.11 + 576.66

$Q_{LCS}$ = 586.09 gal/min

5. Determine flow through a damaged leachate collection pipe using the Mannings equation and assuming a 30% loss of volume.

$Q_{damaged} = 1.49/n * R_{damaged}^{2/3} * S^{1/2} * A$

| | | | |
|---|---|---|---|
| n = Manning's roughness coefficient = | 0.009 | | Refer to Attachment 4 |
| $A_{damaged}$ = 30% less cross section area of flow = | 0.19 | $ft^2$ | |
| $P_{damaged}$ = damaged wetted perimeter = ID*$\pi$ = | 0.91 | feet | |
| $R_{damaged}$ = damaged hydraulic radius = A/$P_w$ = | 0.073 | feet | |
| S = slope of pipe = | 1.13% | | Slope of trench after waste placement, including settlement |

$Q_{damaged}$ = flow through damaged pipe = 0.57 $ft^3$/sec | 254.29 gal/min

$Q_{LCS\ damaged}$ = Gravel Flow + Geocomposite Flow + Pipe Flow = $Q_{gravel} + Q_{geocomposite} + Q_{damaged}$

= 9.31 + 0.11 + 254.29

$Q_{LCS\ damaged}$ = 263.72 gal/min

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| Phase II Section II South Portion | SRF | 4/1/13 |
| Leachate Collection & Removal System | CHECKED | DATE |
| 8-inch Leachate Collection Lateral Trench Capacity Calculations | | |

HELP model results from leachate balance summary report (peak-worst case) filling conditions.

Peak flow = $Q_{max}$ = 237.01 gal/min    From the HELP Model

$Q_{LCS}$ = 586.09 gal/min > $Q_{HELP}$ = 237.01 gal/min    FS = 2.5

$Q_{LCS\ damaged}$ = 333.72 gal/min > $Q_{HELP}$ = 237.01 gal/min    FS = 1.4

CONCLUSION:

Compared to the peak drainage collected from the leachate collection system as predicted in the HELP model analyses, the gravel trench, leachate collection lateral pipe and geocomposite provide adequate flow for the leachate collection system. Furthermore, in accordance with Rule 62-701.400(4)(a)4, the LCRS has sufficient capacity to convey the leachate past a collapse or clog.

# 8-Inch Leachate Detection Header Trench Capacity Calculations

| CLIENT | PROJECT | JOB NO. |
|---|---|---|
| Hardee County | Phase II Section II Expansion | 09199033.23 |

| SUBJECT | BY | DATE |
|---|---|---|
| | SRF | 8/31/12 |
| Leachate Collection & Removal System<br>Leachate Detection Header Trench Capacity Calculations | CHECKED | DATE |

OBJECTIVE: Verify that the stone lined leachate detection header trench can convey the estimated leachate quantities predicted from the HELP model analysis.

KNOWN: Leachate detection header trench cross section.

| | | | | | | |
|---|---|---|---|---|---|---|
| Trench bottom width = | 1.6 | feet | | | | |
| Trench top width = | 4.0 | feet | | | | |
| Trench side slope left = | 2.0 | :1 | | | | |
| Trench side slope right = | 1.0 | :1 | | | | |
| Trench depth = | 3.0 | feet | | | | |
| Trench gravel depth (above pipe) = | 2.28 | feet | | | | |
| Trench area (trapezoid), $A_{trench}$ = | 8.37 | $ft^2$ | | | | |
| Nominal pipe diameter = | 8.0 | inches | SDR 11 | | | |
| Pipe area (ID) = | 0.26 | $ft^2$ | 6.963 | inches | Refer to Attachment 1 | |
| Pipe area (OD) = | 0.41 | $ft^2$ | 8.625 | inches | Refer to Attachment 1 | |

CALCULATIONS: Determine the hydraulic capacity of the leachate detection header trench by calculating the flow through the trench gravel, geocomposite, and leachate detection header pipe. Then, determine the hydraulic capacity of the trench if the leachate detection header pipe was crushed or 50% blocked. Compare results to peak leachate generation predicted by the HELP model.

$Q_{LDS}$ = Gravel Flow + Geocomposite Flow + Pipe Flow = $Q_{gravel} + Q_{geocomposite} + Q_{pipe}$
$Q_{LDS}$ = total flow through leachate detection system trench
$Q_{gravel}$ = flow through gravel
$Q_{geocomposite}$ = flow through geocomposite
$Q_{pipe}$ = flow through pipe

1. Determine flow through gravel using Darcy's Law.
$Q_{gravel} = KiA$

| | | | |
|---|---|---|---|
| K = horizontal hydraulic conductivity = | 10.0 | cm/sec | Refer to Attachment 2 Table 14.1 |
| i = hydraulic gradient = | 0.93% | | Slope of trench after waste placement, including settlement |
| A = cross section area = ($A_{trench}$ - $A_{pipeOD}$) = | 7.96 | $ft^2$ | |
| $Q_{gravel}$ = flow through gravel = | 2.43E-02 | $ft^3$/sec | |
| = | 1.46 | $ft^3$/min | |
| $Q_{gravel}$ = | 10.91 | gal/min | |

2. Determine flow through geocomposite using Darcy's Law.
$Q_{geocomposite} = KiA = Ki(tW) = TiW$

| | | | |
|---|---|---|---|
| K = horizontal hydraulic conductivity = | 21.8 | cm/sec | Refer to Attachment 3 for tri-planar geocomposite hydraulic conductivity calculations based on max waste loading |
| i = hydraulic gradient = | 0.93% | | Slope of trench after waste placement, including settlement |
| t = geonet thickness = | 0.261 | inches | Refer to Attachment 3 for tri-planar geocomposite hydraulic thickness calculations based on max waste loading |
| W = width of trench bottom = | 1.6 | feet | |
| T = transmissivity = Kt = | 1.44E-03 | $m^2$/sec | Refer to Attachment 3 for tri-planar geocomposite hydraulic conductivity calculations based on max waste loading |
| A = cross section area = Wt = | 0.034365 | $ft^2$ | |
| $Q_{geocomposite}$ = | 6.43E-06 | $m^3$/sec | |
| = | 2.27E-04 | $ft^3$/sec | |
| $Q_{geocomposite}$ = | 0.10 | gal/min | |

**Revised April 1, 2013**

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|---|---|---|
| | SRF | 8/31/12 |
| Leachate Collection & Removal System<br>Leachate Detection Header Trench Capacity Calculations | CHECKED | DATE |

3. Determine flow in/through leachate detection header pipe. Verify the perforations in the LCRS are adequate for the peak leachate flow anticipated based on worst-case conditions from the HELP model.

Discharge equation, orifice flow rate = $Q_{orifice} = (C_d)(A_o)(2gh)^{0.5}$

| | | | | |
|---|---|---|---|---|
| $C_d$ = coefficient of discharge = | 0.82 | | | |
| $D_o$ = diameter of orifice = | 0.375 | inch | 0.031 | feet |
| $A_o$ = area of orifice = $(\pi)(D_o)^2$ = | 0.110 | $in^2$ | 0.00077 | $ft^2$ |
| g = gravitational acceleration = | 32.2 | $ft/sec^2$ | | |
| h = static head = | 1.0 | inch | 0.083 | feet |
| $Q_{orifice}$ = | 0.0015 | $ft^3$/s/orifice | 0.65 | gpm/orifice |

| | | | | |
|---|---|---|---|---|
| Total length of header pipe = | 63.5 | feet | | |
| Number of perforations per row per foot of pipe= | 3 | | | |
| Number of row perforations = | 2 | | | |
| Number of perforations per foot of pipe = | 6 | | | |
| Max leachate flow per foot of pipe = | 0.009 | $ft^3$/sec/ft | 3.92 | gpm/ft |
| Total flow into pipe through orifices = | 0.56 | $ft^3$/sec | 249.13 | gal/min |

4. Determine the flow through the leachate detection header pipe using the Manning's equation and assuming a full flowing pipe.

$Q = 1.49/n * R^{2/3} * S^{1/2} * A$

| | | | |
|---|---|---|---|
| n = Manning's roughness coefficient = | 0.009 | | Refer to Attachment 4 |
| A = cross section area of flow (inside) = | 0.26 | $ft^2$ | |
| $P_w$ = wetted perimeter = ID*$\pi$ = | 1.82 | feet | |
| R = Hydraulic radius = A/$P_w$ = | 0.15 | feet | |
| S = slope of pipe = | 0.93% | | Slope of trench after waste placement, including settlement |

$Q_{pipe}$ = flow through pipe = 1.17 $ft^3$/sec | 523.15 gal/min

$Q_{LDS}$ = Gravel Flow + Geocomposite Flow + Pipe Flow = $Q_{gravel} + Q_{geocomposite} + Q_{pipe}$

= 10.91 + 0.10 + 523.15

$Q_{LDS}$ = 534.16 gal/min

5. Determine flow through a damaged leachate detection pipe using the Mannings equation and assuming a 75% loss of volume.

$Q_{damaged} = 1.49/n * R_{damaged}^{2/3} * S^{1/2} * A$

| | | | |
|---|---|---|---|
| n = Manning's roughness coefficient = | 0.009 | | Refer to Attachment 4 |
| $A_{damaged}$ = 50% less cross section area of flow = | 0.13 | $ft^2$ | |
| $P_{damaged}$ = damaged wetted perimeter = ID*$\pi$ = | 0.91 | feet | |
| $R_{damaged}$ = damaged hydraulic radius = A/$P_w$ = | 0.036 | feet | |
| S = slope of pipe = | 0.93% | | Slope of trench after waste placement, including settlement |

$Q_{damaged}$ = flow through damaged pipe = 0.23 $ft^3$/sec | 103.81 gal/min

$Q_{LDS\ damaged}$ = Gravel Flow + Geocomposite Flow + Pipe Flow = $Q_{gravel} + Q_{geocomposite} + Q_{damaged}$

= 10.91 + 0.10 + 103.81

$Q_{LDS\ damaged}$ = 114.81 gal/min

| CLIENT | PROJECT | JOB NO. |
|---|---|---|
| Hardee County | Phase II Section II Expansion | 09199033.23 |

| SUBJECT | BY | DATE |
|---|---|---|
| | SRF | 8/31/12 |
| Leachate Collection & Removal System<br>Leachate Detection Header Trench Capacity Calculations | CHECKED | DATE |

HELP model results from leachate balance summary report (peak-worst case) filling conditions.

Peak flow = $Q_{max}$ = 0.88 gal/min    From the HELP Model

$Q_{LCS}$ = 534.16 gal/min > $Q_{HELP}$ = 0.88 gal/min    FS = 607.7

$Q_{LCS\ damaged}$ = 114.81 gal/min > $Q_{HELP}$ = 0.88 gal/min    FS = 130.6

CONCLUSION:

Compared to the peak drainage collected from the leachate detection system as predicted in the HELP model analyses, the gravel trench, leachate detection header pipe and geocomposite provide adequate flow for the leachate detection system. Furthermore, in accordance with Rule 62-701.400(4)(a)4, the LCRS has sufficient capacity to convey the leachate past a collapse or clog.

# Leachate Detection System
# Lateral Trench Capacity Calculations

SCS ENGINEERS

SHEET 1 OF 1

| CLIENT | PROJECT | JOB NO. | |
|---|---|---|---|
| Hardee County | Phase II Section II Expansion | 09199033.23 | |
| SUBJECT | | BY | DATE |
| | | SRF | 8/31/12 |
| Leachate Collection & Removal System | | CHECKED | DATE |
| Leachate Detection Lateral Trench Capacity Calculations | | | |

OBJECTIVE: Verify that the leachate detection lateral trenches can convey the estimated leachate quantities predicted from the HELP model analysis.

CALCULATIONS: Determine the hydraulic capacity of the leachate detection lateral trench by calculating the flow through the geocomposite.

$Q_{LDS}$ = Geocomposite Flow = $Q_{geocomposite}$

$Q_{LDS}$ = total flow through leachate detection system trench

$Q_{geocomposite}$ = KiA = Ki(tW) = TiW

| | | | |
|---|---|---|---|
| K = horizontal hydraulic conductivity = | 21.8 | cm/sec | Refer to Attachment 1 for tri-planar geocomposite hydraulic conductivity calculations based on max waste loading |
| i = hydraulic gradient = | 1.13% | | Slope of trench after waste placement, including settlement |
| t = geonet thickness = | 0.261 | inches | Refer to Attachment 1 for tri-planar geocomposite thickness calculations based on max waste loading |
| t = | 0.522 | inches | (Use two layers of tri-planar geocomposite in the detection trench) |
| W = width of trench bottom = | 6.0 | feet | |
| W = width of tri-planar used for flow = | 10.0 | feet | |
| T = transmissivity = Kt = | 0.00289 | $m^2$/sec | Refer to Attachment 1 for tri-planar geocomposite hydraulic conductivity calculations based on max waste loading (Use two layers of tri-planar geocomposite in the detection trench) |
| A = cross section area = Wt = | 0.435 | $ft^2$ | |
| $Q_{geocomposite}$ = | 9.96E-05 | $m^3$/sec | |
| = | 3.51E-03 | $ft^3$/sec | |
| $Q_{geocomposite}$ = | 2.58 | gal/min | |

HELP model results from leachate balance summary report (peak-worst case) filling conditions.

Peak flow = $Q_{max}$ = 1,265.80 gpd

= 0.88 gal/min

$Q_{LCS}$ = 2.58 gal/min > $Q_{HELP}$ = 0.88 gal/min FS = 2.9

CONCLUSION:

Compared to the peak drainage collected from the leachate detection system as predicted in the HELP model analyses, the leachate detection trench provides adequate flow for the leachate detection system.

Revised April 1, 2013

# Attachment O

## Florida Jetclean Report
*Hardee County Landfill 2012 LCS & GCS Pipe Maintenance*
*Phase I LCS & Phase II LCS/GCS*

**FLORIDA JETCLEAN**

HIGH PRESSURE WATER JETTING
PIPELINE VIDEO INSPECTION (EX)
VACUUM TRUCK SERVICES
LASER PROFILING / NO DIG REPAIRS

7538 DUNBRIDGE DR., ODESSA, FL 33556
TEL: 800-226-8013 FAX: 813-926-4616
WEB: WWW.FLORIDAJETCLEAN.COM
EMAIL: FLORIDAJETCLEAN@YAHOO.COM

# Hardee County Landfill
# 2012 LCS & GCS Pipe Maintenance
# Phase I LCS & Phase II LCS/GCS

## Work Performed
## December 2012

Conducted By:
**Florida Jetclean**
**800-226-8013**

# FLORIDA JETCLEAN

HIGH PRESSURE WATER JETTING
PIPELINE VIDEO INSPECTION (EX)
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TEL: 800-226-8013 FAX: 813-926-4616
WEB: WWW.FLORIDAJETCLEAN.COM
EMAIL: FLORIDAJETCLEAN@YAHOO.COM

DATE : 12/31/2012
TO : Teresa Carver - Hardee County, Shane Fischer – SCS Engineers
FROM : Ralph Calistri (floridajetclean@yahoo.com)
SUBJECT : Hardee County LF – Phase I LCS & Phase II LCS/GCS - Maintenance

Florida Jetclean completed the high-pressure water-jetting and explosion-proof video-inspection work at the Hardee County landfill (Phase I Leachate Collection & Phase II Leachate and Groundwater Collection) on 12/18/2012. This report contains the applicable Jetting Logs, CCTV Survey List, Pipe Graphic Reports, and DVD inspection footage for complete reference.

## *PHASE I - LEACHATE COLLECTION SYSTEM:*

All accessible Phase I leachate collection piping was jetcleaned utilizing high-pressure water-jetting nozzle. Upon completion of jetcleaning activities, all debris, silt, and sludge were vacuum removed from the accessible Phase I manholes and lift station. Manholes 5, 6, and 7 could not be located and provided no access into the leachate collection system, but the adjoining pipe segments were also jetcleaned from the manhole(s) on the other end of the pipes where possible. Jetting distances achieved in each access location are documented in the below table:

### *** JETTING LOG ***

| LOCATION | ACHIEVED DISTANCE (ft) * | RESULT |
|---|---|---|
| Manhole 1 to 2 | 447' | Entire pipe cleaned |
| Manhole 2 to 3 | 397' | Entire pipe cleaned |
| Manhole 4 to 3 | 432' | Entire pipe cleaned |
| Manhole 4 to 5 | 390' | Entire pipe cleaned |
| Manhole 5 to 6 | 395' | Entire pipe cleaned |
| Manhole LS to 7 | 617' | Entire pipe cleaned |
| Manhole 7 to 6 | 154' | Entire pipe cleaned |
| Manhole 1 to 9 | 120' | Entire pipe cleaned |
| Manhole 9 to LS | 100' | Entire pipe cleaned |

The explosion-proof video-inspections of the Phase I leachate collection pipes (see attached CCTV Survey List, Pipe Graphic Reports and DVD inspection footage) show that with the exception of the following noted areas of concern, all pipes viewed with the inspection camera were clean and defect free. In any areas where video quality was obscured by high liquid levels, the fact that both the inspection camera and the high-pressure jetting nozzle were not restricted through those areas in any way would support the contention that those areas of the leachate collection system are also in good working order.

- Manholes 5, 6, and 7 could not be located and therefore provided no access into the leachate collection system for pipe video-inspections.
- Pipe runs MH9-MH1, MH9-LS, and LS-MH7 had high leachate levels and could not be pumped further down by landfill staff. As a result, the pipe openings in these manholes were submerged under liquid and could not be accessed for proper video-inspection camera insertion.
- MH4-MH5 - The video-inspection camera could not progress past 276.1' of the total pipe length of 390'. Since the inspection-camera was under murky leachate at the point of the stoppage, the reason for the camera's impasse could not be visually identified. Since MH5 could not be located, there was no additional access to attempt to inspect the pipe from the other side to better identify the cause of the camera stoppage. It is important to note that the jetting nozzle was able to pass through this entire pipe length without obstruction, indicating the existence of some capability for leachate flow.

## *PHASE II SECTION I - GROUNDWATER COLLECTION SYSTEM:*

All Phase II - Section I groundwater collection pipes were jetcleaned utilizing high-pressure water-jetting nozzle. Upon completion of jetcleaning activities, all debris, silt, and sludge were vacuum removed from the accessible wet well. Jetting distances achieved in each access location are documented in the below table:

### *** JETTING LOG ***

| LOCATION | ACHIEVED DISTANCE (ft) * | RESULT |
|---|---|---|
| CO1 | 800' | Entire pipe cleaned |
| CO2 | 730' | Entire pipe cleaned |
| CO3 | 710' | Entire pipe cleaned |
| CO4 | 690' | Entire pipe cleaned |
| CO5 | 670' | Entire pipe cleaned |
| CO6 | 650' | Entire pipe cleaned |
| CO7 | 640' | Entire pipe cleaned |
| CO8 | 630' | Entire pipe cleaned |
| CO9 | 620' | Entire pipe cleaned |
| Wetwell to Header | 180' | Entire pipe cleaned |

The explosion-proof video-inspections of the Phase II - Section I groundwater collection pipes (see attached CCTV Survey List, Pipe Graphic Reports and DVD inspection footage) show that all pipes viewed with the inspection camera were clean and defect free. In any areas where video quality was obscured by high liquid levels, the fact that both the inspection camera and the high-pressure jetting nozzle were not restricted through those areas in any way would support the contention that those areas of the groundwater collection system are also in good working order.

## *PHASE II SECTION I - LEACHATE COLLECTION SYSTEM:*

All accessible Phase II - Section I leachate collection piping was jetcleaned utilizing high-pressure water-jetting nozzle. Upon completion of jetcleaning activities, all debris, silt, and sludge were vacuum removed from the accessible Phase II - Section I sump. Jetting distances achieved in each access location are documented in the below table:

## *** JETTING LOG ***

| LOCATION | ACHIEVED DISTANCE ft) * | RESULT |
|---|---|---|
| South CO to Sump.Riser | 690' | Entire pipe cleaned |
| Center CO (West to East) | 620' | Entire pipe cleaned |
| North CO to Sump.Riser | 562' | Entire pipe cleaned |
| Detection CO to Sump | 204' | Entire pipe cleaned |

The explosion-proof video-inspections of the Phase II - Section I leachate collection pipes (see attached CCTV Survey List, Pipe Graphic Reports and DVD inspection footage) show that all pipes viewed with the inspection camera were clean and defect free. In any areas where video quality was obscured by high liquid levels, the fact that both the inspection camera and the high-pressure jetting nozzle were not restricted through those areas in any way would support the contention that those areas of the leachate collection system are also in good working order.

Please call with questions or concerns at 800-226-8013.

Regards,
Ralph Calistri
Ralph Calistri - Florida Jetclean

CCTV Surveys List for SCS

Number of surveys in this list is 18 as of Wednesday, December 19, 2012

**Unit of measure:** ft

| Setup | Date | Street | Start MH | Finish MH | Dir | Size inch | Pre Clean | Vid Cassette | Scheduled Length | Surveyed Length |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | GROUND WATER SYSTEM | GWCO.1 | HEADER.1 | D | 8 | Y | DVD.1 | 800.4 | 800.4 |
| 2 | 12/17/2012 | GROUND WATER SYSTEM | GW CO.2 | HEADER.2 | D | 8 | Y | DVD.1 | 712.0 | 712.0 |
| 3 | 12/17/2012 | GROUND WATER SYSTEM | GW CO.3 | HEADER.3 | D | 8 | Y | DVD.1 | 689.4 | 689.4 |
| 4 | 12/17/2012 | GROUND WATER SYSTEM | GW CO.4 | HEADER.4 | D | 8 | Y | DVD.1 | 677.7 | 677.7 |
| 5 | 12/17/2012 | GROUND WATER SYSTEM | GW CO.5 | HEADER.5 | D | 8 | Y | DVD.1 | 662.7 | 662.7 |
| 6 | 12/17/2012 | GROUND WATER SYSTEM | GW CO.6 | HEADER.6 | D | 8 | Y | DVD.2 | 650.9 | 650.9 |
| 7 | 12/18/2012 | GROUND WATER SYSTEM | GW CO.7 | HEADER.7 | D | 8 | Y | DVD.2 | 638.2 | 638.2 |
| 8 | 12/18/2012 | GROUND WATER SYSTEM | GW CO.8 | HEADER.8 | D | 8 | Y | DVD.2 | 626.8 | 626.8 |
| 9 | 12/18/2012 | GROUND WATER SYSTEM | GW CO.9 | HEADER.9 | D | 8 | Y | DVD.2 | 619.3 | 619.3 |
| 10 | 12/18/2012 | GROUND WATER SYSTEM | WET WELL | HEADER | U | 12 | Y | DVD.2 | 68.1 | 68.1 |
| 11 | 12/18/2012 | LEACHATE COLLECTION SYSTEM | SOUTH CO | SUMP RISER | D | 8 | Y | DVD.3 | 690.9 | 690.9 |
| 12 | 12/18/2012 | LEACHATE COLLECTION SYSTEM | W.CENT.CO | E.CENT.CO | D | 8 | Y | DVD.3 | 620.8 | 620.8 |
| 13 | 12/18/2012 | LEACHATE COLLECTION SYSTEM | NORTH.CO | SUMP RISER | D | 8 | Y | DVD.3 | 561.2 | 561.2 |
| 14 | 12/18/2012 | LEACHATE COLLECTION SYSTEM | DET CO | DET.SUMP | D | 8 | Y | DVD.3 | 204.2 | 204.2 |
| 15 | 12/18/2012 | LEACHATE COLL PHASE.1 | MH.4 | MH.5 | U | 8 | N | DVD.3 | 389.0 | 276.1 |
| 16 | 12/18/2012 | LEACHATE COLL PHASE.1 | MH.4 | MH.3 | D | 8 | N | DVD.3 | 432.4 | 432.4 |
| 17 | 12/18/2012 | LEACHATE COLL PHASE.1 | MH.2 | MH.3 | U | 8 | N | DVD.3 | 396.3 | 396.3 |
| 18 | 12/18/2012 | LEACHATE COLL PHASE.1 | MH.2 | MH.1 | D | 8 | N | DVD.3 | 446.6 | 446.6 |
| | | | | | | | | **Total Scheduled Length** | 9,886.9 | |
| | | | | | | | | **Total Length Surveyed** | | 9,774.0 |

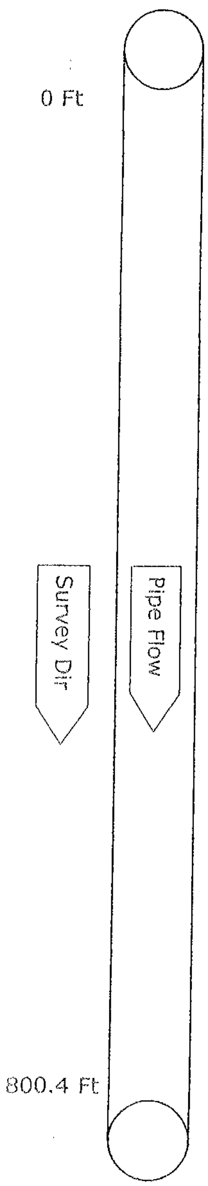
## Pipe Graphic Report of PLR GWCO.1 X for SCS

| | | | | | |
|---|---|---|---|---|---|
| **Work Order** 2012 | **Contract** | | **Video** DVD.1 | **Setup** 1 | |
| **Facility** | **Operator** Supervisor | | **Van Ref** 3 | **Surveyed On** | |

**Street Name** GROUND WATER SYSTEM **City** HARDEE CO. LANDFILL
**Location type** LANDFILL
**Surface** Mown lawn
**Survey purpose** Re-survey for any reason **Weather** Dry

| | | |
|---|---|---|
| **Pipe Use** LEACHATE | **Schedule length** 800.4 Ft | **From** GWCO.1 **Depth** Ft |
| **Shape** Circular | **Size** 8 **by** ins | **To** HEADER.1 **Depth** Ft |
| **Material** Polyethylene - High density | **Joint spacing** Ft | **Direction** Downstream |
| **Lining** | **Year laid** | **Pre-clean** Y **Last cleaned** |

**General note** VIDEO INSPECTION OF GROUND WATER PIPEING SYSTEM
**Location note** PHASE2 SECTION1 CLEANOUTS FOR GROUND WATER.




0.0 Ft Start of Survey
Manhole/Node [GWCO.1]
Water level 0

683.3 Ft Camera under water

713.8 Ft Camera Submerged End

730.0 Ft Camera under water

800.4 Ft Manhole/Node [HEADER.1]
Finish of Surveys

## Pipe Graphic Report of PLR GW CO.2 X for SCS

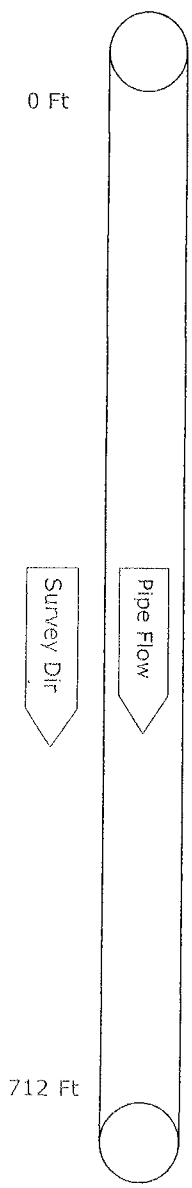
| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Work Order** | 2012 | **Contract** | | **Video** | DVD.1 | **Setup** | 2 |
| **Facility** | | **Operator** | Supervisor | **Van Ref** | 3 | **Surveyed On** | 12/17/2012 |

| | | | |
|---|---|---|---|
| **Street Name** | GROUND WATER SYSTEM | **City** | HARDEE CO. LANDFILL |
| **Location type** | LANDFILL | | |
| **Surface** | Mown lawn | | |
| **Survey purpose** | Re-survey for any reason | **Weather** | Dry |

| | | | | | |
|---|---|---|---|---|---|
| **Pipe Use** | LEACHATE | **Schedule length** | 712.0 Ft | **From** GW CO.2 | **Depth** Ft |
| **Shape** | Circular | **Size** 8 **by** | ins | **To** HEADER.2 | **Depth** Ft |
| **Material** | Polyethylene - High density | **Joint spacing** | Ft | **Direction** Downstream | |
| **Lining** | | **Year laid** | | **Pre-clean** Y | **Last cleaned** |

**General note** VIDEO INSPECTION OF GROUND WATER PIPEING SYSTEM

**Location note** PHASE2 SECTION1 CLEANOUTS FOR GROUND WATER.




| | |
|---|---|
| 0.0 Ft | Start of Survey<br>Manhole/Node [GW CO.2]<br>Water level 0 |
| 585.3 Ft | Camera under water |
| 712.0 Ft | Manhole/Node [HEADER.2]<br>Finish of Surveys |

## Pipe Graphic Report of PLR GW CO.3 X for SCS

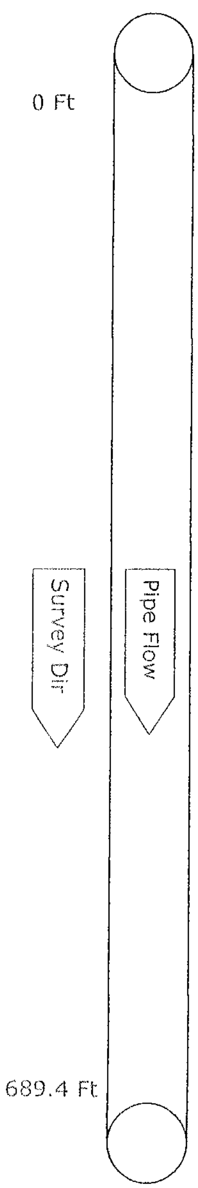
| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Work Order** | 2012 | **Contract** | | **Video** | DVD.1 | **Setup** | 3 |
| **Facility** | | **Operator** | Supervisor | **Van Ref** | 3 | **Surveyed On** | 12/17/2012 |

| | | | |
|---|---|---|---|
| **Street Name** | GROUND WATER SYSTEM | **City** | HARDEE CO. LANDFILL |
| **Location type** | LANDFILL | | |
| **Surface** | Mown lawn | | |
| **Survey purpose** | Re-survey for any reason | **Weather** | Dry |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Pipe Use** | LEACHATE | **Schedule length** | 689.4 Ft | **From** | GW CO.3 | **Depth** | Ft |
| **Shape** | Circular | **Size** | 8 **by** ins | **To** | HEADER.3 | **Depth** | Ft |
| **Material** | Polyethylene - High density | **Joint spacing** | Ft | **Direction** | Downstream | | |
| **Lining** | | **Year laid** | | **Pre-clean** | Y | **Last cleaned** | |

**General note** VIDEO INSPECTION OF GROUND WATER PIPEING SYSTEM

**Location note** PHASE2 SECTION1 CLEANOUTS FOR GROUND WATER.




| | |
|---|---|
| 0.0 Ft | Start of Survey<br>Manhole/Node [GW CO.3]<br>Water level 0 |
| 576.2 Ft | Camera under water |
| 689.4 Ft | Manhole/Node [HEADER.3]<br>Finish of Surveys |

## Pipe Graphic Report of PLR GW CO.4 X for SCS

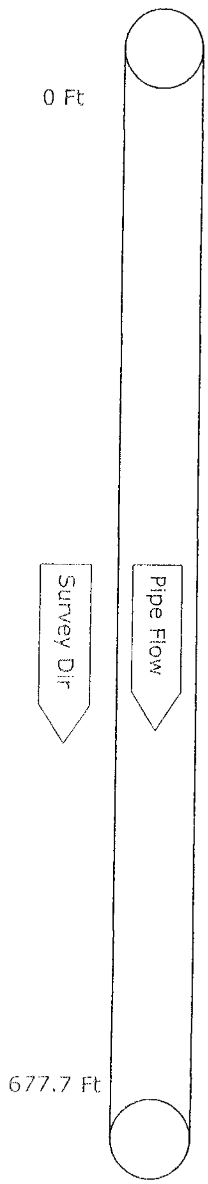
| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Work Order** | 2012 | **Contract** | | **Video** | DVD.1 | **Setup** | 4 |
| **Facility** | | **Operator** | Supervisor | **Van Ref** | 3 | **Surveyed On** | 12/17/2012 |

| | | | |
|---|---|---|---|
| **Street Name** | GROUND WATER SYSTEM | **City** | HARDEE CO. LANDFILL |
| **Location type** | LANDFILL | | |
| **Surface** | Mown lawn | | |
| **Survey purpose** | Re-survey for any reason | **Weather** | Dry |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Pipe Use** | LEACHATE | **Schedule length** | 677.7 Ft | **From** | GW CO.4 | **Depth** | Ft |
| **Shape** | Circular | **Size** | 8 **by** ins | **To** | HEADER.4 | **Depth** | Ft |
| **Material** | Polyethylene - High density | **Joint spacing** | Ft | **Direction** | Downstream | | |
| **Lining** | | **Year laid** | | **Pre-clean** | Y | **Last cleaned** | |

**General note** VIDEO INSPECTION OF GROUND WATER PIPEING SYSTEM

**Location note** PHASE2 SECTION1 CLEANOUTS FOR GROUND WATER.




0.0 Ft Start of Survey
Manhole/Node [GW CO.4]
Water level 0

529.2 Ft Camera under water

677.7 Ft Manhole/Node [HEADER.4]
Finish of Surveys

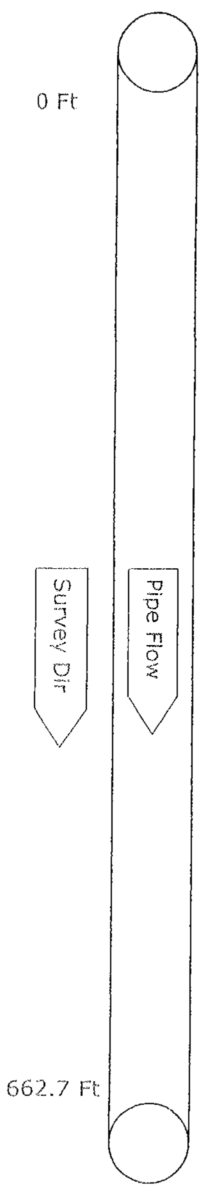
## Pipe Graphic Report of PLR GW CO.5 X for SCS

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Work Order** | 2012 | **Contract** | | **Video** | DVD.1 | **Setup** | 5 |
| **Facility** | | **Operator** | Supervisor | **Van Ref** | 3 | **Surveyed On** | 12/17/2012 |

| | | | |
|---|---|---|---|
| **Street Name** | GROUND WATER SYSTEM | **City** | HARDEE CO. LANDFILL |
| **Location type** | LANDFILL | | |
| **Surface** | Mown lawn | | |
| **Survey purpose** | Re-survey for any reason | **Weather** | Dry |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Pipe Use** | LEACHATE | **Schedule length** | 662.7 Ft | **From** | GW CO.5 | **Depth** | Ft |
| **Shape** | Circular | **Size** | 8 **by** ins | **To** | HEADER.5 | **Depth** | Ft |
| **Material** | Polyethylene - High density | **Joint spacing** | Ft | **Direction** | Downstream | | |
| **Lining** | | **Year laid** | | **Pre-clean** | Y | **Last cleaned** | |

| | |
|---|---|
| **General note** | VIDEO INSPECTION OF GROUND WATER PIPEING SYSTEM |
| **Location note** | PHASE2 SECTION1 CLEANOUTS FOR GROUND WATER. |




0.0 Ft — Start of Survey
Manhole/Node [GW CO.5]
Water level 0

553.7 Ft — Camera under water

662.7 Ft — Manhole/Node [HEADER.5]
Finish of Surveys

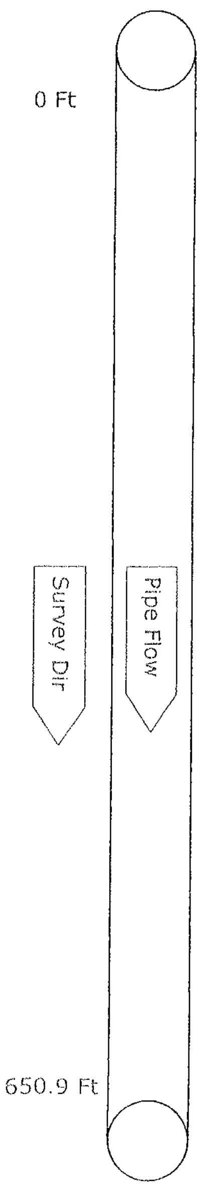
## Pipe Graphic Report of PLR GW CO.6 X for SCS

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Work Order** | 2012 | **Contract** | | **Video** | DVD.2 | **Setup** | 6 |
| **Facility** | | **Operator** | Supervisor | **Van Ref** | 3 | **Surveyed On** | 12/17/2012 |

| | | | |
|---|---|---|---|
| **Street Name** | GROUND WATER SYSTEM | **City** | HARDEE CO. LANDFILL |
| **Location type** | LANDFILL | | |
| **Surface** | Mown lawn | | |
| **Survey purpose** | Re-survey for any reason | **Weather** | Dry |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Pipe Use** | LEACHATE | **Schedule length** | 650.9 Ft | **From** | GW CO.6 | **Depth** | Ft |
| **Shape** | Circular | **Size** | 8 **by** ins | **To** | HEADER.6 | **Depth** | Ft |
| **Material** | Polyethylene - High density | **Joint spacing** | Ft | **Direction** | Downstream | | |
| **Lining** | | **Year laid** | | **Pre-clean** | Y | **Last cleaned** | |

| | |
|---|---|
| **General note** | VIDEO INSPECTION OF GROUND WATER PIPEING SYSTEM |
| **Location note** | PHASE2 SECTION1 CLEANOUTS FOR GROUND WATER. |




| | |
|---|---|
| 0.0 Ft | Start of Survey<br>Manhole/Node [GW CO.6]<br>Water level 0 |
| 561.8 Ft | Camera under water |
| 650.9 Ft | Manhole/Node [HEADER.6]<br>Finish of Surveys |

**Pipe Graphic Report of PLR** GW CO.7 X **for** SCS

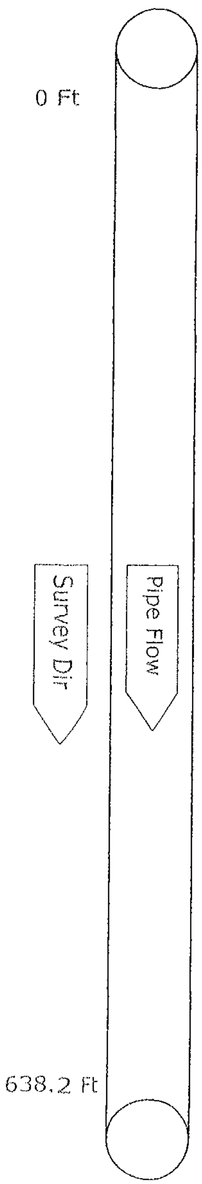
| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Work Order** | 2012 | **Contract** | | **Video** | DVD.2 | **Setup** | 7 |
| **Facility** | | **Operator** | Supervisor | **Van Ref** | 3 | **Surveyed On** | 12/18/2012 |

| | | | |
|---|---|---|---|
| **Street Name** | GROUND WATER SYSTEM | **City** | HARDEE CO. LANDFILL |
| **Location type** | LANDFILL | | |
| **Surface** | Mown lawn | | |
| **Survey purpose** | Re-survey for any reason | **Weather** | Dry |

| | | | | | |
|---|---|---|---|---|---|
| **Pipe Use** | LEACHATE | **Schedule length** | 638.2 Ft | **From** GW CO.7 | **Depth** Ft |
| **Shape** | Circular | **Size** 8 **by** | ins | **To** HEADER.7 | **Depth** Ft |
| **Material** | Polyethylene - High density | **Joint spacing** | Ft | **Direction** Downstream | |
| **Lining** | | **Year laid** | | **Pre-clean** Y | **Last cleaned** |

**General note** VIDEO INSPECTION OF GROUND WATER PIPEING SYSTEM

**Location note** PHASE2 SECTION1 CLEANOUTS FOR GROUND WATER SYSTEM.




0.0 Ft — Start of Survey; Manhole/Node [GW CO.7]; Water level 0

538.2 Ft — Camera under water

638.2 Ft — Manhole/Node [HEADER.7]; Finish of Surveys

# Attachment P

- Revised Section 5 of the CQA Plan
- Revised Section 6 of the CQA Plan
- Revised Specification Section 02077 - Geosynthetic Clay Liner
- Revised Specification Section 02220 - Excavation, Backfill, Fill, and Grading
- Revised Specification Section 02776 - High Density Polyethylene (HDPE) Geomembrane Liner
- Revised Specification Section 02930 - Tri-Planar Geocomposite
- Revised Specification Section 02931 - Bi-Planar Geocomposite
- Specification Section 02940 - Geotextile
- Specification Section 02941 - Geosynthetic Rain Tarp
- Revised Specification Section 11200 - Leachate Collection and Detection Pumps

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# Hardee County Landfill Phase II Section II Expansion Construction Quality Assurance (CQA) Plan

## Hardee County, Florida

Prepared for:

**Hardee County**

Solid Waste Department
685 Airport Road
Wauchula, FL 33873
(863) 773-5089

Prepared by:

**SCS ENGINEERS**
4041 Park Oaks Blvd, Suite 100
Tampa, FL 33610
(813) 621-0080

File No. 09199033.23
August 31, 2012
Revised April 1, 2013

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# Phase II Section II Expansion
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4/1/13
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# 5.0 EARTH MATERIAL QUALITY ASSURANCE

## 5.1 GENERAL

This section of the CQA Plan describes CQA procedures for earth material (e.g. soil and rock) components of the project.

CQC testing and Contractor installation requirements are outlined in the Technical Specifications.

## 5.2 TESTING PROGRAM

The two categories of QA testing covered in this CQA Plan include Pre-Construction Testing and Construction Testing. Within these categories, QA testing shall consist of the following:

- Material Evaluation.
- Construction Quality Evaluation.
- Special Testing.

## 5.3 MATERIAL EVALUATION

Pre-construction ~~M~~materials evaluations shall be performed on samples from potential soil borrow sources by the Contractors independent CQC Laboratory prior to incorporation into construction to ascertain their acceptability as construction materials. Testing shall be performed by the Soils CQA Laboratory during the course of the work to verify continued material compliance with the Plans and Technical Specifications.

Criteria to be used for determination of acceptability of earth materials for use during construction shall be as defined in the Plans and Technical Specifications. All evaluation tests are to be performed in the Soils CQA Laboratory which has been approved for use by the Owner or CQA Consultant. Test reports will verify compliance with or state deviation from the applicable ASTM Standards or other accepted standards as outlined in the Technical Specifications.

All soil materials shall meet or exceed the project Technical Specifications.

### 5.3.1 Hydraulic Conductivity Evaluations Pre-construction Materials Evaluations

Unless otherwise indicated in the Plans or Technical Specifications the following tests shall be performed on materials to identify ~~from~~ potential soil borrow sources by the Contractors independent CQC Laboratory prior to incorporation of the material into construction to ascertain their acceptability as construction materials. Testing shall be performed by the Soils CQA Laboratory during the course of the work to verify continued material compliance with the Plans and Technical Specifications for material that has been incorporated into the work.~~:~~

- Natural Moisture Content (ASTM D2216)
- Standard Proctor (ASTM D698)
- Atterberg Limits (ASTM D4318)
- Sieve Analysis (ASTM D422)
- Soil Classification (ASTM D2487)

### 5.3.2 Hydraulic Conductivity Testing

Hydraulic conductivity evaluations shall be conducted on the Geosynthetic Clay Liner (GCL) and sand drainage layers. Acceptance criteria of the GCL are based on measured values of hydraulic conductivity shall be based on project Specifications. Tests may be performed using laboratory equipment and methods that are suitable for the soil type or the geosynthetic material. High permeability materials, such as gravels and sands may be tested using constant head methods in rigid wall or flexible wall permeameter. Low permeability materials such as clays and silts may also be tested in rigid or flexible wall permeameters using falling head methods, provided that sample preparation is performed carefully.

### 5.3.3 General Fill Soil Testing

Prior to the installation of General Fill, the Contractor or CQC Consultant shall provide the test results on the General Fill from potential soil borrow sources, as required by the Technical Specifications, to the CQA Consultant for approval. Upon receipt of the test information, the CQA Consultant will collect one random sample from the material and test it as required by the Technical Specifications and provide approval to the Contractor prior to incorporation of the material into construction.

### 5.3.4 Subbase Soil Fill Testing

Prior to the installation of subbase soil fill, the Contractor~~'s~~ or CQC Consultant shall provide the test results on the subbase soil fill from potential soil borrow sources, as required by the Technical Specifications, to the CQA Consultant for approval. Upon receipt of the test information, the CQA Consultant will collect one random sample from the material and test it as required by the Technical Specifications and provide approval to the Contractor prior to incorporation of the material into construction.

### 5.3.5 Structural Fill Soil Testing

Prior to the installation of structural fill material, the Contractor~~'s~~ or CQC Consultant shall provide the test results on the structural fill soil from potential soil borrow sources, as required by the Technical Specifications, to the CQA Consultant for approval. Upon receipt of the test information, the CQA Consultant will collect one random sample from the material and test it as required by the Technical Specifications and provide approval to the Contractor prior to incorporation of the material into construction.

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#### 5.3.6 Protective Soil/Drainage Sand Material Testing

Prior to the installation of the protective soil/drainage sand material, the Contractor's or CQC Consultant shall provide the test results on the protective/drainage soil from potential soil borrow sources, as required by the Technical Specifications, to the CQA Consultant for approval. Upon receipt of the test information, the CQA Consultant will collect one random sample from the material and test it as required by the Technical Specifications and provide approval to the Contractor prior to incorporation of the material into construction.

#### 5.3.7 Leachate Trench Gravel Material Testing

Prior to the installation of the leachate trench gravel material, the Contractor's or CQC Consultant shall provide the test results on the leachate trench gravel from potential soil borrow sources, as required by the Technical Specifications, to the CQA Consultant for approval. Upon receipt of the test information, the CQA Consultant will collect one random sample from the material and test it as required by the Technical Specifications and provide approval to the Contractor prior to incorporation of the material into construction.

#### 5.3.8 Groundwater Collection System Gravel Material Testing

Prior to the installation of the groundwater collection system gravel material, the Contractor's or CQC Consultant shall provide the test results on the groundwater collection system gravel from potential soil borrow sources, as required by the Technical Specifications, to the CQA Consultant for approval. Upon receipt of the test information, the CQA Consultant will collect one random sample from the material and test it as required by the Technical Specifications and provide approval to the Contractor prior to incorporation of the material into construction.

### 5.4 CONSTRUCTION QUALITY EVALUATION

Construction quality evaluation shall be performed on all soil components of the construction. These evaluations shall be performed at the frequencies indicated in the Technical Specifications. Criteria to be used for determination of acceptability of the construction work shall be as identified in the Technical Specifications.

Construction evaluation testing includes the visual observations of the work; in-place density/moisture content testing; surveys of as-built conditions and elevations; thickness monitoring; and special testing. Observation of the construction work shall include the following:

- Size of foreign materials and stones and other physical properties of the soil during processing, placement and compaction.
- Thickness of lifts as loosely placed and as compacted.
- Action of the compaction equipment on the construction surface (pumping, cracking, etc.).

Determinations of in-place moisture and density shall be performed in accordance with the Technical Specifications.

### 5.4.1 Deficiencies

If defects are discovered in the earthwork, the extent and nature shall be evaluated by the CQA Consultant. If a defect is indicated by a failing test, the CQA Consultant shall determine the limits of the affected area by additional tests, observations, a review of records, and other means deemed appropriate. If the defect is related to adverse site conditions, the CQA Consultant shall define the limits and nature of the defect.

### 5.4.2 Notification

The CQA Consultant shall notify the Owner and Contractor after determining the nature and extent of the defect. Appropriate retests shall be scheduled by the CQA Consultant when the work deficiency is corrected.

### 5.4.3 Repairs and Retesting

Deficiencies shall be corrected by the Contractor to the satisfaction of the CQA Consultant. The CQA Consultant shall also verify that all installation requirements as outlined in the Technical Specifications and this CQA Plan (i.e., material quality, thickness and compaction) have been met and that all submittals are provided.

## 5.5 SPECIAL TESTING

Special testing to determine the acceptability of materials shall be conducted at the direction of the Owner, the CQA Consultant or their representative. Criteria to be used for the determination of acceptability shall be as established by the Owner, the CQA Consultant or their representative.

# 6.0 GEOSYNTHETIC MATERIAL QUALITY ASSURANCE

## 6.1 GEOMEMBRANE

This QA testing program has been established to verify that the specified geomembrane (60 mil textured HDPE) are manufactured, installed and tested according to the Technical Specifications.

### 6.1.1 Manufacturer Quality Control Documentation

The Geomembrane Manufacturer shall provide documentation and certification that the material meets the requirements outlined in the Technical Specifications and that adequate quality control measures have been implemented during the manufacturing process.

The following should be provided prior to shipment of the geomembrane:

- A properties value certification including at a minimum, guaranteed values for all geomembrane properties required by the Technical Specifications.
- An inventory list of quantities with descriptions of materials which comprise the geomembrane shipment(s).

The CQA Consultant shall verify that the property values certified by the Geomembrane Manufacturer meet the test methods listed in the Technical Specifications and Manufacturer's guaranteed minimum values.

### 6.1.2 Manufacturer's Quality Control Certificate

Prior to shipment, the Geomembrane Manufacturer shall also provide the CQA Consultant with quality control certificates for the geomembrane, signed by a responsible party employed by the Geomembrane Manufacturer. The Geomembrane Manufacturer shall be required to perform, at a minimum, the tests listed in the Technical Specifications.

The CQA Consultant shall review the quality control certificates and verify the certificates have been provided at the specified frequencies for all materials and rolls. The CQA Consultant shall also review the quality control certificates and verify that the test methods meet the requirements included in the Technical Specifications and the Manufacturer's guaranteed minimum values which were provided prior to shipment.

#### 6.1.2.1 Delivery and Storage

Upon delivery to the site, visual inspection by the Installer and the CQA Consultant shall be conducted on all rolls for evidence of defects or damage. This inspection shall be done without unrolling the rolls unless damage or defects are detected.

The Installer shall be responsible for the storage of the geomembranes on-site. The storage space shall provide protection from theft, vandalism and traffic. The storage location shall be such that exposure to environmental factors, construction activities and handling are minimized.

#### 6.1.2.2 Conformance Sampling and Testing

The required number of conformance sample(s) of the specified geomembrane (60 mil textured High Density Polyethylene (HDPE) geomembrane) will be collected and tested by the Owner's representative prior to shipment of the material to the project site. The Owner's representative shall select the rolls to be tested. Samples shall not include the first complete revolution. The sample shall be a minimum four feet, as measured along the width of the roll, and extend three feet along the roll. Samples shall be taken at a rate of at least one sample per lot, but at a rate not less than one conformance test per every 100,000 square feet or portion thereof. Samples shall not include any portion of a roll which has been subjected to excess pressure or stretching. All lots of material and the particular test sample that represents each lot will be defined before the samples are obtained. These conformance sample(s) shall be sent to the Geosynthetics CQA Laboratory for testing to verify conformance to the values listed in Table 02776-1 of Technical Specification 02776 High Density Polyethylene (HDPE) Geomembrane Liner. These tests shall be performed prior to installation of the geomembrane. The Geomembrane conformance sample shall be tested for the following:

1. Thickness (ASTM D5994) - One test per 100,000 $ft^2$.
2. Carbon Black Content (ASTM D1603) - One test per 100,000 $ft^2$.
3. Carbon Black Dispersion (ASTM D5596) - One test per 100,000 $ft^2$.
4. Density (ASTM D1505 or ASTM D792) - One test per 100,000 $ft^2$.
5. Tensile Properties Each Direction (ASTM D6693 Type IV) - One test per 100,000 $ft^2$.
6. Bi-planar Geocomposite/Geomembrane Interface Friction Angle (ASTM D5321) - One representative sample of the Bi-planar/Geomembrane

    A. Direct Shear Test (Interface Shear Resistance) - The Owner's representative will perform one (1) direct shear test in accordance with ASTM D5321 on representative samples of the bi-planar geocomposite and 60 mil textured HDPE geomembrane. The following testing parameters will be followed for the Direct Shear Testing with the results submitted to the ENGINEER:

        1. Testing to be conducted under fully saturated (water) conditions.
        2. Three Normal Loads = 1,000, 2~~3~~,000, and 4~~6~~,000 psf.
        3. Test Configuration: bi-planar geocomposite clamped to top box
           textured geomembrane clamped to bottom box
        4. Strain Rate = 0.040 in/min.
        5. Continue testing to ensure a full 3 inches of displacement.

6. Plot and report (Peak and Residual values) for the best fit line through each of the three test results.

7. A minimum PEAK value of 0 psf adhesion and 20.5º for the interface friction angle is required for this project (based upon the best fit line).

8. Adhesion may be considered by the ENGINEER to determine equivalent stability for this project.

7. Tri-planar/Geomembrane Interface Friction Angle (ASTM D5321) - One representative sample of the Tri-planar/Geomembrane

A. Direct Shear Test (Interface Shear Resistance) - The Owner's representative will perform one Direct Shear Test in accordance with ASTM D5321 on representative samples of the tri-planar geocomposite and 60 mil textured HDPE geomembrane. The following testing parameters will be followed for the Direct Shear Testing with the results submitted to the ENGINEER:

1. Testing to be conducted under fully saturated (water) conditions.

2. Three Normal Loads = 1,000, 2~~3~~,000, and 4~~6~~,000 psf.

3. Test Configuration: tri-planar geocomposite clamped to top box
textured geomembrane clamped to bottom box

4. Strain Rate = 0.040 in/min.

5. Continue testing to ensure a full 3 inches of displacement.

6. Plot and report (Peak and Residual values) for the best fit line through each of the three test results.

7. A minimum PEAK value of 0 psf adhesion and 20.5º for the interface friction angle is required for this project (based upon the best fit line).

8. Adhesion may be considered by the ENGINEER to determine equivalent stability for this project.

8. Geomembrane/GCL Interface Friction Angle (ASTM D5321) - One representative sample of the Geomembrane/GCL

A. Direct Shear Test (Interface Shear Resistance) - The Owner's representative will perform one Direct Shear Test in accordance with ASTM D5321 on representative samples of the GCL and 60 mil textured HDPE geomembrane. The following testing parameters will be followed for the Direct Shear Testing with the results submitted to the ENGINEER:

1. Testing to be conducted under fully saturated (water) conditions.

2. Three Normal Loads = 1,000, 2~~3~~,000, and 4~~6~~,000 psf.

3. Test Configuration: textured geomembrane clamped to top box
   GCL clamped to bottom box

4. Strain Rate = 0.040 in/min.

5. Continue testing to ensure a full 3 inches of displacement.

6. Plot and report (Peak and Residual values) for the best fit line through each of the three test results.

7. A minimum PEAK value of 0 psf adhesion and 20.5º for the interface friction angle is required for this project (based upon the best fit line).

8. Adhesion may be considered by the ENGINEER to determine equivalent stability for this project.

9. Geomembrane/Subbase Interface Friction Angle (ASTM D5321) - One representative sample of the Geomembrane/Subbase

   B. Direct Shear Test (Interface Shear Resistance) - The Owner's representative will perform one Direct Shear Test in accordance with ASTM D5321 on a representative sample of the Geomembrane and the subbase. The following testing parameters will be followed for the Direct Shear Testing with the results submitted to the ENGINEER:

   1. Testing to be conducted under fully saturated (water) conditions.

   2. Three Normal Loads = 1,000, 2,000, and 4,000 psf.

   3. Test Configuration: Geomembrane clamped to top box
      subbase bottom box

   4. Strain Rate = 0.040 in/min.

   5. Continue testing to ensure a full 3 inches of displacement.

   6. Plot and report (Peak and Residual values) for the best fit line through each of the three test results.

   7. A minimum PEAK value of 0 psf adhesion and 20.5º for the interface friction angle is required for this project (based upon the best fit line).

   8. Adhesion may be considered by the ENGINEER to determine equivalent stability for this project.

Prior to the deployment of the geomembrane, the CQA Consultant shall review all conformance test results and report any nonconformance to the Owner, Installer and Manufacturer. The CQA Consultant shall be responsible for verifying that all the test results meet or exceed the property values listed in the Technical Specifications.

If failing test results may be the result of the sampling process or due to the Geosynthetics CQA Laboratory incorrectly conducting the test, the Manufacturer may request a retest to be conducted at the Geosynthetics CQA Laboratory in the presence of a representative of the Manufacturer.

All material from a lot represented by a failing test result shall be rejected, or additional conformance test samples may be taken to isolate the portion of the lot not meeting the Technical Specifications (this procedure is valid only when rolls in a lot are consecutively produced and numbered from one manufacturing line). Additional samples shall be taken from rolls on either side of the failing roll, until passing test results are achieved, to establish the range of failure within the lot. All rolls lying within this range of failure shall be rejected.

### 6.1.3 Subbase Preparation and Acceptance

The Contractor shall be responsible for preparing the Subbase upon which the GCL will be placed according to the Technical Specifications. Prior to acceptance, the CQA Consultant shall verify that:

- A qualified land surveyor has verified all lines and grades.
- The supporting soil provides a firm, unyielding foundation.
- The surface to be lined is relatively smooth and free of stones and sharp materials (greater than ½-inch in any dimension), protrusions, irregularities, roots, loose soil, abrupt changes in grade, or other conditions that may puncture or abrade the geomembrane.
- There is no standing water or areas excessively softened by high moisture content.
- All tests have been completed and meet the Technical Specification requirements and no other tests are necessary.

The Installer shall certify, in writing, that the surface on which the geomembrane will be installed is acceptable. A "Certificate of Subbase Acceptance" shall be co-signed by the Installer and the CQA Consultant prior to commencement of geomembrane installation in the area under consideration and a copy of this certificate provided to the Owner.

After the supporting soil has been accepted by the Installer, it shall be the Installer's responsibility to indicate to the CQA Consultant any change in the supporting soil condition that may require correction. If the CQA Consultant concurs with the Installer, then the Owner shall ensure that the supporting soil is repaired.

### 6.1.4 Subbase Repair

At any time during the GCL installation, the CQA Consultant shall indicate to the Installer and

Owner locations which may not provide adequate support to the GCL so the areas in question can be tested and, if necessary, repaired.

Special care shall be taken to avoid desiccation cracking of the underlying soil layer. To that end the soil surface shall be observed by the Installer and the CQA Consultant and the decision to repair cracks, if any, shall be made by the Owner and the Design Engineer.

### 6.1.5 Anchor Trenches

The CQA Consultant shall verify that the anchor trenches have been constructed according to the Plans and Technical Specifications.

Rounded or smoothed corners shall be provided where the geomembrane enters the trench so as to avoid sharp bends in the geomembrane. No loose or excessively wet soil shall be allowed to underlie the geomembrane in the anchor trenches.

The anchor trench shall be adequately drained to prevent ponding or otherwise softening of the adjacent soils while the trench is open. The anchor trench shall be carefully backfilled and compacted by the Contractor or the Installer, as outlined in the Technical Specifications. Care shall be taken when backfilling the trenches to prevent bridging of the geomembrane or damage.

### 6.1.6 Field Panel Identification

The CQA Consultant shall verify that each field panel is given a unique identification code (number or letter-numbered) consistent with the layout plan. This identification code shall be agreed upon by the Installer and CQA Consultant. The CQA Consultant and Installer shall establish a table or chart showing correspondence between roll numbers and field panel identification codes. The field panel identification code shall be used for all QA documentation.

The CQA Consultant shall verify that field panels are installed at the location indicated in the Installer's layout plan, as approved or modified, and that the Installer has marked the identification code and roll number on each installed panel. The Installer and CQA Consultant shall also verify that the condition of the supporting soil has not changed detrimentally during installation. The CQA Consultant shall record the identification code, location, and date of installation of each field panel.

### 6.1.7 Field Panel Placement and Deployment

Geomembrane panel placement shall not be done during any precipitation, in the presence of excessive moisture (e.g., fog, dew), in areas of ponded water, or in the presence of strong winds. Manufacturer's recommendations or the Technical Specifications should be followed, whichever is more stringent, for extreme ambient temperature conditions.

Panels shall be oriented according to the Installer's panel layout drawing as approved by the CQA Consultant. Seams shall be located outside of areas of potential high stress conditions, at slope intersections and corners, or other areas considered critical. The CQA Consultant shall review the seam orientations prior to seaming operations to determine if these conditions are satisfied.

The CQA Consultant shall verify that the geomembrane handling equipment used does not pose risk of damage to the geomembrane or subgrade, and that the Installer's personnel take care in handling the geomembrane at all times.

Contact between the Subbase soil and the GCL shall be maintained in all areas. The Installer shall take into account ambient temperature and its effect on the thermal expansion and contraction of the geomembrane. The geomembrane materials shall be deployed in a manner which minimizes wrinkling. Partial backfilling of anchor trenches, adequate loading of the toe of slope during lower ambient temperatures is recommended to prevent displacement by bridging.

The CQA Consultant shall also verify and notify the Owner that:

- Equipment used does not damage the geomembrane during trafficking, handling, excessive heat or other means.
- The method of deploying the geomembrane does not cause excessive scratches or crimps in the geomembrane, and does not damage the approved subgrade surface.
- Personnel working on the geomembrane do not smoke or wear damaging shoes.
- The geomembrane is protected by appropriate means in areas of excessive traffic.
- Adequate ballast (e.g., sand bags) has been placed to prevent wind uplift and is not likely to damage the geomembrane. Continuous loading is recommended along edges of panels in high winds, or when work is terminated for several days or longer periods.

The CQA Consultant shall visually inspect each panel for defects or damage after placement and prior to seaming. Damaged panels or portions of damaged panels shall be marked and repaired, or removed from the work area. Repairs shall be made according to procedures described in the Technical Specifications.

### 6.1.8 Field Seaming

#### 6.1.8.1 Personnel Requirement

The Installer shall be pre-qualified in accordance with the Technical Specifications and approved by the Owner.

The Installer's Superintendent shall be qualified based on previously demonstrated experience, management ability, and authority. The Superintendent is responsible for the Installer's field crew and will represent the Installer at all project meetings.

#### 6.1.8.2 Seam Layout

Prior to the installation of geomembrane, the Installer shall provide the Owner and CQA Consultant with a panel layout drawing showing all expected major panel seams. The Owner or CQA Consultant shall approve in writing the panel layout drawing.

#### 6.1.8.3 Seaming Methods

Accepted seaming methods include double wedge fusion welding and extrusion welding which will result in seams that meet testing requirements as indicated in the Technical Specifications for both destructive and non-destructive samples.

Fusion-welding apparatus shall be an automated, roller-mounted device. The fusion-welding apparatus shall be equipped with gauges indicating the applicable temperatures. The CQA Consultant shall log ambient, seaming apparatus and geomembrane surface temperatures.

Extrusion-welding apparatus shall be equipped with gauges indicating the temperature in the apparatus and at the nozzle.

The Installer shall provide documentation regarding the extrudate to the CQA Consultant, and shall certify that the extrudate is compatible with the Technical Specifications and is comprised of the same resin as the geomembrane sheeting.

The CQA Consultant shall log apparatus temperatures, extrudate temperatures, ambient temperatures, and geomembrane surface temperatures at appropriate intervals.

#### 6.1.8.4 Seam Preparation

The CQA Consultant shall verify that:

- Seams are aligned with the fewest possible number of wrinkles and “fishmouths.”
- Prior to seaming, the seam area is clean and free of moisture, dust, dirt, debris of any kind, and foreign material.
- If seam overlap grinding is required, the process is completed according to the Manufacturer’s instructions within one hour of the seaming operation, and does not damage the geomembrane.
- For cross seams, the edge of the cross seam is ground to a smooth incline (top and bottom) prior to welding.
- A smooth insulating plate or fabric is placed beneath the hot welding apparatus after usage.
- The geomembrane is protected from damage in heavily trafficked areas.

- A movable protective layer (i.e., plywood, geomembrane) may be used as necessary directly below each overlap of geomembrane that is to be seamed to prevent buildup of moisture between the sheets.

- The panels of geomembrane have a finished overlap of 4 inches for extrusion welding and 6 inches for fusion welding, but in any event sufficient overlap shall be provided to allow peel tests to be performed on the seam.

- The procedure used to temporarily bond adjacent panels together does not damage the geomembrane.

#### 6.1.8.5 Weather Conditions for Seaming

The Installer and CQA Consultant shall observe weather conditions during seaming operations to determine if excessive temperatures, moisture or humidity, or winds exist that could impact the welding process.

As indicated in the Technical Specifications, welding shall not occur when ambient air temperatures measured one-foot above the geomembrane are below 32º F or above 104º F and as noted in the Technical Specifications. Preheating of the seams may be used if trial seams have been performed using the same preheating method(s) and meet all criteria for acceptance. Wind conditions shall also be considered in determination of acceptable ambient conditions.

#### 6.1.8.6 General Seaming Procedures

During seaming, the CQA Consultant shall verify the following conditions:

- Seaming shall extend to the outside edge of panels placed within the anchor trench.

- A firm substrate shall be provided using a flat board or similar hard surface directly under the seam overlap to achieve proper support, if necessary.

- "Fishmouths" or wrinkles at the seam overlap shall be cut along the ridge in order to achieve a flat overlap. The cut "fishmouth" or wrinkle shall be seamed and any portion where the overlap is inadequate shall be patched with an oval or round geomembrane patch that extends a minimum of 6 inches beyond the cut in all directions.

- If the Installer proposes to conduct seaming operations outside of the approved conditions as specified herein (i.e., outside the weather parameters or night operations), written information and supporting data verifying seam quality can be maintained shall be submitted to the Engineer for review and approval 72 hours in advance. Alternate seaming operations will not be allowed without prior approval from the Engineer. Contract Documents and Specifications for placing and seaming the geomembrane shall apply to all Work conditions.

- Startup testing is conducted and recorded prior to initiating welding.

#### 6.1.8.7 Trial Welds

The CQA consultant will observe and document the trial welds conducted by the Contractor.

- Perform trial welds on geomembrane samples to verify welding equipment is operating properly.
- Make trial welds under the same surface and environmental conditions as the production welds, i.e., in contact with subgrade and similar ambient temperature.
- Minimum of two trial welds per day, per welding apparatus, one made prior to the start of work and one completed at mid shift.
- Cut four, one inch wide by 6 inch long test strips from the trial weld.
- Quantitatively test specimens for peel adhesion and then for shear strength.
- Trial weld specimens shall pass when the minimum results, as indicated in Table 02776-2, are achieved in both peel and shear tests.
    - The break, when peel testing, occurs in the liner material itself, not through peel separation (FTB).
    - The break is ductile.
- Repeat the trial weld, in its entirety, when any of the trial weld samples fail in either peel or shear.
- No welding equipment or welder shall be allowed to perform production welds until equipment and welders have successfully completed passing trial welds.

### 6.1.9 Seam Testing

#### 6.1.9.1 Nondestructive Testing of Field Seams

The Installer shall nondestructively test all field seams over their full length using a vacuum test unit, air pressure test (double fusion seams only), or other approved method. The purpose of this testing is to determine the continuity of the seams only. Nondestructive testing shall be performed as work progresses, not at completion.

The CQA Consultant shall observe nondestructive testing procedures and inform the Installer and Owner of required repairs. The CQA Consultant shall record the location, date, name, and outcome of all testing.

The Installer shall complete required repairs in accordance with the Technical Specifications. The CQA Consultant shall observe the repair and testing of the repair, document the repair and test results, and mark on the geomembrane that the repair has been completed. All repairs shall be shown on the Record Drawings (e.g. the panel layout sheet) and in repair logs and on daily reports.

Vacuum testing equipment and methods are discussed in the Technical Specifications.

Air pressure testing procedures are applicable to fusion-welding that produces a double seam with an enclosed air channel. The equipment and methods are discussed in the Technical Specifications.

#### 6.1.9.2 Destructive Testing

Destructive seam tests shall be performed on seam samples cut from the geomembrane locations selected by the CQA Consultant. The purpose of these tests is to evaluate seam strength. Seam strength testing shall be done as the seaming work progresses, not at the completion of all field seaming.

The CQA Consultant shall select locations where seam samples will be cut by the Installer for laboratory testing. Those locations shall be established as follows:

- ~~A minimum average frequency of one test location per 500 feet of seam length or one test location per seam, whichever is greater.~~Installed geomembrane shall be tested at a rate of one test per 500 linear feet of welded seam at locations selected by the CQA Consultant.
- At least one location for each seaming machine each day.
- At locations where the CQA Consultant suspects that inadequate seaming methods or conditions occurred or other factors causing to reduce seam strength exist.

The Installer shall not be informed in advance of the locations where the destructive seam samples will be taken.

#### 6.1.9.3 Sampling Procedures

Samples shall be cut by the Installer at locations selected by the CQA Consultant as the seaming progresses, such that laboratory test results are available before the geomembrane is covered by another material.

The CQA Consultant shall observe the sample cutting, assign a number to each sample, and mark it accordingly, and record the sample location on the layout drawing.

All holes in the geomembrane resulting from destructive seam sampling shall be immediately repaired in accordance with specified repair procedures. The continuity of the new seams in the repaired area shall be non-destructively tested according to procedures described herein.

The sample for laboratory testing shall be 12 inches wide across the seam by 42 inches long with the seam centered lengthwise. The sample shall be cut into three segments and distributed as follows:

- 12 inches x 14 inches to the Installer for laboratory testing.
- 12 inches x 14 inches to the Geosynthetics CQA Laboratory for testing.
- 12 inches x 14 inches to the Owner.

The CQA Consultant is responsible for packaging and shipping samples to the Geosynthetics CQA Laboratory in a manner that will not damage the samples.

#### 6.1.9.4 Geosynthetics CQA Laboratory

Evaluation of test results shall be made in accordance with ASTM D6392 "Practice for Determining the Integrity of Field Seams Used in Joining Polymer Sheet Membranes". The minimum acceptable values to be obtained in these tests are those indicated in Table 02776-2 of Technical Specification 02776 High Density Polyethylene (HDPE) Geomembrane Liner and all specimens must separate by FTB failure for each test in order for the seam to pass destructive test sampling. At least five specimens shall be tested for each test method. Specimens shall be selected from the samples and tested alternately (i.e., peel, shear, peel, shear, etc.). For double wedge welds, both inner and outer seams shall be tested and determined to be acceptable.

Table 2776-2: Minimum Weld Values for HDPE Geomembranes

| PROPERTY | TEST METHOD | VALUE |
|---|---|---|
| Peel | ASTM D6392 | |
| Wedge Weld (lb/in width) | | 98 |
| Extrusion Weld (lb/in width) | | 78 |
| Shear | ASTM D6392 | |
| Wedge Weld (lb/in width) | | 120 |
| Extrusion Weld (lb/in width) | | 120 |

The Geosynthetics CQA Laboratory shall provide verbal test results no more than 24 hours after they receive the samples. The CQA Consultant shall review laboratory test results as soon as they become available, and make appropriate recommendations to the Installer.

#### 6.1.9.5 Procedures for Destructive Test Failures

All acceptable seams must be bounded by two locations from which samples passing laboratory destructive tests have been taken. In cases exceeding 150 feet of reconstructed seam, a sample taken from the zone in which the seam has been reconstructed must pass destructive testing.

The procedures outlined in the Technical Specifications shall apply whenever a sample fails a destructive test, whether that test is conducted by the CQA Consultant, the Installer, the Contractors independent CQC Laboratory, or by field tensiometer.

The CQA Consultant shall document all actions taken in conjunction with destructive test failures.

#### 6.1.10 Defects, Repairs and Wrinkles

The entire geomembrane, including seams, shall be visually examined by the CQA Consultant for identification of visual defects, holes, blisters, undispersed raw materials and signs of contamination by foreign matter. The surface of the geomembrane shall be clean at the time of examination. The geomembrane surface shall be swept or washed by the Installer if dust, mud or other matter inhibits examination. All areas having defects and/or requiring repairs shall be repaired.

Work shall not proceed with any materials which will cover locations which have been repaired until the CQA Consultant has re-examined the repaired area and applicable laboratory test results with passing values are available.

Panels or portions of panels which are, in the opinion of the CQA Consultant, damaged beyond repair shall be removed from the site and replaced. Damage, which in the CQA Consultant's opinion, can be repaired may be repaired or replaced.

Any portion of the geomembrane exhibiting a flaw or failing a destructive or nondestructive test shall be repaired. Several procedures exist for the repair of these areas. The final decision as to the appropriate repair procedure shall be agreed upon between the Installer, CQA Consultant and Design Engineer.

Each repair shall be numbered and logged. Each repair shall be non-destructively tested using the methods described in the Technical Specifications as appropriate. Repairs which pass the non-destructive test shall be taken as an indication of an adequate repair. Large caps (over 150 feet) shall require destructive test sampling. In the case of failed tests, the repair shall be redone and retested until a passing test results. The CQA Consultant shall observe all repairs and all non-destructive testing of repairs, note on the membrane that it has been repaired, and document each repair thoroughly.

When seaming of the geomembrane is completed (or when seaming of a large area of the geomembrane is completed) and prior to placing overlying materials, the CQA Consultant shall indicate which wrinkles should be cut and re-seamed by the Installer. Wrinkle size shall be evaluated during the time of day and under conditions similar to those expected when overlying protective cover/drainage layer material is to be placed. All wrinkles higher than they are wide (across their base) or more than 6 inches high shall be removed by repair methods and retested.

## 6.2 GEOTEXTILES

This Quality Assurance testing program has been established to verify that specified geotextiles are manufactured, installed and tested according to the Technical Specifications.

### 6.2.1 Manufacturer Quality Control Documentation

The Geotextile Manufacturer shall provide the CQA Consultant the following information prior to the installation of the geotextile. Quality Control tests shall be performed in accordance with test methods and frequencies required by the Technical Specifications.

- A list of materials which comprise the geotextile and a Specification for the geotextile which includes all properties contained in the Technical Specifications measured using the appropriate test methods.

- A written certification signed by an officer or the Quality Control Manager that the geotextile delivered for the project has minimum average roll value properties which meet or exceed the properties provided in the Technical Specification and is guaranteed by the Manufacturer.

- Written certification that the Manufacturer has continuously inspected the geotextile for the presence of needles and found the geotextile to be needle free.

- Quality Control test results performed by the Manufacturer in accordance with test methods and frequencies required by the project Technical Specifications to verify the geotextile meets the Technical Specifications.

- Quality Control Certifications, which shall include roll identification numbers, sampling procedures, and Quality Control test results signed by a responsible party employed by the Manufacturer. At a minimum, Quality Control test results shall be provided for:

  1. Mass/Unit Area, oz/ $yd^2$ (ASTM D5261) - One test per 100,000 $ft^2$.

  2. Apparent Opening Size, US Sieve (ASTM D4751) - One test per 100,000 $ft^2$.

  3. Flow Rate, gpm/$ft^2$ (ASTM D4491) - One test per 100,000 $ft^2$.

  4. CBR Puncture Strength, lbs/in (ASTM D6241) - One test per 100,000 $ft^2$.

  5. Grab Tensile Strength, lbs (ASTM D4632) - One test per 100,000 $ft^2$.

  6. Trapezoidal Tear Strength, lbs/in (ASTM D4533) - One test per 100,000 $ft^2$.

All rolls of geotextile shall be identified by the Manufacturer with the following:

- Manufacturer's Name.

- Roll Number.

- Product Identification.

- Roll Dimensions.

The CQA Consultant shall review these documents to verify the following:

- Property values certified by the Manufacturer meet all Specifications listed in the Technical Specifications.

- The Manufacturer's measurements of properties are properly documented and test methods used acceptable.
- Rolls are properly labeled.
- Project Technical Specifications shall be met with the certified minimum average roll properties.
- Quality control certificates have been provided at the specified frequency for all rolls.

The CQA Consultant shall report any discrepancies to the Owner, Installer and Manufacturer.

#### 6.2.2 Conformance Sampling and Testing

The required number of conformance sample(s) of the geotextile will be collected and tested by the Owner's Representative prior to shipment of the material to the project site. The Owner's Representative shall select the rolls to be tested. Samples shall not include the first complete revolution. The sample shall be a minimum four feet, as measured along the width of the roll, and extend three feet along the roll. Samples shall be taken at a rate of one per lot, but at a rate not less than one conformance test per 100,000 square feet or portion thereof. Samples shall not include any portion of a roll which has been subjected to excess pressure or stretching. All lots of material and the particular test sample that represents each lot will be defined before the samples are obtained. These conformance sample(s) shall be sent to the Geosynthetics CQA Laboratory for testing to verify conformance to the values listed in the Technical Specifications. These tests shall be performed prior to installation of the geotextile. At a minimum, geotextile conformance tests performed are as follows:

1. Mass/Unit Area, oz/ $yd^2$ (ASTM D5261) - One test per 100,000 $ft^2$.
2. Apparent Opening Size, US Sieve (ASTM D4751) - One test per 100,000 $ft^2$.
3. Flow Rate, gpm/$ft^2$ (ASTM D4491) - One test per 100,000 $ft^2$.
4. CBR Puncture Strength, lbs/in (ASTM D6241) - One test per 100,000 $ft^2$.
5. Grab Tensile Strength, lbs (ASTM D4632) - One test per 100,000 $ft^2$.
6. Trapezoidal Tear Strength, lbs/in (ASTM D4533) - One test per 100,000 $ft^2$.

Prior to the deployment of the geotextile, the CQA Consultant shall review all conformance test results and report any nonconformance to the Owner, Installer and Manufacturer. The CQA Consultant shall be responsible for verifying that all the test results meet or exceed the property values listed in the Technical Specifications.

If failing test results may be the result of the sampling process or due to the Geosynthetics CQA Laboratory incorrectly conducting the test, the Manufacturer may request a retest to be conducted at the Geosynthetics CQA Laboratory in the presence of a representative of the Manufacturer.

All material from a lot represented by a failing test result shall be rejected, or additional conformance test samples may be taken to isolate the portion of the lot not meeting Specifications (this procedure is valid only when rolls in a lot are consecutively produced and numbered from one manufacturing line). Additional samples shall be taken from rolls on either side of the failing roll, until passing test results are achieved, to establish the range of failure within the lot. All rolls lying within this range of failure shall be rejected.

### 6.2.3 Geotextile Storage, Handling and Placement

Geotextile shall be protected from ultraviolet light exposure, precipitation, mud, puncture, cutting, or other deleterious conditions during shipment, handling and storage. Geotextile rolls shall be shipped and stored in relatively opaque and watertight wrapping which shall be removed shortly before deployment.

The Installer shall handle all geotextile in such a manner as to minimize damage, and the following shall be complied with:

- All deployed geotextile shall be stabilized with sandbags or the equivalent ballast in the presence of wind. Such sandbags shall remain until replaced with cover material.
- The entire surface of the geotextile shall be visually inspected to ensure that no potentially harmful foreign objects are present.
- On slopes, the geotextiles shall be securely anchored in the anchor trench and rolled down the slope in such a manner as to continually keep the geotextile sheet in tension.
- Geotextiles shall be cut using an approved geotextile cutter only. If in place, special care must be taken to protect other materials from damage which could be caused by the cutting of the geotextiles.
- The Installer shall take any necessary precautions to prevent damage to underlying layers during placement of the geotextile.
- Care shall be taken not to entrap stones, excessive dust, or moisture within the geotextile that could damage the geomembrane, result in clogging of drains or filters, or hamper subsequent seaming.
- After installation, a visual examination of the geotextile shall be carried out over the entire surface, to verify that no potentially harmful foreign objects, such as needles or staples, are present.

### 6.2.4 Seaming Procedures

Geotextile shall be overlapped in accordance with the requirements of the Technical Specifications. On slopes steeper than 10 feet horizontal to 1 foot vertical (10H:1V), all geotextiles shall be continuously sewn.

Sewing shall be done using polymeric thread with chemical or ultraviolet light resistant properties equal to or greater than those of the geotextile.

#### 6.2.5 Defects and Repairs

Holes or tears in the geotextile shall be repaired with a patch of the same geotextile double-sewn or heat-tacked into place. Repairs occurring on slopes steeper than 10H:1V shall be double-sewn in place. Should any tear exceed ten percent of the width of the roll, that roll shall be removed and replaced. Soil or other material which may have penetrated the torn geotextile shall be removed.

The CQA Consultant shall observe any repairs and report any noncompliance to the Installer and Owner.

#### 6.2.6 Placement of Soil Materials

The Contractor or Installer shall place all soil materials on top of a geotextile in such a manner as to minimize:

- Damage to the geotextile.
- Slippage of the geotextile on underlying layers.
- Excess tensile stresses in the geotextile.

Any noncompliance shall be noted by the CQA Consultant and reported to the Installer and Owner.

### 6.3 GEOCOMPOSITES

This Quality Assurance testing program has been established to verify that specified geocomposites are manufactured, installed and tested according to the Technical Specifications.

#### 6.3.1 Manufacturer Quality Control Documentation

The geocomposite Manufacturer shall provide the CQA Consultant the following information prior to the installation of the geocomposite. Quality Control tests shall be performed in accordance with test methods and frequencies required by the Technical Specifications.

- A list of materials which comprise the geotextile and geonet (geocomposite) and a Specification for each which includes all properties contained in the Technical Specifications measured using the appropriate test methods.
- A Specification for the fused geotextile and geonet (geocomposite) which includes all properties contained in the Technical Specifications, measured using the appropriate test methods.

- A written certification signed by an officer or the Quality Control Manager that the geocomposites delivered for the project have minimum average roll value properties which meet or exceed the properties provided in the Technical Specification and is guaranteed by the Manufacturer.

- A written certification that the Manufacturer has continuously inspected the geotextile for the presence of needles and has found the geotextile to be needle free.

- Quality Control test results performed by the Manufacturer in accordance with test methods and frequencies required by the project Technical Specifications to verify the geotextile meets the Technical Specifications.

- Quality Control Certifications, which shall include roll identification numbers, sampling procedures, and quality control test results for the geotextile, geonet, and geocomposite signed by a responsible party employed by the Manufacturer.

All rolls of geocomposite shall be identified by the Manufacturer with the following:

- Manufacturer's Name

- Product Identification

- Lot Number

- Roll Number

- Roll Dimensions.

The CQA Consultant shall examine the rolls of geocomposite upon delivery to the project site and any deviation from the above requirements shall be reported by the CQA Consultant to the Installer and Owner.

### 6.3.2 Manufacturer Test Results

Results of Quality Control tests conducted by the Manufacturer shall be supplied to the CQA Consultant to verify the geocomposite meets the project Technical Specifications. At a minimum, the following test results shall be provided.

#### 6.3.2.1 HDPE Resin

1. Polymer Density, g/cm (ASTM D1505) - One test per batch.

2. Polymer Melt Index (ASTM D1238) - One test per batch.

#### 6.3.2.2 Geonet

1. Polymer Density, g/cm (ASTM D1505) - One test per 100,000 $ft^2$.

2. Mass per Unit Area, lbs/ft$^2$ (ASTM D3776) - One test per 100,000 ft$^2$.

3. Thickness, mil (ASTM D1777) - One test per 100,000 ft$^2$.

### 6.3.3 Geotextile

1. Flow Rate, gpm/ft$^2$ (ASTM D4491) - One test per 100,000 ft$^2$.

2. Mass per Unit Area, oz/yd$^2$ (ASTM D5261) - One test per 100,000 ft$^2$.

3. Apparent Opening Size (AOS), US Sieve (ASTM D4751) - One test per 100,000 ft$^2$.

4. Grab Tensile, lbs (ASTM D4632) - One test per 100,000 ft$^2$.

5. Trapezoidal Tear Strength, lbs (ASTM D4533) - One test per 100,000 ft$^2$.

6. Puncture Resistance, lbs (ASTM D4833) - One test per 100,000 ft$^2$.

### 6.3.4 Geocomposite

1. Transmissivity, m$^2$/sec (ASTM D4716) - One test per 100,000 ft$^2$.

2. Ply Adhesion (ASTM D7005) - One test per 100,000 ft$^2$.

### 6.3.5 Manufacturer Test Results

The CQA Consultant shall review these documents to verify that:

- Property values certified by the Manufacturer meet all Technical Specifications.

- The Manufacturer's measurements of properties are properly documented and test methods used acceptable.

- Rolls are properly labeled.

- Project Technical Specifications shall be met with the certified minimum average roll properties.

- Quality Control Certificates have been provided at the specified frequency for all rolls.

The CQA Consultant shall report any noncompliance to the Owner, Installer and Manufacturer.

### 6.3.6 Tri-planar Conformance Sampling and Testing

The required number of conformance sample(s) of the tri-planar geocomposite will be collected and tested by the Owner's Representative prior to shipment of the material to the project site. The Owner's Representative shall select the rolls to be tested. Samples shall not include the first complete revolution. The sample shall be a minimum four feet, as measured along the width of the roll, and extend three feet along the roll. Samples shall be taken at a rate of at least one sample per lot, but at a rate not less than one conformance test per every 100,000 square feet or portion thereof. Samples shall not include any portion of a roll which has been subjected to excess pressure or stretching. All lots of material and the particular test sample that represents each lot will be defined before the samples are obtained. These conformance sample(s) shall be sent to the Geosynthetics CQA Laboratory for testing to verify conformance to the values listed in the Technical Specifications. These tests shall be performed prior to installation of the geocomposite. At a minimum, conformance tests performed are as follows:

#### 6.3.6.1 Geonet

1. Thickness, mils (ASTM D~~1777~~5199) - One test per 100,000 $ft^2$.
2. Tensile Strength (ASTM D~~5035~~7179) - One test per 100,000 $ft^2$.
3. Carbon Black (ASTM D~~4218~~1603) - One test per 100,000 $ft^2$.
4. Polymer Density, g/cm (ASTM D1505) - One test per 100,000 $ft^2$.

#### 6.3.6.2 Geotextile

1. Fabric Weight, oz/$yd^2$ (ASTM D5261) - One test per 100,000 $ft^2$.
2. Apparent Opening Size, US Sieve (ASTM D4751) - One test per 100,000 $ft^2$.
3. Puncture Resistance, lbs (ASTM D4833) - One test per 100,000 $ft^2$.
4. Flow Rate, gpm/$ft^2$ (ASTM D4491) - One test per 100,000 $ft^2$.
5. Grab Tensile/Elongation, lbs (ASTM D4632) - One test per 100,000 $ft^2$.

#### 6.3.6.3 Geocomposite

~~1. Thickness, mil (ASTM D1777) - One test per 100,000 $ft^2$.~~

~~2.~~1. Ply Adhesion, lbs/inch (ASTM D7005) - One test per 100,000 $ft^2$.

~~3.~~2. Transmissivity, $m^2$/sec (ASTM D4716) - One test per 100,000 $ft^2$.

~~4.~~3. Tri-planar/Geomembrane Interface Friction Angle (ASTM D5321) - One representative sample of the Tri-planar/Geomembrane

   A. Direct Shear Test (Interface Shear Resistance) - The Owner's representative will perform one Direct Shear Test in accordance with ASTM D5321 on representative samples of the tri-planar geocomposite and 60 mil textured HDPE geomembrane. The following testing parameters will be followed for the Direct Shear Testing with the results submitted to the ENGINEER:

1. Testing to be conducted under fully saturated (water) conditions.

2. Three Normal Loads = 1,000, 2~~3~~,000, and 4~~6~~,000 psf.

3. Test Configuration: tri-planar geocomposite clamped to top box
   textured geomembrane clamped to bottom box

4. Strain Rate = 0.040 in/min.

5. Continue testing to ensure a full 3 inches of displacement.

6. Plot and report (Peak and Residual values) for the best fit line through each of the three test results.

7. A minimum PEAK value of 0 psf adhesion and 20.5º for the interface friction angle is required for this project (based upon the best fit line).

8. Adhesion may be considered by the ENGINEER to determine equivalent stability for this project.

Prior to the deployment of the geocomposite, the CQA Consultant shall review all conformance test results and report any nonconformance to the Owner, Installer and Manufacturer. The CQA Consultant shall be responsible for verifying that all the test results meet or exceed the property values listed on Tables 02930-1, 02930-2 and 02930-3 of Technical Specification 02930 Tri-planar Geocomposite.

### 6.3.7 Bi-planar Conformance Sampling and Testing

The required number of conformance sample(s) of the bi-planar geocomposite will be collected and tested by the Owner's Representative prior to shipment of the material to the project site. The Owner's Representative shall select the rolls to be tested. Samples shall not include the first complete revolution. The sample shall be a minimum four feet, as measured along the width of the roll, and extend three feet along the roll. Samples shall be taken at a rate of at least one sample per lot, but at a rate not less than one conformance test per every 100,000 square feet or portion thereof. Samples shall not include any portion of a roll which has been subjected to excess pressure or stretching. All lots of material and the particular test sample that represents each lot will be defined before the samples are obtained. These conformance sample(s) shall be sent to the Geosynthetics CQA Laboratory for testing to verify conformance to the values listed in the Technical Specifications. These tests shall be performed prior to installation of the geocomposite. At a minimum, conformance tests performed are as follows:

#### 6.3.7.1 Geonet

1. Thickness, mils (ASTM D~~1777~~5199) - One test per 100,000 $ft^2$.

2. Tensile Strength (ASTM D~~5035~~7179) - One test per 100,000 $ft^2$.

3. Carbon Black (ASTM D42181603) - One test per 100,000 $ft^2$.

4. Polymer Density, g/cm (ASTM D1505) - One test per 100,000 $ft^2$.

#### 6.3.7.2 Geotextile

1. Fabric Weight, $oz/yd^2$ (ASTM D5261) - One test per 100,000 $ft^2$.

2. Apparent Opening Size, US Sieve (ASTM D4751) - One test per 100,000 $ft^2$.

3. Puncture Resistance, lbs (ASTM D4833) - One test per 100,000 $ft^2$.

4. Flow Rate, $gpm/ft^2$ (ASTM D4491) - One test per 100,000 $ft^2$.

5. Grab Tensile/Elongation, lbs (ASTM D4632) - One test per 100,000 $ft^2$.

#### 6.3.7.3 Geocomposite

~~1. Thickness, mil (ASTM D1777) - One test per 100,000 $ft^2$.~~

~~2.~~1. Ply Adhesion, lbs/inch (ASTM D7005) - One test per 100,000 $ft^2$.

2. Transmissivity, $m^2/sec$ (ASTM D4716) - One test per 100,000 $ft^2$.

3. Drainage sand/Bi-planar Interface Friction Angle (ASTM D5321) - One representative sample of the Drainage sand/Bi-planar.

   A. Direct Shear Test (Interface Shear Resistance) - The Owner's representative will perform one Direct Shear Test in accordance with ASTM D5321 on representative samples of the drainage sand and bi-planar geocomposite. The following testing parameters will be followed for the Direct Shear Testing with the results submitted to the ENGINEER:

      1. Testing to be conducted under fully saturated (water) conditions.

      2. Three Normal Loads = 1,000, 2,000, and 4,000 psf.

      3. Test Configuration: drainage sand top box
         bi-planar geocomposite clamped to bottom box

      4. Strain Rate = 0.040 in/min.

      5. Continue testing to ensure a full 3 inches of displacement.

      6. Plot and report (Peak and Residual values) for the best fit line through each of the three test results.

7. A minimum PEAK value of 0 psf adhesion and 20.5º for the interface friction angle is required for this project (based upon the best fit line).

8. Adhesion may be considered by the ENGINEER to determine equivalent stability for this project.

3.4. Bi-planar/Geomembrane Interface Friction Angle (ASTM D5321) - One representative sample of the Bi-planar/Geomembrane

A. Direct Shear Test (Interface Shear Resistance) - The Owner's representative will perform one Direct Shear Test in accordance with ASTM D5321 on representative samples of the bi-planar geocomposite and 60 mil textured HDPE geomembrane. The following testing parameters will be followed for the Direct Shear Testing with the results submitted to the ENGINEER:

1. Testing to be conducted under fully saturated (water) conditions.

2. Three Normal Loads = 1,000, 23,000, and 46,000 psf.

3. Test Configuration: bi-planar geocomposite clamped to top box
   textured geomembrane clamped to bottom box

4. Strain Rate = 0.040 in/min.

5. Continue testing to ensure a full 3 inches of displacement.

6. Plot and report (Peak and Residual values) for the best fit line through each of the three test results.

7. A minimum PEAK value of 0 psf adhesion and 20.5º for the interface friction angle is required for this project (based upon the best fit line).

8. Adhesion may be considered by the ENGINEER to determine equivalent stability for this project.

Prior to the deployment of the geocomposite, the CQA Consultant shall review all conformance test results and report any nonconformance to the Owner, Installer and Manufacturer. The CQA Consultant shall be responsible for verifying that all the test results meet or exceed the property values listed on Tables 02931-1, 02931-2 and 02931-3 of Technical Specification 02931 Bi-planar Geocomposite.

If failing test results may be the result of the sampling process or due to the Geosynthetics CQA Laboratory incorrectly conducting the test, the Manufacturer may request a retest to be conducted at the Geosynthetics CQA Laboratory in the presence of a representative of the Manufacturer.

All material from a lot represented by a failing test result shall be rejected, or additional conformance test samples may be taken to isolate the portion of the lot not meeting

Specifications (this procedure is valid only when rolls in a lot are consecutively produced and numbered from one manufacturing line). Additional samples shall be taken from rolls on either side of the failing roll, until passing test results are achieved, to establish the range of failure within the lot. All rolls lying within this range of failure shall be rejected.

### 6.3.8 Geocomposite Storage, Handling and Placement

Geocomposite shall be protected from ultraviolet light exposure, precipitation, mud, puncture, cutting, or other deleterious conditions during shipment, handling and storage. Geocomposite rolls shall be shipped and stored in relatively opaque and watertight wrapping which shall be removed shortly before deployment.

The Installer shall handle all geocomposite rolls in such a manner as to minimize damage, and the following shall be complied with:

- All deployed geocomposite shall be stabilized with sandbags or equivalent ballast in the presence of wind. Such sandbags shall remain until replaced with cover material.
- The entire surface of the geocomposite shall be visually inspected to ensure that no potentially harmful foreign objects are present.
- During placement of the geocomposite, care shall be taken not to entrap any dirt or excessive dust in the geocomposite that could cause clogging of the drainage system and/or stones that could damage the adjacent geomembrane or hamper subsequent seaming. If dirt or excessive dust is entrapped in the geocomposite, it should be hosed clean prior to placement of the next material on top of it.
- On slopes, the geocomposite shall be secured in the anchor trench and the material rolled down the slope in such a manner as to continually keep the geocomposite sheet in tension. If necessary, the geocomposite shall be positioned by hand after being unrolled to minimize wrinkles.
- Geocomposites shall be cut using an approved cutter only. If in place, special care must be taken to protect other materials from damage which could be caused by the cutting of the geocomposite.
- The Installer shall take any necessary precautions to prevent damage to underlying layers during placement of the geocomposite.
- After installation, a visual examination of the geocomposite shall be carried out over the entire surface, to verify that no potentially harmful foreign objects, such as needles or staples, are present.

The CQA Consultant shall report any noncompliance to the Owner and Installer.

#### 6.3.9 Seaming Procedures

The end of each roll of geocomposite shall be overlapped a minimum of 6 inches. The geonet portion shall be shingled, with the uphill end overlapping the downhill end and tied 2 feet on center at a minimum. The bottom layer of geotextile shall be overlapped a minimum of 6 inches. The upper layer of geotextile shall be machine sewn. Sewing shall be done using polymeric thread with chemical or ultraviolet light resistant properties equal to or greater than those of the geotextile. Where the geocomposite is to terminate, the upper geotextile shall be folded over the ends with a minimum of 12 inches of geotextile placed under the geocomposite.

At roll sides, the material shall be overlapped a minimum of 4 inches. The bottom geotextile shall be overlapped. The geonet shall be overlapped and tied a minimum of 5 feet on center with nylon ties as described above. The upper layer of geotextile shall be machine sewn as described above.

#### 6.3.10 Defects and Repairs

Generally, damaged, soiled, or delaminated products shall be discarded. Holes or tears 2 inches or smaller in diameter may be repaired by snipping our protruding geonet and machine sewing or thermal bonding a geotextile patch over the hole. The patch shall be a minimum of 12 inches larger than the damaged area in all directions. If thermal bonding is conducted, care shall be taken to prevent excessive heat damage to the surrounding geosynthetics. Panels with holes or tears greater than 2 inches in diameter through the product shall be repaired by replacing the entire panel width.

The CQA Consultant shall report any noncompliance to the Owner and Installer.

#### 6.3.11 Placement of Soil Materials

The Contractor or Installer shall place all soil materials on top of a geotextile in such a manner as to prevent:

- Damage to the geocomposite.
- Slippage of the geocomposite on underlying layers.
- Excess wrinkles and tensile stresses in the geocomposite.

The CQA Consultant shall report any noncompliance to the Owner and Contractor or Installer.

### 6.4 GEOSYNTHETIC CLAY LINER (GCL)

The following quality assurance testing program has been established to verify that the specified GCL is manufactured, tested, transported, stored and installed according to the project Specifications.

### 6.4.1 Manufacturer Quality Control Documentation

The GCL Manufacturer shall provide the CQA Consultant with the following information prior to the installation of the GCL:

- A list of materials Specification for the GCL which includes all properties contained in the project Specifications measured using the appropriate test methods.

- Written certification that the minimum average roll values provided in the Specification are guaranteed by the Manufacturer.

- Written certification that the Manufacturer has continuously inspected the geotextile component of the GCL for the presence of needles and found the geotextile to be needle free.

- Quality control certifications, which shall include GCL roll identification numbers, sampling procedures, and quality control test results signed by a responsible party employed by the Manufacturer such as the Manufacturer Quality Assurance/Manufacturer Quality Control (MQA/MQC) Manager, Production Manager, or Technical Services Manager. At a minimum, results shall be provided for the following:

    1. Grab Strength (ASTM D 4632) - One test per 200,000 square feet.

    2. Grab Elongation (ASTM D4632) - One test per 200,000 square feet.

    3. Peel Strength (ASTM D4632) - 15 lbs. (min).

    4. Permeability (ASTM D5887) - Weekly, minimum 20 values reported.

    5. Mass per unit area (ASTM D5993) - One test per 40,000 square feet.

- Accessory bentonite used for sealing seams, penetrations, or repairs, shall be the same granular bentonite as used in the production of the GCL itself with the properties listed below:

    1. Swell Index (ASTM D5890).

    2. Moisture Content (ASTM D4643).

    3. Fluid Loss (ASTM D5891).

The CQA Consultant shall review these documents provided by the Manufacturer to verify the following:

- Results of quality control tests conducted by the Manufacturer meet all of the requirements for the GCL listed in the project Specifications.

- The Manufacturer's measurements of properties are properly documented and the test methods used are acceptable.
- Quality control certificates have been provided at the specified frequency for all rolls.
- Quality control tests were performed in accordance with test methods and frequencies required by the project Specifications

Any noncompliance shall be noted by the CQA Consultant and reported to the Installer and Owner.

### 6.4.2 Conformance Sampling and Testing

Conformance sample(s) of the GCL will be collected and tested by the Owner's representative prior to shipment of the material to the project site. The Owner's representative shall select the rolls to be tested. Samples will not include any portion of a roll which has been subjected to excess pressure or stretching. All lots of material and the particular test sample that represents each lot will be defined before the samples are obtained. At a minimum, GCL conformance tests performed are as follows:

1. Mass Per Unit Area (ASTM D5993) - One test per 40,000 square feet.
2. Bentonite Swell Index (ASTM D5890) - One test per 100,000 square feet.
3. Permeability (ASTM D5887) - One test per 100,000 square feet.
4. GCL/Subbase Interface Friction Angle (ASTM D5321) - One representative sample of the GCL/Subbase.

    B. Direct Shear Test (Interface Shear Resistance) - The Owner's representative will perform one Direct Shear Test in accordance with ASTM D5321 on representative samples of the GCL and subbase. The following testing parameters will be followed for the Direct Shear Testing with the results submitted to the ENGINEER:

    1. Testing to be conducted under fully saturated (water) conditions.
    2. Three Normal Loads = 1,000, 2~~3~~,000, and 4~~6~~,000 psf.
    3. Test Configuration: GCL clamped to top box<br>subbase bottom box
    4. Strain Rate = 0.040 in/min.
    5. Continue testing to ensure a full 3 inches of displacement.
    6. Plot and report (Peak and Residual values) for the best fit line through each of the three test results.

7. A minimum PEAK value of 0 psf adhesion and 20.5º for the interface friction angle is required for this project (based upon the best fit line).

8. Adhesion may be considered by the ENGINEER to determine equivalent stability for this project.

5. GCL/Geomembrane Interface Friction Angle (ASTM D5321) - One representative sample of the GCL/Geomembrane.

   A. Direct Shear Test (Interface Shear Resistance) - The Owner's representative will perform one Direct Shear Test in accordance with ASTM D5321 on representative samples of the GCL and 60 mil textured HDPE geomembrane. The following testing parameters will be followed for the Direct Shear Testing with the results submitted to the ENGINEER:

      1. Testing to be conducted under fully saturated (water) conditions.

      2. Three Normal Loads = 1,000, 2~~3~~,000, and 4~~6~~,000 psf.

      3. Test Configuration: textured geomembrane clamped to top box
         GCL clamped to bottom box

      4. Strain Rate = 0.040 in/min.

      5. Continue testing to ensure a full 3 inches of displacement.

      6. Plot and report (Peak and Residual values) for the best fit line through each of the three test results.

      7. A minimum PEAK value of 0 psf adhesion and 20.5º for the interface friction angle is required for this project (based upon the best fit line).

      8. Adhesion may be considered by the ENGINEER to determine equivalent stability for this project.

6. Direct Shear Test (Internal Shear Resistance) (ASTM D5321) - One representative sample of the GCL.

   A. GCL shall have a PEAK internal friction angle of 20.5 degrees and as determined in the laboratory using, under fully hydrated conditions, and a confining pressure loading of 1,000, 2~~3~~,000, and 4~~6~~,000 psf.

The CQA Consultant shall review all conformance test results and accept or reject the roll prior to deployment. The CQA Consultant is responsible for reviewing test results to verify that the property values meet or exceed values listed in the project Specifications. All nonconforming test results shall be reported to the County and Installer.

If any failing test results may be the result of the CQA Geosynthetics Laboratory incorrectly conducting the test, the Manufacturer may request a retest to be conducted at the CQA Geosynthetics Laboratory in the presence of a representative of the Manufacturer. All material from a lot represented by a failing test should be rejected or additional conformance test samples may be taken to isolate the portion of the lot not meeting Specifications. (This procedure is only valid when rolls in a lot are consecutively produced and numbered from one manufacturing line).

Additional samples shall be taken from rolls either side of the failing roll, until passing test results are achieved, to establish the range of failure within the lot. All rolls lying within this range of failure shall be rejected.

### 6.4.3 Labeling and Packing

Each GCL roll shall be individually packaged in moisture resistant plastic sleeves and protected to prevent damage during shipment. The cardboard cores shall be sufficiently strong to resist collapse during transit and handling.

All rolls of GCL shall be identified by the Manufacturer with the following:

1. Product identification information (Manufacturer name and address, brand name, product code).
2. Product lot number and individual roll number.
3. Date of fabrication.
4. Roll length and width.
5. Total roll weight.
6. Proper direction of unrolling and/or unfolding to facilitate layout and positioning in field.

### 6.4.4 Delivery, Storage, and Handling

The Manufacturer shall identify, in writing, the proper equipment and methods for loading, shipping, and unloading materials to the project.

The Manufacturer shall provide, in writing, the proper storage procedures for the products delivered to the site.

GCL shall be protected from ultraviolet light exposure, precipitation, mud, puncture, cutting, or other deleterious conditions during delivery, storage and handling. Rolls shall be shipped and stored in relatively opaque and watertight wrapping which shall be removed shortly before deployment.

The Installer shall handle all GCL in such a manner as to minimize damage and the following shall be complied with:

- The Contractor shall provide the proper equipment and labor necessary to unload the material upon delivery to the project.
- GCL must be supported during handling to ensure worker safety and to prevent damage. Under approved circumstances only, shall the rolls be dragged, lifted from one end, lifted with only the forks of a lift truck or pushed to the ground from the delivery vehicle.
- Prior to departing the site, the Manufacturer or Manufacturer's representative will inspect the storage of the material for compliance with the procedures outlined by the Manufacturer.
- Each GCL roll shall be visually inspected by the Contractor when unloaded to determine if any packaging or material has been damaged during transit.
- Rolls of GCL exhibiting damage shall be marked and set aside for closer examination during deployment.
- Minor rips or tears in the plastic packaging shall be repaired with moisture resistant tape prior to being placed in storage to prevent moisture damage.
- GCL rolls delivered to the project site shall be only those indicated on GCL manufacturing quality control certificates.

### 6.4.5 Storage, Stockpiling and Staging Procedures

- Storage of the GCL rolls shall be the responsibility of the Contractor. The materials shall be unloaded by the Contractor in areas designated by the Owner. The materials shall not be stored or unloaded in areas that will impair the operations of the landfill facility or be deleterious to the materials.
- All GCL rolls shall be stored and maintained dry in a flat location area away from high-traffic areas but sufficiently close to the active work area to minimize handling.
- The presence of free-flowing water within the GCL packaging will require that roll to be set aside for further examination to ascertain the extent of damage. Free-flowing water within the GCL packaging shall be cause for rejection of that roll by the Engineer.
- GCL shall be stored no higher than three to four rolls high or limited to the height at which the handling apparatus may be safely handled by installation personnel. Stacks or tiers of rolls should be situated in a manner that prevents sliding or rolling by "choking" the bottom layer of rolls.
- Rolls shall not be stacked on uneven or discontinuous surfaces in order to prevent bending, deformation, damage to the GCL or cause difficulty inserting the core pipe.
- An additional tarpaulin or plastic sheet shall be used over the stacked rolls to provide extra protection for GCL material stored outdoors.

- Bagged bentonite material shall be stored and tarped next to GCL rolls unless other more protective measures are available. Bags shall be stored on pallets or other suitably dry surface which will prevent undue prehydration until installation.

### 6.4.6 Seaming Procedures

- All GCL seams shall be formed in accordance with the Manufacturer's recommendations.

- A minimum 6 inch overlap should exist at longitudinal seam locations and at least 12 inches at panel ends. The lap line and match lines printed on the panels shall be used to assist in obtaining this overlap. The edges of the GCL panels should be adjusted to smooth out any wrinkles, creases, or "fishmouths" in order to maximize contact with the underlying existing sideslope geomembrane liner and panel.

- All GCL seams shall be formed by executing a bentonite-enhanced overlap to ensure that a continuous seal is achieved between panels. After the overlying panel is placed, its edge shall be pulled back to expose the overlap zone. Any soil or debris present in the overlap zone or entrapped in the geotextiles shall be removed. A fillet of granular bentonite shall then be poured in a continuous manner along the overlap zone at a rate of at least one-quarter pound per lineal foot to ensure that a continuous seal is achieved between panels.

- On gently sloping areas where seams may be placed across the slope, overlaps should be "shingled" so as to prevent flow into the seam.

### 6.4.7 Damage Repair

- Prior to cover material placement, damage to the GCL shall be identified and repaired by the Installer. Damage is defined as cuts, rips or tears in the geotextiles, delamination of geotextiles, displaced panel or hydrated areas in the GCL.

- Rips or tears on flat and sloped surfaces may be repaired by completely exposing the affected area, removing all foreign objects or soil, and by then placing a patch cut from unused GCL over the damage (damaged material may be left in place), with a minimum overlap of 12 inches on all edges. Accessory bentonite shall then be placed between the patch edges and the repaired material at a rate of one-quarter pound per lineal foot of edge spread in a continuous six inch fillet, and the patch shall be placed over the area. An epoxy-based adhesive shall be used to keep the patch in position during backfill operations.

- Displaced panels shall be adjusted to the correct position and orientation. The adjusted panel shall then be inspected for any geotextile damage or bentonite loss. Damage shall be repaired by the above procedure.

- If the GCL is prematurely hydrated, the Installer shall notify the QA/QC Representative for a site specific determination as to whether the material is acceptable or if alternative measures must be taken to ensure the quality of the design.

### 6.4.8 Material Placement On Top Of GCL

The GCL shall be covered the same day as it is installed with the HDPE geomembrane liner. Only the amount of GCL that can be anchored, inspected, repaired, and covered in the same day should be installed.

During placement of overlying materials (geomembrane, geocomposite, etc.) upon the GCL, precautions shall be taken to prevent damaging the GCL by restricting heavy equipment traffic. Unrolling the geomembrane can be accomplished through the use of lightweight, rubber-tired equipment such as a 4-wheel all-terrain vehicle (ATV). No vehicles larger than a ATV are allowed in direct contact with the GCL. This vehicle can be driven directly on the GCL, provided the ATV makes no sudden stops, starts, or turns.

The Installer shall place all HDPE geomembrane liner on top of the GCL in such a manner as to minimize:

- Damage to the GCL.
- Slippage of the GCL.
- Excess tensile stresses in the GCL

The GCL should not be covered before observation and acceptance by the QCA Representative.

## SECTION 02077

## GEOSYNTHETIC CLAY LINER (GCL)

### PART 1 - GENERAL

### 1.01 DESCRIPTION

A. Scope of WORK:

1. Furnish all labor, transportation, materials, supervision, administration, management, quality control and installation equipment necessary for the manufacturing, storage, delivery, installation and testing of a Geosynthetic Clay Liner (GCL) portion as herein specified and as shown on the Drawings. The supply and installation of these materials shall be in strict accordance with the Specifications and Drawings and the MANUFACTURER'S instructions.

2. All material shall conform to the following requirements and shall be of new stock of the highest grade available, free from defects and recently manufactured.

3. All installation shall be in conformance with the MANUFACTURER'S recommendations and with current industry standards.

4. All WORK shall be performed in strict accordance with the lines, grades, cross-sections, and dimensions as shown on the Contract Drawings.

### 1.02 APPLICABLE STANDARDS OR REFERENCES

A. The following American Society of Testing and Materials (ASTM) test methods shall be incorporated into this Specification in their entirety, subject to the indicated test modifications:

ASTM D 4632 - "Standard Test Method for Grab Breaking Load and Elongation of Geotextiles"
ASTM D 4643 - "Determination of Water (Moisture) Content of Soil by the Microwave Oven Method"
ASTM D 5084 - "Standard Test Method for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter"
ASTM D 5261 - "Standard Test Method for Measuring Mass Per Unit Area of Geotextiles"
ASTM D 5321 - "Determining the Coefficient of Soil and Geosynthetic or Geosynthetic and Geosynthetic Friction by the Direct Shear Method"
ASTM D 5887 - "Measurement of Index Flux Through Saturated Geosynthetic Clay Liner Specimens Using a Flexible Wall Permeameter"

ASTM D 5888 - "Standard Guide for Storage and Handling of Geosynthetic Clay Liners"
ASTM D 5889 - "Standard Practice for Quality Control of Geosynthetic Clay Liners"
ASTM D 5890 - "Standard Test Method for Swell Index of Clay Mineral Component of Geosynthetic Clay Liners"
ASTM D 5891 - "Standard Test Method for Fluid Loss of Clay Component of Geosynthetic Clay Liners"
ASTM D 5993 - "Standard Test Method for Measuring Mass Per Unit of Geosynthetic Clay Liners"
ASTM D 6102 - "Standard Guide for Installation of Geosynthetic Clay Liners"
ASTM D 6243 - "Standard Test Method for Determining the Internal and Interface Shear Resistance of Geosynthetic Clay Liner by the Direct Shear Method"
ASTM D 6496 - "Standard Test Method for Determining Average Bonding Peel Strength Between the Top and Bottom Layers of Needle-Punched Geosynthetic Clay Liners"
ASTM D 6768 - "Standard Test Method for Tensile Strength of Geosynthetic Clay Liners"
ASTM E 96 - "Standard Test Methods for Water Vapor Transmission of Materials"
GRI Test Method GCL-2, Geosynthetic Research Institute - "Permeability of Geosynthetic Clay Liner (GCL's)"

## 1.03 QUALIFICATIONS

A. GCL MANUFACTURER Qualifications:

1. Qualified GCL MANUFACTURER'S shall be a company, corporation, or firm regularly engaged in the development and manufacture of GCL's with a history of successful production of GCL's for a minimum period of three (3) years. The GCL MANUFACTURER must have produced at least 10 million square feet of GCL. The MANUFACTURER shall submit written information as follows:

a. Corporate background and information.

b. Manufacturing capabilities including;

1. Information on plant size, equipment, qualified personnel, number of shifts per day, and capacity per shift.

2. Daily production quantity with sufficient production capacity available to meet the demands of the project schedule for this contract.

3. Quality control procedures (manual) for manufacturing.

4. List of material properties including certified test results, to which GCL material samples are attached.

B. GCL INSTALLER Qualifications:

1. The GCL INSTALLER must either have installed at least 1 million square feet of GCL, or must provide to the ENGINEER satisfactory evidence, through similar experience in the installation of other types of geosynthetics, that the GCL will be installed satisfactory. The INSTALLER shall submit written information as follows:

a. Name of location of project and date of installation;

b. Contact name and phone number for each project; and

c. GCL type and surface area installed.

## 1.04 CONSTRUCTION QUALITY CONTROL/QUALITY ASSURANCE

A. Construction Quality Control (CQC) shall be performed by the GCL INSTALLER. The INSTALLER'S responsibilities shall include, but not be limited to:

1. Supervise all GCL installation activities.

2. Perform and document Quality Control testing as specified herein.

3. Certify GCL materials and installation as meeting requirements of the Contract Documents.

B. Construction Quality Assurance (CQA) will be performed by a designated CQA CONSULTANT retained by the OWNER. The CQA CONSULTANT, or his CONSTRUCTION QUALITY ASSURANCE (CQA) REPRESENTATIVE, shall observe and inspect the GCL installation activities and conduct CQA testing at a random frequency and location. The CQA CONSULTANT shall submit a final report, signed and sealed by a professional engineer licensed in the State of Florida, certifying the test results.

C. Based upon review of the CQC and CQA final reports, the ENGINEER will provide certification to the regulatory agencies that the GCL was installed in accordance with the Contract Documents.

D. The CONTRACTOR shall schedule WORK to provide sufficient time as required to complete CQC and CQA testing and documentation prior to placing any overlying layers above the GCL and shall keep the CQC/CQA CONSULTANT'S laboratory informed of the construction progress to provide sufficient time for laboratory testing.

## 1.05 SUBMITTALS

A. GCL MANUFACTURER'S Qualifications.

B. GCL INSTALLER'S Qualifications.

C. Construction Quality Assurance Manual.

D. The GCL shall be tested for the parameters and requirements listed on TABLE 02077-1 GCL MANUFACTURING QUALITY CONTROL TESTING to evaluate stress deformation characteristics. This testing shall be performed by the MANUFACTURER or the MANUFACTURER'S certified testing laboratory. Samples which do not satisfy the Contract Specifications shall be cause to reject applicable rolls. If a GCL sample fails to meet Specifications, subsequent tests shall be performed at random on additional GCL samples produced from the same batch to determine whether all rolls produced from the same batch shall be regarded as unsatisfactory and therefore, rejected. This additional testing, at the MANUFACTURER'S discretion and expense, may be performed to more closely identify the rolls that do not comply with the Specifications.

E. The tests specified on TABLE 02077-1 GCL MANUFACTURING QUALITY CONTROL TESTING shall be performed by the MANUFACTURER or MANUFACTURER'S testing laboratory for the material to be delivered and installed on this project. Samples shall be taken across the entire width of the rolls. The averaged test results of the GCL samples shall meet or exceed the Specifications. Certifications of the test results obtained shall be provided to the ENGINEER and recorded on the Quality Control Certificates.

F. The MANUFACTURER shall provide the ENGINEER with the Manufacturer Quality Assurance/Manufacturer Quality Control (MQA/MQC) Certifications for each shipment of GCL. The Certifications shall be signed by a responsible party employed by the MANUFACTURER such as the MQA/MQC Manager, Production Manager, or Technical Services Manager. The MQA/MQC Certifications shall include:

1. GCL lot and roll numbers (with corresponding shipping information).

2. The results of MQA/MQC testing performed by the MANUFACTURER. At a minimum, the tests specified on TABLE 02077-1 GCL MANUFACTURING QUALITY CONTROL TESTING shall be performed by the MANUFACTURER.

**TABLE 02077-1 GCL MANUFACTURING QUALITY CONTROL TESTING**

| TEST | PROCEDURE | FREQUENCY | VALUE |
|---|---|---|---|
| Tensile~~Grab~~ Strength | ASTM D~~4632~~6768 | 200,000 SF | 30 (lbs/in) |
| ~~Grab Elongation~~ | ~~ASTM D4632~~ | ~~200,000 SF~~ | |
| Peel Strength | ASTM D~~4632~~6496 | 200,000 SF ~~15 lbs. (min)~~ | 3.5 lbs/in (min) |
| Permeability | ASTM D5887 GRI GCL-2 | Weekly, min. 20 values reported | 5 x $10^{-9}$ (cm/sec) (max) |
| Mass Per Unit Area | ASTM D5993 | 40,000 SF | 0.75 (at 0% moisture) (psf) |

G. The CONTRACTOR shall submit to the ENGINEER a physical sample of the GCL used in the final construction. The sample shall be labeled with the MANUFACTURER'S name, product identification, lot number and roll number.

H. The MANUFACTURER shall provide, in writing, the proper size equipment, loading, unloading, and handling procedures for all products delivered to the project.

I. The MANUFACTURER shall provide proper storage procedures for keeping the GCL from begin damaged or pre-hydrated by weather or outdoor exposure.

J. The date of shipment of GCL from the MANUFACTURER. A minimum of thirty (30) calendar days shall be provided to the ENGINEER so as to provide sufficient time to perform conformance sampling and receive laboratory test results prior to material shipment.

K. Direct Shear Test Results (Interface Shear Resistance): The CONTRACTOR shall provide Direct Shear Test Results tests demonstrating compliance with Part 2.01(G).

L. Direct Shear Test Results (Interface Shear Resistance): CONTRACTOR shall provide Direct Shear Test Results tests demonstrating compliance with Part 2.01(H).

M. Direct Shear Test Results (Internal Shear Resistance): CONTRACTOR shall provide Direct Shear Test Results tests demonstrating compliance with Part 2.01(I).

N. GCL Installation Plan as submitted by the INSTALLER for approval at least fourteen (14) calendar days prior to delivery of the GCL materials to the site.

O. Prior to GCL installation, the INSTALLER shall submit a Certification of Subsurface Acceptability signed by the GCL INSTALLER and the CQA REPRESENTATIVE.

P. Prior to GCL installation, the CONTRACTOR shall supply the ENGINEER with survey data that clearly indicates the grades and elevation meet the project Specifications.

Q. Provide MANUFACTURER'S extended warranty or guarantee, with OWNER named as beneficiary, in writing for the following listed below:

1. Unless otherwise stated in this Specification, the CONTRACTOR shall guarantee the materials of all products supplied on a non-prorated basis as a part of this WORK for a minimum period of fifteen (15) years following Final Acceptance by the OWNER. The CONTRACTOR shall repair or replace, at no additional expense to OWNER or ENGINEER, any defective materials or products that fail to meet the design requirements. Repair or replacement of such defective material and/or products shall be completed within thirty (30) calendar days of notification by the OWNER.

2. Unless otherwise stated in this Specification, the CONTRACTOR shall guarantee the workmanship of all services supplied as part of this WORK for a minimum period of two (2) years following acceptance by the OWNER. The CONTRACTOR shall repair or replace, at no additional expense to OWNER or ENGINEER, any defective WORK that fails to meet the design requirements. Repair or replacement of such defective WORK shall be completed within thirty (30) calendar days of notification by the OWNER.

3. Warranty conditions proposed by the MANUFACTURER/INSTALLER concerning limits of liability will be evaluated upon receipt and must be acceptable to the OWNER prior to installation of the GCL. Proposed Warranty Conditions shall be submitted to the ENGINEER within twenty-one (21) calendar days after Award of Contract for review and acceptance.

## PART 2 - PRODUCTS

### 2.01 MATERIALS

A. The GCL shall be comprised of new, first-quality products designed and manufactured specifically for the purpose intended. The GCL shall be a factory manufactured hydraulic barrier consisting of sodium bentonite clay supported by geotextiles that are held together by needling. The GCL shall have the properties necessary to achieve compliance with the requirements in this Specification.

B. The GCL shall be the following, or an ENGINEER-approved equal, if it can be documented that the material meets or exceeds these Specifications:

- Bentofix NWL-35 as manufactured by Bentofix Technologies, Inc. or
- CETCO Bentomat ST

C. GCL shall be manufactured so that bentonite shall be continuously contained throughout the GCL and to support geotextile so that no displacement of bentonite occurs when material is unrolled, moved, cut, torn, or punctured. Encapsulating geotextile materials shall protect bentonite and be sufficiently porous to allow bentonite flow-through to create positive bentonite-to-bentonite seal at seams.

D. The GCL shall be produced free of holes, blisters, or contamination by foreign matter. Rolls manufactured with inclusions, bubbles, or not complying with the Specifications shall be rejected and not delivered to the project.

E. Any accessory bentonite used for sealing seams, penetrations, or repairs, shall be the same granular bentonite as used in the production of the GCL itself with the properties listed below:

| PROPERTY | ASTM TEST METHOD | VALUE |
|---|---|---|
| Swell Index | D5890 | 24 ml/2g (min) |
| Moisture Content | D4643 | 12% (max) |
| Fluid Loss | D5891 | 18 ml (max) |

F. Panels of bentonite and encapsulating geotextiles manufactured shall perform as a continuous lining. The finished GCL shall have the physical properties listed below:

**FINISHED GCL PROPERTIES**

| PROPERTY | ASTM TEST METHOD | VALUE |
|---|---|---|
| Bentonite Mass/Area | D5993 | 0.75 (at 0% moisture) (psf) |
| Non-woven Cover Geotextile Weight | D5261 | 6 (oz/sq yd) |
| Tensile~~Grab~~ Strength | D6768 | 30 (lbs/in) |
| Index Flux at 5 psi effective confining stress and 2 psi head using de-aired tap water | D5887 | $1 \times 10^{-8}$ (max) m/sec |
| Permeability with landfill leachate | D5887 | $5 \times 10^{-9}$ (cm/sec) |
| Permeability with groundwater under 4~~6~~,000 psf normal load | D5887/D6766 | $1 \times 10^{-5}$ (cm/sec) |
| Finished GCL roll width | Linear Measurement | 12 (feet) |
| Finished GCL roll length | Linear Measurement | 150 (feet) |

G. Direct Shear Test (Interface Shear Resistance): The CONTRACTOR will perform one (1) direct shear test, in accordance with ASTM D5321, on representative samples of the GCL/Subbase to be provided for this project. The following testing parameters will be followed for the direct shear testing with the results submitted to the ENGINEER:

1. Testing to be conducted under fully saturated (water) conditions.

2. Three Normal Loads = 1,000, 2~~3~~,000, and 4~~6~~,000 psf.

3. Strain Rate = 0.040 in/min.

4. Continue testing to ensure a full 3-inch of displacement.

5. Plot and report (Peak and Residual values) for the best fit line through each of the three test results.

6. A minimum PEAK value of 0 psf adhesion and 20.5 degrees friction is required for this project (based upon the best fit line).

7. Adhesion may be considered by the ENGINEER to determine equivalent stability for this project.

H. Direct Shear Test (Interface Shear Resistance): The CONTRACTOR will perform one (1) direct shear test, in accordance with ASTM D5321, on representative samples of the GCL/Geomembrane (textured) to be provided for this project. The following testing parameters will be followed for the direct shear testing with the results submitted to the ENGINEER:

1. Testing to be conducted under fully saturated (water) conditions.

2. Three Normal Loads = 1,000, 2~~3~~,000, and 4~~6~~,000 psf.

3. Strain Rate = 0.040 in/min.

4. Continue testing to ensure a full 3-inch of displacement.

5. Plot and report (Peak and Residual values) for the best fit line through each of the three test results.

6. A minimum PEAK value of 0 psf adhesion and 20.5 degrees friction is required for this project (based upon the best fit line).

7. Adhesion may be considered by the ENGINEER to determine equivalent stability for this project

I. Direct Shear Test (Internal Shear Resistance): The CONTRACTOR will perform one (1) direct shear test, in accordance with ASTM D5321, on a representative sample of the GCL to be provided for this project with the results submitted to the ENGINEER. GCL shall have a PEAK internal friction angle of 20.5 degrees and as determined in the laboratory using ASTM D 5321, under fully hydrated conditions, and a confining pressure loading of 1,000, 2~~3~~,000, and 4~~6~~,000 psf.

J. The CONTRACTOR shall perform three (3) permeability tests and three (3) compatibility tests according to ASTM D5887 and EPA 9100 each on representative sample of the GCL using leachate and groundwater from the existing Hardee County Landfill prior to shipment of the GCL material to the project site. The CONTRACTOR will obtain up to 50 gallons each of leachate from the OWNER'S Landfill and onsite groundwater for the testing. GCL must meet the permeability requirements stated above for the finished GCL for tests with leachate and groundwater. CQC CONSULTANT shall issue a certified detailed report in accordance with ASTM D5887 to the ENGINEER.

## 2.02 CONFORMANCE TESTING (CQA)

A. In-Plant Conformance Sample Testing Services. The OWNER'S REPRESENTATIVE and CQA CONSULTANT have qualified personnel to collect conformance samples directly at the following facilities.

- Bentofix Technologies, Inc.

B. The CONTRACTOR shall inform, in writing, the ENGINEER fourteen (14) calendar days prior to the actual date of shipment of material to the site.

C. Conformance sample(s) of the GCL will be collected by the OWNER'S REPRESENTATIVE or CQA CONSULTANT prior to shipment to the site. Conformance sample(s) of the GCL will be tested by the CQA CONSULTANT prior to shipment to the site. If the material is shipped to the project and does not meet the project Specifications, then all cost associated with collecting, testing, and shipping samples from the project will be the CONTRACTOR'S responsibility.

D. Conformance Sample Test Frequency (CQA). The GCL shall be randomly sampled by the OWNER'S REPRESENTATIVE prior to delivery of material to the project site. The initial conformance testing shall be at the OWNER'S expense. The initial conformance tests shall include the following:

1. Mass Per Unit Area (ASTM D5993) - One test per 40,000 square feet.

2. Bentonite Swell Index (ASTM D5890) - One test per 100,000 square feet.

3. Permeability (ASTM D5887) - One test per 100,000 square feet.

E. Samples which do not meet the Specifications shall be cause to reject applicable rolls.

## PART 3 - EXECUTION

### 3.01 LABELING, PACKING

A. Each GCL roll shall be individually packaged in moisture resistant plastic sleeves and protected to prevent damage during shipment. The cardboard cores shall be sufficiently strong to resist collapse during transit and handling.

B. Prior to shipment, the MANUFACTURER shall label each roll, both on the GCL roll and on the surface of the plastic protective sleeve. Labels shall be resistant to fading and moisture degradation to ensure legibility at the time of the installation. Each package shall be prominently identified in the same manner as the product within and showing the date of shipment. At a minimum each roll label shall identify the following characteristics:

1. Product identification information (manufacturer name and address, brand name, product code).

2. Product lot number and individual roll number.

3. Date of fabrication.

4. Roll length and width.

5. Total roll weight.

6. Proper direction of unrolling and/or unfolding to facilitate layout and positioning in field.

C. All GCL rolls shall be labeled and bagged in packaging that is resistant to degradation by ultraviolet (UV) light, and is moisture resistant

### 3.02 DELIVERY, STORAGE AND HANDLING

A. The MANUFACTURER shall identify, in writing, the proper equipment and methods for loading, shipping, and unloading materials to the project.

B. The MANUFACTURER shall provide, in writing, the proper storage procedures for the products delivered to the site.

C. The CONTRACTOR shall provide the proper equipment and labor necessary to unload the material upon delivery to the project.

D. GCL must be supported during handling to ensure worker safety and to prevent damage. Under approved circumstances only, shall the rolls be dragged, lifted from one end, lifted with only the forks of a lift truck or pushed to the ground from the delivery vehicle.

E. Each GCL roll shall be visually inspected by the CONTRACTOR when unloaded to determine if any packaging or material has been damaged during transit.

F. Rolls of GCL exhibiting damage shall be marked and set aside for closer examination during deployment.

G. Minor rips or tears in the plastic packaging shall be repaired with moisture resistant tape prior to being placed in storage to prevent moisture damage.

H. GCL rolls delivered to the project site shall be only those indicated on GCL Manufacturing Quality Control Certificates.

## 3.03 STORAGE / STOCKPILING / STAGING

A. Storage of the GCL rolls shall be the responsibility of the CONTRACTOR. The materials shall be unloaded by the CONTRACTOR in areas designated by the OWNER. If the OWNER has not specified a storage area, the CONTRACTOR shall determine an area for storage of the materials to meet the WORK schedule requirements. In any case the materials shall not be stored or unloaded in areas that will impair the operations of the landfill facility or be deleterious to the materials.

B. All GCL rolls shall be stored and maintained dry in a flat location area away from high-traffic areas but sufficiently close to the WORK area to minimize handling.

C. The presence of free-flowing water within the GCL packaging will require that roll to be set aside for further examination to ascertain the extent of damage. Free-flowing water within the GCL packaging shall be cause for rejection of that roll by the ENGINEER.

D. GCL shall be stored no higher than three to four rolls high or limited to the height at which the handling apparatus may be safely handled by installation personnel. Stacks or tiers of rolls should be situated in a manner that prevents sliding or rolling by "choking" the bottom layer of rolls.

E. Rolls shall not be stacked on uneven or discontinuous surfaces in order to prevent bending, deformation, damage to the GCL or cause difficulty inserting the core pipe.

F. An additional tarpaulin or plastic sheet shall be used over the stacked rolls to provide extra protection for GCL material stored outdoors.

G. Bagged bentonite material shall be stored and tarped next to GCL rolls unless other more protective measures are available. Bags shall be stored on pallets or other suitably dry surface which will prevent undue prehydration until installation.

## 3.04 GCL SUBGRADE PREPARATION

A. The CONTRACTOR shall use extreme care while exposing the existing sideslope geomembrane liner system in the areas proposed for GCL so as not to damage the existing geomembrane liner. The CONTRACTOR shall hand excavate as necessary to prepare the area for installation of the GCL in the areas of the existing geomembrane liner. Any damage resulting from the CONTRACTOR'S operations shall be repaired by the CONTRACTOR to original conditions or replaced with new materials at no additional cost to the OWNER. Repairs shall be as directed by the ENGINEER with approved materials.

B. The surface to be lined with GCL shall be free of all rocks (greater than 1/4- inch in any dimension), sticks (greater than 1/4-inch in diameter), roots, grass, refuse, sharp objects, or debris of any kind. The surface shall provide a firm, unyielding foundation for the GCL with no sudden, sharp, or abrupt changes or breaks in grade. No standing water or excessive moisture shall be allowed.

C. The area upon which the GCL material will be installed shall be inspected by the CQA REPRESENTATIVE and certified by the GCL INSTALLER to be in accordance with the requirements of this Specification.

D. It shall be the INSTALLER'S responsibility to indicate to the ENGINEER any change in the condition of the area to be lined with GCL that could cause the area to be out of compliance with any of the requirements of this Section or the project Specification rendering the GCL unacceptable for deployment.

## 3.05 GCL PLACEMENT

A. Placement of the GCL shall be conducted in accordance with the MANUFACTURER'S recommendations and with the direction provided herein. Any deviations from these procedures must be reviewed and accepted by the ENGINEER prior to construction.

B. The use of equipment capable of freely suspending the GCL roll is required. A spreader bar and core pipe are also required for supporting the roll and allowing it to unroll freely. The core pipe and spreader bar shall not bend or flex excessively when a full roll is lifted.

C. Deployment should proceed from the highest elevation to the lowest to facilitate drainage in the event of precipitation.

D. Deployment on flat areas shall be conducted in the same manner as that for the slopes, however, care should be taken to minimize "dragging" the GCL. Slip-sheet may be used to facilitate positioning of the liner while ensuring the GCL is not damaged from underlying sources.

E. Panels shall be placed free of tension or stress yet without wrinkles or folds. It is not permissible to stretch the GCL in order to fit a designated area.

F. Panels shall not be dragged into position except where necessary to obtain the correct overlap for adjacent panels.

G. Panels shall not be placed during adverse weather conditions, including rain, high wind, or any other weather conditions which might be deleterious to the materials or the installation. GCL shall be "dry" when installed and "dry" when covered with overlying materials.

H. The CONTRACTOR shall unwrap and install only as much GCL in one working day as can be covered. In no case shall the GCL be exposed to the elements at the end of the day.

I. Cover as soon as possible to protect the GCL from hydration, environmental effects and damage.

J. Remove and replace panels hydrated or partially hydrated without overlying material cover.

## 3.06 GCL PANEL SEAMING

A. All GCL seams shall be formed in accordance with the MANUFACTURER'S recommendations.

B. A 6-inch lap line and a 9-inch match line shall be imprinted on both edges of the upper geotextile component of the GCL to assist in installation overlap quality control. Lines shall be printed as continuous dashes in easily observable non-toxic ink

C. A minimum 6 inch overlap should exist at longitudinal seam locations and at least 12 inches at panel ends. The lap line and match lines printed on the panels shall be used to assist in obtaining this overlap. The edges of the GCL panels should be adjusted to smooth out any wrinkles, creases, or "fishmouths" in order to maximize contact with the underlying existing sideslope geomembrane liner and panel.

D. All GCL seams shall be formed by executing a bentonite-enhanced overlap to ensure that a continuous seal is achieved between panels. After the overlying panel is placed, its edge shall be pulled back to expose the overlap zone. Any soil or debris present in the overlap zone or entrapped in the geotextiles shall be removed. A fillet of granular bentonite shall then be poured in a continuous manner along the overlap zone at a rate of at least one-quarter pound per lineal foot to ensure that a continuous seal is achieved between panels.

E. On gently sloping areas where seams may be placed across the slope, overlaps should be "shingled" so as to prevent flow into the seam.

## 3.07 DAMAGE REPAIR

A. Prior to cover material placement, damage to the GCL shall be identified and repaired by the INSTALLER. Damage is defined as cuts, rips or tears in the geotextiles, delamination of geotextiles, displaced panel or hydrated areas in the GCL.

B. Rips or tears on flat and sloped surfaces may be repaired by completely exposing the affected area, removing all foreign objects or soil, and by then placing a patch cut from unused GCL over the damage (damaged material may be left in place), with a minimum overlap of 12 inches on all edges. Accessory bentonite shall then be placed between the patch edges and the repaired material at a rate of one-quarter pound per lineal foot of edge spread in a continuous six inch fillet, and the patch shall be placed over the area. An epoxy-based adhesive shall be used to keep the patch in position during backfill operations.

C. Displaced panels shall be adjusted to the correct position and orientation. The adjusted panel shall then be inspected for any geotextile damage or bentonite loss. Damage shall be repaired by the above procedure.

D. If the GCL is prematurely hydrated, the INSTALLER shall notify the QCA REPRESENTATIVE for a site specific determination as to whether the material is acceptable or if alternative measures must be taken to ensure the quality of the design.

## 3.08 DETAIL WORK

A. Detail WORK, defined as the WORK necessary to seal the liner to pipe penetrations, foundation walls, drainage structures, spillways, and other appurtenances, shall be performed as recommended by the GCL MANUFACTURER. Recommended installation details shall be provided in the Installation Plan.

## 3.09 PLACEMENT OF OVERLYING MATERIALS

A. During placement of overlying materials (geomembrane, geocomposite, etc.) upon the GCL, precautions shall be taken to prevent damaging the GCL by restricting heavy equipment traffic. Unrolling the geomembrane can be accomplished through the use of lightweight, rubber-tired equipment such as a 4-wheel all-terrain vehicle (ATV). No vehicles larger than a ATV are allowed in direct contact with the GCL. This vehicle can be driven directly on the GCL, provided the ATV makes no sudden stops, starts, or turns.

B. The GCL should not be covered before observation and acceptance by the QCA REPRESENTATIVE.

C. Geomembrane to be installed over the GCL shall be installed in accordance with installation requirements in Section 02776 High Density Polyethylene (HDPE) Geomembrane Liner and the Drawings.

**END OF SECTION**

## SECTION 02220

## EXCAVATION, BACKFILL, FILL, AND GRADING

### PART 1 - GENERAL

### 1.01 DESCRIPTION

A. The WORK specified in this Section includes excavating, trenching, transporting, stockpiling, placing, backfilling, compacting, grading, disposing of materials, field testing, and quality control/quality assurance laboratory services required for the construction and appurtenances necessary for the WORK as shown on the Contract Drawings and described in the Specifications.

B. Excavated soil that does not contain waste, as determined by the ENGINEER, may be reused and incorporated into the project if it meets the requirements of this Section.

C. Excavation, backfilling, sampling, and testing shall be performed by the CONTRACTOR only when the ENGINEER or CQA REPRESENTATIVE is present. A minimum of 24 hours prior notice shall be provided to the ENGINEER or CQA REPRESENTATIVE.

D. Upon identification, the CONTRACTOR shall notify the ENGINEER in writing if the site conditions encountered during construction differ from that indicated on the Contract Drawings. Notification by the CONTRATOR shall include an explicit description of the differences.

E. The CONTRACTOR shall be responsible for controlling stormwater runoff from the adjacent landfill slope through the use of berms, dikes, and swales to direct stormwater away from construction areas and to areas where the CONTRACTOR shall remove stormwater from the excavation through the use of temporary pumps or other means and methods.

~~D.~~F. Construction Quality Assurance (CQA) will be performed by a designated CQA CONSULTANT retained by the OWNER. The CQA CONSULTANT, or his CQA REPRESENTATIVE, shall observe and inspect all geotechnical activities and conduct CQA testing at a random frequency and location.

~~E.~~G. Any damage to the existing landfill liner systems or any other features shall be repaired as directed by the ENGINEER at the CONTRACTOR'S expense.

### 1.02 DEFINITIONS

A. Topsoil - A fertile, natural or amended soil, typical of locality, free from large stones, roots, sticks, clay, weeds, and sod, and suitable for use as a growing medium for vegetation.

B. Suitable Soil - Soil that meets the requirements as specified in Part 2.

C. Unsuitable Soil - Soil that does not meet the requirements as specified in Part 2.

D. General Fill - Suitable soil that is placed back into the project area and compacted after unsuitable soils are excavated and removed. General Fill shall be compacted to meet the specified requirements contained within this Section.

E. Structural Fill - Soil that is called out in specific locations for the project which are required as opposed to General Fill. The Structural Fill shall be compacted to meet the specified requirements contained within this Section.

F. CQC CONSULTANT - Independent geotechnical consultant retained by the CONTRACTOR to perform the Construction Quality Control (CQC) testing of the material sources, materials and in-place density testing. The CQC CONSULTANT shall oversee the geotechnical activities and the Quality Control testing services as presented in these Specifications for the CONTRACTOR.

~~F.~~G. CQA CONSULTANT - Construction Quality Assurance (CQA) will be performed by a designated CQA CONSULTANT retained by the OWNER. The CQA CONSULTANT, or his CQA REPRESENTATIVE, shall observe and inspect all geotechnical activities and conduct CQA testing at a random frequency and location.

## 1.03 PROJECT CONDITIONS

A. Existing project conditions are shown on the Contract Drawings or otherwise described herein.

B. This information has been obtained from existing records. It is not guaranteed to be correct or complete and is shown for the convenience of the CONTRACTOR. The CONTRACTOR shall explore ahead of the required excavation to determine the exact location of all existing structures, utilities, etc.

C. Structures shall be supported and protected from damage by the CONTRACTOR. If structures are broken or damaged, the CONTRACTOR shall restore structures, utilities, etc. to their original condition at no additional cost to the OWNER. Repair of damaged features or structures shall be approved by the ENGINEER and OWNER.

## 1.04 QUALITY CONTROL

A. Construction Quality Control (CQC) will be performed by an independent geotechnical consultant retained by the CONTRACTOR. The CQC

CONSULTANT cannot be the same CONSULTANT retained by the OWNER for the Construction Quality Assurance (CQA).

B. The CQC CONSULTANT shall oversee all geotechnical activities and the Quality Control testing as specified herein to be performed by the CONTRACTOR. The CQC CONSULTANT shall perform CQC testing of the material borrow sources, materials, and in-place density testing and moisture content.

~~B.~~1. Testing shall be performed by the Soils CQA Laboratory during the course of the WORK to verify continued material compliance with the Plans and Technical Specifications.

~~B.~~C. Refer to Part 1.05.C of this Section for the information to be submitted for the qualifications of the CQC CONSULTANT.

## 1.05 SUBMITTALS

A. Health and Safety Plan

1. The CONTRACTOR shall prepare and submit a Health and Safety Plan to the ENGINEER. The review of the Health and Safety Plan by the ENGINEER shall be for method and content only, and to inform the ENGINEER of the health and safety procedures which must be followed by the ENGINEER and OWNER.

2. The CONTRACTOR shall retain complete responsibility for the application, adequacy and safety of the methods chosen. However, construction shall not begin until the Health and Safety Plan has been submitted and reviewed by the ENGINEER.

3. The Health and Safety Plan shall include descriptions of the methods, equipment, and safety procedures to be used during construction activities including excavating, backfilling, and compacting. In preparing the Health and Safety Plan, the CONTRACTOR shall consider the various materials that may be encountered while conducting all operations necessary to complete the WORK.

4. Refer to Section 01800 Health and Safety.

B. Excavation Plan

1. Prior to beginning WORK, the CONTRACTOR shall provide a detailed Excavation Plan to the ENGINEER for review and approval for addressing excavation, soil segregation, backfilling, compacting, grading etc. that are addressed in this Section prior to starting WORK.

2. The Excavation Plan shall include methods of excavation, stormwater run-on and runoff control, slope stabilization, shoring, stockpiling, stormwater removal, and backfilling techniques.

3. The Excavation Plan shall include a breakdown of each of the soil types specified for backfill, possible sources of each, and shall show that sufficient quantity is available from the borrow sources identified to complete the project.

4. The Excavation Plan shall address safety issues in consideration of OSHA, Federal, State, and local safety requirements, and the document "A Compilation of Landfill Gas Laboratory and Field Practices and Procedures - Health and Safety Section" (Safety Guidelines) prepared by the Solid Waste Association of North America (SWANA), Landfill Gas Division, August 1991. A copy of this document is attached at the end of Section 01800 Health and Safety Requirements for reference.

5. Excavation may be made without sheeting and bracing within the limitations and requirements of the governmental agencies having jurisdiction. Failure of the ENGINEER or CQA REPRESENTATIVE to order the use of bracing or sheeting and shoring or direct changes to systems in place, shall not in any way or to any extent relieve the CONTRACTOR of any responsibility concerning the condition of excavations or of his obligations under the Contract. The CONTRACTOR shall be responsible for the condition of all excavations. All slides and caves shall be removed without extra compensation, at whatever time and under whatever circumstances that they may occur.

6. All excavation shall comply with the applicable requirements as stated in the following:

   a. OSHA excavation safety standards 29 CFR, 1926-650, subpart P.

   b. State (Trench Safety Act Section 553.60-553.64 Florida Statutes) and County construction safety regulations.

   c. Trench safety guidelines as specified by the Landfill Gas Division of the Solid Waste Association of North America (SWANA).

7. The Excavation Plan shall include temporary controls for stormwater runoff and erosion control in full conformance with all existing permits. The CONTRACTOR is responsible for directing, controlling and managing stormwater runoff from all areas surrounding the construction including runoff from the landfill slopes.

8. The CONTRACTOR shall be responsible for vehicle traffic safety and shall coordinate with the OWNER to determine site-specific safety concerns.

9. The CONTRACTOR shall sweep or wash paved roadways which become covered with soil. The CONTRACTOR shall provide all equipment, water, and personnel necessary to clear the paved roads.

C. Qualifications of the CQC CONSULTANT

1. The Qualifications of the geotechnical CQC CONSULTANT retained by the CONTRACTOR shall be submitted to the ENGINEER at least 15 calendar days prior to conducting any geotechnical laboratory or field testing related to the project. The submittal shall include, at a minimum, the following information:

a. The resumes of key personnel involved in the geotechnical testing and observation activities. Key personnel shall include field personnel, laboratory personnel and immediate supervisors. The CQC CONSULTANT shall have a minimum experience of 2 prior similar projects (landfills only) within the last 5 years.

b. Written confirmation that the CQC CONSULTANT has sufficient personnel and equipment available to meet the project schedule.

c. Written confirmation the project Specifications have been received and that WORK shall be performed in compliance with the project Specifications.

D. Construction Quality Control (CQC) Plan

1. The CONTRACTOR shall provide a detailed Construction Quality Control (CQC) Plan signed by the CONTRACTOR addressing procedures and schedules for material source certifications, testing soils, testing in-place soils, submitting test results to the ENGINEER for review, and retesting failed tests.

E. Construction Quality Control Submittals

1. During construction, the CONTRACTOR shall submit CQC Test Reports and documentation generated by the CQC CONSULTANT signed and sealed by a Professional Engineer licensed in the State of Florida for review. Electronic copies shall be submitted to the ENGINEER within 72 hours after sampling or testing for each test required. Hard copy signed-and-sealed test reports shall be submitted to the ENGINEER within 7 days of sampling or testing for each test required.

2. CQC Test Reports for different material types or standards shall receive a unique submittal number and shall not be combined with other material types on any pages in the report.

3. After construction, the CQC CONSULTANT shall prepare a Final Report certifying the geotechnical activities performed on the project are in accordance with the Specifications. The final report shall be signed and sealed by a Professional Engineer licensed in the State of Florida and submitted to the ENGINEER. The Final Report shall include at a minimum:

   a. Field Density Test Report (with field activity log and test location map).

   b. Summary of test results from both qualifying the products and during placement.

F. Drainage Material Installation Plan

1. The CONTRACTOR shall provide a detailed Drainage Material Installation Plan signed by the CONTRACTOR addressing the placement methods of the Protective Soil/Drainage Sand Layer and Leachate Collection and Removal System Trench Gravel to demonstrate that the bottom liner geosynthetic materials will be protected and safeguarded from damage during placement of the overlying materials.

2. The Drainage Material Installation Plan shall include material types, minimum thickness of each lift of materials during placement, description of thickness markers, methods for measuring material thicknesses, and methods for removing markers. The marker shall be free standing and shall not be sharp or pointed so it cannot damage the geosynthetic liner materials if hit by equipment.

3. The Drainage Material Installation Plan shall include a method for removing markers without disturbing in-place materials.

G. Borrow Source Materials - Pre-construction Materials Evaluation

1. For any off-site material borrow sources, the CONTRACTOR shall notify the ENGINEER in writing of the material source for each soil type specified within Part 2 of this Section at least 21 calendar days prior to the date of anticipated use of such material. Notification shall include at a minimum:

   a. Supplier's name

b. Borrow location

c. Documentation confirming adequate quantities are available to complete the WORK

d. A representative sample of the proposed material, consisting of one 5-gallon, sealed container

e. Test results as required within Part 2 of this Section

2. The CONTRACTOR shall submit to the ENGINEER the CQC CONSULTANT'S laboratory test results for each soil type specified within Part 2 of this Section at least 21 calendar days prior to the date of anticipated use of such material. Materials shall not be incorporated into the project until approved by the ENGINEER.

3. The CONTRACTOR shall submit Material Source Certificates of Compliance signed by the CONTRACTOR for each of the proposed materials, General Fill, Structural Fill, Protective Soil/Drainage Sand Layer, Leachate Collection and Removal System Trench Gravel, and Groundwater Underdrain Gravel from each of the proposed sources to the ENGINEER. The Material Source Certificates of Compliance shall include the project title, project location, soil type, source name and description, proposed use, test identification number and laboratory test results.

~~3.~~4. Pre-construction materials evaluations shall be performed on samples from potential soil borrow sources by the CONTRACTORS independent CQC Laboratory prior to incorporation into construction to ascertain their acceptability as construction materials. Testing shall be performed by the Soils CQA Laboratory during the course of the WORK to verify continued material compliance with the Plans and Technical Specifications.

H. Pipe Surveys

1. Proposed stationing and pipeline identification procedures. Prior to the start of any pipe installation, the CONTRACTOR shall supply an example layout drawing showing how the header and laterals will be marked with stations for the conformance surveys. The example layout drawing and stations must be consistent with the requirements of Sections 01300 Contractor Submittals and 01050 Site Conditions Survey.

2. The CONTRACTOR shall include in their daily report a daily log detailing length of trench excavated and backfilled, with reference to pipe stationing and details sufficient to properly describe the WORK completed to date.

I. Topographic Surveys

1. Prior to performing any earthwork, a pre-construction survey (Record Drawing) of the limits of construction and 25 feet beyond the limits of construction as defined in the Contract Documents will be prepared by a registered land surveyor licensed in the State of Florida. The topographic information shall be collected on a 50 foot by 50 foot grid, at a minimum, and as necessary (i.e., spot elevations, grade breaks, ditches, mounds, etc.) so as to provide an accurate representation of the contour topography.

2. A location survey of the edge of the existing 60 mil textured HDPE geomembrane along the western side of the closed Phase I landfill area. This survey shall represent the limits of the existing geomembrane and shall be staked and surveyed every 25 feet.

3. A location survey of the edge of the existing 60 mil textured HDPE geomembrane along the western side of the active Phase II Section I landfill area. This survey shall represent the limits of the existing geomembrane and shall be staked and surveyed every 25 feet.

4. A location survey of the western-most existing HDPE Groundwater Collection System (GCS) pipes inverts and western-most existing Leachate Collection and Removal System (LCRS) pipes invert along the western side of the active Phase II Section I landfill area. This survey shall represent the existing GCS and LCRS pipes and shall be staked and surveyed as required.

5. A topographic survey (Record Drawing) of the completed top of Subbase Surface Layer shall be collected on a 50 foot by 50 foot grid, at a minimum, and as necessary (i.e., spot elevations, grade breaks, points referenced in the control points table, etc.) so as to provide an accurate representation of the contour topography. This survey shall be representative of the top of the Subbase Surface Layer prior to placement of the Geosynthetic Clay Liner (GCL).

    a. No GCL installation shall occur until the survey of the surface upon which the GCL is to be installed (Subbase) has been completed, submitted, reviewed and approval received from the ENGINEER.

6. A topographic survey (Record Drawing) of the top of the installed Protective Soil/Drainage Sand Layer shall be collected on a 50 foot by 50 foot grid, at a minimum, and as necessary (i.e., spot elevations, grade breaks, sideslopes, points referenced in the control points table, etc.) so as to provide an accurate representation of the contour topography. A minimum of 24 inches measured perpendicular to the slope, is required

above the primary geocomposite.

7. Refer to Section 01050 Site Conditions Survey.

J. Certification of Subbase Acceptance

1. Upon completion of the Subbase Layer construction and acceptance of the topographic survey (Record Drawing) of the completed Subbase Layer, refer to Section 1.05.G.5 of this Section, a "Certificate of Subbase Acceptance" shall be co-signed by the INSTALLER along with the CQA REPRESENTATIVE prior to the installation of the GCL certifying the Subbase Layer was constructed in accordance with the approved Contract Documents and Specifications.

2. Refer to Section 02077 Geosynthetic Clay Liner (GCL).

K. Submittal Review

1. The CONTRACTOR shall schedule all WORK to allow at least 30 working days for submittal review and approval by the ENGINEER. There shall be no additional compensation to the CONTRACTOR for any construction delays caused by the CONTRACTOR'S failure to plan, obtain approval or schedule WORK to include all CQC/CQA testing.

2. Refer to Section 01300 Contractor Submittals.

## 1.06 SITE ACCESS

A. WORK shall be performed so as to not block or hinder site access, except as authorized by the OWNER.

# PART 2 - PRODUCTS

## 2.01 EXISTING SUBGRADE SOILS

A. Existing Subgrade Soils shall be non-organic, free of debris, sticks, roots, stones and sharp materials greater than ½-inch in any dimension.

B. Subgrade Soils shall be well-graded sand (SW), poorly graded sand (SP), poorly graded sand with clay (SP-SC), poorly graded sand with silt (SP-SM), well graded sand with clay (SW-SC), well graded sand with silt (SW-SM), or clayey sand (SC) as classified by the Unified Soil Classification System (USCS), or other soil as approved by the ENGINEER. For soils with Atterberg Limits, Liquid Limit shall be less than 50 with a Plasticity Index less than 20.

C. Unsuitable Subgrade Soils

1. ASTM D2487 Soil Classification Groups: ML, MH, OH, OL and PT.

2. Soils excessively wet or dry at time of compaction. Allow such material to dry, or moisten, as required, to bring material generally within 3 percent of optimum moisture content range for specified compaction.

3. Soils, which yield or exhibit pumping due to excessive moisture shall be excavated and replaced with General Fill that meets the project Specifications.

4. CONTRACTOR shall excavate unsuitable soils to 2 feet below and around bottom liner system area as shown on the Contract Drawings. Excavated unsuitable soils shall be backfilled with General Fill that meets the project Specifications.

5. Prior to placement, CQC CONSULTANT shall provide laboratory test results in accordance with Table 02220-1.

   ~~5.~~a. Pre-construction materials evaluations shall be performed on samples from potential soil borrow sources by the CONTRACTORS independent CQC Laboratory prior to incorporation into construction to ascertain their acceptability as construction materials. Testing shall be performed by the Soils CQA Laboratory during the course of the WORK to verify continued material compliance with the Plans and Technical Specifications.

6. During placement, all materials shall be tested by the CQC CONSULTANT in accordance with Table 02220-2.

   ~~6.~~a. Testing shall be performed by the Soils CQA Laboratory during the course of the WORK to verify continued material compliance with the Plans and Technical Specifications.

## 2.02 GENERAL FILL

A. General Fill shall be non-organic, free of debris, sticks, roots, stones and sharp materials greater than 1/2-inch in any dimension.

B. In the areas where General Fill is placed and compacted to bring the Expansion bottom to the lines and grades as shown on the Contract Drawings for use as the Subbase of the GCL it shall be chemically compatible with the GCL in accordance with ASTM D6141.

C. General Fill shall be well-graded sand (SW), poorly graded sand (SP), poorly graded sand with clay (SP-SC), poorly graded sand with silt (SP-SM), well graded sand with clay (SW-SC), well graded sand with silt (SW-SM), or clayey sand (SC) as classified by USCS, or other soil as approved by the ENGINEER. For soils with Atterberg Limits, Liquid Limit shall be less than 50 with a Plasticity Index less than 20.

D. Unsuitable General Fill

1. ASTM D2487 Soil Classification Groups: ML, MH, OH, OL and PT.

2. Soils also include satisfactory soils not maintained within 3 percent of optimum moisture content at the time of compaction.

E. Prior to placement, CQC CONSULTANT shall provide laboratory test results in accordance with Table 02220-1.

E.1. Pre-construction materials evaluations shall be performed on samples from potential soil borrow sources by the CONTRACTORS independent CQC Laboratory prior to incorporation into construction to ascertain their acceptability as construction materials. Testing shall be performed by the Soils CQA Laboratory during the course of the WORK to verify continued material compliance with the Plans and Technical Specifications.

F. During placement, all materials shall be tested by the CQC CONSULTANT in accordance with Table 02220-2.

F.1. Testing shall be performed by the Soils CQA Laboratory during the course of the WORK to verify continued material compliance with the Plans and Technical Specifications.

## 2.03 STRUCTURAL FILL

A. Structural Fill soils non-organic, free of debris, sticks, roots, stones and sharp materials greater than 1/2-inch in any dimension.

B. Structural Fill shall be well-graded sand (SW), poorly graded sand (SP), poorly graded sand with clay (SP-SC), poorly graded sand with silt (SP-SM), well graded sand with clay (SW-SC), well graded sand with silt (SW-SM), or clayey sand (SC) as classified by USCS, or other soil as approved by the ENGINEER.

C. Unsuitable Structural Fill

1. ASTM D2487 Soil Classification Groups: ML, MH, OH, OL and PT.

2. Soils also include satisfactory soils not maintained within 3 percent of optimum moisture content at the time of compaction.

D. Prior to placement, CQC CONSULTANT shall provide laboratory test results in accordance with Table 02220-1.

~~D.~~1. Pre-construction materials evaluations shall be performed on samples from potential soil borrow sources by the CONTRACTORS independent CQC Laboratory prior to incorporation into construction to ascertain their acceptability as construction materials. Testing shall be performed by the Soils CQA Laboratory during the course of the WORK to verify continued material compliance with the Plans and Technical Specifications.

E. During placement, all materials shall be tested by the CQC CONSULTANT in accordance with Table 02220-2.

~~E.~~1. Testing shall be performed by the Soils CQA Laboratory during the course of the WORK to verify continued material compliance with the Plans and Technical Specifications.

## 2.04 PROTECTIVE SOIL/DRAINAGE SAND

A. Protective Soil/Drainage Sand shall be non-carbonate, non-organic, free of debris, waste, sticks, roots, organics, or other deleterious materials and stones larger than 1/4-inch in any dimension.

B. The material shall be sand with a minimum hydraulic conductivity of $1x10^{-3}$ cm/sec (0.001 cm/sec) when placed in accordance with this Section. The laboratory hydraulic conductivity test shall be performed in accordance with ASTM D2434 on a sample compacted to 95 percent Standard Proctor dry density.

C. Protective Soil/Drainage Sand shall meet the following gradation requirements:

| SIEVE SIZE | MAXIMUM PERCENT PASSING |
|---|---|
| No. 4 | 100 |
| No. 30 | 95 |
| No. 50 | 65 |
| No. 70 | 20 |
| No. 200 | 10 |

D. The above gradations may be modified by the ENGINEER if the Protective Soil/Drainage Sand gradation varies from the gradation curve above but still meets the following:

1. Geotextile requirements refer to Section 02940 Geotextile.

2. Interface shear strength requirements refer to Section 02931 Bi-planar Geocomposite.

E. Prior to placement, CQC CONSULTANT shall provide laboratory test results in accordance with Table 02220-1.

E.1. Pre-construction materials evaluations shall be performed on samples from potential soil borrow sources by the CONTRACTORS independent CQC Laboratory prior to incorporation into construction to ascertain their acceptability as construction materials. Testing shall be performed by the Soils CQA Laboratory during the course of the WORK to verify continued material compliance with the Plans and Technical Specifications.

F. During placement, all materials shall be tested by the CQC CONSULTANT in accordance with Table 02220-2.

F.1. Testing shall be performed by the Soils CQA Laboratory during the course of the WORK to verify continued material compliance with the Plans and Technical Specifications.

## 2.05 LEACHATE TRENCH GRAVEL

A. Leachate Trench Gravel placed around the leachate collection pipes shall be non-carbonate, non-organic, free of debris, waste, vegetation, sticks, roots, organics, or other deleterious materials.

B. Leachate Trench Gravel shall be rounded to well-rounded quartz or granite-based gravel.

C. The gradation shall comply with the requirements for No. 4 aggregate as specified in the Florida Department of Transportation's (FDOT), Standard Specifications for Road and Bridge Construction (2000), Section 901, Table 1, Standard Sizes of Coarse Aggregate, or other materials as approved by the ENGINEER.

D. Prior to placement, CQC CONSULTANT shall provide laboratory test results in accordance with Table 02220-1.

D.1. Pre-construction materials evaluations shall be performed on samples from potential soil borrow sources by the CONTRACTORS independent CQC Laboratory prior to incorporation into construction to ascertain their acceptability as construction materials. Testing shall be performed by the Soils CQA Laboratory during the course of the WORK to verify continued material compliance with the Plans and Technical Specifications.

E. During placement, all materials shall be tested by the CQC CONSULTANT in accordance with Table 02220-2.

~~E.~~1. Testing shall be performed by the Soils CQA Laboratory during the course of the WORK to verify continued material compliance with the Plans and Technical Specifications.

## 2.06 GROUNDWATER COLLECTION SYSTEM GRAVEL

A. Groundwater Collection System Gravel placed around the groundwater collection system pipes shall be non-carbonate, non-organic, free of debris, waste, vegetation, sticks, roots, organics, or other deleterious materials.

B. Groundwater Collection System Gravel shall be limerock, quartz or granite-based crushed or rounded river rock, washed and free of deleterious material.

C. The gradation shall comply with the requirements for No. 4 or 57 aggregate as specified in the Florida Department of Transportation's (FDOT), Standard Specifications for Road and Bridge Construction (2000), Section 901, Table 1, Standard Sizes of Coarse Aggregate, or other materials as approved by the ENGINEER.

D. Prior to placement, CQC CONSULTANT shall provide laboratory test results in accordance with Table 02220-1.

~~D.~~1. Pre-construction materials evaluations shall be performed on samples from potential soil borrow sources by the CONTRACTORS independent CQC Laboratory prior to incorporation into construction to ascertain their acceptability as construction materials. Testing shall be performed by the Soils CQA Laboratory during the course of the WORK to verify continued material compliance with the Plans and Technical Specifications.

E. During placement, all materials shall be tested by the CQC CONSULTANT in accordance with Table 02220-2.

~~E.~~1. Testing shall be performed by the Soils CQA Laboratory during the course of the WORK to verify continued material compliance with the Plans and Technical Specifications.

## 2.07 TOPSOIL

A. Topsoil shall be fertile, natural or amended soil, typical of the locality, free of debris, waste, large stones, roots, sticks, clay, peat, weeds and sod, and obtained from naturally well drained areas.

B. Topsoil shall not be excessively acid or alkaline nor contain toxic material harmful to plant growth. The source of the topsoil shall be approved by the ENGINEER prior to placement by the CONTRACTOR.

C. Upon request by the ENGINEER, the CONTRACTOR shall submit representative samples for use in sodding and seeding operations and results of analysis by a private laboratory to determine nutrient content.

D. The material shall comply with the requirements of FDOT's Standard Specifications for Road and Bridge Construction (2000), Section 987 for Topsoil.

## PART 3 - EXECUTION

### 3.01 PREPARATION

A. The CONTRACTOR is responsible for layout of all excavations and establishment of grades as shown on the Contract Drawings. CONTRACTOR shall replace existing survey markers to original location if disturbed or destroyed at no additional cost to OWNER. Layout WORK shall be performed by a licensed land surveyor registered in the State of Florida.

B. Prior to clearing, grubbing and stripping of the project area the CONTRACTOR shall have performed and submitted to the ENGINEER the topographic surveys as required in Section 01050 Site Conditions Survey.

C. The CONTRACTOR shall provide protection as required to prevent damage to existing improvements indicated to remain in place.

### 3.02 TEMPORARY EROSION AND SEDIMENTATION CONTROL

A. The CONTRACTOR shall provide temporary erosion and sedimentation control methods in accordance with requirements of authorities having jurisdiction, as specified in the Contract Documents and in Section 01568 Temporary Erosion and Sedimentation Control.

B. The CONTRACTOR shall protect excavated/graded areas against action of elements. Re-establish grades where settlement, washouts, or erosion damage occurs. Any erosion that takes place during the construction of the project shall be repaired by the CONTRACTOR at no additional cost to the OWNER as per the Specifications provided herein.

### 3.03 CLEARING, GRUBBING, AND STRIPPING

A. Clear areas required for access to the site and execution of the WORK. Clearing and grubbing shall consist of the complete removal and disposal of all trees, brush, stumps, roots, grass, weeds, rubbish and all other obstructions resting on or protruding through the surface of the existing ground and the surface of the areas to be excavated which are understood by generally accepted practice not to be suitable for construction.

B. Clearing and grubbing shall be accomplished in all areas designated for site grading. Areas to be excavated or filled upon shall be stripped of grass and roots to a depth of six (6) inches. Stripped materials suitable for topsoil shall be stockpiled for later use and all other material shall be disposed of onsite by the CONTRACTOR.

C. Where clearing, grubbing or excavation is conducted within the area where the bottom liner system will be installed, all stumps, roots and other debris protruding through or appearing at the ground surface shall be removed to a depth of not less than 18 inches below the ground surface and the voids replaced with General Fill and compacted with equipment suitable for the WORK to bring the material to the required density and grade as specified in this Section.

## 3.04 DEWATERING

A. Water that enters excavations with waste shall be considered leachate and shall not be discharged to the ground or other means that are typical for stormwater. Water determined to be leachate by the ENGINEER shall be pumped into sealed tanks, hauled and disposed into Manhole No. 9 located at the southeast corner of the Phase I area, or as directed by the ENGINEER.

B. The CONTRACTOR shall at all times during construction provide and maintain proper equipment and facilities to remove water entering excavations. CONTRACTOR shall keep such excavations dry so as to obtain a satisfactory foundation condition for all WORK.

C. Do not allow water to accumulate in excavations. Remove water to prevent softening of foundation bottom and soil changes detrimental to stability of subgrades and foundations. Subgrade soils which become soft, loose, “quick”, or otherwise unsatisfactory for support of structure as a result of inadequate dewatering or other construction methods shall be removed and replaced by suitable materials as approved by the ENGINEER at the CONTRACTOR’S expense. Provide and maintain pumps, sumps, suction and discharge lines, and other dewatering system components necessary to convey water away from excavations.

D. CONTRACTOR shall establish and maintain temporary drainage ditches and other diversions outside excavation limits to convey rain water and water removed from excavations to collecting or runoff areas as deemed necessary. Do not use trench excavations as temporary drainage ditches.

E. Disposal of Water Removed by Dewatering

1. Water conveyed away from excavations which has not contacted waste materials shall be discharged to areas approved by the ENGINEER.

2. Dispose of water by procedures approved by the ENGINEER in such a manner as to cause no inconvenience to the OWNER, the ENGINEER, or others involved in WORK about the site.

## 3.05 DISPOSAL OF WASTE MATERIAL

A. Material that does not contain waste, as determined by the ENGINEER, and meets the project Specifications, shall be reused and incorporated into the project.

B. The CONTRACTOR shall be responsible for loading and transporting waste and waste materials not incorporated into the project to the landfill (active Phase II Section I filling area) working face or other area as directed by the OWNER for disposal. The OWNER will not charge the CONTRACTOR a tipping fee, but the CONTRACTOR shall be responsible for all other costs.

C. Exposed waste, or soil containing waste materials, shall not be allowed to remain exposed overnight. At the end of each work day, the CONTRACTOR shall cover exposed waste, or soil containing waste materials, in a temporary or permanent manner by the means of an earthen cover or suitable tarp. At no time shall water exposed to waste be allowed to enter the stormwater management system. Water exposed to waste shall be considered leachate and handled accordingly.

## 3.06 STOCKPILE OF MATERIALS

A. Excavated material shall be transported to stockpile areas designated by the OWNER for surplus or unsuitable materials. No materials shall be removed from the site or disposed of by the CONTRACTOR except as directed by the ENGINEER. Excavated materials may be segregated during excavation and the ENGINEER or CQA REPRESENTATIVE shall direct locations for segregated materials. The CONTRACTOR shall coordinate disposal activities with the ENGINEER to not interfere with on-going landfill operations activities.

B. The CONTRACTOR shall be responsible for vehicle traffic safety and shall coordinate with the ENGINEER to determine site-specific safety concerns.

C. The CONTRACTOR shall sweep or wash paved roadways that become covered with soil. The CONTRACTOR shall provide all equipment, water, and personnel necessary to clear the paved roads. This activity shall be performed at a minimum of once per week or as the CQA REPRESENTATIVE directs.

## 3.07 EXCAVATION

A. Layout all excavations and establish grades as shown on the Contract Drawings. Replace existing survey markers at original location if disturbed or destroyed. Layout work shall be performed by a licensed land surveyor registered in the State of Florida.

B. The CONTRACTOR shall provide drainage at all times during construction by shaping excavated areas and maintaining ditches and berms. CONTRACTOR will protect graded areas against action of elements and re-establish grades where settlement, washouts, or erosion damage occurs. Damaged areas shall be repaired at no additional cost to the OWNER.

C. The CONTRACTOR shall excavate soil as required to the lines, grades, and elevations indicated on the Contract Drawings as needed to construct the subbase. Excavate unsuitable subgrade soils to 18 inches vertically and horizontally from the lines and grades shown on the Contract Drawings. Backfill excavated unsuitable subgrade soil with General Fill and compacted with equipment suitable for the WORK to bring the material to the required density and grade.

D. If the bottom of any excavation is removed below the limits shown on the Contract Drawings, it shall be backfilled at the CONTRACTOR'S expense with material approved by the ENGINEER at no additional cost to the OWNER.

E. Excavation, backfilling, sampling, and testing shall be performed by the CONTRACTOR'S CQC CONSULTANT only when the CQA REPRESENTATIVE is present. A minimum of 24-hours prior notice shall be given to the ENGINEER and CQA REPRESENTATIVE.

F. All excavations shall conform to the Health and Safety Plan and Excavation Plan submitted by the CONTRACTOR.

## 3.08 SUBBASE PREPARATION

A. Conduct excavation activities, perform grading improvements, and construct embankments to the lines and grades shown on Contract Drawings in preparation for GCL placement. Smooth finish surface within specified tolerances, compact with uniform levels or slopes between points where elevations are indicated or between such points and existing grades. The ENGINEER reserves the right to make adjustments or revisions in lines or grades as the WORK progresses while still achieving the intent of the grading plan.

B. Compact (and moisture condition as needed) the existing exposed satisfactory subgrade soils to a minimum of 90% relative compaction as determined by ASTM D698. The exposed subgrade soils shall be proof-rolled a minimum of 4 complete passes with a vibratory steel drum roller (with vibratory action turned on) or other equipment approved by the ENGINEER.

C. Areas that cannot be made to compact readily, deflect, pump or rut under this operation shall be removed and replaced with General Fill and compacted as indicated in Part 3.09 of this Section. Subgrade soils excessively wet or dry are considered unsuitable soils and shall be removed and replaced with General Fill and compacted as indicated in Part 3.09 of this Section. Care shall be taken when selecting construction equipment sizes and the amount of traffic on the subgrade. The combination of heavy construction equipment and excess surface moisture can cause pumping and deterioration of the near surface soils.

D. In cuts, all loose or protruding rocks on the excavated sideslopes shall be loosened and removed to line or finished grade of slope. All cut and fill slopes shall be as shown on the Contract Drawings or as directed by the ENGINEER.

E. Areas of the prepared subbase which do not achieve the lines and grades shown on Contract Drawings, the CONTRACTOR shall place and compact General Fill in accordance with Part 3.09 of this Section to achieve the lines and grades.

F. Within the area which GCL will be placed, remove any debris, sticks, roots, stones and sharp materials greater than ½-inch in any dimension from the finished subbase surface. Smooth finished subbase surface to remove rutting and tire marks. The CONTRACTOR shall avoid sharp turns, sudden starts or stops, spinning and digging of tracks, or any other operation that could damage the surface.

G. Grade the prepared subbase to the required vertical tolerance. By survey methods, verify that all grades, slopes and elevations conform to specified requirements. Record elevations of each component in accordance with Section 01050 Site Condition Surveys. If there is a discrepancy, immediately notify the ENGINEER. Do not proceed with installation in an area of discrepancy until the ENGINEER gives approval.

H. Maintain proper drainage during grading operations until final acceptance. Repair any fill or grading materials which may be lost or displaced as a result of natural causes such as storms, squalls, etc., with acceptable material. Repair shall be performed at no additional cost to the OWNER. The additional survey or documentation necessary to conduct the repairs shall be at no additional cost to the OWNER.

I. Maintain the soil moisture until covered by GCL and liner materials. The groundwater level shall be maintained during construction as required in Section 02140 Dewatering.

J. Placement of GCL on the completed subbase shall not begin until the "Certificate of Subbase Acceptance" has been co-signed by the INSTALLER along with the CQA REPRESENTATIVE certifying the Subbase Layer was constructed in accordance with the approved Contract Documents and Specifications. Refer to Section 02077 Geosynthetic Clay Liner (GCL).

K. Placement of GCL on the completed subbase shall not begin until the topographic survey (Record Drawing) of the completed Subbase Layer has been submitted by the CONTRACTOR and approved by the ENGINEER. Refer to Section 01050 Site Condition Surveys.

L. Prior to material placement, CQC CONSULTANT shall provide laboratory test results in accordance with Table 02220-1.

L.1. Pre-construction materials evaluations shall be performed on samples from potential soil borrow sources by the CONTRACTORS independent CQC Laboratory prior to incorporation into construction to ascertain their acceptability as construction materials. Testing shall be performed by the Soils CQA Laboratory during the course of the WORK to verify continued material compliance with the Plans and Technical Specifications.

M. During material placement, all materials shall be tested by the CQC CONSULTANT in accordance with Table 02220-2.

M.1. Testing shall be performed by the Soils CQA Laboratory during the course of the WORK to verify continued material compliance with the Plans and Technical Specifications.

## 3.09 PLACEMENT OF SOIL FILL AND COMPACTION

A. Place designated soil fill materials, General Fill or Structural Fill, perform grading improvements, compact, and construct embankments to the lines and grades shown on Contract Drawings. Smooth finish surface within specified tolerances, compact with uniform levels or slopes between points where elevations are indicated or between such points and existing grades. The ENGINEER reserves the right to make adjustments or revisions in lines or grades as the WORK progresses while still achieving the intent of the grading plan.

B. Place designated soil fill material in the areas required in loose lifts not exceeding 12 inches.

C. Each lift shall be compacted to the required density based on the type of soil fill material.

1. General Fill - Compact each lift to a minimum of 90% relative compaction as determined by ASTM D698.

2. Structural Fill - Compact each lift to a minimum of 95% relative compaction as determined by ASTM D698.

D. Compaction equipment used is at the discretion of the CONTRACTOR.

E. Areas that deflect, pump or rut under this operation shall be reworked by the CONTRACTOR.

F. Within the General Fill area which GCL will be placed, remove any debris, sticks, roots, stones and sharp materials greater than ½-inch in any dimension from the finished subbase surface. Smooth finished subbase surface to remove rutting and tire marks. The CONTRACTOR shall avoid sharp turns, sudden starts or stops, spinning and digging of tracks, or any other operation that could damage the surface.

G. Grade the prepared filled area to the required vertical tolerance. By survey methods, verify that all grades, slopes and elevations conform to specified requirements. Record elevations of each component in accordance with Section 01050 Site Condition Surveys. If there is a discrepancy, immediately notify the ENGINEER. Do not proceed with installation in an area of discrepancy until the ENGINEER gives approval.

H. Maintain proper drainage during grading operations until final acceptance. Repair any fill or grading materials which may be lost or displaced as a result of natural causes such as storms, squalls, etc., with acceptable material. Repair shall be performed at no additional cost to the OWNER. The additional survey or documentation necessary to conduct the repairs shall be at no additional cost to the OWNER.

I. Maintain the soil moisture within the area which GCL will be placed until covered by GCL and liner materials. The groundwater level shall be maintained during construction as required in Section 02140 Dewatering.

J. Placement within areas intended for GCL installation shall not begin until the "Certificate of Subbase Acceptance" has been co-signed by the INSTALLER along with the CQA REPRESENTATIVE certifying the Subbase Layer was constructed in accordance with the approved Contract Documents and Specifications. Refer to Section 02077 Geosynthetic Clay Liner (GCL).

K. Placement within areas intended for GCL installation shall not begin until the topographic survey (Record Drawing) of the completed Subbase Layer has been submitted by the CONTRACTOR and approved by the ENGINEER. Refer to Section 01050 Site Condition Surveys.

L. Prior to material placement, CQC CONSULTANT shall provide laboratory test results in accordance with Table 02220-1.

~~L.~~1. Pre-construction materials evaluations shall be performed on samples from potential soil borrow sources by the CONTRACTORS independent CQC Laboratory prior to incorporation into construction to ascertain their acceptability as construction materials. Testing shall be performed by the Soils CQA Laboratory during the course of the WORK to verify continued material compliance with the Plans and Technical Specifications.

M. During material placement, all materials shall be tested by the CQC CONSULTANT in accordance with Table 02220-2.

~~M.~~1. Testing shall be performed by the Soils CQA Laboratory during the course of the WORK to verify continued material compliance with the Plans and Technical Specifications.

## 3.10 PLACEMENT OF GROUNDWATER COLLECTION SYSTEM GRAVEL

A. Place Groundwater Collection System Gravel around the groundwater collection pipes wrapped with woven geotextile to the lines and grades shown on the Contract Drawings.

B. Refer to Section 02940 Geotextile.

## 3.11 PLACEMENT OF LEACHATE TRENCH GRAVEL

A. Placement of the Leachate Collection System materials will only occur after the underlying geosynthetic material installations are complete and approved in accordance with the Specifications. Placement of the Leachate Collection System materials shall be conducted in accordance with the Drainage Material Installation Plan submitted by the CONTRACTOR.

B. Place Leachate Trench Gravel around the leachate collection pipes wrapped with woven geotextile to the lines and grades shown on the Contract Drawings.

C. Refer to Section 02940 Geotextile.

## 3.12 PLACEMENT OF PROTECTIVE/DRAINAGE SOIL

A. Placement of the Protective Soil/Drainage Sand materials will only occur after the underlying geosynthetic material installations are complete and approved in accordance with the Specifications. Placement of Protective Soil/Drainage Sand shall be conducted in accordance with the Drainage Material Installation Plan submitted by the CONTRACTOR.

B. Place Protective Soil/Drainage Sand in one lift to the lines and grades shown on the Contract Drawings. The CONTRACTOR shall place a minimum of 24 inches of Protective Soil/Drainage Sand (measured perpendicular to the slope) meeting the requirements specified in this Section.

C. Low ground pressure equipment shall be used to place and spread the Protective Soil/Drainage Sand. The CONTRACTOR shall use extreme care when working above the geosynthetic liner system. A minimum of 18 inches of soil shall be between the low ground pressure equipment and the geosynthetic liner system at all times. Any damage to the geosynthetic liner system shall be repaired by the CONTRACTOR at no additional cost to OWNER.

D. Place Protective Soil/Drainage Sand in a manner to not cause wrinkles and undue stresses to the underlying geosynthetic liner system.

E. The CONTRACTOR shall provide and maintain a means of continuously observing the installed depth of the Protective Soil/Drainage Sand as indicated in the Drainage Material Installation Plan on the required grid intervals. If temporary markers are used, the marker shall be free standing and shall not be sharp or pointed so it cannot damage the geosynthetic liner materials if hit by equipment. Markers shall be removed after use and shall not be abandoned in-place after Protective Soil/Drainage Sand installation.

F. Maintain proper drainage during grading operations until final acceptance. Repair any fill or grading materials which may be lost or displaced as a result of natural causes such as storms, squalls, etc., with acceptable material. Repair shall be performed at no additional cost to the OWNER. The additional survey or documentation necessary to conduct the repairs shall be at no additional cost to the OWNER.

G. By survey methods, verify that all grades, slopes and elevations conform to specified requirements. Record elevations in accordance with Section 01050 Site Condition Surveys. If there is a discrepancy, immediately notify the ENGINEER. Do not proceed with installation in an area of discrepancy until the ENGINEER gives approval.

H. A Geosynthetic Rain Tarp shall be required on a portion of the Protective Soil/Drainage Sand as indicated on the Contract Drawings. Refer to Section 02941 Geosynthetic Rain Tarp.

## 3.13 PLACEMENT OF TOPSOIL

A. Place Topsoil, perform grading improvements, and construct embankments to the lines and grades shown on Contract Drawings. Smooth finish surface within specified tolerances, compact with uniform levels or slopes between points where elevations are indicated or between such points and existing grades. The ENGINEER reserves the right to make adjustments or revisions in lines or grades as the WORK progresses while still achieving the intent of the grading plan.

B. Materials excessively wet or dry are considered unsuitable. Allow such material to dry, or moisten, as required, to bring material generally within 3 percent of optimum moisture content range for specified compaction.

C. Maintain proper drainage during grading operations until final acceptance. Repair any fill or grading materials which may be lost or displaced as a result of natural causes such as storms, squalls, etc., with acceptable material. Repair shall be performed at no additional cost to the OWNER. The additional survey or documentation necessary to conduct the repairs shall be at no additional cost to the OWNER.

## 3.14 SODDING/REVEGETATION

A. Grass seeding and mulching shall be required in the entire area of the CONTRACTOR'S construction staging/laydown area, regardless of the approximate limits that may be indicated on the Contract Drawings. Refer to Section 02900 Seeding and Sodding.

B. CONTRACTOR shall maintain the seeded and sodded areas in accordance with Section 02900 Seeding and Sodding Part 3.06.

## 3.15 TESTING REQUIREMENTS DURING PLACMENT

A. Prior to material placement, CQC CONSULTANT shall provide laboratory test results in accordance with Table 02220-1.

~~A.~~ 1. Pre-construction materials evaluations shall be performed on samples from potential soil borrow sources by the CONTRACTORS independent CQC Laboratory prior to incorporation into construction to ascertain their acceptability as construction materials. Testing shall be performed by the Soils CQA Laboratory during the course of the WORK to verify continued material compliance with the Plans and Technical Specifications.

B. During material placement, all materials shall be tested by the CQC CONSULTANT in accordance with Table 02220-2.

~~B.~~ 1. Testing shall be performed by the Soils CQA Laboratory during the course of the WORK to verify continued material compliance with the Plans and Technical Specifications.

C. Composite soil samples are not allowed.

D. Nuclear determination of field density may be used.

E. Location of field moisture-density tests shall be approved by the ENGINEER.

## 3.16 TOLERANCES

A. The CONTRACTOR shall bring final grading to within the tolerances specified in Section 01050 Site Conditions Survey.

## 3.17 DUST CONTROL

A. The CONTRACTOR shall spray water over the construction area, haul roads, or other places impacted by the CONTRACTOR, in order to limit airborne dust, or as directed by the ENGINEER or OWNER.

B. If due to construction activities the dust reduces the visibility so vehicles and personnel are limited and cause an Health and Safety problem, all construction activities will be stopped immediately until the CONTRACTOR applies water to the construction area, haul roads, or other places being impacted by the CONTRACTOR'S activities.

**TABLE 02220-1 SOIL QUALIFICATION TESTING**

| MATERIAL | TEST | ASTM NO. | FREQUENCY |
|---|---|---|---|
| General Fill | Natural Moisture Content | ASTM D2216 | 1 test per source or change in material |
| | Standard Proctor | ASTM D698 | |
| | Soil Classification | ASTM D2487 | |
| | Sieve Analysis | ASTM D422 | |
| | Atterberg Limits | ASTM D4318 | |
| Structural Fill | Natural Moisture Content | ASTM D2216 | 1 test per source or change in material |
| | Soil Classification | ASTM D2487 | |
| | Sieve Analysis | ASTM D422 | |
| | Atterberg Limits | ASTM D4318 | |
| | Standard Proctor | ASTM D698 | |
| Protective Soil/Drainage Sand | Sieve Analysis | ASTM D422 | 1 test per source or change in material sample compacted to 90% Standard Proctor in lab |
| | Hydraulic Conductivity | ASTM D2434 | |
| Groundwater Collection System Gravel | Sieve Analysis | ASTM D422 | 1 test per source or change in material |
| Groundwater Collection System Gravel | Sieve Analysis | ASTM D422 | 1 test per source or change in material |
| Topsoil | Soil Classification | ASTM D2487 | 1 test per source or change in material |
| | Organic Content | ASTM D2974 | |

**TABLE 02220-2 TESTING DURING PLACMENT**

| MATERIAL | TEST | ASTM NO. | FREQUENCY | VALUE |
|---|---|---|---|---|
| In-place Density Testing (Subgrade) | Density | ASTM D2937 | 2/acre | 90% of Standard Proctor |
| In-place Density Testing (General Fill and Structural Fill) | Density | ASTM D2937 | 2/acre/lift | 95% of Standard Proctor |
| General Fill | Natural Moisture Content | ASTM D2216 | 1/5,000 CY | |
| | Standard Proctor | ASTM D698 | | Five Point Test |
| | Soil Classification | ASTM D2487 | | See 02220-2.02.C |
| | Sieve Analysis | ASTM D422 | | |
| | Atterberg Limits | ASTM D4318 | | |
| Structural Fill | Natural Moisture Content | ASTM D2216 | 1/5,000 CY | |
| | Standard Proctor | ASTM D698 | | Five Point Test |
| | Soil Classification | ASTM D2487 | | See 02220-2.03.B |
| | Sieve Analysis | ASTM D422 | | |
| | Atterberg Limits | ASTM D4318 | | |
| Protective Soil/Drainage Sand | Sieve Analysis | ASTM D422 | 1/5,000 CY | See 02220-2.04.C |
| | Hydraulic Conductivity (@90% Std Proctor) | ASTM D2434 | | $1.0 \times 10^{-3}$ cm/sec |
| Groundwater Collection System Gravel | Sieve Analysis | ASTM D422 | 1/5,000 CY | No. 4 or 57 |
| Groundwater Collection System Gravel | Sieve Analysis | ASTM D422 | 1/5,000 CY | No. 4 or 57 |
| Topsoil | Organic Content | ASTM D2974 | 1 test per source or change in material | 2 to 10 percent |

**END OF SECTION**

**SECTION 02776**

**HIGH DENSITY POLYETHYLENE (HDPE)
GEOMEMBRANE LINER**

## PART 1 - GENERAL

### 1.01 DESCRIPTION

A. The work specified in this Section includes manufacture, handling, transportation, storage and all equipment and labor necessary for installing, seaming, repairing, and testing 60 mil textured High Density Polyethylene (HDPE) geomembrane as as shown on the Drawings and as specified herein.

B. The WORK specified in this Section includes manufacturing and installing the 60 mil textured HDPE geomembrane liner system as part of the project as shown on the Contract Drawings and described in the Specifications.

C. All materials shall conform to the following requirements and shall be of new stock of the highest grade available, free from defects, and recently manufactured.

D. All installation shall be in conformance with the MANUFACTURER'S recommendations and with current industry standards.

### 1.02 CONSTRUCTION QUALITY CONTROL/QUALITY ASSURANCE

A. Construction Quality Control (CQC) shall be performed by the geomembrane INSTALLER. The INSTALLER'S responsibilities shall include, but are not limited to the following:

1. Supervise all geomembrane installation activities.

2. Perform and document CQC testing as specified herein.

3. Certify geomembrane materials and installation as meeting requirements of the Contract Documents and Specifications.

B. Construction Quality Assurance (CQA) will be performed by a designated CQA CONSULTANT and QA TESTING LABORATORY retained by the OWNER.

C. The CQA CONSULTANT or OWNER'S REPRESENTATIVE shall obtain samples and perform conformance testing of the geomembrane as indicated in Section 2.02 of this Section.

D. The CQA CONSULTANT, or his CQA REPRESENTATIVE, shall observe and monitor the geomembrane installation activities and obtain and perform CQA testing at random frequencies and locations.

E. The CQA CONSULTANT shall submit a final report, signed and sealed by a professional engineer licensed in the State of Florida, certifying the test results.

F. Based upon review of the CQC and CQA final reports, the CQA CONSULTANT will provide certification to the regulatory agencies that the geomembrane was installed in accordance with the Contract Documents.

G. The CONTRACTOR shall schedule WORK to provide sufficient time as required to complete CQC and CQA field testing and documentation prior to placing any overlying layers above the geomembrane and shall keep the CQA CONSULTANT'S QA TESTING LABORATORY informed of the construction progress to provide sufficient time for laboratory testing.

## 1.03 DEFINITIONS

A. Lot - A quantity of resin (usually the capacity of one rail car) used in the manufacture of geomembranes. Finished roll will be identified by a roll number traceable to the resin lot used.

B. Construction Quality Assurance Consultant (CQA CONSULTANT) - Party, independent from the MANUFACTURER and INSTALLER that is responsible for observing and documenting activities related to quality assurance during the lining system construction.

C. ENGINEER - The person, firm or corporation named as such in the Agreement.

D. Geomembrane Manufacturer (MANUFACTURER) - The party responsible for manufacturing the geomembrane rolls.

E. Geosynthetic Quality Assurance Laboratory (QA TESTING LABORATORY) - Party, independent from the CONTRACTOR~~OWNER~~, MANUFACTURER and INSTALLER, responsible for conducting laboratory tests on samples of geosynthetics obtained during manufacturing, usually under the direction of the OWNER and CQA CONSULTANT.

F. INSTALLER - Party responsible for field handling, storing, deploying, seaming and testing of the geomembrane seams.

G. Panel - Unit area of a geomembrane that will be seamed in the field that is larger than 100 $ft^2$.

H. Patch - Unit area of a geomembrane that will be seamed in the field that is less than 100 $ft^2$.

## 1.04 QUALIFICATIONS

A. For general information purposes only, Geomembrane MANUFACTURER'S are the following or an ENGINEER approved equal:

1. GSE Lining Technology, Inc.
2. Poly-Flex, Inc.
3. Agru/America, Inc.

B. MANUFACTURER Qualifications - A qualified MANUFACTURER shall be a company, corporation, or firm regularly engaged in the development and manufacture of geomembranes with a history of successful production of geomembrane for a minimum period of 5 years. The geomembrane rolls shall be manufactured by a single MANUFACTURER. A company other than manufacturer may supply the geomembrane, however, the MANUFACTURER of the geomembrane shall be required to submit and meet the requirements stated in this Section. The MANUFACTURER shall submit written information on the following:

1. Information on plant size (square feet of geomembrane produced daily), number of shifts, and capacity of each shift.
2. Daily production quantity shall be sufficient to meet the demands of the schedule for this WORK.
3. Quality Control program manual of descriptive documentation for production. The manual shall define sampling procedures, test frequencies and methods. The MANUFACTURER shall, at a minimum, comply with the Quality Control Specifications for this WORK.
4. A statement from the MANUFACTURER stating the Manufacturing Quality Control measures specified for this WORK will be followed and the manufactured geomembrane products will meet or exceed the product Specifications for this WORK.
5. Verification that the MANUFACTURER has successfully supplied geomembrane for a minimum of 6 projects in the United States, during the last 5 years, of similar size and scope totaling to a minimum of 10 million square feet of installed geomembrane. Projects shall be considered similar only if the Manufacturer had total manufacturing responsibility for

geomembrane production and the installed geomembrane has successfully fulfilled its primary function for a minimum of 2 years. The Manufacturer shall submit written information as follows:

a. Name and location of project and date of installation.

b. Contact name and phone number for each project.

b. Geomembrane thickness and surface area of geomembrane installed.

C. Fabricator Qualifications: Qualified Fabricator shall be a company, corporation, or firm regularly engaged in the seaming and fabrication of geomembrane products, under factory-controlled conditions, for the installation of geomembrane under field conditions. The Fabricator usually seams together combinations of smaller rolls of geomembrane into larger factory panels for deployment in the field. The geomembrane shall be fabricated by a single Fabricator. The Fabricator shall submit written information on the following:

1. Information on plant size (square feet of geomembrane fabricated daily), number of shifts, and capacity of each shift.

2. Daily production quantity shall be sufficient to meet the demands of the schedule for this WORK.

3. Quality Control procedures (manual) for fabrication. The manual shall define sampling procedures, test frequencies and methods. The Fabricator shall, at a minimum, comply with the quality control specification for this WORK.

4. A statement from the Fabricator stating the fabrication quality control measures specified for this WORK will be followed and the fabricated geomembrane products will meet or exceed the product specifications for this WORK.

5. The Fabricator shall have successfully fabricated geomembrane products for at least 6 projects, during the last 5 years, of similar size and function totaling a minimum of 10 million square feet of installed geomembrane. Projects shall be considered similar only if the Fabricator had total fabrication responsibility for geomembrane production and the installed geomembrane has successfully fulfilled its primary function for a minimum of 2 years. The Fabricator shall submit written information as follows:

a. Name and location of project and date of installation.

b. Contact name and phone number for each project.

c. Geomembrane thickness and surface area geomembrane installed.

D. INSTALLER Qualifications - A qualified INSTALLER shall be a company, corporation, or a single INSTALLER. The INSTALLER shall submit written information on the following:

1. INSTALLER shall have installed a minimum of 10,000,000 square feet of HDPE geomembrane during the last 5 years or otherwise demonstrate they are qualified to perform the WORK.

2. INSTALLER shall have worked in a similar capacity on at least 6 projects similar in complexity to the project described in the Contract Documents.

3. The INSTALLER shall provide a minimum of one Field Installation Supervisor for WORK on the project.

   a. The Field Installation Supervisor qualifications to be assigned to this WORK shall have directly supervised the installation of a minimum of 2,000,000 square feet of geomembrane. No geomembrane shall be installed without the presence of the Field Installation Supervisor.

4. The INSTALLER shall provide a minimum of one Master Seamer for work on the project.

   a. All personnel performing seaming operations shall be qualified by experience or by successfully passing seaming tests. At least one seamer shall have experience seaming a minimum of 1,000,000 linear feet of geomembrane seams using the same type of seaming apparatus to be used for this WORK. No seaming shall be carried out without the presence of the master seamer within the immediate vicinity.

5. Installation quality control testing personnel in the field shall have a minimum of 400,000 square feet of geomembrane quality control testing. Only the actual square footage that the personnel have directly performed quality control testing on shall be counted as fulfillment of the minimum square footage.

6. Quality Assurance/Quality Control Field Program - The INSTALLER shall, at a minimum, comply with the Specifications for this WORK. The QA/QC Field Program shall provide for recording all inspection and testing of all WORK items to ensure conformance to the applicable

Contract Documents and Specifications with respect to materials, workmanship, construction, functional performance and identification. If differences exist between the INSTALLER'S Quality Control procedures and the Quality Control procedures specified by the ENGINEER or CQA CONSULTANT the procedures specified for the WORK shall govern installation. The QA/QC Field Program shall be subject to approval by the ENGINEER and include:

a. Storage and Handling (equipment).

b. Panel Identification.

c. Panel Inspection.

d. Panel Layout Drawings/Shop Drawings.

e. Seam Identification.

f. Seaming Process and Equipment.

g. Seaming Inspection.

h. Non-Destructive Tests (Seams, Repairs, Geomembrane Boots).

i. Destructive Tests.

j. Laboratory Tests.

k. Methods for Testing and Calibration of Field Testing Equipment.

l. Corrective Actions (i.e., addition of geomembrane, reduction of geomembrane, topography changes).

m. Procedures for Development of Record Drawings.

n. Weather Contingencies.

o. Record Keeping.

7. A statement from the INSTALLER stating the installation Quality Control measures specified for this WORK will be followed and the installed geomembrane products will meet or exceed the product Specifications for this WORK.

## 1.05 SUBMITTALS

A. The CONTRACTOR shall submit in writing to the ENGINEER, for approval, prior to delivery of the geomembrane to the site and prior to installation of the geomembrane material documentation on the following:

1. MANUFACTURER'S Qualification.

2. Fabricator's Qualification (If a Fabricator is used).

3. INSTALLER'S Qualification.

4. Materials warranty.

5. Geomembrane Resin information and MANUFACTURER Quality Control Certificates.

6. Geomembrane MANUFACTURER material properties sheet, including at a minimum all properties specified in GRI GM13, including test methods used and Quality Control Certificates.

7. Fabricator's Quality Control Certificates & Material Certification (if used).

8. Geomembrane Accessories.

9. Extrudate rod resin information.

10. Recommended loading, unloading, and handling equipment (include model number or load capacity).

11. A list indicating correlation between the MANUFACTURER Quality Control Certificates and individual geomembrane rolls.

12. The date of shipment of geomembrane from the MANUFACTURER. A minimum of 14 days shall be given to the ENGINEER so as to provide sufficient time to perform conformance sampling and receive laboratory test results prior to shipment.

13. Direct Shear Test (Interface Shear Resistance): Direct Shear Test Results tests demonstrating compliance with Part 2.01.D.

14. Direct Shear Test Results (interface): Direct Shear Test Results tests demonstrating compliance with Part 2.01~~2~~.E.

B. Installation Plan: The INSTALLER shall furnish the following information to the ENGINEER and OWNER prior to installation:

1. Installation layout drawing drawn to scale.

   a. Must show proposed geomembrane panel layout including field seams and details, panel location, orientation, identification, and installed square footage of geomembrane.

   b. Must be approved prior to installing the geomembrane.

      1) Approved drawings will be for concept only and actual panel placement will be determined by site conditions.

2. INSTALLER'S Geosynthetic Field Installation Quality Assurance Plan.

3. Description of welding equipment, techniques, and materials.

4. Complete set of forms used to record installation QA\QC data.

5. Resumes of key geomembrane installation personnel. (The Field Installation Supervisor, Master Seamer, and quality control personnel shall be clearly identified).

6. Non-destructive test methods for geomembrane seams and repairs.

7. Warranty (Workmanship).

C. Resin - MANUFACTURER Quality Control Certificate, written on the MANUFACTURER'S company letterhead, shall be provided for the raw resin material used to produce each roll of geomembrane. The frequency of the testing of the resin batches shall be per MANUFACTURER'S Quality Control Plan but shall not be less than 1 test per resin lot. A resin lot is defined as 180,000 pounds or less of raw resin material. Resin shall meet the following minimum requirements:

| PROPERTY | TEST METHOD | VALUE |
|---|---|---|
| Density (g/cm$^3$) | ASTM D1505 | 0.932 to 0.950 |
| Melt Flow Index (g/10 min.) | ASTM D1238 | ≤ 1.0 |

Any geomembrane manufactured from resin not meeting the WORK Specifications shall be rejected and shall not be delivered to the project.

D. Sheet - MANUFACTURER Quality Control Certificate, written on the MANUFACTURER'S company letterhead, shall be provided for each roll of geomembrane, including roll identification number, and the results (listed individually) of quality assurance/quality control testing performed by the Manufacturer. A lot is defined as a group of consecutively numbered rolls manufactured from the same resin batch or production line. At a minimum, the following tests shall be performed at a frequency of one test per 50,000 square feet of material per lot. Testing procedures and results shall conform to Table 02776-1 of this Section.

1. Statement certifying no recycled polymer and no more than 10% rework of the same type of material is added to the resin (product run may be recycled).

| TEST | PROCEDURE |
|---|---|
| Density | ASTM D1505 |
| Thickness | ASTM D5994 |
| Tensile Property (each direction) | ASTM D638 |
| Yield Stress | ASTM D638 |
| Yield Elongation | ASTM D638 |
| Break Stress | ASTM D638 |
| Break Elongation | ASTM D638 |
| Carbon Black Content | ASTM D1603 |
| Carbon Black Dispersion[1] | ASTM D5596 |

Note 1 - Carbon black dispersion for 10 different views: all 10 in categories 1, 2.

E. The INSTALLER will submit the following to the ENGINEER upon completion of geomembrane installation:

1. Certificate stating the geomembrane has been installed in accordance with the Contract Documents.

2. Material and installation warranties.

3. Record Drawings: The CONTRACTOR shall submit a panel layout drawing reflecting as-built conditions and related installation details (i.e., panel layout, penetrations, boots, connections, seam type) of the actual geomembrane lining system. The panel layout record drawings shall:

   a. Be at the same scale as the Contract Drawings, and use applicable drafting standards including a border identifying the INSTALLER, OWNER, project name and drawing name.

   b. Indicate the installed field panel and seam numbering, configuration and dimensions, geomembrane penetrations, and berms. The CQC CONSULTANT shall correlate the identification numbers for each roll of material to the installation field panel.

   c. Include the installed area, in square feet, of installed geomembrane.

d. Include the locations of destructive samples and repairs with the correct corresponding sample number.

F. Prior to geomembrane installation, the CONTRACTOR shall supply the ENGINEER with survey data that clearly indicates the grades and elevation meet the Contract Documents and Specifications.

G. Upon completion of the subbase construction, prior to deploying the geomembrane, a "Certificate of Subbase Acceptance" shall be co-signed by the CONTRACTOR along with the INSTALLER prior to the installation of the 60 mil textured HDPE geomembrane certifying the Subbase was constructed in accordance with the approved Contract Documents and Specifications.

H. If the INSTALLER proposes to conduct seaming operations outside of the approved conditions as specified herein (i.e., outside the weather parameters or night operations), written information and supporting data verifying seam quality can be maintained shall be submitted to the ENGINEER for review and approval. Alternate seaming operations will not be allowed without prior approval from the ENGINEER.

## 1.06 MATERIAL LABELING, DELIVERY, STORAGE AND HANDLING

A. Labeling - Each roll of geomembrane delivered to the site shall be labeled by the MANUFACTURER. The label will identify:

1. MANUFACTURER'S name
2. Product identification
3. Thickness
4. Length
5. Width
6. Roll number

B. Delivery - Rolls of liner will be prepared to ship by appropriate means to prevent damage to the material and to facilitate off-loading.

C. Storage - Storage requirements for the materials shall be specified by the MANUFACTURER and INSTALLER. At a minimum, the storage location for geomembrane material, provided by the OWNER to protect the geomembrane from punctures, abrasions and excessive dirt and moisture, shall have the following characteristics:

1. Rolls shall be fully supported on pallets or other devices to be prevented from contacting the ground.

2. Water shall be prevented from accumulating beneath the rolls.

3. Geomembrane rolls shall not be stacked upon one another to the extent that deformation of the core or flattening of the rolls occurs.

4. Outdoor storage should not be allowed to exceed six months.

5. Protected from theft and vandalism.

6. Adjacent to the area being lined.

D. Handling - Each roll of geomembrane delivered to the site shall inspected by the CONTRACTOR, at a minimum, as follows:

1. The CONTRACTOR shall provide transportation, labor, and handling for delivery of the geomembrane to and from the project site. Special transportation or handling requirements required for the geomembrane shall be provided by the CONTRACTOR.

2. The equipment for transportation, handling, loading and unloading the geomembrane shall be of sufficient size and capacity to safely and efficiently handle geomembrane materials without damage or personnel injury occurring. The type, size and capacity shall be according to the MANUFACTURER and INSTALLER requirements.

3. The CONTRACTOR shall provide all equipment and labor necessary for the loading, unloading, handling, and installation of the geomembrane.

4. Upon delivery to the project site, the geomembrane material shall be inspected by the CONTRACTOR to confirm that proper labeling, transportation, handling, and storage procedures are followed. Damaged materials will be identified and repaired or rejected at the discretion of the ENGINEER. Materials to be repaired as specified herein. Repairs will be at no additional cost to the OWNER. Rejected materials will be identified and removed from the project site at no additional cost to the OWNER.

5. Each roll shall be delivered to the site bearing markings which provide the roll number, thickness of the material, length and width of the material,

and the proper direction to unroll the material to facilitate layout and positioning in the field.

6. The materials shall be unloaded by the CONTRACTOR in areas designated by the OWNER. If the OWNER has not specified a storage area, the CONTRACTOR shall determine an area for storage of the materials to meet the WORK schedule requirements. In any case the materials shall not be stored or unloaded in areas that will impair the operations of the landfill facility or be deleterious to the materials.

7. Protection shall be provided, at a minimum, from puncture, cutting, ultraviolet radiation, precipitation, dirt or other damaging or deleterious conditions.

## 1.07 MATERIAL AND INSTALLATION WARRANTY

A. Material shall be warranted, on a pro-rata basis against MANUFACTURER'S defects for a period of 5 years from the date of final acceptance.

B. Installation shall be warranted against defects in workmanship for a period of two year from the date of final acceptance.

# PART 2 - PRODUCTS

## 2.01 GEOMEMBRANE

A. Material shall be 60 mil textured HDPE geomembrane as shown on the Contract Drawings and specified herein.

B. Geomembrane Rolls

1. Do not exceed a combined maximum total of 1 percent by weight of additives other than carbon black.

2. Geomembrane shall be free of holes, blisters, undispersed raw materials, nicks and cuts on roll edges or any sign of contamination by foreign matter. If pinholes are located, identified and indicated during manufacturing, these pinholes may be corrected during installation in accordance with the MANUFACTURER'S recommendations.

3. Geomembrane material is to be supplied in roll form. Each roll is to be identified with labels indicating the information provided in Section 1.06.A.

4. The 60 mil textured HDPE geomembrane shall conform to the physical properties requirements, at a minimum, as shown in Table 02776-1 or the most current GRI standard for this product. Values presented in Table 02776-1 are based upon standard GRI GM13 established by the Geosynthetics Research Institute (GRI) for HDPE.

5. The geomembrane shall be packaged and shipped by the MANUFACTURER in a manner to protect the integrity of the geomembrane from damage.

C. Extrudate Rod or Bead

1. Extrudate material shall be made from same type resin as the geomembrane.

2. Additives shall be thoroughly dispersed.

3. Materials shall be free of contamination by moisture or foreign matter.

D. Direct Shear Test (Interface Shear Resistance) - The CONTRACTOR will perform one Direct Shear Test in accordance with ASTM D5321 on representative samples of the bi-planar geocomposite and 60 mil textured HDPE geomembrane. The cost for shipping and testing the samples shall be included in the price of the materials. The following testing parameters will be followed for the Direct Shear Testing with the results submitted to the ENGINEER:

1. Testing to be conducted under fully saturated (water) conditions.

2. Three Normal Loads = 1,000, 2~~3~~,000, and 4~~6~~,000 psf.

3. Test Configuration: bi-planar geocomposite clamped to top box
textured geomembrane clamped to bottom box

4. Strain Rate = 0.040 in/min.

5. Continue testing to ensure a full 3 inches of displacement.

6. Plot and report (Peak and Residual values) for the best fit line through each of the three test results.

7. A minimum PEAK value of 0 psf adhesion and 20.5º for the interface friction angle is required for this project (based upon the best fit line).

8. Adhesion may be considered by the ENGINEER to determine equivalent stability for this project.

E. Direct Shear Test (Interface Shear Resistance) - The CONTRACTOR will perform one Direct Shear Test in accordance with ASTM D5321 on representative samples of the tri-planar geocomposite and 60 mil textured HDPE geomembrane. The cost for shipping and testing the samples shall be included in the price of the materials. The following testing parameters will be followed for the Direct Shear Testing with the results submitted to the ENGINEER:

1. Testing to be conducted under fully saturated (water) conditions.

2. Three Normal Loads = 1,000, 2~~3~~,000, and 4~~6~~,000 psf.

3. Test Configuration: tri-planar geocomposite clamped to top box
textured geomembrane clamped to bottom box

4. Strain Rate = 0.040 in/min.

5. Continue testing to ensure a full 3 inches of displacement.

6. Plot and report (Peak and Residual values) for the best fit line through each of the three test results.

7. A minimum PEAK value of 0 psf adhesion and 20.5º for the interface friction angle is required for this project (based upon the best fit line).

8. Adhesion may be considered by the ENGINEER to determine equivalent stability for this project.

F. Direct Shear Test (Interface Shear Resistance) - The CONTRACTOR will perform one Direct Shear Test in accordance with ASTM D5321 on representative samples of the 60 mil textured HDPE geomembrane and Geosynthetic Clay Liner (GCL). The cost for shipping and testing the samples shall be included in the price of the materials. The following testing parameters will be followed for the Direct Shear Testing with the results submitted to the ENGINEER:

1. Testing to be conducted under fully saturated (water) conditions.

2. Three Normal Loads = 1,000, 2,000, and 4,000 psf.

3. Test Configuration: textured geomembrane clamped to top box
GCL clamped to bottom box

4. Strain Rate = 0.040 in/min.

5. Continue testing to ensure a full 3 inches of displacement.

6. Plot and report (Peak and Residual values) for the best fit line through each of the three test results.

7. A minimum PEAK value of 0 psf adhesion and 20.5º for the interface friction angle is required for this project (based upon the best fit line). Adhesion may be considered by the ENGINEER to determine equivalent stability for this project.

G. Direct Shear Test (Interface Shear Resistance) - The CONTRACTOR will perform one Direct Shear Test in accordance with ASTM D5321 on representative samples of the 60 mil textured HDPE geomembrane and Subbase. The cost for shipping and testing the samples shall be included in the price of the materials. The following testing parameters will be followed for the Direct Shear Testing with the results submitted to the ENGINEER:

1. Testing to be conducted under fully saturated (water) conditions.

2. Three Normal Loads = 1,000, 2,000, and 4,000 psf.

3. Test Configuration: textured geomembrane clamped to top box<br>Subbase bottom box

4. Strain Rate = 0.040 in/min.

5. Continue testing to ensure a full 3 inches of displacement.

6. Plot and report (Peak and Residual values) for the best fit line through each of the three test results.

7. A minimum PEAK value of 0 psf adhesion and 20.5º for the interface friction angle is required for this project (based upon the best fit line). Adhesion may be considered by the ENGINEER to determine equivalent stability for this project.

## 2.02 CQA CONFORMANCE TESTING

A. In-Plant Conformance Sample Testing Services - The OWNER'S REPRESENTATIVE and CQA CONSULTANT have qualified personnel to collect conformance samples directly at the following facilities:

- GSE Lining Company- Houston, Texas
- AGRU America - Kingwood, Texas
- Poly-Flex, Inc. - Grand Prairie, Texas

1. Conformance sample(s) of the geomembrane will be collected by the OWNER'S REPRESENTATIVE or CQA CONSULTANT prior to shipment to the site.

2. Conformance sample(s) of the geomembrane will be tested by the CQA CONSULTANT prior to shipment to the site.

3. The CONTRACTOR shall coordinate with the MANUFACTURER, CQA CONSULTANT, and OWNER to schedule the date of delivery of the geomembrane to the site.

4. The CONTRACTOR shall inform, in writing, the CQA CONSULTANT and ENGINEER 14 days prior to the actual date of shipment from the MANUFACTURER. Geomembrane shall not be shipped prior to testing without OWNER'S approval.

5. Geomembrane products shipped to the site without prior sampling and approved conformance test results shall be sampled and tested upon delivery to the project site by the CQA CONSULTANT. All costs associated with collecting and shipping samples from the project site will be the CONTRACTOR'S responsibility. The CONTRACTOR shall allow a minimum of 7 days for sampling and testing approval of geomembrane materials upon delivery to the project site prior to installation.

6. Once sampled at the MANUFACTURER'S plant geomembrane products shall not be added or removed from the shipment. Upon addition or removal of products the following conditions shall prevail:

    a. Geomembrane products added shall be sampled for conformance testing at the CONTRACTOR'S expense.

    b. Individual geomembrane products removed from the shipment, which have been previously sampled or tested - Additional samples that have identical lot or batch numbers shall be sampled for conformance testing at the CONTRACTOR'S expense.

B. Conformance Sample Test Frequency (CQA) - The geomembrane shall be randomly sampled and tested by the OWNER'S REPRESENTATIVE or CQA CONSULTANT at a minimum of one sample per lotbut at a rate of not less than one sample every 100,000 square feet of installed material from consecutively numbered rolls, whichever is smaller. A lot is defined as a group of consecutively numbered rolls manufactured from the same resin batch or production line. The initial conformance testing shall be at the OWNER'S expense.

C. The initial conformance tests shall include the following:

| PROPERTY | TEST METHOD |
|---|---|
| Thickness | ASTM D5994 |
| Carbon Black Content | ASTM D1603 |
| Carbon Black Dispersion | ASTM D5596 |
| Density | ASTM D1505 or ASTM D792 |
| Tensile Properties (each direction) | ASTM D6693 Type IV |
| Geomembrane/Subbase Interface Friction Angle | ASTM D5321 |
| Geomembrane/GCL Interface Friction Angle | ASTM D5321 |
| Geomembrane/tri-planar Interface Interface Friction Angle | ASTM D5321 |
| Geomembrane/bi-planar Interface Friction Angle | ASTM D5321 |

Note: Required test results shall be in conformance with Table 02776-1.

D. Samples shall be taken across the entire width of the rolls and shall not include the first three feet if stored outside or damaged. The averaged test results of the geomembrane samples shall meet or exceed the Contract Documents and Specifications.

E. Samples that do not satisfy the Contract Documents and Specifications shall be cause to reject applicable rolls. If a geomembrane sample fails to meet Contract Documents and Specifications, subsequent tests shall be performed at random on additional geomembrane samples produced from the same resin batch to determine whether all rolls produced from the same batch shall be considered as unsatisfactory and therefore rejected. This additional testing, at no additional cost to the COUNTY, may be performed to more closely identify the rolls which do not comply with the specifications. Rejected rolls will not be installed and shall be removed from the project site at no additional cost to the OWNER.

F. The CQA CONSULTANT will conduct one test on the actual extrudate welding rod used in the field for seaming and repairing the geomembrane panels to verify the material is compatible with the geomembrane. The tests shall consist of the following:

| PROPERTY | TEST METHOD |
|---|---|
| Density | (ASTM D792 Method A or ASTM D1505) |
| Carbon Black Content | ASTM D1603 |

## PART 3 - EXECUTION

### 3.01 GEOMEMBRANE SUBBASE

A. Surface to be lined shall be smooth and tested in accordance with Section 02220 Excavation, Backfill, Fill, and Grading for Subbase Material. The area shall be free of all rocks (greater than ½- inch in any dimension), sticks (greater than ½-inch in diameter), roots, grass, refuse, sharp objects, or debris of any kind. The surface shall provide a firm, unyielding foundation for the geomembrane with no sudden, sharp, or abrupt changes or breaks in grade. No standing water or excessive moisture shall be allowed.

B. All areas that have been subject to erosion shall be repaired as required in Section 02220 Excavation, Backfill, Fill, and Grading. The repaired surface for geomembrane placement shall be even with no abrupt changes or breaks in grade. No standing water or excessive moisture shall be allowed.

## 3.02 EQUIPMENT

A. Welding equipment and accessories shall meet the following requirements:

1. Gauges showing temperatures in apparatus (extrusion welder) or wedge (wedge welder) shall be present.

2. An adequate number of welding apparati shall be available to avoid delaying WORK.

3. Power source must be capable of providing constant voltage under combined line load.

## 3.03 DEPLOYMENT

A. All activities by personnel and equipment in the vicinity of the geomembrane during and after geomembrane placement shall be monitored by the CONTRACTOR to insure that the geomembrane and geomembrane foundation are not damaged.

B. Assign each panel a simple and logical identifying code. The coding system shall be subject to approval and shall be determined at the job site.

C. Visually inspect the geomembrane during deployment for imperfections and mark faulty or suspect areas. Field panels shall not be placed if any of following conditions exists: inadequate geomembrane foundation, precipitation, presence of excessive moisture (i.e. fog, dew), ponded water, or presence of excessive winds.

D. Deployment of geomembrane panels shall be performed in a manner that will comply with the following guidelines:

1. Unroll geomembrane using methods that will not damage geomembrane and will protect underlying surface from damage (spreader bar, protected equipment bucket).

2. Place ballast (commonly sandbags) on geomembrane which will not damage geomembrane to prevent wind uplift. The CONTRACTOR shall have sufficient sand bags or other appropriate anchoring materials on site to secure the geomembrane. CONTRACTOR shall replace or repair all geomembrane damaged (as determined by the ENGINEER) by wind or insufficient anchoring at no additional cost to the OWNER.

3. Personnel walking on geomembrane shall not engage in activities or wear shoes that could damage it. Smoking will not be permitted on the geomembrane.

4. Do not allow heavy vehicular traffic directly on geomembrane. Rubber-tired ATV's and trucks are acceptable if wheel contact is less than 6 psi.

5. Protect geomembrane in areas of heavy traffic by placing protective cover over the geomembrane.

E. Sufficient material (slack) shall be provided to allow for thermal expansion and contraction of the material. The geomembrane shall be installed so as to conform to the contours and grade breaks. The geomembrane shall remain in contact with the underlying soils. Sand bags or excess material, placed during deployment, shall be used to prevent bridging due to temperature or installation procedures. Allowances for additional material due to temperature and installation procedures shall be included in the bid and at no additional cost to the OWNER.

F. "Fishmouths" or wrinkles at the seam overlaps shall be cut along the ridge of the wrinkle in order to achieve a flat overlap. The cut fishmouths or wrinkles shall be seamed and any portion where the overlap is inadequate shall then be patched with an oval or round patch of the same geomembrane extending a minimum of 6 inches beyond the cut in all directions.

G. If the INSTALLER proposes to conduct seaming operations outside of the approved conditions as specified herein (i.e., outside the weather parameters or night operations), written information and supporting data verifying seam quality can be maintained shall be submitted to the ENGINEER for review and approval 72 hours in advance. Alternate seaming operations will not be allowed without prior approval from the ENGINEER. If during the course of the WORK, the ENGINEER, CQA CONSULTANT, or OWNER decides the WORK is inadequate, the CONTRACTOR shall adjust operations as required or WORK shall ceased. Contract Documents and Specifications for placing and seaming the geomembrane shall apply to all WORK conditions.

## 3.04 FIELD SEAMING

A. Seams shall meet the following requirements:

1. To the maximum extent possible, orient seams parallel to line of slope, i.e., down and not across slope.

2. Minimize number of field seams in corners, odd-shaped geometric locations and outside corners.

3. Slope seams (panels) shall extend a minimum of five-feet beyond the grade break into the flat area.

4. Use a sequential seam numbering system compatible with panel numbering system that is agreeable to the CQA CONSULTANT and INSTALLER.

5. Align seam overlaps consistent with the requirements of the welding equipment being used. A 6 inch overlap is commonly suggested.

B. During welding operations provide at least one Master Seamer who shall provide direct supervision over other welders as necessary.

C. Extrusion Welding

1. Hot-air tack adjacent pieces together using procedures that do not damage the geomembrane.

2. Clean geomembrane surfaces by disc grinder or equivalent.

3. Purge welding apparatus of heat-degraded extrudate before welding.

D. Hot Wedge Welding

1. Welding apparatus shall be a self-propelled device equipped with an electronic controller which displays applicable temperatures.

2. Clean seam area of dust, mud, moisture and debris immediately ahead of hot wedge welder.

3. Protect against moisture build-up between sheets.

E. Trial Welds

1. Perform trial welds on geomembrane samples to verify welding equipment is operating properly.

2. Make trial welds under the same surface and environmental conditions as the production welds, i.e., in contact with subgrade and similar ambient temperature.

3. Minimum of two trial welds per day, per welding apparatus, one made prior to the start of work and one completed at mid shift.

4. Cut four, one inch wide by 6 inch long test strips from the trial weld.

5. Quantitatively test specimens for peel adhesion and then for shear strength.

6. Trial weld specimens shall pass when the minimum results, as indicated in Table 02776-2, are achieved in both peel and shear tests.

    a. The break, when peel testing, occurs in the liner material itself, not through peel separation (FTB).

    b. The break is ductile.

7. Repeat the trial weld, in its entirety, when any of the trial weld samples fail in either peel or shear.

8. No welding equipment or welder shall be allowed to perform production welds until equipment and welders have successfully completed trial weld.

B. Seaming shall not proceed when ambient air temperature or adverse weather conditions jeopardize the integrity of the liner installation. Immediately prior to seaming procedures, the seam area shall be completely free of moisture, dirt, or foreign material of any kind. INSTALLER shall demonstrate that acceptable seaming can be performed by completing acceptable trial welds.

F. Defects and Repairs

1. Examine all seams and non-seam areas of the geomembrane for defects, holes, blisters, undispersed raw materials, and any sign of contamination by foreign matter.

2. Repair and non-destructively test each suspect location in both seam and non-seam areas. Do not cover geomembrane at locations that have been repaired until test results with passing values are available.

## 3.05 FIELD QUALITY ASSURANCE

A. MANUFACTURER and INSTALLER shall participate in and conform to all terms and requirements of the OWNER'S CQA Plan. CONTRACTOR shall be responsible for assuring this participation.

B. Welding equipment shall be calibrated prior to each day's welding in accordance with the Installation Plan. The INSTALLER shall record all calibration data for inclusion in the final report. Additional test welds shall be performed for each welding machine every 4 hours, if welder is turned off, prior to starting work, after lunch, or as directed by the CQA CONSULTANT.

## 3.06 NON-DESTRUCTIVE TESTING

A. Non-destructive testing shall be carried out as the seaming progresses. All seams shall be non-destructively tested. Insufficient seams shall be labeled, recorded, repaired and re-tested.

1. Vacuum Box Testing - Shall be performed in accordance with ASTM D5641, Standard Practice for Geomembrane Seam Evaluation by Vacuum Chamber.

a. Shall be required for all extrusion welds, except for those welds inaccessible to the vacuum box, such as geomembrane boots. Air pressure gauges shall read 0 psi when testing apparatus is not turned on. Pressure gauges not reading 0 psi shall be replaced. Vacuum box apparatus shall be capable of sustaining a vacuum pressure 5 psi (gauge) for 10 seconds while placed on a seam. The following procedures shall be followed:

1) Energize the vacuum pump and reduce the tank pressure to approximately 10 inches of mercury, i.e., 5 psi gauge. All gauges shall read 0 psi when the vacuum pump is not turned on. Gauges not reading 0 psi shall be replaced.

2) Wet a strip of geomembrane approximately 4 inches by 24 inches with a soapy solution.

3) Place the box over the wetted soapy area.

4) Close the bleed valve and open the vacuum valve.

5) Ensure that a leak tight seal is created.

6) For a period of not less than 10 seconds, examine the geomembrane through the viewing window for the presence of soap bubbles, which would indicate defects in the geomembrane.

7) If no bubble appears after 10 seconds, close the vacuum valve and open the bleed valve, move the box over the next adjoining area with a minimum 3 inches overlap, and repeat the process.

8) All areas where soap bubbles appear shall be marked and repaired by extrusion weld or patching.

2. Air Pressure Testing - Shall be performed in accordance with ASTM D5820, Standard Practice for Pressurized Air Channel Evaluation of Dual Seamed Geomembranes.

a. Testing apparatus shall be capable of generating a minimum pressure of 25 psi. Air pressure gauges shall read 0 psi when testing apparatus is not turned on. Pressure gauges not reading 0 psi shall be replaced. The air channel shall be pressurized from 25 to 30 psi and allowed to stabilize. Once stabilized, the channel pressure shall be sustained for a minimum of 5 minutes. If loss of pressure is more than 2 psi, or the pressure does not stabilize, the seam shall be rejected, the faulty area located and repaired and the seam re-tested. The following procedures shall be followed:

1) Seal both ends of the seam to be tested.

2) Insert needle or other approved pressure feed device into the tunnel created by the fusion weld.

3) Insert a protective cushion between the air pump and the geomembrane.

4) Energize the air pump to a pressure between 25 and 30 psi, close valve, allow channel pressure to stabilize, and sustain channel pressure for approximately 5 minutes.

5) If loss of pressure is more than 2 psi or does not stabilize, locate faulty area and repair.

6) After a seam has passed a pressure test, release pressure at the end of seam that is opposite the air pump and pressure gauge assembly to ensure that the seam is continuous and has been completely tested.

B. The CQA CONSULTANT shall include all results from the destructive and non-destructive seam tests into the final report.

## 3.07 DESTRUCTIVE TESTING

A. Performed by the CQA CONSULTANT with assistance from the INSTALLER.

B. Location and Frequency of Testing

1. Installed geomembrane shall be tested at a rate of one test per 500 linear feet of welded seam at locations selected by the CQA CONSULTANT.

2. Test locations will be determined after seaming.

C. Sampling procedures are performed as follows:

1. INSTALLER shall cut samples at locations designated by the CQA CONSULTANT as the seaming progresses in order to obtain field laboratory test results before the geomembrane is covered.

2. CQA CONSULTANT will number each sample and the location will be noted on the installation as-built.

3. The CQC CONSULTANT shall remove the sample with the seam centered lengthwise, approximately 12 inches wide across the seam by 42 inches long, and test a portion of the geomembrane seam in accordance with the CQA Plan. The location shall be recorded, repaired and tested. The repair of the destructive seam samples shall be at no additional cost to the OWNER. The CQC CONSULTANT shall distribution as follows:

   a. A 12 inch by 14 inch portion to the CQA CONSULTANT for Third Party Laboratory Quality Assurance testing.

   b. A 12 inch by 14 inch portion shall be retained by the INSTALLER for field testing.

   c. A 12 inch by 14 inch portion to the OWNER for archive storage.

4. Testing performed on each sample shall include geomembrane peel adhesion and seam strength. Seam peel strength and shear strength shall meet the requirements specified in Table 02776-2.

**TABLE 2776-2 MINIMUM PEEL AND SHEAR SEAM STRENGTH VALUES**

| PROPERTY | TEST METHOD | VALUE |
|---|---|---|
| Peel | ASTM D6392 | |
| Wedge Weld (lb/in width) | | 98 |
| Extrusion Weld (lb/in width) | | 78 |
| Shear | ASTM D6392 | |
| Wedge Weld (lb/in width) | | 120 |
| Extrusion Weld (lb/in width) | | 120 |

5. Ten 1-inch wide strips shall be cut from the CQC CONSULTANT'S portion of the sample and these shall be tested in the field by the INSTALLER.

6. Field Testing - The ten 1-inch wide strips shall be tested by the CQC CONSULTANT in the field using a tensiometer, five for peel and five for shear, and shall meet the Specifications. If any field test sample fails to pass, then the procedures outlined in Section 3.07.C.(8) shall be followed.

7. Laboratory Testing - Testing by the CQA CONSULTANT will include Seam Strength and Peel Adhesion. A total of 5 specimens will be tested from each sample for each test method. All of the 5 specimens must pass the minimum pounds per inch value listed in Table 02776-2 and all specimens must separate by FTB failure for each test in order for the seam to pass destructive test sampling. The results will not be averaged. Specimens will be selected alternately, by test, from the samples (i.e., peel, shear, peel, shear). The CQA CONSULTANT will provide test results to the CONTRACTOR no more than 24 hours after the samples are received at the laboratory. The only exception shall be weekends or official holidays when the laboratories are closed. Arrangements to schedule testing of destructive samples on weekends and holidays shall be approved by the CQA CONSULTANT 24 hours in advance. Additional costs for lab work on holidays or weekends shall be at no additional expense to the OWNER and shall be paid by the CONTRACTOR.

8. Procedures for Destructive Test Failure - The following procedures shall apply whenever a sample fails the destructive test, whether the test is conducted by the CQA CONSULTANT'S laboratory or by field tensiometer. The geomembrane INSTALLER shall have two options, the cost of which shall be at no additional expense to the OWNER:

    a. The geomembrane INSTALLER can reconstruct the seam between any two passed test locations.

    b. The geomembrane INSTALLER can trace the welding path to an intermediate location at 10 feet, minimum, from the location of the failed test in each direction, and take a specimen for an additional field test at each location. If these additional specimens pass the test, then full laboratory destructive samples shall be taken. These additional tests shall be at the expense of the CONTRACTOR. If these laboratory samples pass the test, then the seam shall be reconstructed between these locations. If either sample fails, then the process shall be repeated to establish the zone in which the seam should be reconstructed. In any case, all acceptable seams must be bounded by two locations from which samples passing laboratory destructive tests have been taken. In cases exceeding 150 feet of reconstructed seam, a sample taken from within the reconstructed zone must pass destructive testing. Whenever a sample fails, additional testing may be required for seams that were welded by the same welder and/or welding apparatus or welded during the same time shift. Such additional testing shall be at the CONTRACTOR'S expense.

## 3.08 REPAIR PROCEDURES

A. All seams and non-seam areas of the geomembrane shall be inspected by the INSTALLER and CQA CONSULTANT for defects, holes, blisters, undispersed raw materials, and any sign of contamination by foreign matter. The surface of the geomembrane shall be clean at the time of inspection. The geomembrane surface shall be brushed, blown, or washed by the CONTRACTOR if the amount of dust, mud or debris inhibits inspection. The CQA CONSULTANT shall decide if cleaning of the geomembrane is needed to facilitate inspection. The INSTALLER shall be responsible for repair of defective areas at no additional expense to the OWNER.

B. Agreement upon the appropriate repair method shall be decided between CQA CONSULTANT and INSTALLER by using one of the following repair methods:

1. Patching - Patches shall be round or oval in shape made of the same geomembrane and extend a minimum of 6 inches beyond the edge of defects. All patches shall be of the same compound and thickness as the geomembrane specified. All patches shall have their top edge beveled with an angle grinder prior to placement on the geomembrane. Patches shall be applied using approved methods only.

2. Abrading and Re-welding - Used to repair short section of a seam.

3. Spot Welding - Used to repair pinholes or other minor, localized flaws or where geomembrane thickness has been reduced.

4. Capping - Used to repair long lengths of failed seams.

5. Remove the unacceptable seam and replace with new material.

C. The following procedures shall be observed when a repair method is used:

1. All geomembrane surfaces shall be clean and dry at the time of repair.

2. Surfaces of the polyethylene which are to be repaired by extrusion welds shall be lightly abraded to assure cleanliness.

3. Extend patches or caps at least 6 inches for extrusion welds and 4 inches for wedge welds beyond the edge of the defect, and around all corners of patch material.

D. Repair Verification

1. Each repair shall be non-destructively tested. In addition the CQA CONSULTANT may require a destructive seam sample be obtained from a repaired seam. Repairs that pass the non-destructive and/or destructive test shall be taken as an indication of an adequate repair. Failed tests indicate that the repair shall be repeated and retested until passing test results are achieved.

2. Number and log each patch repair (performed by CQA CONSULTANT).

## 3.09 ANCHOR TRENCH

A. The anchor trench shall be excavated prior to geomembrane installation. No loose soil, roots, rocks, or materials capable of damaging the geomembrane shall be allowed beneath the geomembrane. The anchor trench shall be backfilled and compacted as indicated on the Drawings, and in a manner that prevents any damage to the geomembrane. The geomembrane shall not have sharply folded corners when placed into the anchor trench. The geomembrane shall be welded the entire length of the panel, including through the entire dimension of the trench.

## 3.10 OVERLYING GEOCOMPOSITE

A. During placement of the geocomposite upon the geomembrane, precautions shall be taken to prevent damage to the geomembrane by restricting heavy equipment traffic. Unrolling the geocomposite can be accomplished through the use of lightweight, rubber-tired equipment such as a 4-wheel all-terrain vehicle (ATV). This vehicle can be driven directly on the geomembrane, provided the ATV makes no sudden stops, starts, or turns.

B. Geomembrane which is covered prior to approval by the CQA CONSULTANT shall be uncovered at no additional cost to the OWNER.

C. The CONTRACTOR shall schedule his work so as to permit as much time as needed for testing and CQC/CQA documentation before placing the overlying soil layer(s).

D. The CONTRACTOR shall place the overlying geocomposite layer immediately upon approval of the geomembrane by the CQA CONSULTANT to prevent damage, uplift, or degradation of the geomembrane.

## 3.11 SURVEY CONTROL STAKES

A. Survey stakes in the vicinity of the geomembrane shall be placed with care as not to penetrate the geomembrane liner. Plastic traffic cones, cardboard tubes or other items as approved by the ENGINEER may be used as survey control devices.

## 3.12 FINAL ACCEPTANCE

A. The CONTRACTOR shall retain ownership and responsibility for the installed geomembrane until final acceptance by the OWNER.

B. Final acceptance of the geomembrane by the OWNER will occur when:

1. All installation activities are completed.

2. All documentation of installation is completed and the INSTALLER'S final report is submitted to and accepted by the ENGINEER.

3. All documents presented in Section 1.06 have been submitted to the ENGINEER and approved.

## TABLE 02776-1 GEOMEMBRANE MATERIAL PROPERTIES
## HIGH DENSITY POLYETHYLENE (HDPE) GEOMEMBRANE
## 60-MIL TEXTURED

| PROPERTY | TEST METHOD | 60 mils | TEST FREQUENCY (minimum) |
|---|---|---|---|
| Thickness (min. avg.)<br>• lowest individual for 8 out of 10 values<br>• lowest individual for any of the 10 values | ASTM D5994 | nom. (-5%)<br>-10%<br>-15% | per roll |
| Asperity Height (min. avg.) *(1)* | ASTM D7466 | 10 mil | every 2nd roll *(1) (2)* |
| Density (min. avg.) | ASTM D1505/D792 | 0.939 g/cc | 1 per 50,000 $ft^2$ |
| Tensile Properties (min. avg.) *(3)*<br>• Yield Strength<br>• Break Strength<br>• Yield Elongation<br>• Break Elongation | ASTM D6693 Type IV | 126 lbs/in (min)<br>90 lbs/in (min)<br>12% (each)<br>100% (min) | 1 per 50,000 $ft^2$<br>1 per 50,000 $ft^2$<br>1 per 50,000 $ft^2$<br>1 per 50,000 $ft^2$ |
| Tear Resistance (min. avg.) | ASTM D1004 | 42 lb | 1 per 100,000 $ft^2$ |
| Puncture Resistance (min. avg.) | ASTM D4833 | 90 lb | 1 per 100,000 $ft^2$ |
| Stress Crack Resistance *(2)* | ASTM D5397 | 300 hour min. | per GRI GM10 |
| Carbon Black Content | ASTM D1603 *(5)* | 2.0 - 3.0% | 1 per 50,000 $ft^2$ |
| Carbon Black Dispersion | ASTM D5596 | Note *(6)* | 1 per 100,000 $ft^2$ |
| Oxidative Induction Time (OIT) (min. avg.)<br>(a) Standard OIT *(7)*<br>- or -<br>(b) High Pressure OIT | ASTM D3895<br><br>ASTM D5885 | 100 minutes min.<br><br>400 minutes min. | per each formulation |
| UV Resistance<br>(a) Standard OIT (min. avg.)<br>- or -<br>(b) High Pressure OIT (min. avg.) - % retained after 1600 hrs | ASTM D3895<br><br>ASTM D5885 | N.R.<br><br>35% | per each formulation |

Notes

*(1)* Report all 10 readings and an average reading for each side.

*(2)* Perform 10 readings on both sides of each roll if textured on both sides, one side if textured on one site.

*(3)* Machine direction (MD) and cross machine direction (XMD) average values should be on the basis of 5 test specimens each direction.
- Yeild elongation is calculated using a gauge length of 1.3 inches. Break elongation is calculated using a gage length of 2.0 in.

*(4)* The SP-NCTL test is not appropriate for testing geomembranes with textured or irregular rough surfaces. Test should be conducted on the smooth edges of textured rolls or on smooth sheets made from the same formulation as tht being used for the textured sheet.

*(5)* Other methods such as D 4218 (muffle furnace) or microwave methods are acceptable if an appropriate correlation to D1603 (tube furnace) can be established.

*(6)* Carbon black dispersion (only near spherical agglomerates) for 10 different views:
- Minimum of 9 in Categories 1 or 2, and 1 in Category 3.

*(7)* The manufacturer has the option to select either one of the OIT (ASTM D5885) per GRI GM13 requirments. It is also recommended to evaluate samples at 30 and 60 days to compare with the 90 day response.

## END OF SECTION

**SECTION 02930**

**TRI-PLANAR GEOCOMPOSITE**

## PART 1 - GENERAL

### 1.01 DESCRIPTION

A. The WORK specified in this Section includes the manufacture, fabrication, testing, and installation of geocomposite (i.e., composite geonet). The Contract Drawings call for a bi-planar geocomposite, which is a three-layer material, comprised of an inner core of high density polyethylene (HDPE) geonet between an upper and lower layer of geotextile. The geotextile is thermally fused to both sides of the geonet.

B. All testing specified in this Section is Quality Control (QC) testing and is the CONTRACTOR'S responsibility and all costs shall be included in the Bid Price. The OWNER is responsible for the Quality Assurance (QA) testing described in the FDEP approved CQA Plan.

C. All products or components of the geocomposite, used for construction shall be obtained from a single MANUFACTURER. Fusion of the geonet and geotextile, for each product, shall be completed by a single MANUFACTURER.

### 1.02 CONSTRUCTION QUALITY CONTROL/QUALITY ASSURANCE

A. Construction Quality Control (CQC) shall be performed by the geocomposite INSTALLER. The INSTALLER'S responsibilities shall include, but are not limited to the following:

1. Supervise all geocomposite installation activities.

2. Certify geocomposite materials and installation as meeting requirements of the Contract Documents.

B. Construction Quality Assurance (CQA) will be performed by a designated CQA CONSULTANT and QA TESTING LABORATORY retained by the OWNER.

C. The CQA CONSULTANT or OWNER'S REPRESENTATIVE shall obtain samples and perform conformance testing of the geocomposite as indicated in Section 3.02.C of this Section.

D. The CQA CONSULTANT, or his CQA REPRESENTATIVE, shall observe and monitor the geocomposite installation activities.

E. The CQA CONSULTANT shall submit a final report, signed and sealed by a professional engineer licensed in the State of Florida, certifying the test results.

F. Based upon review of the CQC and CQA final reports, the CQA CONSULTANT will provide certification to the regulatory agencies that the geocomposite was installed in accordance with the Contract Documents.

G. The CONTRACTOR shall schedule WORK to provide sufficient time as required to complete CQC and CQA field testing and documentation prior to placing any overlying layers above the geocomposite and shall keep the CQA CONSULTANT'S QA TESTING LABORATORY informed of the construction progress to provide sufficient time for laboratory testing.

## 1.03 SUBMITTALS

A. Data showing MANUFACTURER has a minimum of 5,000,000 $ft^2$ of experience.

B. Product Information: The CONTRACTOR shall submit to the ENGINEER for approval, in writing, 14 calendar days prior to installation the following information:

1. Prequalification: Submit independent laboratory test results demonstrating compliance with the material properties listed in Table 02930-1, Table 02930-2, and Table 02930-3. In addition, the MANUFACTURER must provide a certificate of compliance which states that the material to be installed will use the same manufacturing techniques, resin type, and formulation as that for which test results are submitted.

2. Transmissivity: Submit MANUFACTURER'S test data that indicates transmissivity values shown in Table 02930-3 can be met at 100 hours of testing.

3. Roll Layout Drawings: Submit at a minimum, a geocomposite roll layout drawing and installation details. The roll layout drawing shall be drawn to scale and shall be coordinated with the geomembrane panel layout. Installation details shall include cross sections, temporary anchorage, anchor trenches, and other terminations.

4. Protection from Wind and Weather: Submit methodology to protect each product from wind, dirt, and direct sunlight. At a minimum, the methodology shall reflect that materials shall be shipped and stored in rolls furnished at the manufacturing facility to prevent exposure of the geotextile to ultraviolet light, precipitation, moisture, mud, dirt, dust, puncture, or other damaging conditions.

5. Rolls of products shall not be stacked upon one another to the extent that deformation of the core occurs. If stored outdoors, they shall be elevated from the ground and protected with a waterproof cover. Outdoor storage should not be allowed to exceed 6 months. For storage for more than 6 months, a temporary enclosure shall be constructed so that the geocomposite rolls are stored inside an enclosed facility.

6. Material Data: Submit complete MANUFACTURER'S Specifications, descriptive drawings, and literature for each product, including the product identification and suppliers of the polymer resin and recommended method for handling and storage of all materials prior to installation. Describe the MANUFACTURER'S methodology to comply with the requirements specified for Manufacturing Quality Control.

7. Manufacturing Quality Control (MQC): Submit a complete description of the MANUFACTURER'S formal Quality Control/Quality Assurance Programs for manufacturing, fabricating, handling, installing, and testing. The description shall include, but not be limited to, polymer resin supplier and product identification, acceptance testing, production testing, installation inspection, installation techniques, repairs, and acceptance. The document shall include a complete description of methods for both roll end and roll side joining.

8. Installation Instructions: Submit samples of the product with a complete set of Specifications, and MANUFACTURER'S complete written instructions for storage, handling, installation and joining.

9. Qualifications: Submit MANUFACTURER'S qualifications for each product.

10. Geonet Resin: Submit the name of the HDPE resin supplier, the production plant, the brand name, and name of resin used to manufacture the product.

C. Manufacturing Quality Control (MQC): Submit the following Manufacturing Quality Control Information to the CQA CONSULTANT prior to material shipment:

1. Production Dates: Submit statement of production dates for each product.

2. Test Reports: See Part 3.01 of this Section for tests and test frequencies.

## PART 2 - PRODUCTS

### 2.01 GEONET

A. The geonet shall be manufactured by extruding two sets of strands to form a structure to provide planar water flow meeting the requirements listed in Table 02930-1.

B. The geonet shall consist of new, first-quality products designed and manufactured specifically for the intended purpose designated in this specification, as satisfactorily demonstrated by prior use. The geonet shall contain stabilizers to prevent ultraviolet light degradation. The HDPE shall be unmodified HDPE containing no plasticizer, fillers, chemical additives, reclaimed polymers, or extenders. Approximately 2 percent carbon black shall be added to the resin for ultraviolet resistance. The only other allowable compound elements shall be anti-oxidants and heat stabilizers, of which up to 1.5 percent total, as required for manufacturing, may be added.

### 2.02 GEOTEXTILE

A. The geotextile shall meet the requirements listed in Table 02930-2.

### 2.03 GEOCOMPOSITE

A. For general information purposes only, the geocomposite shall be the 300 mil Tendrain 770-2, as manufactured by TENAX Corporation, or an ENGINEER approved equal.

B. The final product material shall meet the requirements listed in Table 02930-3.

C. Manufacturer: The geocomposite shall be fabricated by heat bonding the geotextile to both sides of the geonet. No burn-through of geotextiles shall be permitted. No glue or adhesive shall be permitted. The bond between the geotextile and the geonet shall meet the requirements listed in Table 02930-3.

D. Labels: Geocomposite shall be supplied in rolls, marked or tagged with the following information:

1. MANUFACTURER'S name.

2. Product identification.

3. Lot number.

4. Roll number.

5. Roll dimensions.

E. Roll Dimensions: The geocomposite shall be supplied as a continuous sheet with no factory seams. During installation, the roll length shall be maximized to provide the largest manageable roll for the fewest field seams.

## PART 3 - EXECUTION

### 3.01 MANUFACTURING QUALITY CONTROL TESTING

A. All of the specified tests are the CONTRACTOR'S responsibility. Testing during manufacturing shall be accomplished by the MANUFACTURER'S laboratory.

B. HDPE resin shall be tested at a frequency of one test per resin batch for compliance with Table 02930-1. One batch is defined as one rail car load of resin. The finished rolls shall be identified by a roll number corresponding to the resin batch used. The following minimum test frequencies shall be observed:

| PROPERTY | TEST METHOD | MINIMUM FREQUENCY |
|---|---|---|
| Polymer Density | ASTM D1505 | 1 per batch |
| Polymer Melt Index | ASTM D1238 | 1 per batch |

C. The geonet shall be tested during manufacturing for compliance with Table 02930-1. The following minimum test frequencies shall be observed:

| PROPERTY | TEST METHOD | MINIMUM FREQUENCY |
|---|---|---|
| Polymer Density | ASTM D1505 | 1/100,000 sf |
| Mass per Unit Area | ASTM D3776 | 1/100,000 sf |
| Thickness | ASTM D1777 | 1/100,000 sf |

D. Geotextile shall be tested during manufacturing for compliance with Table 02930-2. The following minimum test frequencies shall be observed:

| PROPERTY | TEST METHOD | MINIMUM FREQUENCY |
|---|---|---|
| Flow Rate | ASTM D4491 | 1/100,000 sf |
| Mass per Unit Area | ASTM D5261 | 1/100,000 sf |
| AOS | ASTM D4751 | 1/100,000 sf |
| Grab Tensile | ASTM D4632 | 1/100,000 sf |
| Trapezoidal Tear Strength | ASTM D4533 | 1/100,000 sf |
| Puncture Resistance | ASTM D4833 | 1/100,000 sf |

E. Upon fusion of the geotextile and geonet, the product shall be tested during manufacturing for compliance with Table 02930-3. The following minimum test frequencies shall be observed:

| PROPERTY | TEST METHOD | MINIMUM FREQUENCY |
|---|---|---|
| Transmissivity | ASTM D4716 | 1/100,000 sf |
| Ply Adhesion (minimum) | ASTM D7005 | 1/100,000 sf |

F. The CONTRACTOR shall inspect every roll for bonding integrity between the geonet and the geotextile. All poorly bonded and/or delaminated material shall be rejected.

## 3.02 CQA CONFORMANCE TESTING

A. In-Plant Conformance Sample Testing Services - The OWNER'S REPRESENTATIVE and CQA CONSULTANT have qualified personnel to collect conformance samples directly.

1. Conformance sample(s) of the geocomposite will be collected by the OWNER'S REPRESENTATIVE or CQA CONSULTANT prior to shipment to the site.

2. Conformance sample(s) of the geocomposite will be tested by the CQA CONSULTANT prior to shipment to the site

3. The CONTRACTOR shall coordinate with the MANUFACTURER, CQA CONSULTANT, and OWNER to schedule the date of delivery of the geocomposite to the site.

4. The CONTRACTOR shall inform, in writing, the CQA CONSULTANT and ENGINEER 14 days prior to the actual date of shipment from the MANUFACTURER. Geocomposite shall not be shipped prior to testing without OWNER'S approval.

5. Geocomposite products shipped to the site without prior sampling and approved conformance test results shall be sampled and tested upon delivery to the project site by the CQA CONSULTANT. All costs associated with collecting and shipping samples from the project site will be the CONTRACTOR'S responsibility. The CONTRACTOR shall allow a minimum of 7 days for sampling and testing approval of geocomposite materials upon delivery to the project site prior to installation.

6. Once sampled at the MANUFACTURER'S plant geocomposite products shall not be added or removed from the shipment. Upon addition or removal of products the following conditions shall prevail:

a. Geocomposite products added shall be sampled for conformance testing at the CONTRACTOR'S expense.

b. Individual geocomposite products removed from the shipment, which have been previously sampled or tested - Additional samples that have identical lot or batch numbers shall be sampled for conformance testing at the CONTRACTOR'S expense.

B. Conformance Sample Test Frequency. The geocomposite shall be randomly sampled and tested by the OWNER'S REPRESENTATIVE or CQA CONSULTANT at a minimum of one sample per lot but at a rate of not less than one sample every 100,000 square feet of material from consecutively numbered rolls, whichever is smaller. A lot is defined as a group of consecutively numbered rolls manufactured from the same resin batch or production line. The initial conformance testing shall be at the OWNER'S expense.

C. The initial conformance tests shall include the following:

| PROPERTY | TEST METHOD |
|---|---|
| **GEONET** | |
| Thickness | ASTM D~~1777~~5199 |
| Tensile Strength | ASTM D~~5035~~7179 |
| Carbon Black | ASTM D~~4218~~1603 |
| Polymer Density | ASTM D1505 |
| **GEOTEXTILE** | |
| Fabric Weight | ASTM D5261 |
| Apparent Opening Size | ASTM D4751 |
| Puncture Resistance | ASTM D4833 |
| Flow Rate | ASTM D4491 |
| Grab Tensile/Elongation | ASTM D4632 |
| **GEOCOMPOSITE** | |
| ~~Thickness~~ | ~~ASTM D1777~~ |
| Ply Adhesion | ASTM D7005 |
| Transmissivity | ASTM D4716 |
| Interface Friction Angle for geocomposite/60 mil HDPE geomembrane | ASTM D5321 |

Note: Required test results shall be in conformance with Table 02930-1, Table 02930-2, and Table 02930-3.

D. Samples shall be taken across the entire width of the rolls and shall not include the first three feet if stored outside or damaged. The averaged test results of the geocomposite samples shall meet or exceed the Contract Documents and Specifications.

E. Samples that do not satisfy the Contract Documents and Specifications shall be cause to reject applicable rolls. If a geocomposite sample fails to meet Contract Documents and Specifications, subsequent tests shall be performed at random on additional geocomposite samples produced from the same resin batch to determine whether all rolls produced from the same batch shall be considered as unsatisfactory and therefore rejected. Rejected rolls will not be installed and shall be removed from the project site at no additional cost to the OWNER

## 3.03 FIELD QUALITY CONTROL

A. Field Joining: The CONTRACTOR shall inspect all roll end joints and roll side joints. The results of these inspections shall be documented in the daily reports. Field joints shall comply with the requirements of Table 02930-4.

B. Quality Control Reporting Procedures: All information regarding the installation of the geocomposite will be recorded in the CONTRACTOR'S daily report. This information shall include:

1. Reference to product submittals, certifications, substitutions and approvals.
2. Dates of installation.
3. Location and quantity of materials installed.
4. Statement of whether materials were installed in accordance with the Technical Specifications.
5. Additional information as required.
6. All product certifications, filed appropriately for future reference.

## 3.04 MANUFACTURER'S RECOMMENDATIONS

A. Each product shall be installed in accordance with the Contract Documents and Specifications and the MANUFACTURER'S recommendations. In case of a conflict between these documents, the more stringent requirements shall apply.

## 3.05 CLEANLINESS

A. The interface between the geocomposite and the geomembrane shall be clean, dry, and free of dirt and dust during installation. If dirt, dust, or water is present, the CONTRACTOR shall clean the work area. Products which are clogged with silts or other materials shall be discarded and shall not be installed.

## 3.06 ROLL JOINING METHODS

A. Table 02930-4 summarizes acceptable roll joining methods.

B. Lap Seams: The bottom layer of geotextile shall be lap seamed. Lap seaming is accomplished by overlapping adjacent geotextile a minimum of 6 inches.

C. Nylon Ties: The geonet shall be overlapped and fastened with nylon ties. Nylon ties shall be yellow or white in color to facilitate inspection.

D. Machine Sewn Seams: The top layer of geotextile shall be sewn. Sewing shall be accomplished with a lock-stitching sewing machine. The thread shall be polymeric thread which complies with MANUFACTURER'S recommendations. The seam shall be placed at a minimum of 4 inches from the geotextile edges. The finished seam shall be folded to one side.

## 3.07 ROLL JOINING REQUIREMENTS

A. The minimum requirements for joining rolls are specified in Table 02930-4.

B. Roll Ends: The end of each roll of geocomposite shall be overlapped a minimum of 6 inches. The geonet portion shall be shingled, with the uphill end overlapping the downhill end. The geonet portion shall be tied 2 feet on center at a minimum. The bottom layer of geotextile shall be overlapped a minimum of 6 inches. The upper layer of geotextile shall be machine sewn. Where the geocomposite is to terminate, the upper geotextile shall be folded over the ends with a minimum of 12 inches of geotextile placed under the geocomposite.

C. Adjacent Roll Sides: At roll sides, the material shall be overlapped a minimum of 4 inches. The bottom geotextile shall be overlapped. The geonet shall be overlapped and tied a minimum of 5 feet on center with nylon ties as described above. The upper layer of geotextile shall be machine sewn as described above.

## 3.08 INSTALLATION

A. The product shall be installed in accordance with the MANUFACTURER'S recommendations or as specified herein, whichever is more stringent.

B. Orientation:

1. Geocomposite shall be rolled down the slope in such a manner as to continually keep the material in tension. If necessary, the material shall be positioned by hand after unrolling to minimize wrinkles. The material shall not be unrolled laterally (i.e., across the slope).

C. The CONTRACTOR shall provide sufficient ballast and temporary anchorage to protect the product. The CONTRACTOR is responsible for protecting the product from damage due to weather at all times.

D. Physical Damage:

1. Personnel walking on the product shall not engage in activities or wear footwear that could damage the material. Smoking shall not be permitted on or near the geosynthetics.

2. Vehicular traffic shall not be permitted on the geosynthetics. Equipment shall not damage the material by handling, trafficking, or leakage of hydrocarbons. The surface shall not be used as a work area for preparing patches, storing tools and supplies, or other uses.

E. Bridging: The product shall be installed to avoid bridging.

F. Corners: In corners, where overlaps between rolls are staggered, an extra roll shall be installed from the top to the bottom of the slope.

G. Weather Protection: Each product shall be protected from direct sunlight or precipitation prior to installation. After installation this product shall not be exposed to direct sunlight and shall be covered within 30 days of installation. Product which is exposed to direct sunlight for 30 days or more shall be replaced at the CONTRACTOR'S expense.

H. If there are any obstructions (such as outlet pipes) while deploying the geocomposite, the geocomposite shall be cut to fit around the obstruction. Care should be taken as to make sure there is no gap between the obstruction and the geocomposite. The geocomposite should be cut in a way that the lower geotextile has an excess overhang. There must be enough of the upper geotextile to be able to tuck the upper geotextile back under the geocomposite to protect the exposed geonet core. This will prevent any soil particles from migrating into the geonet core flow channels.

I. It is the CONTRACTOR'S responsibility to provide all labor and materials for protection of the product during the period of time prior to installation of overlying soils. The CONTRACTOR'S protection method is subject to the approval of the ENGINEER.

## 3.09 REPAIRS

A. Limitations - In general, damaged, soiled, or delaminated products shall be discarded. Products which have major damage, which require extensive repairs or replacement, shall be discarded at the CONTRACTOR'S expense.

B. Minor Damage - Minor damage is defined as a hole 2 inches or smaller in diameter in the product. Minor damage shall be repaired by snipping out protruding geonet and machine sewing or thermal bonding a geotextile patch over the hole. The patch shall be a minimum of 12 inches larger than the damaged area in all directions. If thermal bonding is conducted, care shall be taken to prevent excessive heat damage to the surrounding geosythetics.

C. Major Damage - Major damage is defined as a hole larger than 2 inches in diameter through the product. Major damage shall be repaired by replacing the entire panel width.

## 3.10 PLACEMENT OF PROTECTIVE SOIL/DRAINAGE SAND SURFACE LAYER

A. Placement of Protective Soil/Drainage Sand Layer over the geocomposite and geomembrane by the CONTRACTOR shall be conducted in accordance with the requirements included in Section 02220 Excavation, Backfill, Fill, and Grading.

**TABLE 02930-1 GEONET PROPERTIES**

| PROPERTY | QUALIFIER | UNIT | TEST METHOD | SPECIFIED VALUE |
|---|---|---|---|---|
| Thickness (Note 1) | Minimum Average | mil | ASTM D~~1777~~5199 | 300 |
| Tensile Strength (machine direction) | Minimum Average | lbs/in | ASTM D~~5035~~7179 | 60 |
| Carbon Black | Range | percent | ASTM D1603 | 2-3 |
| Polymer Density, Resin | Minimum Average | $g/cm^3$ | ASTM D1505 | 0.940 |

Note: Specified geonet thickness is a minimum value; a geonet with a greater thickness may be required to meet the geocomposite Transmissivity requirement.

**TABLE 02930-2 GEOTEXTILE PROPERTIES**

| PROPERTY | QUALIFIER | UNIT | TEST METHOD | SPECIFIED VALUE |
|---|---|---|---|---|
| Fabric Weight | MARV | $oz/yd^2$ | ASTM D5261 | 6 |
| Grab ~~Strength~~ Tensile/Elongation | MARV | Lbs | ASTM D4632 | 157 |
| Puncture Resistance | MARV | Lbs | ASTM D4833 | 56 |
| Flow Rate | MARV | $gpm/ft^2$ | ASTM D4491 | 0.5 |
| AOS | MaxARV | sieve size (mm) | ASTM D4751 | #70 (0.212) |

**TABLE 02930-3 GEOCOMPOSITE PROPERTIES**

| PROPERTY | QUALIFIER | UNIT | TEST METHOD | SPECIFIED VALUE |
|---|---|---|---|---|
| Transmissivity (Note 1) | Minimum | $m^2$/sec | ASTM D4716 | $4.8 \times 10^{-3}$ |
| Ply Adhesion | Average | lbs/inch | ASTM D7005 | 1.0 |
| Coefficient of Interface Friction w/ Geomembrane (Note 2) | Minimum | degrees | ASTM D5321 | Peak 20.5$^{O}$ |

Notes:

1. Per ASTM D4716 with a normal stress of 4~~6~~,000 psf; water at 20$^{o}$C (68$^{o}$F); with a gradient of 0.02; testing configuration of geomembrane/geocomposite/geomembrane; and a test time period of 100 hours. Apply normal stress, under saturated conditions, for 1 hour minimum prior to start of test. Test data from the MANUFACTURER using the identical testing configuration and parameter shall indicate that transmissivity values when tested in excess of 100 hours do not fall below the minimum value of Table 02930-3. Report to provide hydraulic conductivity and transmissivity.

2. Interface Friction Angle (ASTM D5321), one representative test with the proposed geocomposite and the geomembrane material. The testing criteria are as follows. The direct shear box shall be a minimum of 12 inches by 12 inches. Each normal load shall be preload at the specified normal load, for a minimum of 1 hour, prior to testing to dissipate pore pressures. Fully saturate soil prior to testing for each normal load. The specified testing Normal Stresses are 1,000, 2~~3~~,000, and 4~~6~~,000 psf. The strain rate is 1 mm/min (0.04 in/min). The minimum PEAK interface friction angle shall be 20.5 degrees. The interface friction angle shall be the result of a linear regression line drawn continuously through the three shear strength results obtained for the normal loads specified following the procedures outlined in ASTM D5321. Provide the results of peak and residual values. Adhesion value may be considered in determining the effective interface friction angle.

**TABLE 02930-4 GEOCOMPOSITE JOINING METHODS**

| LOCATION | LAYER | JOINING METHOD | MIN. OVERLAP | TYING FREQUENCY |
|---|---|---|---|---|
| Roll End (See Note 1) | Upper geotextile | Machine sewing | 4" | N/A |
| | Geonet | Nylon ties | 6" | 2' on center |
| | Lower geotextile | overlap | 6" | N/A |

| | | | | |
|---|---|---|---|---|
| Roll Side | Upper geotextile | Machine sewing | 4" | N/A |
| | Geonet | Nylon ties | 4" | 5' on center |
| | Lower geotextile | overlap | 6" | N/A |
| Repair of minor damage (See Note 2) | Upper geotextile | Machine sewing/ thermal bonding | 12" | N/A |
| | Geonet | N/A | N/A | N/A |

Notes:

1. At termination of geocomposite fold over upper geotextile as defined in Part 3.07.B.

2. Minor damage is defined in Part 3.09.B.

**END OF SECTION**

## SECTION 02931

## BI-PLANAR GEOCOMPOSITE

### PART 1 - GENERAL

### 1.01 DESCRIPTION

A. The WORK specified in this Section includes the manufacture, fabrication, testing, and installation of geocomposite (i.e., composite geonet). The Contract Drawings call for a bi-planar geocomposite, which is a three-layer material, comprised of an inner core of high density polyethylene (HDPE) geonet between an upper and lower layer of non-woven geotextile. The geotextile is thermally fused to both sides of the geonet.

B. All testing specified in this Section is Quality Control (QC) testing and is the CONTRACTOR'S responsibility and all costs shall be included in the Bid Price. The OWNER is responsible for the Quality Assurance (QA) testing described in the FDEP approved CQA Plan.

C. All products or components of the geocomposite, used for construction shall be obtained from a single MANUFACTURER. Fusion of the geonet and geotextile, for each product, shall be completed by a single MANUFACTURER.

### 1.02 CONSTRUCTION QUALITY CONTROL/QUALITY ASSURANCE

A. Construction Quality Control (CQC) shall be performed by the geocomposite INSTALLER. The INSTALLER'S responsibilities shall include, but are not limited to the following:

1. Supervise all geocomposite installation activities.

2. Certify geocomposite materials and installation as meeting requirements of the Contract Documents.

B. Construction Quality Assurance (CQA) will be performed by a designated CQA CONSULTANT and QA TESTING LABORATORY retained by the OWNER.

C. The CQA CONSULTANT or OWNER'S REPRESENTATIVE shall obtain samples and perform conformance testing of the geocomposite as indicated in Section 3.02.C of this Section.

D. The CQA CONSULTANT, or his CQA REPRESENTATIVE, shall observe and monitor the geocomposite installation activities.

E. The CQA CONSULTANT shall submit a final report, signed and sealed by a professional engineer licensed in the State of Florida, certifying the test results.

F. Based upon review of the CQC and CQA final reports, the CQA CONSULTANT will provide certification to the regulatory agencies that the geocomposite was installed in accordance with the Contract Documents.

G. The CONTRACTOR shall schedule WORK to provide sufficient time as required to complete CQC and CQA field testing and documentation prior to placing any overlying layers above the geocomposite and shall keep the CQA CONSULTANT'S QA TESTING LABORATORY informed of the construction progress to provide sufficient time for laboratory testing.

## 1.03 SUBMITTALS

A. Data showing MANUFACTURER has a minimum of 5,000,000 $ft^2$ of experience.

B. Product Information: The CONTRACTOR shall submit to the ENGINEER for approval, in writing, 14 calendar days prior to installation the following information:

1. Prequalification: Submit independent laboratory test results demonstrating compliance with the material properties listed in Table 02931-1, Table 02931-2, and Table 02931-3. In addition, the MANUFACTURER must provide a certificate of compliance which states that the material to be installed will use the same manufacturing techniques, resin type, and formulation as that for which test results are submitted.

2. Transmissivity: Submit MANUFACTURER'S test data that indicates transmissivity values shown in Table 02931-3 can be met at 100 hours of testing.

3. Roll Layout Drawings: Submit at a minimum, a geocomposite roll layout drawing and installation details. The roll layout drawing shall be drawn to scale and shall be coordinated with the geomembrane panel layout. Installation details shall include cross sections, temporary anchorage, anchor trenches, and other terminations.

4. Protection from Wind and Weather: Submit methodology to protect each product from wind, dirt, and direct sunlight. At a minimum, the methodology shall reflect that materials shall be shipped and stored in rolls furnished at the manufacturing facility to prevent exposure of the geotextile to ultraviolet light, precipitation, moisture, mud, dirt, dust, puncture, or other damaging conditions.

5. Rolls of products shall not be stacked upon one another to the extent that deformation of the core occurs. If stored outdoors, they shall be elevated from the ground and protected with a waterproof cover. Outdoor storage should not be allowed to exceed 6 months. For storage for more than 6 months, a temporary enclosure shall be constructed so that the geocomposite rolls are stored inside an enclosed facility.

6. Material Data: Submit complete MANUFACTURER'S Specifications, descriptive drawings, and literature for each product, including the product identification and suppliers of the polymer resin and recommended method for handling and storage of all materials prior to installation. Describe the MANUFACTURER'S methodology to comply with the requirements specified for Manufacturing Quality Control.

7. Manufacturing Quality Control (MQC): Submit a complete description of the MANUFACTURER'S formal Quality Control/Quality Assurance Programs for manufacturing, fabricating, handling, installing, and testing. The description shall include, but not be limited to, polymer resin supplier and product identification, acceptance testing, production testing, installation inspection, installation techniques, repairs, and acceptance. The document shall include a complete description of methods for both roll end and roll side joining.

8. Installation Instructions: Submit samples of the product with a complete set of Specifications, and MANUFACTURER'S complete written instructions for storage, handling, installation and joining.

9. Qualifications: Submit MANUFACTURER'S qualifications for each product.

10. Geonet Resin: Submit the name of the HDPE resin supplier, the production plant, the brand name, and name of resin used to manufacture the product.

C. Manufacturing Quality Control (MQC): Submit the following Manufacturing Quality Control Information to the CQA CONSULTANT prior to material shipment:

1. Production Dates: Submit statement of production dates for each product.

2. Test Reports: See Part 3.01 of this Section for tests and test frequencies.

## PART 2 - PRODUCTS

### 2.01 GEONET

A. The geonet shall be manufactured by extruding two sets of strands to form a structure to provide planar water flow meeting the requirements listed in Table 02931-1.

B. The geonet shall consist of new, first-quality products designed and manufactured specifically for the intended purpose designated in this specification, as satisfactorily demonstrated by prior use. The geonet shall contain stabilizers to prevent ultraviolet light degradation. The HDPE shall be unmodified HDPE containing no plasticizer, fillers, chemical additives, reclaimed polymers, or extenders. Approximately 2 percent carbon black shall be added to the resin for ultraviolet resistance. The only other allowable compound elements shall be anti-oxidants and heat stabilizers, of which up to 1.5 percent total, as required for manufacturing, may be added.

### 2.02 GEOTEXTILE

A. The geotextile shall meet the requirements listed in Table 02931-2.

### 2.03 GEOCOMPOSITE

A. For general information purposes only, the geocomposite shall be the 300 mil GSE FabriNet UF as manufactured by GSE Lining Technology, Inc., or an ENGINEER approved equal.

B. The final product material shall meet the requirements listed in Table 02931-3.

C. Manufacturer: The geocomposite shall be fabricated by heat bonding the geotextile to both sides of the geonet. No burn-through of geotextiles shall be permitted. No glue or adhesive shall be permitted. The bond between the geotextile and the geonet shall meet the requirements listed in Table 02931-3.

D. Labels: Geocomposite shall be supplied in rolls, marked or tagged with the following information:

1. MANUFACTURER'S name.

2. Product identification.

3. Lot number.

4. Roll number.

5. Roll dimensions.

E. Roll Dimensions: The geocomposite shall be supplied as a continuous sheet with no factory seams. During installation, the roll length shall be maximized to provide the largest manageable roll for the fewest field seams.

## PART 3 - EXECUTION

## 3.01 MANUFACTURING QUALITY CONTROL TESTING

A. All of the specified tests are the CONTRACTOR'S responsibility. Testing during manufacturing shall be accomplished by the MANUFACTURER'S laboratory.

B. HDPE resin shall be tested at a frequency of one test per resin batch for compliance with Table 02931-1. One batch is defined as one rail car load of resin. The finished rolls shall be identified by a roll number corresponding to the resin batch used. The following minimum test frequencies shall be observed:

| PROPERTY | TEST METHOD | MINIMUM FREQUENCY |
|---|---|---|
| Polymer Density | ASTM D1505 | 1 per batch |
| Polymer Melt Index | ASTM D1238 | 1 per batch |

C. The geonet shall be tested during manufacturing for compliance with Table 02931-1. The following minimum test frequencies shall be observed:

| PROPERTY | TEST METHOD | MINIMUM FREQUENCY |
|---|---|---|
| Polymer Density | ASTM D1505 | 1/100,000 sf |
| Mass per Unit Area | ASTM D3776 | 1/100,000 sf |
| Thickness | ASTM D1777 | 1/100,000 sf |

D. Geotextile shall be tested during manufacturing for compliance with Table 02931-2. The following minimum test frequencies shall be observed:

| PROPERTY | TEST METHOD | MINIMUM FREQUENCY |
|---|---|---|
| Flow Rate | ASTM D4491 | 1/100,000 sf |
| Mass per Unit Area | ASTM D5261 | 1/100,000 sf |
| AOS | ASTM D4751 | 1/100,000 sf |
| Grab Tensile | ASTM D4632 | 1/100,000 sf |
| Trapezoidal Tear Strength | ASTM D4533 | 1/100,000 sf |
| Puncture Resistance | ASTM D4833 | 1/100,000 sf |

E. Upon fusion of the geotextile and geonet, the product shall be tested during manufacturing for compliance with Table 02931-3. The following minimum test frequencies shall be observed:

| PROPERTY | TEST METHOD | MINIMUM FREQUENCY |
|---|---|---|
| Transmissivity | ASTM D4716 | 1/100,000 sf |
| Ply Adhesion (minimum) | ASTM D7005 | 1/100,000 sf |

F. The CONTRACTOR shall inspect every roll for bonding integrity between the geonet and the geotextile. All poorly bonded and/or delaminated material shall be rejected.

## 3.02 CQA CONFORMANCE TESTING

A. In-Plant Conformance Sample Testing Services - The OWNER'S REPRESENTATIVE and CQA CONSULTANT have qualified personnel to collect conformance samples directly at the following facilities:

- GSE Lining Company- Houston, Texas
- AGRU America - Kingwood, Texas
- Poly-Flex, Inc. - Grand Prairie, Texas

1. Conformance sample(s) of the geocomposite will be collected by the OWNER'S REPRESENTATIVE or CQA CONSULTANT prior to shipment to the site.

2. Conformance sample(s) of the geocomposite will be tested by the CQA CONSULTANT prior to shipment to the site

3. The CONTRACTOR shall coordinate with the MANUFACTURER, CQA CONSULTANT, and OWNER to schedule the date of delivery of the geocomposite to the site.

4. The CONTRACTOR shall inform, in writing, the CQA CONSULTANT and ENGINEER 14 days prior to the actual date of shipment from the MANUFACTURER. Geocomposite shall not be shipped prior to testing without OWNER'S approval.

5. Geocomposite products shipped to the site without prior sampling and approved conformance test results shall be sampled and tested upon delivery to the project site by the CQA CONSULTANT. All costs associated with collecting and shipping samples from the project site will be the CONTRACTOR'S responsibility. The CONTRACTOR shall allow

a minimum of 7 days for sampling and testing approval of geocomposite materials upon delivery to the project site prior to installation.

6. Once sampled at the MANUFACTURER'S plant geocomposite products shall not be added or removed from the shipment. Upon addition or removal of products the following conditions shall prevail:

   a. Geocomposite products added shall be sampled for conformance testing at the CONTRACTOR'S expense.

   b. Individual geocomposite products removed from the shipment, which have been previously sampled or tested - Additional samples that have identical lot or batch numbers shall be sampled for conformance testing at the CONTRACTOR'S expense.

B. Conformance Sample Test Frequency. The geocomposite shall be randomly sampled and tested by the OWNER'S REPRESENTATIVE or CQA CONSULTANT at a minimum of one sample per lot but at a rate of not less than one sample every 100,000 square feet of material from consecutively numbered rolls, whichever is smaller. A lot is defined as a group of consecutively numbered rolls manufactured from the same resin batch or production line. The initial conformance testing shall be at the OWNER'S expense.

C. The initial conformance tests shall include the following:

| PROPERTY | TEST METHOD |
|---|---|
| **GEONET** | |
| Thickness | ASTM D~~1777~~5199 |
| Tensile Strength | ASTM D~~5035~~7179 |
| Carbon Black | ASTM D~~4218~~1603 |
| Polymer Density | ASTM D1505 |
| **GEOTEXTILE** | |
| Fabric Weight | ASTM D5261 |
| Apparent Opening Size | ASTM D4751 |
| Puncture Resistance | ASTM D4833 |
| Flow Rate | ASTM D4491 |
| Grab Tensile/Elongation | ASTM D4632 |
| **GEOCOMPOSITE** | |
| ~~Thickness~~ | ~~ASTM D1777~~ |
| Ply Adhesion | ASTM D7005 |
| Transmissivity | ASTM D4716 |
| Interface Friction Angle for Drainage sand/geocomposite | ASTM D5321 |
| Interface Friction Angle for | |

| | |
|---|---|
| geocomposite/60 mil HDPE geomembrane | ASTM D5321 |

Note: Required test results shall be in conformance with Table 02931-1, Table 02931-2, and Table 02931-3.

D. Samples shall be taken across the entire width of the rolls and shall not include the first three feet if stored outside or damaged. The averaged test results of the geocomposite samples shall meet or exceed the Contract Documents and Specifications.

E. Samples that do not satisfy the Contract Documents and Specifications shall be cause to reject applicable rolls. If a geocomposite sample fails to meet Contract Documents and Specifications, subsequent tests shall be performed at random on additional geocomposite samples produced from the same resin batch to determine whether all rolls produced from the same batch shall be considered as unsatisfactory and therefore rejected. Rejected rolls will not be installed and shall be removed from the project site at no additional cost to the OWNER

## 3.03 FIELD QUALITY CONTROL

A. Field Joining: The CONTRACTOR shall inspect all roll end joints and roll side joints. The results of these inspections shall be documented in the daily reports. Field joints shall comply with the requirements of Table 02931-4.

B. Quality Control Reporting Procedures: All information regarding the installation of the geocomposite will be recorded in the CONTRACTOR'S daily report. This information shall include:

1. Reference to product submittals, certifications, substitutions and approvals.

2. Dates of installation.

3. Location and quantity of materials installed.

4. Statement of whether materials were installed in accordance with the Technical Specifications.

5. Additional information as required.

6. All product certifications, filed appropriately for future reference.

## 3.04 MANUFACTURER'S RECOMMENDATIONS

A. Each product shall be installed in accordance with the Contract Documents and

Specifications and the MANUFACTURER'S recommendations. In case of a conflict between these documents, the more stringent requirements shall apply.

## 3.05 CLEANLINESS

A. The interface between the geocomposite and the geomembrane shall be clean, dry, and free of dirt and dust during installation. If dirt, dust, or water is present, the CONTRACTOR shall clean the work area. Products which are clogged with silts or other materials shall be discarded and shall not be installed.

## 3.06 ROLL JOINING METHODS

A. Table 02931-4 summarizes acceptable roll joining methods.

B. Lap Seams: The bottom layer of geotextile shall be lap seamed. Lap seaming is accomplished by overlapping adjacent geotextile a minimum of 6 inches.

C. Nylon Ties: The geonet shall be overlapped and fastened with nylon ties. Nylon ties shall be yellow or white in color to facilitate inspection.

D. Machine Sewn Seams: The top layer of geotextile shall be sewn. Sewing shall be accomplished with a lock-stitching sewing machine. The thread shall be polymeric thread which complies with MANUFACTURER'S recommendations. The seam shall be placed at a minimum of 4 inches from the geotextile edges. The finished seam shall be folded to one side.

## 3.07 ROLL JOINING REQUIREMENTS

A. The minimum requirements for joining rolls are specified in Table 02931-4.

B. Roll Ends: The end of each roll of geocomposite shall be overlapped a minimum of 6 inches. The geonet portion shall be shingled, with the uphill end overlapping the downhill end. The geonet portion shall be tied 2 feet on center at a minimum. The bottom layer of geotextile shall be overlapped a minimum of 6 inches. The upper layer of geotextile shall be machine sewn. Where the geocomposite is to terminate, the upper geotextile shall be folded over the ends with a minimum of 12 inches of geotextile placed under the geocomposite.

C. Adjacent Roll Sides: At roll sides, the material shall be overlapped a minimum of 4 inches. The bottom geotextile shall be overlapped. The geonet shall be overlapped and tied a minimum of 5 feet on center with nylon ties as described above. The upper layer of geotextile shall be machine sewn as described above.

## 3.08 INSTALLATION

A. The product shall be installed in accordance with the MANUFACTURER'S recommendations or as specified herein, whichever is more stringent.

B. Orientation:

1. Geocomposite shall be rolled down the slope in such a manner as to continually keep the material in tension. If necessary, the material shall be positioned by hand after unrolling to minimize wrinkles. The material shall not be unrolled laterally (i.e., across the slope).

C. The CONTRACTOR shall provide sufficient ballast and temporary anchorage to protect the product. The CONTRACTOR is responsible for protecting the product from damage due to weather at all times.

D. Physical Damage:

1. Personnel walking on the product shall not engage in activities or wear footwear that could damage the material. Smoking shall not be permitted on or near the geosynthetics.

2. Vehicular traffic shall not be permitted on the geosynthetics. Equipment shall not damage the material by handling, trafficking, or leakage of hydrocarbons. The surface shall not be used as a work area for preparing patches, storing tools and supplies, or other uses.

E. Bridging: The product shall be installed to avoid bridging.

F. Corners: In corners, where overlaps between rolls are staggered, an extra roll shall be installed from the top to the bottom of the slope.

G. Weather Protection: Each product shall be protected from direct sunlight or precipitation prior to installation. After installation this product shall not be exposed to direct sunlight and shall be covered within 30 days of installation. Product which is exposed to direct sunlight for 30 days or more shall be replaced at the CONTRACTOR'S expense.

H. If there are any obstructions (such as outlet pipes) while deploying the geocomposite, the geocomposite shall be cut to fit around the obstruction. Care should be taken as to make sure there is no gap between the obstruction and the geocomposite. The geocomposite should be cut in a way that the lower geotextile has an excess overhang. There must be enough of the upper geotextile to be able to tuck the upper geotextile back under the geocomposite to protect the exposed geonet core. This will prevent any soil particles from migrating into the geonet core flow channels.

I. It is the CONTRACTOR'S responsibility to provide all labor and materials for protection of the product during the period of time prior to installation of overlying soils. The CONTRACTOR'S protection method is subject to the approval of the ENGINEER.

## 3.09 REPAIRS

A. Limitations - In general, damaged, soiled, or delaminated products shall be discarded. Products which have major damage, which require extensive repairs or replacement, shall be discarded at the CONTRACTOR'S expense.

B. Minor Damage - Minor damage is defined as a hole 2 inches or smaller in diameter in the product. Minor damage shall be repaired by snipping out protruding geonet and machine sewing or thermal bonding a geotextile patch over the hole. The patch shall be a minimum of 12 inches larger than the damaged area in all directions. If thermal bonding is conducted, care shall be taken to prevent excessive heat damage to the surrounding geosythetics.

C. Major Damage - Major damage is defined as a hole larger than 2 inches in diameter through the product. Major damage shall be repaired by replacing the entire panel width.

## 3.10 PLACEMENT OF PROTECTIVE SOIL/DRAINAGE SAND SURFACE LAYER

A. Placement of Protective Soil/Drainage Sand Layer over the geocomposite and geomembrane by the CONTRACTOR shall be conducted in accordance with the requirements included in Section 02220 Excavation, Backfill, Fill, and Grading.

**TABLE 02931-1 GEONET PROPERTIES**

| PROPERTY | QUALIFIER | UNIT | TEST METHOD | SPECIFIED VALUE |
|---|---|---|---|---|
| Thickness (Note 1) | Minimum Average | mil | ASTM D~~1777~~5199 | 300 |
| Tensile Strength (machine direction) | Minimum Average | lbs/in | ASTM D~~5035~~7179 | 75 |
| Carbon Black | Range | percent | ASTM D1603 | 2-3 |
| Polymer Density, Resin | Minimum Average | $g/cm^3$ | ASTM D1505 | 0.940 |

Note: Specified geonet thickness is a minimum value; a geonet with a greater thickness may be required to meet the geocomposite Transmissivity requirement.

**TABLE 02931-2 GEOTEXTILE PROPERTIES**

| PROPERTY | QUALIFIER | UNIT | TEST METHOD | SPECIFIED VALUE |
|---|---|---|---|---|
| Fabric Weight | MARV | oz/yd$^2$ | ASTM D5261 | 8 |
| Grab ~~Strength~~ Tensile/Elongation | MARV | Lbs | ASTM D4632 | 220 |
| Puncture Resistance | MARV | Lbs | ASTM D4833 | 120 |
| Flow Rate | MARV | gpm/ft$^2$ | ASTM D4491 | 110 |
| AOS | MaxARV | sieve size (mm) | ASTM D4751 | #70 (0.210) |

**TABLE 02931-3 GEOCOMPOSITE PROPERTIES**

| PROPERTY | QUALIFIER | UNIT | TEST METHOD | SPECIFIED VALUE |
|---|---|---|---|---|
| Transmissivity (Note 1) | Minimum | m$^2$/sec | ASTM D4716 | 1.9x10$^{-3}$ |
| Ply Adhesion | Average | lbs/inch | ASTM D7005 | 1.0 |
| Coefficient of Interface Friction w/ Geomembrane (Note 2) | Minimum | degrees | ASTM D5321 | Peak 20.5$^O$ |
| Coefficient of Interface Friction w/ Drainage Sand (Note 3) | Minimum | degrees | ASTM D5321 | Peak 20.5$^O$ |

Notes:

1. Per ASTM D4716 with a normal stress of 4~~6~~,000 psf; water at 20°C (68°F); with a gradient of 0.02; testing configuration of Ottawa sand/geocomposite/geomembrane; and a test time period of 100 hours. Apply normal stress, under saturated conditions, for 1 hour minimum prior to start of test. Test data from the MANUFACTURER using the identical testing configuration and parameter shall indicate that transmissivity values when tested in excess of 100 hours do not fall below the minimum value of Table 02931-3. Report to provide hydraulic conductivity and transmissivity.

2. Interface Friction Angle (ASTM D5321), one representative test with the proposed geocomposite and the geomembrane material. The testing criteria are as follows. The direct shear box shall be a minimum of 12 inches by 12 inches. Each normal load shall be preload at the specified normal load, for a minimum of 1 hour, prior to testing to dissipate pore pressures. Fully saturate soil prior to testing for each normal load. The specified testing Normal Stresses are 1,000, 2~~3~~,000, and 4~~6~~,000 psf. The strain rate is 1 mm/min (0.04 in/min). The minimum PEAK interface friction angle shall be 20.5

degrees. The interface friction angle shall be the result of a linear regression line drawn continuously through the three shear strength results obtained for the normal loads specified following the procedures outlined in ASTM D5321. Provide the results of peak and residual values. Adhesion value may be considered in determining the effective interface friction angle.

3. Interface Friction Angle (ASTM D5321), one representative test with the proposed geocomposite and the drainage sand material. The testing criteria are as follows: The proposed protective soil material shall be prepared and molded to a minimum of 90% of the Standard Proctor (ASTM D698). The direct shear box shall be a minimum of 12 inches by 12 inches. Each normal load shall be preload at the specified normal load, for a minimum of 24 hours, prior to testing to dissipate pore pressures. Fully saturate soil prior to testing for each normal load. The specified testing Normal Stresses are 1,000, 2~~3~~,000, and 4~~6~~,000 psf. The strain rate is1 mm/min (0.04 in/min). The minimum PEAK interface friction angle shall be 20.5 degrees. The interface friction angle shall be the result of a linear regression line drawn continuously through the three shear strength results obtained for the normal loads specified following the procedures outlined in ASTM D5321. Provide the results of peak and residual values. Adhesion value may be considered in determining the effective interface friction angle.

**TABLE 02931-4 GEOCOMPOSITE JOINING METHODS**

| LOCATION | **LAYER** | **JOINING METHOD** | **MIN. OVERLAP** | **TYING FREQUENCY** |
|---|---|---|---|---|
| Roll End (See Note 1) | Upper geotextile | Machine sewing | 4" | N/A |
| | Geonet | Nylon ties | 6" | 2' on center |
| | Lower geotextile | overlap | 6" | N/A |
| Roll Side | Upper geotextile | Machine sewing | 4" | N/A |
| | Geonet | Nylon ties | 4" | 5' on center |
| | Lower geotextile | overlap | 6" | N/A |
| Repair of minor damage (See Note 2) | Upper geotextile | Machine sewing/ thermal bonding | 12" | N/A |
| | Geonet | N/A | N/A | N/A |

Notes:

1. At termination of geocomposite fold over upper geotextile as defined in Part 3.07.B.

2. Minor damage is defined in Part 3.09.B.

**END OF SECTION**

## SECTION 02940

## GEOTEXTILE

### PART 1 - GENERAL

### 1.01 SUMMARY

A. The WORK specified in this Section includes the manufacture, testing, and installation of woven geotextile for the Leachate Collection and Removal System and the extension to the existing Groundwater Dewatering System as shown on the Contract Drawings and as specified herein.

### 1.02 SUBMITTALS

A. Submit MANUFACTURER'S prequalification, test reports and data, specifications, installation instructions and roll dimensions.

B. Submit copies of evaluation reports provided by the MANUFACTURER demonstrating that properties for the materials comply with Specification requirements.

C. ENGINEER'S approval shall be obtained prior to the use of any materials in the project.

### PART 2 - PRODUCTS

### 2.01 GEOTEXTILE

A. Material shall be a woven monofilament geotextile equivalent to Filterweave 402 as manufactured by TenCate Mirafi, or ENGINEER approved substitution conforming to the following minimum properties:

| CHARACTERISTICS | SPECIFICATION | TEST METHOD |
|---|---|---|
| Mass/Unit Area | 5.6 oz/yd$^2$ | ASTM D5261 |
| Apparent Opening Size | #40 Sieve (0.425 mm) | ASTM D4751 |
| Flow Rate | 140 gal/min/ft$^2$ | ASTM D4491 |
| CBR Puncture Strength | 600 lbs/in | ASTM D6241 |
| Wide Width Tensile Strength (CD) | 135 lbs/in @ ultimate | ASTM D4595 |
| Grab Tensile Strength | 365 x 200 lbs | ASTM D4632 |
| Trapezoidal Tear Strength | 115 x 75 lbs/in | ASTM D4533 |

B. Geotextile shall be tested by the MANUFACTURER for the compliance with the following frequencies. Minimum test frequencies shall be observed:

| PROPERTY | TEST METHOD | MINIMUM FREQUENCY |
|---|---|---|
| Mass/Unit Area | ASTM D5261 | 1/100,000 sf |
| Apparent Opening Size | ASTM D4751 | 1/100,000 sf |
| Flow Rate | ASTM D4491 | 1/100,000 sf |
| CBR Puncture Strength | ASTM D6241 | 1/100,000 sf |
| Wide Width Tensile Strength (CD) | ASTM D4595 | 1/100,000 sf |
| Grab Tensile Strength | ASTM D4632 | 1/100,000 sf |
| Trapezoidal Tear Strength | ASTM D4533 | 1/100,000 sf |

## PART 3 - EXECUTION

### 3.01 SHIPPING AND HANDLING

A. The MANUFACTURER typically assumes responsibility for initial loading and shipping of geotextiles. Unloading, on-site handling, and storage shall be the responsibility of the CONTRACTOR.

B. A visual inspection of each roll should be made as it is unloaded to identify if any packaging has been damaged. Rolls with damaged packaging should be repaired prior to being placed in storage.

C. The CONTRACTOR shall contact the MANUFACTURER prior to shipment to ascertain the appropriateness of the proposed unloading methods and equipment to be utilized.

D. The CONTRACTOR assumes all liability with regards to shipping, transport and unloading of the geotextiles required to complete the WORK. The OWNER shall not be responsible for damaged, lost or mis-stocked shipments, or mishandled or damaged materials.

### 3.02 PROTECTION AND STORAGE

A. Each roll of material shall have a MANUFACTURER’S identification label. Each roll shall be labeled to provide product identification adequate for inventory and quality control purposes. The label shall provide as a minimum the MANUFACTURER’S name, product identification, lot number, roll number, and roll dimensions. Rolls shall be labeled as per ASTM D4873, Standard Guide for Identification, Storage, and Handling of Geosynthetic Rolls and Samples.

B. Materials shall be shipped and stored in rolls furnished at the manufacturing facility to prevent exposure of the geotextile to ultraviolet light, precipitation, moisture, mud, dirt, dust, puncture, or other damaging conditions.

C. Rolls of geotextiles should not be stacked upon one another to the extent that deformation of the core occurs. Outdoor storage shall not exceed 6 months.

D. Storage of the geotextile rolls shall be the responsibility of the CONTRACTOR. A dedicated storage area shall be selected at the site that is away from high traffic areas and is level, dry, and well-drained.

E. Rolls should be stored in a manner that prevents sliding or rolling from the stacks. This may be accomplished by the use of chock blocks or by use of the dunnage shipped between rolls. Rolls should be stacked at a height no greater than the lifting apparatus can be safely handled (typically no higher than four rolls).

F. All stored geotextiles must be covered with a plastic sheet or tarpaulin until their installation. Covering shall protect the geotextile from ultraviolet light exposure, precipitation, mud, dirt, puncture, cutting or any other damaging or deleterious conditions.

G. Geotextiles shall not be exposed to sunlight for more than 15 days unless otherwise specified and guaranteed by the geotextile manufacturer.

## 3.03 INSTALLATION

A. Geotextiles shall be installed in accordance with the MANUFACTURER'S recommendations. No equipment shall be allowed to operate on the geotextile, and any tears or damage to the geotextile shall be repaired prior to placement in the trench. The surface of the geotextile shall be kept relatively clean and free of debris during installation.

B. Geotextile shall not be placed in a trench that is excessively wet or has standing water.

C. Geotextile shall be overlapped in the trench as shown in the Contract Drawings. Overlapped material can be sewn to maintain overlap during backfilling operations.

D. Geotextile sheets shall be joined in accordance with the MANUFACTURER'S recommendations.

E. The CONTRACTOR shall place all cover materials in such a manner to prevent damage to the materials, slippage of the underlying layers, and excessive tensile stresses in the materials.

## 3.04 REPAIRS

A. Geotextile damaged during placement shall be replaced or repaired at the CONTRACTOR'S expense in accordance with MANUFACTURER'S recommendation. The CONTRACTOR shall be responsible for the documentation of repairs describing location and type of repair. Repair documentation shall be submitted to the ENGINEER.

## 3.05 GEOTEXTILE EXPOSURE FOLLOWING PLACEMENT

A. Exposure of geotextiles to the elements between the time the geotextile is placed in the trench to the time backfilling operations are complete shall be limited to a maximum of 30 days to minimize ultraviolet damage. Any geotextile exposed to sunlight for more than 30 days shall be removed and replaced with new material at the CONTRACTOR'S expense.

**END OF SECTION**

**SECTION 02941**

**GEOSYNTHETIC RAIN TARP**

## PART 1 - GENERAL

### 1.01 DESCRIPTION

A. The WORK specified in this Section includes the manufacture, testing, and installation of a geosynthetic rain tarp as shown on the Contract Drawings and as specified herein.

### 1.02 SUBMITTALS

A. Submit MANUFACTURER'S test reports and data, specifications, installation instructions, and roll dimensions.

B. Submit copies of evaluation reports provided by the MANUFACTURER demonstrating that properties for the materials comply with Specification requirements.

C. ENGINEER'S approval shall be obtained prior to the use of any materials in the project.

### 1.03 PROTECTION AND STORAGE

A. Each roll of material shall have a MANUFACTURER'S identification label. Each roll shall be labeled to provide product identification adequate for inventory and quality control purposes. The label shall provide, as a minimum, the MANUFACTURER'S name, product identification, lot number, roll number, and roll dimensions. Rolls shall be labeled as per ASTM D4873, Standard Guide for Identification, Storage, and Handling of Geosynthetic Rolls and Samples.

B. Materials shall be shipped and stored in rolls furnished at the manufacturing facility to prevent exposure of the geosynthetic to ultraviolet light, precipitation, moisture, mud, dirt, dust, puncture, or other damaging conditions.

C. Rolls of material should not be stacked upon one another to the extent that deformation of the core occurs. Outdoor storage shall not exceed six months.

## PART 2 - PRODUCTS

### 2.01 GEOSYNTHETIC RAIN TARP

A. Material shall be a laminated polyethylene film or a polymer type membrane such as Dura-Skrim 12BBR as manufactured by Raven Industries, PPL-12 Liner/Top

Cover as manufactured by Bend Tarp and Liner, Inc., or a ENGINEER'S approved substitution conforming to the following minimum properties:

| CHARACTERISTICS | SPECIFICATION |
|---|---|
| Nominal Thickness | 12 mil |
| Moisture Vapor Transmission | 0.36 $g/m^2$-day or less |

B. The material shall be tested by the MANUFACTURER for the compliance with the following properties:

| PROPERTY | TEST METHOD |
|---|---|
| Permeability | ASTM D4491<br>or ASTM E96 |
| Tensile Strength | ASTM D751 |
| Grab Tensile | ASTM D751 |
| Moisture Vapor Transmission | ASTM E96 |

## PART 3 - EXECUTION

### 3.01 INSTALLATION

A. The rain tarp shall be installed along the surface of the drainage sand within the entire northern portion of the Phase II Section II Expansion (not to be placed on the center or south portions) in accordance with the MANUFACTURER'S recommendations at locations as shown on the Contract Drawings. Ballast such as sand bags shall be placed on the rain tarp to avoid uplift due to wind. No equipment shall be allowed to operate on the rain tarp, and any tears or damage to the rain tarp shall be repaired prior to placement. The surface of the rain tarp shall be kept relatively clean and free of debris during installation.

B. The rain tarp shall be installed along the surface of the existing sod along the entire western side slope of the Phase I landfill area adjacent to the north and center portions of the Phase II Section II Expansion in accordance with the MANUFACTURER'S recommendations at locations as shown on the Contract Drawings. Ballast such as sand bags shall be placed on the rain tarp to avoid uplift due to wind. No equipment shall be allowed to operate on the rain tarp, and any tears or damage to the rain tarp shall be repaired prior to placement. The surface of the rain tarp shall be kept relatively clean and free of debris during installation. Any damage to the existing Phase I landfill liner systems or any other features shall be repaired as directed by the ENGINEER at the CONTRACTOR'S expense.

C. Sheets shall be joined in accordance with the MANUFACTURER'S recommendations.

D. The CONTRACTOR shall place all cover materials in such a manner to prevent damage to the materials, slippage of the underlying layers, and excessive tensile stresses in the materials.

## 3.02 REPAIRS

A. Rain tarp damaged during placement or before final acceptance shall be replaced or repaired at the CONTRACTOR'S expense in accordance with MANUFACTURER'S recommendation. The CONTRACTOR shall be responsible for the documentation of repairs describing location and type of repair. Repair documentation shall be submitted to the ENGINEER.

**END OF SECTION**

SECTION 11200

LEACHATE COLLECTION AND DETECTION PUMPS

# PART 1 - GENERAL

## 1.01 WORK INCLUDED

A. The work included under this section consists of furnishing one leachate collection pump and one leachate detection pump and installing one leachate pumping system including control panel, pipe connection flow meters, sampling ports, telemetry system, primary and secondary discharges connected to the cleanouts of the primary leachate collection system connected to the existing Phase II Section I area, spare parts supply, and related equipment which should be fully tested and in operating condition as shown on the Contract Drawings and Specifications.

## 1.02 QUALITY ASSURANCE

A. Unit Responsibility: The pumps, motors, control elements, carriage, discharge hose, and appurtenances shall be supplied by the pump supplier to assure unit responsibility. The pump supplier shall have experience in providing complete systems and equipment for leachate removal.

B. Pumps and motors shall have the manufacturer's name, address, type or style, model or serial number, and catalog number on a plate secured to the item of equipment.

C. The CONTRACTOR shall become familiar with all details of the WORK, verify all dimensions in the field, and shall advise the ENGINEER of any discrepancy before performing the WORK.

D. Factory Tests: Pumps shall be tested by the manufacturer or a nationally recognized testing agency in compliance with Hydraulic Institute Standards. The pump supplier shall perform the following tests on each pump before shipment from the factory. Certified test results shall be submitted to the ENGINEER.

1. Meg the pump to check for insulation breaks or moisture.

2. Run the pump dry for a minimum of five minutes to ensure integrity of mechanical seal and oil lifter. Also check rotation of electric motor in both directions.

E. Parts Stocking Program: The pump supplier shall provide the OWNER the following spare parts which should be retained on the landfill site for use as necessary.

1. Spare pump end.

2. Spare motor.

3. Spare Power Cable - 100 feet in length (Includes cable entrance and gland fittings.

4. Spare Transducer - With 100 feet of signal cable (Transducer is to be surge suppressed).

F. Each submittal for equipment, components or system components shall be accompanied by an "Equipment Warranty and Certification Form" which is provided in table 11200-A. The form shall be duly executed by an authorized principal of the manufacturer warranting and certifying that the equipment and system components proposed meets or exceeds the specifications, is suitable for its intended purpose and will provide satisfactory performance at the design criteria specified. In the event that the manufacturer is not the supplier, an authorized principal of the supplier shall also execute the equipment warranty and certification form.

## 1.03 SUBMITTALS

A. The CONTRACTOR shall provide shop drawings prepared by the manufacturer and submitted to the ENGINEER for review prior to the manufacture of the proposed equipment. The shop drawings shall include outline dimensions and external connection diagrams. A list of components, pump performance curve showing performance from shutoff to run out as well as a copy of the manufacturers warranty shall be included with each submittal. The manufacturer shall provide to the CONTRACTOR the required number of submittals at no extra cost to the CONTRACTOR. In addition the shop drawings shall include the following:

1. Full description and schematic of mechanical seal design, operation and protection devices, including oil lifter design and operation.

2. Full description and schematic of motor cable entrance. Must indicate anti wicking device as well as cable strain relief design.

3. Comprehensive two dimensional AutoCAD drawing of the panel exterior as viewed from the front and side. Must also include complete control panel interior layout showing location of panel component parts as well as full electrical schematic of control panel operation.

4. Must include manufacturer's warranty which shall be a minimum of three (3) years from date of installation of the pump, and controls.

B. Operating Instruction: For the pump furnished under this Section, the CONTRACTOR shall submit the operation and maintenance manuals. At a minimum these manuals shall include:

1. General - equipment function, description, normal and limiting operating characteristics.

2. Installation instructions.

3. Operation instructions - start up procedure, normal operating conditions, and emergency and normal shutdown procedures.

4. Lubrication and maintenance instructions (if any).

5. Troubleshooting guide.

6. Suggested parts that should be held on site as spares that are non mandatory as listed in Section 1.02.E of this Specification.

7. Drawings - cross sectional views, assembly and wiring diagrams.

8. Pump performance curves.

C. Factory Performance Test Data: A qualified technician from the factory shall be provided for one (1) day to instruct representatives of the OWNER and the ENGINEER on proper operation and maintenance. With the permission of the OWNER, this WORK may be conducted in conjunction with the inspection of the installation and system start up per Section 3 of this Section. If during start up there is an equipment failure due to the pump manufacturers design or fabrication of the equipment, additional services shall be provided at no additional cost to the OWNER. No factory "representative" shall complete the start up. System start up shall be completed by a factory technician. This technician should be a direct employee of the manufacturer who has had first hand dealings with the equipment through its production at the factory.

D. Certifications: The CONTRACTOR shall furnish the ENGINEER with a written certification signed by the manufacturer that the equipment has been properly installed and is free from stress imposed by piping or mounting bolts. The form should indicate that all equipment has been operated without fault under full load conditions and that satisfactory operation has been obtained.

## 1.04 MANUFACTURER'S SERVICES

A. The CONTRACTOR shall obtain the services of the manufacturer's representative experienced in the installation, adjustment, and operation of the equipment specified. The representative shall supervise the installation, adjustment, and testing of the equipment.

## 1.05 DELIVERY, STOREAGE AND HANDLING

A. Deliver a complete system to include all parts listed in submittal sent to ENGINEER.

B. Store in a weather tight building or suitable covering to protect against damage of any nature.

C. Handle during delivery, storage and installation in a manner to prevent damage of any nature.

## 1.06 WARRANTY AND GUARANTEES

A. The supplier of the leachate removal system will provide all warranty services against defects in material and workmanship for a period of 36 months from the date of start up and OWNER'S final inspection and acceptance to the effect that any defective equipment shall be repaired or replaced without cost or obligation to the OWNER.

# PART 2 - PRODUCTS

## 2.01 PUMPS

A. The CONTRACTOR shall furnish and install one complete leachate pumping system. The leachate collection pump, leachate detection pump, control panel and flow meter shall be manufactured by Sligo Systems, Lake Helen, FL (386-218-4981) or ENGINEER approved equal.

1. The leachate collection pump model shall be a Sligo Systems Series ~~3~~4-7.5~~4~~-~~5~~4 unit with a 3-inch discharge, 100 foot power lead and 100 foot lifting cable configured for sidelope riser installation.

2. The leachate detection pump model shall be a Sligo Systems Series 1-0.5-2PU unit with a 2-inch discharge, 100 foot power lead and 100 foot lifting cable configured for sidelope riser installation.

B. The submersible pumps:

1. Should be capable of handling raw leachate.

2. The pump shall use a single stage or multi-vane, open type impeller capable of obtaining the required flow and head. The impellers shall be fabricated from ASTM A532 93d, class 3 type A high chrome steel.

3. The pump must be capable of running dry continuously without damaging the rotating assembly, seal, bearings or motor.

4. The pump must be capable of ingesting and passing solid matter including silt, sand, sediment, HDPE shavings as well as rock particles that may be flushed through the system periodically.

5. The pump shall include a motor cable entrance with an anti-wicking block created by a break in the power cable insulation to prevent liquid migration into the motor housing in the event that the power cable is damaged. Hermetically sealed designs are insufficient. The cable entrance shall include a rubber boot that accommodates differences in thermal expansion between the epoxy potting compound and the motor housing. A limited compression tightening plate shall be used to compress and seal this rubber boot to the motor housing. The rubber boot shall incorporate a strain relief feature that limits the cable bending radius and prevents the conductors from being damaged or cyclically fatigued.

6. The pump shall be manufactured out of cast iron with an ASTM rating of class 35, A48.

7. Dual inside mechanical seals with silicon carbide faced shall be used to prevent pumped liquid from entering the motor. The seals shall be contained within an oil filled seal chamber. No contact with the pumped liquid is permitted. An oil lifter must be used to ensure that both seal faces are continuously cooled and lubricated by the oil. With the pump running dry, the seals must be capable of operating for at least one hour without damage.

8. The pump shaft shall be supported by double shielded, permanently lubricated, high temperature C3 ball bearings with a minimum B10 life of 60,000 hours. Shaft bearing designs that require lubrication via the pumped liquid are not acceptable.

9. The pump shall be fabricated for use in a 24-inch SDR11 riser pipe application and must be able to move through the HDPE pipe a distance of at least 50 feet. The pumping unit shall be enclosed in an engineered polymer skid to enable the pump to slide down the riser pipe and negotiate bends without hanging up on seams or any riser pipe imperfections. The polymer skid will use no moving parts. Wheels shall not be used as a means to send the pump down the riser pipe

10. No built in check valve inside the pump will be permitted. Check valves shall be 304 stainless steel, dual plate, wafer style and located on the discharge hose assembly and easily accessible for maintenance. If a check valve is to be located at the pump discharge, the valve should be bored

with a 3/16” bleed-hole that will allow the discharge line to be emptied prior to removing the pump for maintenance.

C. Pump and motor capacity shall meet the following requirements:

| | Leachate Collection | Leachate Detection |
|---|---|---|
| Model | 34-7.54-54 | 1-0.5-2PU |
| Pumps Required | 1 | 1 |
| Operating Duty Point | 220 gpm @ 29 ft TDH | 2 gpm @ 11 ft TDH |
| Maximum Motor Hp | 7.55.0 | 0.5 |
| Voltage | 240 | 240 |
| Phase | 3 | 3 |
| Frequency, Hertz | 60 | 60 |
| Panel Source | New Panel | New Panel |

## 2.02 CONTROL PANEL

A. The single control panel shall operate the Sligo Systems Series 34-7.54-5 and 1-0.5-2PU leachate pumps. The panel shall operate in duplex, individual mode of control. The two pumps will be operated independently. Each pump will be turned on when its specific on level setpoint is reached and turned off when its specific off level setpoint is reached. The control panel will provide level control and include motor starters, breakers, overload protection devices and circuit breakers (fuses will not be used as primary protection devices). Panel will provide protection against phase loss and rapid pump cycling. The panel will include a TVSS system as well as additional lightning protection as deemed appropriate. Panel will include an intrinsically safe barrier for level sensor connection. A low voltage control circuit and power transformer shall be provided. A thermostat will be included for interior temperature control of the panel body. Power feed to the panel will be 4 wire, 240 volt, 3 phase, 60 Hz. Panel shall be UL698A listed and labeled.

B. Control Scheme:

1. Primary - Level sensor control as detailed above.

2. Backup 1 - In the event that the submersible level sensor is faulted, the controller will automatically switch to low flow operating logic. If pump flow rate falls below a user set rate for at user set period of time then the pump is stopped. After a user set sump recharge time period the controller will start the pump and the cycle begins again.

3. Backup 2 - In the event that the submersible level sensor is faulted AND the flowmeter is faulted / not installed, the controller will automatically

switch to low current operating logic. If pump motor current draw falls below a user set level for at user set period of time (indicating dry run) then the pump is stopped. After a user set sump recharge time period the controller will start the pump and the cycle begins again.

4. Backup 3 - In the event that the pump run time exceeds a user set maximum run time the pump is disabled, an alarm is set. User interaction is required to restart the pump. The user will have the ability to disable this backup scheme and alarm will be set indication that this backup has been bypassed.

C. Control shall be accomplished via a microprocessor based controller with the requisite number of digital and 4-20 mA analog I/O. A NEMA 4X 7" (minimum) back-lit color graphical TFT LCD touch screen display on the face of the control panel will provide current pump and system status as well as any alarms. This user interface will permit the user to access and change operating set points, delay timer setting, and system settings through a direct entry keypad. Access to these settings shall be password protected. Any time that the user changes the set point or accesses the system settings then that fact will be recorded in a user accessible time stamped alarm log. All system parameters, current operating settings and alarms shall be held in retentive memory such that operation can be resumed after a loss of power.

D. During normal operation the screen will display sump level, pump off, pump on, and high alarm set point settings. The screen will also display current pump mode, flow rate and discharge pressure. Pump mode selection shall be made with panel mounted NEMA 4X HOA switches. The switches will remain in the Auto or Off position when placed in that position by the operator. The switches will not be able to remain in the Hand mode unless physically held in that position by the operator. The controller shall monitor the following alarm conditions.

| **Alarm** | **Action** | **Beacon** |
|---|---|---|
| High Sump Level | -- | Red |
| Over/Under voltage | Stop pumps until corrected | Red |
| Loss of phase | Stop pumps until corrected | Red |
| Pump / motor starter failure | Take pump out of Lead/lag Logic | Red |
| Level sensor fault | Switch to backup control logic | Red |
| Flowmeter fault | -- | Blue |
| Forcemain pressure sensor fault | -- | Blue |
| Low Flow | -- | Blue |
| No Flow | Stop Pump. Retry a user defined number of times at a user defined interval. If no response take pump | Blue then Red |

| | | |
|---|---|---|
| | out of lead/lag logic. | |
| Force main pressure over limit | -- | Blue |
| Motor amp draw over maintenance limit | -- | Blue |
| Pump overrun time limit exceeded | Stop pump until user resets system. | Red |

E. The individual alarm trigger points and on / off delay settings shall be adjustable via a touch screen menu. Access to these set points shall be password protected. When an alarm is triggered, a context sensitive alarm screen giving troubleshooting guidelines / suggested resolutions shall be accessible to the user. The alarm condition shall be logged in a user accessible time stamped alarm log. The display shall also include the manufacturers 24 hour technical assistance telephone number that the operator can call should the fault remain after basic on site troubleshooting. User accessible trending screens shall graphically display sump level, flow rate and discharge pressure trends for at least the previous 80 hours of operation.

F. The controller shall read flowmeter rate and total via HART protocol. 4-20 mA (rate) and digital pulse (totalizer count) inputs are not acceptable.

G. The controller shall be "SCADA ready." Addition of a radio unit and a single RJ45 connection shall allow network access to and from the controller's data and command registers. Communication protocol shall be MODBUS RTU or TCP.

H. Each pump shall drive a panel mounted non reset type elapsed time meter which will indicate total hours that the pump has run. The run time will be measured up to 99999.9 hours.

I. The control panel shall be manufactured out of 14 gauge, unpainted 304 stainless steel and meet NEMA 4X standards. The enclosure door shall be hinged along its length allowing the door to open out 180 degrees. The door shall have a gasket with a rubber composition material around the perimeter and shall be installed with a retainer to assure a positive weatherproof seal. A stainless steel drip shield shall be included. The panel must be capable of being padlocked. The main power disconnect shall be located on the inner door of the panel. The inner door should not be capable of being opened unless the panel power is disconnected. A generator receptacle must be provided on the side of the control panel.

J. Control panel shall include a viewing window to allow the components mounted on the inner door to be seen without the need to open the front of the enclosure. A NEMA 4X momentary on reset / acknowledge push button shall be mounted on the side of the enclosure.

K. The control panel shall be equipped with a NEMA 4 (watertight), red and blue colored beacons on top of the panel that will flash if the pump is called on. Rotating beacons are not acceptable.

L. Motor starters shall be open form, across the line, UL/HP rated with individual overload protection built in each leg. Motor starter contact and coil shall be replaceable from the front of the starter without removing it from its position. Adjustable overloads will be used. They shall provide visual trip indication on the overload itself as well as illuminate a motor trip light on the panel inner door. The overload shall be sized for the full load amperage draw of the pump motor.

M. A courtesy 110V / single phase GCFI duplex power receptacle shall be provided on the inner door. This receptacle shall be protected by an individual 15A circuit breaker.

N. Pilot lights, push buttons, switches, circuit breakers, components, and devices shall all be labeled with nameplates. Internal panel control components shall also be labeled identifying the component function.

O. All nameplates shall be three ply phenolic, engraved through the first layer. Lettering shall be 0.5cm (3/16") minimum in height and securely fixed to the respective panel location.

P. A pocket shall be provided on the inner door to house operations manuals.

Q. Radio communication must be provided between the leachate control panel and the Phase II Section I control panel or master lift station. If the master lift station is pumping then the Phase II Section I leachate pumps are already prevented from pumping and the Phase II Section II Expansion leachate pumps will be prevented from pumping, if the Phase II Section I leachate pumps are pumping the master lift station is already prevented from pumping and the Phase II Section II pumps may operate. Under the conditions noted, the lagging system will begin pumping when the active system pumps stop. This capability must be fully automatic and self restarting. No cables will be used. Radio telemetry will be the only acceptable form of controlling this function.

R. Methane Gas - Combustible Gas Detector

1. A Methane Gas combustible gas detector will be installed inside the control panel. The detector shall be a micro-processor based and be self calibrating. It shall be designed to monitor gases and vapors within the lower explosive limit (LEL) and provide status indication and alarm outputs.

2. All of the gas detectors electronics shall be in one self contained, explosion proofed housing and provide a 4-20mA signal which is proportional to 0 to 100% of LEL.

3. A three digit digital display must be included on the front of the sensor housing. This display shall continuously indicate gas concentrations during normal operation or while in a calibration mode.

4. The detector must have built in dual redundant MODBUS Communication. The sensor shall be able to communicate with the control panel PLC. When a high level of gas is sensed, the gas detector will send a signal to the PLC which will in turn display a warning screen on the NEMA 4X 7" (minimum) back-lit color graphical TFT LCD touch screen display on the front of the control panel, indicating an abnormal level of combustible gas inside the panel enclosure itself.

5. Sensor type shall be continuous diffusion, low temperature catalytic bead. Sensor life shall be 5 years.

6. Accuracy shall be +/- 3% LEL up to 50% LEL. Accuracy shall be +/- 5% LEL when equal to or greater than 51% LEL.

7. Zero drift shall be less than 5% of full scale per year. Measuring ranges will be 0-100% LEL

8. Gas detector shall meet the intent of CSA/FM Class 1, Division 1 groups B, C & D; Class 1, zone 1 Ex d IIB+H2, T6.

9. Gas detector shall meet the intent of ATEX T5 EEX d IIB.

10. Detector shall be capable of operating in temperatures between -40 Deg F through 200 Deg F.

11. Detector shall be capable of operating in humidity ranges between 5% and 100% RH without failure. Detector shall be "non-condensing."

12. Detector shall be powered by 20 - 36VDC - 250mA max.

13. Detector shall have an analog signal of 0-20mA (650 Ohms max load).

14. The detector shall have a RS-485 output which shall be dual MODBUS RTU suitable for linking up to 128 units or up to 247 units with repeaters.

15. Baud rates will be 2400, 4800, 9600 or 19,200 BPS.

16. The gas detector shall weight no more than 5.5 lbs.

17. The gas detector shall be 6.4'' in length, 3.4'' in height and 4.1'' in width.

S. Hydrogen Sulfide - Intelligent Gas Detector

1. A Hydrogen Sulfide combustible gas detector will be installed inside the control panel.

2. The detector shall be a micro-processor based and be self calibrating. The detector shall be designed to detect Hydrogen Sulfide in parts per million (ppm) levels and provide status indication and alarm outputs.

3. All of the gas detectors electronics shall be in one self contained, explosion proofed housing. The detector shall provide a 4-20mA signal which is proportional to 0 to 100% of the detection range at the sensor.

4. A three digit digital display must be included on the front of the sensor housing. This display shall continuously indicate gas concentrations during normal operation or while in a calibration mode.

5. The detector must have built in dual redundant MODBUS Communication. The sensor shall be able to communicate with the control panel PLC. When a high level of gas is sensed, the gas detector will send a signal to the PLC which will in turn display a warning screen on the NEMA 4X 7" (minimum) back-lit color graphical TFT LCD touch screen display on the front of the control panel, indicating an abnormal level of combustible gas inside the panel enclosure itself.

6. Sensor range shall be 0-20 ppm, 0-50 ppm or 0-10 ppm.

7. Sensor type shall be continuous diffusion, adsorption type metal oxide semiconductor (MOS). Sensor life shall be 5 years.

8. Repeatability shall be +/- 2ppm or 10% of the applied gas, whichever is greater.

9. Response time shall be T50 – less than 1 minute (screen) Response time shall be T50 – less than 2 minutes (sintered) with full scale gas applied.

10. Measuring ranges will be 0-20 ppm, 0-50 ppm, 0-100 ppm.

11. Gas detector shall meet the intent of CSA/FM Class 1, Division 1 groups B, C & D; Class 1, zone 1 Ex d IIB+H2, T6.

12. Gas detector shall meet the intent of ATEX T5 EEX d IIB.

13. Detector shall be capable of operating in temperatures between -40 Deg F through 167 Deg F.

14. Detector shall be capable of operating in humidity ranges between 5% and 100% RH without failure. Detector shall be "non-condensing."

15. Detector shall be power by 20 - 36VDC - 250mA max.

16. Detector shall have an analog signal of 0-20mA (650 Ohms max load).

17. The detector shall have a RS-485 output which shall be dual MODBUS RTU suitable for linking up to 128 units or up to 247 units with repeaters.

18. Baud rates will be 2400, 4800, 9600 or 19,200 BPS.

19. The gas detector shall weight no more than 5.5 lbs.

20. The gas detector shall be 6.4'' in length, 3.4'' in height and 4.1'' in width.

**2.03 SUBMERSIBLE LEVEL SENSOR**

A. Submersible level sensors will be used as a means to indicate liquid level in the sump. This level sensor will be surge suppressed and have an integral signal cable of appropriate length. The sensor will be mounted outside the body of the pump for ease of cleaning / replacement while being protected from damage during installation or extraction of the pump from the sump.

B. Transducer must me manufactured our of stainless steel

C. Static accuracy shall be +/- 1.00%

D. Resolution shall be infinitesimal.

E. Excitation shall be 10 to 40VDC, input current (max) will be 20mA and output will be 4-20mA (2 wire)

F. Output impedance will be 100 megohms at 50 VDC

G. Compensated operating temperature range shall accommodate 0 degrees Celsius through 50 degrees Celsius. Operating temperature range shall accommodate a span of -20 degrees Celsius through 70 degrees Celsius.

H. Transducer assembly must be surge suppressed. The suppression (lightening protection) shall be capable of responding to any surge within a time period of less than 10 nanoseconds after identification.

## 2.04 ELECTROMAG FLOW METER

A. The flow meter shall be capable of handling raw leachate and be a Sligo Systems Model 8705 flow tube with an integral mount 8732E transmitter as manufactured by Rosemount-Emerson Process Management or approved equal.

B. Be designed to fit a 6-inch discharge line for the primary and a 2-inch discharge line for the secondary. Connection to flowmeter shall be achieved via a 150 lb ANSI flanged configuration.

C. Be capable of operation with a minimum of 2 times pipe diameter upstream and no straight pipe limitations downstream of the meter to achieve maximum accuracy.

D. Utilize a electromagnetic design to measure and record flow rates and volumetric total. Flowmeters that utilize moving parts (such as paddlewheel or turbine style) to measure and record flow rates will not be acceptable.

E. Have an accuracy of ± 0.25% full scale.

F. Operate off 24VDC, and be capable of transmitting a 4-20mA flow signal, a pulsed totalizer signal and incorporate a full HART protocol data and diagnostics capability.

G. Incorporate diagnostic feature for fault alarms.

H. Be capable of detecting "empty pipe", forward or reverse flow and net totalization.

I. Allow user defined presets for damping and low-flow cutoff.

## 2.05 PUMP RETRIEVAL CABLE

A. Retrieval cable should be a minimum of 3/8" diameter and made of stainless steel. All cable retaining hardware shall be made of stainless steel.

B. Cable shall be attached to the top of the pump in a secure manner as to facilitate its removal from the riser pipe assembly.

## 2.06 BREAKOUT BOXES

A. Contractor shall supply three (3) separate electrical breakout boxes with the following performance, design and construction criteria.

B. Breakout/Junction Boxes shall:

1. Be incorporated into the power, flowmeter, and pressure transducer cabling system to ensure that no gas migration occurs from the sump into the control panel.

2. Meet NEMA 4X standards.

3. Have a hinged front door and pad-lockable quick release latches to facilitate easy access. Screws to secure the front of the breakout box will not be acceptable.

4. All exposed fittings and fixtures will be stainless steel.

5. Electrical terminal connections inside the box must be DIN rail mounted. Multiple terminal strips will not be acceptable. Each terminal must be able to be separated from the rest without the need to replace the complete connector strip.

6. All conduit connections between the breakout boxes to the main control panel must be completely "sealed off" with an epoxy based potting compound to prevent gas migration into the control panel.

C. Power Cable Breakout/Junction Box - Model SSBOB-P-2 manufactured by Sligo Systems, Lake Helen, FL (386-218-4981) or approved equal.

D. Flow Meter / Pressure Sensor Breakout/Junction Box - Model SSBOB-F-2 manufactured by Sligo Systems, Lake Helen, FL (386-218-4981) or approved equal.

E. Submersible Level Sensor Breakout/Junction Box - Model SSBOB-T-2 manufactured by Sligo Systems, Lake Helen, FL (386-218-4981) or approved equal.

## PART 3 - EXECUTION

### 3.01 PUMP INSTALLATION

A. Pumping equipment and appurtenances shall be installed in the position indicated and in accordance with the manufacturer's written instructions. All appurtenances required for a complete and operating pumping system shall be provided, including but not limited to such items as piping, conduit, valves, wall sleeves, wall pipes, concrete foundations, anchors, grouting, pumps, starters, power supply, and controls.

## 3.02 FIELD TESTING AND ADJUSTING EQUIPMENT

A. Field supervisor: The manufacturer will furnish a suitably qualified technician to inspect the completed installation, make necessary adjustments and instruct operating personnel in the proper care and operation of the equipment, prior to the final acceptance of the pumping station. No distributor, representative or agent acting on behalf of the manufacturer shall be approved to complete start up services. This task must be reviewed and completed by a direct employee of the manufacturer.

B. Field Test: When the pumping facility is complete and ready for operation, then the station shall be inspected and tested for compliance to the Contract Documents. Test of equipment shall be made by the CONTRACTOR in the presence of the ENGINEER, electrical sub contractor, equipment manufacturer and the OWNER. The equipment tests shall include, but will not be limited to the following:

1. Pumps and motors: Pumps shall be run dry to ensure their run dry compatibility as well as being run in the sump under “wet” conditions. A determination shall be made of the pumping capacity. Performance of the pumps shall meet the specified criteria when field tested.

2. Electrical: Readings shall be made of the voltage and amperage draw and recorded on the manufacturers start up form. This form should be kept by the manufacturer, ENGINEER, CONTRACTOR and OWNER for future reference.

3. Controls: Control primary elements shall be tested to determine satisfactory performance for starting and stopping at the proper liquid levels. Pump sequence and alarm functions will also be tested.

4. Equipment: Equipment shall be operated to determine that the pump is located in the correct position in the riser assembly. A check will be conducted to ensure that there is no overloading of the pump or any overheating in any of the controls. A check will be conducted for any abnormal vibration that may be evident in the discharge plumbing. Pump will be raised and reset to ensure correct placement in riser pipe.

5. Inspection: An inspection of all mechanical and electrical equipment, controls, piping, valves, fittings, brackets, mountings, seals, conduit, painting and component features shall be made while the station is being tested to determine performance and compliance with design requirements and the specification.

6. Structure: The station shall be inspected for performance, structural soundness and water tightness.

7. Repairs, adjustments and replacement: The CONTRACTOR shall make any and all necessary repairs, adjustments and replace any component parts until performance has been demonstrated to the satisfaction of the ENGINEER. The CONTRACTOR shall bear the cost of any repair, adjustment and replacement.

8. Pump and Controls manufacturer must submit to the ENGINEER for review a full synopsis outlining occasions where the pump assembly has been:

    1. Run dry without damage

    2. Operated under conditions whereby solids at least 3/8" have been passed through the pump assembly without degrading the pump performance or damaging the pump or motor assembly.

9. The pumps, control panel, flow meters and break out boxes shall be supplied by the one manufacturer.

Table 11200-A

EQUIPMENT WARRANTY AND CERTIFICATION FORM

Project: Hardee County

Project No.:____________________

The undersigned hereby attests that he has examined all the referenced project drawings and specifications and hereby warrants and certifies that the equipment, component, or system he proposes to furnish and deliver meets or exceeds the contract specification, is suitable for its intended purpose and installation, and will provide satisfactory performance at the design criteria specified. This warranty shall be in addition to and not in lieu of all other warranties, express and implied.

Equipment: ____________________________________________

Manufacturer: ____________________________________________

Address: ____________________________________________

By: ____________________________________________

Type Name and Title)____________________________________________

(Seal)

____________________________________________

(Signature/Date)

Equipment Warranty and Certification must be signed by a Principal Person (President, Vice-President, etc.) of the equipment manufacturer. In the event the manufacturer is not the Supplier, then a Principal Person of the Supplier **must also** sign this form.

By: ____________________________________________

(Type Name and Title)

(Seal)

____________________________________________

(Signature/Date)

**END OF SECTION**

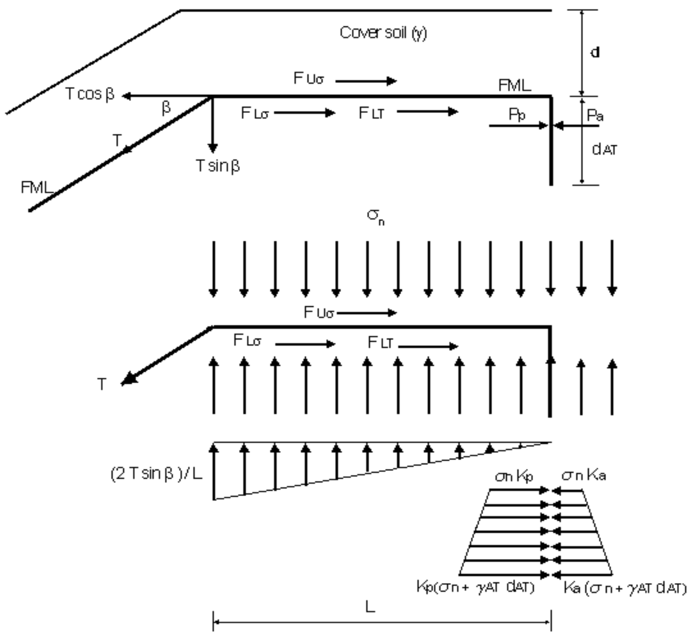
# Attachment Q

# Revised Anchor Trench Calculations

| CLIENT | PROJECT | JOB NO. |
|---|---|---|
| Hardee County | Phase II Section II Expansion | 09199033.23 |

| SUBJECT | BY | DATE |
|---|---|---|
| | SRF | 8/31/12 |
| Anchor Trench Calculations | CHECKED | DATE |

OBJECTIVE: Calculate anchor trench runout length L and anchor depth dimensions $d_{AT}$.




Cross Section of Geomembrane Runout Section with Anchor Trench and Related Stresses and Forces Involved

Refer to Attachment 1 Designing with Gesoynthetics, 5th Ed., Keorner

Refer to Attachment 2 Geotechnical Aspects of Landfill Design and Construction

CALCULATIONS:

$\Sigma F_x = 0$

$T_{ult}\ \cos\beta = F_{U\sigma} + F_{L\sigma} + F_{LT} - P_A + P_P$

WHERE:

$T_{ult}$ = ultimate force in geomembrane at yield

$T_{allow}$ = allowable force in geomembrane = $s_{allow}\, t$, where

$s_{allow}$ = allowable stress in geomembrane

$\tau$ = geomembrane thickness

$\beta$ = sideslope angle

$F_{U\sigma}$ = shear force above geomembrane due to cover soil (note that for thin cover soils tensile cracking will occur and this value will be negligible)

$F_{L\sigma}$ = shear force below geomembrane due to cover soil

$F_{LT}$ = shear force below geomembrane due to vertical component of T

$d_{cs}$ = the depth of cover soil

$\delta$ = angle of shearing resistance between geomembrane and adjacent material (i.e., soil or geotextile)

$P_A$ = active earth pressure against the backfill side of the anchor trench

$P_P$ = passive earth pressure against the in-situ side of the anchor trench

$P_A = 1/2\ (\gamma_{AT} d_{AT}) K_A d_{AT} + (\sigma_n) K_A d_{AT}$

$P_A = (0.5\gamma_{AT} d_{AT} + \sigma_n) K_A d_{AT}$

$P_P = (0.5\gamma_{AT} d_{AT} + \sigma_n) K_P d_{AT}$

| CLIENT | PROJECT | JOB NO. |
|---|---|---|
| Hardee County | Phase II Section II Expansion | 09199033.23 |

| SUBJECT | BY | DATE |
|---|---|---|
| Anchor Trench Calculations | SRF | 8/31/12 |
| | CHECKED | DATE |

WHERE:

$L_{RO}$ = minimum liner runout distance
$\gamma_{CS}$ = unit weight of cover soil
$\gamma_{AT}$ = unit weight of soil in anchor trench
$d_{CS}$ = thickness of cover soil
$d_{AT}$ = depth of the anchor trench
$\delta_L$ = interface friction angle between liner and soil subgrade
$\delta_U$ = interface friction angle between liner and cover soil
$\sigma_n$ = applied normal stress from cover soil
$K_A$ = coefficient of active earth pressure = $\tan^2(45 - \phi/2)$
$K_P$ = coefficient of passive earth pressure = $\tan^2(45 + \phi/2)$
$\phi$ = angle of shearing resistance of respective soil

GIVEN:

| | | | |
|---|---|---|---|
| $T_{ult}$ @yield = | 126.0 | lb/in | Refer to Attachment 3 |
| = | 1512.0 | lb/ft | |
| $\tau$ = | 60.00 | mil | |
| $\sigma_{ult}$ = | 2100.0 | $lb/in^2$ | |
| $\gamma_{cs}$ = | 115.0 | $lbs/ft^3$ | Refer to Attachment 65 |
| $d_{cs}$ = | 2.00 | ft | |
| $\sigma_n$ = | 230.0 | $lbs/ft^2$ | |
| $\gamma_{AT}$ = | 115.0 | $lbs/ft^3$ | Refer to Attachment 65 |
| $\delta_L$ = | 20.5 | degrees | ~~Refer to Attachment 4~~ |
| $\beta$ = | 18.4 | degrees | |
| $\phi$ = | 30.0 | degrees | Refer to Attachment 54 |

$\beta = \tan^{-1}(m/z)$

| | |
|---|---|
| m = | 1 |
| z = | 3 |

DETERMINE:

$F_{U\sigma} = \sigma_n \tan \delta_u (L_{RO})$
$F_{U\sigma}$ = 0.0 lb/ft (assume negligible, $\delta_U = 0$)

$F_{L\sigma} = \sigma_n \tan \delta_u (L_{RO})$
$F_{L\sigma}$ = 86.0 $L_{RO}$ lb/ft

$F_{LT} = T_{ult} \sin \beta \tan \delta_L$
$F_{LT}$ = 178.8 lb/ft

$K_A$ = 0.33
$K_P$ = 3.00

$P_A = (0.5\gamma_{AT} d_{AT} + \sigma_n) K_A d_{AT}$
$P_A$ = 19.17 $d^2_{AT}$ + 76.67 $d_{AT}$

$P_P = (0.5\gamma_{AT} d_{AT} + \sigma_n) K_P d_{AT}$
$P_P$ = 172.5 $d^2_{AT}$ + 690.0 $d_{AT}$

SCS ENGINEERS



| CLIENT | PROJECT | JOB NO. |
|---|---|---|
| Hardee County | Phase II Section II Expansion | 09199033.23 |

| SUBJECT | BY | DATE |
|---|---|---|
| | SRF | 8/31/12 |
| Anchor Trench Calculations | CHECKED | DATE |

$T_{ult} \cos \beta - F_{LT} = F_{U\sigma} + F_{L\sigma} - P_A + P_P$

1255.6 = 86.0 $L_{RO}$ + 613.3 $d_{AT}$ + 153.3 $d^2_{AT}$

Find $L_{RO}$ at a given $d_{AT}$

| | | | | |
|---|---|---|---|---|
| $d_{AT}$ = | 0.50 ft | 1.00 ft | 1.50 ft | 2.00 ft |
| $L_{RO}$ = | 10.59 ft | 5.69 ft | -0.11 ft | -6.80 ft |

Recommend using: $d_{AT}$ = 2.0 ft

$L_{RO}$ = 2.0 ft

From Equation (1):

Anchorage Ratio, AR = RHS / LHS

AR = Horizontal forces T @ anchor trench & runout / horizontal force T @ geomembrane

= 2190.8 / 1434.4

= 1.5

CONCLUSION:

- Recommend a horizontal anchor of 2 feet runout length, assuming tensile (ult) at yield of 126 lbs/in, (lowest published value) and cover soil thickness = 24 inches; other components such as composite drainage net assume not in tension or the load is transferred to the weakest interface.
- Assume shear strength efficiency is 100% between the interfaces; in reality it is not due to presence of wrinkles with liner.
- Anchor trench dominates
- Anchor trench dimensions depends on the cover soil thickness, interface friction angle of soil/geomembrane interface, internal friction angle of soil backfill and soil unit weight assumed in the calculations.
  Recommended anchor trench dimensions are within typical values used in landfill design.

Notes:

| | | | |
|---|---|---|---|
| Anchorage Ratio | > | 1 | Anchor trench dominates |
| Anchorage Ratio | = | 1 | Balanced Design |
| Anchorage Ratio | < | 1 | Geomembrane pull-out mode |

# Attachment R

- Revised Bi-Planar Transmissivity Calculations
- Revised Tri-Planar Transmissivity Calculations
- SKAPS Bi-Planar Transmissivity Calculations

# Revised Bi-Planar Transmissivity Calculations

SCS ENGINEERS

SHEET 1 OF 5

| CLIENT | PROJECT | JOB NO. |
|---|---|---|
| Hardee County | Phase II Section II Expansion | 09199033.23 |

| SUBJECT | BY | DATE |
|---|---|---|
| Leachate Collection & Removal System<br>Bi-planar Geocomposite<br>Transmissivity/Hydraulic Conductivity Calculations | SRF | 8/31/12 |
| | CHECKED | DATE |

OBJECTIVE:

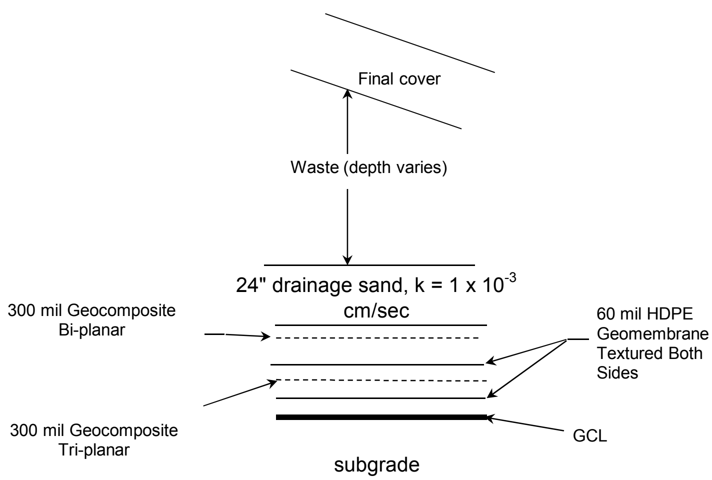
To determine the design hydraulic conductivity, design thickness, and porosity of the geocomposite selected for use in the leachate detection system at various loads using manufacturer's testing data. The calculations for the long-term transmissivity of the geocomposite are based on 100 hour transmissivity values.

REFERENCES:

1. Attachment 1 - GRI Standard - GC8 Technical Release, April 17, 2001.
2. Attachment 2 - Bi-planar material properties (FabriNet UF Geocomposite) data sheets.
3. Attachment 3 - Correspondence from manufacturer for bi-planar 100 hour transmissivity values.
4. Attachment 4 - Soil properties

PROCEDURE:

1. Geocomposite properties are dependent on landfill load, leachate and other conditions. Determine loads on geocomposite.
2. GRI Standard - GC8 is a way to determine geocomposite allowable flow rates based on site specific landfill conditions.
3. Calculate the downstream hydraulic conductivity (k) for various landfill conditions.
4. Determine the hydraulic conductivity for different loading conditions.
5. Use Table 4 - "Default Soil, Waste, and Geosynthetic Characteristics" for soil texture within the HELP model.
6. Use calculated values to run the HELP model.




**Revised April 1, 2013**

| CLIENT | PROJECT | JOB NO. |
|---|---|---|
| Hardee County | Phase II Section II Expansion | 09199033.23 |

| SUBJECT | BY | DATE |
|---|---|---|
| Leachate Collection & Removal System<br>Bi-planar Geocomposite<br>Transmissivity/Hydraulic Conductivity Calculations | SRF | 8/31/12 |
| | CHECKED | DATE |

EQUATIONS:

Refer to Attachment 1 developed from Equation (1) and Equation (2) pg GC8-3

$$\theta_{allow} = \frac{\theta_{ultimate}}{RF_{IN} * RF_{CC} * RF_{BC} * RF_{CR} * FS}$$

Where:

$\theta_{allow}$ = Allowable transmissivity

$\theta_{ultimate}$ = Ultimate transmissivity (manufacturer's) under simulated conditions for 100 hours

$RF_{IN}$ = Reduction Factor for elastic deformation, or intrusion of the adjacent geotextiles into the drainage channel

$RF_{CC}$ = Reduction Factor for Chemical Clogging and/or precipitation of chemicals in the drainage core space

$RF_{BC}$ = Reduction Factor for Biological Clogging in the drainage core space

$RF_{CR}$ = Reduction Factor for Creep deformation of the drainage core and/or adjacent geotextile into the drainage channel

FS = Factor of Safety

$$RF_{CR} = \left[\frac{(t'/t) - (1 - n_{original})}{(t_{CR}/t) - (1 - n_{original})}\right]^3$$

Refer to Attachment 1 Equation (6) pg GC8-6

Where:

t' = Thickness at 100 hours

t = Virgin thickness

$t_{CR}$ = Thickness at > 100 hours

$n_{original}$ = Original porosity

$$= 1 - \left[\frac{\mu}{\rho \times t}\right]$$

Refer to Attachment 1 Equation (7) pg GC8-7

μ = mass unit area

ρ = density

$$k = \frac{\theta_{allow}}{t'}$$

Where:

k = Hydraulic conductivity, cm/sec

NOTE:

$RF_{IN}$ accounts for the geotextile encroaching on the geonet under a constant loading. A 100-hour transmissivity test accounts for intrusion. After the 100-hour seat time, the geotextile has already begun to intrude into the geonet, therefore, the transmissivity value reflects the intrusion. The transmissivity values for these calculations are all based on the 100-hour test, therefore, $RF_{IN}$ = 1.0.

**Revised April 1, 2013**

| CLIENT | PROJECT | JOB NO. |
|---|---|---|
| Hardee County | Phase II Section II Expansion | 09199033.23 |

| SUBJECT | BY | DATE |
|---|---|---|
| Leachate Collection & Removal System<br>Bi-planar Geocomposite<br>Transmissivity/Hydraulic Conductivity Calculations | SRF | 8/31/12 |
| | CHECKED | DATE |

OBJECTIVE: To determine the load on the bottom liner geocomposite under different scenarios.

KNOWN: Landfill cross-section

| | | | |
|---|---|---|---|
| Bottom liner low point elevation = | 80.0 | ft NGVD | Low point between north and center portions of Expansion. |
| Elevation over low point = | 143.5 | ft NGVD | |
| Max depth = | 63.5 | ft | |
| Final cover = | 115.0 | pcf | Refer to Attachment 4 |
| Intermediate/daily cover = | 115.0 | pcf | Refer to Attachment 4 |
| Waste/cover = | 60.0 | pcf | |
| Drainage sand = | 115.0 | pcf | Refer to Attachment 4 |

**Scenario 1 - open cell, 0 ft waste**

| Material | Material Density (pcf) | Depth of Material (ft) | Load (psf) | | |
|---|---|---|---|---|---|
| Waste/cover | 60.0 | 0.0 | 0.0 | | |
| Drainage sand | 115.0 | 2.0 | 230.0 | | |
| **Total** | | **2.0** | **230.0** | **=>** | **500** |

**Scenario 2 - 10 ft waste + 6-inch daily cover**

| Material | Material Density (pcf) | Depth of Material (ft) | Load (psf) | | |
|---|---|---|---|---|---|
| Daily cover | 115.0 | 0.5 | 57.5 | | |
| Waste/cover | 60.0 | 10.0 | 600.0 | | |
| Drainage sand | 115.0 | 2.0 | 230.0 | | |
| **Total** | | **12.5** | **887.5** | **=>** | **1,000** |

**Scenario 3 - 25 ft waste + 6-inch daily cover**

| Material | Material Density (pcf) | Depth of Material (ft) | Load (psf) | | |
|---|---|---|---|---|---|
| Daily cover | 115.0 | 0.5 | 57.5 | | |
| Waste/cover | 60.0 | 25.0 | 1,500.0 | | |
| Drainage sand | 115.0 | 2.0 | 230.0 | | |
| **Total** | | **27.5** | **1,787.5** | **=>** | **2,000** |

**Scenario 4 - 60 ft waste + 6-inch daily cover + 1 ft intermediate cover**

| Material | Material Density (pcf) | Depth of Material (ft) | Load (psf) | | |
|---|---|---|---|---|---|
| Int cover | 115.0 | 1.0 | 115.0 | | |
| Daily cover | 115.0 | 0.5 | 57.5 | | |
| Waste/cover | 60.0 | 60.0 | 3,600.0 | | |
| Drainage sand | 115.0 | 2.0 | 230.0 | | |
| **Total** | | **63.5** | **4,002.5** | **=>** | **4,000** |

**Revised April 1, 2013**

| CLIENT | PROJECT | JOB NO. |
|---|---|---|
| Hardee County | Phase II Section II Expansion | 09199033.23 |

| SUBJECT | BY | DATE |
|---|---|---|
| Leachate Collection & Removal System | SRF | 8/31/12 |
| Bi-planar Geocomposite | CHECKED | DATE |
| Transmissivity/Hydraulic Conductivity Calculations | | |

## BI-PLANAR (PRIMARY COLLECTION SYSTEM)

PURPOSE:

Calculate the design transmissivity, k, of a 300-mil bi-planar geocomposite under boundary conditions for various site specific loading conditions.

From the GSE technical department, the following Transmissivity ($\theta$) values are known:
(Based on FabriNet UF geocomposite specifications).

| FabriNet UF | | soil/geocomposite/geomembrane |
|---|---|---|
| @ 2% Gradient | | Manufacturer's 100 hour $\theta_{100}$ Data |
| Load (psf) | $\theta_{ultimate}$ ($m^2$/sec) | Refer to Attachment 3 |
| 1,000 | 3.00E-03 | |
| 2,000 | 2.30E-03 | (interpolated value) |
| 4,000 | 2.10E-03 | (interpolated value) |
| 5,000 | 2.00E-03 | |
| 6,000 | 1.90E-03 | (interpolated value) |
| 10,000 | 1.50E-03 | |

Reduction Factors

RF - Intrusion, $RF_{IN}$
RF - Chemical Clogging, $RF_{CC}$
RF - Biological Clogging, $RF_{BC}$
RF - Creep, $RF_{CR}$
FS - Factor of Safety

thickness, t = 300 mil
0.30 inches
0.762 cm

Equations

$$\theta_{allow} = \frac{\theta_{ultimate}}{RF_{IN} * RF_{CC} * RF_{BC} * RF_{CR} * FS}$$

$$t' = \frac{t}{RF_{CR}}$$

$$k = \frac{\theta_{allow}}{t'}$$

Leachate Collection System

| | | | | |
|---|---|---|---|---|
| Chemical Clogging $RF_{CC}$ = | 1.5 | to | 2.0 | Refer to Attachment 1 pg GC8-9 |
| Biological Clogging $RF_{BC}$ = | 1.1 | to | 1.3 | Refer to Attachment 1 pg GC8-9 |

Leachate Detection System

| | | | | |
|---|---|---|---|---|
| Chemical Clogging $RF_{CC}$ = | 1.1 | to | 1.5 | Refer to Attachment 1 pg GC8-9 |
| Biological Clogging $RF_{BC}$ = | 1.1 | to | 1.3 | Refer to Attachment 1 pg GC8-9 |

**Revised April 1, 2013**

| CLIENT | PROJECT | JOB NO. |
|---|---|---|
| Hardee County | Phase II Section II Expansion | 09199033.23 |

| SUBJECT | BY | DATE |
|---|---|---|
| Leachate Collection & Removal System | SRF | 8/31/12 |
| Bi-planar Geocomposite | CHECKED | DATE |
| Transmissivity/Hydraulic Conductivity Calculations | | |

**BI-PLANAR (PRIMARY COLLECTION SYSTEM)**

**Scenario 1 - open cell, 0 ft waste**
**and**
**Scenario 2 - 10 ft waste + 6-inch daily cover**

Reduction Factors

$RF_{IN}$ = 1.0
$RF_{CC}$ = 1.5
$RF_{BC}$ = 1.1
$RF_{CR}$ = 1.0
FS = 2.0

Refer to Attachment 1 pg GC8-9

thickness, t = 300 mil
0.30 inches
0.762 cm

| @ 2.0% Gradient | | | | | | |
|---|---|---|---|---|---|---|
| Load (psf) | $\theta_{Ultimate}$ ($m^2$/sec) | $\theta_{allow}$ ($m^2$/sec) | $\theta_{allow}$ ($cm^2$/sec) | t' (cm) | k (cm/sec) | |
| 1,000 | 3.00E-03 | 9.09E-04 | 9.1 | 0.762 | 11.9 | Scenario 1 and 2 |

t' = 0.300 inches

**Scenario 3 - 25 ft waste + 6-inch daily cover**

Reduction Factors

$RF_{IN}$ = 1.0
$RF_{CC}$ = 1.8
$RF_{BC}$ = 1.2
$RF_{CR}$ = 1.10
FS = 2.0

Refer to Attachment 1 pg GC8-9

thickness, t = 300 mil
0.30 inches
0.762 cm

| @ 2.0% Gradient | | | | | | |
|---|---|---|---|---|---|---|
| Load (psf) | $\theta_{Ultimate}$ ($m^2$/sec) | $\theta_{allow}$ ($m^2$/sec) | $\theta_{allow}$ ($cm^2$/sec) | t' (cm) | k (cm/sec) | |
| 2,000 | 2.30E-03 | 4.98E-04 | 5.0 | 0.693 | 7.2 | Scenario 3 |

t' = 0.273 inches

**Scenario 4 - 60 ft waste + 6-inch daily cover + 1 ft intermediate cover**

Reduction Factors

$RF_{IN}$ = 1.0
$RF_{CC}$ = 2.0
$RF_{BC}$ = 1.3
$RF_{CR}$ = 1.15
FS = 2.0

Refer to Attachment 1 pg GC8-9

thickness, t = 300 mil
0.30 inches
0.762 cm

| @ 2.0% Gradient | | | | | | |
|---|---|---|---|---|---|---|
| Load (psf) | $\theta_{Ultimate}$ ($m^2$/sec) | $\theta_{allow}$ ($m^2$/sec) | $\theta_{allow}$ ($cm^2$/sec) | t' (cm) | k (cm/sec) | |
| 4,000 | 2.10E-03 | 3.51E-04 | 3.5 | 0.663 | 5.3 | Scenario 4 |

t' = 0.261 inches

**Revised April 1, 2013**

# Revised Tri-Planar Transmissivity Calculations

SCS ENGINEERS

SHEET 1 OF 5

| CLIENT | PROJECT | JOB NO. |
|---|---|---|
| Hardee County | Phase II Section II Expansion | 09199033.23 |

| SUBJECT | BY | DATE |
|---|---|---|
| Leachate Collection & Removal System<br>Tri-planar Geocomposite<br>Transmissivity/Hydraulic Conductivity Calculations | SRF | 8/31/12 |
| | CHECKED | DATE |

OBJECTIVE:

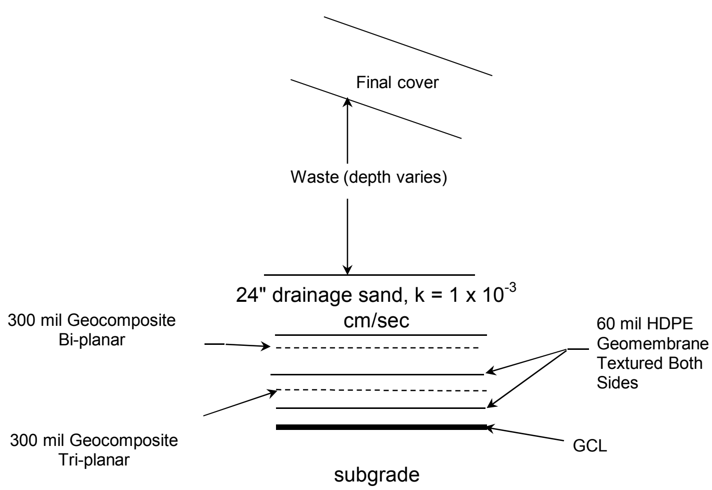
To determine the design hydraulic conductivity, design thickness, and porosity of the geocomposite selected for use in the leachate detection system at various loads using manufacturer's testing data. The calculations for the long-term transmissivity of the geocomposite are based on 100 hour transmissivity values.

REFERENCES:

1. Attachment 1 - GRI Standard - GC8 Technical Release, April 17, 2001.
2. Attachment 2 - Tri-planar material properties (Tendrain 770-2 Double sided Geocomposite) data sheets.
3. Attachment 3 - Correspondence from manufacturer for tri-planar 100 hour transmissivity values.
4. Attachment 4 - Soil properties

PROCEDURE:

1. Geocomposite properties are dependent on landfill load, leachate and other conditions. Determine loads on geocomposite.
2. GRI Standard - GC8 is a way to determine geocomposite allowable flow rates based on site specific landfill conditions.
3. Calculate the downstream hydraulic conductivity (k) for various landfill conditions.
4. Determine the hydraulic conductivity for different loading conditions.
5. Use Table 4 - "Default Soil, Waste, and Geosynthetic Characteristics" for soil texture within the HELP model.
6. Use calculated values to run the HELP model.




**Revised April 1, 2013**

| CLIENT | PROJECT | JOB NO. |
|---|---|---|
| Hardee County | Phase II Section II Expansion | 09199033.23 |

| SUBJECT | BY | DATE |
|---|---|---|
| Leachate Collection & Removal System<br>Tri-planar Geocomposite<br>Transmissivity/Hydraulic Conductivity Calculations | SRF | 8/31/12 |
| | CHECKED | DATE |

EQUATIONS:

Refer to Attachment 1 developed from Equation (1) and Equation (2) pg GC8-3

$$\theta_{allow} = \frac{\theta_{ultimate}}{RF_{IN} * RF_{CC} * RF_{BC} * RF_{CR} * FS}$$

Where:

$\theta_{allow}$ = Allowable transmissivity

$\theta_{ultimate}$ = Ultimate transmissivity (manufacturer's) under simulated conditions for 100 hours

$RF_{IN}$ = Reduction Factor for elastic deformation, or intrusion of the adjacent geotextiles into the drainage channel

$RF_{CC}$ = Reduction Factor for Chemical Clogging and/or precipitation of chemicals in the drainage core space

$RF_{BC}$ = Reduction Factor for Biological Clogging in the drainage core space

$RF_{CR}$ = Reduction Factor for Creep deformation of the drainage core and/or adjacent geotextile into the drainage channel

FS = Factor of Safety

$$RF_{CR} = \left[\frac{(t'/t) - (1 - n_{original})}{(t_{CR}/t) - (1 - n_{original})}\right]^3$$

Refer to Attachment 1 Equation (6) pg GC8-6

Where:

t' = Thickness at 100 hours

t = Virgin thickness

$t_{CR}$ = Thickness at > 100 hours

$n_{original}$ = Original porosity

$$= 1 - \left[\frac{\mu}{\rho \times t}\right]$$

Refer to Attachment 1 Equation (7) pg GC8-7

$\mu$ = mass unit area

$\rho$ = density

$$k = \frac{\theta_{allow}}{t'}$$

Where:

k = Hydraulic conductivity, cm/sec

NOTE:

$RF_{IN}$ accounts for the geotextile encroaching on the geonet under a constant loading. A 100-hour transmissivity test accounts for intrusion. After the 100-hour seat time, the geotextile has already begun to intrude into the geonet, therefore, the transmissivity value reflects the intrusion. The transmissivity values for these calculations are all based on the 100-hour test, therefore, $RF_{IN}$ = 1.0.

**Revised April 1, 2013**

| CLIENT | PROJECT | JOB NO. |
|---|---|---|
| Hardee County | Phase II Section II Expansion | 09199033.23 |

| SUBJECT | BY | DATE |
|---|---|---|
| Leachate Collection & Removal System<br>Tri-planar Geocomposite<br>Transmissivity/Hydraulic Conductivity Calculations | SRF | 8/31/12 |
| | CHECKED | DATE |

OBJECTIVE: To determine the load on the bottom liner geocomposite under different scenarios.

KNOWN: Landfill cross-section

| | | | |
|---|---|---|---|
| Bottom liner low point elevation = | 80.0 | ft NGVD | Low point between north and center portions of Expansion. |
| Elevation over low point = | 143.5 | ft NGVD | |
| Max depth = | 63.5 | ft | |
| Final cover = | 115.0 | pcf | Refer to Attachment 4 |
| Intermediate/daily cover = | 115.0 | pcf | Refer to Attachment 4 |
| Waste/cover = | 60.0 | pcf | |
| Drainage sand = | 115.0 | pcf | Refer to Attachment 4 |

**Scenario 1 - open cell, 0 ft waste**

| Material | Material Density (pcf) | Depth of Material (ft) | Load (psf) | | |
|---|---|---|---|---|---|
| Waste/cover | 60.0 | 0.0 | 0.0 | | |
| Drainage sand | 115.0 | 2.0 | 230.0 | | |
| **Total** | | **2.0** | **230.0** | **=>** | **500** |

**Scenario 2 - 10 ft waste + 6-inch daily cover**

| Material | Material Density (pcf) | Depth of Material (ft) | Load (psf) | | |
|---|---|---|---|---|---|
| Daily cover | 115.0 | 0.5 | 57.5 | | |
| Waste/cover | 60.0 | 10.0 | 600.0 | | |
| Drainage sand | 115.0 | 2.0 | 230.0 | | |
| **Total** | | **12.5** | **887.5** | **=>** | **1,000** |

**Scenario 3 - 25 ft waste + 6-inch daily cover**

| Material | Material Density (pcf) | Depth of Material (ft) | Load (psf) | | |
|---|---|---|---|---|---|
| Daily cover | 115.0 | 0.5 | 57.5 | | |
| Waste/cover | 60.0 | 25.0 | 1,500.0 | | |
| Drainage sand | 115.0 | 2.0 | 230.0 | | |
| **Total** | | **27.5** | **1,787.5** | **=>** | **2,000** |

**Scenario 4 - 60 ft waste + 6-inch daily cover + 1 ft intermediate cover**

| Material | Material Density (pcf) | Depth of Material (ft) | Load (psf) | | |
|---|---|---|---|---|---|
| Int cover | 115.0 | 1.0 | 115.0 | | |
| Daily cover | 115.0 | 0.5 | 57.5 | | |
| Waste/cover | 60.0 | 60.0 | 3,600.0 | | |
| Drainage sand | 115.0 | 2.0 | 230.0 | | |
| **Total** | | **63.5** | **4,002.5** | **=>** | **4,000** |

**Revised April 1, 2013**

| CLIENT | PROJECT | JOB NO. |
| --- | --- | --- |
| Hardee County | Phase II Section II Expansion | 09199033.23 |

| SUBJECT | BY | DATE |
| --- | --- | --- |
| Leachate Collection & Removal System | SRF | 8/31/12 |
| Tri-planar Geocomposite | CHECKED | DATE |
| Transmissivity/Hydraulic Conductivity Calculations | | |

## TRI-PLANAR (SECONDARY COLLECTION SYSTEM)

PURPOSE:

Calculate the design transmissivity, k, of a 300-mil tri-planar geocomposite under boundary conditions for various site specific loading conditions.

From the SYNTEC technical department, the following Transmissivity (θ) values are known:
(Based on TENDRAIN 770-2 geocomposite specifications ).

| TENDRAIN 770-2 | | geomembrane/geocomposite/geomembrane |
| --- | --- | --- |
| @ 2% Gradient | | Manufacturer's 100 hour $\theta_{100}$ Data |
| Load (psf) | $\theta_{ultimate}$ ($m^2$/sec) | Refer to Attachment 3 |
| 1,000 | 7.50E-03 | |
| 2,000 | 7.00E-03 | |
| 4,000 | 6.00E-03 | |
| 5,000 | 5.00E-03 | |
| 10,000 | 4.00E-03 | |

Reduction Factors

RF - Intrusion, $RF_{IN}$

RF - Chemical Clogging, $RF_{CC}$

RF - Biological Clogging, $RF_{BC}$

RF - Creep, $RF_{CR}$

FS - Factor of Safety

thickness, t = 300 mil
0.30 inches
0.762 cm

Equations

$$\theta_{allow} = \frac{\theta_{ultimate}}{RF_{IN} * RF_{CC} * RF_{BC} * RF_{CR} * FS}$$

$$t' = \frac{t}{RF_{CR}}$$

$$k = \frac{\theta_{allow}}{t'}$$

Leachate Collection System

| | | | | |
| --- | --- | --- | --- | --- |
| Chemical Clogging $RF_{CC}$ = | 1.5 | to | 2.0 | Refer to Attachment 1 pg GC8-9 |
| Biological Clogging $RF_{BC}$ = | 1.1 | to | 1.3 | Refer to Attachment 1 pg GC8-9 |

Leachate Detection System

| | | | | |
| --- | --- | --- | --- | --- |
| Chemical Clogging $RF_{CC}$ = | 1.1 | to | 1.5 | Refer to Attachment 1 pg GC8-9 |
| Biological Clogging $RF_{BC}$ = | 1.1 | to | 1.3 | Refer to Attachment 1 pg GC8-9 |

**Revised April 1, 2013**

| CLIENT | PROJECT | JOB NO. |
|---|---|---|
| Hardee County | Phase II Section II Expansion | 09199033.23 |

| SUBJECT | BY | DATE |
|---|---|---|
| Leachate Collection & Removal System<br>Tri-planar Geocomposite<br>Transmissivity/Hydraulic Conductivity Calculations | SRF | 8/31/12 |
| | CHECKED | DATE |

## TRI-PLANAR (SECONDARY COLLECTION SYSTEM)

**Scenario 1 - open cell, 0 ft waste**
**and**
**Scenario 2 - 10 ft waste + 6-inch daily cover**

Reduction Factors

$RF_{IN}$ = 1.0
$RF_{CC}$ = 1.1
$RF_{BC}$ = 1.1
$RF_{CR}$ = 1.0
FS = 2.0

Refer to Attachment 1 pg GC8-9

thickness, t = 300 mil
0.30 inches
0.762 cm

| @ 2.0% Gradient | | | | | | |
|---|---|---|---|---|---|---|
| Load (psf) | $\theta_{Ultimate}$ ($m^2$/sec) | $\theta_{allow}$ ($m^2$/sec) | $\theta_{allow}$ ($cm^2$/sec) | t' (cm) | k (cm/sec) | |
| 1,000 | 7.50E-03 | 3.10E-03 | 31.0 | 0.762 | 40.7 | Scenario 1 and 2 |

t' = 0.300 inches

**Scenario 3 - 25 ft waste + 6-inch daily cover**

Reduction Factors

$RF_{IN}$ = 1.0
$RF_{CC}$ = 1.3
$RF_{BC}$ = 1.2
$RF_{CR}$ = 1.10
FS = 2.0

Refer to Attachment 1 pg GC8-9

thickness, t = 300 mil
0.30 inches
0.762 cm

| @ 2.0% Gradient | | | | | | |
|---|---|---|---|---|---|---|
| Load (psf) | $\theta_{Ultimate}$ ($m^2$/sec) | $\theta_{allow}$ ($m^2$/sec) | $\theta_{allow}$ ($cm^2$/sec) | t' (cm) | k (cm/sec) | |
| 2,000 | 7.00E-03 | 2.04E-03 | 20.4 | 0.693 | 29.4 | Scenario 3 |

t' = 0.273 inches

**Scenario 4 - 60 ft waste + 6-inch daily cover + 1 ft intermediate cover**

Reduction Factors

$RF_{IN}$ = 1.0
$RF_{CC}$ = 1.5
$RF_{BC}$ = 1.3
$RF_{CR}$ = 1.15
FS = 2.0

Refer to Attachment 1 pg GC8-9

thickness, t = 300 mil
0.30 inches
0.762 cm

0.001444

| @ 2.0% Gradient | | | | | | |
|---|---|---|---|---|---|---|
| Load (psf) | $\theta_{Ultimate}$ ($m^2$/sec) | $\theta_{allow}$ ($m^2$/sec) | $\theta_{allow}$ ($cm^2$/sec) | t' (cm) | k (cm/sec) | |
| 4,000 | 6.00E-03 | 1.44E-03 | 14.4 | 0.663 | 21.8 | Scenario 4 |

t' = 0.261 inches

**Revised April 1, 2013**

# SKAPS Bi-Planar Transmissivity Calculations

SCS ENGINEERS



| CLIENT | PROJECT | JOB NO. |
|---|---|---|
| Hardee County | Phase II Section II Expansion | 09199033.23 |

| SUBJECT | BY | DATE |
|---|---|---|
| Leachate Collection & Removal System<br>Bi-planar Geocomposite<br>Transmissivity/Hydraulic Conductivity Calculations | SRF | 4/1/13 |
| | CHECKED | DATE |

OBJECTIVE:

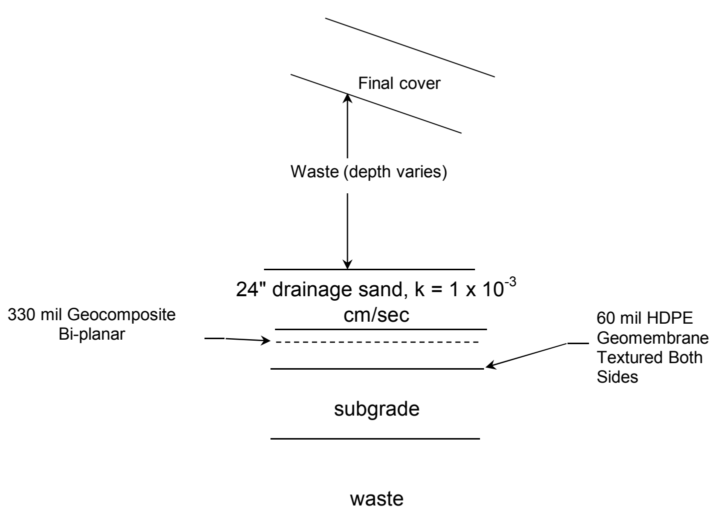
To determine the design hydraulic conductivity, design thickness, and porosity of the geocomposite selected for use in the leachate collection system at various loads using CQA testing data. The calculations for the long-term transmissivity of the geocomposite are based on 100 hour transmissivity values.

REFERENCES:

1. Attachment 1 - GRI Standard - GC8 Technical Release, April 17, 2001
2. Attachment 2 - Bi-planar material properties (SKAPS TN330-2-8) data sheets.
3. Attachment 3 - CQA Testing Data from construction of the Hardee County Landfill Phase I Closure Project
4. Attachment 4 - Soil properties

PROCEDURE:

1. Geocomposite properties are dependent on landfill load, leachate and other conditions. Determine loads on geocomposite.
2. GRI Standard - GC8 is a way to determine geocomposite allowable flow rates based on site specific landfill conditions.
3. Calculate the downstream hydraulic conductivity (k) for various landfill conditions.
4. Determine the hydraulic conductivity for different loading conditions.
5. Use Table 4 - "Default Soil, Waste, and Geosynthetic Characteristics" for soil texture within the HELP model.
6. Use calculated values to run the HELP model.



| CLIENT | PROJECT | JOB NO. |
|---|---|---|
| Hardee County | Phase II Section II Expansion | 09199033.23 |

| SUBJECT | BY | DATE |
|---|---|---|
| Leachate Collection & Removal System<br>Bi-planar Geocomposite<br>Transmissivity/Hydraulic Conductivity Calculations | SRF | 4/1/13 |
| | CHECKED | DATE |

EQUATIONS:

Refer to Attachment 1 developed from Equation (1) and Equation (2) pg GC8-3

$$\theta_{allow} = \frac{\theta_{ultimate}}{RF_{IN} * RF_{CC} * RF_{BC} * RF_{CR} * FS}$$

Where:

$\theta_{allow}$ = Allowable transmissivity
$\theta_{ultimate}$ = Ultimate transmissivity (manufacturer's) under simulated conditions for 100 hours
$RF_{IN}$ = Reduction Factor for elastic deformation, or intrusion of the adjacent geotextiles into the drainage channel
$RF_{CC}$ = Reduction Factor for Chemical Clogging and/or precipitation of chemicals in the drainage core space
$RF_{BC}$ = Reduction Factor for Biological Clogging in the drainage core space
$RF_{CR}$ = Reduction Factor for Creep deformation of the drainage core and/or adjacent geotextile into the drainage channel
FS = Factor of Safety

$$RF_{CR} = \left[\frac{(t'/t) - (1 - n_{original})}{(t_{CR}/t) - (1 - n_{original})}\right]^3$$

Refer to Attachment 1 Equation (6) pg GC8-6

Where:

t' = Thickness at 100 hours
t = Virgin thickness
$t_{CR}$ = Thickness at > 100 hours

$n_{original}$ = Original porosity

$$= 1 - \left[\frac{\mu}{\rho \times t}\right]$$

Refer to Attachment 1 Equation (7) pg GC8-7

$\mu$ = mass unit area
$\rho$ = density

$$k = \frac{\theta_{allow}}{t'}$$

Where:

k = Hydraulic conductivity, cm/sec

NOTE:

$RF_{IN}$ accounts for the geotextile encroaching on the geonet under a constant loading. A 100-hour transmissivity test accounts for intrusion. After the 100-hour seat time, the geotextile has already begun to intrude into the geonet, therefore, the transmissivity value reflects the intrusion. The transmissivity values for these calculations are all based on the 100-hour test, therefore, $RF_{IN}$ = 1.0.

SCS ENGINEERS

SHEET 3 OF 5

| CLIENT | PROJECT | JOB NO. |
|---|---|---|
| Hardee County | Phase II Section II Expansion | 09199033.23 |

| SUBJECT | BY | DATE |
|---|---|---|
| Leachate Collection & Removal System<br>Bi-planar Geocomposite<br>Transmissivity/Hydraulic Conductivity Calculations | SRF | 4/1/13 |
| | CHECKED | DATE |

OBJECTIVE: To determine the load on the Phase I sideslope bottom liner geocomposite under different scenarios.

KNOWN: Landfill cross-section

| | | | |
|---|---|---|---|
| Bottom sideslope low elevation = | 90.0 | ft NGVD | |
| Elevation over sideslop low point = | 140.0 | ft NGVD | |
| Max depth = | 25.0 | ft | Average of worse-case depth over Phase I sideslope |
| Final cover = | 115.0 | pcf | Refer to Attachment 4 |
| Intermediate/daily cover = | 115.0 | pcf | Refer to Attachment 4 |
| Waste/cover = | 60.0 | pcf | |
| Drainage sand = | 115.0 | pcf | Refer to Attachment 4 |

**Scenario 1 - open cell, 0 ft waste**

| Material | Material Density (pcf) | Depth of Material (ft) | Load (psf) | | |
|---|---|---|---|---|---|
| Waste/cover | 60.0 | 0.0 | 0.0 | | |
| Drainage sand | 115.0 | 2.0 | 230.0 | | |
| **Total** | | **2.0** | **230.0** | **=>** | **500** |

**Scenario 2 - 10 ft waste+ 6-inch daily cover**

| Material | Material Density (pcf) | Depth of Material (ft) | Load (psf) | | |
|---|---|---|---|---|---|
| Daily cover | 115.0 | 0.5 | 57.5 | | |
| Waste/cover | 60.0 | 10.0 | 600.0 | | |
| Drainage sand | 115.0 | 2.0 | 230.0 | | |
| **Total** | | **12.5** | **887.5** | **=>** | **1,000** |

**Scenario 3 - 15 ft waste + 6-inch daily cover**

| Material | Material Density (pcf) | Depth of Material (ft) | Load (psf) | | |
|---|---|---|---|---|---|
| Daily cover | 115.0 | 0.5 | 57.5 | | |
| Waste/cover | 60.0 | 15.0 | 900 | | |
| Drainage sand | 115.0 | 2.0 | 230 | | |
| **Total** | | **17.5** | **1,187.5** | **=>** | **1,500** |

**Scenario 3 - 25 ft waste + 6-inch daily cover + 1 ft intermediate cover**

| Material | Material Density (pcf) | Depth of Material (ft) | Load (psf) | | |
|---|---|---|---|---|---|
| Int cover | 115.0 | 1.0 | 115.0 | | |
| Daily cover | 115.0 | 0.5 | 57.5 | | |
| Waste/cover | 60.0 | 25.0 | 1,500.0 | | |
| Drainage sand | 115.0 | 2.0 | 230.0 | | |
| **Total** | | **28.5** | **1,902.5** | **=>** | **2,000** |

| CLIENT | PROJECT | JOB NO. |
|---|---|---|
| Hardee County | Phase II Section II Expansion | 09199033.23 |

| SUBJECT | BY | DATE |
|---|---|---|
| Leachate Collection & Removal System | SRF | 4/1/13 |
| Bi-planar Geocomposite | CHECKED | DATE |
| Transmissivity/Hydraulic Conductivity Calculations | | |

## BI-PLANAR (PRIMARY COLLECTION SYSTEM)

PURPOSE:

Calculate the design transmissivity, k, of a 330-mil bi-planar geocomposite under boundary conditions for various site specific loading conditions.

From the CQA conformance testing conducted during the Hardee Phase I Closure Project, the following Transmissivity (q) values are known. Based on SKAPS TN330-2-8 geocomposite.

| SKAPS TN330-2-8 | | soil/geocomposite/geomembrane | | |
|---|---|---|---|---|
| @ 33% Gradient | | CQA 100 hour $\theta_{100}$ Data | | |
| Load (psf) | $\theta_{ultimate}$ ($m^2$/sec) | Refer to Attachment 3 | Load 800 psf | Load 5,000 psf |
| 800 | 2.18E-03 | Average CQA testing value | 1.93E-03 | 1.50E-03 |
| 1,000 | 2.15E-03 | (interpolated value) | 1.82E-03 | 1.40E-03 |
| 1,500 | 2.07E-03 | (interpolated value) | 2.90E-03 | 2.01E-03 |
| 2,000 | 2.00E-03 | (interpolated value) | 2.06E-03 | 1.31E-03 |
| 4,000 | 1.70E-03 | Average CQA testing value = | 2.18E-03 | 1.56E-03 |
| 5,000 | 1.56E-03 | | | |

Reduction Factors

RF - Intrusion, $RF_{IN}$

RF - Chemical Clogging, $RF_{CC}$

RF - Biological Clogging, $RF_{BC}$

RF - Creep, $RF_{CR}$

FS - Factor of Safety

thickness, t = 330 mil

0.33 inches

0.8382 cm

Equations

$$\theta_{allow} = \frac{\theta_{ultimate}}{RF_{IN} * RF_{CC} * RF_{BC} * RF_{CR} * FS}$$

$$t' = \frac{t}{RF_{CR}}$$

$$k = \frac{\theta_{allow}}{t'}$$

Leachate Collection System

| | | | | |
|---|---|---|---|---|
| Chemical Clogging $RF_{CC}$ = | 1.5 | to | 2.0 | Refer to Attachment 1 pg GC8-9 |
| Biological Clogging $RF_{BC}$ = | 1.1 | to | 1.3 | Refer to Attachment 1 pg GC8-9 |

Leachate Detection System

| | | | | |
|---|---|---|---|---|
| Chemical Clogging $RF_{CC}$ = | 1.1 | to | 1.5 | Refer to Attachment 1 pg GC8-9 |
| Biological Clogging $RF_{BC}$ = | 1.1 | to | 1.3 | Refer to Attachment 1 pg GC8-9 |

SCS ENGINEERS

SHEET 5 OF 5

| CLIENT | PROJECT | JOB NO. |
|---|---|---|
| Hardee County | Phase II Section II Expansion | 09199033.23 |

| SUBJECT | BY | DATE |
|---|---|---|
| Leachate Collection & Removal System<br>Bi-planar Geocomposite<br>Transmissivity/Hydraulic Conductivity Calculations | SRF | 4/1/13 |
| | CHECKED | DATE |

## BI-PLANAR (PRIMARY COLLECTION SYSTEM)

**Scenario 1 - open cell, 0 ft waste**
**and**
**Scenario 2 - 10 ft waste+ 6-inch daily cover**

Reduction Factors

$RF_{IN}$ = 1.0
$RF_{CC}$ = 1.5
$RF_{BC}$ = 1.1
$RF_{CR}$ = 1.0
FS = 2.0

Refer to Attachment 1 pg GC8-9

thickness, t = 330 mil
0.33 inches
0.8382 cm

| @ 33% Gradient | | | | | | |
|---|---|---|---|---|---|---|
| Load (psf) | $\theta_{Ultimate}$ ($m^2$/sec) | $\theta_{allow}$ ($m^2$/sec) | $\theta_{allow}$ ($cm^2$/sec) | t' (cm) | k (cm/sec) | |
| 1,000 | 2.15E-03 | 6.51E-04 | 6.5 | 0.8382 | 7.8 | Scenario 1 and 2 |

t' = 0.330 inches

**Scenario 3 - 15 ft waste + 6-inch daily cover**

Reduction Factors

$RF_{IN}$ = 1.0
$RF_{CC}$ = 1.8
$RF_{BC}$ = 1.2
$RF_{CR}$ = 1.10
FS = 2.0

Refer to Attachment 1 pg GC8-9

thickness, t = 330 mil
0.33 inches
0.8382 cm

| @ 33% Gradient | | | | | | |
|---|---|---|---|---|---|---|
| Load (psf) | $\theta_{Ultimate}$ ($m^2$/sec) | $\theta_{allow}$ ($m^2$/sec) | $\theta_{allow}$ ($cm^2$/sec) | t' (cm) | k (cm/sec) | |
| 1,500 | 2.07E-03 | 4.49E-04 | 4.5 | 0.762 | 5.70 | Scenario 3 |

t' = 0.300 inches

**Scenario 3 - 25 ft waste + 6-inch daily cover + 1 ft intermediate cover**

Reduction Factors

$RF_{IN}$ = 1.0
$RF_{CC}$ = 2.0
$RF_{BC}$ = 1.3
$RF_{CR}$ = 1.15
FS = 2.0

Refer to Attachment 1 pg GC8-9

thickness, t = 330 mil
0.33 inches
0.8382 cm

| @ 33% Gradient | | | | | | |
|---|---|---|---|---|---|---|
| Load (psf) | $\theta_{Ultimate}$ ($m^2$/sec) | $\theta_{allow}$ ($m^2$/sec) | $\theta_{allow}$ ($cm^2$/sec) | t' (cm) | k (cm/sec) | |
| 2,000 | 2.00E-03 | 3.34E-04 | 3.3 | 0.729 | 4.6 | Scenario 4 |

t' = 0.287 inches

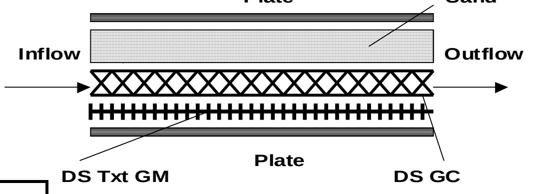
# GEOCOMPOSITE TEST RESULTS

**TRI Client: SCS Engineers**
**Project: Hardee County Phase 1 Closure**

**Material: Skaps TN 330-2-8 Double Sided Geocomposite**
**Sample Identification: 396010006**
**TRI Log #: E2348-72-01**

| PARAMETER | TEST REPLICATE NUMBER | | | | | | | | | | MEAN | STD. DEV. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | | |

**Hydraulic Transmissivity (ASTM D 4716)**

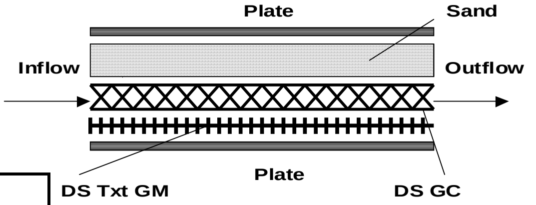



| Direction Tested: Machine Direction | |
|---|---|
| Normal Load (psf): | 5,000 |
| Hydraulic Gradient: | 0.33 |
| Test Length (in) | 12 |
| Test Width (in) | 12 |

Plate / Ottawa Sand / GC Sample / 60 mil. TXHDGM / Plate

| Seat Time (hours) | | Specimen | 1 | | | MEAN | STD. DEV. |
|---|---|---|---|---|---|---|---|
| | Volume (cc) | | 927 | 903 | 899 | | |
| | Time (s) | | 5.46 | 5.41 | 5.41 | | |
| 1 | Flow Rate (GPM/ft width) | | 2.69 | 2.65 | 2.63 | 2.66 | 0.03 |
| | Transmissivity (m^2/s) | | 1.69E-03 | 1.66E-03 | 1.65E-03 | 1.67E-03 | 1.89E-05 |
| | Test Temp (C) | | | 20.0 | | | |
| | Temp. Corr. Factor | | | 1.000 | | | |

**Hydraulic Transmissivity (ASTM D 4716)**




| Direction Tested: Machine Direction | |
|---|---|
| Normal Load (psf): | 5,000 |
| Hydraulic Gradient: | 0.33 |
| Test Length (in) | 12 |
| Test Width (in) | 12 |

Plate / Ottawa Sand / GC Sample / 60 mil. TXHDGM / Plate

| Seat Time (hours) | | Specimen | 1 | | | MEAN | STD. DEV. |
|---|---|---|---|---|---|---|---|
| | Pre-Test Thickness (in) | | | 0.479 | | | |
| | Post-Test Thickness (in) | | | 0.451 | | | |
| | Volume (cc) | | 836 | 804 | 800 | | |
| | Time (s) | | 5.46 | 5.36 | 5.36 | | |
| | Flow Rate (GPM/ft width) | | 2.43 | 2.38 | 2.37 | 2.39 | 0.03 |
| 100 | Transmissivity (m^2/s) | | 1.52E-03 | 1.49E-03 | 1.48E-03 | 1.50E-03 | 2.04E-05 |
| | Permeability (cm/s) | | 13.3 | 13.0 | 12.9 | 13.1 | 0.2 |
| | Test Temp (C) | | | 20.0 | | | |
| | Temp. Corr. Factor | | | 1.000 | | | |

MD Machine Direction TD Transverse Direction NA Not Available

The testing is based upon accepted industry practice as well as the test method listed. Test results reported herein do not apply to samples other than those tested. TRI neither accepts responsibility for nor makes claim as to the final use and purpose of the material. TRI observes and maintains client confidentiality. TRI limits reproduction of this report, except in full, without prior approval of TRI.

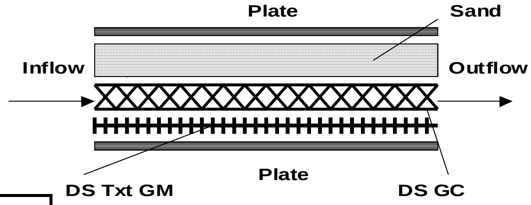
# GEOCOMPOSITE TEST RESULTS

**TRI Client: SCS Engineers**
**Project: Hardee County Phase 1 Closure**

**Material: Skaps TN 330-2-8 Double Sided Geocomposite**
**Sample Identification: 346010046**
**TRI Log #: E2348-72-01**

**PARAMETER** — **TEST REPLICATE NUMBER** (1 2 3 4 5 6 7 8 9 10) — **MEAN** — **STD. DEV.**

## Hydraulic Transmissivity (ASTM D 4716)



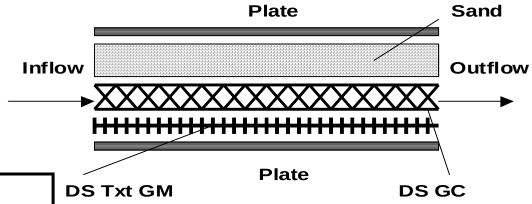

Direction Tested: Machine Direction

| | |
|---|---|
| Normal Load (psf): | 5,000 |
| Hydraulic Gradient: | 0.33 |
| Test Length (in) | 12 |
| Test Width (in) | 12 |

Plate / Ottawa Sand / GC Sample / 60 mil. TXHDGM / Plate

| Seat Time (hours) | Parameter | Specimen 1 | | | MEAN | STD. DEV. |
|---|---|---|---|---|---|---|
| | Volume (cc) | 803 | 801 | 796 | | |
| | Time (s) | 5.40 | 5.38 | 5.43 | | |
| 1 | Flow Rate (GPM/ft width) | 2.36 | 2.36 | 2.32 | **2.35** | 0.02 |
| | Transmissivity (m^2/s) | 1.48E-03 | 1.48E-03 | 1.46E-03 | **1.47E-03** | 1.27E-05 |
| | Test Temp (C) | | 20.0 | | | |
| | Temp. Corr. Factor | | 1.000 | | | |

## Hydraulic Transmissivity (ASTM D 4716)




Direction Tested: Machine Direction

| | |
|---|---|
| Normal Load (psf): | 5,000 |
| Hydraulic Gradient: | 0.33 |
| Test Length (in) | 12 |
| Test Width (in) | 12 |

Plate / Ottawa Sand / GC Sample / 60 mil. TXHDGM / Plate

| Seat Time (hours) | Parameter | Specimen 1 | | | MEAN | STD. DEV. |
|---|---|---|---|---|---|---|
| | Pre-Test Thickness (in) | | 0.464 | | | |
| | Post-Test Thickness (in) | | 0.443 | | | |
| | Volume (cc) | 723 | 724 | 833 | | |
| | Time (s) | 5.32 | 5.33 | 5.50 | | |
| | Flow Rate (GPM/ft width) | 2.15 | 2.15 | 2.40 | **2.24** | 0.14 |
| 100 | Transmissivity (m^2/s) | 1.35E-03 | 1.35E-03 | 1.51E-03 | **1.40E-03** | 8.95E-05 |
| | Permeability (cm/s) | 12.0 | 12.0 | 13.4 | **12.5** | 0.8 |
| | Test Temp (C) | | 20.0 | | | |
| | Temp. Corr. Factor | | 1.000 | | | |

MD Machine Direction  TD Transverse Direction  NA Not Available

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*A Texas Research International Company*

# GEOCOMPOSITE TEST RESULTS

**TRI Client: SCS Engineers**
**Project: Hardee County Phase 1 Closure**

**Material: Skaps TN 330-2-8 Double Sided Geocomposite**
**Sample Identification: 346010090**
**TRI Log #: E2348-72-01**

| PARAMETER | TEST REPLICATE NUMBER | | | | | | | | | | MEAN | STD. DEV. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | | |

**Hydraulic Transmissivity (ASTM D 4716)**

Direction Tested: Machine Direction

| | |
|---|---|
| Normal Load (psf): | 5,000 |
| Hydraulic Gradient: | 0.33 |
| Test Length (in) | 12 |
| Test Width (in) | 12 |

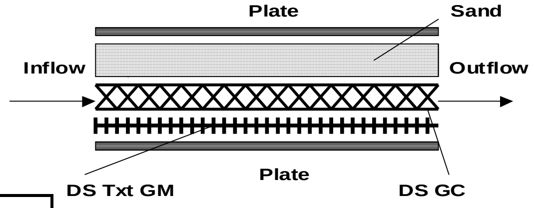



Plate / Ottawa Sand / GC Sample / 60 mil. TXHDGM / Plate

| Seat Time (hours) | | Specimen | | 1 | | MEAN | STD. DEV. |
|---|---|---|---|---|---|---|---|
| | Volume (cc) | | 1159 | 1157 | 1116 | | |
| | Time (s) | | 5.50 | 5.41 | 5.32 | | |
| 1 | Flow Rate (GPM/ft width) | | 3.34 | 3.39 | 3.33 | **3.35** | 0.03 |
| | Transmissivity (m^2/s) | | 2.10E-03 | 2.13E-03 | 2.09E-03 | **2.10E-03** | 2.13E-05 |
| | Test Temp (C) | | | 20.0 | | | |
| | Temp. Corr. Factor | | | 1.000 | | | |

**Hydraulic Transmissivity (ASTM D 4716)**

Direction Tested: Machine Direction

| | |
|---|---|
| Normal Load (psf): | 5,000 |
| Hydraulic Gradient: | 0.33 |
| Test Length (in) | 12 |
| Test Width (in) | 12 |

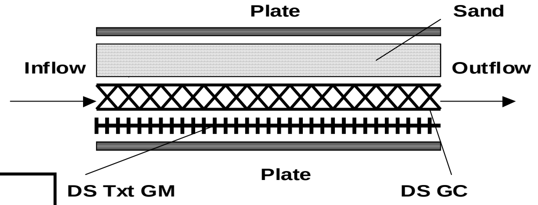



Plate / Ottawa Sand / GC Sample / 60 mil. TXHDGM / Plate

| Seat Time (hours) | | Specimen | | 1 | | MEAN | STD. DEV. |
|---|---|---|---|---|---|---|---|
| | Pre-Test Thickness (in) | | | 0.460 | | | |
| | Post-Test Thickness (in) | | | 0.438 | | | |
| | Volume (cc) | | 1087 | 1068 | 1082 | | |
| | Time (s) | | 5.46 | 5.23 | 5.30 | | |
| | Flow Rate (GPM/ft width) | | 3.16 | 3.24 | 3.24 | **3.21** | 0.05 |
| 100 | Transmissivity (m^2/s) | | 1.98E-03 | 2.03E-03 | 2.03E-03 | **2.01E-03** | 2.92E-05 |
| | Permeability (cm/s) | | 17.8 | 18.2 | 18.2 | **18.1** | 0.3 |
| | Test Temp (C) | | | 20.0 | | | |
| | Temp. Corr. Factor | | | 1.000 | | | |

MD Machine Direction TD Transverse Direction NA Not Available




**GeosyntheticTesting.com**
9063 Bee Caves Road / Austin, TX 78733 / 512 263 2101 / fax: 512 263 2558

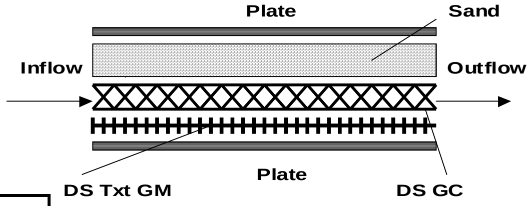
# GEOCOMPOSITE TEST RESULTS

**TRI Client: SCS Engineers**
**Project: Hardee County Phase 1 Closure**

**Material: Skaps TN 330-2-8 Double Sided Geocomposite**
**Sample Identification: 346010140**
**TRI Log #: E2348-72-01**

| PARAMETER | TEST REPLICATE NUMBER | | | | | | | | | | MEAN | STD. DEV. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | | |

**Hydraulic Transmissivity (ASTM D 4716)**



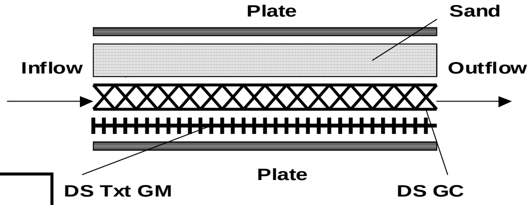

Direction Tested: Machine Direction

| | |
|---|---|
| Normal Load (psf): | 5,000 |
| Hydraulic Gradient: | 0.33 |
| Test Length (in) | 12 |
| Test Width (in) | 12 |

Plate / Ottawa Sand / GC Sample / 60 mil. TXHDGM / Plate

| Seat Time (hours) | Specimen | 1 | | | MEAN | STD. DEV. |
|---|---|---|---|---|---|---|
| | Volume (cc) | 860 | 867 | 856 | | |
| | Time (s) | 5.44 | 5.46 | 5.41 | | |
| 1 | Flow Rate (GPM/ft width) | 2.51 | 2.52 | 2.51 | **2.51** | 0.01 |
| | Transmissivity (m^2/s) | 1.57E-03 | 1.58E-03 | 1.57E-03 | **1.57E-03** | 3.70E-06 |
| | Test Temp (C) | | 20.0 | | | |
| | Temp. Corr. Factor | | 1.000 | | | |

**Hydraulic Transmissivity (ASTM D 4716)**




Direction Tested: Machine Direction

| | |
|---|---|
| Normal Load (psf): | 5,000 |
| Hydraulic Gradient: | 0.33 |
| Test Length (in) | 12 |
| Test Width (in) | 12 |

Plate / Ottawa Sand / GC Sample / 60 mil. TXHDGM / Plate

| Seat Time (hours) | Specimen | 1 | | | MEAN | STD. DEV. |
|---|---|---|---|---|---|---|
| | Pre-Test Thickness (in) | | 0.474 | | | |
| | Post-Test Thickness (in) | | 0.451 | | | |
| | Volume (cc) | 720 | 722 | 739 | | |
| | Time (s) | 5.90 | 5.32 | 5.35 | | |
| | Flow Rate (GPM/ft width) | 1.93 | 2.15 | 2.19 | **2.09** | 0.14 |
| 100 | Transmissivity (m^2/s) | 1.21E-03 | 1.35E-03 | 1.37E-03 | **1.31E-03** | 8.63E-05 |
| | Permeability (cm/s) | 10.6 | 11.8 | 12.0 | **11.5** | 0.8 |
| | Test Temp (C) | | 20.0 | | | |
| | Temp. Corr. Factor | | 1.000 | | | |

MD Machine Direction TD Transverse Direction NA Not Available

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## GEOCOMPOSITE TEST RESULTS

**TRI Client: SCS Engineers**
**Project: Hardee County Phase 1 Closure**

**Material: Skaps TN 330-2-8 Double Sided Geocomposite**
**Sample Identification: 396010179**
**TRI Log #: E2348-73-02**

| PARAMETER | TEST REPLICATE NUMBER | | | | | | | | | | MEAN | STD. DEV. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | | |

**Hydraulic Transmissivity (ASTM D 4716)**

Direction Tested: Machine Direction

| | |
|---|---|
| Normal Load (psf): | 800 |
| Hydraulic Gradient: | 0.33 |
| Test Length (in) | 12 |
| Test Width (in) | 12 |

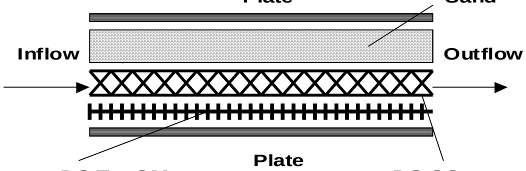



Plate / Ottawa Sand / GC Sample / 40 mil. LL MSGM / Plate

| Seat Time (hours) | | Specimen 1 | | | MEAN | STD. DEV. |
|---|---|---|---|---|---|---|
| 1 | Volume (cc) | 1068 | 1046 | 1069 | | |
| | Time (s) | 5.10 | 5.01 | 5.10 | | |
| | Flow Rate (GPM/ft width) | 3.32 | 3.31 | 3.32 | **3.32** | 0.01 |
| | Transmissivity (m^2/s) | 2.08E-03 | 2.08E-03 | 2.08E-03 | **2.08E-03** | 4.29E-06 |
| | Test Temp (C) | | 20.0 | | | |
| | Temp. Corr. Factor | | 1.000 | | | |

**Hydraulic Transmissivity (ASTM D 4716)**

Direction Tested: Machine Direction

| | |
|---|---|
| Normal Load (psf): | 800 |
| Hydraulic Gradient: | 0.33 |
| Test Length (in) | 12 |
| Test Width (in) | 12 |

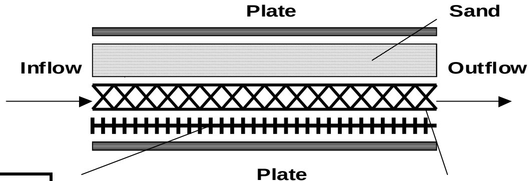



Plate / Ottawa Sand / GC Sample / 40 mil. LL MSGM / Plate

| Seat Time (hours) | | Specimen 1 | | | MEAN | STD. DEV. |
|---|---|---|---|---|---|---|
| 100 | Pre-Test Thickness (in) | | 0.476 | | | |
| | Post-Test Thickness (in) | | 0.463 | | | |
| | Volume (cc) | 970 | 997 | 988 | | |
| | Time (s) | 5.00 | 5.12 | 5.07 | | |
| | Flow Rate (GPM/ft width) | 3.08 | 3.09 | 3.09 | **3.08** | 0.01 |
| | Transmissivity (m^2/s) | 1.93E-03 | 1.94E-03 | 1.94E-03 | **1.93E-03** | 4.64E-06 |
| | Permeability (cm/s) | 16.4 | 16.5 | 16.5 | **16.4** | 0.0 |
| | Test Temp (C) | | 20.0 | | | |
| | Temp. Corr. Factor | | 1.000 | | | |

MD Machine Direction     TD Transverse Direction     NA Not Available

# GEOCOMPOSITE TEST RESULTS

**TRI Client: SCS Engineers**
**Project: Hardee County Phase 1 Closure**

**Material: Skaps TN 330-2-8 Double Sided Geocomposite**
**Sample Identification: 396010222**
**TRI Log #: E2348-73-02**

| PARAMETER | TEST REPLICATE NUMBER | | | | | | | | | | MEAN | STD. DEV. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | | |

**Hydraulic Transmissivity (ASTM D 4716)**

Direction Tested: Machine Direction

| | |
|---|---|
| Normal Load (psf): | 800 |
| Hydraulic Gradient: | 0.33 |
| Test Length (in) | 12 |
| Test Width (in) | 12 |

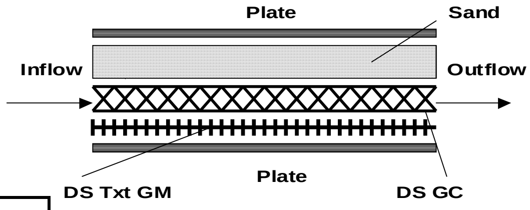



Plate / Ottawa Sand / GC Sample / 40 mil. LL MSGM / Plate

| Seat Time (hours) | | Specimen | 1 | | | MEAN | STD. DEV. |
|---|---|---|---|---|---|---|---|
| | Volume (cc) | | 1002 | 1022 | 1025 | | |
| | Time (s) | | 5.04 | 5.12 | 5.12 | | |
| 1 | Flow Rate (GPM/ft width) | | 3.15 | 3.16 | 3.17 | **3.16** | 0.01 |
| | Transmissivity (m^2/s) | | 1.98E-03 | 1.98E-03 | 1.99E-03 | **1.98E-03** | 6.92E-06 |
| | Test Temp (C) | | | 20.0 | | | |
| | Temp. Corr. Factor | | | 1.000 | | | |

**Hydraulic Transmissivity (ASTM D 4716)**

Direction Tested: Machine Direction

| | |
|---|---|
| Normal Load (psf): | 800 |
| Hydraulic Gradient: | 0.33 |
| Test Length (in) | 12 |
| Test Width (in) | 12 |

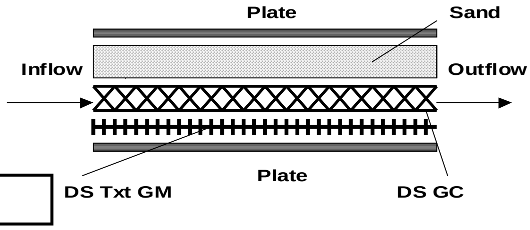



Plate / Ottawa Sand / GC Sample / 40 mil. LL MSGM / Plate

| Seat Time (hours) | | Specimen | 1 | | | MEAN | STD. DEV. |
|---|---|---|---|---|---|---|---|
| | Pre-Test Thickness (in) | | | 0.479 | | | |
| | Post-Test Thickness (in) | | | 0.465 | | | |
| | Volume (cc) | | 948 | 940 | 943 | | |
| | Time (s) | | 5.18 | 5.13 | 5.13 | | |
| | Flow Rate (GPM/ft width) | | 2.90 | 2.90 | 2.91 | **2.91** | 0.01 |
| 100 | Transmissivity (m^2/s) | | 1.82E-03 | 1.82E-03 | 1.83E-03 | **1.82E-03** | 4.15E-06 |
| | Permeability (cm/s) | | 15.4 | 15.4 | 15.5 | **15.4** | 0.0 |
| | Test Temp (C) | | | 20.0 | | | |
| | Temp. Corr. Factor | | | 1.000 | | | |

MD Machine Direction TD Transverse Direction NA Not Available

# GEOCOMPOSITE TEST RESULTS

**TRI Client: SCS Engineers**
**Project: Hardee County Phase 1 Closure**

**Material: Skaps TN 330-2-8 Double Sided Geocomposite**
**Sample Identification: 396010268**
**TRI Log #: E2348-73-02**

| PARAMETER | TEST REPLICATE NUMBER | | | | | | | | | | MEAN | STD. DEV. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | | |

**Hydraulic Transmissivity (ASTM D 4716)**

Direction Tested: Machine Direction

| | |
|---|---|
| Normal Load (psf): | 800 |
| Hydraulic Gradient: | 0.33 |
| Test Length (in) | 12 |
| Test Width (in) | 12 |

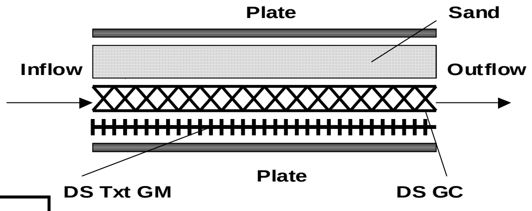



Plate / Ottawa Sand / GC Sample / 40 mil. LL MSGM / Plate

| Seat Time (hours) | | Specimen 1 | | | MEAN | STD. DEV. |
|---|---|---|---|---|---|---|
| | Volume (cc) | 1568 | 1573 | 1544 | | |
| | Time (s) | 5.09 | 5.10 | 5.04 | | |
| 1 | Flow Rate (GPM/ft width) | 4.88 | 4.89 | 4.86 | **4.88** | 0.02 |
| | Transmissivity (m^2/s) | 3.06E-03 | 3.07E-03 | 3.05E-03 | **3.06E-03** | 1.10E-05 |
| | Test Temp (C) | | 20.0 | | | |
| | Temp. Corr. Factor | | 1.000 | | | |

**Hydraulic Transmissivity (ASTM D 4716)**

Direction Tested: Machine Direction

| | |
|---|---|
| Normal Load (psf): | 800 |
| Hydraulic Gradient: | 0.33 |
| Test Length (in) | 12 |
| Test Width (in) | 12 |

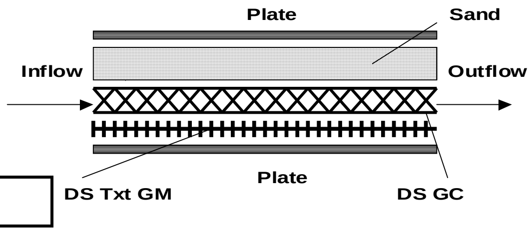



Plate / Ottawa Sand / GC Sample / 40 mil. LL MSGM / Plate

| Seat Time (hours) | | Specimen 1 | | | MEAN | STD. DEV. |
|---|---|---|---|---|---|---|
| | Pre-Test Thickness (in) | | 0.474 | | | |
| | Post-Test Thickness (in) | | 0.465 | | | |
| | Volume (cc) | 1491 | 1480 | 1465 | | |
| | Time (s) | 5.09 | 5.07 | 5.04 | | |
| | Flow Rate (GPM/ft width) | 4.64 | 4.63 | 4.61 | **4.63** | 0.02 |
| 100 | Transmissivity (m^2/s) | 2.91E-03 | 2.90E-03 | 2.89E-03 | **2.90E-03** | 1.12E-05 |
| | Permeability (cm/s) | 24.7 | 24.6 | 24.5 | **24.6** | 0.1 |
| | Test Temp (C) | | 20.0 | | | |
| | Temp. Corr. Factor | | 1.000 | | | |

MD Machine Direction TD Transverse Direction NA Not Available

# GEOCOMPOSITE TEST RESULTS

**TRI Client: SCS Engineers**
**Project: Hardee County Phase 1 Closure**

**Material: Skaps TN 330-2-8 Double Sided Geocomposite**
**Sample Identification: 396010290**
**TRI Log #: E2348-80-01**

| PARAMETER | TEST REPLICATE NUMBER | | | | | | | | | | MEAN | STD. DEV. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | | |

**Hydraulic Transmissivity (ASTM D 4716)**

Direction Tested: Machine Direction

| | |
|---|---|
| Normal Load (psf): | 800 |
| Hydraulic Gradient: | 0.33 |
| Test Length (in) | 12 |
| Test Width (in) | 12 |

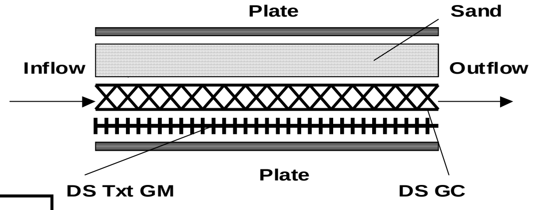



Plate / Ottawa Sand / GC Sample / 40 mil. LL MSGM / Plate

| Seat Time (hours) | | Specimen | | 1 | | MEAN | STD. DEV. |
|---|---|---|---|---|---|---|---|
| | Volume (cc) | | 1085 | 1080 | 1069 | | |
| | Time (s) | | 5.10 | 5.07 | 5.04 | | |
| 1 | Flow Rate (GPM/ft width) | | 3.37 | 3.38 | 3.36 | **3.37** | 0.01 |
| | Transmissivity (m^2/s) | | 2.12E-03 | 2.12E-03 | 2.11E-03 | **2.11E-03** | 4.67E-06 |
| | Test Temp (C) | | | 20.0 | | | |
| | Temp. Corr. Factor | | | 1.000 | | | |

**Hydraulic Transmissivity (ASTM D 4716)**

Direction Tested: Machine Direction

| | |
|---|---|
| Normal Load (psf): | 800 |
| Hydraulic Gradient: | 0.33 |
| Test Length (in) | 12 |
| Test Width (in) | 12 |

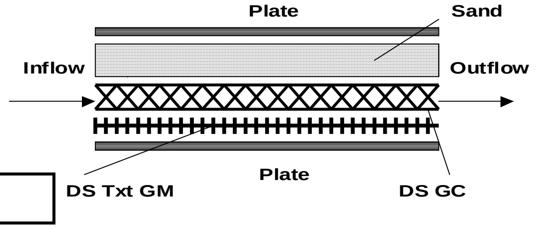



Plate / Ottawa Sand / GC Sample / 40 mil. LL MSGM / Plate

| Seat Time (hours) | | Specimen | | 1 | | MEAN | STD. DEV. |
|---|---|---|---|---|---|---|---|
| | Pre-Test Thickness (in) | | | 0.457 | | | |
| | Post-Test Thickness (in) | | | 0.449 | | | |
| | Volume (cc) | | 1053 | 1040 | 1072 | | |
| | Time (s) | | 5.09 | 5.00 | 5.15 | | |
| | Flow Rate (GPM/ft width) | | 3.28 | 3.30 | 3.30 | **3.29** | 0.01 |
| 100 | Transmissivity (m^2/s) | | 2.06E-03 | 2.07E-03 | 2.07E-03 | **2.06E-03** | 6.94E-06 |
| | Permeability (cm/s) | | 18.0 | 18.1 | 18.1 | **18.1** | 0.1 |
| | Test Temp (C) | | | 20.0 | | | |
| | Temp. Corr. Factor | | | 1.000 | | | |

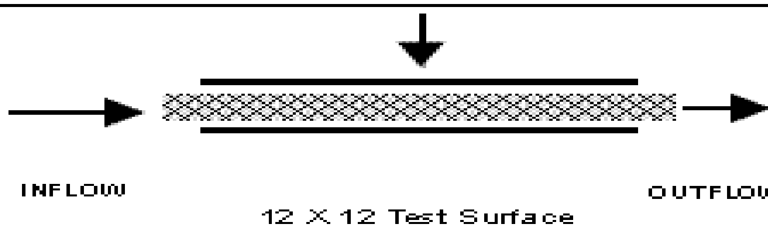
MD Machine Direction TD Transverse Direction NA Not Available

SKAPS Industries

# ASTM D 4716

| | | | |
|---|---|---|---|
| **Client:** | National Lining Systems Inc | **Job #** | 3960 |
| **Project:** | Hardee County Regional Landfill, FL | | |
| **Product:** | TN330-2-8 | | |

**Test Configuration:**




**Test Information:**

| | | | |
|---|---|---|---|
| **Boundary Conditions:** | Sand<br>Geocomposite<br>Liner | **Normal Load:** | 800 psf |
| | | **Gradient:** | 0.33 ft |
| | | **Seating Time:** | 100 hours |
| | | **Flow Direction:** | MD |

**Test Results:**

| Roll No. | Pressure (psf) | Gradient, ft | Transmissivity, $m^2$/sec |
|---|---|---|---|
| | | | 100 hours |
| 396010120 | 800 | 0.33 | $1.82 \times 10^{-3}$ |
| 396010160 | | | $1.80 \times 10^{-3}$ |

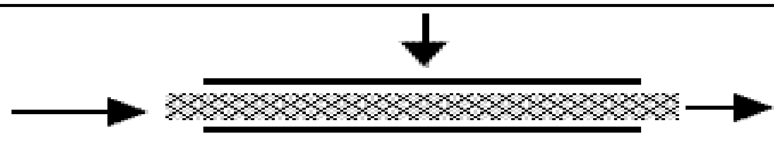
571 Industrial Parkway, Commerce, GA 30529 **Phone:** 706-336-7000 **Fax:** 706-336-7007 **Email:** skaps@skaps.com

SKAPS Industries

# ASTM D 4716

**Client:** National Lining Systems Inc
**Project:** Hardee County Regional Landfill, FL
**Product:** TN330-2-8
**Job #** 3960

**Test Configuration:**




**Test Information:**

**Boundary Conditions:** Sand / Geocomposite / Liner

**Normal Load:** 5000 psf
**Gradient:** 0.33 ft
**Seating Time:** 100 hours
**Flow Direction:** MD

**Test Results:**

| Roll No. | Pressure (psf) | Gradient, ft | Transmissivity, $m^2$/sec 100 hours |
|---|---|---|---|
| 396010120 | 5000 | 0.33 | $1.29 \times 10^{-3}$ |
| 396010160 | | | $1.37 \times 10^{-3}$ |

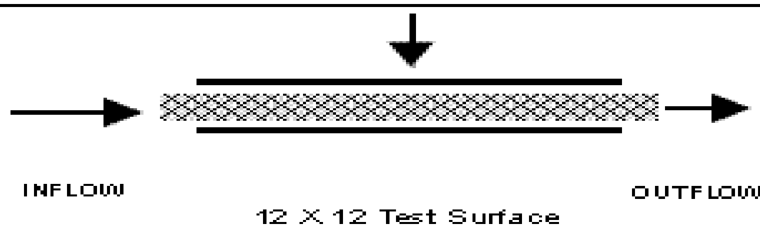
571 Industrial Parkway, Commerce, GA 30529 **Phone:** 706-336-7000 **Fax:** 706-336-7007 **Email:** skaps@skaps.com

SKAPS Industries

# ASTM D 4716

| | | | |
|---|---|---|---|
| **Client:** | National Lining Systems Inc | **Job #** | 3960 |
| **Project:** | Hardee County Regional Landfill, FL | | |
| **Product:** | TN330-2-8 | | |
| **Roll #** | 396010200 | | |

**Test Configuration:**




**Test Information:**

| | | | |
|---|---|---|---|
| **Boundary Conditions:** | Sand<br>Geocomposite<br>Liner | **Normal Load:** | 800 psf |
| | | **Gradient:** | 0.33 ft |
| | | **Seating Time:** | 100 hours |
| | | **Flow Direction:** | MD |

**Test Results:**

| Pressure (psf) | Gradient, ft | Transmissivity, $m^2$/sec |
|---|---|---|
| | | 100 hours |
| 800 | 0.33 | $1.85 \times 10^{-3}$ |

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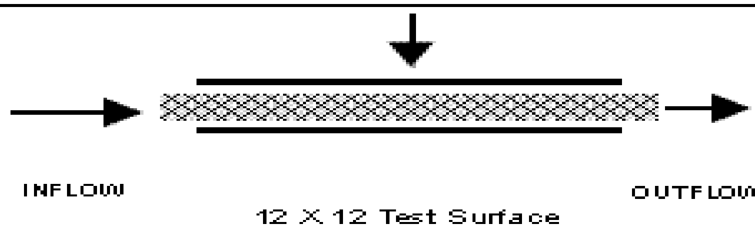
SKAPS Industries

# ASTM D 4716

| | | | |
|---|---|---|---|
| **Client:** | National Lining Systems Inc | **Job #** | 3960 |
| **Project:** | Hardee County Regional Landfill, FL | | |
| **Product:** | TN330-2-8 | | |
| **Roll #** | 396010200 | | |

**Test Configuration:**




**Test Information:**

| | | | |
|---|---|---|---|
| **Boundary Conditions:** | Sand<br>Geocomposite<br>Liner | **Normal Load:** | 5000 psf |
| | | **Gradient:** | 0.33 ft |
| | | **Seating Time:** | 100 hours |
| | | **Flow Direction:** | MD |

**Test Results:**

| Pressure (psf) | Gradient, ft | Transmissivity, $m^2$/sec |
|---|---|---|
| | | 100 hours |
| 5000 | 0.33 | $1.26 \times 10^{-3}$ |

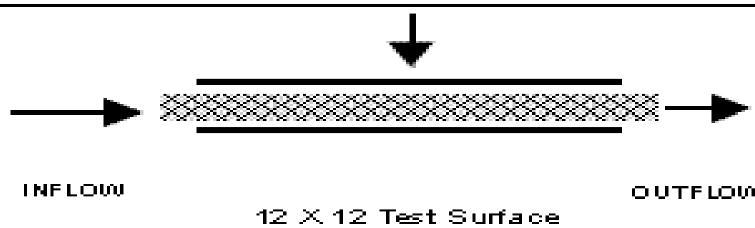
571 Industrial Parkway, Commerce, GA 30529 **Phone:** 706-336-7000 **Fax:** 706-336-7007 **Email:** skaps@skaps.com

**SKAPS Industries**

# ASTM D 4716

| | | | |
|---|---|---|---|
| **Client:** | National Lining Systems Inc | **Job #** | 3960 |
| **Project:** | Hardee County Regional Landfill, FL | | |
| **Product:** | TN330-2-8 | | |
| **Roll #** | 396010200 | | |

**Test Configuration:**




**Test Information:**

| | | | |
|---|---|---|---|
| **Boundary Conditions:** | Sand<br>Geocomposite<br>Liner | **Normal Load:** | 800 psf |
| | | **Gradient:** | 0.33 ft |
| | | **Seating Time:** | 100 hours |
| | | **Flow Direction:** | MD |

**Test Results:**

| Pressure (psf) | Gradient, ft | Transmissivity, $m^2$/sec |
|---|---|---|
| | | 100 hours |
| 800 | 0.33 | $1.85 \times 10^{-3}$ |

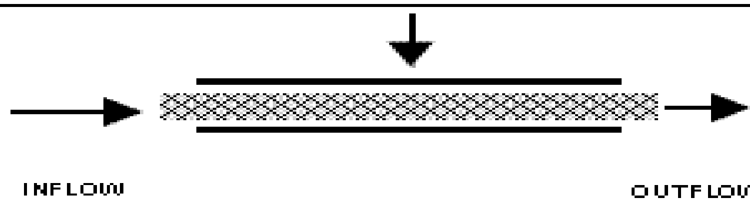
571 Industrial Parkway, Commerce, GA 30529 **Phone:** 706-336-7000 **Fax:** 706-336-7007 **Email:** skaps@skaps.com

SKAPS Industries

# ASTM D 4716

| | | | |
|---|---|---|---|
| **Client:** | National Lining Systems Inc | **Job #** | 3960 |
| **Project:** | Hardee County Regional Landfill, FL | | |
| **Product:** | TN330-2-8 | | |
| **Roll #** | 396010200 | | |

**Test Configuration:**




**Test Information:**

| | | | |
|---|---|---|---|
| **Boundary Conditions:** | Sand<br>Geocomposite<br>Liner | **Normal Load:** | 5000 psf |
| | | **Gradient:** | 0.33 ft |
| | | **Seating Time:** | 100 hours |
| | | **Flow Direction:** | MD |

**Test Results:**

| Pressure (psf) | Gradient, ft | Transmissivity, $m^2$/sec |
|---|---|---|
| | | 100 hours |
| 5000 | 0.33 | $1.26 \times 10^{-3}$ |

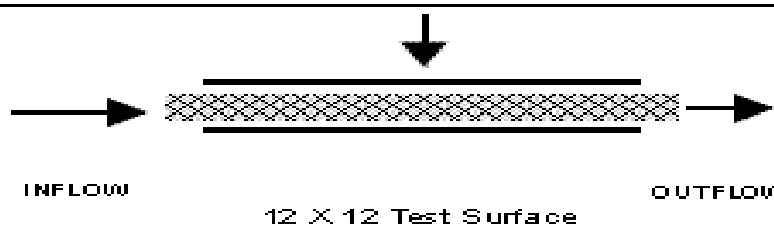
571 Industrial Parkway, Commerce, GA 30529 **Phone:** 706-336-7000 **Fax:** 706-336-7007 **Email:** skaps@skaps.com

**SKAPS Industries**

# ASTM D 4716

| | | | |
|---|---|---|---|
| **Client:** | National Lining Systems Inc | **Job #** | 3960 |
| **Project:** | Hardee County Regional Landfill, FL | | |
| **Product:** | TN330-2-8 | | |

**Test Configuration:**




**Test Information:**

| | | | |
|---|---|---|---|
| **Boundary Conditions:** | Sand<br>Geocomposite<br>Liner | **Normal Load:** | 800 psf |
| | | **Gradient:** | 0.33 ft |
| | | **Seating Time:** | 100 hours |
| | | **Flow Direction:** | MD |

**Test Results:**

| Roll No. | Pressure (psf) | Gradient, ft | Transmissivity, $m^2$/sec<br>100 hours |
|---|---|---|---|
| 396010240 | 800 | 0.33 | $1.78 \times 10^{-3}$ |
| 396010280 | | | $1.83 \times 10^{-3}$ |

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

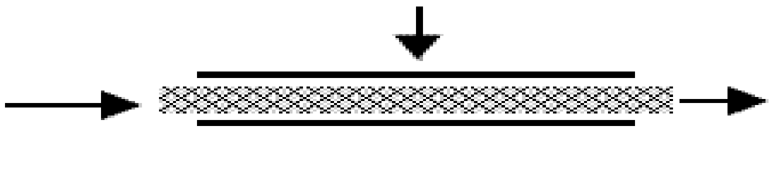
SKAPS Industries

# ASTM D 4716

**Client:** National Lining Systems Inc
**Project:** Hardee County Regional Landfill, FL
**Product:** TN330-2-8

**Job #** 3960

**Test Configuration:**




**Test Information:**

**Boundary Conditions:** Sand / Geocomposite / Liner

**Normal Load:** 5000 psf
**Gradient:** 0.33 ft
**Seating Time:** 100 hours
**Flow Direction:** MD

**Test Results:**

| Roll No. | Pressure (psf) | Gradient, ft | Transmissivity, $m^2/sec$ 100 hours |
|---|---|---|---|
| 396010240 | 5000 | 0.33 | $1.34 \times 10^{-3}$ |
| 396010280 | | | $1.28 \times 10^{-3}$ |

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

# Attachment S

# Revised Leachate Collection and Leachate Detection Pump Calculations

SCS ENGINEERS



| CLIENT | PROJECT | JOB NO. |
|---|---|---|
| Hardee County | Phase II Section II Expansion | 09199033.23 |

| SUBJECT | BY | DATE |
|---|---|---|
| | SRF | 8/31/12 |
| Leachate Collection & Removal System<br>Pump Calculations Section A - Riser (Primary Pump) | CHECKED | DATE |

Pipe Inside Diameter (in) = 2.826 3-inch Driscoplex pipe SDR 11

Pipe Length (ft) = 50.0 Area = 0.0435 $ft^2$

C-Factor = 130 Plastic $R_h$ = D/4 = 0.059 ft

Refer to Attachment 1 for Driscoplex properties

$S^{0.54}$ = Q / (1.318*C*A*$R_h^{0.63}$) = 0.798 Q

S = 0.65909879 $Q^{1.8519}$

$H_f$ = L * S Hazen Williams

$H_v$ = K $V^2$/(2*g) Minor losses (head loss) due to fittings (valves, elbows, etc.)

$H_t$ = $H_f$ + $H_v$

TDH = ΔH + $H_f$ + $H_v$ Total Dynamic Head

| Fittings | Quantity | K Value | Total K |
|---|---|---|---|
| 22.5 el = | 1 | 0.12 | 0.12 |
| 90 el = | 5 | 0.30 | 1.50 |
| Swing Check Valve = | 1 | 2.30 | 2.30 |
| Gate Valve (open) = | 1 | 0.19 | 0.19 |
| Air Release Valve = | 1 | 0.30 | 0.30 |
| Tee - through flow = | 1 | 0.60 | 0.60 |
| Entrance Loss = | 1 | 0.5 | 0.50 |
| | | Total | 5.51 |

K-Values

| | |
|---|---|
| 22.5 el | 0.12 |
| 45 el | 0.25 |
| 90 el | 0.30 |
| Butterfly Valve (full open) | 0.30 |
| Cross (bend) | 1.80 |
| Cross (through flow) | 0.60 |
| Entrance | 0.50 |
| Exit | 1.00 |
| Expansion Joint | 0.20 |
| Gate Valve (open) | 0.19 |
| Plug Valve (full open) | 0.85 |
| Reducer | 0.25 |
| Swing Check Valve | 2.30 |
| Tee - branch flow | 1.80 |
| Tee - through flow | 0.60 |
| Ultrasonic flow meter | 0.00 |
| Wye (through flow) | 0.60 |

| Q (gpm) | Q (cfs) | $H_f$ (ft) | V (ft/s) | $H_v$ (ft) | $H_t$ (ft) |
|---|---|---|---|---|---|
| 0 | 0.000 | 0.00 | 0.00 | 0.00 | 0.00 |
| 5 | 0.011 | 0.01 | 0.26 | 0.01 | 0.01 |
| 10 | 0.022 | 0.03 | 0.51 | 0.02 | 0.05 |
| 15 | 0.033 | 0.06 | 0.77 | 0.05 | 0.11 |
| 20 | 0.045 | 0.10 | 1.02 | 0.09 | 0.19 |
| 30 | 0.067 | 0.22 | 1.54 | 0.20 | 0.42 |
| 40 | 0.089 | 0.37 | 2.05 | 0.36 | 0.73 |
| 50 | 0.111 | 0.57 | 2.56 | 0.56 | 1.13 |
| 70 | 0.156 | 1.06 | 3.58 | 1.10 | 2.15 |
| 90 | 0.201 | 1.68 | 4.61 | 1.82 | 3.50 |
| 110 | 0.245 | 2.44 | 5.63 | 2.71 | 5.15 |
| 130 | 0.290 | 3.32 | 6.65 | 3.79 | 7.11 |
| 150 | 0.334 | 4.33 | 7.68 | 5.04 | 9.37 |
| 170 | 0.379 | 5.46 | 8.70 | 6.48 | 11.93 |
| 190 | 0.423 | 6.71 | 9.72 | 8.09 | 14.80 |
| 210 | 0.468 | 8.07 | 10.75 | 9.88 | 17.96 |
| 220 | 0.490 | 8.80 | 11.26 | 10.85 | 19.64 |
| 225 | 0.501 | 9.17 | 11.51 | 11.34 | 20.52 |
| 230 | 0.512 | 9.55 | 11.77 | 11.85 | 21.41 |
| 250 | 0.557 | 11.15 | 12.79 | 14.00 | 25.15 |
| 255 | 0.568 | 11.57 | 13.05 | 14.57 | 26.14 |
| 260 | 0.579 | 11.99 | 13.31 | 15.15 | 27.14 |
| 270 | 0.602 | 12.86 | 13.82 | 16.34 | 29.19 |
| 275 | 0.613 | 13.30 | 14.07 | 16.95 | 30.25 |
| 280 | 0.624 | 13.75 | 14.33 | 17.57 | 31.32 |
| 285 | 0.635 | 14.21 | 14.59 | 18.20 | 32.41 |
| 290 | 0.646 | 14.68 | 14.84 | 18.84 | 33.52 |
| 300 | 0.668 | 15.63 | 15.35 | 20.17 | 35.80 |
| 310 | 0.691 | 16.61 | 15.86 | 21.53 | 38.14 |
| 320 | 0.713 | 17.61 | 16.38 | 22.95 | 40.56 |
| 330 | 0.735 | 18.65 | 16.89 | 24.40 | 43.05 |
| 340 | 0.758 | 19.70 | 17.40 | 25.90 | 45.61 |
| 350 | 0.780 | 20.79 | 17.91 | 27.45 | 48.24 |
| 360 | 0.802 | 21.91 | 18.42 | 29.04 | 50.95 |
| 370 | 0.824 | 23.05 | 18.94 | 30.68 | 53.72 |
| 380 | 0.847 | 24.21 | 19.45 | 32.36 | 56.57 |
| 390 | 0.869 | 25.41 | 19.96 | 34.08 | 59.49 |

C-Values

| | |
|---|---|
| New DI | 140 |
| Old DI | 100 |
| PCCP | 100 |
| Plastic | 130 |
| Semi-New | 120 |

Refer to Attachment 2 Design of Polyethylene Piping Systems Chapter 6 page 167 for values

Peak flow from the Help model

**Revised April 1, 2013**

SCS ENGINEERS



| CLIENT | PROJECT | JOB NO. |
|---|---|---|
| Hardee County | Phase II Section II Expansion | 09199033.23 |

| SUBJECT | BY | DATE |
|---|---|---|
| | SRF | 8/31/12 |
| Leachate Collection & Removal System | CHECKED | DATE |
| Pump Calculations Section B - Forcemain (Primary Pump) | | |

Pipe Inside Diameter (in) = 3.636 4-inch Driscoplex pipe SDR 11

Pipe Length (ft) = 810 Area = 0.0721 $ft^2$

C-Factor = 130 Plastic $R_h$ = D/4 = 0.076 ft

Refer to Attachment 1 for Driscoplex properties

$S^{0.54} = Q / (1.318*C*A*R_h^{0.63})$ = 0.412 Q

S = 0.19314351 $Q^{1.8519}$

$H_f = L * S$ Hazen Williams

$H_v = K V^2/(2*g)$ Minor losses (head loss) due to fittings (valves, elbows, etc.)

$H_t = H_f + H_v$

TDH = $\Delta H + H_f + H_v$ Total Dynamic Head

| Fittings | Quantity | K Value | Total K |
|---|---|---|---|
| 90 el = | 7 | 0.30 | 2.10 |
| Tee - through flow = | 2 | 0.60 | 1.20 |
| Swing Check Valve = | 1 | 2.30 | 2.30 |
| Gate Valve (open) = | 1 | 0.19 | 0.19 |
| Air Release Valve = | 1 | 0.30 | 0.30 |
| | | | |
| | | | |
| | | Total | 6.09 |

K-Values

| | |
|---|---|
| 22.5 el | 0.12 |
| 45 el | 0.25 |
| 90 el | 0.30 |
| Butterfly Valve (full open) | 0.30 |
| Cross (bend) | 1.80 |
| Cross (through flow) | 0.60 |
| Entrance | 0.50 |
| Exit | 1.00 |
| Expansion Joint | 0.20 |
| Gate Valve (open) | 0.19 |
| Plug Valve (full open) | 0.85 |
| Reducer | 0.25 |
| Swing Check Valve | 2.30 |
| Tee - branch flow | 1.80 |
| Tee - through flow | 0.60 |
| Ultrasonic flow meter | 0.00 |
| Wye (through flow) | 0.60 |

| Q (gpm) | Q (cfs) | $H_f$ (ft) | V (ft/s) | $H_v$ (ft) | $H_t$ (ft) |
|---|---|---|---|---|---|
| 0 | 0.000 | 0.00 | 0.00 | 0.00 | 0.00 |
| 5 | 0.011 | 0.04 | 0.15 | 0.00 | 0.04 |
| 10 | 0.022 | 0.14 | 0.31 | 0.01 | 0.15 |
| 15 | 0.033 | 0.29 | 0.46 | 0.02 | 0.31 |
| 20 | 0.045 | 0.49 | 0.62 | 0.04 | 0.53 |
| 30 | 0.067 | 1.04 | 0.93 | 0.08 | 1.12 |
| 40 | 0.089 | 1.78 | 1.24 | 0.14 | 1.92 |
| 50 | 0.111 | 2.69 | 1.55 | 0.23 | 2.91 |
| 70 | 0.156 | 5.01 | 2.16 | 0.44 | 5.45 |
| 90 | 0.201 | 7.98 | 2.78 | 0.73 | 8.71 |
| 110 | 0.245 | 11.57 | 3.40 | 1.09 | 12.67 |
| 130 | 0.290 | 15.77 | 4.02 | 1.53 | 17.30 |
| 150 | 0.334 | 20.55 | 4.64 | 2.03 | 22.59 |
| 170 | 0.379 | 25.91 | 5.26 | 2.61 | 28.53 |
| 190 | 0.423 | 31.84 | 5.87 | 3.26 | 35.10 |
| 210 | 0.468 | 38.33 | 6.49 | 3.99 | 42.31 |
| 220 | 0.490 | 41.77 | 6.80 | 4.37 | 46.15 |
| 225 | 0.501 | 43.55 | 6.96 | 4.58 | 48.12 |
| 230 | 0.512 | 45.36 | 7.11 | 4.78 | 50.14 |
| 250 | 0.557 | 52.93 | 7.73 | 5.65 | 58.58 |
| 255 | 0.568 | 54.91 | 7.88 | 5.88 | 60.79 |
| 260 | 0.579 | 56.92 | 8.04 | 6.11 | 63.03 |
| 270 | 0.602 | 61.04 | 8.35 | 6.59 | 67.63 |
| 275 | 0.613 | 63.15 | 8.50 | 6.83 | 69.98 |
| 280 | 0.624 | 65.29 | 8.66 | 7.09 | 72.38 |
| 285 | 0.635 | 67.47 | 8.81 | 7.34 | 74.81 |
| 290 | 0.646 | 69.68 | 8.97 | 7.60 | 77.28 |
| 300 | 0.668 | 74.19 | 9.27 | 8.13 | 82.33 |
| 310 | 0.691 | 78.84 | 9.58 | 8.69 | 87.52 |
| 320 | 0.713 | 83.61 | 9.89 | 9.25 | 92.87 |
| 330 | 0.735 | 88.51 | 10.20 | 9.84 | 98.36 |
| 340 | 0.758 | 93.54 | 10.51 | 10.45 | 103.99 |
| 350 | 0.780 | 98.70 | 10.82 | 11.07 | 109.78 |
| 360 | 0.802 | 103.99 | 11.13 | 11.71 | 115.70 |
| 370 | 0.824 | 109.40 | 11.44 | 12.37 | 121.78 |
| 380 | 0.847 | 114.94 | 11.75 | 13.05 | 127.99 |
| 390 | 0.869 | 120.61 | 12.06 | 13.75 | 134.35 |

C-Values

| | |
|---|---|
| New DI | 140 |
| Old DI | 100 |
| PCCP | 100 |
| Plastic | 130 |
| Semi-New | 120 |

Refer to Attachment 2 Design of Polyethylene Piping Systems Chapter 6 page 167 for values

Peak Flow from the Help model

**Revised April 1, 2013**

| CLIENT | PROJECT | JOB NO. |
|---|---|---|
| Hardee County | Phase II Section II Expansion | 09199033.23 |

| SUBJECT | BY | DATE |
|---|---|---|
| | SRF | 8/31/12 |
| Leachate Collection & Removal System<br>Pump Calculations | CHECKED | DATE |

Sum of Flow Versus Total Dynamic Head (TDH)

ΔH = Static Head = 10.00 feet

| | Section A Riser | Section B Forcemain | | |
|---|---|---|---|---|
| Q (gpm) | $H_t$ (ft) | $H_t$ (ft) | ΔH (ft) | TDH (ft) |
| 0 | 0.00 | 0.00 | 10 | 10.00 |
| 5 | 0.01 | 0.04 | 10 | 10.05 |
| 10 | 0.05 | 0.15 | 10 | 10.20 |
| 15 | 0.11 | 0.31 | 10 | 10.42 |
| 20 | 0.19 | 0.53 | 10 | 10.72 |
| 30 | 0.42 | 1.12 | 10 | 11.55 |
| 40 | 0.73 | 1.92 | 10 | 12.66 |
| 50 | 1.13 | 2.91 | 10 | 14.04 |
| 70 | 2.15 | 5.45 | 10 | 17.61 |
| 90 | 3.50 | 8.71 | 10 | 22.21 |
| 110 | 5.15 | 12.67 | 10 | 27.82 |
| 130 | 7.11 | 17.30 | 10 | 34.40 |
| 150 | 9.37 | 22.59 | 10 | 41.96 |
| 170 | 11.93 | 28.53 | 10 | 50.46 |
| 190 | 14.80 | 35.10 | 10 | 59.90 |
| 210 | 17.96 | 42.31 | 10 | 70.27 |
| 220 | 19.64 | 46.15 | 10 | 75.79 |
| 225 | 20.52 | 48.12 | 10 | 78.64 |
| 230 | 21.41 | 50.14 | 10 | 81.55 |
| 250 | 25.15 | 58.58 | 10 | 93.74 |
| 255 | 26.14 | 60.79 | 10 | 96.92 |
| 260 | 27.14 | 63.03 | 10 | 100.17 |
| 270 | 29.19 | 67.63 | 10 | 106.82 |
| 275 | 30.25 | 69.98 | 10 | 110.23 |
| 280 | 31.32 | 72.38 | 10 | 113.70 |
| 285 | 32.41 | 74.81 | 10 | 117.22 |
| 290 | 33.52 | 77.28 | 10 | 120.80 |
| 300 | 35.80 | 82.33 | 10 | 128.12 |
| 310 | 38.14 | 87.52 | 10 | 135.66 |
| 320 | 40.56 | 92.87 | 10 | 143.42 |
| 330 | 43.05 | 98.36 | 10 | 151.40 |
| 340 | 45.61 | 103.99 | 10 | 159.60 |
| 350 | 48.24 | 109.78 | 10 | 168.02 |
| 360 | 50.95 | 115.70 | 10 | 176.65 |
| 370 | 53.72 | 121.78 | 10 | 185.50 |
| 380 | 56.57 | 127.99 | 10 | 194.56 |
| 390 | 59.49 | 134.35 | 10 | 203.84 |
| 400 | 62.48 | 140.86 | 10 | 213.33 |
| 410 | 65.54 | 147.50 | 10 | 223.04 |
| 420 | 68.67 | 154.29 | 10 | 232.96 |
| 430 | 71.87 | 161.22 | 10 | 243.09 |
| 440 | 75.15 | 168.29 | 10 | 253.44 |
| 450 | 78.49 | 175.50 | 10 | 263.99 |
| 460 | 81.90 | 182.86 | 10 | 274.76 |
| 470 | 85.39 | 190.35 | 10 | 285.74 |

SCS ENGINEERS



| CLIENT | PROJECT | JOB NO. |
|---|---|---|
| Hardee County | Phase II Section II Expansion | 09199033.23 |

| SUBJECT | BY | DATE |
|---|---|---|
| Leachate Collection & Removal System<br>Pump Calculations | SRF | 8/31/12 |
| | CHECKED | DATE |

K-values

| | |
|---|---|
| 90 el | 0.3 |
| 45 el | 0.25 |
| 22.5 el | 0.12 |
| Butterfly Valve (full open) | 0.3 |
| Swing Check Valve | 2.3 |
| Gate Valve (open) | 0.19 |
| Plug Valve (full open) | 0.85 |
| Entrance | 0.5 |
| Exit | 1 |
| Reducer (use vel. ff small end) | 0.25 |
| Tee - through flow | 0.6 |
| Tee - 90 deg turn | 1.8 |
| Ultrasonic flow meter | |
| Expansion Joint | 0.2 |
| Cross (through flow) | 0.6 |
| Cross (bend) | 1.80 |
| Wye (through flow) | 0.60 |

C-Values

| | |
|---|---|
| Old DI | 100 |
| Semi-New | 120 |
| New DI | 140 |
| PCCP | 100 |
| Plastic | 130 |

Refer to Attachment 2 Design of Polyethylene Piping Systems Chapter 6 page 167 for values

SCS ENGINEERS



| CLIENT | PROJECT | JOB NO. |
|---|---|---|
| Hardee County | Phase II Section II Expansion | 09199033.23 |

| SUBJECT | BY | DATE |
|---|---|---|
| | SRF | 8/31/12 |
| Leachate Collection & Removal System<br>Pump Calculations Section A - Riser (Primary Pump) | CHECKED | DATE |

Pipe Inside Diameter (in) = 1.917 2-inch Driscoplex pipe SDR 11 — Refer to Attachment 1 for Driscoplex properties

Pipe Length (ft) = 34.0 Area = 0.0200 $ft^2$

C-Factor = 130 Plastic $R_h$ = D/4 = 0.040 ft

$S^{0.54} = Q / (1.318 \cdot C \cdot A \cdot R_h^{0.63})$ = 2.216 Q

S = 4.36366757 $Q^{1.8519}$

$H_f = L \cdot S$ Hazen Williams

$H_v = K V^2/(2 \cdot g)$ Minor losses (head loss) due to fittings (valves, elbows, etc.)

$H_t = H_f + H_v$

TDH = $\Delta H + H_f + H_v$ Total Dynamic Head

| Fittings | Quantity | K Value | Total K |
|---|---|---|---|
| 22.5 el = | 1 | 0.12 | 0.12 |
| 90 el = | 6 | 0.30 | 1.80 |
| Swing Check Valve = | 1 | 2.30 | 2.30 |
| Gate Valve (open) = | 1 | 0.19 | 0.19 |
| Air Release Valve = | 1 | 0.30 | 0.30 |
| Entrance Loss = | 1 | 0.50 | 0.50 |
| | | | |
| | | Total | 5.21 |

K-Values

| | |
|---|---|
| 22.5 el | 0.12 |
| 45 el | 0.25 |
| 90 el | 0.30 |
| Butterfly Valve (full open) | 0.30 |
| Cross (bend) | 1.80 |
| Cross (through flow) | 0.60 |
| Entrance | 0.50 |
| Exit | 1.00 |
| Expansion Joint | 0.20 |
| Gate Valve (open) | 0.19 |
| Plug Valve (full open) | 0.85 |
| Reducer | 0.25 |
| Swing Check Valve | 2.30 |
| Tee - branch flow | 1.80 |
| Tee - through flow | 0.60 |
| Ultrasonic flow meter | 0.00 |
| Wye (through flow) | 0.60 |

| Q (gpm) | Q (cfs) | $H_f$ (ft) | V (ft/s) | $H_v$ (ft) | $H_t$ (ft) |
|---|---|---|---|---|---|
| 0 | 0.000 | 0.00 | 0.00 | 0.00 | 0.00 |
| 5 | 0.011 | 0.04 | 0.56 | 0.03 | 0.06 |
| 10 | 0.022 | 0.13 | 1.11 | 0.10 | 0.23 |
| 15 | 0.033 | 0.27 | 1.67 | 0.23 | 0.50 |
| 20 | 0.045 | 0.47 | 2.22 | 0.40 | 0.87 |
| 30 | 0.067 | 0.99 | 3.34 | 0.90 | 1.89 |
| 40 | 0.089 | 1.69 | 4.45 | 1.60 | 3.29 |
| 50 | 0.111 | 2.55 | 5.56 | 2.50 | 5.05 |
| 70 | 0.156 | 4.75 | 7.79 | 4.90 | 9.66 |
| 90 | 0.201 | 7.57 | 10.01 | 8.11 | 15.67 |
| 110 | 0.245 | 10.97 | 12.23 | 12.11 | 23.08 |
| 130 | 0.290 | 14.95 | 14.46 | 16.91 | 31.86 |
| 150 | 0.334 | 19.49 | 16.68 | 22.51 | 42.01 |
| 170 | 0.379 | 24.58 | 18.91 | 28.92 | 53.49 |
| 190 | 0.423 | 30.20 | 21.13 | 36.12 | 66.32 |
| 210 | 0.468 | 36.35 | 23.36 | 44.13 | 80.48 |
| 220 | 0.490 | 39.62 | 24.47 | 48.43 | 88.05 |
| 225 | 0.501 | 41.30 | 25.02 | 50.66 | 91.96 |
| 230 | 0.512 | 43.02 | 25.58 | 52.93 | 95.95 |
| 250 | 0.557 | 50.20 | 27.80 | 62.54 | 112.74 |
| 255 | 0.568 | 52.07 | 28.36 | 65.07 | 117.14 |
| 260 | 0.579 | 53.98 | 28.92 | 67.64 | 121.62 |
| 270 | 0.602 | 57.89 | 30.03 | 72.95 | 130.84 |
| 275 | 0.613 | 59.89 | 30.58 | 75.67 | 135.56 |
| 280 | 0.624 | 61.92 | 31.14 | 78.45 | 140.37 |
| 285 | 0.635 | 63.98 | 31.70 | 81.28 | 145.26 |
| 290 | 0.646 | 66.08 | 32.25 | 84.16 | 150.23 |
| 300 | 0.668 | 70.36 | 33.36 | 90.06 | 160.42 |
| 310 | 0.691 | 74.76 | 34.48 | 96.16 | 170.93 |
| 320 | 0.713 | 79.29 | 35.59 | 102.47 | 181.76 |
| 330 | 0.735 | 83.94 | 36.70 | 108.97 | 192.91 |
| 340 | 0.758 | 88.71 | 37.81 | 115.68 | 204.39 |
| 350 | 0.780 | 93.61 | 38.93 | 122.58 | 216.19 |
| 360 | 0.802 | 98.62 | 40.04 | 129.69 | 228.30 |
| 370 | 0.824 | 103.75 | 41.15 | 136.99 | 240.74 |
| 380 | 0.847 | 109.00 | 42.26 | 144.49 | 253.50 |
| 390 | 0.869 | 114.38 | 43.37 | 152.20 | 266.58 |

C-Values

| | |
|---|---|
| New DI | 140 |
| Old DI | 100 |
| PCCP | 100 |
| Plastic | 130 |
| Semi-New | 120 |

Refer to Attachment 2 Design of Polyethylene Piping Systems Chapter 6 page 167 for values

Peak Flow from the Help model

**Revised April 1, 2013**

| CLIENT | PROJECT | JOB NO. |
|---|---|---|
| Hardee County | Phase II Section II Expansion | 09199033.23 |

| SUBJECT | BY | DATE |
|---|---|---|
| | SRF | 8/31/12 |
| Leachate Collection & Removal System | CHECKED | DATE |
| Pump Calculations Section B - Forcemain (Primary Pump) | | |

Pipe Inside Diameter (in) = 1.917 2-inch Driscoplex pipe SDR 11

Refer to Attachment 1 for Driscoplex properties

Pipe Length (ft) = 10 Area = 0.0200 $ft^2$

C-Factor = 130 Plastic $R_h$ = D/4 = 0.040 ft

$S^{0.54}$ = Q / (1.318*C*A*$R_h^{0.63}$) = 2.216 Q

S = 4.36366757 $Q^{1.8519}$

$H_f$ = L * S Hazen Williams

$H_v$ = K $V^2$/(2*g) Minor losses (head loss) due to fittings (valves, elbows, etc.)

$H_t$ = $H_f$ + $H_v$

TDH = ΔH + $H_f$ + $H_v$ Total Dynamic Head

| Fittings | Quantity | K Value | Total K |
|---|---|---|---|
| Tee - through flow = | 1 | 0.60 | 0.60 |
| 90 el = | 2 | 0.30 | 0.60 |
| | | | |
| | | Total | 1.20 |

**K-Values**

| | |
|---|---|
| 22.5 el | 0.12 |
| 45 el | 0.25 |
| 90 el | 0.30 |
| Butterfly Valve (full open) | 0.30 |
| Cross (bend) | 1.80 |
| Cross (through flow) | 0.60 |
| Entrance | 0.50 |
| Exit | 1.00 |
| Expansion Joint | 0.20 |
| Gate Valve (open) | 0.19 |
| Plug Valve (full open) | 0.85 |
| Reducer | 0.25 |
| Swing Check Valve | 2.30 |
| Tee - branch flow | 1.80 |
| Tee - through flow | 0.60 |
| Ultrasonic flow meter | 0.00 |
| Wye (through flow) | 0.60 |

| Q (gpm) | Q (cfs) | $H_f$ (ft) | V (ft/s) | $H_v$ (ft) | $H_t$ (ft) |
|---|---|---|---|---|---|
| 0 | 0.000 | 0.00 | 0.00 | 0.00 | 0.00 |
| 5 | 0.011 | 0.01 | 0.56 | 0.01 | 0.02 |
| 10 | 0.022 | 0.04 | 1.11 | 0.02 | 0.06 |
| 15 | 0.033 | 0.08 | 1.67 | 0.05 | 0.13 |
| 20 | 0.045 | 0.14 | 2.22 | 0.09 | 0.23 |
| 30 | 0.067 | 0.29 | 3.34 | 0.21 | 0.50 |
| 40 | 0.089 | 0.50 | 4.45 | 0.37 | 0.86 |
| 50 | 0.111 | 0.75 | 5.56 | 0.58 | 1.33 |
| 70 | 0.156 | 1.40 | 7.79 | 1.13 | 2.53 |
| 90 | 0.201 | 2.23 | 10.01 | 1.87 | 4.09 |
| 110 | 0.245 | 3.23 | 12.23 | 2.79 | 6.02 |
| 130 | 0.290 | 4.40 | 14.46 | 3.90 | 8.29 |
| 150 | 0.334 | 5.73 | 16.68 | 5.19 | 10.92 |
| 170 | 0.379 | 7.23 | 18.91 | 6.66 | 13.89 |
| 190 | 0.423 | 8.88 | 21.13 | 8.32 | 17.20 |
| 210 | 0.468 | 10.69 | 23.36 | 10.16 | 20.85 |
| 220 | 0.490 | 11.65 | 24.47 | 11.16 | 22.81 |
| 225 | 0.501 | 12.15 | 25.02 | 11.67 | 23.81 |
| 230 | 0.512 | 12.65 | 25.58 | 12.19 | 24.84 |
| 250 | 0.557 | 14.76 | 27.80 | 14.40 | 29.17 |
| 255 | 0.568 | 15.32 | 28.36 | 14.99 | 30.30 |
| 260 | 0.579 | 15.88 | 28.92 | 15.58 | 31.46 |
| 270 | 0.602 | 17.03 | 30.03 | 16.80 | 33.83 |
| 275 | 0.613 | 17.61 | 30.58 | 17.43 | 35.04 |
| 280 | 0.624 | 18.21 | 31.14 | 18.07 | 36.28 |
| 285 | 0.635 | 18.82 | 31.70 | 18.72 | 37.54 |
| 290 | 0.646 | 19.43 | 32.25 | 19.38 | 38.82 |
| 300 | 0.668 | 20.69 | 33.36 | 20.74 | 41.44 |
| 310 | 0.691 | 21.99 | 34.48 | 22.15 | 44.14 |
| 320 | 0.713 | 23.32 | 35.59 | 23.60 | 46.92 |
| 330 | 0.735 | 24.69 | 36.70 | 25.10 | 49.79 |
| 340 | 0.758 | 26.09 | 37.81 | 26.64 | 52.74 |
| 350 | 0.780 | 27.53 | 38.93 | 28.23 | 55.76 |
| 360 | 0.802 | 29.01 | 40.04 | 29.87 | 58.88 |
| 370 | 0.824 | 30.52 | 41.15 | 31.55 | 62.07 |
| 380 | 0.847 | 32.06 | 42.26 | 33.28 | 65.34 |
| 390 | 0.869 | 33.64 | 43.37 | 35.06 | 68.70 |

**C-Values**

| | |
|---|---|
| New DI | 140 |
| Old DI | 100 |
| PCCP | 100 |
| Plastic | 130 |
| Semi-New | 120 |

Refer to Attachment 2 Design of Polyethylene Piping Systems Chapter 6 page 167 for values

Peak Flow from the Help model

**Revised April 1, 2013**

SCS ENGINEERS



| CLIENT | PROJECT | JOB NO. |
|---|---|---|
| Hardee County | Phase II Section II Expansion | 09199033.23 |

| SUBJECT | BY | DATE |
|---|---|---|
| | SRF | 8/31/12 |
| Leachate Collection & Removal System | CHECKED | DATE |
| Pump Calculations | | |

Sum of Flow Versus Total Dynamic Head (TDH)

ΔH = Static Head = 10.00 feet

| | Section A | Section B | | |
|---|---|---|---|---|
| | Riser | Forcemain | | |
| Q (gpm) | $H_t$ (ft) | $H_t$ (ft) | ΔH (ft) | TDH (ft) |
| 0 | 0.00 | 0.00 | 10 | 10.00 |
| 5 | 0.06 | 0.02 | 10 | 10.08 |
| 10 | 0.23 | 0.06 | 10 | 10.29 |
| 15 | 0.50 | 0.13 | 10 | 10.63 |
| 20 | 0.87 | 0.23 | 10 | 11.10 |
| 30 | 1.89 | 0.50 | 10 | 12.39 |
| 40 | 3.29 | 0.86 | 10 | 14.15 |
| 50 | 5.05 | 1.33 | 10 | 16.38 |
| 70 | 9.66 | 2.53 | 10 | 22.18 |
| 90 | 15.67 | 4.09 | 10 | 29.77 |
| 110 | 23.08 | 6.02 | 10 | 39.10 |
| 130 | 31.86 | 8.29 | 10 | 50.16 |
| 150 | 42.01 | 10.92 | 10 | 62.92 |
| 170 | 53.49 | 13.89 | 10 | 77.38 |
| 190 | 66.32 | 17.20 | 10 | 93.52 |
| 210 | 80.48 | 20.85 | 10 | 111.33 |
| 220 | 88.05 | 22.81 | 10 | 120.85 |
| 225 | 91.96 | 23.81 | 10 | 125.77 |
| 230 | 95.95 | 24.84 | 10 | 130.79 |
| 250 | 112.74 | 29.17 | 10 | 151.91 |
| 255 | 117.14 | 30.30 | 10 | 157.44 |
| 260 | 121.62 | 31.46 | 10 | 163.08 |
| 270 | 130.84 | 33.83 | 10 | 174.66 |
| 275 | 135.56 | 35.04 | 10 | 180.61 |
| 280 | 140.37 | 36.28 | 10 | 186.65 |
| 285 | 145.26 | 37.54 | 10 | 192.80 |
| 290 | 150.23 | 38.82 | 10 | 199.05 |
| 300 | 160.42 | 41.44 | 10 | 211.86 |
| 310 | 170.93 | 44.14 | 10 | 225.07 |
| 320 | 181.76 | 46.92 | 10 | 238.68 |
| 330 | 192.91 | 49.79 | 10 | 252.70 |
| 340 | 204.39 | 52.74 | 10 | 267.12 |
| 350 | 216.19 | 55.76 | 10 | 281.95 |
| 360 | 228.30 | 58.88 | 10 | 297.18 |
| 370 | 240.74 | 62.07 | 10 | 312.81 |
| 380 | 253.50 | 65.34 | 10 | 328.84 |
| 390 | 266.58 | 68.70 | 10 | 345.27 |
| 400 | 279.97 | 72.13 | 10 | 362.10 |
| 410 | 293.68 | 75.65 | 10 | 379.33 |
| 420 | 307.72 | 79.24 | 10 | 396.96 |
| 430 | 322.07 | 82.92 | 10 | 414.99 |
| 440 | 336.73 | 86.68 | 10 | 433.41 |
| 450 | 351.71 | 90.52 | 10 | 452.23 |
| 460 | 367.01 | 94.44 | 10 | 471.45 |
| 470 | 382.63 | 98.44 | 10 | 491.07 |

Refer to Attachment 3 for pump selection

**Revised April 1, 2013**

| CLIENT | PROJECT | JOB NO. |
|---|---|---|
| Hardee County | Phase II Section II Expansion | 09199033.23 |

| SUBJECT | BY | DATE |
|---|---|---|
| | SRF | 8/31/12 |
| Leachate Collection & Removal System<br>Pump Calculations | CHECKED | DATE |

K-values

| | |
|---|---|
| 90 el | 0.3 |
| 45 el | 0.25 |
| 22.5 el | 0.12 |
| Butterfly Valve (full open) | 0.3 |
| Swing Check Valve | 2.3 |
| Gate Valve (open) | 0.19 |
| Plug Valve (full open) | 0.85 |
| Entrance | 0.5 |
| Exit | 1 |
| Reducer (use vel. ff small end) | 0.25 |
| Tee - through flow | 0.6 |
| Tee - 90 deg turn | 1.8 |
| Ultrasonic flow meter | |
| Expansion Joint | 0.2 |
| Cross (through flow) | 0.6 |
| Cross (bend) | 1.80 |
| Wye (through flow) | 0.60 |

C-Values

| | |
|---|---|
| Old DI | 100 |
| Semi-New | 120 |
| New DI | 140 |
| PCCP | 100 |
| Plastic | 130 |

Refer to Attachment 2 Design of Polyethylene Piping Systems Chapter 6 page 167 for values

# Attachment T

- Summary Table and 8-Inch Leachate Collection Lateral Pipe Crushing and Flow Capacity Calculations North and Center Portions
- Summary Table and 8-Inch Leachate Collection Lateral Pipe Crushing and Flow Capacity Calculations South Portion
- Summary Table and 10-Inch Leachate Collection Lateral Pipe Crushing and Flow Capacity Calculations North and Center Portions
- Summary Table and 8-Inch Leachate Detection Header Pipe Crushing and Flow Capacity Calculations North and Center Portions
- Summary Table and 12-Inch Leachate Collection Header Pipe Crushing and Flow Capacity Calculations North and Center Portions
- Summary Table and 8-Inch Leachate Collection Lateral Pipe Crushing and Flow Capacity Calculations Phase II Section I
- Phase I 8 Inch Perforated ADS Pipe

# Summary Table and 8-Inch Leachate Collection Lateral Pipe Crushing and Flow Capacity Calculations North and Center Portions

SCS ENGINEERS



| CLIENT | PROJECT | JOB NO. |
|---|---|---|
| Hardee County | Phase II Section II Expansion | 09199033.23 |

| SUBJECT | BY | DATE |
|---|---|---|
| Phase II Section II **RAI No. 1** | SRF | 4/1/13 |
| Summary Table Pipe Crushing **Operations** | CHECKED | DATE |
| **8" Diameter Leachate Collection Laterals North and Center Portions** | | |

| Description | Waste Height (ft) | Fill Height (ft) | Pipe Diameter (in) | Type of Calculation | Design Value | Calculated Value | Units | Safety Factor* |
|---|---|---|---|---|---|---|---|---|
| CAT D7R Series II | 0 | 2 | 8 | Flow Capacity | 1914.47 | 20.69 | cf/day/ft of pipe | 92.54 |
| | | | | Buckling | 220.98 | 5.59 | psi | 39.51 |
| | | | | Compressive Stress | 800 | 30.76 | psi | 26.01 |
| | | | | Bending Strain | 5.0% | 0.2% | % | 31.30 |
| CAT D7R Series II | 10 | 12 | 8 | Flow Capacity | 1914.47 | 20.69 | cf/day/ft of pipe | 92.54 |
| | | | | Buckling | 276.42 | 8.59 | psi | 32.17 |
| | | | | Compressive Stress | 800 | 47.26 | psi | 16.93 |
| | | | | Bending Strain | 5.0% | 0.2% | % | 20.37 |
| CAT D7R Series II | 25 | 27 | 8 | Flow Capacity | 1914.47 | 20.69 | cf/day/ft of pipe | 92.54 |
| | | | | Buckling | 352.25 | 12.46 | psi | 28.28 |
| | | | | Compressive Stress | 800 | 68.52 | psi | 11.68 |
| | | | | Bending Strain | 5.0% | 0.4% | % | 14.05 |
| CAT D7R Series II | 60 | 65 | 8 | Flow Capacity | 1914.47 | 20.69 | cf/day/ft of pipe | 92.54 |
| | | | | Buckling | 435.54 | 22.43 | psi | 19.41 |
| | | | | Compressive Stress | 800 | 123.40 | psi | 6.48 |
| | | | | Bending Strain | 5.0% | 0.6% | % | 7.80 |
| CAT 826 G Series II Compactor | 0 | 2 | 8 | Flow Capacity | 1914.47 | 20.69 | cf/day/ft of pipe | 92.54 |
| | | | | Buckling | 220.98 | 11.53 | psi | 19.17 |
| | | | | Compressive Stress | 800 | 63.42 | psi | 12.61 |
| | | | | Bending Strain | 5.0% | 0.3% | % | 15.18 |
| CAT 826 G Series II Compactor | 10 | 12 | 8 | Flow Capacity | 1914.47 | 20.69 | cf/day/ft of pipe | 92.54 |
| | | | | Buckling | 276.42 | 9.63 | psi | 28.71 |
| | | | | Compressive Stress | 800 | 52.97 | psi | 15.10 |
| | | | | Bending Strain | 5.0% | 0.3% | % | 18.18 |
| CAT 826 G Series II Compactor | 25 | 27 | 8 | Flow Capacity | 1914.47 | 20.69 | cf/day/ft of pipe | 92.54 |
| | | | | Buckling | 352.25 | 12.83 | psi | 27.46 |
| | | | | Compressive Stress | 800 | 70.56 | psi | 11.34 |
| | | | | Bending Strain | 5.0% | 0.4% | % | 13.65 |
| CAT 826 G Series II Compactor | 60 | 65 | 8 | Flow Capacity | 1914.47 | 20.69 | cf/day/ft of pipe | 92.54 |
| | | | | Buckling | 435.54 | 22.52 | psi | 19.34 |
| | | | | Compressive Stress | 800 | 123.89 | psi | 6.46 |
| | | | | Bending Strain | 5.0% | 0.6% | % | 7.77 |

* Safety Factor = Design Value/Calculated Value

**Revised April 1, 2013**

SCS ENGINEERS



| CLIENT | PROJECT | JOB NO. |
|---|---|---|
| Hardee County | Phase II Section II Expansion | 09199033.23 |

| SUBJECT | BY | DATE |
|---|---|---|
| Phase II Section II **RAI No. 1** | SRF | 4/1/13 |
| Summary Table Pipe Crushing **Construction** | CHECKED | DATE |
| **8" Diameter Leachate Collection Laterals North and Center Portions** | | |

| Description | Waste Height (ft) | Fill Height (ft) | Pipe Diameter (in) | Type of Calculation | Design Value | Calculated Value | Units | Safety Factor* |
|---|---|---|---|---|---|---|---|---|
| CAT D6R XW Series II | 0 | 1 | 8 | Flow Capacity | 1914.47 | 20.69 | cf/day/ft of pipe | 92.54 |
| | | | | Buckling | 204.95 | 2.93 | psi | 69.91 |
| | | | | Compressive Stress | 800 | 16.12 | psi | 49.61 |
| | | | | Bending Strain | 5.0% | 0.1% | % | 59.71 |

* Safety Factor = Design Value/Calculated Value

**Revised April 1, 2013**

| CLIENT | PROJECT | JOB NO. |
|---|---|---|
| Hardee County | Phase II Section II Expansion | 09199033.23 |

| SUBJECT | BY | DATE |
|---|---|---|
| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Collection Lateral** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **0 Feet Waste** | | |

Load on Pipe (Overburden)

Prism Loads, $P_E$ = wH

w = unit weight

H = depth

| | Depth (ft) | Unit Weight ($lb/ft^3$) | $P_E$ ($lb/ft^2$) |
|---|---|---|---|
| Final cover | 0.0 | 115.0 | 0.0 |
| Intermediate cover | 0.0 | 115.0 | 0.0 |
| Waste/cover | 0.0 | 60.0 | 0.0 |
| Drainage sand | 2.0 | 115.0 | 230.0 |
| Rock (No. 89 & No. 57) | 2.0 | 140.0 | 280.0 |

TOTAL SOIL PRISM LOAD $P_E$: 510.0 $lb/ft^2$

Total Depth = 4.0 ft

Soil Arching, $P_m = C_D wB$

NOTE: The waste unit weight represents the combined unit weight of waste, daily cover, and moisture.

Pm = vertical soil pressure

B = trench width at pipe crown 6.0 ft

$C_D$ = load coefficient $= \frac{1 - e^{-2Ku'H/B}}{2Ku'}$ Equation 7-3, Source No. 1

e = natural log base number

K = Rankine earth pressure coefficient = $\tan^2(45-0.5*\phi)$

$\phi$ = internal soil friction angle = 27.0 degrees

u' = friction coefficient between backfill and trench sides = tan $\phi$

| Soil Type | Ku' |
|---|---|
| Saturated Clay | 0.110 |
| Ordinary Clay | 0.130 |
| Saturated Top Soil | 0.150 |
| Sand and Gravel | 0.165 |
| Clean Granular Soil | 0.192 |

| | Ku' | $C_D$ | $P_m$ ($lb/ft^2$) |
|---|---|---|---|
| Cover Soil | 0.150 | 0.00 | 0 |
| Int Cover | 0.165 | 0.00 | 0 |
| Waste | 0.191 | 0.00 | 0 |
| Drainage Sand | 0.165 | 0.32 | 217.8 |
| Granular Soil | 0.192 | 0.31 | 262.8 |

TOTAL SOIL ARCHING LOAD $P_M$: 480.6 $lb/ft^2$

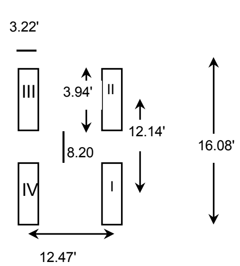
MODIFIED ARCHING LOAD = $0.6P_M + 0.4P_E$: 492.37 $lb/ft^2$

OVERBURDEN LOAD: 492.37 $lb/ft^2$

Load on Pipe With Equipment Refer to Attachment

Operation w/ CAT 826G Series II Compactor 0 Feet Waste

Equipment Weight = 81,498.0 psf




| | | | |
|---|---|---|---|
| Track per Load = $q_r$ = | 1,670.20 | psf | (Rear) |
| Track per Load = $q_{fr}$ = | 1,541.72 | psf | (Front) |
| Length of Track = L = | 3.22 | ft | (contact length) |
| Length of Track = b = | 8.20 | ft | |
| Track Width = | 12.47 | ft | |
| Track Width (I to II) = | 16.08 | ft | |

SCS ENGINEERS

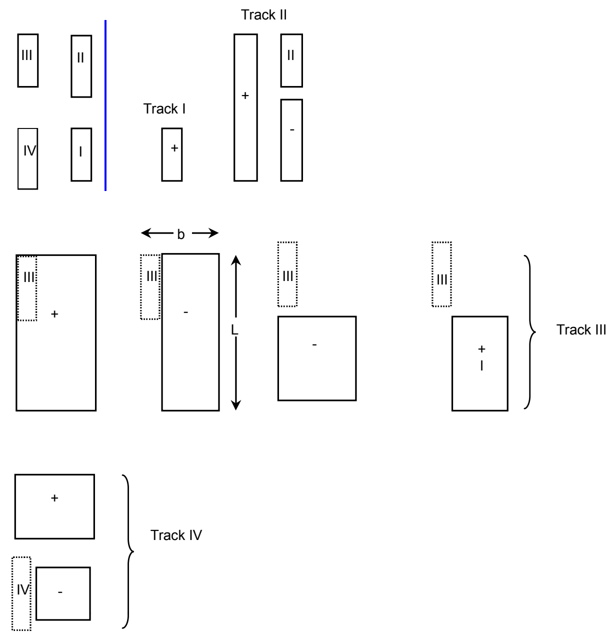
SHEET 2 OF 10

| CLIENT | PROJECT | JOB NO. |
|---|---|---|
| Hardee County | Phase II Section II Expansion | 09199033.23 |

| SUBJECT | BY | DATE |
|---|---|---|
| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Collection Lateral** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **0 Feet Waste** | | |

Load on Pipe

Alternative 1: Track Adjacent and Parallel to Pipe




| | b | L | z | m = b/z | n = L/z | I* | I** | I | |
|---|---|---|---|---|---|---|---|---|---|
| Track I | 8.2 | 3 | 4 | 2.05 | 0.81 | 0.182 | 0.241 | 0.18205 | (ADD) |
| | | | | | | | | | |
| Track II | 8.2 | 16.1 | 4 | 2.05 | 4.02 | -0.010 | 0.240 | 0.23973 | (ADD) |
| | 8.2 | 11.4 | 4 | 2.05 | 2.86 | -0.012 | 0.238 | 0.23802 | (SUBTRACT) |
| | | | | | | | | | |
| Track IV | 12.47 | 3.22 | 4 | 3.12 | 0.81 | 0.185 | 0.231 | 0.18478 | (ADD) |
| | 12.47 | 3.22 | 4 | 3.12 | 0.81 | 0.185 | 0.231 | 0.18478 | (SUBTRACT) |
| | | | | | | | | | |
| Track III | 12.47 | 16.08 | 4 | 3.12 | 4.02 | -0.004 | 0.246 | 0.24588 | (ADD) |
| | 4.27 | 16.08 | 4 | 1.07 | 4.02 | -0.041 | 0.209 | 0.20918 | (SUBTRACT) |
| | 12.47 | 11.42 | 4 | 3.12 | 2.86 | -0.006 | 0.244 | 0.24379 | (SUBTRACT) |
| | 4.27 | 8.47 | 4 | 1.07 | 2.12 | 0.206 | 0.226 | 0.20553 | (ADD) |

$\text{Live Load}_1 = q_r(\Sigma I) + q_{fr}(\Sigma II) + q_{fr}(\Sigma III) + q_r(\Sigma IV)$

$\text{Live Load}_1 =$ 304.29 psf

SCS ENGINEERS

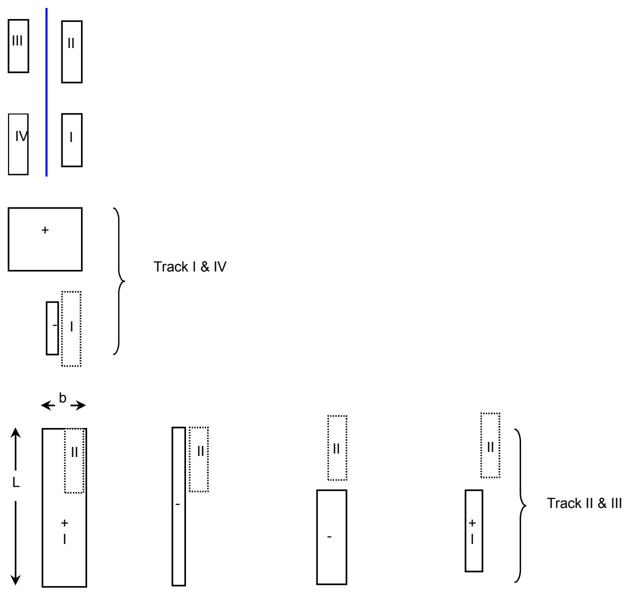
SHEET 3 OF 10

| CLIENT | PROJECT | JOB NO. |
|---|---|---|
| Hardee County | Phase II Section II Expansion | 09199033.23 |

| SUBJECT | BY | DATE |
|---|---|---|
| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Collection Lateral** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **0 Feet Waste** | | |

Load on Pipe

Alternative 2: Track Stradling and Parallel to Pipe




| | b | L | z | m = b/z | n = L/z | I* | I** | I | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | |
| Track I | 6.2 | 3.2 | 4 | 1.6 | 0.8 | 0.177 | 0.250 | 0.17733 | (ADD) |
| & IV | -2.0 | 3.2 | 4 | -0.5 | 0.8 | -0.109 | 0.230 | -0.10926 | (SUBTRACT) |
| | | | | | | | | | |
| Track II | 6.2 | 16.08 | 4 | 1.6 | 4.0 | -0.019 | 0.231 | 0.23095 | (ADD) |
| & III | -2.0 | 16.08 | 4 | -0.5 | 4.0 | -0.135 | 0.255 | -0.13546 | (SUBTRACT) |
| | 6.2 | 12.86 | 4 | 1.6 | 3.2 | -0.020 | 0.230 | 0.23021 | (SUBTRACT) |
| | -2.0 | 12.86 | 4 | -0.5 | 3.2 | -0.135 | 0.253 | -0.13519 | (ADD) |

Live $Load_2 = [q_r (\Sigma I) + q_{fr} (\Sigma II)] * 2$

Live $Load_2 =$ 960.43 psf

SCS ENGINEERS

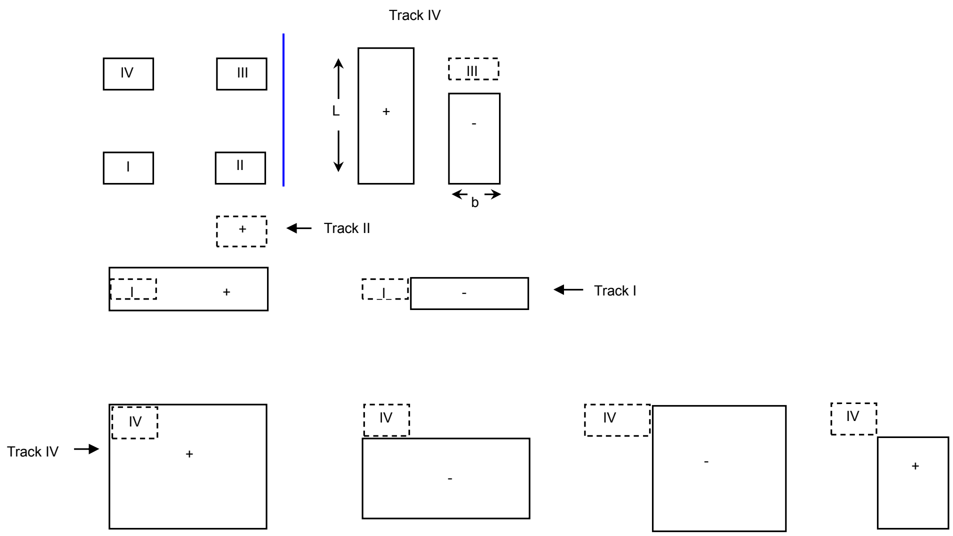
SHEET 4 OF 10

| CLIENT | PROJECT | JOB NO. |
|---|---|---|
| Hardee County | Phase II Section II Expansion | 09199033.23 |

| SUBJECT | BY | DATE |
|---|---|---|
| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Collection Lateral** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **0 Feet Waste** | | |

Load on Pipe

Alternative 3: Track Perpendicular to Pipe




| | b | L | z | m = b/z | n = L/z | I* | I** | I | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | |
| Track I | 16.1 | 8.2 | 4 | 4.0 | 2.1 | -0.010 | 0.240 | 0.23973 | (ADD) |
| | 12.9 | 8.2 | 4 | 3.2 | 2.1 | -0.011 | 0.239 | 0.23883 | (SUBTRACT) |
| | | | | | | | | | |
| Track II | 3.2 | 8.2 | 4 | 0.8 | 2.1 | 0.182 | 0.241 | 0.18205 | (ADD) |
| | | | | | | | | | |
| Track III | 3.2 | 12.5 | 4 | 0.8 | 3.1 | 0.185 | 0.231 | 0.18478 | (ADD) |
| | 3.2 | 4.3 | 4 | 0.8 | 1.1 | 0.164 | 0.262 | 0.16364 | (SUBTRACT) |
| | | | | | | | | | |
| Track IV | 16.1 | 12.5 | 4 | 4.0 | 3.1 | -0.004 | 0.246 | 0.24588 | (ADD) |
| | 16.1 | 4.3 | 4 | 4.0 | 1.1 | -0.041 | 0.209 | 0.20918 | (SUBTRACT) |
| | 12.9 | 12.5 | 4 | 3.2 | 3.1 | -0.005 | 0.245 | 0.24477 | (SUBTRACT) |
| | 12.9 | 4.3 | 4 | 3.2 | 1.1 | 0.209 | 0.213 | 0.20863 | (ADD) |

Live Load$_3$ = $q_r(\Sigma I) + q_{fr}(\Sigma II) + q_{fr}(\Sigma III) + q_r(\Sigma IV)$

Live Load$_3$ = 315.70 psf

LARGEST EQUIPEMENT LOAD = 960.43 lb/ft$^2$

VERTICAL OVERBURDEN LOAD = 492.37 lb/ft$^2$

VERTICAL EQUIPMENT LOAD = 960.43 lb/ft$^2$

TOTAL VERTICAL LOAD APPLIED TO PIPE, $P_T$ = 1452.80 lb/ft$^2$ = 10.09 lb/in$^2$

| CLIENT | PROJECT | JOB NO. |
|---|---|---|
| Hardee County | Phase II Section II Expansion | 09199033.23 |

| SUBJECT | BY | DATE |
|---|---|---|
| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Collection Lateral** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **0 Feet Waste** | | |

Verify that perforations in the LCRS are adequate for the peak leachate flow.

Use discharge equation:

$Q = (Cd)(Ao)(2gh)^{0.5}$

$C_d$ = coeffiecient of discharge = 0.6 for short tube discharge with fluid/wall separation; conservative value.

$A_o$ = Area of orifice ($\pi D^2/4$)

g = gravitational acceleration (32.3 $ft^2/s$)

h = static head (ft)

Assumptions and Givens:

| | | | |
|---|---|---|---|
| | 4.55 | acres | North and center portion of landfill bottom |
| 1. No. acres of landfill expansion = | 3.08 | acres | - North & center less area from eastern grade break of bottom |
| 2. Total length of pipe per expansion = | 1,888.1 | ft | area draining into eastern 10-inch lateral collection |
| 3. Total number of laterals = | 2.0 | | - (2) 8-inch laterals collect drainage from this bottom area |
| 4. Length of pipe per lateral = | 944.1 | ft | - (1) 10-inch lateral collects the remaining drainage |
| 5. Perforation diameter = | 0.375 | inch | - Refer to calcs for 10" diameter leachate collection lateral |
| 6. No. perforations/ft pipe = | 6.0 | perforations/ft of pipe length | |
| 7. Maximum head over pipe = | 1.0 | ft | |
| 8. Per HELP model summary table, $Q_{peak}$ = | 202.93 | gal/min | refer to HELP Model Summary Table |
| 9. Per HELP model summary table, $Q_{peak}$ = | 39,063.5 | cf/day | refer to HELP Model Summary Table |
| 10. Maximum flow/lateral = | 19,531.7 | cf/day/lateral | |
| 11. Maximum leachate flow/ft of pipe = | 20.69 | cf/day/ft of pipe | |

Solution:

$A_o = 0.25(\Pi)(d)^2 =$ 0.00077 $ft^2$

1. Flow per orifice, $Q = (Cd)(Ao)(2gh)^{0.5} =$ 0.0037 $ft^3/s$

2. Flow per ft of pipe = (Q)(# perfs/ft) = 0.02 $ft^3/s$ per ft of pipe

= 1,914.5 cf/day/ft of pipe

Conclusion:

Design capacity exceeds estimated generation

1914.47 cf/day/ft of pipe >>> 20.69 cf/day/ft of pipe

Perforations are adequate to handle the maximum leachate flow.

SCS ENGINEERS



| CLIENT | PROJECT | JOB NO. |
|---|---|---|
| Hardee County | Phase II Section II Expansion | 09199033.23 |

| SUBJECT | BY | DATE |
|---|---|---|
| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Collection Lateral** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **0 Feet Waste** | | |

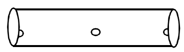
Effective pressure on pipe due to perforations:

$P_{EFF} = \dfrac{P_T \times 12}{(12 - L_P)}$ Source 3, EPA SW-870, p. 382

$L_P$ = Total accumulated length of perforations in one foot of pipe.

Since each perforation is 0.375 inch diameter and spaced at 6.0 inch on center,

$L_P$ = 1.5 inch



$P_T$ = 10.1 psi

$P_{EFF}$ = 11.5 psi

$P_{EFF}$ = 1660.3 psf

Check actual compressive pressure ($S_A$) per Driscopipe manual:

$S_A$ = 0.5 x (SDR - 1) x P(eff) = 57.7 psi

The recommended, long-term compressive strength ($Y_s$) design value for Driscoplex polyethylene pipe is 800 lb/in$^2$.

Source No. 1

| $S_A$ (psi): | | $Y_s$ (psi): |
|---|---|---|
| 57.7 | < | 800.0 |

Pipe passes wall compressive stress perforation calculations TRUE

FS = 13.9

| CLIENT | PROJECT | JOB NO. |
|---|---|---|
| Hardee County | Phase II Section II Expansion | 09199033.23 |

| SUBJECT | BY | DATE |
|---|---|---|
| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Collection Lateral** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **0 Feet Waste** | | |

Constrained pipe wall buckling (for Driscoplex OD controlled pipe)

$P_{WC} = \frac{5.65 * \{RB'E'\ E*[12(DR-1)^3]^{-1}\}^{0.5}}{N}$ Source 1, Equation 7-5

$P_{WC}$ = allowable constrained buckling pressure (lb/in$^2$)

R = buoyancy reduction factor = 1 - 0.33 * (H'/H) Source 1, Equation 7-34

H' = groundwater height above pipe (ft) 0.0 ft

H = cover above pipe (ft) 4.0 ft

B' = elastic support factor =( 1+ 4*e$^{-0.065H}$ )$^{-1}$ Source 1, Equation 7-35

E' = soil reaction modulus (lb/in$^2$) 3000.0 lb/in$^2$ for mod comp/crushed rock, 'Source 1, Table 7-7

E = elastic modulus (lb/in$^2$) 100000.0 lb/in$^2$ for long term load at 100$^o$F, 'Source 1, Table 5-1

I = moment of inertia = t$^3$ / 12 0.0 in$^4$/in

$D_o$ = pipe outer diameter (in) 8.625 SDR 11 pipe (Driscopipe) to be used

t = pipe wall thickness (in) 0.784 SDR 11 pipe (Driscopipe) to be used

DR = pipe dimension ratio = $D_o$ / t 11.0 SDR 11 pipe (Driscopipe) to be used

$D_I$ = pipe inner diameter = $D_o$ - 2t (in) 7.1 SDR 11 pipe (Driscopipe) to be used

N = safety factor 2.0

| Cover (ft) | (ft) | (ft) | B' | R | (lb/in$^2$) |
|---|---|---|---|---|---|
| 4.0 | 4 | 0 | 0.24 | 1.00 | 220.98 |

$P_{WC}$ = 220.98 lb/in$^2$

$P_{EFF}$ = 11.53 lb/in$^2$

Pipe passes contrained wall buckling calculations TRUE FS = 19.2

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| CLIENT | PROJECT | JOB NO. |
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| SUBJECT | BY | DATE |
|---|---|---|
| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Collection Lateral** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **0 Feet Waste** | | |

Constrained Pipe Wall Compressive Stress (for Driscoplex OD controlled pipe)

$S = \frac{P_T D_o}{288t}$ Source No. 1

S = pipe wall compressive stress (lb/in$^2$)

| | | |
|---|---|---|
| $P_T$ = vertical load applied to pipe w/ perfs (lb/ft$^2$) | 1660.3 | lb/ft$^2$ |
| $D_o$ = pipe outside diameter (in) | 8.63 | SDR 11 pipe (Driscopipe) to be used |
| t = pipe wall thickness (in) | 0.784 | SDR 11 pipe (Driscopipe) to be used |

$S = \frac{P_T D_o}{288t} =$ 63.4 lb/in$^2$

The recommended, long-term compressive strength ($Y_s$) design value for Driscoplex polyethylene pipe is 800 lb/in$^2$.

Source No. 1

| S (psi): | | $Y_s$ (psi): |
|---|---|---|
| 63.4 | < | 800.0 |

Pipe passes wall compressive stress calculations TRUE

FS = 12.6

| CLIENT | PROJECT | JOB NO. |
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| SUBJECT | BY | DATE |
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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Collection Lateral** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **0 Feet Waste** | | |

Iowa Formula

$\Delta X = \dfrac{D_L K W_c r^3}{EI + 0.06er^4}$ Source 2, Equation 3.4 Buried Pipe Design, A.P. Moser, Chapter 3

$\Delta X$ = horizontal deflection (in)

$D_L$ = deflection lag factor

K = bedding constant | 0.1 | typical value Source 2, Buried Pipe Design, A.P. Moser, Chapter 3

$W_c$ = Marston's load per unit length of pipe (lb/in)

r = mean radius of the pipe (in)

E = modulus of elasticity (lb/in$^2$)

I = moment of inertia of the pipe wall per unit length (in$^3$)

e = modulus of passive resistance fo the side fill (lb/in$^2$(in))

Modified Iowa Formula

$\Delta X = \dfrac{D_L K W_c r_m^3}{EI + 0.06E'r_m^3}$ Source 2, Equation 3.5 Buried Pipe Design, A.P. Moser, Chapter 3

| | | |
|---|---|---|
| $\Delta X$ = horizontal deflection (in) | | |
| $D_L$ = deflection lag factor | 1.0 | Prism Load used |
| Typical Value for Marston Load 1.5 | | |
| Typical Value for Prism Load 1.0 | | |
| K = bedding constant | 0.1 | typical value Buried Pipe Design, A.P. Moser, Chapter 3 |
| $P_T$ = Vertical load on pipe w/ perfs | 11.53 | lb/in$^2$ 1660 lb/ft$^2$ |
| $W_c$ = Marston's load per unit length of pipe = $P_T$ * $D_o$ (lb/in) | 99.45 | lb/in |
| $D_o$ = pipe outer diameter (in) | 8.63 | SDR 11 pipe (Driscopipe) to be used |
| t = pipe wall thickness (in) | 0.78 | SDR 11 pipe (Driscopipe) to be used |
| $D_I$ = pipe inner diameter = $D_o$-2t (in) | 7.06 | SDR 11 pipe (Driscopipe) to be used |
| $D_m$ = pipe mean diameter = $D_o$ - 1.06t Source 1, Equation 7-27 | 7.79 | SDR 11 pipe (Driscopipe) to be used |
| $r_m$ = mean radius of the pipe (in) | 3.90 | SDR 11 pipe (Driscopipe) to be used |
| E = modulus of elasticity (lb/in$^2$) | 100,000.0 | lb/in2 for long term load at 100oF, 'Source 1, Table 5-1 |
| I = moment of inertia of the pipe wall per unit length | 0.040 | in$^4$/in |
| E' = modulus of soil reaction | 3,000.0 | lb/in$^2$ for moderate compaction and fine grained soils |

$\Delta X = \dfrac{D_L K W_c r_m^3}{EI + 0.06E'r_m^3}$ = 0.040 inch Source 2, Equation 3.5 Buried Pipe Design, A.P. Moser, Chapter 3

% Ring Deflection = ($\Delta X/D_m$) x 100 = 0.51% Source 1, Equation 7-31

Ring Bending Strain

$e = \dfrac{f_D \Delta X 2C}{D_M^2} \times 100$ Source 1, Equation 7-39

| | | |
|---|---|---|
| e = wall strain (%) | | |
| $f_D$ = deformation shape factor | 6 | Source 1, non-elliptical shape |
| $D_M$ = mean diameter (in) | | |
| C = outer fiber wall centroid = 0.5 (1.06t) | 0.416 | Source 1, Equation 7-41 |
| $\Delta X$ = ring deflection = $D_X/D_m$ | 0.005 | |

$e = f_D \dfrac{(\Delta X)}{D_M} \dfrac{(2C)}{D_M} \times 100$ = 0.3% Source 1, Equation 7-39

The maximum ring bending strain for high performance polyethylene non-pressure pipe is = 5.0%

Pipe passes ring bending strain calculations TRUE

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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Collection Lateral** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **0 Feet Waste** | | |

SOURCES

1.) Attachment - 1 - Chevron Phillips Chemical Company, Bulletin - Book 2 Chapter 5, 2003

2.) Attachment - 2 - Buried Pipe Design, A.P. Moser, Chapter 3

3.) Attachment - 3 - EPA, Lining of Waste Impoundment and Disposal Facilities, SW-870

4.) Attachment - 4 - Driscoplex Pipe Properties

5.) Attachment - 5 - CAT 826G Series II Compactor Data Sheet

6.) Attachment - 6 - CAT D7R Series II Equipment Data Sheet

7.) Attachment - 7 - CAT D6R XW Series II Equipment Data Sheet

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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Collection Lateral** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **10 Feet Waste** | | |

Load on Pipe (Overburden)

Prism Loads, $P_E$ = wH

w = unit weight

H = depth

| | Depth (ft) | Unit Weight ($lb/ft^3$) | $P_E$ ($lb/ft^2$) |
|---|---|---|---|
| Final cover | 0.0 | 115.0 | 0.0 |
| Intermediate cover | 0.0 | 115.0 | 0.0 |
| Waste/cover | 10.0 | 60.0 | 600.0 |
| Drainage sand | 2.0 | 115.0 | 230.0 |
| Rock (No. 89 & No. 57) | 2.0 | 140.0 | 280.0 |

TOTAL SOIL PRISM LOAD $P_E$: 1110.0 $lb/ft^2$

Total Depth = 14.0 ft

Soil Arching, $P_m = C_D wB$

Pm = vertical soil pressure

B = trench width at pipe crown 6.0 ft

$C_D$ = load coefficient $= \frac{1 - e^{-2Ku'H/B}}{2Ku'}$ Equation 7-3, Source No. 1

e = natural log base number

K = Rankine earth pressure coefficient = $\tan^2(45-0.5*\phi)$

$\phi$ = internal soil friction angle = 27.0 degrees

u' = friction coefficient between backfill and trench sides = tan $\phi$

NOTE: The waste unit weight represents the combined unit weight of waste, daily cover, and moisture.

| Soil Type | Ku' |
|---|---|
| Saturated Clay | 0.110 |
| Ordinary Clay | 0.130 |
| Saturated Top Soil | 0.150 |
| Sand and Gravel | 0.165 |
| Clean Granular Soil | 0.192 |

| | Ku' | $C_D$ | $P_m$ ($lb/ft^2$) |
|---|---|---|---|
| Cover Soil | 0.150 | 0.00 | 0 |
| Int Cover | 0.165 | 0.00 | 0 |
| Waste | 0.191 | 1.23 | 444 |
| Drainage Sand | 0.165 | 0.32 | 217.8 |
| Granular Soil | 0.192 | 0.31 | 262.8 |

TOTAL SOIL ARCHING LOAD $P_M$: 924.2 $lb/ft^2$

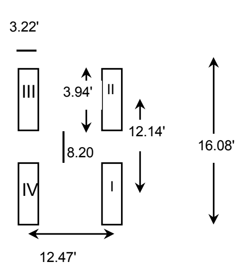
MODIFIED ARCHING LOAD = $0.6P_M+0.4P_E$: 998.53 $lb/ft^2$

OVERBURDEN LOAD: 998.53 $lb/ft^2$

Load on Pipe With Equipment Refer to Attachment

Operation w/ CAT 826G Series II Compactor 10 Feet Waste

Equipment Weight = 81,498.0 psf




| | | | |
|---|---|---|---|
| Track per Load = $q_r$ = | 1,670.20 | psf | (Rear) |
| Track per Load = $q_{fr}$ = | 1,541.72 | psf | (Front) |
| Length of Track = L = | 3.22 | ft | (contact length) |
| Length of Track = b = | 8.20 | ft | |
| Track Width = | 12.47 | ft | |
| Track Width (I to II) = | 16.08 | ft | |

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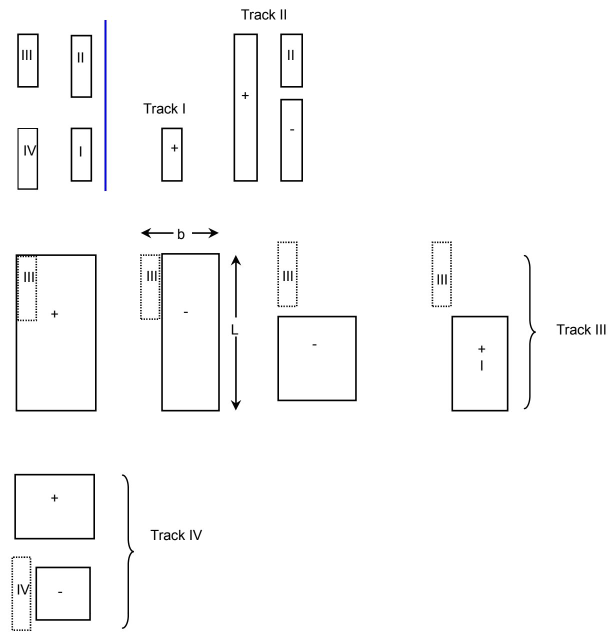
| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Collection Lateral** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **10 Feet Waste** | | |

Load on Pipe

Alternative 1: Track Adjacent and Parallel to Pipe




| | b | L | z | m = b/z | n = L/z | I* | I** | I | |
|---|---|---|---|---|---|---|---|---|---|
| Track I | 8.2 | 3 | 14 | 0.59 | 0.23 | 0.049 | 0.263 | 0.04882 | (ADD) |
| | | | | | | | | | |
| Track II | 8.2 | 16.1 | 14 | 0.59 | 1.15 | 0.139 | 0.265 | 0.13939 | (ADD) |
| | 8.2 | 11.4 | 14 | 0.59 | 0.82 | 0.124 | 0.270 | 0.12392 | (SUBTRACT) |
| | | | | | | | | | |
| Track IV | 12.47 | 3.22 | 14 | 0.89 | 0.23 | 0.060 | 0.262 | 0.05999 | (ADD) |
| | 12.47 | 3.22 | 14 | 0.89 | 0.23 | 0.060 | 0.262 | 0.05999 | (SUBTRACT) |
| | | | | | | | | | |
| Track III | 12.47 | 16.08 | 14 | 0.89 | 1.15 | 0.175 | 0.258 | 0.17489 | (ADD) |
| | 4.27 | 16.08 | 14 | 0.31 | 1.15 | 0.084 | 0.263 | 0.08363 | (SUBTRACT) |
| | 12.47 | 11.42 | 14 | 0.89 | 0.82 | 0.154 | 0.266 | 0.15446 | (SUBTRACT) |
| | 4.27 | 8.47 | 14 | 0.31 | 0.61 | 0.064 | 0.266 | 0.06417 | (ADD) |

$\text{Live Load}_1 = q_r(\Sigma I) + q_{fr}(\Sigma II) + q_{fr}(\Sigma III) + q_r(\Sigma IV)$

$\text{Live Load}_1 =$ 106.88 psf

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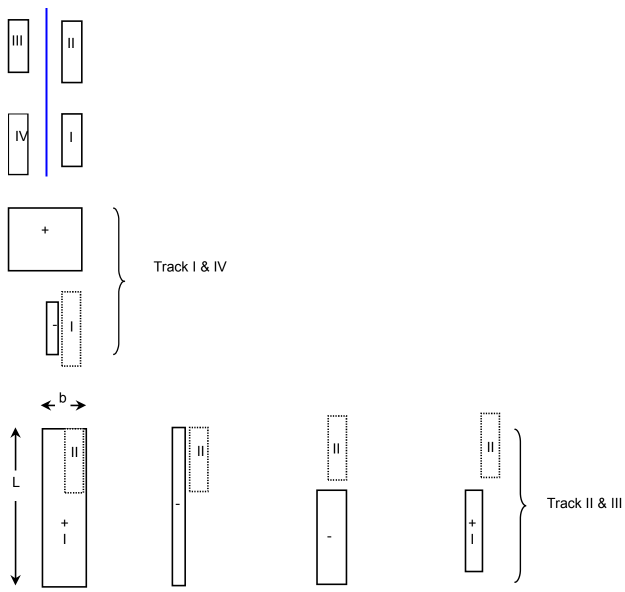
| Operation w/ CAT 826G Series II Compactor **10 Feet Waste** | | |

Load on Pipe

Alternative 2: Track Stradling and Parallel to Pipe




| | b | L | z | m = b/z | n = L/z | I* | I** | I | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | |
| Track I | 6.2 | 3.2 | 14 | 0.4 | 0.2 | 0.041 | 0.261 | 0.04054 | (ADD) |
| & IV | -2.0 | 3.2 | 14 | -0.1 | 0.2 | -0.015 | 0.245 | -0.01454 | (SUBTRACT) |
| | | | | | | | | | |
| Track II | 6.2 | 16.08 | 14 | 0.4 | 1.1 | 0.115 | 0.265 | 0.11458 | (ADD) |
| & III | -2.0 | 16.08 | 14 | -0.1 | 1.1 | -0.040 | 0.243 | -0.04040 | (SUBTRACT) |
| | 6.2 | 12.86 | 14 | 0.4 | 0.9 | 0.107 | 0.268 | 0.10711 | (SUBTRACT) |
| | -2.0 | 12.86 | 14 | -0.1 | 0.9 | -0.038 | 0.242 | -0.03788 | (ADD) |

Live $Load_2$ = $[q_r (\Sigma I) + q_{fr} (\Sigma II)] * 2$

Live $Load_2$ = 214.77 psf

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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
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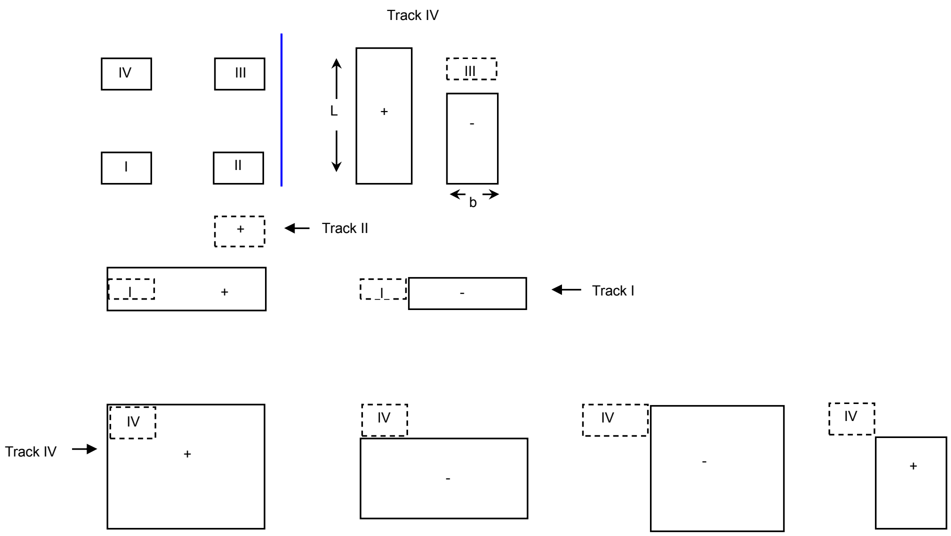
Load on Pipe

Alternative 3: Track Perpendicular to Pipe




| | b | L | z | m = b/z | n = L/z | I* | I** | I | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | |
| Track I | 16.1 | 8.2 | 14 | 1.1 | 0.6 | 0.139 | 0.265 | 0.13939 | (ADD) |
| | 12.9 | 8.2 | 14 | 0.9 | 0.6 | 0.130 | 0.269 | 0.13005 | (SUBTRACT) |
| | | | | | | | | | |
| Track II | 3.2 | 8.2 | 14 | 0.2 | 0.6 | 0.049 | 0.263 | 0.04882 | (ADD) |
| | | | | | | | | | |
| Track III | 3.2 | 12.5 | 14 | 0.2 | 0.9 | 0.060 | 0.262 | 0.05999 | (ADD) |
| | 3.2 | 4.3 | 14 | 0.2 | 0.3 | 0.030 | 0.259 | 0.02986 | (SUBTRACT) |
| | | | | | | | | | |
| Track IV | 16.1 | 12.5 | 14 | 1.1 | 0.9 | 0.175 | 0.258 | 0.17489 | (ADD) |
| | 16.1 | 4.3 | 14 | 1.1 | 0.3 | 0.084 | 0.263 | 0.08363 | (SUBTRACT) |
| | 12.9 | 12.5 | 14 | 0.9 | 0.9 | 0.162 | 0.264 | 0.16248 | (SUBTRACT) |
| | 12.9 | 4.3 | 14 | 0.9 | 0.3 | 0.078 | 0.265 | 0.07831 | (ADD) |

Live $Load_3 = q_r(\Sigma I) + q_{fr}(\Sigma II) + q_{fr}(\Sigma III) + q_r(\Sigma IV)$

Live $Load_3 =$ 149.14 psf

LARGEST EQUIPEMENT LOAD = 214.77 $lb/ft^2$

VERTICAL OVERBURDEN LOAD = 998.53 $lb/ft^2$

VERTICAL EQUIPMENT LOAD = 214.77 $lb/ft^2$

TOTAL VERTICAL LOAD APPLIED TO PIPE, $P_T =$ 1213.30 $lb/ft^2$ = 8.43 $lb/in^2$

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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Collection Lateral** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **10 Feet Waste** | | |

Verify that perforations in the LCRS are adequate for the peak leachate flow.

Use discharge equation:

$Q = (Cd)(Ao)(2gh)^{0.5}$

$C_d$ = coeffiecient of discharge = 0.6 for short tube discharge with fluid/wall separation; conservative value.

$A_o$ = Area of orifice ($\pi D^2/4$)

g = gravitational acceleration (32.3 $ft^2/s$)

h = static head (ft)

| Assumptions and Givens: | 4.55 | acres | North and center portion of landfill bottom |
|---|---|---|---|
| 1. No. acres of landfill expansion = | 3.08 | acres | - North & center less area from eastern grade break of bottom |
| 2. Total length of pipe per expansion = | 1,888.1 | ft | area draining into eastern 10-inch lateral collection |
| 3. Total number of laterals = | 2.0 | | - (2) 8-inch laterals collect drainage from this bottom area |
| 4. Length of pipe per lateral = | 944.1 | ft | - (1) 10-inch lateral collects the remaining drainage |
| 5. Perforation diameter = | 0.375 | inch | - Refer to calcs for 10" diameter leachate collection lateral |
| 6. No. perforations/ft pipe = | 6.0 | perforations/ft of pipe length | |
| 7. Maximum head over pipe = | 1.0 | ft | |
| 8. Per HELP model summary table, $Q_{peak}$ = | 202.93 | gal/min | refer to HELP Model Summary Table |
| 9. Per HELP model summary table, $Q_{peak}$ = | 39,063.5 | cf/day | refer to HELP Model Summary Table |
| 10. Maximum flow/lateral = | 19,531.7 | cf/day/lateral | |
| 11. Maximum leachate flow/ft of pipe = | 20.69 | cf/day/ft of pipe | |

Solution:

$A_o = 0.25(\Pi)(d)^2 =$ 0.00077 $ft^2$

1. Flow per orifice, $Q = (Cd)(Ao)(2gh)^{0.5} =$ 0.0037 $ft^3/s$

2. Flow per ft of pipe = (Q)(# perfs/ft) = 0.02 $ft^3/s$ per ft of pipe

= 1914.47 cf/day/ft of pipe

Conclusion:

Design capacity exceeds estimated generation

1914.47 cf/day/ft of pipe >>> 20.69 cf/day/ft of pipe

Perforations are adequate to handle the maximum leachate flow.

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| Operation w/ CAT 826G Series II Compactor **10 Feet Waste** | | |

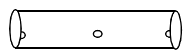
Effective pressure on pipe due to perforations:

$P_{EFF} = \frac{P_T \times 12}{(12 - L_P)}$ Source 3, EPA SW-870, p. 382

$L_P$ = Total accumulated length of perforations in one foot of pipe.

Since each perforation is 0.375 inch diameter and spaced at 6.0 inch on center,

$L_P$ = 1.5 inch



$P_T$ = 8.4 psi

$P_{EFF}$ = 9.6 psi

$P_{EFF}$ = 1386.6 psf

Check actual compressive pressure ($S_A$) per Driscopipe manual:

$S_A$ = 0.5 x (SDR - 1) x P(eff) = 48.2 psi

The recommended, long-term compressive strength ($Y_s$) design value for Driscoplex polyethylene pipe is 800 lb/in$^2$.

Source No. 1

| $S_A$ (psi): | | $Y_s$ (psi): |
|---|---|---|
| 48.2 | < | 800.0 |

Pipe passes wall compressive stress perforation calculations TRUE

FS = 16.6

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| **8" Diameter Leachate Collection Lateral** | CHECKED | DATE |
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Constrained pipe wall buckling (for Driscoplex OD controlled pipe)

$P_{WC} = \frac{5.65 * \{RB'E'\ E*[12(DR-1)^3]^{-1}\}^{0.5}}{N}$ Source 1, Equation 7-5

$P_{WC}$ = allowable constrained buckling pressure ($lb/in^2$)

R = buoyancy reduction factor = 1 - 0.33 * (H'/H) Source 1, Equation 7-34

H' = groundwater height above pipe (ft) 0.0 ft

H = cover above pipe (ft) 14.0 ft

B' = elastic support factor =$( 1+ 4*e^{-0.065H} )^{-1}$ Source 1, Equation 7-35

E' = soil reaction modulus ($lb/in^2$) 3000.0 $lb/in^2$ for mod comp/crushed rock, 'Source 1, Table 7-7

E = elastic modulus ($lb/in^2$) 100000.0 $lb/in^2$ for long term load at 100°F, 'Source 1, Table 5-1

I = moment of inertia = $t^3$ / 12 0.0 $in^4/in$

$D_o$ = pipe outer diameter (in) 8.625 SDR 11 pipe (Driscopipe) to be used

t = pipe wall thickness (in) 0.784 SDR 11 pipe (Driscopipe) to be used

DR = pipe dimension ratio = $D_o$ / t 11.0 SDR 11 pipe (Driscopipe) to be used

$D_I$ = pipe inner diameter = $D_o$ - 2t (in) 7.1 SDR 11 pipe (Driscopipe) to be used

N = safety factor 2.0

| Cover (ft) | (ft) | (ft) | B' | R | ($lb/in^2$) |
|---|---|---|---|---|---|
| 14.0 | 14 | 0 | 0.38 | 1.00 | 276.42 |

$P_{WC}$ = 276.42 $lb/in^2$

$P_{EFF}$ = 9.63 $lb/in^2$

Pipe passes contrained wall buckling calculations TRUE FS = 28.7

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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Collection Lateral** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **10 Feet Waste** | | |

Constrained Pipe Wall Compressive Stress (for Driscoplex OD controlled pipe)

$$S = \frac{P_T D_o}{288t}$$ Source No. 1

S = pipe wall compressive stress ($lb/in^2$)

$P_T$ = vertical load applied to pipe w/ perfs ($lb/ft^2$) | 1386.6 | $lb/ft^2$

$D_o$ = pipe outside diameter (in) | 8.63 | SDR 11 pipe (Driscopipe) to be used

t = pipe wall thickness (in) | 0.784 | SDR 11 pipe (Driscopipe) to be used

$$S = \frac{P_T D_o}{288t} =$$ 53.0 $lb/in^2$

The recommended, long-term compressive strength ($Y_s$) design value for Driscoplex polyethylene pipe is 800 $lb/in^2$.

Source No. 1

| S (psi): | | $Y_s$ (psi): |
|---|---|---|
| 53.0 | < | 800.0 |

Pipe passes wall compressive stress calculations TRUE

FS = 15.1

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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Collection Lateral** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **10 Feet Waste** | | |

Iowa Formula

$\Delta X = \dfrac{D_L K W_c r^3}{EI + 0.06er^4}$ Source 2, Equation 3.4 Buried Pipe Design, A.P. Moser, Chapter 3

$\Delta X$ = horizontal deflection (in)

$D_L$ = deflection lag factor

K = bedding constant — 0.1 — typical value Source 2, Buried Pipe Design, A.P. Moser, Chapter 3

$W_c$ = Marston's load per unit length of pipe (lb/in)

r = mean radius of the pipe (in)

E = modulus of elasticity (lb/in$^2$)

I = moment of inertia of the pipe wall per unit length (in$^3$)

e = modulus of passive resistance fo the side fill (lb/in$^2$(in))

Modified Iowa Formula

$\Delta X = \dfrac{D_L K W_c r_m^3}{EI + 0.06E'r_m^3}$ Source 2, Equation 3.5 Buried Pipe Design, A.P. Moser, Chapter 3

$\Delta X$ = horizontal deflection (in)

| | | |
|---|---|---|
| $D_L$ = deflection lag factor | 1.0 | Prism Load used |
| Typical Value for Marston Load | 1.5 | |
| Typical Value for Prism Load | 1.0 | |
| K = bedding constant | 0.1 | typical value Buried Pipe Design, A.P. Moser, Chapter 3 |
| $P_T$ = Vertical load on pipe w/ perfs | 9.63 | lb/in$^2$ — 1387 lb/ft$^2$ |
| $W_c$ = Marston's load per unit length of pipe = $P_T$ * $D_o$ (lb/in) | 83.05 | lb/in |
| $D_o$ = pipe outer diameter (in) | 8.63 | SDR 11 pipe (Driscopipe) to be used |
| t = pipe wall thickness (in) | 0.78 | SDR 11 pipe (Driscopipe) to be used |
| $D_I$ = pipe inner diameter = $D_o$-2t (in) | 7.06 | SDR 11 pipe (Driscopipe) to be used |
| $D_m$ = pipe mean diameter = $D_o$ - 1.06t Source 1, Equation 7-27 | 7.79 | SDR 11 pipe (Driscopipe) to be used |
| $r_m$ = mean radius of the pipe (in) | 3.90 | SDR 11 pipe (Driscopipe) to be used |
| E = modulus of elasticity (lb/in$^2$) | 100,000.0 | lb/in2 for long term load at 100oF, 'Source 1, Table 5-1 |
| I = moment of inertia of the pipe wall per unit length | 0.040 | in$^4$/in |
| E' = modulus of soil reaction | 3,000.0 | lb/in$^2$ for moderate compaction and fine grained soils |

$\Delta X = \dfrac{D_L K W_c r_m^3}{EI + 0.06E'r_m^3}$ = 0.034 inch — Source 2, Equation 3.5 Buried Pipe Design, A.P. Moser, Chapter 3

% Ring Deflection = ($\Delta X/D_m$) x 100 = 0.43% Source 1, Equation 7-31

Ring Bending Strain

$e = \dfrac{f_D \Delta X 2C}{D_M^2} \times 100$ Source 1, Equation 7-39

e = wall strain (%)

| | | |
|---|---|---|
| $f_D$ = deformation shape factor | 6 | Source 1, non-elliptical shape |
| $D_M$ = mean diameter (in) | | |
| C = outer fiber wall centroid = 0.5 (1.06t) | 0.416 | Source 1, Equation 7-41 |
| $\Delta X$ = ring deflection = $D_X/D_m$ | 0.004 | |

$e = f_D \dfrac{(\Delta X)}{D_M}\dfrac{(2C)}{D_M} \times 100$ = 0.3% Source 1, Equation 7-39

The maximum ring bending strain for high performance polyethylene non-pressure pipe is = 5.0%

Pipe passes ring bending strain calculations TRUE

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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Collection Lateral** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **10 Feet Waste** | | |

SOURCES

1.) Attachment - 1 - Chevron Phillips Chemical Company, Bulletin - Book 2 Chapter 5, 2003

2.) Attachment - 2 - Buried Pipe Design, A.P. Moser, Chapter 3

3.) Attachment - 3 - EPA, Lining of Waste Impoundment and Disposal Facilities, SW-870

4.) Attachment - 4 - Driscoplex Pipe Properties

5.) Attachment - 5 - CAT 826G Series II Compactor Data Sheet

6.) Attachment - 6 - CAT D7R Series II Equipment Data Sheet

7.) Attachment - 7 - CAT D6R XW Series II Equipment Data Sheet

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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
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| Operation w/ CAT 826G Series II Compactor **25 Feet Waste** | | |

Load on Pipe (Overburden)

Prism Loads, $P_E$ = wH

w = unit weight

H = depth

| | Depth (ft) | Unit Weight (lb/ft$^3$) | $P_E$ (lb/ft$^2$) |
|---|---|---|---|
| Final cover | 0.0 | 115.0 | 0.0 |
| Intermediate cover | 0.0 | 115.0 | 0.0 |
| Waste/cover | 25.0 | 60.0 | 1500.0 |
| Drainage sand | 2.0 | 115.0 | 230.0 |
| Rock (No. 89 & No. 57) | 2.0 | 140.0 | 280.0 |

TOTAL SOIL PRISM LOAD $P_E$: 2010.0 lb/ft$^2$

Total Depth = 29.0 ft

Soil Arching, $P_m = C_D w B$

Pm = vertical soil pressure

B = trench width at pipe crown 6.0 ft

$C_D$ = load coefficient $= \frac{1 - e^{-2Ku'H/B}}{2Ku'}$ Equation 7-3, Source No. 1

NOTE: The waste unit weight represents the combined unit weight of waste, daily cover, and moisture.

e = natural log base number

K = Rankine earth pressure coefficient = $\tan^2(45-0.5*\phi)$

$\phi$ = internal soil friction angle = 27.0 degrees

u' = friction coefficient between backfill and trench sides = tan $\phi$

| Soil Type | Ku' |
|---|---|
| Saturated Clay | 0.110 |
| Ordinary Clay | 0.130 |
| Saturated Top Soil | 0.150 |
| Sand and Gravel | 0.165 |
| Clean Granular Soil | 0.192 |

| | Ku' | $C_D$ | $P_m$ (lb/ft$^2$) |
|---|---|---|---|
| Cover Soil | 0.150 | 0.00 | 0 |
| Int Cover | 0.165 | 0.00 | 0 |
| Waste | 0.191 | 2.08 | 750 |
| Drainage Sand | 0.165 | 0.32 | 217.8 |
| Granular Soil | 0.192 | 0.31 | 262.8 |

TOTAL SOIL ARCHING LOAD $P_M$: 1,230.4 lb/ft$^2$

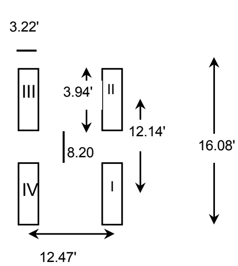
MODIFIED ARCHING LOAD = $0.6P_M+0.4P_E$: 1,542.23 lb/ft$^2$

OVERBURDEN LOAD: 1,542.23 lb/ft$^2$

Load on Pipe With Equipment Refer to Attachment

Operation w/ CAT 826G Series II Compactor 25 Feet Waste

Equipment Weight = 81,498.0 psf




Track per Load = $q_r$ = 1,670.20 psf (Rear)

Track per Load = $q_{fr}$ = 1,541.72 psf (Front)

Length of Track = L = 3.22 ft (contact length)

Length of Track = b = 8.20 ft

Track Width = 12.47 ft

Track Width (I to II) = 16.08 ft

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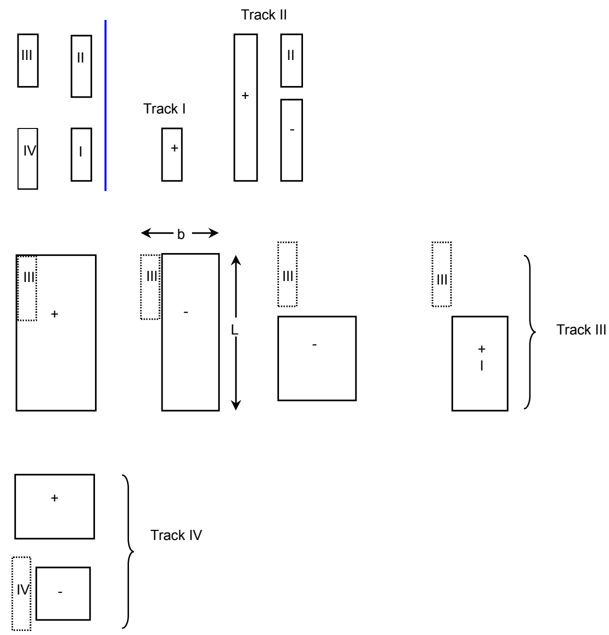
| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Collection Lateral** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **25 Feet Waste** | | |

Load on Pipe

Alternative 1: Track Adjacent and Parallel to Pipe




| | b | L | z | m = b/z | n = L/z | I* | I** | I | |
|---|---|---|---|---|---|---|---|---|---|
| Track I | 8.2 | 3 | 29 | 0.28 | 0.11 | 0.014 | 0.254 | 0.01393 | (ADD) |
| | | | | | | | | | |
| Track II | 8.2 | 16.1 | 29 | 0.28 | 0.55 | 0.057 | 0.265 | 0.05688 | (ADD) |
| | 8.2 | 11.4 | 29 | 0.28 | 0.39 | 0.044 | 0.263 | 0.04447 | (SUBTRACT) |
| | | | | | | | | | |
| Track IV | 12.47 | 3.22 | 29 | 0.43 | 0.11 | 0.020 | 0.256 | 0.01966 | (ADD) |
| | 12.47 | 3.22 | 29 | 0.43 | 0.11 | 0.020 | 0.256 | 0.01966 | (SUBTRACT) |
| | | | | | | | | | |
| Track III | 12.47 | 16.08 | 29 | 0.43 | 0.55 | 0.081 | 0.269 | 0.08065 | (ADD) |
| | 4.27 | 16.08 | 29 | 0.15 | 0.55 | 0.031 | 0.258 | 0.03090 | (SUBTRACT) |
| | 12.47 | 11.42 | 29 | 0.43 | 0.39 | 0.063 | 0.267 | 0.06292 | (SUBTRACT) |
| | 4.27 | 8.47 | 29 | 0.15 | 0.29 | 0.019 | 0.256 | 0.01886 | (ADD) |

Live Load$_1$ = $q_r(\Sigma I) + q_{fr}(\Sigma II) + q_{fr}(\Sigma III) + q_r(\Sigma IV)$

Live Load$_1$ = 51.18 psf

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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
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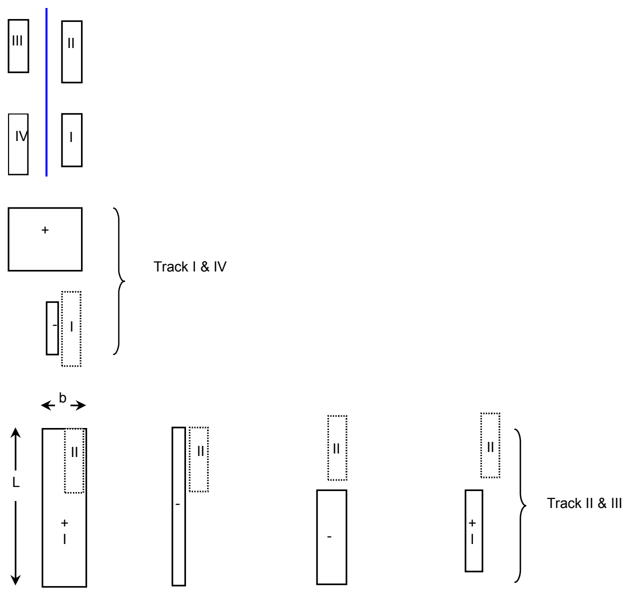
| Operation w/ CAT 826G Series II Compactor **25 Feet Waste** | | |

Load on Pipe

Alternative 2: Track Stradling and Parallel to Pipe




| | b | L | z | m = b/z | n = L/z | I* | I** | I | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | |
| Track I | 6.2 | 3.2 | 29 | 0.2 | 0.1 | 0.011 | 0.253 | 0.01087 | (ADD) |
| & IV | -2.0 | 3.2 | 29 | -0.1 | 0.1 | -0.004 | 0.249 | -0.00354 | (SUBTRACT) |
| | | | | | | | | | |
| Track II | 6.2 | 16.08 | 29 | 0.2 | 0.6 | 0.044 | 0.262 | 0.04431 | (ADD) |
| & III | -2.0 | 16.08 | 29 | -0.1 | 0.6 | -0.014 | 0.246 | -0.01441 | (SUBTRACT) |
| | 6.2 | 12.86 | 29 | 0.2 | 0.4 | 0.038 | 0.261 | 0.03796 | (SUBTRACT) |
| | -2.0 | 12.86 | 29 | -0.1 | 0.4 | -0.012 | 0.246 | -0.01235 | (ADD) |

Live $Load_2 = [q_r(\Sigma I) + q_{fr}(\Sigma II)] * 2$

Live $Load_2 =$ 74.06 psf

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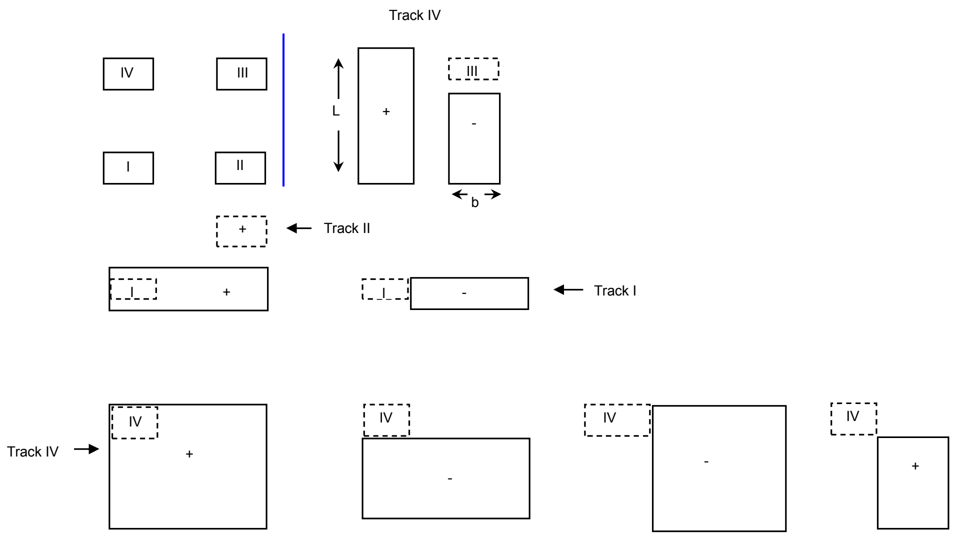
Load on Pipe

Alternative 3: Track Perpendicular to Pipe




| | b | L | z | m = b/z | n = L/z | I* | I** | I | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | |
| Track I | 16.1 | 8.2 | 29 | 0.6 | 0.3 | 0.057 | 0.265 | 0.05688 | (ADD) |
| | 12.9 | 8.2 | 29 | 0.4 | 0.3 | 0.049 | 0.264 | 0.04871 | (SUBTRACT) |
| | | | | | | | | | |
| Track II | 3.2 | 8.2 | 29 | 0.1 | 0.3 | 0.014 | 0.254 | 0.01393 | (ADD) |
| | | | | | | | | | |
| Track III | 3.2 | 12.5 | 29 | 0.1 | 0.4 | 0.020 | 0.256 | 0.01966 | (ADD) |
| | 3.2 | 4.3 | 29 | 0.1 | 0.1 | 0.008 | 0.252 | 0.00759 | (SUBTRACT) |
| | | | | | | | | | |
| Track IV | 16.1 | 12.5 | 29 | 0.6 | 0.4 | 0.081 | 0.269 | 0.08065 | (ADD) |
| | 16.1 | 4.3 | 29 | 0.6 | 0.1 | 0.031 | 0.258 | 0.03090 | (SUBTRACT) |
| | 12.9 | 12.5 | 29 | 0.4 | 0.4 | 0.069 | 0.268 | 0.06896 | (SUBTRACT) |
| | 12.9 | 4.3 | 29 | 0.4 | 0.1 | 0.026 | 0.258 | 0.02649 | (ADD) |

Live Load$_3$ = $q_r(\Sigma I) + q_{fr}(\Sigma II) + q_{fr}(\Sigma III) + q_r(\Sigma IV)$

Live Load$_3$ = 65.88 psf

LARGEST EQUIPEMENT LOAD = 74.06 lb/ft$^2$

VERTICAL OVERBURDEN LOAD = 1542.23 lb/ft$^2$

VERTICAL EQUIPMENT LOAD = 74.06 lb/ft$^2$

TOTAL VERTICAL LOAD APPLIED TO PIPE, $P_T$ = 1616.28 lb/ft$^2$ = 11.22 lb/in$^2$

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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Collection Lateral** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **25 Feet Waste** | | |

Verify that perforations in the LCRS are adequate for the peak leachate flow.

Use discharge equation:

$Q = (Cd)(Ao)(2gh)^{0.5}$

$C_d$ = coeffiecient of discharge = 0.6 for short tube discharge with fluid/wall separation; conservative value.

$A_o$ = Area of orifice ($\pi D^2/4$)

g = gravitational acceleration (32.3 $ft^2/s$)

h = static head (ft)

| Assumptions and Givens: | 4.55 | acres | North and center portion of landfill bottom |
|---|---|---|---|
| 1. No. acres of landfill expansion = | 3.08 | acres | - North & center less area from eastern grade break of bottom |
| 2. Total length of pipe per expansion = | 1,888.1 | ft | area draining into eastern 10-inch lateral collection |
| 3. Total number of laterals = | 2.0 | | - (2) 8-inch laterals collect drainage from this bottom area |
| 4. Length of pipe per lateral = | 944.1 | ft | - (1) 10-inch lateral collects the remaining drainage |
| 5. Perforation diameter = | 0.375 | inch | - Refer to calcs for 10" diameter leachate collection lateral |
| 6. No. perforations/ft pipe = | 6.0 | perforations/ft of pipe length | |
| 7. Maximum head over pipe = | 1.0 | ft | |
| 8. Per HELP model summary table, $Q_{peak}$ = | 202.93 | gal/min | refer to HELP Model Summary Table |
| 9. Per HELP model summary table, $Q_{peak}$ = | 39,063.5 | cf/day | refer to HELP Model Summary Table |
| 10. Maximum flow/lateral = | 19,531.7 | cf/day/lateral | |
| 11. Maximum leachate flow/ft of pipe = | 20.69 | cf/day/ft of pipe | |

Solution:

$A_o = 0.25(\Pi)(d)^2 =$ 0.00077 $ft^2$

1. Flow per orifice, $Q = (Cd)(Ao)(2gh)^{0.5}$ = 0.0037 $ft^3/s$

2. Flow per ft of pipe = (Q)(# perfs/ft) = 0.02 $ft^3/s$ per ft of pipe

= 1914.47 cf/day/ft of pipe

Conclusion:

Design capacity exceeds estimated generation

1914.47 cf/day/ft of pipe >>> 20.69 cf/day/ft of pipe

Perforations are adequate to handle the maximum leachate flow.

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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Collection Lateral** | CHECKED | DATE |
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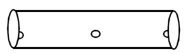
Effective pressure on pipe due to perforations:

$P_{EFF} = \frac{P_T \times 12}{(12 - L_P)}$ Source 3, EPA SW-870, p. 382

$L_P$ = Total accumulated length of perforations in one foot of pipe.

Since each perforation is 0.375 inch diameter and spaced at 6.0 inch on center,

$L_P$ = 1.5 inch



$P_T$ = 11.2 psi

$P_{EFF}$ = 12.8 psi

$P_{EFF}$ = 1847.2 psf

Check actual compressive pressure ($S_A$) per Driscopipe manual:

$S_A$ = 0.5 x (SDR - 1) x P(eff) = 64.1 psi

The recommended, long-term compressive strength ($Y_s$) design value for Driscoplex polyethylene pipe is 800 lb/in$^2$.

Source No. 1

| $S_A$ (psi): | | $Y_s$ (psi): |
|---|---|---|
| 64.1 | < | 800.0 |

Pipe passes wall compressive stress perforation calculations TRUE

FS = 12.5

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Constrained pipe wall buckling (for Driscoplex OD controlled pipe)

$P_{WC} = \frac{5.65 * \{RB'E' E*[12(DR-1)^3]^{-1}\}^{0.5}}{N}$ Source 1, Equation 7-5

$P_{WC}$ = allowable constrained buckling pressure (lb/in$^2$)

| | | |
|---|---|---|
| R = buoyancy reduction factor = 1 - 0.33 * (H'/H) | Source 1, Equation 7-34 | |
| H' = groundwater height above pipe (ft) | 0.0 | ft |
| H = cover above pipe (ft) | 29.0 | ft |
| B' = elastic support factor =( 1+ 4*$e^{-0.065H}$ )$^{-1}$ | Source 1, Equation 7-35 | |
| E' = soil reaction modulus (lb/in$^2$) | 3000.0 | lb/in$^2$ for mod comp/crushed rock, 'Source 1, Table 7-7 |
| E = elastic modulus (lb/in$^2$) | 100000.0 | lb/in$^2$ for long term load at 100$^o$F, 'Source 1, Table 5-1 |
| I = moment of inertia = $t^3$ / 12 | 0.0 | in$^4$/in |
| $D_o$ = pipe outer diameter (in) | 8.625 | SDR 11 pipe (Driscopipe) to be used |
| t = pipe wall thickness (in) | 0.784 | SDR 11 pipe (Driscopipe) to be used |
| DR = pipe dimension ratio = $D_o$ / t | 11.0 | SDR 11 pipe (Driscopipe) to be used |
| $D_I$ = pipe inner diameter = $D_o$ - 2t (in) | 7.1 | SDR 11 pipe (Driscopipe) to be used |
| N = safety factor | 2.0 | |

| Cover (ft) | (ft) | (ft) | B' | R | (lb/in$^2$) |
|---|---|---|---|---|---|
| 29.0 | 29 | 0 | 0.62 | 1.00 | 352.25 |

$P_{WC}$ = 352.25 lb/in$^2$

$P_{EFF}$ = 12.83 lb/in$^2$

Pipe passes contrained wall buckling calculations TRUE FS = 27.5

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|---|---|---|
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| Pipe Crushing Calculations **RAI No. 1**<br>**8" Diameter Leachate Collection Lateral** | SRF | 4/1/13 |
| Operation w/ CAT 826G Series II Compactor **25 Feet Waste** | CHECKED | DATE |

Constrained Pipe Wall Compressive Stress (for Driscoplex OD controlled pipe)

$$S = \frac{P_T D_o}{288t}$$ Source No. 1

S = pipe wall compressive stress ($lb/in^2$)

| | | |
|---|---|---|
| $P_T$ = vertical load applied to pipe w/ perfs ($lb/ft^2$) | 1847.2 | $lb/ft^2$ |
| $D_o$ = pipe outside diameter (in) | 8.63 | SDR 11 pipe (Driscopipe) to be used |
| t = pipe wall thickness (in) | 0.784 | SDR 11 pipe (Driscopipe) to be used |

$$S = \frac{P_T D_o}{288t} = 70.6 \ lb/in^2$$

The recommended, long-term compressive strength ($Y_s$) design value for Driscoplex polyethylene pipe is 800 $lb/in^2$.

Source No. 1

| S (psi): | | $Y_s$ (psi): |
|---|---|---|
| 70.6 | < | 800.0 |

Pipe passes wall compressive stress calculations TRUE

FS = 11.3

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Iowa Formula

$\Delta X = \dfrac{D_L K W_c r^3}{EI + 0.06er^4}$ Source 2, Equation 3.4 Buried Pipe Design, A.P. Moser, Chapter 3

$\Delta X$ = horizontal deflection (in)

$D_L$ = deflection lag factor

K = bedding constant | 0.1 | typical value Source 2, Buried Pipe Design, A.P. Moser, Chapter 3

$W_c$ = Marston's load per unit length of pipe (lb/in)

r = mean radius of the pipe (in)

E = modulus of elasticity (lb/in$^2$)

I = moment of inertia of the pipe wall per unit length (in$^3$)

e = modulus of passive resistance fo the side fill (lb/in$^2$(in))

Modified Iowa Formula

$\Delta X = \dfrac{D_L K W_c r_m^3}{EI + 0.06E'r_m^3}$ Source 2, Equation 3.5 Buried Pipe Design, A.P. Moser, Chapter 3

$\Delta X$ = horizontal deflection (in)

| | | | |
|---|---|---|---|
| $D_L$ = deflection lag factor | | 1.0 | Prism Load used |
| Typical Value for Marston Load | 1.5 | | |
| Typical Value for Prism Load | 1.0 | | |
| K = bedding constant | | 0.1 | typical value Buried Pipe Design, A.P. Moser, Chapter 3 |
| $P_T$ = Vertical load on pipe w/ perfs | | 12.83 | lb/in$^2$ 1847 lb/ft$^2$ |
| $W_c$ = Marston's load per unit length of pipe = $P_T$ * $D_o$ (lb/in) | | 110.64 | lb/in |
| $D_o$ = pipe outer diameter (in) | | 8.63 | SDR 11 pipe (Driscopipe) to be used |
| t = pipe wall thickness (in) | | 0.78 | SDR 11 pipe (Driscopipe) to be used |
| $D_I$ = pipe inner diameter = $D_o$-2t (in) | | 7.06 | SDR 11 pipe (Driscopipe) to be used |
| $D_m$ = pipe mean diameter = $D_o$ - 1.06t Source 1, Equation 7-27 | | 7.79 | SDR 11 pipe (Driscopipe) to be used |
| $r_m$ = mean radius of the pipe (in) | | 3.90 | SDR 11 pipe (Driscopipe) to be used |
| E = modulus of elasticity (lb/in$^2$) | | 100,000.0 | lb/in2 for long term load at 100oF, 'Source 1, Table 5-1 |
| I = moment of inertia of the pipe wall per unit length | | 0.040 | in$^4$/in |
| E' = modulus of soil reaction | | 3,000.0 | lb/in$^2$ for moderate compaction and fine grained soils |

$\Delta X = \dfrac{D_L K W_c r_m^3}{EI + 0.06E'r_m^3}$ = 0.045 inch Source 2, Equation 3.5 Buried Pipe Design, A.P. Moser, Chapter 3

% Ring Deflection = ($\Delta X/D_m$) x 100 = 0.57% Source 1, Equation 7-31

Ring Bending Strain

$e = \dfrac{f_D \Delta X 2C}{D_M^2} \times 100$ Source 1, Equation 7-39

e = wall strain (%)

| | | |
|---|---|---|
| $f_D$ = deformation shape factor | 6 | Source 1, non-elliptical shape |
| $D_M$ = mean diameter (in) | | |
| C = outer fiber wall centroid = 0.5 (1.06t) | 0.416 | Source 1, Equation 7-41 |
| $\Delta X$ = ring deflection = $D_X/D_m$ | 0.006 | |

$e = f_D \dfrac{(\Delta X)}{D_M} \dfrac{(2C)}{D_M} \times 100$ = 0.4% Source 1, Equation 7-39

The maximum ring bending strain for high performance polyethylene non-pressure pipe is = 5.0%

Pipe passes ring bending strain calculations TRUE

| CLIENT | PROJECT | JOB NO. |
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| SUBJECT | BY | DATE |
|---|---|---|
| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Collection Lateral** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **25 Feet Waste** | | |

SOURCES

1.) Attachment - 1 - Chevron Phillips Chemical Company, Bulletin - Book 2 Chapter 5, 2003

2.) Attachment - 2 - Buried Pipe Design, A.P. Moser, Chapter 3

3.) Attachment - 3 - EPA, Lining of Waste Impoundment and Disposal Facilities, SW-870

4.) Attachment - 4 - Driscoplex Pipe Properties

5.) Attachment - 5 - CAT 826G Series II Compactor Data Sheet

6.) Attachment - 6 - CAT D7R Series II Equipment Data Sheet

7.) Attachment - 7 - CAT D6R XW Series II Equipment Data Sheet

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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Collection Lateral** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **60 Feet Waste** | | |

Load on Pipe (Overburden)

Prism Loads, $P_E$ = wH

w = unit weight

H = depth

| | Depth (ft) | Unit Weight ($lb/ft^3$) | $P_E$ ($lb/ft^2$) |
|---|---|---|---|
| Final cover | 2.0 | 115.0 | 230.0 |
| Intermediate cover | 1.0 | 115.0 | 115.0 |
| Waste/cover | 60.0 | 60.0 | 3600.0 |
| Drainage sand | 2.0 | 115.0 | 230.0 |
| Rock (No. 89 & No. 57) | 2.0 | 140.0 | 280.0 |

TOTAL SOIL PRISM LOAD $P_E$: 4455.0 $lb/ft^2$

Total Depth = 67.0 ft

Soil Arching, $P_m = C_D w B$

NOTE: The waste unit weight represents the combined unit weight of waste, daily cover, and moisture.

Pm = vertical soil pressure

B = trench width at pipe crown 6.0 ft

$C_D$ = load coefficient $= \frac{1 - e^{-2Ku'H/B}}{2Ku'}$ Equation 7-3, Source No. 1

e = natural log base number

K = Rankine earth pressure coefficient = $\tan^2(45-0.5*\phi)$

$\phi$ = internal soil friction angle = 27.0 degrees

u' = friction coefficient between backfill and trench sides = tan $\phi$

| Soil Type | Ku' |
|---|---|
| Saturated Clay | 0.110 |
| Ordinary Clay | 0.130 |
| Saturated Top Soil | 0.150 |
| Sand and Gravel | 0.165 |
| Clean Granular Soil | 0.192 |

| | Ku' | $C_D$ | $P_m$ ($lb/ft^2$) |
|---|---|---|---|
| Cover Soil | 0.150 | 0.32 | 219 |
| Int Cover | 0.165 | 0.16 | 112 |
| Waste | 0.191 | 2.56 | 920 |
| Drainage Sand | 0.165 | 0.32 | 217.8 |
| Granular Soil | 0.192 | 0.31 | 262.8 |

TOTAL SOIL ARCHING LOAD $P_M$: 1,731.6 $lb/ft^2$

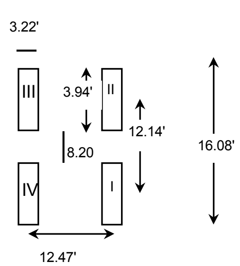
MODIFIED ARCHING LOAD = $0.6P_M+0.4P_E$: 2,820.98 $lb/ft^2$

OVERBURDEN LOAD: 2,820.98 $lb/ft^2$

Load on Pipe With Equipment Refer to Attachment

Operation w/ CAT 826G Series II Compactor 60 Feet Waste

Equipment Weight = 81,498.0 psf




| | | | |
|---|---|---|---|
| Track per Load = $q_r$ = | 1,670.20 | psf | (Rear) |
| Track per Load = $q_{fr}$ = | 1,541.72 | psf | (Front) |
| Length of Track = L = | 3.22 | ft | (contact length) |
| Length of Track = b = | 8.20 | ft | |
| Track Width = | 12.47 | ft | |
| Track Width (I to II) = | 16.08 | ft | |

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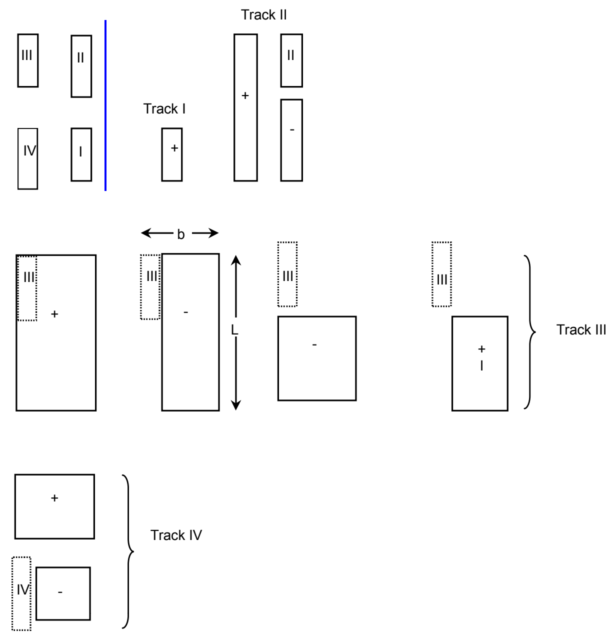
| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Collection Lateral** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **60 Feet Waste** | | |

Load on Pipe

Alternative 1: Track Adjacent and Parallel to Pipe




| | b | L | z | m = b/z | n = L/z | I* | I** | I | |
|---|---|---|---|---|---|---|---|---|---|
| Track I | 8.2 | 3 | 67 | 0.12 | 0.05 | 0.003 | 0.251 | 0.00277 | (ADD) |
| | | | | | | | | | |
| Track II | 8.2 | 16.1 | 67 | 0.12 | 0.24 | 0.013 | 0.254 | 0.01323 | (ADD) |
| | 8.2 | 11.4 | 67 | 0.12 | 0.17 | 0.010 | 0.253 | 0.00961 | (SUBTRACT) |
| | | | | | | | | | |
| Track IV | 12.47 | 3.22 | 67 | 0.19 | 0.05 | 0.004 | 0.251 | 0.00414 | (ADD) |
| | 12.47 | 3.22 | 67 | 0.19 | 0.05 | 0.004 | 0.251 | 0.00414 | (SUBTRACT) |
| | | | | | | | | | |
| Track III | 12.47 | 16.08 | 67 | 0.19 | 0.24 | 0.020 | 0.256 | 0.01980 | (ADD) |
| | 4.27 | 16.08 | 67 | 0.06 | 0.24 | 0.007 | 0.252 | 0.00695 | (SUBTRACT) |
| | 12.47 | 11.42 | 67 | 0.19 | 0.17 | 0.014 | 0.255 | 0.01438 | (SUBTRACT) |
| | 4.27 | 8.47 | 67 | 0.06 | 0.13 | 0.004 | 0.251 | 0.00378 | (ADD) |

$\text{Live Load}_1 = q_r(\Sigma I) + q_{fr}(\Sigma II) + q_{fr}(\Sigma III) + q_r(\Sigma IV)$

$\text{Live Load}_1 =$ 13.68 psf

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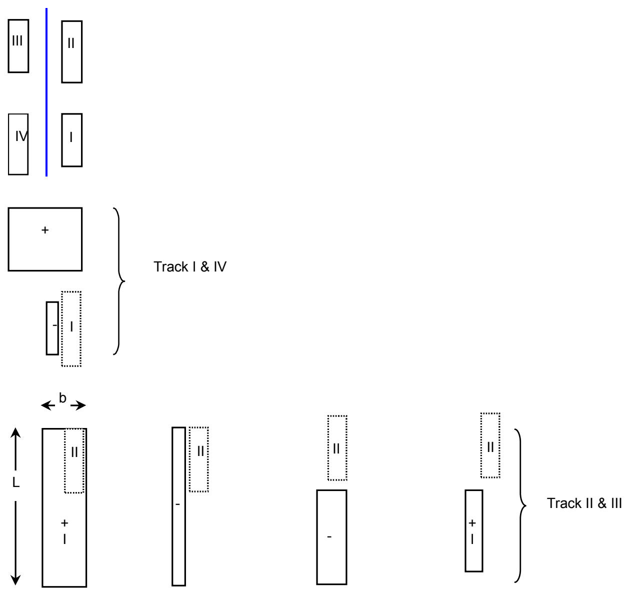
| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Collection Lateral** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **60 Feet Waste** | | |

Load on Pipe

Alternative 2: Track Stradling and Parallel to Pipe




| | b | L | z | m = b/z | n = L/z | I* | I** | I | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | |
| Track I | 6.2 | 3.2 | 67 | 0.1 | 0.0 | 0.002 | 0.251 | 0.00212 | (ADD) |
| & IV | -2.0 | 3.2 | 67 | 0.0 | 0.0 | -0.001 | 0.250 | -0.00067 | (SUBTRACT) |
| | | | | | | | | | |
| Track II | 6.2 | 16.08 | 67 | 0.1 | 0.2 | 0.010 | 0.253 | 0.01011 | (ADD) |
| & III | -2.0 | 16.08 | 67 | 0.0 | 0.2 | -0.003 | 0.249 | -0.00321 | (SUBTRACT) |
| | 6.2 | 12.86 | 67 | 0.1 | 0.2 | 0.008 | 0.253 | 0.00822 | (SUBTRACT) |
| | -2.0 | 12.86 | 67 | 0.0 | 0.2 | -0.003 | 0.249 | -0.00261 | (ADD) |

$\text{Live Load}_2 = [q_r\,(\Sigma I) + q_{fr}\,(\Sigma II)] * 2$

$\text{Live Load}_2 =$ 16.99 psf

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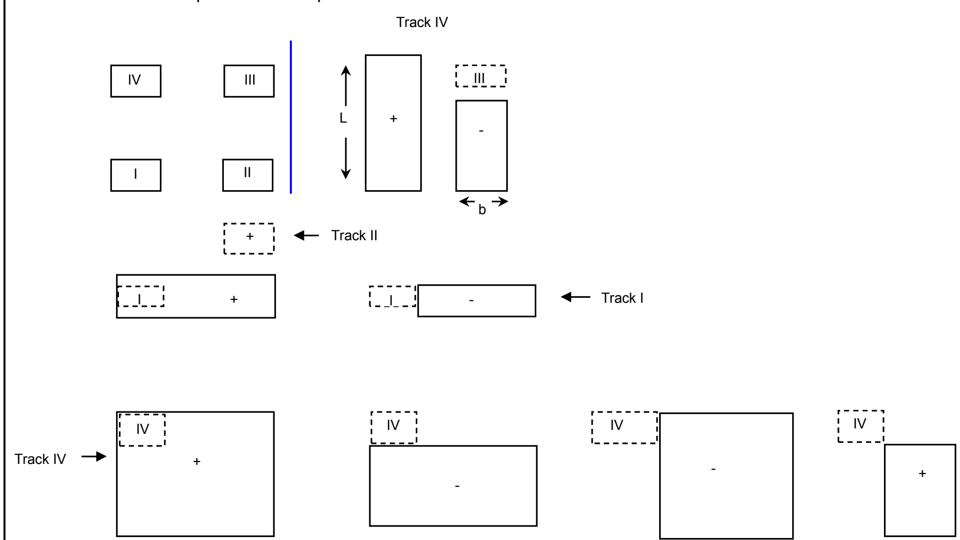
| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Collection Lateral** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **60 Feet Waste** | | |

Load on Pipe

Alternative 3: Track Perpendicular to Pipe




| | b | L | z | m = b/z | n = L/z | I* | I** | I | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | |
| Track I | 16.1 | 8.2 | 67 | 0.2 | 0.1 | 0.013 | 0.254 | 0.01323 | (ADD) |
| | 12.9 | 8.2 | 67 | 0.2 | 0.1 | 0.011 | 0.253 | 0.01075 | (SUBTRACT) |
| | | | | | | | | | |
| Track II | 3.2 | 8.2 | 67 | 0.0 | 0.1 | 0.003 | 0.251 | 0.00277 | (ADD) |
| | | | | | | | | | |
| Track III | 3.2 | 12.5 | 67 | 0.0 | 0.2 | 0.004 | 0.251 | 0.00414 | (ADD) |
| | 3.2 | 4.3 | 67 | 0.0 | 0.1 | 0.001 | 0.250 | 0.00145 | (SUBTRACT) |
| | | | | | | | | | |
| Track IV | 16.1 | 12.5 | 67 | 0.2 | 0.2 | 0.020 | 0.256 | 0.01980 | (ADD) |
| | 16.1 | 4.3 | 67 | 0.2 | 0.1 | 0.007 | 0.252 | 0.00695 | (SUBTRACT) |
| | 12.9 | 12.5 | 67 | 0.2 | 0.2 | 0.016 | 0.255 | 0.01610 | (SUBTRACT) |
| | 12.9 | 4.3 | 67 | 0.2 | 0.1 | 0.006 | 0.252 | 0.00565 | (ADD) |

Live $Load_3 = q_r(\Sigma I) + q_{fr}(\Sigma II) + q_{fr}(\Sigma III) + q_r(\Sigma IV)$

Live $Load_3$ = 16.57 psf

LARGEST EQUIPEMENT LOAD = 16.99 $lb/ft^2$

VERTICAL OVERBURDEN LOAD = 2820.98 $lb/ft^2$

VERTICAL EQUIPMENT LOAD = 16.99 $lb/ft^2$

TOTAL VERTICAL LOAD APPLIED TO PIPE, $P_T$ = 2837.98 $lb/ft^2$ = 19.71 $lb/in^2$

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| SUBJECT | BY | DATE |
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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Collection Lateral** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **60 Feet Waste** | | |

Verify that perforations in the LCRS are adequate for the peak leachate flow.

Use discharge equation:

$Q = (Cd)(Ao)(2gh)^{0.5}$

$C_d$ = coeffiecient of discharge = 0.6 for short tube discharge with fluid/wall separation; conservative value.

$A_o$ = Area of orifice ($\pi D^2/4$)

g = gravitational acceleration (32.3 $ft^2/s$)

h = static head (ft)

| Assumptions and Givens: | 4.55 | acres | North and center portion of landfill bottom |
|---|---|---|---|
| 1. No. acres of landfill expansion = | 3.08 | acres | - North & center less area from eastern grade break of bottom |
| 2. Total length of pipe per expansion = | 1,888.1 | ft | area draining into eastern 10-inch lateral collection |
| 3. Total number of laterals = | 2.0 | | - (2) 8-inch laterals collect drainage from this bottom area |
| 4. Length of pipe per lateral = | 944.1 | ft | - (1) 10-inch lateral collects the remaining drainage |
| 5. Perforation diameter = | 0.375 | inch | - Refer to calcs for 10" diameter leachate collection lateral |
| 6. No. perforations/ft pipe = | 6.0 | perforations/ft of pipe length | |
| 7. Maximum head over pipe = | 1.0 | ft | |
| 8. Per HELP model summary table, $Q_{peak}$ = | 202.93 | gal/min | refer to HELP Model Summary Table |
| 9. Per HELP model summary table, $Q_{peak}$ = | 39,063.5 | cf/day | refer to HELP Model Summary Table |
| 10. Maximum flow/lateral = | 19,531.7 | cf/day/lateral | |
| 11. Maximum leachate flow/ft of pipe = | 20.69 | cf/day/ft of pipe | |

Solution:

$A_o = 0.25(\Pi)(d)^2 =$ 0.00077 $ft^2$

1. Flow per orifice, $Q = (Cd)(Ao)(2gh)^{0.5} =$ 0.0037 $ft^3/s$

2. Flow per ft of pipe = (Q)(# perfs/ft) = 0.02 $ft^3/s$ per ft of pipe

= 1914.47 cf/day/ft of pipe

Conclusion:

Design capacity exceeds estimated generation

1914.47 cf/day/ft of pipe >>> 20.69 cf/day/ft of pipe

Perforations are adequate to handle the maximum leachate flow.

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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Collection Lateral** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **60 Feet Waste** | | |

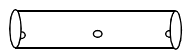
Effective pressure on pipe due to perforations:

$P_{EFF} = \dfrac{P_T \times 12}{(12-L_P)}$ Source 3, EPA SW-870, p. 382

$L_P$ = Total accumulated length of perforations in one foot of pipe.

Since each perforation is 0.375 inch diameter and spaced at 6.0 inch on center,

$L_P$ = 1.5 inch



$P_T$ = 19.7 psi

$P_{EFF}$ = 22.5 psi

$P_{EFF}$ = 3243.4 psf

Check actual compressive pressure ($S_A$) per Driscopipe manual:

$S_A$ = 0.5 x (SDR - 1) x P(eff) = 112.6 psi

The recommended, long-term compressive strength ($Y_s$) design value for Driscoplex polyethylene pipe is 800 lb/in$^2$.

Source No. 1

| $S_A$ (psi): | | $Y_s$ (psi): |
|---|---|---|
| 112.6 | < | 800.0 |

Pipe passes wall compressive stress perforation calculations TRUE FS = 7.1

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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Collection Lateral** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **60 Feet Waste** | | |

Constrained pipe wall buckling (for Driscoplex OD controlled pipe)

$P_{WC} = \frac{5.65 * \{RB'E' E^*[12(DR-1)^3]^{-1}\}^{0.5}}{N}$ Source 1, Equation 7-5

$P_{WC}$ = allowable constrained buckling pressure (lb/in$^2$)

R = buoyancy reduction factor = 1 - 0.33 * (H'/H) Source 1, Equation 7-34

| | | |
|---|---|---|
| H' = groundwater height above pipe (ft) | 0.0 | ft |
| H = cover above pipe (ft) | 67.0 | ft |
| B' = elastic support factor =( 1+ 4*$e^{-0.065H}$ )$^{-1}$ | Source 1, Equation 7-35 | |
| E' = soil reaction modulus (lb/in$^2$) | 3000.0 | lb/in$^2$ for mod comp/crushed rock, 'Source 1, Table 7-7 |
| E = elastic modulus (lb/in$^2$) | 100000.0 | lb/in$^2$ for long term load at 100$^o$F, 'Source 1, Table 5-1 |
| I = moment of inertia = t$^3$ / 12 | 0.0 | in$^4$/in |
| $D_o$ = pipe outer diameter (in) | 8.625 | SDR 11 pipe (Driscopipe) to be used |
| t = pipe wall thickness (in) | 0.784 | SDR 11 pipe (Driscopipe) to be used |
| DR = pipe dimension ratio = $D_o$ / t | 11.0 | SDR 11 pipe (Driscopipe) to be used |
| $D_I$ = pipe inner diameter = $D_o$ - 2t (in) | 7.1 | SDR 11 pipe (Driscopipe) to be used |
| N = safety factor | 2.0 | |

| Cover (ft) | (ft) | (ft) | B' | R | (lb/in$^2$) |
|---|---|---|---|---|---|
| 67.0 | 67 | 0 | 0.95 | 1.00 | 435.54 |

$P_{WC}$ = 435.54 lb/in$^2$
$P_{EFF}$ = 22.52 lb/in$^2$

Pipe passes contrained wall buckling calculations TRUE FS = 19.3

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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Collection Lateral** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **60 Feet Waste** | | |

Constrained Pipe Wall Compressive Stress (for Driscoplex OD controlled pipe)

$$S = \frac{P_T D_o}{288t}$$ Source No. 1

S = pipe wall compressive stress ($lb/in^2$)

| | | |
|---|---|---|
| $P_T$ = vertical load applied to pipe w/ perfs ($lb/ft^2$) | 3243.4 | $lb/ft^2$ |
| $D_o$ = pipe outside diameter (in) | 8.63 | SDR 11 pipe (Driscopipe) to be used |
| t = pipe wall thickness (in) | 0.784 | SDR 11 pipe (Driscopipe) to be used |

$$S = \frac{P_T D_o}{288t} = 123.9 \ lb/in^2$$

The recommended, long-term compressive strength ($Y_s$) design value for Driscoplex polyethylene pipe is 800 $lb/in^2$.

Source No. 1

| S (psi): | | $Y_s$ (psi): |
|---|---|---|
| 123.9 | < | 800.0 |

Pipe passes wall compressive stress calculations TRUE

FS = 6.5

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| **8" Diameter Leachate Collection Lateral** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **60 Feet Waste** | | |

Iowa Formula

$\Delta X = \frac{D_L K W_c r^3}{EI + 0.06er^4}$ Source 2, Equation 3.4 Buried Pipe Design, A.P. Moser, Chapter 3

$\Delta X$ = horizontal deflection (in)

$D_L$ = deflection lag factor

K = bedding constant | 0.1 | typical value Source 2, Buried Pipe Design, A.P. Moser, Chapter 3

$W_c$ = Marston's load per unit length of pipe (lb/in)

r = mean radius of the pipe (in)

E = modulus of elasticity ($lb/in^2$)

I = moment of inertia of the pipe wall per unit length ($in^3$)

e = modulus of passive resistance fo the side fill ($lb/in^2(in)$)

Modified Iowa Formula

$\Delta X = \frac{D_L K W_c r_m^3}{EI + 0.06E'r_m^3}$ Source 2, Equation 3.5 Buried Pipe Design, A.P. Moser, Chapter 3

$\Delta X$ = horizontal deflection (in)

| | | |
|---|---|---|
| $D_L$ = deflection lag factor | 1.0 | Prism Load used |
| Typical Value for Marston Load | 1.5 | |
| Typical Value for Prism Load | 1.0 | |
| K = bedding constant | 0.1 | typical value Buried Pipe Design, A.P. Moser, Chapter 3 |
| $P_T$ = Vertical load on pipe w/ perfs | 22.52 | $lb/in^2$ 3243 $lb/ft^2$ |
| $W_c$ = Marston's load per unit length of pipe = $P_T * D_o$ (lb/in) | 194.27 | lb/in |
| $D_o$ = pipe outer diameter (in) | 8.63 | SDR 11 pipe (Driscopipe) to be used |
| t = pipe wall thickness (in) | 0.78 | SDR 11 pipe (Driscopipe) to be used |
| $D_I$ = pipe inner diameter = $D_o$-2t (in) | 7.06 | SDR 11 pipe (Driscopipe) to be used |
| $D_m$ = pipe mean diameter = $D_o$ - 1.06t Source 1, Equation 7-27 | 7.79 | SDR 11 pipe (Driscopipe) to be used |
| $r_m$ = mean radius of the pipe (in) | 3.90 | SDR 11 pipe (Driscopipe) to be used |
| E = modulus of elasticity ($lb/in^2$) | 100,000.0 | lb/in2 for long term load at 100oF, 'Source 1, Table 5-1 |
| I = moment of inertia of the pipe wall per unit length | 0.040 | $in^4/in$ |
| E' = modulus of soil reaction | 3,000.0 | $lb/in^2$ for moderate compaction and fine grained soils |

$\Delta X = \frac{D_L K W_c r_m^3}{EI + 0.06E'r_m^3}$ = 0.078 inch    Source 2, Equation 3.5 Buried Pipe Design, A.P. Moser, Chapter 3

% Ring Deflection = ($\Delta X/D_m$) x 100 = 1.01% Source 1, Equation 7-31

Ring Bending Strain

$e = \frac{f_D \Delta X 2C}{D_M^2} \times 100$ Source 1, Equation 7-39

e = wall strain (%)

| | | |
|---|---|---|
| $f_D$ = deformation shape factor | 6 | Source 1, non-elliptical shape |
| $D_M$ = mean diameter (in) | | |
| C = outer fiber wall centroid = 0.5 (1.06t) | 0.416 | Source 1, Equation 7-41 |
| $\Delta X$ = ring deflection = $D_X/D_m$ | 0.010 | |

$e = f_D \left(\frac{\Delta X}{D_M}\right)\left(\frac{2C}{D_M}\right) \times 100$ = 0.6% Source 1, Equation 7-39

The maximum ring bending strain for high performance polyethylene non-pressure pipe is = 5.0%

Pipe passes ring bending strain calculations TRUE

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| **8" Diameter Leachate Collection Lateral** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **60 Feet Waste** | | |

SOURCES

1.) Attachment - 1 - Chevron Phillips Chemical Company, Bulletin - Book 2 Chapter 5, 2003

2.) Attachment - 2 - Buried Pipe Design, A.P. Moser, Chapter 3

3.) Attachment - 3 - EPA, Lining of Waste Impoundment and Disposal Facilities, SW-870

4.) Attachment - 4 - Driscoplex Pipe Properties

5.) Attachment - 5 - CAT 826G Series II Compactor Data Sheet

6.) Attachment - 6 - CAT D7R Series II Equipment Data Sheet

7.) Attachment - 7 - CAT D6R XW Series II Equipment Data Sheet

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|---|---|---|
| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Collection Lateral Construction** w/ CAT D6R XW Series II | CHECKED | DATE |

Load on Pipe (Overburden)

Prism Loads, $P_E$ = wH

w = unit weight

H = depth

| | Depth (ft) | Unit Weight (lb/ft$^3$) | $P_E$ (lb/ft$^2$) |
|---|---|---|---|
| Final cover | 0.0 | 115.0 | 0.0 |
| Intermediate cover | 0.0 | 115.0 | 0.0 |
| Waste/cover | 0.0 | 60.0 | 0.0 |
| Drainage sand | 0.0 | 115.0 | 0.0 |
| Rock (No. 89 & No. 57) | 1.0 | 140.0 | 140.0 |

TOTAL SOIL PRISM LOAD $P_E$: 140.0 lb/ft$^2$

Total Depth = 1.0 ft

Soil Arching, $P_m = C_D wB$

NOTE: The waste unit weight represents the combined unit weight of waste, daily cover, and moisture.

Pm = vertical soil pressure

B = trench width at pipe crown 6.0 ft

$C_D$ = load coefficient $= \frac{1 - e^{-2Ku'H/B}}{2Ku'}$ Equation 7-3, Source No. 1

e = natural log base number

K = Rankine earth pressure coefficient = $\tan^2(45-0.5*\phi)$

$\phi$ = internal soil friction angle = 27.0 degrees

u' = friction coefficient between backfill and trench sides = tan $\phi$

| Soil Type | Ku' |
|---|---|
| Saturated Clay | 0.110 |
| Ordinary Clay | 0.130 |
| Saturated Top Soil | 0.150 |
| Sand and Gravel | 0.165 |
| Clean Granular Soil | 0.192 |

| | Ku' | $C_D$ | $P_m$ (lb/ft$^2$) |
|---|---|---|---|
| Cover Soil | 0.150 | 0.00 | 0 |
| Int Cover | 0.165 | 0.00 | 0 |
| Waste | 0.191 | 0.00 | 0 |
| Drainage Sand | 0.165 | 0.00 | 0.0 |
| Granular Soil | 0.192 | 0.16 | 135.6 |

TOTAL SOIL ARCHING LOAD $P_M$: 135.6 lb/ft$^2$

MODIFIED ARCHING LOAD = $0.6P_M+0.4P_E$: 137.37 lb/ft$^2$

OVERBURDEN LOAD: 137.37 lb/ft$^2$

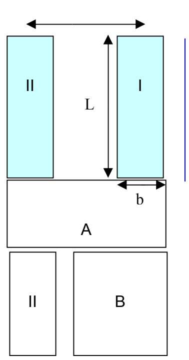
Load on Pipe With Equipment Refer to Attachment

Construction w/ CAT D6R XW Series II

| | | | | | |
|---|---|---|---|---|---|
| Equipment Weight = | 43,888.0 | psf | Length of Track = L = | 111.0 | in |
| Number of Tracks = | 2.0 | | Track Width = b = | 30.0 | in |
| Track Load = $q_r$ = | 21,944.0 | psf | Track Gauge = G = | 80.0 | in |
| Ground contact area/track = | 23.1 | psf | Equipment Width "A" = | 116.0 | in |

Live Load = q*Ic q = track load 948.93 psf

Ic = Influence coefficient




| | b (ft) | L (ft) | z (ft) | m = b/z | n = L/z | I* | I** | I |
|---|---|---|---|---|---|---|---|---|
| I | 2.50 | 9.3 | 1.0 | 2.50 | 9.25 | -0.006 | 0.244 | 0.24428 |
| A | 9.17 | 9.3 | 1.0 | 9.17 | 9.25 | 0.000 | 0.250 | 0.24976 |
| B | 6.67 | 9.3 | 1.0 | 6.67 | 9.25 | 0.000 | 0.250 | 0.24957 |

Live Load$_1$ = I + II = $q_I(I_I) + q_A(I_A) - q_B(I_B)$ = 231.99 lb/ft$^2$

$q_I(I_I)$ = 231.81

$q_A(I_A)$ = 237.01

$q_B(I_B)$ = 236.82

Load on Pipe (Equipment) = 231.99 lb/ft$^2$

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| **8" Diameter Leachate Collection Lateral Construction** w/ CAT D6R XW Series II | CHECKED | DATE |

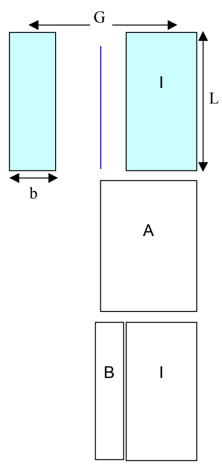
Load on Pipe (Equipment) *Continued*

Live Load = $q*I_c$

$q$ = track load 948.93 $lb/ft^2$

$I_c$ = Influence coefficient

Alternative 2: Track stradling and parallel to pipe



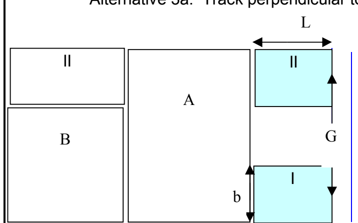

| | b | L | z | m = b/z | n = L/z | I* | I** | I |
|---|---|---|---|---|---|---|---|---|
| A | 4.83 | 9.3 | 1 | 4.83 | 9.25 | -0.001 | 0.249 | 0.24904 |
| B | 2.33 | 9.3 | 1 | 2.33 | 9.25 | -0.007 | 0.243 | 0.24315 |

Live $Load_2$ = 2 * (A - B) = 2 * ($q_A I_A$ - $q_B I_B$) = 11.18 $lb/ft^2$

| | |
|---|---|
| $q_A(I_A)$ = | 236.32 |
| $q_B(I_B)$ = | 230.73 |

Load on Pipe (Equipment) = 11.18 $lb/ft^2$

Alternative 3a: Track perpendicular to pipe




| | b | L | z | m = b/z | n = L/z | I* | I** | I |
|---|---|---|---|---|---|---|---|---|
| I | 2.50 | 9.3 | 1 | 2.50 | 9.25 | -0.006 | 0.244 | 0.24428 |
| A | 9.67 | 9.3 | 1 | 9.67 | 9.25 | 0.000 | 0.250 | 0.24978 |
| B | 7.17 | 9.3 | 1 | 7.17 | 9.25 | 0.000 | 0.250 | 0.24963 |

Live $Load_3$ = I + II = $q_I(I_I)$ + $q_A(I_A)$ - $q_B(I_B)$ = 231.95 $lb/ft^2$

| | |
|---|---|
| $q_I(I_I)$ = | 231.81 |
| $q_A(I_A)$ = | 237.02 |
| $q_B(I_B)$ = | 236.88 |

Load on Pipe (Equipment) = 231.95 $lb/ft^2$

LARGEST EQUIPEMENT LOAD = 231.99 $lb/ft^2$

VERTICAL OVERBURDEN LOAD = 137.37 $lb/ft^2$

VERTICAL EQUIPMENT LOAD = 231.99 $lb/ft^2$

TOTAL VERTICAL LOAD APPLIED TO PIPE, $P_T$ = 369.36 $lb/ft^2$ = 2.57 $lb/in^2$

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Verify that perforations in the LCRS are adequate for the peak leachate flow.

Use discharge equation:

$Q = (Cd)(Ao)(2gh)^{0.5}$

$C_d$ = coeffiecient of discharge = 0.6 for short tube discharge with fluid/wall separation; conservative value.

$A_o$ = Area of orifice ($\pi D^2/4$)

g = gravitational acceleration (32.3 $ft^2/s$)

h = static head (ft)

| Assumptions and Givens: | | | |
|---|---|---|---|
| | 4.55 | acres | North and center portion of landfill bottom |
| 1. No. acres of landfill expansion = | 3.08 | acres | - North & center less area from eastern grade break of bottom |
| 2. Total length of pipe per expansion = | 1,888.1 | ft | area draining into eastern 10-inch lateral collection |
| 3. Total number of laterals = | 2.0 | | - (2) 8-inch laterals collect drainage from this bottom area |
| 4. Length of pipe per lateral = | 944.1 | ft | - (1) 10-inch lateral collects the remaining drainage |
| 5. Perforation diameter = | 0.375 | inch | - Refer to calcs for 10" diameter leachate collection lateral |
| 6. No. perforations/ft pipe = | 6.0 | perforations/ft of pipe length | |
| 7. Maximum head over pipe = | 1.0 | ft | |
| 8. Per HELP model summary table, $Q_{peak}$ = | 202.93 | gal/min | refer to HELP Model Summary Table |
| 9. Per HELP model summary table, $Q_{peak}$ = | 39,063.5 | cf/day | refer to HELP Model Summary Table |
| 10. Maximum flow/lateral = | 19,531.7 | cf/day/lateral | |
| 11. Maximum leachate flow/ft of pipe = | 20.69 | cf/day/ft of pipe | |

Solution:

$A_o = 0.25(\Pi)(d)^2 =$ 0.00077 $ft^2$

1. Flow per orifice, $Q = (Cd)(Ao)(2gh)^{0.5} =$ 0.0037 $ft^3/s$

2. Flow per ft of pipe = (Q)(# perfs/ft) = 0.02 $ft^3/s$ per ft of pipe

= 1914.47 cf/day/ft of pipe

Conclusion:

Design capacity exceeds estimated generation

1914.47 cf/day/ft of pipe >>> 20.69 cf/day/ft of pipe

Perforations are adequate to handle the maximum leachate flow.

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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Collection Lateral Construction** w/ CAT D6R XW Series II | CHECKED | DATE |

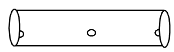
Effective pressure on pipe due to perforations:

$P_{EFF} = \dfrac{P_T \times 12}{(12-L_P)}$ Source 3, EPA SW-870, p. 382

$L_P$ = Total accumulated length of perforations in one foot of pipe.

Since each perforation is 0.375 inch diameter and spaced at 6.0 inch on center,

$L_P$ = 1.5 inch



$P_T$ = 2.6 psi

$P_{EFF}$ = 2.9 psi

$P_{EFF}$ = 422.1 psf

Check actual compressive pressure ($S_A$) per Driscopipe manual:

$S_A$ = 0.5 x (SDR - 1) x P(eff) = 14.7 psi

The recommended, long-term compressive strength ($Y_s$) design value for Driscoplex polyethylene pipe is 800 lb/in$^2$.

Source No. 1

| $S_A$ (psi): | | $Y_s$ (psi): |
| --- | --- | --- |
| 14.7 | < | 800.0 |

Pipe passes wall compressive stress perforation calculations TRUE

FS = 54.6

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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Collection Lateral Construction** w/ CAT D6R XW Series II | CHECKED | DATE |

Constrained pipe wall buckling (for Driscoplex OD controlled pipe)

$P_{WC} = \frac{5.65 * \{RB'E' E^*[12(DR-1)^3]^{-1}\}^{0.5}}{N}$ Source 1, Equation 7-5

$P_{WC}$ = allowable constrained buckling pressure ($lb/in^2$)

| | | |
|---|---|---|
| R = buoyancy reduction factor = 1 - 0.33 * (H'/H) | Source 1, Equation 7-34 | |
| H' = groundwater height above pipe (ft) | 0.0 | ft |
| H = cover above pipe (ft) | 1.0 | ft |
| B' = elastic support factor =( 1+ 4*$e^{-0.065H}$ )$^{-1}$ | Source 1, Equation 7-35 | |
| E' = soil reaction modulus ($lb/in^2$) | 3000.0 | $lb/in^2$ for mod comp/crushed rock, 'Source 1, Table 7-7 |
| E = elastic modulus ($lb/in^2$) | 100000.0 | $lb/in^2$ for long term load at 100°F, 'Source 1, Table 5-1 |
| I = moment of inertia = $t^3$ / 12 | 0.0 | $in^4$/in |
| $D_o$ = pipe outer diameter (in) | 8.625 | SDR 11 pipe (Driscopipe) to be used |
| t = pipe wall thickness (in) | 0.784 | SDR 11 pipe (Driscopipe) to be used |
| DR = pipe dimension ratio = $D_o$ / t | 11.0 | SDR 11 pipe (Driscopipe) to be used |
| $D_I$ = pipe inner diameter = $D_o$ - 2t (in) | 7.1 | SDR 11 pipe (Driscopipe) to be used |
| N = safety factor | 2.0 | |

| Cover (ft) | (ft) | (ft) | B' | R | ($lb/in^2$) |
|---|---|---|---|---|---|
| 1.0 | 1 | 0 | 0.21 | 1.00 | 204.95 |

$P_{WC}$ = 204.95 $lb/in^2$

$P_{EFF}$ = 2.93 $lb/in^2$

Pipe passes contrained wall buckling calculations TRUE FS = 69.9

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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Collection Lateral Construction** w/ CAT D6R XW Series II | CHECKED | DATE |

Constrained Pipe Wall Compressive Stress (for Driscoplex OD controlled pipe)

$S = \frac{P_T D_o}{288t}$ Source No. 1

S = pipe wall compressive stress ($lb/in^2$)

$P_T$ = vertical load applied to pipe w/ perfs ($lb/ft^2$) | 422.1 | $lb/ft^2$

$D_o$ = pipe outside diameter (in) | 8.63 | SDR 11 pipe (Driscopipe) to be used

t = pipe wall thickness (in) | 0.784 | SDR 11 pipe (Driscopipe) to be used

$S = \frac{P_T D_o}{288t} =$ 16.1 $lb/in^2$

The recommended, long-term compressive strength ($Y_s$) design value for Driscoplex polyethylene pipe is 800 $lb/in^2$.

Source No. 1

| S (psi): | | $Y_s$ (psi): |
|---|---|---|
| 16.1 | < | 800.0 |

Pipe passes wall compressive stress calculations TRUE

FS = 49.6

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| Pipe Crushing Calculations **RAI No. 1** | | SRF | 4/1/13 |
| **8" Diameter Leachate Collection Lateral Construction** w/ CAT D6R XW Series II | | CHECKED | DATE |

Iowa Formula

$\Delta X = \dfrac{D_L K W_c r^3}{EI + 0.06er^4}$ Source 2, Equation 3.4 Buried Pipe Design, A.P. Moser, Chapter 3

$\Delta X$ = horizontal deflection (in)

$D_L$ = deflection lag factor

K = bedding constant — 0.1 — typical value Source 2, Buried Pipe Design, A.P. Moser, Chapter 3

$W_c$ = Marston's load per unit length of pipe (lb/in)

r = mean radius of the pipe (in)

E = modulus of elasticity ($lb/in^2$)

I = moment of inertia of the pipe wall per unit length ($in^3$)

e = modulus of passive resistance fo the side fill ($lb/in^2(in)$)

Modified Iowa Formula

$\Delta X = \dfrac{D_L K W_c r_m^3}{EI + 0.06E'r_m^3}$ Source 2, Equation 3.5 Buried Pipe Design, A.P. Moser, Chapter 3

$\Delta X$ = horizontal deflection (in)

| | | |
|---|---|---|
| $D_L$ = deflection lag factor | 1.0 | Prism Load used |
| Typical Value for Marston Load | 1.5 | |
| Typical Value for Prism Load | 1.0 | |
| K = bedding constant | 0.1 | typical value Buried Pipe Design, A.P. Moser, Chapter 3 |
| $P_T$ = Vertical load on pipe w/ perfs | 2.93 | $lb/in^2$ — 422 $lb/ft^2$ |
| $W_c$ = Marston's load per unit length of pipe = $P_T$ * $D_o$ (lb/in) | 25.28 | lb/in |
| $D_o$ = pipe outer diameter (in) | 8.63 | SDR 11 pipe (Driscopipe) to be used |
| t = pipe wall thickness (in) | 0.78 | SDR 11 pipe (Driscopipe) to be used |
| $D_I$ = pipe inner diameter = $D_o$-2t (in) | 7.06 | SDR 11 pipe (Driscopipe) to be used |
| $D_m$ = pipe mean diameter = $D_o$ - 1.06t Source 1, Equation 7-27 | 7.79 | SDR 11 pipe (Driscopipe) to be used |
| $r_m$ = mean radius of the pipe (in) | 3.90 | SDR 11 pipe (Driscopipe) to be used |
| E = modulus of elasticity ($lb/in^2$) | 100,000.0 | lb/in2 for long term load at 100oF, 'Source 1, Table 5-1 |
| I = moment of inertia of the pipe wall per unit length | 0.040 | $in^4/in$ |
| E' = modulus of soil reaction | 3,000.0 | $lb/in^2$ for moderate compaction and fine grained soils |

$\Delta X = \dfrac{D_L K W_c r_m^3}{EI + 0.06E'r_m^3}$ = 0.010 inch Source 2, Equation 3.5 Buried Pipe Design, A.P. Moser, Chapter 3

% Ring Deflection = $(\Delta X/D_m)$ x 100 = 0.13% Source 1, Equation 7-31

Ring Bending Strain

$e = \dfrac{f_D \Delta X 2C}{D_M^2} \times 100$ Source 1, Equation 7-39

e = wall strain (%)

| | | |
|---|---|---|
| $f_D$ = deformation shape factor | 6 | Source 1, non-elliptical shape |
| $D_M$ = mean diameter (in) | | |
| C = outer fiber wall centroid = 0.5 (1.06t) | 0.416 | Source 1, Equation 7-41 |
| $\Delta X$ = ring deflection = $D_X/D_m$ | 0.001 | |

$e = f_D \dfrac{(\Delta X)}{D_M}\dfrac{(2C)}{D_M} \times 100$ = 0.1% Source 1, Equation 7-39

The maximum ring bending strain for high performance polyethylene non-pressure pipe is = 5.0%

Pipe passes ring bending strain calculations TRUE

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| **8" Diameter Leachate Collection Lateral Construction** w/ CAT D6R XW Series II | CHECKED | DATE |

SOURCES

1.) Attachment - 1 - Chevron Phillips Chemical Company, Bulletin - Book 2 Chapter 5, 2003

2.) Attachment - 2 - Buried Pipe Design, A.P. Moser, Chapter 3

3.) Attachment - 3 - EPA, Lining of Waste Impoundment and Disposal Facilities, SW-870

4.) Attachment - 4 - Driscoplex Pipe Properties

5.) Attachment - 5 - CAT 826G Series II Compactor Data Sheet

6.) Attachment - 6 - CAT D7R Series II Equipment Data Sheet

7.) Attachment - 7 - CAT D6R XW Series II Equipment Data Sheet

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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Collection Lateral** | CHECKED | DATE |
| Operation w/ CAT D7R Series II **0 Feet Waste** | | |

Load on Pipe (Overburden)

Prism Loads, $P_E$ = wH

w = unit weight

H = depth

| | Depth (ft) | Unit Weight ($lb/ft^3$) | $P_E$ ($lb/ft^2$) |
|---|---|---|---|
| Final cover | 0.0 | 115.0 | 0.0 |
| Intermediate cover | 0.0 | 115.0 | 0.0 |
| Waste/cover | 0.0 | 60.0 | 0.0 |
| Drainage sand | 2.0 | 115.0 | 230.0 |
| Rock (No. 89 & No. 57) | 2.0 | 140.0 | 280.0 |

TOTAL SOIL PRISM LOAD $P_E$: 510.0 $lb/ft^2$

Total Depth = 4.0 ft

Soil Arching, $P_m = C_D wB$

NOTE: The waste unit weight represents the combined unit weight of waste, daily cover, and moisture.

Pm = vertical soil pressure

B = trench width at pipe crown 6.0 ft

$C_D$ = load coefficient $= \dfrac{1 - e^{-2Ku'H/B}}{2Ku'}$ Equation 7-3, Source No. 1

e = natural log base number

K = Rankine earth pressure coefficient = $\tan^2(45-0.5*\phi)$

$\phi$ = internal soil friction angle = 27.0 degrees

u' = friction coefficient between backfill and trench sides = tan $\phi$

| Soil Type | Ku' |
|---|---|
| Saturated Clay | 0.110 |
| Ordinary Clay | 0.130 |
| Saturated Top Soil | 0.150 |
| Sand and Gravel | 0.165 |
| Clean Granular Soil | 0.192 |

| | Ku' | $C_D$ | $P_m$ ($lb/ft^2$) |
|---|---|---|---|
| Cover Soil | 0.150 | 0.00 | 0 |
| Int Cover | 0.165 | 0.00 | 0 |
| Waste | 0.191 | 0.00 | 0 |
| Drainage Sand | 0.165 | 0.32 | 217.8 |
| Granular Soil | 0.192 | 0.31 | 262.8 |

TOTAL SOIL ARCHING LOAD $P_M$: 480.6 $lb/ft^2$

MODIFIED ARCHING LOAD = $0.6P_M+0.4P_E$: 492.37 $lb/ft^2$

OVERBURDEN LOAD: 492.37 $lb/ft^2$

Load on Pipe With Equipment Refer to Attachment

Operation w/ CAT D7R Series II 0 Feet Waste

Equipment Weight = 54,573.0 psf

Number of Tracks = 2.0

Track Load = $q_r$ = 27,286.5 psf

Ground contact area/track = 17.3 psf

Length of Track = L = 113.0 in

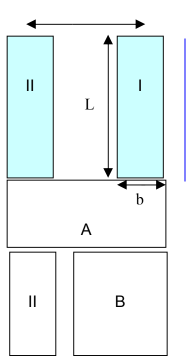
Track Width = b = 22.0 in

Track Gauge = G = 78.0 in

Equipment Width "A" = 113.0 in

Live Load = q*Ic q = track load 1,580.55 psf

Ic = Influence coefficient




| | b (ft) | L (ft) | z (ft) | m = b/z | n = L/z | I* | I** | I |
|---|---|---|---|---|---|---|---|---|
| I | 1.83 | 9.4 | 4.0 | 0.46 | 2.35 | 0.127 | 0.252 | 0.12736 |
| A | 8.33 | 9.4 | 4.0 | 2.08 | 2.35 | -0.014 | 0.236 | 0.23624 |
| B | 6.50 | 9.4 | 4.0 | 1.63 | 2.35 | -0.021 | 0.229 | 0.22928 |

Live $Load_1$ = I + II = $q_I(I_I) + q_A(I_A) - q_B(I_B)$ = 212.30 $lb/ft^2$

$q_I(I_I)$ = 201.29

$q_A(I_A)$ = 373.39

$q_B(I_B)$ = 362.39

Load on Pipe (Equipment) = 212.30 $lb/ft^2$

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| **8" Diameter Leachate Collection Lateral** | CHECKED | DATE |
| Operation w/ CAT D7R Series II **0 Feet Waste** | | |

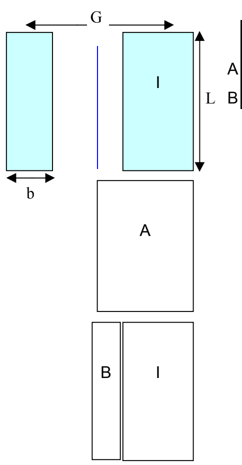
Load on Pipe (Equipment) *Continued*

Live Load = $q*I_c$

$q$ = track load 1580.55 $lb/ft^2$

$I_c$ = Influence coefficient

Alternative 2: Track stradling and parallel to pipe



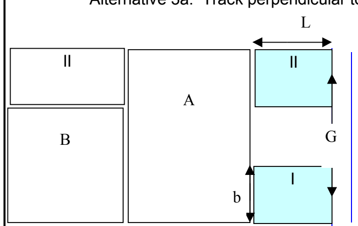

| | b | L | z | m = b/z | n = L/z | I* | I** | I |
|---|---|---|---|---|---|---|---|---|
| A | 4.71 | 9.4 | 4 | 1.18 | 2.35 | 0.213 | 0.216 | 0.21333 |
| B | 2.88 | 9.4 | 4 | 0.72 | 2.35 | 0.173 | 0.242 | 0.17258 |

Live $Load_2$ = 2 * (A - B) = 2 * $(q_A I_A - q_B I_B)$ = 128.82 $lb/ft^2$

| | |
|---|---|
| $q_A(I_A)$ = | 337.19 |
| $q_B(I_B)$ = | 272.78 |

Load on Pipe (Equipment) = 128.82 $lb/ft^2$

Alternative 3a: Track perpendicular to pipe




| | b | L | z | m = b/z | n = L/z | I* | I** | I |
|---|---|---|---|---|---|---|---|---|
| I | 1.83 | 9.4 | 4 | 0.46 | 2.35 | 0.127 | 0.252 | 0.12736 |
| A | 9.42 | 9.4 | 4 | 2.35 | 2.35 | -0.012 | 0.238 | 0.23841 |
| B | 7.58 | 9.4 | 4 | 1.90 | 2.35 | -0.016 | 0.234 | 0.23405 |

Live $Load_3$ = I + II = $q_I(I_I) + q_A(I_A) - q_B(I_B)$ = 208.18 $lb/ft^2$

| | |
|---|---|
| $q_I(I_I)$ = | 201.29 |
| $q_A(I_A)$ = | 376.82 |
| $q_B(I_B)$ = | 369.93 |

Load on Pipe (Equipment) = 208.18 $lb/ft^2$

LARGEST EQUIPEMENT LOAD = 212.30 $lb/ft^2$

VERTICAL OVERBURDEN LOAD = 492.37 $lb/ft^2$

VERTICAL EQUIPMENT LOAD = 212.30 $lb/ft^2$

TOTAL VERTICAL LOAD APPLIED TO PIPE, $P_T$ = 704.67 $lb/ft^2$ = 4.89 $lb/in^2$

| CLIENT | PROJECT | JOB NO. |
|---|---|---|
| Hardee County | Phase II Section II Expansion | 09199033.23 |

| SUBJECT | BY | DATE |
|---|---|---|
| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Collection Lateral** | CHECKED | DATE |
| Operation w/ CAT D7R Series II **0 Feet Waste** | | |

Verify that perforations in the LCRS are adequate for the peak leachate flow.

Use discharge equation:

$Q = (Cd)(Ao)(2gh)^{0.5}$

$C_d$ = coeffiecient of discharge = 0.6 for short tube discharge with fluid/wall separation; conservative value.

$A_o$ = Area of orifice ($\pi D^2/4$)

g = gravitational acceleration (32.3 $ft^2/s$)

h = static head (ft)

| Assumptions and Givens: | | | |
|---|---|---|---|
| | 4.55 | acres | North and center portion of landfill bottom |
| 1. No. acres of landfill expansion = | 3.08 | acres | - North & center less area from eastern grade break of bottom |
| 2. Total length of pipe per expansion = | 1,888.1 | ft | area draining into eastern 10-inch lateral collection |
| 3. Number of laterals = | 2.0 | | - (2) 8-inch laterals collect drainage from this bottom area |
| 4. Total length of pipe per lateral = | 944.1 | ft | - (1) 10-inch lateral collects the remaining drainage |
| 5. Perforation diameter = | 0.375 | inch | - Refer to calcs for 10" diameter leachate collection lateral |
| 6. No. perforations/ft pipe = | 6.0 | perforations/ft of pipe length | |
| 7. Maximum head over pipe = | 1.0 | ft | |
| 8. Per HELP model summary table, $Q_{peak}$ = | 202.93 | gal/min | refer to HELP Model Summary Table |
| 9. Per HELP model summary table, $Q_{peak}$ = | 39,063.5 | cf/day | refer to HELP Model Summary Table |
| 10. Maximum flow/lateral = | 19,531.7 | cf/day/lateral | |
| 11. Maximum leachate flow/ft of pipe = | 20.69 | cf/day/ft of pipe | |

Solution:

$A_o = 0.25(\Pi)(d)^2 =$ 0.00077 $ft^2$

1. Flow per orifice, $Q = (Cd)(Ao)(2gh)^{0.5} =$ 0.0037 $ft^3/s$

2. Flow per ft of pipe = (Q)(# perfs/ft) = 0.02 $ft^3/s$ per ft of pipe

= 1914.47 cf/day/ft of pipe

Conclusion:

Design capacity exceeds estimated generation

1914.47 cf/day/ft of pipe >>> 20.69 cf/day/ft of pipe

Perforations are adequate to handle the maximum leachate flow.

| CLIENT | PROJECT | JOB NO. |
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| Hardee County | Phase II Section II Expansion | 09199033.23 |

| SUBJECT | BY | DATE |
|---|---|---|
| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Collection Lateral** | CHECKED | DATE |
| Operation w/ CAT D7R Series II **0 Feet Waste** | | |

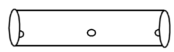
Effective pressure on pipe due to perforations:

$$P_{EFF} = \frac{P_T \times 12}{(12 - L_P)}$$ Source 3, EPA SW-870, p. 382

$L_P$ = Total accumulated length of perforations in one foot of pipe.

Since each perforation is 0.375 inch diameter and spaced at 6.0 inch on center,

$L_P$ = 1.5 inch



$P_T$ = 4.9 psi

$P_{EFF}$ = 5.6 psi

$P_{EFF}$ = 805.3 psf

Check actual compressive pressure ($S_A$) per Driscopipe manual:

$S_A$ = 0.5 x (SDR - 1) x P(eff) = 28.0 psi

The recommended, long-term compressive strength ($Y_s$) design value for Driscoplex polyethylene pipe is 800 lb/in$^2$.

Source No. 1

| $S_A$ (psi): | | $Y_s$ (psi): |
|---|---|---|
| 28.0 | < | 800.0 |

Pipe passes wall compressive stress perforation calculations TRUE

FS = 28.6

| SCS ENGINEERS | | |
|---|---|---|
| SHEET 5 OF 8 | | |
| CLIENT<br>Hardee County | PROJECT<br>Phase II Section II Expansion | JOB NO.<br>09199033.23 |

| SUBJECT | BY | DATE |
|---|---|---|
| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Collection Lateral** | CHECKED | DATE |
| Operation w/ CAT D7R Series II **0 Feet Waste** | | |

Constrained pipe wall buckling (for Driscoplex OD controlled pipe)

$P_{WC} = \frac{5.65 * \{RB'E' E*[12(DR-1)^3]^{-1}\}^{0.5}}{N}$ Source 1, Equation 7-5

$P_{WC}$ = allowable constrained buckling pressure (lb/in$^2$)

R = buoyancy reduction factor = 1 - 0.33 * (H'/H) Source 1, Equation 7-34

| | | |
|---|---|---|
| H' = groundwater height above pipe (ft) | 0.0 | ft |
| H = cover above pipe (ft) | 4.0 | ft |
| B' = elastic support factor =( 1+ 4*$e^{-0.065H}$ )$^{-1}$ | | Source 1, Equation 7-35 |
| E' = soil reaction modulus (lb/in$^2$) | 3000.0 | lb/in$^2$ for mod comp/crushed rock, 'Source 1, Table 7-7 |
| E = elastic modulus (lb/in$^2$) | 100000.0 | lb/in$^2$ for long term load at 100$^o$F, 'Source 1, Table 5-1 |
| I = moment of inertia = $t^3$ / 12 | 0.0 | in$^4$/in |
| $D_o$ = pipe outer diameter (in) | 8.625 | SDR 11 pipe (Driscopipe) to be used |
| t = pipe wall thickness (in) | 0.784 | SDR 11 pipe (Driscopipe) to be used |
| DR = pipe dimension ratio = $D_o$ / t | 11.0 | SDR 11 pipe (Driscopipe) to be used |
| $D_I$ = pipe inner diameter = $D_o$ - 2t (in) | 7.1 | SDR 11 pipe (Driscopipe) to be used |
| N = safety factor | 2.0 | |

| Cover (ft) | (ft) | (ft) | B' | R | (lb/in$^2$) |
|---|---|---|---|---|---|
| 0.0 | 4 | 0 | 0.24 | 1.00 | 220.98 |

$P_{WC}$ = 220.98 lb/in$^2$

$P_{EFF}$ = 5.59 lb/in$^2$

Pipe passes contrained wall buckling calculations TRUE FS = 39.5

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| SUBJECT | BY | DATE |
| --- | --- | --- |
| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Collection Lateral** | CHECKED | DATE |
| Operation w/ CAT D7R Series II **0 Feet Waste** | | |

Constrained Pipe Wall Compressive Stress (for Driscoplex OD controlled pipe)

$S = \frac{P_T D_o}{288t}$ Source No. 1

$S$ = pipe wall compressive stress ($lb/in^2$)

| | | |
| --- | --- | --- |
| $P_T$ = vertical load applied to pipe w/ perfs ($lb/ft^2$) | 805.3 | $lb/ft^2$ |
| $D_o$ = pipe outside diameter (in) | 8.63 | SDR 11 pipe (Driscopipe) to be used |
| t = pipe wall thickness (in) | 0.784 | SDR 11 pipe (Driscopipe) to be used |

$S = \frac{P_T D_o}{288t} =$ 30.8 $lb/in^2$

The recommended, long-term compressive strength ($Y_s$) design value for Driscoplex polyethylene pipe is 800 $lb/in^2$.

Source No. 1

| S (psi): | | $Y_s$ (psi): |
| --- | --- | --- |
| 30.8 | < | 800.0 |

Pipe passes wall compressive stress calculations TRUE

FS = 26.0

SCS ENGINEERS



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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Collection Lateral** | CHECKED | DATE |
| Operation w/ CAT D7R Series II **0 Feet Waste** | | |

Iowa Formula

$\Delta X = \dfrac{D_L K W_c r^3}{EI + 0.06er^4}$ Source 2, Equation 3.4 Buried Pipe Design, A.P. Moser, Chapter 3

$\Delta X$ = horizontal deflection (in)

$D_L$ = deflection lag factor

K = bedding constant | 0.1 | typical value Source 2, Buried Pipe Design, A.P. Moser, Chapter 3

$W_c$ = Marston's load per unit length of pipe (lb/in)

r = mean radius of the pipe (in)

E = modulus of elasticity (lb/in$^2$)

I = moment of inertia of the pipe wall per unit length (in$^3$)

e = modulus of passive resistance fo the side fill (lb/in$^2$(in))

Modified Iowa Formula

$\Delta X = \dfrac{D_L K W_c r_m^3}{EI + 0.06E'r_m^3}$ Source 2, Equation 3.5 Buried Pipe Design, A.P. Moser, Chapter 3

$\Delta X$ = horizontal deflection (in)

| | | | |
|---|---|---|---|
| $D_L$ = deflection lag factor | | 1.0 | Prism Load used |
| Typical Value for Marston Load | 1.5 | | |
| Typical Value for Prism Load | 1.0 | | |
| K = bedding constant | | 0.1 | typical value Buried Pipe Design, A.P. Moser, Chapter 3 |
| $P_T$ = Vertical load on pipe w/ perfs | | 5.59 | lb/in$^2$ 805 lb/ft$^2$ |
| $W_c$ = Marston's load per unit length of pipe = $P_T$ * $D_o$ (lb/in) | | 48.24 | lb/in |
| $D_o$ = pipe outer diameter (in) | | 8.63 | SDR 11 pipe (Driscopipe) to be used |
| t = pipe wall thickness (in) | | 0.78 | SDR 11 pipe (Driscopipe) to be used |
| $D_I$ = pipe inner diameter = $D_o$-2t (in) | | 7.06 | SDR 11 pipe (Driscopipe) to be used |
| $D_m$ = pipe mean diameter = $D_o$ - 1.06t Source 1, Equation 7-27 | | 7.79 | SDR 11 pipe (Driscopipe) to be used |
| $r_m$ = mean radius of the pipe (in) | | 3.90 | SDR 11 pipe (Driscopipe) to be used |
| E = modulus of elasticity (lb/in$^2$) | | 100,000.0 | lb/in2 for long term load at 100oF, 'Source 1, Table 5-1 |
| I = moment of inertia of the pipe wall per unit length | | 0.040 | in$^4$/in |
| E' = modulus of soil reaction | | 3,000.0 | lb/in$^2$ for moderate compaction and fine grained soils |

$\Delta X = \dfrac{D_l K W_c r_m^3}{EI + 0.06E'r_m^3}$ = 0.019 inch Source 2, Equation 3.5 Buried Pipe Design, A.P. Moser, Chapter 3

% Ring Deflection = ($\Delta X/D_m$) x 100 = 0.25% Source 1, Equation 7-31

Ring Bending Strain

$e = \dfrac{f_D \Delta X 2C}{D_M^2} \times 100$ Source 1, Equation 7-39

e = wall strain (%)

| | | |
|---|---|---|
| $f_D$ = deformation shape factor | 6 | Source 1, non-elliptical shape |
| $D_M$ = mean diameter (in) | | |
| C = outer fiber wall centroid = 0.5 (1.06t) | 0.416 | Source 1, Equation 7-41 |
| $\Delta X$ = ring deflection = $D_X/D_m$ | 0.002 | |

$e = f_D \dfrac{(\Delta X)}{D_M}\dfrac{(2C)}{D_M} \times 100$ = 0.2% Source 1, Equation 7-39

The maximum ring bending strain for high performance polyethylene non-pressure pipe is = 5.0%

Pipe passes ring bending strain calculations TRUE

| SCS ENGINEERS | | | | |
|---|---|---|---|---|
| | | SHEET 8 | OF 8 | |
| CLIENT<br>Hardee County | PROJECT<br>Phase II Section II Expansion | | JOB NO.<br>09199033.23 | |
| SUBJECT<br>Pipe Crushing Calculations **RAI No. 1** | | BY<br>SRF | DATE<br>4/1/13 | |
| **8" Diameter Leachate Collection Lateral**<br>Operation w/ CAT D7R Series II **0 Feet Waste** | | CHECKED | DATE | |

SOURCES

1.) Attachment - 1 - Chevron Phillips Chemical Company, Bulletin - Book 2 Chapter 5, 2003

2.) Attachment - 2 - Buried Pipe Design, A.P. Moser, Chapter 3

3.) Attachment - 3 - EPA, Lining of Waste Impoundment and Disposal Facilities, SW-870

4.) Attachment - 4 - Driscoplex Pipe Properties

5.) Attachment - 5 - CAT 826G Series II Compactor Data Sheet

6.) Attachment - 6 - CAT D7R Series II Equipment Data Sheet

7.) Attachment - 7 - CAT D6R XW Series II Equipment Data Sheet

SCS ENGINEERS

SHEET 1 OF 8

| CLIENT | PROJECT | JOB NO. |
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| Hardee County | Phase II Section II Expansion | 09199033.23 |

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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Collection Lateral** | CHECKED | DATE |
| Operation w/ CAT D7R Series II 1**0 Feet Waste** | | |

Load on Pipe (Overburden)

Prism Loads, $P_E$ = wH

w = unit weight

H = depth

| | Depth (ft) | Unit Weight ($lb/ft^3$) | $P_E$ ($lb/ft^2$) |
|---|---|---|---|
| Final cover | 0.0 | 115.0 | 0.0 |
| Intermediate cover | 0.0 | 115.0 | 0.0 |
| Waste/cover | 10.0 | 60.0 | 600.0 |
| Drainage sand | 2.0 | 115.0 | 230.0 |
| Rock (No. 89 & No. 57) | 2.0 | 140.0 | 280.0 |

TOTAL SOIL PRISM LOAD $P_E$: 1110.0 $lb/ft^2$

Total Depth = 14.0 ft

Soil Arching, $P_m = C_D wB$

NOTE: The waste unit weight represents the combined unit weight of waste, daily cover, and moisture.

Pm = vertical soil pressure

B = trench width at pipe crown 6.0 ft

$C_D$ = load coefficient $= \frac{1 - e^{-2Ku'H/B}}{2Ku'}$ Equation 7-3, Source No. 1

e = natural log base number

K = Rankine earth pressure coefficient = $\tan^2(45-0.5*\phi)$

$\phi$ = internal soil friction angle = 27.0 degrees

u' = friction coefficient between backfill and trench sides = tan $\phi$

| Soil Type | Ku' |
|---|---|
| Saturated Clay | 0.110 |
| Ordinary Clay | 0.130 |
| Saturated Top Soil | 0.150 |
| Sand and Gravel | 0.165 |
| Clean Granular Soil | 0.192 |

| | Ku' | $C_D$ | $P_m$ ($lb/ft^2$) |
|---|---|---|---|
| Cover Soil | 0.150 | 0.00 | 0 |
| Int Cover | 0.165 | 0.00 | 0 |
| Waste | 0.191 | 1.23 | 444 |
| Drainage Sand | 0.165 | 0.32 | 217.8 |
| Granular Soil | 0.192 | 0.31 | 262.8 |

TOTAL SOIL ARCHING LOAD $P_M$: 924.2 $lb/ft^2$

MODIFIED ARCHING LOAD = $0.6P_M+0.4P_E$: 998.53 $lb/ft^2$

OVERBURDEN LOAD: 998.53 $lb/ft^2$

Load on Pipe With Equipment Refer to Attachment

Operation w/ CAT D7R Series II 10 Feet Waste

Equipment Weight = 54,573.0 psf

Number of Tracks = 2.0

Track Load = $q_r$ = 27,286.5 psf

Ground contact area/track = 17.3 psf

Length of Track = L = 113.0 in

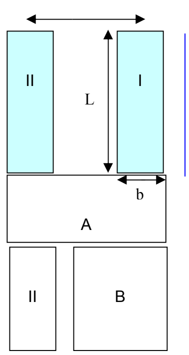
Track Width = b = 22.0 in

Track Gauge = G = 78.0 in

Equipment Width "A" = 113.0 in

Live Load = q*Ic q = track load 1,580.55 psf

Ic = Influence coefficient




| | b (ft) | L (ft) | z (ft) | m = b/z | n = L/z | I* | I** | I |
|---|---|---|---|---|---|---|---|---|
| I | 1.83 | 9.4 | 14.0 | 0.13 | 0.67 | 0.031 | 0.258 | 0.03087 |
| A | 8.33 | 9.4 | 14.0 | 0.60 | 0.67 | 0.114 | 0.272 | 0.11372 |
| B | 6.50 | 9.4 | 14.0 | 0.46 | 0.67 | 0.096 | 0.270 | 0.09592 |

Live $Load_1$ = $I + II = q_I(I_I) + q_A(I_A) - q_B(I_B)$ = 76.94 $lb/ft^2$

$q_I(I_I)$ = 48.80

$q_A(I_A)$ = 179.74

$q_B(I_B)$ = 151.60

Load on Pipe (Equipment) = 76.94 $lb/ft^2$

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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Collection Lateral** | CHECKED | DATE |
| Operation w/ CAT D7R Series II 1**0 Feet Waste** | | |

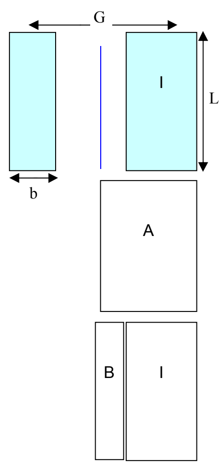
Load on Pipe (Equipment) *Continued*

Live Load = $q*I_c$

q = track load 1580.55 $lb/ft^2$

$I_c$ = Influence coefficient

Alternative 2: Track stradling and parallel to pipe



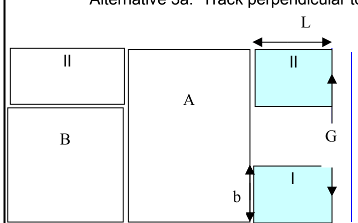

| | b | L | z | m = b/z | n = L/z | I* | I** | I |
|---|---|---|---|---|---|---|---|---|
| A | 4.71 | 9.4 | 14 | 0.34 | 0.67 | 0.074 | 0.267 | 0.07413 |
| B | 2.88 | 9.4 | 14 | 0.21 | 0.67 | 0.048 | 0.262 | 0.04754 |

Live $Load_2$ = 2 * (A - B) = 2 * $(q_A I_A - q_B I_B)$ = 84.04 $lb/ft^2$

| | |
|---|---|
| $q_A(I_A)$ = | 117.16 |
| $q_B(I_B)$ = | 75.14 |

Load on Pipe (Equipment) = 84.04 $lb/ft^2$

Alternative 3a: Track perpendicular to pipe




| | b | L | z | m = b/z | n = L/z | I* | I** | I |
|---|---|---|---|---|---|---|---|---|
| I | 1.83 | 9.4 | 14 | 0.13 | 0.67 | 0.031 | 0.258 | 0.03087 |
| A | 9.42 | 9.4 | 14 | 0.67 | 0.67 | 0.122 | 0.271 | 0.12225 |
| B | 7.58 | 9.4 | 14 | 0.54 | 0.67 | 0.107 | 0.271 | 0.10697 |

Live $Load_3$ = I + II = $q_I(I_I) + q_A(I_A) - q_B(I_B)$ = 72.96 $lb/ft^2$

| | |
|---|---|
| $q_I(I_I)$ = | 48.80 |
| $q_A(I_A)$ = | 193.23 |
| $q_B(I_B)$ = | 169.07 |

Load on Pipe (Equipment) = 72.96 $lb/ft^2$

LARGEST EQUIPEMENT LOAD = 84.04 $lb/ft^2$

VERTICAL OVERBURDEN LOAD = 998.53 $lb/ft^2$

VERTICAL EQUIPMENT LOAD = 84.04 $lb/ft^2$

TOTAL VERTICAL LOAD APPLIED TO PIPE, $P_T$ = 1,082.58 $lb/ft^2$ = 7.52 $lb/in^2$

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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Collection Lateral** | CHECKED | DATE |
| Operation w/ CAT D7R Series II 10 **Feet Waste** | | |

Verify that perforations in the LCRS are adequate for the peak leachate flow.

Use discharge equation:

$Q = (Cd)(Ao)(2gh)^{0.5}$

$C_d$ = coeffiecient of discharge = 0.6 for short tube discharge with fluid/wall separation; conservative value.

$A_o$ = Area of orifice ($\pi D^2/4$)

g = gravitational acceleration (32.3 $ft^2/s$)

h = static head (ft)

Assumptions and Givens:

| | | | |
|---|---|---|---|
| | 4.55 | acres | North and center portion of landfill bottom |
| 1. No. acres of landfill expansion = | 3.08 | acres | - North & center less area from eastern grade break of bottom |
| 2. Total length of pipe per expansion = | 1,888.1 | ft | area draining into eastern 10-inch lateral collection |
| 3. Number of laterals = | 2.0 | | - (2) 8-inch laterals collect drainage from this bottom area |
| 4. Total length of pipe per lateral = | 944.1 | ft | - (1) 10-inch lateral collects the remaining drainage |
| 5. Perforation diameter = | 0.375 | inch | - Refer to calcs for 10" diameter leachate collection lateral |
| 6. No. perforations/ft pipe = | 6.0 | perforations/ft of pipe length | |
| 7. Maximum head over pipe = | 1.0 | ft | |
| 8. Per HELP model summary table, $Q_{peak}$ = | 202.93 | gal/min | refer to HELP Model Summary Table |
| 9. Per HELP model summary table, $Q_{peak}$ = | 39,063.5 | cf/day | refer to HELP Model Summary Table |
| 10. Maximum flow/lateral = | 19,531.7 | cf/day/lateral | |
| 11. Maximum leachate flow/ft of pipe = | 20.69 | cf/day/ft of pipe | |

Solution:

$A_o = 0.25(\Pi)(d)^2 =$ 0.00077 $ft^2$

1. Flow per orifice, $Q = (Cd)(Ao)(2gh)^{0.5} =$ 0.0037 $ft^3/s$

2. Flow per ft of pipe = (Q)(# perfs/ft) = 0.02 $ft^3/s$ per ft of pipe

= 1914.47 cf/day/ft of pipe

Conclusion:

Design capacity exceeds estimated generation

1914.47 cf/day/ft of pipe >>> 20.69 cf/day/ft of pipe

Perforations are adequate to handle the maximum leachate flow.

| CLIENT | PROJECT | JOB NO. |
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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Collection Lateral** | CHECKED | DATE |
| Operation w/ CAT D7R Series II **10 Feet Waste** | | |

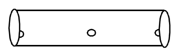
Effective pressure on pipe due to perforations:

$P_{EFF} = \frac{P_T \times 12}{(12-L_P)}$ Source 3, EPA SW-870, p. 382

$L_P$ = Total accumulated length of perforations in one foot of pipe.

Since each perforation is 0.375 inch diameter and spaced at 6.0 inch on center,

$L_P$ = 1.5 inch



$P_T$ = 7.5 psi

$P_{EFF}$ = 8.6 psi

$P_{EFF}$ = 1237.2 psf

Check actual compressive pressure ($S_A$) per Driscopipe manual:

$S_A$ = 0.5 x (SDR - 1) x P(eff) = 43.0 psi

The recommended, long-term compressive strength ($Y_s$) design value for Driscoplex polyethylene pipe is 800 lb/in$^2$.

Source No. 1

| $S_A$ (psi): | | $Y_s$ (psi): |
|---|---|---|
| 43.0 | < | 800.0 |

Pipe passes wall compressive stress perforation calculations TRUE

FS = 18.6

| CLIENT | PROJECT | JOB NO. |
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| **8" Diameter Leachate Collection Lateral** | CHECKED | DATE |
| Operation w/ CAT D7R Series II 1**0 Feet Waste** | | |

Constrained pipe wall buckling (for Driscoplex OD controlled pipe)

$$P_{WC} = \frac{5.65 * \{RB'E' \; E*[12(DR-1)^3]^{-1}\}^{0.5}}{N}$$ Source 1, Equation 7-5

$P_{WC}$ = allowable constrained buckling pressure (lb/in$^2$)

R = buoyancy reduction factor = 1 - 0.33 * (H'/H) Source 1, Equation 7-34

| | | |
|---|---|---|
| H' = groundwater height above pipe (ft) | 0.0 | ft |
| H = cover above pipe (ft) | 14.0 | ft |
| B' = elastic support factor =( 1+ 4*e$^{-0.065H}$ )$^{-1}$ | | Source 1, Equation 7-35 |
| E' = soil reaction modulus (lb/in$^2$) | 3000.0 | lb/in$^2$ for mod comp/crushed rock, 'Source 1, Table 7-7 |
| E = elastic modulus (lb/in$^2$) | 100000.0 | lb/in$^2$ for long term load at 100$^o$F, 'Source 1, Table 5-1 |
| I = moment of inertia = t$^3$ / 12 | 0.0 | in$^4$/in |
| $D_o$ = pipe outer diameter (in) | 8.625 | SDR 11 pipe (Driscopipe) to be used |
| t = pipe wall thickness (in) | 0.784 | SDR 11 pipe (Driscopipe) to be used |
| DR = pipe dimension ratio = $D_o$ / t | 11.0 | SDR 11 pipe (Driscopipe) to be used |
| $D_I$ = pipe inner diameter = $D_o$ - 2t (in) | 7.1 | SDR 11 pipe (Driscopipe) to be used |
| N = safety factor | 2.0 | |

| Cover (ft) | (ft) | (ft) | B' | R | (lb/in$^2$) |
|---|---|---|---|---|---|
| 10.0 | 14 | 0 | 0.38 | 1.00 | 276.42 |

$P_{WC}$ = 276.42 lb/in$^2$

$P_{EFF}$ = 8.59 lb/in$^2$

Pipe passes contrained wall buckling calculations TRUE FS = 32.2

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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Collection Lateral** | CHECKED | DATE |
| Operation w/ CAT D7R Series II 1**0 Feet Waste** | | |

Constrained Pipe Wall Compressive Stress (for Driscoplex OD controlled pipe)

$S = \frac{P_T D_o}{288t}$ Source No. 1

S = pipe wall compressive stress ($lb/in^2$)

$P_T$ = vertical load applied to pipe w/ perfs ($lb/ft^2$) | 1237.2 | $lb/ft^2$

$D_o$ = pipe outside diameter (in) | 8.63 | SDR 11 pipe (Driscopipe) to be used

t = pipe wall thickness (in) | 0.784 | SDR 11 pipe (Driscopipe) to be used

$S = \frac{P_T D_o}{288t} =$ 47.3 $lb/in^2$

The recommended, long-term compressive strength ($Y_s$) design value for Driscoplex polyethylene pipe is 800 $lb/in^2$.

Source No. 1

| S (psi): | | $Y_s$ (psi): |
|---|---|---|
| 47.3 | < | 800.0 |

Pipe passes wall compressive stress calculations TRUE

FS = 16.9

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| **8" Diameter Leachate Collection Lateral** | CHECKED | DATE |
| Operation w/ CAT D7R Series II 1**0 Feet Waste** | | |

Iowa Formula

$\Delta X = \dfrac{D_L K W_c r^3}{EI + 0.06er^4}$ Source 2, Equation 3.4 Buried Pipe Design, A.P. Moser, Chapter 3

$\Delta X$ = horizontal deflection (in)

$D_L$ = deflection lag factor

K = bedding constant | 0.1 | typical value Source 2, Buried Pipe Design, A.P. Moser, Chapter 3

$W_c$ = Marston's load per unit length of pipe (lb/in)

r = mean radius of the pipe (in)

E = modulus of elasticity ($lb/in^2$)

I = moment of inertia of the pipe wall per unit length ($in^3$)

e = modulus of passive resistance fo the side fill ($lb/in^2(in)$)

Modified Iowa Formula

$\Delta X = \dfrac{D_L K W_c r_m^3}{EI + 0.06E'r_m^3}$ Source 2, Equation 3.5 Buried Pipe Design, A.P. Moser, Chapter 3

$\Delta X$ = horizontal deflection (in)

| | | | |
|---|---|---|---|
| $D_L$ = deflection lag factor | | 1.0 | Prism Load used |
| Typical Value for Marston Load | 1.5 | | |
| Typical Value for Prism Load | 1.0 | | |
| K = bedding constant | | 0.1 | typical value Buried Pipe Design, A.P. Moser, Chapter 3 |
| $P_T$ = Vertical load on pipe w/ perfs | | 8.59 | $lb/in^2$ 1237 $lb/ft^2$ |
| $W_c$ = Marston's load per unit length of pipe = $P_T * D_o$ (lb/in) | | 74.10 | lb/in |
| $D_o$ = pipe outer diameter (in) | | 8.63 | SDR 11 pipe (Driscopipe) to be used |
| t = pipe wall thickness (in) | | 0.78 | SDR 11 pipe (Driscopipe) to be used |
| $D_I$ = pipe inner diameter = $D_o$-2t (in) | | 7.06 | SDR 11 pipe (Driscopipe) to be used |
| $D_m$ = pipe mean diameter = $D_o$ - 1.06t Source 1, Equation 7-27 | | 7.79 | SDR 11 pipe (Driscopipe) to be used |
| $r_m$ = mean radius of the pipe (in) | | 3.90 | SDR 11 pipe (Driscopipe) to be used |
| E = modulus of elasticity ($lb/in^2$) | | 100,000.0 | lb/in2 for long term load at 100oF, 'Source 1, Table 5-1 |
| I = moment of inertia of the pipe wall per unit length | | 0.040 | $in^4/in$ |
| E' = modulus of soil reaction | | 3,000.0 | $lb/in^2$ for moderate compaction and fine grained soils |

$\Delta X = \dfrac{D_I K W_c r_m^3}{EI + 0.06E'r_m^3}$ = 0.030 inch Source 2, Equation 3.5 Buried Pipe Design, A.P. Moser, Chapter 3

% Ring Deflection = $(\Delta X/D_m)$ x 100 = 0.38% Source 1, Equation 7-31

Ring Bending Strain

$e = \dfrac{f_D \Delta X 2C}{D_M^2} \times 100$ Source 1, Equation 7-39

e = wall strain (%)

| | | |
|---|---|---|
| $f_D$ = deformation shape factor | 6 | Source 1, non-elliptical shape |
| $D_M$ = mean diameter (in) | | |
| C = outer fiber wall centroid = 0.5 (1.06t) | 0.416 | Source 1, Equation 7-41 |
| $\Delta X$ = ring deflection = $D_X/D_m$ | 0.004 | |

$e = f_D \dfrac{(\Delta X)}{D_M}\dfrac{(2C)}{D_M} \times 100$ = 0.2% Source 1, Equation 7-39

The maximum ring bending strain for high performance polyethylene non-pressure pipe is = 5.0%

Pipe passes ring bending strain calculations TRUE

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| Operation w/ CAT D7R Series II 1**0 Feet Waste** | | |

SOURCES

1.) Attachment - 1 - Chevron Phillips Chemical Company, Bulletin - Book 2 Chapter 5, 2003

2.) Attachment - 2 - Buried Pipe Design, A.P. Moser, Chapter 3

3.) Attachment - 3 - EPA, Lining of Waste Impoundment and Disposal Facilities, SW-870

4.) Attachment - 4 - Driscoplex Pipe Properties

5.) Attachment - 5 - CAT 826G Series II Compactor Data Sheet

6.) Attachment - 6 - CAT D7R Series II Equipment Data Sheet

7.) Attachment - 7 - CAT D6R XW Series II Equipment Data Sheet

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Load on Pipe (Overburden)

Prism Loads, $P_E = wH$

w = unit weight

H = depth

| | Depth (ft) | Unit Weight ($lb/ft^3$) | $P_E$ ($lb/ft^2$) |
|---|---|---|---|
| Final cover | 0.0 | 115.0 | 0.0 |
| Intermediate cover | 0.0 | 115.0 | 0.0 |
| Waste/cover | 25.0 | 60.0 | 1500.0 |
| Drainage sand | 2.0 | 115.0 | 230.0 |
| Rock (No. 89 & No. 57) | 2.0 | 140.0 | 280.0 |

TOTAL SOIL PRISM LOAD $P_E$: 2010.0 $lb/ft^2$

Total Depth = 29.0 ft

Soil Arching, $P_m = C_D wB$

NOTE: The waste unit weight represents the combined unit weight of waste, daily cover, and moisture.

Pm = vertical soil pressure

B = trench width at pipe crown 6.0 ft

$C_D$ = load coefficient $= \frac{1 - e^{-2Ku'H/B}}{2Ku'}$ Equation 7-3, Source No. 1

e = natural log base number

K = Rankine earth pressure coefficient = $\tan^2(45-0.5*\phi)$

$\phi$ = internal soil friction angle = 27.0 degrees

u' = friction coefficient between backfill and trench sides = tan $\phi$

| Soil Type | Ku' |
|---|---|
| Saturated Clay | 0.110 |
| Ordinary Clay | 0.130 |
| Saturated Top Soil | 0.150 |
| Sand and Gravel | 0.165 |
| Clean Granular Soil | 0.192 |

| | Ku' | $C_D$ | $P_m$ ($lb/ft^2$) |
|---|---|---|---|
| Cover Soil | 0.150 | 0.00 | 0 |
| Int Cover | 0.165 | 0.00 | 0 |
| Waste | 0.191 | 2.08 | 750 |
| Drainage Sand | 0.165 | 0.32 | 217.8 |
| Granular Soil | 0.192 | 0.31 | 262.8 |

TOTAL SOIL ARCHING LOAD $P_M$: 1,230.4 $lb/ft^2$

MODIFIED ARCHING LOAD = $0.6P_M+0.4P_E$: 1,542.23 $lb/ft^2$

OVERBURDEN LOAD: 1,542.23 $lb/ft^2$

Load on Pipe With Equipment Refer to Attachment

Operation w/ CAT D7R Series II 25 Feet Waste

Equipment Weight = 54,573.0 psf

Number of Tracks = 2.0

Track Load = $q_r$ = 27,286.5 psf

Ground contact area/track = 17.3 psf

Length of Track = L = 113.0 in

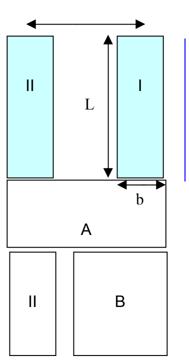
Track Width = b = 22.0 in

Track Gauge = G = 78.0 in

Equipment Width "A" = 113.0 in

Live Load = q*Ic q = track load 1,580.55 psf

Ic = Influence coefficient




| | b (ft) | L (ft) | z (ft) | m = b/z | n = L/z | I* | I** | I |
|---|---|---|---|---|---|---|---|---|
| I | 1.83 | 9.4 | 29.0 | 0.06 | 0.32 | 0.009 | 0.253 | 0.00900 |
| A | 8.33 | 9.4 | 29.0 | 0.29 | 0.32 | 0.039 | 0.261 | 0.03850 |
| B | 6.50 | 9.4 | 29.0 | 0.22 | 0.32 | 0.031 | 0.259 | 0.03077 |

Live $Load_1$ = I + II = $q_I(I_I) + q_A(I_A) - q_B(I_B)$ = 26.45 $lb/ft^2$

$q_I(I_I)$ = 14.22

$q_A(I_A)$ = 60.86

$q_B(I_B)$ = 48.63

Load on Pipe (Equipment) = 26.45 $lb/ft^2$

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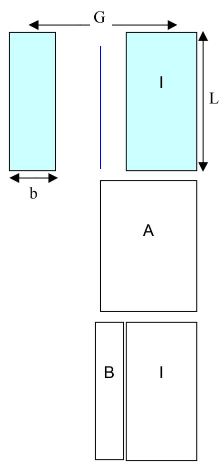
Load on Pipe (Equipment) *Continued*

Live Load = $q*I_c$

$q$ = track load 1580.55 $lb/ft^2$

$I_c$ = Influence coefficient

Alternative 2: Track stradling and parallel to pipe



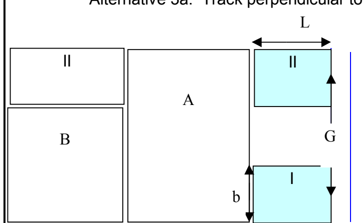

| | b | L | z | m = b/z | n = L/z | I* | I** | I |
|---|---|---|---|---|---|---|---|---|
| A | 4.71 | 9.4 | 29 | 0.16 | 0.32 | 0.023 | 0.257 | 0.02270 |
| B | 2.88 | 9.4 | 29 | 0.10 | 0.32 | 0.014 | 0.254 | 0.01404 |

$Live Load_2$ = 2 * (A - B) = 2 * ($q_A I_A$ - $q_B I_B$) = 27.36 $lb/ft^2$

| | |
|---|---|
| $q_A(I_A)$ = | 35.88 |
| $q_B(I_B)$ = | 22.20 |

Load on Pipe (Equipment) = 27.36 $lb/ft^2$

Alternative 3a: Track perpendicular to pipe




| | b | L | z | m = b/z | n = L/z | I* | I** | I |
|---|---|---|---|---|---|---|---|---|
| I | 1.83 | 9.4 | 29 | 0.06 | 0.32 | 0.009 | 0.253 | 0.00900 |
| A | 9.42 | 9.4 | 29 | 0.32 | 0.32 | 0.043 | 0.262 | 0.04279 |
| B | 7.58 | 9.4 | 29 | 0.26 | 0.32 | 0.035 | 0.261 | 0.03541 |

$Live Load_3$ = I + II = $q_I(I_I)$ + $q_A(I_A)$ - $q_B(I_B)$ = 25.90 $lb/ft^2$

| | |
|---|---|
| $q_I(I_I)$ = | 14.22 |
| $q_A(I_A)$ = | 67.64 |
| $q_B(I_B)$ = | 55.96 |

Load on Pipe (Equipment) = 25.90 $lb/ft^2$

LARGEST EQUIPEMENT LOAD = 27.36 $lb/ft^2$

VERTICAL OVERBURDEN LOAD = 1,542.23 $lb/ft^2$

VERTICAL EQUIPMENT LOAD = 27.36 $lb/ft^2$

TOTAL VERTICAL LOAD APPLIED TO PIPE, $P_T$ = 1,569.59 $lb/ft^2$ = 10.90 $lb/in^2$

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Verify that perforations in the LCRS are adequate for the peak leachate flow.

Use discharge equation:

$Q = (Cd)(Ao)(2gh)^{0.5}$

$C_d$ = coeffiecient of discharge = 0.6 for short tube discharge with fluid/wall separation; conservative value.

$A_o$ = Area of orifice ($\pi D^2/4$)

g = gravitational acceleration (32.3 $ft^2/s$)

h = static head (ft)

Assumptions and Givens:

| | | | |
|---|---|---|---|
| | 4.55 | acres | North and center portion of landfill bottom |
| 1. No. acres of landfill expansion = | 3.08 | acres | - North & center less area from eastern grade break of bottom |
| 2. Total length of pipe per expansion = | 1,888.1 | ft | area draining into eastern 10-inch lateral collection |
| 3. Number of laterals = | 2.0 | | - (2) 8-inch laterals collect drainage from this bottom area |
| 4. Total length of pipe per lateral = | 944.1 | ft | - (1) 10-inch lateral collects the remaining drainage |
| 5. Perforation diameter = | 0.375 | inch | - Refer to calcs for 10" diameter leachate collection lateral |
| 6. No. perforations/ft pipe = | 6.0 | perforations/ft of pipe length | |
| 7. Maximum head over pipe = | 1.0 | ft | |
| 8. Per HELP model summary table, $Q_{peak}$ = | 202.93 | gal/min | refer to HELP Model Summary Table |
| 9. Per HELP model summary table, $Q_{peak}$ = | 39,063.5 | cf/day | refer to HELP Model Summary Table |
| 10. Maximum flow/lateral = | 19,531.7 | cf/day/lateral | |
| 11. Maximum leachate flow/ft of pipe = | 20.69 | cf/day/ft of pipe | |

Solution:

$A_o = 0.25(\Pi)(d)^2 =$ 0.00077 $ft^2$

1. Flow per orifice, $Q = (Cd)(Ao)(2gh)^{0.5} =$ 0.0037 $ft^3/s$

2. Flow per ft of pipe = (Q)(# perfs/ft) = 0.02 $ft^3/s$ per ft of pipe

= 1914.47 cf/day/ft of pipe

Conclusion:

Design capacity exceeds estimated generation

1914.47 cf/day/ft of pipe >>> 20.69 cf/day/ft of pipe

Perforations are adequate to handle the maximum leachate flow.

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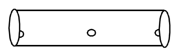
Effective pressure on pipe due to perforations:

$P_{EFF} = \dfrac{P_T \times 12}{(12-L_P)}$ Source 3, EPA SW-870, p. 382

$L_P$ = Total accumulated length of perforations in one foot of pipe.

Since each perforation is 0.375 inch diameter and spaced at 6.0 inch on center,

$L_P$ = 1.5 inch



$P_T$ = 10.9 psi

$P_{EFF}$ = 12.5 psi

$P_{EFF}$ = 1793.8 psf

Check actual compressive pressure ($S_A$) per Driscopipe manual:

$S_A$ = 0.5 x (SDR - 1) x P(eff) = 62.3 psi

The recommended, long-term compressive strength ($Y_s$) design value for Driscoplex polyethylene pipe is 800 lb/in$^2$.

Source No. 1

| $S_A$ (psi): | | $Y_s$ (psi): |
|---|---|---|
| 62.3 | < | 800.0 |

Pipe passes wall compressive stress perforation calculations TRUE

FS = 12.8

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Constrained pipe wall buckling (for Driscoplex OD controlled pipe)

$P_{WC} = \frac{5.65 * \{RB'E' \, E*[12(DR-1)^3]^{-1}\}^{0.5}}{N}$ Source 1, Equation 7-5

$P_{WC}$ = allowable constrained buckling pressure (lb/in$^2$)

R = buoyancy reduction factor = 1 - 0.33 * (H'/H) Source 1, Equation 7-34

| | | |
|---|---|---|
| H' = groundwater height above pipe (ft) | 0.0 | ft |
| H = cover above pipe (ft) | 29.0 | ft |
| B' = elastic support factor =( 1+ 4*e$^{-0.065H}$ )$^{-1}$ | | Source 1, Equation 7-35 |
| E' = soil reaction modulus (lb/in$^2$) | 3000.0 | lb/in$^2$ for mod comp/crushed rock, 'Source 1, Table 7-7 |
| E = elastic modulus (lb/in$^2$) | 100000.0 | lb/in$^2$ for long term load at 100°F, 'Source 1, Table 5-1 |
| I = moment of inertia = t$^3$ / 12 | 0.0 | in$^4$/in |
| $D_o$ = pipe outer diameter (in) | 8.625 | SDR 11 pipe (Driscopipe) to be used |
| t = pipe wall thickness (in) | 0.784 | SDR 11 pipe (Driscopipe) to be used |
| DR = pipe dimension ratio = $D_o$ / t | 11.0 | SDR 11 pipe (Driscopipe) to be used |
| $D_I$ = pipe inner diameter = $D_o$ - 2t (in) | 7.1 | SDR 11 pipe (Driscopipe) to be used |
| N = safety factor | 2.0 | |

| Cover (ft) | (ft) | (ft) | B' | R | (lb/in$^2$) |
|---|---|---|---|---|---|
| 25.0 | 29 | 0 | 0.62 | 1.00 | 352.25 |

$P_{WC}$ = 352.25 lb/in$^2$

$P_{EFF}$ = 12.46 lb/in$^2$

Pipe passes contrained wall buckling calculations TRUE FS = 28.3

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Constrained Pipe Wall Compressive Stress (for Driscoplex OD controlled pipe)

$$S = \frac{P_T D_o}{288t}$$ Source No. 1

S = pipe wall compressive stress (lb/in$^2$)

| | | |
|---|---|---|
| $P_T$ = vertical load applied to pipe w/ perfs (lb/ft$^2$) | 1793.8 | lb/ft$^2$ |
| $D_o$ = pipe outside diameter (in) | 8.63 | SDR 11 pipe (Driscopipe) to be used |
| t = pipe wall thickness (in) | 0.784 | SDR 11 pipe (Driscopipe) to be used |

$$S = \frac{P_T D_o}{288t} = 68.5 \text{ lb/in}^2$$

The recommended, long-term compressive strength ($Y_s$) design value for Driscoplex polyethylene pipe is 800 lb/in$^2$.

Source No. 1

| S (psi): | | $Y_s$ (psi): |
|---|---|---|
| 68.5 | < | 800.0 |

Pipe passes wall compressive stress calculations TRUE FS = 11.7

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| Operation w/ CAT D7R Series II **25 Feet Waste** | | |

Iowa Formula

$\Delta X = \frac{D_L K W_c r^3}{EI + 0.06er^4}$ Source 2, Equation 3.4 Buried Pipe Design, A.P. Moser, Chapter 3

$\Delta X$ = horizontal deflection (in)

$D_L$ = deflection lag factor

K = bedding constant | 0.1 | typical value Source 2, Buried Pipe Design, A.P. Moser, Chapter 3

$W_c$ = Marston's load per unit length of pipe (lb/in)

r = mean radius of the pipe (in)

E = modulus of elasticity (lb/in$^2$)

I = moment of inertia of the pipe wall per unit length (in$^3$)

e = modulus of passive resistance fo the side fill (lb/in$^2$(in))

Modified Iowa Formula

$\Delta X = \frac{D_L K W_c r_m^3}{EI + 0.06E'r_m^3}$ Source 2, Equation 3.5 Buried Pipe Design, A.P. Moser, Chapter 3

$\Delta X$ = horizontal deflection (in)

| | | | |
|---|---|---|---|
| $D_L$ = deflection lag factor | | 1.0 | Prism Load used |
| Typical Value for Marston Load | 1.5 | | |
| Typical Value for Prism Load | 1.0 | | |
| K = bedding constant | | 0.1 | typical value Buried Pipe Design, A.P. Moser, Chapter 3 |
| $P_T$ = Vertical load on pipe w/ perfs | | 12.46 | lb/in$^2$ 1794 lb/ft$^2$ |
| $W_c$ = Marston's load per unit length of pipe = $P_T$ * $D_o$ (lb/in) | | 107.44 | lb/in |
| $D_o$ = pipe outer diameter (in) | | 8.63 | SDR 11 pipe (Driscopipe) to be used |
| t = pipe wall thickness (in) | | 0.78 | SDR 11 pipe (Driscopipe) to be used |
| $D_I$ = pipe inner diameter = $D_o$-2t (in) | | 7.06 | SDR 11 pipe (Driscopipe) to be used |
| $D_m$ = pipe mean diameter = $D_o$ - 1.06t Source 1, Equation 7-27 | | 7.79 | SDR 11 pipe (Driscopipe) to be used |
| $r_m$ = mean radius of the pipe (in) | | 3.90 | SDR 11 pipe (Driscopipe) to be used |
| E = modulus of elasticity (lb/in$^2$) | | 100,000.0 | lb/in2 for long term load at 100oF, 'Source 1, Table 5-1 |
| I = moment of inertia of the pipe wall per unit length | | 0.040 | in$^4$/in |
| E' = modulus of soil reaction | | 3,000.0 | lb/in$^2$ for moderate compaction and fine grained soils |

$\Delta X = \frac{D_L K W_c r_m^3}{EI + 0.06E'r_m^3}$ = 0.043 inch Source 2, Equation 3.5 Buried Pipe Design, A.P. Moser, Chapter 3

% Ring Deflection = ($\Delta X/D_m$) x 100 = 0.56% Source 1, Equation 7-31

Ring Bending Strain

$e = \frac{f_D \Delta X 2C}{D_M^2} \times 100$ Source 1, Equation 7-39

e = wall strain (%)

| | | |
|---|---|---|
| $f_D$ = deformation shape factor | 6 | Source 1, non-elliptical shape |
| $D_M$ = mean diameter (in) | | |
| C = outer fiber wall centroid = 0.5 (1.06t) | 0.416 | Source 1, Equation 7-41 |
| $\Delta X$ = ring deflection = $D_X/D_m$ | 0.006 | |

$e = f_D \frac{\Delta X}{D_M} \frac{2C}{D_M} \times 100$ = 0.4% Source 1, Equation 7-39

The maximum ring bending strain for high performance polyethylene non-pressure pipe is = 5.0%

Pipe passes ring bending strain calculations TRUE

| CLIENT | PROJECT | JOB NO. |
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| SUBJECT | BY | DATE |
|---|---|---|
| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Collection Lateral** | CHECKED | DATE |
| Operation w/ CAT D7R Series II **25 Feet Waste** | | |

SOURCES

1.) Attachment - 1 - Chevron Phillips Chemical Company, Bulletin - Book 2 Chapter 5, 2003

2.) Attachment - 2 - Buried Pipe Design, A.P. Moser, Chapter 3

3.) Attachment - 3 - EPA, Lining of Waste Impoundment and Disposal Facilities, SW-870

4.) Attachment - 4 - Driscoplex Pipe Properties

5.) Attachment - 5 - CAT 826G Series II Compactor Data Sheet

6.) Attachment - 6 - CAT D7R Series II Equipment Data Sheet

7.) Attachment - 7 - CAT D6R XW Series II Equipment Data Sheet

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| CLIENT | PROJECT | JOB NO. |
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| Hardee County | Phase II Section II Expansion | 09199033.23 |

| SUBJECT | BY | DATE |
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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Collection Lateral** | CHECKED | DATE |
| Operation w/ CAT D7R Series II **60 Feet Waste** | | |

Load on Pipe (Overburden)

Prism Loads, $P_E$ = wH

w = unit weight

H = depth

| | Depth (ft) | Unit Weight ($lb/ft^3$) | $P_E$ ($lb/ft^2$) |
|---|---|---|---|
| Final cover | 2.0 | 115.0 | 230.0 |
| Intermediate cover | 1.0 | 115.0 | 115.0 |
| Waste/cover | 60.0 | 60.0 | 3600.0 |
| Drainage sand | 2.0 | 115.0 | 230.0 |
| Rock (No. 89 & No. 57) | 2.0 | 140.0 | 280.0 |

TOTAL SOIL PRISM LOAD $P_E$: 4455.0 $lb/ft^2$

Total Depth = 67.0 ft

Soil Arching, $P_m = C_D wB$

NOTE: The waste unit weight represents the combined unit weight of waste, daily cover, and moisture.

Pm = vertical soil pressure

B = trench width at pipe crown 6.0 ft

$C_D$ = load coefficient $= \frac{1 - e^{-2Ku'H/B}}{2Ku'}$ Equation 7-3, Source No. 1

e = natural log base number

K = Rankine earth pressure coefficient = $\tan^2(45-0.5*\phi)$

$\phi$ = internal soil friction angle = 27.0 degrees

u' = friction coefficient between backfill and trench sides = tan $\phi$

| Soil Type | Ku' |
|---|---|
| Saturated Clay | 0.110 |
| Ordinary Clay | 0.130 |
| Saturated Top Soil | 0.150 |
| Sand and Gravel | 0.165 |
| Clean Granular Soil | 0.192 |

| | Ku' | $C_D$ | $P_m$ ($lb/ft^2$) |
|---|---|---|---|
| Cover Soil | 0.150 | 0.32 | 219 |
| Int Cover | 0.165 | 0.16 | 112 |
| Waste | 0.191 | 2.56 | 920 |
| Drainage Sand | 0.165 | 0.32 | 217.8 |
| Granular Soil | 0.192 | 0.31 | 262.8 |

TOTAL SOIL ARCHING LOAD $P_M$: 1,731.6 $lb/ft^2$

MODIFIED ARCHING LOAD = $0.6P_M+0.4P_E$: 2,820.98 $lb/ft^2$

OVERBURDEN LOAD: 2,820.98 $lb/ft^2$

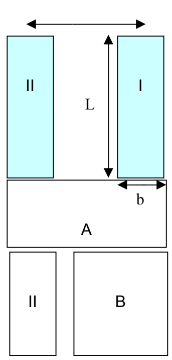
Load on Pipe With Equipment Refer to Attachment

Operation w/ CAT D7R Series II 60 Feet Waste

| | | | | | |
|---|---|---|---|---|---|
| Equipment Weight = | 54,573.0 | psf | Length of Track = L = | 113.0 | in |
| Number of Tracks = | 2.0 | | Track Width = b = | 22.0 | in |
| Track Load = $q_r$ = | 27,286.5 | psf | Track Gauge = G = | 78.0 | in |
| Ground contact area/track = | 17.3 | psf | Equipment Width "A" = | 113.0 | in |

Live Load = q*Ic q = track load 1,580.55 psf

Ic = Influence coefficient




| | b (ft) | L (ft) | z (ft) | m = b/z | n = L/z | I* | I** | I |
|---|---|---|---|---|---|---|---|---|
| I | 1.83 | 9.4 | 67.0 | 0.03 | 0.14 | 0.002 | 0.251 | 0.00181 |
| A | 8.33 | 9.4 | 67.0 | 0.12 | 0.14 | 0.008 | 0.253 | 0.00811 |
| B | 6.50 | 9.4 | 67.0 | 0.10 | 0.14 | 0.006 | 0.252 | 0.00636 |

Live $Load_1$ = I + II = $q_I(I_I) + q_A(I_A) - q_B(I_B)$ = 5.62 $lb/ft^2$

$q_I(I_I)$ = 2.85

$q_A(I_A)$ = 12.82

$q_B(I_B)$ = 10.05

Load on Pipe (Equipment) = 5.62 $lb/ft^2$

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|---|---|---|
| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Collection Lateral** | CHECKED | DATE |
| Operation w/ CAT D7R Series II **60 Feet Waste** | | |

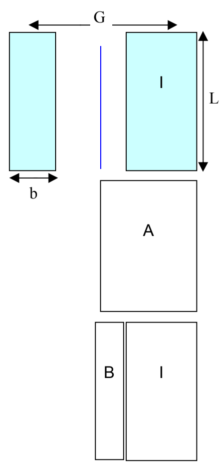
Load on Pipe (Equipment) *Continued*

Live Load = $q*I_c$

$q$ = track load 1580.55 $lb/ft^2$

$I_c$ = Influence coefficient

Alternative 2: Track stradling and parallel to pipe



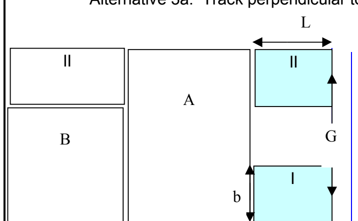

| | b | L | z | m = b/z | n = L/z | I* | I** | I |
|---|---|---|---|---|---|---|---|---|
| A | 4.71 | 9.4 | 67 | 0.07 | 0.14 | 0.005 | 0.252 | 0.00462 |
| B | 2.88 | 9.4 | 67 | 0.04 | 0.14 | 0.003 | 0.251 | 0.00283 |

Live $Load_2$ = 2 * (A - B) = 2 * ($q_AI_A$ - $q_BI_B$) = 5.66 $lb/ft^2$

| | |
|---|---|
| $q_A(I_A)$ = | 7.30 |
| $q_B(I_B)$ = | 4.47 |

Load on Pipe (Equipment) = 5.66 $lb/ft^2$

Alternative 3a: Track perpendicular to pipe




| | b | L | z | m = b/z | n = L/z | I* | I** | I |
|---|---|---|---|---|---|---|---|---|
| I | 1.83 | 9.4 | 67 | 0.03 | 0.14 | 0.002 | 0.251 | 0.00181 |
| A | 9.42 | 9.4 | 67 | 0.14 | 0.14 | 0.009 | 0.253 | 0.00913 |
| B | 7.58 | 9.4 | 67 | 0.11 | 0.14 | 0.007 | 0.252 | 0.00739 |

Live $Load_3$ = I + II = $q_I(I_I)$ + $q_A(I_A)$ - $q_B(I_B)$ = 5.60 $lb/ft^2$

| | |
|---|---|
| $q_I(I_I)$ = | 2.85 |
| $q_A(I_A)$ = | 14.43 |
| $q_B(I_B)$ = | 11.69 |

Load on Pipe (Equipment) = 5.60 $lb/ft^2$

LARGEST EQUIPEMENT LOAD = 5.66 $lb/ft^2$

VERTICAL OVERBURDEN LOAD = 2,820.98 $lb/ft^2$

VERTICAL EQUIPMENT LOAD = 5.66 $lb/ft^2$

TOTAL VERTICAL LOAD APPLIED TO PIPE, $P_T$ = 2,826.65 $lb/ft^2$ = 19.63 $lb/in^2$

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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Collection Lateral** | CHECKED | DATE |
| Operation w/ CAT D7R Series II **60 Feet Waste** | | |

Verify that perforations in the LCRS are adequate for the peak leachate flow.

Use discharge equation:

$Q = (Cd)(Ao)(2gh)^{0.5}$

$C_d$ = coeffiecient of discharge = 0.6 for short tube discharge with fluid/wall separation; conservative value.

$A_o$ = Area of orifice ($\pi D^2/4$)

g = gravitational acceleration (32.3 $ft^2/s$)

h = static head (ft)

Assumptions and Givens:

| | | | |
|---|---|---|---|
| | 4.55 | acres | North and center portion of landfill bottom |
| 1. No. acres of landfill expansion = | 3.08 | acres | - North & center less area from eastern grade break of bottom area draining into eastern 10-inch lateral collection |
| 2. Total length of pipe per expansion = | 1,888.1 | ft | |
| 3. Number of laterals = | 2.0 | | - (2) 8-inch laterals collect drainage from this bottom area |
| 4. Total length of pipe per lateral = | 944.1 | ft | - (1) 10-inch lateral collects the remaining drainage |
| 5. Perforation diameter = | 0.375 | inch | - Refer to calcs for 10" diameter leachate collection lateral |
| 6. No. perforations/ft pipe = | 6.0 | perforations/ft of pipe length | |
| 7. Maximum head over pipe = | 1.0 | ft | |
| 8. Per HELP model summary table, $Q_{peak}$ = | 202.93 | gal/min | refer to HELP Model Summary Table |
| 9. Per HELP model summary table, $Q_{peak}$ = | 39,063.5 | cf/day | refer to HELP Model Summary Table |
| 10. Maximum flow/lateral = | 19,531.7 | cf/day/lateral | |
| 11. Maximum leachate flow/ft of pipe = | 20.69 | cf/day/ft of pipe | |

Solution:

$A_o = 0.25(\Pi)(d)^2 =$ 0.00077 $ft^2$

1. Flow per orifice, $Q = (Cd)(Ao)(2gh)^{0.5} =$ 0.0037 $ft^3/s$

2. Flow per ft of pipe = (Q)(# perfs/ft) = 0.02 $ft^3/s$ per ft of pipe

= 1914.47 cf/day/ft of pipe

Conclusion:

Design capacity exceeds estimated generation

1914.47 cf/day/ft of pipe >>> 20.69 cf/day/ft of pipe

Perforations are adequate to handle the maximum leachate flow.

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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Collection Lateral** | CHECKED | DATE |
| Operation w/ CAT D7R Series II **60 Feet Waste** | | |

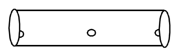
Effective pressure on pipe due to perforations:

$P_{EFF} = \frac{P_T \times 12}{(12 - L_P)}$ Source 3, EPA SW-870, p. 382

$L_P$ = Total accumulated length of perforations in one foot of pipe.

Since each perforation is 0.375 inch diameter and spaced at 6.0 inch on center,

$L_P$ = 1.5 inch



$P_T$ = 19.6 psi

$P_{EFF}$ = 22.4 psi

$P_{EFF}$ = 3230.5 psf

Check actual compressive pressure ($S_A$) per Driscopipe manual:

$S_A$ = 0.5 x (SDR - 1) x P(eff) = 112.2 psi

The recommended, long-term compressive strength ($Y_s$) design value for Driscoplex polyethylene pipe is 800 lb/in$^2$.

Source No. 1

| $S_A$ (psi): | | $Y_s$ (psi): |
|---|---|---|
| 112.2 | < | 800.0 |

Pipe passes wall compressive stress perforation calculations TRUE

FS = 7.1

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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Collection Lateral** | CHECKED | DATE |
| Operation w/ CAT D7R Series II **60 Feet Waste** | | |

Constrained pipe wall buckling (for Driscoplex OD controlled pipe)

$P_{WC} = \frac{5.65 * \{RB'E' E*[12(DR-1)^3]^{-1}\}^{0.5}}{N}$ Source 1, Equation 7-5

$P_{WC}$ = allowable constrained buckling pressure (lb/in$^2$)

R = buoyancy reduction factor = 1 - 0.33 * (H'/H) Source 1, Equation 7-34

| | | |
|---|---|---|
| H' = groundwater height above pipe (ft) | 0.0 | ft |
| H = cover above pipe (ft) | 67.0 | ft |
| B' = elastic support factor =( 1+ 4*e$^{-0.065H}$ )$^{-1}$ | | Source 1, Equation 7-35 |
| E' = soil reaction modulus (lb/in$^2$) | 3000.0 | lb/in$^2$ for mod comp/crushed rock, 'Source 1, Table 7-7 |
| E = elastic modulus (lb/in$^2$) | 100000.0 | lb/in$^2$ for long term load at 100$^o$F, 'Source 1, Table 5-1 |
| I = moment of inertia = t$^3$ / 12 | 0.0 | in$^4$/in |
| $D_o$ = pipe outer diameter (in) | 8.625 | SDR 11 pipe (Driscopipe) to be used |
| t = pipe wall thickness (in) | 0.784 | SDR 11 pipe (Driscopipe) to be used |
| DR = pipe dimension ratio = $D_o$ / t | 11.0 | SDR 11 pipe (Driscopipe) to be used |
| $D_I$ = pipe inner diameter = $D_o$ - 2t (in) | 7.1 | SDR 11 pipe (Driscopipe) to be used |
| N = safety factor | 2.0 | |

| Cover (ft) | (ft) | (ft) | B' | R | 2 (lb/in ) |
|---|---|---|---|---|---|
| 60.0 | 67 | 0 | 0.95 | 1.00 | 435.54 |

$P_{WC}$ = 435.54 lb/in$^2$

$P_{EFF}$ = 22.43 lb/in$^2$

Pipe passes contrained wall buckling calculations TRUE FS = 19.4

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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Collection Lateral** | CHECKED | DATE |
| Operation w/ CAT D7R Series II **60 Feet Waste** | | |

Constrained Pipe Wall Compressive Stress (for Driscoplex OD controlled pipe)

$S = \frac{P_T D_o}{288t}$ Source No. 1

S = pipe wall compressive stress ($lb/in^2$)

| | | |
|---|---|---|
| $P_T$ = vertical load applied to pipe w/ perfs ($lb/ft^2$) | 3230.5 | $lb/ft^2$ |
| $D_o$ = pipe outside diameter (in) | 8.63 | SDR 11 pipe (Driscopipe) to be used |
| t = pipe wall thickness (in) | 0.784 | SDR 11 pipe (Driscopipe) to be used |

$S = \frac{P_T D_o}{288t} =$ 123.4 $lb/in^2$

The recommended, long-term compressive strength ($Y_s$) design value for Driscoplex polyethylene pipe is 800 $lb/in^2$.

Source No. 1

| S (psi): | | $Y_s$ (psi): |
|---|---|---|
| 123.4 | < | 800.0 |

Pipe passes wall compressive stress calculations TRUE FS = 6.5

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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Collection Lateral** | CHECKED | DATE |
| Operation w/ CAT D7R Series II **60 Feet Waste** | | |

Iowa Formula

$\Delta X = \dfrac{D_L K W_c r^3}{EI + 0.06er^4}$ Source 2, Equation 3.4 Buried Pipe Design, A.P. Moser, Chapter 3

$\Delta X$ = horizontal deflection (in)

$D_L$ = deflection lag factor

K = bedding constant 0.1 typical value Source 2, Buried Pipe Design, A.P. Moser, Chapter 3

$W_c$ = Marston's load per unit length of pipe (lb/in)

r = mean radius of the pipe (in)

E = modulus of elasticity ($lb/in^2$)

I = moment of inertia of the pipe wall per unit length ($in^3$)

e = modulus of passive resistance fo the side fill ($lb/in^2(in)$)

Modified Iowa Formula

$\Delta X = \dfrac{D_L K W_c r_m^3}{EI + 0.06E'r_m^3}$ Source 2, Equation 3.5 Buried Pipe Design, A.P. Moser, Chapter 3

$\Delta X$ = horizontal deflection (in)

| | | |
|---|---|---|
| $D_L$ = deflection lag factor | 1.0 | Prism Load used |
| Typical Value for Marston Load | 1.5 | |
| Typical Value for Prism Load | 1.0 | |
| K = bedding constant | 0.1 | typical value Buried Pipe Design, A.P. Moser, Chapter 3 |
| $P_T$ = Vertical load on pipe w/ perfs | 22.43 | $lb/in^2$ 3230 $lb/ft^2$ |
| $W_c$ = Marston's load per unit length of pipe = $P_T$ * $D_o$ (lb/in) | 193.49 | lb/in |
| $D_o$ = pipe outer diameter (in) | 8.63 | SDR 11 pipe (Driscopipe) to be used |
| t = pipe wall thickness (in) | 0.78 | SDR 11 pipe (Driscopipe) to be used |
| $D_I$ = pipe inner diameter = $D_o$-2t (in) | 7.06 | SDR 11 pipe (Driscopipe) to be used |
| $D_m$ = pipe mean diameter = $D_o$ - 1.06t Source 1, Equation 7-27 | 7.79 | SDR 11 pipe (Driscopipe) to be used |
| $r_m$ = mean radius of the pipe (in) | 3.90 | SDR 11 pipe (Driscopipe) to be used |
| E = modulus of elasticity ($lb/in^2$) | 100,000.0 | lb/in2 for long term load at 100oF, 'Source 1, Table 5-1 |
| I = moment of inertia of the pipe wall per unit length | 0.040 | $in^4/in$ |
| E' = modulus of soil reaction | 3,000.0 | $lb/in^2$ for moderate compaction and fine grained soils |

$\Delta X = \dfrac{D_L K W_c r_m^3}{EI + 0.06E'r_m^3}$ = 0.078 inch Source 2, Equation 3.5 Buried Pipe Design, A.P. Moser, Chapter 3

% Ring Deflection = $(\Delta X/D_m)$ x 100 = 1.00% Source 1, Equation 7-31

Ring Bending Strain

$e = \dfrac{f_D \Delta X 2C}{D_M^2} \times 100$ Source 1, Equation 7-39

e = wall strain (%)

| | | |
|---|---|---|
| $f_D$ = deformation shape factor | 6 | Source 1, non-elliptical shape |
| $D_M$ = mean diameter (in) | | |
| C = outer fiber wall centroid = 0.5 (1.06t) | 0.416 | Source 1, Equation 7-41 |
| $\Delta X$ = ring deflection = $D_X/D_m$ | 0.010 | |

$e = f_D \dfrac{(\Delta X)}{D_M}\dfrac{(2C)}{D_M} \times 100$ = 0.6% Source 1, Equation 7-39

The maximum ring bending strain for high performance polyethylene non-pressure pipe is = 5.0%

Pipe passes ring bending strain calculations TRUE

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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Collection Lateral** | CHECKED | DATE |
| Operation w/ CAT D7R Series II **60 Feet Waste** | | |

SOURCES

1.) Attachment - 1 - Chevron Phillips Chemical Company, Bulletin - Book 2 Chapter 5, 2003

2.) Attachment - 2 - Buried Pipe Design, A.P. Moser, Chapter 3

3.) Attachment - 3 - EPA, Lining of Waste Impoundment and Disposal Facilities, SW-870

4.) Attachment - 4 - Driscoplex Pipe Properties

5.) Attachment - 5 - CAT 826G Series II Compactor Data Sheet

6.) Attachment - 6 - CAT D7R Series II Equipment Data Sheet

7.) Attachment - 7 - CAT D6R XW Series II Equipment Data Sheet

# Summary Table and 8-Inch Leachate Collection Lateral Pipe Crushing and Flow Capacity Calculations South Portion

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| SUBJECT | BY | DATE |
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| Phase II Section II **RAI No. 1** | SRF | 4/1/13 |
| Summary Table Pipe Crushing **Operations** | CHECKED | DATE |
| **8" Diameter Leachate Collection Laterals PII SII South Portion** | | |

| Description | Waste Height (ft) | Fill Height (ft) | Pipe Diameter (in) | Type of Calculation | Design Value | Calculated Value | Units | Safety Factor* |
|---|---|---|---|---|---|---|---|---|
| CAT D7R Series II | 0 | 2 | 8 | Flow Capacity | 1914.47 | 84.54 | cf/day/ft of pipe | 22.64 |
| | | | | Buckling | 220.98 | 5.59 | psi | 39.51 |
| | | | | Compressive Stress | 800 | 30.76 | psi | 26.01 |
| | | | | Bending Strain | 5.0% | 0.2% | % | 31.30 |
| CAT D7R Series II | 10 | 12 | 8 | Flow Capacity | 1914.47 | 84.54 | cf/day/ft of pipe | 22.64 |
| | | | | Buckling | 276.42 | 8.59 | psi | 32.17 |
| | | | | Compressive Stress | 800 | 47.26 | psi | 16.93 |
| | | | | Bending Strain | 5.0% | 0.2% | % | 20.37 |
| CAT D7R Series II | 25 | 27 | 8 | Flow Capacity | 1914.47 | 84.54 | cf/day/ft of pipe | 22.64 |
| | | | | Buckling | 352.25 | 12.46 | psi | 28.28 |
| | | | | Compressive Stress | 800 | 68.52 | psi | 11.68 |
| | | | | Bending Strain | 5.0% | 0.4% | % | 14.05 |
| CAT D7R Series II | 60 | 65 | 8 | Flow Capacity | 1914.47 | 84.54 | cf/day/ft of pipe | 22.64 |
| | | | | Buckling | 435.54 | 22.43 | psi | 19.41 |
| | | | | Compressive Stress | 800 | 123.40 | psi | 6.48 |
| | | | | Bending Strain | 5.0% | 0.6% | % | 7.80 |
| CAT 826 G Series II Compactor | 0 | 2 | 8 | Flow Capacity | 1914.47 | 84.54 | cf/day/ft of pipe | 22.64 |
| | | | | Buckling | 220.98 | 11.53 | psi | 19.17 |
| | | | | Compressive Stress | 800 | 63.42 | psi | 12.61 |
| | | | | Bending Strain | 5.0% | 0.3% | % | 15.18 |
| CAT 826 G Series II Compactor | 10 | 12 | 8 | Flow Capacity | 1914.47 | 84.54 | cf/day/ft of pipe | 22.64 |
| | | | | Buckling | 276.42 | 9.63 | psi | 28.71 |
| | | | | Compressive Stress | 800 | 52.97 | psi | 15.10 |
| | | | | Bending Strain | 5.0% | 0.3% | % | 18.18 |
| CAT 826 G Series II Compactor | 25 | 27 | 8 | Flow Capacity | 1914.47 | 84.54 | cf/day/ft of pipe | 22.64 |
| | | | | Buckling | 352.25 | 12.83 | psi | 27.46 |
| | | | | Compressive Stress | 800 | 70.56 | psi | 11.34 |
| | | | | Bending Strain | 5.0% | 0.4% | % | 13.65 |
| CAT 826 G Series II Compactor | 60 | 65 | 8 | Flow Capacity | 1914.47 | 84.54 | cf/day/ft of pipe | 22.64 |
| | | | | Buckling | 435.54 | 22.52 | psi | 19.34 |
| | | | | Compressive Stress | 800 | 123.89 | psi | 6.46 |
| | | | | Bending Strain | 5.0% | 0.6% | % | 7.77 |

* Safety Factor = Design Value/Calculated Value

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| Phase II Section II **RAI No. 1** | SRF | 4/1/13 |
| Summary Table Pipe Crushing **Construction** | CHECKED | DATE |
| **8" Diameter Leachate Collection Laterals PII SII South Portion** | | |

| Description | Waste Height (ft) | Fill Height (ft) | Pipe Diameter (in) | Type of Calculation | Design Value | Calculated Value | Units | Safety Factor* |
|---|---|---|---|---|---|---|---|---|
| CAT D6R XW Series II | 0 | 1 | 8 | Flow Capacity | 1914.47 | 84.54 | cf/day/ft of pipe | 22.64 |
| | | | | Buckling | 204.95 | 2.93 | psi | 69.91 |
| | | | | Compressive Stress | 800 | 16.12 | psi | 49.61 |
| | | | | Bending Strain | 5.0% | 0.1% | % | 59.71 |

* Safety Factor = Design Value/Calculated Value

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| CLIENT | PROJECT | JOB NO. |
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|---|---|---|
| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Collection Lateral** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **0 Feet Waste** | | |

Load on Pipe (Overburden)

Prism Loads, $P_E$ = wH

w = unit weight

H = depth

| | Depth (ft) | Unit Weight ($lb/ft^3$) | $P_E$ ($lb/ft^2$) |
|---|---|---|---|
| Final cover | 0.0 | 115.0 | 0.0 |
| Intermediate cover | 0.0 | 115.0 | 0.0 |
| Waste/cover | 0.0 | 60.0 | 0.0 |
| Drainage sand | 2.0 | 115.0 | 230.0 |
| Rock (No. 89 & No. 57) | 2.0 | 140.0 | 280.0 |

TOTAL SOIL PRISM LOAD $P_E$: 510.0 $lb/ft^2$

Total Depth = 4.0 ft

Soil Arching, $P_m = C_D wB$

Pm = vertical soil pressure

B = trench width at pipe crown 6.0 ft

$C_D$ = load coefficient $= \frac{1 - e^{-2Ku'H/B}}{2Ku'}$ Equation 7-3, Source No. 1

e = natural log base number

K = Rankine earth pressure coefficient = $\tan^2(45-0.5*\phi)$

$\phi$ = internal soil friction angle = 27.0 degrees

u' = friction coefficient between backfill and trench sides = tan $\phi$

NOTE: The waste unit weight represents the combined unit weight of waste, daily cover, and moisture.

| Soil Type | Ku' |
|---|---|
| Saturated Clay | 0.110 |
| Ordinary Clay | 0.130 |
| Saturated Top Soil | 0.150 |
| Sand and Gravel | 0.165 |
| Clean Granular Soil | 0.192 |

| | Ku' | $C_D$ | $P_m$ ($lb/ft^2$) |
|---|---|---|---|
| Cover Soil | 0.150 | 0.00 | 0 |
| Int Cover | 0.165 | 0.00 | 0 |
| Waste | 0.191 | 0.00 | 0 |
| Drainage Sand | 0.165 | 0.32 | 217.8 |
| Granular Soil | 0.192 | 0.31 | 262.8 |

TOTAL SOIL ARCHING LOAD $P_M$: 480.6 $lb/ft^2$

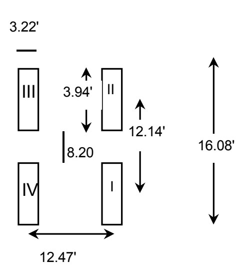
MODIFIED ARCHING LOAD = $0.6P_M+0.4P_E$: 492.37 $lb/ft^2$

OVERBURDEN LOAD: 492.37 $lb/ft^2$

Load on Pipe With Equipment Refer to Attachment

Operation w/ CAT 826G Series II Compactor 0 Feet Waste

Equipment Weight = 81,498.0 psf




| | | | |
|---|---|---|---|
| Track per Load = $q_r$ = | 1,670.20 | psf | (Rear) |
| Track per Load = $q_{fr}$ = | 1,541.72 | psf | (Front) |
| Length of Track = L = | 3.22 | ft | (contact length) |
| Length of Track = b = | 8.20 | ft | |
| Track Width = | 12.47 | ft | |
| Track Width (I to II) = | 16.08 | ft | |

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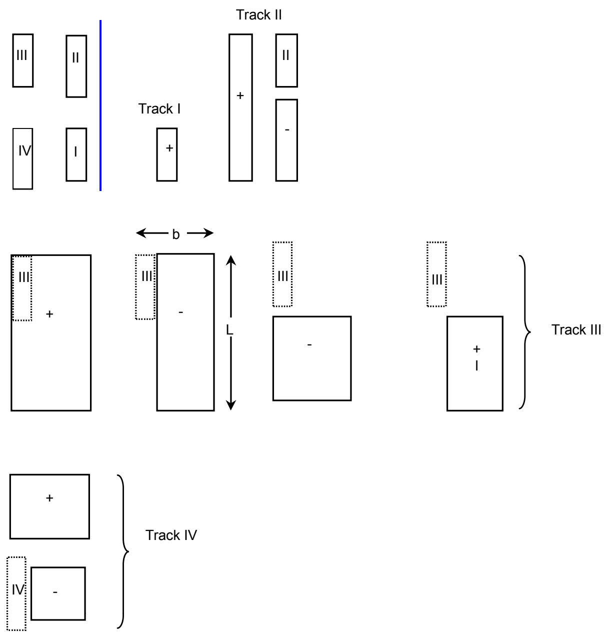
| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Collection Lateral** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **0 Feet Waste** | | |

Load on Pipe

Alternative 1: Track Adjacent and Parallel to Pipe




| | b | L | z | m = b/z | n = L/z | I* | I** | I | |
|---|---|---|---|---|---|---|---|---|---|
| Track I | 8.2 | 3 | 4 | 2.05 | 0.81 | 0.182 | 0.241 | 0.18205 | (ADD) |
| | | | | | | | | | |
| Track II | 8.2 | 16.1 | 4 | 2.05 | 4.02 | -0.010 | 0.240 | 0.23973 | (ADD) |
| | 8.2 | 11.4 | 4 | 2.05 | 2.86 | -0.012 | 0.238 | 0.23802 | (SUBTRACT) |
| | | | | | | | | | |
| Track IV | 12.47 | 3.22 | 4 | 3.12 | 0.81 | 0.185 | 0.231 | 0.18478 | (ADD) |
| | 12.47 | 3.22 | 4 | 3.12 | 0.81 | 0.185 | 0.231 | 0.18478 | (SUBTRACT) |
| | | | | | | | | | |
| Track III | 12.47 | 16.08 | 4 | 3.12 | 4.02 | -0.004 | 0.246 | 0.24588 | (ADD) |
| | 4.27 | 16.08 | 4 | 1.07 | 4.02 | -0.041 | 0.209 | 0.20918 | (SUBTRACT) |
| | 12.47 | 11.42 | 4 | 3.12 | 2.86 | -0.006 | 0.244 | 0.24379 | (SUBTRACT) |
| | 4.27 | 8.47 | 4 | 1.07 | 2.12 | 0.206 | 0.226 | 0.20553 | (ADD) |

$\text{Live Load}_1 = q_r(\Sigma I) + q_{fr}(\Sigma II) + q_{fr}(\Sigma III) + q_r(\Sigma IV)$

$\text{Live Load}_1 =$ 304.29 psf

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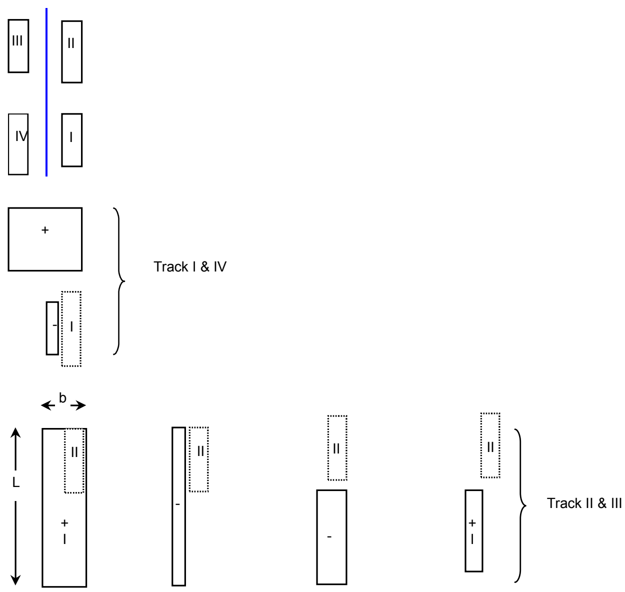
| Operation w/ CAT 826G Series II Compactor **0 Feet Waste** | | |

Load on Pipe

Alternative 2: Track Stradling and Parallel to Pipe




| | b | L | z | m = b/z | n = L/z | I* | I** | I | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | |
| Track I | 6.2 | 3.2 | 4 | 1.6 | 0.8 | 0.177 | 0.250 | 0.17733 | (ADD) |
| & IV | -2.0 | 3.2 | 4 | -0.5 | 0.8 | -0.109 | 0.230 | -0.10926 | (SUBTRACT) |
| | | | | | | | | | |
| Track II | 6.2 | 16.08 | 4 | 1.6 | 4.0 | -0.019 | 0.231 | 0.23095 | (ADD) |
| & III | -2.0 | 16.08 | 4 | -0.5 | 4.0 | -0.135 | 0.255 | -0.13546 | (SUBTRACT) |
| | 6.2 | 12.86 | 4 | 1.6 | 3.2 | -0.020 | 0.230 | 0.23021 | (SUBTRACT) |
| | -2.0 | 12.86 | 4 | -0.5 | 3.2 | -0.135 | 0.253 | -0.13519 | (ADD) |

Live $Load_2$ = $[q_r(\Sigma I) + q_{fr}(\Sigma II)] * 2$

Live $Load_2$ = 960.43 psf

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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
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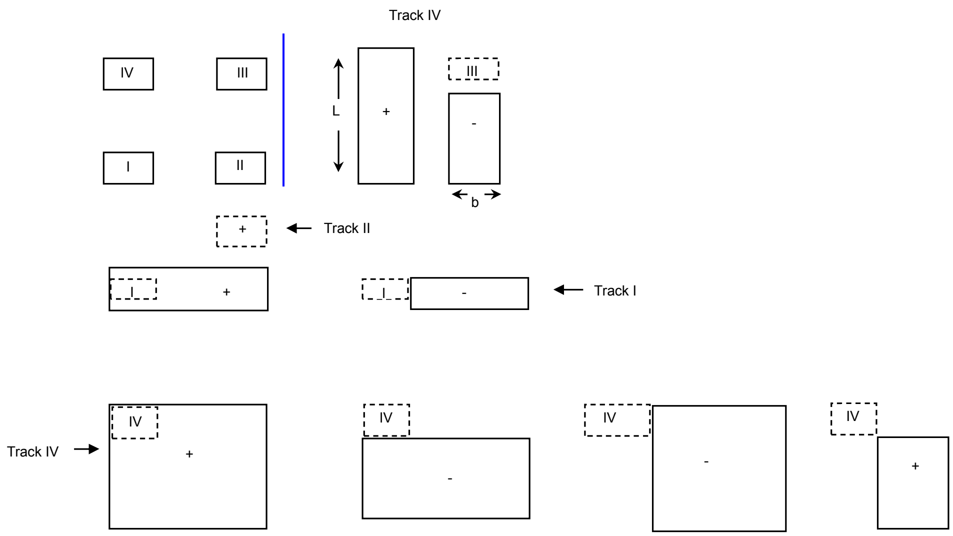
Load on Pipe

Alternative 3: Track Perpendicular to Pipe




| | b | L | z | m = b/z | n = L/z | I* | I** | I | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | |
| Track I | 16.1 | 8.2 | 4 | 4.0 | 2.1 | -0.010 | 0.240 | 0.23973 | (ADD) |
| | 12.9 | 8.2 | 4 | 3.2 | 2.1 | -0.011 | 0.239 | 0.23883 | (SUBTRACT) |
| | | | | | | | | | |
| Track II | 3.2 | 8.2 | 4 | 0.8 | 2.1 | 0.182 | 0.241 | 0.18205 | (ADD) |
| | | | | | | | | | |
| Track III | 3.2 | 12.5 | 4 | 0.8 | 3.1 | 0.185 | 0.231 | 0.18478 | (ADD) |
| | 3.2 | 4.3 | 4 | 0.8 | 1.1 | 0.164 | 0.262 | 0.16364 | (SUBTRACT) |
| | | | | | | | | | |
| Track IV | 16.1 | 12.5 | 4 | 4.0 | 3.1 | -0.004 | 0.246 | 0.24588 | (ADD) |
| | 16.1 | 4.3 | 4 | 4.0 | 1.1 | -0.041 | 0.209 | 0.20918 | (SUBTRACT) |
| | 12.9 | 12.5 | 4 | 3.2 | 3.1 | -0.005 | 0.245 | 0.24477 | (SUBTRACT) |
| | 12.9 | 4.3 | 4 | 3.2 | 1.1 | 0.209 | 0.213 | 0.20863 | (ADD) |

Live Load$_3$ = $q_r\,(\Sigma I) + q_{fr}\,(\Sigma II) + q_{fr}\,(\Sigma III) + q_r\,(\Sigma IV)$

Live Load$_3$ = 315.70 psf

LARGEST EQUIPEMENT LOAD = 960.43 lb/ft$^2$

VERTICAL OVERBURDEN LOAD = 492.37 lb/ft$^2$

VERTICAL EQUIPMENT LOAD = 960.43 lb/ft$^2$

TOTAL VERTICAL LOAD APPLIED TO PIPE, $P_T$ = 1452.80 lb/ft$^2$ = 10.09 lb/in$^2$

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Verify that perforations in the LCRS are adequate for the peak leachate flow.

Use discharge equation:

$Q = (Cd)(Ao)(2gh)^{0.5}$

$C_d$ = coeffiecient of discharge = 0.6 for short tube discharge with fluid/wall separation; conservative value.

$A_o$ = Area of orifice ($\pi D^2/4$)

g = gravitational acceleration (32.3 $ft^2/s$)

h = static head (ft)

Assumptions and Givens:

| | | | |
|---|---|---|---|
| 1. No. acres of landfill expansion = | 1.63 | acres | - Phase II Section II south portion |
| 2. Total length of pipe per expansion = | 539.7 | ft | |
| 3. Total number of laterals = | 3.0 | | |
| 4. Length of pipe per lateral = | 179.9 | ft | |
| 5. Perforation diameter = | 0.375 | inch | |
| 6. No. perforations/ft pipe = | 6.0 | perforations/ft of pipe length | |
| 7. Maximum head over pipe = | 1.0 | ft | |
| 8. Per HELP model summary table, $Q_{peak}$ = | 237.01 | gal/min | refer to HELP Model Summary Table |
| 9. Per HELP model summary table, $Q_{peak}$ = | 45,624.6 | cf/day | refer to HELP Model Summary Table |
| 10. Maximum flow/lateral = | 15,208.2 | cf/day/lateral | |
| 11. Maximum leachate flow/ft of pipe = | 84.54 | cf/day/ft of pipe | |

Solution:

$A_o = 0.25(\Pi)(d)^2$ = 0.00077 $ft^2$

1. Flow per orifice, $Q = (Cd)(Ao)(2gh)^{0.5}$ = 0.0037 $ft^3/s$

2. Flow per ft of pipe = (Q)(# perfs/ft) = 0.02 $ft^3/s$ per ft of pipe

= 1,914.5 cf/day/ft of pipe

Conclusion:

Design capacity exceeds estimated generation

1914.47 cf/day/ft of pipe >>> 84.54 cf/day/ft of pipe

Perforations are adequate to handle the maximum leachate flow.

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| **8" Diameter Leachate Collection Lateral** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **0 Feet Waste** | | |

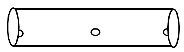
Effective pressure on pipe due to perforations:

$P_{EFF} = \frac{P_T \times 12}{(12 - L_P)}$ Source 3, EPA SW-870, p. 382

$L_P$ = Total accumulated length of perforations in one foot of pipe.

Since each perforation is 0.375 inch diameter and spaced at 6.0 inch on center,

$L_P$ = 1.5 inch



$P_T$ = 10.1 psi

$P_{EFF}$ = 11.5 psi

$P_{EFF}$ = 1660.3 psf

Check actual compressive pressure ($S_A$) per Driscopipe manual:

$S_A$ = 0.5 x (SDR - 1) x P(eff) = 57.7 psi

The recommended, long-term compressive strength ($Y_s$) design value for Driscoplex polyethylene pipe is 800 lb/in$^2$.

Source No. 1

| $S_A$ (psi): | | $Y_s$ (psi): |
|---|---|---|
| 57.7 | < | 800.0 |

Pipe passes wall compressive stress perforation calculations TRUE

FS = 13.9

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| **8" Diameter Leachate Collection Lateral** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **0 Feet Waste** | | |

Constrained pipe wall buckling (for Driscoplex OD controlled pipe)

$P_{WC} = \dfrac{5.65 * \{RB'E' E^*[12(DR-1)^3]^{-1}\}^{0.5}}{N}$ Source 1, Equation 7-5

$P_{WC}$ = allowable constrained buckling pressure (lb/in$^2$)

| | | |
|---|---|---|
| R = buoyancy reduction factor = 1 - 0.33 * (H'/H) | Source 1, Equation 7-34 | |
| H' = groundwater height above pipe (ft) | 0.0 | ft |
| H = cover above pipe (ft) | 4.0 | ft |
| B' = elastic support factor =( 1+ 4*e$^{-0.065H}$ )$^{-1}$ | Source 1, Equation 7-35 | |
| E' = soil reaction modulus (lb/in$^2$) | 3000.0 | lb/in$^2$ for mod comp/crushed rock, 'Source 1, Table 7-7 |
| E = elastic modulus (lb/in$^2$) | 100000.0 | lb/in$^2$ for long term load at 100$^o$F, 'Source 1, Table 5-1 |
| I = moment of inertia = t$^3$ / 12 | 0.0 | in$^4$/in |
| $D_o$ = pipe outer diameter (in) | 8.625 | SDR 11 pipe (Driscopipe) to be used |
| t = pipe wall thickness (in) | 0.784 | SDR 11 pipe (Driscopipe) to be used |
| DR = pipe dimension ratio = $D_o$ / t | 11.0 | SDR 11 pipe (Driscopipe) to be used |
| $D_I$ = pipe inner diameter = $D_o$ - 2t (in) | 7.1 | SDR 11 pipe (Driscopipe) to be used |
| N = safety factor | 2.0 | |

| Cover (ft) | (ft) | (ft) | B' | R | (lb/in$^2$) |
|---|---|---|---|---|---|
| 4.0 | 4 | 0 | 0.24 | 1.00 | 220.98 |

$P_{WC}$ = 220.98 lb/in$^2$
$P_{EFF}$ = 11.53 lb/in$^2$

Pipe passes contrained wall buckling calculations TRUE FS = 19.2

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| **8" Diameter Leachate Collection Lateral** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **0 Feet Waste** | | |

Constrained Pipe Wall Compressive Stress (for Driscoplex OD controlled pipe)

$S = \frac{P_T D_o}{288t}$ Source No. 1

S = pipe wall compressive stress (lb/in$^2$)

$P_T$ = vertical load applied to pipe w/ perfs (lb/ft$^2$) 1660.3 lb/ft$^2$

$D_o$ = pipe outside diameter (in) 8.63 SDR 11 pipe (Driscopipe) to be used

t = pipe wall thickness (in) 0.784 SDR 11 pipe (Driscopipe) to be used

$S = \frac{P_T D_o}{288t} =$ 63.4 lb/in$^2$

The recommended, long-term compressive strength ($Y_s$) design value for Driscoplex polyethylene pipe is 800 lb/in$^2$.

Source No. 1

| S (psi): | | $Y_s$ (psi): |
|---|---|---|
| 63.4 | < | 800.0 |

Pipe passes wall compressive stress calculations TRUE

FS = 12.6

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Iowa Formula

$\Delta X = \dfrac{D_L K W_c r^3}{EI + 0.06er^4}$ Source 2, Equation 3.4 Buried Pipe Design, A.P. Moser, Chapter 3

$\Delta X$ = horizontal deflection (in)

$D_L$ = deflection lag factor

K = bedding constant 0.1 typical value Source 2, Buried Pipe Design, A.P. Moser, Chapter 3

$W_c$ = Marston's load per unit length of pipe (lb/in)

r = mean radius of the pipe (in)

E = modulus of elasticity ($lb/in^2$)

I = moment of inertia of the pipe wall per unit length ($in^3$)

e = modulus of passive resistance fo the side fill ($lb/in^2(in)$)

Modified Iowa Formula

$\Delta X = \dfrac{D_L K W_c r_m^3}{EI + 0.06E'r_m^3}$ Source 2, Equation 3.5 Buried Pipe Design, A.P. Moser, Chapter 3

$\Delta X$ = horizontal deflection (in)

| | | |
|---|---|---|
| $D_L$ = deflection lag factor | 1.0 | Prism Load used |
| Typical Value for Marston Load | 1.5 | |
| Typical Value for Prism Load | 1.0 | |
| K = bedding constant | 0.1 | typical value Buried Pipe Design, A.P. Moser, Chapter 3 |
| $P_T$ = Vertical load on pipe w/ perfs | 11.53 | $lb/in^2$ — 1660 $lb/ft^2$ |
| $W_c$ = Marston's load per unit length of pipe = $P_T * D_o$ (lb/in) | 99.45 | lb/in |
| $D_o$ = pipe outer diameter (in) | 8.63 | SDR 11 pipe (Driscopipe) to be used |
| t = pipe wall thickness (in) | 0.78 | SDR 11 pipe (Driscopipe) to be used |
| $D_I$ = pipe inner diameter = $D_o$-2t (in) | 7.06 | SDR 11 pipe (Driscopipe) to be used |
| $D_m$ = pipe mean diameter = $D_o$ - 1.06t Source 1, Equation 7-27 | 7.79 | SDR 11 pipe (Driscopipe) to be used |
| $r_m$ = mean radius of the pipe (in) | 3.90 | SDR 11 pipe (Driscopipe) to be used |
| E = modulus of elasticity ($lb/in^2$) | 100,000.0 | lb/in2 for long term load at 100oF, 'Source 1, Table 5-1 |
| I = moment of inertia of the pipe wall per unit length | 0.040 | $in^4/in$ |
| E' = modulus of soil reaction | 3,000.0 | $lb/in^2$ for moderate compaction and fine grained soils |

$\Delta X = \dfrac{D_L K W_c r_m^3}{EI + 0.06E'r_m^3}$ = 0.040 inch Source 2, Equation 3.5 Buried Pipe Design, A.P. Moser, Chapter 3

% Ring Deflection = $(\Delta X/D_m)$ x 100 = 0.51% Source 1, Equation 7-31

Ring Bending Strain

$e = \dfrac{f_D \Delta X 2C}{D_M^2} \times 100$ Source 1, Equation 7-39

e = wall strain (%)

| | | |
|---|---|---|
| $f_D$ = deformation shape factor | 6 | Source 1, non-elliptical shape |
| $D_M$ = mean diameter (in) | | |
| C = outer fiber wall centroid = 0.5 (1.06t) | 0.416 | Source 1, Equation 7-41 |
| $\Delta X$ = ring deflection = $D_X/D_m$ | 0.005 | |

$e = f_D \left(\dfrac{\Delta X}{D_M}\right)\left(\dfrac{2C}{D_M}\right) \times 100$ = 0.3% Source 1, Equation 7-39

The maximum ring bending strain for high performance polyethylene non-pressure pipe is 5.0%

Pipe passes ring bending strain calculations TRUE

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| Operation w/ CAT 826G Series II Compactor **0 Feet Waste** | | |

SOURCES

1.) Attachment - 1 - Chevron Phillips Chemical Company, Bulletin - Book 2 Chapter 5, 2003

2.) Attachment - 2 - Buried Pipe Design, A.P. Moser, Chapter 3

3.) Attachment - 3 - EPA, Lining of Waste Impoundment and Disposal Facilities, SW-870

4.) Attachment - 4 - Driscoplex Pipe Properties

5.) Attachment - 5 - CAT 826G Series II Compactor Data Sheet

6.) Attachment - 6 - CAT D7R Series II Equipment Data Sheet

7.) Attachment - 7 - CAT D6R XW Series II Equipment Data Sheet

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| Operation w/ CAT 826G Series II Compactor **10 Feet Waste** | | |

Load on Pipe (Overburden)

Prism Loads, $P_E$ = wH

w = unit weight

H = depth

| | Depth (ft) | Unit Weight ($lb/ft^3$) | $P_E$ ($lb/ft^2$) |
|---|---|---|---|
| Final cover | 0.0 | 115.0 | 0.0 |
| Intermediate cover | 0.0 | 115.0 | 0.0 |
| Waste/cover | 10.0 | 60.0 | 600.0 |
| Drainage sand | 2.0 | 115.0 | 230.0 |
| Rock (No. 89 & No. 57) | 2.0 | 140.0 | 280.0 |

TOTAL SOIL PRISM LOAD $P_E$: 1110.0 $lb/ft^2$

Total Depth = 14.0 ft

Soil Arching, $P_m = C_D wB$

Pm = vertical soil pressure

B = trench width at pipe crown 6.0 ft

$C_D$ = load coefficient $= \frac{1 - e^{-2Ku'H/B}}{2Ku'}$ Equation 7-3, Source No. 1

NOTE: The waste unit weight represents the combined unit weight of waste, daily cover, and moisture.

e = natural log base number

K = Rankine earth pressure coefficient = $\tan^2(45-0.5*\phi)$

$\phi$ = internal soil friction angle = 27.0 degrees

u' = friction coefficient between backfill and trench sides = tan $\phi$

| Soil Type | Ku' |
|---|---|
| Saturated Clay | 0.110 |
| Ordinary Clay | 0.130 |
| Saturated Top Soil | 0.150 |
| Sand and Gravel | 0.165 |
| Clean Granular Soil | 0.192 |

| | Ku' | $C_D$ | $P_m$ ($lb/ft^2$) |
|---|---|---|---|
| Cover Soil | 0.150 | 0.00 | 0 |
| Int Cover | 0.165 | 0.00 | 0 |
| Waste | 0.191 | 1.23 | 444 |
| Drainage Sand | 0.165 | 0.32 | 217.8 |
| Granular Soil | 0.192 | 0.31 | 262.8 |

TOTAL SOIL ARCHING LOAD $P_M$: 924.2 $lb/ft^2$

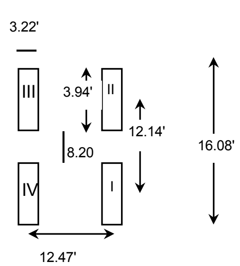
MODIFIED ARCHING LOAD = $0.6P_M+0.4P_E$: 998.53 $lb/ft^2$

OVERBURDEN LOAD: 998.53 $lb/ft^2$

Load on Pipe With Equipment Refer to Attachment

Operation w/ CAT 826G Series II Compactor 10 Feet Waste

Equipment Weight = 81,498.0 psf




| | | | |
|---|---|---|---|
| Track per Load = $q_r$ = | 1,670.20 | psf | (Rear) |
| Track per Load = $q_{fr}$ = | 1,541.72 | psf | (Front) |
| Length of Track = L = | 3.22 | ft | (contact length) |
| Length of Track = b = | 8.20 | ft | |
| Track Width = | 12.47 | ft | |
| Track Width (I to II) = | 16.08 | ft | |

SCS ENGINEERS

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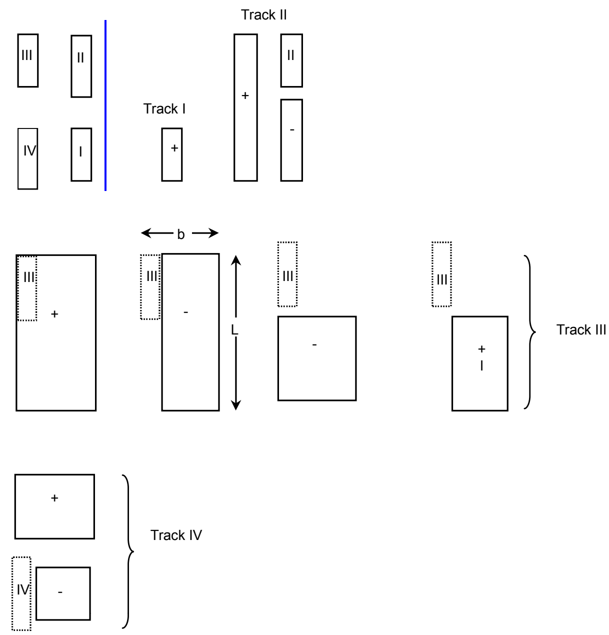
| CLIENT | PROJECT | JOB NO. |
|---|---|---|
| Hardee County | Phase II Section II Expansion | 09199033.23 |

| SUBJECT | BY | DATE |
|---|---|---|
| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Collection Lateral** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **10 Feet Waste** | | |

Load on Pipe

Alternative 1: Track Adjacent and Parallel to Pipe




| | b | L | z | m = b/z | n = L/z | I* | I** | I | |
|---|---|---|---|---|---|---|---|---|---|
| Track I | 8.2 | 3 | 14 | 0.59 | 0.23 | 0.049 | 0.263 | 0.04882 | (ADD) |
| | | | | | | | | | |
| Track II | 8.2 | 16.1 | 14 | 0.59 | 1.15 | 0.139 | 0.265 | 0.13939 | (ADD) |
| | 8.2 | 11.4 | 14 | 0.59 | 0.82 | 0.124 | 0.270 | 0.12392 | (SUBTRACT) |
| | | | | | | | | | |
| Track IV | 12.47 | 3.22 | 14 | 0.89 | 0.23 | 0.060 | 0.262 | 0.05999 | (ADD) |
| | 12.47 | 3.22 | 14 | 0.89 | 0.23 | 0.060 | 0.262 | 0.05999 | (SUBTRACT) |
| | | | | | | | | | |
| Track III | 12.47 | 16.08 | 14 | 0.89 | 1.15 | 0.175 | 0.258 | 0.17489 | (ADD) |
| | 4.27 | 16.08 | 14 | 0.31 | 1.15 | 0.084 | 0.263 | 0.08363 | (SUBTRACT) |
| | 12.47 | 11.42 | 14 | 0.89 | 0.82 | 0.154 | 0.266 | 0.15446 | (SUBTRACT) |
| | 4.27 | 8.47 | 14 | 0.31 | 0.61 | 0.064 | 0.266 | 0.06417 | (ADD) |

$\text{Live Load}_1 = q_r(\Sigma I) + q_{fr}(\Sigma II) + q_{fr}(\Sigma III) + q_r(\Sigma IV)$

$\text{Live Load}_1 =$ 106.88 psf

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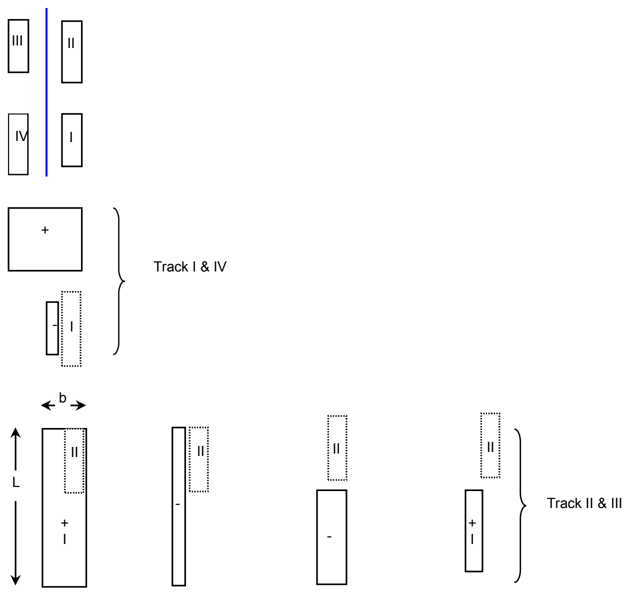
| CLIENT | PROJECT | JOB NO. |
|---|---|---|
| Hardee County | Phase II Section II Expansion | 09199033.23 |

| SUBJECT | BY | DATE |
|---|---|---|
| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Collection Lateral** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **10 Feet Waste** | | |

Load on Pipe

Alternative 2: Track Stradling and Parallel to Pipe




| | b | L | z | m = b/z | n = L/z | I* | I** | I | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | |
| Track I | 6.2 | 3.2 | 14 | 0.4 | 0.2 | 0.041 | 0.261 | 0.04054 | (ADD) |
| & IV | -2.0 | 3.2 | 14 | -0.1 | 0.2 | -0.015 | 0.245 | -0.01454 | (SUBTRACT) |
| | | | | | | | | | |
| Track II | 6.2 | 16.08 | 14 | 0.4 | 1.1 | 0.115 | 0.265 | 0.11458 | (ADD) |
| & III | -2.0 | 16.08 | 14 | -0.1 | 1.1 | -0.040 | 0.243 | -0.04040 | (SUBTRACT) |
| | 6.2 | 12.86 | 14 | 0.4 | 0.9 | 0.107 | 0.268 | 0.10711 | (SUBTRACT) |
| | -2.0 | 12.86 | 14 | -0.1 | 0.9 | -0.038 | 0.242 | -0.03788 | (ADD) |

Live $Load_2$ = $[q_r(\Sigma I) + q_{fr}(\Sigma II)] * 2$

Live $Load_2$ = 214.77 psf

| CLIENT | PROJECT | JOB NO. |
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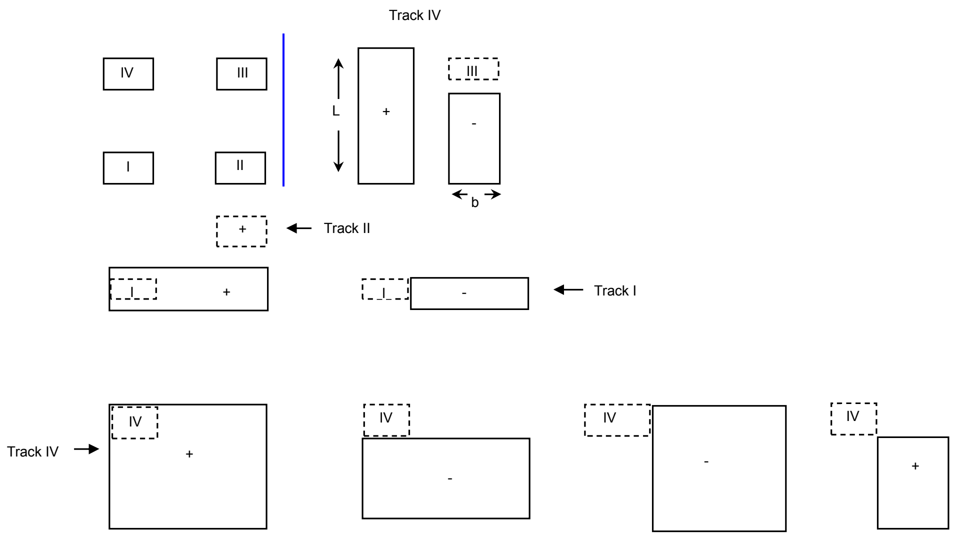
| Hardee County | Phase II Section II Expansion | 09199033.23 |

| SUBJECT | BY | DATE |
|---|---|---|
| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Collection Lateral** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **10 Feet Waste** | | |

Load on Pipe

Alternative 3: Track Perpendicular to Pipe




| | b | L | z | m = b/z | n = L/z | I* | I** | I | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | |
| Track I | 16.1 | 8.2 | 14 | 1.1 | 0.6 | 0.139 | 0.265 | 0.13939 | (ADD) |
| | 12.9 | 8.2 | 14 | 0.9 | 0.6 | 0.130 | 0.269 | 0.13005 | (SUBTRACT) |
| | | | | | | | | | |
| Track II | 3.2 | 8.2 | 14 | 0.2 | 0.6 | 0.049 | 0.263 | 0.04882 | (ADD) |
| | | | | | | | | | |
| Track III | 3.2 | 12.5 | 14 | 0.2 | 0.9 | 0.060 | 0.262 | 0.05999 | (ADD) |
| | 3.2 | 4.3 | 14 | 0.2 | 0.3 | 0.030 | 0.259 | 0.02986 | (SUBTRACT) |
| | | | | | | | | | |
| Track IV | 16.1 | 12.5 | 14 | 1.1 | 0.9 | 0.175 | 0.258 | 0.17489 | (ADD) |
| | 16.1 | 4.3 | 14 | 1.1 | 0.3 | 0.084 | 0.263 | 0.08363 | (SUBTRACT) |
| | 12.9 | 12.5 | 14 | 0.9 | 0.9 | 0.162 | 0.264 | 0.16248 | (SUBTRACT) |
| | 12.9 | 4.3 | 14 | 0.9 | 0.3 | 0.078 | 0.265 | 0.07831 | (ADD) |

Live $Load_3$ = $q_r(\Sigma I) + q_{fr}(\Sigma II) + q_{fr}(\Sigma III) + q_r(\Sigma IV)$

Live $Load_3$ = 149.14 psf

LARGEST EQUIPEMENT LOAD = 214.77 $lb/ft^2$

VERTICAL OVERBURDEN LOAD = 998.53 $lb/ft^2$

VERTICAL EQUIPMENT LOAD = 214.77 $lb/ft^2$

TOTAL VERTICAL LOAD APPLIED TO PIPE, $P_T$ = 1213.30 $lb/ft^2$ = 8.43 $lb/in^2$

| CLIENT | PROJECT | JOB NO. |
|---|---|---|
| Hardee County | Phase II Section II Expansion | 09199033.23 |

| SUBJECT | BY | DATE |
|---|---|---|
| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Collection Lateral** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **10 Feet Waste** | | |

Verify that perforations in the LCRS are adequate for the peak leachate flow.

Use discharge equation:

$Q = (Cd)(Ao)(2gh)^{0.5}$

$C_d$ = coefficient of discharge = 0.6 for short tube discharge with fluid/wall separation; conservative value.

$A_o$ = Area of orifice ($\pi D^2/4$)

g = gravitational acceleration (32.3 $ft^2/s$)

h = static head (ft)

Assumptions and Givens:

| | | | |
|---|---|---|---|
| 1. No. acres of landfill expansion = | 1.63 | acres | - Phase II Section II south portion |
| 2. Total length of pipe per expansion = | 539.7 | ft | |
| 3. Total number of laterals = | 3.0 | | |
| 4. Length of pipe per lateral = | 179.9 | ft | |
| 5. Perforation diameter = | 0.375 | inch | |
| 6. No. perforations/ft pipe = | 6.0 | perforations/ft of pipe length | |
| 7. Maximum head over pipe = | 1.0 | ft | |
| 8. Per HELP model summary table, $Q_{peak}$ = | 237.01 | gal/min | refer to HELP Model Summary Table |
| 9. Per HELP model summary table, $Q_{peak}$ = | 45,624.6 | cf/day | refer to HELP Model Summary Table |
| 10. Maximum flow/lateral = | 15,208.2 | cf/day/lateral | |
| 11. Maximum leachate flow/ft of pipe = | 84.54 | cf/day/ft of pipe | |

Solution:

$A_o = 0.25(\Pi)(d)^2 =$ 0.00077 $ft^2$

1. Flow per orifice, $Q = (Cd)(Ao)(2gh)^{0.5} =$ 0.0037 $ft^3/s$

2. Flow per ft of pipe = (Q)(# perfs/ft) = 0.02 $ft^3/s$ per ft of pipe

= 1914.47 cf/day/ft of pipe

Conclusion:

Design capacity exceeds estimated generation

1914.47 cf/day/ft of pipe >>> 84.54 cf/day/ft of pipe

Perforations are adequate to handle the maximum leachate flow.

SCS ENGINEERS

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| CLIENT | PROJECT | JOB NO. |
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| Hardee County | Phase II Section II Expansion | 09199033.23 |

| SUBJECT | BY | DATE |
|---|---|---|
| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Collection Lateral** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **10 Feet Waste** | | |

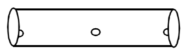
Effective pressure on pipe due to perforations:

$P_{EFF} = \frac{P_T \times 12}{(12-L_P)}$ Source 3, EPA SW-870, p. 382

$L_P$ = Total accumulated length of perforations in one foot of pipe.

Since each perforation is 0.375 inch diameter and spaced at 6.0 inch on center,

$L_P$ = 1.5 inch



$P_T$ = 8.4 psi

$P_{EFF}$ = 9.6 psi

$P_{EFF}$ = 1386.6 psf

Check actual compressive pressure ($S_A$) per Driscopipe manual:

$S_A$ = 0.5 x (SDR - 1) x P(eff) = 48.2 psi

The recommended, long-term compressive strength ($Y_s$) design value for Driscoplex polyethylene pipe is 800 lb/in$^2$.

Source No. 1

| $S_A$ (psi): | | $Y_s$ (psi): |
|---|---|---|
| 48.2 | < | 800.0 |

Pipe passes wall compressive stress perforation calculations TRUE

FS = 16.6

SCS ENGINEERS



| CLIENT | PROJECT | JOB NO. |
|---|---|---|
| Hardee County | Phase II Section II Expansion | 09199033.23 |

| SUBJECT | BY | DATE |
|---|---|---|
| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Collection Lateral** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **10 Feet Waste** | | |

Constrained pipe wall buckling (for Driscoplex OD controlled pipe)

$P_{WC} = \frac{5.65 * \{RB'E' E^*[12(DR-1)^3]^{-1}\}^{0.5}}{N}$ Source 1, Equation 7-5

$P_{WC}$ = allowable constrained buckling pressure (lb/in$^2$)

| | | |
|---|---|---|
| R = buoyancy reduction factor = 1 - 0.33 * (H'/H) | Source 1, Equation 7-34 | |
| H' = groundwater height above pipe (ft) | 0.0 | ft |
| H = cover above pipe (ft) | 14.0 | ft |
| B' = elastic support factor =( 1+ 4*$e^{-0.065H}$ )$^{-1}$ | Source 1, Equation 7-35 | |
| E' = soil reaction modulus (lb/in$^2$) | 3000.0 | lb/in$^2$ for mod comp/crushed rock, 'Source 1, Table 7-7 |
| E = elastic modulus (lb/in$^2$) | 100000.0 | lb/in$^2$ for long term load at 100°F, 'Source 1, Table 5-1 |
| I = moment of inertia = $t^3$ / 12 | 0.0 | in$^4$/in |
| $D_o$ = pipe outer diameter (in) | 8.625 | SDR 11 pipe (Driscopipe) to be used |
| t = pipe wall thickness (in) | 0.784 | SDR 11 pipe (Driscopipe) to be used |
| DR = pipe dimension ratio = $D_o$ / t | 11.0 | SDR 11 pipe (Driscopipe) to be used |
| $D_I$ = pipe inner diameter = $D_o$ - 2t (in) | 7.1 | SDR 11 pipe (Driscopipe) to be used |
| N = safety factor | 2.0 | |

| Cover (ft) | (ft) | (ft) | B' | R | (lb/in$^2$) |
|---|---|---|---|---|---|
| 14.0 | 14 | 0 | 0.38 | 1.00 | 276.42 |

$P_{WC}$ = 276.42 lb/in$^2$

$P_{EFF}$ = 9.63 lb/in$^2$

Pipe passes contrained wall buckling calculations TRUE FS = 28.7

| CLIENT | PROJECT | JOB NO. |
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| SUBJECT | BY | DATE |
|---|---|---|
| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Collection Lateral** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **10 Feet Waste** | | |

Constrained Pipe Wall Compressive Stress (for Driscoplex OD controlled pipe)

$S = \frac{P_T D_o}{288t}$ Source No. 1

S = pipe wall compressive stress ($lb/in^2$)

$P_T$ = vertical load applied to pipe w/ perfs ($lb/ft^2$) 1386.6 $lb/ft^2$

$D_o$ = pipe outside diameter (in) 8.63 SDR 11 pipe (Driscopipe) to be used

t = pipe wall thickness (in) 0.784 SDR 11 pipe (Driscopipe) to be used

$S = \frac{P_T D_o}{288t} =$ 53.0 $lb/in^2$

The recommended, long-term compressive strength ($Y_s$) design value for Driscoplex polyethylene pipe is 800 $lb/in^2$.

Source No. 1

| S (psi): | | $Y_s$ (psi): |
|---|---|---|
| 53.0 | < | 800.0 |

Pipe passes wall compressive stress calculations TRUE FS = 15.1

| CLIENT | PROJECT | JOB NO. |
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| SUBJECT | BY | DATE |
|---|---|---|
| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Collection Lateral** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **10 Feet Waste** | | |

Iowa Formula

$\Delta X = \dfrac{D_L K W_c r^3}{EI + 0.06er^4}$ Source 2, Equation 3.4 Buried Pipe Design, A.P. Moser, Chapter 3

$\Delta X$ = horizontal deflection (in)
$D_L$ = deflection lag factor
K = bedding constant — 0.1 typical value Source 2, Buried Pipe Design, A.P. Moser, Chapter 3
$W_c$ = Marston's load per unit length of pipe (lb/in)
r = mean radius of the pipe (in)
E = modulus of elasticity (lb/in$^2$)
I = moment of inertia of the pipe wall per unit length (in$^3$)
e = modulus of passive resistance fo the side fill (lb/in$^2$(in))

Modified Iowa Formula

$\Delta X = \dfrac{D_L K W_c r_m^3}{EI + 0.06E'r_m^3}$ Source 2, Equation 3.5 Buried Pipe Design, A.P. Moser, Chapter 3

| | | |
|---|---|---|
| $\Delta X$ = horizontal deflection (in) | | |
| $D_L$ = deflection lag factor | 1.0 | Prism Load used |
| Typical Value for Marston Load | 1.5 | |
| Typical Value for Prism Load | 1.0 | |
| K = bedding constant | 0.1 | typical value Buried Pipe Design, A.P. Moser, Chapter 3 |
| $P_T$ = Vertical load on pipe w/ perfs | 9.63 | lb/in$^2$ — 1387 lb/ft$^2$ |
| $W_c$ = Marston's load per unit length of pipe = $P_T$ * $D_o$ (lb/in) | 83.05 | lb/in |
| $D_o$ = pipe outer diameter (in) | 8.63 | SDR 11 pipe (Driscopipe) to be used |
| t = pipe wall thickness (in) | 0.78 | SDR 11 pipe (Driscopipe) to be used |
| $D_I$ = pipe inner diameter = $D_o$-2t (in) | 7.06 | SDR 11 pipe (Driscopipe) to be used |
| $D_m$ = pipe mean diameter = $D_o$ - 1.06t Source 1, Equation 7-27 | 7.79 | SDR 11 pipe (Driscopipe) to be used |
| $r_m$ = mean radius of the pipe (in) | 3.90 | SDR 11 pipe (Driscopipe) to be used |
| E = modulus of elasticity (lb/in$^2$) | 100,000.0 | lb/in2 for long term load at 100oF, 'Source 1, Table 5-1 |
| I = moment of inertia of the pipe wall per unit length | 0.040 | in$^4$/in |
| E' = modulus of soil reaction | 3,000.0 | lb/in$^2$ for moderate compaction and fine grained soils |

$\Delta X = \dfrac{D_L K W_c r_m^3}{EI + 0.06E'r_m^3}$ = 0.034 inch — Source 2, Equation 3.5 Buried Pipe Design, A.P. Moser, Chapter 3

% Ring Deflection = ($\Delta X/D_m$) x 100 = 0.43% Source 1, Equation 7-31

Ring Bending Strain

$e = \dfrac{f_D \Delta X 2C}{D_M^2} \times 100$ Source 1, Equation 7-39

| | | |
|---|---|---|
| e = wall strain (%) | | |
| $f_D$ = deformation shape factor | 6 | Source 1, non-elliptical shape |
| $D_M$ = mean diameter (in) | | |
| C = outer fiber wall centroid = 0.5 (1.06t) | 0.416 | Source 1, Equation 7-41 |
| $\Delta X$ = ring deflection = $D_X/D_m$ | 0.004 | |

$e = f_D \left(\dfrac{\Delta X}{D_M}\right)\left(\dfrac{2C}{D_M}\right) \times 100$ = 0.3% Source 1, Equation 7-39

The maximum ring bending strain for high performance polyethylene non-pressure pipe is 5.0%

Pipe passes ring bending strain calculations TRUE

| CLIENT | PROJECT | JOB NO. |
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| Hardee County | Phase II Section II Expansion | 09199033.23 |

| SUBJECT | BY | DATE |
|---|---|---|
| Pipe Crushing Calculations **RAI No. 1**<br>**8" Diameter Leachate Collection Lateral** | SRF | 4/1/13 |
| Operation w/ CAT 826G Series II Compactor **10 Feet Waste** | CHECKED | DATE |

SOURCES

1.) Attachment - 1 - Chevron Phillips Chemical Company, Bulletin - Book 2 Chapter 5, 2003

2.) Attachment - 2 - Buried Pipe Design, A.P. Moser, Chapter 3

3.) Attachment - 3 - EPA, Lining of Waste Impoundment and Disposal Facilities, SW-870

4.) Attachment - 4 - Driscoplex Pipe Properties

5.) Attachment - 5 - CAT 826G Series II Compactor Data Sheet

6.) Attachment - 6 - CAT D7R Series II Equipment Data Sheet

7.) Attachment - 7 - CAT D6R XW Series II Equipment Data Sheet

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| CLIENT | PROJECT | JOB NO. |
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| Hardee County | Phase II Section II Expansion | 09199033.23 |

| SUBJECT | BY | DATE |
|---|---|---|
| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Collection Lateral** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **25 Feet Waste** | | |

Load on Pipe (Overburden)

Prism Loads, $P_E$ = wH

w = unit weight

H = depth

| | Depth (ft) | Unit Weight (lb/ft$^3$) | $P_E$ (lb/ft$^2$) |
|---|---|---|---|
| Final cover | 0.0 | 115.0 | 0.0 |
| Intermediate cover | 0.0 | 115.0 | 0.0 |
| Waste/cover | 25.0 | 60.0 | 1500.0 |
| Drainage sand | 2.0 | 115.0 | 230.0 |
| Rock (No. 89 & No. 57) | 2.0 | 140.0 | 280.0 |

TOTAL SOIL PRISM LOAD $P_E$: 2010.0 lb/ft$^2$

Total Depth = 29.0 ft

Soil Arching, $P_m = C_D wB$

NOTE: The waste unit weight represents the combined unit weight of waste, daily cover, and moisture.

Pm = vertical soil pressure

B = trench width at pipe crown 6.0 ft

$C_D$ = load coefficient $= \frac{1 - e^{-2Ku'H/B}}{2Ku'}$ Equation 7-3, Source No. 1

e = natural log base number

K = Rankine earth pressure coefficient = $\tan^2(45-0.5*\phi)$

$\phi$ = internal soil friction angle = 27.0 degrees

u' = friction coefficient between backfill and trench sides = tan $\phi$

| Soil Type | Ku' |
|---|---|
| Saturated Clay | 0.110 |
| Ordinary Clay | 0.130 |
| Saturated Top Soil | 0.150 |
| Sand and Gravel | 0.165 |
| Clean Granular Soil | 0.192 |

| | Ku' | $C_D$ | $P_m$ (lb/ft$^2$) |
|---|---|---|---|
| Cover Soil | 0.150 | 0.00 | 0 |
| Int Cover | 0.165 | 0.00 | 0 |
| Waste | 0.191 | 2.08 | 750 |
| Drainage Sand | 0.165 | 0.32 | 217.8 |
| Granular Soil | 0.192 | 0.31 | 262.8 |

TOTAL SOIL ARCHING LOAD $P_M$: 1,230.4 lb/ft$^2$

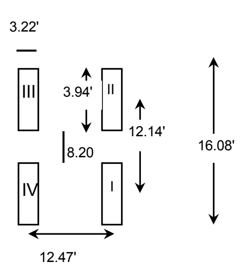
MODIFIED ARCHING LOAD = $0.6P_M+0.4P_E$: 1,542.23 lb/ft$^2$

OVERBURDEN LOAD: 1,542.23 lb/ft$^2$

Load on Pipe With Equipment Refer to Attachment

Operation w/ CAT 826G Series II Compactor 25 Feet Waste

Equipment Weight = 81,498.0 psf




Track per Load = $q_r$ = 1,670.20 psf (Rear)

Track per Load = $q_{fr}$ = 1,541.72 psf (Front)

Length of Track = L = 3.22 ft (contact length)

Length of Track = b = 8.20 ft

Track Width = 12.47 ft

Track Width (I to II) = 16.08 ft

SCS ENGINEERS

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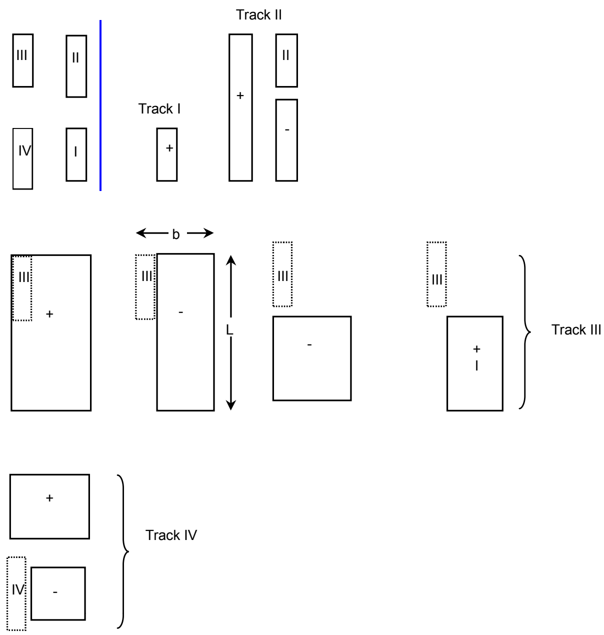
| CLIENT | PROJECT | JOB NO. |
|---|---|---|
| Hardee County | Phase II Section II Expansion | 09199033.23 |

| SUBJECT | BY | DATE |
|---|---|---|
| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Collection Lateral** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **25 Feet Waste** | | |

Load on Pipe

Alternative 1: Track Adjacent and Parallel to Pipe




| | b | L | z | m = b/z | n = L/z | I* | I** | I | |
|---|---|---|---|---|---|---|---|---|---|
| Track I | 8.2 | 3 | 29 | 0.28 | 0.11 | 0.014 | 0.254 | 0.01393 | (ADD) |
| | | | | | | | | | |
| Track II | 8.2 | 16.1 | 29 | 0.28 | 0.55 | 0.057 | 0.265 | 0.05688 | (ADD) |
| | 8.2 | 11.4 | 29 | 0.28 | 0.39 | 0.044 | 0.263 | 0.04447 | (SUBTRACT) |
| | | | | | | | | | |
| Track IV | 12.47 | 3.22 | 29 | 0.43 | 0.11 | 0.020 | 0.256 | 0.01966 | (ADD) |
| | 12.47 | 3.22 | 29 | 0.43 | 0.11 | 0.020 | 0.256 | 0.01966 | (SUBTRACT) |
| | | | | | | | | | |
| Track III | 12.47 | 16.08 | 29 | 0.43 | 0.55 | 0.081 | 0.269 | 0.08065 | (ADD) |
| | 4.27 | 16.08 | 29 | 0.15 | 0.55 | 0.031 | 0.258 | 0.03090 | (SUBTRACT) |
| | 12.47 | 11.42 | 29 | 0.43 | 0.39 | 0.063 | 0.267 | 0.06292 | (SUBTRACT) |
| | 4.27 | 8.47 | 29 | 0.15 | 0.29 | 0.019 | 0.256 | 0.01886 | (ADD) |

$\text{Live Load}_1 = q_r(\Sigma I) + q_{fr}(\Sigma II) + q_{fr}(\Sigma III) + q_r(\Sigma IV)$

$\text{Live Load}_1 =$ 51.18 psf

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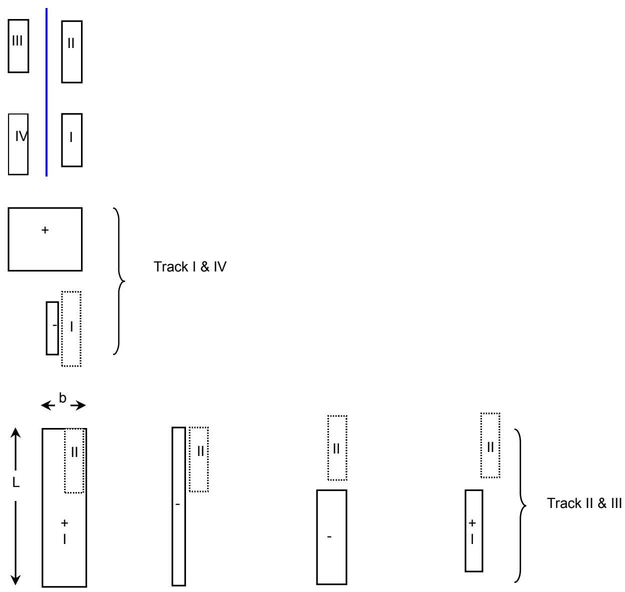
| Hardee County | Phase II Section II Expansion | 09199033.23 |

| SUBJECT | BY | DATE |
|---|---|---|
| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Collection Lateral** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **25 Feet Waste** | | |

Load on Pipe

Alternative 2: Track Stradling and Parallel to Pipe




| | b | L | z | m = b/z | n = L/z | I* | I** | I | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | |
| Track I | 6.2 | 3.2 | 29 | 0.2 | 0.1 | 0.011 | 0.253 | 0.01087 | (ADD) |
| & IV | -2.0 | 3.2 | 29 | -0.1 | 0.1 | -0.004 | 0.249 | -0.00354 | (SUBTRACT) |
| | | | | | | | | | |
| Track II | 6.2 | 16.08 | 29 | 0.2 | 0.6 | 0.044 | 0.262 | 0.04431 | (ADD) |
| & III | -2.0 | 16.08 | 29 | -0.1 | 0.6 | -0.014 | 0.246 | -0.01441 | (SUBTRACT) |
| | 6.2 | 12.86 | 29 | 0.2 | 0.4 | 0.038 | 0.261 | 0.03796 | (SUBTRACT) |
| | -2.0 | 12.86 | 29 | -0.1 | 0.4 | -0.012 | 0.246 | -0.01235 | (ADD) |

$\text{Live Load}_2 = [q_r (\Sigma I) + q_{fr} (\Sigma II)] * 2$

$\text{Live Load}_2 =$ 74.06 psf

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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Collection Lateral** | CHECKED | DATE |
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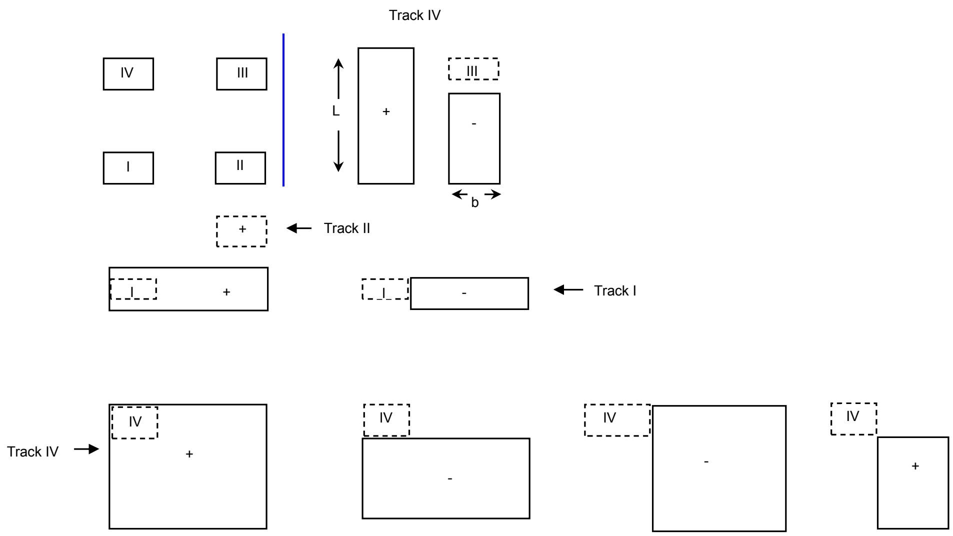
Load on Pipe

Alternative 3: Track Perpendicular to Pipe




| | b | L | z | m = b/z | n = L/z | I* | I** | I | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | |
| Track I | 16.1 | 8.2 | 29 | 0.6 | 0.3 | 0.057 | 0.265 | 0.05688 | (ADD) |
| | 12.9 | 8.2 | 29 | 0.4 | 0.3 | 0.049 | 0.264 | 0.04871 | (SUBTRACT) |
| | | | | | | | | | |
| Track II | 3.2 | 8.2 | 29 | 0.1 | 0.3 | 0.014 | 0.254 | 0.01393 | (ADD) |
| | | | | | | | | | |
| Track III | 3.2 | 12.5 | 29 | 0.1 | 0.4 | 0.020 | 0.256 | 0.01966 | (ADD) |
| | 3.2 | 4.3 | 29 | 0.1 | 0.1 | 0.008 | 0.252 | 0.00759 | (SUBTRACT) |
| | | | | | | | | | |
| Track IV | 16.1 | 12.5 | 29 | 0.6 | 0.4 | 0.081 | 0.269 | 0.08065 | (ADD) |
| | 16.1 | 4.3 | 29 | 0.6 | 0.1 | 0.031 | 0.258 | 0.03090 | (SUBTRACT) |
| | 12.9 | 12.5 | 29 | 0.4 | 0.4 | 0.069 | 0.268 | 0.06896 | (SUBTRACT) |
| | 12.9 | 4.3 | 29 | 0.4 | 0.1 | 0.026 | 0.258 | 0.02649 | (ADD) |

Live Load$_3$ = $q_r(\Sigma I) + q_{fr}(\Sigma II) + q_{fr}(\Sigma III) + q_r(\Sigma IV)$

Live Load$_3$ = 65.88 psf

LARGEST EQUIPEMENT LOAD = 74.06 lb/ft$^2$

VERTICAL OVERBURDEN LOAD = 1542.23 lb/ft$^2$

VERTICAL EQUIPMENT LOAD = 74.06 lb/ft$^2$

TOTAL VERTICAL LOAD APPLIED TO PIPE, $P_T$ = 1616.28 lb/ft$^2$ = 11.22 lb/in$^2$

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Verify that perforations in the LCRS are adequate for the peak leachate flow.

Use discharge equation:

$Q = (Cd)(Ao)(2gh)^{0.5}$

$C_d$ = coeffiecient of discharge = 0.6 for short tube discharge with fluid/wall separation; conservative value.

$A_o$ = Area of orifice ($\pi D^2/4$)

g = gravitational acceleration (32.3 $ft^2/s$)

h = static head (ft)

Assumptions and Givens:

| | | | |
| --- | --- | --- | --- |
| 1. No. acres of landfill expansion = | 1.63 | acres | - Phase II Section II south portion |
| 2. Total length of pipe per expansion = | 539.7 | ft | |
| 3. Total number of laterals = | 3.0 | | |
| 4. Length of pipe per lateral = | 179.9 | ft | |
| 5. Perforation diameter = | 0.375 | inch | |
| 6. No. perforations/ft pipe = | 6.0 | perforations/ft of pipe length | |
| 7. Maximum head over pipe = | 1.0 | ft | |
| 8. Per HELP model summary table, $Q_{peak}$ = | 237.01 | gal/min | refer to HELP Model Summary Table |
| 9. Per HELP model summary table, $Q_{peak}$ = | 45,624.6 | cf/day | refer to HELP Model Summary Table |
| 10. Maximum flow/lateral = | 15,208.2 | cf/day/lateral | |
| 11. Maximum leachate flow/ft of pipe = | 84.54 | cf/day/ft of pipe | |

Solution:

$A_o = 0.25(\Pi)(d)^2 =$ 0.00077 $ft^2$

1. Flow per orifice, $Q = (Cd)(Ao)(2gh)^{0.5}$ = 0.0037 $ft^3/s$

2. Flow per ft of pipe = (Q)(# perfs/ft) = 0.02 $ft^3/s$ per ft of pipe

= 1914.47 cf/day/ft of pipe

Conclusion:

Design capacity exceeds estimated generation

1914.47 cf/day/ft of pipe >>> 84.54 cf/day/ft of pipe

Perforations are adequate to handle the maximum leachate flow.

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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Collection Lateral** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **25 Feet Waste** | | |

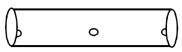
Effective pressure on pipe due to perforations:

$P_{EFF} = \frac{P_T \times 12}{(12 - L_P)}$ Source 3, EPA SW-870, p. 382

$L_P$ = Total accumulated length of perforations in one foot of pipe.

Since each perforation is 0.375 inch diameter and spaced at 6.0 inch on center,

$L_P$ = 1.5 inch



$P_T$ = 11.2 psi

$P_{EFF}$ = 12.8 psi

$P_{EFF}$ = 1847.2 psf

Check actual compressive pressure ($S_A$) per Driscopipe manual:

$S_A$ = 0.5 x (SDR - 1) x P(eff) = 64.1 psi

The recommended, long-term compressive strength ($Y_s$) design value for Driscoplex polyethylene pipe is 800 lb/in$^2$.

Source No. 1

| $S_A$ (psi): | | $Y_s$ (psi): |
|---|---|---|
| 64.1 | < | 800.0 |

Pipe passes wall compressive stress perforation calculations TRUE

FS = 12.5

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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Collection Lateral** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **25 Feet Waste** | | |

Constrained pipe wall buckling (for Driscoplex OD controlled pipe)

$P_{WC} = \frac{5.65 * \{RB'E' E*[12(DR-1)^3]^{-1}\}^{0.5}}{N}$ Source 1, Equation 7-5

$P_{WC}$ = allowable constrained buckling pressure (lb/in$^2$)

R = buoyancy reduction factor = 1 - 0.33 * (H'/H) Source 1, Equation 7-34

H' = groundwater height above pipe (ft) 0.0 ft

H = cover above pipe (ft) 29.0 ft

B' = elastic support factor =( 1+ 4*$e^{-0.065H}$ )$^{-1}$ Source 1, Equation 7-35

E' = soil reaction modulus (lb/in$^2$) 3000.0 lb/in$^2$ for mod comp/crushed rock, 'Source 1, Table 7-7

E = elastic modulus (lb/in$^2$) 100000.0 lb/in$^2$ for long term load at 100°F, 'Source 1, Table 5-1

I = moment of inertia = $t^3$ / 12 0.0 in$^4$/in

$D_o$ = pipe outer diameter (in) 8.625 SDR 11 pipe (Driscopipe) to be used

t = pipe wall thickness (in) 0.784 SDR 11 pipe (Driscopipe) to be used

DR = pipe dimension ratio = $D_o$ / t 11.0 SDR 11 pipe (Driscopipe) to be used

$D_I$ = pipe inner diameter = $D_o$ - 2t (in) 7.1 SDR 11 pipe (Driscopipe) to be used

N = safety factor 2.0

| Cover (ft) | (ft) | (ft) | B' | R | (lb/in$^2$) |
|---|---|---|---|---|---|
| 29.0 | 29 | 0 | 0.62 | 1.00 | 352.25 |

$P_{WC}$ = 352.25 lb/in$^2$

$P_{EFF}$ = 12.83 lb/in$^2$

Pipe passes contrained wall buckling calculations TRUE FS = 27.5

| SCS ENGINEERS | | | |
|---|---|---|---|
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| SUBJECT<br>Pipe Crushing Calculations **RAI No. 1**<br>**8" Diameter Leachate Collection Lateral**<br>Operation w/ CAT 826G Series II Compactor **25 Feet Waste** | | BY<br>SRF<br>CHECKED | DATE<br>4/1/13<br>DATE |

Constrained Pipe Wall Compressive Stress (for Driscoplex OD controlled pipe)

$S = \frac{P_T D_o}{288t}$ Source No. 1

S = pipe wall compressive stress ($lb/in^2$)

$P_T$ = vertical load applied to pipe w/ perfs ($lb/ft^2$) | 1847.2 | $lb/ft^2$

$D_o$ = pipe outside diameter (in) | 8.63 | SDR 11 pipe (Driscopipe) to be used

t = pipe wall thickness (in) | 0.784 | SDR 11 pipe (Driscopipe) to be used

$S = \frac{P_T D_o}{288t} =$ 70.6 $lb/in^2$

The recommended, long-term compressive strength ($Y_s$) design value for Driscoplex polyethylene pipe is 800 $lb/in^2$.

Source No. 1

| S (psi): | | $Y_s$ (psi): |
|---|---|---|
| 70.6 | < | 800.0 |

Pipe passes wall compressive stress calculations TRUE

FS = 11.3

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Iowa Formula

$\Delta X = \dfrac{D_L K W_c r^3}{EI + 0.06er^4}$ Source 2, Equation 3.4 Buried Pipe Design, A.P. Moser, Chapter 3

$\Delta X$ = horizontal deflection (in)
$D_L$ = deflection lag factor
K = bedding constant | 0.1 | typical value Source 2, Buried Pipe Design, A.P. Moser, Chapter 3
$W_c$ = Marston's load per unit length of pipe (lb/in)
r = mean radius of the pipe (in)
E = modulus of elasticity ($lb/in^2$)
I = moment of inertia of the pipe wall per unit length ($in^3$)
e = modulus of passive resistance fo the side fill ($lb/in^2(in)$)

Modified Iowa Formula

$\Delta X = \dfrac{D_L K W_c r_m^3}{EI + 0.06E'r_m^3}$ Source 2, Equation 3.5 Buried Pipe Design, A.P. Moser, Chapter 3

| | | |
|---|---|---|
| $\Delta X$ = horizontal deflection (in) | | |
| $D_L$ = deflection lag factor | 1.0 | Prism Load used |
| Typical Value for Marston Load | 1.5 | |
| Typical Value for Prism Load | 1.0 | |
| K = bedding constant | 0.1 | typical value Buried Pipe Design, A.P. Moser, Chapter 3 |
| $P_T$ = Vertical load on pipe w/ perfs | 12.83 | $lb/in^2$ 1847 $lb/ft^2$ |
| $W_c$ = Marston's load per unit length of pipe = $P_T * D_o$ (lb/in) | 110.64 | lb/in |
| $D_o$ = pipe outer diameter (in) | 8.63 | SDR 11 pipe (Driscopipe) to be used |
| t = pipe wall thickness (in) | 0.78 | SDR 11 pipe (Driscopipe) to be used |
| $D_I$ = pipe inner diameter = $D_o$-2t (in) | 7.06 | SDR 11 pipe (Driscopipe) to be used |
| $D_m$ = pipe mean diameter = $D_o$ - 1.06t Source 1, Equation 7-27 | 7.79 | SDR 11 pipe (Driscopipe) to be used |
| $r_m$ = mean radius of the pipe (in) | 3.90 | SDR 11 pipe (Driscopipe) to be used |
| E = modulus of elasticity ($lb/in^2$) | 100,000.0 | lb/in2 for long term load at 100oF, 'Source 1, Table 5-1 |
| I = moment of inertia of the pipe wall per unit length | 0.040 | $in^4/in$ |
| E' = modulus of soil reaction | 3,000.0 | $lb/in^2$ for moderate compaction and fine grained soils |

$\Delta X = \dfrac{D_L K W_c r_m^3}{EI + 0.06E'r_m^3}$ = 0.045 inch    Source 2, Equation 3.5 Buried Pipe Design, A.P. Moser, Chapter 3

% Ring Deflection = $(\Delta X/D_m) \times 100$ = 0.57% Source 1, Equation 7-31

Ring Bending Strain

$e = \dfrac{f_D \Delta X 2C}{D_M^2} \times 100$ Source 1, Equation 7-39

| | | |
|---|---|---|
| e = wall strain (%) | | |
| $f_D$ = deformation shape factor | 6 | Source 1, non-elliptical shape |
| $D_M$ = mean diameter (in) | | |
| C = outer fiber wall centroid = 0.5 (1.06t) | 0.416 | Source 1, Equation 7-41 |
| $\Delta X$ = ring deflection = $D_X/D_m$ | 0.006 | |

$e = f_D \left(\dfrac{\Delta X}{D_M}\right)\left(\dfrac{2C}{D_M}\right) \times 100$ = 0.4% Source 1, Equation 7-39

The maximum ring bending strain for high performance polyethylene non-pressure pipe is 5.0%

Pipe passes ring bending strain calculations TRUE

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| Operation w/ CAT 826G Series II Compactor **25 Feet Waste** | | |

SOURCES

1.) Attachment - 1 - Chevron Phillips Chemical Company, Bulletin - Book 2 Chapter 5, 2003

2.) Attachment - 2 - Buried Pipe Design, A.P. Moser, Chapter 3

3.) Attachment - 3 - EPA, Lining of Waste Impoundment and Disposal Facilities, SW-870

4.) Attachment - 4 - Driscoplex Pipe Properties

5.) Attachment - 5 - CAT 826G Series II Compactor Data Sheet

6.) Attachment - 6 - CAT D7R Series II Equipment Data Sheet

7.) Attachment - 7 - CAT D6R XW Series II Equipment Data Sheet

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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Collection Lateral** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **60 Feet Waste** | | |

Load on Pipe (Overburden)

Prism Loads, $P_E$ = wH

w = unit weight

H = depth

| | Depth (ft) | Unit Weight ($lb/ft^3$) | $P_E$ ($lb/ft^2$) |
|---|---|---|---|
| Final cover | 2.0 | 115.0 | 230.0 |
| Intermediate cover | 1.0 | 115.0 | 115.0 |
| Waste/cover | 60.0 | 60.0 | 3600.0 |
| Drainage sand | 2.0 | 115.0 | 230.0 |
| Rock (No. 89 & No. 57) | 2.0 | 140.0 | 280.0 |

TOTAL SOIL PRISM LOAD $P_E$: 4455.0 $lb/ft^2$

Total Depth = 67.0 ft

Soil Arching, $P_m = C_D wB$

Pm = vertical soil pressure

B = trench width at pipe crown 6.0 ft

$C_D$ = load coefficient $= \frac{1 - e^{-2Ku'H/B}}{2Ku'}$ Equation 7-3, Source No. 1

NOTE: The waste unit weight represents the combined unit weight of waste, daily cover, and moisture.

e = natural log base number

K = Rankine earth pressure coefficient = $\tan^2(45-0.5*\phi)$

$\phi$ = internal soil friction angle = 27.0 degrees

u' = friction coefficient between backfill and trench sides = tan $\phi$

| Soil Type | Ku' |
|---|---|
| Saturated Clay | 0.110 |
| Ordinary Clay | 0.130 |
| Saturated Top Soil | 0.150 |
| Sand and Gravel | 0.165 |
| Clean Granular Soil | 0.192 |

| | Ku' | $C_D$ | $P_m$ ($lb/ft^2$) |
|---|---|---|---|
| Cover Soil | 0.150 | 0.32 | 219 |
| Int Cover | 0.165 | 0.16 | 112 |
| Waste | 0.191 | 2.56 | 920 |
| Drainage Sand | 0.165 | 0.32 | 217.8 |
| Granular Soil | 0.192 | 0.31 | 262.8 |

TOTAL SOIL ARCHING LOAD $P_M$: 1,731.6 $lb/ft^2$

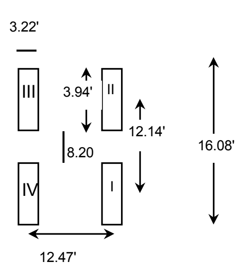
MODIFIED ARCHING LOAD = $0.6P_M+0.4P_E$: 2,820.98 $lb/ft^2$

OVERBURDEN LOAD: 2,820.98 $lb/ft^2$

Load on Pipe With Equipment Refer to Attachment

Operation w/ CAT 826G Series II Compactor 60 Feet Waste

Equipment Weight = 81,498.0 psf




| | | | |
|---|---|---|---|
| Track per Load = $q_r$ = | 1,670.20 | psf | (Rear) |
| Track per Load = $q_{fr}$ = | 1,541.72 | psf | (Front) |
| Length of Track = L = | 3.22 | ft | (contact length) |
| Length of Track = b = | 8.20 | ft | |
| Track Width = | 12.47 | ft | |
| Track Width (I to II) = | 16.08 | ft | |

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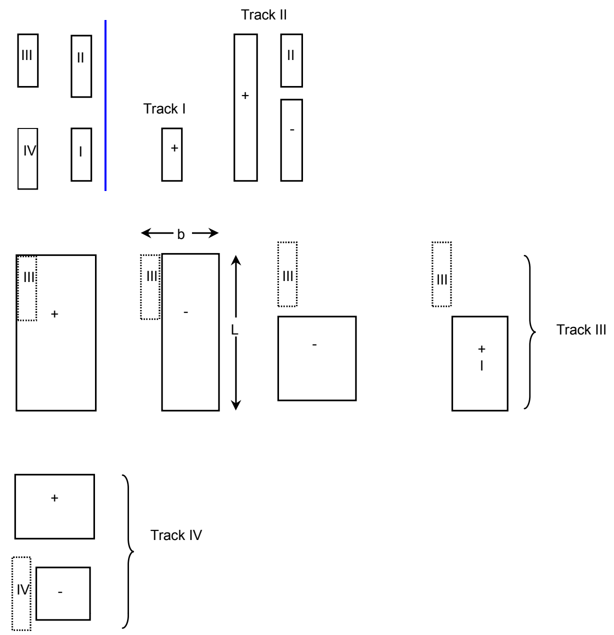
| **8" Diameter Leachate Collection Lateral** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **60 Feet Waste** | | |

Load on Pipe

Alternative 1: Track Adjacent and Parallel to Pipe




| | b | L | z | m = b/z | n = L/z | I* | I** | I | |
|---|---|---|---|---|---|---|---|---|---|
| Track I | 8.2 | 3 | 67 | 0.12 | 0.05 | 0.003 | 0.251 | 0.00277 | (ADD) |
| | | | | | | | | | |
| Track II | 8.2 | 16.1 | 67 | 0.12 | 0.24 | 0.013 | 0.254 | 0.01323 | (ADD) |
| | 8.2 | 11.4 | 67 | 0.12 | 0.17 | 0.010 | 0.253 | 0.00961 | (SUBTRACT) |
| | | | | | | | | | |
| Track IV | 12.47 | 3.22 | 67 | 0.19 | 0.05 | 0.004 | 0.251 | 0.00414 | (ADD) |
| | 12.47 | 3.22 | 67 | 0.19 | 0.05 | 0.004 | 0.251 | 0.00414 | (SUBTRACT) |
| | | | | | | | | | |
| Track III | 12.47 | 16.08 | 67 | 0.19 | 0.24 | 0.020 | 0.256 | 0.01980 | (ADD) |
| | 4.27 | 16.08 | 67 | 0.06 | 0.24 | 0.007 | 0.252 | 0.00695 | (SUBTRACT) |
| | 12.47 | 11.42 | 67 | 0.19 | 0.17 | 0.014 | 0.255 | 0.01438 | (SUBTRACT) |
| | 4.27 | 8.47 | 67 | 0.06 | 0.13 | 0.004 | 0.251 | 0.00378 | (ADD) |

Live $Load_1 = q_r(\Sigma I) + q_{fr}(\Sigma II) + q_{fr}(\Sigma III) + q_r(\Sigma IV)$

Live $Load_1 =$ 13.68 psf

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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
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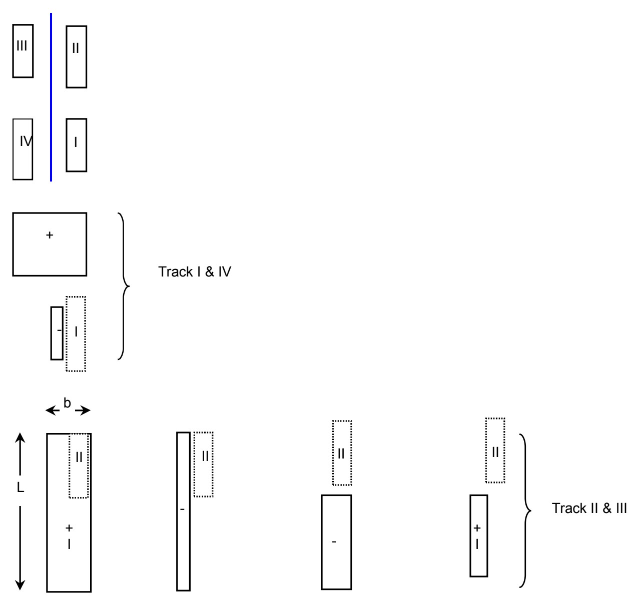
| Operation w/ CAT 826G Series II Compactor **60 Feet Waste** | | |

Load on Pipe

Alternative 2: Track Stradling and Parallel to Pipe




| | b | L | z | m = b/z | n = L/z | I* | I** | I | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | |
| Track I | 6.2 | 3.2 | 67 | 0.1 | 0.0 | 0.002 | 0.251 | 0.00212 | (ADD) |
| & IV | -2.0 | 3.2 | 67 | 0.0 | 0.0 | -0.001 | 0.250 | -0.00067 | (SUBTRACT) |
| | | | | | | | | | |
| Track II | 6.2 | 16.08 | 67 | 0.1 | 0.2 | 0.010 | 0.253 | 0.01011 | (ADD) |
| & III | -2.0 | 16.08 | 67 | 0.0 | 0.2 | -0.003 | 0.249 | -0.00321 | (SUBTRACT) |
| | 6.2 | 12.86 | 67 | 0.1 | 0.2 | 0.008 | 0.253 | 0.00822 | (SUBTRACT) |
| | -2.0 | 12.86 | 67 | 0.0 | 0.2 | -0.003 | 0.249 | -0.00261 | (ADD) |

Live $Load_2$ = $[q_r (\Sigma I) + q_{fr} (\Sigma II)] * 2$

Live $Load_2$ = 16.99 psf

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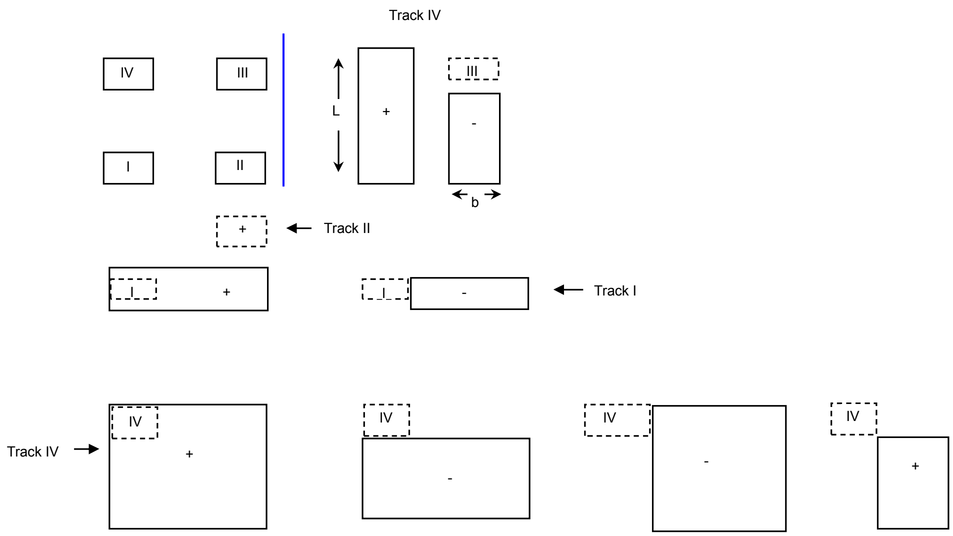
| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Collection Lateral** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **60 Feet Waste** | | |

Load on Pipe

Alternative 3: Track Perpendicular to Pipe




| | b | L | z | m = b/z | n = L/z | I* | I** | I | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | |
| Track I | 16.1 | 8.2 | 67 | 0.2 | 0.1 | 0.013 | 0.254 | 0.01323 | (ADD) |
| | 12.9 | 8.2 | 67 | 0.2 | 0.1 | 0.011 | 0.253 | 0.01075 | (SUBTRACT) |
| | | | | | | | | | |
| Track II | 3.2 | 8.2 | 67 | 0.0 | 0.1 | 0.003 | 0.251 | 0.00277 | (ADD) |
| | | | | | | | | | |
| Track III | 3.2 | 12.5 | 67 | 0.0 | 0.2 | 0.004 | 0.251 | 0.00414 | (ADD) |
| | 3.2 | 4.3 | 67 | 0.0 | 0.1 | 0.001 | 0.250 | 0.00145 | (SUBTRACT) |
| | | | | | | | | | |
| Track IV | 16.1 | 12.5 | 67 | 0.2 | 0.2 | 0.020 | 0.256 | 0.01980 | (ADD) |
| | 16.1 | 4.3 | 67 | 0.2 | 0.1 | 0.007 | 0.252 | 0.00695 | (SUBTRACT) |
| | 12.9 | 12.5 | 67 | 0.2 | 0.2 | 0.016 | 0.255 | 0.01610 | (SUBTRACT) |
| | 12.9 | 4.3 | 67 | 0.2 | 0.1 | 0.006 | 0.252 | 0.00565 | (ADD) |

Live $Load_3$ = $q_r(\Sigma I) + q_{fr}(\Sigma II) + q_{fr}(\Sigma III) + q_r(\Sigma IV)$

Live $Load_3$ = 16.57 psf

LARGEST EQUIPEMENT LOAD = 16.99 $lb/ft^2$

VERTICAL OVERBURDEN LOAD = 2820.98 $lb/ft^2$

VERTICAL EQUIPMENT LOAD = 16.99 $lb/ft^2$

TOTAL VERTICAL LOAD APPLIED TO PIPE, $P_T$ = 2837.98 $lb/ft^2$ = 19.71 $lb/in^2$

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|---|---|---|
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| **8" Diameter Leachate Collection Lateral** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **60 Feet Waste** | | |

Verify that perforations in the LCRS are adequate for the peak leachate flow.

Use discharge equation:

$Q = (Cd)(Ao)(2gh)^{0.5}$

$C_d$ = coeffiecient of discharge = 0.6 for short tube discharge with fluid/wall separation; conservative value.

$A_o$ = Area of orifice ($\pi D^2/4$)

g = gravitational acceleration (32.3 $ft^2/s$)

h = static head (ft)

Assumptions and Givens:

| | | | |
|---|---|---|---|
| 1. No. acres of landfill expansion = | 1.63 | acres | - Phase II Section II south portion |
| 2. Total length of pipe per expansion = | 539.7 | ft | |
| 3. Total number of laterals = | 3.0 | | |
| 4. Length of pipe per lateral = | 179.9 | ft | |
| 5. Perforation diameter = | 0.375 | inch | |
| 6. No. perforations/ft pipe = | 6.0 | perforations/ft of pipe length | |
| 7. Maximum head over pipe = | 1.0 | ft | |
| 8. Per HELP model summary table, $Q_{peak}$ = | 237.01 | gal/min | refer to HELP Model Summary Table |
| 9. Per HELP model summary table, $Q_{peak}$ = | 45,624.6 | cf/day | refer to HELP Model Summary Table |
| 10. Maximum flow/lateral = | 15,208.2 | cf/day/lateral | |
| 11. Maximum leachate flow/ft of pipe = | 84.54 | cf/day/ft of pipe | |

Solution:

$A_o = 0.25(\Pi)(d)^2 =$ 0.00077 $ft^2$

1. Flow per orifice, $Q = (Cd)(Ao)(2gh)^{0.5}$ = 0.0037 $ft^3/s$

2. Flow per ft of pipe = (Q)(# perfs/ft) = 0.02 $ft^3/s$ per ft of pipe

= 1914.47 cf/day/ft of pipe

Conclusion:

Design capacity exceeds estimated generation

1914.47 cf/day/ft of pipe >>> 84.54 cf/day/ft of pipe

Perforations are adequate to handle the maximum leachate flow.

| CLIENT | PROJECT | JOB NO. |
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| **8" Diameter Leachate Collection Lateral** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **60 Feet Waste** | | |

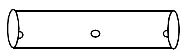
Effective pressure on pipe due to perforations:

$P_{EFF} = \frac{P_T \times 12}{(12 - L_P)}$ Source 3, EPA SW-870, p. 382

$L_P$ = Total accumulated length of perforations in one foot of pipe.

Since each perforation is 0.375 inch diameter and spaced at 6.0 inch on center,

$L_P$ = 1.5 inch



$P_T$ = 19.7 psi

$P_{EFF}$ = 22.5 psi

$P_{EFF}$ = 3243.4 psf

Check actual compressive pressure ($S_A$) per Driscopipe manual:

$S_A$ = 0.5 x (SDR - 1) x P(eff) = 112.6 psi

The recommended, long-term compressive strength ($Y_s$) design value for Driscoplex polyethylene pipe is 800 lb/in$^2$.

Source No. 1

| $S_A$ (psi): | | $Y_s$ (psi): |
|---|---|---|
| 112.6 | < | 800.0 |

Pipe passes wall compressive stress perforation calculations TRUE

FS = 7.1

SCS ENGINEERS



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Constrained pipe wall buckling (for Driscoplex OD controlled pipe)

$$P_{WC} = \frac{5.65 * \{RB'E'\ E*[12(DR-1)^3]^{-1}\}^{0.5}}{N}$$ Source 1, Equation 7-5

$P_{WC}$ = allowable constrained buckling pressure (lb/in$^2$)

| | | |
|---|---|---|
| R = buoyancy reduction factor = 1 - 0.33 * (H'/H) | Source 1, Equation 7-34 | |
| H' = groundwater height above pipe (ft) | 0.0 | ft |
| H = cover above pipe (ft) | 67.0 | ft |
| B' = elastic support factor =( 1+ 4*e$^{-0.065H}$ )$^{-1}$ | Source 1, Equation 7-35 | |
| E' = soil reaction modulus (lb/in$^2$) | 3000.0 | lb/in$^2$ for mod comp/crushed rock, 'Source 1, Table 7-7 |
| E = elastic modulus (lb/in$^2$) | 100000.0 | lb/in$^2$ for long term load at 100°F, 'Source 1, Table 5-1 |
| I = moment of inertia = t$^3$ / 12 | 0.0 | in$^4$/in |
| $D_o$ = pipe outer diameter (in) | 8.625 | SDR 11 pipe (Driscopipe) to be used |
| t = pipe wall thickness (in) | 0.784 | SDR 11 pipe (Driscopipe) to be used |
| DR = pipe dimension ratio = $D_o$ / t | 11.0 | SDR 11 pipe (Driscopipe) to be used |
| $D_I$ = pipe inner diameter = $D_o$ - 2t (in) | 7.1 | SDR 11 pipe (Driscopipe) to be used |
| N = safety factor | 2.0 | |

| Cover (ft) | (ft) | (ft) | B' | R | (lb/in$^2$) |
|---|---|---|---|---|---|
| 67.0 | 67 | 0 | 0.95 | 1.00 | 435.54 |

$P_{WC}$ = 435.54 lb/in$^2$

$P_{EFF}$ = 22.52 lb/in$^2$

Pipe passes contrained wall buckling calculations: TRUE  FS = 19.3

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| Operation w/ CAT 826G Series II Compactor **60 Feet Waste** | | |

Constrained Pipe Wall Compressive Stress (for Driscoplex OD controlled pipe)

$S = \frac{P_T D_o}{288t}$ Source No. 1

S = pipe wall compressive stress ($lb/in^2$)

$P_T$ = vertical load applied to pipe w/ perfs ($lb/ft^2$) 3243.4 $lb/ft^2$

$D_o$ = pipe outside diameter (in) 8.63 SDR 11 pipe (Driscopipe) to be used

t = pipe wall thickness (in) 0.784 SDR 11 pipe (Driscopipe) to be used

$S = \frac{P_T D_o}{288t} =$ 123.9 $lb/in^2$

The recommended, long-term compressive strength ($Y_s$) design value for Driscoplex polyethylene pipe is 800 $lb/in^2$.

Source No. 1

| S (psi): | | $Y_s$ (psi): |
|---|---|---|
| 123.9 | < | 800.0 |

Pipe passes wall compressive stress calculations TRUE FS = 6.5

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Iowa Formula

$\Delta X = \frac{D_L K W_c r^3}{EI + 0.06er^4}$ Source 2, Equation 3.4 Buried Pipe Design, A.P. Moser, Chapter 3

$\Delta X$ = horizontal deflection (in)

$D_L$ = deflection lag factor

K = bedding constant | 0.1 | typical value Source 2, Buried Pipe Design, A.P. Moser, Chapter 3

$W_c$ = Marston's load per unit length of pipe (lb/in)

r = mean radius of the pipe (in)

E = modulus of elasticity ($lb/in^2$)

I = moment of inertia of the pipe wall per unit length ($in^3$)

e = modulus of passive resistance fo the side fill ($lb/in^2(in)$)

Modified Iowa Formula

$\Delta X = \frac{D_L K W_c r_m^3}{EI + 0.06E'r_m^3}$ Source 2, Equation 3.5 Buried Pipe Design, A.P. Moser, Chapter 3

$\Delta X$ = horizontal deflection (in)

| | | | |
|---|---|---|---|
| $D_L$ = deflection lag factor | | 1.0 | Prism Load used |
| Typical Value for Marston Load | 1.5 | | |
| Typical Value for Prism Load | 1.0 | | |
| K = bedding constant | | 0.1 | typical value Buried Pipe Design, A.P. Moser, Chapter 3 |
| $P_T$ = Vertical load on pipe w/ perfs | | 22.52 | $lb/in^2$ 3243 $lb/ft^2$ |
| $W_c$ = Marston's load per unit length of pipe = $P_T$ * $D_o$ (lb/in) | | 194.27 | lb/in |
| $D_o$ = pipe outer diameter (in) | | 8.63 | SDR 11 pipe (Driscopipe) to be used |
| t = pipe wall thickness (in) | | 0.78 | SDR 11 pipe (Driscopipe) to be used |
| $D_I$ = pipe inner diameter = $D_o$-2t (in) | | 7.06 | SDR 11 pipe (Driscopipe) to be used |
| $D_m$ = pipe mean diameter = $D_o$ - 1.06t Source 1, Equation 7-27 | | 7.79 | SDR 11 pipe (Driscopipe) to be used |
| $r_m$ = mean radius of the pipe (in) | | 3.90 | SDR 11 pipe (Driscopipe) to be used |
| E = modulus of elasticity ($lb/in^2$) | | 100,000.0 | lb/in2 for long term load at 100oF, 'Source 1, Table 5-1 |
| I = moment of inertia of the pipe wall per unit length | | 0.040 | $in^4/in$ |
| E' = modulus of soil reaction | | 3,000.0 | $lb/in^2$ for moderate compaction and fine grained soils |

$\Delta X = \frac{D_L K W_c r_m^3}{EI + 0.06E'r_m^3}$ = 0.078 inch Source 2, Equation 3.5 Buried Pipe Design, A.P. Moser, Chapter 3

% Ring Deflection = ($\Delta X/D_m$) x 100 = 1.01% Source 1, Equation 7-31

Ring Bending Strain

$e = \frac{f_D \Delta X 2C}{D_M^2} \times 100$ Source 1, Equation 7-39

e = wall strain (%)

| | | |
|---|---|---|
| $f_D$ = deformation shape factor | 6 | Source 1, non-elliptical shape |
| $D_M$ = mean diameter (in) | | |
| C = outer fiber wall centroid = 0.5 (1.06t) | 0.416 | Source 1, Equation 7-41 |
| $\Delta X$ = ring deflection = $D_X/D_m$ | 0.010 | |

$e = f_D \left(\frac{\Delta X}{D_M}\right)\left(\frac{2C}{D_M}\right) \times 100$ = 0.6% Source 1, Equation 7-39

The maximum ring bending strain for high performance polyethylene non-pressure pipe is 5.0%

Pipe passes ring bending strain calculations TRUE

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| **8" Diameter Leachate Collection Lateral** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **60 Feet Waste** | | |

SOURCES

1.) Attachment - 1 - Chevron Phillips Chemical Company, Bulletin - Book 2 Chapter 5, 2003

2.) Attachment - 2 - Buried Pipe Design, A.P. Moser, Chapter 3

3.) Attachment - 3 - EPA, Lining of Waste Impoundment and Disposal Facilities, SW-870

4.) Attachment - 4 - Driscoplex Pipe Properties

5.) Attachment - 5 - CAT 826G Series II Compactor Data Sheet

6.) Attachment - 6 - CAT D7R Series II Equipment Data Sheet

7.) Attachment - 7 - CAT D6R XW Series II Equipment Data Sheet

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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Collection Lateral Construction** w/ CAT D6R XW Series II | CHECKED | DATE |

Load on Pipe (Overburden)

Prism Loads, $P_E$ = wH

w = unit weight

H = depth

| | Depth (ft) | Unit Weight ($lb/ft^3$) | $P_E$ ($lb/ft^2$) |
|---|---|---|---|
| Final cover | 0.0 | 115.0 | 0.0 |
| Intermediate cover | 0.0 | 115.0 | 0.0 |
| Waste/cover | 0.0 | 60.0 | 0.0 |
| Drainage sand | 0.0 | 115.0 | 0.0 |
| Rock (No. 89 & No. 57) | 1.0 | 140.0 | 140.0 |

TOTAL SOIL PRISM LOAD $P_E$: 140.0 $lb/ft^2$

Total Depth = 1.0 ft

Soil Arching, $P_m = C_D wB$

NOTE: The waste unit weight represents the combined unit weight of waste, daily cover, and moisture.

Pm = vertical soil pressure

B = trench width at pipe crown 6.0 ft

$C_D$ = load coefficient $= \frac{1 - e^{-2Ku'H/B}}{2Ku'}$ Equation 7-3, Source No. 1

e = natural log base number

K = Rankine earth pressure coefficient = $\tan^2(45-0.5*\phi)$

$\phi$ = internal soil friction angle = 27.0 degrees

u' = friction coefficient between backfill and trench sides = tan $\phi$

| Soil Type | Ku' |
|---|---|
| Saturated Clay | 0.110 |
| Ordinary Clay | 0.130 |
| Saturated Top Soil | 0.150 |
| Sand and Gravel | 0.165 |
| Clean Granular Soil | 0.192 |

| | Ku' | $C_D$ | $P_m$ ($lb/ft^2$) |
|---|---|---|---|
| Cover Soil | 0.150 | 0.00 | 0 |
| Int Cover | 0.165 | 0.00 | 0 |
| Waste | 0.191 | 0.00 | 0 |
| Drainage Sand | 0.165 | 0.00 | 0.0 |
| Granular Soil | 0.192 | 0.16 | 135.6 |

TOTAL SOIL ARCHING LOAD $P_M$: 135.6 $lb/ft^2$

MODIFIED ARCHING LOAD = $0.6P_M+0.4P_E$: 137.37 $lb/ft^2$

OVERBURDEN LOAD: 137.37 $lb/ft^2$

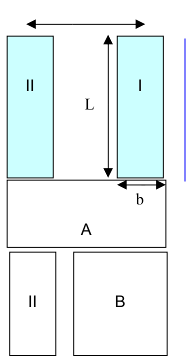
Load on Pipe With Equipment Refer to Attachment

Construction w/ CAT D6R XW Series II

| | | | | | |
|---|---|---|---|---|---|
| Equipment Weight = | 43,888.0 | psf | Length of Track = L = | 111.0 | in |
| Number of Tracks = | 2.0 | | Track Width = b = | 30.0 | in |
| Track Load = $q_r$ = | 21,944.0 | psf | Track Gauge = G = | 80.0 | in |
| Ground contact area/track = | 23.1 | psf | Equipment Width "A" = | 116.0 | in |

Live Load = q*Ic q = track load 948.93 psf

Ic = Influence coefficient




| | b (ft) | L (ft) | z (ft) | m = b/z | n = L/z | I* | I** | I |
|---|---|---|---|---|---|---|---|---|
| I | 2.50 | 9.3 | 1.0 | 2.50 | 9.25 | -0.006 | 0.244 | 0.24428 |
| A | 9.17 | 9.3 | 1.0 | 9.17 | 9.25 | 0.000 | 0.250 | 0.24976 |
| B | 6.67 | 9.3 | 1.0 | 6.67 | 9.25 | 0.000 | 0.250 | 0.24957 |

Live $Load_1$ = I + II = $q_I(I_I) + q_A(I_A) - q_B(I_B)$ = 231.99 $lb/ft^2$

$q_I(I_I)$ = 231.81

$q_A(I_A)$ = 237.01

$q_B(I_B)$ = 236.82

Load on Pipe (Equipment) = 231.99 $lb/ft^2$

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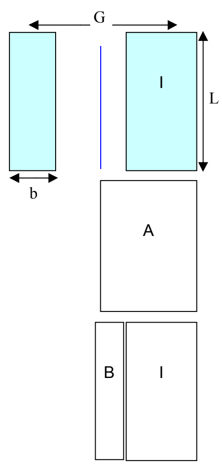
Load on Pipe (Equipment) *Continued*

Live Load = $q*I_c$

q = track load | 948.93 | $lb/ft^2$

$I_c$ = Influence coefficient

Alternative 2: Track stradling and parallel to pipe



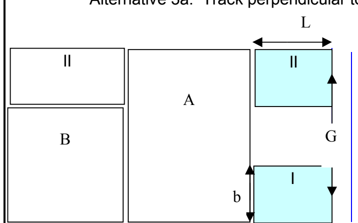

| | b | L | z | m = b/z | n = L/z | I* | I** | I |
|---|---|---|---|---|---|---|---|---|
| A | 4.83 | 9.3 | 1 | 4.83 | 9.25 | -0.001 | 0.249 | 0.24904 |
| B | 2.33 | 9.3 | 1 | 2.33 | 9.25 | -0.007 | 0.243 | 0.24315 |

$Live\ Load_2 = 2 * (A - B) = 2 * (q_A I_A - q_B I_B) =$ 11.18 $lb/ft^2$

| | |
|---|---|
| $q_A(I_A)$ = | 236.32 |
| $q_B(I_B)$ = | 230.73 |

Load on Pipe (Equipment) = 11.18 $lb/ft^2$

Alternative 3a: Track perpendicular to pipe




| | b | L | z | m = b/z | n = L/z | I* | I** | I |
|---|---|---|---|---|---|---|---|---|
| I | 2.50 | 9.3 | 1 | 2.50 | 9.25 | -0.006 | 0.244 | 0.24428 |
| A | 9.67 | 9.3 | 1 | 9.67 | 9.25 | 0.000 | 0.250 | 0.24978 |
| B | 7.17 | 9.3 | 1 | 7.17 | 9.25 | 0.000 | 0.250 | 0.24963 |

$Live\ Load_3 = I + II = q_I(I_I) + q_A(I_A) - q_B(I_B) =$ 231.95 $lb/ft^2$

| | |
|---|---|
| $q_I(I_I)$ = | 231.81 |
| $q_A(I_A)$ = | 237.02 |
| $q_B(I_B)$ = | 236.88 |

Load on Pipe (Equipment) = 231.95 $lb/ft^2$

LARGEST EQUIPEMENT LOAD = 231.99 $lb/ft^2$

VERTICAL OVERBURDEN LOAD = 137.37 $lb/ft^2$

VERTICAL EQUIPMENT LOAD = 231.99 $lb/ft^2$

TOTAL VERTICAL LOAD APPLIED TO PIPE, $P_T$ = 369.36 $lb/ft^2$ = 2.57 $lb/in^2$

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Verify that perforations in the LCRS are adequate for the peak leachate flow.

Use discharge equation:

$Q = (Cd)(Ao)(2gh)^{0.5}$

$C_d$ = coeffiecient of discharge = 0.6 for short tube discharge with fluid/wall separation; conservative value.

$A_o$ = Area of orifice ($\pi D^2/4$)

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Assumptions and Givens:

| | | | |
|---|---|---|---|
| 1. No. acres of landfill expansion = | 1.63 | acres | - Phase II Section II south portion |
| 2. Total length of pipe per expansion = | 539.7 | ft | |
| 3. Total number of laterals = | 3.0 | | |
| 4. Length of pipe per lateral = | 179.9 | ft | |
| 5. Perforation diameter = | 0.375 | inch | |
| 6. No. perforations/ft pipe = | 6.0 | perforations/ft of pipe length | |
| 7. Maximum head over pipe = | 1.0 | ft | |
| 8. Per HELP model summary table, $Q_{peak}$ = | 237.01 | gal/min | refer to HELP Model Summary Table |
| 9. Per HELP model summary table, $Q_{peak}$ = | 45,624.6 | cf/day | refer to HELP Model Summary Table |
| 10. Maximum flow/lateral = | 15,208.2 | cf/day/lateral | |
| 11. Maximum leachate flow/ft of pipe = | 84.54 | cf/day/ft of pipe | |

Solution:

$A_o = 0.25(\Pi)(d)^2 =$ 0.00077 $ft^2$

1. Flow per orifice, $Q = (Cd)(Ao)(2gh)^{0.5}$ = 0.0037 $ft^3/s$

2. Flow per ft of pipe = (Q)(# perfs/ft) = 0.02 $ft^3/s$ per ft of pipe

= 1914.47 cf/day/ft of pipe

Conclusion:

Design capacity exceeds estimated generation

1914.47 cf/day/ft of pipe >>> 84.54 cf/day/ft of pipe

Perforations are adequate to handle the maximum leachate flow.

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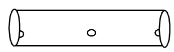
Effective pressure on pipe due to perforations:

$P_{EFF} = \frac{P_T \times 12}{(12-L_P)}$ Source 3, EPA SW-870, p. 382

$L_P$ = Total accumulated length of perforations in one foot of pipe.

Since each perforation is 0.375 inch diameter and spaced at 6.0 inch on center,

$L_P$ = 1.5 inch



$P_T$ = 2.6 psi

$P_{EFF}$ = 2.9 psi

$P_{EFF}$ = 422.1 psf

Check actual compressive pressure ($S_A$) per Driscopipe manual:

$S_A$ = 0.5 x (SDR - 1) x P(eff) = 14.7 psi

The recommended, long-term compressive strength ($Y_s$) design value for Driscoplex polyethylene pipe is 800 lb/in$^2$.

Source No. 1

| $S_A$ (psi): | | $Y_s$ (psi): |
|---|---|---|
| 14.7 | < | 800.0 |

Pipe passes wall compressive stress perforation calculations TRUE

FS = 54.6

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| SUBJECT | BY | DATE |
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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Collection Lateral Construction** w/ CAT D6R XW Series II | CHECKED | DATE |

Constrained pipe wall buckling (for Driscoplex OD controlled pipe)

$P_{WC} = \frac{5.65 * \{RB'E' \, E*[12(DR-1)^3]^{-1}\}^{0.5}}{N}$ Source 1, Equation 7-5

$P_{WC}$ = allowable constrained buckling pressure (lb/in$^2$)

R = buoyancy reduction factor = 1 - 0.33 * (H'/H) Source 1, Equation 7-34

| | | |
|---|---|---|
| H' = groundwater height above pipe (ft) | 0.0 | ft |
| H = cover above pipe (ft) | 1.0 | ft |
| B' = elastic support factor =( 1+ 4*e$^{-0.065H}$ )$^{-1}$ | | Source 1, Equation 7-35 |
| E' = soil reaction modulus (lb/in$^2$) | 3000.0 | lb/in$^2$ for mod comp/crushed rock, 'Source 1, Table 7-7 |
| E = elastic modulus (lb/in$^2$) | 100000.0 | lb/in$^2$ for long term load at 100$^o$F, 'Source 1, Table 5-1 |
| I = moment of inertia = t$^3$ / 12 | 0.0 | in$^4$/in |
| $D_o$ = pipe outer diameter (in) | 8.625 | SDR 11 pipe (Driscopipe) to be used |
| t = pipe wall thickness (in) | 0.784 | SDR 11 pipe (Driscopipe) to be used |
| DR = pipe dimension ratio = $D_o$ / t | 11.0 | SDR 11 pipe (Driscopipe) to be used |
| $D_I$ = pipe inner diameter = $D_o$ - 2t (in) | 7.1 | SDR 11 pipe (Driscopipe) to be used |
| N = safety factor | 2.0 | |

| Cover (ft) | (ft) | (ft) | B' | R | (lb/in$^2$) |
|---|---|---|---|---|---|
| 1.0 | 1 | 0 | 0.21 | 1.00 | 204.95 |

$P_{WC}$ = 204.95 lb/in$^2$

$P_{EFF}$ = 2.93 lb/in$^2$

Pipe passes contrained wall buckling calculations TRUE FS = 69.9

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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
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Constrained Pipe Wall Compressive Stress (for Driscoplex OD controlled pipe)

$S = \frac{P_T D_o}{288t}$ Source No. 1

S = pipe wall compressive stress ($lb/in^2$)

$P_T$ = vertical load applied to pipe w/ perfs ($lb/ft^2$) 422.1 $lb/ft^2$

$D_o$ = pipe outside diameter (in) 8.63 SDR 11 pipe (Driscopipe) to be used

t = pipe wall thickness (in) 0.784 SDR 11 pipe (Driscopipe) to be used

$S = \frac{P_T D_o}{288t}$ = 16.1 $lb/in^2$

The recommended, long-term compressive strength ($Y_s$) design value for Driscoplex polyethylene pipe is 800 $lb/in^2$.

Source No. 1

| S (psi): | | $Y_s$ (psi): |
| --- | --- | --- |
| 16.1 | < | 800.0 |

Pipe passes wall compressive stress calculations TRUE FS = 49.6

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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Collection Lateral Construction** w/ CAT D6R XW Series II | CHECKED | DATE |

Iowa Formula

$\Delta X = \dfrac{D_L K W_c r^3}{EI + 0.06er^4}$ Source 2, Equation 3.4 Buried Pipe Design, A.P. Moser, Chapter 3

$\Delta X$ = horizontal deflection (in)

$D_L$ = deflection lag factor

K = bedding constant | 0.1 | typical value Source 2, Buried Pipe Design, A.P. Moser, Chapter 3

$W_c$ = Marston's load per unit length of pipe (lb/in)

r = mean radius of the pipe (in)

E = modulus of elasticity ($lb/in^2$)

I = moment of inertia of the pipe wall per unit length ($in^3$)

e = modulus of passive resistance fo the side fill ($lb/in^2(in)$)

Modified Iowa Formula

$\Delta X = \dfrac{D_L K W_c r_m^3}{EI + 0.06E'r_m^3}$ Source 2, Equation 3.5 Buried Pipe Design, A.P. Moser, Chapter 3

$\Delta X$ = horizontal deflection (in)

| | | | | |
|---|---|---|---|---|
| $D_L$ = deflection lag factor | | 1.0 | Prism Load used | |
| Typical Value for Marston Load | 1.5 | | | |
| Typical Value for Prism Load | 1.0 | | | |
| K = bedding constant | | 0.1 | typical value Buried Pipe Design, A.P. Moser, Chapter 3 | |
| $P_T$ = Vertical load on pipe w/ perfs | | 2.93 | $lb/in^2$ | 422 $lb/ft^2$ |
| $W_c$ = Marston's load per unit length of pipe = $P_T * D_o$ (lb/in) | | 25.28 | lb/in | |
| $D_o$ = pipe outer diameter (in) | | 8.63 | SDR 11 pipe (Driscopipe) to be used | |
| t = pipe wall thickness (in) | | 0.78 | SDR 11 pipe (Driscopipe) to be used | |
| $D_I$ = pipe inner diameter = $D_o$-2t (in) | | 7.06 | SDR 11 pipe (Driscopipe) to be used | |
| $D_m$ = pipe mean diameter = $D_o$ - 1.06t Source 1, Equation 7-27 | | 7.79 | SDR 11 pipe (Driscopipe) to be used | |
| $r_m$ = mean radius of the pipe (in) | | 3.90 | SDR 11 pipe (Driscopipe) to be used | |
| E = modulus of elasticity ($lb/in^2$) | | 100,000.0 | lb/in2 for long term load at 100oF, 'Source 1, Table 5-1 | |
| I = moment of inertia of the pipe wall per unit length | | 0.040 | $in^4/in$ | |
| E' = modulus of soil reaction | | 3,000.0 | $lb/in^2$ for moderate compaction and fine grained soils | |

$\Delta X = \dfrac{D_L K W_c r_m^3}{EI + 0.06E'r_m^3}$ = 0.010 inch — Source 2, Equation 3.5 Buried Pipe Design, A.P. Moser, Chapter 3

% Ring Deflection = $(\Delta X/D_m) \times 100$ = 0.13% Source 1, Equation 7-31

Ring Bending Strain

$e = \dfrac{f_D \Delta X 2C}{D_M^2} \times 100$ Source 1, Equation 7-39

e = wall strain (%)

| | | | |
|---|---|---|---|
| $f_D$ = deformation shape factor | 6 | Source 1, non-elliptical shape |
| $D_M$ = mean diameter (in) | | |
| C = outer fiber wall centroid = 0.5 (1.06t) | 0.416 | Source 1, Equation 7-41 |
| $\Delta X$ = ring deflection = $D_X/D_m$ | 0.001 | |

$e = f_D \left(\dfrac{\Delta X}{D_M}\right)\left(\dfrac{2C}{D_M}\right) \times 100$ = 0.1% Source 1, Equation 7-39

The maximum ring bending strain for high performance polyethylene non-pressure pipe is 5.0%

Pipe passes ring bending strain calculations TRUE

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| **8" Diameter Leachate Collection Lateral Construction** w/ CAT D6R XW Series II | CHECKED | DATE |

SOURCES

1.) Attachment - 1 - Chevron Phillips Chemical Company, Bulletin - Book 2 Chapter 5, 2003

2.) Attachment - 2 - Buried Pipe Design, A.P. Moser, Chapter 3

3.) Attachment - 3 - EPA, Lining of Waste Impoundment and Disposal Facilities, SW-870

4.) Attachment - 4 - Driscoplex Pipe Properties

5.) Attachment - 5 - CAT 826G Series II Compactor Data Sheet

6.) Attachment - 6 - CAT D7R Series II Equipment Data Sheet

7.) Attachment - 7 - CAT D6R XW Series II Equipment Data Sheet

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| SUBJECT | BY | DATE |
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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Collection Lateral** | CHECKED | DATE |
| Operation w/ CAT D7R Series II **0 Feet Waste** | | |

Load on Pipe (Overburden)

Prism Loads, $P_E$ = wH

w = unit weight

H = depth

| | Depth (ft) | Unit Weight ($lb/ft^3$) | $P_E$ ($lb/ft^2$) |
|---|---|---|---|
| Final cover | 0.0 | 115.0 | 0.0 |
| Intermediate cover | 0.0 | 115.0 | 0.0 |
| Waste/cover | 0.0 | 60.0 | 0.0 |
| Drainage sand | 2.0 | 115.0 | 230.0 |
| Rock (No. 89 & No. 57) | 2.0 | 140.0 | 280.0 |

TOTAL SOIL PRISM LOAD $P_E$: 510.0 $lb/ft^2$

Total Depth = 4.0 ft

Soil Arching, $P_m = C_D wB$

NOTE: The waste unit weight represents the combined unit weight of waste, daily cover, and moisture.

Pm = vertical soil pressure

B = trench width at pipe crown 6.0 ft

$C_D$ = load coefficient $= \frac{1 - e^{-2Ku'H/B}}{2Ku'}$ Equation 7-3, Source No. 1

e = natural log base number

K = Rankine earth pressure coefficient = $\tan^2(45-0.5*\phi)$

$\phi$ = internal soil friction angle = 27.0 degrees

u' = friction coefficient between backfill and trench sides = tan $\phi$

| Soil Type | Ku' |
|---|---|
| Saturated Clay | 0.110 |
| Ordinary Clay | 0.130 |
| Saturated Top Soil | 0.150 |
| Sand and Gravel | 0.165 |
| Clean Granular Soil | 0.192 |

| | Ku' | $C_D$ | $P_m$ ($lb/ft^2$) |
|---|---|---|---|
| Cover Soil | 0.150 | 0.00 | 0 |
| Int Cover | 0.165 | 0.00 | 0 |
| Waste | 0.191 | 0.00 | 0 |
| Drainage Sand | 0.165 | 0.32 | 217.8 |
| Granular Soil | 0.192 | 0.31 | 262.8 |

TOTAL SOIL ARCHING LOAD $P_M$: 480.6 $lb/ft^2$

MODIFIED ARCHING LOAD = $0.6P_M+0.4P_E$: 492.37 $lb/ft^2$

OVERBURDEN LOAD: 492.37 $lb/ft^2$

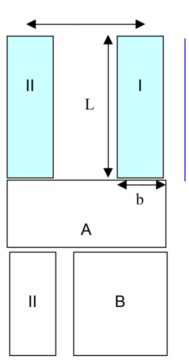
Load on Pipe With Equipment Refer to Attachment

Operation w/ CAT D7R Series II 0 Feet Waste

| | | | | | |
|---|---|---|---|---|---|
| Equipment Weight = | 54,573.0 | psf | Length of Track = L = | 113.0 | in |
| Number of Tracks = | 2.0 | | Track Width = b = | 22.0 | in |
| Track Load = $q_r$ = | 27,286.5 | psf | Track Gauge = G = | 78.0 | in |
| Ground contact area/track = | 17.3 | psf | Equipment Width "A" = | 113.0 | in |

Live Load = q*Ic q = track load 1,580.55 psf

Ic = Influence coefficient




| | b (ft) | L (ft) | z (ft) | m = b/z | n = L/z | I* | I** | I |
|---|---|---|---|---|---|---|---|---|
| I | 1.83 | 9.4 | 4.0 | 0.46 | 2.35 | 0.127 | 0.252 | 0.12736 |
| A | 8.33 | 9.4 | 4.0 | 2.08 | 2.35 | -0.014 | 0.236 | 0.23624 |
| B | 6.50 | 9.4 | 4.0 | 1.63 | 2.35 | -0.021 | 0.229 | 0.22928 |

Live $Load_1$ = I + II = $q_I(I_I) + q_A(I_A) - q_B(I_B)$ = 212.30 $lb/ft^2$

$q_I(I_I)$ = 201.29

$q_A(I_A)$ = 373.39

$q_B(I_B)$ = 362.39

Load on Pipe (Equipment) = 212.30 $lb/ft^2$

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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Collection Lateral** | CHECKED | DATE |
| Operation w/ CAT D7R Series II **0 Feet Waste** | | |

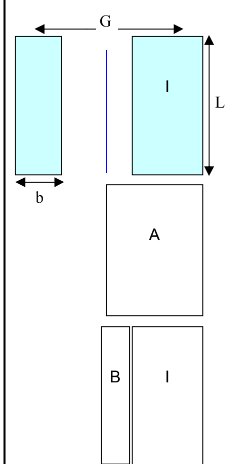
Load on Pipe (Equipment) *Continued*

Live Load = $q*I_c$

$q$ = track load 1580.55 $lb/ft^2$

$I_c$ = Influence coefficient

Alternative 2: Track stradling and parallel to pipe



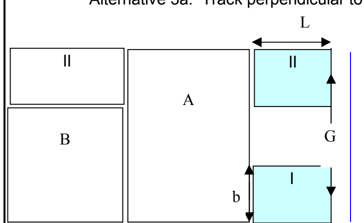

| | b | L | z | m = b/z | n = L/z | I* | I** | I |
|---|---|---|---|---|---|---|---|---|
| A | 4.71 | 9.4 | 4 | 1.18 | 2.35 | 0.213 | 0.216 | 0.21333 |
| B | 2.88 | 9.4 | 4 | 0.72 | 2.35 | 0.173 | 0.242 | 0.17258 |

Live $Load_2$ = 2 * (A - B) = 2 * ($q_AI_A$ - $q_BI_B$) = 128.82 $lb/ft^2$

| | |
|---|---|
| $q_A(I_A)$ = | 337.19 |
| $q_B(I_B)$ = | 272.78 |

Load on Pipe (Equipment) = 128.82 $lb/ft^2$

Alternative 3a: Track perpendicular to pipe




| | b | L | z | m = b/z | n = L/z | I* | I** | I |
|---|---|---|---|---|---|---|---|---|
| I | 1.83 | 9.4 | 4 | 0.46 | 2.35 | 0.127 | 0.252 | 0.12736 |
| A | 9.42 | 9.4 | 4 | 2.35 | 2.35 | -0.012 | 0.238 | 0.23841 |
| B | 7.58 | 9.4 | 4 | 1.90 | 2.35 | -0.016 | 0.234 | 0.23405 |

Live $Load_3$ = I + II = $q_I(I_I)$ + $q_A(I_A)$ - $q_B(I_B)$ = 208.18 $lb/ft^2$

| | |
|---|---|
| $q_I(I_I)$ = | 201.29 |
| $q_A(I_A)$ = | 376.82 |
| $q_B(I_B)$ = | 369.93 |

Load on Pipe (Equipment) = 208.18 $lb/ft^2$

LARGEST EQUIPEMENT LOAD = 212.30 $lb/ft^2$

VERTICAL OVERBURDEN LOAD = 492.37 $lb/ft^2$

VERTICAL EQUIPMENT LOAD = 212.30 $lb/ft^2$

TOTAL VERTICAL LOAD APPLIED TO PIPE, $P_T$ = 704.67 $lb/ft^2$ = 4.89 $lb/in^2$

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| Operation w/ CAT D7R Series II **0 Feet Waste** | | |

Verify that perforations in the LCRS are adequate for the peak leachate flow.

Use discharge equation:

$Q = (Cd)(Ao)(2gh)^{0.5}$

$C_d$ = coeffiecient of discharge = 0.6 for short tube discharge with fluid/wall separation; conservative value.

$A_o$ = Area of orifice ($\pi D^2/4$)

g = gravitational acceleration (32.3 $ft^2/s$)

h = static head (ft)

Assumptions and Givens:

| | | | |
|---|---|---|---|
| 1. No. acres of landfill expansion = | 1.63 | acres | - Phase II Section II south portion |
| 2. Total length of pipe per expansion = | 539.7 | ft | |
| 3. Number of laterals = | 3.0 | | |
| 4. Total length of pipe per lateral = | 179.9 | ft | |
| 5. Perforation diameter = | 0.375 | inch | |
| 6. No. perforations/ft pipe = | 6.0 | perforations/ft of pipe length | |
| 7. Maximum head over pipe = | 1.0 | ft | |
| 8. Per HELP model summary table, $Q_{peak}$ = | 237.01 | gal/min | refer to HELP Model Summary Table |
| 9. Per HELP model summary table, $Q_{peak}$ = | 45,624.6 | cf/day | refer to HELP Model Summary Table |
| 10. Maximum flow/lateral = | 15,208.2 | cf/day/lateral | |
| 11. Maximum leachate flow/ft of pipe = | 84.54 | cf/day/ft of pipe | |

Solution:

$A_o = 0.25(\Pi)(d)^2 =$ 0.00077 $ft^2$

1. Flow per orifice, $Q = (Cd)(Ao)(2gh)^{0.5}$ = 0.0037 $ft^3/s$

2. Flow per ft of pipe = (Q)(# perfs/ft) = 0.02 $ft^3/s$ per ft of pipe

= 1914.47 cf/day/ft of pipe

Conclusion:

Design capacity exceeds estimated generation

1914.47 cf/day/ft of pipe >>> 84.54 cf/day/ft of pipe

Perforations are adequate to handle the maximum leachate flow.

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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
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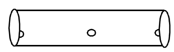
Effective pressure on pipe due to perforations:

$P_{EFF} = \frac{P_T \times 12}{(12-L_P)}$ Source 3, EPA SW-870, p. 382

$L_P$ = Total accumulated length of perforations in one foot of pipe.

Since each perforation is 0.375 inch diameter and spaced at 6.0 inch on center,

$L_P$ = 1.5 inch



$P_T$ = 4.9 psi

$P_{EFF}$ = 5.6 psi

$P_{EFF}$ = 805.3 psf

Check actual compressive pressure ($S_A$) per Driscopipe manual:

$S_A$ = 0.5 x (SDR - 1) x P(eff) = 28.0 psi

The recommended, long-term compressive strength ($Y_s$) design value for Driscoplex polyethylene pipe is 800 lb/in$^2$.

Source No. 1

| $S_A$ (psi): | | $Y_s$ (psi): |
|---|---|---|
| 28.0 | < | 800.0 |

Pipe passes wall compressive stress perforation calculations TRUE

FS = 28.6

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| **8" Diameter Leachate Collection Lateral** | CHECKED | DATE |
| Operation w/ CAT D7R Series II **0 Feet Waste** | | |

Constrained pipe wall buckling (for Driscoplex OD controlled pipe)

$P_{WC} = \frac{5.65 * \{RB'E' E*[12(DR-1)^3]^{-1}\}^{0.5}}{N}$ Source 1, Equation 7-5

$P_{WC}$ = allowable constrained buckling pressure (lb/in²)

R = buoyancy reduction factor = 1 - 0.33 * (H'/H) Source 1, Equation 7-34

H' = groundwater height above pipe (ft) 0.0 ft

H = cover above pipe (ft) 4.0 ft

B' = elastic support factor =$( 1+ 4*e^{-0.065H} )^{-1}$ Source 1, Equation 7-35

E' = soil reaction modulus (lb/in²) 3000.0 lb/in² for mod comp/crushed rock, 'Source 1, Table 7-7

E = elastic modulus (lb/in²) 100000.0 lb/in² for long term load at 100°F, 'Source 1, Table 5-1

I = moment of inertia = $t^3$ / 12 0.0 in⁴/in

$D_o$ = pipe outer diameter (in) 8.625 SDR 11 pipe (Driscopipe) to be used

t = pipe wall thickness (in) 0.784 SDR 11 pipe (Driscopipe) to be used

DR = pipe dimension ratio = $D_o$ / t 11.0 SDR 11 pipe (Driscopipe) to be used

$D_I$ = pipe inner diameter = $D_o$ - 2t (in) 7.1 SDR 11 pipe (Driscopipe) to be used

N = safety factor 2.0

| Cover (ft) | (ft) | (ft) | B' | R | (lb/in²) |
|---|---|---|---|---|---|
| 0.0 | 4 | 0 | 0.24 | 1.00 | 220.98 |

$P_{WC}$ = 220.98 lb/in²

$P_{EFF}$ = 5.59 lb/in²

Pipe passes contrained wall buckling calculations TRUE FS = 39.5

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Constrained Pipe Wall Compressive Stress (for Driscoplex OD controlled pipe)

$S = \frac{P_T D_o}{288t}$ Source No. 1

S = pipe wall compressive stress (lb/in$^2$)

| | | |
|---|---|---|
| $P_T$ = vertical load applied to pipe w/ perfs (lb/ft$^2$) | 805.3 | lb/ft$^2$ |
| $D_o$ = pipe outside diameter (in) | 8.63 | SDR 11 pipe (Driscopipe) to be used |
| t = pipe wall thickness (in) | 0.784 | SDR 11 pipe (Driscopipe) to be used |

$S = \frac{P_T D_o}{288t} =$ 30.8 lb/in$^2$

The recommended, long-term compressive strength ($Y_s$) design value for Driscoplex polyethylene pipe is 800 lb/in$^2$.

Source No. 1

| S (psi): | | $Y_s$ (psi): |
|---|---|---|
| 30.8 | < | 800.0 |

Pipe passes wall compressive stress calculations TRUE FS = 26.0

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| Operation w/ CAT D7R Series II **0 Feet Waste** | | |

Iowa Formula

$\Delta X = \dfrac{D_L K W_c r^3}{EI + 0.06er^4}$ Source 2, Equation 3.4 Buried Pipe Design, A.P. Moser, Chapter 3

$\Delta X$ = horizontal deflection (in)

$D_L$ = deflection lag factor

K = bedding constant 0.1 typical value Source 2, Buried Pipe Design, A.P. Moser, Chapter 3

$W_c$ = Marston's load per unit length of pipe (lb/in)

r = mean radius of the pipe (in)

E = modulus of elasticity (lb/in$^2$)

I = moment of inertia of the pipe wall per unit length (in$^3$)

e = modulus of passive resistance fo the side fill (lb/in$^2$(in))

Modified Iowa Formula

$\Delta X = \dfrac{D_L K W_c r_m^3}{EI + 0.06E'r_m^3}$ Source 2, Equation 3.5 Buried Pipe Design, A.P. Moser, Chapter 3

| | | |
|---|---|---|
| $\Delta X$ = horizontal deflection (in) | | |
| $D_L$ = deflection lag factor | 1.0 | Prism Load used |
| Typical Value for Marston Load | 1.5 | |
| Typical Value for Prism Load | 1.0 | |
| K = bedding constant | 0.1 | typical value Buried Pipe Design, A.P. Moser, Chapter 3 |
| $P_T$ = Vertical load on pipe w/ perfs | 5.59 | lb/in$^2$ 805 lb/ft$^2$ |
| $W_c$ = Marston's load per unit length of pipe = $P_T$ * $D_o$ (lb/in) | 48.24 | lb/in |
| $D_o$ = pipe outer diameter (in) | 8.63 | SDR 11 pipe (Driscopipe) to be used |
| t = pipe wall thickness (in) | 0.78 | SDR 11 pipe (Driscopipe) to be used |
| $D_I$ = pipe inner diameter = $D_o$-2t (in) | 7.06 | SDR 11 pipe (Driscopipe) to be used |
| $D_m$ = pipe mean diameter = $D_o$ - 1.06t Source 1, Equation 7-27 | 7.79 | SDR 11 pipe (Driscopipe) to be used |
| $r_m$ = mean radius of the pipe (in) | 3.90 | SDR 11 pipe (Driscopipe) to be used |
| E = modulus of elasticity (lb/in$^2$) | 100,000.0 | lb/in2 for long term load at 100oF, 'Source 1, Table 5-1 |
| I = moment of inertia of the pipe wall per unit length | 0.040 | in$^4$/in |
| E' = modulus of soil reaction | 3,000.0 | lb/in$^2$ for moderate compaction and fine grained soils |

$\Delta X = \dfrac{D_L K W_c r_m^3}{EI + 0.06E'r_m^3}$ = 0.019 inch Source 2, Equation 3.5 Buried Pipe Design, A.P. Moser, Chapter 3

% Ring Deflection = ($\Delta X/D_m$) x 100 = 0.25% Source 1, Equation 7-31

Ring Bending Strain

$e = \dfrac{f_D \Delta X 2C}{D_M^2} \times 100$ Source 1, Equation 7-39

e = wall strain (%)

| | | |
|---|---|---|
| $f_D$ = deformation shape factor | 6 | Source 1, non-elliptical shape |
| $D_M$ = mean diameter (in) | | |
| C = outer fiber wall centroid = 0.5 (1.06t) | 0.416 | Source 1, Equation 7-41 |
| $\Delta X$ = ring deflection = $D_X/D_m$ | 0.002 | |

$e = f_D \left(\dfrac{\Delta X}{D_M}\right)\left(\dfrac{2C}{D_M}\right) \times 100$ = 0.2% Source 1, Equation 7-39

The maximum ring bending strain for high performance polyethylene non-pressure pipe is 5.0%

Pipe passes ring bending strain calculations TRUE

| SCS ENGINEERS | | | | |
|---|---|---|---|---|
| | | SHEET 8 OF 8 | | |
| CLIENT<br>Hardee County | PROJECT<br>Phase II Section II Expansion | | JOB NO.<br>09199033.23 | |
| SUBJECT<br>Pipe Crushing Calculations **RAI No. 1** | | BY<br>SRF | | DATE<br>4/1/13 |
| **8" Diameter Leachate Collection Lateral**<br>Operation w/ CAT D7R Series II **0 Feet Waste** | | CHECKED | | DATE |

SOURCES

1.) Attachment - 1 - Chevron Phillips Chemical Company, Bulletin - Book 2 Chapter 5, 2003

2.) Attachment - 2 - Buried Pipe Design, A.P. Moser, Chapter 3

3.) Attachment - 3 - EPA, Lining of Waste Impoundment and Disposal Facilities, SW-870

4.) Attachment - 4 - Driscoplex Pipe Properties

5.) Attachment - 5 - CAT 826G Series II Compactor Data Sheet

6.) Attachment - 6 - CAT D7R Series II Equipment Data Sheet

7.) Attachment - 7 - CAT D6R XW Series II Equipment Data Sheet

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| CLIENT | PROJECT | JOB NO. |
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| Hardee County | Phase II Section II Expansion | 09199033.23 |

| SUBJECT | BY | DATE |
|---|---|---|
| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Collection Lateral** | CHECKED | DATE |
| Operation w/ CAT D7R Series II 1**0 Feet Waste** | | |

Load on Pipe (Overburden)

Prism Loads, $P_E$ = wH

w = unit weight

H = depth

| | Depth (ft) | Unit Weight (lb/ft$^3$) | $P_E$ (lb/ft$^2$) |
|---|---|---|---|
| Final cover | 0.0 | 115.0 | 0.0 |
| Intermediate cover | 0.0 | 115.0 | 0.0 |
| Waste/cover | 10.0 | 60.0 | 600.0 |
| Drainage sand | 2.0 | 115.0 | 230.0 |
| Rock (No. 89 & No. 57) | 2.0 | 140.0 | 280.0 |

TOTAL SOIL PRISM LOAD $P_E$: 1110.0 lb/ft$^2$

Total Depth = 14.0 ft

Soil Arching, $P_m$ = $C_D$wB

NOTE: The waste unit weight represents the combined unit weight of waste, daily cover, and moisture.

Pm = vertical soil pressure

B = trench width at pipe crown 6.0 ft

$C_D$ = load coefficient $= \frac{1 - e^{-2Ku'H/B}}{2Ku'}$ Equation 7-3, Source No. 1

e = natural log base number

K = Rankine earth pressure coefficient = $\tan^2(45-0.5*\phi)$

$\phi$ = internal soil friction angle = 27.0 degrees

u' = friction coefficient between backfill and trench sides = tan $\phi$

| Soil Type | Ku' |
|---|---|
| Saturated Clay | 0.110 |
| Ordinary Clay | 0.130 |
| Saturated Top Soil | 0.150 |
| Sand and Gravel | 0.165 |
| Clean Granular Soil | 0.192 |

| | Ku' | $C_D$ | $P_m$ (lb/ft$^2$) |
|---|---|---|---|
| Cover Soil | 0.150 | 0.00 | 0 |
| Int Cover | 0.165 | 0.00 | 0 |
| Waste | 0.191 | 1.23 | 444 |
| Drainage Sand | 0.165 | 0.32 | 217.8 |
| Granular Soil | 0.192 | 0.31 | 262.8 |

TOTAL SOIL ARCHING LOAD $P_M$: 924.2 lb/ft$^2$

MODIFIED ARCHING LOAD = $0.6P_M+0.4P_E$: 998.53 lb/ft$^2$

OVERBURDEN LOAD: 998.53 lb/ft$^2$

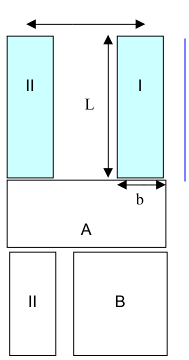
Load on Pipe With Equipment Refer to Attachment

Operation w/ CAT D7R Series II 10 Feet Waste

| | | | | | |
|---|---|---|---|---|---|
| Equipment Weight = | 54,573.0 | psf | Length of Track = L = | 113.0 | in |
| Number of Tracks = | 2.0 | | Track Width = b = | 22.0 | in |
| Track Load = $q_r$ = | 27,286.5 | psf | Track Gauge = G = | 78.0 | in |
| Ground contact area/track = | 17.3 | psf | Equipment Width "A" = | 113.0 | in |

Live Load = q*Ic q = track load 1,580.55 psf

Ic = Influence coefficient




| | b (ft) | L (ft) | z (ft) | m = b/z | n = L/z | I* | I** | I |
|---|---|---|---|---|---|---|---|---|
| I | 1.83 | 9.4 | 14.0 | 0.13 | 0.67 | 0.031 | 0.258 | 0.03087 |
| A | 8.33 | 9.4 | 14.0 | 0.60 | 0.67 | 0.114 | 0.272 | 0.11372 |
| B | 6.50 | 9.4 | 14.0 | 0.46 | 0.67 | 0.096 | 0.270 | 0.09592 |

Live $Load_1$ = I + II = $q_I(I_I) + q_A(I_A) - q_B(I_B)$ = 76.94 lb/ft$^2$

$q_I(I_I)$ = 48.80

$q_A(I_A)$ = 179.74

$q_B(I_B)$ = 151.60

Load on Pipe (Equipment) = 76.94 lb/ft$^2$

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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Collection Lateral** | CHECKED | DATE |
| Operation w/ CAT D7R Series II 1**0 Feet Waste** | | |

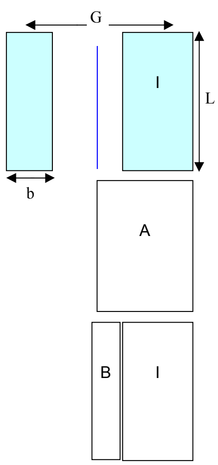
Load on Pipe (Equipment) *Continued*

Live Load = $q*I_c$

q = track load [1580.55] $lb/ft^2$

$I_c$ = Influence coefficient

Alternative 2: Track stradling and parallel to pipe



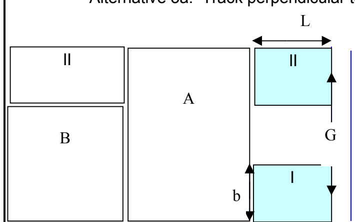

| | b | L | z | m = b/z | n = L/z | I* | I** | I |
|---|---|---|---|---|---|---|---|---|
| A | 4.71 | 9.4 | 14 | 0.34 | 0.67 | 0.074 | 0.267 | 0.07413 |
| B | 2.88 | 9.4 | 14 | 0.21 | 0.67 | 0.048 | 0.262 | 0.04754 |

Live $Load_2$ = 2 * (A - B) = 2 * ($q_A I_A$ - $q_B I_B$) = 84.04 $lb/ft^2$

| | |
|---|---|
| $q_A(I_A)$ = | 117.16 |
| $q_B(I_B)$ = | 75.14 |

Load on Pipe (Equipment) = 84.04 $lb/ft^2$

Alternative 3a: Track perpendicular to pipe




| | b | L | z | m = b/z | n = L/z | I* | I** | I |
|---|---|---|---|---|---|---|---|---|
| I | 1.83 | 9.4 | 14 | 0.13 | 0.67 | 0.031 | 0.258 | 0.03087 |
| A | 9.42 | 9.4 | 14 | 0.67 | 0.67 | 0.122 | 0.271 | 0.12225 |
| B | 7.58 | 9.4 | 14 | 0.54 | 0.67 | 0.107 | 0.271 | 0.10697 |

Live $Load_3$ = I + II = $q_I(I_I)$ + $q_A(I_A)$ - $q_B(I_B)$ = 72.96 $lb/ft^2$

| | |
|---|---|
| $q_I(I_I)$ = | 48.80 |
| $q_A(I_A)$ = | 193.23 |
| $q_B(I_B)$ = | 169.07 |

Load on Pipe (Equipment) = 72.96 $lb/ft^2$

LARGEST EQUIPEMENT LOAD = 84.04 $lb/ft^2$

VERTICAL OVERBURDEN LOAD = 998.53 $lb/ft^2$

VERTICAL EQUIPMENT LOAD = 84.04 $lb/ft^2$

TOTAL VERTICAL LOAD APPLIED TO PIPE, $P_T$ = 1,082.58 $lb/ft^2$ = 7.52 $lb/in^2$

| CLIENT | PROJECT | JOB NO. |
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| SUBJECT | BY | DATE |
|---|---|---|
| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Collection Lateral** | CHECKED | DATE |
| Operation w/ CAT D7R Series II 10 **Feet Waste** | | |

Verify that perforations in the LCRS are adequate for the peak leachate flow.

Use discharge equation:

$Q = (Cd)(Ao)(2gh)^{0.5}$

$C_d$ = coeffiecient of discharge = 0.6 for short tube discharge with fluid/wall separation; conservative value.

$A_o$ = Area of orifice ($\pi D^2/4$)

g = gravitational acceleration (32.3 $ft^2/s$)

h = static head (ft)

Assumptions and Givens:

| | | | |
|---|---|---|---|
| 1. No. acres of landfill expansion = | 1.63 | acres | - Phase II Section II south portion |
| 2. Total length of pipe per expansion = | 539.7 | ft | |
| 3. Number of laterals = | 3.0 | | |
| 4. Total length of pipe per lateral = | 179.9 | ft | |
| 5. Perforation diameter = | 0.375 | inch | |
| 6. No. perforations/ft pipe = | 6.0 | perforations/ft of pipe length | |
| 7. Maximum head over pipe = | 1.0 | ft | |
| 8. Per HELP model summary table, $Q_{peak}$ = | 237.01 | gal/min | refer to HELP Model Summary Table |
| 9. Per HELP model summary table, $Q_{peak}$ = | 45,624.6 | cf/day | refer to HELP Model Summary Table |
| 10. Maximum flow/lateral = | 15,208.2 | cf/day/lateral | |
| 11. Maximum leachate flow/ft of pipe = | 84.54 | cf/day/ft of pipe | |

Solution:

$A_o = 0.25(\Pi)(d)^2 =$ 0.00077 $ft^2$

1. Flow per orifice, $Q = (Cd)(Ao)(2gh)^{0.5} =$ 0.0037 $ft^3/s$

2. Flow per ft of pipe = (Q)(# perfs/ft) = 0.02 $ft^3/s$ per ft of pipe

= 1914.47 cf/day/ft of pipe

Conclusion:

Design capacity exceeds estimated generation

1914.47 cf/day/ft of pipe >>> 84.54 cf/day/ft of pipe

Perforations are adequate to handle the maximum leachate flow.

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| CLIENT | PROJECT | JOB NO. |
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| Hardee County | Phase II Section II Expansion | 09199033.23 |

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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Collection Lateral** | CHECKED | DATE |
| Operation w/ CAT D7R Series II **10 Feet Waste** | | |

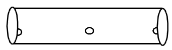
Effective pressure on pipe due to perforations:

$P_{EFF} = \frac{P_T \times 12}{(12-L_P)}$ Source 3, EPA SW-870, p. 382

$L_P$ = Total accumulated length of perforations in one foot of pipe.

Since each perforation is 0.375 inch diameter and spaced at 6.0 inch on center,

$L_P$ = 1.5 inch



$P_T$ = 7.5 psi

$P_{EFF}$ = 8.6 psi

$P_{EFF}$ = 1237.2 psf

Check actual compressive pressure ($S_A$) per Driscopipe manual:

$S_A$ = 0.5 x (SDR - 1) x P(eff) = 43.0 psi

The recommended, long-term compressive strength ($Y_s$) design value for Driscoplex polyethylene pipe is 800 lb/in$^2$.

Source No. 1

| $S_A$ (psi): | | $Y_s$ (psi): |
|---|---|---|
| 43.0 | < | 800.0 |

Pipe passes wall compressive stress perforation calculations TRUE

FS = 18.6

SCS ENGINEERS

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| CLIENT | PROJECT | JOB NO. |
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| Hardee County | Phase II Section II Expansion | 09199033.23 |

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|---|---|---|
| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Collection Lateral** | CHECKED | DATE |
| Operation w/ CAT D7R Series II 1**0 Feet Waste** | | |

Constrained pipe wall buckling (for Driscoplex OD controlled pipe)

$P_{WC} = \frac{5.65 * \{RB'E' E^*[12(DR-1)^3]^{-1}\}^{0.5}}{N}$ Source 1, Equation 7-5

$P_{WC}$ = allowable constrained buckling pressure (lb/in$^2$)

R = buoyancy reduction factor = 1 - 0.33 * (H'/H) Source 1, Equation 7-34

| | | |
|---|---|---|
| H' = groundwater height above pipe (ft) | 0.0 | ft |
| H = cover above pipe (ft) | 14.0 | ft |
| B' = elastic support factor =( 1+ 4*$e^{-0.065H}$ )$^{-1}$ | | Source 1, Equation 7-35 |
| E' = soil reaction modulus (lb/in$^2$) | 3000.0 | lb/in$^2$ for mod comp/crushed rock, 'Source 1, Table 7-7 |
| E = elastic modulus (lb/in$^2$) | 100000.0 | lb/in$^2$ for long term load at 100$^o$F, 'Source 1, Table 5-1 |
| I = moment of inertia = $t^3$ / 12 | 0.0 | in$^4$/in |
| $D_o$ = pipe outer diameter (in) | 8.625 | SDR 11 pipe (Driscopipe) to be used |
| t = pipe wall thickness (in) | 0.784 | SDR 11 pipe (Driscopipe) to be used |
| DR = pipe dimension ratio = $D_o$ / t | 11.0 | SDR 11 pipe (Driscopipe) to be used |
| $D_I$ = pipe inner diameter = $D_o$ - 2t (in) | 7.1 | SDR 11 pipe (Driscopipe) to be used |
| N = safety factor | 2.0 | |

| Cover (ft) | (ft) | (ft) | B' | R | (lb/in$^2$) |
|---|---|---|---|---|---|
| 10.0 | 14 | 0 | 0.38 | 1.00 | 276.42 |

$P_{WC}$ = 276.42 lb/in$^2$

$P_{EFF}$ = 8.59 lb/in$^2$

Pipe passes contrained wall buckling calculations TRUE FS = 32.2

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| CLIENT | PROJECT | JOB NO. |
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| SUBJECT | BY | DATE |
|---|---|---|
| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Collection Lateral** | CHECKED | DATE |
| Operation w/ CAT D7R Series II 1**0 Feet Waste** | | |

Constrained Pipe Wall Compressive Stress (for Driscoplex OD controlled pipe)

$S = \frac{P_T D_o}{288t}$ Source No. 1

S = pipe wall compressive stress (lb/in$^2$)

$P_T$ = vertical load applied to pipe w/ perfs (lb/ft$^2$) 1237.2 lb/ft$^2$

$D_o$ = pipe outside diameter (in) 8.63 SDR 11 pipe (Driscopipe) to be used

t = pipe wall thickness (in) 0.784 SDR 11 pipe (Driscopipe) to be used

$S = \frac{P_T D_o}{288t}$ = 47.3 lb/in$^2$

The recommended, long-term compressive strength ($Y_s$) design value for Driscoplex polyethylene pipe is 800 lb/in$^2$.

Source No. 1

| S (psi): | | $Y_s$ (psi): |
|---|---|---|
| 47.3 | < | 800.0 |

Pipe passes wall compressive stress calculations TRUE FS = 16.9

| CLIENT | PROJECT | JOB NO. |
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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Collection Lateral** | CHECKED | DATE |
| Operation w/ CAT D7R Series II 1**0 Feet Waste** | | |

Iowa Formula

$\Delta X = \frac{D_L K W_c r^3}{EI + 0.06er^4}$ Source 2, Equation 3.4 Buried Pipe Design, A.P. Moser, Chapter 3

$\Delta X$ = horizontal deflection (in)
$D_L$ = deflection lag factor
K = bedding constant | 0.1 | typical value Source 2, Buried Pipe Design, A.P. Moser, Chapter 3
$W_c$ = Marston's load per unit length of pipe (lb/in)
r = mean radius of the pipe (in)
E = modulus of elasticity (lb/in$^2$)
I = moment of inertia of the pipe wall per unit length (in$^3$)
e = modulus of passive resistance fo the side fill (lb/in$^2$(in))

Modified Iowa Formula

$\Delta X = \frac{D_L K W_c r_m^3}{EI + 0.06E'r_m^3}$ Source 2, Equation 3.5 Buried Pipe Design, A.P. Moser, Chapter 3

| | | |
|---|---|---|
| $\Delta X$ = horizontal deflection (in) | | |
| $D_L$ = deflection lag factor | 1.0 | Prism Load used |
| Typical Value for Marston Load 1.5 | | |
| Typical Value for Prism Load 1.0 | | |
| K = bedding constant | 0.1 | typical value Buried Pipe Design, A.P. Moser, Chapter 3 |
| $P_T$ = Vertical load on pipe w/ perfs | 8.59 | lb/in$^2$ 1237 lb/ft$^2$ |
| $W_c$ = Marston's load per unit length of pipe = $P_T * D_o$ (lb/in) | 74.10 | lb/in |
| $D_o$ = pipe outer diameter (in) | 8.63 | SDR 11 pipe (Driscopipe) to be used |
| t = pipe wall thickness (in) | 0.78 | SDR 11 pipe (Driscopipe) to be used |
| $D_I$ = pipe inner diameter = $D_o$-2t (in) | 7.06 | SDR 11 pipe (Driscopipe) to be used |
| $D_m$ = pipe mean diameter = $D_o$ - 1.06t Source 1, Equation 7-27 | 7.79 | SDR 11 pipe (Driscopipe) to be used |
| $r_m$ = mean radius of the pipe (in) | 3.90 | SDR 11 pipe (Driscopipe) to be used |
| E = modulus of elasticity (lb/in$^2$) | 100,000.0 | lb/in2 for long term load at 100oF, 'Source 1, Table 5-1 |
| I = moment of inertia of the pipe wall per unit length | 0.040 | in$^4$/in |
| E' = modulus of soil reaction | 3,000.0 | lb/in$^2$ for moderate compaction and fine grained soils |

$\Delta X = \frac{D_L K W_c r_m^3}{EI + 0.06E'r_m^3}$ = 0.030 inch Source 2, Equation 3.5 Buried Pipe Design, A.P. Moser, Chapter 3

% Ring Deflection = ($\Delta X/D_m$) x 100 = 0.38% Source 1, Equation 7-31

Ring Bending Strain

$e = \frac{f_D \Delta X 2C}{D_M^2} \times 100$ Source 1, Equation 7-39

e = wall strain (%)

| | | |
|---|---|---|
| $f_D$ = deformation shape factor | 6 | Source 1, non-elliptical shape |
| $D_M$ = mean diameter (in) | | |
| C = outer fiber wall centroid = 0.5 (1.06t) | 0.416 | Source 1, Equation 7-41 |
| $\Delta X$ = ring deflection = $D_X/D_m$ | 0.004 | |

$e = f_D \frac{\Delta X}{D_M} \frac{2C}{D_M} \times 100$ = 0.2% Source 1, Equation 7-39

The maximum ring bending strain for high performance polyethylene non-pressure pipe is 5.0%

Pipe passes ring bending strain calculations TRUE

| CLIENT | PROJECT | JOB NO. |
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| SUBJECT | BY | DATE |
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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Collection Lateral** | CHECKED | DATE |
| Operation w/ CAT D7R Series II 1**0 Feet Waste** | | |

SOURCES

1.) Attachment - 1 - Chevron Phillips Chemical Company, Bulletin - Book 2 Chapter 5, 2003

2.) Attachment - 2 - Buried Pipe Design, A.P. Moser, Chapter 3

3.) Attachment - 3 - EPA, Lining of Waste Impoundment and Disposal Facilities, SW-870

4.) Attachment - 4 - Driscoplex Pipe Properties

5.) Attachment - 5 - CAT 826G Series II Compactor Data Sheet

6.) Attachment - 6 - CAT D7R Series II Equipment Data Sheet

7.) Attachment - 7 - CAT D6R XW Series II Equipment Data Sheet

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| CLIENT | PROJECT | JOB NO. |
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| Hardee County | Phase II Section II Expansion | 09199033.23 |

| SUBJECT | BY | DATE |
|---|---|---|
| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Collection Lateral** | CHECKED | DATE |
| Operation w/ CAT D7R Series II **25 Feet Waste** | | |

Load on Pipe (Overburden)

Prism Loads, $P_E$ = wH

w = unit weight

H = depth

| | Depth (ft) | Unit Weight (lb/ft$^3$) | $P_E$ (lb/ft$^2$) |
|---|---|---|---|
| Final cover | 0.0 | 115.0 | 0.0 |
| Intermediate cover | 0.0 | 115.0 | 0.0 |
| Waste/cover | 25.0 | 60.0 | 1500.0 |
| Drainage sand | 2.0 | 115.0 | 230.0 |
| Rock (No. 89 & No. 57) | 2.0 | 140.0 | 280.0 |

TOTAL SOIL PRISM LOAD $P_E$: 2010.0 lb/ft$^2$

Total Depth = 29.0 ft

Soil Arching, $P_m = C_D wB$

NOTE: The waste unit weight represents the combined unit weight of waste, daily cover, and moisture.

Pm = vertical soil pressure

B = trench width at pipe crown 6.0 ft

$C_D$ = load coefficient $= \frac{1 - e^{-2Ku'H/B}}{2Ku'}$ Equation 7-3, Source No. 1

e = natural log base number

K = Rankine earth pressure coefficient = $\tan^2(45-0.5*\phi)$

$\phi$ = internal soil friction angle = 27.0 degrees

u' = friction coefficient between backfill and trench sides = tan $\phi$

| Soil Type | Ku' |
|---|---|
| Saturated Clay | 0.110 |
| Ordinary Clay | 0.130 |
| Saturated Top Soil | 0.150 |
| Sand and Gravel | 0.165 |
| Clean Granular Soil | 0.192 |

| | Ku' | $C_D$ | $P_m$ (lb/ft$^2$) |
|---|---|---|---|
| Cover Soil | 0.150 | 0.00 | 0 |
| Int Cover | 0.165 | 0.00 | 0 |
| Waste | 0.191 | 2.08 | 750 |
| Drainage Sand | 0.165 | 0.32 | 217.8 |
| Granular Soil | 0.192 | 0.31 | 262.8 |

TOTAL SOIL ARCHING LOAD $P_M$: 1,230.4 lb/ft$^2$

MODIFIED ARCHING LOAD = $0.6P_M + 0.4P_E$: 1,542.23 lb/ft$^2$

OVERBURDEN LOAD: 1,542.23 lb/ft$^2$

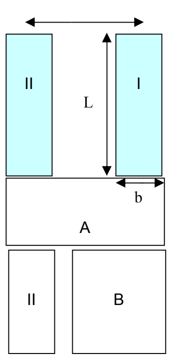
Load on Pipe With Equipment Refer to Attachment

Operation w/ CAT D7R Series II 25 Feet Waste

| | | | | | |
|---|---|---|---|---|---|
| Equipment Weight = | 54,573.0 | psf | Length of Track = L = | 113.0 | in |
| Number of Tracks = | 2.0 | | Track Width = b = | 22.0 | in |
| Track Load = $q_r$ = | 27,286.5 | psf | Track Gauge = G = | 78.0 | in |
| Ground contact area/track = | 17.3 | psf | Equipment Width "A" = | 113.0 | in |

Live Load = q*Ic q = track load 1,580.55 psf

Ic = Influence coefficient




| | b (ft) | L (ft) | z (ft) | m = b/z | n = L/z | I* | I** | I |
|---|---|---|---|---|---|---|---|---|
| I | 1.83 | 9.4 | 29.0 | 0.06 | 0.32 | 0.009 | 0.253 | 0.00900 |
| A | 8.33 | 9.4 | 29.0 | 0.29 | 0.32 | 0.039 | 0.261 | 0.03850 |
| B | 6.50 | 9.4 | 29.0 | 0.22 | 0.32 | 0.031 | 0.259 | 0.03077 |

Live Load$_1$ = I + II = $q_I(I_I) + q_A(I_A) - q_B(I_B)$ = 26.45 lb/ft$^2$

$q_I(I_I)$ = 14.22

$q_A(I_A)$ = 60.86

$q_B(I_B)$ = 48.63

Load on Pipe (Equipment) = 26.45 lb/ft$^2$

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| CLIENT | PROJECT | JOB NO. |
|---|---|---|
| Hardee County | Phase II Section II Expansion | 09199033.23 |

| SUBJECT | BY | DATE |
|---|---|---|
| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Collection Lateral** | CHECKED | DATE |
| Operation w/ CAT D7R Series II **25 Feet Waste** | | |

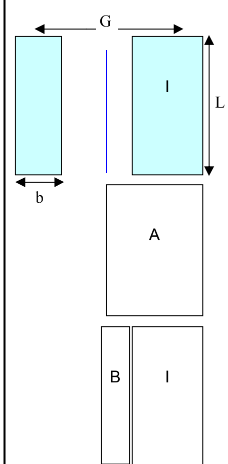
Load on Pipe (Equipment) *Continued*

Live Load = $q*I_c$

$q$ = track load 1580.55 $lb/ft^2$

$I_c$ = Influence coefficient

Alternative 2: Track stradling and parallel to pipe



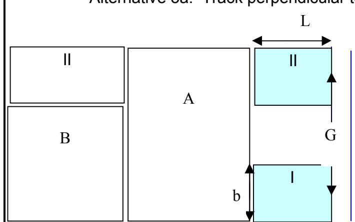

| | b | L | z | m = b/z | n = L/z | I* | I** | I |
|---|---|---|---|---|---|---|---|---|
| A | 4.71 | 9.4 | 29 | 0.16 | 0.32 | 0.023 | 0.257 | 0.02270 |
| B | 2.88 | 9.4 | 29 | 0.10 | 0.32 | 0.014 | 0.254 | 0.01404 |

Live Load$_2$ = 2 * (A - B) = 2 * ($q_A I_A$ - $q_B I_B$) = 27.36 $lb/ft^2$

| | |
|---|---|
| $q_A(I_A)$ = | 35.88 |
| $q_B(I_B)$ = | 22.20 |

Load on Pipe (Equipment) = 27.36 $lb/ft^2$

Alternative 3a: Track perpendicular to pipe




| | b | L | z | m = b/z | n = L/z | I* | I** | I |
|---|---|---|---|---|---|---|---|---|
| I | 1.83 | 9.4 | 29 | 0.06 | 0.32 | 0.009 | 0.253 | 0.00900 |
| A | 9.42 | 9.4 | 29 | 0.32 | 0.32 | 0.043 | 0.262 | 0.04279 |
| B | 7.58 | 9.4 | 29 | 0.26 | 0.32 | 0.035 | 0.261 | 0.03541 |

Live Load$_3$ = I + II = $q_I(I_I)$ + $q_A(I_A)$ - $q_B(I_B)$ = 25.90 $lb/ft^2$

| | |
|---|---|
| $q_I(I_I)$ = | 14.22 |
| $q_A(I_A)$ = | 67.64 |
| $q_B(I_B)$ = | 55.96 |

Load on Pipe (Equipment) = 25.90 $lb/ft^2$

LARGEST EQUIPEMENT LOAD = 27.36 $lb/ft^2$

VERTICAL OVERBURDEN LOAD = 1,542.23 $lb/ft^2$

VERTICAL EQUIPMENT LOAD = 27.36 $lb/ft^2$

TOTAL VERTICAL LOAD APPLIED TO PIPE, $P_T$ = 1,569.59 $lb/ft^2$ = 10.90 $lb/in^2$

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|---|---|---|
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Verify that perforations in the LCRS are adequate for the peak leachate flow.

Use discharge equation:

$Q = (Cd)(Ao)(2gh)^{0.5}$

$C_d$ = coeffiecient of discharge = 0.6 for short tube discharge with fluid/wall separation; conservative value.

$A_o$ = Area of orifice ($\pi D^2/4$)

g = gravitational acceleration (32.3 $ft^2/s$)

h = static head (ft)

Assumptions and Givens:

| | | | |
|---|---|---|---|
| 1. No. acres of landfill expansion = | 1.63 | acres | - Phase II Section II south portion |
| 2. Total length of pipe per expansion = | 539.7 | ft | |
| 3. Number of laterals = | 3.0 | | |
| 4. Total length of pipe per lateral = | 179.9 | ft | |
| 5. Perforation diameter = | 0.375 | inch | |
| 6. No. perforations/ft pipe = | 6.0 | perforations/ft of pipe length | |
| 7. Maximum head over pipe = | 1.0 | ft | |
| 8. Per HELP model summary table, $Q_{peak}$ = | 237.01 | gal/min | refer to HELP Model Summary Table |
| 9. Per HELP model summary table, $Q_{peak}$ = | 45,624.6 | cf/day | refer to HELP Model Summary Table |
| 10. Maximum flow/lateral = | 15,208.2 | cf/day/lateral | |
| 11. Maximum leachate flow/ft of pipe = | 84.54 | cf/day/ft of pipe | |

Solution:

$A_o = 0.25(\Pi)(d)^2 =$ 0.00077 $ft^2$

1. Flow per orifice, $Q = (Cd)(Ao)(2gh)^{0.5} =$ 0.0037 $ft^3/s$

2. Flow per ft of pipe = (Q)(# perfs/ft) = 0.02 $ft^3/s$ per ft of pipe

= 1914.47 cf/day/ft of pipe

Conclusion:

Design capacity exceeds estimated generation

1914.47 cf/day/ft of pipe >>> 84.54 cf/day/ft of pipe

Perforations are adequate to handle the maximum leachate flow.

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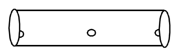
Effective pressure on pipe due to perforations:

$P_{EFF} = \frac{P_T \times 12}{(12 - L_P)}$ Source 3, EPA SW-870, p. 382

$L_P$ = Total accumulated length of perforations in one foot of pipe.

Since each perforation is 0.375 inch diameter and spaced at 6.0 inch on center,

$L_P$ = 1.5 inch



$P_T$ = 10.9 psi

$P_{EFF}$ = 12.5 psi

$P_{EFF}$ = 1793.8 psf

Check actual compressive pressure ($S_A$) per Driscopipe manual:

$S_A$ = 0.5 x (SDR - 1) x P(eff) = 62.3 psi

The recommended, long-term compressive strength ($Y_s$) design value for Driscoplex polyethylene pipe is 800 lb/in$^2$.

Source No. 1

| $S_A$ (psi): | | $Y_s$ (psi): |
|---|---|---|
| 62.3 | < | 800.0 |

Pipe passes wall compressive stress perforation calculations TRUE

FS = 12.8

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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Collection Lateral** | CHECKED | DATE |
| Operation w/ CAT D7R Series II **25 Feet Waste** | | |

Constrained pipe wall buckling (for Driscoplex OD controlled pipe)

$P_{WC} = \frac{5.65 * \{RB'E' E^*[12(DR-1)^3]^{-1}\}^{0.5}}{N}$ Source 1, Equation 7-5

$P_{WC}$ = allowable constrained buckling pressure (lb/in$^2$)

R = buoyancy reduction factor = 1 - 0.33 * (H'/H) Source 1, Equation 7-34

| | | |
|---|---|---|
| H' = groundwater height above pipe (ft) | 0.0 | ft |
| H = cover above pipe (ft) | 29.0 | ft |
| B' = elastic support factor =( 1+ 4*$e^{-0.065H}$ )$^{-1}$ | | Source 1, Equation 7-35 |
| E' = soil reaction modulus (lb/in$^2$) | 3000.0 | lb/in$^2$ for mod comp/crushed rock, 'Source 1, Table 7-7 |
| E = elastic modulus (lb/in$^2$) | 100000.0 | lb/in$^2$ for long term load at 100°F, 'Source 1, Table 5-1 |
| I = moment of inertia = $t^3$ / 12 | 0.0 | in$^4$/in |
| $D_o$ = pipe outer diameter (in) | 8.625 | SDR 11 pipe (Driscopipe) to be used |
| t = pipe wall thickness (in) | 0.784 | SDR 11 pipe (Driscopipe) to be used |
| DR = pipe dimension ratio = $D_o$ / t | 11.0 | SDR 11 pipe (Driscopipe) to be used |
| $D_I$ = pipe inner diameter = $D_o$ - 2t (in) | 7.1 | SDR 11 pipe (Driscopipe) to be used |
| N = safety factor | 2.0 | |

| Cover (ft) | (ft) | (ft) | B' | R | (lb/in$^2$) |
|---|---|---|---|---|---|
| 25.0 | 29 | 0 | 0.62 | 1.00 | 352.25 |

$P_{WC}$ = 352.25 lb/in$^2$

$P_{EFF}$ = 12.46 lb/in$^2$

Pipe passes contrained wall buckling calculations TRUE FS = 28.3

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| Operation w/ CAT D7R Series II **25 Feet Waste** | | |

Constrained Pipe Wall Compressive Stress (for Driscoplex OD controlled pipe)

$S = \frac{P_T D_o}{288t}$ Source No. 1

S = pipe wall compressive stress (lb/in$^2$)

| | | |
|---|---|---|
| $P_T$ = vertical load applied to pipe w/ perfs (lb/ft$^2$) | 1793.8 | lb/ft$^2$ |
| $D_o$ = pipe outside diameter (in) | 8.63 | SDR 11 pipe (Driscopipe) to be used |
| t = pipe wall thickness (in) | 0.784 | SDR 11 pipe (Driscopipe) to be used |

$S = \frac{P_T D_o}{288t} =$ 68.5 lb/in$^2$

The recommended, long-term compressive strength ($Y_s$) design value for Driscoplex polyethylene pipe is 800 lb/in$^2$.

Source No. 1

| S (psi): | | $Y_s$ (psi): |
|---|---|---|
| 68.5 | < | 800.0 |

Pipe passes wall compressive stress calculations TRUE

FS = 11.7

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Iowa Formula

$\Delta X = \dfrac{D_L K W_c r^3}{EI + 0.06er^4}$ Source 2, Equation 3.4 Buried Pipe Design, A.P. Moser, Chapter 3

$\Delta X$ = horizontal deflection (in)

$D_L$ = deflection lag factor

K = bedding constant | 0.1 | typical value Source 2, Buried Pipe Design, A.P. Moser, Chapter 3

$W_c$ = Marston's load per unit length of pipe (lb/in)

r = mean radius of the pipe (in)

E = modulus of elasticity (lb/in$^2$)

I = moment of inertia of the pipe wall per unit length (in$^3$)

e = modulus of passive resistance fo the side fill (lb/in$^2$(in))

Modified Iowa Formula

$\Delta X = \dfrac{D_L K W_c r_m^3}{EI + 0.06E'r_m^3}$ Source 2, Equation 3.5 Buried Pipe Design, A.P. Moser, Chapter 3

| | | |
|---|---|---|
| $\Delta X$ = horizontal deflection (in) | | |
| $D_L$ = deflection lag factor | 1.0 | Prism Load used |
| Typical Value for Marston Load | 1.5 | |
| Typical Value for Prism Load | 1.0 | |
| K = bedding constant | 0.1 | typical value Buried Pipe Design, A.P. Moser, Chapter 3 |
| $P_T$ = Vertical load on pipe w/ perfs | 12.46 | lb/in$^2$ 1794 lb/ft$^2$ |
| $W_c$ = Marston's load per unit length of pipe = $P_T$ * $D_o$ (lb/in) | 107.44 | lb/in |
| $D_o$ = pipe outer diameter (in) | 8.63 | SDR 11 pipe (Driscopipe) to be used |
| t = pipe wall thickness (in) | 0.78 | SDR 11 pipe (Driscopipe) to be used |
| $D_I$ = pipe inner diameter = $D_o$-2t (in) | 7.06 | SDR 11 pipe (Driscopipe) to be used |
| $D_m$ = pipe mean diameter = $D_o$ - 1.06t Source 1, Equation 7-27 | 7.79 | SDR 11 pipe (Driscopipe) to be used |
| $r_m$ = mean radius of the pipe (in) | 3.90 | SDR 11 pipe (Driscopipe) to be used |
| E = modulus of elasticity (lb/in$^2$) | 100,000.0 | lb/in2 for long term load at 100oF, 'Source 1, Table 5-1 |
| I = moment of inertia of the pipe wall per unit length | 0.040 | in$^4$/in |
| E' = modulus of soil reaction | 3,000.0 | lb/in$^2$ for moderate compaction and fine grained soils |

$\Delta X = \dfrac{D_L K W_c r_m^3}{EI + 0.06E'r_m^3} =$ 0.043 inch Source 2, Equation 3.5 Buried Pipe Design, A.P. Moser, Chapter 3

% Ring Deflection = $(\Delta X/D_m) \times 100$ = 0.56% Source 1, Equation 7-31

Ring Bending Strain

$e = \dfrac{f_D \Delta X 2C}{D_M^2} \times 100$ Source 1, Equation 7-39

| | | |
|---|---|---|
| e = wall strain (%) | | |
| $f_D$ = deformation shape factor | 6 | Source 1, non-elliptical shape |
| $D_M$ = mean diameter (in) | | |
| C = outer fiber wall centroid = 0.5 (1.06t) | 0.416 | Source 1, Equation 7-41 |
| $\Delta X$ = ring deflection = $D_X/D_m$ | 0.006 | |

$e = f_D\left(\dfrac{\Delta X}{D_M}\right)\left(\dfrac{2C}{D_M}\right) \times 100 =$ 0.4% Source 1, Equation 7-39

The maximum ring bending strain for high performance polyethylene non-pressure pipe is 5.0%

Pipe passes ring bending strain calculations TRUE

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| **8" Diameter Leachate Collection Lateral** | CHECKED | DATE |
| Operation w/ CAT D7R Series II **25 Feet Waste** | | |

SOURCES

1.) Attachment - 1 - Chevron Phillips Chemical Company, Bulletin - Book 2 Chapter 5, 2003

2.) Attachment - 2 - Buried Pipe Design, A.P. Moser, Chapter 3

3.) Attachment - 3 - EPA, Lining of Waste Impoundment and Disposal Facilities, SW-870

4.) Attachment - 4 - Driscoplex Pipe Properties

5.) Attachment - 5 - CAT 826G Series II Compactor Data Sheet

6.) Attachment - 6 - CAT D7R Series II Equipment Data Sheet

7.) Attachment - 7 - CAT D6R XW Series II Equipment Data Sheet

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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
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| Operation w/ CAT D7R Series II **60 Feet Waste** | | |

Load on Pipe (Overburden)

Prism Loads, $P_E$ = wH

w = unit weight

H = depth

| | Depth (ft) | Unit Weight ($lb/ft^3$) | $P_E$ ($lb/ft^2$) |
|---|---|---|---|
| Final cover | 2.0 | 115.0 | 230.0 |
| Intermediate cover | 1.0 | 115.0 | 115.0 |
| Waste/cover | 60.0 | 60.0 | 3600.0 |
| Drainage sand | 2.0 | 115.0 | 230.0 |
| Rock (No. 89 & No. 57) | 2.0 | 140.0 | 280.0 |

TOTAL SOIL PRISM LOAD $P_E$: 4455.0 $lb/ft^2$

Total Depth = 67.0 ft

Soil Arching, $P_m = C_D wB$

NOTE: The waste unit weight represents the combined unit weight of waste, daily cover, and moisture.

Pm = vertical soil pressure

B = trench width at pipe crown 6.0 ft

$C_D$ = load coefficient $= \frac{1 - e^{-2Ku'H/B}}{2Ku'}$ Equation 7-3, Source No. 1

e = natural log base number

K = Rankine earth pressure coefficient = $\tan^2(45-0.5*\phi)$

$\phi$ = internal soil friction angle = 27.0 degrees

u' = friction coefficient between backfill and trench sides = tan $\phi$

| Soil Type | Ku' |
|---|---|
| Saturated Clay | 0.110 |
| Ordinary Clay | 0.130 |
| Saturated Top Soil | 0.150 |
| Sand and Gravel | 0.165 |
| Clean Granular Soil | 0.192 |

| | Ku' | $C_D$ | $P_m$ ($lb/ft^2$) |
|---|---|---|---|
| Cover Soil | 0.150 | 0.32 | 219 |
| Int Cover | 0.165 | 0.16 | 112 |
| Waste | 0.191 | 2.56 | 920 |
| Drainage Sand | 0.165 | 0.32 | 217.8 |
| Granular Soil | 0.192 | 0.31 | 262.8 |

TOTAL SOIL ARCHING LOAD $P_M$: 1,731.6 $lb/ft^2$

MODIFIED ARCHING LOAD = $0.6P_M+0.4P_E$: 2,820.98 $lb/ft^2$

OVERBURDEN LOAD: 2,820.98 $lb/ft^2$

Load on Pipe With Equipment Refer to Attachment

Operation w/ CAT D7R Series II 60 Feet Waste

Equipment Weight = 54,573.0 psf

Number of Tracks = 2.0

Track Load = $q_r$ = 27,286.5 psf

Ground contact area/track = 17.3 psf

Length of Track = L = 113.0 in

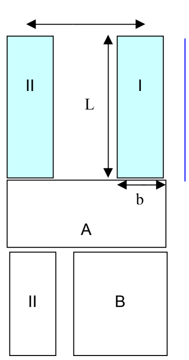
Track Width = b = 22.0 in

Track Gauge = G = 78.0 in

Equipment Width "A" = 113.0 in

Live Load = q*Ic q = track load 1,580.55 psf

Ic = Influence coefficient




| | b (ft) | L (ft) | z (ft) | m = b/z | n = L/z | I* | I** | I |
|---|---|---|---|---|---|---|---|---|
| I | 1.83 | 9.4 | 67.0 | 0.03 | 0.14 | 0.002 | 0.251 | 0.00181 |
| A | 8.33 | 9.4 | 67.0 | 0.12 | 0.14 | 0.008 | 0.253 | 0.00811 |
| B | 6.50 | 9.4 | 67.0 | 0.10 | 0.14 | 0.006 | 0.252 | 0.00636 |

$\text{Live Load}_1 = I + II = q_I(I_I) + q_A(I_A) - q_B(I_B) =$ 5.62 $lb/ft^2$

$q_I(I_I)$ = 2.85

$q_A(I_A)$ = 12.82

$q_B(I_B)$ = 10.05

Load on Pipe (Equipment) = 5.62 $lb/ft^2$

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| Operation w/ CAT D7R Series II **60 Feet Waste** | | |

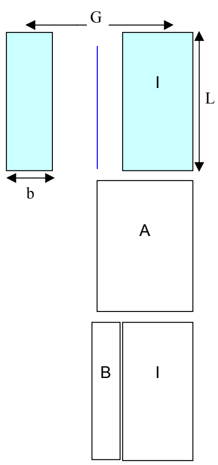
Load on Pipe (Equipment) *Continued*

Live Load = $q*I_c$

$q$ = track load 1580.55 lb/ft$^2$

$I_c$ = Influence coefficient

Alternative 2: Track stradling and parallel to pipe



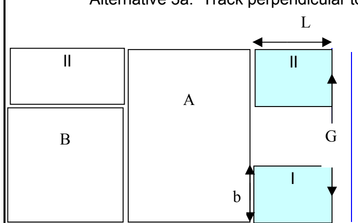

| | b | L | z | m = b/z | n = L/z | I* | I** | I |
|---|---|---|---|---|---|---|---|---|
| A | 4.71 | 9.4 | 67 | 0.07 | 0.14 | 0.005 | 0.252 | 0.00462 |
| B | 2.88 | 9.4 | 67 | 0.04 | 0.14 | 0.003 | 0.251 | 0.00283 |

Live Load$_2$ = 2 * (A - B) = 2 * ($q_A I_A$ - $q_B I_B$) = 5.66 lb/ft$^2$

| | |
|---|---|
| $q_A(I_A)$ = | 7.30 |
| $q_B(I_B)$ = | 4.47 |

Load on Pipe (Equipment) = 5.66 lb/ft$^2$

Alternative 3a: Track perpendicular to pipe




| | b | L | z | m = b/z | n = L/z | I* | I** | I |
|---|---|---|---|---|---|---|---|---|
| I | 1.83 | 9.4 | 67 | 0.03 | 0.14 | 0.002 | 0.251 | 0.00181 |
| A | 9.42 | 9.4 | 67 | 0.14 | 0.14 | 0.009 | 0.253 | 0.00913 |
| B | 7.58 | 9.4 | 67 | 0.11 | 0.14 | 0.007 | 0.252 | 0.00739 |

Live Load$_3$ = I + II = $q_I(I_I)$ + $q_A(I_A)$ - $q_B(I_B)$ = 5.60 lb/ft$^2$

| | |
|---|---|
| $q_I(I_I)$ = | 2.85 |
| $q_A(I_A)$ = | 14.43 |
| $q_B(I_B)$ = | 11.69 |

Load on Pipe (Equipment) = 5.60 lb/ft$^2$

LARGEST EQUIPEMENT LOAD = 5.66 lb/ft$^2$

VERTICAL OVERBURDEN LOAD = 2,820.98 lb/ft$^2$

VERTICAL EQUIPMENT LOAD = 5.66 lb/ft$^2$

TOTAL VERTICAL LOAD APPLIED TO PIPE, $P_T$ = 2,826.65 lb/ft$^2$ = 19.63 lb/in$^2$

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| Operation w/ CAT D7R Series II **60 Feet Waste** | | |

Verify that perforations in the LCRS are adequate for the peak leachate flow.

Use discharge equation:

$Q = (Cd)(Ao)(2gh)^{0.5}$

$C_d$ = coeffiecient of discharge = 0.6 for short tube discharge with fluid/wall separation; conservative value.

$A_o$ = Area of orifice ($\pi D^2/4$)

g = gravitational acceleration (32.3 $ft^2/s$)

h = static head (ft)

Assumptions and Givens:

| | | | |
|---|---|---|---|
| 1. No. acres of landfill expansion = | 1.63 | acres | - Phase II Section II south portion |
| 2. Total length of pipe per expansion = | 539.7 | ft | |
| 3. Number of laterals = | 3.0 | | |
| 4. Total length of pipe per lateral = | 179.9 | ft | |
| 5. Perforation diameter = | 0.375 | inch | |
| 6. No. perforations/ft pipe = | 6.0 | perforations/ft of pipe length | |
| 7. Maximum head over pipe = | 1.0 | ft | |
| 8. Per HELP model summary table, $Q_{peak}$ = | 237.01 | gal/min | refer to HELP Model Summary Table |
| 9. Per HELP model summary table, $Q_{peak}$ = | 45,624.6 | cf/day | refer to HELP Model Summary Table |
| 10. Maximum flow/lateral = | 15,208.2 | cf/day/lateral | |
| 11. Maximum leachate flow/ft of pipe = | 84.54 | cf/day/ft of pipe | |

Solution:

$A_o = 0.25(\Pi)(d)^2 =$ 0.00077 $ft^2$

1. Flow per orifice, $Q = (Cd)(Ao)(2gh)^{0.5} =$ 0.0037 $ft^3/s$

2. Flow per ft of pipe = (Q)(# perfs/ft) = 0.02 $ft^3/s$ per ft of pipe

= 1914.47 cf/day/ft of pipe

Conclusion:

Design capacity exceeds estimated generation

1914.47 cf/day/ft of pipe >>> 84.54 cf/day/ft of pipe

Perforations are adequate to handle the maximum leachate flow.

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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Collection Lateral** | CHECKED | DATE |
| Operation w/ CAT D7R Series II **60 Feet Waste** | | |

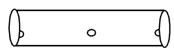
Effective pressure on pipe due to perforations:

$P_{EFF} = \frac{P_T \times 12}{(12 - L_P)}$ Source 3, EPA SW-870, p. 382

$L_P$ = Total accumulated length of perforations in one foot of pipe.

Since each perforation is 0.375 inch diameter and spaced at 6.0 inch on center,

$L_P$ = 1.5 inch



$P_T$ = 19.6 psi

$P_{EFF}$ = 22.4 psi

$P_{EFF}$ = 3230.5 psf

Check actual compressive pressure ($S_A$) per Driscopipe manual:

$S_A$ = 0.5 x (SDR - 1) x P(eff) = 112.2 psi

The recommended, long-term compressive strength ($Y_s$) design value for Driscoplex polyethylene pipe is 800 $lb/in^2$.

Source No. 1

| $S_A$ (psi): | | $Y_s$ (psi): |
|---|---|---|
| 112.2 | < | 800.0 |

Pipe passes wall compressive stress perforation calculations TRUE

FS = 7.1

| SCS ENGINEERS | | | |
|---|---|---|---|
| | | SHEET 5 | OF 8 |
| CLIENT<br>Hardee County | PROJECT<br>Phase II Section II Expansion | JOB NO.<br>09199033.23 | |
| SUBJECT<br>Pipe Crushing Calculations **RAI No. 1** | | BY<br>SRF | DATE<br>4/1/13 |
| **8" Diameter Leachate Collection Lateral**<br>Operation w/ CAT D7R Series II **60 Feet Waste** | | CHECKED | DATE |

Constrained pipe wall buckling (for Driscoplex OD controlled pipe)

$P_{WC} = \frac{5.65 * \{RB'E' E*[12(DR-1)^3]^{-1}\}^{0.5}}{N}$ Source 1, Equation 7-5

$P_{WC}$ = allowable constrained buckling pressure (lb/in$^2$)

| | | |
|---|---|---|
| R = buoyancy reduction factor = 1 - 0.33 * (H'/H) | Source 1, Equation 7-34 | |
| H' = groundwater height above pipe (ft) | 0.0 | ft |
| H = cover above pipe (ft) | 67.0 | ft |
| B' = elastic support factor =( 1+ 4*$e^{-0.065H}$ )$^{-1}$ | Source 1, Equation 7-35 | |
| E' = soil reaction modulus (lb/in$^2$) | 3000.0 | lb/in$^2$ for mod comp/crushed rock, 'Source 1, Table 7-7 |
| E = elastic modulus (lb/in$^2$) | 100000.0 | lb/in$^2$ for long term load at 100$^o$F, 'Source 1, Table 5-1 |
| I = moment of inertia = $t^3$ / 12 | 0.0 | in$^4$/in |
| $D_o$ = pipe outer diameter (in) | 8.625 | SDR 11 pipe (Driscopipe) to be used |
| t = pipe wall thickness (in) | 0.784 | SDR 11 pipe (Driscopipe) to be used |
| DR = pipe dimension ratio = $D_o$ / t | 11.0 | SDR 11 pipe (Driscopipe) to be used |
| $D_I$ = pipe inner diameter = $D_o$ - 2t (in) | 7.1 | SDR 11 pipe (Driscopipe) to be used |
| N = safety factor | 2.0 | |

| Cover (ft) | (ft) | (ft) | B' | R | (lb/in$^2$) |
|---|---|---|---|---|---|
| 60.0 | 67 | 0 | 0.95 | 1.00 | 435.54 |

$P_{WC}$ = 435.54 lb/in$^2$

$P_{EFF}$ = 22.43 lb/in$^2$

Pipe passes contrained wall buckling calculations TRUE    FS = 19.4

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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Collection Lateral** | CHECKED | DATE |
| Operation w/ CAT D7R Series II **60 Feet Waste** | | |

Constrained Pipe Wall Compressive Stress (for Driscoplex OD controlled pipe)

$S = \frac{P_T D_o}{288t}$ Source No. 1

S = pipe wall compressive stress (lb/in$^2$)

| | | |
|---|---|---|
| $P_T$ = vertical load applied to pipe w/ perfs (lb/ft$^2$) | 3230.5 | lb/ft$^2$ |
| $D_o$ = pipe outside diameter (in) | 8.63 | SDR 11 pipe (Driscopipe) to be used |
| t = pipe wall thickness (in) | 0.784 | SDR 11 pipe (Driscopipe) to be used |

$S = \frac{P_T D_o}{288t} =$ 123.4 lb/in$^2$

The recommended, long-term compressive strength ($Y_s$) design value for Driscoplex polyethylene pipe is 800 lb/in$^2$.

Source No. 1

| S (psi): | | $Y_s$ (psi): |
|---|---|---|
| 123.4 | < | 800.0 |

Pipe passes wall compressive stress calculations TRUE

FS = 6.5

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|---|---|---|
| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Collection Lateral** | CHECKED | DATE |
| Operation w/ CAT D7R Series II **60 Feet Waste** | | |

Iowa Formula

$\Delta X = \dfrac{D_L K W_c r^3}{EI + 0.06er^4}$ Source 2, Equation 3.4 Buried Pipe Design, A.P. Moser, Chapter 3

$\Delta X$ = horizontal deflection (in)

$D_L$ = deflection lag factor

K = bedding constant | 0.1 | typical value Source 2, Buried Pipe Design, A.P. Moser, Chapter 3

$W_c$ = Marston's load per unit length of pipe (lb/in)

r = mean radius of the pipe (in)

E = modulus of elasticity (lb/in$^2$)

I = moment of inertia of the pipe wall per unit length (in$^3$)

e = modulus of passive resistance fo the side fill (lb/in$^2$(in))

Modified Iowa Formula

$\Delta X = \dfrac{D_L K W_c r_m^3}{EI + 0.06E'r_m^3}$ Source 2, Equation 3.5 Buried Pipe Design, A.P. Moser, Chapter 3

$\Delta X$ = horizontal deflection (in)

| | | |
|---|---|---|
| $D_L$ = deflection lag factor | 1.0 | Prism Load used |
| Typical Value for Marston Load | 1.5 | |
| Typical Value for Prism Load | 1.0 | |
| K = bedding constant | 0.1 | typical value Buried Pipe Design, A.P. Moser, Chapter 3 |
| $P_T$ = Vertical load on pipe w/ perfs | 22.43 | lb/in$^2$ 3230 lb/ft$^2$ |
| $W_c$ = Marston's load per unit length of pipe = $P_T * D_o$ (lb/in) | 193.49 | lb/in |
| $D_o$ = pipe outer diameter (in) | 8.63 | SDR 11 pipe (Driscopipe) to be used |
| t = pipe wall thickness (in) | 0.78 | SDR 11 pipe (Driscopipe) to be used |
| $D_I$ = pipe inner diameter = $D_o$-2t (in) | 7.06 | SDR 11 pipe (Driscopipe) to be used |
| $D_m$ = pipe mean diameter = $D_o$ - 1.06t Source 1, Equation 7-27 | 7.79 | SDR 11 pipe (Driscopipe) to be used |
| $r_m$ = mean radius of the pipe (in) | 3.90 | SDR 11 pipe (Driscopipe) to be used |
| E = modulus of elasticity (lb/in$^2$) | 100,000.0 | lb/in2 for long term load at 100oF, 'Source 1, Table 5-1 |
| I = moment of inertia of the pipe wall per unit length | 0.040 | in$^4$/in |
| E' = modulus of soil reaction | 3,000.0 | lb/in$^2$ for moderate compaction and fine grained soils |

$\Delta X = \dfrac{D_L K W_c r_m^3}{EI + 0.06E'r_m^3}$ = 0.078 inch   Source 2, Equation 3.5 Buried Pipe Design, A.P. Moser, Chapter 3

% Ring Deflection = ($\Delta X/D_m$) x 100 = 1.00% Source 1, Equation 7-31

Ring Bending Strain

$e = \dfrac{f_D \Delta X 2C}{D_M^2} \times 100$   Source 1, Equation 7-39

e = wall strain (%)

| | | |
|---|---|---|
| $f_D$ = deformation shape factor | 6 | Source 1, non-elliptical shape |
| $D_M$ = mean diameter (in) | | |
| C = outer fiber wall centroid = 0.5 (1.06t) | 0.416 | Source 1, Equation 7-41 |
| $\Delta X$ = ring deflection = $D_X/D_m$ | 0.010 | |

$e = f_D \left(\dfrac{\Delta X}{D_M}\right)\left(\dfrac{2C}{D_M}\right) \times 100$ = 0.6% Source 1, Equation 7-39

The maximum ring bending strain for high performance polyethylene non-pressure pipe is 5.0%

Pipe passes ring bending strain calculations TRUE

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| SUBJECT | BY | DATE |
|---|---|---|
| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Collection Lateral** | CHECKED | DATE |
| Operation w/ CAT D7R Series II **60 Feet Waste** | | |

SOURCES

1.) Attachment - 1 - Chevron Phillips Chemical Company, Bulletin - Book 2 Chapter 5, 2003

2.) Attachment - 2 - Buried Pipe Design, A.P. Moser, Chapter 3

3.) Attachment - 3 - EPA, Lining of Waste Impoundment and Disposal Facilities, SW-870

4.) Attachment - 4 - Driscoplex Pipe Properties

5.) Attachment - 5 - CAT 826G Series II Compactor Data Sheet

6.) Attachment - 6 - CAT D7R Series II Equipment Data Sheet

7.) Attachment - 7 - CAT D6R XW Series II Equipment Data Sheet

# Summary Table and 10-Inch Leachate Collection Lateral Pipe Crushing and Flow Capacity Calculations North and Center Portions

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| CLIENT | PROJECT | JOB NO. |
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| Hardee County | Phase II Section II Expansion | 09199033.23 |

| SUBJECT | BY | DATE |
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| Phase II Section II **RAI No. 1** | SRF | 4/1/13 |
| Summary Table Pipe Crushing **Operations** | CHECKED | DATE |
| **10" Diameter Leachate Collection Lateral North and Center Portions** | | |

| Description | Waste Height (ft) | Fill Height (ft) | Pipe Diameter (in) | Type of Calculation | Design Value | Calculated Value | Units | Safety Factor* |
|---|---|---|---|---|---|---|---|---|
| CAT D7R Series II | 0 | 2 | 10 | Flow Capacity | 1914.47 | 41.06 | cf/day/ft of pipe | 46.62 |
| | | | | Buckling | 220.92 | 5.59 | psi | 39.50 |
| | | | | Compressive Stress | 800 | 30.77 | psi | 26.00 |
| | | | | Bending Strain | 5.0% | 0.2% | % | 31.30 |
| CAT D7R Series II | 10 | 12 | 10 | Flow Capacity | 1914.47 | 41.06 | cf/day/ft of pipe | 46.62 |
| | | | | Buckling | 276.35 | 8.59 | psi | 32.16 |
| | | | | Compressive Stress | 800 | 47.27 | psi | 16.92 |
| | | | | Bending Strain | 5.0% | 0.2% | % | 20.37 |
| CAT D7R Series II | 25 | 27 | 10 | Flow Capacity | 1914.47 | 41.06 | cf/day/ft of pipe | 46.62 |
| | | | | Buckling | 352.16 | 12.46 | psi | 28.27 |
| | | | | Compressive Stress | 800 | 68.53 | psi | 11.67 |
| | | | | Bending Strain | 5.0% | 0.4% | % | 14.05 |
| CAT D7R Series II | 60 | 65 | 10 | Flow Capacity | 1914.47 | 41.06 | cf/day/ft of pipe | 46.62 |
| | | | | Buckling | 435.42 | 22.43 | psi | 19.41 |
| | | | | Compressive Stress | 800 | 123.42 | psi | 6.48 |
| | | | | Bending Strain | 5.0% | 0.6% | % | 7.80 |
| CAT 826 G Series II Compactor | 0 | 2 | 10 | Flow Capacity | 1914.47 | 41.06 | cf/day/ft of pipe | 46.62 |
| | | | | Buckling | 220.92 | 11.53 | psi | 19.16 |
| | | | | Compressive Stress | 800 | 63.43 | psi | 12.61 |
| | | | | Bending Strain | 5.0% | 0.3% | % | 15.18 |
| CAT 826 G Series II Compactor | 10 | 12 | 10 | Flow Capacity | 1914.47 | 41.06 | cf/day/ft of pipe | 46.62 |
| | | | | Buckling | 276.35 | 9.63 | psi | 28.70 |
| | | | | Compressive Stress | 800 | 52.98 | psi | 15.10 |
| | | | | Bending Strain | 5.0% | 0.3% | % | 18.18 |
| CAT 826 G Series II Compactor | 25 | 27 | 10 | Flow Capacity | 1914.47 | 41.06 | cf/day/ft of pipe | 46.62 |
| | | | | Buckling | 352.16 | 12.83 | psi | 27.45 |
| | | | | Compressive Stress | 800 | 70.57 | psi | 11.34 |
| | | | | Bending Strain | 5.0% | 0.4% | % | 13.65 |
| CAT 826 G Series II Compactor | 60 | 65 | 10 | Flow Capacity | 1914.47 | 41.06 | cf/day/ft of pipe | 46.62 |
| | | | | Buckling | 435.42 | 22.52 | psi | 19.33 |
| | | | | Compressive Stress | 800 | 123.91 | psi | 6.46 |
| | | | | Bending Strain | 5.0% | 0.6% | % | 7.77 |

* Safety Factor = Design Value/Calculated Value

**Revised April 1, 2013**

| CLIENT | PROJECT | JOB NO. |
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| Phase II Section II **RAI No. 1** | SRF | 4/1/13 |
| Summary Table Pipe Crushing **Construction** | CHECKED | DATE |
| **10" Diameter Leachate Collection Lateral North and Center Portions** | | |

| Description | Waste Height (ft) | Fill Height (ft) | Pipe Diameter (in) | Type of Calculation | Design Value | Calculated Value | Units | Safety Factor* |
|---|---|---|---|---|---|---|---|---|
| CAT D6R XW Series II | 0 | 1 | 10 | Flow Capacity | 1914.47 | 41.06 | cf/day/ft of pipe | 46.62 |
| | | | | Buckling | 204.89 | 2.93 | psi | 69.89 |
| | | | | Compressive Stress | 800 | 16.13 | psi | 49.60 |
| | | | | Bending Strain | 5.0% | 0.1% | % | 59.72 |

* Safety Factor = Design Value/Calculated Value

**Revised April 1, 2013**

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| CLIENT | PROJECT | JOB NO. |
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| SUBJECT | BY | DATE |
|---|---|---|
| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **10" Diameter Leachate Collection Lateral Pipe** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **0 Feet Waste** | | |

Load on Pipe (Overburden)

Prism Loads, $P_E$ = wH

w = unit weight

H = depth

| | Depth (ft) | Unit Weight (lb/ft³) | $P_E$ (lb/ft²) |
|---|---|---|---|
| Final cover | 0.0 | 115.0 | 0.0 |
| Intermediate cover | 0.0 | 115.0 | 0.0 |
| Waste/cover | 0.0 | 60.0 | 0.0 |
| Drainage sand | 2.0 | 115.0 | 230.0 |
| Rock (No. 89 & No. 57) | 2.0 | 140.0 | 280.0 |

TOTAL SOIL PRISM LOAD $P_E$: 510.0 lb/ft²

Total Depth = 4.0 ft

Soil Arching, $P_m = C_D wB$

Pm = vertical soil pressure

B = trench width at pipe crown 6.0 ft

$C_D$ = load coefficient $= \frac{1 - e^{-2Ku'H/B}}{2Ku'}$ Equation 7-3, Source No. 1

NOTE: The waste unit weight represents the combined unit weight of waste, daily cover, and moisture.

e = natural log base number

K = Rankine earth pressure coefficient = $\tan^2(45-0.5*\phi)$

$\phi$ = internal soil friction angle = 27.0 degrees

u' = friction coefficient between backfill and trench sides = tan $\phi$

| Soil Type | Ku' |
|---|---|
| Saturated Clay | 0.110 |
| Ordinary Clay | 0.130 |
| Saturated Top Soil | 0.150 |
| Sand and Gravel | 0.165 |
| Clean Granular Soil | 0.192 |

| | Ku' | $C_D$ | $P_m$ (lb/ft²) |
|---|---|---|---|
| Cover Soil | 0.150 | 0.00 | 0 |
| Int Cover | 0.165 | 0.00 | 0 |
| Waste | 0.191 | 0.00 | 0 |
| Drainage Sand | 0.165 | 0.32 | 217.8 |
| Granular Soil | 0.192 | 0.31 | 262.8 |

TOTAL SOIL ARCHING LOAD $P_M$: 480.6 lb/ft²

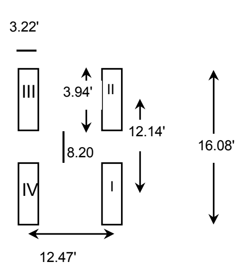
MODIFIED ARCHING LOAD = $0.6P_M+0.4P_E$: 492.37 lb/ft²

OVERBURDEN LOAD: 492.37 lb/ft²

Load on Pipe With Equipment Refer to Attachment

Operation w/ CAT 826G Series II Compactor 0 Feet Waste

Equipment Weight = 81,498.0 psf




| | | | |
|---|---|---|---|
| Track per Load = $q_r$ = | 1,670.20 | psf | (Rear) |
| Track per Load = $q_{fr}$ = | 1,541.72 | psf | (Front) |
| Length of Track = L = | 3.22 | ft | (contact length) |
| Length of Track = b = | 8.20 | ft | |
| Track Width = | 12.47 | ft | |
| Track Width (I to II) = | 16.08 | ft | |

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| SUBJECT | BY | DATE |
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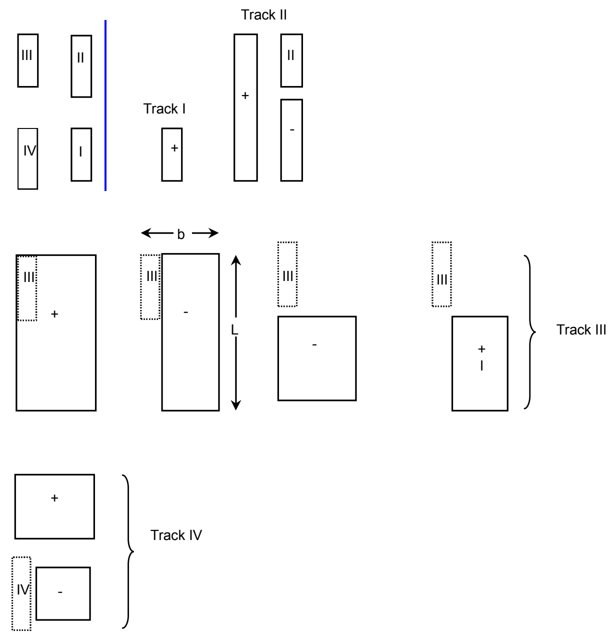
| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **10" Diameter Leachate Collection Lateral Pipe** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **0 Feet Waste** | | |

Load on Pipe

Alternative 1: Track Adjacent and Parallel to Pipe




| | b | L | z | m = b/z | n = L/z | I* | I** | I | |
|---|---|---|---|---|---|---|---|---|---|
| Track I | 8.2 | 3 | 4 | 2.05 | 0.81 | 0.182 | 0.241 | 0.18205 | (ADD) |
| | | | | | | | | | |
| Track II | 8.2 | 16.1 | 4 | 2.05 | 4.02 | -0.010 | 0.240 | 0.23973 | (ADD) |
| | 8.2 | 11.4 | 4 | 2.05 | 2.86 | -0.012 | 0.238 | 0.23802 | (SUBTRACT) |
| | | | | | | | | | |
| Track IV | 12.47 | 3.22 | 4 | 3.12 | 0.81 | 0.185 | 0.231 | 0.18478 | (ADD) |
| | 12.47 | 3.22 | 4 | 3.12 | 0.81 | 0.185 | 0.231 | 0.18478 | (SUBTRACT) |
| | | | | | | | | | |
| Track III | 12.47 | 16.08 | 4 | 3.12 | 4.02 | -0.004 | 0.246 | 0.24588 | (ADD) |
| | 4.27 | 16.08 | 4 | 1.07 | 4.02 | -0.041 | 0.209 | 0.20918 | (SUBTRACT) |
| | 12.47 | 11.42 | 4 | 3.12 | 2.86 | -0.006 | 0.244 | 0.24379 | (SUBTRACT) |
| | 4.27 | 8.47 | 4 | 1.07 | 2.12 | 0.206 | 0.226 | 0.20553 | (ADD) |

$\text{Live Load}_1 = q_r(\Sigma I) + q_{fr}(\Sigma II) + q_{fr}(\Sigma III) + q_r(\Sigma IV)$

$\text{Live Load}_1 =$ 304.29 psf

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| CLIENT | PROJECT | JOB NO. |
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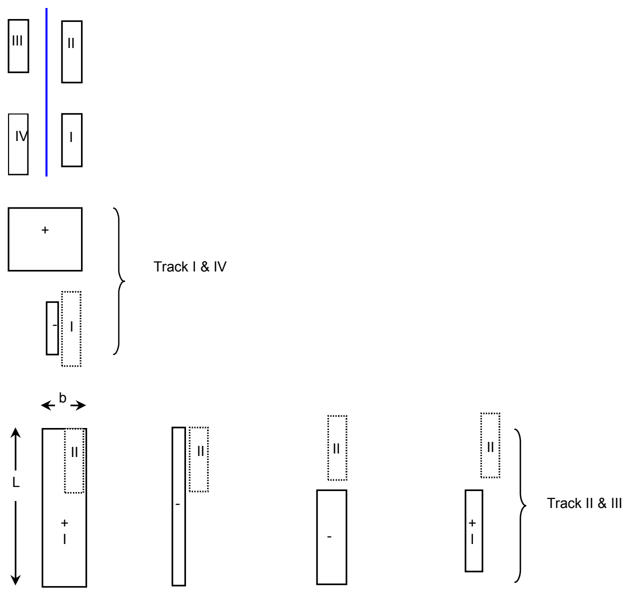
| Hardee County | Phase II Section II Expansion | 09199033.23 |

| SUBJECT | BY | DATE |
|---|---|---|
| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **10" Diameter Leachate Collection Lateral Pipe** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **0 Feet Waste** | | |

Load on Pipe

Alternative 2: Track Stradling and Parallel to Pipe




| | b | L | z | m = b/z | n = L/z | I* | I** | I | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | |
| Track I | 6.2 | 3.2 | 4 | 1.6 | 0.8 | 0.177 | 0.250 | 0.17733 | (ADD) |
| & IV | -2.0 | 3.2 | 4 | -0.5 | 0.8 | -0.109 | 0.230 | -0.10926 | (SUBTRACT) |
| | | | | | | | | | |
| Track II | 6.2 | 16.08 | 4 | 1.6 | 4.0 | -0.019 | 0.231 | 0.23095 | (ADD) |
| & III | -2.0 | 16.08 | 4 | -0.5 | 4.0 | -0.135 | 0.255 | -0.13546 | (SUBTRACT) |
| | 6.2 | 12.86 | 4 | 1.6 | 3.2 | -0.020 | 0.230 | 0.23021 | (SUBTRACT) |
| | -2.0 | 12.86 | 4 | -0.5 | 3.2 | -0.135 | 0.253 | -0.13519 | (ADD) |

Live $Load_2$ = $[q_r (\Sigma I) + q_{fr} (\Sigma II)] * 2$

Live $Load_2$ = 960.43 psf

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| CLIENT | PROJECT | JOB NO. |
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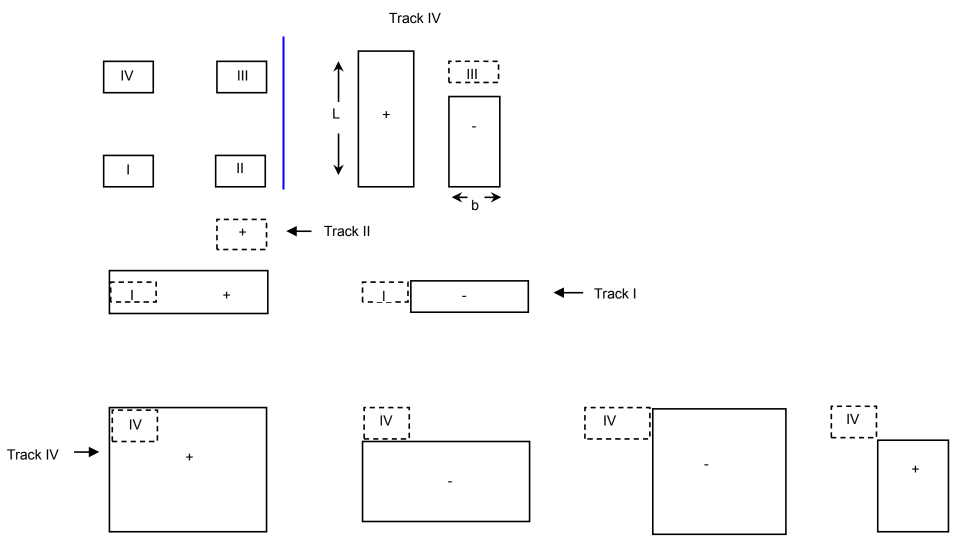
| SUBJECT | BY | DATE |
|---|---|---|
| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **10" Diameter Leachate Collection Lateral Pipe** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **0 Feet Waste** | | |

Load on Pipe

Alternative 3: Track Perpendicular to Pipe




| | b | L | z | m = b/z | n = L/z | I* | I** | I | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | |
| Track I | 16.1 | 8.2 | 4 | 4.0 | 2.1 | -0.010 | 0.240 | 0.23973 | (ADD) |
| | 12.9 | 8.2 | 4 | 3.2 | 2.1 | -0.011 | 0.239 | 0.23883 | (SUBTRACT) |
| | | | | | | | | | |
| Track II | 3.2 | 8.2 | 4 | 0.8 | 2.1 | 0.182 | 0.241 | 0.18205 | (ADD) |
| | | | | | | | | | |
| Track III | 3.2 | 12.5 | 4 | 0.8 | 3.1 | 0.185 | 0.231 | 0.18478 | (ADD) |
| | 3.2 | 4.3 | 4 | 0.8 | 1.1 | 0.164 | 0.262 | 0.16364 | (SUBTRACT) |
| | | | | | | | | | |
| Track IV | 16.1 | 12.5 | 4 | 4.0 | 3.1 | -0.004 | 0.246 | 0.24588 | (ADD) |
| | 16.1 | 4.3 | 4 | 4.0 | 1.1 | -0.041 | 0.209 | 0.20918 | (SUBTRACT) |
| | 12.9 | 12.5 | 4 | 3.2 | 3.1 | -0.005 | 0.245 | 0.24477 | (SUBTRACT) |
| | 12.9 | 4.3 | 4 | 3.2 | 1.1 | 0.209 | 0.213 | 0.20863 | (ADD) |

$\text{Live Load}_3 = q_r(\Sigma I) + q_{fr}(\Sigma II) + q_{fr}(\Sigma III) + q_r(\Sigma IV)$

$\text{Live Load}_3 =$ 315.70 psf

LARGEST EQUIPEMENT LOAD = 960.43 $lb/ft^2$

VERTICAL OVERBURDEN LOAD = 492.37 $lb/ft^2$

VERTICAL EQUIPMENT LOAD = 960.43 $lb/ft^2$

TOTAL VERTICAL LOAD APPLIED TO PIPE, $P_T$ = 1452.80 $lb/ft^2$ = 10.09 $lb/in^2$

| CLIENT | PROJECT | JOB NO. |
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| SUBJECT | BY | DATE |
|---|---|---|
| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **10" Diameter Leachate Collection Lateral Pipe** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **0 Feet Waste** | | |

Verify that perforations in the LCRS are adequate for the peak leachate flow.

Use discharge equation:

$Q = (Cd)(Ao)(2gh)^{0.5}$

$C_d$ = coeffiecient of discharge = 0.6 for short tube discharge with fluid/wall separation; conservative value.

$A_o$ = Area of orifice ($\pi D^2/4$)

g = gravitational acceleration (32.3 $ft^2/s$)

h = static head (ft)

| Assumptions and Givens: | 4.55 | acres | North and center portion of landfill bottom |
|---|---|---|---|
| 1. No. acres of landfill expansion = | 1.47 | acres | - North & center area from eastern grade break of bottom |
| 2. Total length of pipe per expansion = | 951.3 | ft | area draining into eastern 10-inch lateral collection |
| 3. Total number of laterals = | 1.0 | | - (2) 8-inch laterals collect drainage from other bottom area |
| 4. Length of pipe per lateral = | 951.3 | ft | - (1) 10-inch lateral collects the drainage area |
| 5. Perforation diameter = | 0.375 | inch | - Refer to calcs for 8" diameter leachate collection lateral |
| 6. No. perforations/ft pipe = | 6.0 | perforations/ft of pipe length | |
| 7. Maximum head over pipe = | 1.0 | ft | |
| 8. Per HELP model summary table, $Q_{peak}$ = | 202.93 | gal/min | refer to HELP Model Summary Table |
| 9. Per HELP model summary table, $Q_{peak}$ = | 39,063.5 | cf/day | refer to HELP Model Summary Table |
| 10. Maximum flow/lateral = | 39,063.5 | cf/day/lateral | |
| 11. Maximum leachate flow/ft of pipe = | 41.06 | cf/day/ft of pipe | |

Solution:

$A_o = 0.25(\Pi)(d)^2 =$ 0.00077 $ft^2$

1. Flow per orifice, $Q = (Cd)(Ao)(2gh)^{0.5}$ = 0.0037 $ft^3/s$

2. Flow per ft of pipe = (Q)(# perfs/ft) = 0.02 $ft^3/s$ per ft of pipe

= 1914.47 cf/day/ft of pipe

Conclusion:

Design capacity exceeds estimated generation

1914.47 cf/day/ft of pipe >>> 41.06 cf/day/ft of pipe

Perforations are adequate to handle the maximum leachate flow.

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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
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| Operation w/ CAT 826G Series II Compactor **0 Feet Waste** | | |

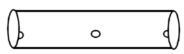
Effective pressure on pipe due to perforations:

$P_{EFF} = \dfrac{P_T \times 12}{(12 - L_P)}$ Source 3, EPA SW-870, p. 382

$L_P$ = Total accumulated length of perforations in one foot of pipe.

Since each perforation is 0.375 inch diameter and spaced at 6.0 inch on center,

$L_P$ = 1.5 inch



$P_T$ = 10.1 psi

$P_{EFF}$ = 11.5 psi

$P_{EFF}$ = 1660.3 psf

Check actual compressive pressure ($S_A$) per Driscopipe manual:

$S_A$ = 0.5 x (SDR - 1) x P(eff) = 57.7 psi

The recommended, long-term compressive strength ($Y_s$) design value for Driscoplex polyethylene pipe is 800 lb/in$^2$.

Source No. 1

| $S_A$ (psi): | | $Y_s$ (psi): |
|---|---|---|
| 57.7 | < | 800.0 |

Pipe passes wall compressive stress perforation calculations TRUE

FS = 13.9

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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
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| Operation w/ CAT 826G Series II Compactor **0 Feet Waste** | | |

Constrained pipe wall buckling (for Driscoplex OD controlled pipe)

$P_{WC} = \dfrac{5.65 * \{RB'E' E*[12(DR-1)^3]^{-1}\}^{0.5}}{N}$ Source 1, Equation 7-5

$P_{WC}$ = allowable constrained buckling pressure (lb/in$^2$)

R = buoyancy reduction factor = 1 - 0.33 * (H'/H) Source 1, Equation 7-34

| | | |
|---|---|---|
| H' = groundwater height above pipe (ft) | 0.0 | ft |
| H = cover above pipe (ft) | 4.0 | ft |
| B' = elastic support factor =( 1+ 4*$e^{-0.065H}$ )$^{-1}$ | | Source 1, Equation 7-35 |
| E' = soil reaction modulus (lb/in$^2$) | 3000.0 | lb/in$^2$ for mod comp/crushed rock, 'Source 1, Table 7-7 |
| E = elastic modulus (lb/in$^2$) | 100000.0 | lb/in$^2$ for long term load at 100$^o$F, 'Source 1, Table 5-1 |
| I = moment of inertia = $t^3$ / 12 | 0.1 | in$^4$/in |
| $D_o$ = pipe outer diameter (in) | 10.750 | SDR 11 pipe (Driscopipe) to be used |
| t = pipe wall thickness (in) | 0.977 | SDR 11 pipe (Driscopipe) to be used |
| DR = pipe dimension ratio = $D_o$ / t | 11.0 | SDR 11 pipe (Driscopipe) to be used |
| $D_I$ = pipe inner diameter = $D_o$ - 2t (in) | 8.8 | SDR 11 pipe (Driscopipe) to be used |
| N = safety factor | 2.0 | |

| Cover (ft) | (ft) | (ft) | B' | R | (lb/in$^2$) |
|---|---|---|---|---|---|
| 4.0 | 4 | 0 | 0.24 | 1.00 | 220.92 |

$P_{WC}$ = 220.92 lb/in$^2$

$P_{EFF}$ = 11.53 lb/in$^2$

Pipe passes contrained wall buckling calculations TRUE FS = 19.2

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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **10" Diameter Leachate Collection Lateral Pipe** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **0 Feet Waste** | | |

Constrained Pipe Wall Compressive Stress (for Driscoplex OD controlled pipe)

$S = \frac{P_T D_o}{288t}$ Source No. 1

S = pipe wall compressive stress ($lb/in^2$)

$P_T$ = vertical load applied to pipe w/ perfs ($lb/ft^2$) 1660.3 $lb/ft^2$

$D_o$ = pipe outside diameter (in) 10.75 SDR 11 pipe (Driscopipe) to be used

t = pipe wall thickness (in) 0.977 SDR 11 pipe (Driscopipe) to be used

$S = \frac{P_T D_o}{288t} =$ 63.4 $lb/in^2$

The recommended, long-term compressive strength ($Y_s$) design value for Driscoplex polyethylene pipe is 800 $lb/in^2$.

Source No. 1

| S (psi): | | $Y_s$ (psi): |
|---|---|---|
| 63.4 | < | 800.0 |

Pipe passes wall compressive stress calculations TRUE

FS = 12.6

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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **10" Diameter Leachate Collection Lateral Pipe** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **0 Feet Waste** | | |

Iowa Formula

$\Delta X = \dfrac{D_L K W_c r^3}{EI + 0.06er^4}$ Source 2, Equation 3.4 Buried Pipe Design, A.P. Moser, Chapter 3

$\Delta X$ = horizontal deflection (in)

$D_L$ = deflection lag factor

K = bedding constant | 0.1 | typical value Source 2, Buried Pipe Design, A.P. Moser, Chapter 3

$W_c$ = Marston's load per unit length of pipe (lb/in)

r = mean radius of the pipe (in)

E = modulus of elasticity ($lb/in^2$)

I = moment of inertia of the pipe wall per unit length ($in^3$)

e = modulus of passive resistance fo the side fill ($lb/in^2(in)$)

Modified Iowa Formula

$\Delta X = \dfrac{D_L K W_c r_m^3}{EI + 0.06E'r_m^3}$ Source 2, Equation 3.5 Buried Pipe Design, A.P. Moser, Chapter 3

$\Delta X$ = horizontal deflection (in)

| | | | | |
|---|---|---|---|---|
| $D_L$ = deflection lag factor | | 1.0 | Prism Load used | |
| Typical Value for Marston Load | 1.5 | | | |
| Typical Value for Prism Load | 1.0 | | | |
| K = bedding constant | | 0.1 | typical value Buried Pipe Design, A.P. Moser, Chapter 3 | |
| $P_T$ = Vertical load on pipe w/ perfs | | 11.53 | $lb/in^2$ | 1660 $lb/ft^2$ |
| $W_c$ = Marston's load per unit length of pipe = $P_T$ * $D_o$ (lb/in) | | 123.95 | lb/in | |
| $D_o$ = pipe outer diameter (in) | | 10.75 | SDR 11 pipe (Driscopipe) to be used | |
| t = pipe wall thickness (in) | | 0.98 | SDR 11 pipe (Driscopipe) to be used | |
| $D_I$ = pipe inner diameter = $D_o$-2t (in) | | 8.80 | SDR 11 pipe (Driscopipe) to be used | |
| $D_m$ = pipe mean diameter = $D_o$ - 1.06t Source 1, Equation 7-27 | | 9.71 | SDR 11 pipe (Driscopipe) to be used | |
| $r_m$ = mean radius of the pipe (in) | | 4.86 | SDR 11 pipe (Driscopipe) to be used | |
| E = modulus of elasticity ($lb/in^2$) | | 100,000.0 | lb/in2 for long term load at 100oF, 'Source 1, Table 5-1 | |
| I = moment of inertia of the pipe wall per unit length | | 0.078 | $in^4/in$ | |
| E' = modulus of soil reaction | | 3,000.0 | $lb/in^2$ for moderate compaction and fine grained soils | |

$\Delta X = \dfrac{D_L K W_c r_m^3}{EI + 0.06E'r_m^3}$ = 0.050 inch Source 2, Equation 3.5 Buried Pipe Design, A.P. Moser, Chapter 3

% Ring Deflection = $(\Delta X/D_m)$ x 100 = 0.51% Source 1, Equation 7-31

Ring Bending Strain

$e = \dfrac{f_D \Delta X 2C}{D_M^2} \times 100$ Source 1, Equation 7-39

e = wall strain (%)

| | | |
|---|---|---|
| $f_D$ = deformation shape factor | 6 | Source 1, non-elliptical shape |
| $D_M$ = mean diameter (in) | | |
| C = outer fiber wall centroid = 0.5 (1.06t) | 0.518 | Source 1, Equation 7-41 |
| $\Delta X$ = ring deflection = $D_X/D_m$ | 0.005 | |

$e = f_D \dfrac{(\Delta X)}{D_M} \dfrac{(2C)}{D_M} \times 100$ = 0.3% Source 1, Equation 7-39

The maximum ring bending strain for high performance polyethylene non-pressure pipe is = 5.0%

Pipe passes ring bending strain calculations TRUE

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| **10" Diameter Leachate Collection Lateral Pipe** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **0 Feet Waste** | | |

SOURCES

1.) Attachment - 1 - Chevron Phillips Chemical Company, Bulletin - Book 2 Chapter 5, 2003

2.) Attachment - 2 - Buried Pipe Design, A.P. Moser, Chapter 3

3.) Attachment - 3 - EPA, Lining of Waste Impoundment and Disposal Facilities, SW-870

4.) Attachment - 4 - Driscoplex Pipe Properties

5.) Attachment - 5 - CAT 826G Series II Compactor Data Sheet

SCS ENGINEERS

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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
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Load on Pipe (Overburden)

Prism Loads, $P_E$ = wH

w = unit weight

H = depth

| | Depth (ft) | Unit Weight ($lb/ft^3$) | $P_E$ ($lb/ft^2$) |
|---|---|---|---|
| Final cover | 0.0 | 115.0 | 0.0 |
| Intermediate cover | 0.0 | 115.0 | 0.0 |
| Waste/cover | 10.0 | 60.0 | 600.0 |
| Drainage sand | 2.0 | 115.0 | 230.0 |
| Rock (No. 89 & No. 57) | 2.0 | 140.0 | 280.0 |

TOTAL SOIL PRISM LOAD $P_E$: 1110.0 $lb/ft^2$

Total Depth = 14.0 ft

Soil Arching, $P_m = C_D wB$

Pm = vertical soil pressure

B = trench width at pipe crown 6.0 ft

$C_D$ = load coefficient $= \frac{1 - e^{-2Ku'H/B}}{2Ku'}$  Equation 7-3, Source No. 1

NOTE: The waste unit weight represents the combined unit weight of waste, daily cover, and moisture.

e = natural log base number

K = Rankine earth pressure coefficient = $\tan^2(45-0.5*\phi)$

$\phi$ = internal soil friction angle = 27.0 degrees

u' = friction coefficient between backfill and trench sides = tan $\phi$

| Soil Type | Ku' |
|---|---|
| Saturated Clay | 0.110 |
| Ordinary Clay | 0.130 |
| Saturated Top Soil | 0.150 |
| Sand and Gravel | 0.165 |
| Clean Granular Soil | 0.192 |

| | Ku' | $C_D$ | $P_m$ ($lb/ft^2$) |
|---|---|---|---|
| Cover Soil | 0.150 | 0.00 | 0 |
| Int Cover | 0.165 | 0.00 | 0 |
| Waste | 0.191 | 1.23 | 444 |
| Drainage Sand | 0.165 | 0.32 | 217.8 |
| Granular Soil | 0.192 | 0.31 | 262.8 |

TOTAL SOIL ARCHING LOAD $P_M$: 924.2 $lb/ft^2$

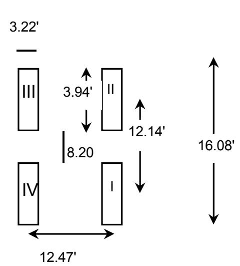
MODIFIED ARCHING LOAD = $0.6P_M + 0.4P_E$: 998.53 $lb/ft^2$

OVERBURDEN LOAD: 998.53 $lb/ft^2$

Load on Pipe With Equipment Refer to Attachment

Operation w/ CAT 826G Series II Compactor 10 Feet Waste

Equipment Weight = 81,498.0 psf




| | | | |
|---|---|---|---|
| Track per Load = $q_r$ = | 1,670.20 | psf | (Rear) |
| Track per Load = $q_{fr}$ = | 1,541.72 | psf | (Front) |
| Length of Track = L = | 3.22 | ft | (contact length) |
| Length of Track = b = | 8.20 | ft | |
| Track Width = | 12.47 | ft | |
| Track Width (I to II) = | 16.08 | ft | |

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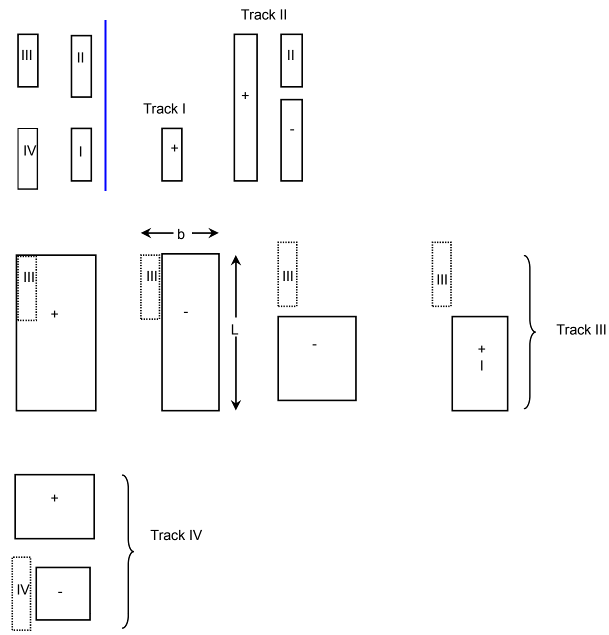
| Operation w/ CAT 826G Series II Compactor **10 Feet Waste** | | |

Load on Pipe

Alternative 1: Track Adjacent and Parallel to Pipe




| | b | L | z | m = b/z | n = L/z | I* | I** | I | |
|---|---|---|---|---|---|---|---|---|---|
| Track I | 8.2 | 3 | 14 | 0.59 | 0.23 | 0.049 | 0.263 | 0.04882 | (ADD) |
| | | | | | | | | | |
| Track II | 8.2 | 16.1 | 14 | 0.59 | 1.15 | 0.139 | 0.265 | 0.13939 | (ADD) |
| | 8.2 | 11.4 | 14 | 0.59 | 0.82 | 0.124 | 0.270 | 0.12392 | (SUBTRACT) |
| | | | | | | | | | |
| Track IV | 12.47 | 3.22 | 14 | 0.89 | 0.23 | 0.060 | 0.262 | 0.05999 | (ADD) |
| | 12.47 | 3.22 | 14 | 0.89 | 0.23 | 0.060 | 0.262 | 0.05999 | (SUBTRACT) |
| | | | | | | | | | |
| Track III | 12.47 | 16.08 | 14 | 0.89 | 1.15 | 0.175 | 0.258 | 0.17489 | (ADD) |
| | 4.27 | 16.08 | 14 | 0.31 | 1.15 | 0.084 | 0.263 | 0.08363 | (SUBTRACT) |
| | 12.47 | 11.42 | 14 | 0.89 | 0.82 | 0.154 | 0.266 | 0.15446 | (SUBTRACT) |
| | 4.27 | 8.47 | 14 | 0.31 | 0.61 | 0.064 | 0.266 | 0.06417 | (ADD) |

$\text{Live Load}_1 = q_r(\Sigma I) + q_{fr}(\Sigma II) + q_{fr}(\Sigma III) + q_r(\Sigma IV)$

$\text{Live Load}_1 =$ 106.88 psf

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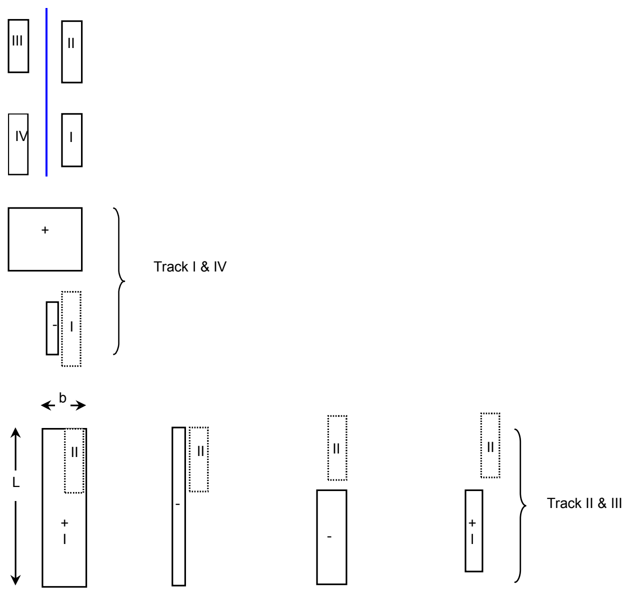
| Operation w/ CAT 826G Series II Compactor **10 Feet Waste** | | |

Load on Pipe

Alternative 2: Track Stradling and Parallel to Pipe




| | b | L | z | m = b/z | n = L/z | I* | I** | I | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | |
| Track I | 6.2 | 3.2 | 14 | 0.4 | 0.2 | 0.041 | 0.261 | 0.04054 | (ADD) |
| & IV | -2.0 | 3.2 | 14 | -0.1 | 0.2 | -0.015 | 0.245 | -0.01454 | (SUBTRACT) |
| | | | | | | | | | |
| Track II | 6.2 | 16.08 | 14 | 0.4 | 1.1 | 0.115 | 0.265 | 0.11458 | (ADD) |
| & III | -2.0 | 16.08 | 14 | -0.1 | 1.1 | -0.040 | 0.243 | -0.04040 | (SUBTRACT) |
| | 6.2 | 12.86 | 14 | 0.4 | 0.9 | 0.107 | 0.268 | 0.10711 | (SUBTRACT) |
| | -2.0 | 12.86 | 14 | -0.1 | 0.9 | -0.038 | 0.242 | -0.03788 | (ADD) |

Live $Load_2 = [q_r (\Sigma I) + q_{fr} (\Sigma II)] * 2$

Live $Load_2 =$ 214.77 psf

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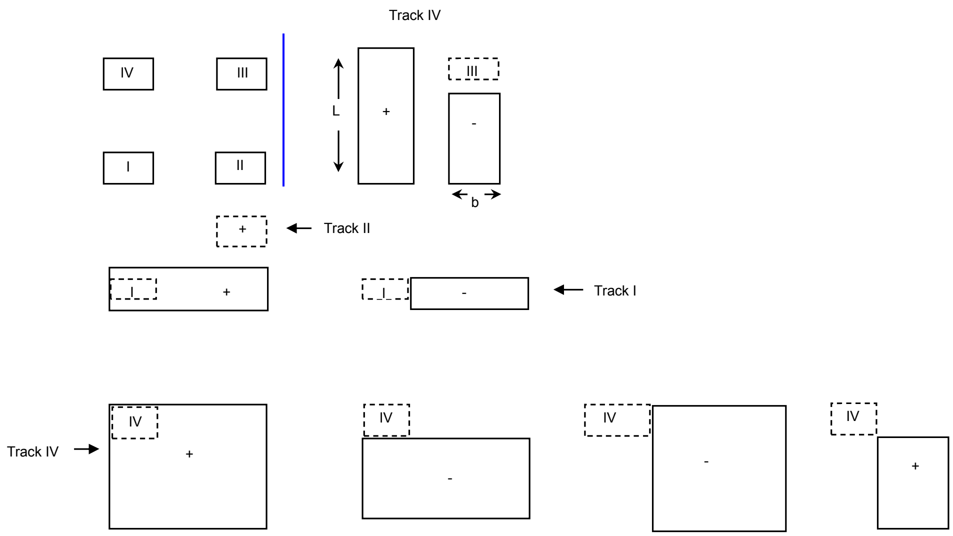
| Operation w/ CAT 826G Series II Compactor **10 Feet Waste** | | |

Load on Pipe

Alternative 3: Track Perpendicular to Pipe




| | b | L | z | m = b/z | n = L/z | I* | I** | I | |
|---|---|---|---|---|---|---|---|---|---|
| Track I | 16.1 | 8.2 | 14 | 1.1 | 0.6 | 0.139 | 0.265 | 0.13939 | (ADD) |
| | 12.9 | 8.2 | 14 | 0.9 | 0.6 | 0.130 | 0.269 | 0.13005 | (SUBTRACT) |
| Track II | 3.2 | 8.2 | 14 | 0.2 | 0.6 | 0.049 | 0.263 | 0.04882 | (ADD) |
| Track III | 3.2 | 12.5 | 14 | 0.2 | 0.9 | 0.060 | 0.262 | 0.05999 | (ADD) |
| | 3.2 | 4.3 | 14 | 0.2 | 0.3 | 0.030 | 0.259 | 0.02986 | (SUBTRACT) |
| Track IV | 16.1 | 12.5 | 14 | 1.1 | 0.9 | 0.175 | 0.258 | 0.17489 | (ADD) |
| | 16.1 | 4.3 | 14 | 1.1 | 0.3 | 0.084 | 0.263 | 0.08363 | (SUBTRACT) |
| | 12.9 | 12.5 | 14 | 0.9 | 0.9 | 0.162 | 0.264 | 0.16248 | (SUBTRACT) |
| | 12.9 | 4.3 | 14 | 0.9 | 0.3 | 0.078 | 0.265 | 0.07831 | (ADD) |

Live Load$_3$ = $q_r(\Sigma I) + q_{fr}(\Sigma II) + q_{fr}(\Sigma III) + q_r(\Sigma IV)$

Live Load$_3$ = 149.14 psf

LARGEST EQUIPEMENT LOAD = 214.77 $lb/ft^2$

VERTICAL OVERBURDEN LOAD = 998.53 $lb/ft^2$

VERTICAL EQUIPMENT LOAD = 214.77 $lb/ft^2$

TOTAL VERTICAL LOAD APPLIED TO PIPE, $P_T$ = 1213.30 $lb/ft^2$ = 8.43 $lb/in^2$

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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **10" Diameter Leachate Collection Lateral Pipe** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **10 Feet Waste** | | |

Verify that perforations in the LCRS are adequate for the peak leachate flow.

Use discharge equation:

$Q = (Cd)(Ao)(2gh)^{0.5}$

$C_d$ = coeffiecient of discharge = 0.6 for short tube discharge with fluid/wall separation; conservative value.

$A_o$ = Area of orifice ($\pi D^2/4$)

g = gravitational acceleration (32.3 $ft^2/s$)

h = static head (ft)

Assumptions and Givens:

| | | | |
|---|---|---|---|
| | 4.55 | acres | North and center portion of landfill bottom |
| 1. No. acres of landfill expansion = | 1.47 | acres | - North & center area from eastern grade break of bottom |
| 2. Total length of pipe per expansion = | 951.3 | ft | area draining into eastern 10-inch lateral collection |
| 3. Total number of laterals = | 1.0 | | - (2) 8-inch laterals collect drainage from other bottom area |
| 4. Length of pipe per lateral = | 951.3 | ft | - (1) 10-inch lateral collects the drainage area |
| 5. Perforation diameter = | 0.375 | inch | - Refer to calcs for 8" diameter leachate collection lateral |
| 6. No. perforations/ft pipe = | 6.0 | perforations/ft of pipe length | |
| 7. Maximum head over pipe = | 1.0 | ft | |
| 8. Per HELP model summary table, $Q_{peak}$ = | 202.93 | gal/min | refer to HELP Model Summary Table |
| 9. Per HELP model summary table, $Q_{peak}$ = | 39,063.5 | cf/day | refer to HELP Model Summary Table |
| 10. Maximum flow/lateral = | 39,063.5 | cf/day/lateral | |
| 11. Maximum leachate flow/ft of pipe = | 41.06 | cf/day/ft of pipe | |

Solution:

$A_o = 0.25(\Pi)(d)^2 =$ 0.00077 $ft^2$

1. Flow per orifice, $Q = (Cd)(Ao)(2gh)^{0.5} =$ 0.0037 $ft^3/s$

2. Flow per ft of pipe = (Q)(# perfs/ft) = 0.02 $ft^3/s$ per ft of pipe

= 1914.47 cf/day/ft of pipe

Conclusion:

Design capacity exceeds estimated generation

1914.47 cf/day/ft of pipe >>> 41.06 cf/day/ft of pipe

Perforations are adequate to handle the maximum leachate flow.

| CLIENT | PROJECT | JOB NO. |
|---|---|---|
| Hardee County | Phase II Section II Expansion | 09199033.23 |

| SUBJECT | BY | DATE |
|---|---|---|
| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **10" Diameter Leachate Collection Lateral Pipe** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **10 Feet Waste** | | |

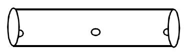
Effective pressure on pipe due to perforations:

$P_{EFF} = \dfrac{P_T \times 12}{(12-L_P)}$ Source 3, EPA SW-870, p. 382

$L_P$ = Total accumulated length of perforations in one foot of pipe.

Since each perforation is 0.375 inch diameter and spaced at 6.0 inch on center,

$L_P$ = 1.5 inch



$P_T$ = 8.4 psi

$P_{EFF}$ = 9.6 psi

$P_{EFF}$ = 1386.6 psf

Check actual compressive pressure ($S_A$) per Driscopipe manual:

$S_A$ = 0.5 x (SDR - 1) x P(eff) = 48.2 psi

The recommended, long-term compressive strength ($Y_s$) design value for Driscoplex polyethylene pipe is 800 lb/in$^2$.

Source No. 1

| $S_A$ (psi): | | $Y_s$ (psi): |
|---|---|---|
| 48.2 | < | 800.0 |

Pipe passes wall compressive stress perforation calculations TRUE FS = 16.6

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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **10" Diameter Leachate Collection Lateral Pipe** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **10 Feet Waste** | | |

Constrained pipe wall buckling (for Driscoplex OD controlled pipe)

$P_{WC} = \frac{5.65 * \{RB'E' E^*[12(DR-1)^3]^{-1}\}^{0.5}}{N}$ Source 1, Equation 7-5

$P_{WC}$ = allowable constrained buckling pressure (lb/in$^2$)

R = buoyancy reduction factor = 1 - 0.33 * (H'/H) Source 1, Equation 7-34

H' = groundwater height above pipe (ft) 0.0 ft

H = cover above pipe (ft) 14.0 ft

B' = elastic support factor =( 1+ 4*$e^{-0.065H}$ )$^{-1}$ Source 1, Equation 7-35

E' = soil reaction modulus (lb/in$^2$) 3000.0 lb/in$^2$ for mod comp/crushed rock, 'Source 1, Table 7-7

E = elastic modulus (lb/in$^2$) 100000.0 lb/in$^2$ for long term load at 100$^o$F, 'Source 1, Table 5-1

I = moment of inertia = $t^3$ / 12 0.1 in$^4$/in

$D_o$ = pipe outer diameter (in) 10.750 SDR 11 pipe (Driscopipe) to be used

t = pipe wall thickness (in) 0.977 SDR 11 pipe (Driscopipe) to be used

DR = pipe dimension ratio = $D_o$ / t 11.0 SDR 11 pipe (Driscopipe) to be used

$D_I$ = pipe inner diameter = $D_o$ - 2t (in) 8.8 SDR 11 pipe (Driscopipe) to be used

N = safety factor 2.0

| Cover (ft) | (ft) | (ft) | B' | R | (lb/in$^2$) |
|---|---|---|---|---|---|
| 14.0 | 14 | 0 | 0.38 | 1.00 | 276.35 |

$P_{WC}$ = 276.35 lb/in$^2$

$P_{EFF}$ = 9.63 lb/in$^2$

Pipe passes contrained wall buckling calculations TRUE FS = 28.7

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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **10" Diameter Leachate Collection Lateral Pipe** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **10 Feet Waste** | | |

Constrained Pipe Wall Compressive Stress (for Driscoplex OD controlled pipe)

$$S = \frac{P_T D_o}{288t}$$ Source No. 1

S = pipe wall compressive stress ($lb/in^2$)

$P_T$ = vertical load applied to pipe w/ perfs ($lb/ft^2$) 1386.6 $lb/ft^2$

$D_o$ = pipe outside diameter (in) 10.75 SDR 11 pipe (Driscopipe) to be used

t = pipe wall thickness (in) 0.977 SDR 11 pipe (Driscopipe) to be used

$$S = \frac{P_T D_o}{288t} = 53.0\ lb/in^2$$

The recommended, long-term compressive strength ($Y_s$) design value for Driscoplex polyethylene pipe is 800 $lb/in^2$.

Source No. 1

| S (psi): | | $Y_s$ (psi): |
|---|---|---|
| 53.0 | < | 800.0 |

Pipe passes wall compressive stress calculations TRUE

FS = 15.1

| CLIENT | PROJECT | JOB NO. | |
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| Pipe Crushing Calculations **RAI No. 1** | | SRF | 4/1/13 |
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| Operation w/ CAT 826G Series II Compactor **10 Feet Waste** | | | |

Iowa Formula

$\Delta X = \dfrac{D_L K W_c r^3}{EI + 0.06 e r^4}$ Source 2, Equation 3.4 Buried Pipe Design, A.P. Moser, Chapter 3

$\Delta X$ = horizontal deflection (in)

$D_L$ = deflection lag factor

K = bedding constant — 0.1 — typical value Source 2, Buried Pipe Design, A.P. Moser, Chapter 3

$W_c$ = Marston's load per unit length of pipe (lb/in)

r = mean radius of the pipe (in)

E = modulus of elasticity (lb/in$^2$)

I = moment of inertia of the pipe wall per unit length (in$^3$)

e = modulus of passive resistance fo the side fill (lb/in$^2$(in))

Modified Iowa Formula

$\Delta X = \dfrac{D_L K W_c r_m^3}{EI + 0.06 E' r_m^3}$ Source 2, Equation 3.5 Buried Pipe Design, A.P. Moser, Chapter 3

$\Delta X$ = horizontal deflection (in)

| | | |
|---|---|---|
| $D_L$ = deflection lag factor | 1.0 | Prism Load used |
| Typical Value for Marston Load | 1.5 | |
| Typical Value for Prism Load | 1.0 | |
| K = bedding constant | 0.1 | typical value Buried Pipe Design, A.P. Moser, Chapter 3 |
| $P_T$ = Vertical load on pipe w/ perfs | 9.63 | lb/in$^2$ — 1387 lb/ft$^2$ |
| $W_c$ = Marston's load per unit length of pipe = $P_T$ * $D_o$ (lb/in) | 103.52 | lb/in |
| $D_o$ = pipe outer diameter (in) | 10.75 | SDR 11 pipe (Driscopipe) to be used |
| t = pipe wall thickness (in) | 0.98 | SDR 11 pipe (Driscopipe) to be used |
| $D_I$ = pipe inner diameter = $D_o$-2t (in) | 8.80 | SDR 11 pipe (Driscopipe) to be used |
| $D_m$ = pipe mean diameter = $D_o$ - 1.06t Source 1, Equation 7-27 | 9.71 | SDR 11 pipe (Driscopipe) to be used |
| $r_m$ = mean radius of the pipe (in) | 4.86 | SDR 11 pipe (Driscopipe) to be used |
| E = modulus of elasticity (lb/in$^2$) | 100,000.0 | lb/in2 for long term load at 100oF, 'Source 1, Table 5-1 |
| I = moment of inertia of the pipe wall per unit length | 0.078 | in$^4$/in |
| E' = modulus of soil reaction | 3,000.0 | lb/in$^2$ for moderate compaction and fine grained soils |

$\Delta X = \dfrac{D_L K W_c r_m^3}{EI + 0.06 E' r_m^3}$ = 0.042 inch — Source 2, Equation 3.5 Buried Pipe Design, A.P. Moser, Chapter 3

% Ring Deflection = $(\Delta X/D_m)$ x 100 = 0.43% — Source 1, Equation 7-31

Ring Bending Strain

$e = \dfrac{f_D \Delta X 2C}{D_M^2} \times 100$ Source 1, Equation 7-39

e = wall strain (%)

| | | |
|---|---|---|
| $f_D$ = deformation shape factor | 6 | Source 1, non-elliptical shape |
| $D_M$ = mean diameter (in) | | |
| C = outer fiber wall centroid = 0.5 (1.06t) | 0.518 | Source 1, Equation 7-41 |
| $\Delta X$ = ring deflection = $D_X/D_m$ | 0.004 | |

$e = f_D \dfrac{(\Delta X)}{D_M} \dfrac{(2C)}{D_M} \times 100$ = 0.3% — Source 1, Equation 7-39

The maximum ring bending strain for high performance polyethylene non-pressure pipe is = 5.0%

Pipe passes ring bending strain calculations — TRUE

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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **10" Diameter Leachate Collection Lateral Pipe** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **10 Feet Waste** | | |

SOURCES

1.) Attachment - 1 - Chevron Phillips Chemical Company, Bulletin - Book 2 Chapter 5, 2003

2.) Attachment - 2 - Buried Pipe Design, A.P. Moser, Chapter 3

3.) Attachment - 3 - EPA, Lining of Waste Impoundment and Disposal Facilities, SW-870

4.) Attachment - 4 - Driscoplex Pipe Properties

5.) Attachment - 5 - CAT 826G Series II Compactor Equipment Data Sheet

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| CLIENT | PROJECT | JOB NO. |
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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **10" Diameter Leachate Collection Lateral Pipe** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **25 Feet Waste** | | |

Load on Pipe (Overburden)

Prism Loads, $P_E$ = wH

w = unit weight

H = depth

| | Depth (ft) | Unit Weight ($lb/ft^3$) | $P_E$ ($lb/ft^2$) |
|---|---|---|---|
| Final cover | 0.0 | 115.0 | 0.0 |
| Intermediate cover | 0.0 | 115.0 | 0.0 |
| Waste/cover | 25.0 | 60.0 | 1500.0 |
| Drainage sand | 2.0 | 115.0 | 230.0 |
| Rock (No. 89 & No. 57) | 2.0 | 140.0 | 280.0 |

TOTAL SOIL PRISM LOAD $P_E$: 2010.0 $lb/ft^2$

Total Depth = 29.0 ft

Soil Arching, $P_m = C_D wB$

Pm = vertical soil pressure

B = trench width at pipe crown 6.0 ft

$C_D$ = load coefficient $= \frac{1 - e^{-2Ku'H/B}}{2Ku'}$ Equation 7-3, Source No. 1

NOTE: The waste unit weight represents the combined unit weight of waste, daily cover, and moisture.

e = natural log base number

K = Rankine earth pressure coefficient = $\tan^2(45-0.5*\phi)$

$\phi$ = internal soil friction angle = 27.0 degrees

u' = friction coefficient between backfill and trench sides = tan $\phi$

| Soil Type | Ku' |
|---|---|
| Saturated Clay | 0.110 |
| Ordinary Clay | 0.130 |
| Saturated Top Soil | 0.150 |
| Sand and Gravel | 0.165 |
| Clean Granular Soil | 0.192 |

| | Ku' | $C_D$ | $P_m$ ($lb/ft^2$) |
|---|---|---|---|
| Cover Soil | 0.150 | 0.00 | 0 |
| Int Cover | 0.165 | 0.00 | 0 |
| Waste | 0.191 | 2.08 | 750 |
| Drainage Sand | 0.165 | 0.32 | 217.8 |
| Granular Soil | 0.192 | 0.31 | 262.8 |

TOTAL SOIL ARCHING LOAD $P_M$: 1,230.4 $lb/ft^2$

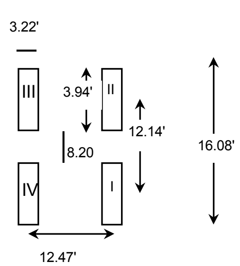
MODIFIED ARCHING LOAD = $0.6P_M+0.4P_E$: 1,542.23 $lb/ft^2$

OVERBURDEN LOAD: 1,542.23 $lb/ft^2$

Load on Pipe With Equipment Refer to Attachment

Operation w/ CAT 826G Series II Compactor 25 Feet Waste

Equipment Weight = 81,498.0 psf




| | | | |
|---|---|---|---|
| Track per Load = $q_r$ = | 1,670.20 | psf | (Rear) |
| Track per Load = $q_{fr}$ = | 1,541.72 | psf | (Front) |
| Length of Track = L = | 3.22 | ft | (contact length) |
| Length of Track = b = | 8.20 | ft | |
| Track Width = | 12.47 | ft | |
| Track Width (I to II) = | 16.08 | ft | |

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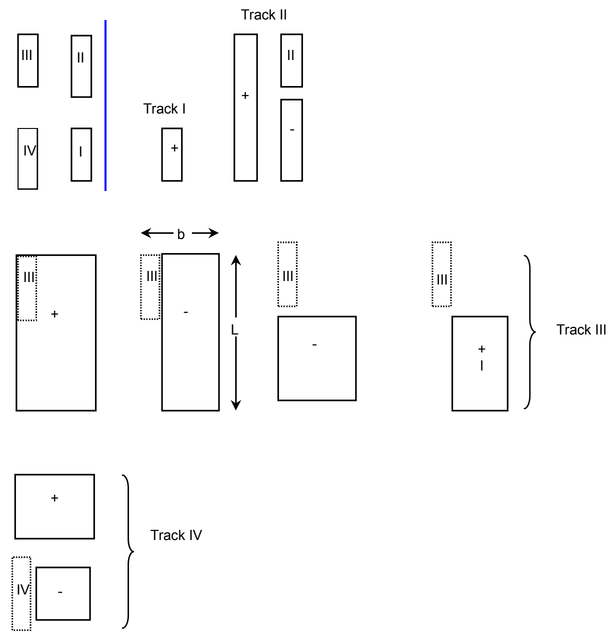
| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **10" Diameter Leachate Collection Lateral Pipe** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **25 Feet Waste** | | |

Load on Pipe

Alternative 1: Track Adjacent and Parallel to Pipe




| | b | L | z | m = b/z | n = L/z | I* | I** | I | |
|---|---|---|---|---|---|---|---|---|---|
| Track I | 8.2 | 3 | 29 | 0.28 | 0.11 | 0.014 | 0.254 | 0.01393 | (ADD) |
| | | | | | | | | | |
| Track II | 8.2 | 16.1 | 29 | 0.28 | 0.55 | 0.057 | 0.265 | 0.05688 | (ADD) |
| | 8.2 | 11.4 | 29 | 0.28 | 0.39 | 0.044 | 0.263 | 0.04447 | (SUBTRACT) |
| | | | | | | | | | |
| Track IV | 12.47 | 3.22 | 29 | 0.43 | 0.11 | 0.020 | 0.256 | 0.01966 | (ADD) |
| | 12.47 | 3.22 | 29 | 0.43 | 0.11 | 0.020 | 0.256 | 0.01966 | (SUBTRACT) |
| | | | | | | | | | |
| Track III | 12.47 | 16.08 | 29 | 0.43 | 0.55 | 0.081 | 0.269 | 0.08065 | (ADD) |
| | 4.27 | 16.08 | 29 | 0.15 | 0.55 | 0.031 | 0.258 | 0.03090 | (SUBTRACT) |
| | 12.47 | 11.42 | 29 | 0.43 | 0.39 | 0.063 | 0.267 | 0.06292 | (SUBTRACT) |
| | 4.27 | 8.47 | 29 | 0.15 | 0.29 | 0.019 | 0.256 | 0.01886 | (ADD) |

Live $\text{Load}_1 = q_r(\Sigma I) + q_{fr}(\Sigma II) + q_{fr}(\Sigma III) + q_r(\Sigma IV)$

Live $\text{Load}_1 =$ 51.18 psf

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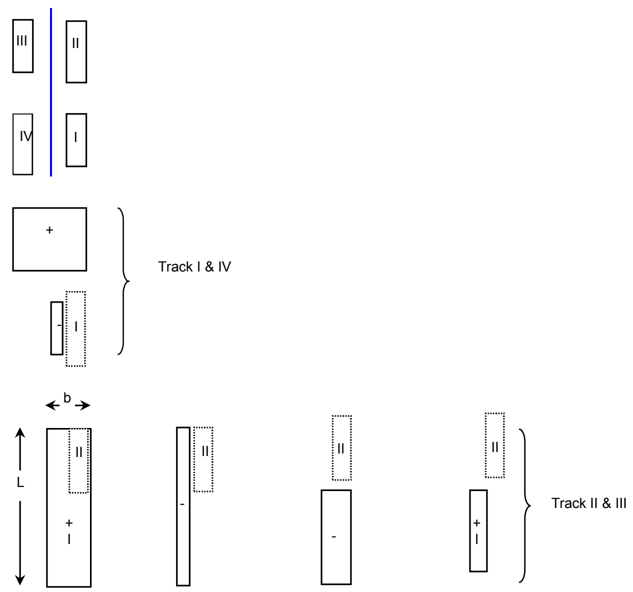
| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **10" Diameter Leachate Collection Lateral Pipe** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **25 Feet Waste** | | |

Load on Pipe

Alternative 2: Track Stradling and Parallel to Pipe




| | b | L | z | m = b/z | n = L/z | I* | I** | I | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | |
| Track I | 6.2 | 3.2 | 29 | 0.2 | 0.1 | 0.011 | 0.253 | 0.01087 | (ADD) |
| & IV | -2.0 | 3.2 | 29 | -0.1 | 0.1 | -0.004 | 0.249 | -0.00354 | (SUBTRACT) |
| | | | | | | | | | |
| Track II | 6.2 | 16.08 | 29 | 0.2 | 0.6 | 0.044 | 0.262 | 0.04431 | (ADD) |
| & III | -2.0 | 16.08 | 29 | -0.1 | 0.6 | -0.014 | 0.246 | -0.01441 | (SUBTRACT) |
| | 6.2 | 12.86 | 29 | 0.2 | 0.4 | 0.038 | 0.261 | 0.03796 | (SUBTRACT) |
| | -2.0 | 12.86 | 29 | -0.1 | 0.4 | -0.012 | 0.246 | -0.01235 | (ADD) |

$\text{Live Load}_2 = [q_r(\Sigma I) + q_{fr}(\Sigma II)] * 2$

$\text{Live Load}_2 =$ 74.06 psf

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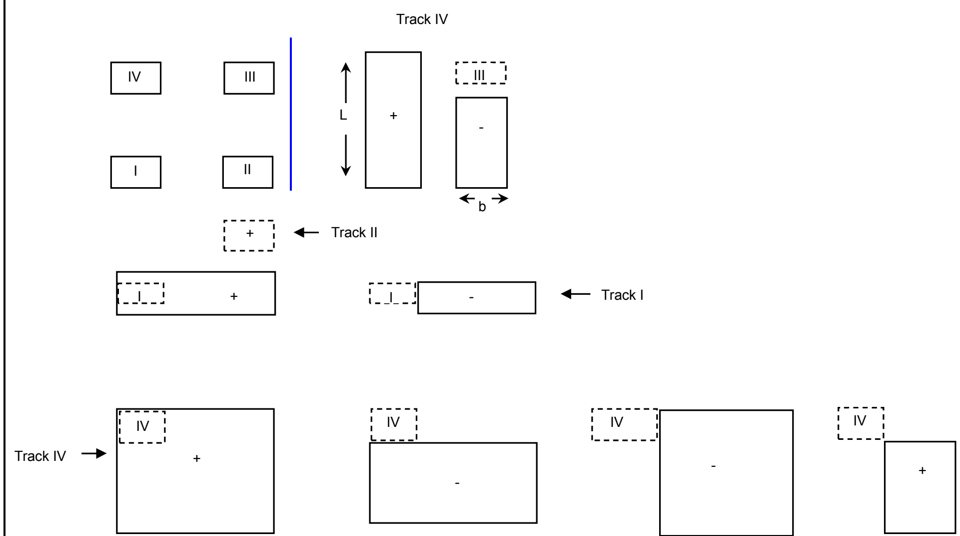
| Operation w/ CAT 826G Series II Compactor **25 Feet Waste** | | |

Load on Pipe

Alternative 3: Track Perpendicular to Pipe




| | b | L | z | m = b/z | n = L/z | I* | I** | I | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | |
| Track I | 16.1 | 8.2 | 29 | 0.6 | 0.3 | 0.057 | 0.265 | 0.05688 | (ADD) |
| | 12.9 | 8.2 | 29 | 0.4 | 0.3 | 0.049 | 0.264 | 0.04871 | (SUBTRACT) |
| | | | | | | | | | |
| Track II | 3.2 | 8.2 | 29 | 0.1 | 0.3 | 0.014 | 0.254 | 0.01393 | (ADD) |
| | | | | | | | | | |
| Track III | 3.2 | 12.5 | 29 | 0.1 | 0.4 | 0.020 | 0.256 | 0.01966 | (ADD) |
| | 3.2 | 4.3 | 29 | 0.1 | 0.1 | 0.008 | 0.252 | 0.00759 | (SUBTRACT) |
| | | | | | | | | | |
| Track IV | 16.1 | 12.5 | 29 | 0.6 | 0.4 | 0.081 | 0.269 | 0.08065 | (ADD) |
| | 16.1 | 4.3 | 29 | 0.6 | 0.1 | 0.031 | 0.258 | 0.03090 | (SUBTRACT) |
| | 12.9 | 12.5 | 29 | 0.4 | 0.4 | 0.069 | 0.268 | 0.06896 | (SUBTRACT) |
| | 12.9 | 4.3 | 29 | 0.4 | 0.1 | 0.026 | 0.258 | 0.02649 | (ADD) |

$\text{Live Load}_3 = q_r(\Sigma I) + q_{fr}(\Sigma II) + q_{fr}(\Sigma III) + q_r(\Sigma IV)$

$\text{Live Load}_3 =$ 65.88 psf

LARGEST EQUIPEMENT LOAD = 74.06 $lb/ft^2$

VERTICAL OVERBURDEN LOAD = 1542.23 $lb/ft^2$

VERTICAL EQUIPMENT LOAD = 74.06 $lb/ft^2$

TOTAL VERTICAL LOAD APPLIED TO PIPE, $P_T$ = 1616.28 $lb/ft^2$ = 11.22 $lb/in^2$

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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **10" Diameter Leachate Collection Lateral Pipe** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **25 Feet Waste** | | |

Verify that perforations in the LCRS are adequate for the peak leachate flow.

Use discharge equation:

$Q = (Cd)(Ao)(2gh)^{0.5}$

$C_d$ = coeffiecient of discharge = 0.6 for short tube discharge with fluid/wall separation; conservative value.

$A_o$ = Area of orifice ($\pi D^2/4$)

g = gravitational acceleration (32.3 $ft^2/s$)

h = static head (ft)

| Assumptions and Givens: | | | |
|---|---|---|---|
| | 4.55 | acres | North and center portion of landfill bottom |
| 1. No. acres of landfill expansion = | 1.47 | acres | - North & center area from eastern grade break of bottom |
| 2. Total length of pipe per expansion = | 951.3 | ft | area draining into eastern 10-inch lateral collection |
| 3. Total number of laterals = | 1.0 | | - (2) 8-inch laterals collect drainage from other bottom area |
| 4. Length of pipe per lateral = | 951.3 | ft | - (1) 10-inch lateral collects the drainage area |
| 5. Perforation diameter = | 0.375 | inch | - Refer to calcs for 8" diameter leachate collection lateral |
| 6. No. perforations/ft pipe = | 6.0 | perforations/ft of pipe length | |
| 7. Maximum head over pipe = | 1.0 | ft | |
| 8. Per HELP model summary table, $Q_{peak}$ = | 202.93 | gal/min | refer to HELP Model Summary Table |
| 9. Per HELP model summary table, $Q_{peak}$ = | 39,063.5 | cf/day | refer to HELP Model Summary Table |
| 10. Maximum flow/lateral = | 39,063.5 | cf/day/lateral | |
| 11. Maximum leachate flow/ft of pipe = | 41.06 | cf/day/ft of pipe | |

Solution:

$A_o = 0.25(\Pi)(d)^2 =$ 0.00077 $ft^2$

1. Flow per orifice, $Q = (Cd)(Ao)(2gh)^{0.5}$ = 0.0037 $ft^3/s$

2. Flow per ft of pipe = (Q)(# perfs/ft) = 0.02 $ft^3/s$ per ft of pipe

= 1914.47 cf/day/ft of pipe

Conclusion:

Design capacity exceeds estimated generation

1914.47 cf/day/ft of pipe >>> 41.06 cf/day/ft of pipe

Perforations are adequate to handle the maximum leachate flow.

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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **10" Diameter Leachate Collection Lateral Pipe** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **25 Feet Waste** | | |

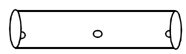
Effective pressure on pipe due to perforations:

$P_{EFF} = \dfrac{P_T \times 12}{(12-L_P)}$ Source 3, EPA SW-870, p. 382

$L_P$ = Total accumulated length of perforations in one foot of pipe.

Since each perforation is 0.375 inch diameter and spaced at 6.0 inch on center,

$L_P$ = 1.5 inch



$P_T$ = 11.2 psi

$P_{EFF}$ = 12.8 psi

$P_{EFF}$ = 1847.2 psf

Check actual compressive pressure ($S_A$) per Driscopipe manual:

$S_A$ = 0.5 x (SDR - 1) x P(eff) = 64.2 psi

The recommended, long-term compressive strength ($Y_s$) design value for Driscoplex polyethylene pipe is 800 lb/in$^2$.

Source No. 1

| $S_A$ (psi): | | $Y_s$ (psi): |
|---|---|---|
| 64.2 | < | 800.0 |

Pipe passes wall compressive stress perforation calculations TRUE

FS = 12.5

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Constrained pipe wall buckling (for Driscoplex OD controlled pipe)

$P_{WC} = \dfrac{5.65 * \{RB'E'\ E*[12(DR-1)^3]^{-1}\}^{0.5}}{N}$ Source 1, Equation 7-5

$P_{WC}$ = allowable constrained buckling pressure (lb/in$^2$)

R = buoyancy reduction factor = 1 - 0.33 * (H'/H) Source 1, Equation 7-34

H' = groundwater height above pipe (ft) | 0.0 | ft

H = cover above pipe (ft) | 29.0 | ft

B' = elastic support factor =( 1+ 4*e$^{-0.065H}$ )$^{-1}$ Source 1, Equation 7-35

| | | |
|---|---|---|
| E' = soil reaction modulus (lb/in$^2$) | 3000.0 | lb/in$^2$ for mod comp/crushed rock, 'Source 1, Table 7-7 |
| E = elastic modulus (lb/in$^2$) | 100000.0 | lb/in$^2$ for long term load at 100$^o$F, 'Source 1, Table 5-1 |
| I = moment of inertia = t$^3$ / 12 | 0.1 | in$^4$/in |
| $D_o$ = pipe outer diameter (in) | 10.750 | SDR 11 pipe (Driscopipe) to be used |
| t = pipe wall thickness (in) | 0.977 | SDR 11 pipe (Driscopipe) to be used |
| DR = pipe dimension ratio = $D_o$ / t | 11.0 | SDR 11 pipe (Driscopipe) to be used |
| $D_I$ = pipe inner diameter = $D_o$ - 2t (in) | 8.8 | SDR 11 pipe (Driscopipe) to be used |
| N = safety factor | 2.0 | |

| Cover (ft) | (ft) | (ft) | B' | R | (lb/in$^2$) |
|---|---|---|---|---|---|
| 29.0 | 29 | 0 | 0.62 | 1.00 | 352.16 |

$P_{WC}$ = 352.16 lb/in$^2$
$P_{EFF}$ = 12.83 lb/in$^2$

Pipe passes contrained wall buckling calculations TRUE FS = 27.5

SCS ENGINEERS

SHEET 8 OF 10

| CLIENT | PROJECT | JOB NO. |
|---|---|---|
| Hardee County | Phase II Section II Expansion | 09199033.23 |

| SUBJECT | BY | DATE |
|---|---|---|
| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **10" Diameter Leachate Collection Lateral Pipe** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **25 Feet Waste** | | |

Constrained Pipe Wall Compressive Stress (for Driscoplex OD controlled pipe)

$S = \frac{P_T D_o}{288t}$ Source No. 1

S = pipe wall compressive stress ($lb/in^2$)

$P_T$ = vertical load applied to pipe w/ perfs ($lb/ft^2$) 1847.2 $lb/ft^2$

$D_o$ = pipe outside diameter (in) 10.75 SDR 11 pipe (Driscopipe) to be used

t = pipe wall thickness (in) 0.977 SDR 11 pipe (Driscopipe) to be used

$S = \frac{P_T D_o}{288t} =$ 70.6 $lb/in^2$

The recommended, long-term compressive strength ($Y_s$) design value for Driscoplex polyethylene pipe is 800 $lb/in^2$.

Source No. 1

| S (psi): | | $Y_s$ (psi): |
|---|---|---|
| 70.6 | < | 800.0 |

Pipe passes wall compressive stress calculations TRUE FS = 11.3

| CLIENT | PROJECT | JOB NO. |
|---|---|---|
| Hardee County | Phase II Section II Expansion | 09199033.23 |

| SUBJECT | BY | DATE |
|---|---|---|
| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **10" Diameter Leachate Collection Lateral Pipe** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **25 Feet Waste** | | |

Iowa Formula

$\Delta X = \frac{D_L K W_c r^3}{EI + 0.06er^4}$ Source 2, Equation 3.4 Buried Pipe Design, A.P. Moser, Chapter 3

$\Delta X$ = horizontal deflection (in)

$D_L$ = deflection lag factor

K = bedding constant | 0.1 | typical value Source 2, Buried Pipe Design, A.P. Moser, Chapter 3

$W_c$ = Marston's load per unit length of pipe (lb/in)

r = mean radius of the pipe (in)

E = modulus of elasticity ($lb/in^2$)

I = moment of inertia of the pipe wall per unit length ($in^3$)

e = modulus of passive resistance fo the side fill ($lb/in^2(in)$)

Modified Iowa Formula

$\Delta X = \frac{D_L K W_c r_m^3}{EI + 0.06E'r_m^3}$ Source 2, Equation 3.5 Buried Pipe Design, A.P. Moser, Chapter 3

$\Delta X$ = horizontal deflection (in)

| | | | |
|---|---|---|---|
| $D_L$ = deflection lag factor | | 1.0 | Prism Load used |
| Typical Value for Marston Load | 1.5 | | |
| Typical Value for Prism Load | 1.0 | | |
| K = bedding constant | | 0.1 | typical value Buried Pipe Design, A.P. Moser, Chapter 3 |
| $P_T$ = Vertical load on pipe w/ perfs | | 12.83 | $lb/in^2$ ; 1847 $lb/ft^2$ |
| $W_c$ = Marston's load per unit length of pipe = $P_T * D_o$ (lb/in) | | 137.90 | lb/in |
| $D_o$ = pipe outer diameter (in) | | 10.75 | SDR 11 pipe (Driscopipe) to be used |
| t = pipe wall thickness (in) | | 0.98 | SDR 11 pipe (Driscopipe) to be used |
| $D_I$ = pipe inner diameter = $D_o$-2t (in) | | 8.80 | SDR 11 pipe (Driscopipe) to be used |
| $D_m$ = pipe mean diameter = $D_o$ - 1.06t Source 1, Equation 7-27 | | 9.71 | SDR 11 pipe (Driscopipe) to be used |
| $r_m$ = mean radius of the pipe (in) | | 4.86 | SDR 11 pipe (Driscopipe) to be used |
| E = modulus of elasticity ($lb/in^2$) | | 100,000.0 | lb/in2 for long term load at 100oF, 'Source 1, Table 5-1 |
| I = moment of inertia of the pipe wall per unit length | | 0.078 | $in^4/in$ |
| E' = modulus of soil reaction | | 3,000.0 | $lb/in^2$ for moderate compaction and fine grained soils |

$\Delta X = \frac{D_L K W_c r_m^3}{EI + 0.06E'r_m^3}$ = 0.056 inch Source 2, Equation 3.5 Buried Pipe Design, A.P. Moser, Chapter 3

% Ring Deflection = $(\Delta X/D_m) \times 100$ = 0.57% Source 1, Equation 7-31

Ring Bending Strain

$e = \frac{f_D \Delta X 2C}{D_M^2} \times 100$ Source 1, Equation 7-39

e = wall strain (%)

| | | |
|---|---|---|
| $f_D$ = deformation shape factor | 6 | Source 1, non-elliptical shape |
| $D_M$ = mean diameter (in) | | |
| C = outer fiber wall centroid = 0.5 (1.06t) | 0.518 | Source 1, Equation 7-41 |
| $\Delta X$ = ring deflection = $D_X/D_m$ | 0.006 | |

$e = f_D \frac{(\Delta X)}{D_M}\frac{(2C)}{D_M} \times 100$ = 0.4% Source 1, Equation 7-39

The maximum ring bending strain for high performance polyethylene non-pressure pipe is = 5.0%

Pipe passes ring bending strain calculations TRUE

| CLIENT | PROJECT | JOB NO. |
|---|---|---|
| Hardee County | Phase II Section II Expansion | 09199033.23 |

| SUBJECT | BY | DATE |
|---|---|---|
| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **10" Diameter Leachate Collection Lateral Pipe** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **25 Feet Waste** | | |

SOURCES

1.) Attachment - 1 - Chevron Phillips Chemical Company, Bulletin - Book 2 Chapter 5, 2003

2.) Attachment - 2 - Buried Pipe Design, A.P. Moser, Chapter 3

3.) Attachment - 3 - EPA, Lining of Waste Impoundment and Disposal Facilities, SW-870

4.) Attachment - 4 - Driscoplex Pipe Properties

5.) Attachment - 5 - CAT 826G Series II Compactor Equipment Data Sheet

SCS ENGINEERS

SHEET 1 OF 10

| CLIENT | PROJECT | JOB NO. |
|---|---|---|
| Hardee County | Phase II Section II Expansion | 09199033.23 |

| SUBJECT | BY | DATE |
|---|---|---|
| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **10" Diameter Leachate Collection Lateral Pipe** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **60 Feet Waste** | | |

Load on Pipe (Overburden)

Prism Loads, $P_E$ = wH

w = unit weight

H = depth

| | Depth (ft) | Unit Weight ($lb/ft^3$) | $P_E$ ($lb/ft^2$) |
|---|---|---|---|
| Final cover | 2.0 | 115.0 | 230.0 |
| Intermediate cover | 1.0 | 115.0 | 115.0 |
| Waste/cover | 60.0 | 60.0 | 3600.0 |
| Drainage sand | 2.0 | 115.0 | 230.0 |
| Rock (No. 89 & No. 57) | 2.0 | 140.0 | 280.0 |

TOTAL SOIL PRISM LOAD $P_E$: 4455.0 $lb/ft^2$

Total Depth = 67.0 ft

Soil Arching, $P_m = C_D wB$

Pm = vertical soil pressure

B = trench width at pipe crown 6.0 ft

$C_D$ = load coefficient $= \frac{1 - e^{-2Ku'H/B}}{2Ku'}$ Equation 7-3, Source No. 1

NOTE: The waste unit weight represents the combined unit weight of waste, daily cover, and moisture.

e = natural log base number

K = Rankine earth pressure coefficient = $\tan^2(45-0.5*\phi)$

$\phi$ = internal soil friction angle = 27.0 degrees

u' = friction coefficient between backfill and trench sides = tan $\phi$

| Soil Type | Ku' |
|---|---|
| Saturated Clay | 0.110 |
| Ordinary Clay | 0.130 |
| Saturated Top Soil | 0.150 |
| Sand and Gravel | 0.165 |
| Clean Granular Soil | 0.192 |

| | Ku' | $C_D$ | $P_m$ ($lb/ft^2$) |
|---|---|---|---|
| Cover Soil | 0.150 | 0.32 | 219 |
| Int Cover | 0.165 | 0.16 | 112 |
| Waste | 0.191 | 2.56 | 920 |
| Drainage Sand | 0.165 | 0.32 | 217.8 |
| Granular Soil | 0.192 | 0.31 | 262.8 |

TOTAL SOIL ARCHING LOAD $P_M$: 1,731.6 $lb/ft^2$

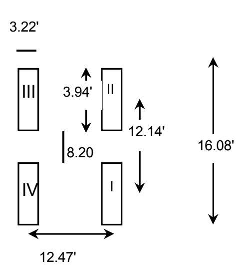
MODIFIED ARCHING LOAD = $0.6P_M+0.4P_E$: 2,820.98 $lb/ft^2$

OVERBURDEN LOAD: 2,820.98 $lb/ft^2$

Load on Pipe With Equipment Refer to Attachment

Operation w/ CAT 826G Series II Compactor 60 Feet Waste

Equipment Weight = 81,498.0 psf




Track per Load = $q_r$ = 1,670.20 psf (Rear)

Track per Load = $q_{fr}$ = 1,541.72 psf (Front)

Length of Track = L = 3.22 ft (contact length)

Length of Track = b = 8.20 ft

Track Width = 12.47 ft

Track Width (I to II) = 16.08 ft

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| CLIENT | PROJECT | JOB NO. |
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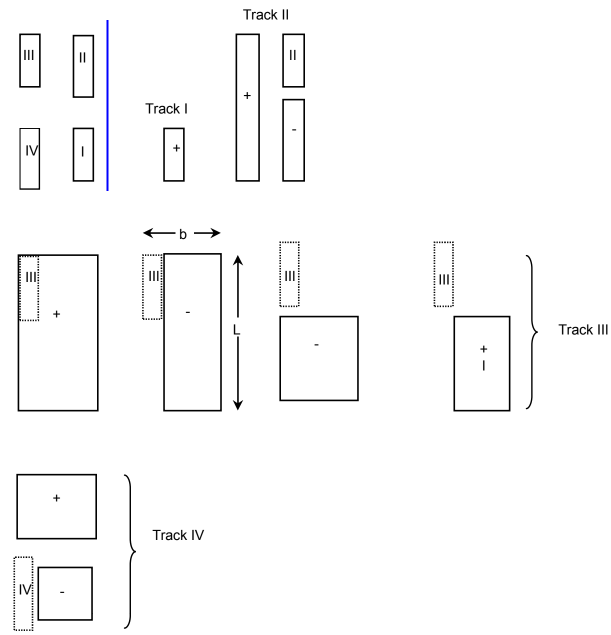
| SUBJECT | BY | DATE |
|---|---|---|
| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **10" Diameter Leachate Collection Lateral Pipe** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **60 Feet Waste** | | |

Load on Pipe

Alternative 1: Track Adjacent and Parallel to Pipe




| | b | L | z | m = b/z | n = L/z | I* | I** | I | |
|---|---|---|---|---|---|---|---|---|---|
| Track I | 8.2 | 3 | 67 | 0.12 | 0.05 | 0.003 | 0.251 | 0.00277 | (ADD) |
| | | | | | | | | | |
| Track II | 8.2 | 16.1 | 67 | 0.12 | 0.24 | 0.013 | 0.254 | 0.01323 | (ADD) |
| | 8.2 | 11.4 | 67 | 0.12 | 0.17 | 0.010 | 0.253 | 0.00961 | (SUBTRACT) |
| | | | | | | | | | |
| Track IV | 12.47 | 3.22 | 67 | 0.19 | 0.05 | 0.004 | 0.251 | 0.00414 | (ADD) |
| | 12.47 | 3.22 | 67 | 0.19 | 0.05 | 0.004 | 0.251 | 0.00414 | (SUBTRACT) |
| | | | | | | | | | |
| Track III | 12.47 | 16.08 | 67 | 0.19 | 0.24 | 0.020 | 0.256 | 0.01980 | (ADD) |
| | 4.27 | 16.08 | 67 | 0.06 | 0.24 | 0.007 | 0.252 | 0.00695 | (SUBTRACT) |
| | 12.47 | 11.42 | 67 | 0.19 | 0.17 | 0.014 | 0.255 | 0.01438 | (SUBTRACT) |
| | 4.27 | 8.47 | 67 | 0.06 | 0.13 | 0.004 | 0.251 | 0.00378 | (ADD) |

Live Load$_1$ = $q_r(\Sigma I) + q_{fr}(\Sigma II) + q_{fr}(\Sigma III) + q_r(\Sigma IV)$

Live Load$_1$ = 13.68 psf

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| CLIENT | PROJECT | JOB NO. |
|---|---|---|
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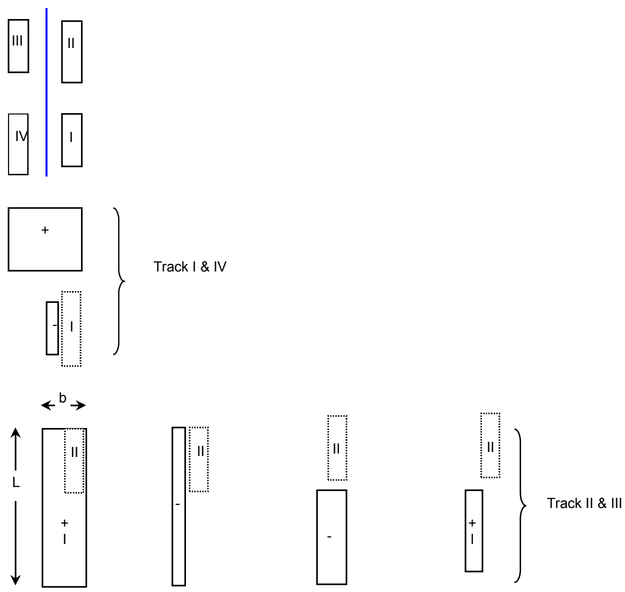
| SUBJECT | BY | DATE |
|---|---|---|
| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **10" Diameter Leachate Collection Lateral Pipe** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **60 Feet Waste** | | |

Load on Pipe

Alternative 2: Track Stradling and Parallel to Pipe




| | b | L | z | m = b/z | n = L/z | I* | I** | I | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | |
| Track I | 6.2 | 3.2 | 67 | 0.1 | 0.0 | 0.002 | 0.251 | 0.00212 | (ADD) |
| & IV | -2.0 | 3.2 | 67 | 0.0 | 0.0 | -0.001 | 0.250 | -0.00067 | (SUBTRACT) |
| | | | | | | | | | |
| Track II | 6.2 | 16.08 | 67 | 0.1 | 0.2 | 0.010 | 0.253 | 0.01011 | (ADD) |
| & III | -2.0 | 16.08 | 67 | 0.0 | 0.2 | -0.003 | 0.249 | -0.00321 | (SUBTRACT) |
| | 6.2 | 12.86 | 67 | 0.1 | 0.2 | 0.008 | 0.253 | 0.00822 | (SUBTRACT) |
| | -2.0 | 12.86 | 67 | 0.0 | 0.2 | -0.003 | 0.249 | -0.00261 | (ADD) |

Live $Load_2$ = $[q_r (\Sigma I) + q_{fr} (\Sigma II)] * 2$

Live $Load_2$ = 16.99 psf

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| CLIENT | PROJECT | JOB NO. | |
|---|---|---|---|
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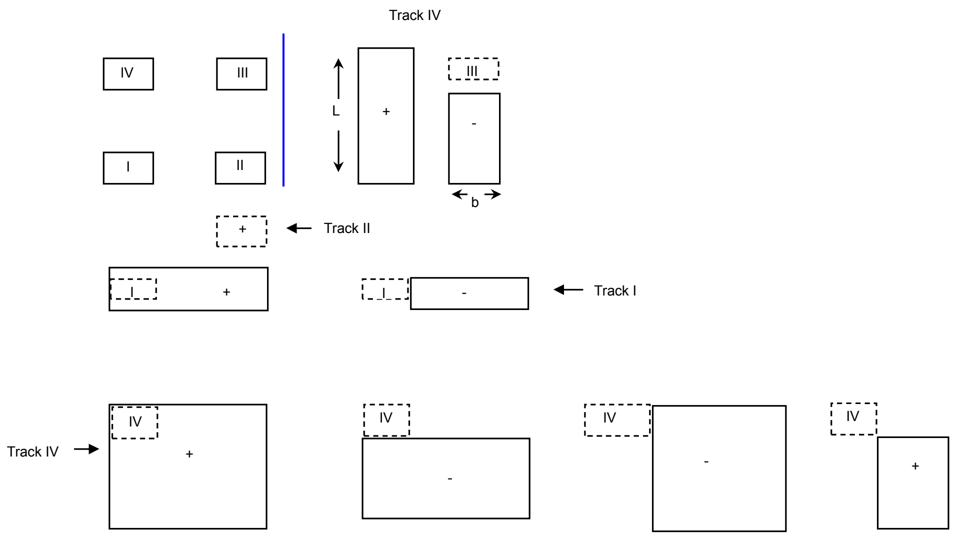
| SUBJECT | | BY | DATE |
| Pipe Crushing Calculations **RAI No. 1** | | SRF | 4/1/13 |
| **10" Diameter Leachate Collection Lateral Pipe** | | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **60 Feet Waste** | | | |

Load on Pipe

Alternative 3: Track Perpendicular to Pipe




| | b | L | z | m = b/z | n = L/z | I* | I** | I | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | |
| Track I | 16.1 | 8.2 | 67 | 0.2 | 0.1 | 0.013 | 0.254 | 0.01323 | (ADD) |
| | 12.9 | 8.2 | 67 | 0.2 | 0.1 | 0.011 | 0.253 | 0.01075 | (SUBTRACT) |
| | | | | | | | | | |
| Track II | 3.2 | 8.2 | 67 | 0.0 | 0.1 | 0.003 | 0.251 | 0.00277 | (ADD) |
| | | | | | | | | | |
| Track III | 3.2 | 12.5 | 67 | 0.0 | 0.2 | 0.004 | 0.251 | 0.00414 | (ADD) |
| | 3.2 | 4.3 | 67 | 0.0 | 0.1 | 0.001 | 0.250 | 0.00145 | (SUBTRACT) |
| | | | | | | | | | |
| Track IV | 16.1 | 12.5 | 67 | 0.2 | 0.2 | 0.020 | 0.256 | 0.01980 | (ADD) |
| | 16.1 | 4.3 | 67 | 0.2 | 0.1 | 0.007 | 0.252 | 0.00695 | (SUBTRACT) |
| | 12.9 | 12.5 | 67 | 0.2 | 0.2 | 0.016 | 0.255 | 0.01610 | (SUBTRACT) |
| | 12.9 | 4.3 | 67 | 0.2 | 0.1 | 0.006 | 0.252 | 0.00565 | (ADD) |

Live Load$_3$ = $q_r(\Sigma I) + q_{fr}(\Sigma II) + q_{fr}(\Sigma III) + q_r(\Sigma IV)$

Live Load$_3$ = 16.57 psf

LARGEST EQUIPEMENT LOAD = 16.99 lb/ft$^2$

VERTICAL OVERBURDEN LOAD = 2820.98 lb/ft$^2$

VERTICAL EQUIPMENT LOAD = 16.99 lb/ft$^2$

TOTAL VERTICAL LOAD APPLIED TO PIPE, $P_T$ = 2837.98 lb/ft$^2$ = 19.71 lb/in$^2$

SCS ENGINEERS



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| SUBJECT | BY | DATE |
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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **10" Diameter Leachate Collection Lateral Pipe** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **60 Feet Waste** | | |

Verify that perforations in the LCRS are adequate for the peak leachate flow.

Use discharge equation:

$Q = (Cd)(Ao)(2gh)^{0.5}$

$C_d$ = coeffiecient of discharge = 0.6 for short tube discharge with fluid/wall separation; conservative value.

$A_o$ = Area of orifice ($\pi D^2/4$)

g = gravitational acceleration (32.3 $ft^2/s$)

h = static head (ft)

| Assumptions and Givens: | 4.55 | acres | North and center portion of landfill bottom |
|---|---|---|---|
| 1. No. acres of landfill expansion = | 1.47 | acres | - North & center area from eastern grade break of bottom |
| 2. Total length of pipe per expansion = | 951.3 | ft | area draining into eastern 10-inch lateral collection |
| 3. Total number of laterals = | 1.0 | | - (2) 8-inch laterals collect drainage from other bottom area |
| 4. Length of pipe per lateral = | 951.3 | ft | - (1) 10-inch lateral collects the drainage area |
| 5. Perforation diameter = | 0.375 | inch | - Refer to calcs for 8" diameter leachate collection lateral |
| 6. No. perforations/ft pipe = | 6.0 | perforations/ft of pipe length | |
| 7. Maximum head over pipe = | 1.0 | ft | |
| 8. Per HELP model summary table, $Q_{peak}$ = | 202.93 | gal/min | refer to HELP Model Summary Table |
| 9. Per HELP model summary table, $Q_{peak}$ = | 39,063.5 | cf/day | refer to HELP Model Summary Table |
| 10. Maximum flow/lateral = | 39,063.5 | cf/day/lateral | |
| 11. Maximum leachate flow/ft of pipe = | 41.06 | cf/day/ft of pipe | |

Solution:

$A_o = 0.25(\Pi)(d)^2 =$ 0.00077 $ft^2$

1. Flow per orifice, $Q = (Cd)(Ao)(2gh)^{0.5} =$ 0.0037 $ft^3/s$

2. Flow per ft of pipe = (Q)(# perfs/ft) = 0.02 $ft^3/s$ per ft of pipe

= 1914.47 cf/day/ft of pipe

Conclusion:

Design capacity exceeds estimated generation

1914.47 cf/day/ft of pipe >>> 41.06 cf/day/ft of pipe

Perforations are adequate to handle the maximum leachate flow.

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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **10" Diameter Leachate Collection Lateral Pipe** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **60 Feet Waste** | | |

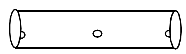
Effective pressure on pipe due to perforations:

$P_{EFF} = \frac{P_T \times 12}{(12-L_P)}$ Source 3, EPA SW-870, p. 382

$L_P$ = Total accumulated length of perforations in one foot of pipe.

Since each perforation is 0.375 inch diameter and spaced at 6.0 inch on center,

$L_P$ = 1.5 inch



$P_T$ = 19.7 psi

$P_{EFF}$ = 22.5 psi

$P_{EFF}$ = 3243.4 psf

Check actual compressive pressure ($S_A$) per Driscopipe manual:

$S_A$ = 0.5 x (SDR - 1) x P(eff) = 112.7 psi

The recommended, long-term compressive strength ($Y_s$) design value for Driscoplex polyethylene pipe is 800 lb/in$^2$.

Source No. 1

| $S_A$ (psi): | | $Y_s$ (psi): |
|---|---|---|
| 112.7 | < | 800.0 |

Pipe passes wall compressive stress perforation calculations TRUE

FS = 7.1

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|---|---|---|
| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **10" Diameter Leachate Collection Lateral Pipe** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **60 Feet Waste** | | |

Constrained pipe wall buckling (for Driscoplex OD controlled pipe)

$$P_{WC} = \frac{5.65 * \{RB'E'\ E*[12(DR-1)^3]^{-1}\}^{0.5}}{N}$$ Source 1, Equation 7-5

$P_{WC}$ = allowable constrained buckling pressure (lb/in$^2$)

| | | |
|---|---|---|
| R = buoyancy reduction factor = 1 - 0.33 * (H'/H) | Source 1, Equation 7-34 | |
| H' = groundwater height above pipe (ft) | 0.0 | ft |
| H = cover above pipe (ft) | 67.0 | ft |
| B' = elastic support factor =( 1+ 4*$e^{-0.065H}$ )$^{-1}$ | Source 1, Equation 7-35 | |
| E' = soil reaction modulus (lb/in$^2$) | 3000.0 | lb/in$^2$ for mod comp/crushed rock, 'Source 1, Table 7-7 |
| E = elastic modulus (lb/in$^2$) | 100000.0 | lb/in$^2$ for long term load at 100°F, 'Source 1, Table 5-1 |
| I = moment of inertia = $t^3$ / 12 | 0.1 | in$^4$/in |
| $D_o$ = pipe outer diameter (in) | 10.750 | SDR 11 pipe (Driscopipe) to be used |
| t = pipe wall thickness (in) | 0.977 | SDR 11 pipe (Driscopipe) to be used |
| DR = pipe dimension ratio = $D_o$ / t | 11.0 | SDR 11 pipe (Driscopipe) to be used |
| $D_I$ = pipe inner diameter = $D_o$ - 2t (in) | 8.8 | SDR 11 pipe (Driscopipe) to be used |
| N = safety factor | 2.0 | |

| Cover (ft) | (ft) | (ft) | B' | R | (lb/in$^2$) |
|---|---|---|---|---|---|
| 67.0 | 67 | 0 | 0.95 | 1.00 | 435.42 |

$P_{WC}$ = 435.42 lb/in$^2$
$P_{EFF}$ = 22.52 lb/in$^2$

Pipe passes contrained wall buckling calculations TRUE FS = 19.3

SCS ENGINEERS



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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **10" Diameter Leachate Collection Lateral Pipe** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **60 Feet Waste** | | |

Constrained Pipe Wall Compressive Stress (for Driscoplex OD controlled pipe)

$$S = \frac{P_T D_o}{288t}$$ Source No. 1

S = pipe wall compressive stress ($lb/in^2$)

| | | |
|---|---|---|
| $P_T$ = vertical load applied to pipe w/ perfs ($lb/ft^2$) | 3243.4 | $lb/ft^2$ |
| $D_o$ = pipe outside diameter (in) | 10.75 | SDR 11 pipe (Driscopipe) to be used |
| t = pipe wall thickness (in) | 0.977 | SDR 11 pipe (Driscopipe) to be used |

$$S = \frac{P_T D_o}{288t} = 123.9 \; lb/in^2$$

The recommended, long-term compressive strength ($Y_s$) design value for Driscoplex polyethylene pipe is 800 $lb/in^2$.

Source No. 1

| S (psi): | | $Y_s$ (psi): |
|---|---|---|
| 123.9 | < | 800.0 |

Pipe passes wall compressive stress calculations TRUE

FS = 6.5

| CLIENT | PROJECT | JOB NO. |
|---|---|---|
| Hardee County | Phase II Section II Expansion | 09199033.23 |

| SUBJECT | BY | DATE |
|---|---|---|
| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **10" Diameter Leachate Collection Lateral Pipe** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **60 Feet Waste** | | |

Iowa Formula

$\Delta X = \dfrac{D_L K W_c r^3}{EI + 0.06er^4}$ Source 2, Equation 3.4 Buried Pipe Design, A.P. Moser, Chapter 3

$\Delta X$ = horizontal deflection (in)

$D_L$ = deflection lag factor

K = bedding constant — 0.1 — typical value Source 2, Buried Pipe Design, A.P. Moser, Chapter 3

$W_c$ = Marston's load per unit length of pipe (lb/in)

r = mean radius of the pipe (in)

E = modulus of elasticity (lb/in$^2$)

I = moment of inertia of the pipe wall per unit length (in$^3$)

e = modulus of passive resistance fo the side fill (lb/in$^2$(in))

Modified Iowa Formula

$\Delta X = \dfrac{D_L K W_c r_m^3}{EI + 0.06E' r_m^3}$ Source 2, Equation 3.5 Buried Pipe Design, A.P. Moser, Chapter 3

$\Delta X$ = horizontal deflection (in)

| | | |
|---|---|---|
| $D_L$ = deflection lag factor | 1.0 | Prism Load used |
| Typical Value for Marston Load | 1.5 | |
| Typical Value for Prism Load | 1.0 | |
| K = bedding constant | 0.1 | typical value Buried Pipe Design, A.P. Moser, Chapter 3 |
| $P_T$ = Vertical load on pipe w/ perfs | 22.52 | lb/in$^2$ — 3243 lb/ft$^2$ |
| $W_c$ = Marston's load per unit length of pipe = $P_T$ * $D_o$ (lb/in) | 242.13 | lb/in |
| $D_o$ = pipe outer diameter (in) | 10.75 | SDR 11 pipe (Driscopipe) to be used |
| t = pipe wall thickness (in) | 0.98 | SDR 11 pipe (Driscopipe) to be used |
| $D_I$ = pipe inner diameter = $D_o$-2t (in) | 8.80 | SDR 11 pipe (Driscopipe) to be used |
| $D_m$ = pipe mean diameter = $D_o$ - 1.06t Source 1, Equation 7-27 | 9.71 | SDR 11 pipe (Driscopipe) to be used |
| $r_m$ = mean radius of the pipe (in) | 4.86 | SDR 11 pipe (Driscopipe) to be used |
| E = modulus of elasticity (lb/in$^2$) | 100,000.0 | lb/in2 for long term load at 100oF, 'Source 1, Table 5-1 |
| I = moment of inertia of the pipe wall per unit length | 0.078 | in$^4$/in |
| E' = modulus of soil reaction | 3,000.0 | lb/in$^2$ for moderate compaction and fine grained soils |

$\Delta X = \dfrac{D_l K W_c r_m^3}{EI + 0.06E' r_m^3}$ = 0.098 inch — Source 2, Equation 3.5 Buried Pipe Design, A.P. Moser, Chapter 3

% Ring Deflection = ($\Delta X/D_m$) x 100 = 1.01% Source 1, Equation 7-31

Ring Bending Strain

$e = \dfrac{f_D \Delta X 2C}{D_M^2} \times 100$ Source 1, Equation 7-39

e = wall strain (%)

| | | |
|---|---|---|
| $f_D$ = deformation shape factor | 6 | Source 1, non-elliptical shape |
| $D_M$ = mean diameter (in) | | |
| C = outer fiber wall centroid = 0.5 (1.06t) | 0.518 | Source 1, Equation 7-41 |
| $\Delta X$ = ring deflection = $D_X/D_m$ | 0.010 | |

$e = f_D \left(\dfrac{\Delta X}{D_M}\right)\left(\dfrac{2C}{D_M}\right) \times 100$ = 0.6% Source 1, Equation 7-39

The maximum ring bending strain for high performance polyethylene non-pressure pipe is = 5.0%

Pipe passes ring bending strain calculations TRUE

| CLIENT | PROJECT | JOB NO. |
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| Hardee County | Phase II Section II Expansion | 09199033.23 |

| SUBJECT | BY | DATE |
| --- | --- | --- |
| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **10" Diameter Leachate Collection Lateral Pipe** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **60 Feet Waste** | | |

SOURCES

1.) Attachment - 1 - Chevron Phillips Chemical Company, Bulletin - Book 2 Chapter 5, 2003

2.) Attachment - 2 - Buried Pipe Design, A.P. Moser, Chapter 3

3.) Attachment - 3 - EPA, Lining of Waste Impoundment and Disposal Facilities, SW-870

4.) Attachment - 4 - Driscoplex Pipe Properties

5.) Attachment - 5 - CAT 826G Series II Compactor Equipment Data Sheet

SCS ENGINEERS

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| CLIENT | PROJECT | JOB NO. |
|---|---|---|
| Hardee County | Phase II Section II Expansion | 09199033.23 |

| SUBJECT | BY | DATE |
|---|---|---|
| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **10" Diameter Leachate Collection Lateral Pipe** | CHECKED | DATE |
| **Construction** w/ CAT D6R XW Series II | | |

Load on Pipe (Overburden)

Prism Loads, $P_E$ = wH

w = unit weight

H = depth

| | Depth (ft) | Unit Weight ($lb/ft^3$) | $P_E$ ($lb/ft^2$) |
|---|---|---|---|
| Final cover | 0.0 | 115.0 | 0.0 |
| Intermediate cover | 0.0 | 115.0 | 0.0 |
| Waste/cover | 0.0 | 60.0 | 0.0 |
| Drainage sand | 0.0 | 115.0 | 0.0 |
| Rock (No. 89 & No. 57) | 1.0 | 140.0 | 140.0 |

TOTAL SOIL PRISM LOAD $P_E$: 140.0 $lb/ft^2$

Total Depth = 1.0 ft

Soil Arching, $P_m = C_D wB$

NOTE: The waste unit weight represents the combined unit weight of waste, daily cover, and moisture.

Pm = vertical soil pressure

B = trench width at pipe crown 6.0 ft

$C_D$ = load coefficient $= \frac{1 - e^{-2Ku'H/B}}{2Ku'}$ Equation 7-3, Source No. 1

e = natural log base number

K = Rankine earth pressure coefficient = $\tan^2(45-0.5*\phi)$

$\phi$ = internal soil friction angle = 27.0 degrees

u' = friction coefficient between backfill and trench sides = tan $\phi$

| Soil Type | Ku' |
|---|---|
| Saturated Clay | 0.110 |
| Ordinary Clay | 0.130 |
| Saturated Top Soil | 0.150 |
| Sand and Gravel | 0.165 |
| Clean Granular Soil | 0.192 |

| | Ku' | $C_D$ | $P_m$ ($lb/ft^2$) |
|---|---|---|---|
| Cover Soil | 0.150 | 0.00 | 0 |
| Int Cover | 0.165 | 0.00 | 0 |
| Waste | 0.191 | 0.00 | 0 |
| Drainage Sand | 0.165 | 0.00 | 0.0 |
| Granular Soil | 0.192 | 0.16 | 135.6 |

TOTAL SOIL ARCHING LOAD $P_M$: 135.6 $lb/ft^2$

MODIFIED ARCHING LOAD = $0.6P_M+0.4P_E$: 137.37 $lb/ft^2$

OVERBURDEN LOAD: 137.37 $lb/ft^2$

Load on Pipe With Equipment Refer to Attachment

Construction w/ CAT D6R XW Series II

Equipment Weight = 43,888.0 psf

Number of Tracks = 2.0

Track Load = $q_r$ = 21,944.0 psf

Ground contact area/track = 23.1 psf

Length of Track = L = 111.0 in

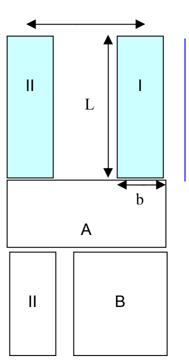
Track Width = b = 30.0 in

Track Gauge = G = 80.0 in

Equipment Width "A" = 116.0 in

Live Load = q*Ic q = track load 948.93 psf

Ic = Influence coefficient




| | b (ft) | L (ft) | z (ft) | m = b/z | n = L/z | I* | I** | I |
|---|---|---|---|---|---|---|---|---|
| I | 2.50 | 9.3 | 1.0 | 2.50 | 9.25 | -0.006 | 0.244 | 0.24428 |
| A | 9.17 | 9.3 | 1.0 | 9.17 | 9.25 | 0.000 | 0.250 | 0.24976 |
| B | 6.67 | 9.3 | 1.0 | 6.67 | 9.25 | 0.000 | 0.250 | 0.24957 |

Live $Load_1$ = I + II = $q_I(I_I) + q_A(I_A) - q_B(I_B)$ = 231.99 $lb/ft^2$

$q_I(I_I)$ = 231.81

$q_A(I_A)$ = 237.01

$q_B(I_B)$ = 236.82

Load on Pipe (Equipment) = 231.99 $lb/ft^2$

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| CLIENT | PROJECT | JOB NO. |
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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **10" Diameter Leachate Collection Lateral Pipe Construction** w/ CAT D6R XW Series II | CHECKED | DATE |

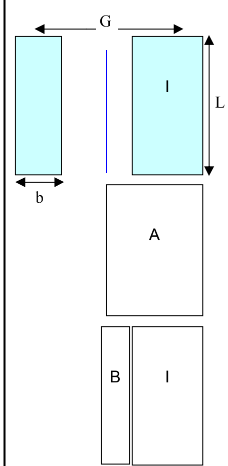
Load on Pipe (Equipment) *Continued*

Live Load = $q*I_c$

q = track load 948.93 $lb/ft^2$

$I_c$ = Influence coefficient

Alternative 2: Track stradling and parallel to pipe



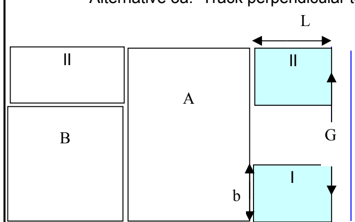

| | b | L | z | m = b/z | n = L/z | I* | I** | I |
|---|---|---|---|---|---|---|---|---|
| A | 4.83 | 9.3 | 1 | 4.83 | 9.25 | -0.001 | 0.249 | 0.24904 |
| B | 2.33 | 9.3 | 1 | 2.33 | 9.25 | -0.007 | 0.243 | 0.24315 |

Live $Load_2$ = 2 * (A - B) = 2 * ($q_AI_A$ - $q_BI_B$) = 11.18 $lb/ft^2$

| | |
|---|---|
| $q_A(I_A)$ = | 236.32 |
| $q_B(I_B)$ = | 230.73 |

Load on Pipe (Equipment) = 11.18 $lb/ft^2$

Alternative 3a: Track perpendicular to pipe




| | b | L | z | m = b/z | n = L/z | I* | I** | I |
|---|---|---|---|---|---|---|---|---|
| I | 2.50 | 9.3 | 1 | 2.50 | 9.25 | -0.006 | 0.244 | 0.24428 |
| A | 9.67 | 9.3 | 1 | 9.67 | 9.25 | 0.000 | 0.250 | 0.24978 |
| B | 7.17 | 9.3 | 1 | 7.17 | 9.25 | 0.000 | 0.250 | 0.24963 |

Live $Load_3$ = I + II = $q_I(I_I)$ + $q_A(I_A)$ - $q_B(I_B)$ = 231.95 $lb/ft^2$

| | |
|---|---|
| $q_I(I_I)$ = | 231.81 |
| $q_A(I_A)$ = | 237.02 |
| $q_B(I_B)$ = | 236.88 |

Load on Pipe (Equipment) = 231.95 $lb/ft^2$

LARGEST EQUIPEMENT LOAD = 231.99 $lb/ft^2$

VERTICAL OVERBURDEN LOAD = 137.37 $lb/ft^2$

VERTICAL EQUIPMENT LOAD = 231.99 $lb/ft^2$

TOTAL VERTICAL LOAD APPLIED TO PIPE, $P_T$ = 369.36 $lb/ft^2$ = 2.57 $lb/in^2$

SCS ENGINEERS

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| CLIENT | PROJECT | JOB NO. |
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| Hardee County | Phase II Section II Expansion | 09199033.23 |

| SUBJECT | BY | DATE |
|---|---|---|
| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **10" Diameter Leachate Collection Lateral Pipe Construction** w/ CAT D6R XW Series II | CHECKED | DATE |

Verify that perforations in the LCRS are adequate for the peak leachate flow.

Use discharge equation:

$Q = (Cd)(Ao)(2gh)^{0.5}$

$C_d$ = coefficient of discharge = 0.6 for short tube discharge with fluid/wall separation; conservative value.

$A_o$ = Area of orifice ($\pi D^2/4$)

g = gravitational acceleration (32.3 $ft^2/s$)

h = static head (ft)

Assumptions and Givens:

| | | | |
|---|---|---|---|
| | 4.55 | acres | North and center portion of landfill bottom |
| 1. No. acres of landfill expansion = | 1.47 | acres | - North & center area from eastern grade break of bottom |
| 2. Total length of pipe per expansion = | 951.3 | ft | area draining into eastern 10-inch lateral collection |
| 3. Number of laterals = | 1.0 | | - (2) 8-inch laterals collect drainage from other bottom area |
| 4. Total length of pipe per lateral = | 951.3 | ft | - (1) 10-inch lateral collects the drainage area |
| 5. Perforation diameter = | 0.375 | inch | - Refer to calcs for 8" diameter leachate collection lateral |
| 6. No. perforations/ft pipe = | 6.0 | perforations/ft of pipe length | |
| 7. Maximum head over pipe = | 1.0 | ft | |
| 8. Per HELP model summary table, $Q_{peak}$ = | 202.93 | gal/min | refer to HELP Model Summary Table |
| 9. Per HELP model summary table, $Q_{peak}$ = | 39,063.5 | cf/day | refer to HELP Model Summary Table |
| 10. Maximum flow/lateral = | 39,063.5 | cf/day/lateral | |
| 11. Maximum leachate flow/ft of pipe = | 41.06 | cf/day/ft of pipe | |

Solution:

$A_o = 0.25(\Pi)(d)^2 =$ 0.00077 $ft^2$

1. Flow per orifice, $Q = (Cd)(Ao)(2gh)^{0.5} =$ 0.0037 $ft^3/s$

2. Flow per ft of pipe = (Q)(# perfs/ft) = 0.02 $ft^3/s$ per ft of pipe

= 1914.47 cf/day/ft of pipe

Conclusion:

Design capacity exceeds estimated generation

1914.47 cf/day/ft of pipe >>> 41.06 cf/day/ft of pipe

Perforations are adequate to handle the maximum leachate flow.

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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **10" Diameter Leachate Collection Lateral Pipe Construction** w/ CAT D6R XW Series II | CHECKED | DATE |

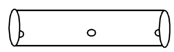
Effective pressure on pipe due to perforations:

$P_{EFF} = \frac{P_T \times 12}{(12-L_P)}$ Source 3, EPA SW-870, p. 382

$L_P$ = Total accumulated length of perforations in one foot of pipe.

Since each perforation is 0.375 inch diameter and spaced at 6.0 inch on center,

$L_P$ = 1.5 inch



$P_T$ = 2.6 psi

$P_{EFF}$ = 2.9 psi

$P_{EFF}$ = 422.1 psf

Check actual compressive pressure ($S_A$) per Driscopipe manual:

$S_A$ = 0.5 x (SDR - 1) x P(eff) = 14.7 psi

The recommended, long-term compressive strength ($Y_s$) design value for Driscoplex polyethylene pipe is 800 lb/in$^2$.

Source No. 1

| $S_A$ (psi): | | $Y_s$ (psi): |
|---|---|---|
| 14.7 | < | 800.0 |

Pipe passes wall compressive stress perforation calculations TRUE

FS = 54.6

| SCS ENGINEERS | | |
|---|---|---|
| | SHEET 5 | OF 8 |
| CLIENT<br>Hardee County | PROJECT<br>Phase II Section II Expansion | JOB NO.<br>09199033.23 |

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|---|---|---|
| Pipe Crushing Calculations **RAI No. 1**<br>**10" Diameter Leachate Collection Lateral Pipe Construction** w/ CAT D6R XW Series II | SRF | 4/1/13 |
| | CHECKED | DATE |

Constrained pipe wall buckling (for Driscoplex OD controlled pipe)

$P_{WC} = \frac{5.65 * \{RB'E' E*[12(DR-1)^3]^{-1}\}^{0.5}}{N}$ Source 1, Equation 7-5

$P_{WC}$ = allowable constrained buckling pressure ($lb/in^2$)

R = buoyancy reduction factor = 1 - 0.33 * (H'/H) Source 1, Equation 7-34

H' = groundwater height above pipe (ft) 0.0 ft

H = cover above pipe (ft) 1.0 ft

B' = elastic support factor =( $1+ 4*e^{-0.065H}$ )$^{-1}$ Source 1, Equation 7-35

E' = soil reaction modulus ($lb/in^2$) 3000.0 $lb/in^2$ for mod comp/crushed rock, 'Source 1, Table 7-7

E = elastic modulus ($lb/in^2$) 100000.0 $lb/in^2$ for long term load at 100°F, 'Source 1, Table 5-1

I = moment of inertia = $t^3$ / 12 0.1 $in^4$/in

$D_o$ = pipe outer diameter (in) 10.750 SDR 11 pipe (Driscopipe) to be used

t = pipe wall thickness (in) 0.977 SDR 11 pipe (Driscopipe) to be used

DR = pipe dimension ratio = $D_o$ / t 11.0 SDR 11 pipe (Driscopipe) to be used

$D_I$ = pipe inner diameter = $D_o$ - 2t (in) 8.8 SDR 11 pipe (Driscopipe) to be used

N = safety factor 2.0

| Cover (ft) | (ft) | (ft) | B' | R | ($lb/in^2$) |
|---|---|---|---|---|---|
| 1.0 | 1 | 0 | 0.21 | 1.00 | 204.89 |

$P_{WC}$ = 204.89 $lb/in^2$

$P_{EFF}$ = 2.93 $lb/in^2$

Pipe passes contrained wall buckling calculations TRUE FS = 69.9

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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **10" Diameter Leachate Collection Lateral Pipe Construction** w/ CAT D6R XW Series II | CHECKED | DATE |

Constrained Pipe Wall Compressive Stress (for Driscoplex OD controlled pipe)

$S = \frac{P_T D_o}{288t}$ Source No. 1

S = pipe wall compressive stress ($lb/in^2$)

$P_T$ = vertical load applied to pipe w/ perfs ($lb/ft^2$) 422.1 $lb/ft^2$

$D_o$ = pipe outside diameter (in) 10.75 SDR 11 pipe (Driscopipe) to be used

t = pipe wall thickness (in) 0.977 SDR 11 pipe (Driscopipe) to be used

$S = \frac{P_T D_o}{288t} =$ 16.1 $lb/in^2$

The recommended, long-term compressive strength ($Y_s$) design value for Driscoplex polyethylene pipe is 800 $lb/in^2$.

Source No. 1

| S (psi): | | $Y_s$ (psi): |
|---|---|---|
| 16.1 | < | 800.0 |

Pipe passes wall compressive stress calculations TRUE FS = 49.6

SCS ENGINEERS

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| CLIENT | PROJECT | JOB NO. | |
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| Pipe Crushing Calculations **RAI No. 1** | | SRF | 4/1/13 |
| **10" Diameter Leachate Collection Lateral Pipe Construction** w/ CAT D6R XW Series II | | CHECKED | DATE |

Iowa Formula

$\Delta X = \frac{D_L K W_c r^3}{EI + 0.06er^4}$ Source 2, Equation 3.4 Buried Pipe Design, A.P. Moser, Chapter 3

$\Delta X$ = horizontal deflection (in)

$D_L$ = deflection lag factor

K = bedding constant | 0.1 | typical value Source 2, Buried Pipe Design, A.P. Moser, Chapter 3

$W_c$ = Marston's load per unit length of pipe (lb/in)

r = mean radius of the pipe (in)

E = modulus of elasticity (lb/in$^2$)

I = moment of inertia of the pipe wall per unit length (in$^3$)

e = modulus of passive resistance fo the side fill (lb/in$^2$(in))

Modified Iowa Formula

$\Delta X = \frac{D_L K W_c r_m^3}{EI + 0.06E' r_m^3}$ Source 2, Equation 3.5 Buried Pipe Design, A.P. Moser, Chapter 3

$\Delta X$ = horizontal deflection (in)

| | | | |
|---|---|---|---|
| $D_L$ = deflection lag factor | | 1.0 | Prism Load used |
| Typical Value for Marston Load | 1.5 | | |
| Typical Value for Prism Load | 1.0 | | |
| K = bedding constant | | 0.1 | typical value Buried Pipe Design, A.P. Moser, Chapter 3 |
| $P_T$ = Vertical load on pipe w/ perfs | | 2.93 | lb/in$^2$ 422 lb/ft$^2$ |
| $W_c$ = Marston's load per unit length of pipe = $P_T$ * $D_o$ (lb/in) | | 31.51 | lb/in |
| $D_o$ = pipe outer diameter (in) | | 10.75 | SDR 11 pipe (Driscopipe) to be used |
| t = pipe wall thickness (in) | | 0.98 | SDR 11 pipe (Driscopipe) to be used |
| $D_I$ = pipe inner diameter = $D_o$-2t (in) | | 8.80 | SDR 11 pipe (Driscopipe) to be used |
| $D_m$ = pipe mean diameter = $D_o$ - 1.06t Source 1, Equation 7-27 | | 9.71 | SDR 11 pipe (Driscopipe) to be used |
| $r_m$ = mean radius of the pipe (in) | | 4.86 | SDR 11 pipe (Driscopipe) to be used |
| E = modulus of elasticity (lb/in$^2$) | | 100,000.0 | lb/in2 for long term load at 100oF, 'Source 1, Table 5-1 |
| I = moment of inertia of the pipe wall per unit length | | 0.078 | in$^4$/in |
| E' = modulus of soil reaction | | 3,000.0 | lb/in$^2$ for moderate compaction and fine grained soils |

$\Delta X = \frac{D_L K W_c r_m^3}{EI + 0.06E' r_m^3} =$ 0.013 inch Source 2, Equation 3.5 Buried Pipe Design, A.P. Moser, Chapter 3

% Ring Deflection = ($\Delta X/D_m$) x 100 = 0.13% Source 1, Equation 7-31

Ring Bending Strain

$e = \frac{f_D \Delta X 2C}{D_M^2} \times 100$ Source 1, Equation 7-39

e = wall strain (%)

| | | |
|---|---|---|
| $f_D$ = deformation shape factor | 6 | Source 1, non-elliptical shape |
| $D_M$ = mean diameter (in) | | |
| C = outer fiber wall centroid = 0.5 (1.06t) | 0.518 | Source 1, Equation 7-41 |
| $\Delta X$ = ring deflection = $D_X/D_m$ | 0.001 | |

$e = f_D \frac{\Delta X}{D_M} \frac{(2C)}{D_M} \times 100 =$ 0.1% Source 1, Equation 7-39

The maximum ring bending strain for high performance polyethylene non-pressure pipe is = 5.0%

Pipe passes ring bending strain calculations TRUE

SCS ENGINEERS



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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **10" Diameter Leachate Collection Lateral Pipe Construction** w/ CAT D6R XW Series II | CHECKED | DATE |

SOURCES

1.) Attachment - 1 - Chevron Phillips Chemical Company, Bulletin - Book 2 Chapter 5, 2003

2.) Attachment - 2 - Buried Pipe Design, A.P. Moser, Chapter 3

3.) Attachment - 3 - EPA, Lining of Waste Impoundment and Disposal Facilities, SW-870

4.) Attachment - 4 - Driscoplex Pipe Properties

5.) Attachment - 5 - CAT 826G Series II Compactor Data Sheet

6.) Attachment - 6 - CAT D7R Series II Equipment Data Sheet

7.) Attachment - 7 - CAT D6R XW Series II Equipment Data Sheet

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| CLIENT | PROJECT | JOB NO. |
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| Hardee County | Phase II Section II Expansion | 09199033.23 |

| SUBJECT | BY | DATE |
|---|---|---|
| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **10" Diameter Leachate Collection Lateral Pipe** | CHECKED | DATE |
| Operation w/ CAT D7R Series II **0 Feet Waste** | | |

Load on Pipe (Overburden)

Prism Loads, $P_E$ = wH

w = unit weight

H = depth

| | Depth (ft) | Unit Weight ($lb/ft^3$) | $P_E$ ($lb/ft^2$) |
|---|---|---|---|
| Final cover | 0.0 | 115.0 | 0.0 |
| Intermediate cover | 0.0 | 115.0 | 0.0 |
| Waste/cover | 0.0 | 60.0 | 0.0 |
| Drainage sand | 2.0 | 115.0 | 230.0 |
| Rock (No. 89 & No. 57) | 2.0 | 140.0 | 280.0 |

TOTAL SOIL PRISM LOAD $P_E$: 510.0 $lb/ft^2$

Total Depth = 4.0 ft

Soil Arching, $P_m = C_D wB$

NOTE: The waste unit weight represents the combined unit weight of waste, daily cover, and moisture.

Pm = vertical soil pressure

B = trench width at pipe crown 6.0 ft

$C_D$ = load coefficient $= \frac{1 - e^{-2Ku'H/B}}{2Ku'}$ Equation 7-3, Source No. 1

e = natural log base number

K = Rankine earth pressure coefficient = $\tan^2(45-0.5*\phi)$

$\phi$ = internal soil friction angle = 27.0 degrees

u' = friction coefficient between backfill and trench sides = tan $\phi$

| Soil Type | Ku' |
|---|---|
| Saturated Clay | 0.110 |
| Ordinary Clay | 0.130 |
| Saturated Top Soil | 0.150 |
| Sand and Gravel | 0.165 |
| Clean Granular Soil | 0.192 |

| | Ku' | $C_D$ | $P_m$ ($lb/ft^2$) |
|---|---|---|---|
| Cover Soil | 0.150 | 0.00 | 0 |
| Int Cover | 0.165 | 0.00 | 0 |
| Waste | 0.191 | 0.00 | 0 |
| Drainage Sand | 0.165 | 0.32 | 217.8 |
| Granular Soil | 0.192 | 0.31 | 262.8 |

TOTAL SOIL ARCHING LOAD $P_M$: 480.6 $lb/ft^2$

MODIFIED ARCHING LOAD = $0.6P_M+0.4P_E$: 492.37 $lb/ft^2$

Load on Pipe With Equipment Refer to Attachment

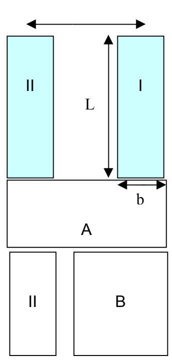
OVERBURDEN LOAD: 492.37 $lb/ft^2$

Operation w/ CAT D7R Series II 0 Feet Waste

| | | | | | |
|---|---|---|---|---|---|
| Equipment Weight = | 54,573.0 | psf | Length of Track = L = | 113.0 | in |
| Number of Tracks = | 2.0 | | Track Width = b = | 22.0 | in |
| Track Load = $q_r$ = | 27,286.5 | psf | Track Gauge = G = | 78.0 | in |
| Ground contact area/track = | 17.3 | psf | Equipment Width "A" = | 113.0 | in |

Live Load = q*Ic q = track load 1,580.55 psf

Ic = Influence coefficient




| | b (ft) | L (ft) | z (ft) | m = b/z | n = L/z | I* | I** | I |
|---|---|---|---|---|---|---|---|---|
| I | 1.83 | 9.4 | 4.0 | 0.46 | 2.35 | 0.127 | 0.252 | 0.12736 |
| A | 8.33 | 9.4 | 4.0 | 2.08 | 2.35 | -0.014 | 0.236 | 0.23624 |
| B | 6.50 | 9.4 | 4.0 | 1.63 | 2.35 | -0.021 | 0.229 | 0.22928 |

Live $Load_1$ = I + II = $q_I(I_I) + q_A(I_A) - q_B(I_B)$ = 212.30 $lb/ft^2$

$q_I(I_I)$ = 201.29

$q_A(I_A)$ = 373.39

$q_B(I_B)$ = 362.39

Load on Pipe (Equipment) = 212.30 $lb/ft^2$

| | | |
|---|---|---|
| CLIENT<br>Hardee County | PROJECT<br>Phase II Section II Expansion | JOB NO.<br>09199033.23 |

| | | |
|---|---|---|
| SUBJECT<br>Pipe Crushing Calculations **RAI No. 1** | BY<br>SRF | DATE<br>4/1/13 |
| **10" Diameter Leachate Collection Lateral Pipe**<br>Operation w/ CAT D7R Series II **0 Feet Waste** | CHECKED | DATE |

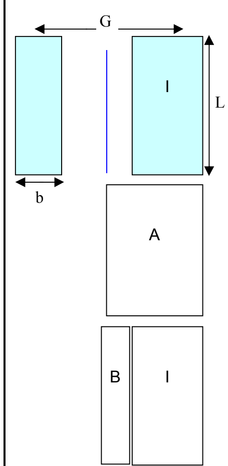
Load on Pipe (Equipment) *Continued*

Live Load = $q*I_c$

q = track load | 1580.55 | $lb/ft^2$

$I_c$ = Influence coefficient

Alternative 2: Track stradling and parallel to pipe



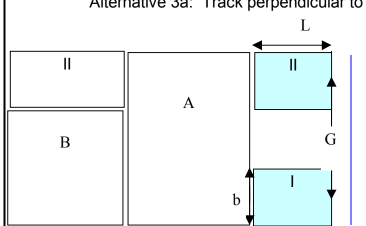

| | b | L | z | m = b/z | n = L/z | I* | I** | I |
|---|---|---|---|---|---|---|---|---|
| A | 4.71 | 9.4 | 4 | 1.18 | 2.35 | 0.213 | 0.216 | 0.21333 |
| B | 2.88 | 9.4 | 4 | 0.72 | 2.35 | 0.173 | 0.242 | 0.17258 |

Live $Load_2$ = 2 * (A - B) = 2 * ($q_AI_A$ - $q_BI_B$) = 128.82 $lb/ft^2$

| | |
|---|---|
| $q_A(I_A)$ = | 337.19 |
| $q_B(I_B)$ = | 272.78 |

Load on Pipe (Equipment) = 128.82 $lb/ft^2$

Alternative 3a: Track perpendicular to pipe




| | b | L | z | m = b/z | n = L/z | I* | I** | I |
|---|---|---|---|---|---|---|---|---|
| I | 1.83 | 9.4 | 4 | 0.46 | 2.35 | 0.127 | 0.252 | 0.12736 |
| A | 9.42 | 9.4 | 4 | 2.35 | 2.35 | -0.012 | 0.238 | 0.23841 |
| B | 7.58 | 9.4 | 4 | 1.90 | 2.35 | -0.016 | 0.234 | 0.23405 |

Live $Load_3$ = I + II = $q_I(I_I)$ + $q_A(I_A)$ - $q_B(I_B)$ = 208.18 $lb/ft^2$

| | |
|---|---|
| $q_I(I_I)$ = | 201.29 |
| $q_A(I_A)$ = | 376.82 |
| $q_B(I_B)$ = | 369.93 |

Load on Pipe (Equipment) = 208.18 $lb/ft^2$

LARGEST EQUIPEMENT LOAD = 212.30 $lb/ft^2$

VERTICAL OVERBURDEN LOAD = 492.37 $lb/ft^2$

VERTICAL EQUIPMENT LOAD = 212.30 $lb/ft^2$

TOTAL VERTICAL LOAD APPLIED TO PIPE, $P_T$ = 704.67 $lb/ft^2$ = 4.89 $lb/in^2$

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Verify that perforations in the LCRS are adequate for the peak leachate flow.

Use discharge equation:

$Q = (Cd)(Ao)(2gh)^{0.5}$

$C_d$ = coeffiecient of discharge = 0.6 for short tube discharge with fluid/wall separation; conservative value.

$A_o$ = Area of orifice ($\pi D^2/4$)

g = gravitational acceleration (32.3 $ft^2/s$)

h = static head (ft)

| Assumptions and Givens: | | | |
|---|---|---|---|
| | 4.55 | acres | North and center portion of landfill bottom |
| 1. No. acres of landfill expansion = | 1.47 | acres | - North & center area from eastern grade break of bottom |
| 2. Total length of pipe per expansion = | 951.3 | ft | area draining into eastern 10-inch lateral collection |
| 3. Number of laterals = | 1.0 | | - (2) 8-inch laterals collect drainage from other bottom area |
| 4. Total length of pipe per lateral = | 951.3 | ft | - (1) 10-inch lateral collects the drainage area |
| 5. Perforation diameter = | 0.375 | inch | - Refer to calcs for 8" diameter leachate collection lateral |
| 6. No. perforations/ft pipe = | 6.0 | perforations/ft of pipe length | |
| 7. Maximum head over pipe = | 1.0 | ft | |
| 8. Per HELP model summary table, $Q_{peak}$ = | 202.93 | gal/min | refer to HELP Model Summary Table |
| 9. Per HELP model summary table, $Q_{peak}$ = | 39,063.5 | cf/day | refer to HELP Model Summary Table |
| 10. Maximum flow/lateral = | 39,063.5 | cf/day/lateral | |
| 11. Maximum leachate flow/ft of pipe = | 41.06 | cf/day/ft of pipe | |

Solution:

$A_o = 0.25(\Pi)(d)^2 =$ 0.00077 $ft^2$

1. Flow per orifice, $Q = (Cd)(Ao)(2gh)^{0.5} =$ 0.0037 $ft^3/s$

2. Flow per ft of pipe = (Q)(# perfs/ft) = 0.02 $ft^3/s$ per ft of pipe

= 1914.47 cf/day/ft of pipe

Conclusion:

Design capacity exceeds estimated generation

1914.47 cf/day/ft of pipe >>> 41.06 cf/day/ft of pipe

Perforations are adequate to handle the maximum leachate flow.

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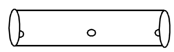
Effective pressure on pipe due to perforations:

$P_{EFF} = \frac{P_T \times 12}{(12 - L_P)}$ Source 3, EPA SW-870, p. 382

$L_P$ = Total accumulated length of perforations in one foot of pipe.

Since each perforation is 0.375 inch diameter and spaced at 6.0 inch on center,

$L_P$ = 1.5 inch



$P_T$ = 4.9 psi

$P_{EFF}$ = 5.6 psi

$P_{EFF}$ = 805.3 psf

Check actual compressive pressure ($S_A$) per Driscopipe manual:

$S_A$ = 0.5 x (SDR - 1) x P(eff) = 28.0 psi

The recommended, long-term compressive strength ($Y_s$) design value for Driscoplex polyethylene pipe is 800 lb/in$^2$.

Source No. 1

| $S_A$ (psi): | | $Y_s$ (psi): |
|---|---|---|
| 28.0 | < | 800.0 |

Pipe passes wall compressive stress perforation calculations TRUE

FS = 28.6

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Constrained pipe wall buckling (for Driscoplex OD controlled pipe)

$P_{WC} = \frac{5.65 * \{RB'E' E*[12(DR-1)^3]^{-1}\}^{0.5}}{N}$ Source 1, Equation 7-5

$P_{WC}$ = allowable constrained buckling pressure (lb/in$^2$)

R = buoyancy reduction factor = 1 - 0.33 * (H'/H) Source 1, Equation 7-34

| | | | |
|---|---|---|---|
| H' = groundwater height above pipe (ft) | 0.0 | ft | |
| H = cover above pipe (ft) | 4.0 | ft | |
| B' = elastic support factor =( 1+ 4*e$^{-0.065H}$ )$^{-1}$ | Source 1, Equation 7-35 | | |
| E' = soil reaction modulus (lb/in$^2$) | 3000.0 | lb/in$^2$ | for mod comp/crushed rock, 'Source 1, Table 7-7 |
| E = elastic modulus (lb/in$^2$) | 100000.0 | lb/in$^2$ | for long term load at 100$^o$F, 'Source 1, Table 5-1 |
| I = moment of inertia = t$^3$ / 12 | 0.1 | in$^4$/in | |
| $D_o$ = pipe outer diameter (in) | 10.750 | SDR 11 pipe (Driscopipe) to be used | |
| t = pipe wall thickness (in) | 0.977 | SDR 11 pipe (Driscopipe) to be used | |
| DR = pipe dimension ratio = $D_o$ / t | 11.0 | SDR 11 pipe (Driscopipe) to be used | |
| $D_I$ = pipe inner diameter = $D_o$ - 2t (in) | 8.8 | SDR 11 pipe (Driscopipe) to be used | |
| N = safety factor | 2.0 | | |

| Cover (ft) | (ft) | (ft) | B' | R | (lb/in$^2$) |
|---|---|---|---|---|---|
| 4.0 | 4 | 0 | 0.24 | 1.00 | 220.92 |

$P_{WC}$ = 220.92 lb/in$^2$

$P_{EFF}$ = 5.59 lb/in$^2$

Pipe passes contrained wall buckling calculations TRUE FS = 39.5

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| Operation w/ CAT D7R Series II **0 Feet Waste** | | |

Constrained Pipe Wall Compressive Stress (for Driscoplex OD controlled pipe)

$S = \frac{P_T D_o}{288t}$ Source No. 1

S = pipe wall compressive stress ($lb/in^2$)

$P_T$ = vertical load applied to pipe w/ perfs ($lb/ft^2$) | 805.3 | $lb/ft^2$

$D_o$ = pipe outside diameter (in) | 10.75 | SDR 11 pipe (Driscopipe) to be used

t = pipe wall thickness (in) | 0.977 | SDR 11 pipe (Driscopipe) to be used

$S = \frac{P_T D_o}{288t} =$ 30.8 $lb/in^2$

The recommended, long-term compressive strength ($Y_s$) design value for Driscoplex polyethylene pipe is 800 $lb/in^2$.

Source No. 1

| S (psi): | | $Y_s$ (psi): |
|---|---|---|
| 30.8 | < | 800.0 |

Pipe passes wall compressive stress calculations TRUE FS = 26.0

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Iowa Formula

$\Delta X = \dfrac{D_L K W_c r^3}{EI + 0.06er^4}$ Source 2, Equation 3.4 Buried Pipe Design, A.P. Moser, Chapter 3

$\Delta X$ = horizontal deflection (in)

$D_L$ = deflection lag factor

K = bedding constant 0.1 typical value Source 2, Buried Pipe Design, A.P. Moser, Chapter 3

$W_c$ = Marston's load per unit length of pipe (lb/in)

r = mean radius of the pipe (in)

E = modulus of elasticity ($lb/in^2$)

I = moment of inertia of the pipe wall per unit length ($in^3$)

e = modulus of passive resistance fo the side fill ($lb/in^2(in)$)

Modified Iowa Formula

$\Delta X = \dfrac{D_L K W_c r_m^3}{EI + 0.06E'r_m^3}$ Source 2, Equation 3.5 Buried Pipe Design, A.P. Moser, Chapter 3

| | | |
|---|---|---|
| $\Delta X$ = horizontal deflection (in) | | |
| $D_L$ = deflection lag factor | 1.0 | Prism Load used |
| Typical Value for Marston Load | 1.5 | |
| Typical Value for Prism Load | 1.0 | |
| K = bedding constant | 0.1 | typical value Buried Pipe Design, A.P. Moser, Chapter 3 |
| $P_T$ = Vertical load on pipe w/ perfs | 5.59 | $lb/in^2$ 805 $lb/ft^2$ |
| $W_c$ = Marston's load per unit length of pipe = $P_T * D_o$ (lb/in) | 60.12 | lb/in |
| $D_o$ = pipe outer diameter (in) | 10.75 | SDR 11 pipe (Driscopipe) to be used |
| t = pipe wall thickness (in) | 0.98 | SDR 11 pipe (Driscopipe) to be used |
| $D_I$ = pipe inner diameter = $D_o$-2t (in) | 8.80 | SDR 11 pipe (Driscopipe) to be used |
| $D_m$ = pipe mean diameter = $D_o$ - 1.06t Source 1, Equation 7-27 | 9.71 | SDR 11 pipe (Driscopipe) to be used |
| $r_m$ = mean radius of the pipe (in) | 4.86 | SDR 11 pipe (Driscopipe) to be used |
| E = modulus of elasticity ($lb/in^2$) | 100,000.0 | lb/in2 for long term load at 100oF, 'Source 1, Table 5-1 |
| I = moment of inertia of the pipe wall per unit length | 0.078 | $in^4/in$ |
| E' = modulus of soil reaction | 3,000.0 | $lb/in^2$ for moderate compaction and fine grained soils |

$\Delta X = \dfrac{D_L K W_c r_m^3}{EI + 0.06E'r_m^3}$ = 0.024 inch Source 2, Equation 3.5 Buried Pipe Design, A.P. Moser, Chapter 3

% Ring Deflection = $(\Delta X/D_m) \times 100$ = 0.25% Source 1, Equation 7-31

Ring Bending Strain

$e = \dfrac{f_D \Delta X 2C}{D_M^2} \times 100$ Source 1, Equation 7-39

| | | |
|---|---|---|
| e = wall strain (%) | | |
| $f_D$ = deformation shape factor | 6 | Source 1, non-elliptical shape |
| $D_M$ = mean diameter (in) | | |
| C = outer fiber wall centroid = 0.5 (1.06t) | 0.518 | Source 1, Equation 7-41 |
| $\Delta X$ = ring deflection = $D_X/D_m$ | 0.002 | |

$e = f_D \dfrac{(\Delta X)}{D_M} \dfrac{(2C)}{D_M} \times 100$ = 0.2% Source 1, Equation 7-39

The maximum ring bending strain for high performance polyethylene non-pressure pipe is = 5.0%

Pipe passes ring bending strain calculations TRUE

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| **10" Diameter Leachate Collection Lateral Pipe** | CHECKED | DATE |
| Operation w/ CAT D7R Series II **0 Feet Waste** | | |

<u>SOURCES</u>

1.) Attachment - 1 - Chevron Phillips Chemical Company, Bulletin - Book 2 Chapter 5, 2003

2.) Attachment - 2 - Buried Pipe Design, A.P. Moser, Chapter 3

3.) Attachment - 3 - EPA, Lining of Waste Impoundment and Disposal Facilities, SW-870

4.) Attachment - 4 - Driscoplex Pipe Properties

5.) Attachment - 5 - CAT 826G Series II Compactor Data Sheet

6.) Attachment - 6 - CAT D7R Series II Equipment Data Sheet

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Load on Pipe (Overburden)

Prism Loads, $P_E$ = wH

w = unit weight

H = depth

| | Depth (ft) | Unit Weight ($lb/ft^3$) | $P_E$ ($lb/ft^2$) |
|---|---|---|---|
| Final cover | 0.0 | 115.0 | 0.0 |
| Intermediate cover | 0.0 | 115.0 | 0.0 |
| Waste/cover | 10.0 | 60.0 | 600.0 |
| Drainage sand | 2.0 | 115.0 | 230.0 |
| Rock (No. 89 & No. 57) | 2.0 | 140.0 | 280.0 |

TOTAL SOIL PRISM LOAD $P_E$: 1110.0 $lb/ft^2$

Total Depth = 14.0 ft

Soil Arching, $P_m = C_D wB$

NOTE: The waste unit weight represents the combined unit weight of waste, daily cover, and moisture.

Pm = vertical soil pressure

B = trench width at pipe crown 6.0 ft

$C_D$ = load coefficient $= \frac{1 - e^{-2Ku'H/B}}{2Ku'}$ Equation 7-3, Source No. 1

e = natural log base number

K = Rankine earth pressure coefficient = $\tan^2(45-0.5*\phi)$

$\phi$ = internal soil friction angle = 27.0 degrees

u' = friction coefficient between backfill and trench sides = tan $\phi$

| Soil Type | Ku' |
|---|---|
| Saturated Clay | 0.110 |
| Ordinary Clay | 0.130 |
| Saturated Top Soil | 0.150 |
| Sand and Gravel | 0.165 |
| Clean Granular Soil | 0.192 |

| | Ku' | $C_D$ | $P_m$ ($lb/ft^2$) |
|---|---|---|---|
| Cover Soil | 0.150 | 0.00 | 0 |
| Int Cover | 0.165 | 0.00 | 0 |
| Waste | 0.191 | 1.23 | 444 |
| Drainage Sand | 0.165 | 0.32 | 217.8 |
| Granular Soil | 0.192 | 0.31 | 262.8 |

TOTAL SOIL ARCHING LOAD $P_M$: 924.2 $lb/ft^2$

MODIFIED ARCHING LOAD = $0.6P_M+0.4P_E$: 998.53 $lb/ft^2$

OVERBURDEN LOAD: 998.53 $lb/ft^2$

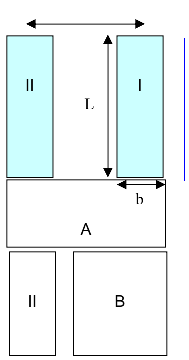
Load on Pipe With Equipment Refer to Attachment

Operation w/ CAT D7R Series II 10 Feet Waste

| | | | | | |
|---|---|---|---|---|---|
| Equipment Weight = | 54,573.0 | psf | Length of Track = L = | 113.0 | in |
| Number of Tracks = | 2.0 | | Track Width = b = | 22.0 | in |
| Track Load = $q_r$ = | 27,286.5 | psf | Track Gauge = G = | 78.0 | in |
| Ground contact area/track = | 17.3 | psf | Equipment Width "A" = | 113.0 | in |

Live Load = q*Ic q = track load 1,580.55 psf

Ic = Influence coefficient




| | b (ft) | L (ft) | z (ft) | m = b/z | n = L/z | I* | I** | I |
|---|---|---|---|---|---|---|---|---|
| I | 1.83 | 9.4 | 14.0 | 0.13 | 0.67 | 0.031 | 0.258 | 0.03087 |
| A | 8.33 | 9.4 | 14.0 | 0.60 | 0.67 | 0.114 | 0.272 | 0.11372 |
| B | 6.50 | 9.4 | 14.0 | 0.46 | 0.67 | 0.096 | 0.270 | 0.09592 |

Live $Load_1$ = I + II = $q_I(I_I) + q_A(I_A) - q_B(I_B)$ = 76.94 $lb/ft^2$

$q_I(I_I)$ = 48.80

$q_A(I_A)$ = 179.74

$q_B(I_B)$ = 151.60

Load on Pipe (Equipment) = 76.94 $lb/ft^2$

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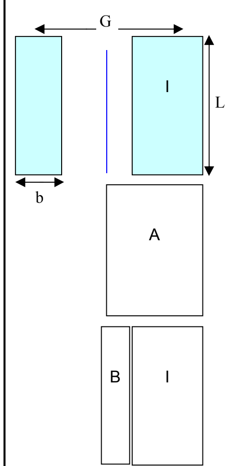
Load on Pipe (Equipment) *Continued*

Live Load = $q*I_c$

$q$ = track load 1580.55 $lb/ft^2$

$I_c$ = Influence coefficient

Alternative 2: Track stradling and parallel to pipe



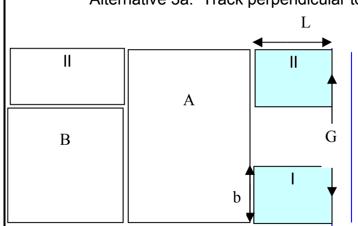

| | b | L | z | m = b/z | n = L/z | I* | I** | I |
|---|---|---|---|---|---|---|---|---|
| A | 4.71 | 9.4 | 14 | 0.34 | 0.67 | 0.074 | 0.267 | 0.07413 |
| B | 2.88 | 9.4 | 14 | 0.21 | 0.67 | 0.048 | 0.262 | 0.04754 |

$Live\ Load_2 = 2 * (A - B) = 2 * (q_A I_A - q_B I_B) =$ 84.04 $lb/ft^2$

| | |
|---|---|
| $q_A(I_A)$ = | 117.16 |
| $q_B(I_B)$ = | 75.14 |

Load on Pipe (Equipment) = 84.04 $lb/ft^2$

Alternative 3a: Track perpendicular to pipe




| | b | L | z | m = b/z | n = L/z | I* | I** | I |
|---|---|---|---|---|---|---|---|---|
| I | 1.83 | 9.4 | 14 | 0.13 | 0.67 | 0.031 | 0.258 | 0.03087 |
| A | 9.42 | 9.4 | 14 | 0.67 | 0.67 | 0.122 | 0.271 | 0.12225 |
| B | 7.58 | 9.4 | 14 | 0.54 | 0.67 | 0.107 | 0.271 | 0.10697 |

$Live\ Load_3 = I + II = q_I(I_I) + q_A(I_A) - q_B(I_B) =$ 72.96 $lb/ft^2$

| | |
|---|---|
| $q_I(I_I)$ = | 48.80 |
| $q_A(I_A)$ = | 193.23 |
| $q_B(I_B)$ = | 169.07 |

Load on Pipe (Equipment) = 72.96 $lb/ft^2$

LARGEST EQUIPEMENT LOAD = 84.04 $lb/ft^2$

VERTICAL OVERBURDEN LOAD = 998.53 $lb/ft^2$

VERTICAL EQUIPMENT LOAD = 84.04 $lb/ft^2$

TOTAL VERTICAL LOAD APPLIED TO PIPE, $P_T$ = 1,082.58 $lb/ft^2$ = 7.52 $lb/in^2$

SCS ENGINEERS

SHEET 3 OF 8

| CLIENT | PROJECT | JOB NO. |
|---|---|---|
| Hardee County | Phase II Section II Expansion | 09199033.23 |

| SUBJECT | BY | DATE |
|---|---|---|
| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **10" Diameter Leachate Collection Lateral Pipe** | CHECKED | DATE |
| Operation w/ CAT D7R Series II 10 **Feet Waste** | | |

Verify that perforations in the LCRS are adequate for the peak leachate flow.

Use discharge equation:

$Q = (Cd)(Ao)(2gh)^{0.5}$

$C_d$ = coeffiecient of discharge = 0.6 for short tube discharge with fluid/wall separation; conservative value.

$A_o$ = Area of orifice ($\pi D^2/4$)

g = gravitational acceleration (32.3 $ft^2/s$)

h = static head (ft)

| Assumptions and Givens: | 4.55 | acres | North and center portion of landfill bottom |
|---|---|---|---|
| 1. No. acres of landfill expansion = | 1.47 | acres | - North & center area from eastern grade break of bottom |
| 2. Total length of pipe per expansion = | 951.3 | ft | area draining into eastern 10-inch lateral collection |
| 3. Number of laterals = | 1.0 | | - (2) 8-inch laterals collect drainage from other bottom area |
| 4. Total length of pipe per lateral = | 951.3 | ft | - (1) 10-inch lateral collects the drainage area |
| 5. Perforation diameter = | 0.375 | inch | - Refer to calcs for 8" diameter leachate collection lateral |
| 6. No. perforations/ft pipe = | 6.0 | perforations/ft of pipe length | |
| 7. Maximum head over pipe = | 1.0 | ft | |
| 8. Per HELP model summary table, $Q_{peak}$ = | 202.93 | gal/min | refer to HELP Model Summary Table |
| 9. Per HELP model summary table, $Q_{peak}$ = | 39,063.5 | cf/day | refer to HELP Model Summary Table |
| 10. Maximum flow/lateral = | 39,063.5 | cf/day/lateral | |
| 11. Maximum leachate flow/ft of pipe = | 41.06 | cf/day/ft of pipe | |

Solution:

$A_o = 0.25(\Pi)(d)^2 =$ 0.00077 $ft^2$

1. Flow per orifice, $Q = (Cd)(Ao)(2gh)^{0.5}$ = 0.0037 $ft^3/s$

2. Flow per ft of pipe = (Q)(# perfs/ft) = 0.02 $ft^3/s$ per ft of pipe

= 1914.47 cf/day/ft of pipe

Conclusion:

Design capacity exceeds estimated generation

1914.47 cf/day/ft of pipe >>> 41.06 cf/day/ft of pipe

Perforations are adequate to handle the maximum leachate flow.

SCS ENGINEERS

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| CLIENT | PROJECT | JOB NO. |
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| Hardee County | Phase II Section II Expansion | 09199033.23 |

| SUBJECT | BY | DATE |
|---|---|---|
| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **10" Diameter Leachate Collection Lateral Pipe** | CHECKED | DATE |
| Operation w/ CAT D7R Series II **10 Feet Waste** | | |

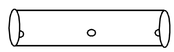
Effective pressure on pipe due to perforations:

$P_{EFF} = \frac{P_T \times 12}{(12 - L_P)}$ Source 3, EPA SW-870, p. 382

$L_P$ = Total accumulated length of perforations in one foot of pipe.

Since each perforation is 0.375 inch diameter and spaced at 6.0 inch on center,

$L_P$ = 1.5 inch



$P_T$ = 7.5 psi

$P_{EFF}$ = 8.6 psi

$P_{EFF}$ = 1237.2 psf

Check actual compressive pressure ($S_A$) per Driscopipe manual:

$S_A$ = 0.5 x (SDR - 1) x P(eff) = 43.0 psi

The recommended, long-term compressive strength ($Y_s$) design value for Driscoplex polyethylene pipe is 800 lb/in$^2$.

Source No. 1

| $S_A$ (psi): | | $Y_s$ (psi): |
|---|---|---|
| 43.0 | < | 800.0 |

Pipe passes wall compressive stress perforation calculations TRUE

FS = 18.6

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| SUBJECT | BY | DATE |
|---|---|---|
| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **10" Diameter Leachate Collection Lateral Pipe** | CHECKED | DATE |
| Operation w/ CAT D7R Series II 1**0 Feet Waste** | | |

Constrained pipe wall buckling (for Driscoplex OD controlled pipe)

$P_{WC} = \frac{5.65 * \{RB'E' E*[12(DR-1)^3]^{-1}\}^{0.5}}{N}$ Source 1, Equation 7-5

$P_{WC}$ = allowable constrained buckling pressure (lb/in$^2$)

| | | |
|---|---|---|
| R = buoyancy reduction factor = 1 - 0.33 * (H'/H) | Source 1, Equation 7-34 | |
| H' = groundwater height above pipe (ft) | 0.0 | ft |
| H = cover above pipe (ft) | 14.0 | ft |
| B' = elastic support factor =( 1+ 4*e$^{-0.065H}$ )$^{-1}$ | Source 1, Equation 7-35 | |
| E' = soil reaction modulus (lb/in$^2$) | 3000.0 | lb/in$^2$ for mod comp/crushed rock, 'Source 1, Table 7-7 |
| E = elastic modulus (lb/in$^2$) | 100000.0 | lb/in$^2$ for long term load at 100$^o$F, 'Source 1, Table 5-1 |
| I = moment of inertia = t$^3$ / 12 | 0.1 | in$^4$/in |
| $D_o$ = pipe outer diameter (in) | 10.750 | SDR 11 pipe (Driscopipe) to be used |
| t = pipe wall thickness (in) | 0.977 | SDR 11 pipe (Driscopipe) to be used |
| DR = pipe dimension ratio = $D_o$ / t | 11.0 | SDR 11 pipe (Driscopipe) to be used |
| $D_I$ = pipe inner diameter = $D_o$ - 2t (in) | 8.8 | SDR 11 pipe (Driscopipe) to be used |
| N = safety factor | 2.0 | |

| Cover (ft) | (ft) | (ft) | B' | R | (lb/in$^2$) |
|---|---|---|---|---|---|
| 10.0 | 14 | 0 | 0.38 | 1.00 | 276.35 |

$P_{WC}$ = 276.35 lb/in$^2$

$P_{EFF}$ = 8.59 lb/in$^2$

Pipe passes contrained wall buckling calculations TRUE FS = 32.2

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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **10" Diameter Leachate Collection Lateral Pipe** | CHECKED | DATE |
| Operation w/ CAT D7R Series II 1**0 Feet Waste** | | |

Constrained Pipe Wall Compressive Stress (for Driscoplex OD controlled pipe)

$S = \frac{P_T D_o}{288t}$ Source No. 1

S = pipe wall compressive stress (lb/in$^2$)

$P_T$ = vertical load applied to pipe w/ perfs (lb/ft$^2$) | 1237.2 | lb/ft$^2$

$D_o$ = pipe outside diameter (in) | 10.75 | SDR 11 pipe (Driscopipe) to be used

t = pipe wall thickness (in) | 0.977 | SDR 11 pipe (Driscopipe) to be used

$S = \frac{P_T D_o}{288t} =$ 47.3 lb/in$^2$

The recommended, long-term compressive strength ($Y_s$) design value for Driscoplex polyethylene pipe is 800 lb/in$^2$.

Source No. 1

| S (psi): | | $Y_s$ (psi): |
|---|---|---|
| 47.3 | < | 800.0 |

Pipe passes wall compressive stress calculations TRUE

FS = 16.9

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|---|---|---|
| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **10" Diameter Leachate Collection Lateral Pipe** | CHECKED | DATE |
| Operation w/ CAT D7R Series II 10 **Feet Waste** | | |

Iowa Formula

$$\Delta X = \frac{D_L K W_c r^3}{EI + 0.06 e r^4}$$ Source 2, Equation 3.4 Buried Pipe Design, A.P. Moser, Chapter 3

$\Delta X$ = horizontal deflection (in)

$D_L$ = deflection lag factor

K = bedding constant — 0.1 — typical value Source 2, Buried Pipe Design, A.P. Moser, Chapter 3

$W_c$ = Marston's load per unit length of pipe (lb/in)

r = mean radius of the pipe (in)

E = modulus of elasticity (lb/in$^2$)

I = moment of inertia of the pipe wall per unit length (in$^3$)

e = modulus of passive resistance fo the side fill (lb/in$^2$(in))

Modified Iowa Formula

$$\Delta X = \frac{D_L K W_c r_m^3}{EI + 0.06 E' r_m^3}$$ Source 2, Equation 3.5 Buried Pipe Design, A.P. Moser, Chapter 3

$\Delta X$ = horizontal deflection (in)

| | | | |
|---|---|---|---|
| $D_L$ = deflection lag factor | | 1.0 | Prism Load used |
| Typical Value for Marston Load | 1.5 | | |
| Typical Value for Prism Load | 1.0 | | |
| K = bedding constant | | 0.1 | typical value Buried Pipe Design, A.P. Moser, Chapter 3 |
| $P_T$ = Vertical load on pipe w/ perfs | | 8.59 | lb/in$^2$ — 1237 lb/ft$^2$ |
| $W_c$ = Marston's load per unit length of pipe = $P_T$ * $D_o$ (lb/in) | | 92.36 | lb/in |
| $D_o$ = pipe outer diameter (in) | | 10.75 | SDR 11 pipe (Driscopipe) to be used |
| t = pipe wall thickness (in) | | 0.98 | SDR 11 pipe (Driscopipe) to be used |
| $D_I$ = pipe inner diameter = $D_o$-2t (in) | | 8.80 | SDR 11 pipe (Driscopipe) to be used |
| $D_m$ = pipe mean diameter = $D_o$ - 1.06t Source 1, Equation 7-27 | | 9.71 | SDR 11 pipe (Driscopipe) to be used |
| $r_m$ = mean radius of the pipe (in) | | 4.86 | SDR 11 pipe (Driscopipe) to be used |
| E = modulus of elasticity (lb/in$^2$) | | 100,000.0 | lb/in2 for long term load at 100oF, 'Source 1, Table 5-1 |
| I = moment of inertia of the pipe wall per unit length | | 0.078 | in$^4$/in |
| E' = modulus of soil reaction | | 3,000.0 | lb/in$^2$ for moderate compaction and fine grained soils |

$$\Delta X = \frac{D_L K W_c r_m^3}{EI + 0.06 E' r_m^3} = 0.037 \text{ inch}$$ Source 2, Equation 3.5 Buried Pipe Design, A.P. Moser, Chapter 3

% Ring Deflection = ($\Delta X/D_m$) x 100 = 0.38% Source 1, Equation 7-31

Ring Bending Strain

$$e = \frac{f_D \Delta X 2C}{D_M^2} \times 100$$ Source 1, Equation 7-39

e = wall strain (%)

| | | |
|---|---|---|
| $f_D$ = deformation shape factor | 6 | Source 1, non-elliptical shape |
| $D_M$ = mean diameter (in) | | |
| C = outer fiber wall centroid = 0.5 (1.06t) | 0.518 | Source 1, Equation 7-41 |
| $\Delta X$ = ring deflection = $D_X/D_m$ | 0.004 | |

$$e = f_D \frac{(\Delta X)}{D_M} \frac{(2C)}{D_M} \times 100 = 0.2\%$$ Source 1, Equation 7-39

The maximum ring bending strain for high performance polyethylene non-pressure pipe is = 5.0%

Pipe passes ring bending strain calculations TRUE

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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **10" Diameter Leachate Collection Lateral Pipe** | CHECKED | DATE |
| Operation w/ CAT D7R Series II 1**0 Feet Waste** | | |

SOURCES

1.) Attachment - 1 - Chevron Phillips Chemical Company, Bulletin - Book 2 Chapter 5, 2003

2.) Attachment - 2 - Buried Pipe Design, A.P. Moser, Chapter 3

3.) Attachment - 3 - EPA, Lining of Waste Impoundment and Disposal Facilities, SW-870

4.) Attachment - 4 - Driscoplex Pipe Properties

5.) Attachment - 5 - CAT 826G Series II Compactor Data Sheet

6.) Attachment - 6 - CAT D7R Series II Equipment Data Sheet

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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **10" Diameter Leachate Collection Lateral Pipe** | CHECKED | DATE |
| Operation w/ CAT D7R Series II **25 Feet Waste** | | |

Load on Pipe (Overburden)

Prism Loads, $P_E = wH$

w = unit weight

H = depth

| | Depth (ft) | Unit Weight ($lb/ft^3$) | $P_E$ ($lb/ft^2$) |
|---|---|---|---|
| Final cover | 0.0 | 115.0 | 0.0 |
| Intermediate cover | 0.0 | 115.0 | 0.0 |
| Waste/cover | 25.0 | 60.0 | 1500.0 |
| Drainage sand | 2.0 | 115.0 | 230.0 |
| Rock (No. 89 & No. 57) | 2.0 | 140.0 | 280.0 |

TOTAL SOIL PRISM LOAD $P_E$: 2010.0 $lb/ft^2$

Total Depth = 29.0 ft

Soil Arching, $P_m = C_D wB$

NOTE: The waste unit weight represents the combined unit weight of waste, daily cover, and moisture.

Pm = vertical soil pressure

B = trench width at pipe crown 6.0 ft

$C_D$ = load coefficient $= \frac{1 - e^{-2Ku'H/B}}{2Ku'}$ Equation 7-3, Source No. 1

e = natural log base number

K = Rankine earth pressure coefficient = $\tan^2(45-0.5*\phi)$

$\phi$ = internal soil friction angle = 27.0 degrees

u' = friction coefficient between backfill and trench sides = tan $\phi$

| Soil Type | Ku' |
|---|---|
| Saturated Clay | 0.110 |
| Ordinary Clay | 0.130 |
| Saturated Top Soil | 0.150 |
| Sand and Gravel | 0.165 |
| Clean Granular Soil | 0.192 |

| | Ku' | $C_D$ | $P_m$ ($lb/ft^2$) |
|---|---|---|---|
| Cover Soil | 0.150 | 0.00 | 0 |
| Int Cover | 0.165 | 0.00 | 0 |
| Waste | 0.191 | 2.08 | 750 |
| Drainage Sand | 0.165 | 0.32 | 217.8 |
| Granular Soil | 0.192 | 0.31 | 262.8 |

TOTAL SOIL ARCHING LOAD $P_M$: 1,230.4 $lb/ft^2$

MODIFIED ARCHING LOAD = $0.6P_M+0.4P_E$: 1,542.23 $lb/ft^2$

OVERBURDEN LOAD: 1,542.23 $lb/ft^2$

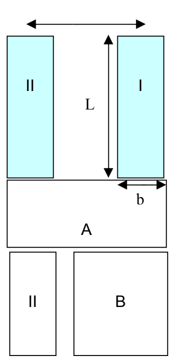
Load on Pipe With Equipment Refer to Attachment

Operation w/ CAT D7R Series II 25 Feet Waste

| | | | | | |
|---|---|---|---|---|---|
| Equipment Weight = | 54,573.0 | psf | Length of Track = L = | 113.0 | in |
| Number of Tracks = | 2.0 | | Track Width = b = | 22.0 | in |
| Track Load = $q_r$ = | 27,286.5 | psf | Track Gauge = G = | 78.0 | in |
| Ground contact area/track = | 17.3 | psf | Equipment Width "A" = | 113.0 | in |

Live Load = q*Ic q = track load 1,580.55 psf

Ic = Influence coefficient




| | b (ft) | L (ft) | z (ft) | m = b/z | n = L/z | I* | I** | I |
|---|---|---|---|---|---|---|---|---|
| I | 1.83 | 9.4 | 29.0 | 0.06 | 0.32 | 0.009 | 0.253 | 0.00900 |
| A | 8.33 | 9.4 | 29.0 | 0.29 | 0.32 | 0.039 | 0.261 | 0.03850 |
| B | 6.50 | 9.4 | 29.0 | 0.22 | 0.32 | 0.031 | 0.259 | 0.03077 |

$\text{Live Load}_1 = I + II = q_I(I_I) + q_A(I_A) - q_B(I_B) =$ 26.45 $lb/ft^2$

$q_I(I_I) =$ 14.22

$q_A(I_A) =$ 60.86

$q_B(I_B) =$ 48.63

Load on Pipe (Equipment) = 26.45 $lb/ft^2$

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| **10" Diameter Leachate Collection Lateral Pipe** | CHECKED | DATE |
| Operation w/ CAT D7R Series II **25 Feet Waste** | | |

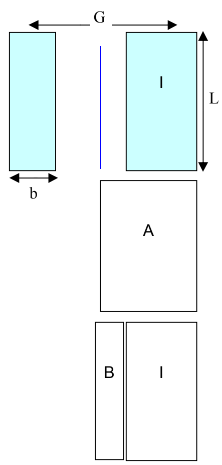
Load on Pipe (Equipment) *Continued*

Live Load = $q*I_c$

$q$ = track load 1580.55 $lb/ft^2$

$I_c$ = Influence coefficient

Alternative 2: Track stradling and parallel to pipe



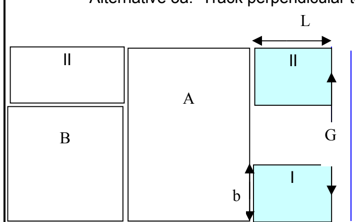

| | b | L | z | m = b/z | n = L/z | I* | I** | I |
|---|---|---|---|---|---|---|---|---|
| A | 4.71 | 9.4 | 29 | 0.16 | 0.32 | 0.023 | 0.257 | 0.02270 |
| B | 2.88 | 9.4 | 29 | 0.10 | 0.32 | 0.014 | 0.254 | 0.01404 |

Live $Load_2$ = 2 * (A - B) = 2 * ($q_A I_A$ - $q_B I_B$) = 27.36 $lb/ft^2$

| | |
|---|---|
| $q_A(I_A)$ = | 35.88 |
| $q_B(I_B)$ = | 22.20 |

Load on Pipe (Equipment) = 27.36 $lb/ft^2$

Alternative 3a: Track perpendicular to pipe




| | b | L | z | m = b/z | n = L/z | I* | I** | I |
|---|---|---|---|---|---|---|---|---|
| I | 1.83 | 9.4 | 29 | 0.06 | 0.32 | 0.009 | 0.253 | 0.00900 |
| A | 9.42 | 9.4 | 29 | 0.32 | 0.32 | 0.043 | 0.262 | 0.04279 |
| B | 7.58 | 9.4 | 29 | 0.26 | 0.32 | 0.035 | 0.261 | 0.03541 |

Live $Load_3$ = I + II = $q_I(I_I)$ + $q_A(I_A)$ - $q_B(I_B)$ = 25.90 $lb/ft^2$

| | |
|---|---|
| $q_I(I_I)$ = | 14.22 |
| $q_A(I_A)$ = | 67.64 |
| $q_B(I_B)$ = | 55.96 |

Load on Pipe (Equipment) = 25.90 $lb/ft^2$

LARGEST EQUIPEMENT LOAD = 27.36 $lb/ft^2$

VERTICAL OVERBURDEN LOAD = 1,542.23 $lb/ft^2$

VERTICAL EQUIPMENT LOAD = 27.36 $lb/ft^2$

TOTAL VERTICAL LOAD APPLIED TO PIPE, $P_T$ = 1,569.59 $lb/ft^2$ = 10.90 $lb/in^2$

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| CLIENT | PROJECT | JOB NO. |
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| SUBJECT | BY | DATE |
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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **10" Diameter Leachate Collection Lateral Pipe** | CHECKED | DATE |
| Operation w/ CAT D7R Series II **25 Feet Waste** | | |

Verify that perforations in the LCRS are adequate for the peak leachate flow.

Use discharge equation:

$Q = (Cd)(Ao)(2gh)^{0.5}$

$C_d$ = coeffiecient of discharge = 0.6 for short tube discharge with fluid/wall separation; conservative value.

$A_o$ = Area of orifice ($\pi D^2/4$)

g = gravitational acceleration (32.3 $ft^2/s$)

h = static head (ft)

| Assumptions and Givens: | | | |
|---|---|---|---|
| | 4.55 | acres | North and center portion of landfill bottom |
| 1. No. acres of landfill expansion = | 1.47 | acres | - North & center area from eastern grade break of bottom |
| 2. Total length of pipe per expansion = | 951.3 | ft | area draining into eastern 10-inch lateral collection |
| 3. Number of laterals = | 1.0 | | - (2) 8-inch laterals collect drainage from other bottom area |
| 4. Total length of pipe per lateral = | 951.3 | ft | - (1) 10-inch lateral collects the drainage area |
| 5. Perforation diameter = | 0.375 | inch | - Refer to calcs for 8" diameter leachate collection lateral |
| 6. No. perforations/ft pipe = | 6.0 | perforations/ft of pipe length | |
| 7. Maximum head over pipe = | 1.0 | ft | |
| 8. Per HELP model summary table, $Q_{peak}$ = | 202.93 | gal/min | refer to HELP Model Summary Table |
| 9. Per HELP model summary table, $Q_{peak}$ = | 39,063.5 | cf/day | refer to HELP Model Summary Table |
| 10. Maximum flow/lateral = | 39,063.5 | cf/day/lateral | |
| 11. Maximum leachate flow/ft of pipe = | 41.06 | cf/day/ft of pipe | |

Solution:

$A_o = 0.25(\Pi)(d)^2 =$ 0.00077 $ft^2$

1. Flow per orifice, $Q = (Cd)(Ao)(2gh)^{0.5} =$ 0.0037 $ft^3/s$

2. Flow per ft of pipe = (Q)(# perfs/ft) = 0.02 $ft^3/s$ per ft of pipe

= 1914.47 cf/day/ft of pipe

Conclusion:

Design capacity exceeds estimated generation

1914.47 cf/day/ft of pipe >>> 41.06 cf/day/ft of pipe

Perforations are adequate to handle the maximum leachate flow.

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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **10" Diameter Leachate Collection Lateral Pipe** | CHECKED | DATE |
| Operation w/ CAT D7R Series II **25 Feet Waste** | | |

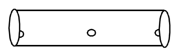
Effective pressure on pipe due to perforations:

$P_{EFF} = \frac{P_T \times 12}{(12-L_P)}$ Source 3, EPA SW-870, p. 382

$L_P$ = Total accumulated length of perforations in one foot of pipe.

Since each perforation is 0.375 inch diameter and spaced at 6.0 inch on center,

$L_P$ = 1.5 inch



$P_T$ = 10.9 psi

$P_{EFF}$ = 12.5 psi

$P_{EFF}$ = 1793.8 psf

Check actual compressive pressure ($S_A$) per Driscopipe manual:

$S_A$ = 0.5 x (SDR - 1) x P(eff) = 62.3 psi

The recommended, long-term compressive strength ($Y_s$) design value for Driscoplex polyethylene pipe is 800 lb/in$^2$.

Source No. 1

| $S_A$ (psi): | | $Y_s$ (psi): |
|---|---|---|
| 62.3 | < | 800.0 |

Pipe passes wall compressive stress perforation calculations TRUE

FS = 12.8

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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **10" Diameter Leachate Collection Lateral Pipe** | CHECKED | DATE |
| Operation w/ CAT D7R Series II **25 Feet Waste** | | |

Constrained pipe wall buckling (for Driscoplex OD controlled pipe)

$P_{WC} = \frac{5.65 * \{RB'E' E^*[12(DR-1)^3]^{-1}\}^{0.5}}{N}$  Source 1, Equation 7-5

$P_{WC}$ = allowable constrained buckling pressure (lb/in$^2$)

R = buoyancy reduction factor = 1 - 0.33 * (H'/H)  Source 1, Equation 7-34

| | | |
|---|---|---|
| H' = groundwater height above pipe (ft) | 0.0 | ft |
| H = cover above pipe (ft) | 29.0 | ft |
| B' = elastic support factor =( 1+ 4*e$^{-0.065H}$ )$^{-1}$ | Source 1, Equation 7-35 | |
| E' = soil reaction modulus (lb/in$^2$) | 3000.0 | lb/in$^2$ for mod comp/crushed rock, 'Source 1, Table 7-7 |
| E = elastic modulus (lb/in$^2$) | 100000.0 | lb/in$^2$ for long term load at 100$^o$F, 'Source 1, Table 5-1 |
| I = moment of inertia = t$^3$ / 12 | 0.1 | in$^4$/in |
| $D_o$ = pipe outer diameter (in) | 10.750 | SDR 11 pipe (Driscopipe) to be used |
| t = pipe wall thickness (in) | 0.977 | SDR 11 pipe (Driscopipe) to be used |
| DR = pipe dimension ratio = $D_o$ / t | 11.0 | SDR 11 pipe (Driscopipe) to be used |
| $D_I$ = pipe inner diameter = $D_o$ - 2t (in) | 8.8 | SDR 11 pipe (Driscopipe) to be used |
| N = safety factor | 2.0 | |

| Cover (ft) | (ft) | (ft) | B' | R | (lb/in$^2$) |
|---|---|---|---|---|---|
| 25.0 | 29 | 0 | 0.62 | 1.00 | 352.16 |

$P_{WC}$ = 352.16 lb/in$^2$

$P_{EFF}$ = 12.46 lb/in$^2$

Pipe passes contrained wall buckling calculations TRUE  FS = 28.3

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|---|---|---|
| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **10" Diameter Leachate Collection Lateral Pipe** | CHECKED | DATE |
| Operation w/ CAT D7R Series II **25 Feet Waste** | | |

Constrained Pipe Wall Compressive Stress (for Driscoplex OD controlled pipe)

$S = \frac{P_T D_o}{288t}$ Source No. 1

S = pipe wall compressive stress ($lb/in^2$)

$P_T$ = vertical load applied to pipe w/ perfs ($lb/ft^2$) 1793.8 $lb/ft^2$

$D_o$ = pipe outside diameter (in) 10.75 SDR 11 pipe (Driscopipe) to be used

t = pipe wall thickness (in) 0.977 SDR 11 pipe (Driscopipe) to be used

$S = \frac{P_T D_o}{288t} =$ 68.5 $lb/in^2$

The recommended, long-term compressive strength ($Y_s$) design value for Driscoplex polyethylene pipe is 800 $lb/in^2$.

Source No. 1

| S (psi): | | $Y_s$ (psi): |
|---|---|---|
| 68.5 | < | 800.0 |

Pipe passes wall compressive stress calculations TRUE FS = 11.7

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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **10" Diameter Leachate Collection Lateral Pipe** | CHECKED | DATE |
| Operation w/ CAT D7R Series II **25 Feet Waste** | | |

Iowa Formula

$\Delta X = \dfrac{D_L K W_c r^3}{EI + 0.06 e r^4}$ Source 2, Equation 3.4 Buried Pipe Design, A.P. Moser, Chapter 3

$\Delta X$ = horizontal deflection (in)

$D_L$ = deflection lag factor

K = bedding constant | 0.1 | typical value Source 2, Buried Pipe Design, A.P. Moser, Chapter 3

$W_c$ = Marston's load per unit length of pipe (lb/in)

r = mean radius of the pipe (in)

E = modulus of elasticity ($lb/in^2$)

I = moment of inertia of the pipe wall per unit length ($in^3$)

e = modulus of passive resistance fo the side fill ($lb/in^2(in)$)

Modified Iowa Formula

$\Delta X = \dfrac{D_L K W_c r_m^3}{EI + 0.06E' r_m^3}$ Source 2, Equation 3.5 Buried Pipe Design, A.P. Moser, Chapter 3

$\Delta X$ = horizontal deflection (in)

| | | | |
|---|---|---|---|
| $D_L$ = deflection lag factor | | 1.0 | Prism Load used |
| Typical Value for Marston Load | 1.5 | | |
| Typical Value for Prism Load | 1.0 | | |
| K = bedding constant | | 0.1 | typical value Buried Pipe Design, A.P. Moser, Chapter 3 |
| $P_T$ = Vertical load on pipe w/ perfs | | 12.46 | $lb/in^2$   1794 $lb/ft^2$ |
| $W_c$ = Marston's load per unit length of pipe = $P_T$ * $D_o$ (lb/in) | | 133.91 | lb/in |
| $D_o$ = pipe outer diameter (in) | | 10.75 | SDR 11 pipe (Driscopipe) to be used |
| t = pipe wall thickness (in) | | 0.98 | SDR 11 pipe (Driscopipe) to be used |
| $D_I$ = pipe inner diameter = $D_o$-2t (in) | | 8.80 | SDR 11 pipe (Driscopipe) to be used |
| $D_m$ = pipe mean diameter = $D_o$ - 1.06t Source 1, Equation 7-27 | | 9.71 | SDR 11 pipe (Driscopipe) to be used |
| $r_m$ = mean radius of the pipe (in) | | 4.86 | SDR 11 pipe (Driscopipe) to be used |
| E = modulus of elasticity ($lb/in^2$) | | 100,000.0 | lb/in2 for long term load at 100oF, 'Source 1, Table 5-1 |
| I = moment of inertia of the pipe wall per unit length | | 0.078 | $in^4/in$ |
| E' = modulus of soil reaction | | 3,000.0 | $lb/in^2$ for moderate compaction and fine grained soils |

$\Delta X = \dfrac{D_L K W_c r_m^3}{EI + 0.06E' r_m^3}$ = 0.054 inch Source 2, Equation 3.5 Buried Pipe Design, A.P. Moser, Chapter 3

% Ring Deflection = ($\Delta X/D_m$) x 100 = 0.56% Source 1, Equation 7-31

Ring Bending Strain

$e = \dfrac{f_D \Delta X 2C}{D_M^2} \times 100$ Source 1, Equation 7-39

e = wall strain (%)

| | | |
|---|---|---|
| $f_D$ = deformation shape factor | 6 | Source 1, non-elliptical shape |
| $D_M$ = mean diameter (in) | | |
| C = outer fiber wall centroid = 0.5 (1.06t) | 0.518 | Source 1, Equation 7-41 |
| $\Delta X$ = ring deflection = $D_X/D_m$ | 0.006 | |

$e = f_D \dfrac{\Delta X}{D_M} \dfrac{2C}{D_M} \times 100$ = 0.4% Source 1, Equation 7-39

The maximum ring bending strain for high performance polyethylene non-pressure pipe is = 5.0%

Pipe passes ring bending strain calculations TRUE

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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **10" Diameter Leachate Collection Lateral Pipe** | CHECKED | DATE |
| Operation w/ CAT D7R Series II **25 Feet Waste** | | |

SOURCES

1.) Attachment - 1 - Chevron Phillips Chemical Company, Bulletin - Book 2 Chapter 5, 2003

2.) Attachment - 2 - Buried Pipe Design, A.P. Moser, Chapter 3

3.) Attachment - 3 - EPA, Lining of Waste Impoundment and Disposal Facilities, SW-870

4.) Attachment - 4 - Driscoplex Pipe Properties

5.) Attachment - 5 - CAT 826G Series II Compactor Data Sheet

6.) Attachment - 6 - CAT D7R Series II Equipment Data Sheet

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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **10" Diameter Leachate Collection Lateral Pipe** | CHECKED | DATE |
| Operation w/ CAT D7R Series II **60 Feet Waste** | | |

Load on Pipe (Overburden)

Prism Loads, $P_E$ = wH

w = unit weight

H = depth

| | Depth (ft) | Unit Weight ($lb/ft^3$) | $P_E$ ($lb/ft^2$) |
|---|---|---|---|
| Final cover | 2.0 | 115.0 | 230.0 |
| Intermediate cover | 1.0 | 115.0 | 115.0 |
| Waste/cover | 60.0 | 60.0 | 3600.0 |
| Drainage sand | 2.0 | 115.0 | 230.0 |
| Rock (No. 89 & No. 57) | 2.0 | 140.0 | 280.0 |

TOTAL SOIL PRISM LOAD $P_E$: 4455.0 $lb/ft^2$

Total Depth = 67.0 ft

Soil Arching, $P_m = C_D wB$

Pm = vertical soil pressure

B = trench width at pipe crown 6.0 ft

$C_D$ = load coefficient $= \frac{1 - e^{-2Ku'H/B}}{2Ku'}$ Equation 7-3, Source No. 1

NOTE: The waste unit weight represents the combined unit weight of waste, daily cover, and moisture.

e = natural log base number

K = Rankine earth pressure coefficient = $\tan^2(45-0.5*\phi)$

$\phi$ = internal soil friction angle = 27.0 degrees

u' = friction coefficient between backfill and trench sides = tan $\phi$

| Soil Type | Ku' |
|---|---|
| Saturated Clay | 0.110 |
| Ordinary Clay | 0.130 |
| Saturated Top Soil | 0.150 |
| Sand and Gravel | 0.165 |
| Clean Granular Soil | 0.192 |

| | Ku' | $C_D$ | $P_m$ ($lb/ft^2$) |
|---|---|---|---|
| Cover Soil | 0.150 | 0.32 | 219 |
| Int Cover | 0.165 | 0.16 | 112 |
| Waste | 0.191 | 2.56 | 920 |
| Drainage Sand | 0.165 | 0.32 | 217.8 |
| Granular Soil | 0.192 | 0.31 | 262.8 |

TOTAL SOIL ARCHING LOAD $P_M$: 1,731.6 $lb/ft^2$

MODIFIED ARCHING LOAD = $0.6P_M+0.4P_E$: 2,820.98 $lb/ft^2$

OVERBURDEN LOAD: 2,820.98 $lb/ft^2$

Load on Pipe With Equipment Refer to Attachment

Operation w/ CAT D7R Series II 60 Feet Waste

Equipment Weight = 54,573.0 psf

Number of Tracks = 2.0

Track Load = $q_r$ = 27,286.5 psf

Ground contact area/track = 17.3 psf

Length of Track = L = 113.0 in

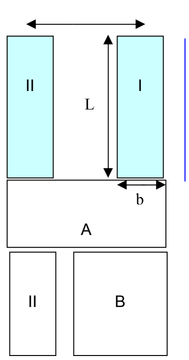
Track Width = b = 22.0 in

Track Gauge = G = 78.0 in

Equipment Width "A" = 113.0 in

Live Load = q*Ic q = track load 1,580.55 psf

Ic = Influence coefficient




| | b (ft) | L (ft) | z (ft) | m = b/z | n = L/z | I* | I** | I |
|---|---|---|---|---|---|---|---|---|
| I | 1.83 | 9.4 | 67.0 | 0.03 | 0.14 | 0.002 | 0.251 | 0.00181 |
| A | 8.33 | 9.4 | 67.0 | 0.12 | 0.14 | 0.008 | 0.253 | 0.00811 |
| B | 6.50 | 9.4 | 67.0 | 0.10 | 0.14 | 0.006 | 0.252 | 0.00636 |

Live $Load_1$ = I + II = $q_I(I_I) + q_A(I_A) - q_B(I_B)$ = 5.62 $lb/ft^2$

$q_I(I_I)$ = 2.85

$q_A(I_A)$ = 12.82

$q_B(I_B)$ = 10.05

Load on Pipe (Equipment) = 5.62 $lb/ft^2$

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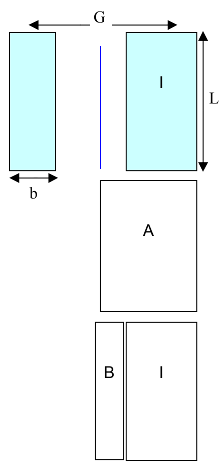
Load on Pipe (Equipment) *Continued*

Live Load = $q*I_c$

q = track load 1580.55 $lb/ft^2$

$I_c$ = Influence coefficient

Alternative 2: Track stradling and parallel to pipe



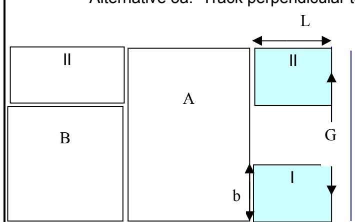

| | b | L | z | m = b/z | n = L/z | I* | I** | I |
|---|---|---|---|---|---|---|---|---|
| A | 4.71 | 9.4 | 67 | 0.07 | 0.14 | 0.005 | 0.252 | 0.00462 |
| B | 2.88 | 9.4 | 67 | 0.04 | 0.14 | 0.003 | 0.251 | 0.00283 |

Live $Load_2$ = 2 * (A - B) = 2 * ($q_A I_A$ - $q_B I_B$) = 5.66 $lb/ft^2$

| | |
|---|---|
| $q_A(I_A)$ = | 7.30 |
| $q_B(I_B)$ = | 4.47 |

Load on Pipe (Equipment) = 5.66 $lb/ft^2$

Alternative 3a: Track perpendicular to pipe




| | b | L | z | m = b/z | n = L/z | I* | I** | I |
|---|---|---|---|---|---|---|---|---|
| I | 1.83 | 9.4 | 67 | 0.03 | 0.14 | 0.002 | 0.251 | 0.00181 |
| A | 9.42 | 9.4 | 67 | 0.14 | 0.14 | 0.009 | 0.253 | 0.00913 |
| B | 7.58 | 9.4 | 67 | 0.11 | 0.14 | 0.007 | 0.252 | 0.00739 |

Live $Load_3$ = I + II = $q_I(I_I)$ + $q_A(I_A)$ - $q_B(I_B)$ = 5.60 $lb/ft^2$

| | |
|---|---|
| $q_I(I_I)$ = | 2.85 |
| $q_A(I_A)$ = | 14.43 |
| $q_B(I_B)$ = | 11.69 |

Load on Pipe (Equipment) = 5.60 $lb/ft^2$

LARGEST EQUIPEMENT LOAD = 5.66 $lb/ft^2$

VERTICAL OVERBURDEN LOAD = 2,820.98 $lb/ft^2$

VERTICAL EQUIPMENT LOAD = 5.66 $lb/ft^2$

TOTAL VERTICAL LOAD APPLIED TO PIPE, $P_T$ = 2,826.65 $lb/ft^2$ = 19.63 $lb/in^2$

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Verify that perforations in the LCRS are adequate for the peak leachate flow.

Use discharge equation:

$Q = (Cd)(Ao)(2gh)^{0.5}$

$C_d$ = coeffiecient of discharge = 0.6 for short tube discharge with fluid/wall separation; conservative value.

$A_o$ = Area of orifice ($\pi D^2/4$)

g = gravitational acceleration (32.3 $ft^2/s$)

h = static head (ft)

| Assumptions and Givens: | | | |
|---|---|---|---|
| | 4.55 | acres | North and center portion of landfill bottom |
| 1. No. acres of landfill expansion = | 1.47 | acres | - North & center area from eastern grade break of bottom |
| 2. Total length of pipe per expansion = | 951.3 | ft | area draining into eastern 10-inch lateral collection |
| 3. Number of laterals = | 1.0 | | - (2) 8-inch laterals collect drainage from other bottom area |
| 4. Total length of pipe per lateral = | 951.3 | ft | - (1) 10-inch lateral collects the drainage area |
| 5. Perforation diameter = | 0.375 | inch | - Refer to calcs for 8" diameter leachate collection lateral |
| 6. No. perforations/ft pipe = | 6.0 | perforations/ft of pipe length | |
| 7. Maximum head over pipe = | 1.0 | ft | |
| 8. Per HELP model summary table, $Q_{peak}$ = | 202.93 | gal/min | refer to HELP Model Summary Table |
| 9. Per HELP model summary table, $Q_{peak}$ = | 39,063.5 | cf/day | refer to HELP Model Summary Table |
| 10. Maximum flow/lateral = | 39,063.5 | cf/day/lateral | |
| 11. Maximum leachate flow/ft of pipe = | 41.06 | cf/day/ft of pipe | |

Solution:

$A_o = 0.25(\Pi)(d)^2 =$ 0.00077 $ft^2$

1. Flow per orifice, $Q = (Cd)(Ao)(2gh)^{0.5} =$ 0.0037 $ft^3/s$

2. Flow per ft of pipe = (Q)(# perfs/ft) = 0.02 $ft^3/s$ per ft of pipe

= 1914.47 cf/day/ft of pipe

Conclusion:

Design capacity exceeds estimated generation

1914.47 cf/day/ft of pipe >>> 41.06 cf/day/ft of pipe

Perforations are adequate to handle the maximum leachate flow.

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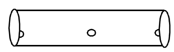
Effective pressure on pipe due to perforations:

$P_{EFF} = \frac{P_T \times 12}{(12 - L_P)}$ Source 3, EPA SW-870, p. 382

$L_P$ = Total accumulated length of perforations in one foot of pipe.

Since each perforation is 0.375 inch diameter and spaced at 6.0 inch on center,

$L_P$ = 1.5 inch



$P_T$ = 19.6 psi

$P_{EFF}$ = 22.4 psi

$P_{EFF}$ = 3230.5 psf

Check actual compressive pressure ($S_A$) per Driscopipe manual:

$S_A$ = 0.5 x (SDR - 1) x P(eff) = 112.2 psi

The recommended, long-term compressive strength ($Y_s$) design value for Driscoplex polyethylene pipe is 800 lb/in$^2$.

Source No. 1

| $S_A$ (psi): | | $Y_s$ (psi): |
|---|---|---|
| 112.2 | < | 800.0 |

Pipe passes wall compressive stress perforation calculations TRUE

FS = 7.1

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Constrained pipe wall buckling (for Driscoplex OD controlled pipe)

$P_{WC} = \frac{5.65 * \{RB'E' \, E*[12(DR-1)^3]^{-1}\}^{0.5}}{N}$ Source 1, Equation 7-5

$P_{WC}$ = allowable constrained buckling pressure ($lb/in^2$)

R = buoyancy reduction factor = 1 - 0.33 * (H'/H) Source 1, Equation 7-34

| | | |
|---|---|---|
| H' = groundwater height above pipe (ft) | 0.0 | ft |
| H = cover above pipe (ft) | 67.0 | ft |
| B' = elastic support factor =( 1+ 4*$e^{-0.065H}$ )$^{-1}$ | | Source 1, Equation 7-35 |
| E' = soil reaction modulus ($lb/in^2$) | 3000.0 | $lb/in^2$ for mod comp/crushed rock, 'Source 1, Table 7-7 |
| E = elastic modulus ($lb/in^2$) | 100000.0 | $lb/in^2$ for long term load at 100°F, 'Source 1, Table 5-1 |
| I = moment of inertia = $t^3$ / 12 | 0.1 | $in^4$/in |
| $D_o$ = pipe outer diameter (in) | 10.750 | SDR 11 pipe (Driscopipe) to be used |
| t = pipe wall thickness (in) | 0.977 | SDR 11 pipe (Driscopipe) to be used |
| DR = pipe dimension ratio = $D_o$ / t | 11.0 | SDR 11 pipe (Driscopipe) to be used |
| $D_I$ = pipe inner diameter = $D_o$ - 2t (in) | 8.8 | SDR 11 pipe (Driscopipe) to be used |
| N = safety factor | 2.0 | |

| Cover (ft) | (ft) | (ft) | B' | R | ($lb/in^2$) |
|---|---|---|---|---|---|
| 60.0 | 67 | 0 | 0.95 | 1.00 | 435.42 |

$P_{WC}$ = 435.42 $lb/in^2$

$P_{EFF}$ = 22.43 $lb/in^2$

Pipe passes contrained wall buckling calculations TRUE FS = 19.4

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| Operation w/ CAT D7R Series II **60 Feet Waste** | | |

Constrained Pipe Wall Compressive Stress (for Driscoplex OD controlled pipe)

$S = \frac{P_T D_o}{288t}$ Source No. 1

S = pipe wall compressive stress ($lb/in^2$)

$P_T$ = vertical load applied to pipe w/ perfs ($lb/ft^2$) 3230.5 $lb/ft^2$

$D_o$ = pipe outside diameter (in) 10.75 SDR 11 pipe (Driscopipe) to be used

t = pipe wall thickness (in) 0.977 SDR 11 pipe (Driscopipe) to be used

$S = \frac{P_T D_o}{288t} =$ 123.4 $lb/in^2$

The recommended, long-term compressive strength ($Y_s$) design value for Driscoplex polyethylene pipe is 800 $lb/in^2$.

Source No. 1

| S (psi): | | $Y_s$ (psi): |
|---|---|---|
| 123.4 | < | 800.0 |

Pipe passes wall compressive stress calculations TRUE FS = 6.5

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| **10" Diameter Leachate Collection Lateral Pipe** | CHECKED | DATE |
| Operation w/ CAT D7R Series II **60 Feet Waste** | | |

Iowa Formula

$\Delta X = \frac{D_L K W_c r^3}{EI + 0.06er^4}$ Source 2, Equation 3.4 Buried Pipe Design, A.P. Moser, Chapter 3

$\Delta X$ = horizontal deflection (in)

$D_L$ = deflection lag factor

K = bedding constant | 0.1 | typical value Source 2, Buried Pipe Design, A.P. Moser, Chapter 3

$W_c$ = Marston's load per unit length of pipe (lb/in)

r = mean radius of the pipe (in)

E = modulus of elasticity (lb/in$^2$)

I = moment of inertia of the pipe wall per unit length (in$^3$)

e = modulus of passive resistance fo the side fill (lb/in$^2$(in))

Modified Iowa Formula

$\Delta X = \frac{D_L K W_c r_m^3}{EI + 0.06E'r_m^3}$ Source 2, Equation 3.5 Buried Pipe Design, A.P. Moser, Chapter 3

$\Delta X$ = horizontal deflection (in)

| | | | |
|---|---|---|---|
| $D_L$ = deflection lag factor | | 1.0 | Prism Load used |
| Typical Value for Marston Load | 1.5 | | |
| Typical Value for Prism Load | 1.0 | | |
| K = bedding constant | | 0.1 | typical value Buried Pipe Design, A.P. Moser, Chapter 3 |
| $P_T$ = Vertical load on pipe w/ perfs | | 22.43 | lb/in$^2$ 3230 lb/ft$^2$ |
| $W_c$ = Marston's load per unit length of pipe = $P_T$ * $D_o$ (lb/in) | | 241.16 | lb/in |
| $D_o$ = pipe outer diameter (in) | | 10.75 | SDR 11 pipe (Driscopipe) to be used |
| t = pipe wall thickness (in) | | 0.98 | SDR 11 pipe (Driscopipe) to be used |
| $D_I$ = pipe inner diameter = $D_o$-2t (in) | | 8.80 | SDR 11 pipe (Driscopipe) to be used |
| $D_m$ = pipe mean diameter = $D_o$ - 1.06t Source 1, Equation 7-27 | | 9.71 | SDR 11 pipe (Driscopipe) to be used |
| $r_m$ = mean radius of the pipe (in) | | 4.86 | SDR 11 pipe (Driscopipe) to be used |
| E = modulus of elasticity (lb/in$^2$) | | 100,000.0 | lb/in2 for long term load at 100oF, 'Source 1, Table 5-1 |
| I = moment of inertia of the pipe wall per unit length | | 0.078 | in$^4$/in |
| E' = modulus of soil reaction | | 3,000.0 | lb/in$^2$ for moderate compaction and fine grained soils |

$\Delta X = \frac{D_L K W_c r_m^3}{EI + 0.06E'r_m^3}$ = 0.097 inch Source 2, Equation 3.5 Buried Pipe Design, A.P. Moser, Chapter 3

% Ring Deflection = ($\Delta X/D_m$) x 100 = 1.00% Source 1, Equation 7-31

Ring Bending Strain

$e = \frac{f_D \Delta X 2C}{D_M^2} \times 100$ Source 1, Equation 7-39

e = wall strain (%)

| | | |
|---|---|---|
| $f_D$ = deformation shape factor | 6 | Source 1, non-elliptical shape |
| $D_M$ = mean diameter (in) | | |
| C = outer fiber wall centroid = 0.5 (1.06t) | 0.518 | Source 1, Equation 7-41 |
| $\Delta X$ = ring deflection = $D_X/D_m$ | 0.010 | |

$e = f_D \frac{(\Delta X)}{D_M} \frac{(2C)}{D_M} \times 100$ = 0.6% Source 1, Equation 7-39

The maximum ring bending strain for high performance polyethylene non-pressure pipe is = 5.0%

Pipe passes ring bending strain calculations TRUE

| CLIENT | PROJECT | JOB NO. |
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| SUBJECT | BY | DATE |
|---|---|---|
| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **10" Diameter Leachate Collection Lateral Pipe** | CHECKED | DATE |
| Operation w/ CAT D7R Series II **60 Feet Waste** | | |

SOURCES

1.) Attachment - 1 - Chevron Phillips Chemical Company, Bulletin - Book 2 Chapter 5, 2003

2.) Attachment - 2 - Buried Pipe Design, A.P. Moser, Chapter 3

3.) Attachment - 3 - EPA, Lining of Waste Impoundment and Disposal Facilities, SW-870

4.) Attachment - 4 - Driscoplex Pipe Properties

5.) Attachment - 5 - CAT 826G Series II Compactor Data Sheet

6.) Attachment - 6 - CAT D7R Series II Equipment Data Sheet

# Summary Table and 8-Inch Leachate Detection Header Pipe Crushing and Flow Capacity Calculations North and Center Portions

SCS ENGINEERS



| CLIENT | PROJECT | JOB NO. |
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| Hardee County | Phase II Section II Expansion | 09199033.23 |

| SUBJECT | BY | DATE |
|---|---|---|
| Phase II Section II **RAI No. 1** | SRF | 4/1/13 |
| Summary Table Pipe Crushing **Operations** | CHECKED | DATE |
| **8" Diameter Leachate Detection Header North and Center Portions** | | |

| Description | Waste Height (ft) | Fill Height (ft) | Pipe Diameter (in) | Type of Calculation | Design Value | Calculated Value | Units | Safety Factor* |
|---|---|---|---|---|---|---|---|---|
| CAT D7R Series II | 0 | 2 | 8 | Flow Capacity | 1914.47 | 1.22 | cf/day/ft of pipe | 1568.65 |
| | | | | Buckling | 220.98 | 5.59 | psi | 39.51 |
| | | | | Compressive Stress | 800 | 30.76 | psi | 26.01 |
| | | | | Bending Strain | 5.0% | 0.2% | % | 31.30 |
| CAT D7R Series II | 10 | 12 | 8 | Flow Capacity | 1914.47 | 1.22 | cf/day/ft of pipe | 1568.65 |
| | | | | Buckling | 276.42 | 8.59 | psi | 32.17 |
| | | | | Compressive Stress | 800 | 47.26 | psi | 16.93 |
| | | | | Bending Strain | 5.0% | 0.2% | % | 20.37 |
| CAT D7R Series II | 25 | 27 | 8 | Flow Capacity | 1914.47 | 1.22 | cf/day/ft of pipe | 1568.65 |
| | | | | Buckling | 352.25 | 12.46 | psi | 28.28 |
| | | | | Compressive Stress | 800 | 68.52 | psi | 11.68 |
| | | | | Bending Strain | 5.0% | 0.4% | % | 14.05 |
| CAT D7R Series II | 60 | 65 | 8 | Flow Capacity | 1914.47 | 1.22 | cf/day/ft of pipe | 1568.65 |
| | | | | Buckling | 435.54 | 22.43 | psi | 19.41 |
| | | | | Compressive Stress | 800 | 123.40 | psi | 6.48 |
| | | | | Bending Strain | 5.0% | 0.6% | % | 7.80 |
| CAT 826 G Series II Compactor | 0 | 2 | 8 | Flow Capacity | 1914.47 | 1.22 | cf/day/ft of pipe | 1568.65 |
| | | | | Buckling | 220.98 | 11.53 | psi | 19.17 |
| | | | | Compressive Stress | 800 | 63.42 | psi | 12.61 |
| | | | | Bending Strain | 5.0% | 0.3% | % | 15.18 |
| CAT 826 G Series II Compactor | 10 | 12 | 8 | Flow Capacity | 1914.47 | 1.22 | cf/day/ft of pipe | 1568.65 |
| | | | | Buckling | 276.42 | 9.63 | psi | 28.71 |
| | | | | Compressive Stress | 800 | 52.97 | psi | 15.10 |
| | | | | Bending Strain | 5.0% | 0.3% | % | 18.18 |
| CAT 826 G Series II Compactor | 25 | 27 | 8 | Flow Capacity | 1914.47 | 1.22 | cf/day/ft of pipe | 1568.65 |
| | | | | Buckling | 352.25 | 12.83 | psi | 27.46 |
| | | | | Compressive Stress | 800 | 70.56 | psi | 11.34 |
| | | | | Bending Strain | 5.0% | 0.4% | % | 13.65 |
| CAT 826 G Series II Compactor | 60 | 65 | 8 | Flow Capacity | 1914.47 | 1.22 | cf/day/ft of pipe | 1568.65 |
| | | | | Buckling | 435.54 | 22.52 | psi | 19.34 |
| | | | | Compressive Stress | 800 | 123.89 | psi | 6.46 |
| | | | | Bending Strain | 5.0% | 0.6% | % | 7.77 |

* Safety Factor = Design Value/Calculated Value

**Revised April 1, 2013**

SCS ENGINEERS

SHEET 2 OF 2

| CLIENT | PROJECT | JOB NO. |
|---|---|---|
| Hardee County | Phase II Section II Expansion | 09199033.23 |

| SUBJECT | BY | DATE |
|---|---|---|
| Phase II Section II **RAI No. 1** | SRF | 4/1/13 |
| Summary Table Pipe Crushing **Construction** | CHECKED | DATE |
| **8" Diameter Leachate Detection Header North and Center Portions** | | |

| Description | Waste Height (ft) | Fill Height (ft) | Pipe Diameter (in) | Type of Calculation | Design Value | Calculated Value | Units | Safety Factor* |
|---|---|---|---|---|---|---|---|---|
| CAT D6R XW Series II | 0 | 1 | 8 | Flow Capacity | 1914.47 | 440.11 | cf/day/ft of pipe | 4.35 |
| | | | | Buckling | 204.96 | 2.93 | psi | 69.92 |
| | | | | Compressive Stress | 800 | 16.12 | psi | 49.61 |
| | | | | Bending Strain | 5.0% | 0.1% | % | 59.71 |

* Safety Factor = Design Value/Calculated Value

**Revised April 1, 2013**

SCS ENGINEERS

SHEET 1 OF 10

| CLIENT | PROJECT | JOB NO. |
|---|---|---|
| Hardee County | Phase II Section II Expansion | 09199033.23 |

| SUBJECT | BY | DATE |
|---|---|---|
| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Detection Header** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **0 Feet Waste** | | |

Load on Pipe (Overburden)

Prism Loads, $P_E$ = wH

w = unit weight

H = depth

| | Depth (ft) | Unit Weight (lb/ft$^3$) | $P_E$ (lb/ft$^2$) |
|---|---|---|---|
| Final cover | 0.0 | 115.0 | 0.0 |
| Intermediate cover | 0.0 | 115.0 | 0.0 |
| Waste/cover | 0.0 | 60.0 | 0.0 |
| Drainage sand | 2.0 | 115.0 | 230.0 |
| Rock (No. 89 & No. 57) | 2.0 | 140.0 | 280.0 |

TOTAL SOIL PRISM LOAD $P_E$: 510.0 lb/ft$^2$

Total Depth = 4.0 ft

Soil Arching, $P_m = C_D wB$

Pm = vertical soil pressure

B = trench width at pipe crown 6.0 ft

$C_D$ = load coefficient $= \frac{1 - e^{-2Ku'H/B}}{2Ku'}$ Equation 7-3, Source No. 1

NOTE: The waste unit weight represents the combined unit weight of waste, daily cover, and moisture.

e = natural log base number

K = Rankine earth pressure coefficient = $\tan^2(45-0.5*\phi)$

$\phi$ = internal soil friction angle = 27.0 degrees

u' = friction coefficient between backfill and trench sides = tan $\phi$

| Soil Type | Ku' |
|---|---|
| Saturated Clay | 0.110 |
| Ordinary Clay | 0.130 |
| Saturated Top Soil | 0.150 |
| Sand and Gravel | 0.165 |
| Clean Granular Soil | 0.192 |

| | Ku' | $C_D$ | $P_m$ (lb/ft$^2$) |
|---|---|---|---|
| Cover Soil | 0.150 | 0.00 | 0 |
| Int Cover | 0.165 | 0.00 | 0 |
| Waste | 0.191 | 0.00 | 0 |
| Drainage Sand | 0.165 | 0.32 | 217.8 |
| Granular Soil | 0.192 | 0.31 | 262.8 |

TOTAL SOIL ARCHING LOAD $P_M$: 480.6 lb/ft$^2$

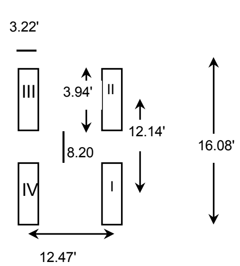
MODIFIED ARCHING LOAD = $0.6P_M+0.4P_E$: 492.37 lb/ft$^2$

OVERBURDEN LOAD: 492.37 lb/ft$^2$

Load on Pipe With Equipment Refer to Attachment

Operation w/ CAT 826G Series II Compactor 0 Feet Waste

Equipment Weight = 81,498.0 psf




| | | | |
|---|---|---|---|
| Track per Load = $q_r$ = | 1,670.20 | psf | (Rear) |
| Track per Load = $q_{fr}$ = | 1,541.72 | psf | (Front) |
| Length of Track = L = | 3.22 | ft | (contact length) |
| Length of Track = b = | 8.20 | ft | |
| Track Width = | 12.47 | ft | |
| Track Width (I to II) = | 16.08 | ft | |

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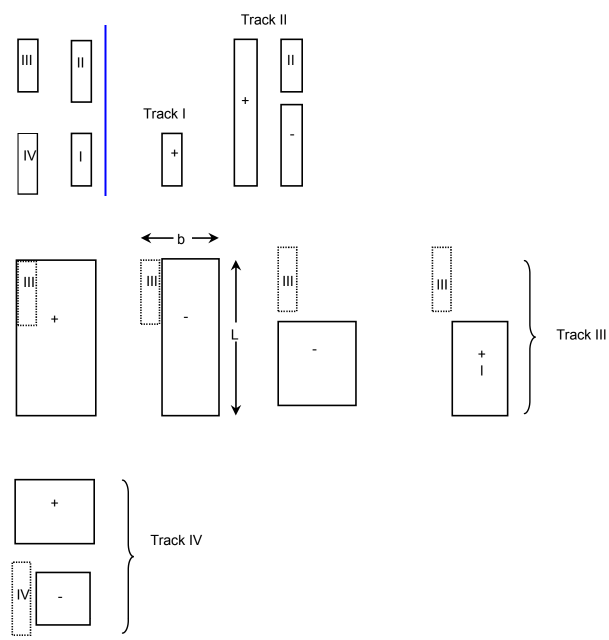
| SUBJECT | BY | DATE |
|---|---|---|
| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Detection Header** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **0 Feet Waste** | | |

Load on Pipe

Alternative 1: Track Adjacent and Parallel to Pipe




| | b | L | z | m = b/z | n = L/z | I* | I** | I | |
|---|---|---|---|---|---|---|---|---|---|
| Track I | 8.2 | 3 | 4 | 2.05 | 0.81 | 0.182 | 0.241 | 0.18205 | (ADD) |
| | | | | | | | | | |
| Track II | 8.2 | 16.1 | 4 | 2.05 | 4.02 | -0.010 | 0.240 | 0.23973 | (ADD) |
| | 8.2 | 11.4 | 4 | 2.05 | 2.86 | -0.012 | 0.238 | 0.23802 | (SUBTRACT) |
| | | | | | | | | | |
| Track IV | 12.47 | 3.22 | 4 | 3.12 | 0.81 | 0.185 | 0.231 | 0.18478 | (ADD) |
| | 12.47 | 3.22 | 4 | 3.12 | 0.81 | 0.185 | 0.231 | 0.18478 | (SUBTRACT) |
| | | | | | | | | | |
| Track III | 12.47 | 16.08 | 4 | 3.12 | 4.02 | -0.004 | 0.246 | 0.24588 | (ADD) |
| | 4.27 | 16.08 | 4 | 1.07 | 4.02 | -0.041 | 0.209 | 0.20918 | (SUBTRACT) |
| | 12.47 | 11.42 | 4 | 3.12 | 2.86 | -0.006 | 0.244 | 0.24379 | (SUBTRACT) |
| | 4.27 | 8.47 | 4 | 1.07 | 2.12 | 0.206 | 0.226 | 0.20553 | (ADD) |

Live Load$_1$ = $q_r(\Sigma I) + q_{fr}(\Sigma II) + q_{fr}(\Sigma III) + q_r(\Sigma IV)$

Live Load$_1$ = 304.29 psf

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| CLIENT | PROJECT | JOB NO. |
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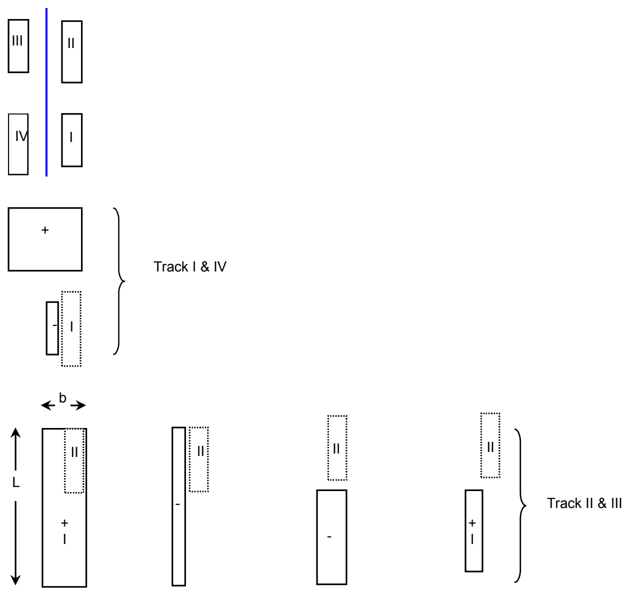
| Hardee County | Phase II Section II Expansion | 09199033.23 |

| SUBJECT | BY | DATE |
|---|---|---|
| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Detection Header** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **0 Feet Waste** | | |

Load on Pipe

Alternative 2: Track Stradling and Parallel to Pipe




| | b | L | z | m = b/z | n = L/z | I* | I** | I | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | |
| Track I | 6.2 | 3.2 | 4 | 1.6 | 0.8 | 0.177 | 0.250 | 0.17733 | (ADD) |
| & IV | -2.0 | 3.2 | 4 | -0.5 | 0.8 | -0.109 | 0.230 | -0.10926 | (SUBTRACT) |
| | | | | | | | | | |
| Track II | 6.2 | 16.08 | 4 | 1.6 | 4.0 | -0.019 | 0.231 | 0.23095 | (ADD) |
| & III | -2.0 | 16.08 | 4 | -0.5 | 4.0 | -0.135 | 0.255 | -0.13546 | (SUBTRACT) |
| | 6.2 | 12.86 | 4 | 1.6 | 3.2 | -0.020 | 0.230 | 0.23021 | (SUBTRACT) |
| | -2.0 | 12.86 | 4 | -0.5 | 3.2 | -0.135 | 0.253 | -0.13519 | (ADD) |

Live $Load_2$ = $[q_r (\Sigma I) + q_{fr} (\Sigma II)] * 2$

Live $Load_2$ = 960.43 psf

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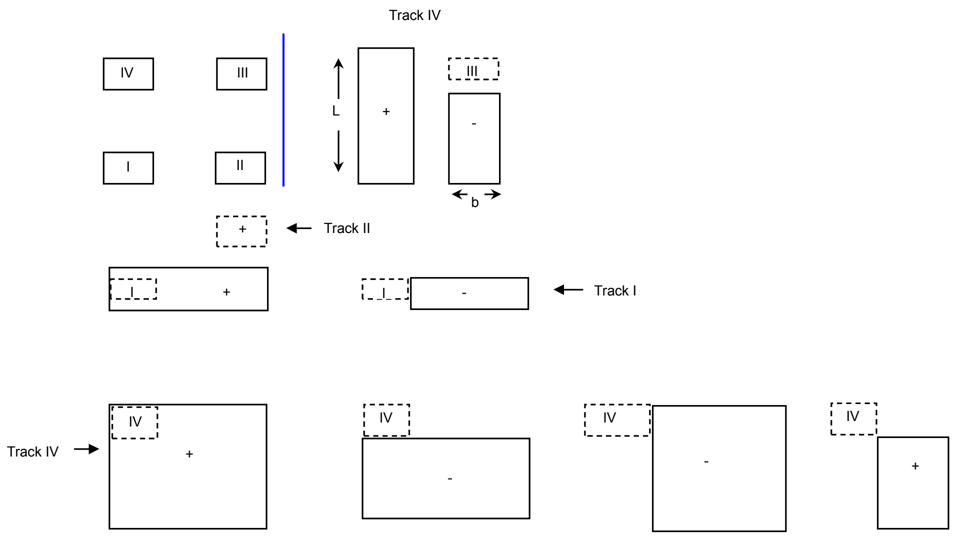
| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Detection Header** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **0 Feet Waste** | | |

Load on Pipe

Alternative 3: Track Perpendicular to Pipe




| | b | L | z | m = b/z | n = L/z | I* | I** | I | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | |
| Track I | 16.1 | 8.2 | 4 | 4.0 | 2.1 | -0.010 | 0.240 | 0.23973 | (ADD) |
| | 12.9 | 8.2 | 4 | 3.2 | 2.1 | -0.011 | 0.239 | 0.23883 | (SUBTRACT) |
| | | | | | | | | | |
| Track II | 3.2 | 8.2 | 4 | 0.8 | 2.1 | 0.182 | 0.241 | 0.18205 | (ADD) |
| | | | | | | | | | |
| Track III | 3.2 | 12.5 | 4 | 0.8 | 3.1 | 0.185 | 0.231 | 0.18478 | (ADD) |
| | 3.2 | 4.3 | 4 | 0.8 | 1.1 | 0.164 | 0.262 | 0.16364 | (SUBTRACT) |
| | | | | | | | | | |
| Track IV | 16.1 | 12.5 | 4 | 4.0 | 3.1 | -0.004 | 0.246 | 0.24588 | (ADD) |
| | 16.1 | 4.3 | 4 | 4.0 | 1.1 | -0.041 | 0.209 | 0.20918 | (SUBTRACT) |
| | 12.9 | 12.5 | 4 | 3.2 | 3.1 | -0.005 | 0.245 | 0.24477 | (SUBTRACT) |
| | 12.9 | 4.3 | 4 | 3.2 | 1.1 | 0.209 | 0.213 | 0.20863 | (ADD) |

Live Load$_3$ = $q_r(\Sigma I) + q_{fr}(\Sigma II) + q_{fr}(\Sigma III) + q_r(\Sigma IV)$

Live Load$_3$ = 315.70 psf

LARGEST EQUIPEMENT LOAD = 960.43 lb/ft$^2$

VERTICAL OVERBURDEN LOAD = 492.37 lb/ft$^2$

VERTICAL EQUIPMENT LOAD = 960.43 lb/ft$^2$

TOTAL VERTICAL LOAD APPLIED TO PIPE, $P_T$ = 1452.80 lb/ft$^2$ = 10.09 lb/in$^2$

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| CLIENT | PROJECT | JOB NO. |
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| Hardee County | Phase II Section II Expansion | 09199033.23 |

| SUBJECT | BY | DATE |
|---|---|---|
| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Detection Header** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **0 Feet Waste** | | |

Verify that perforations in the LCRS are adequate for the peak leachate flow.

Use discharge equation:

$Q = (Cd)(Ao)(2gh)^{0.5}$

$C_d$ = coeffiecient of discharge = 0.6 for short tube discharge with fluid/wall separation; conservative value.

$A_o$ = Area of orifice ($\pi D^2/4$)

g = gravitational acceleration (32.3 $ft^2/s$)

h = static head (ft)

Assumptions and Givens:

| | | | |
|---|---|---|---|
| 1. No. acres of landfill expansion = | 4.55 | acres | North and center portion of landfill bottom |
| 2. Total length of pipe per expansion = | 138.8 | ft | |
| 3. Total number of laterals = | 1.0 | | |
| 4. Length of pipe per lateral = | 138.8 | ft | |
| 5. Perforation diameter = | 0.375 | inch | |
| 6. No. perforations/ft pipe = | 6.0 | perforations/ft of pipe length | |
| 7. Maximum head over pipe = | 1.0 | ft | |
| 8. Per HELP model summary table, $Q_{peak}$ = | 0.88 | gal/min | refer to HELP Model Summary Table |
| 9. Per HELP model summary table, $Q_{peak}$ = | 169.4 | cf/day | refer to HELP Model Summary Table |
| 10. Maximum flow/lateral = | 169.4 | cf/day/lateral | |
| 11. Maximum leachate flow/ft of pipe = | 1.22 | cf/day/ft of pipe | |

Solution:

$A_o = 0.25(\Pi)(d)^2 =$ 0.00077 $ft^2$

1. Flow per orifice, $Q = (Cd)(Ao)(2gh)^{0.5} =$ 0.0037 $ft^3/s$

2. Flow per ft of pipe = (Q)(# perfs/ft) = 0.02 $ft^3/s$ per ft of pipe

= 1914.47 cf/day/ft of pipe

Conclusion:

Design capacity exceeds estimated generation

1914.47 cf/day/ft of pipe >>> 1.22 cf/day/ft of pipe

Perforations are adequate to handle the maximum leachate flow.

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| CLIENT | PROJECT | JOB NO. |
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| Hardee County | Phase II Section II Expansion | 09199033.23 |

| SUBJECT | BY | DATE |
|---|---|---|
| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Detection Header** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **0 Feet Waste** | | |

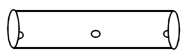
Effective pressure on pipe due to perforations:

$P_{EFF} = \frac{P_T \times 12}{(12 - L_P)}$ Source 3, EPA SW-870, p. 382

$L_P$ = Total accumulated length of perforations in one foot of pipe.

Since each perforation is 0.375 inch diameter and spaced at 6.0 inch on center,

$L_P$ = 1.5 inch



$P_T$ = 10.1 psi

$P_{EFF}$ = 11.5 psi

$P_{EFF}$ = 1660.3 psf

Check actual compressive pressure ($S_A$) per Driscopipe manual:

$S_A$ = 0.5 x (SDR - 1) x P(eff) = 57.7 psi

The recommended, long-term compressive strength ($Y_s$) design value for Driscoplex polyethylene pipe is 800 lb/in$^2$.

Source No. 1

| $S_A$ (psi): | | $Y_s$ (psi): |
|---|---|---|
| 57.7 | < | 800.0 |

Pipe passes wall compressive stress perforation calculations TRUE

FS = 13.9

| CLIENT | PROJECT | JOB NO. |
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| Hardee County | Phase II Section II Expansion | 09199033.23 |

| SUBJECT | BY | DATE |
|---|---|---|
| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Detection Header** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **0 Feet Waste** | | |

Constrained pipe wall buckling (for Driscoplex OD controlled pipe)

$P_{WC} = \dfrac{5.65 * \{RB'E'\ E*[12(DR-1)^3]^{-1}\}^{0.5}}{N}$ Source 1, Equation 7-5

$P_{WC}$ = allowable constrained buckling pressure (lb/in$^2$)

R = buoyancy reduction factor = 1 - 0.33 * (H'/H) Source 1, Equation 7-34

| | | |
|---|---|---|
| H' = groundwater height above pipe (ft) | 0.0 | ft |
| H = cover above pipe (ft) | 4.0 | ft |
| B' = elastic support factor $=(1+4*e^{-0.065H})^{-1}$ | Source 1, Equation 7-35 | |
| E' = soil reaction modulus (lb/in$^2$) | 3000.0 | lb/in$^2$ for mod comp/crushed rock, 'Source 1, Table 7-7 |
| E = elastic modulus (lb/in$^2$) | 100000.0 | lb/in$^2$ for long term load at 100$^o$F, 'Source 1, Table 5-1 |
| I = moment of inertia = $t^3$ / 12 | 0.0 | in$^4$/in |
| $D_o$ = pipe outer diameter (in) | 8.625 | SDR 11 pipe (Driscopipe) to be used |
| t = pipe wall thickness (in) | 0.784 | SDR 11 pipe (Driscopipe) to be used |
| DR = pipe dimension ratio = $D_o$ / t | 11.0 | SDR 11 pipe (Driscopipe) to be used |
| $D_I$ = pipe inner diameter = $D_o$ - 2t (in) | 7.1 | SDR 11 pipe (Driscopipe) to be used |
| N = safety factor | 2.0 | |

| Cover (ft) | (ft) | (ft) | B' | R | (lb/in$^2$) |
|---|---|---|---|---|---|
| 4.0 | 4 | 0 | 0.24 | 1.00 | 220.98 |

$P_{WC}$ = 220.98 lb/in$^2$

$P_{EFF}$ = 11.53 lb/in$^2$

Pipe passes contrained wall buckling calculations TRUE FS = 19.2

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| Hardee County | Phase II Section II Expansion | 09199033.23 |

| SUBJECT | BY | DATE |
|---|---|---|
| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Detection Header** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **0 Feet Waste** | | |

Constrained Pipe Wall Compressive Stress (for Driscoplex OD controlled pipe)

$S = \frac{P_T D_o}{288t}$ Source No. 1

S = pipe wall compressive stress ($lb/in^2$)

| | | |
|---|---|---|
| $P_T$ = vertical load applied to pipe w/ perfs ($lb/ft^2$) | 1660.3 | $lb/ft^2$ |
| $D_o$ = pipe outside diameter (in) | 8.63 | SDR 11 pipe (Driscopipe) to be used |
| t = pipe wall thickness (in) | 0.784 | SDR 11 pipe (Driscopipe) to be used |

$S = \frac{P_T D_o}{288t} =$ 63.4 $lb/in^2$

The recommended, long-term compressive strength ($Y_s$) design value for Driscoplex polyethylene pipe is 800 $lb/in^2$.

Source No. 1

| S (psi): | | $Y_s$ (psi): |
|---|---|---|
| 63.4 | < | 800.0 |

Pipe passes wall compressive stress calculations TRUE

FS = 12.6

| CLIENT | PROJECT | JOB NO. |
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| SUBJECT | BY | DATE |
|---|---|---|
| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Detection Header** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **0 Feet Waste** | | |

Iowa Formula

$\Delta X = \dfrac{D_L K W_c r^3}{EI + 0.06er^4}$ Source 2, Equation 3.4 Buried Pipe Design, A.P. Moser, Chapter 3

$\Delta X$ = horizontal deflection (in)

$D_L$ = deflection lag factor

K = bedding constant | 0.1 | typical value Source 2, Buried Pipe Design, A.P. Moser, Chapter 3

$W_c$ = Marston's load per unit length of pipe (lb/in)

r = mean radius of the pipe (in)

E = modulus of elasticity ($lb/in^2$)

I = moment of inertia of the pipe wall per unit length ($in^3$)

e = modulus of passive resistance fo the side fill ($lb/in^2(in)$)

Modified Iowa Formula

$\Delta X = \dfrac{D_L K W_c r_m^3}{EI + 0.06E'r_m^3}$ Source 2, Equation 3.5 Buried Pipe Design, A.P. Moser, Chapter 3

$\Delta X$ = horizontal deflection (in)

| | | | |
|---|---|---|---|
| $D_L$ = deflection lag factor | | 1.0 | Prism Load used |
| Typical Value for Marston Load | 1.5 | | |
| Typical Value for Prism Load | 1.0 | | |
| K = bedding constant | | 0.1 | typical value Buried Pipe Design, A.P. Moser, Chapter 3 |
| $P_T$ = Vertical load on pipe w/ perfs | | 11.53 | $lb/in^2$ — 1660 $lb/ft^2$ |
| $W_c$ = Marston's load per unit length of pipe = $P_T * D_o$ (lb/in) | | 99.45 | lb/in |
| $D_o$ = pipe outer diameter (in) | | 8.63 | SDR 11 pipe (Driscopipe) to be used |
| t = pipe wall thickness (in) | | 0.78 | SDR 11 pipe (Driscopipe) to be used |
| $D_I$ = pipe inner diameter = $D_o$-2t (in) | | 7.06 | SDR 11 pipe (Driscopipe) to be used |
| $D_m$ = pipe mean diameter = $D_o$ - 1.06t Source 1, Equation 7-27 | | 7.79 | SDR 11 pipe (Driscopipe) to be used |
| $r_m$ = mean radius of the pipe (in) | | 3.90 | SDR 11 pipe (Driscopipe) to be used |
| E = modulus of elasticity ($lb/in^2$) | | 100,000.0 | lb/in2 for long term load at 100oF, 'Source 1, Table 5-1 |
| I = moment of inertia of the pipe wall per unit length | | 0.040 | $in^4/in$ |
| E' = modulus of soil reaction | | 3,000.0 | $lb/in^2$ for moderate compaction and fine grained soils |

$\Delta X = \dfrac{D_L K W_c r_m^3}{EI + 0.06E'r_m^3}$ = 0.040 inch Source 2, Equation 3.5 Buried Pipe Design, A.P. Moser, Chapter 3

% Ring Deflection = ($\Delta X/D_m$) x 100 = 0.51% Source 1, Equation 7-31

Ring Bending Strain

$e = \dfrac{f_D \Delta X 2C}{D_M^2} \times 100$ Source 1, Equation 7-39

e = wall strain (%)

| | | |
|---|---|---|
| $f_D$ = deformation shape factor | 6 | Source 1, non-elliptical shape |
| $D_M$ = mean diameter (in) | | |
| C = outer fiber wall centroid = 0.5 (1.06t) | 0.416 | Source 1, Equation 7-41 |
| $\Delta X$ = ring deflection = $D_X/D_m$ | 0.005 | |

$e = f_D \left(\dfrac{\Delta X}{D_M}\right)\left(\dfrac{2C}{D_M}\right) \times 100$ = 0.3% Source 1, Equation 7-39

The maximum ring bending strain for high performance polyethylene non-pressure pipe is 5.0%

Pipe passes ring bending strain calculations TRUE

| CLIENT | PROJECT | JOB NO. |
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| SUBJECT | BY | DATE |
|---|---|---|
| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Detection Header** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **0 Feet Waste** | | |

SOURCES

1.) Attachment - 1 - Chevron Phillips Chemical Company, Bulletin - Book 2 Chapter 5, 2003

2.) Attachment - 2 - Buried Pipe Design, A.P. Moser, Chapter 3

3.) Attachment - 3 - EPA, Lining of Waste Impoundment and Disposal Facilities, SW-870

4.) Attachment - 4 - Driscoplex Pipe Properties

5.) Attachment - 5 - CAT 826G Series II Compactor Data Sheet

6.) Attachment - 6 - CAT D7R Series II Equipment Data Sheet

7.) Attachment - 7 - CAT D6R XW Series II Equipment Data Sheet

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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Detection Header** | CHECKED | DATE |
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Load on Pipe (Overburden)

Prism Loads, $P_E = wH$

w = unit weight

H = depth

| | Depth (ft) | Unit Weight ($lb/ft^3$) | $P_E$ ($lb/ft^2$) |
|---|---|---|---|
| Final cover | 0.0 | 115.0 | 0.0 |
| Intermediate cover | 0.0 | 115.0 | 0.0 |
| Waste/cover | 10.0 | 60.0 | 600.0 |
| Drainage sand | 2.0 | 115.0 | 230.0 |
| Rock (No. 89 & No. 57) | 2.0 | 140.0 | 280.0 |

TOTAL SOIL PRISM LOAD $P_E$: 1110.0 $lb/ft^2$

Total Depth = 14.0 ft

Soil Arching, $P_m = C_D wB$

NOTE: The waste unit weight represents the combined unit weight of waste, daily cover, and moisture.

Pm = vertical soil pressure

B = trench width at pipe crown 6.0 ft

$C_D$ = load coefficient $= \frac{1 - e^{-2Ku'H/B}}{2Ku'}$ Equation 7-3, Source No. 1

e = natural log base number

K = Rankine earth pressure coefficient = $\tan^2(45-0.5*\phi)$

$\phi$ = internal soil friction angle = 27.0 degrees

u' = friction coefficient between backfill and trench sides = tan $\phi$

| Soil Type | Ku' |
|---|---|
| Saturated Clay | 0.110 |
| Ordinary Clay | 0.130 |
| Saturated Top Soil | 0.150 |
| Sand and Gravel | 0.165 |
| Clean Granular Soil | 0.192 |

| | Ku' | $C_D$ | $P_m$ ($lb/ft^2$) |
|---|---|---|---|
| Cover Soil | 0.150 | 0.00 | 0 |
| Int Cover | 0.165 | 0.00 | 0 |
| Waste | 0.191 | 1.23 | 444 |
| Drainage Sand | 0.165 | 0.32 | 217.8 |
| Granular Soil | 0.192 | 0.31 | 262.8 |

TOTAL SOIL ARCHING LOAD $P_M$: 924.2 $lb/ft^2$

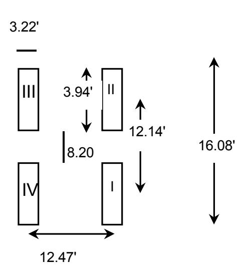
MODIFIED ARCHING LOAD = $0.6P_M+0.4P_E$: 998.53 $lb/ft^2$

OVERBURDEN LOAD: 998.53 $lb/ft^2$

Load on Pipe With Equipment Refer to Attachment

Operation w/ CAT 826G Series II Compactor 10 Feet Waste

Equipment Weight = 81,498.0 psf




Track per Load = $q_r$ = 1,670.20 psf (Rear)

Track per Load = $q_{fr}$ = 1,541.72 psf (Front)

Length of Track = L = 3.22 ft (contact length)

Length of Track = b = 8.20 ft

Track Width = 12.47 ft

Track Width (I to II) = 16.08 ft

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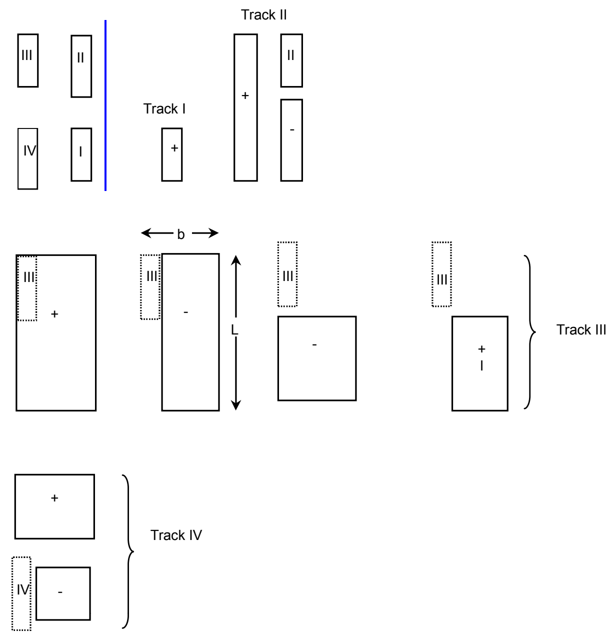
| Operation w/ CAT 826G Series II Compactor **10 Feet Waste** | | |

Load on Pipe

Alternative 1: Track Adjacent and Parallel to Pipe




| | b | L | z | m = b/z | n = L/z | I* | I** | I | |
|---|---|---|---|---|---|---|---|---|---|
| Track I | 8.2 | 3 | 14 | 0.59 | 0.23 | 0.049 | 0.263 | 0.04882 | (ADD) |
| | | | | | | | | | |
| Track II | 8.2 | 16.1 | 14 | 0.59 | 1.15 | 0.139 | 0.265 | 0.13939 | (ADD) |
| | 8.2 | 11.4 | 14 | 0.59 | 0.82 | 0.124 | 0.270 | 0.12392 | (SUBTRACT) |
| | | | | | | | | | |
| Track IV | 12.47 | 3.22 | 14 | 0.89 | 0.23 | 0.060 | 0.262 | 0.05999 | (ADD) |
| | 12.47 | 3.22 | 14 | 0.89 | 0.23 | 0.060 | 0.262 | 0.05999 | (SUBTRACT) |
| | | | | | | | | | |
| Track III | 12.47 | 16.08 | 14 | 0.89 | 1.15 | 0.175 | 0.258 | 0.17489 | (ADD) |
| | 4.27 | 16.08 | 14 | 0.31 | 1.15 | 0.084 | 0.263 | 0.08363 | (SUBTRACT) |
| | 12.47 | 11.42 | 14 | 0.89 | 0.82 | 0.154 | 0.266 | 0.15446 | (SUBTRACT) |
| | 4.27 | 8.47 | 14 | 0.31 | 0.61 | 0.064 | 0.266 | 0.06417 | (ADD) |

$\text{Live Load}_1 = q_r(\Sigma I) + q_{fr}(\Sigma II) + q_{fr}(\Sigma III) + q_r(\Sigma IV)$

$\text{Live Load}_1 =$ 106.88 psf

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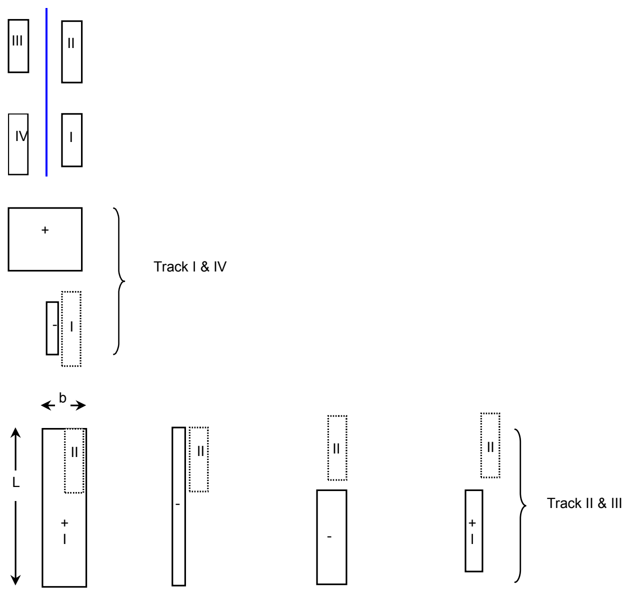
Load on Pipe

Alternative 2: Track Stradling and Parallel to Pipe




| | b | L | z | m = b/z | n = L/z | I* | I** | I | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | |
| Track I | 6.2 | 3.2 | 14 | 0.4 | 0.2 | 0.041 | 0.261 | 0.04054 | (ADD) |
| & IV | -2.0 | 3.2 | 14 | -0.1 | 0.2 | -0.015 | 0.245 | -0.01454 | (SUBTRACT) |
| | | | | | | | | | |
| Track II | 6.2 | 16.08 | 14 | 0.4 | 1.1 | 0.115 | 0.265 | 0.11458 | (ADD) |
| & III | -2.0 | 16.08 | 14 | -0.1 | 1.1 | -0.040 | 0.243 | -0.04040 | (SUBTRACT) |
| | 6.2 | 12.86 | 14 | 0.4 | 0.9 | 0.107 | 0.268 | 0.10711 | (SUBTRACT) |
| | -2.0 | 12.86 | 14 | -0.1 | 0.9 | -0.038 | 0.242 | -0.03788 | (ADD) |

Live $Load_2$ = $[q_r (\Sigma I) + q_{fr} (\Sigma II)] * 2$

Live $Load_2$ = 214.77 psf

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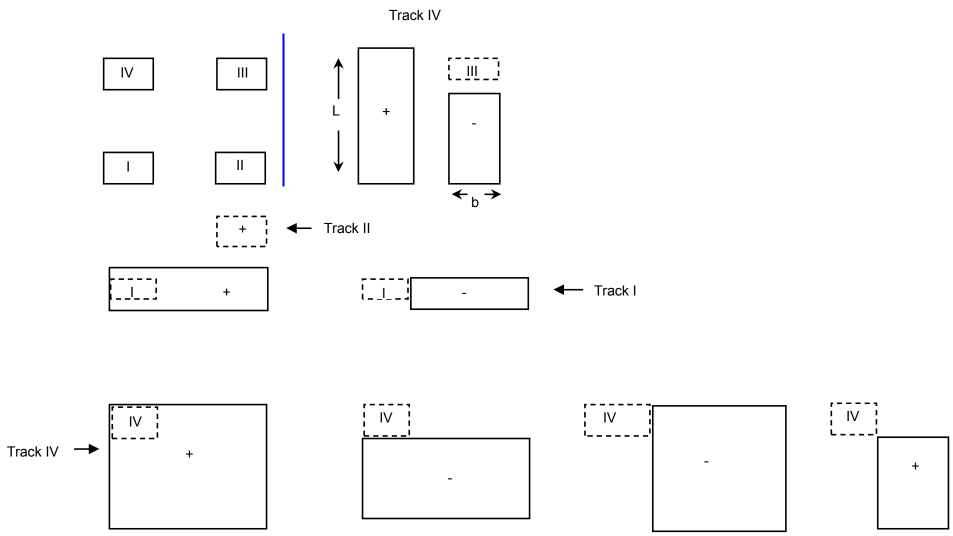
Load on Pipe

Alternative 3: Track Perpendicular to Pipe




| | b | L | z | m = b/z | n = L/z | I* | I** | I | |
|---|---|---|---|---|---|---|---|---|---|
| Track I | 16.1 | 8.2 | 14 | 1.1 | 0.6 | 0.139 | 0.265 | 0.13939 | (ADD) |
| | 12.9 | 8.2 | 14 | 0.9 | 0.6 | 0.130 | 0.269 | 0.13005 | (SUBTRACT) |
| Track II | 3.2 | 8.2 | 14 | 0.2 | 0.6 | 0.049 | 0.263 | 0.04882 | (ADD) |
| Track III | 3.2 | 12.5 | 14 | 0.2 | 0.9 | 0.060 | 0.262 | 0.05999 | (ADD) |
| | 3.2 | 4.3 | 14 | 0.2 | 0.3 | 0.030 | 0.259 | 0.02986 | (SUBTRACT) |
| Track IV | 16.1 | 12.5 | 14 | 1.1 | 0.9 | 0.175 | 0.258 | 0.17489 | (ADD) |
| | 16.1 | 4.3 | 14 | 1.1 | 0.3 | 0.084 | 0.263 | 0.08363 | (SUBTRACT) |
| | 12.9 | 12.5 | 14 | 0.9 | 0.9 | 0.162 | 0.264 | 0.16248 | (SUBTRACT) |
| | 12.9 | 4.3 | 14 | 0.9 | 0.3 | 0.078 | 0.265 | 0.07831 | (ADD) |

Live Load$_3$ = $q_r(\Sigma I) + q_{fr}(\Sigma II) + q_{fr}(\Sigma III) + q_r(\Sigma IV)$

Live Load$_3$ = 149.14 psf

LARGEST EQUIPEMENT LOAD = 214.77 lb/ft$^2$

VERTICAL OVERBURDEN LOAD = 998.53 lb/ft$^2$

VERTICAL EQUIPMENT LOAD = 214.77 lb/ft$^2$

TOTAL VERTICAL LOAD APPLIED TO PIPE, $P_T$ = 1213.30 lb/ft$^2$ = 8.43 lb/in$^2$

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Verify that perforations in the LCRS are adequate for the peak leachate flow.

Use discharge equation:

$Q = (Cd)(Ao)(2gh)^{0.5}$

$C_d$ = coeffiecient of discharge = 0.6 for short tube discharge with fluid/wall separation; conservative value.

$A_o$ = Area of orifice ($\pi D^2/4$)

g = gravitational acceleration (32.3 $ft^2/s$)

h = static head (ft)

Assumptions and Givens:

| | | | |
|---|---|---|---|
| 1. No. acres of landfill expansion = | 4.55 | acres | North and center portion of landfill bottom |
| 2. Total length of pipe per expansion = | 138.8 | ft | |
| 3. Total number of laterals = | 1.0 | | |
| 4. Length of pipe per lateral = | 138.8 | ft | |
| 5. Perforation diameter = | 0.375 | inch | |
| 6. No. perforations/ft pipe = | 6.0 | perforations/ft of pipe length | |
| 7. Maximum head over pipe = | 1.0 | ft | |
| 8. Per HELP model summary table, $Q_{peak}$ = | 0.88 | gal/min | refer to HELP Model Summary Table |
| 9. Per HELP model summary table, $Q_{peak}$ = | 169.4 | cf/day | refer to HELP Model Summary Table |
| 10. Maximum flow/lateral = | 169.4 | cf/day/lateral | |
| 11. Maximum leachate flow/ft of pipe = | 1.22 | cf/day/ft of pipe | |

Solution:

$A_o = 0.25(\Pi)(d)^2 =$ 0.00077 $ft^2$

1. Flow per orifice, $Q = (Cd)(Ao)(2gh)^{0.5} =$ 0.0037 $ft^3/s$

2. Flow per ft of pipe = (Q)(# perfs/ft) = 0.02 $ft^3/s$ per ft of pipe

= 1914.47 cf/day/ft of pipe

Conclusion:

Design capacity exceeds estimated generation

1914.47 cf/day/ft of pipe >>> 1.22 cf/day/ft of pipe

Perforations are adequate to handle the maximum leachate flow.

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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Detection Header** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **10 Feet Waste** | | |

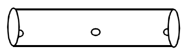
Effective pressure on pipe due to perforations:

$P_{EFF} = \dfrac{P_T \times 12}{(12 - L_P)}$ Source 3, EPA SW-870, p. 382

$L_P$ = Total accumulated length of perforations in one foot of pipe.

Since each perforation is 0.375 inch diameter and spaced at 6.0 inch on center,

$L_P$ = 1.5 inch



$P_T$ = 8.4 psi

$P_{EFF}$ = 9.6 psi

$P_{EFF}$ = 1386.6 psf

Check actual compressive pressure ($S_A$) per Driscopipe manual:

$S_A$ = 0.5 x (SDR - 1) x P(eff) = 48.2 psi

The recommended, long-term compressive strength ($Y_s$) design value for Driscoplex polyethylene pipe is 800 lb/in$^2$.

Source No. 1

| $S_A$ (psi): | | $Y_s$ (psi): |
|---|---|---|
| 48.2 | < | 800.0 |

Pipe passes wall compressive stress perforation calculations TRUE

FS = 16.6

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| Operation w/ CAT 826G Series II Compactor **10 Feet Waste** | | |

Constrained pipe wall buckling (for Driscoplex OD controlled pipe)

$P_{WC} = \dfrac{5.65 * \{RB'E'\ E*[12(DR-1)^3]^{-1}\}^{0.5}}{N}$ Source 1, Equation 7-5

$P_{WC}$ = allowable constrained buckling pressure (lb/in$^2$)

R = buoyancy reduction factor = 1 - 0.33 * (H'/H) Source 1, Equation 7-34

H' = groundwater height above pipe (ft) 0.0 ft

H = cover above pipe (ft) 14.0 ft

B' = elastic support factor =$( 1+ 4*e^{-0.065H} )^{-1}$ Source 1, Equation 7-35

E' = soil reaction modulus (lb/in$^2$) 3000.0 lb/in$^2$ for mod comp/crushed rock, 'Source 1, Table 7-7

E = elastic modulus (lb/in$^2$) 100000.0 lb/in$^2$ for long term load at 100$^o$F, 'Source 1, Table 5-1

I = moment of inertia = $t^3$ / 12 0.0 in$^4$/in

$D_o$ = pipe outer diameter (in) 8.625 SDR 11 pipe (Driscopipe) to be used

t = pipe wall thickness (in) 0.784 SDR 11 pipe (Driscopipe) to be used

DR = pipe dimension ratio = $D_o$ / t 11.0 SDR 11 pipe (Driscopipe) to be used

$D_I$ = pipe inner diameter = $D_o$ - 2t (in) 7.1 SDR 11 pipe (Driscopipe) to be used

N = safety factor 2.0

| Cover (ft) | (ft) | (ft) | B' | R | (lb/in$^2$) |
|---|---|---|---|---|---|
| 14.0 | 14 | 0 | 0.38 | 1.00 | 276.42 |

$P_{WC}$ = 276.42 lb/in$^2$

$P_{EFF}$ = 9.63 lb/in$^2$

Pipe passes contrained wall buckling calculations TRUE FS = 28.7

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Constrained Pipe Wall Compressive Stress (for Driscoplex OD controlled pipe)

$S = \frac{P_T D_o}{288t}$ Source No. 1

$S$ = pipe wall compressive stress (lb/in$^2$)

| | | |
|---|---|---|
| $P_T$ = vertical load applied to pipe w/ perfs (lb/ft$^2$) | 1386.6 | lb/ft$^2$ |
| $D_o$ = pipe outside diameter (in) | 8.63 | SDR 11 pipe (Driscopipe) to be used |
| t = pipe wall thickness (in) | 0.784 | SDR 11 pipe (Driscopipe) to be used |

$S = \frac{P_T D_o}{288t} =$ 53.0 lb/in$^2$

The recommended, long-term compressive strength ($Y_s$) design value for Driscoplex polyethylene pipe is 800 lb/in$^2$.

Source No. 1

| S (psi): | | $Y_s$ (psi): |
|---|---|---|
| 53.0 | < | 800.0 |

Pipe passes wall compressive stress calculations TRUE

FS = 15.1

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Iowa Formula

$$\Delta X = \frac{D_L K W_c r^3}{EI + 0.06er^4}$$ Source 2, Equation 3.4 Buried Pipe Design, A.P. Moser, Chapter 3

$\Delta X$ = horizontal deflection (in)

$D_L$ = deflection lag factor

K = bedding constant — 0.1 — typical value Source 2, Buried Pipe Design, A.P. Moser, Chapter 3

$W_c$ = Marston's load per unit length of pipe (lb/in)

r = mean radius of the pipe (in)

E = modulus of elasticity ($lb/in^2$)

I = moment of inertia of the pipe wall per unit length ($in^3$)

e = modulus of passive resistance fo the side fill ($lb/in^2(in)$)

Modified Iowa Formula

$$\Delta X = \frac{D_L K W_c r_m^3}{EI + 0.06E'r_m^3}$$ Source 2, Equation 3.5 Buried Pipe Design, A.P. Moser, Chapter 3

$\Delta X$ = horizontal deflection (in)

| | | | | |
|---|---|---|---|---|
| $D_L$ = deflection lag factor | | 1.0 | Prism Load used | |
| Typical Value for Marston Load | 1.5 | | | |
| Typical Value for Prism Load | 1.0 | | | |
| K = bedding constant | | 0.1 | typical value Buried Pipe Design, A.P. Moser, Chapter 3 | |
| $P_T$ = Vertical load on pipe w/ perfs | | 9.63 | $lb/in^2$ | 1387 $lb/ft^2$ |
| $W_c$ = Marston's load per unit length of pipe = $P_T * D_o$ (lb/in) | | 83.05 | lb/in | |
| $D_o$ = pipe outer diameter (in) | | 8.63 | SDR 11 pipe (Driscopipe) to be used | |
| t = pipe wall thickness (in) | | 0.78 | SDR 11 pipe (Driscopipe) to be used | |
| $D_I$ = pipe inner diameter = $D_o$-2t (in) | | 7.06 | SDR 11 pipe (Driscopipe) to be used | |
| $D_m$ = pipe mean diameter = $D_o$ - 1.06t Source 1, Equation 7-27 | | 7.79 | SDR 11 pipe (Driscopipe) to be used | |
| $r_m$ = mean radius of the pipe (in) | | 3.90 | SDR 11 pipe (Driscopipe) to be used | |
| E = modulus of elasticity ($lb/in^2$) | | 100,000.0 | lb/in2 for long term load at 100oF, 'Source 1, Table 5-1 | |
| I = moment of inertia of the pipe wall per unit length | | 0.040 | $in^4/in$ | |
| E' = modulus of soil reaction | | 3,000.0 | $lb/in^2$ for moderate compaction and fine grained soils | |

$$\Delta X = \frac{D_L K W_c r_m^3}{EI + 0.06E'r_m^3} =$$ 0.034 inch — Source 2, Equation 3.5 Buried Pipe Design, A.P. Moser, Chapter 3

% Ring Deflection = $(\Delta X/D_m) \times 100$ = 0.43% Source 1, Equation 7-31

Ring Bending Strain

$$e = \frac{f_D \Delta X 2C}{D_M^2} \times 100$$ Source 1, Equation 7-39

e = wall strain (%)

| | | |
|---|---|---|
| $f_D$ = deformation shape factor | 6 | Source 1, non-elliptical shape |
| $D_M$ = mean diameter (in) | | |
| C = outer fiber wall centroid = 0.5 (1.06t) | 0.416 | Source 1, Equation 7-41 |
| $\Delta X$ = ring deflection = $D_X/D_m$ | 0.004 | |

$$e = f_D \frac{\Delta X}{D_M} \frac{(2C)}{D_M} \times 100 =$$ 0.3% Source 1, Equation 7-39

The maximum ring bending strain for high performance polyethylene non-pressure pipe is = 5.0%

Pipe passes ring bending strain calculations TRUE

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| Operation w/ CAT 826G Series II Compactor **10 Feet Waste** | | |

SOURCES

1.) Attachment - 1 - Chevron Phillips Chemical Company, Bulletin - Book 2 Chapter 5, 2003

2.) Attachment - 2 - Buried Pipe Design, A.P. Moser, Chapter 3

3.) Attachment - 3 - EPA, Lining of Waste Impoundment and Disposal Facilities, SW-870

4.) Attachment - 4 - Driscoplex Pipe Properties

5.) Attachment - 5 - CAT 826G Series II Compactor Data Sheet

6.) Attachment - 6 - CAT D7R Series II Equipment Data Sheet

7.) Attachment - 7 - CAT D6R XW Series II Equipment Data Sheet

SCS ENGINEERS

SHEET 1 OF 10

| CLIENT | PROJECT | JOB NO. |
|---|---|---|
| Hardee County | Phase II Section II Expansion | 09199033.23 |

| SUBJECT | BY | DATE |
|---|---|---|
| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Detection Header** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **25 Feet Waste** | | |

Load on Pipe (Overburden)

Prism Loads, $P_E = wH$

w = unit weight

H = depth

| | Depth (ft) | Unit Weight (lb/ft$^3$) | $P_E$ (lb/ft$^2$) |
|---|---|---|---|
| Final cover | 0.0 | 115.0 | 0.0 |
| Intermediate cover | 0.0 | 115.0 | 0.0 |
| Waste/cover | 25.0 | 60.0 | 1500.0 |
| Drainage sand | 2.0 | 115.0 | 230.0 |
| Rock (No. 89 & No. 57) | 2.0 | 140.0 | 280.0 |

TOTAL SOIL PRISM LOAD $P_E$: 2010.0 lb/ft$^2$

Total Depth = 29.0 ft

Soil Arching, $P_m = C_D w B$

Pm = vertical soil pressure

B = trench width at pipe crown 6.0 ft

$C_D$ = load coefficient $= \dfrac{1 - e^{-2Ku'H/B}}{2Ku'}$ Equation 7-3, Source No. 1

e = natural log base number

K = Rankine earth pressure coefficient = $\tan^2(45-0.5*\phi)$

$\phi$ = internal soil friction angle = 27.0 degrees

u' = friction coefficient between backfill and trench sides = tan $\phi$

NOTE: The waste unit weight represents the combined unit weight of waste, daily cover, and moisture.

| Soil Type | Ku' |
|---|---|
| Saturated Clay | 0.110 |
| Ordinary Clay | 0.130 |
| Saturated Top Soil | 0.150 |
| Sand and Gravel | 0.165 |
| Clean Granular Soil | 0.192 |

| | Ku' | $C_D$ | $P_m$ (lb/ft$^2$) |
|---|---|---|---|
| Cover Soil | 0.150 | 0.00 | 0 |
| Int Cover | 0.165 | 0.00 | 0 |
| Waste | 0.191 | 2.08 | 750 |
| Drainage Sand | 0.165 | 0.32 | 217.8 |
| Granular Soil | 0.192 | 0.31 | 262.8 |

TOTAL SOIL ARCHING LOAD $P_M$: 1,230.4 lb/ft$^2$

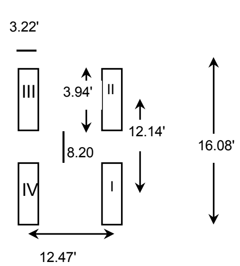
MODIFIED ARCHING LOAD = $0.6P_M+0.4P_E$: 1,542.23 lb/ft$^2$

OVERBURDEN LOAD: 1,542.23 lb/ft$^2$

Load on Pipe With Equipment Refer to Attachment

Operation w/ CAT 826G Series II Compactor 25 Feet Waste

Equipment Weight = 81,498.0 psf




| | | | |
|---|---|---|---|
| Track per Load = $q_r$ = | 1,670.20 | psf | (Rear) |
| Track per Load = $q_{fr}$ = | 1,541.72 | psf | (Front) |
| Length of Track = L = | 3.22 | ft | (contact length) |
| Length of Track = b = | 8.20 | ft | |
| Track Width = | 12.47 | ft | |
| Track Width (I to II) = | 16.08 | ft | |

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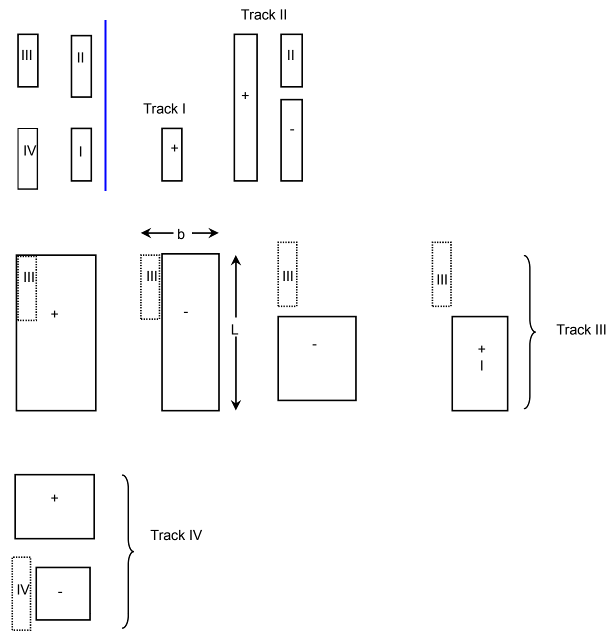
| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Detection Header** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **25 Feet Waste** | | |

Load on Pipe

Alternative 1: Track Adjacent and Parallel to Pipe




| | b | L | z | m = b/z | n = L/z | I* | I** | I | |
|---|---|---|---|---|---|---|---|---|---|
| Track I | 8.2 | 3 | 29 | 0.28 | 0.11 | 0.014 | 0.254 | 0.01393 | (ADD) |
| | | | | | | | | | |
| Track II | 8.2 | 16.1 | 29 | 0.28 | 0.55 | 0.057 | 0.265 | 0.05688 | (ADD) |
| | 8.2 | 11.4 | 29 | 0.28 | 0.39 | 0.044 | 0.263 | 0.04447 | (SUBTRACT) |
| | | | | | | | | | |
| Track IV | 12.47 | 3.22 | 29 | 0.43 | 0.11 | 0.020 | 0.256 | 0.01966 | (ADD) |
| | 12.47 | 3.22 | 29 | 0.43 | 0.11 | 0.020 | 0.256 | 0.01966 | (SUBTRACT) |
| | | | | | | | | | |
| Track III | 12.47 | 16.08 | 29 | 0.43 | 0.55 | 0.081 | 0.269 | 0.08065 | (ADD) |
| | 4.27 | 16.08 | 29 | 0.15 | 0.55 | 0.031 | 0.258 | 0.03090 | (SUBTRACT) |
| | 12.47 | 11.42 | 29 | 0.43 | 0.39 | 0.063 | 0.267 | 0.06292 | (SUBTRACT) |
| | 4.27 | 8.47 | 29 | 0.15 | 0.29 | 0.019 | 0.256 | 0.01886 | (ADD) |

Live Load$_1$ = $q_r(\Sigma I) + q_{fr}(\Sigma II) + q_{fr}(\Sigma III) + q_r(\Sigma IV)$

Live Load$_1$ = 51.18 psf

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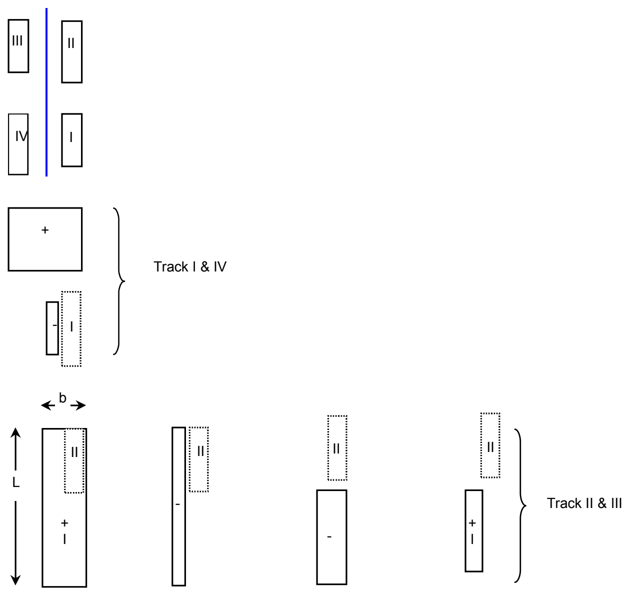
| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Detection Header** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **25 Feet Waste** | | |

Load on Pipe

Alternative 2: Track Stradling and Parallel to Pipe




| | b | L | z | m = b/z | n = L/z | I* | I** | I | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | |
| Track I | 6.2 | 3.2 | 29 | 0.2 | 0.1 | 0.011 | 0.253 | 0.01087 | (ADD) |
| & IV | -2.0 | 3.2 | 29 | -0.1 | 0.1 | -0.004 | 0.249 | -0.00354 | (SUBTRACT) |
| | | | | | | | | | |
| Track II | 6.2 | 16.08 | 29 | 0.2 | 0.6 | 0.044 | 0.262 | 0.04431 | (ADD) |
| & III | -2.0 | 16.08 | 29 | -0.1 | 0.6 | -0.014 | 0.246 | -0.01441 | (SUBTRACT) |
| | 6.2 | 12.86 | 29 | 0.2 | 0.4 | 0.038 | 0.261 | 0.03796 | (SUBTRACT) |
| | -2.0 | 12.86 | 29 | -0.1 | 0.4 | -0.012 | 0.246 | -0.01235 | (ADD) |

Live $Load_2 = [q_r (\Sigma I) + q_{fr} (\Sigma II)] * 2$

Live $Load_2 =$ 74.06 psf

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| CLIENT | PROJECT | JOB NO. |
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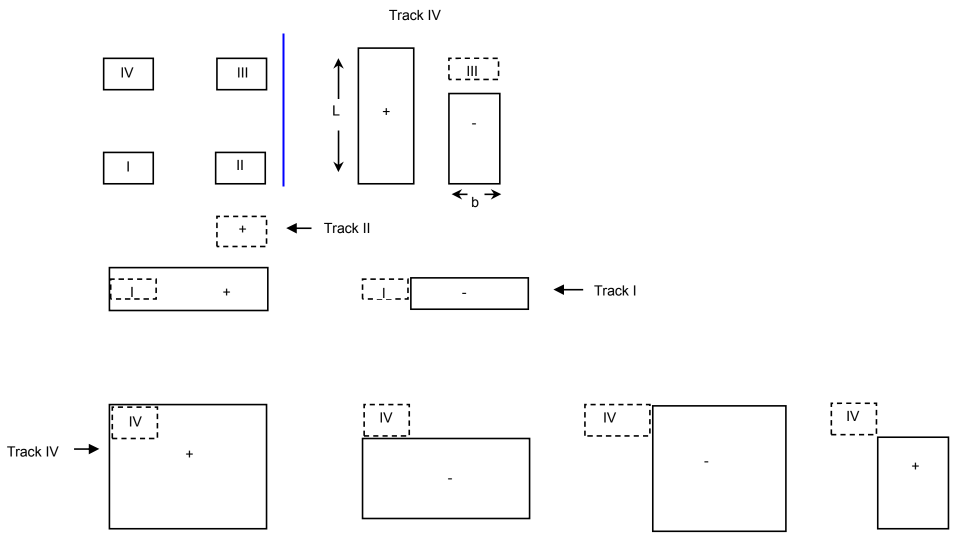
| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Detection Header** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **25 Feet Waste** | | |

Load on Pipe

Alternative 3: Track Perpendicular to Pipe




| | b | L | z | m = b/z | n = L/z | I* | I** | I | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | |
| Track I | 16.1 | 8.2 | 29 | 0.6 | 0.3 | 0.057 | 0.265 | 0.05688 | (ADD) |
| | 12.9 | 8.2 | 29 | 0.4 | 0.3 | 0.049 | 0.264 | 0.04871 | (SUBTRACT) |
| | | | | | | | | | |
| Track II | 3.2 | 8.2 | 29 | 0.1 | 0.3 | 0.014 | 0.254 | 0.01393 | (ADD) |
| | | | | | | | | | |
| Track III | 3.2 | 12.5 | 29 | 0.1 | 0.4 | 0.020 | 0.256 | 0.01966 | (ADD) |
| | 3.2 | 4.3 | 29 | 0.1 | 0.1 | 0.008 | 0.252 | 0.00759 | (SUBTRACT) |
| | | | | | | | | | |
| Track IV | 16.1 | 12.5 | 29 | 0.6 | 0.4 | 0.081 | 0.269 | 0.08065 | (ADD) |
| | 16.1 | 4.3 | 29 | 0.6 | 0.1 | 0.031 | 0.258 | 0.03090 | (SUBTRACT) |
| | 12.9 | 12.5 | 29 | 0.4 | 0.4 | 0.069 | 0.268 | 0.06896 | (SUBTRACT) |
| | 12.9 | 4.3 | 29 | 0.4 | 0.1 | 0.026 | 0.258 | 0.02649 | (ADD) |

Live $Load_3$ = $q_r(\Sigma I) + q_{fr}(\Sigma II) + q_{fr}(\Sigma III) + q_r(\Sigma IV)$

Live $Load_3$ = 65.88 psf

LARGEST EQUIPEMENT LOAD = 74.06 $lb/ft^2$

VERTICAL OVERBURDEN LOAD = 1542.23 $lb/ft^2$

VERTICAL EQUIPMENT LOAD = 74.06 $lb/ft^2$

TOTAL VERTICAL LOAD APPLIED TO PIPE, $P_T$ = 1616.28 $lb/ft^2$ = 11.22 $lb/in^2$

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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Detection Header** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **25 Feet Waste** | | |

Verify that perforations in the LCRS are adequate for the peak leachate flow.

Use discharge equation:

$Q = (Cd)(Ao)(2gh)^{0.5}$

$C_d$ = coeffiecient of discharge = 0.6 for short tube discharge with fluid/wall separation; conservative value.

$A_o$ = Area of orifice ($\pi D^2/4$)

g = gravitational acceleration (32.3 $ft^2/s$)

h = static head (ft)

Assumptions and Givens:

| | | | |
|---|---|---|---|
| 1. No. acres of landfill expansion = | 4.55 | acres | North and center portion of landfill bottom |
| 2. Total length of pipe per expansion = | 138.8 | ft | |
| 3. Total number of laterals = | 1.0 | | |
| 4. Length of pipe per lateral = | 138.8 | ft | |
| 5. Perforation diameter = | 0.375 | inch | |
| 6. No. perforations/ft pipe = | 6.0 | perforations/ft of pipe length | |
| 7. Maximum head over pipe = | 1.0 | ft | |
| 8. Per HELP model summary table, $Q_{peak}$ = | 0.88 | gal/min | refer to HELP Model Summary Table |
| 9. Per HELP model summary table, $Q_{peak}$ = | 169.4 | cf/day | refer to HELP Model Summary Table |
| 10. Maximum flow/lateral = | 169.4 | cf/day/lateral | |
| 11. Maximum leachate flow/ft of pipe = | 1.22 | cf/day/ft of pipe | |

Solution:

$A_o = 0.25(\Pi)(d)^2 =$ 0.00077 $ft^2$

1. Flow per orifice, $Q = (Cd)(Ao)(2gh)^{0.5} =$ 0.0037 $ft^3/s$

2. Flow per ft of pipe = (Q)(# perfs/ft) = 0.02 $ft^3/s$ per ft of pipe

= 1914.47 cf/day/ft of pipe

Conclusion:

Design capacity exceeds estimated generation

1914.47 cf/day/ft of pipe >>> 1.22 cf/day/ft of pipe

Perforations are adequate to handle the maximum leachate flow.

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| Operation w/ CAT 826G Series II Compactor **25 Feet Waste** | | |

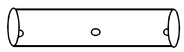
Effective pressure on pipe due to perforations:

$P_{EFF} = \frac{P_T \times 12}{(12 - L_P)}$ Source 3, EPA SW-870, p. 382

$L_P$ = Total accumulated length of perforations in one foot of pipe.

Since each perforation is 0.375 inch diameter and spaced at 6.0 inch on center,

$L_P$ = 1.5 inch



$P_T$ = 11.2 psi

$P_{EFF}$ = 12.8 psi

$P_{EFF}$ = 1847.2 psf

Check actual compressive pressure ($S_A$) per Driscopipe manual:

$S_A$ = 0.5 x (SDR - 1) x P(eff) = 64.1 psi

The recommended, long-term compressive strength ($Y_s$) design value for Driscoplex polyethylene pipe is 800 lb/in$^2$.

Source No. 1

| $S_A$ (psi): | | $Y_s$ (psi): |
|---|---|---|
| 64.1 | < | 800.0 |

Pipe passes wall compressive stress perforation calculations TRUE

FS = 12.5

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| Operation w/ CAT 826G Series II Compactor **25 Feet Waste** | | |

Constrained pipe wall buckling (for Driscoplex OD controlled pipe)

$$P_{WC} = \frac{5.65 * \{RB'E'\ E*[12(DR-1)^3]^{-1}\}^{0.5}}{N}$$ Source 1, Equation 7-5

$P_{WC}$ = allowable constrained buckling pressure ($lb/in^2$)

R = buoyancy reduction factor = 1 - 0.33 * (H'/H) Source 1, Equation 7-34

H' = groundwater height above pipe (ft) 0.0 ft

H = cover above pipe (ft) 29.0 ft

B' = elastic support factor =$( 1+ 4*e^{-0.065H} )^{-1}$ Source 1, Equation 7-35

E' = soil reaction modulus ($lb/in^2$) 3000.0 $lb/in^2$ for mod comp/crushed rock, 'Source 1, Table 7-7

E = elastic modulus ($lb/in^2$) 100000.0 $lb/in^2$ for long term load at 100°F, 'Source 1, Table 5-1

I = moment of inertia = $t^3$ / 12 0.0 $in^4/in$

$D_o$ = pipe outer diameter (in) 8.625 SDR 11 pipe (Driscopipe) to be used

t = pipe wall thickness (in) 0.784 SDR 11 pipe (Driscopipe) to be used

DR = pipe dimension ratio = $D_o$ / t 11.0 SDR 11 pipe (Driscopipe) to be used

$D_I$ = pipe inner diameter = $D_o$ - 2t (in) 7.1 SDR 11 pipe (Driscopipe) to be used

N = safety factor 2.0

| Cover (ft) | (ft) | (ft) | B' | R | ($lb/in^2$) |
|---|---|---|---|---|---|
| 29.0 | 29 | 0 | 0.62 | 1.00 | 352.25 |

$P_{WC}$ = 352.25 $lb/in^2$

$P_{EFF}$ = 12.83 $lb/in^2$

Pipe passes contrained wall buckling calculations TRUE FS = 27.5

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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
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| Operation w/ CAT 826G Series II Compactor **25 Feet Waste** | | |

Constrained Pipe Wall Compressive Stress (for Driscoplex OD controlled pipe)

$S = \frac{P_T D_o}{288t}$ Source No. 1

S = pipe wall compressive stress ($lb/in^2$)

$P_T$ = vertical load applied to pipe w/ perfs ($lb/ft^2$) | 1847.2 | $lb/ft^2$

$D_o$ = pipe outside diameter (in) | 8.63 | SDR 11 pipe (Driscopipe) to be used

t = pipe wall thickness (in) | 0.784 | SDR 11 pipe (Driscopipe) to be used

$S = \frac{P_T D_o}{288t} =$ 70.6 $lb/in^2$

The recommended, long-term compressive strength ($Y_s$) design value for Driscoplex polyethylene pipe is 800 $lb/in^2$.

Source No. 1

| S (psi): | | $Y_s$ (psi): |
|---|---|---|
| 70.6 | < | 800.0 |

Pipe passes wall compressive stress calculations TRUE

FS = 11.3

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| Operation w/ CAT 826G Series II Compactor **25 Feet Waste** | | |

Iowa Formula

$\Delta X = \dfrac{D_L K W_c r^3}{EI + 0.06er^4}$ Source 2, Equation 3.4 Buried Pipe Design, A.P. Moser, Chapter 3

$\Delta X$ = horizontal deflection (in)

$D_L$ = deflection lag factor

K = bedding constant — 0.1 typical value Source 2, Buried Pipe Design, A.P. Moser, Chapter 3

$W_c$ = Marston's load per unit length of pipe (lb/in)

r = mean radius of the pipe (in)

E = modulus of elasticity ($lb/in^2$)

I = moment of inertia of the pipe wall per unit length ($in^3$)

e = modulus of passive resistance fo the side fill ($lb/in^2$(in))

Modified Iowa Formula

$\Delta X = \dfrac{D_L K W_c r_m^3}{EI + 0.06E'r_m^3}$ Source 2, Equation 3.5 Buried Pipe Design, A.P. Moser, Chapter 3

$\Delta X$ = horizontal deflection (in)

| | | |
|---|---|---|
| $D_L$ = deflection lag factor | 1.0 | Prism Load used |
| Typical Value for Marston Load | 1.5 | |
| Typical Value for Prism Load | 1.0 | |
| K = bedding constant | 0.1 | typical value Buried Pipe Design, A.P. Moser, Chapter 3 |
| $P_T$ = Vertical load on pipe w/ perfs | 12.83 | $lb/in^2$ — 1847 $lb/ft^2$ |
| $W_c$ = Marston's load per unit length of pipe = $P_T$ * $D_o$ (lb/in) | 110.64 | lb/in |
| $D_o$ = pipe outer diameter (in) | 8.63 | SDR 11 pipe (Driscopipe) to be used |
| t = pipe wall thickness (in) | 0.78 | SDR 11 pipe (Driscopipe) to be used |
| $D_I$ = pipe inner diameter = $D_o$-2t (in) | 7.06 | SDR 11 pipe (Driscopipe) to be used |
| $D_m$ = pipe mean diameter = $D_o$ - 1.06t Source 1, Equation 7-27 | 7.79 | SDR 11 pipe (Driscopipe) to be used |
| $r_m$ = mean radius of the pipe (in) | 3.90 | SDR 11 pipe (Driscopipe) to be used |
| E = modulus of elasticity ($lb/in^2$) | 100,000.0 | lb/in2 for long term load at 100oF, 'Source 1, Table 5-1 |
| I = moment of inertia of the pipe wall per unit length | 0.040 | $in^4$/in |
| E' = modulus of soil reaction | 3,000.0 | $lb/in^2$ for moderate compaction and fine grained soils |

$\Delta X = \dfrac{D_L K W_c r_m^3}{EI + 0.06E'r_m^3}$ = 0.045 inch — Source 2, Equation 3.5 Buried Pipe Design, A.P. Moser, Chapter 3

% Ring Deflection = $(\Delta X/D_m)$ x 100 = 0.57% Source 1, Equation 7-31

Ring Bending Strain

$e = \dfrac{f_D \Delta X 2C}{D_M^2} \times 100$ Source 1, Equation 7-39

e = wall strain (%)

| | | |
|---|---|---|
| $f_D$ = deformation shape factor | 6 | Source 1, non-elliptical shape |
| $D_M$ = mean diameter (in) | | |
| C = outer fiber wall centroid = 0.5 (1.06t) | 0.416 | Source 1, Equation 7-41 |
| $\Delta X$ = ring deflection = $D_X/D_m$ | 0.006 | |

$e = f_D \left(\dfrac{\Delta X}{D_M}\right)\left(\dfrac{2C}{D_M}\right) \times 100$ = 0.4% Source 1, Equation 7-39

The maximum ring bending strain for high performance polyethylene non-pressure pipe is = 5.0%

Pipe passes ring bending strain calculations TRUE

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| **8" Diameter Leachate Detection Header** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **25 Feet Waste** | | |

SOURCES

1.) Attachment - 1 - Chevron Phillips Chemical Company, Bulletin - Book 2 Chapter 5, 2003

2.) Attachment - 2 - Buried Pipe Design, A.P. Moser, Chapter 3

3.) Attachment - 3 - EPA, Lining of Waste Impoundment and Disposal Facilities, SW-870

4.) Attachment - 4 - Driscoplex Pipe Properties

5.) Attachment - 5 - CAT 826G Series II Compactor Data Sheet

6.) Attachment - 6 - CAT D7R Series II Equipment Data Sheet

7.) Attachment - 7 - CAT D6R XW Series II Equipment Data Sheet

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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Detection Header** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **60 Feet Waste** | | |

Load on Pipe (Overburden)

Prism Loads, $P_E$ = wH

w = unit weight

H = depth

| | Depth (ft) | Unit Weight ($lb/ft^3$) | $P_E$ ($lb/ft^2$) |
|---|---|---|---|
| Final cover | 2.0 | 115.0 | 230.0 |
| Intermediate cover | 1.0 | 115.0 | 115.0 |
| Waste/cover | 60.0 | 60.0 | 3600.0 |
| Drainage sand | 2.0 | 115.0 | 230.0 |
| Rock (No. 89 & No. 57) | 2.0 | 140.0 | 280.0 |

TOTAL SOIL PRISM LOAD $P_E$: 4455.0 $lb/ft^2$

Total Depth = 67.0 ft

Soil Arching, $P_m = C_D w B$

Pm = vertical soil pressure

B = trench width at pipe crown 6.0 ft

$C_D$ = load coefficient $= \frac{1 - e^{-2Ku'H/B}}{2Ku'}$ Equation 7-3, Source No. 1

NOTE: The waste unit weight represents the combined unit weight of waste, daily cover, and moisture.

e = natural log base number

K = Rankine earth pressure coefficient = $\tan^2(45-0.5*\phi)$

$\phi$ = internal soil friction angle = 27.0 degrees

u' = friction coefficient between backfill and trench sides = tan $\phi$

| Soil Type | Ku' |
|---|---|
| Saturated Clay | 0.110 |
| Ordinary Clay | 0.130 |
| Saturated Top Soil | 0.150 |
| Sand and Gravel | 0.165 |
| Clean Granular Soil | 0.192 |

| | Ku' | $C_D$ | $P_m$ ($lb/ft^2$) |
|---|---|---|---|
| Cover Soil | 0.150 | 0.32 | 219 |
| Int Cover | 0.165 | 0.16 | 112 |
| Waste | 0.191 | 2.56 | 920 |
| Drainage Sand | 0.165 | 0.32 | 217.8 |
| Granular Soil | 0.192 | 0.31 | 262.8 |

TOTAL SOIL ARCHING LOAD $P_M$: 1,731.6 $lb/ft^2$

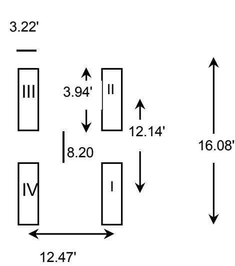
MODIFIED ARCHING LOAD = $0.6P_M+0.4P_E$: 2,820.98 $lb/ft^2$

OVERBURDEN LOAD: 2,820.98 $lb/ft^2$

Load on Pipe With Equipment Refer to Attachment

Operation w/ CAT 826G Series II Compactor 60 Feet Waste

Equipment Weight = 81,498.0 psf




Track per Load = $q_r$ = 1,670.20 psf (Rear)

Track per Load = $q_{fr}$ = 1,541.72 psf (Front)

Length of Track = L = 3.22 ft (contact length)

Length of Track = b = 8.20 ft

Track Width = 12.47 ft

Track Width (I to II) = 16.08 ft

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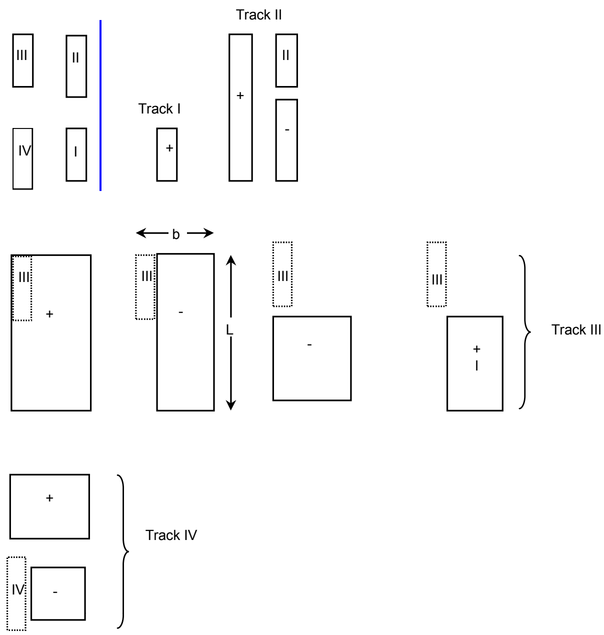
|---|---|---|
| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Detection Header** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **60 Feet Waste** | | |

Load on Pipe

Alternative 1: Track Adjacent and Parallel to Pipe




| | b | L | z | m = b/z | n = L/z | I* | I** | I | |
|---|---|---|---|---|---|---|---|---|---|
| Track I | 8.2 | 3 | 67 | 0.12 | 0.05 | 0.003 | 0.251 | 0.00277 | (ADD) |
| | | | | | | | | | |
| Track II | 8.2 | 16.1 | 67 | 0.12 | 0.24 | 0.013 | 0.254 | 0.01323 | (ADD) |
| | 8.2 | 11.4 | 67 | 0.12 | 0.17 | 0.010 | 0.253 | 0.00961 | (SUBTRACT) |
| | | | | | | | | | |
| Track IV | 12.47 | 3.22 | 67 | 0.19 | 0.05 | 0.004 | 0.251 | 0.00414 | (ADD) |
| | 12.47 | 3.22 | 67 | 0.19 | 0.05 | 0.004 | 0.251 | 0.00414 | (SUBTRACT) |
| | | | | | | | | | |
| Track III | 12.47 | 16.08 | 67 | 0.19 | 0.24 | 0.020 | 0.256 | 0.01980 | (ADD) |
| | 4.27 | 16.08 | 67 | 0.06 | 0.24 | 0.007 | 0.252 | 0.00695 | (SUBTRACT) |
| | 12.47 | 11.42 | 67 | 0.19 | 0.17 | 0.014 | 0.255 | 0.01438 | (SUBTRACT) |
| | 4.27 | 8.47 | 67 | 0.06 | 0.13 | 0.004 | 0.251 | 0.00378 | (ADD) |

Live $\text{Load}_1$ = $q_r(\Sigma I) + q_{fr}(\Sigma II) + q_{fr}(\Sigma III) + q_r(\Sigma IV)$

Live $\text{Load}_1$ = 13.68 psf

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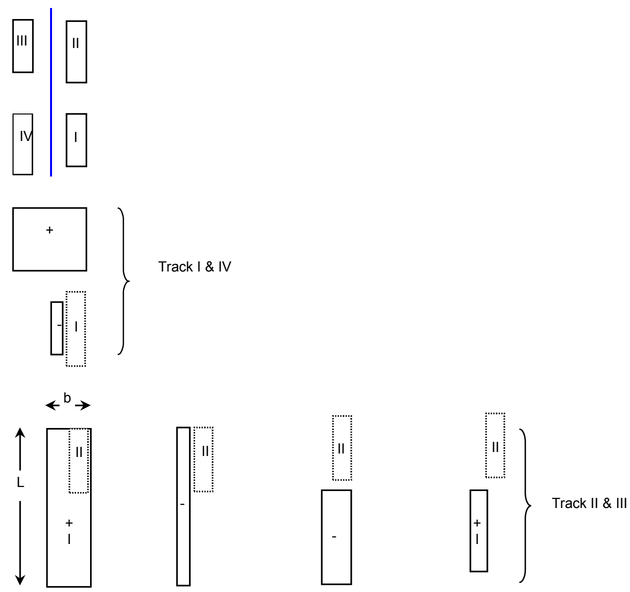
Load on Pipe

Alternative 2: Track Stradling and Parallel to Pipe




| | b | L | z | m = b/z | n = L/z | I* | I** | I | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | |
| Track I | 6.2 | 3.2 | 67 | 0.1 | 0.0 | 0.002 | 0.251 | 0.00212 | (ADD) |
| & IV | -2.0 | 3.2 | 67 | 0.0 | 0.0 | -0.001 | 0.250 | -0.00067 | (SUBTRACT) |
| | | | | | | | | | |
| Track II | 6.2 | 16.08 | 67 | 0.1 | 0.2 | 0.010 | 0.253 | 0.01011 | (ADD) |
| & III | -2.0 | 16.08 | 67 | 0.0 | 0.2 | -0.003 | 0.249 | -0.00321 | (SUBTRACT) |
| | 6.2 | 12.86 | 67 | 0.1 | 0.2 | 0.008 | 0.253 | 0.00822 | (SUBTRACT) |
| | -2.0 | 12.86 | 67 | 0.0 | 0.2 | -0.003 | 0.249 | -0.00261 | (ADD) |

Live $Load_2$ = $[q_r(\Sigma I) + q_{fr}(\Sigma II)] * 2$

Live $Load_2$ = 16.99 psf

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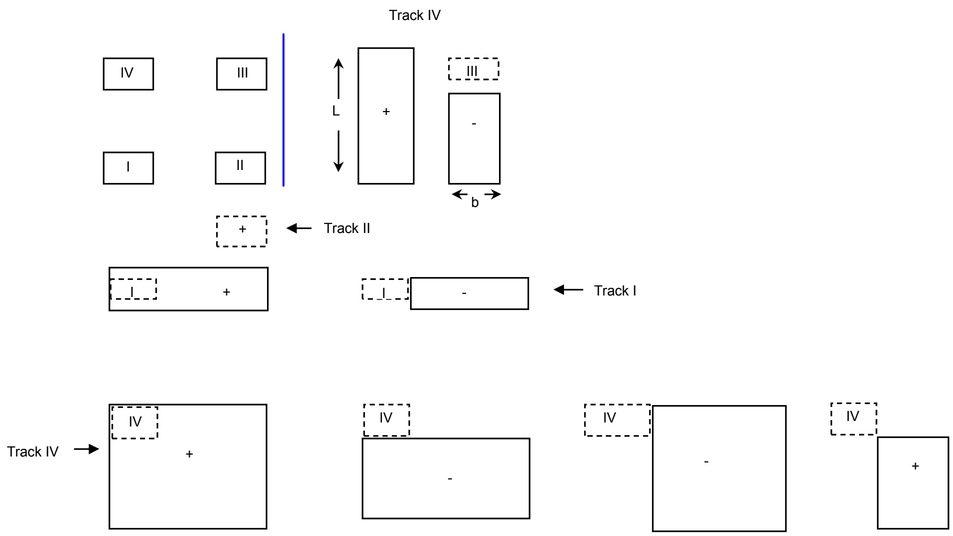
Load on Pipe

Alternative 3: Track Perpendicular to Pipe




| | b | L | z | m = b/z | n = L/z | I* | I** | I | |
|---|---|---|---|---|---|---|---|---|---|
| Track I | 16.1 | 8.2 | 67 | 0.2 | 0.1 | 0.013 | 0.254 | 0.01323 | (ADD) |
| | 12.9 | 8.2 | 67 | 0.2 | 0.1 | 0.011 | 0.253 | 0.01075 | (SUBTRACT) |
| Track II | 3.2 | 8.2 | 67 | 0.0 | 0.1 | 0.003 | 0.251 | 0.00277 | (ADD) |
| Track III | 3.2 | 12.5 | 67 | 0.0 | 0.2 | 0.004 | 0.251 | 0.00414 | (ADD) |
| | 3.2 | 4.3 | 67 | 0.0 | 0.1 | 0.001 | 0.250 | 0.00145 | (SUBTRACT) |
| Track IV | 16.1 | 12.5 | 67 | 0.2 | 0.2 | 0.020 | 0.256 | 0.01980 | (ADD) |
| | 16.1 | 4.3 | 67 | 0.2 | 0.1 | 0.007 | 0.252 | 0.00695 | (SUBTRACT) |
| | 12.9 | 12.5 | 67 | 0.2 | 0.2 | 0.016 | 0.255 | 0.01610 | (SUBTRACT) |
| | 12.9 | 4.3 | 67 | 0.2 | 0.1 | 0.006 | 0.252 | 0.00565 | (ADD) |

Live $Load_3$ = $q_r(\Sigma I) + q_{fr}(\Sigma II) + q_{fr}(\Sigma III) + q_r(\Sigma IV)$

Live $Load_3$ = 16.57 psf

LARGEST EQUIPEMENT LOAD = 16.99 $lb/ft^2$

VERTICAL OVERBURDEN LOAD = 2820.98 $lb/ft^2$

VERTICAL EQUIPMENT LOAD = 16.99 $lb/ft^2$

TOTAL VERTICAL LOAD APPLIED TO PIPE, $P_T$ = 2837.98 $lb/ft^2$ = 19.71 $lb/in^2$

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Verify that perforations in the LCRS are adequate for the peak leachate flow.

Use discharge equation:

$Q = (Cd)(Ao)(2gh)^{0.5}$

$C_d$ = coeffiecient of discharge = 0.6 for short tube discharge with fluid/wall separation; conservative value.

$A_o$ = Area of orifice ($\pi D^2/4$)

g = gravitational acceleration (32.3 $ft^2/s$)

h = static head (ft)

Assumptions and Givens:

| | | | |
|---|---|---|---|
| 1. No. acres of landfill expansion = | 4.55 | acres | North and center portion of landfill bottom |
| 2. Total length of pipe per expansion = | 138.8 | ft | |
| 3. Total number of laterals = | 1.0 | | |
| 4. Length of pipe per lateral = | 138.8 | ft | |
| 5. Perforation diameter = | 0.375 | inch | |
| 6. No. perforations/ft pipe = | 6.0 | perforations/ft of pipe length | |
| 7. Maximum head over pipe = | 1.0 | ft | |
| 8. Per HELP model summary table, $Q_{peak}$ = | 0.88 | gal/min | refer to HELP Model Summary Table |
| 9. Per HELP model summary table, $Q_{peak}$ = | 169.4 | cf/day | refer to HELP Model Summary Table |
| 10. Maximum flow/lateral = | 169.4 | cf/day/lateral | |
| 11. Maximum leachate flow/ft of pipe = | 1.22 | cf/day/ft of pipe | |

Solution:

$A_o = 0.25(\Pi)(d)^2 =$ 0.00077 $ft^2$

1. Flow per orifice, $Q = (Cd)(Ao)(2gh)^{0.5}$ = 0.0037 $ft^3/s$

2. Flow per ft of pipe = (Q)(# perfs/ft) = 0.02 $ft^3/s$ per ft of pipe

= 1914.47 cf/day/ft of pipe

Conclusion:

Design capacity exceeds estimated generation

1914.47 cf/day/ft of pipe >>> 1.22 cf/day/ft of pipe

Perforations are adequate to handle the maximum leachate flow.

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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
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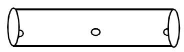
Effective pressure on pipe due to perforations:

$P_{EFF} = \dfrac{P_T \times 12}{(12 - L_P)}$ Source 3, EPA SW-870, p. 382

$L_P$ = Total accumulated length of perforations in one foot of pipe.

Since each perforation is 0.375 inch diameter and spaced at 6.0 inch on center,

$L_P$ = 1.5 inch



$P_T$ = 19.7 psi

$P_{EFF}$ = 22.5 psi

$P_{EFF}$ = 3243.4 psf

Check actual compressive pressure ($S_A$) per Driscopipe manual:

$S_A$ = 0.5 x (SDR - 1) x P(eff) = 112.6 psi

The recommended, long-term compressive strength ($Y_s$) design value for Driscoplex polyethylene pipe is 800 lb/in$^2$.

Source No. 1

| $S_A$ (psi): | | $Y_s$ (psi): |
|---|---|---|
| 112.6 | < | 800.0 |

Pipe passes wall compressive stress perforation calculations TRUE

FS = 7.1

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| **8" Diameter Leachate Detection Header** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **60 Feet Waste** | | |

Constrained pipe wall buckling (for Driscoplex OD controlled pipe)

$P_{WC} = \dfrac{5.65 * \{RB'E' \; E*[12(DR-1)^3]^{-1}\}^{0.5}}{N}$ Source 1, Equation 7-5

$P_{WC}$ = allowable constrained buckling pressure (lb/in$^2$)

| | | |
|---|---|---|
| R = buoyancy reduction factor = 1 - 0.33 * (H'/H) | Source 1, Equation 7-34 | |
| H' = groundwater height above pipe (ft) | 0.0 | ft |
| H = cover above pipe (ft) | 67.0 | ft |
| B' = elastic support factor =( 1+ 4*$e^{-0.065H}$ )$^{-1}$ | Source 1, Equation 7-35 | |
| E' = soil reaction modulus (lb/in$^2$) | 3000.0 | lb/in$^2$ for mod comp/crushed rock, 'Source 1, Table 7-7 |
| E = elastic modulus (lb/in$^2$) | 100000.0 | lb/in$^2$ for long term load at 100$^o$F, 'Source 1, Table 5-1 |
| I = moment of inertia = $t^3$ / 12 | 0.0 | in$^4$/in |
| $D_o$ = pipe outer diameter (in) | 8.625 | SDR 11 pipe (Driscopipe) to be used |
| t = pipe wall thickness (in) | 0.784 | SDR 11 pipe (Driscopipe) to be used |
| DR = pipe dimension ratio = $D_o$ / t | 11.0 | SDR 11 pipe (Driscopipe) to be used |
| $D_I$ = pipe inner diameter = $D_o$ - 2t (in) | 7.1 | SDR 11 pipe (Driscopipe) to be used |
| N = safety factor | 2.0 | |

| Cover (ft) | (ft) | (ft) | B' | R | (lb/in$^2$) |
|---|---|---|---|---|---|
| 67.0 | 67 | 0 | 0.95 | 1.00 | 435.54 |

$P_{WC}$ = 435.54 lb/in$^2$
$P_{EFF}$ = 22.52 lb/in$^2$

Pipe passes contrained wall buckling calculations TRUE FS = 19.3

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| Operation w/ CAT 826G Series II Compactor **60 Feet Waste** | | |

Constrained Pipe Wall Compressive Stress (for Driscoplex OD controlled pipe)

$$S = \frac{P_T D_o}{288t}$$ Source No. 1

S = pipe wall compressive stress ($lb/in^2$)

| | | |
|---|---|---|
| $P_T$ = vertical load applied to pipe w/ perfs ($lb/ft^2$) | 3243.4 | $lb/ft^2$ |
| $D_o$ = pipe outside diameter (in) | 8.63 | SDR 11 pipe (Driscopipe) to be used |
| t = pipe wall thickness (in) | 0.784 | SDR 11 pipe (Driscopipe) to be used |

$$S = \frac{P_T D_o}{288t} = 123.9 \ lb/in^2$$

The recommended, long-term compressive strength ($Y_s$) design value for Driscoplex polyethylene pipe is 800 $lb/in^2$.

Source No. 1

| S (psi): | | $Y_s$ (psi): |
|---|---|---|
| 123.9 | < | 800.0 |

Pipe passes wall compressive stress calculations: TRUE

FS = 6.5

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Iowa Formula

$\Delta X = \dfrac{D_L K W_c r^3}{EI + 0.06er^4}$ Source 2, Equation 3.4 Buried Pipe Design, A.P. Moser, Chapter 3

$\Delta X$ = horizontal deflection (in)

$D_L$ = deflection lag factor

K = bedding constant 0.1 typical value Source 2, Buried Pipe Design, A.P. Moser, Chapter 3

$W_c$ = Marston's load per unit length of pipe (lb/in)

r = mean radius of the pipe (in)

E = modulus of elasticity ($lb/in^2$)

I = moment of inertia of the pipe wall per unit length ($in^3$)

e = modulus of passive resistance fo the side fill ($lb/in^2(in)$)

Modified Iowa Formula

$\Delta X = \dfrac{D_L K W_c r_m^3}{EI + 0.06E'r_m^3}$ Source 2, Equation 3.5 Buried Pipe Design, A.P. Moser, Chapter 3

$\Delta X$ = horizontal deflection (in)

| | | | |
|---|---|---|---|
| $D_L$ = deflection lag factor | | 1.0 | Prism Load used |
| Typical Value for Marston Load | 1.5 | | |
| Typical Value for Prism Load | 1.0 | | |
| K = bedding constant | | 0.1 | typical value Buried Pipe Design, A.P. Moser, Chapter 3 |
| $P_T$ = Vertical load on pipe w/ perfs | | 22.52 | $lb/in^2$ 3243 $lb/ft^2$ |
| $W_c$ = Marston's load per unit length of pipe = $P_T$ * $D_o$ (lb/in) | | 194.27 | lb/in |
| $D_o$ = pipe outer diameter (in) | | 8.63 | SDR 11 pipe (Driscopipe) to be used |
| t = pipe wall thickness (in) | | 0.78 | SDR 11 pipe (Driscopipe) to be used |
| $D_I$ = pipe inner diameter = $D_o$-2t (in) | | 7.06 | SDR 11 pipe (Driscopipe) to be used |
| $D_m$ = pipe mean diameter = $D_o$ - 1.06t Source 1, Equation 7-27 | | 7.79 | SDR 11 pipe (Driscopipe) to be used |
| $r_m$ = mean radius of the pipe (in) | | 3.90 | SDR 11 pipe (Driscopipe) to be used |
| E = modulus of elasticity ($lb/in^2$) | | 100,000.0 | lb/in2 for long term load at 100oF, 'Source 1, Table 5-1 |
| I = moment of inertia of the pipe wall per unit length | | 0.040 | $in^4/in$ |
| E' = modulus of soil reaction | | 3,000.0 | $lb/in^2$ for moderate compaction and fine grained soils |

$\Delta X = \dfrac{D_L K W_c r_m^3}{EI + 0.06E'r_m^3}$ = 0.078 inch Source 2, Equation 3.5 Buried Pipe Design, A.P. Moser, Chapter 3

% Ring Deflection = ($\Delta X/D_m$) x 100 = 1.01% Source 1, Equation 7-31

Ring Bending Strain

$e = \dfrac{f_D \Delta X 2C}{D_M^2} \times 100$ Source 1, Equation 7-39

e = wall strain (%)

| | | |
|---|---|---|
| $f_D$ = deformation shape factor | 6 | Source 1, non-elliptical shape |
| $D_M$ = mean diameter (in) | | |
| C = outer fiber wall centroid = 0.5 (1.06t) | 0.416 | Source 1, Equation 7-41 |
| $\Delta X$ = ring deflection = $D_X/D_m$ | 0.010 | |

$e = f_D \dfrac{\Delta X}{D_M} \dfrac{2C}{D_M} \times 100$ = 0.6% Source 1, Equation 7-39

The maximum ring bending strain for high performance polyethylene non-pressure pipe is = 5.0%

Pipe passes ring bending strain calculations TRUE

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SOURCES

1.) Attachment - 1 - Chevron Phillips Chemical Company, Bulletin - Book 2 Chapter 5, 2003

2.) Attachment - 2 - Buried Pipe Design, A.P. Moser, Chapter 3

3.) Attachment - 3 - EPA, Lining of Waste Impoundment and Disposal Facilities, SW-870

4.) Attachment - 4 - Driscoplex Pipe Properties

5.) Attachment - 5 - CAT 826G Series II Compactor Data Sheet

6.) Attachment - 6 - CAT D7R Series II Equipment Data Sheet

7.) Attachment - 7 - CAT D6R XW Series II Equipment Data Sheet

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Load on Pipe (Overburden)

Prism Loads, $P_E$ = wH

w = unit weight

H = depth

| | Depth (ft) | Unit Weight ($lb/ft^3$) | $P_E$ ($lb/ft^2$) |
|---|---|---|---|
| Final cover | 0.0 | 115.0 | 0.0 |
| Intermediate cover | 0.0 | 115.0 | 0.0 |
| Waste/cover | 0.0 | 60.0 | 0.0 |
| Drainage sand | 0.0 | 115.0 | 0.0 |
| Rock (No. 89 & No. 57) | 1.0 | 140.0 | 140.0 |

TOTAL SOIL PRISM LOAD $P_E$: 140.0 $lb/ft^2$

Total Depth = 1.0 ft

Soil Arching, $P_m = C_D wB$

NOTE: The waste unit weight represents the combined unit weight of waste, daily cover, and moisture.

Pm = vertical soil pressure

B = trench width at pipe crown 6.0 ft

$C_D$ = load coefficient $= \frac{1 - e^{-2Ku'H/B}}{2Ku'}$ Equation 7-3, Source No. 1

e = natural log base number

K = Rankine earth pressure coefficient = $\tan^2(45-0.5*\phi)$

$\phi$ = internal soil friction angle = 27.0 degrees

u' = friction coefficient between backfill and trench sides = tan $\phi$

| Soil Type | Ku' |
|---|---|
| Saturated Clay | 0.110 |
| Ordinary Clay | 0.130 |
| Saturated Top Soil | 0.150 |
| Sand and Gravel | 0.165 |
| Clean Granular Soil | 0.192 |

| | Ku' | $C_D$ | $P_m$ ($lb/ft^2$) |
|---|---|---|---|
| Cover Soil | 0.150 | 0.00 | 0 |
| Int Cover | 0.165 | 0.00 | 0 |
| Waste | 0.191 | 0.00 | 0 |
| Drainage Sand | 0.165 | 0.00 | 0.0 |
| Granular Soil | 0.192 | 0.16 | 135.6 |

TOTAL SOIL ARCHING LOAD $P_M$: 135.6 $lb/ft^2$

MODIFIED ARCHING LOAD = $0.6P_M+0.4P_E$: 137.37 $lb/ft^2$

OVERBURDEN LOAD: 137.37 $lb/ft^2$

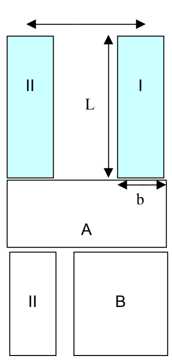
Load on Pipe With Equipment Refer to Attachment

Construction w/ CAT D6R XW Series II

| | | | | | |
|---|---|---|---|---|---|
| Equipment Weight = | 43,888.0 | psf | Length of Track = L = | 111.0 | in |
| Number of Tracks = | 2.0 | | Track Width = b = | 30.0 | in |
| Track Load = $q_r$ = | 21,944.0 | psf | Track Gauge = G = | 80.0 | in |
| Ground contact area/track = | 23.1 | psf | Equipment Width "A" = | 116.0 | in |

Live Load = q*Ic q = track load 948.93 psf

Ic = Influence coefficient




| | b (ft) | L (ft) | z (ft) | m = b/z | n = L/z | I* | I** | I |
|---|---|---|---|---|---|---|---|---|
| I | 2.50 | 9.3 | 1.0 | 2.50 | 9.25 | -0.006 | 0.244 | 0.24428 |
| A | 9.17 | 9.3 | 1.0 | 9.17 | 9.25 | 0.000 | 0.250 | 0.24976 |
| B | 6.67 | 9.3 | 1.0 | 6.67 | 9.25 | 0.000 | 0.250 | 0.24957 |

Live $\text{Load}_1$ = I + II = $q_I(I_I) + q_A(I_A) - q_B(I_B)$ = 231.99 $lb/ft^2$

$q_I(I_I)$ = 231.81

$q_A(I_A)$ = 237.01

$q_B(I_B)$ = 236.82

Load on Pipe (Equipment) = 231.99 $lb/ft^2$

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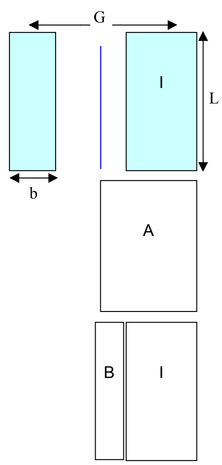
Load on Pipe (Equipment) *Continued*

Live Load = $q*I_c$

$q$ = track load 948.93 $lb/ft^2$

$I_c$ = Influence coefficient

Alternative 2: Track stradling and parallel to pipe



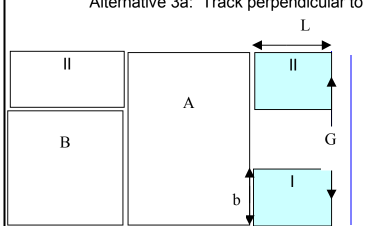

| | b | L | z | m = b/z | n = L/z | I* | I** | I |
|---|---|---|---|---|---|---|---|---|
| A | 4.83 | 9.3 | 1 | 4.83 | 9.25 | -0.001 | 0.249 | 0.24904 |
| B | 2.33 | 9.3 | 1 | 2.33 | 9.25 | -0.007 | 0.243 | 0.24315 |

Live $Load_2$ = 2 * (A - B) = 2 * ($q_A I_A$ - $q_B I_B$) = 11.18 $lb/ft^2$

| | |
|---|---|
| $q_A(I_A)$ = | 236.32 |
| $q_B(I_B)$ = | 230.73 |

Load on Pipe (Equipment) = 11.18 $lb/ft^2$

Alternative 3a: Track perpendicular to pipe




| | b | L | z | m = b/z | n = L/z | I* | I** | I |
|---|---|---|---|---|---|---|---|---|
| I | 2.50 | 9.3 | 1 | 2.50 | 9.25 | -0.006 | 0.244 | 0.24428 |
| A | 9.67 | 9.3 | 1 | 9.67 | 9.25 | 0.000 | 0.250 | 0.24978 |
| B | 7.17 | 9.3 | 1 | 7.17 | 9.25 | 0.000 | 0.250 | 0.24963 |

Live $Load_3$ = I + II = $q_I(I_I)$ + $q_A(I_A)$ - $q_B(I_B)$ = 231.95 $lb/ft^2$

| | |
|---|---|
| $q_I(I_I)$ = | 231.81 |
| $q_A(I_A)$ = | 237.02 |
| $q_B(I_B)$ = | 236.88 |

Load on Pipe (Equipment) = 231.95 $lb/ft^2$

LARGEST EQUIPEMENT LOAD = 231.99 $lb/ft^2$

VERTICAL OVERBURDEN LOAD = 137.37 $lb/ft^2$

VERTICAL EQUIPMENT LOAD = 231.99 $lb/ft^2$

TOTAL VERTICAL LOAD APPLIED TO PIPE, $P_T$ = 369.36 $lb/ft^2$ = 2.57 $lb/in^2$

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| **8" Diameter Leachate Detection Header Construction** w/ CAT D6R XW Series II | CHECKED | DATE |

Verify that perforations in the LCRS are adequate for the peak leachate flow.

Use discharge equation:

$Q = (Cd)(Ao)(2gh)^{0.5}$

$C_d$ = coeffiecient of discharge = 0.6 for short tube discharge with fluid/wall separation; conservative value.

$A_o$ = Area of orifice ($\pi D^2/4$)

g = gravitational acceleration (32.3 $ft^2/s$)

h = static head (ft)

Assumptions and Givens:

| | | | |
|---|---|---|---|
| 1. No. acres of landfill expansion = | 4.55 | acres | North and center portion of landfill bottom |
| 2. Total length of pipe per expansion = | 138.8 | ft | |
| 3. Total number of laterals = | 1.0 | | |
| 4. Length of pipe per lateral = | 138.8 | ft | |
| 5. Perforation diameter = | 0.375 | inch | |
| 6. No. perforations/ft pipe = | 6.0 | perforations/ft of pipe length | |
| 7. Maximum head over pipe = | 1.0 | ft | |
| 8. Per HELP model summary table, $Q_{peak}$ = | 0.88 | gal/min | refer to HELP Model Summary Table |
| 9. Per HELP model summary table, $Q_{peak}$ = | 169.4 | cf/day | refer to HELP Model Summary Table |
| 10. Maximum flow/lateral = | 169.4 | cf/day/lateral | |
| 11. Maximum leachate flow/ft of pipe = | 1.22 | cf/day/ft of pipe | |

Solution:

$A_o = 0.25(\Pi)(d)^2 =$ 0.00077 $ft^2$

1. Flow per orifice, $Q = (Cd)(Ao)(2gh)^{0.5}$ = 0.0037 $ft^3/s$

2. Flow per ft of pipe = (Q)(# perfs/ft) = 0.02 $ft^3/s$ per ft of pipe

= 1914.47 cf/day/ft of pipe

Conclusion:

Design capacity exceeds estimated generation

1914.47 cf/day/ft of pipe >>> 1.22 cf/day/ft of pipe

Perforations are adequate to handle the maximum leachate flow.

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| **8" Diameter Leachate Detection Header Construction** w/ CAT D6R XW Series II | CHECKED | DATE |

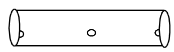
Effective pressure on pipe due to perforations:

$P_{EFF} = \frac{P_T \times 12}{(12-L_P)}$ Source 3, EPA SW-870, p. 382

$L_P$ = Total accumulated length of perforations in one foot of pipe.

Since each perforation is 0.375 inch diameter and spaced at 6.0 inch on center,

$L_P$ = 1.5 inch



$P_T$ = 2.6 psi

$P_{EFF}$ = 2.9 psi

$P_{EFF}$ = 422.1 psf

Check actual compressive pressure ($S_A$) per Driscopipe manual:

$S_A$ = 0.5 x (SDR - 1) x P(eff) = 14.7 psi

The recommended, long-term compressive strength ($Y_s$) design value for Driscoplex polyethylene pipe is 800 lb/in$^2$.

Source No. 1

| $S_A$ (psi): | | $Y_s$ (psi): |
|---|---|---|
| 14.7 | < | 800.0 |

Pipe passes wall compressive stress perforation calculations TRUE

FS = 54.6

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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Detection Header Construction** w/ CAT D6R XW Series II | CHECKED | DATE |

Constrained pipe wall buckling (for Driscoplex OD controlled pipe)

$P_{WC} = \frac{5.65 * \{RB'E' E*[12(DR-1)^3]^{-1}\}^{0.5}}{N}$ Source 1, Equation 7-5

$P_{WC}$ = allowable constrained buckling pressure (lb/in$^2$)

R = buoyancy reduction factor = 1 - 0.33 * (H'/H) Source 1, Equation 7-34

| | | |
|---|---|---|
| H' = groundwater height above pipe (ft) | 0.0 | ft |
| H = cover above pipe (ft) | 1.0 | ft |
| B' = elastic support factor =( 1+ 4*e$^{-0.065H}$ )$^{-1}$ | | Source 1, Equation 7-35 |
| E' = soil reaction modulus (lb/in$^2$) | 3000.0 | lb/in$^2$ for mod comp/crushed rock, 'Source 1, Table 7-7 |
| E = elastic modulus (lb/in$^2$) | 100000.0 | lb/in$^2$ for long term load at 100$^o$F, 'Source 1, Table 5-1 |
| I = moment of inertia = t$^3$ / 12 | 0.0 | in$^4$/in |
| $D_o$ = pipe outer diameter (in) | 8.625 | SDR 11 pipe (Driscopipe) to be used |
| t = pipe wall thickness (in) | 0.784 | SDR 11 pipe (Driscopipe) to be used |
| DR = pipe dimension ratio = $D_o$ / t | 11.0 | SDR 11 pipe (Driscopipe) to be used |
| $D_I$ = pipe inner diameter = $D_o$ - 2t (in) | 7.1 | SDR 11 pipe (Driscopipe) to be used |
| N = safety factor | 2.0 | |

| Cover (ft) | (ft) | (ft) | B' | R | (lb/in$^2$) |
|---|---|---|---|---|---|
| 1.0 | 1 | 0 | 0.21 | 1.00 | 204.95 |

$P_{WC}$ = 204.95 lb/in$^2$

$P_{EFF}$ = 2.93 lb/in$^2$

Pipe passes contrained wall buckling calculations TRUE     FS = 69.9

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Constrained Pipe Wall Compressive Stress (for Driscoplex OD controlled pipe)

$$S = \frac{P_T D_o}{288t}$$ Source No. 1

S = pipe wall compressive stress ($lb/in^2$)

| | | |
|---|---|---|
| $P_T$ = vertical load applied to pipe w/ perfs ($lb/ft^2$) | 422.1 | $lb/ft^2$ |
| $D_o$ = pipe outside diameter (in) | 8.63 | SDR 11 pipe (Driscopipe) to be used |
| t = pipe wall thickness (in) | 0.784 | SDR 11 pipe (Driscopipe) to be used |

$$S = \frac{P_T D_o}{288t} = 16.1 \ lb/in^2$$

The recommended, long-term compressive strength ($Y_s$) design value for Driscoplex polyethylene pipe is 800 $lb/in^2$.

Source No. 1

| S (psi): | | $Y_s$ (psi): |
|---|---|---|
| 16.1 | < | 800.0 |

Pipe passes wall compressive stress calculations TRUE

FS = 49.6

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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Detection Header Construction** w/ CAT D6R XW Series II | CHECKED | DATE |

Iowa Formula

$\Delta X = \frac{D_L K W_c r^3}{EI + 0.06er^4}$ Source 2, Equation 3.4 Buried Pipe Design, A.P. Moser, Chapter 3

$\Delta X$ = horizontal deflection (in)

$D_L$ = deflection lag factor

K = bedding constant | 0.1 | typical value Source 2, Buried Pipe Design, A.P. Moser, Chapter 3

$W_c$ = Marston's load per unit length of pipe (lb/in)

r = mean radius of the pipe (in)

E = modulus of elasticity (lb/in$^2$)

I = moment of inertia of the pipe wall per unit length (in$^3$)

e = modulus of passive resistance fo the side fill (lb/in$^2$(in))

Modified Iowa Formula

$\Delta X = \frac{D_L K W_c r_m^3}{EI + 0.06E'r_m^3}$ Source 2, Equation 3.5 Buried Pipe Design, A.P. Moser, Chapter 3

$\Delta X$ = horizontal deflection (in)

| | | | |
|---|---|---|---|
| $D_L$ = deflection lag factor | | 1.0 | Prism Load used |
| Typical Value for Marston Load | 1.5 | | |
| Typical Value for Prism Load | 1.0 | | |
| K = bedding constant | | 0.1 | typical value Buried Pipe Design, A.P. Moser, Chapter 3 |
| $P_T$ = Vertical load on pipe w/ perfs | | 2.93 | lb/in$^2$ 422 lb/ft$^2$ |
| $W_c$ = Marston's load per unit length of pipe = $P_T$ * $D_o$ (lb/in) | | 25.28 | lb/in |
| $D_o$ = pipe outer diameter (in) | | 8.63 | SDR 11 pipe (Driscopipe) to be used |
| t = pipe wall thickness (in) | | 0.78 | SDR 11 pipe (Driscopipe) to be used |
| $D_I$ = pipe inner diameter = $D_o$-2t (in) | | 7.06 | SDR 11 pipe (Driscopipe) to be used |
| $D_m$ = pipe mean diameter = $D_o$ - 1.06t Source 1, Equation 7-27 | | 7.79 | SDR 11 pipe (Driscopipe) to be used |
| $r_m$ = mean radius of the pipe (in) | | 3.90 | SDR 11 pipe (Driscopipe) to be used |
| E = modulus of elasticity (lb/in$^2$) | | 100,000.0 | lb/in2 for long term load at 100oF, 'Source 1, Table 5-1 |
| I = moment of inertia of the pipe wall per unit length | | 0.040 | in$^4$/in |
| E' = modulus of soil reaction | | 3,000.0 | lb/in$^2$ for moderate compaction and fine grained soils |

$\Delta X = \frac{D_L K W_c r_m^3}{EI + 0.06E'r_m^3}$ = 0.010 inch Source 2, Equation 3.5 Buried Pipe Design, A.P. Moser, Chapter 3

% Ring Deflection = ($\Delta X/D_m$) x 100 = 0.13% Source 1, Equation 7-31

Ring Bending Strain

$e = \frac{f_D \Delta X 2C}{D_M^2} \times 100$ Source 1, Equation 7-39

e = wall strain (%)

| | | |
|---|---|---|
| $f_D$ = deformation shape factor | 6 | Source 1, non-elliptical shape |
| $D_M$ = mean diameter (in) | | |
| C = outer fiber wall centroid = 0.5 (1.06t) | 0.416 | Source 1, Equation 7-41 |
| $\Delta X$ = ring deflection = $D_X/D_m$ | 0.001 | |

$e = f_D \frac{(\Delta X)}{D_M} \frac{(2C)}{D_M} \times 100$ = 0.1% Source 1, Equation 7-39

The maximum ring bending strain for high performance polyethylene non-pressure pipe is = 5.0%

Pipe passes ring bending strain calculations TRUE

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| **8" Diameter Leachate Detection Header Construction** w/ CAT D6R XW Series II | CHECKED | DATE |

SOURCES

1.) Attachment - 1 - Chevron Phillips Chemical Company, Bulletin - Book 2 Chapter 5, 2003

2.) Attachment - 2 - Buried Pipe Design, A.P. Moser, Chapter 3

3.) Attachment - 3 - EPA, Lining of Waste Impoundment and Disposal Facilities, SW-870

4.) Attachment - 4 - Driscoplex Pipe Properties

5.) Attachment - 5 - CAT 826G Series II Compactor Data Sheet

6.) Attachment - 6 - CAT D7R Series II Equipment Data Sheet

7.) Attachment - 7 - CAT D6R XW Series II Equipment Data Sheet

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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Detection Header** | CHECKED | DATE |
| Operation w/ CAT D7R Series II **0 Feet Waste** | | |

Load on Pipe (Overburden)

Prism Loads, $P_E = wH$

w = unit weight

H = depth

| | Depth (ft) | Unit Weight (lb/ft$^3$) | $P_E$ (lb/ft$^2$) |
|---|---|---|---|
| Final cover | 0.0 | 115.0 | 0.0 |
| Intermediate cover | 0.0 | 115.0 | 0.0 |
| Waste/cover | 0.0 | 60.0 | 0.0 |
| Drainage sand | 2.0 | 115.0 | 230.0 |
| Rock (No. 89 & No. 57) | 2.0 | 140.0 | 280.0 |

TOTAL SOIL PRISM LOAD $P_E$: 510.0 lb/ft$^2$

Total Depth = 4.0 ft

Soil Arching, $P_m = C_D wB$

NOTE: The waste unit weight represents the combined unit weight of waste, daily cover, and moisture.

Pm = vertical soil pressure

B = trench width at pipe crown 6.0 ft

$C_D$ = load coefficient $= \frac{1 - e^{-2Ku'H/B}}{2Ku'}$ Equation 7-3, Source No. 1

e = natural log base number

K = Rankine earth pressure coefficient = $\tan^2(45-0.5*\phi)$

$\phi$ = internal soil friction angle = 27.0 degrees

u' = friction coefficient between backfill and trench sides = tan $\phi$

| Soil Type | Ku' |
|---|---|
| Saturated Clay | 0.110 |
| Ordinary Clay | 0.130 |
| Saturated Top Soil | 0.150 |
| Sand and Gravel | 0.165 |
| Clean Granular Soil | 0.192 |

| | Ku' | $C_D$ | $P_m$ (lb/ft$^2$) |
|---|---|---|---|
| Cover Soil | 0.150 | 0.00 | 0 |
| Int Cover | 0.165 | 0.00 | 0 |
| Waste | 0.191 | 0.00 | 0 |
| Drainage Sand | 0.165 | 0.32 | 217.8 |
| Granular Soil | 0.192 | 0.31 | 262.8 |

TOTAL SOIL ARCHING LOAD $P_M$: 480.6 lb/ft$^2$

MODIFIED ARCHING LOAD = $0.6P_M+0.4P_E$: 492.37 lb/ft$^2$

OVERBURDEN LOAD: 492.37 lb/ft$^2$

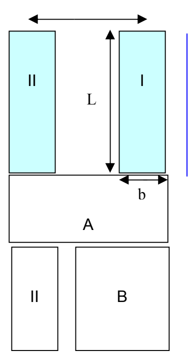
Load on Pipe With Equipment Refer to Attachment

Operation w/ CAT D7R Series II 0 Feet Waste

| | | | | | |
|---|---|---|---|---|---|
| Equipment Weight = | 54,573.0 | psf | Length of Track = L = | 113.0 | in |
| Number of Tracks = | 2.0 | | Track Width = b = | 22.0 | in |
| Track Load = $q_r$ = | 27,286.5 | psf | Track Gauge = G = | 78.0 | in |
| Ground contact area/track = | 17.3 | psf | Equipment Width "A" = | 113.0 | in |

Live Load = q*Ic q = track load 1,580.55 psf

Ic = Influence coefficient




| | b (ft) | L (ft) | z (ft) | m = b/z | n = L/z | I* | I** | I |
|---|---|---|---|---|---|---|---|---|
| I | 1.83 | 9.4 | 4.0 | 0.46 | 2.35 | 0.127 | 0.252 | 0.12736 |
| A | 8.33 | 9.4 | 4.0 | 2.08 | 2.35 | -0.014 | 0.236 | 0.23624 |
| B | 6.50 | 9.4 | 4.0 | 1.63 | 2.35 | -0.021 | 0.229 | 0.22928 |

Live Load$_1$ = I + II = $q_I(I_I) + q_A(I_A) - q_B(I_B)$ = 212.30 lb/ft$^2$

$q_I(I_I)$ = 201.29

$q_A(I_A)$ = 373.39

$q_B(I_B)$ = 362.39

Load on Pipe (Equipment) = 212.30 lb/ft$^2$

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| Operation w/ CAT D7R Series II **0 Feet Waste** | | |

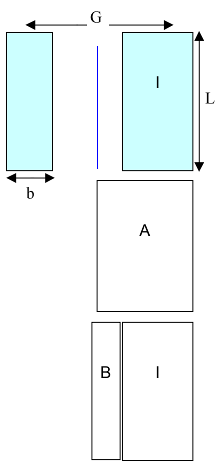
Load on Pipe (Equipment) *Continued*

Live Load = $q*I_c$

$q$ = track load 1580.55 $lb/ft^2$

$I_c$ = Influence coefficient

Alternative 2: Track stradling and parallel to pipe



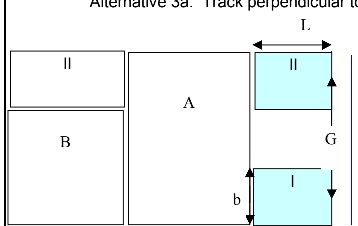

| | b | L | z | m = b/z | n = L/z | I* | I** | I |
|---|---|---|---|---|---|---|---|---|
| A | 4.71 | 9.4 | 4 | 1.18 | 2.35 | 0.213 | 0.216 | 0.21333 |
| B | 2.88 | 9.4 | 4 | 0.72 | 2.35 | 0.173 | 0.242 | 0.17258 |

Live $Load_2$ = 2 * (A - B) = 2 * ($q_A I_A$ - $q_B I_B$) = 128.82 $lb/ft^2$

| | |
|---|---|
| $q_A(I_A)$ = | 337.19 |
| $q_B(I_B)$ = | 272.78 |

Load on Pipe (Equipment) = 128.82 $lb/ft^2$

Alternative 3a: Track perpendicular to pipe




| | b | L | z | m = b/z | n = L/z | I* | I** | I |
|---|---|---|---|---|---|---|---|---|
| I | 1.83 | 9.4 | 4 | 0.46 | 2.35 | 0.127 | 0.252 | 0.12736 |
| A | 9.42 | 9.4 | 4 | 2.35 | 2.35 | -0.012 | 0.238 | 0.23841 |
| B | 7.58 | 9.4 | 4 | 1.90 | 2.35 | -0.016 | 0.234 | 0.23405 |

Live $Load_3$ = I + II = $q_I(I_I)$ + $q_A(I_A)$ - $q_B(I_B)$ = 208.18 $lb/ft^2$

| | |
|---|---|
| $q_I(I_I)$ = | 201.29 |
| $q_A(I_A)$ = | 376.82 |
| $q_B(I_B)$ = | 369.93 |

Load on Pipe (Equipment) = 208.18 $lb/ft^2$

LARGEST EQUIPEMENT LOAD = 212.30 $lb/ft^2$

VERTICAL OVERBURDEN LOAD = 492.37 $lb/ft^2$

VERTICAL EQUIPMENT LOAD = 212.30 $lb/ft^2$

TOTAL VERTICAL LOAD APPLIED TO PIPE, $P_T$ = 704.67 $lb/ft^2$ = 4.89 $lb/in^2$

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| Operation w/ CAT D7R Series II **0 Feet Waste** | | |

Verify that perforations in the LCRS are adequate for the peak leachate flow.

Use discharge equation:

$Q = (Cd)(Ao)(2gh)^{0.5}$

$C_d$ = coeffiecient of discharge = 0.6 for short tube discharge with fluid/wall separation; conservative value.

$A_o$ = Area of orifice ($\pi D^2/4$)

g = gravitational acceleration (32.3 $ft^2/s$)

h = static head (ft)

Assumptions and Givens:

| | | | |
|---|---|---|---|
| 1. No. acres of landfill expansion = | 4.55 | acres | North and center portion of landfill bottom |
| 2. Total length of pipe per expansion = | 138.8 | ft | |
| 3. Number of laterals = | 1.0 | | |
| 4. Total length of pipe per lateral = | 138.8 | ft | |
| 5. Perforation diameter = | 0.375 | inch | |
| 6. No. perforations/ft pipe = | 6.0 | perforations/ft of pipe length | |
| 7. Maximum head over pipe = | 1.0 | ft | |
| 8. Per HELP model summary table, $Q_{peak}$ = | 0.88 | gal/min | refer to HELP Model Summary Table |
| 9. Per HELP model summary table, $Q_{peak}$ = | 169.4 | cf/day | refer to HELP Model Summary Table |
| 10. Maximum flow/lateral = | 169.4 | cf/day/lateral | |
| 11. Maximum leachate flow/ft of pipe = | 1.22 | cf/day/ft of pipe | |

Solution:

$A_o = 0.25(\Pi)(d)^2 =$ 0.00077 $ft^2$

1. Flow per orifice, $Q = (Cd)(Ao)(2gh)^{0.5} =$ 0.0037 $ft^3/s$

2. Flow per ft of pipe = (Q)(# perfs/ft) = 0.02 $ft^3/s$ per ft of pipe

= 1914.47 cf/day/ft of pipe

Conclusion:

Design capacity exceeds estimated generation

1914.47 cf/day/ft of pipe >>> 1.22 cf/day/ft of pipe

Perforations are adequate to handle the maximum leachate flow.

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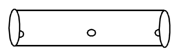
Effective pressure on pipe due to perforations:

$P_{EFF} = \frac{P_T \times 12}{(12-L_P)}$ Source 3, EPA SW-870, p. 382

$L_P$ = Total accumulated length of perforations in one foot of pipe.

Since each perforation is 0.375 inch diameter and spaced at 6.0 inch on center,

$L_P$ = 1.5 inch



$P_T$ = 4.9 psi

$P_{EFF}$ = 5.6 psi

$P_{EFF}$ = 805.3 psf

Check actual compressive pressure ($S_A$) per Driscopipe manual:

$S_A$ = 0.5 x (SDR - 1) x P(eff) = 28.0 psi

The recommended, long-term compressive strength ($Y_s$) design value for Driscoplex polyethylene pipe is 800 lb/in$^2$.

Source No. 1

| $S_A$ (psi): | | $Y_s$ (psi): |
|---|---|---|
| 28.0 | < | 800.0 |

Pipe passes wall compressive stress perforation calculations TRUE

FS = 28.6

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| CLIENT | PROJECT | JOB NO. |
|---|---|---|
| Hardee County | Phase II Section II Expansion | 09199033.23 |

| SUBJECT | BY | DATE |
|---|---|---|
| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Detection Header** | CHECKED | DATE |
| Operation w/ CAT D7R Series II **0 Feet Waste** | | |

Constrained pipe wall buckling (for Driscoplex OD controlled pipe)

$P_{WC} = \frac{5.65 * \{RB'E' E*[12(DR-1)^3]^{-1}\}^{0.5}}{N}$ Source 1, Equation 7-5

$P_{WC}$ = allowable constrained buckling pressure (lb/in$^2$)

| | | | |
|---|---|---|---|
| R = buoyancy reduction factor = 1 - 0.33 * (H'/H) | Source 1, Equation 7-34 | | |
| H' = groundwater height above pipe (ft) | 0.0 | ft | |
| H = cover above pipe (ft) | 4.0 | ft | |
| B' = elastic support factor =( 1+ 4*e$^{-0.065H}$ )$^{-1}$ | Source 1, Equation 7-35 | | |
| E' = soil reaction modulus (lb/in$^2$) | 3000.0 | lb/in$^2$ | for mod comp/crushed rock, 'Source 1, Table 7-7 |
| E = elastic modulus (lb/in$^2$) | 100000.0 | lb/in$^2$ | for long term load at 100$^o$F, 'Source 1, Table 5-1 |
| I = moment of inertia = t$^3$ / 12 | 0.0 | in$^4$/in | |
| $D_o$ = pipe outer diameter (in) | 8.625 | SDR 11 pipe (Driscopipe) to be used | |
| t = pipe wall thickness (in) | 0.784 | SDR 11 pipe (Driscopipe) to be used | |
| DR = pipe dimension ratio = $D_o$ / t | 11.0 | SDR 11 pipe (Driscopipe) to be used | |
| $D_I$ = pipe inner diameter = $D_o$ - 2t (in) | 7.1 | SDR 11 pipe (Driscopipe) to be used | |
| N = safety factor | 2.0 | | |

| Cover (ft) | (ft) | (ft) | B' | R | (lb/in$^2$) |
|---|---|---|---|---|---|
| 0.0 | 4 | 0 | 0.24 | 1.00 | 220.98 |

$P_{WC}$ = 220.98 lb/in$^2$

$P_{EFF}$ = 5.59 lb/in$^2$

Pipe passes contrained wall buckling calculations TRUE FS = 39.5

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| SUBJECT | BY | DATE |
|---|---|---|
| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Detection Header** | CHECKED | DATE |
| Operation w/ CAT D7R Series II **0 Feet Waste** | | |

Constrained Pipe Wall Compressive Stress (for Driscoplex OD controlled pipe)

$S = \frac{P_T D_o}{288t}$ Source No. 1

S = pipe wall compressive stress ($lb/in^2$)

$P_T$ = vertical load applied to pipe w/ perfs ($lb/ft^2$) 805.3 $lb/ft^2$

$D_o$ = pipe outside diameter (in) 8.63 SDR 11 pipe (Driscopipe) to be used

t = pipe wall thickness (in) 0.784 SDR 11 pipe (Driscopipe) to be used

$S = \frac{P_T D_o}{288t} =$ 30.8 $lb/in^2$

The recommended, long-term compressive strength ($Y_s$) design value for Driscoplex polyethylene pipe is 800 $lb/in^2$.

Source No. 1

| S (psi): | | $Y_s$ (psi): |
|---|---|---|
| 30.8 | < | 800.0 |

Pipe passes wall compressive stress calculations TRUE FS = 26.0

SCS ENGINEERS

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| CLIENT | PROJECT | JOB NO. |
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| SUBJECT | BY | DATE |
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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Detection Header** | CHECKED | DATE |
| Operation w/ CAT D7R Series II **0 Feet Waste** | | |

Iowa Formula

$\Delta X = \dfrac{D_L K W_c r^3}{EI + 0.06er^4}$   Source 2, Equation 3.4 Buried Pipe Design, A.P. Moser, Chapter 3

$\Delta X$ = horizontal deflection (in)

$D_L$ = deflection lag factor

K = bedding constant | 0.1 | typical value Source 2, Buried Pipe Design, A.P. Moser, Chapter 3

$W_c$ = Marston's load per unit length of pipe (lb/in)

r = mean radius of the pipe (in)

E = modulus of elasticity (lb/in$^2$)

I = moment of inertia of the pipe wall per unit length (in$^3$)

e = modulus of passive resistance fo the side fill (lb/in$^2$(in))

Modified Iowa Formula

$\Delta X = \dfrac{D_L K W_c r_m^3}{EI + 0.06E'r_m^3}$   Source 2, Equation 3.5 Buried Pipe Design, A.P. Moser, Chapter 3

$\Delta X$ = horizontal deflection (in)

| | | | |
|---|---|---|---|
| $D_L$ = deflection lag factor | | 1.0 | Prism Load used |
| Typical Value for Marston Load | 1.5 | | |
| Typical Value for Prism Load | 1.0 | | |
| K = bedding constant | | 0.1 | typical value Buried Pipe Design, A.P. Moser, Chapter 3 |
| $P_T$ = Vertical load on pipe w/ perfs | | 5.59 | lb/in$^2$ 805 lb/ft$^2$ |
| $W_c$ = Marston's load per unit length of pipe = $P_T$ * $D_o$ (lb/in) | | 48.24 | lb/in |
| $D_o$ = pipe outer diameter (in) | | 8.63 | SDR 11 pipe (Driscopipe) to be used |
| t = pipe wall thickness (in) | | 0.78 | SDR 11 pipe (Driscopipe) to be used |
| $D_I$ = pipe inner diameter = $D_o$-2t (in) | | 7.06 | SDR 11 pipe (Driscopipe) to be used |
| $D_m$ = pipe mean diameter = $D_o$ - 1.06t Source 1, Equation 7-27 | | 7.79 | SDR 11 pipe (Driscopipe) to be used |
| $r_m$ = mean radius of the pipe (in) | | 3.90 | SDR 11 pipe (Driscopipe) to be used |
| E = modulus of elasticity (lb/in$^2$) | | 100,000.0 | lb/in2 for long term load at 100oF, 'Source 1, Table 5-1 |
| I = moment of inertia of the pipe wall per unit length | | 0.040 | in$^4$/in |
| E' = modulus of soil reaction | | 3,000.0 | lb/in$^2$ for moderate compaction and fine grained soils |

$\Delta X = \dfrac{D_L K W_c r_m^3}{EI + 0.06E'r_m^3}$ = 0.019 inch   Source 2, Equation 3.5 Buried Pipe Design, A.P. Moser, Chapter 3

% Ring Deflection = ($\Delta X/D_m$) x 100 = 0.25%   Source 1, Equation 7-31

Ring Bending Strain

$e = \dfrac{f_D \Delta X 2C}{D_M^2} \times 100$   Source 1, Equation 7-39

e = wall strain (%)

$f_D$ = deformation shape factor | 6 | Source 1, non-elliptical shape

$D_M$ = mean diameter (in)

C = outer fiber wall centroid = 0.5 (1.06t) | 0.416 | Source 1, Equation 7-41

$\Delta X$ = ring deflection = $D_X/D_m$ | 0.002

$e = f_D \dfrac{(\Delta X)}{D_M}\dfrac{(2C)}{D_M} \times 100$ = 0.2%   Source 1, Equation 7-39

The maximum ring bending strain for high performance polyethylene non-pressure pipe is = 5.0%

Pipe passes ring bending strain calculations TRUE

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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Detection Header** | CHECKED | DATE |
| Operation w/ CAT D7R Series II **0 Feet Waste** | | |

SOURCES

1.) Attachment - 1 - Chevron Phillips Chemical Company, Bulletin - Book 2 Chapter 5, 2003

2.) Attachment - 2 - Buried Pipe Design, A.P. Moser, Chapter 3

3.) Attachment - 3 - EPA, Lining of Waste Impoundment and Disposal Facilities, SW-870

4.) Attachment - 4 - Driscoplex Pipe Properties

5.) Attachment - 5 - CAT 826G Series II Compactor Data Sheet

6.) Attachment - 6 - CAT D7R Series II Equipment Data Sheet

7.) Attachment - 7 - CAT D6R XW Series II Equipment Data Sheet

SCS ENGINEERS

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| CLIENT | PROJECT | JOB NO. |
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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Detection Header** | CHECKED | DATE |
| Operation w/ CAT D7R Series II **10 Feet Waste** | | |

Load on Pipe (Overburden)

Prism Loads, $P_E = wH$

w = unit weight

H = depth

| | Depth (ft) | Unit Weight (lb/ft$^3$) | $P_E$ (lb/ft$^2$) |
|---|---|---|---|
| Final cover | 0.0 | 115.0 | 0.0 |
| Intermediate cover | 0.0 | 115.0 | 0.0 |
| Waste/cover | 10.0 | 60.0 | 600.0 |
| Drainage sand | 2.0 | 115.0 | 230.0 |
| Rock (No. 89 & No. 57) | 2.0 | 140.0 | 280.0 |

TOTAL SOIL PRISM LOAD $P_E$: 1110.0 lb/ft$^2$

Total Depth = 14.0 ft

Soil Arching, $P_m = C_D wB$

Pm = vertical soil pressure

B = trench width at pipe crown 6.0 ft

$C_D$ = load coefficient $= \frac{1 - e^{-2Ku'H/B}}{2Ku'}$ Equation 7-3, Source No. 1

e = natural log base number

K = Rankine earth pressure coefficient = $\tan^2(45-0.5*\phi)$

$\phi$ = internal soil friction angle = 27.0 degrees

u' = friction coefficient between backfill and trench sides = tan $\phi$

NOTE: The waste unit weight represents the combined unit weight of waste, daily cover, and moisture.

| Soil Type | Ku' |
|---|---|
| Saturated Clay | 0.110 |
| Ordinary Clay | 0.130 |
| Saturated Top Soil | 0.150 |
| Sand and Gravel | 0.165 |
| Clean Granular Soil | 0.192 |

| | Ku' | $C_D$ | $P_m$ (lb/ft$^2$) |
|---|---|---|---|
| Cover Soil | 0.150 | 0.00 | 0 |
| Int Cover | 0.165 | 0.00 | 0 |
| Waste | 0.191 | 1.23 | 444 |
| Drainage Sand | 0.165 | 0.32 | 217.8 |
| Granular Soil | 0.192 | 0.31 | 262.8 |

TOTAL SOIL ARCHING LOAD $P_M$: 924.2 lb/ft$^2$

MODIFIED ARCHING LOAD = $0.6P_M+0.4P_E$: 998.53 lb/ft$^2$

OVERBURDEN LOAD: 998.53 lb/ft$^2$

Load on Pipe With Equipment Refer to Attachment

Operation w/ CAT D7R Series II 10 Feet Waste

Equipment Weight = 54,573.0 psf

Number of Tracks = 2.0

Track Load = $q_r$ = 27,286.5 psf

Ground contact area/track = 17.3 psf

Length of Track = L = 113.0 in

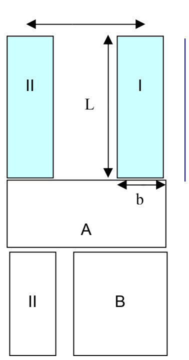
Track Width = b = 22.0 in

Track Gauge = G = 78.0 in

Equipment Width "A" = 113.0 in

Live Load = q*Ic q = track load 1,580.55 psf

Ic = Influence coefficient




| | b (ft) | L (ft) | z (ft) | m = b/z | n = L/z | I* | I** | I |
|---|---|---|---|---|---|---|---|---|
| I | 1.83 | 9.4 | 14.0 | 0.13 | 0.67 | 0.031 | 0.258 | 0.03087 |
| A | 8.33 | 9.4 | 14.0 | 0.60 | 0.67 | 0.114 | 0.272 | 0.11372 |
| B | 6.50 | 9.4 | 14.0 | 0.46 | 0.67 | 0.096 | 0.270 | 0.09592 |

Live Load$_1$ = I + II = $q_I(I_I) + q_A(I_A) - q_B(I_B)$ = 76.94 lb/ft$^2$

$q_I(I_I)$ = 48.80

$q_A(I_A)$ = 179.74

$q_B(I_B)$ = 151.60

Load on Pipe (Equipment) = 76.94 lb/ft$^2$

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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
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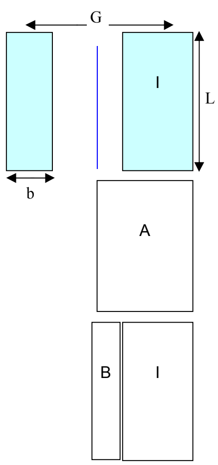
Load on Pipe (Equipment) *Continued*

Live Load = $q*I_c$

$q$ = track load 1580.55 lb/ft$^2$

$I_c$ = Influence coefficient

Alternative 2: Track stradling and parallel to pipe



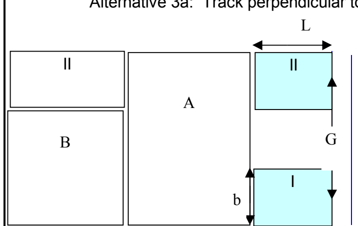

| | b | L | z | m = b/z | n = L/z | I* | I** | I |
|---|---|---|---|---|---|---|---|---|
| A | 4.71 | 9.4 | 14 | 0.34 | 0.67 | 0.074 | 0.267 | 0.07413 |
| B | 2.88 | 9.4 | 14 | 0.21 | 0.67 | 0.048 | 0.262 | 0.04754 |

Live Load$_2$ = 2 * (A - B) = 2 * ($q_A I_A$ - $q_B I_B$) = 84.04 lb/ft$^2$

| | |
|---|---|
| $q_A(I_A)$ = | 117.16 |
| $q_B(I_B)$ = | 75.14 |

Load on Pipe (Equipment) = 84.04 lb/ft$^2$

Alternative 3a: Track perpendicular to pipe




| | b | L | z | m = b/z | n = L/z | I* | I** | I |
|---|---|---|---|---|---|---|---|---|
| I | 1.83 | 9.4 | 14 | 0.13 | 0.67 | 0.031 | 0.258 | 0.03087 |
| A | 9.42 | 9.4 | 14 | 0.67 | 0.67 | 0.122 | 0.271 | 0.12225 |
| B | 7.58 | 9.4 | 14 | 0.54 | 0.67 | 0.107 | 0.271 | 0.10697 |

Live Load$_3$ = I + II = $q_I(I_I)$ + $q_A(I_A)$ - $q_B(I_B)$ = 72.96 lb/ft$^2$

| | |
|---|---|
| $q_I(I_I)$ = | 48.80 |
| $q_A(I_A)$ = | 193.23 |
| $q_B(I_B)$ = | 169.07 |

Load on Pipe (Equipment) = 72.96 lb/ft$^2$

LARGEST EQUIPEMENT LOAD = 84.04 lb/ft$^2$

VERTICAL OVERBURDEN LOAD = 998.53 lb/ft$^2$

VERTICAL EQUIPMENT LOAD = 84.04 lb/ft$^2$

TOTAL VERTICAL LOAD APPLIED TO PIPE, $P_T$ = 1,082.58 lb/ft$^2$ = 7.52 lb/in$^2$

| SCS ENGINEERS | | | |
|---|---|---|---|
| | | SHEET 3 | OF 8 |
| CLIENT<br>Hardee County | PROJECT<br>Phase II Section II Expansion | JOB NO.<br>09199033.23 | |
| SUBJECT<br>Pipe Crushing Calculations **RAI No. 1**<br>**8" Diameter Leachate Detection Header**<br>Operation w/ CAT D7R Series II **10 Feet Waste** | | BY<br>SRF<br>CHECKED | DATE<br>4/1/13<br>DATE |

Verify that perforations in the LCRS are adequate for the peak leachate flow.

Use discharge equation:

$Q = (Cd)(Ao)(2gh)^{0.5}$

$C_d$ = coefficient of discharge = 0.6 for short tube discharge with fluid/wall separation; conservative value.

$A_o$ = Area of orifice ($\pi D^2/4$)

g = gravitational acceleration (32.3 $ft^2/s$)

h = static head (ft)

Assumptions and Givens:

| | | | |
|---|---|---|---|
| 1. No. acres of landfill expansion = | 4.55 | acres | North and center portion of landfill bottom |
| 2. Total length of pipe per expansion = | 138.8 | ft | |
| 3. Number of laterals = | 1.0 | | |
| 4. Total length of pipe per lateral = | 138.8 | ft | |
| 5. Perforation diameter = | 0.375 | inch | |
| 6. No. perforations/ft pipe = | 6.0 | perforations/ft of pipe length | |
| 7. Maximum head over pipe = | 1.0 | ft | |
| 8. Per HELP model summary table, $Q_{peak}$ = | 0.88 | gal/min | refer to HELP Model Summary Table |
| 9. Per HELP model summary table, $Q_{peak}$ = | 169.4 | cf/day | refer to HELP Model Summary Table |
| 10. Maximum flow/lateral = | 169.4 | cf/day/lateral | |
| 11. Maximum leachate flow/ft of pipe = | 1.22 | cf/day/ft of pipe | |

Solution:

$A_o = 0.25(\Pi)(d)^2 =$ 0.00077 $ft^2$

1. Flow per orifice, $Q = (Cd)(Ao)(2gh)^{0.5} =$ 0.0037 $ft^3/s$

2. Flow per ft of pipe = (Q)(# perfs/ft) = 0.02 $ft^3/s$ per ft of pipe

= 1914.47 cf/day/ft of pipe

Conclusion:

Design capacity exceeds estimated generation

1914.47 cf/day/ft of pipe >>> 1.22 cf/day/ft of pipe

Perforations are adequate to handle the maximum leachate flow.

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| Operation w/ CAT D7R Series II **10 Feet Waste** | | |

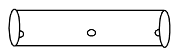
Effective pressure on pipe due to perforations:

$P_{EFF} = \frac{P_T \times 12}{(12-L_P)}$ Source 3, EPA SW-870, p. 382

$L_P$ = Total accumulated length of perforations in one foot of pipe.

Since each perforation is 0.375 inch diameter and spaced at 6.0 inch on center,

$L_P$ = 1.5 inch



$P_T$ = 7.5 psi

$P_{EFF}$ = 8.6 psi

$P_{EFF}$ = 1237.2 psf

Check actual compressive pressure ($S_A$) per Driscopipe manual:

$S_A$ = 0.5 x (SDR - 1) x P(eff) = 43.0 psi

The recommended, long-term compressive strength ($Y_s$) design value for Driscoplex polyethylene pipe is 800 lb/in$^2$.

Source No. 1

| $S_A$ (psi): | | $Y_s$ (psi): |
|---|---|---|
| 43.0 | < | 800.0 |

Pipe passes wall compressive stress perforation calculations TRUE

FS = 18.6

| SCS ENGINEERS | | |
|---|---|---|
| | SHEET 5 | OF 8 |
| CLIENT<br>Hardee County | PROJECT<br>Phase II Section II Expansion | JOB NO.<br>09199033.23 |

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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Detection Header** | CHECKED | DATE |
| Operation w/ CAT D7R Series II **10 Feet Waste** | | |

Constrained pipe wall buckling (for Driscoplex OD controlled pipe)

$P_{WC} = \frac{5.65 * \{RB'E' E*[12(DR-1)^3]^{-1}\}^{0.5}}{N}$ Source 1, Equation 7-5

$P_{WC}$ = allowable constrained buckling pressure ($lb/in^2$)

| | | | |
|---|---|---|---|
| R = buoyancy reduction factor = 1 - 0.33 * (H'/H) | Source 1, Equation 7-34 | | |
| H' = groundwater height above pipe (ft) | 0.0 | ft | |
| H = cover above pipe (ft) | 14.0 | ft | |
| B' = elastic support factor =( $1+ 4*e^{-0.065H}$ $)^{-1}$ | Source 1, Equation 7-35 | | |
| E' = soil reaction modulus ($lb/in^2$) | 3000.0 | $lb/in^2$ | for mod comp/crushed rock, 'Source 1, Table 7-7 |
| E = elastic modulus ($lb/in^2$) | 100000.0 | $lb/in^2$ | for long term load at 100°F, 'Source 1, Table 5-1 |
| I = moment of inertia = $t^3$ / 12 | 0.0 | $in^4/in$ | |
| $D_o$ = pipe outer diameter (in) | 8.625 | SDR 11 pipe (Driscopipe) to be used | |
| t = pipe wall thickness (in) | 0.784 | SDR 11 pipe (Driscopipe) to be used | |
| DR = pipe dimension ratio = $D_o$ / t | 11.0 | SDR 11 pipe (Driscopipe) to be used | |
| $D_I$ = pipe inner diameter = $D_o$ - 2t (in) | 7.1 | SDR 11 pipe (Driscopipe) to be used | |
| N = safety factor | 2.0 | | |

| Cover (ft) | (ft) | (ft) | B' | R | ($lb/in^2$) |
|---|---|---|---|---|---|
| 10.0 | 14 | 0 | 0.38 | 1.00 | 276.42 |

$P_{WC}$ = 276.42 $lb/in^2$

$P_{EFF}$ = 8.59 $lb/in^2$

Pipe passes contrained wall buckling calculations TRUE FS = 32.2

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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Detection Header** | CHECKED | DATE |
| Operation w/ CAT D7R Series II **10 Feet Waste** | | |

Constrained Pipe Wall Compressive Stress (for Driscoplex OD controlled pipe)

$S = \frac{P_T D_o}{288t}$ Source No. 1

S = pipe wall compressive stress ($lb/in^2$)

| | | |
|---|---|---|
| $P_T$ = vertical load applied to pipe w/ perfs ($lb/ft^2$) | 1237.2 | $lb/ft^2$ |
| $D_o$ = pipe outside diameter (in) | 8.63 | SDR 11 pipe (Driscopipe) to be used |
| t = pipe wall thickness (in) | 0.784 | SDR 11 pipe (Driscopipe) to be used |

$S = \frac{P_T D_o}{288t} =$ 47.3 $lb/in^2$

The recommended, long-term compressive strength ($Y_s$) design value for Driscoplex polyethylene pipe is 800 $lb/in^2$.

Source No. 1

| S (psi): | | $Y_s$ (psi): |
|---|---|---|
| 47.3 | < | 800.0 |

Pipe passes wall compressive stress calculations TRUE FS = 16.9

SCS ENGINEERS



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| Pipe Crushing Calculations **RAI No. 1** | | SRF | 4/1/13 |
| **8" Diameter Leachate Detection Header** | | CHECKED | DATE |
| Operation w/ CAT D7R Series II **10 Feet Waste** | | | |

Iowa Formula

$\Delta X = \dfrac{D_L K W_c r^3}{EI + 0.06er^4}$ Source 2, Equation 3.4 Buried Pipe Design, A.P. Moser, Chapter 3

$\Delta X$ = horizontal deflection (in)

$D_L$ = deflection lag factor

K = bedding constant | 0.1 | typical value Source 2, Buried Pipe Design, A.P. Moser, Chapter 3

$W_c$ = Marston's load per unit length of pipe (lb/in)

r = mean radius of the pipe (in)

E = modulus of elasticity ($lb/in^2$)

I = moment of inertia of the pipe wall per unit length ($in^3$)

e = modulus of passive resistance fo the side fill ($lb/in^2(in)$)

Modified Iowa Formula

$\Delta X = \dfrac{D_L K W_c r_m^3}{EI + 0.06E'r_m^3}$ Source 2, Equation 3.5 Buried Pipe Design, A.P. Moser, Chapter 3

$\Delta X$ = horizontal deflection (in)

| | | |
|---|---|---|
| $D_L$ = deflection lag factor | 1.0 | Prism Load used |
| Typical Value for Marston Load | 1.5 | |
| Typical Value for Prism Load | 1.0 | |
| K = bedding constant | 0.1 | typical value Buried Pipe Design, A.P. Moser, Chapter 3 |
| $P_T$ = Vertical load on pipe w/ perfs | 8.59 | $lb/in^2$ 1237 $lb/ft^2$ |
| $W_c$ = Marston's load per unit length of pipe = $P_T$ * $D_o$ (lb/in) | 74.10 | lb/in |
| $D_o$ = pipe outer diameter (in) | 8.63 | SDR 11 pipe (Driscopipe) to be used |
| t = pipe wall thickness (in) | 0.78 | SDR 11 pipe (Driscopipe) to be used |
| $D_I$ = pipe inner diameter = $D_o$-2t (in) | 7.06 | SDR 11 pipe (Driscopipe) to be used |
| $D_m$ = pipe mean diameter = $D_o$ - 1.06t Source 1, Equation 7-27 | 7.79 | SDR 11 pipe (Driscopipe) to be used |
| $r_m$ = mean radius of the pipe (in) | 3.90 | SDR 11 pipe (Driscopipe) to be used |
| E = modulus of elasticity ($lb/in^2$) | 100,000.0 | lb/in2 for long term load at 100oF, 'Source 1, Table 5-1 |
| I = moment of inertia of the pipe wall per unit length | 0.040 | $in^4/in$ |
| E' = modulus of soil reaction | 3,000.0 | $lb/in^2$ for moderate compaction and fine grained soils |

$\Delta X = \dfrac{D_L K W_c r_m^3}{EI + 0.06E'r_m^3}$ = 0.030 inch    Source 2, Equation 3.5 Buried Pipe Design, A.P. Moser, Chapter 3

% Ring Deflection = $(\Delta X/D_m)$ x 100 = 0.38% Source 1, Equation 7-31

Ring Bending Strain

$e = \dfrac{f_D \Delta X 2C}{D_M^2} \times 100$ Source 1, Equation 7-39

e = wall strain (%)

| | | |
|---|---|---|
| $f_D$ = deformation shape factor | 6 | Source 1, non-elliptical shape |
| $D_M$ = mean diameter (in) | | |
| C = outer fiber wall centroid = 0.5 (1.06t) | 0.416 | Source 1, Equation 7-41 |
| $\Delta X$ = ring deflection = $D_X/D_m$ | 0.004 | |

$e = f_D \dfrac{(\Delta X)}{D_M}\dfrac{(2C)}{D_M} \times 100$ = 0.2% Source 1, Equation 7-39

The maximum ring bending strain for high performance polyethylene non-pressure pipe is = 5.0%

Pipe passes ring bending strain calculations TRUE

| CLIENT | PROJECT | JOB NO. |
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| Hardee County | Phase II Section II Expansion | 09199033.23 |

| SUBJECT | BY | DATE |
| --- | --- | --- |
| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Detection Header** | CHECKED | DATE |
| Operation w/ CAT D7R Series II **10 Feet Waste** | | |

SOURCES

1.) Attachment - 1 - Chevron Phillips Chemical Company, Bulletin - Book 2 Chapter 5, 2003

2.) Attachment - 2 - Buried Pipe Design, A.P. Moser, Chapter 3

3.) Attachment - 3 - EPA, Lining of Waste Impoundment and Disposal Facilities, SW-870

4.) Attachment - 4 - Driscoplex Pipe Properties

5.) Attachment - 5 - CAT 826G Series II Compactor Data Sheet

6.) Attachment - 6 - CAT D7R Series II Equipment Data Sheet

7.) Attachment - 7 - CAT D6R XW Series II Equipment Data Sheet

SCS ENGINEERS

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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Detection Header** | CHECKED | DATE |
| Operation w/ CAT D7R Series II **25 Feet Waste** | | |

Load on Pipe (Overburden)

Prism Loads, $P_E$ = wH

w = unit weight

H = depth

| | Depth (ft) | Unit Weight ($lb/ft^3$) | $P_E$ ($lb/ft^2$) |
|---|---|---|---|
| Final cover | 0.0 | 115.0 | 0.0 |
| Intermediate cover | 0.0 | 115.0 | 0.0 |
| Waste/cover | 25.0 | 60.0 | 1500.0 |
| Drainage sand | 2.0 | 115.0 | 230.0 |
| Rock (No. 89 & No. 57) | 2.0 | 140.0 | 280.0 |

TOTAL SOIL PRISM LOAD $P_E$: 2010.0 $lb/ft^2$

Total Depth = 29.0 ft

Soil Arching, $P_m = C_D wB$

Pm = vertical soil pressure

B = trench width at pipe crown 6.0 ft

$C_D$ = load coefficient $= \frac{1 - e^{-2Ku'H/B}}{2Ku'}$ Equation 7-3, Source No. 1

e = natural log base number

K = Rankine earth pressure coefficient = $\tan^2(45-0.5*\phi)$

$\phi$ = internal soil friction angle = 27.0 degrees

u' = friction coefficient between backfill and trench sides = tan $\phi$

NOTE: The waste unit weight represents the combined unit weight of waste, daily cover, and moisture.

| Soil Type | Ku' |
|---|---|
| Saturated Clay | 0.110 |
| Ordinary Clay | 0.130 |
| Saturated Top Soil | 0.150 |
| Sand and Gravel | 0.165 |
| Clean Granular Soil | 0.192 |

| | Ku' | $C_D$ | $P_m$ ($lb/ft^2$) |
|---|---|---|---|
| Cover Soil | 0.150 | 0.00 | 0 |
| Int Cover | 0.165 | 0.00 | 0 |
| Waste | 0.191 | 2.08 | 750 |
| Drainage Sand | 0.165 | 0.32 | 217.8 |
| Granular Soil | 0.192 | 0.31 | 262.8 |

TOTAL SOIL ARCHING LOAD $P_M$: 1,230.4 $lb/ft^2$

MODIFIED ARCHING LOAD = $0.6P_M+0.4P_E$: 1,542.23 $lb/ft^2$

OVERBURDEN LOAD: 1,542.23 $lb/ft^2$

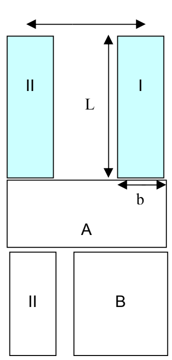
Load on Pipe With Equipment Refer to Attachment

Operation w/ CAT D7R Series II 25 Feet Waste

| | | | | | |
|---|---|---|---|---|---|
| Equipment Weight = | 54,573.0 | psf | Length of Track = L = | 113.0 | in |
| Number of Tracks = | 2.0 | | Track Width = b = | 22.0 | in |
| Track Load = $q_r$ = | 27,286.5 | psf | Track Gauge = G = | 78.0 | in |
| Ground contact area/track = | 17.3 | psf | Equipment Width "A" = | 113.0 | in |

Live Load = q*Ic q = track load 1,580.55 psf

Ic = Influence coefficient




| | b (ft) | L (ft) | z (ft) | m = b/z | n = L/z | I* | I** | I |
|---|---|---|---|---|---|---|---|---|
| I | 1.83 | 9.4 | 29.0 | 0.06 | 0.32 | 0.009 | 0.253 | 0.00900 |
| A | 8.33 | 9.4 | 29.0 | 0.29 | 0.32 | 0.039 | 0.261 | 0.03850 |
| B | 6.50 | 9.4 | 29.0 | 0.22 | 0.32 | 0.031 | 0.259 | 0.03077 |

Live $Load_1$ = I + II = $q_I(I_I) + q_A(I_A) - q_B(I_B)$ = 26.45 $lb/ft^2$

$q_I(I_I)$ = 14.22

$q_A(I_A)$ = 60.86

$q_B(I_B)$ = 48.63

Load on Pipe (Equipment) = 26.45 $lb/ft^2$

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| CLIENT | PROJECT | JOB NO. |
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|---|---|---|
| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Detection Header** | CHECKED | DATE |
| Operation w/ CAT D7R Series II **25 Feet Waste** | | |

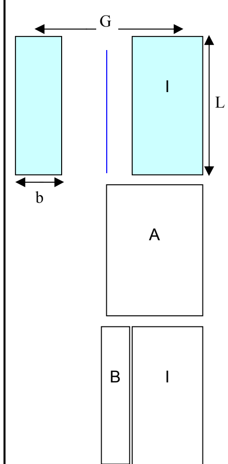
Load on Pipe (Equipment) *Continued*

Live Load = $q*I_c$

$q$ = track load 1580.55 lb/ft$^2$

$I_c$ = Influence coefficient

Alternative 2: Track stradling and parallel to pipe



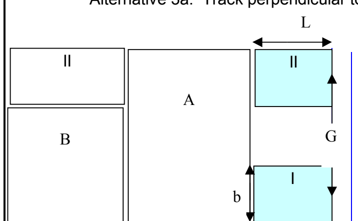

| | b | L | z | m = b/z | n = L/z | I* | I** | I |
|---|---|---|---|---|---|---|---|---|
| A | 4.71 | 9.4 | 29 | 0.16 | 0.32 | 0.023 | 0.257 | 0.02270 |
| B | 2.88 | 9.4 | 29 | 0.10 | 0.32 | 0.014 | 0.254 | 0.01404 |

Live Load$_2$ = 2 * (A - B) = 2 * ($q_A I_A$ - $q_B I_B$) = 27.36 lb/ft$^2$

| | |
|---|---|
| $q_A(I_A)$ = | 35.88 |
| $q_B(I_B)$ = | 22.20 |

Load on Pipe (Equipment) = 27.36 lb/ft$^2$

Alternative 3a: Track perpendicular to pipe




| | b | L | z | m = b/z | n = L/z | I* | I** | I |
|---|---|---|---|---|---|---|---|---|
| I | 1.83 | 9.4 | 29 | 0.06 | 0.32 | 0.009 | 0.253 | 0.00900 |
| A | 9.42 | 9.4 | 29 | 0.32 | 0.32 | 0.043 | 0.262 | 0.04279 |
| B | 7.58 | 9.4 | 29 | 0.26 | 0.32 | 0.035 | 0.261 | 0.03541 |

Live Load$_3$ = I + II = $q_I(I_I)$ + $q_A(I_A)$ - $q_B(I_B)$ = 25.90 lb/ft$^2$

| | |
|---|---|
| $q_I(I_I)$ = | 14.22 |
| $q_A(I_A)$ = | 67.64 |
| $q_B(I_B)$ = | 55.96 |

Load on Pipe (Equipment) = 25.90 lb/ft$^2$

LARGEST EQUIPEMENT LOAD = 27.36 lb/ft$^2$

VERTICAL OVERBURDEN LOAD = 1,542.23 lb/ft$^2$

VERTICAL EQUIPMENT LOAD = 27.36 lb/ft$^2$

TOTAL VERTICAL LOAD APPLIED TO PIPE, $P_T$ = 1,569.59 lb/ft$^2$ = 10.90 lb/in$^2$

SCS ENGINEERS

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| CLIENT | PROJECT | JOB NO. |
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| SUBJECT | BY | DATE |
|---|---|---|
| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Detection Header** | CHECKED | DATE |
| Operation w/ CAT D7R Series II **25 Feet Waste** | | |

Verify that perforations in the LCRS are adequate for the peak leachate flow.

Use discharge equation:

$Q = (Cd)(Ao)(2gh)^{0.5}$

$C_d$ = coeffiecient of discharge = 0.6 for short tube discharge with fluid/wall separation; conservative value.

$A_o$ = Area of orifice ($\pi D^2/4$)

g = gravitational acceleration (32.3 $ft^2/s$)

h = static head (ft)

Assumptions and Givens:

| | | | |
|---|---|---|---|
| 1. No. acres of landfill expansion = | 4.55 | acres | North and center portion of landfill bottom |
| 2. Total length of pipe per expansion = | 138.8 | ft | |
| 3. Number of laterals = | 1.0 | | |
| 4. Total length of pipe per lateral = | 138.8 | ft | |
| 5. Perforation diameter = | 0.375 | inch | |
| 6. No. perforations/ft pipe = | 6.0 | perforations/ft of pipe length | |
| 7. Maximum head over pipe = | 1.0 | ft | |
| 8. Per HELP model summary table, $Q_{peak}$ = | 0.88 | gal/min | refer to HELP Model Summary Table |
| 9. Per HELP model summary table, $Q_{peak}$ = | 169.4 | cf/day | refer to HELP Model Summary Table |
| 10. Maximum flow/lateral = | 169.4 | cf/day/lateral | |
| 11. Maximum leachate flow/ft of pipe = | 1.22 | cf/day/ft of pipe | |

Solution:

$A_o = 0.25(\Pi)(d)^2 =$ 0.00077 $ft^2$

1. Flow per orifice, $Q = (Cd)(Ao)(2gh)^{0.5} =$ 0.0037 $ft^3/s$

2. Flow per ft of pipe = (Q)(# perfs/ft) = 0.02 $ft^3/s$ per ft of pipe

= 1914.47 cf/day/ft of pipe

Conclusion:

Design capacity exceeds estimated generation

1914.47 cf/day/ft of pipe >>> 1.22 cf/day/ft of pipe

Perforations are adequate to handle the maximum leachate flow.

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| CLIENT | PROJECT | JOB NO. |
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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Detection Header** | CHECKED | DATE |
| Operation w/ CAT D7R Series II **25 Feet Waste** | | |

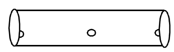
Effective pressure on pipe due to perforations:

$P_{EFF} = \frac{P_T \times 12}{(12-L_P)}$ Source 3, EPA SW-870, p. 382

$L_P$ = Total accumulated length of perforations in one foot of pipe.

Since each perforation is 0.375 inch diameter and spaced at 6.0 inch on center,

$L_P$ = 1.5 inch



$P_T$ = 10.9 psi

$P_{EFF}$ = 12.5 psi

$P_{EFF}$ = 1793.8 psf

Check actual compressive pressure ($S_A$) per Driscopipe manual:

$S_A$ = 0.5 x (SDR - 1) x P(eff) = 62.3 psi

The recommended, long-term compressive strength ($Y_s$) design value for Driscoplex polyethylene pipe is 800 lb/in$^2$.

Source No. 1

| $S_A$ (psi): | | $Y_s$ (psi): |
|---|---|---|
| 62.3 | < | 800.0 |

Pipe passes wall compressive stress perforation calculations TRUE

FS = 12.8

SCS ENGINEERS

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| CLIENT | PROJECT | JOB NO. |
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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Detection Header** | CHECKED | DATE |
| Operation w/ CAT D7R Series II **25 Feet Waste** | | |

Constrained pipe wall buckling (for Driscoplex OD controlled pipe)

$P_{WC} = \frac{5.65 * \{RB'E'\ E*[12(DR-1)^3]^{-1}\}^{0.5}}{N}$ Source 1, Equation 7-5

$P_{WC}$ = allowable constrained buckling pressure (lb/in$^2$)

| | | |
|---|---|---|
| R = buoyancy reduction factor = 1 - 0.33 * (H'/H) | Source 1, Equation 7-34 | |
| H' = groundwater height above pipe (ft) | 0.0 | ft |
| H = cover above pipe (ft) | 29.0 | ft |
| B' = elastic support factor =( 1+ 4*e$^{-0.065H}$ )$^{-1}$ | Source 1, Equation 7-35 | |
| E' = soil reaction modulus (lb/in$^2$) | 3000.0 | lb/in$^2$ for mod comp/crushed rock, 'Source 1, Table 7-7 |
| E = elastic modulus (lb/in$^2$) | 100000.0 | lb/in$^2$ for long term load at 100$^o$F, 'Source 1, Table 5-1 |
| I = moment of inertia = t$^3$ / 12 | 0.0 | in$^4$/in |
| $D_o$ = pipe outer diameter (in) | 8.625 | SDR 11 pipe (Driscopipe) to be used |
| t = pipe wall thickness (in) | 0.784 | SDR 11 pipe (Driscopipe) to be used |
| DR = pipe dimension ratio = $D_o$ / t | 11.0 | SDR 11 pipe (Driscopipe) to be used |
| $D_I$ = pipe inner diameter = $D_o$ - 2t (in) | 7.1 | SDR 11 pipe (Driscopipe) to be used |
| N = safety factor | 2.0 | |

| Cover (ft) | (ft) | (ft) | B' | R | (lb/in$^2$) |
|---|---|---|---|---|---|
| 25.0 | 29 | 0 | 0.62 | 1.00 | 352.25 |

$P_{WC}$ = 352.25 lb/in$^2$

$P_{EFF}$ = 12.46 lb/in$^2$

Pipe passes contrained wall buckling calculations TRUE FS = 28.3

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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Detection Header** | CHECKED | DATE |
| Operation w/ CAT D7R Series II **25 Feet Waste** | | |

Constrained Pipe Wall Compressive Stress (for Driscoplex OD controlled pipe)

$S = \frac{P_T D_o}{288t}$ Source No. 1

S = pipe wall compressive stress ($lb/in^2$)

| | | |
|---|---|---|
| $P_T$ = vertical load applied to pipe w/ perfs ($lb/ft^2$) | 1793.8 | $lb/ft^2$ |
| $D_o$ = pipe outside diameter (in) | 8.63 | SDR 11 pipe (Driscopipe) to be used |
| t = pipe wall thickness (in) | 0.784 | SDR 11 pipe (Driscopipe) to be used |

$S = \frac{P_T D_o}{288t} =$ 68.5 $lb/in^2$

The recommended, long-term compressive strength ($Y_s$) design value for Driscoplex polyethylene pipe is 800 $lb/in^2$.

Source No. 1

| S (psi): | | $Y_s$ (psi): |
|---|---|---|
| 68.5 | < | 800.0 |

Pipe passes wall compressive stress calculations TRUE

FS = 11.7

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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Detection Header** | CHECKED | DATE |
| Operation w/ CAT D7R Series II **25 Feet Waste** | | |

Iowa Formula

$\Delta X = \dfrac{D_L K W_c r^3}{EI + 0.06er^4}$ Source 2, Equation 3.4 Buried Pipe Design, A.P. Moser, Chapter 3

$\Delta X$ = horizontal deflection (in)

$D_L$ = deflection lag factor

K = bedding constant | 0.1 | typical value Source 2, Buried Pipe Design, A.P. Moser, Chapter 3

$W_c$ = Marston's load per unit length of pipe (lb/in)

r = mean radius of the pipe (in)

E = modulus of elasticity (lb/in$^2$)

I = moment of inertia of the pipe wall per unit length (in$^3$)

e = modulus of passive resistance fo the side fill (lb/in$^2$(in))

Modified Iowa Formula

$\Delta X = \dfrac{D_L K W_c r_m^3}{EI + 0.06E'r_m^3}$ Source 2, Equation 3.5 Buried Pipe Design, A.P. Moser, Chapter 3

$\Delta X$ = horizontal deflection (in)

| | | | |
|---|---|---|---|
| $D_L$ = deflection lag factor | | 1.0 | Prism Load used |
| Typical Value for Marston Load | 1.5 | | |
| Typical Value for Prism Load | 1.0 | | |
| K = bedding constant | | 0.1 | typical value Buried Pipe Design, A.P. Moser, Chapter 3 |
| $P_T$ = Vertical load on pipe w/ perfs | | 12.46 | lb/in$^2$ 1794 lb/ft$^2$ |
| $W_c$ = Marston's load per unit length of pipe = $P_T$ * $D_o$ (lb/in) | | 107.44 | lb/in |
| $D_o$ = pipe outer diameter (in) | | 8.63 | SDR 11 pipe (Driscopipe) to be used |
| t = pipe wall thickness (in) | | 0.78 | SDR 11 pipe (Driscopipe) to be used |
| $D_I$ = pipe inner diameter = $D_o$-2t (in) | | 7.06 | SDR 11 pipe (Driscopipe) to be used |
| $D_m$ = pipe mean diameter = $D_o$ - 1.06t Source 1, Equation 7-27 | | 7.79 | SDR 11 pipe (Driscopipe) to be used |
| $r_m$ = mean radius of the pipe (in) | | 3.90 | SDR 11 pipe (Driscopipe) to be used |
| E = modulus of elasticity (lb/in$^2$) | | 100,000.0 | lb/in2 for long term load at 100oF, 'Source 1, Table 5-1 |
| I = moment of inertia of the pipe wall per unit length | | 0.040 | in$^4$/in |
| E' = modulus of soil reaction | | 3,000.0 | lb/in$^2$ for moderate compaction and fine grained soils |

$\Delta X = \dfrac{D_L K W_c r_m^3}{EI + 0.06E'r_m^3} =$ 0.043 inch Source 2, Equation 3.5 Buried Pipe Design, A.P. Moser, Chapter 3

% Ring Deflection = $(\Delta X/D_m)$ x 100 = 0.56% Source 1, Equation 7-31

Ring Bending Strain

$e = \dfrac{f_D \Delta X 2C}{D_M^2} \times 100$ Source 1, Equation 7-39

e = wall strain (%)

$f_D$ = deformation shape factor | 6 | Source 1, non-elliptical shape

$D_M$ = mean diameter (in)

C = outer fiber wall centroid = 0.5 (1.06t) | 0.416 | Source 1, Equation 7-41

$\Delta X$ = ring deflection = $D_X/D_m$ | 0.006

$e = f_D \left(\dfrac{\Delta X}{D_M}\right)\left(\dfrac{2C}{D_M}\right) \times 100 =$ 0.4% Source 1, Equation 7-39

The maximum ring bending strain for high performance polyethylene non-pressure pipe is = 5.0%

Pipe passes ring bending strain calculations TRUE

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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Detection Header** | CHECKED | DATE |
| Operation w/ CAT D7R Series II **25 Feet Waste** | | |

SOURCES

1.) Attachment - 1 - Chevron Phillips Chemical Company, Bulletin - Book 2 Chapter 5, 2003

2.) Attachment - 2 - Buried Pipe Design, A.P. Moser, Chapter 3

3.) Attachment - 3 - EPA, Lining of Waste Impoundment and Disposal Facilities, SW-870

4.) Attachment - 4 - Driscoplex Pipe Properties

5.) Attachment - 5 - CAT 826G Series II Compactor Data Sheet

6.) Attachment - 6 - CAT D7R Series II Equipment Data Sheet

7.) Attachment - 7 - CAT D6R XW Series II Equipment Data Sheet

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| CLIENT | PROJECT | JOB NO. |
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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Detection Header** | CHECKED | DATE |
| Operation w/ CAT D7R Series II **60 Feet Waste** | | |

Load on Pipe (Overburden)

Prism Loads, $P_E = wH$

w = unit weight

H = depth

| | Depth (ft) | Unit Weight ($lb/ft^3$) | $P_E$ ($lb/ft^2$) |
|---|---|---|---|
| Final cover | 2.0 | 115.0 | 230.0 |
| Intermediate cover | 1.0 | 115.0 | 115.0 |
| Waste/cover | 60.0 | 60.0 | 3600.0 |
| Drainage sand | 2.0 | 115.0 | 230.0 |
| Rock (No. 89 & No. 57) | 2.0 | 140.0 | 280.0 |

TOTAL SOIL PRISM LOAD $P_E$: 4455.0 $lb/ft^2$

Total Depth = 67.0 ft

Soil Arching, $P_m = C_D wB$

NOTE: The waste unit weight represents the combined unit weight of waste, daily cover, and moisture.

Pm = vertical soil pressure

B = trench width at pipe crown 6.0 ft

$C_D$ = load coefficient $= \frac{1 - e^{-2Ku'H/B}}{2Ku'}$ Equation 7-3, Source No. 1

e = natural log base number

K = Rankine earth pressure coefficient = $\tan^2(45-0.5*\phi)$

$\phi$ = internal soil friction angle = 27.0 degrees

u' = friction coefficient between backfill and trench sides = tan $\phi$

| Soil Type | Ku' |
|---|---|
| Saturated Clay | 0.110 |
| Ordinary Clay | 0.130 |
| Saturated Top Soil | 0.150 |
| Sand and Gravel | 0.165 |
| Clean Granular Soil | 0.192 |

| | Ku' | $C_D$ | $P_m$ ($lb/ft^2$) |
|---|---|---|---|
| Cover Soil | 0.150 | 0.32 | 219 |
| Int Cover | 0.165 | 0.16 | 112 |
| Waste | 0.191 | 2.56 | 920 |
| Drainage Sand | 0.165 | 0.32 | 217.8 |
| Granular Soil | 0.192 | 0.31 | 262.8 |

TOTAL SOIL ARCHING LOAD $P_M$: 1,731.6 $lb/ft^2$

MODIFIED ARCHING LOAD = $0.6P_M+0.4P_E$: 2,820.98 $lb/ft^2$

OVERBURDEN LOAD: 2,820.98 $lb/ft^2$

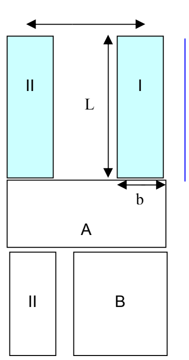
Load on Pipe With Equipment Refer to Attachment

Operation w/ CAT D7R Series II 60 Feet Waste

| | | | | | |
|---|---|---|---|---|---|
| Equipment Weight = | 54,573.0 | psf | Length of Track = L = | 113.0 | in |
| Number of Tracks = | 2.0 | | Track Width = b = | 22.0 | in |
| Track Load = $q_r$ = | 27,286.5 | psf | Track Gauge = G = | 78.0 | in |
| Ground contact area/track = | 17.3 | psf | Equipment Width "A" = | 113.0 | in |

Live Load = q*Ic   q = track load 1,580.55 psf

Ic = Influence coefficient




| | b (ft) | L (ft) | z (ft) | m = b/z | n = L/z | I* | I** | I |
|---|---|---|---|---|---|---|---|---|
| I | 1.83 | 9.4 | 67.0 | 0.03 | 0.14 | 0.002 | 0.251 | 0.00181 |
| A | 8.33 | 9.4 | 67.0 | 0.12 | 0.14 | 0.008 | 0.253 | 0.00811 |
| B | 6.50 | 9.4 | 67.0 | 0.10 | 0.14 | 0.006 | 0.252 | 0.00636 |

Live $Load_1$ = I + II = $q_I(I_I) + q_A(I_A) - q_B(I_B)$ = 5.62 $lb/ft^2$

$q_I(I_I)$ = 2.85

$q_A(I_A)$ = 12.82

$q_B(I_B)$ = 10.05

Load on Pipe (Equipment) = 5.62 $lb/ft^2$

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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Detection Header** | CHECKED | DATE |
| Operation w/ CAT D7R Series II **60 Feet Waste** | | |

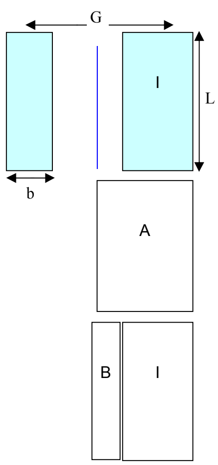
Load on Pipe (Equipment) *Continued*

Live Load = $q*I_c$

$q$ = track load 1580.55 $lb/ft^2$

$I_c$ = Influence coefficient

Alternative 2: Track stradling and parallel to pipe



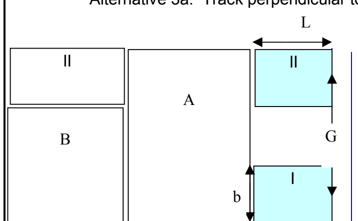

| | b | L | z | m = b/z | n = L/z | I* | I** | I |
|---|---|---|---|---|---|---|---|---|
| A | 4.71 | 9.4 | 67 | 0.07 | 0.14 | 0.005 | 0.252 | 0.00462 |
| B | 2.88 | 9.4 | 67 | 0.04 | 0.14 | 0.003 | 0.251 | 0.00283 |

Live $Load_2$ = 2 * (A - B) = 2 * ($q_A I_A$ - $q_B I_B$) = 5.66 $lb/ft^2$

| | |
|---|---|
| $q_A(I_A)$ = | 7.30 |
| $q_B(I_B)$ = | 4.47 |

Load on Pipe (Equipment) = 5.66 $lb/ft^2$

Alternative 3a: Track perpendicular to pipe




| | b | L | z | m = b/z | n = L/z | I* | I** | I |
|---|---|---|---|---|---|---|---|---|
| I | 1.83 | 9.4 | 67 | 0.03 | 0.14 | 0.002 | 0.251 | 0.00181 |
| A | 9.42 | 9.4 | 67 | 0.14 | 0.14 | 0.009 | 0.253 | 0.00913 |
| B | 7.58 | 9.4 | 67 | 0.11 | 0.14 | 0.007 | 0.252 | 0.00739 |

Live $Load_3$ = I + II = $q_I(I_I)$ + $q_A(I_A)$ - $q_B(I_B)$ = 5.60 $lb/ft^2$

| | |
|---|---|
| $q_I(I_I)$ = | 2.85 |
| $q_A(I_A)$ = | 14.43 |
| $q_B(I_B)$ = | 11.69 |

Load on Pipe (Equipment) = 5.60 $lb/ft^2$

LARGEST EQUIPEMENT LOAD = 5.66 $lb/ft^2$

VERTICAL OVERBURDEN LOAD = 2,820.98 $lb/ft^2$

VERTICAL EQUIPMENT LOAD = 5.66 $lb/ft^2$

TOTAL VERTICAL LOAD APPLIED TO PIPE, $P_T$ = 2,826.65 $lb/ft^2$ = 19.63 $lb/in^2$

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| Operation w/ CAT D7R Series II **60 Feet Waste** | | |

Verify that perforations in the LCRS are adequate for the peak leachate flow.

Use discharge equation:

$Q = (Cd)(Ao)(2gh)^{0.5}$

$C_d$ = coeffiecient of discharge = 0.6 for short tube discharge with fluid/wall separation; conservative value.

$A_o$ = Area of orifice ($\pi D^2/4$)

g = gravitational acceleration (32.3 $ft^2/s$)

h = static head (ft)

Assumptions and Givens:

| | | | |
|---|---|---|---|
| 1. No. acres of landfill expansion = | 4.55 | acres | North and center portion of landfill bottom |
| 2. Total length of pipe per expansion = | 138.8 | ft | |
| 3. Number of laterals = | 1.0 | | |
| 4. Total length of pipe per lateral = | 138.8 | ft | |
| 5. Perforation diameter = | 0.375 | inch | |
| 6. No. perforations/ft pipe = | 6.0 | perforations/ft of pipe length | |
| 7. Maximum head over pipe = | 1.0 | ft | |
| 8. Per HELP model summary table, $Q_{peak}$ = | 0.88 | gal/min | refer to HELP Model Summary Table |
| 9. Per HELP model summary table, $Q_{peak}$ = | 169.4 | cf/day | refer to HELP Model Summary Table |
| 10. Maximum flow/lateral = | 169.4 | cf/day/lateral | |
| 11. Maximum leachate flow/ft of pipe = | 1.22 | cf/day/ft of pipe | |

Solution:

$A_o = 0.25(\Pi)(d)^2 =$ 0.00077 $ft^2$

1. Flow per orifice, $Q = (Cd)(Ao)(2gh)^{0.5}$ = 0.0037 $ft^3/s$

2. Flow per ft of pipe = (Q)(# perfs/ft) = 0.02 $ft^3/s$ per ft of pipe

= 1914.47 cf/day/ft of pipe

Conclusion:

Design capacity exceeds estimated generation

1914.47 cf/day/ft of pipe >>> 1.22 cf/day/ft of pipe

Perforations are adequate to handle the maximum leachate flow.

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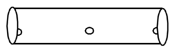
Effective pressure on pipe due to perforations:

$P_{EFF} = \frac{P_T \times 12}{(12-L_P)}$ Source 3, EPA SW-870, p. 382

$L_P$ = Total accumulated length of perforations in one foot of pipe.

Since each perforation is 0.375 inch diameter and spaced at 6.0 inch on center,

$L_P$ = 1.5 inch



$P_T$ = 19.6 psi

$P_{EFF}$ = 22.4 psi

$P_{EFF}$ = 3230.5 psf

Check actual compressive pressure ($S_A$) per Driscopipe manual:

$S_A$ = 0.5 x (SDR - 1) x P(eff) = 112.2 psi

The recommended, long-term compressive strength ($Y_s$) design value for Driscoplex polyethylene pipe is 800 lb/in$^2$.

Source No. 1

| $S_A$ (psi): | | $Y_s$ (psi): |
|---|---|---|
| 112.2 | < | 800.0 |

Pipe passes wall compressive stress perforation calculations TRUE

FS = 7.1

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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
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| Operation w/ CAT D7R Series II **60 Feet Waste** | | |

Constrained pipe wall buckling (for Driscoplex OD controlled pipe)

$P_{WC} = \frac{5.65 * \{RB'E' E*[12(DR-1)^3]^{-1}\}^{0.5}}{N}$ Source 1, Equation 7-5

$P_{WC}$ = allowable constrained buckling pressure (lb/in$^2$)

R = buoyancy reduction factor = 1 - 0.33 * (H'/H) Source 1, Equation 7-34

| | | |
|---|---|---|
| H' = groundwater height above pipe (ft) | 0.0 | ft |
| H = cover above pipe (ft) | 67.0 | ft |
| B' = elastic support factor =( 1+ 4*e$^{-0.065H}$ )$^{-1}$ | | Source 1, Equation 7-35 |
| E' = soil reaction modulus (lb/in$^2$) | 3000.0 | lb/in$^2$ for mod comp/crushed rock, 'Source 1, Table 7-7 |
| E = elastic modulus (lb/in$^2$) | 100000.0 | lb/in$^2$ for long term load at 100$^o$F, 'Source 1, Table 5-1 |
| I = moment of inertia = t$^3$ / 12 | 0.0 | in$^4$/in |
| $D_o$ = pipe outer diameter (in) | 8.625 | SDR 11 pipe (Driscopipe) to be used |
| t = pipe wall thickness (in) | 0.784 | SDR 11 pipe (Driscopipe) to be used |
| DR = pipe dimension ratio = $D_o$ / t | 11.0 | SDR 11 pipe (Driscopipe) to be used |
| $D_I$ = pipe inner diameter = $D_o$ - 2t (in) | 7.1 | SDR 11 pipe (Driscopipe) to be used |
| N = safety factor | 2.0 | |

| Cover (ft) | (ft) | (ft) | B' | R | (lb/in$^2$) |
|---|---|---|---|---|---|
| 60.0 | 67 | 0 | 0.95 | 1.00 | 435.54 |

$P_{WC}$ = 435.54 lb/in$^2$

$P_{EFF}$ = 22.43 lb/in$^2$

Pipe passes contrained wall buckling calculations TRUE FS = 19.4

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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
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| Operation w/ CAT D7R Series II **60 Feet Waste** | | |

Constrained Pipe Wall Compressive Stress (for Driscoplex OD controlled pipe)

$S = \frac{P_T D_o}{288t}$ Source No. 1

S = pipe wall compressive stress ($lb/in^2$)

$P_T$ = vertical load applied to pipe w/ perfs ($lb/ft^2$) 3230.5 $lb/ft^2$

$D_o$ = pipe outside diameter (in) 8.63 SDR 11 pipe (Driscopipe) to be used

t = pipe wall thickness (in) 0.784 SDR 11 pipe (Driscopipe) to be used

$S = \frac{P_T D_o}{288t} =$ 123.4 $lb/in^2$

The recommended, long-term compressive strength ($Y_s$) design value for Driscoplex polyethylene pipe is 800 $lb/in^2$.

Source No. 1

| S (psi): | | $Y_s$ (psi): |
|---|---|---|
| 123.4 | < | 800.0 |

Pipe passes wall compressive stress calculations TRUE

FS = 6.5

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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
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| Operation w/ CAT D7R Series II **60 Feet Waste** | | |

Iowa Formula

$$\Delta X = \frac{D_L K W_c r^3}{EI + 0.06er^4}$$ Source 2, Equation 3.4 Buried Pipe Design, A.P. Moser, Chapter 3

$\Delta X$ = horizontal deflection (in)

$D_L$ = deflection lag factor

K = bedding constant | 0.1 | typical value Source 2, Buried Pipe Design, A.P. Moser, Chapter 3

$W_c$ = Marston's load per unit length of pipe (lb/in)

r = mean radius of the pipe (in)

E = modulus of elasticity (lb/in$^2$)

I = moment of inertia of the pipe wall per unit length (in$^3$)

e = modulus of passive resistance fo the side fill (lb/in$^2$(in))

Modified Iowa Formula

$$\Delta X = \frac{D_L K W_c r_m^3}{EI + 0.06E'r_m^3}$$ Source 2, Equation 3.5 Buried Pipe Design, A.P. Moser, Chapter 3

$\Delta X$ = horizontal deflection (in)

| | | |
|---|---|---|
| $D_L$ = deflection lag factor | 1.0 | Prism Load used |
| Typical Value for Marston Load | 1.5 | |
| Typical Value for Prism Load | 1.0 | |
| K = bedding constant | 0.1 | typical value Buried Pipe Design, A.P. Moser, Chapter 3 |
| $P_T$ = Vertical load on pipe w/ perfs | 22.43 | lb/in$^2$ — 3230 lb/ft$^2$ |
| $W_c$ = Marston's load per unit length of pipe = $P_T$ * $D_o$ (lb/in) | 193.49 | lb/in |
| $D_o$ = pipe outer diameter (in) | 8.63 | SDR 11 pipe (Driscopipe) to be used |
| t = pipe wall thickness (in) | 0.78 | SDR 11 pipe (Driscopipe) to be used |
| $D_I$ = pipe inner diameter = $D_o$-2t (in) | 7.06 | SDR 11 pipe (Driscopipe) to be used |
| $D_m$ = pipe mean diameter = $D_o$ - 1.06t Source 1, Equation 7-27 | 7.79 | SDR 11 pipe (Driscopipe) to be used |
| $r_m$ = mean radius of the pipe (in) | 3.90 | SDR 11 pipe (Driscopipe) to be used |
| E = modulus of elasticity (lb/in$^2$) | 100,000.0 | lb/in2 for long term load at 100oF, 'Source 1, Table 5-1 |
| I = moment of inertia of the pipe wall per unit length | 0.040 | in$^4$/in |
| E' = modulus of soil reaction | 3,000.0 | lb/in$^2$ for moderate compaction and fine grained soils |

$$\Delta X = \frac{D_L K W_c r_m^3}{EI + 0.06E'r_m^3} = 0.078 \text{ inch}$$ Source 2, Equation 3.5 Buried Pipe Design, A.P. Moser, Chapter 3

% Ring Deflection = ($\Delta X/D_m$) x 100 = 1.00% Source 1, Equation 7-31

Ring Bending Strain

$$e = \frac{f_D \Delta X 2C}{D_M^2} \times 100$$ Source 1, Equation 7-39

e = wall strain (%)

| | | |
|---|---|---|
| $f_D$ = deformation shape factor | 6 | Source 1, non-elliptical shape |
| $D_M$ = mean diameter (in) | | |
| C = outer fiber wall centroid = 0.5 (1.06t) | 0.416 | Source 1, Equation 7-41 |
| $\Delta X$ = ring deflection = $D_X/D_m$ | 0.010 | |

$$e = f_D \frac{\Delta X}{D_M} \frac{(2C)}{D_M} \times 100 = 0.6\%$$ Source 1, Equation 7-39

The maximum ring bending strain for high performance polyethylene non-pressure pipe is = 5.0%

Pipe passes ring bending strain calculations TRUE

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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Detection Header** Operation w/ CAT D7R Series II **60 Feet Waste** | CHECKED | DATE |

SOURCES

1.) Attachment - 1 - Chevron Phillips Chemical Company, Bulletin - Book 2 Chapter 5, 2003

2.) Attachment - 2 - Buried Pipe Design, A.P. Moser, Chapter 3

3.) Attachment - 3 - EPA, Lining of Waste Impoundment and Disposal Facilities, SW-870

4.) Attachment - 4 - Driscoplex Pipe Properties

5.) Attachment - 5 - CAT 826G Series II Compactor Data Sheet

6.) Attachment - 6 - CAT D7R Series II Equipment Data Sheet

7.) Attachment - 7 - CAT D6R XW Series II Equipment Data Sheet

# Summary Table and 12-Inch Leachate Collection Header Pipe Crushing and Flow Capacity Calculations North and Center Portions

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| Phase II Section II **RAI No. 1** | SRF | 4/1/13 |
| Summary Table Pipe Crushing **Operations** | CHECKED | DATE |
| **12" Diameter Leachate Collection System North and Center Portions** | | |

| Description | Waste Height (ft) | Fill Height (ft) | Pipe Diameter (in) | Type of Calculation | Design Value | Calculated Value | Units | Safety Factor* |
|---|---|---|---|---|---|---|---|---|
| CAT D7R Series II | 0 | 2 | 12 | Flow Capacity | 1914.47 | 281.44 | cf/day/ft of pipe | 6.80 |
| | | | | Buckling | 220.99 | 5.59 | psi | 39.52 |
| | | | | Compressive Stress | 800 | 30.76 | psi | 26.01 |
| | | | | Bending Strain | 5.0% | 0.2% | % | 31.30 |
| CAT D7R Series II | 10 | 12 | 12 | Flow Capacity | 1914.47 | 281.44 | cf/day/ft of pipe | 6.80 |
| | | | | Buckling | 276.44 | 8.59 | psi | 32.17 |
| | | | | Compressive Stress | 800 | 47.26 | psi | 16.93 |
| | | | | Bending Strain | 5.0% | 0.2% | % | 20.37 |
| CAT D7R Series II | 25 | 27 | 12 | Flow Capacity | 1914.47 | 281.44 | cf/day/ft of pipe | 6.80 |
| | | | | Buckling | 352.27 | 12.46 | psi | 28.28 |
| | | | | Compressive Stress | 800 | 68.52 | psi | 11.68 |
| | | | | Bending Strain | 5.0% | 0.4% | % | 14.05 |
| CAT D7R Series II | 60 | 65 | 12 | Flow Capacity | 1914.47 | 281.44 | cf/day/ft of pipe | 6.80 |
| | | | | Buckling | 435.57 | 22.43 | psi | 19.42 |
| | | | | Compressive Stress | 800 | 123.40 | psi | 6.48 |
| | | | | Bending Strain | 5.0% | 0.6% | % | 7.80 |
| CAT 826 G Series II Compactor | 0 | 2 | 12 | Flow Capacity | 1914.47 | 281.44 | cf/day/ft of pipe | 6.80 |
| | | | | Buckling | 220.99 | 11.53 | psi | 19.17 |
| | | | | Compressive Stress | 800 | 63.42 | psi | 12.61 |
| | | | | Bending Strain | 5.0% | 0.3% | % | 15.18 |
| CAT 826 G Series II Compactor | 10 | 12 | 12 | Flow Capacity | 1914.47 | 281.44 | cf/day/ft of pipe | 6.80 |
| | | | | Buckling | 276.44 | 9.63 | psi | 28.71 |
| | | | | Compressive Stress | 800 | 52.97 | psi | 15.10 |
| | | | | Bending Strain | 5.0% | 0.3% | % | 18.18 |
| CAT 826 G Series II Compactor | 25 | 27 | 12 | Flow Capacity | 1914.47 | 281.44 | cf/day/ft of pipe | 6.80 |
| | | | | Buckling | 352.27 | 12.83 | psi | 27.46 |
| | | | | Compressive Stress | 800 | 70.56 | psi | 11.34 |
| | | | | Bending Strain | 5.0% | 0.4% | % | 13.65 |
| CAT 826 G Series II Compactor | 60 | 65 | 12 | Flow Capacity | 1914.47 | 281.44 | cf/day/ft of pipe | 6.80 |
| | | | | Buckling | 435.57 | 22.52 | psi | 19.34 |
| | | | | Compressive Stress | 800 | 123.89 | psi | 6.46 |
| | | | | Bending Strain | 5.0% | 0.6% | % | 7.77 |

* Safety Factor = Design Value/Calculated Value

**Revised April 1, 2013**

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| Phase II Section II **RAI No. 1** | SRF | 4/1/13 |
| Summary Table Pipe Crushing **Construction** | CHECKED | DATE |
| **12" Diameter Leachate Collection System North and Center Portions** | | |

| Description | Waste Height (ft) | Fill Height (ft) | Pipe Diameter (in) | Type of Calculation | Design Value | Calculated Value | Units | Safety Factor* |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| CAT D6R XW Series II | 0 | 1 | 12 | Flow Capacity | 1914.47 | 281.44 | cf/day/ft of pipe | 6.80 |
| | | | | Buckling | 204.96 | 2.93 | psi | 69.92 |
| | | | | Compressive Stress | 800 | 16.12 | psi | 49.61 |
| | | | | Bending Strain | 5.0% | 0.1% | % | 59.71 |

* Safety Factor = Design Value/Calculated Value

**Revised April 1, 2013**

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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **12" Diameter Leachate Collection Header System** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **0 Feet Waste** | | |

Load on Pipe (Overburden)

Prism Loads, $P_E$ = wH

w = unit weight

H = depth

| | Depth (ft) | Unit Weight ($lb/ft^3$) | $P_E$ ($lb/ft^2$) |
|---|---|---|---|
| Final cover | 0.0 | 115.0 | 0.0 |
| Intermediate cover | 0.0 | 115.0 | 0.0 |
| Waste/cover | 0.0 | 60.0 | 0.0 |
| Drainage sand | 2.0 | 115.0 | 230.0 |
| Rock (No. 89 & No. 57) | 2.0 | 140.0 | 280.0 |

TOTAL SOIL PRISM LOAD $P_E$: 510.0 $lb/ft^2$

Total Depth = 4.0 ft

Soil Arching, $P_m = C_D w B$

NOTE: The waste unit weight represents the combined unit weight of waste, daily cover, and moisture.

Pm = vertical soil pressure

B = trench width at pipe crown 6.0 ft

$C_D$ = load coefficient $= \frac{1 - e^{-2Ku'H/B}}{2Ku'}$ Equation 7-3, Source No. 1

e = natural log base number

K = Rankine earth pressure coefficient = $\tan^2(45-0.5*\phi)$

$\phi$ = internal soil friction angle = 27.0 degrees

u' = friction coefficient between backfill and trench sides = tan $\phi$

| Soil Type | Ku' |
|---|---|
| Saturated Clay | 0.110 |
| Ordinary Clay | 0.130 |
| Saturated Top Soil | 0.150 |
| Sand and Gravel | 0.165 |
| Clean Granular Soil | 0.192 |

| | Ku' | $C_D$ | $P_m$ ($lb/ft^2$) |
|---|---|---|---|
| Cover Soil | 0.150 | 0.00 | 0 |
| Int Cover | 0.165 | 0.00 | 0 |
| Waste | 0.191 | 0.00 | 0 |
| Drainage Sand | 0.165 | 0.32 | 217.8 |
| Granular Soil | 0.192 | 0.31 | 262.8 |

TOTAL SOIL ARCHING LOAD $P_M$: 480.6 $lb/ft^2$

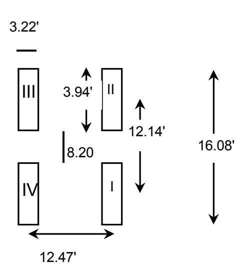
MODIFIED ARCHING LOAD = $0.6P_M+0.4P_E$: 492.37 $lb/ft^2$

OVERBURDEN LOAD: 492.37 $lb/ft^2$

Load on Pipe With Equipment Refer to Attachment

Operation w/ CAT 826G Series II Compactor 0 Feet Waste

Equipment Weight = 81,498.0 psf




Track per Load = $q_r$ = 1,670.20 psf (Rear)

Track per Load = $q_{fr}$ = 1,541.72 psf (Front)

Length of Track = L = 3.22 ft (contact length)

Length of Track = b = 8.20 ft

Track Width = 12.47 ft

Track Width (I to II) = 16.08 ft

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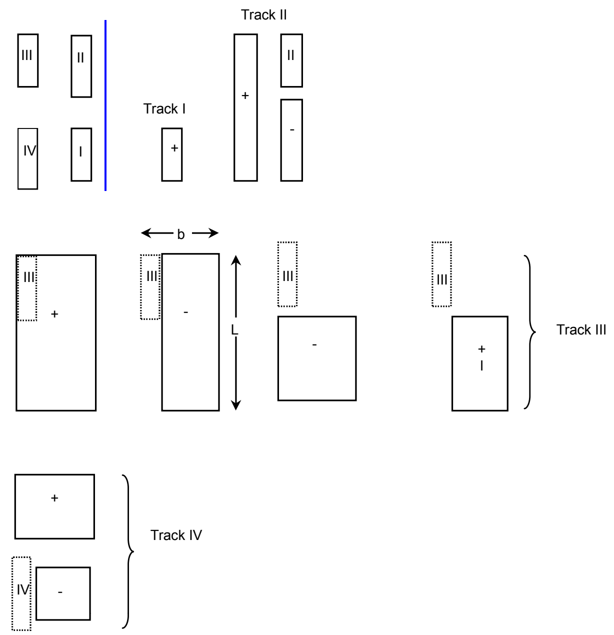
| **12" Diameter Leachate Collection Header System** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **0 Feet Waste** | | |

Load on Pipe

Alternative 1: Track Adjacent and Parallel to Pipe




| | b | L | z | m = b/z | n = L/z | I* | I** | I | |
|---|---|---|---|---|---|---|---|---|---|
| Track I | 8.2 | 3 | 4 | 2.05 | 0.81 | 0.182 | 0.241 | 0.18205 | (ADD) |
| | | | | | | | | | |
| Track II | 8.2 | 16.1 | 4 | 2.05 | 4.02 | -0.010 | 0.240 | 0.23973 | (ADD) |
| | 8.2 | 11.4 | 4 | 2.05 | 2.86 | -0.012 | 0.238 | 0.23802 | (SUBTRACT) |
| | | | | | | | | | |
| Track IV | 12.47 | 3.22 | 4 | 3.12 | 0.81 | 0.185 | 0.231 | 0.18478 | (ADD) |
| | 12.47 | 3.22 | 4 | 3.12 | 0.81 | 0.185 | 0.231 | 0.18478 | (SUBTRACT) |
| | | | | | | | | | |
| Track III | 12.47 | 16.08 | 4 | 3.12 | 4.02 | -0.004 | 0.246 | 0.24588 | (ADD) |
| | 4.27 | 16.08 | 4 | 1.07 | 4.02 | -0.041 | 0.209 | 0.20918 | (SUBTRACT) |
| | 12.47 | 11.42 | 4 | 3.12 | 2.86 | -0.006 | 0.244 | 0.24379 | (SUBTRACT) |
| | 4.27 | 8.47 | 4 | 1.07 | 2.12 | 0.206 | 0.226 | 0.20553 | (ADD) |

Live Load$_1$ = $q_r(\Sigma I) + q_{fr}(\Sigma II) + q_{fr}(\Sigma III) + q_r(\Sigma IV)$

Live Load$_1$ = 304.29 psf

SCS ENGINEERS

SHEET 3 OF 10

| CLIENT | PROJECT | JOB NO. |
|---|---|---|
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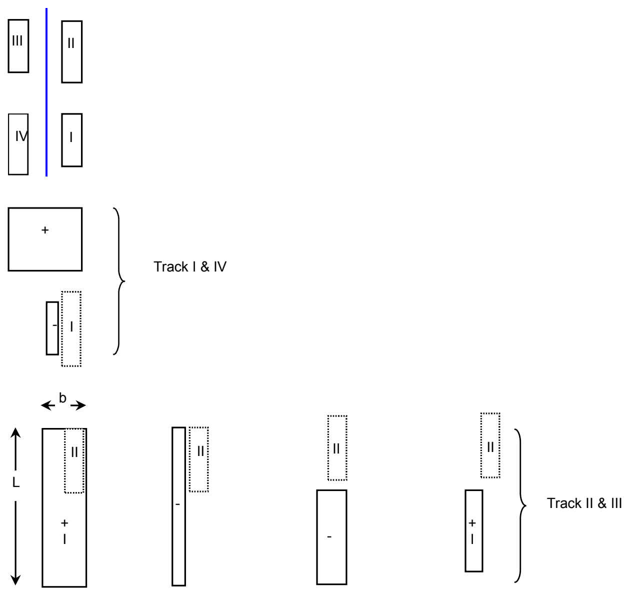
| SUBJECT | BY | DATE |
|---|---|---|
| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **12" Diameter Leachate Collection Header System** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **0 Feet Waste** | | |

Load on Pipe

Alternative 2: Track Stradling and Parallel to Pipe




| | b | L | z | m = b/z | n = L/z | I* | I** | I | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | |
| Track I | 6.2 | 3.2 | 4 | 1.6 | 0.8 | 0.177 | 0.250 | 0.17733 | (ADD) |
| & IV | -2.0 | 3.2 | 4 | -0.5 | 0.8 | -0.109 | 0.230 | -0.10926 | (SUBTRACT) |
| | | | | | | | | | |
| Track II | 6.2 | 16.08 | 4 | 1.6 | 4.0 | -0.019 | 0.231 | 0.23095 | (ADD) |
| & III | -2.0 | 16.08 | 4 | -0.5 | 4.0 | -0.135 | 0.255 | -0.13546 | (SUBTRACT) |
| | 6.2 | 12.86 | 4 | 1.6 | 3.2 | -0.020 | 0.230 | 0.23021 | (SUBTRACT) |
| | -2.0 | 12.86 | 4 | -0.5 | 3.2 | -0.135 | 0.253 | -0.13519 | (ADD) |

Live $Load_2 = [q_r(\Sigma I) + q_{fr}(\Sigma II)] * 2$

Live $Load_2 =$ 960.43 psf

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| CLIENT | PROJECT | JOB NO. |
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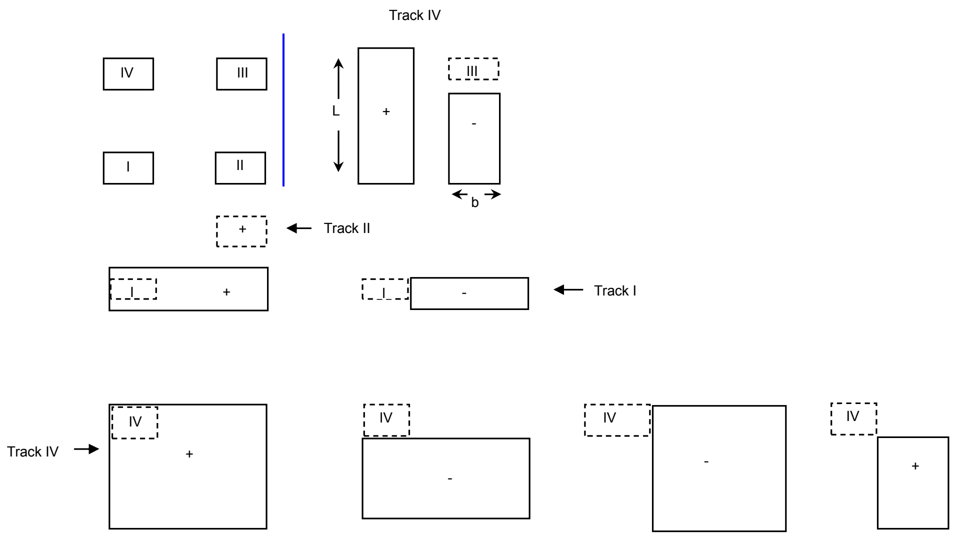
| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **12" Diameter Leachate Collection Header System** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **0 Feet Waste** | | |

Load on Pipe

Alternative 3: Track Perpendicular to Pipe




| | b | L | z | m = b/z | n = L/z | I* | I** | I | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | |
| Track I | 16.1 | 8.2 | 4 | 4.0 | 2.1 | -0.010 | 0.240 | 0.23973 | (ADD) |
| | 12.9 | 8.2 | 4 | 3.2 | 2.1 | -0.011 | 0.239 | 0.23883 | (SUBTRACT) |
| | | | | | | | | | |
| Track II | 3.2 | 8.2 | 4 | 0.8 | 2.1 | 0.182 | 0.241 | 0.18205 | (ADD) |
| | | | | | | | | | |
| Track III | 3.2 | 12.5 | 4 | 0.8 | 3.1 | 0.185 | 0.231 | 0.18478 | (ADD) |
| | 3.2 | 4.3 | 4 | 0.8 | 1.1 | 0.164 | 0.262 | 0.16364 | (SUBTRACT) |
| | | | | | | | | | |
| Track IV | 16.1 | 12.5 | 4 | 4.0 | 3.1 | -0.004 | 0.246 | 0.24588 | (ADD) |
| | 16.1 | 4.3 | 4 | 4.0 | 1.1 | -0.041 | 0.209 | 0.20918 | (SUBTRACT) |
| | 12.9 | 12.5 | 4 | 3.2 | 3.1 | -0.005 | 0.245 | 0.24477 | (SUBTRACT) |
| | 12.9 | 4.3 | 4 | 3.2 | 1.1 | 0.209 | 0.213 | 0.20863 | (ADD) |

Live Load$_3$ = $q_r(\Sigma I) + q_{fr}(\Sigma II) + q_{fr}(\Sigma III) + q_r(\Sigma IV)$

Live Load$_3$ = 315.70 psf

LARGEST EQUIPEMENT LOAD = 960.43 lb/ft$^2$

VERTICAL OVERBURDEN LOAD = 492.37 lb/ft$^2$

VERTICAL EQUIPMENT LOAD = 960.43 lb/ft$^2$

TOTAL VERTICAL LOAD APPLIED TO PIPE, $P_T$ = 1452.80 lb/ft$^2$ = 10.09 lb/in$^2$

| SCS ENGINEERS | | | |
|---|---|---|---|
| | | SHEET 5 | OF 10 |
| CLIENT<br>Hardee County | PROJECT<br>Phase II Section II Expansion | JOB NO.<br>09199033.23 | |
| SUBJECT<br>Pipe Crushing Calculations **RAI No. 1** | | BY<br>SRF | DATE<br>4/1/13 |
| **12" Diameter Leachate Collection Header System**<br>Operation w/ CAT 826G Series II Compactor **0 Feet Waste** | | CHECKED | DATE |

Verify that perforations in the LCRS are adequate for the peak leachate flow.

Use discharge equation:

$Q = (Cd)(Ao)(2gh)^{0.5}$

$C_d$ = coefficient of discharge = 0.6 for short tube discharge with fluid/wall separation; conservative value.

$A_o$ = Area of orifice ($\pi D^2/4$)

g = gravitational acceleration (32.3 $ft^2/s$)

h = static head (ft)

Assumptions and Givens:

| | | | |
|---|---|---|---|
| 1. No. acres of landfill expansion = | 4.55 | acres | North and center portion of landfill bottom |
| 2. Total length of pipe per expansion = | 138.8 | ft | |
| 3. Total number of laterals = | 1.0 | | |
| 4. Length of pipe per lateral = | 138.8 | ft | |
| 5. Perforation diameter = | 0.375 | inch | |
| 6. No. perforations/ft pipe = | 6.0 | perforations/ft of pipe length | |
| 7. Maximum head over pipe = | 1.0 | ft | |
| 8. Per HELP model summary table, $Q_{peak}$ = | 202.93 | gal/min | refer to HELP Model Summary Table |
| 9. Per HELP model summary table, $Q_{peak}$ = | 39,063.5 | cf/day | refer to HELP Model Summary Table |
| 10. Maximum flow/lateral = | 39,063.5 | cf/day/lateral | |
| 11. Maximum leachate flow/ft of pipe = | 281.44 | cf/day/ft of pipe | |

Solution:

$A_o = 0.25(\Pi)(d)^2 =$ 0.00077 $ft^2$

1. Flow per orifice, $Q = (Cd)(Ao)(2gh)^{0.5} =$ 0.0037 $ft^3/s$

2. Flow per ft of pipe = (Q)(# perfs/ft) = 0.02 $ft^3/s$ per ft of pipe

= 1914.47 cf/day/ft of pipe

Conclusion:

Design capacity exceeds estimated generation

1914.47 cf/day/ft of pipe >>> 281.44 cf/day/ft of pipe

Perforations are adequate to handle the maximum leachate flow.

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| **12" Diameter Leachate Collection Header System** | CHECKED | DATE |
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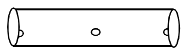
Effective pressure on pipe due to perforations:

$P_{EFF} = \dfrac{P_T \times 12}{(12-L_P)}$ Source 3, EPA SW-870, p. 382

$L_P$ = Total accumulated length of perforations in one foot of pipe.

Since each perforation is 0.375 inch diameter and spaced at 6.0 inch on center,

$L_P$ = 1.5 inch



$P_T$ = 10.1 psi

$P_{EFF}$ = 11.5 psi

$P_{EFF}$ = 1660.3 psf

Check actual compressive pressure ($S_A$) per Driscopipe manual:

$S_A$ = 0.5 x (SDR - 1) x P(eff) = 57.7 psi

The recommended, long-term compressive strength ($Y_s$) design value for Driscoplex polyethylene pipe is 800 lb/in$^2$.

Source No. 1

| $S_A$ (psi): | | $Y_s$ (psi): |
|---|---|---|
| 57.7 | < | 800.0 |

Pipe passes wall compressive stress perforation calculations TRUE

FS = 13.9

SCS ENGINEERS

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Constrained pipe wall buckling (for Driscoplex OD controlled pipe)

$P_{WC} = \dfrac{5.65 * \{RB'E'\ E*[12(DR-1)^3]^{-1}\}^{0.5}}{N}$ Source 1, Equation 7-5

$P_{WC}$ = allowable constrained buckling pressure (lb/in$^2$)

R = buoyancy reduction factor = 1 - 0.33 * (H'/H) Source 1, Equation 7-34

H' = groundwater height above pipe (ft) 0.0 ft

H = cover above pipe (ft) 4.0 ft

B' = elastic support factor =( 1+ 4*$e^{-0.065H}$ )$^{-1}$ Source 1, Equation 7-35

E' = soil reaction modulus (lb/in$^2$) 3000.0 lb/in$^2$ for mod comp/crushed rock, 'Source 1, Table 7-7

E = elastic modulus (lb/in$^2$) 100000.0 lb/in$^2$ for long term load at 100$^o$F, 'Source 1, Table 5-1

I = moment of inertia = $t^3$ / 12 0.1 in$^4$/in

$D_o$ = pipe outer diameter (in) 12.750 SDR 11 pipe (Driscopipe) to be used

t = pipe wall thickness (in) 1.159 SDR 11 pipe (Driscopipe) to be used

DR = pipe dimension ratio = $D_o$ / t 11.0 SDR 11 pipe (Driscopipe) to be used

$D_I$ = pipe inner diameter = $D_o$ - 2t (in) 10.4 SDR 11 pipe (Driscopipe) to be used

N = safety factor 2.0

| Cover (ft) | (ft) | (ft) | B' | R | (lb/in$^2$) |
|---|---|---|---|---|---|
| 4.0 | 4 | 0 | 0.24 | 1.00 | 220.99 |

$P_{WC}$ = 220.99 lb/in$^2$

$P_{EFF}$ = 11.53 lb/in$^2$

Pipe passes contrained wall buckling calculations TRUE FS = 19.2

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| Operation w/ CAT 826G Series II Compactor **0 Feet Waste** | | |

Constrained Pipe Wall Compressive Stress (for Driscoplex OD controlled pipe)

$$S = \frac{P_T D_o}{288t}$$ Source No. 1

S = pipe wall compressive stress ($lb/in^2$)

| | | |
|---|---|---|
| $P_T$ = vertical load applied to pipe w/ perfs ($lb/ft^2$) | 1660.3 | $lb/ft^2$ |
| $D_o$ = pipe outside diameter (in) | 12.75 | SDR 11 pipe (Driscopipe) to be used |
| t = pipe wall thickness (in) | 1.159 | SDR 11 pipe (Driscopipe) to be used |

$$S = \frac{P_T D_o}{288t} = 63.4 \ lb/in^2$$

The recommended, long-term compressive strength ($Y_s$) design value for Driscoplex polyethylene pipe is 800 $lb/in^2$.

Source No. 1

| S (psi): | | $Y_s$ (psi): |
|---|---|---|
| 63.4 | < | 800.0 |

Pipe passes wall compressive stress calculations TRUE

FS = 12.6

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| Operation w/ CAT 826G Series II Compactor **0 Feet Waste** | | |

Iowa Formula

$$\Delta X = \frac{D_L K W_c r^3}{EI + 0.06er^4}$$ Source 2, Equation 3.4 Buried Pipe Design, A.P. Moser, Chapter 3

$\Delta X$ = horizontal deflection (in)

$D_L$ = deflection lag factor

K = bedding constant — 0.1 — typical value Source 2, Buried Pipe Design, A.P. Moser, Chapter 3

$W_c$ = Marston's load per unit length of pipe (lb/in)

r = mean radius of the pipe (in)

E = modulus of elasticity (lb/in$^2$)

I = moment of inertia of the pipe wall per unit length (in$^3$)

e = modulus of passive resistance fo the side fill (lb/in$^2$(in))

Modified Iowa Formula

$$\Delta X = \frac{D_L K W_c r_m^3}{EI + 0.06E'r_m^3}$$ Source 2, Equation 3.5 Buried Pipe Design, A.P. Moser, Chapter 3

$\Delta X$ = horizontal deflection (in)

| | | | | | |
|---|---|---|---|---|---|
| $D_L$ = deflection lag factor | | 1.0 | Prism Load used | | |
| Typical Value for Marston Load | 1.5 | | | | |
| Typical Value for Prism Load | 1.0 | | | | |
| K = bedding constant | | 0.1 | typical value Buried Pipe Design, A.P. Moser, Chapter 3 | | |
| $P_T$ = Vertical load on pipe w/ perfs | | 11.53 | lb/in$^2$ | 1660 | lb/ft$^2$ |
| $W_c$ = Marston's load per unit length of pipe = $P_T$ * $D_o$ (lb/in) | | 147.01 | lb/in | | |
| $D_o$ = pipe outer diameter (in) | | 12.75 | SDR 11 pipe (Driscopipe) to be used | | |
| t = pipe wall thickness (in) | | 1.16 | SDR 11 pipe (Driscopipe) to be used | | |
| $D_I$ = pipe inner diameter = $D_o$-2t (in) | | 10.43 | SDR 11 pipe (Driscopipe) to be used | | |
| $D_m$ = pipe mean diameter = $D_o$ - 1.06t Source 1, Equation 7-27 | | 11.52 | SDR 11 pipe (Driscopipe) to be used | | |
| $r_m$ = mean radius of the pipe (in) | | 5.76 | SDR 11 pipe (Driscopipe) to be used | | |
| E = modulus of elasticity (lb/in$^2$) | | 100,000.0 | lb/in2 for long term load at 100oF, 'Source 1, Table 5-1 | | |
| I = moment of inertia of the pipe wall per unit length | | 0.130 | in$^4$/in | | |
| E' = modulus of soil reaction | | 3,000.0 | lb/in$^2$ for moderate compaction and fine grained soils | | |

$$\Delta X = \frac{D_L K W_c r_m^3}{EI + 0.06E'r_m^3} = 0.059 \text{ inch}$$ Source 2, Equation 3.5 Buried Pipe Design, A.P. Moser, Chapter 3

% Ring Deflection = ($\Delta X/D_m$) x 100 = 0.51% Source 1, Equation 7-31

Ring Bending Strain

$$e = \frac{f_D \Delta X 2C}{D_M^2} \times 100$$ Source 1, Equation 7-39

e = wall strain (%)

$f_D$ = deformation shape factor — 6 — Source 1, non-elliptical shape

$D_M$ = mean diameter (in)

C = outer fiber wall centroid = 0.5 (1.06t) — 0.614 — Source 1, Equation 7-41

$\Delta X$ = ring deflection = $D_X/D_m$ — 0.005

$$e = f_D \left(\frac{\Delta X}{D_M}\right)\left(\frac{2C}{D_M}\right) \times 100 = 0.3\%$$ Source 1, Equation 7-39

The maximum ring bending strain for high performance polyethylene non-pressure pipe is = 5.0%

Pipe passes ring bending strain calculations TRUE

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SOURCES

1.) Attachment - 1 - Chevron Phillips Chemical Company, Bulletin - Book 2 Chapter 5, 2003

2.) Attachment - 2 - Buried Pipe Design, A.P. Moser, Chapter 3

3.) Attachment - 3 - EPA, Lining of Waste Impoundment and Disposal Facilities, SW-870

4.) Attachment - 4 - Driscoplex Pipe Properties

5.) Attachment - 5 - CAT 826G Series II Compactor Data Sheet

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Load on Pipe (Overburden)

Prism Loads, $P_E$ = wH

w = unit weight

H = depth

| | Depth (ft) | Unit Weight ($lb/ft^3$) | $P_E$ ($lb/ft^2$) |
|---|---|---|---|
| Final cover | 0.0 | 115.0 | 0.0 |
| Intermediate cover | 0.0 | 115.0 | 0.0 |
| Waste/cover | 10.0 | 60.0 | 600.0 |
| Drainage sand | 2.0 | 115.0 | 230.0 |
| Rock (No. 89 & No. 57) | 2.0 | 140.0 | 280.0 |

TOTAL SOIL PRISM LOAD $P_E$: 1110.0 $lb/ft^2$

Total Depth = 14.0 ft

Soil Arching, $P_m = C_D wB$

NOTE: The waste unit weight represents the combined unit weight of waste, daily cover, and moisture.

Pm = vertical soil pressure

B = trench width at pipe crown 6.0 ft

$C_D$ = load coefficient $= \frac{1 - e^{-2Ku'H/B}}{2Ku'}$ Equation 7-3, Source No. 1

e = natural log base number

K = Rankine earth pressure coefficient = $\tan^2(45-0.5*\phi)$

$\phi$ = internal soil friction angle = 27.0 degrees

u' = friction coefficient between backfill and trench sides = tan $\phi$

| Soil Type | Ku' |
|---|---|
| Saturated Clay | 0.110 |
| Ordinary Clay | 0.130 |
| Saturated Top Soil | 0.150 |
| Sand and Gravel | 0.165 |
| Clean Granular Soil | 0.192 |

| | Ku' | $C_D$ | $P_m$ ($lb/ft^2$) |
|---|---|---|---|
| Cover Soil | 0.150 | 0.00 | 0 |
| Int Cover | 0.165 | 0.00 | 0 |
| Waste | 0.191 | 1.23 | 444 |
| Drainage Sand | 0.165 | 0.32 | 217.8 |
| Granular Soil | 0.192 | 0.31 | 262.8 |

TOTAL SOIL ARCHING LOAD $P_M$: 924.2 $lb/ft^2$

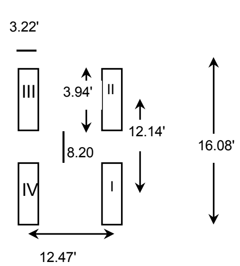
MODIFIED ARCHING LOAD = $0.6P_M+0.4P_E$: 998.53 $lb/ft^2$

OVERBURDEN LOAD: 998.53 $lb/ft^2$

Load on Pipe With Equipment Refer to Attachment

Operation w/ CAT 826G Series II Compactor 10 Feet Waste

Equipment Weight = 81,498.0 psf




| | | | |
|---|---|---|---|
| Track per Load = $q_r$ = | 1,670.20 | psf | (Rear) |
| Track per Load = $q_{fr}$ = | 1,541.72 | psf | (Front) |
| Length of Track = L = | 3.22 | ft | (contact length) |
| Length of Track = b = | 8.20 | ft | |
| Track Width = | 12.47 | ft | |
| Track Width (I to II) = | 16.08 | ft | |

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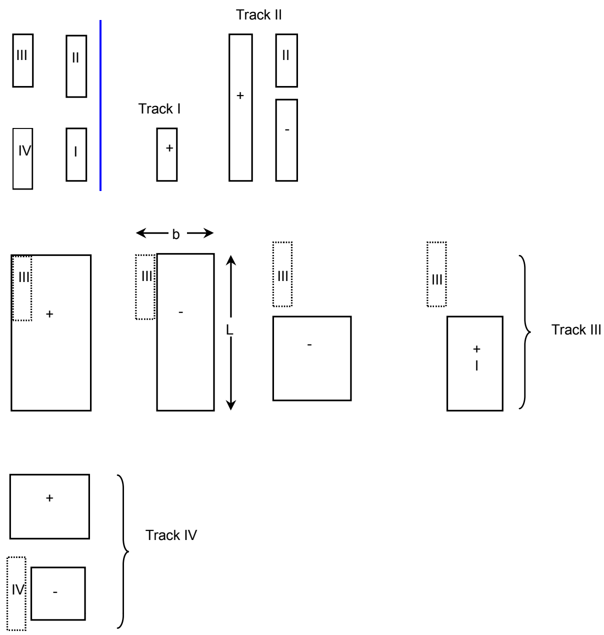
| **12" Diameter Leachate Collection Header System** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **10 Feet Waste** | | |

Load on Pipe

Alternative 1: Track Adjacent and Parallel to Pipe




| | b | L | z | m = b/z | n = L/z | I* | I** | I | |
|---|---|---|---|---|---|---|---|---|---|
| Track I | 8.2 | 3 | 14 | 0.59 | 0.23 | 0.049 | 0.263 | 0.04882 | (ADD) |
| | | | | | | | | | |
| Track II | 8.2 | 16.1 | 14 | 0.59 | 1.15 | 0.139 | 0.265 | 0.13939 | (ADD) |
| | 8.2 | 11.4 | 14 | 0.59 | 0.82 | 0.124 | 0.270 | 0.12392 | (SUBTRACT) |
| | | | | | | | | | |
| Track IV | 12.47 | 3.22 | 14 | 0.89 | 0.23 | 0.060 | 0.262 | 0.05999 | (ADD) |
| | 12.47 | 3.22 | 14 | 0.89 | 0.23 | 0.060 | 0.262 | 0.05999 | (SUBTRACT) |
| | | | | | | | | | |
| Track III | 12.47 | 16.08 | 14 | 0.89 | 1.15 | 0.175 | 0.258 | 0.17489 | (ADD) |
| | 4.27 | 16.08 | 14 | 0.31 | 1.15 | 0.084 | 0.263 | 0.08363 | (SUBTRACT) |
| | 12.47 | 11.42 | 14 | 0.89 | 0.82 | 0.154 | 0.266 | 0.15446 | (SUBTRACT) |
| | 4.27 | 8.47 | 14 | 0.31 | 0.61 | 0.064 | 0.266 | 0.06417 | (ADD) |

Live Load$_1$ = $q_r (\Sigma I) + q_{fr} (\Sigma II) + q_{fr} (\Sigma III) + q_r (\Sigma IV)$

Live Load$_1$ = 106.88 psf

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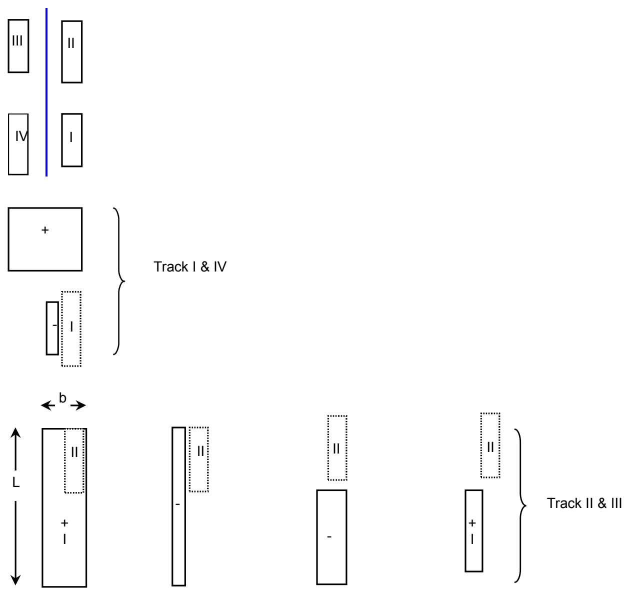
Load on Pipe

Alternative 2: Track Stradling and Parallel to Pipe




| | b | L | z | m = b/z | n = L/z | I* | I** | I | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | |
| Track I | 6.2 | 3.2 | 14 | 0.4 | 0.2 | 0.041 | 0.261 | 0.04054 | (ADD) |
| & IV | -2.0 | 3.2 | 14 | -0.1 | 0.2 | -0.015 | 0.245 | -0.01454 | (SUBTRACT) |
| | | | | | | | | | |
| Track II | 6.2 | 16.08 | 14 | 0.4 | 1.1 | 0.115 | 0.265 | 0.11458 | (ADD) |
| & III | -2.0 | 16.08 | 14 | -0.1 | 1.1 | -0.040 | 0.243 | -0.04040 | (SUBTRACT) |
| | 6.2 | 12.86 | 14 | 0.4 | 0.9 | 0.107 | 0.268 | 0.10711 | (SUBTRACT) |
| | -2.0 | 12.86 | 14 | -0.1 | 0.9 | -0.038 | 0.242 | -0.03788 | (ADD) |

Live Load$_2$ = $[q_r(\Sigma I) + q_{fr}(\Sigma II)] * 2$

Live Load$_2$ = 214.77 psf

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| CLIENT | PROJECT | JOB NO. |
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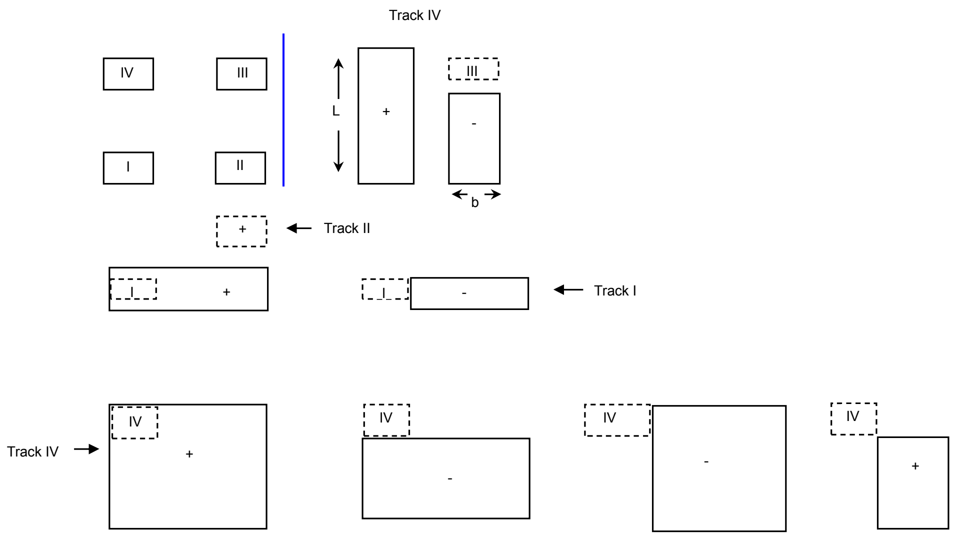
| SUBJECT | BY | DATE |
|---|---|---|
| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **12" Diameter Leachate Collection Header System** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **10 Feet Waste** | | |

Load on Pipe

Alternative 3: Track Perpendicular to Pipe




| | b | L | z | m = b/z | n = L/z | I* | I** | I | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | |
| Track I | 16.1 | 8.2 | 14 | 1.1 | 0.6 | 0.139 | 0.265 | 0.13939 | (ADD) |
| | 12.9 | 8.2 | 14 | 0.9 | 0.6 | 0.130 | 0.269 | 0.13005 | (SUBTRACT) |
| | | | | | | | | | |
| Track II | 3.2 | 8.2 | 14 | 0.2 | 0.6 | 0.049 | 0.263 | 0.04882 | (ADD) |
| | | | | | | | | | |
| Track III | 3.2 | 12.5 | 14 | 0.2 | 0.9 | 0.060 | 0.262 | 0.05999 | (ADD) |
| | 3.2 | 4.3 | 14 | 0.2 | 0.3 | 0.030 | 0.259 | 0.02986 | (SUBTRACT) |
| | | | | | | | | | |
| Track IV | 16.1 | 12.5 | 14 | 1.1 | 0.9 | 0.175 | 0.258 | 0.17489 | (ADD) |
| | 16.1 | 4.3 | 14 | 1.1 | 0.3 | 0.084 | 0.263 | 0.08363 | (SUBTRACT) |
| | 12.9 | 12.5 | 14 | 0.9 | 0.9 | 0.162 | 0.264 | 0.16248 | (SUBTRACT) |
| | 12.9 | 4.3 | 14 | 0.9 | 0.3 | 0.078 | 0.265 | 0.07831 | (ADD) |

Live $\text{Load}_3 = q_r(\Sigma I) + q_{fr}(\Sigma II) + q_{fr}(\Sigma III) + q_r(\Sigma IV)$

Live $\text{Load}_3 =$ 149.14 psf

LARGEST EQUIPEMENT LOAD = 214.77 $lb/ft^2$

VERTICAL OVERBURDEN LOAD = 998.53 $lb/ft^2$

VERTICAL EQUIPMENT LOAD = 214.77 $lb/ft^2$

TOTAL VERTICAL LOAD APPLIED TO PIPE, $P_T$ = 1213.30 $lb/ft^2$ = 8.43 $lb/in^2$

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Verify that perforations in the LCRS are adequate for the peak leachate flow.

Use discharge equation:

$Q = (Cd)(Ao)(2gh)^{0.5}$

$C_d$ = coeffiecient of discharge = 0.6 for short tube discharge with fluid/wall separation; conservative value.

$A_o$ = Area of orifice ($\pi D^2/4$)

g = gravitational acceleration (32.3 $ft^2/s$)

h = static head (ft)

Assumptions and Givens:

| | | | |
|---|---|---|---|
| 1. No. acres of landfill expansion = | 4.55 | acres | North and center portion of landfill bottom |
| 2. Total length of pipe per expansion = | 138.8 | ft | |
| 3. Total number of laterals = | 1.0 | | |
| 4. Length of pipe per lateral = | 138.8 | ft | |
| 5. Perforation diameter = | 0.375 | inch | |
| 6. No. perforations/ft pipe = | 6.0 | perforations/ft of pipe length | |
| 7. Maximum head over pipe = | 1.0 | ft | |
| 8. Per HELP model summary table, $Q_{peak}$ = | 202.93 | gal/min | refer to HELP Model Summary Table |
| 9. Per HELP model summary table, $Q_{peak}$ = | 39,063.5 | cf/day | refer to HELP Model Summary Table |
| 10. Maximum flow/lateral = | 39,063.5 | cf/day/lateral | |
| 11. Maximum leachate flow/ft of pipe = | 281.44 | cf/day/ft of pipe | |

Solution:

$A_o = 0.25(\Pi)(d)^2 =$ 0.00077 $ft^2$

1. Flow per orifice, $Q = (Cd)(Ao)(2gh)^{0.5} =$ 0.0037 $ft^3/s$

2. Flow per ft of pipe = (Q)(# perfs/ft) = 0.02 $ft^3/s$ per ft of pipe

= 1914.47 cf/day/ft of pipe

Conclusion:

Design capacity exceeds estimated generation

1914.47 cf/day/ft of pipe >>> 281.44 cf/day/ft of pipe

Perforations are adequate to handle the maximum leachate flow.

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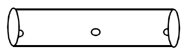
Effective pressure on pipe due to perforations:

$$P_{EFF} = \frac{P_T \times 12}{(12-L_P)}$$ Source 3, EPA SW-870, p. 382

$L_P$ = Total accumulated length of perforations in one foot of pipe.

Since each perforation is 0.375 inch diameter and spaced at 6.0 inch on center,

$L_P$ = 1.5 inch



$P_T$ = 8.4 psi

$P_{EFF}$ = 9.6 psi

$P_{EFF}$ = 1386.6 psf

Check actual compressive pressure ($S_A$) per Driscopipe manual:

$S_A$ = 0.5 x (SDR - 1) x P(eff) = 48.2 psi

The recommended, long-term compressive strength ($Y_s$) design value for Driscoplex polyethylene pipe is 800 lb/in$^2$.

Source No. 1

| $S_A$ (psi): | | $Y_s$ (psi): |
|---|---|---|
| 48.2 | < | 800.0 |

Pipe passes wall compressive stress perforation calculations TRUE

FS = 16.6

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| Operation w/ CAT 826G Series II Compactor **10 Feet Waste** | | |

Constrained pipe wall buckling (for Driscoplex OD controlled pipe)

$P_{WC} = \frac{5.65 * \{RB'E' E*[12(DR-1)^3]^{-1}\}^{0.5}}{N}$ Source 1, Equation 7-5

$P_{WC}$ = allowable constrained buckling pressure (lb/in$^2$)

| | | |
|---|---|---|
| R = buoyancy reduction factor = 1 - 0.33 * (H'/H) | Source 1, Equation 7-34 | |
| H' = groundwater height above pipe (ft) | 0.0 | ft |
| H = cover above pipe (ft) | 14.0 | ft |
| B' = elastic support factor =( 1+ 4*$e^{-0.065H}$ )$^{-1}$ | Source 1, Equation 7-35 | |
| E' = soil reaction modulus (lb/in$^2$) | 3000.0 | lb/in$^2$ for mod comp/crushed rock, 'Source 1, Table 7-7 |
| E = elastic modulus (lb/in$^2$) | 100000.0 | lb/in$^2$ for long term load at 100°F, 'Source 1, Table 5-1 |
| I = moment of inertia = $t^3$ / 12 | 0.1 | in$^4$/in |
| $D_o$ = pipe outer diameter (in) | 12.750 | SDR 11 pipe (Driscopipe) to be used |
| t = pipe wall thickness (in) | 1.159 | SDR 11 pipe (Driscopipe) to be used |
| DR = pipe dimension ratio = $D_o$ / t | 11.0 | SDR 11 pipe (Driscopipe) to be used |
| $D_I$ = pipe inner diameter = $D_o$ - 2t (in) | 10.4 | SDR 11 pipe (Driscopipe) to be used |
| N = safety factor | 2.0 | |

| Cover (ft) | (ft) | (ft) | B' | R | (lb/in$^2$) |
|---|---|---|---|---|---|
| 14.0 | 14 | 0 | 0.38 | 1.00 | 276.44 |

$P_{WC}$ = 276.44 lb/in$^2$

$P_{EFF}$ = 9.63 lb/in$^2$

Pipe passes contrained wall buckling calculations TRUE FS = 28.7

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| Operation w/ CAT 826G Series II Compactor **10 Feet Waste** | | |

Constrained Pipe Wall Compressive Stress (for Driscoplex OD controlled pipe)

$$S = \frac{P_T D_o}{288t}$$ Source No. 1

S = pipe wall compressive stress (lb/in$^2$)

$P_T$ = vertical load applied to pipe w/ perfs (lb/ft$^2$) 1386.6 lb/ft$^2$

$D_o$ = pipe outside diameter (in) 12.75 SDR 11 pipe (Driscopipe) to be used

t = pipe wall thickness (in) 1.159 SDR 11 pipe (Driscopipe) to be used

$$S = \frac{P_T D_o}{288t} = 53.0 \text{ lb/in}^2$$

The recommended, long-term compressive strength ($Y_s$) design value for Driscoplex polyethylene pipe is 800 lb/in$^2$.

Source No. 1

| S (psi): | | $Y_s$ (psi): |
|---|---|---|
| 53.0 | < | 800.0 |

Pipe passes wall compressive stress calculations TRUE

FS = 15.1

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| Operation w/ CAT 826G Series II Compactor **10 Feet Waste** | | | |

Iowa Formula

$$\Delta X = \frac{D_L K W_c r^3}{EI + 0.06er^4}$$ Source 2, Equation 3.4 Buried Pipe Design, A.P. Moser, Chapter 3

$\Delta X$ = horizontal deflection (in)
$D_L$ = deflection lag factor
K = bedding constant — 0.1 typical value Source 2, Buried Pipe Design, A.P. Moser, Chapter 3
$W_c$ = Marston's load per unit length of pipe (lb/in)
r = mean radius of the pipe (in)
E = modulus of elasticity ($lb/in^2$)
I = moment of inertia of the pipe wall per unit length ($in^3$)
e = modulus of passive resistance fo the side fill ($lb/in^2(in)$)

Modified Iowa Formula

$$\Delta X = \frac{D_L K W_c r_m^3}{EI + 0.06E'r_m^3}$$ Source 2, Equation 3.5 Buried Pipe Design, A.P. Moser, Chapter 3

| | | | |
|---|---|---|---|
| $\Delta X$ = horizontal deflection (in) | | | |
| $D_L$ = deflection lag factor | | 1.0 | Prism Load used |
| Typical Value for Marston Load | 1.5 | | |
| Typical Value for Prism Load | 1.0 | | |
| K = bedding constant | | 0.1 | typical value Buried Pipe Design, A.P. Moser, Chapter 3 |
| $P_T$ = Vertical load on pipe w/ perfs | | 9.63 | $lb/in^2$ — 1387 $lb/ft^2$ |
| $W_c$ = Marston's load per unit length of pipe = $P_T * D_o$ (lb/in) | | 122.77 | lb/in |
| $D_o$ = pipe outer diameter (in) | | 12.75 | SDR 11 pipe (Driscopipe) to be used |
| t = pipe wall thickness (in) | | 1.16 | SDR 11 pipe (Driscopipe) to be used |
| $D_I$ = pipe inner diameter = $D_o$-2t (in) | | 10.43 | SDR 11 pipe (Driscopipe) to be used |
| $D_m$ = pipe mean diameter = $D_o$ - 1.06t Source 1, Equation 7-27 | | 11.52 | SDR 11 pipe (Driscopipe) to be used |
| $r_m$ = mean radius of the pipe (in) | | 5.76 | SDR 11 pipe (Driscopipe) to be used |
| E = modulus of elasticity ($lb/in^2$) | | 100,000.0 | lb/in2 for long term load at 100oF, 'Source 1, Table 5-1 |
| I = moment of inertia of the pipe wall per unit length | | 0.130 | $in^4/in$ |
| E' = modulus of soil reaction | | 3,000.0 | $lb/in^2$ for moderate compaction and fine grained soils |

$$\Delta X = \frac{D_L K W_c r_m^3}{EI + 0.06E'r_m^3} = 0.050 \text{ inch}$$ Source 2, Equation 3.5 Buried Pipe Design, A.P. Moser, Chapter 3

% Ring Deflection = $(\Delta X/D_m) \times 100$ = 0.43% Source 1, Equation 7-31

Ring Bending Strain

$$e = \frac{f_D \Delta X 2C}{D_M^2} \times 100$$ Source 1, Equation 7-39

| | | |
|---|---|---|
| e = wall strain (%) | | |
| $f_D$ = deformation shape factor | 6 | Source 1, non-elliptical shape |
| $D_M$ = mean diameter (in) | | |
| C = outer fiber wall centroid = 0.5 (1.06t) | 0.614 | Source 1, Equation 7-41 |
| $\Delta X$ = ring deflection = $D_X/D_m$ | 0.004 | |

$$e = f_D \frac{\Delta X}{D_M} \frac{2C}{D_M} \times 100 = 0.3\%$$ Source 1, Equation 7-39

The maximum ring bending strain for high performance polyethylene non-pressure pipe is = 5.0%

Pipe passes ring bending strain calculations: TRUE

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<u>SOURCES</u>

1.) Attachment - 1 - Chevron Phillips Chemical Company, Bulletin - Book 2 Chapter 5, 2003

2.) Attachment - 2 - Buried Pipe Design, A.P. Moser, Chapter 3

3.) Attachment - 3 - EPA, Lining of Waste Impoundment and Disposal Facilities, SW-870

4.) Attachment - 4 - Driscoplex Pipe Properties

5.) Attachment - 5 - CAT 826G Series II Compactor Equipment Data Sheet

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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **12" Diameter Leachate Collection Header System** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **25 Feet Waste** | | |

Load on Pipe (Overburden)

Prism Loads, $P_E = wH$

w = unit weight

H = depth

| | Depth (ft) | Unit Weight ($lb/ft^3$) | $P_E$ ($lb/ft^2$) |
|---|---|---|---|
| Final cover | 0.0 | 115.0 | 0.0 |
| Intermediate cover | 0.0 | 115.0 | 0.0 |
| Waste/cover | 25.0 | 60.0 | 1500.0 |
| Drainage sand | 2.0 | 115.0 | 230.0 |
| Rock (No. 89 & No. 57) | 2.0 | 140.0 | 280.0 |

TOTAL SOIL PRISM LOAD $P_E$: 2010.0 $lb/ft^2$

Total Depth = 29.0 ft

Soil Arching, $P_m = C_D w B$

Pm = vertical soil pressure

B = trench width at pipe crown 6.0 ft

$C_D$ = load coefficient $= \dfrac{1 - e^{-2Ku'H/B}}{2Ku'}$ Equation 7-3, Source No. 1

e = natural log base number

K = Rankine earth pressure coefficient = $\tan^2(45-0.5*\phi)$

$\phi$ = internal soil friction angle = 27.0 degrees

u' = friction coefficient between backfill and trench sides = tan $\phi$

NOTE: The waste unit weight represents the combined unit weight of waste, daily cover, and moisture.

| Soil Type | Ku' |
|---|---|
| Saturated Clay | 0.110 |
| Ordinary Clay | 0.130 |
| Saturated Top Soil | 0.150 |
| Sand and Gravel | 0.165 |
| Clean Granular Soil | 0.192 |

| | Ku' | $C_D$ | $P_m$ ($lb/ft^2$) |
|---|---|---|---|
| Cover Soil | 0.150 | 0.00 | 0 |
| Int Cover | 0.165 | 0.00 | 0 |
| Waste | 0.191 | 2.08 | 750 |
| Drainage Sand | 0.165 | 0.32 | 217.8 |
| Granular Soil | 0.192 | 0.31 | 262.8 |

TOTAL SOIL ARCHING LOAD $P_M$: 1,230.4 $lb/ft^2$

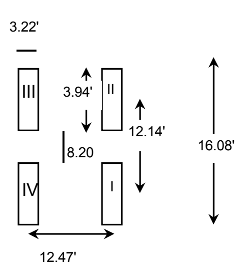
MODIFIED ARCHING LOAD = $0.6P_M+0.4P_E$: 1,542.23 $lb/ft^2$

OVERBURDEN LOAD: 1,542.23 $lb/ft^2$

Load on Pipe With Equipment Refer to Attachment

Operation w/ CAT 826G Series II Compactor 25 Feet Waste

Equipment Weight = 81,498.0 psf




| | | | |
|---|---|---|---|
| Track per Load = $q_r$ = | 1,670.20 | psf | (Rear) |
| Track per Load = $q_{fr}$ = | 1,541.72 | psf | (Front) |
| Length of Track = L = | 3.22 | ft | (contact length) |
| Length of Track = b = | 8.20 | ft | |
| Track Width = | 12.47 | ft | |
| Track Width (I to II) = | 16.08 | ft | |

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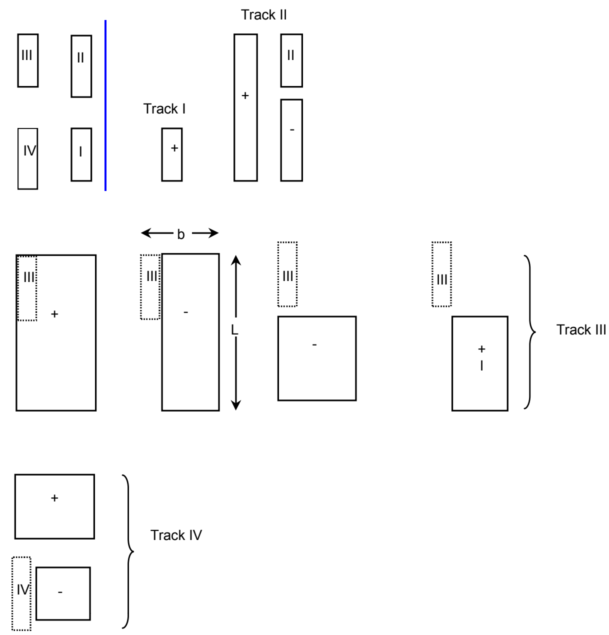
| Operation w/ CAT 826G Series II Compactor **25 Feet Waste** | | |

Load on Pipe

Alternative 1: Track Adjacent and Parallel to Pipe




| | b | L | z | m = b/z | n = L/z | I* | I** | I | |
|---|---|---|---|---|---|---|---|---|---|
| Track I | 8.2 | 3 | 29 | 0.28 | 0.11 | 0.014 | 0.254 | 0.01393 | (ADD) |
| | | | | | | | | | |
| Track II | 8.2 | 16.1 | 29 | 0.28 | 0.55 | 0.057 | 0.265 | 0.05688 | (ADD) |
| | 8.2 | 11.4 | 29 | 0.28 | 0.39 | 0.044 | 0.263 | 0.04447 | (SUBTRACT) |
| | | | | | | | | | |
| Track IV | 12.47 | 3.22 | 29 | 0.43 | 0.11 | 0.020 | 0.256 | 0.01966 | (ADD) |
| | 12.47 | 3.22 | 29 | 0.43 | 0.11 | 0.020 | 0.256 | 0.01966 | (SUBTRACT) |
| | | | | | | | | | |
| Track III | 12.47 | 16.08 | 29 | 0.43 | 0.55 | 0.081 | 0.269 | 0.08065 | (ADD) |
| | 4.27 | 16.08 | 29 | 0.15 | 0.55 | 0.031 | 0.258 | 0.03090 | (SUBTRACT) |
| | 12.47 | 11.42 | 29 | 0.43 | 0.39 | 0.063 | 0.267 | 0.06292 | (SUBTRACT) |
| | 4.27 | 8.47 | 29 | 0.15 | 0.29 | 0.019 | 0.256 | 0.01886 | (ADD) |

$\text{Live Load}_1 = q_r(\Sigma I) + q_{fr}(\Sigma II) + q_{fr}(\Sigma III) + q_r(\Sigma IV)$

$\text{Live Load}_1 =$ 51.18 psf

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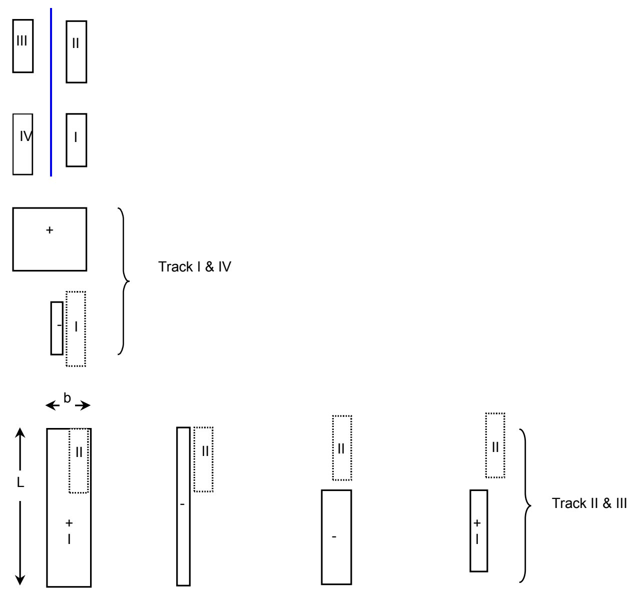
Load on Pipe

Alternative 2: Track Stradling and Parallel to Pipe




| | b | L | z | m = b/z | n = L/z | I* | I** | I | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | |
| Track I | 6.2 | 3.2 | 29 | 0.2 | 0.1 | 0.011 | 0.253 | 0.01087 | (ADD) |
| & IV | -2.0 | 3.2 | 29 | -0.1 | 0.1 | -0.004 | 0.249 | -0.00354 | (SUBTRACT) |
| | | | | | | | | | |
| Track II | 6.2 | 16.08 | 29 | 0.2 | 0.6 | 0.044 | 0.262 | 0.04431 | (ADD) |
| & III | -2.0 | 16.08 | 29 | -0.1 | 0.6 | -0.014 | 0.246 | -0.01441 | (SUBTRACT) |
| | 6.2 | 12.86 | 29 | 0.2 | 0.4 | 0.038 | 0.261 | 0.03796 | (SUBTRACT) |
| | -2.0 | 12.86 | 29 | -0.1 | 0.4 | -0.012 | 0.246 | -0.01235 | (ADD) |

Live $Load_2$ = $[q_r (\Sigma I) + q_{fr} (\Sigma II)] * 2$

Live $Load_2$ = 74.06 psf

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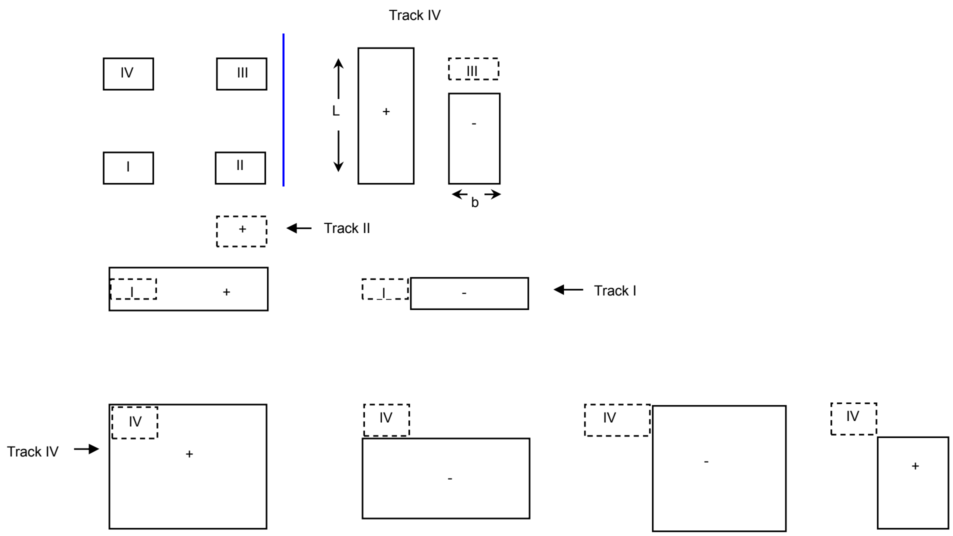
Load on Pipe

Alternative 3: Track Perpendicular to Pipe




| | b | L | z | m = b/z | n = L/z | I* | I** | I | |
|---|---|---|---|---|---|---|---|---|---|
| Track I | 16.1 | 8.2 | 29 | 0.6 | 0.3 | 0.057 | 0.265 | 0.05688 | (ADD) |
| | 12.9 | 8.2 | 29 | 0.4 | 0.3 | 0.049 | 0.264 | 0.04871 | (SUBTRACT) |
| Track II | 3.2 | 8.2 | 29 | 0.1 | 0.3 | 0.014 | 0.254 | 0.01393 | (ADD) |
| Track III | 3.2 | 12.5 | 29 | 0.1 | 0.4 | 0.020 | 0.256 | 0.01966 | (ADD) |
| | 3.2 | 4.3 | 29 | 0.1 | 0.1 | 0.008 | 0.252 | 0.00759 | (SUBTRACT) |
| Track IV | 16.1 | 12.5 | 29 | 0.6 | 0.4 | 0.081 | 0.269 | 0.08065 | (ADD) |
| | 16.1 | 4.3 | 29 | 0.6 | 0.1 | 0.031 | 0.258 | 0.03090 | (SUBTRACT) |
| | 12.9 | 12.5 | 29 | 0.4 | 0.4 | 0.069 | 0.268 | 0.06896 | (SUBTRACT) |
| | 12.9 | 4.3 | 29 | 0.4 | 0.1 | 0.026 | 0.258 | 0.02649 | (ADD) |

Live $Load_3$ = $q_r(\Sigma I) + q_{fr}(\Sigma II) + q_{fr}(\Sigma III) + q_r(\Sigma IV)$

Live $Load_3$ = 65.88 psf

LARGEST EQUIPEMENT LOAD = 74.06 $lb/ft^2$

VERTICAL OVERBURDEN LOAD = 1542.23 $lb/ft^2$

VERTICAL EQUIPMENT LOAD = 74.06 $lb/ft^2$

TOTAL VERTICAL LOAD APPLIED TO PIPE, $P_T$ = 1616.28 $lb/ft^2$ = 11.22 $lb/in^2$

| CLIENT | PROJECT | JOB NO. |
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| SUBJECT | BY | DATE |
|---|---|---|
| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **12" Diameter Leachate Collection Header System** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **25 Feet Waste** | | |

Verify that perforations in the LCRS are adequate for the peak leachate flow.

Use discharge equation:

$Q = (Cd)(Ao)(2gh)^{0.5}$

$C_d$ = coeffiecient of discharge = 0.6 for short tube discharge with fluid/wall separation; conservative value.

$A_o$ = Area of orifice ($\pi D^2/4$)

g = gravitational acceleration (32.3 $ft^2/s$)

h = static head (ft)

Assumptions and Givens:

| | | | |
|---|---|---|---|
| 1. No. acres of landfill expansion = | 4.55 | acres | North and center portion of landfill bottom |
| 2. Total length of pipe per expansion = | 138.8 | ft | |
| 3. Total number of laterals = | 1.0 | | |
| 4. Length of pipe per lateral = | 138.8 | ft | |
| 5. Perforation diameter = | 0.375 | inch | |
| 6. No. perforations/ft pipe = | 6.0 | perforations/ft of pipe length | |
| 7. Maximum head over pipe = | 1.0 | ft | |
| 8. Per HELP model summary table, $Q_{peak}$ = | 202.93 | gal/min | refer to HELP Model Summary Table |
| 9. Per HELP model summary table, $Q_{peak}$ = | 39,063.5 | cf/day | refer to HELP Model Summary Table |
| 10. Maximum flow/lateral = | 39,063.5 | cf/day/lateral | |
| 11. Maximum leachate flow/ft of pipe = | 281.44 | cf/day/ft of pipe | |

Solution:

$A_o = 0.25(\Pi)(d)^2 =$ 0.00077 $ft^2$

1. Flow per orifice, $Q = (Cd)(Ao)(2gh)^{0.5}$ = 0.0037 $ft^3/s$

2. Flow per ft of pipe = (Q)(# perfs/ft) = 0.02 $ft^3/s$ per ft of pipe

= 1914.47 cf/day/ft of pipe

Conclusion:

Design capacity exceeds estimated generation

1914.47 cf/day/ft of pipe >>> 281.44 cf/day/ft of pipe

Perforations are adequate to handle the maximum leachate flow.

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| Operation w/ CAT 826G Series II Compactor **25 Feet Waste** | | |

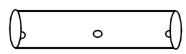
Effective pressure on pipe due to perforations:

$P_{EFF} = \dfrac{P_T \times 12}{(12 - L_P)}$ Source 3, EPA SW-870, p. 382

$L_P$ = Total accumulated length of perforations in one foot of pipe.

Since each perforation is 0.375 inch diameter and spaced at 6.0 inch on center,

$L_P$ = 1.5 inch



$P_T$ = 11.2 psi

$P_{EFF}$ = 12.8 psi

$P_{EFF}$ = 1847.2 psf

Check actual compressive pressure ($S_A$) per Driscopipe manual:

$S_A$ = 0.5 x (SDR - 1) x P(eff) = 64.1 psi

The recommended, long-term compressive strength ($Y_s$) design value for Driscoplex polyethylene pipe is 800 lb/in$^2$.

Source No. 1

| $S_A$ (psi): | | $Y_s$ (psi): |
|---|---|---|
| 64.1 | < | 800.0 |

Pipe passes wall compressive stress perforation calculations TRUE

FS = 12.5

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| Operation w/ CAT 826G Series II Compactor **25 Feet Waste** | | |

Constrained pipe wall buckling (for Driscoplex OD controlled pipe)

$P_{WC} = \dfrac{5.65 * \{RB'E' \; E*[12(DR-1)^3]^{-1}\}^{0.5}}{N}$    Source 1, Equation 7-5

$P_{WC}$ = allowable constrained buckling pressure (lb/in$^2$)

R = buoyancy reduction factor = 1 - 0.33 * (H'/H)    Source 1, Equation 7-34

H' = groundwater height above pipe (ft) | 0.0 | ft

H = cover above pipe (ft) | 29.0 | ft

B' = elastic support factor =( 1+ 4*e$^{-0.065H}$ )$^{-1}$    Source 1, Equation 7-35

E' = soil reaction modulus (lb/in$^2$) | 3000.0 | lb/in$^2$ for mod comp/crushed rock, 'Source 1, Table 7-7

E = elastic modulus (lb/in$^2$) | 100000.0 | lb/in$^2$ for long term load at 100$^o$F, 'Source 1, Table 5-1

I = moment of inertia = t$^3$ / 12 | 0.1 | in$^4$/in

$D_o$ = pipe outer diameter (in) | 12.750 | SDR 11 pipe (Driscopipe) to be used

t = pipe wall thickness (in) | 1.159 | SDR 11 pipe (Driscopipe) to be used

DR = pipe dimension ratio = $D_o$ / t | 11.0 | SDR 11 pipe (Driscopipe) to be used

$D_I$ = pipe inner diameter = $D_o$ - 2t (in) | 10.4 | SDR 11 pipe (Driscopipe) to be used

N = safety factor | 2.0

| Cover (ft) | (ft) | (ft) | B' | R | (lb/in$^2$) |
| --- | --- | --- | --- | --- | --- |
| 29.0 | 29 | 0 | 0.62 | 1.00 | 352.27 |

$P_{WC}$ = 352.27 lb/in$^2$

$P_{EFF}$ = 12.83 lb/in$^2$

Pipe passes contrained wall buckling calculations TRUE    FS = 27.5

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| **12" Diameter Leachate Collection Header System** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **25 Feet Waste** | | |

Constrained Pipe Wall Compressive Stress (for Driscoplex OD controlled pipe)

$$S = \frac{P_T D_o}{288t}$$ Source No. 1

S = pipe wall compressive stress (lb/in$^2$)

| | | |
|---|---|---|
| $P_T$ = vertical load applied to pipe w/ perfs (lb/ft$^2$) | 1847.2 | lb/ft$^2$ |
| $D_o$ = pipe outside diameter (in) | 12.75 | SDR 11 pipe (Driscopipe) to be used |
| t = pipe wall thickness (in) | 1.159 | SDR 11 pipe (Driscopipe) to be used |

$$S = \frac{P_T D_o}{288t} = 70.6 \text{ lb/in}^2$$

The recommended, long-term compressive strength ($Y_s$) design value for Driscoplex polyethylene pipe is 800 lb/in$^2$.

Source No. 1

| S (psi): | | $Y_s$ (psi): |
|---|---|---|
| 70.6 | < | 800.0 |

Pipe passes wall compressive stress calculations TRUE

FS = 11.3

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| Operation w/ CAT 826G Series II Compactor **25 Feet Waste** | | |

Iowa Formula

$$\Delta X = \frac{D_L K W_c r^3}{EI + 0.06er^4}$$ Source 2, Equation 3.4 Buried Pipe Design, A.P. Moser, Chapter 3

$\Delta X$ = horizontal deflection (in)

$D_L$ = deflection lag factor

K = bedding constant — 0.1 — typical value Source 2, Buried Pipe Design, A.P. Moser, Chapter 3

$W_c$ = Marston's load per unit length of pipe (lb/in)

r = mean radius of the pipe (in)

E = modulus of elasticity ($lb/in^2$)

I = moment of inertia of the pipe wall per unit length ($in^3$)

e = modulus of passive resistance fo the side fill ($lb/in^2(in)$)

Modified Iowa Formula

$$\Delta X = \frac{D_L K W_c r_m^3}{EI + 0.06E'r_m^3}$$ Source 2, Equation 3.5 Buried Pipe Design, A.P. Moser, Chapter 3

$\Delta X$ = horizontal deflection (in)

| | | | |
|---|---|---|---|
| $D_L$ = deflection lag factor | | 1.0 | Prism Load used |
| Typical Value for Marston Load | 1.5 | | |
| Typical Value for Prism Load | 1.0 | | |
| K = bedding constant | | 0.1 | typical value Buried Pipe Design, A.P. Moser, Chapter 3 |
| $P_T$ = Vertical load on pipe w/ perfs | | 12.83 | $lb/in^2$ — 1847 $lb/ft^2$ |
| $W_c$ = Marston's load per unit length of pipe = $P_T$ * $D_o$ (lb/in) | | 163.55 | lb/in |
| $D_o$ = pipe outer diameter (in) | | 12.75 | SDR 11 pipe (Driscopipe) to be used |
| t = pipe wall thickness (in) | | 1.16 | SDR 11 pipe (Driscopipe) to be used |
| $D_I$ = pipe inner diameter = $D_o$-2t (in) | | 10.43 | SDR 11 pipe (Driscopipe) to be used |
| $D_m$ = pipe mean diameter = $D_o$ - 1.06t Source 1, Equation 7-27 | | 11.52 | SDR 11 pipe (Driscopipe) to be used |
| $r_m$ = mean radius of the pipe (in) | | 5.76 | SDR 11 pipe (Driscopipe) to be used |
| E = modulus of elasticity ($lb/in^2$) | | 100,000.0 | lb/in2 for long term load at 100oF, 'Source 1, Table 5-1 |
| I = moment of inertia of the pipe wall per unit length | | 0.130 | $in^4/in$ |
| E' = modulus of soil reaction | | 3,000.0 | $lb/in^2$ for moderate compaction and fine grained soils |

$$\Delta X = \frac{D_L K W_c r_m^3}{EI + 0.06E'r_m^3} = 0.066$$ inch Source 2, Equation 3.5 Buried Pipe Design, A.P. Moser, Chapter 3

% Ring Deflection = $(\Delta X/D_m)$ x 100 = 0.57% Source 1, Equation 7-31

Ring Bending Strain

$$e = \frac{f_D \Delta X 2C}{D_M^2} \times 100$$ Source 1, Equation 7-39

e = wall strain (%)

| | | |
|---|---|---|
| $f_D$ = deformation shape factor | 6 | Source 1, non-elliptical shape |
| $D_M$ = mean diameter (in) | | |
| C = outer fiber wall centroid = 0.5 (1.06t) | 0.614 | Source 1, Equation 7-41 |
| $\Delta X$ = ring deflection = $D_X/D_m$ | 0.006 | |

$$e = f_D \frac{(\Delta X)}{D_M} \frac{(2C)}{D_M} \times 100 = 0.4\%$$ Source 1, Equation 7-39

The maximum ring bending strain for high performance polyethylene non-pressure pipe is = 5.0%

Pipe passes ring bending strain calculations TRUE

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| **12" Diameter Leachate Collection Header System** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **25 Feet Waste** | | |

SOURCES

1.) Attachment - 1 - Chevron Phillips Chemical Company, Bulletin - Book 2 Chapter 5, 2003

2.) Attachment - 2 - Buried Pipe Design, A.P. Moser, Chapter 3

3.) Attachment - 3 - EPA, Lining of Waste Impoundment and Disposal Facilities, SW-870

4.) Attachment - 4 - Driscoplex Pipe Properties

5.) Attachment - 5 - CAT 826G Series II Compactor Equipment Data Sheet

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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **12" Diameter Leachate Collection Header System** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **60 Feet Waste** | | |

Load on Pipe (Overburden)

Prism Loads, $P_E$ = wH

w = unit weight

H = depth

| | Depth (ft) | Unit Weight ($lb/ft^3$) | $P_E$ ($lb/ft^2$) |
|---|---|---|---|
| Final cover | 2.0 | 115.0 | 230.0 |
| Intermediate cover | 1.0 | 115.0 | 115.0 |
| Waste/cover | 60.0 | 60.0 | 3600.0 |
| Drainage sand | 2.0 | 115.0 | 230.0 |
| Rock (No. 89 & No. 57) | 2.0 | 140.0 | 280.0 |

TOTAL SOIL PRISM LOAD $P_E$: 4455.0 $lb/ft^2$

Total Depth = 67.0 ft

Soil Arching, $P_m = C_D wB$

NOTE: The waste unit weight represents the combined unit weight of waste, daily cover, and moisture.

Pm = vertical soil pressure

B = trench width at pipe crown 6.0 ft

$C_D$ = load coefficient $= \frac{1 - e^{-2Ku'H/B}}{2Ku'}$ Equation 7-3, Source No. 1

e = natural log base number

K = Rankine earth pressure coefficient = $\tan^2(45-0.5*\phi)$

$\phi$ = internal soil friction angle = 27.0 degrees

u' = friction coefficient between backfill and trench sides = tan $\phi$

| Soil Type | Ku' |
|---|---|
| Saturated Clay | 0.110 |
| Ordinary Clay | 0.130 |
| Saturated Top Soil | 0.150 |
| Sand and Gravel | 0.165 |
| Clean Granular Soil | 0.192 |

| | Ku' | $C_D$ | $P_m$ ($lb/ft^2$) |
|---|---|---|---|
| Cover Soil | 0.150 | 0.32 | 219 |
| Int Cover | 0.165 | 0.16 | 112 |
| Waste | 0.191 | 2.56 | 920 |
| Drainage Sand | 0.165 | 0.32 | 217.8 |
| Granular Soil | 0.192 | 0.31 | 262.8 |

TOTAL SOIL ARCHING LOAD $P_M$: 1,731.6 $lb/ft^2$

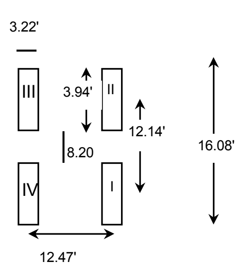
MODIFIED ARCHING LOAD = $0.6P_M+0.4P_E$: 2,820.98 $lb/ft^2$

OVERBURDEN LOAD: 2,820.98 $lb/ft^2$

Load on Pipe With Equipment Refer to Attachment

Operation w/ CAT 826G Series II Compactor 60 Feet Waste

Equipment Weight = 81,498.0 psf




Track per Load = $q_r$ = 1,670.20 psf (Rear)

Track per Load = $q_{fr}$ = 1,541.72 psf (Front)

Length of Track = L = 3.22 ft (contact length)

Length of Track = b = 8.20 ft

Track Width = 12.47 ft

Track Width (I to II) = 16.08 ft

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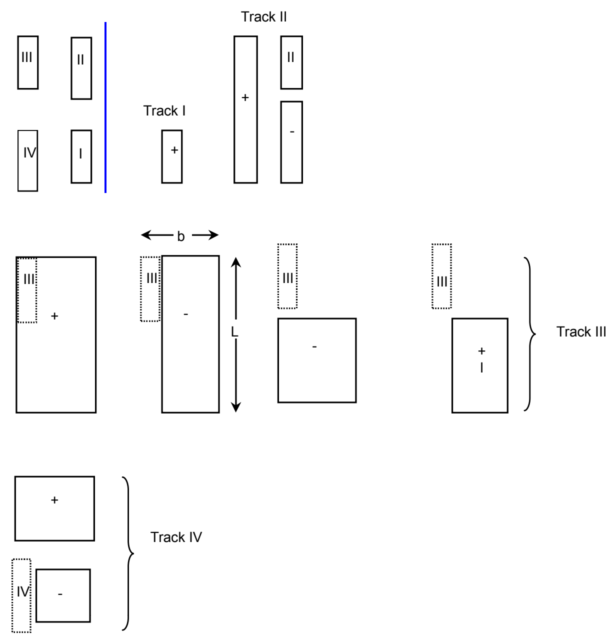
| **12" Diameter Leachate Collection Header System** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **60 Feet Waste** | | |

Load on Pipe

Alternative 1: Track Adjacent and Parallel to Pipe




| | b | L | z | m = b/z | n = L/z | I* | I** | I | |
|---|---|---|---|---|---|---|---|---|---|
| Track I | 8.2 | 3 | 67 | 0.12 | 0.05 | 0.003 | 0.251 | 0.00277 | (ADD) |
| | | | | | | | | | |
| Track II | 8.2 | 16.1 | 67 | 0.12 | 0.24 | 0.013 | 0.254 | 0.01323 | (ADD) |
| | 8.2 | 11.4 | 67 | 0.12 | 0.17 | 0.010 | 0.253 | 0.00961 | (SUBTRACT) |
| | | | | | | | | | |
| Track IV | 12.47 | 3.22 | 67 | 0.19 | 0.05 | 0.004 | 0.251 | 0.00414 | (ADD) |
| | 12.47 | 3.22 | 67 | 0.19 | 0.05 | 0.004 | 0.251 | 0.00414 | (SUBTRACT) |
| | | | | | | | | | |
| Track III | 12.47 | 16.08 | 67 | 0.19 | 0.24 | 0.020 | 0.256 | 0.01980 | (ADD) |
| | 4.27 | 16.08 | 67 | 0.06 | 0.24 | 0.007 | 0.252 | 0.00695 | (SUBTRACT) |
| | 12.47 | 11.42 | 67 | 0.19 | 0.17 | 0.014 | 0.255 | 0.01438 | (SUBTRACT) |
| | 4.27 | 8.47 | 67 | 0.06 | 0.13 | 0.004 | 0.251 | 0.00378 | (ADD) |

$\text{Live Load}_1 = q_r(\Sigma I) + q_{fr}(\Sigma II) + q_{fr}(\Sigma III) + q_r(\Sigma IV)$

$\text{Live Load}_1 =$ 13.68 psf

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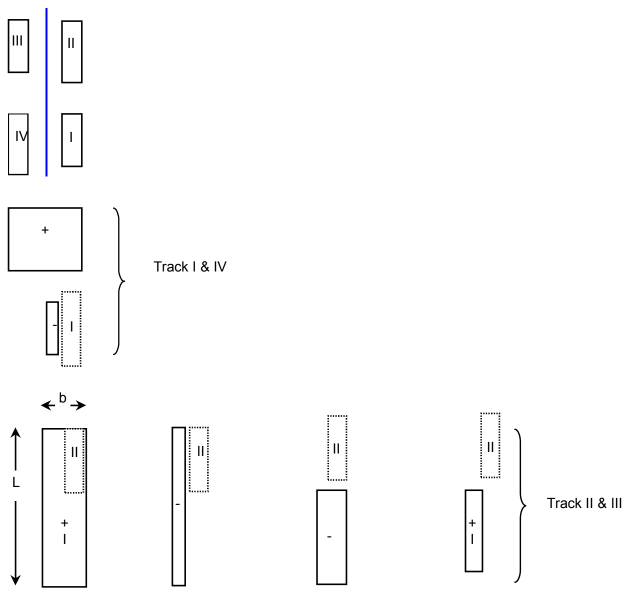
| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **12" Diameter Leachate Collection Header System** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **60 Feet Waste** | | |

Load on Pipe

Alternative 2: Track Stradling and Parallel to Pipe




| | b | L | z | m = b/z | n = L/z | I* | I** | I | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | |
| Track I | 6.2 | 3.2 | 67 | 0.1 | 0.0 | 0.002 | 0.251 | 0.00212 | (ADD) |
| & IV | -2.0 | 3.2 | 67 | 0.0 | 0.0 | -0.001 | 0.250 | -0.00067 | (SUBTRACT) |
| | | | | | | | | | |
| Track II | 6.2 | 16.08 | 67 | 0.1 | 0.2 | 0.010 | 0.253 | 0.01011 | (ADD) |
| & III | -2.0 | 16.08 | 67 | 0.0 | 0.2 | -0.003 | 0.249 | -0.00321 | (SUBTRACT) |
| | 6.2 | 12.86 | 67 | 0.1 | 0.2 | 0.008 | 0.253 | 0.00822 | (SUBTRACT) |
| | -2.0 | 12.86 | 67 | 0.0 | 0.2 | -0.003 | 0.249 | -0.00261 | (ADD) |

Live $Load_2$ = $[q_r (\Sigma I) + q_{fr} (\Sigma II)] * 2$

Live $Load_2$ = 16.99 psf

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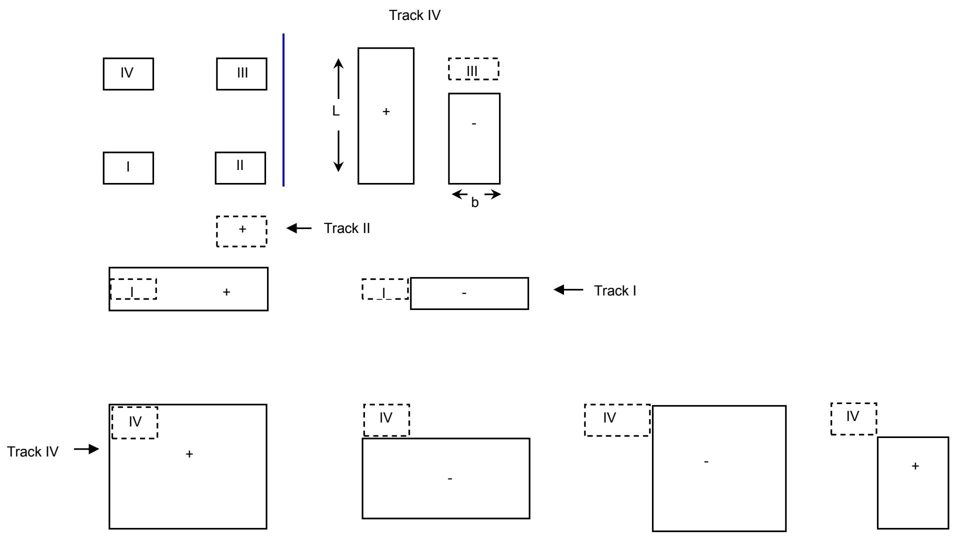
Load on Pipe

Alternative 3: Track Perpendicular to Pipe




| | b | L | z | m = b/z | n = L/z | I* | I** | I | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | |
| Track I | 16.1 | 8.2 | 67 | 0.2 | 0.1 | 0.013 | 0.254 | 0.01323 | (ADD) |
| | 12.9 | 8.2 | 67 | 0.2 | 0.1 | 0.011 | 0.253 | 0.01075 | (SUBTRACT) |
| | | | | | | | | | |
| Track II | 3.2 | 8.2 | 67 | 0.0 | 0.1 | 0.003 | 0.251 | 0.00277 | (ADD) |
| | | | | | | | | | |
| Track III | 3.2 | 12.5 | 67 | 0.0 | 0.2 | 0.004 | 0.251 | 0.00414 | (ADD) |
| | 3.2 | 4.3 | 67 | 0.0 | 0.1 | 0.001 | 0.250 | 0.00145 | (SUBTRACT) |
| | | | | | | | | | |
| Track IV | 16.1 | 12.5 | 67 | 0.2 | 0.2 | 0.020 | 0.256 | 0.01980 | (ADD) |
| | 16.1 | 4.3 | 67 | 0.2 | 0.1 | 0.007 | 0.252 | 0.00695 | (SUBTRACT) |
| | 12.9 | 12.5 | 67 | 0.2 | 0.2 | 0.016 | 0.255 | 0.01610 | (SUBTRACT) |
| | 12.9 | 4.3 | 67 | 0.2 | 0.1 | 0.006 | 0.252 | 0.00565 | (ADD) |

Live $Load_3$ = $q_r(\Sigma I) + q_{fr}(\Sigma II) + q_{fr}(\Sigma III) + q_r(\Sigma IV)$

Live $Load_3$ = 16.57 psf

LARGEST EQUIPEMENT LOAD = 16.99 $lb/ft^2$

VERTICAL OVERBURDEN LOAD = 2820.98 $lb/ft^2$

VERTICAL EQUIPMENT LOAD = 16.99 $lb/ft^2$

TOTAL VERTICAL LOAD APPLIED TO PIPE, $P_T$ = 2837.98 $lb/ft^2$ = 19.71 $lb/in^2$

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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **12" Diameter Leachate Collection Header System** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **60 Feet Waste** | | |

Verify that perforations in the LCRS are adequate for the peak leachate flow.

Use discharge equation:

$Q = (Cd)(Ao)(2gh)^{0.5}$

$C_d$ = coeffiecient of discharge = 0.6 for short tube discharge with fluid/wall separation; conservative value.

$A_o$ = Area of orifice ($\pi D^2/4$)

g = gravitational acceleration (32.3 $ft^2/s$)

h = static head (ft)

Assumptions and Givens:

| | | | | |
|---|---|---|---|---|
| 1. No. acres of landfill expansion = | 4.55 | acres | North and center portion of landfill bottom |
| 2. Total length of pipe per expansion = | 138.8 | ft | |
| 3. Total number of laterals = | 1.0 | | |
| 4. Length of pipe per lateral = | 138.8 | ft | |
| 5. Perforation diameter = | 0.375 | inch | |
| 6. No. perforations/ft pipe = | 6.0 | perforations/ft of pipe length | |
| 7. Maximum head over pipe = | 1.0 | ft | |
| 8. Per HELP model summary table, $Q_{peak}$ = | 202.93 | gal/min | refer to HELP Model Summary Table |
| 9. Per HELP model summary table, $Q_{peak}$ = | 39,063.5 | cf/day | refer to HELP Model Summary Table |
| 10. Maximum flow/lateral = | 39,063.5 | cf/day/lateral | |
| 11. Maximum leachate flow/ft of pipe = | 281.44 | cf/day/ft of pipe | |

Solution:

$A_o = 0.25(\Pi)(d)^2 =$ 0.00077 $ft^2$

1. Flow per orifice, $Q = (Cd)(Ao)(2gh)^{0.5}$ = 0.0037 $ft^3/s$

2. Flow per ft of pipe = (Q)(# perfs/ft) = 0.02 $ft^3/s$ per ft of pipe

= 1914.47 cf/day/ft of pipe

Conclusion:

Design capacity exceeds estimated generation

1914.47 cf/day/ft of pipe >>> 281.44 cf/day/ft of pipe

Perforations are adequate to handle the maximum leachate flow.

SCS ENGINEERS

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| SUBJECT | BY | DATE |
|---|---|---|
| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **12" Diameter Leachate Collection Header System** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **60 Feet Waste** | | |

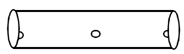
Effective pressure on pipe due to perforations:

$P_{EFF} = \frac{P_T \times 12}{(12-L_P)}$ Source 3, EPA SW-870, p. 382

$L_P$ = Total accumulated length of perforations in one foot of pipe.

Since each perforation is 0.375 inch diameter and spaced at 6.0 inch on center,

$L_P$ = 1.5 inch



$P_T$ = 19.7 psi

$P_{EFF}$ = 22.5 psi

$P_{EFF}$ = 3243.4 psf

Check actual compressive pressure ($S_A$) per Driscopipe manual:

$S_A$ = 0.5 x (SDR - 1) x P(eff) = 112.6 psi

The recommended, long-term compressive strength ($Y_s$) design value for Driscoplex polyethylene pipe is 800 lb/in$^2$.

Source No. 1

| $S_A$ (psi): | | $Y_s$ (psi): |
|---|---|---|
| 112.6 | < | 800.0 |

Pipe passes wall compressive stress perforation calculations TRUE

FS = 7.1

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|---|---|---|
| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **12" Diameter Leachate Collection Header System** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **60 Feet Waste** | | |

Constrained pipe wall buckling (for Driscoplex OD controlled pipe)

$P_{WC} = \frac{5.65 * \{RB'E'\ E*[12(DR-1)^3]^{-1}\}^{0.5}}{N}$ Source 1, Equation 7-5

$P_{WC}$ = allowable constrained buckling pressure (lb/in$^2$)

R = buoyancy reduction factor = 1 - 0.33 * (H'/H) Source 1, Equation 7-34

| | | |
|---|---|---|
| H' = groundwater height above pipe (ft) | 0.0 | ft |
| H = cover above pipe (ft) | 67.0 | ft |
| B' = elastic support factor =( 1+ 4*e$^{-0.065H}$ )$^{-1}$ | | Source 1, Equation 7-35 |
| E' = soil reaction modulus (lb/in$^2$) | 3000.0 | lb/in$^2$ for mod comp/crushed rock, 'Source 1, Table 7-7 |
| E = elastic modulus (lb/in$^2$) | 100000.0 | lb/in$^2$ for long term load at 100$^o$F, 'Source 1, Table 5-1 |
| I = moment of inertia = t$^3$ / 12 | 0.1 | in$^4$/in |
| $D_o$ = pipe outer diameter (in) | 12.750 | SDR 11 pipe (Driscopipe) to be used |
| t = pipe wall thickness (in) | 1.159 | SDR 11 pipe (Driscopipe) to be used |
| DR = pipe dimension ratio = $D_o$ / t | 11.0 | SDR 11 pipe (Driscopipe) to be used |
| $D_I$ = pipe inner diameter = $D_o$ - 2t (in) | 10.4 | SDR 11 pipe (Driscopipe) to be used |
| N = safety factor | 2.0 | |

| Cover (ft) | (ft) | (ft) | B' | R | (lb/in$^2$) |
|---|---|---|---|---|---|
| 67.0 | 67 | 0 | 0.95 | 1.00 | 435.57 |

$P_{WC}$ = 435.57 lb/in$^2$
$P_{EFF}$ = 22.52 lb/in$^2$

Pipe passes contrained wall buckling calculations TRUE FS = 19.3

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Constrained Pipe Wall Compressive Stress (for Driscoplex OD controlled pipe)

$$S = \frac{P_T D_o}{288t}$$ Source No. 1

S = pipe wall compressive stress (lb/in$^2$)

| | | |
|---|---|---|
| $P_T$ = vertical load applied to pipe w/ perfs (lb/ft$^2$) | 3243.4 | lb/ft$^2$ |
| $D_o$ = pipe outside diameter (in) | 12.75 | SDR 11 pipe (Driscopipe) to be used |
| t = pipe wall thickness (in) | 1.159 | SDR 11 pipe (Driscopipe) to be used |

$$S = \frac{P_T D_o}{288t} = 123.9 \text{ lb/in}^2$$

The recommended, long-term compressive strength ($Y_s$) design value for Driscoplex polyethylene pipe is 800 lb/in$^2$.

Source No. 1

| S (psi): | | $Y_s$ (psi): |
|---|---|---|
| 123.9 | < | 800.0 |

Pipe passes wall compressive stress calculations: TRUE

FS = 6.5

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| Operation w/ CAT 826G Series II Compactor **60 Feet Waste** | | |

Iowa Formula

$$\Delta X = \frac{D_L K W_c r^3}{EI + 0.06er^4}$$ Source 2, Equation 3.4 Buried Pipe Design, A.P. Moser, Chapter 3

$\Delta X$ = horizontal deflection (in)
$D_L$ = deflection lag factor
K = bedding constant 0.1 typical value Source 2, Buried Pipe Design, A.P. Moser, Chapter 3
$W_c$ = Marston's load per unit length of pipe (lb/in)
r = mean radius of the pipe (in)
E = modulus of elasticity (lb/in$^2$)
I = moment of inertia of the pipe wall per unit length (in$^3$)
e = modulus of passive resistance fo the side fill (lb/in$^2$(in))

Modified Iowa Formula

$$\Delta X = \frac{D_L K W_c r_m^3}{EI + 0.06E'r_m^3}$$ Source 2, Equation 3.5 Buried Pipe Design, A.P. Moser, Chapter 3

$\Delta X$ = horizontal deflection (in)

| | | |
|---|---|---|
| $D_L$ = deflection lag factor | 1.0 | Prism Load used |
| Typical Value for Marston Load 1.5 | | |
| Typical Value for Prism Load 1.0 | | |
| K = bedding constant | 0.1 | typical value Buried Pipe Design, A.P. Moser, Chapter 3 |
| $P_T$ = Vertical load on pipe w/ perfs | 22.52 | lb/in$^2$ 3243 lb/ft$^2$ |
| $W_c$ = Marston's load per unit length of pipe = $P_T$ * $D_o$ (lb/in) | 287.18 | lb/in |
| $D_o$ = pipe outer diameter (in) | 12.75 | SDR 11 pipe (Driscopipe) to be used |
| t = pipe wall thickness (in) | 1.16 | SDR 11 pipe (Driscopipe) to be used |
| $D_I$ = pipe inner diameter = $D_o$-2t (in) | 10.43 | SDR 11 pipe (Driscopipe) to be used |
| $D_m$ = pipe mean diameter = $D_o$ - 1.06t Source 1, Equation 7-27 | 11.52 | SDR 11 pipe (Driscopipe) to be used |
| $r_m$ = mean radius of the pipe (in) | 5.76 | SDR 11 pipe (Driscopipe) to be used |
| E = modulus of elasticity (lb/in$^2$) | 100,000.0 | lb/in2 for long term load at 100oF, 'Source 1, Table 5-1 |
| I = moment of inertia of the pipe wall per unit length | 0.130 | in$^4$/in |
| E' = modulus of soil reaction | 3,000.0 | lb/in$^2$ for moderate compaction and fine grained soils |

$$\Delta X = \frac{D_L K W_c r_m^3}{EI + 0.06E'r_m^3} = 0.116 \text{ inch}$$ Source 2, Equation 3.5 Buried Pipe Design, A.P. Moser, Chapter 3

% Ring Deflection = ($\Delta X/D_m$) x 100 = 1.01% Source 1, Equation 7-31

Ring Bending Strain

$$e = \frac{f_D \Delta X 2C}{D_M^2} \times 100$$ Source 1, Equation 7-39

e = wall strain (%)

| | | |
|---|---|---|
| $f_D$ = deformation shape factor | 6 | Source 1, non-elliptical shape |
| $D_M$ = mean diameter (in) | | |
| C = outer fiber wall centroid = 0.5 (1.06t) | 0.614 | Source 1, Equation 7-41 |
| $\Delta X$ = ring deflection = $D_X/D_m$ | 0.010 | |

$$e = f_D \frac{(\Delta X)}{D_M} \frac{(2C)}{D_M} \times 100 = 0.6\%$$ Source 1, Equation 7-39

The maximum ring bending strain for high performance polyethylene non-pressure pipe is = 5.0%

Pipe passes ring bending strain calculations TRUE

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SOURCES

1.) Attachment - 1 - Chevron Phillips Chemical Company, Bulletin - Book 2 Chapter 5, 2003

2.) Attachment - 2 - Buried Pipe Design, A.P. Moser, Chapter 3

3.) Attachment - 3 - EPA, Lining of Waste Impoundment and Disposal Facilities, SW-870

4.) Attachment - 4 - Driscoplex Pipe Properties

5.) Attachment - 5 - CAT 826G Series II Compactor Equipment Data Sheet

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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
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| **Construction** w/ CAT D6R XW Series II | | |

Load on Pipe (Overburden)

Prism Loads, $P_E$ = wH

w = unit weight

H = depth

| | Depth (ft) | Unit Weight ($lb/ft^3$) | $P_E$ ($lb/ft^2$) |
|---|---|---|---|
| Final cover | 0.0 | 115.0 | 0.0 |
| Intermediate cover | 0.0 | 115.0 | 0.0 |
| Waste/cover | 0.0 | 60.0 | 0.0 |
| Drainage sand | 0.0 | 115.0 | 0.0 |
| Rock (No. 89 & No. 57) | 1.0 | 140.0 | 140.0 |

TOTAL SOIL PRISM LOAD $P_E$: 140.0 $lb/ft^2$

Total Depth = 1.0 ft

Soil Arching, $P_m = C_D wB$

NOTE: The waste unit weight represents the combined unit weight of waste, daily cover, and moisture.

Pm = vertical soil pressure

B = trench width at pipe crown 6.0 ft

$C_D$ = load coefficient $= \frac{1 - e^{-2Ku'H/B}}{2Ku'}$ Equation 7-3, Source No. 1

e = natural log base number

K = Rankine earth pressure coefficient = $\tan^2(45-0.5*\phi)$

$\phi$ = internal soil friction angle = 27.0 degrees

u' = friction coefficient between backfill and trench sides = tan $\phi$

| Soil Type | Ku' |
|---|---|
| Saturated Clay | 0.110 |
| Ordinary Clay | 0.130 |
| Saturated Top Soil | 0.150 |
| Sand and Gravel | 0.165 |
| Clean Granular Soil | 0.192 |

| | Ku' | $C_D$ | $P_m$ ($lb/ft^2$) |
|---|---|---|---|
| Cover Soil | 0.150 | 0.00 | 0 |
| Int Cover | 0.165 | 0.00 | 0 |
| Waste | 0.191 | 0.00 | 0 |
| Drainage Sand | 0.165 | 0.00 | 0.0 |
| Granular Soil | 0.192 | 0.16 | 135.6 |

TOTAL SOIL ARCHING LOAD $P_M$: 135.6 $lb/ft^2$

MODIFIED ARCHING LOAD = $0.6P_M+0.4P_E$: 137.37 $lb/ft^2$

OVERBURDEN LOAD: 137.37 $lb/ft^2$

Load on Pipe With Equipment Refer to Attachment

Construction w/ CAT D6R XW Series II

Equipment Weight = 43,888.0 psf

Number of Tracks = 2.0

Track Load = $q_r$ = 21,944.0 psf

Ground contact area/track = 23.1 psf

Length of Track = L = 111.0 in

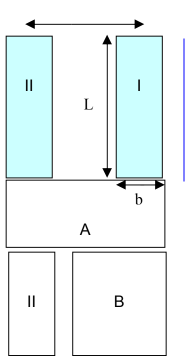
Track Width = b = 30.0 in

Track Gauge = G = 80.0 in

Equipment Width "A" = 116.0 in

Live Load = q*Ic q = track load 948.93 psf

Ic = Influence coefficient




| | b (ft) | L (ft) | z (ft) | m = b/z | n = L/z | I* | I** | I |
|---|---|---|---|---|---|---|---|---|
| I | 2.50 | 9.3 | 1.0 | 2.50 | 9.25 | -0.006 | 0.244 | 0.24428 |
| A | 9.17 | 9.3 | 1.0 | 9.17 | 9.25 | 0.000 | 0.250 | 0.24976 |
| B | 6.67 | 9.3 | 1.0 | 6.67 | 9.25 | 0.000 | 0.250 | 0.24957 |

Live $Load_1$ = I + II = $q_I(I_I) + q_A(I_A) - q_B(I_B)$ = 231.99 $lb/ft^2$

$q_I(I_I)$ = 231.81

$q_A(I_A)$ = 237.01

$q_B(I_B)$ = 236.82

Load on Pipe (Equipment) = 231.99 $lb/ft^2$

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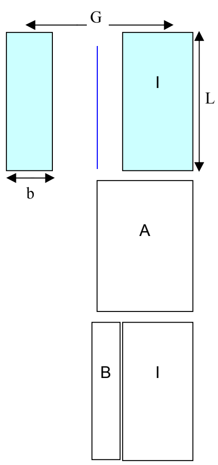
Load on Pipe (Equipment) *Continued*

Live Load = q*$I_c$

q = track load | 948.93 | lb/ft$^2$

$I_c$ = Influence coefficient

Alternative 2: Track stradling and parallel to pipe



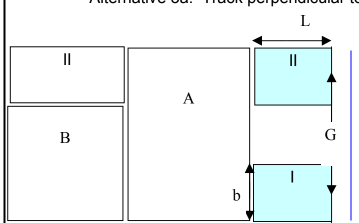

| | b | L | z | m = b/z | n = L/z | I* | I** | I |
|---|---|---|---|---|---|---|---|---|
| A | 4.83 | 9.3 | 1 | 4.83 | 9.25 | -0.001 | 0.249 | 0.24904 |
| B | 2.33 | 9.3 | 1 | 2.33 | 9.25 | -0.007 | 0.243 | 0.24315 |

Live $Load_2$ = 2 * (A - B) = 2 * ($q_A I_A$ - $q_B I_B$) = 11.18 lb/ft$^2$

| | |
|---|---|
| $q_A(I_A)$ = | 236.32 |
| $q_B(I_B)$ = | 230.73 |

Load on Pipe (Equipment) = 11.18 lb/ft$^2$

Alternative 3a: Track perpendicular to pipe




| | b | L | z | m = b/z | n = L/z | I* | I** | I |
|---|---|---|---|---|---|---|---|---|
| I | 2.50 | 9.3 | 1 | 2.50 | 9.25 | -0.006 | 0.244 | 0.24428 |
| A | 9.67 | 9.3 | 1 | 9.67 | 9.25 | 0.000 | 0.250 | 0.24978 |
| B | 7.17 | 9.3 | 1 | 7.17 | 9.25 | 0.000 | 0.250 | 0.24963 |

Live $Load_3$ = I + II = $q_I(I_I)$ + $q_A(I_A)$ - $q_B(I_B)$ = 231.95 lb/ft$^2$

| | |
|---|---|
| $q_I(I_I)$ = | 231.81 |
| $q_A(I_A)$ = | 237.02 |
| $q_B(I_B)$ = | 236.88 |

Load on Pipe (Equipment) = 231.95 lb/ft$^2$

LARGEST EQUIPEMENT LOAD = 231.99 lb/ft$^2$

VERTICAL OVERBURDEN LOAD = 137.37 lb/ft$^2$

VERTICAL EQUIPMENT LOAD = 231.99 lb/ft$^2$

TOTAL VERTICAL LOAD APPLIED TO PIPE, $P_T$ = 369.36 lb/ft$^2$ = 2.57 lb/in$^2$

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| **Construction** w/ CAT D6R XW Series II | | |

Verify that perforations in the LCRS are adequate for the peak leachate flow.

Use discharge equation:

$Q = (Cd)(Ao)(2gh)^{0.5}$

$C_d$ = coeffiecient of discharge = 0.6 for short tube discharge with fluid/wall separation; conservative value.

$A_o$ = Area of orifice ($\pi D^2/4$)

g = gravitational acceleration (32.3 $ft^2/s$)

h = static head (ft)

Assumptions and Givens:

| | | | |
|---|---|---|---|
| 1. No. acres of landfill expansion = | 4.55 | acres | North and center portion of landfill bottom |
| 2. Total length of pipe per expansion = | 138.8 | ft | |
| 3. Number of laterals = | 1.0 | | |
| 4. Total length of pipe per lateral = | 138.8 | ft | |
| 5. Perforation diameter = | 0.375 | inch | |
| 6. No. perforations/ft pipe = | 6.0 | perforations/ft of pipe length | |
| 7. Maximum head over pipe = | 1.0 | ft | |
| 8. Per HELP model summary table, $Q_{peak}$ = | 202.93 | gal/min | refer to HELP Model Summary Table |
| 9. Per HELP model summary table, $Q_{peak}$ = | 39,063.5 | cf/day | refer to HELP Model Summary Table |
| 10. Maximum flow/lateral = | 39,063.5 | cf/day/lateral | |
| 11. Maximum leachate flow/ft of pipe = | 281.44 | cf/day/ft of pipe | |

Solution:

$A_o = 0.25(\Pi)(d)^2 =$ 0.00077 $ft^2$

1. Flow per orifice, $Q = (Cd)(Ao)(2gh)^{0.5}$ = 0.0037 $ft^3/s$

2. Flow per ft of pipe = (Q)(# perfs/ft) = 0.02 $ft^3/s$ per ft of pipe

= 1914.47 cf/day/ft of pipe

Conclusion:

Design capacity exceeds estimated generation

1914.47 cf/day/ft of pipe >>> 281.44 cf/day/ft of pipe

Perforations are adequate to handle the maximum leachate flow.

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| **Construction** w/ CAT D6R XW Series II | | |

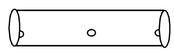
Effective pressure on pipe due to perforations:

$P_{EFF} = \frac{P_T \times 12}{(12-L_P)}$ Source 3, EPA SW-870, p. 382

$L_P$ = Total accumulated length of perforations in one foot of pipe.

Since each perforation is 0.375 inch diameter and spaced at 6.0 inch on center,

$L_P$ = 1.5 inch



$P_T$ = 2.6 psi

$P_{EFF}$ = 2.9 psi

$P_{EFF}$ = 422.1 psf

Check actual compressive pressure ($S_A$) per Driscopipe manual:

$S_A$ = 0.5 x (SDR - 1) x P(eff) = 14.7 psi

The recommended, long-term compressive strength ($Y_s$) design value for Driscoplex polyethylene pipe is 800 lb/in$^2$.

Source No. 1

| $S_A$ (psi): | | $Y_s$ (psi): |
|---|---|---|
| 14.7 | < | 800.0 |

Pipe passes wall compressive stress perforation calculations TRUE

FS = 54.6

| SCS ENGINEERS | | |
|---|---|---|
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Constrained pipe wall buckling (for Driscoplex OD controlled pipe)

$P_{WC} = \frac{5.65 * \{RB'E' E*[12(DR-1)^3]^{-1}\}^{0.5}}{N}$ Source 1, Equation 7-5

$P_{WC}$ = allowable constrained buckling pressure (lb/in$^2$)

| | | |
|---|---|---|
| R = buoyancy reduction factor = 1 - 0.33 * (H'/H) | | Source 1, Equation 7-34 |
| H' = groundwater height above pipe (ft) | 0.0 | ft |
| H = cover above pipe (ft) | 1.0 | ft |
| B' = elastic support factor =( 1+ 4*e$^{-0.065H}$ )$^{-1}$ | | Source 1, Equation 7-35 |
| E' = soil reaction modulus (lb/in$^2$) | 3000.0 | lb/in$^2$ for mod comp/crushed rock, 'Source 1, Table 7-7 |
| E = elastic modulus (lb/in$^2$) | 100000.0 | lb/in$^2$ for long term load at 100$^o$F, 'Source 1, Table 5-1 |
| I = moment of inertia = t$^3$ / 12 | 0.1 | in$^4$/in |
| $D_o$ = pipe outer diameter (in) | 12.750 | SDR 11 pipe (Driscopipe) to be used |
| t = pipe wall thickness (in) | 1.159 | SDR 11 pipe (Driscopipe) to be used |
| DR = pipe dimension ratio = $D_o$ / t | 11.0 | SDR 11 pipe (Driscopipe) to be used |
| $D_I$ = pipe inner diameter = $D_o$ - 2t (in) | 10.4 | SDR 11 pipe (Driscopipe) to be used |
| N = safety factor | 2.0 | |

| Cover (ft) | (ft) | (ft) | B' | R | (lb/in$^2$) |
|---|---|---|---|---|---|
| 1.0 | 1 | 0 | 0.21 | 1.00 | 204.96 |

$P_{WC}$ = 204.96 lb/in$^2$

$P_{EFF}$ = 2.93 lb/in$^2$

Pipe passes contrained wall buckling calculations TRUE FS = 69.9

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Constrained Pipe Wall Compressive Stress (for Driscoplex OD controlled pipe)

$S = \frac{P_T D_o}{288t}$ Source No. 1

S = pipe wall compressive stress ($lb/in^2$)

$P_T$ = vertical load applied to pipe w/ perfs ($lb/ft^2$) 422.1 $lb/ft^2$

$D_o$ = pipe outside diameter (in) 12.75 SDR 11 pipe (Driscopipe) to be used

t = pipe wall thickness (in) 1.159 SDR 11 pipe (Driscopipe) to be used

$S = \frac{P_T D_o}{288t} =$ 16.1 $lb/in^2$

The recommended, long-term compressive strength ($Y_s$) design value for Driscoplex polyethylene pipe is 800 $lb/in^2$.

Source No. 1

| S (psi): | | $Y_s$ (psi): |
|---|---|---|
| 16.1 | < | 800.0 |

Pipe passes wall compressive stress calculations TRUE FS = 49.6

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Iowa Formula

$\Delta X = \dfrac{D_L K W_c r^3}{EI + 0.06er^4}$ Source 2, Equation 3.4 Buried Pipe Design, A.P. Moser, Chapter 3

$\Delta X$ = horizontal deflection (in)

$D_L$ = deflection lag factor

K = bedding constant 0.1 typical value Source 2, Buried Pipe Design, A.P. Moser, Chapter 3

$W_c$ = Marston's load per unit length of pipe (lb/in)

r = mean radius of the pipe (in)

E = modulus of elasticity ($lb/in^2$)

I = moment of inertia of the pipe wall per unit length ($in^3$)

e = modulus of passive resistance fo the side fill ($lb/in^2(in)$)

Modified Iowa Formula

$\Delta X = \dfrac{D_L K W_c r_m^3}{EI + 0.06E'r_m^3}$ Source 2, Equation 3.5 Buried Pipe Design, A.P. Moser, Chapter 3

$\Delta X$ = horizontal deflection (in)

| | | | |
|---|---|---|---|
| $D_L$ = deflection lag factor | | 1.0 | Prism Load used |
| Typical Value for Marston Load | 1.5 | | |
| Typical Value for Prism Load | 1.0 | | |
| K = bedding constant | | 0.1 | typical value Buried Pipe Design, A.P. Moser, Chapter 3 |
| $P_T$ = Vertical load on pipe w/ perfs | | 2.93 | $lb/in^2$ 422 $lb/ft^2$ |
| $W_c$ = Marston's load per unit length of pipe = $P_T$ * $D_o$ (lb/in) | | 37.38 | lb/in |
| $D_o$ = pipe outer diameter (in) | | 12.75 | SDR 11 pipe (Driscopipe) to be used |
| t = pipe wall thickness (in) | | 1.16 | SDR 11 pipe (Driscopipe) to be used |
| $D_I$ = pipe inner diameter = $D_o$-2t (in) | | 10.43 | SDR 11 pipe (Driscopipe) to be used |
| $D_m$ = pipe mean diameter = $D_o$ - 1.06t Source 1, Equation 7-27 | | 11.52 | SDR 11 pipe (Driscopipe) to be used |
| $r_m$ = mean radius of the pipe (in) | | 5.76 | SDR 11 pipe (Driscopipe) to be used |
| E = modulus of elasticity ($lb/in^2$) | | 100,000.0 | lb/in2 for long term load at 100oF, 'Source 1, Table 5-1 |
| I = moment of inertia of the pipe wall per unit length | | 0.130 | $in^4/in$ |
| E' = modulus of soil reaction | | 3,000.0 | $lb/in^2$ for moderate compaction and fine grained soils |

$\Delta X = \dfrac{D_L K W_c r_m^3}{EI + 0.06E'r_m^3}$ = 0.015 inch Source 2, Equation 3.5 Buried Pipe Design, A.P. Moser, Chapter 3

% Ring Deflection = ($\Delta X/D_m$) x 100 = 0.13% Source 1, Equation 7-31

Ring Bending Strain

$e = \dfrac{f_D \Delta X 2C}{D_M^2} \times 100$ Source 1, Equation 7-39

e = wall strain (%)

$f_D$ = deformation shape factor 6 Source 1, non-elliptical shape

$D_M$ = mean diameter (in)

C = outer fiber wall centroid = 0.5 (1.06t) 0.614 Source 1, Equation 7-41

$\Delta X$ = ring deflection = $D_X/D_m$ 0.001

$e = f_D \left(\dfrac{\Delta X}{D_M}\right)\left(\dfrac{2C}{D_M}\right) \times 100$ = 0.1% Source 1, Equation 7-39

The maximum ring bending strain for high performance polyethylene non-pressure pipe is = 5.0%

Pipe passes ring bending strain calculations TRUE

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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **12" Diameter Leachate Collection Header System Construction** w/ CAT D6R XW Series II | CHECKED | DATE |

SOURCES

1.) Attachment - 1 - Chevron Phillips Chemical Company, Bulletin - Book 2 Chapter 5, 2003

2.) Attachment - 2 - Buried Pipe Design, A.P. Moser, Chapter 3

3.) Attachment - 3 - EPA, Lining of Waste Impoundment and Disposal Facilities, SW-870

4.) Attachment - 4 - Driscoplex Pipe Properties

5.) Attachment - 5 - CAT 826G Series II Compactor Data Sheet

6.) Attachment - 6 - CAT D7R Series II Equipment Data Sheet

7.) Attachment - 7 - CAT D6R XW Series II Equipment Data Sheet

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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **12" Diameter Leachate Collection Header System** | CHECKED | DATE |
| Operation w/ CAT D7R Series II **0 Feet Waste** | | |

Load on Pipe (Overburden)

Prism Loads, $P_E = wH$

w = unit weight

H = depth

| | Depth (ft) | Unit Weight ($lb/ft^3$) | $P_E$ ($lb/ft^2$) |
|---|---|---|---|
| Final cover | 0.0 | 115.0 | 0.0 |
| Intermediate cover | 0.0 | 115.0 | 0.0 |
| Waste/cover | 0.0 | 60.0 | 0.0 |
| Drainage sand | 2.0 | 115.0 | 230.0 |
| Rock (No. 89 & No. 57) | 2.0 | 140.0 | 280.0 |

TOTAL SOIL PRISM LOAD $P_E$: 510.0 $lb/ft^2$

Total Depth = 4.0 ft

Soil Arching, $P_m = C_D wB$

NOTE: The waste unit weight represents the combined unit weight of waste, daily cover, and moisture.

Pm = vertical soil pressure

B = trench width at pipe crown 6.0 ft

$C_D$ = load coefficient $= \frac{1 - e^{-2Ku'H/B}}{2Ku'}$ Equation 7-3, Source No. 1

e = natural log base number

K = Rankine earth pressure coefficient = $\tan^2(45-0.5*\phi)$

$\phi$ = internal soil friction angle = 27.0 degrees

u' = friction coefficient between backfill and trench sides = $\tan \phi$

| Soil Type | Ku' |
|---|---|
| Saturated Clay | 0.110 |
| Ordinary Clay | 0.130 |
| Saturated Top Soil | 0.150 |
| Sand and Gravel | 0.165 |
| Clean Granular Soil | 0.192 |

| | Ku' | $C_D$ | $P_m$ ($lb/ft^2$) |
|---|---|---|---|
| Cover Soil | 0.150 | 0.00 | 0 |
| Int Cover | 0.165 | 0.00 | 0 |
| Waste | 0.191 | 0.00 | 0 |
| Drainage Sand | 0.165 | 0.32 | 217.8 |
| Granular Soil | 0.192 | 0.31 | 262.8 |

TOTAL SOIL ARCHING LOAD $P_M$: 480.6 $lb/ft^2$

MODIFIED ARCHING LOAD = $0.6P_M+0.4P_E$: 492.37 $lb/ft^2$

OVERBURDEN LOAD: 492.37 $lb/ft^2$

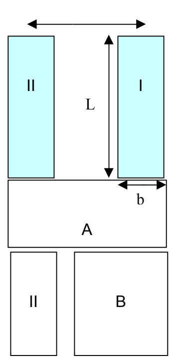
Load on Pipe With Equipment Refer to Attachment

Operation w/ CAT D7R Series II 0 Feet Waste

| | | | | | |
|---|---|---|---|---|---|
| Equipment Weight = | 54,573.0 | psf | Length of Track = L = | 113.0 | in |
| Number of Tracks = | 2.0 | | Track Width = b = | 22.0 | in |
| Track Load = $q_r$ = | 27,286.5 | psf | Track Gauge = G = | 78.0 | in |
| Ground contact area/track = | 17.3 | psf | Equipment Width "A" = | 113.0 | in |

Live Load = q*Ic q = track load 1,580.55 psf

Ic = Influence coefficient




| | b (ft) | L (ft) | z (ft) | m = b/z | n = L/z | I* | I** | I |
|---|---|---|---|---|---|---|---|---|
| I | 1.83 | 9.4 | 4.0 | 0.46 | 2.35 | 0.127 | 0.252 | 0.12736 |
| A | 8.33 | 9.4 | 4.0 | 2.08 | 2.35 | -0.014 | 0.236 | 0.23624 |
| B | 6.50 | 9.4 | 4.0 | 1.63 | 2.35 | -0.021 | 0.229 | 0.22928 |

Live $Load_1$ = I + II = $q_I(I_I) + q_A(I_A) - q_B(I_B)$ = 212.30 $lb/ft^2$

$q_I(I_I)$ = 201.29

$q_A(I_A)$ = 373.39

$q_B(I_B)$ = 362.39

Load on Pipe (Equipment) = 212.30 $lb/ft^2$

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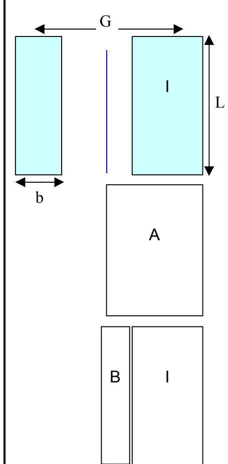
Load on Pipe (Equipment) *Continued*

Live Load = $q*I_c$

$q$ = track load 1580.55 lb/ft$^2$

$I_c$ = Influence coefficient

Alternative 2: Track stradling and parallel to pipe



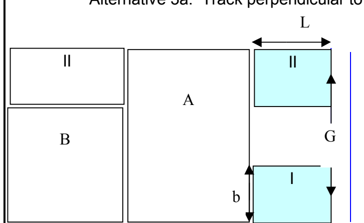

| | b | L | z | m = b/z | n = L/z | I* | I** | I |
|---|---|---|---|---|---|---|---|---|
| A | 4.71 | 9.4 | 4 | 1.18 | 2.35 | 0.213 | 0.216 | 0.21333 |
| B | 2.88 | 9.4 | 4 | 0.72 | 2.35 | 0.173 | 0.242 | 0.17258 |

Live Load$_2$ = 2 * (A - B) = 2 * ($q_A I_A$ - $q_B I_B$) = 128.82 lb/ft$^2$

| | |
|---|---|
| $q_A(I_A)$ = | 337.19 |
| $q_B(I_B)$ = | 272.78 |

Load on Pipe (Equipment) = 128.82 lb/ft$^2$

Alternative 3a: Track perpendicular to pipe




| | b | L | z | m = b/z | n = L/z | I* | I** | I |
|---|---|---|---|---|---|---|---|---|
| I | 1.83 | 9.4 | 4 | 0.46 | 2.35 | 0.127 | 0.252 | 0.12736 |
| A | 9.42 | 9.4 | 4 | 2.35 | 2.35 | -0.012 | 0.238 | 0.23841 |
| B | 7.58 | 9.4 | 4 | 1.90 | 2.35 | -0.016 | 0.234 | 0.23405 |

Live Load$_3$ = I + II = $q_I(I_I)$ + $q_A(I_A)$ - $q_B(I_B)$ = 208.18 lb/ft$^2$

| | |
|---|---|
| $q_I(I_I)$ = | 201.29 |
| $q_A(I_A)$ = | 376.82 |
| $q_B(I_B)$ = | 369.93 |

Load on Pipe (Equipment) = 208.18 lb/ft$^2$

LARGEST EQUIPEMENT LOAD = 212.30 lb/ft$^2$

VERTICAL OVERBURDEN LOAD = 492.37 lb/ft$^2$

VERTICAL EQUIPMENT LOAD = 212.30 lb/ft$^2$

TOTAL VERTICAL LOAD APPLIED TO PIPE, $P_T$ = 704.67 lb/ft$^2$ = 4.89 lb/in$^2$

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Verify that perforations in the LCRS are adequate for the peak leachate flow.

Use discharge equation:

$Q = (Cd)(Ao)(2gh)^{0.5}$

$C_d$ = coeffiecient of discharge = 0.6 for short tube discharge with fluid/wall separation; conservative value.

$A_o$ = Area of orifice ($\pi D^2/4$)

g = gravitational acceleration (32.3 $ft^2/s$)

h = static head (ft)

Assumptions and Givens:

| | | | |
|---|---|---|---|
| 1. No. acres of landfill expansion = | 4.55 | acres | North and center portion of landfill bottom |
| 2. Total length of pipe per expansion = | 138.8 | ft | |
| 3. Number of laterals = | 1.0 | | |
| 4. Total length of pipe per lateral = | 138.8 | ft | |
| 5. Perforation diameter = | 0.375 | inch | |
| 6. No. perforations/ft pipe = | 6.0 | perforations/ft of pipe length | |
| 7. Maximum head over pipe = | 1.0 | ft | |
| 8. Per HELP model summary table, $Q_{peak}$ = | 202.93 | gal/min | refer to HELP Model Summary Table |
| 9. Per HELP model summary table, $Q_{peak}$ = | 39,063.5 | cf/day | refer to HELP Model Summary Table |
| 10. Maximum flow/lateral = | 39,063.5 | cf/day/lateral | |
| 11. Maximum leachate flow/ft of pipe = | 281.44 | cf/day/ft of pipe | |

Solution:

$A_o = 0.25(\Pi)(d)^2 =$ 0.00077 $ft^2$

1. Flow per orifice, $Q = (Cd)(Ao)(2gh)^{0.5}$ = 0.0037 $ft^3/s$

2. Flow per ft of pipe = (Q)(# perfs/ft) = 0.02 $ft^3/s$ per ft of pipe

= 1914.47 cf/day/ft of pipe

Conclusion:

Design capacity exceeds estimated generation

1914.47 cf/day/ft of pipe >>> 281.44 cf/day/ft of pipe

Perforations are adequate to handle the maximum leachate flow.

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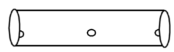
Effective pressure on pipe due to perforations:

$P_{EFF} = \frac{P_T \times 12}{(12-L_P)}$ Source 3, EPA SW-870, p. 382

$L_P$ = Total accumulated length of perforations in one foot of pipe.

Since each perforation is 0.375 inch diameter and spaced at 6.0 inch on center,

$L_P$ = 1.5 inch



$P_T$ = 4.9 psi

$P_{EFF}$ = 5.6 psi

$P_{EFF}$ = 805.3 psf

Check actual compressive pressure ($S_A$) per Driscopipe manual:

$S_A$ = 0.5 x (SDR - 1) x P(eff) = 28.0 psi

The recommended, long-term compressive strength ($Y_s$) design value for Driscoplex polyethylene pipe is 800 lb/in$^2$.

Source No. 1

| $S_A$ (psi): | | $Y_s$ (psi): |
| --- | --- | --- |
| 28.0 | < | 800.0 |

Pipe passes wall compressive stress perforation calculations TRUE

FS = 28.6

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Constrained pipe wall buckling (for Driscoplex OD controlled pipe)

$$P_{WC} = \frac{5.65 * \{RB'E' E*[12(DR-1)^3]^{-1}\}^{0.5}}{N}$$ Source 1, Equation 7-5

$P_{WC}$ = allowable constrained buckling pressure (lb/in$^2$)

| | | |
|---|---|---|
| R = buoyancy reduction factor = 1 - 0.33 * (H'/H) | | Source 1, Equation 7-34 |
| H' = groundwater height above pipe (ft) | 0.0 | ft |
| H = cover above pipe (ft) | 4.0 | ft |
| B' = elastic support factor =( 1+ 4*e$^{-0.065H}$ )$^{-1}$ | | Source 1, Equation 7-35 |
| E' = soil reaction modulus (lb/in$^2$) | 3000.0 | lb/in$^2$ for mod comp/crushed rock, 'Source 1, Table 7-7 |
| E = elastic modulus (lb/in$^2$) | 100000.0 | lb/in$^2$ for long term load at 100$^o$F, 'Source 1, Table 5-1 |
| I = moment of inertia = t$^3$ / 12 | 0.1 | in$^4$/in |
| $D_o$ = pipe outer diameter (in) | 12.750 | SDR 11 pipe (Driscopipe) to be used |
| t = pipe wall thickness (in) | 1.159 | SDR 11 pipe (Driscopipe) to be used |
| DR = pipe dimension ratio = $D_o$ / t | 11.0 | SDR 11 pipe (Driscopipe) to be used |
| $D_I$ = pipe inner diameter = $D_o$ - 2t (in) | 10.4 | SDR 11 pipe (Driscopipe) to be used |
| N = safety factor | 2.0 | |

| Cover (ft) | (ft) | (ft) | B' | R | (lb/in$^2$) |
|---|---|---|---|---|---|
| 4.0 | 4 | 0 | 0.24 | 1.00 | 220.99 |

$P_{WC}$ = 220.99 lb/in$^2$

$P_{EFF}$ = 5.59 lb/in$^2$

Pipe passes contrained wall buckling calculations TRUE

FS = 39.5

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Constrained Pipe Wall Compressive Stress (for Driscoplex OD controlled pipe)

$S = \frac{P_T D_o}{288t}$ Source No. 1

S = pipe wall compressive stress ($lb/in^2$)

$P_T$ = vertical load applied to pipe w/ perfs ($lb/ft^2$) 805.3 $lb/ft^2$

$D_o$ = pipe outside diameter (in) 12.75 SDR 11 pipe (Driscopipe) to be used

t = pipe wall thickness (in) 1.159 SDR 11 pipe (Driscopipe) to be used

$S = \frac{P_T D_o}{288t} =$ 30.8 $lb/in^2$

The recommended, long-term compressive strength ($Y_s$) design value for Driscoplex polyethylene pipe is 800 $lb/in^2$.

Source No. 1

| S (psi): | | $Y_s$ (psi): |
|---|---|---|
| 30.8 | < | 800.0 |

Pipe passes wall compressive stress calculations TRUE

FS = 26.0

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Iowa Formula

$\Delta X = \dfrac{D_L K W_c r^3}{EI + 0.06er^4}$ Source 2, Equation 3.4 Buried Pipe Design, A.P. Moser, Chapter 3

$\Delta X$ = horizontal deflection (in)

$D_L$ = deflection lag factor

K = bedding constant | 0.1 | typical value Source 2, Buried Pipe Design, A.P. Moser, Chapter 3

$W_c$ = Marston's load per unit length of pipe (lb/in)

r = mean radius of the pipe (in)

E = modulus of elasticity (lb/in$^2$)

I = moment of inertia of the pipe wall per unit length (in$^3$)

e = modulus of passive resistance fo the side fill (lb/in$^2$(in))

Modified Iowa Formula

$\Delta X = \dfrac{D_L K W_c r_m^3}{EI + 0.06E'r_m^3}$ Source 2, Equation 3.5 Buried Pipe Design, A.P. Moser, Chapter 3

$\Delta X$ = horizontal deflection (in)

| | | | |
|---|---|---|---|
| $D_L$ = deflection lag factor | 1.0 | Prism Load used | |
| Typical Value for Marston Load | 1.5 | | |
| Typical Value for Prism Load | 1.0 | | |
| K = bedding constant | 0.1 | typical value Buried Pipe Design, A.P. Moser, Chapter 3 | |
| $P_T$ = Vertical load on pipe w/ perfs | 5.59 | lb/in$^2$ | 805 lb/ft$^2$ |
| $W_c$ = Marston's load per unit length of pipe = $P_T$ * $D_o$ (lb/in) | 71.31 | lb/in | |
| $D_o$ = pipe outer diameter (in) | 12.75 | SDR 11 pipe (Driscopipe) to be used | |
| t = pipe wall thickness (in) | 1.16 | SDR 11 pipe (Driscopipe) to be used | |
| $D_I$ = pipe inner diameter = $D_o$-2t (in) | 10.43 | SDR 11 pipe (Driscopipe) to be used | |
| $D_m$ = pipe mean diameter = $D_o$ - 1.06t Source 1, Equation 7-27 | 11.52 | SDR 11 pipe (Driscopipe) to be used | |
| $r_m$ = mean radius of the pipe (in) | 5.76 | SDR 11 pipe (Driscopipe) to be used | |
| E = modulus of elasticity (lb/in$^2$) | 100,000.0 | lb/in2 for long term load at 100oF, 'Source 1, Table 5-1 | |
| I = moment of inertia of the pipe wall per unit length | 0.130 | in$^4$/in | |
| E' = modulus of soil reaction | 3,000.0 | lb/in$^2$ for moderate compaction and fine grained soils | |

$\Delta X = \dfrac{D_L K W_c r_m^3}{EI + 0.06E'r_m^3}$ = 0.029 inch Source 2, Equation 3.5 Buried Pipe Design, A.P. Moser, Chapter 3

% Ring Deflection = ($\Delta X/D_m$) x 100 = 0.25% Source 1, Equation 7-31

Ring Bending Strain

$e = \dfrac{f_D \Delta X 2C}{D_M^2} \times 100$ Source 1, Equation 7-39

e = wall strain (%)

| | | |
|---|---|---|
| $f_D$ = deformation shape factor | 6 | Source 1, non-elliptical shape |
| $D_M$ = mean diameter (in) | | |
| C = outer fiber wall centroid = 0.5 (1.06t) | 0.614 | Source 1, Equation 7-41 |
| $\Delta X$ = ring deflection = $D_X/D_m$ | 0.002 | |

$e = f_D \dfrac{(\Delta X)}{D_M} \dfrac{(2C)}{D_M} \times 100$ = 0.2% Source 1, Equation 7-39

The maximum ring bending strain for high performance polyethylene non-pressure pipe is = 5.0%

Pipe passes ring bending strain calculations TRUE

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| Operation w/ CAT D7R Series II **0 Feet Waste** | | |

SOURCES

1.) Attachment - 1 - Chevron Phillips Chemical Company, Bulletin - Book 2 Chapter 5, 2003

2.) Attachment - 2 - Buried Pipe Design, A.P. Moser, Chapter 3

3.) Attachment - 3 - EPA, Lining of Waste Impoundment and Disposal Facilities, SW-870

4.) Attachment - 4 - Driscoplex Pipe Properties

5.) Attachment - 5 - CAT 826G Series II Compactor Data Sheet

6.) Attachment - 6 - CAT D7R Series II Equipment Data Sheet

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| Operation w/ CAT D7R Series II 1**0 Feet Waste** | | |

Load on Pipe (Overburden)

Prism Loads, $P_E = wH$

w = unit weight

H = depth

| | Depth (ft) | Unit Weight ($lb/ft^3$) | $P_E$ ($lb/ft^2$) |
|---|---|---|---|
| Final cover | 0.0 | 115.0 | 0.0 |
| Intermediate cover | 0.0 | 115.0 | 0.0 |
| Waste/cover | 10.0 | 60.0 | 600.0 |
| Drainage sand | 2.0 | 115.0 | 230.0 |
| Rock (No. 89 & No. 57) | 2.0 | 140.0 | 280.0 |

TOTAL SOIL PRISM LOAD $P_E$: 1110.0 $lb/ft^2$

Total Depth = 14.0 ft

Soil Arching, $P_m = C_D wB$

NOTE: The waste unit weight represents the combined unit weight of waste, daily cover, and moisture.

Pm = vertical soil pressure

B = trench width at pipe crown 6.0 ft

$C_D$ = load coefficient $= \frac{1 - e^{-2Ku'H/B}}{2Ku'}$ Equation 7-3, Source No. 1

e = natural log base number

K = Rankine earth pressure coefficient = $\tan^2(45-0.5*\phi)$

$\phi$ = internal soil friction angle = 27.0 degrees

u' = friction coefficient between backfill and trench sides = tan $\phi$

| Soil Type | Ku' |
|---|---|
| Saturated Clay | 0.110 |
| Ordinary Clay | 0.130 |
| Saturated Top Soil | 0.150 |
| Sand and Gravel | 0.165 |
| Clean Granular Soil | 0.192 |

| | Ku' | $C_D$ | $P_m$ ($lb/ft^2$) |
|---|---|---|---|
| Cover Soil | 0.150 | 0.00 | 0 |
| Int Cover | 0.165 | 0.00 | 0 |
| Waste | 0.191 | 1.23 | 444 |
| Drainage Sand | 0.165 | 0.32 | 217.8 |
| Granular Soil | 0.192 | 0.31 | 262.8 |

TOTAL SOIL ARCHING LOAD $P_M$: 924.2 $lb/ft^2$

MODIFIED ARCHING LOAD = $0.6P_M+0.4P_E$: 998.53 $lb/ft^2$

OVERBURDEN LOAD: 998.53 $lb/ft^2$

Load on Pipe With Equipment Refer to Attachment

Operation w/ CAT D7R Series II 10 Feet Waste

Equipment Weight = 54,573.0 psf

Number of Tracks = 2.0

Track Load = $q_r$ = 27,286.5 psf

Ground contact area/track = 17.3 psf

Length of Track = L = 113.0 in

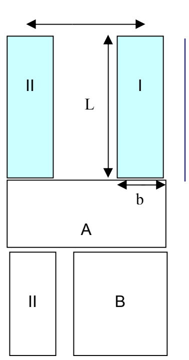
Track Width = b = 22.0 in

Track Gauge = G = 78.0 in

Equipment Width "A" = 113.0 in

Live Load = q*Ic q = track load 1,580.55 psf

Ic = Influence coefficient




| | b (ft) | L (ft) | z (ft) | m = b/z | n = L/z | I* | I** | I |
|---|---|---|---|---|---|---|---|---|
| I | 1.83 | 9.4 | 14.0 | 0.13 | 0.67 | 0.031 | 0.258 | 0.03087 |
| A | 8.33 | 9.4 | 14.0 | 0.60 | 0.67 | 0.114 | 0.272 | 0.11372 |
| B | 6.50 | 9.4 | 14.0 | 0.46 | 0.67 | 0.096 | 0.270 | 0.09592 |

Live $Load_1$ $= I + II = q_I(I_I) + q_A(I_A) - q_B(I_B)$ = 76.94 $lb/ft^2$

$q_I(I_I)$ = 48.80

$q_A(I_A)$ = 179.74

$q_B(I_B)$ = 151.60

Load on Pipe (Equipment) = 76.94 $lb/ft^2$

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| Operation w/ CAT D7R Series II 1**0 Feet Waste** | | |

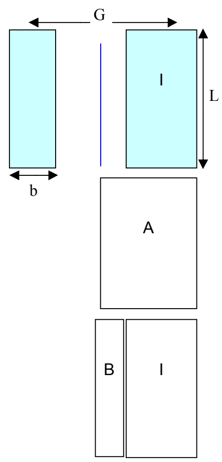
Load on Pipe (Equipment) *Continued*

Live Load = $q*I_c$

$q$ = track load 1580.55 $lb/ft^2$

$I_c$ = Influence coefficient

Alternative 2: Track stradling and parallel to pipe



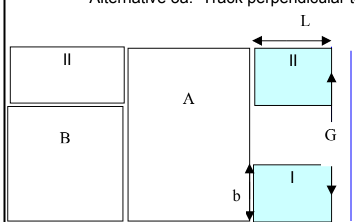

| | b | L | z | m = b/z | n = L/z | I* | I** | I |
|---|---|---|---|---|---|---|---|---|
| A | 4.71 | 9.4 | 14 | 0.34 | 0.67 | 0.074 | 0.267 | 0.07413 |
| B | 2.88 | 9.4 | 14 | 0.21 | 0.67 | 0.048 | 0.262 | 0.04754 |

Live Load$_2$ = 2 * (A - B) = 2 * ($q_A I_A$ - $q_B I_B$) = 84.04 $lb/ft^2$

| | |
|---|---|
| $q_A(I_A)$ = | 117.16 |
| $q_B(I_B)$ = | 75.14 |

Load on Pipe (Equipment) = 84.04 $lb/ft^2$

Alternative 3a: Track perpendicular to pipe




| | b | L | z | m = b/z | n = L/z | I* | I** | I |
|---|---|---|---|---|---|---|---|---|
| I | 1.83 | 9.4 | 14 | 0.13 | 0.67 | 0.031 | 0.258 | 0.03087 |
| A | 9.42 | 9.4 | 14 | 0.67 | 0.67 | 0.122 | 0.271 | 0.12225 |
| B | 7.58 | 9.4 | 14 | 0.54 | 0.67 | 0.107 | 0.271 | 0.10697 |

Live Load$_3$ = I + II = $q_I(I_I)$ + $q_A(I_A)$ - $q_B(I_B)$ = 72.96 $lb/ft^2$

| | |
|---|---|
| $q_I(I_I)$ = | 48.80 |
| $q_A(I_A)$ = | 193.23 |
| $q_B(I_B)$ = | 169.07 |

Load on Pipe (Equipment) = 72.96 $lb/ft^2$

LARGEST EQUIPEMENT LOAD = 84.04 $lb/ft^2$

VERTICAL OVERBURDEN LOAD = 998.53 $lb/ft^2$

VERTICAL EQUIPMENT LOAD = 84.04 $lb/ft^2$

TOTAL VERTICAL LOAD APPLIED TO PIPE, $P_T$ = 1,082.58 $lb/ft^2$ = 7.52 $lb/in^2$

SCS ENGINEERS

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| Operation w/ CAT D7R Series II 10 **Feet Waste** | | |

Verify that perforations in the LCRS are adequate for the peak leachate flow.

Use discharge equation:

$Q = (Cd)(Ao)(2gh)^{0.5}$

$C_d$ = coeffiecient of discharge = 0.6 for short tube discharge with fluid/wall separation; conservative value.

$A_o$ = Area of orifice ($\pi D^2/4$)

g = gravitational acceleration (32.3 $ft^2/s$)

h = static head (ft)

Assumptions and Givens:

| | | | |
|---|---|---|---|
| 1. No. acres of landfill expansion = | 4.55 | acres | North and center portion of landfill bottom |
| 2. Total length of pipe per expansion = | 138.8 | ft | |
| 3. Number of laterals = | 1.0 | | |
| 4. Total length of pipe per lateral = | 138.8 | ft | |
| 5. Perforation diameter = | 0.375 | inch | |
| 6. No. perforations/ft pipe = | 6.0 | perforations/ft of pipe length | |
| 7. Maximum head over pipe = | 1.0 | ft | |
| 8. Per HELP model summary table, $Q_{peak}$ = | 202.93 | gal/min | refer to HELP Model Summary Table |
| 9. Per HELP model summary table, $Q_{peak}$ = | 39,063.5 | cf/day | refer to HELP Model Summary Table |
| 10. Maximum flow/lateral = | 39,063.5 | cf/day/lateral | |
| 11. Maximum leachate flow/ft of pipe = | 281.44 | cf/day/ft of pipe | |

Solution:

$A_o = 0.25(\Pi)(d)^2 =$ 0.00077 $ft^2$

1. Flow per orifice, $Q = (Cd)(Ao)(2gh)^{0.5}$ = 0.0037 $ft^3/s$

2. Flow per ft of pipe = (Q)(# perfs/ft) = 0.02 $ft^3/s$ per ft of pipe

= 1914.47 cf/day/ft of pipe

Conclusion:

Design capacity exceeds estimated generation

1914.47 cf/day/ft of pipe >>> 281.44 cf/day/ft of pipe

Perforations are adequate to handle the maximum leachate flow.

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| Operation w/ CAT D7R Series II **10 Feet Waste** | | |

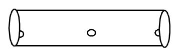
Effective pressure on pipe due to perforations:

$P_{EFF} = \frac{P_T \times 12}{(12 - L_P)}$ Source 3, EPA SW-870, p. 382

$L_P$ = Total accumulated length of perforations in one foot of pipe.

Since each perforation is 0.375 inch diameter and spaced at 6.0 inch on center,

$L_P$ = 1.5 inch



$P_T$ = 7.5 psi

$P_{EFF}$ = 8.6 psi

$P_{EFF}$ = 1237.2 psf

Check actual compressive pressure ($S_A$) per Driscopipe manual:

$S_A$ = 0.5 x (SDR - 1) x P(eff) = 43.0 psi

The recommended, long-term compressive strength ($Y_s$) design value for Driscoplex polyethylene pipe is 800 lb/in$^2$.

Source No. 1

| $S_A$ (psi): | | $Y_s$ (psi): |
|---|---|---|
| 43.0 | < | 800.0 |

Pipe passes wall compressive stress perforation calculations TRUE

FS = 18.6

SCS ENGINEERS

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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
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| Operation w/ CAT D7R Series II 1**0 Feet Waste** | | |

Constrained pipe wall buckling (for Driscoplex OD controlled pipe)

$P_{WC} = \frac{5.65 * \{RB'E' E*[12(DR-1)^3]^{-1}\}^{0.5}}{N}$ Source 1, Equation 7-5

$P_{WC}$ = allowable constrained buckling pressure (lb/in$^2$)

| | | |
|---|---|---|
| R = buoyancy reduction factor = 1 - 0.33 * (H'/H) | | Source 1, Equation 7-34 |
| H' = groundwater height above pipe (ft) | 0.0 | ft |
| H = cover above pipe (ft) | 14.0 | ft |
| B' = elastic support factor =( 1+ 4*e$^{-0.065H}$ )$^{-1}$ | | Source 1, Equation 7-35 |
| E' = soil reaction modulus (lb/in$^2$) | 3000.0 | lb/in$^2$ for mod comp/crushed rock, 'Source 1, Table 7-7 |
| E = elastic modulus (lb/in$^2$) | 100000.0 | lb/in$^2$ for long term load at 100$^o$F, 'Source 1, Table 5-1 |
| I = moment of inertia = t$^3$ / 12 | 0.1 | in$^4$/in |
| $D_o$ = pipe outer diameter (in) | 12.750 | SDR 11 pipe (Driscopipe) to be used |
| t = pipe wall thickness (in) | 1.159 | SDR 11 pipe (Driscopipe) to be used |
| DR = pipe dimension ratio = $D_o$ / t | 11.0 | SDR 11 pipe (Driscopipe) to be used |
| $D_I$ = pipe inner diameter = $D_o$ - 2t (in) | 10.4 | SDR 11 pipe (Driscopipe) to be used |
| N = safety factor | 2.0 | |

| Cover (ft) | (ft) | (ft) | B' | R | (lb/in$^2$) |
|---|---|---|---|---|---|
| 10.0 | 14 | 0 | 0.38 | 1.00 | 276.44 |

$P_{WC}$ = 276.44 lb/in$^2$

$P_{EFF}$ = 8.59 lb/in$^2$

Pipe passes contrained wall buckling calculations TRUE FS = 32.2

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| Operation w/ CAT D7R Series II 1**0 Feet Waste** | | |

Constrained Pipe Wall Compressive Stress (for Driscoplex OD controlled pipe)

$S = \frac{P_T D_o}{288t}$ Source No. 1

S = pipe wall compressive stress ($lb/in^2$)

$P_T$ = vertical load applied to pipe w/ perfs ($lb/ft^2$) 1237.2 $lb/ft^2$

$D_o$ = pipe outside diameter (in) 12.75 SDR 11 pipe (Driscopipe) to be used

t = pipe wall thickness (in) 1.159 SDR 11 pipe (Driscopipe) to be used

$S = \frac{P_T D_o}{288t} =$ 47.3 $lb/in^2$

The recommended, long-term compressive strength ($Y_s$) design value for Driscoplex polyethylene pipe is 800 $lb/in^2$.

Source No. 1

| S (psi): | | $Y_s$ (psi): |
| --- | --- | --- |
| 47.3 | < | 800.0 |

Pipe passes wall compressive stress calculations TRUE

FS = 16.9

SCS ENGINEERS

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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
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| Operation w/ CAT D7R Series II 1**0 Feet Waste** | | |

Iowa Formula

$\Delta X = \dfrac{D_L K W_c r^3}{EI + 0.06er^4}$ Source 2, Equation 3.4 Buried Pipe Design, A.P. Moser, Chapter 3

$\Delta X$ = horizontal deflection (in)

$D_L$ = deflection lag factor

K = bedding constant | 0.1 | typical value Source 2, Buried Pipe Design, A.P. Moser, Chapter 3

$W_c$ = Marston's load per unit length of pipe (lb/in)

r = mean radius of the pipe (in)

E = modulus of elasticity (lb/in$^2$)

I = moment of inertia of the pipe wall per unit length (in$^3$)

e = modulus of passive resistance fo the side fill (lb/in$^2$(in))

Modified Iowa Formula

$\Delta X = \dfrac{D_L K W_c r_m^3}{EI + 0.06E'r_m^3}$ Source 2, Equation 3.5 Buried Pipe Design, A.P. Moser, Chapter 3

$\Delta X$ = horizontal deflection (in)

| | | | |
|---|---|---|---|
| $D_L$ = deflection lag factor | | 1.0 | Prism Load used |
| Typical Value for Marston Load | 1.5 | | |
| Typical Value for Prism Load | 1.0 | | |
| K = bedding constant | | 0.1 | typical value Buried Pipe Design, A.P. Moser, Chapter 3 |
| $P_T$ = Vertical load on pipe w/ perfs | | 8.59 | lb/in$^2$ 1237 lb/ft$^2$ |
| $W_c$ = Marston's load per unit length of pipe = $P_T$ * $D_o$ (lb/in) | | 109.55 | lb/in |
| $D_o$ = pipe outer diameter (in) | | 12.75 | SDR 11 pipe (Driscopipe) to be used |
| t = pipe wall thickness (in) | | 1.16 | SDR 11 pipe (Driscopipe) to be used |
| $D_I$ = pipe inner diameter = $D_o$-2t (in) | | 10.43 | SDR 11 pipe (Driscopipe) to be used |
| $D_m$ = pipe mean diameter = $D_o$ - 1.06t Source 1, Equation 7-27 | | 11.52 | SDR 11 pipe (Driscopipe) to be used |
| $r_m$ = mean radius of the pipe (in) | | 5.76 | SDR 11 pipe (Driscopipe) to be used |
| E = modulus of elasticity (lb/in$^2$) | | 100,000.0 | lb/in2 for long term load at 100oF, 'Source 1, Table 5-1 |
| I = moment of inertia of the pipe wall per unit length | | 0.130 | in$^4$/in |
| E' = modulus of soil reaction | | 3,000.0 | lb/in$^2$ for moderate compaction and fine grained soils |

$\Delta X = \dfrac{D_L K W_c r_m^3}{EI + 0.06E'r_m^3}$ = 0.044 inch Source 2, Equation 3.5 Buried Pipe Design, A.P. Moser, Chapter 3

% Ring Deflection = ($\Delta X/D_m$) x 100 = 0.38% Source 1, Equation 7-31

Ring Bending Strain

$e = \dfrac{f_D \Delta X 2C}{D_M^2} \times 100$ Source 1, Equation 7-39

e = wall strain (%)

| | | |
|---|---|---|
| $f_D$ = deformation shape factor | 6 | Source 1, non-elliptical shape |
| $D_M$ = mean diameter (in) | | |
| C = outer fiber wall centroid = 0.5 (1.06t) | 0.614 | Source 1, Equation 7-41 |
| $\Delta X$ = ring deflection = $D_X/D_m$ | 0.004 | |

$e = f_D \dfrac{\Delta X}{D_M} \dfrac{2C}{D_M} \times 100$ = 0.2% Source 1, Equation 7-39

The maximum ring bending strain for high performance polyethylene non-pressure pipe is = 5.0%

Pipe passes ring bending strain calculations TRUE

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| **12" Diameter Leachate Collection Header System** Operation w/ CAT D7R Series II 1**0 Feet Waste** | CHECKED | DATE |

SOURCES

1.) Attachment - 1 - Chevron Phillips Chemical Company, Bulletin - Book 2 Chapter 5, 2003

2.) Attachment - 2 - Buried Pipe Design, A.P. Moser, Chapter 3

3.) Attachment - 3 - EPA, Lining of Waste Impoundment and Disposal Facilities, SW-870

4.) Attachment - 4 - Driscoplex Pipe Properties

5.) Attachment - 5 - CAT 826G Series II Compactor Data Sheet

6.) Attachment - 6 - CAT D7R Series II Equipment Data Sheet

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| Operation w/ CAT D7R Series II **25 Feet Waste** | | |

Load on Pipe (Overburden)

Prism Loads, $P_E$ = wH

w = unit weight

H = depth

| | Depth (ft) | Unit Weight ($lb/ft^3$) | $P_E$ ($lb/ft^2$) |
|---|---|---|---|
| Final cover | 0.0 | 115.0 | 0.0 |
| Intermediate cover | 0.0 | 115.0 | 0.0 |
| Waste/cover | 25.0 | 60.0 | 1500.0 |
| Drainage sand | 2.0 | 115.0 | 230.0 |
| Rock (No. 89 & No. 57) | 2.0 | 140.0 | 280.0 |

TOTAL SOIL PRISM LOAD $P_E$: 2010.0 $lb/ft^2$

Total Depth = 29.0 ft

Soil Arching, $P_m = C_D wB$

NOTE: The waste unit weight represents the combined unit weight of waste, daily cover, and moisture.

Pm = vertical soil pressure

B = trench width at pipe crown 6.0 ft

$C_D$ = load coefficient $= \frac{1 - e^{-2Ku'H/B}}{2Ku'}$ Equation 7-3, Source No. 1

e = natural log base number

K = Rankine earth pressure coefficient = $\tan^2(45-0.5*\phi)$

$\phi$ = internal soil friction angle = 27.0 degrees

u' = friction coefficient between backfill and trench sides = tan $\phi$

| Soil Type | Ku' |
|---|---|
| Saturated Clay | 0.110 |
| Ordinary Clay | 0.130 |
| Saturated Top Soil | 0.150 |
| Sand and Gravel | 0.165 |
| Clean Granular Soil | 0.192 |

| | Ku' | $C_D$ | $P_m$ ($lb/ft^2$) |
|---|---|---|---|
| Cover Soil | 0.150 | 0.00 | 0 |
| Int Cover | 0.165 | 0.00 | 0 |
| Waste | 0.191 | 2.08 | 750 |
| Drainage Sand | 0.165 | 0.32 | 217.8 |
| Granular Soil | 0.192 | 0.31 | 262.8 |

TOTAL SOIL ARCHING LOAD $P_M$: 1,230.4 $lb/ft^2$

MODIFIED ARCHING LOAD = $0.6P_M+0.4P_E$: 1,542.23 $lb/ft^2$

OVERBURDEN LOAD: 1,542.23 $lb/ft^2$

Load on Pipe With Equipment Refer to Attachment

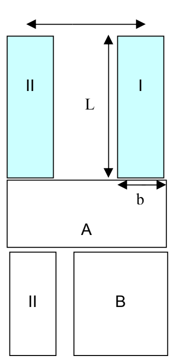
Operation w/ CAT D7R Series II 25 Feet Waste

| | | |
|---|---|---|
| Equipment Weight = | 54,573.0 | psf |
| Number of Tracks = | 2.0 | |
| Track Load = $q_r$ = | 27,286.5 | psf |
| Ground contact area/track = | 17.3 | psf |

| | | |
|---|---|---|
| Length of Track = L = | 113.0 | in |
| Track Width = b = | 22.0 | in |
| Track Gauge = G = | 78.0 | in |
| Equipment Width "A" = | 113.0 | in |

Live Load = q*Ic q = track load 1,580.55 psf

Ic = Influence coefficient




| | b (ft) | L (ft) | z (ft) | m = b/z | n = L/z | I* | I** | I |
|---|---|---|---|---|---|---|---|---|
| I | 1.83 | 9.4 | 29.0 | 0.06 | 0.32 | 0.009 | 0.253 | 0.00900 |
| A | 8.33 | 9.4 | 29.0 | 0.29 | 0.32 | 0.039 | 0.261 | 0.03850 |
| B | 6.50 | 9.4 | 29.0 | 0.22 | 0.32 | 0.031 | 0.259 | 0.03077 |

$\text{Live Load}_1 = I + II = q_I(I_I) + q_A(I_A) - q_B(I_B)$ = 26.45 $lb/ft^2$

$q_I(I_I)$ = 14.22

$q_A(I_A)$ = 60.86

$q_B(I_B)$ = 48.63

Load on Pipe (Equipment) = 26.45 $lb/ft^2$

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| Operation w/ CAT D7R Series II **25 Feet Waste** | | |

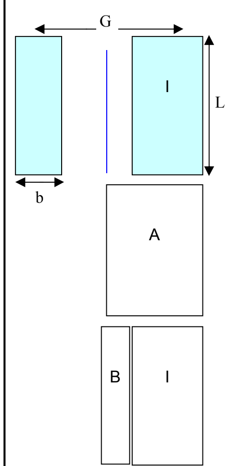
Load on Pipe (Equipment) *Continued*

Live Load = $q*I_c$

$q$ = track load 1580.55 $lb/ft^2$

$I_c$ = Influence coefficient

Alternative 2: Track stradling and parallel to pipe



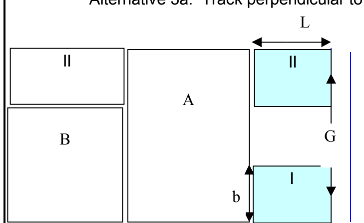

| | b | L | z | m = b/z | n = L/z | I* | I** | I |
|---|---|---|---|---|---|---|---|---|
| A | 4.71 | 9.4 | 29 | 0.16 | 0.32 | 0.023 | 0.257 | 0.02270 |
| B | 2.88 | 9.4 | 29 | 0.10 | 0.32 | 0.014 | 0.254 | 0.01404 |

Live $Load_2$ = 2 * (A - B) = 2 * ($q_A I_A$ - $q_B I_B$) = 27.36 $lb/ft^2$

| | |
|---|---|
| $q_A(I_A)$ = | 35.88 |
| $q_B(I_B)$ = | 22.20 |

Load on Pipe (Equipment) = 27.36 $lb/ft^2$

Alternative 3a: Track perpendicular to pipe




| | b | L | z | m = b/z | n = L/z | I* | I** | I |
|---|---|---|---|---|---|---|---|---|
| I | 1.83 | 9.4 | 29 | 0.06 | 0.32 | 0.009 | 0.253 | 0.00900 |
| A | 9.42 | 9.4 | 29 | 0.32 | 0.32 | 0.043 | 0.262 | 0.04279 |
| B | 7.58 | 9.4 | 29 | 0.26 | 0.32 | 0.035 | 0.261 | 0.03541 |

Live $Load_3$ = I + II = $q_I(I_I)$ + $q_A(I_A)$ - $q_B(I_B)$ = 25.90 $lb/ft^2$

| | |
|---|---|
| $q_I(I_I)$ = | 14.22 |
| $q_A(I_A)$ = | 67.64 |
| $q_B(I_B)$ = | 55.96 |

Load on Pipe (Equipment) = 25.90 $lb/ft^2$

LARGEST EQUIPEMENT LOAD = 27.36 $lb/ft^2$

VERTICAL OVERBURDEN LOAD = 1,542.23 $lb/ft^2$

VERTICAL EQUIPMENT LOAD = 27.36 $lb/ft^2$

TOTAL VERTICAL LOAD APPLIED TO PIPE, $P_T$ = 1,569.59 $lb/ft^2$ = 10.90 $lb/in^2$

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| Operation w/ CAT D7R Series II **25 Feet Waste** | | |

Verify that perforations in the LCRS are adequate for the peak leachate flow.

Use discharge equation:

$Q = (Cd)(Ao)(2gh)^{0.5}$

$C_d$ = coeffiecient of discharge = 0.6 for short tube discharge with fluid/wall separation; conservative value.

$A_o$ = Area of orifice ($\pi D^2/4$)

g = gravitational acceleration (32.3 $ft^2/s$)

h = static head (ft)

Assumptions and Givens:

| | | | |
|---|---|---|---|
| 1. No. acres of landfill expansion = | 4.55 | acres | North and center portion of landfill bottom |
| 2. Total length of pipe per expansion = | 138.8 | ft | |
| 3. Number of laterals = | 1.0 | | |
| 4. Total length of pipe per lateral = | 138.8 | ft | |
| 5. Perforation diameter = | 0.375 | inch | |
| 6. No. perforations/ft pipe = | 6.0 | perforations/ft of pipe length | |
| 7. Maximum head over pipe = | 1.0 | ft | |
| 8. Per HELP model summary table, $Q_{peak}$ = | 202.93 | gal/min | refer to HELP Model Summary Table |
| 9. Per HELP model summary table, $Q_{peak}$ = | 39,063.5 | cf/day | refer to HELP Model Summary Table |
| 10. Maximum flow/lateral = | 39,063.5 | cf/day/lateral | |
| 11. Maximum leachate flow/ft of pipe = | 281.44 | cf/day/ft of pipe | |

Solution:

$A_o = 0.25(\Pi)(d)^2 =$ 0.00077 $ft^2$

1. Flow per orifice, $Q = (Cd)(Ao)(2gh)^{0.5}$ = 0.0037 $ft^3/s$

2. Flow per ft of pipe = (Q)(# perfs/ft) = 0.02 $ft^3/s$ per ft of pipe

= 1914.47 cf/day/ft of pipe

Conclusion:

Design capacity exceeds estimated generation

1914.47 cf/day/ft of pipe >>> 281.44 cf/day/ft of pipe

Perforations are adequate to handle the maximum leachate flow.

SCS ENGINEERS

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| CLIENT | PROJECT | JOB NO. |
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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **12" Diameter Leachate Collection Header System** | CHECKED | DATE |
| Operation w/ CAT D7R Series II **25 Feet Waste** | | |

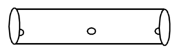
Effective pressure on pipe due to perforations:

$P_{EFF} = \frac{P_T \times 12}{(12-L_P)}$ Source 3, EPA SW-870, p. 382

$L_P$ = Total accumulated length of perforations in one foot of pipe.

Since each perforation is 0.375 inch diameter and spaced at 6.0 inch on center,

$L_P$ = 1.5 inch



$P_T$ = 10.9 psi

$P_{EFF}$ = 12.5 psi

$P_{EFF}$ = 1793.8 psf

Check actual compressive pressure ($S_A$) per Driscopipe manual:

$S_A$ = 0.5 x (SDR - 1) x P(eff) = 62.3 psi

The recommended, long-term compressive strength ($Y_s$) design value for Driscoplex polyethylene pipe is 800 lb/in$^2$.

Source No. 1

| $S_A$ (psi): | | $Y_s$ (psi): |
|---|---|---|
| 62.3 | < | 800.0 |

Pipe passes wall compressive stress perforation calculations TRUE

FS = 12.8

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| CLIENT | PROJECT | JOB NO. |
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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **12" Diameter Leachate Collection Header System** | CHECKED | DATE |
| Operation w/ CAT D7R Series II **25 Feet Waste** | | |

Constrained pipe wall buckling (for Driscoplex OD controlled pipe)

$P_{WC} = \dfrac{5.65 * \{RB'E' E*[12(DR-1)^3]^{-1}\}^{0.5}}{N}$ Source 1, Equation 7-5

$P_{WC}$ = allowable constrained buckling pressure ($lb/in^2$)

| | | |
|---|---|---|
| R = buoyancy reduction factor = 1 - 0.33 * (H'/H) | | Source 1, Equation 7-34 |
| H' = groundwater height above pipe (ft) | 0.0 | ft |
| H = cover above pipe (ft) | 29.0 | ft |
| B' = elastic support factor =( 1+ 4*$e^{-0.065H}$ )$^{-1}$ | | Source 1, Equation 7-35 |
| E' = soil reaction modulus ($lb/in^2$) | 3000.0 | $lb/in^2$ for mod comp/crushed rock, 'Source 1, Table 7-7 |
| E = elastic modulus ($lb/in^2$) | 100000.0 | $lb/in^2$ for long term load at 100°F, 'Source 1, Table 5-1 |
| I = moment of inertia = $t^3$ / 12 | 0.1 | $in^4/in$ |
| $D_o$ = pipe outer diameter (in) | 12.750 | SDR 11 pipe (Driscopipe) to be used |
| t = pipe wall thickness (in) | 1.159 | SDR 11 pipe (Driscopipe) to be used |
| DR = pipe dimension ratio = $D_o$ / t | 11.0 | SDR 11 pipe (Driscopipe) to be used |
| $D_I$ = pipe inner diameter = $D_o$ - 2t (in) | 10.4 | SDR 11 pipe (Driscopipe) to be used |
| N = safety factor | 2.0 | |

| Cover (ft) | (ft) | (ft) | B' | R | ($lb/in^2$) |
|---|---|---|---|---|---|
| 25.0 | 29 | 0 | 0.62 | 1.00 | 352.27 |

$P_{WC}$ = 352.27 $lb/in^2$

$P_{EFF}$ = 12.46 $lb/in^2$

Pipe passes contrained wall buckling calculations TRUE FS = 28.3

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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **12" Diameter Leachate Collection Header System** | CHECKED | DATE |
| Operation w/ CAT D7R Series II **25 Feet Waste** | | |

Constrained Pipe Wall Compressive Stress (for Driscoplex OD controlled pipe)

$S = \frac{P_T D_o}{288t}$ Source No. 1

S = pipe wall compressive stress ($lb/in^2$)

| | | |
| --- | --- | --- |
| $P_T$ = vertical load applied to pipe w/ perfs ($lb/ft^2$) | 1793.8 | $lb/ft^2$ |
| $D_o$ = pipe outside diameter (in) | 12.75 | SDR 11 pipe (Driscopipe) to be used |
| t = pipe wall thickness (in) | 1.159 | SDR 11 pipe (Driscopipe) to be used |

$S = \frac{P_T D_o}{288t} =$ 68.5 $lb/in^2$

The recommended, long-term compressive strength ($Y_s$) design value for Driscoplex polyethylene pipe is 800 $lb/in^2$.

Source No. 1

| S (psi): | | $Y_s$ (psi): |
| --- | --- | --- |
| 68.5 | < | 800.0 |

Pipe passes wall compressive stress calculations TRUE

FS = 11.7

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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
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| Operation w/ CAT D7R Series II **25 Feet Waste** | | |

Iowa Formula

$\Delta X = \dfrac{D_L K W_c r^3}{EI + 0.06er^4}$ Source 2, Equation 3.4 Buried Pipe Design, A.P. Moser, Chapter 3

$\Delta X$ = horizontal deflection (in)

$D_L$ = deflection lag factor

K = bedding constant | 0.1 | typical value Source 2, Buried Pipe Design, A.P. Moser, Chapter 3

$W_c$ = Marston's load per unit length of pipe (lb/in)

r = mean radius of the pipe (in)

E = modulus of elasticity ($lb/in^2$)

I = moment of inertia of the pipe wall per unit length ($in^3$)

e = modulus of passive resistance fo the side fill ($lb/in^2(in)$)

Modified Iowa Formula

$\Delta X = \dfrac{D_L K W_c r_m^3}{EI + 0.06E'r_m^3}$ Source 2, Equation 3.5 Buried Pipe Design, A.P. Moser, Chapter 3

| | | |
|---|---|---|
| $\Delta X$ = horizontal deflection (in) | | |
| $D_L$ = deflection lag factor | 1.0 | Prism Load used |
| Typical Value for Marston Load | 1.5 | |
| Typical Value for Prism Load | 1.0 | |
| K = bedding constant | 0.1 | typical value Buried Pipe Design, A.P. Moser, Chapter 3 |
| $P_T$ = Vertical load on pipe w/ perfs | 12.46 | $lb/in^2$ 1794 $lb/ft^2$ |
| $W_c$ = Marston's load per unit length of pipe = $P_T * D_o$ (lb/in) | 158.83 | lb/in |
| $D_o$ = pipe outer diameter (in) | 12.75 | SDR 11 pipe (Driscopipe) to be used |
| t = pipe wall thickness (in) | 1.16 | SDR 11 pipe (Driscopipe) to be used |
| $D_I$ = pipe inner diameter = $D_o$-2t (in) | 10.43 | SDR 11 pipe (Driscopipe) to be used |
| $D_m$ = pipe mean diameter = $D_o$ - 1.06t Source 1, Equation 7-27 | 11.52 | SDR 11 pipe (Driscopipe) to be used |
| $r_m$ = mean radius of the pipe (in) | 5.76 | SDR 11 pipe (Driscopipe) to be used |
| E = modulus of elasticity ($lb/in^2$) | 100,000.0 | lb/in2 for long term load at 100oF, 'Source 1, Table 5-1 |
| I = moment of inertia of the pipe wall per unit length | 0.130 | $in^4/in$ |
| E' = modulus of soil reaction | 3,000.0 | $lb/in^2$ for moderate compaction and fine grained soils |

$\Delta X = \dfrac{D_L K W_c r_m^3}{EI + 0.06E'r_m^3}$ = 0.064 inch Source 2, Equation 3.5 Buried Pipe Design, A.P. Moser, Chapter 3

% Ring Deflection = $(\Delta X/D_m) \times 100$ = 0.56% Source 1, Equation 7-31

Ring Bending Strain

$e = \dfrac{f_D \Delta X 2C}{D_M^2} \times 100$ Source 1, Equation 7-39

| | | |
|---|---|---|
| e = wall strain (%) | | |
| $f_D$ = deformation shape factor | 6 | Source 1, non-elliptical shape |
| $D_M$ = mean diameter (in) | | |
| C = outer fiber wall centroid = 0.5 (1.06t) | 0.614 | Source 1, Equation 7-41 |
| $\Delta X$ = ring deflection = $D_X/D_m$ | 0.006 | |

$e = f_D \left(\dfrac{\Delta X}{D_M}\right)\left(\dfrac{2C}{D_M}\right) \times 100$ = 0.4% Source 1, Equation 7-39

The maximum ring bending strain for high performance polyethylene non-pressure pipe is = 5.0%

Pipe passes ring bending strain calculations TRUE

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| Operation w/ CAT D7R Series II **25 Feet Waste** | | |

SOURCES

1.) Attachment - 1 - Chevron Phillips Chemical Company, Bulletin - Book 2 Chapter 5, 2003

2.) Attachment - 2 - Buried Pipe Design, A.P. Moser, Chapter 3

3.) Attachment - 3 - EPA, Lining of Waste Impoundment and Disposal Facilities, SW-870

4.) Attachment - 4 - Driscoplex Pipe Properties

5.) Attachment - 5 - CAT 826G Series II Compactor Data Sheet

6.) Attachment - 6 - CAT D7R Series II Equipment Data Sheet

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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
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| Operation w/ CAT D7R Series II **60 Feet Waste** | | |

Load on Pipe (Overburden)

Prism Loads, $P_E$ = wH

w = unit weight

H = depth

| | Depth (ft) | Unit Weight (lb/ft$^3$) | $P_E$ (lb/ft$^2$) |
|---|---|---|---|
| Final cover | 2.0 | 115.0 | 230.0 |
| Intermediate cover | 1.0 | 115.0 | 115.0 |
| Waste/cover | 60.0 | 60.0 | 3600.0 |
| Drainage sand | 2.0 | 115.0 | 230.0 |
| Rock (No. 89 & No. 57) | 2.0 | 140.0 | 280.0 |

TOTAL SOIL PRISM LOAD $P_E$: 4455.0 lb/ft$^2$

Total Depth = 67.0 ft

Soil Arching, $P_m = C_D wB$

NOTE: The waste unit weight represents the combined unit weight of waste, daily cover, and moisture.

Pm = vertical soil pressure

B = trench width at pipe crown 6.0 ft

$C_D$ = load coefficient $= \frac{1 - e^{-2Ku'H/B}}{2Ku'}$ Equation 7-3, Source No. 1

e = natural log base number

K = Rankine earth pressure coefficient = $\tan^2(45-0.5*\phi)$

$\phi$ = internal soil friction angle = 27.0 degrees

u' = friction coefficient between backfill and trench sides = tan $\phi$

| Soil Type | Ku' |
|---|---|
| Saturated Clay | 0.110 |
| Ordinary Clay | 0.130 |
| Saturated Top Soil | 0.150 |
| Sand and Gravel | 0.165 |
| Clean Granular Soil | 0.192 |

| | Ku' | $C_D$ | $P_m$ (lb/ft$^2$) |
|---|---|---|---|
| Cover Soil | 0.150 | 0.32 | 219 |
| Int Cover | 0.165 | 0.16 | 112 |
| Waste | 0.191 | 2.56 | 920 |
| Drainage Sand | 0.165 | 0.32 | 217.8 |
| Granular Soil | 0.192 | 0.31 | 262.8 |

TOTAL SOIL ARCHING LOAD $P_M$: 1,731.6 lb/ft$^2$

MODIFIED ARCHING LOAD = $0.6P_M+0.4P_E$: 2,820.98 lb/ft$^2$

OVERBURDEN LOAD: 2,820.98 lb/ft$^2$

Load on Pipe With Equipment Refer to Attachment

Operation w/ CAT D7R Series II 60 Feet Waste

Equipment Weight = 54,573.0 psf

Number of Tracks = 2.0

Track Load = $q_r$ = 27,286.5 psf

Ground contact area/track = 17.3 psf

Length of Track = L = 113.0 in

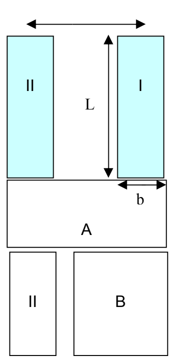
Track Width = b = 22.0 in

Track Gauge = G = 78.0 in

Equipment Width "A" = 113.0 in

Live Load = q*Ic q = track load 1,580.55 psf

Ic = Influence coefficient




| | b (ft) | L (ft) | z (ft) | m = b/z | n = L/z | I* | I** | I |
|---|---|---|---|---|---|---|---|---|
| I | 1.83 | 9.4 | 67.0 | 0.03 | 0.14 | 0.002 | 0.251 | 0.00181 |
| A | 8.33 | 9.4 | 67.0 | 0.12 | 0.14 | 0.008 | 0.253 | 0.00811 |
| B | 6.50 | 9.4 | 67.0 | 0.10 | 0.14 | 0.006 | 0.252 | 0.00636 |

Live Load$_1$ = I + II = $q_I(I_I) + q_A(I_A) - q_B(I_B)$ = 5.62 lb/ft$^2$

$q_I(I_I)$ = 2.85

$q_A(I_A)$ = 12.82

$q_B(I_B)$ = 10.05

Load on Pipe (Equipment) = 5.62 lb/ft$^2$

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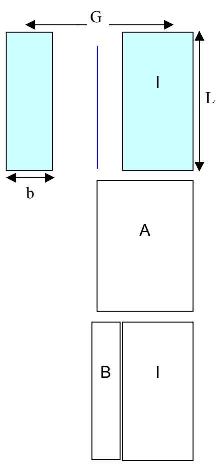
Load on Pipe (Equipment) *Continued*

Live Load = $q*I_c$

q = track load 1580.55 $lb/ft^2$

$I_c$ = Influence coefficient

Alternative 2: Track stradling and parallel to pipe



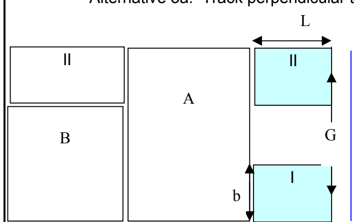

| | b | L | z | m = b/z | n = L/z | I* | I** | I |
|---|---|---|---|---|---|---|---|---|
| A | 4.71 | 9.4 | 67 | 0.07 | 0.14 | 0.005 | 0.252 | 0.00462 |
| B | 2.88 | 9.4 | 67 | 0.04 | 0.14 | 0.003 | 0.251 | 0.00283 |

$\text{Live Load}_2 = 2 * (A - B) = 2 * (q_A I_A - q_B I_B) =$ 5.66 $lb/ft^2$

| | |
|---|---|
| $q_A(I_A)$ = | 7.30 |
| $q_B(I_B)$ = | 4.47 |

Load on Pipe (Equipment) = 5.66 $lb/ft^2$

Alternative 3a: Track perpendicular to pipe




| | b | L | z | m = b/z | n = L/z | I* | I** | I |
|---|---|---|---|---|---|---|---|---|
| I | 1.83 | 9.4 | 67 | 0.03 | 0.14 | 0.002 | 0.251 | 0.00181 |
| A | 9.42 | 9.4 | 67 | 0.14 | 0.14 | 0.009 | 0.253 | 0.00913 |
| B | 7.58 | 9.4 | 67 | 0.11 | 0.14 | 0.007 | 0.252 | 0.00739 |

$\text{Live Load}_3 = I + II = q_I(I_I) + q_A(I_A) - q_B(I_B) =$ 5.60 $lb/ft^2$

| | |
|---|---|
| $q_I(I_I)$ = | 2.85 |
| $q_A(I_A)$ = | 14.43 |
| $q_B(I_B)$ = | 11.69 |

Load on Pipe (Equipment) = 5.60 $lb/ft^2$

LARGEST EQUIPEMENT LOAD = 5.66 $lb/ft^2$

VERTICAL OVERBURDEN LOAD = 2,820.98 $lb/ft^2$

VERTICAL EQUIPMENT LOAD = 5.66 $lb/ft^2$

TOTAL VERTICAL LOAD APPLIED TO PIPE, $P_T$ = 2,826.65 $lb/ft^2$ = 19.63 $lb/in^2$

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Verify that perforations in the LCRS are adequate for the peak leachate flow.

Use discharge equation:

$Q = (Cd)(Ao)(2gh)^{0.5}$

$C_d$ = coeffiecient of discharge = 0.6 for short tube discharge with fluid/wall separation; conservative value.

$A_o$ = Area of orifice ($\pi D^2/4$)

g = gravitational acceleration (32.3 $ft^2/s$)

h = static head (ft)

Assumptions and Givens:

| | | | |
|---|---|---|---|
| 1. No. acres of landfill expansion = | 4.55 | acres | North and center portion of landfill bottom |
| 2. Total length of pipe per expansion = | 138.8 | ft | |
| 3. Number of laterals = | 1.0 | | |
| 4. Total length of pipe per lateral = | 138.8 | ft | |
| 5. Perforation diameter = | 0.375 | inch | |
| 6. No. perforations/ft pipe = | 6.0 | perforations/ft of pipe length | |
| 7. Maximum head over pipe = | 1.0 | ft | |
| 8. Per HELP model summary table, $Q_{peak}$ = | 202.93 | gal/min | refer to HELP Model Summary Table |
| 9. Per HELP model summary table, $Q_{peak}$ = | 39,063.5 | cf/day | refer to HELP Model Summary Table |
| 10. Maximum flow/lateral = | 39,063.5 | cf/day/lateral | |
| 11. Maximum leachate flow/ft of pipe = | 281.44 | cf/day/ft of pipe | |

Solution:

$A_o = 0.25(\Pi)(d)^2 =$ 0.00077 $ft^2$

1. Flow per orifice, $Q = (Cd)(Ao)(2gh)^{0.5}$ = 0.0037 $ft^3/s$

2. Flow per ft of pipe = (Q)(# perfs/ft) = 0.02 $ft^3/s$ per ft of pipe

= 1914.47 cf/day/ft of pipe

Conclusion:

Design capacity exceeds estimated generation

1914.47 cf/day/ft of pipe >>> 281.44 cf/day/ft of pipe

Perforations are adequate to handle the maximum leachate flow.

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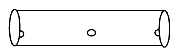
Effective pressure on pipe due to perforations:

$P_{EFF} = \frac{P_T \times 12}{(12 - L_P)}$ Source 3, EPA SW-870, p. 382

$L_P$ = Total accumulated length of perforations in one foot of pipe.

Since each perforation is 0.375 inch diameter and spaced at 6.0 inch on center,

$L_P$ = 1.5 inch



$P_T$ = 19.6 psi

$P_{EFF}$ = 22.4 psi

$P_{EFF}$ = 3230.5 psf

Check actual compressive pressure ($S_A$) per Driscopipe manual:

$S_A$ = 0.5 x (SDR - 1) x P(eff) = 112.2 psi

The recommended, long-term compressive strength ($Y_s$) design value for Driscoplex polyethylene pipe is 800 lb/in$^2$.

Source No. 1

| $S_A$ (psi): | | $Y_s$ (psi): |
|---|---|---|
| 112.2 | < | 800.0 |

Pipe passes wall compressive stress perforation calculations TRUE

FS = 7.1

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Constrained pipe wall buckling (for Driscoplex OD controlled pipe)

$P_{WC} = \frac{5.65 * \{RB'E' E*[12(DR-1)^3]^{-1}\}^{0.5}}{N}$ Source 1, Equation 7-5

$P_{WC}$ = allowable constrained buckling pressure (lb/in$^2$)

| | | |
|---|---|---|
| R = buoyancy reduction factor = 1 - 0.33 * (H'/H) | | Source 1, Equation 7-34 |
| H' = groundwater height above pipe (ft) | 0.0 | ft |
| H = cover above pipe (ft) | 67.0 | ft |
| B' = elastic support factor =( 1+ 4*e$^{-0.065H}$ )$^{-1}$ | | Source 1, Equation 7-35 |
| E' = soil reaction modulus (lb/in$^2$) | 3000.0 | lb/in$^2$ for mod comp/crushed rock, 'Source 1, Table 7-7 |
| E = elastic modulus (lb/in$^2$) | 100000.0 | lb/in$^2$ for long term load at 100$^o$F, 'Source 1, Table 5-1 |
| I = moment of inertia = t$^3$ / 12 | 0.1 | in$^4$/in |
| $D_o$ = pipe outer diameter (in) | 12.750 | SDR 11 pipe (Driscopipe) to be used |
| t = pipe wall thickness (in) | 1.159 | SDR 11 pipe (Driscopipe) to be used |
| DR = pipe dimension ratio = $D_o$ / t | 11.0 | SDR 11 pipe (Driscopipe) to be used |
| $D_I$ = pipe inner diameter = $D_o$ - 2t (in) | 10.4 | SDR 11 pipe (Driscopipe) to be used |
| N = safety factor | 2.0 | |

| Cover (ft) | (ft) | (ft) | B' | R | (lb/in$^2$) |
|---|---|---|---|---|---|
| 60.0 | 67 | 0 | 0.95 | 1.00 | 435.57 |

$P_{WC}$ = 435.57 lb/in$^2$
$P_{EFF}$ = 22.43 lb/in$^2$

Pipe passes contrained wall buckling calculations TRUE     FS = 19.4

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Constrained Pipe Wall Compressive Stress (for Driscoplex OD controlled pipe)

$S = \frac{P_T D_o}{288t}$ Source No. 1

S = pipe wall compressive stress ($lb/in^2$)

| | | |
|---|---|---|
| $P_T$ = vertical load applied to pipe w/ perfs ($lb/ft^2$) | 3230.5 | $lb/ft^2$ |
| $D_o$ = pipe outside diameter (in) | 12.75 | SDR 11 pipe (Driscopipe) to be used |
| t = pipe wall thickness (in) | 1.159 | SDR 11 pipe (Driscopipe) to be used |

$S = \frac{P_T D_o}{288t} =$ 123.4 $lb/in^2$

The recommended, long-term compressive strength ($Y_s$) design value for Driscoplex polyethylene pipe is 800 $lb/in^2$.

Source No. 1

| S (psi): | | $Y_s$ (psi): |
|---|---|---|
| 123.4 | < | 800.0 |

Pipe passes wall compressive stress calculations TRUE

FS = 6.5

SCS ENGINEERS

SHEET 7 OF 8

| CLIENT | PROJECT | JOB NO. |
|---|---|---|
| Hardee County | Phase II Section II Expansion | 09199033.23 |

| SUBJECT | BY | DATE |
|---|---|---|
| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **12" Diameter Leachate Collection Header System** | CHECKED | DATE |
| Operation w/ CAT D7R Series II **60 Feet Waste** | | |

Iowa Formula

$$\Delta X = \frac{D_L K W_c r^3}{EI + 0.06er^4}$$ Source 2, Equation 3.4 Buried Pipe Design, A.P. Moser, Chapter 3

$\Delta X$ = horizontal deflection (in)

$D_L$ = deflection lag factor

K = bedding constant | 0.1 | typical value Source 2, Buried Pipe Design, A.P. Moser, Chapter 3

$W_c$ = Marston's load per unit length of pipe (lb/in)

r = mean radius of the pipe (in)

E = modulus of elasticity (lb/in$^2$)

I = moment of inertia of the pipe wall per unit length (in$^3$)

e = modulus of passive resistance fo the side fill (lb/in$^2$(in))

Modified Iowa Formula

$$\Delta X = \frac{D_L K W_c r_m^3}{EI + 0.06E'r_m^3}$$ Source 2, Equation 3.5 Buried Pipe Design, A.P. Moser, Chapter 3

$\Delta X$ = horizontal deflection (in)

| | | | |
|---|---|---|---|
| $D_L$ = deflection lag factor | | 1.0 | Prism Load used |
| Typical Value for Marston Load | 1.5 | | |
| Typical Value for Prism Load | 1.0 | | |
| K = bedding constant | | 0.1 | typical value Buried Pipe Design, A.P. Moser, Chapter 3 |
| $P_T$ = Vertical load on pipe w/ perfs | | 22.43 | lb/in$^2$ 3230 lb/ft$^2$ |
| $W_c$ = Marston's load per unit length of pipe = $P_T$ * $D_o$ (lb/in) | | 286.03 | lb/in |
| $D_o$ = pipe outer diameter (in) | | 12.75 | SDR 11 pipe (Driscopipe) to be used |
| t = pipe wall thickness (in) | | 1.16 | SDR 11 pipe (Driscopipe) to be used |
| $D_I$ = pipe inner diameter = $D_o$-2t (in) | | 10.43 | SDR 11 pipe (Driscopipe) to be used |
| $D_m$ = pipe mean diameter = $D_o$ - 1.06t Source 1, Equation 7-27 | | 11.52 | SDR 11 pipe (Driscopipe) to be used |
| $r_m$ = mean radius of the pipe (in) | | 5.76 | SDR 11 pipe (Driscopipe) to be used |
| E = modulus of elasticity (lb/in$^2$) | | 100,000.0 | lb/in2 for long term load at 100oF, 'Source 1, Table 5-1 |
| I = moment of inertia of the pipe wall per unit length | | 0.130 | in$^4$/in |
| E' = modulus of soil reaction | | 3,000.0 | lb/in$^2$ for moderate compaction and fine grained soils |

$$\Delta X = \frac{D_L K W_c r_m^3}{EI + 0.06E'r_m^3} = 0.115$$ inch Source 2, Equation 3.5 Buried Pipe Design, A.P. Moser, Chapter 3

% Ring Deflection = ($\Delta X/D_m$) x 100 = 1.00% Source 1, Equation 7-31

Ring Bending Strain

$$e = \frac{f_D \Delta X 2C}{D_M^2} \times 100$$ Source 1, Equation 7-39

e = wall strain (%)

| | | |
|---|---|---|
| $f_D$ = deformation shape factor | 6 | Source 1, non-elliptical shape |
| $D_M$ = mean diameter (in) | | |
| C = outer fiber wall centroid = 0.5 (1.06t) | 0.614 | Source 1, Equation 7-41 |
| $\Delta X$ = ring deflection = $D_X/D_m$ | 0.010 | |

$$e = f_D \frac{\Delta X}{D_M} \frac{2C}{D_M} \times 100 = 0.6\%$$ Source 1, Equation 7-39

The maximum ring bending strain for high performance polyethylene non-pressure pipe is = 5.0%

Pipe passes ring bending strain calculations TRUE

| CLIENT | PROJECT | JOB NO. |
|---|---|---|
| Hardee County | Phase II Section II Expansion | 09199033.23 |

| SUBJECT | BY | DATE |
|---|---|---|
| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **12" Diameter Leachate Collection Header System** Operation w/ CAT D7R Series II **60 Feet Waste** | CHECKED | DATE |

SOURCES

1.) Attachment - 1 - Chevron Phillips Chemical Company, Bulletin - Book 2 Chapter 5, 2003

2.) Attachment - 2 - Buried Pipe Design, A.P. Moser, Chapter 3

3.) Attachment - 3 - EPA, Lining of Waste Impoundment and Disposal Facilities, SW-870

4.) Attachment - 4 - Driscoplex Pipe Properties

5.) Attachment - 5 - CAT 826G Series II Compactor Data Sheet

6.) Attachment - 6 - CAT D7R Series II Equipment Data Sheet

# Summary Table and 8-Inch Leachate Collection Lateral Pipe Crushing and Flow Capacity Calculations Phase II Section I

SCS ENGINEERS

SHEET 1 OF 1

| CLIENT | PROJECT | JOB NO. |
|---|---|---|
| Hardee County | Phase II Section II Expansion | 09199033.23 |

| SUBJECT | BY | DATE |
|---|---|---|
| Phase II Section II **RAI No. 1** | SRF | 4/1/13 |
| Summary Table Pipe Crushing **Operations** | CHECKED | DATE |
| **8" Diameter Leachate Collection Laterals Phase II Section I** | | |

| Description | Waste Height (ft) | Fill Height (ft) | Pipe Diameter (in) | Type of Calculation | Design Value | Calculated Value | Units | Safety Factor* |
|---|---|---|---|---|---|---|---|---|
| CAT D7R Series II | 40 | 2 | 8 | Flow Capacity | 1914.47 | 31.98 | cf/day/ft of pipe | 59.87 |
| | | | | Buckling | 402.82 | 15.76 | psi | 25.56 |
| | | | | Compressive Stress | 800 | 86.68 | psi | 9.23 |
| | | | | Bending Strain | 5.0% | 0.5% | % | 11.11 |
| CAT D7R Series II | 60 | 62 | 8 | Flow Capacity | 1914.47 | 31.98 | cf/day/ft of pipe | 59.87 |
| | | | | Buckling | 435.54 | 22.43 | psi | 19.41 |
| | | | | Compressive Stress | 800 | 123.40 | psi | 6.48 |
| | | | | Bending Strain | 5.0% | 0.6% | % | 7.80 |
| CAT 826 G Series II Compactor | 40 | 42 | 8 | Flow Capacity | 1914.47 | 31.98 | cf/day/ft of pipe | 59.87 |
| | | | | Buckling | 402.82 | 15.95 | psi | 25.26 |
| | | | | Compressive Stress | 800 | 87.73 | psi | 9.12 |
| | | | | Bending Strain | 5.0% | 0.5% | % | 10.98 |
| CAT 826 G Series II Compactor | 60 | 62 | 8 | Flow Capacity | 1914.47 | 31.98 | cf/day/ft of pipe | 59.87 |
| | | | | Buckling | 435.54 | 22.52 | psi | 19.34 |
| | | | | Compressive Stress | 800 | 123.89 | psi | 6.46 |
| | | | | Bending Strain | 5.0% | 0.6% | % | 7.77 |

* Safety Factor = Design Value/Calculated Value

SCS ENGINEERS

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| CLIENT | PROJECT | JOB NO. | |
|---|---|---|---|
| Hardee County | Phase II Section II Expansion | 09199033.23 | |
| SUBJECT | | BY | DATE |
| Pipe Crushing Calculations **RAI No. 1** | | SRF | 4/1/13 |
| **8" Diameter Leachate Collection Lateral** | | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **40 Feet Waste** | | | |

Load on Pipe (Overburden)

Prism Loads, $P_E$ = wH

w = unit weight

H = depth

| | Depth (ft) | Unit Weight (lb/ft$^3$) | $P_E$ (lb/ft$^2$) |
|---|---|---|---|
| Final cover | 0.0 | 115.0 | 0.0 |
| Intermediate cover | 0.0 | 115.0 | 0.0 |
| Waste/cover | 40.0 | 60.0 | 2400.0 |
| Drainage sand | 2.0 | 115.0 | 230.0 |
| Rock (No. 89 & No. 57) | 2.0 | 140.0 | 280.0 |

TOTAL SOIL PRISM LOAD $P_E$: 2910.0 lb/ft$^2$

Total Depth = 44.0 ft

Soil Arching, $P_m$ = $C_D$wB

Pm = vertical soil pressure

B = trench width at pipe crown 6.0 ft

$C_D$ = load coefficient $= \frac{1 - e^{-2Ku'H/B}}{2Ku'}$ Equation 7-3, Source No. 1

NOTE: The waste unit weight represents the combined unit weight of waste, daily cover, and moisture.

e = natural log base number

K = Rankine earth pressure coefficient = $\tan^2(45-0.5*\phi)$

$\phi$ = internal soil friction angle = 27.0 degrees

u' = friction coefficient between backfill and trench sides = tan $\phi$

| Soil Type | Ku' |
|---|---|
| Saturated Clay | 0.110 |
| Ordinary Clay | 0.130 |
| Saturated Top Soil | 0.150 |
| Sand and Gravel | 0.165 |
| Clean Granular Soil | 0.192 |

| | Ku' | $C_D$ | $P_m$ (lb/ft$^2$) |
|---|---|---|---|
| Cover Soil | 0.150 | 0.00 | 0 |
| Int Cover | 0.165 | 0.00 | 0 |
| Waste | 0.191 | 2.41 | 867 |
| Drainage Sand | 0.165 | 0.32 | 217.8 |
| Granular Soil | 0.192 | 0.31 | 262.8 |

TOTAL SOIL ARCHING LOAD $P_M$: 1,348.0 lb/ft$^2$

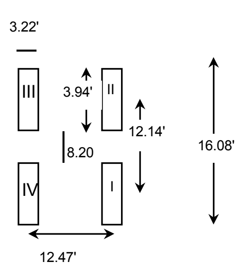
MODIFIED ARCHING LOAD = $0.6P_M+0.4P_E$: 1,972.79 lb/ft$^2$

OVERBURDEN LOAD: 1,972.79 lb/ft$^2$

Load on Pipe With Equipment Refer to Attachment

Operation w/ CAT 826G Series II Compactor 40 Feet Waste

Equipment Weight = 81,498.0 psf




| | | | |
|---|---|---|---|
| Track per Load = $q_r$ = | 1,670.20 | psf | (Rear) |
| Track per Load = $q_{fr}$ = | 1,541.72 | psf | (Front) |
| Length of Track = L = | 3.22 | ft | (contact length) |
| Length of Track = b = | 8.20 | ft | |
| Track Width = | 12.47 | ft | |
| Track Width (I to II) = | 16.08 | ft | |

SCS ENGINEERS

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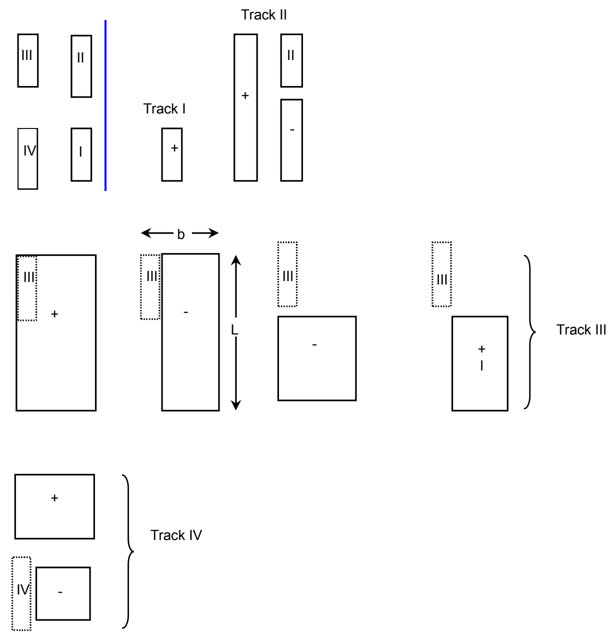
| CLIENT | PROJECT | JOB NO. |
|---|---|---|
| Hardee County | Phase II Section II Expansion | 09199033.23 |

| SUBJECT | BY | DATE |
|---|---|---|
| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Collection Lateral** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **40 Feet Waste** | | |

Load on Pipe

Alternative 1: Track Adjacent and Parallel to Pipe




| | b | L | z | m = b/z | n = L/z | I* | I** | I | |
|---|---|---|---|---|---|---|---|---|---|
| Track I | 8.2 | 3 | 44 | 0.19 | 0.07 | 0.006 | 0.252 | 0.00630 | (ADD) |
| | | | | | | | | | |
| Track II | 8.2 | 16.1 | 44 | 0.19 | 0.37 | 0.029 | 0.259 | 0.02855 | (ADD) |
| | 8.2 | 11.4 | 44 | 0.19 | 0.26 | 0.021 | 0.257 | 0.02129 | (SUBTRACT) |
| | | | | | | | | | |
| Track IV | 12.47 | 3.22 | 44 | 0.28 | 0.07 | 0.009 | 0.253 | 0.00925 | (ADD) |
| | 12.47 | 3.22 | 44 | 0.28 | 0.07 | 0.009 | 0.253 | 0.00925 | (SUBTRACT) |
| | | | | | | | | | |
| Track III | 12.47 | 16.08 | 44 | 0.28 | 0.37 | 0.042 | 0.262 | 0.04197 | (ADD) |
| | 4.27 | 16.08 | 44 | 0.10 | 0.37 | 0.015 | 0.255 | 0.01517 | (SUBTRACT) |
| | 12.47 | 11.42 | 44 | 0.28 | 0.26 | 0.031 | 0.259 | 0.03126 | (SUBTRACT) |
| | 4.27 | 8.47 | 44 | 0.10 | 0.19 | 0.009 | 0.253 | 0.00859 | (ADD) |

$\text{Live Load}_1 = q_r(\Sigma I) + q_{fr}(\Sigma II) + q_{fr}(\Sigma III) + q_r(\Sigma IV)$

$\text{Live Load}_1 =$ 28.09 psf

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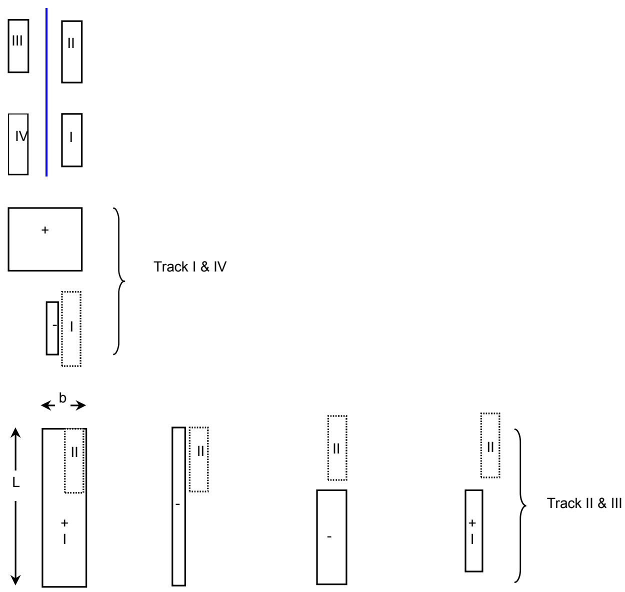
| CLIENT | PROJECT | JOB NO. |
|---|---|---|
| Hardee County | Phase II Section II Expansion | 09199033.23 |

| SUBJECT | BY | DATE |
|---|---|---|
| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Collection Lateral** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **40 Feet Waste** | | |

Load on Pipe

Alternative 2: Track Stradling and Parallel to Pipe




| | b | L | z | m = b/z | n = L/z | I* | I** | I | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | |
| Track I | 6.2 | 3.2 | 44 | 0.1 | 0.1 | 0.005 | 0.252 | 0.00485 | (ADD) |
| & IV | -2.0 | 3.2 | 44 | 0.0 | 0.1 | -0.002 | 0.249 | -0.00155 | (SUBTRACT) |
| | | | | | | | | | |
| Track II | 6.2 | 16.08 | 44 | 0.1 | 0.4 | 0.022 | 0.257 | 0.02196 | (ADD) |
| & III | -2.0 | 16.08 | 44 | 0.0 | 0.4 | -0.007 | 0.248 | -0.00702 | (SUBTRACT) |
| | 6.2 | 12.86 | 44 | 0.1 | 0.3 | 0.018 | 0.256 | 0.01819 | (SUBTRACT) |
| | -2.0 | 12.86 | 44 | 0.0 | 0.3 | -0.006 | 0.248 | -0.00582 | (ADD) |

Live $Load_2$ = $[q_r\,(\Sigma I) + q_{fr}\,(\Sigma II)] * 2$

Live $Load_2$ = 36.72 psf

| CLIENT | PROJECT | JOB NO. |
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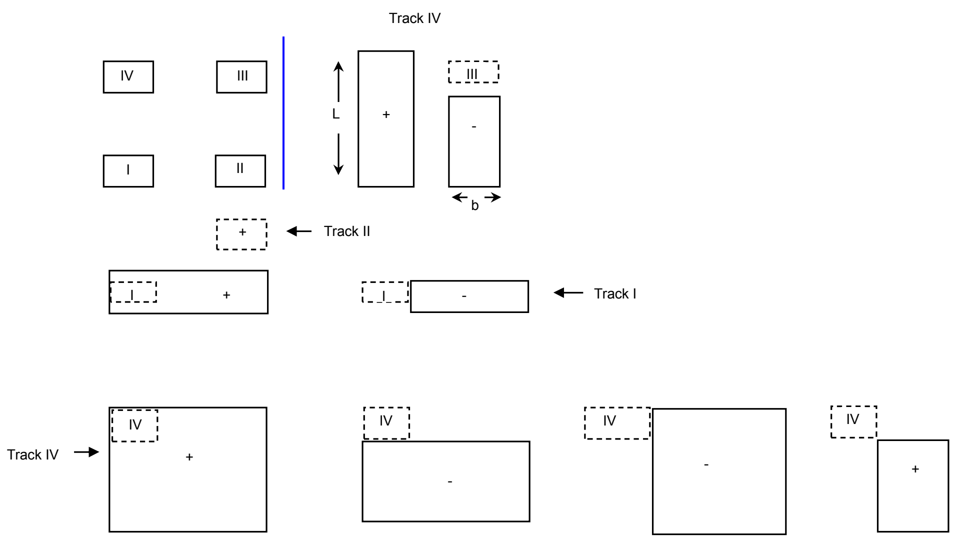
| SUBJECT | BY | DATE |
|---|---|---|
| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Collection Lateral** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **40 Feet Waste** | | |

Load on Pipe

Alternative 3: Track Perpendicular to Pipe




| | b | L | z | m = b/z | n = L/z | I* | I** | I | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | |
| Track I | 16.1 | 8.2 | 44 | 0.4 | 0.2 | 0.029 | 0.259 | 0.02855 | (ADD) |
| | 12.9 | 8.2 | 44 | 0.3 | 0.2 | 0.024 | 0.257 | 0.02365 | (SUBTRACT) |
| | | | | | | | | | |
| Track II | 3.2 | 8.2 | 44 | 0.1 | 0.2 | 0.006 | 0.252 | 0.00630 | (ADD) |
| | | | | | | | | | |
| Track III | 3.2 | 12.5 | 44 | 0.1 | 0.3 | 0.009 | 0.253 | 0.00925 | (ADD) |
| | 3.2 | 4.3 | 44 | 0.1 | 0.1 | 0.003 | 0.251 | 0.00335 | (SUBTRACT) |
| | | | | | | | | | |
| Track IV | 16.1 | 12.5 | 44 | 0.4 | 0.3 | 0.042 | 0.262 | 0.04197 | (ADD) |
| | 16.1 | 4.3 | 44 | 0.4 | 0.1 | 0.015 | 0.255 | 0.01517 | (SUBTRACT) |
| | 12.9 | 12.5 | 44 | 0.3 | 0.3 | 0.035 | 0.260 | 0.03474 | (SUBTRACT) |
| | 12.9 | 4.3 | 44 | 0.3 | 0.1 | 0.013 | 0.254 | 0.01256 | (ADD) |

Live $Load_3$ = $q_r(\Sigma I) + q_{fr}(\Sigma II) + q_{fr}(\Sigma III) + q_r(\Sigma IV)$

Live $Load_3$ = 34.74 psf

LARGEST EQUIPEMENT LOAD = 36.72 $lb/ft^2$

VERTICAL OVERBURDEN LOAD = 1972.79 $lb/ft^2$

VERTICAL EQUIPMENT LOAD = 36.72 $lb/ft^2$

TOTAL VERTICAL LOAD APPLIED TO PIPE, $P_T$ = 2009.52 $lb/ft^2$ = 13.95 $lb/in^2$

SCS ENGINEERS

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| CLIENT | PROJECT | JOB NO. |
|---|---|---|
| Hardee County | Phase II Section II Expansion | 09199033.23 |

| SUBJECT | BY | DATE |
|---|---|---|
| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Collection Lateral** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **40 Feet Waste** | | |

Verify that perforations in the LCRS are adequate for the peak leachate flow.

Use discharge equation:

$Q = (Cd)(Ao)(2gh)^{0.5}$

$C_d$ = coeffiecient of discharge = 0.6 for short tube discharge with fluid/wall separation; conservative value.

$A_o$ = Area of orifice ($\pi D^2/4$)

g = gravitational acceleration (32.3 $ft^2/s$)

h = static head (ft)

| | | | |
|---|---|---|---|
| | 1.63 | acres | Phase II Section II south portion |
| Assumptions and Givens: | 5.00 | acres | Phase II Section I area |
| 1. No. acres of landfill expansion = | 5.00 | acres | - Use Phase II Section I area in calcs. If LCS pipes can |
| 2. Total length of pipe per expansion = | 2,020.0 | ft | handle this flow they will also handle the flow in the |
| 3. Total number of laterals = | 3.0 | | Phase II Section II Expansion south portion which has |
| 4. Length of pipe per lateral = | 673.3 | ft | less flow. Includes flow from north, center, south, |
| 5. Perforation diameter = | 0.375 | inch | Phase I south sideslope and Phase II Section I area. |
| 6. No. perforations/ft pipe = | 6.0 | perforations/ft of pipe length | |
| 7. Maximum head over pipe = | 1.0 | ft | |
| 8. Per HELP model summary table, $Q_{peak}$ = | 335.56 | gal/min | refer to HELP Model Summary Table |
| 9. Per HELP model summary table, $Q_{peak}$ = | 64,595.3 | cf/day | refer to HELP Model Summary Table |
| 10. Maximum flow/lateral = | 21,531.8 | cf/day/lateral | |
| 11. Maximum leachate flow/ft of pipe = | 31.98 | cf/day/ft of pipe | |

Solution:

$A_o = 0.25(\Pi)(d)^2 =$ 0.00077 $ft^2$

1. Flow per orifice, $Q = (Cd)(Ao)(2gh)^{0.5} =$ 0.0037 $ft^3/s$

2. Flow per ft of pipe = (Q)(# perfs/ft) = 0.02 $ft^3/s$ per ft of pipe

= 1914.47 cf/day/ft of pipe

Conclusion:

Design capacity exceeds estimated generation

1914.47 cf/day/ft of pipe >>> 31.98 cf/day/ft of pipe

Perforations are adequate to handle the maximum leachate flow.

| CLIENT | PROJECT | JOB NO. |
| --- | --- | --- |
| Hardee County | Phase II Section II Expansion | 09199033.23 |

| SUBJECT | BY | DATE |
| --- | --- | --- |
| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Collection Lateral** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **40 Feet Waste** | | |

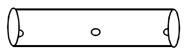
Effective pressure on pipe due to perforations:

$$P_{EFF} = \frac{P_T \times 12}{(12 - L_P)}$$ Source 3, EPA SW-870, p. 382

$L_P$ = Total accumulated length of perforations in one foot of pipe.

Since each perforation is 0.375 inch diameter and spaced at 6.0 inch on center,

$L_P$ = 1.5 inch



$P_T$ = 14.0 psi

$P_{EFF}$ = 15.9 psi

$P_{EFF}$ = 2296.6 psf

Check actual compressive pressure ($S_A$) per Driscopipe manual:

$S_A$ = 0.5 x (SDR - 1) x P(eff) = 79.8 psi

The recommended, long-term compressive strength ($Y_s$) design value for Driscoplex polyethylene pipe is 800 lb/in$^2$.

Source No. 1

| $S_A$ (psi): | | $Y_s$ (psi): |
| --- | --- | --- |
| 79.8 | < | 800.0 |

Pipe passes wall compressive stress perforation calculations TRUE

FS = 10.0

| CLIENT | PROJECT | JOB NO. |
|---|---|---|
| Hardee County | Phase II Section II Expansion | 09199033.23 |

| SUBJECT | BY | DATE |
|---|---|---|
| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Collection Lateral** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **40 Feet Waste** | | |

Constrained pipe wall buckling (for Driscoplex OD controlled pipe)

$$P_{WC} = \frac{5.65 * \{RB'E' E*[12(DR-1)^3]^{-1}\}^{0.5}}{N}$$ Source 1, Equation 7-5

$P_{WC}$ = allowable constrained buckling pressure (lb/in$^2$)

| | | |
|---|---|---|
| R = buoyancy reduction factor = 1 - 0.33 * (H'/H) | Source 1, Equation 7-34 | |
| H' = groundwater height above pipe (ft) | 0.0 | ft |
| H = cover above pipe (ft) | 44.0 | ft |
| B' = elastic support factor =( 1+ 4*$e^{-0.065H}$ )$^{-1}$ | Source 1, Equation 7-35 | |
| E' = soil reaction modulus (lb/in$^2$) | 3000.0 | lb/in$^2$ for mod comp/crushed rock, 'Source 1, Table 7-7 |
| E = elastic modulus (lb/in$^2$) | 100000.0 | lb/in$^2$ for long term load at 100$^o$F, 'Source 1, Table 5-1 |
| I = moment of inertia = $t^3$ / 12 | 0.0 | in$^4$/in |
| $D_o$ = pipe outer diameter (in) | 8.625 | SDR 11 pipe (Driscopipe) to be used |
| t = pipe wall thickness (in) | 0.784 | SDR 11 pipe (Driscopipe) to be used |
| DR = pipe dimension ratio = $D_o$ / t | 11.0 | SDR 11 pipe (Driscopipe) to be used |
| $D_I$ = pipe inner diameter = $D_o$ - 2t (in) | 7.1 | SDR 11 pipe (Driscopipe) to be used |
| N = safety factor | 2.0 | |

| Cover (ft) | (ft) | (ft) | B' | R | (lb/in$^2$) |
|---|---|---|---|---|---|
| 44.0 | 44 | 0 | 0.81 | 1.00 | 402.82 |

$P_{WC}$ = 402.82 lb/in$^2$
$P_{EFF}$ = 15.95 lb/in$^2$

Pipe passes contrained wall buckling calculations TRUE    FS = 25.3

| CLIENT | PROJECT | JOB NO. |
|---|---|---|
| Hardee County | Phase II Section II Expansion | 09199033.23 |

| SUBJECT | BY | DATE |
|---|---|---|
| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Collection Lateral** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **40 Feet Waste** | | |

Constrained Pipe Wall Compressive Stress (for Driscoplex OD controlled pipe)

$S = \frac{P_T D_o}{288t}$ Source No. 1

$S$ = pipe wall compressive stress (lb/in$^2$)

$P_T$ = vertical load applied to pipe w/ perfs (lb/ft$^2$) | 2296.6 | lb/ft$^2$

$D_o$ = pipe outside diameter (in) | 8.63 | SDR 11 pipe (Driscopipe) to be used

t = pipe wall thickness (in) | 0.784 | SDR 11 pipe (Driscopipe) to be used

$S = \frac{P_T D_o}{288t} =$ 87.7 lb/in$^2$

The recommended, long-term compressive strength ($Y_s$) design value for Driscoplex polyethylene pipe is 800 lb/in$^2$.

Source No. 1

| S (psi): | | $Y_s$ (psi): |
|---|---|---|
| 87.7 | < | 800.0 |

Pipe passes wall compressive stress calculations: TRUE

FS = 9.1

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| Pipe Crushing Calculations **RAI No. 1**<br>**8" Diameter Leachate Collection Lateral** | SRF | 4/1/13 |
| Operation w/ CAT 826G Series II Compactor **40 Feet Waste** | CHECKED | DATE |

Iowa Formula

$$\Delta X = \frac{D_L K W_c r^3}{EI + 0.06er^4}$$ Source 2, Equation 3.4 Buried Pipe Design, A.P. Moser, Chapter 3

$\Delta X$ = horizontal deflection (in)

$D_L$ = deflection lag factor

K = bedding constant | 0.1 | typical value Source 2, Buried Pipe Design, A.P. Moser, Chapter 3

$W_c$ = Marston's load per unit length of pipe (lb/in)

r = mean radius of the pipe (in)

E = modulus of elasticity ($lb/in^2$)

I = moment of inertia of the pipe wall per unit length ($in^3$)

e = modulus of passive resistance fo the side fill ($lb/in^2(in)$)

Modified Iowa Formula

$$\Delta X = \frac{D_L K W_c r_m^3}{EI + 0.06E'r_m^3}$$ Source 2, Equation 3.5 Buried Pipe Design, A.P. Moser, Chapter 3

$\Delta X$ = horizontal deflection (in)

| | | | |
|---|---|---|---|
| $D_L$ = deflection lag factor | | 1.0 | Prism Load used |
| Typical Value for Marston Load | 1.5 | | |
| Typical Value for Prism Load | 1.0 | | |
| K = bedding constant | | 0.1 | typical value Buried Pipe Design, A.P. Moser, Chapter 3 |
| $P_T$ = Vertical load on pipe w/ perfs | | 15.95 | $lb/in^2$   2297 $lb/ft^2$ |
| $W_c$ = Marston's load per unit length of pipe = $P_T$ * $D_o$ (lb/in) | | 137.56 | lb/in |
| $D_o$ = pipe outer diameter (in) | | 8.63 | SDR 11 pipe (Driscopipe) to be used |
| t = pipe wall thickness (in) | | 0.78 | SDR 11 pipe (Driscopipe) to be used |
| $D_I$ = pipe inner diameter = $D_o$-2t (in) | | 7.06 | SDR 11 pipe (Driscopipe) to be used |
| $D_m$ = pipe mean diameter = $D_o$ - 1.06t Source 1, Equation 7-27 | | 7.79 | SDR 11 pipe (Driscopipe) to be used |
| $r_m$ = mean radius of the pipe (in) | | 3.90 | SDR 11 pipe (Driscopipe) to be used |
| E = modulus of elasticity ($lb/in^2$) | | 100,000.0 | lb/in2 for long term load at 100oF, 'Source 1, Table 5-1 |
| I = moment of inertia of the pipe wall per unit length | | 0.040 | $in^4/in$ |
| E' = modulus of soil reaction | | 3,000.0 | $lb/in^2$ for moderate compaction and fine grained soils |

$$\Delta X = \frac{D_L K W_c r_m^3}{EI + 0.06E'r_m^3} = 0.055$$ inch — Source 2, Equation 3.5 Buried Pipe Design, A.P. Moser, Chapter 3

% Ring Deflection = $(\Delta X/D_m)$ x 100 = 0.71% Source 1, Equation 7-31

Ring Bending Strain

$$e = \frac{f_D \Delta X 2C}{D_M^2} \times 100$$ Source 1, Equation 7-39

e = wall strain (%)

| | | |
|---|---|---|
| $f_D$ = deformation shape factor | 6 | Source 1, non-elliptical shape |
| $D_M$ = mean diameter (in) | | |
| C = outer fiber wall centroid = 0.5 (1.06t) | 0.416 | Source 1, Equation 7-41 |
| $\Delta X$ = ring deflection = $D_X/D_m$ | 0.007 | |

$$e = f_D \frac{(\Delta X)}{D_M} \frac{(2C)}{D_M} \times 100 = 0.5\%$$ Source 1, Equation 7-39

The maximum ring bending strain for high performance polyethylene non-pressure pipe is = 5.0%

Pipe passes ring bending strain calculations TRUE

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| **8" Diameter Leachate Collection Lateral** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **40 Feet Waste** | | |

SOURCES

1.) Attachment - 1 - Chevron Phillips Chemical Company, Bulletin - Book 2 Chapter 5, 2003

2.) Attachment - 2 - Buried Pipe Design, A.P. Moser, Chapter 3

3.) Attachment - 3 - EPA, Lining of Waste Impoundment and Disposal Facilities, SW-870

4.) Attachment - 4 - Driscoplex Pipe Properties

5.) Attachment - 5 - CAT 826G Series II Compactor Data Sheet

6.) Attachment - 6 - CAT D7R Series II Equipment Data Sheet

7.) Attachment - 7 - CAT D6R XW Series II Equipment Data Sheet

| SCS ENGINEERS | | |
|---|---|---|
| SHEET 1 OF 10 | | |
| CLIENT<br>Hardee County | PROJECT<br>Phase II Section II Expansion | JOB NO.<br>09199033.23 |
| SUBJECT<br>Pipe Crushing Calculations **RAI No. 1**<br>**8" Diameter Leachate Collection Lateral**<br>Operation w/ CAT 826G Series II Compactor **60 Feet Waste** | BY<br>SRF<br>CHECKED | DATE<br>4/1/13<br>DATE |

Load on Pipe (Overburden)

Prism Loads, $P_E$ = wH

w = unit weight

H = depth

| | Depth (ft) | Unit Weight ($lb/ft^3$) | $P_E$ ($lb/ft^2$) |
|---|---|---|---|
| Final cover | 2.0 | 115.0 | 230.0 |
| Intermediate cover | 1.0 | 115.0 | 115.0 |
| Waste/cover | 60.0 | 60.0 | 3600.0 |
| Drainage sand | 2.0 | 115.0 | 230.0 |
| Rock (No. 89 & No. 57) | 2.0 | 140.0 | 280.0 |

TOTAL SOIL PRISM LOAD $P_E$: 4455.0 $lb/ft^2$

Total Depth = 67.0 ft

Soil Arching, $P_m = C_D wB$

Pm = vertical soil pressure

B = trench width at pipe crown 6.0 ft

$C_D$ = load coefficient $= \frac{1 - e^{-2Ku'H/B}}{2Ku'}$ Equation 7-3, Source No. 1

NOTE: The waste unit weight represents the combined unit weight of waste, daily cover, and moisture.

e = natural log base number

K = Rankine earth pressure coefficient = $\tan^2(45-0.5*\phi)$

$\phi$ = internal soil friction angle = 27.0 degrees

u' = friction coefficient between backfill and trench sides = tan $\phi$

| Soil Type | Ku' |
|---|---|
| Saturated Clay | 0.110 |
| Ordinary Clay | 0.130 |
| Saturated Top Soil | 0.150 |
| Sand and Gravel | 0.165 |
| Clean Granular Soil | 0.192 |

| | Ku' | $C_D$ | $P_m$ ($lb/ft^2$) |
|---|---|---|---|
| Cover Soil | 0.150 | 0.32 | 219 |
| Int Cover | 0.165 | 0.16 | 112 |
| Waste | 0.191 | 2.56 | 920 |
| Drainage Sand | 0.165 | 0.32 | 217.8 |
| Granular Soil | 0.192 | 0.31 | 262.8 |

TOTAL SOIL ARCHING LOAD $P_M$: 1,731.6 $lb/ft^2$

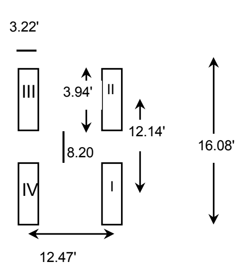
MODIFIED ARCHING LOAD = $0.6P_M + 0.4P_E$: 2,820.98 $lb/ft^2$

OVERBURDEN LOAD: 2,820.98 $lb/ft^2$

Load on Pipe With Equipment Refer to Attachment

Operation w/ CAT 826G Series II Compactor 60 Feet Waste

Equipment Weight = 81,498.0 psf




| | | | |
|---|---|---|---|
| Track per Load = $q_r$ = | 1,670.20 | psf | (Rear) |
| Track per Load = $q_{fr}$ = | 1,541.72 | psf | (Front) |
| Length of Track = L = | 3.22 | ft | (contact length) |
| Length of Track = b = | 8.20 | ft | |
| Track Width = | 12.47 | ft | |
| Track Width (I to II) = | 16.08 | ft | |

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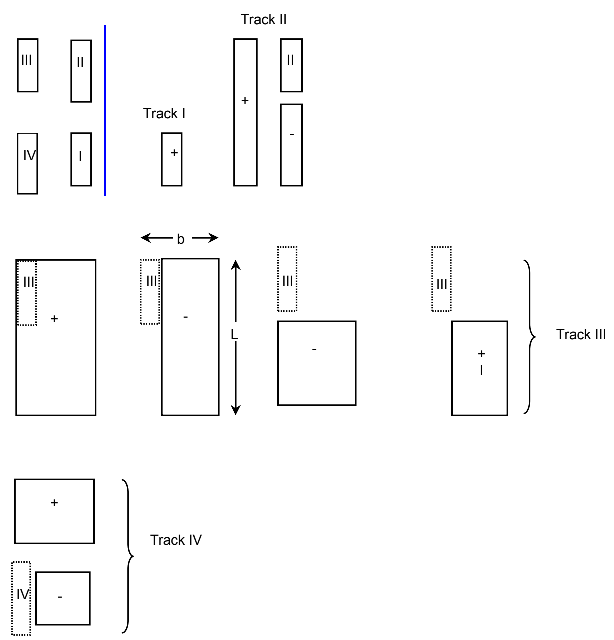
| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Collection Lateral** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **60 Feet Waste** | | |

Load on Pipe

Alternative 1: Track Adjacent and Parallel to Pipe




| | b | L | z | m = b/z | n = L/z | I* | I** | I | |
|---|---|---|---|---|---|---|---|---|---|
| Track I | 8.2 | 3 | 67 | 0.12 | 0.05 | 0.003 | 0.251 | 0.00277 | (ADD) |
| | | | | | | | | | |
| Track II | 8.2 | 16.1 | 67 | 0.12 | 0.24 | 0.013 | 0.254 | 0.01323 | (ADD) |
| | 8.2 | 11.4 | 67 | 0.12 | 0.17 | 0.010 | 0.253 | 0.00961 | (SUBTRACT) |
| | | | | | | | | | |
| Track IV | 12.47 | 3.22 | 67 | 0.19 | 0.05 | 0.004 | 0.251 | 0.00414 | (ADD) |
| | 12.47 | 3.22 | 67 | 0.19 | 0.05 | 0.004 | 0.251 | 0.00414 | (SUBTRACT) |
| | | | | | | | | | |
| Track III | 12.47 | 16.08 | 67 | 0.19 | 0.24 | 0.020 | 0.256 | 0.01980 | (ADD) |
| | 4.27 | 16.08 | 67 | 0.06 | 0.24 | 0.007 | 0.252 | 0.00695 | (SUBTRACT) |
| | 12.47 | 11.42 | 67 | 0.19 | 0.17 | 0.014 | 0.255 | 0.01438 | (SUBTRACT) |
| | 4.27 | 8.47 | 67 | 0.06 | 0.13 | 0.004 | 0.251 | 0.00378 | (ADD) |

$\text{Live Load}_1 = q_r(\Sigma I) + q_{fr}(\Sigma II) + q_{fr}(\Sigma III) + q_r(\Sigma IV)$

$\text{Live Load}_1 =$ 13.68 psf

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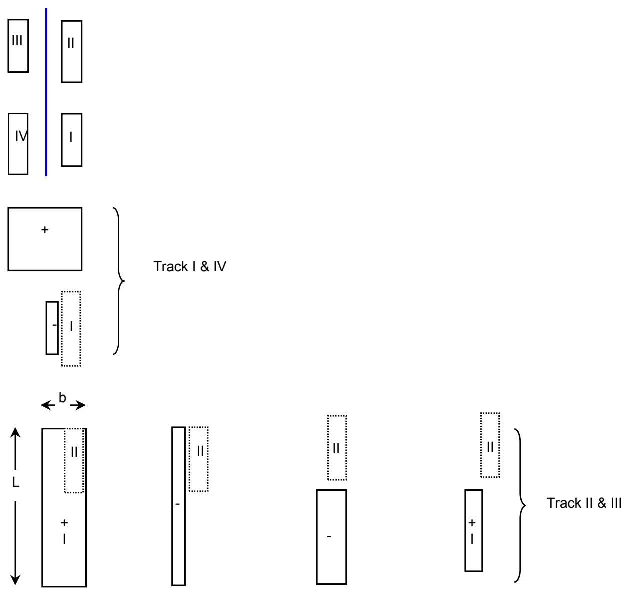
| **8" Diameter Leachate Collection Lateral** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **60 Feet Waste** | | |

Load on Pipe

Alternative 2: Track Stradling and Parallel to Pipe




| | b | L | z | m = b/z | n = L/z | I* | I** | I | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | |
| Track I | 6.2 | 3.2 | 67 | 0.1 | 0.0 | 0.002 | 0.251 | 0.00212 | (ADD) |
| & IV | -2.0 | 3.2 | 67 | 0.0 | 0.0 | -0.001 | 0.250 | -0.00067 | (SUBTRACT) |
| | | | | | | | | | |
| Track II | 6.2 | 16.08 | 67 | 0.1 | 0.2 | 0.010 | 0.253 | 0.01011 | (ADD) |
| & III | -2.0 | 16.08 | 67 | 0.0 | 0.2 | -0.003 | 0.249 | -0.00321 | (SUBTRACT) |
| | 6.2 | 12.86 | 67 | 0.1 | 0.2 | 0.008 | 0.253 | 0.00822 | (SUBTRACT) |
| | -2.0 | 12.86 | 67 | 0.0 | 0.2 | -0.003 | 0.249 | -0.00261 | (ADD) |

$\text{Live Load}_2 = [q_r\,(\Sigma I) + q_{fr}\,(\Sigma II)] * 2$

$\text{Live Load}_2 =$ 16.99 psf

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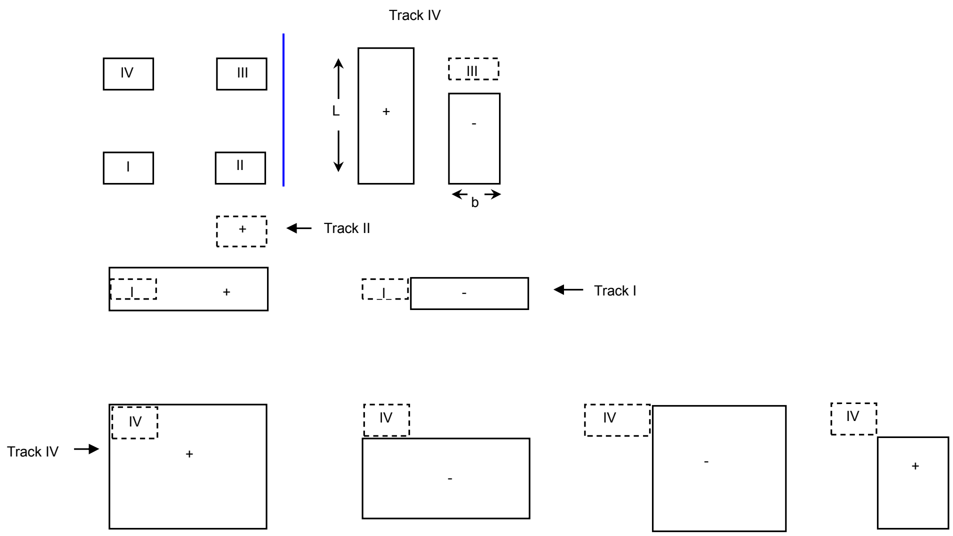
Load on Pipe

Alternative 3: Track Perpendicular to Pipe




| | b | L | z | m = b/z | n = L/z | I* | I** | I | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | |
| Track I | 16.1 | 8.2 | 67 | 0.2 | 0.1 | 0.013 | 0.254 | 0.01323 | (ADD) |
| | 12.9 | 8.2 | 67 | 0.2 | 0.1 | 0.011 | 0.253 | 0.01075 | (SUBTRACT) |
| | | | | | | | | | |
| Track II | 3.2 | 8.2 | 67 | 0.0 | 0.1 | 0.003 | 0.251 | 0.00277 | (ADD) |
| | | | | | | | | | |
| Track III | 3.2 | 12.5 | 67 | 0.0 | 0.2 | 0.004 | 0.251 | 0.00414 | (ADD) |
| | 3.2 | 4.3 | 67 | 0.0 | 0.1 | 0.001 | 0.250 | 0.00145 | (SUBTRACT) |
| | | | | | | | | | |
| Track IV | 16.1 | 12.5 | 67 | 0.2 | 0.2 | 0.020 | 0.256 | 0.01980 | (ADD) |
| | 16.1 | 4.3 | 67 | 0.2 | 0.1 | 0.007 | 0.252 | 0.00695 | (SUBTRACT) |
| | 12.9 | 12.5 | 67 | 0.2 | 0.2 | 0.016 | 0.255 | 0.01610 | (SUBTRACT) |
| | 12.9 | 4.3 | 67 | 0.2 | 0.1 | 0.006 | 0.252 | 0.00565 | (ADD) |

Live $\text{Load}_3$ = $q_r(\Sigma I) + q_{fr}(\Sigma II) + q_{fr}(\Sigma III) + q_r(\Sigma IV)$

Live $\text{Load}_3$ = 16.57 psf

LARGEST EQUIPEMENT LOAD = 16.99 $lb/ft^2$

VERTICAL OVERBURDEN LOAD = 2820.98 $lb/ft^2$

VERTICAL EQUIPMENT LOAD = 16.99 $lb/ft^2$

TOTAL VERTICAL LOAD APPLIED TO PIPE, $P_T$ = 2837.98 $lb/ft^2$ = 19.71 $lb/in^2$

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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Collection Lateral** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **60 Feet Waste** | | |

Verify that perforations in the LCRS are adequate for the peak leachate flow.

Use discharge equation:

$Q = (Cd)(Ao)(2gh)^{0.5}$

$C_d$ = coefficient of discharge = 0.6 for short tube discharge with fluid/wall separation; conservative value.

$A_o$ = Area of orifice ($\pi D^2/4$)

g = gravitational acceleration (32.3 $ft^2/s$)

h = static head (ft)

| | | | |
|---|---|---|---|
| | 1.63 | acres | Phase II Section II south portion |
| Assumptions and Givens: | 5.00 | acres | Phase II Section I area |
| 1. No. acres of landfill expansion = | 5.00 | acres | - Use Phase II Section I area in calcs. If LCS pipes can |
| 2. Total length of pipe per expansion = | 2,020.0 | ft | handle this flow they will also handle the flow in the |
| 3. Total number of laterals = | 3.0 | | Phase II Section II Expansion south portion which has |
| 4. Length of pipe per lateral = | 673.3 | ft | less flow. Includes flow from north, center, south, |
| 5. Perforation diameter = | 0.375 | inch | Phase I south sideslope and Phase II Section I area. |
| 6. No. perforations/ft pipe = | 6.0 | perforations/ft of pipe length | |
| 7. Maximum head over pipe = | 1.0 | ft | |
| 8. Per HELP model summary table, $Q_{peak}$ = | 335.56 | gal/min | refer to HELP Model Summary Table |
| 9. Per HELP model summary table, $Q_{peak}$ = | 64,595.3 | cf/day | refer to HELP Model Summary Table |
| 10. Maximum flow/lateral = | 21,531.8 | cf/day/lateral | |
| 11. Maximum leachate flow/ft of pipe = | 31.98 | cf/day/ft of pipe | |

Solution:

$A_o = 0.25(\Pi)(d)^2 =$ 0.00077 $ft^2$

1. Flow per orifice, $Q = (Cd)(Ao)(2gh)^{0.5} =$ 0.0037 $ft^3/s$

2. Flow per ft of pipe = (Q)(# perfs/ft) = 0.02 $ft^3/s$ per ft of pipe

= 1914.47 cf/day/ft of pipe

Conclusion:

Design capacity exceeds estimated generation

1914.47 cf/day/ft of pipe >>> 31.98 cf/day/ft of pipe

Perforations are adequate to handle the maximum leachate flow.

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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Collection Lateral** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **60 Feet Waste** | | |

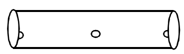
Effective pressure on pipe due to perforations:

$P_{EFF} = \dfrac{P_T \times 12}{(12 - L_P)}$ Source 3, EPA SW-870, p. 382

$L_P$ = Total accumulated length of perforations in one foot of pipe.

Since each perforation is 0.375 inch diameter and spaced at 6.0 inch on center,

$L_P$ = 1.5 inch



$P_T$ = 19.7 psi

$P_{EFF}$ = 22.5 psi

$P_{EFF}$ = 3243.4 psf

Check actual compressive pressure ($S_A$) per Driscopipe manual:

$S_A$ = 0.5 x (SDR - 1) x P(eff) = 112.6 psi

The recommended, long-term compressive strength ($Y_s$) design value for Driscoplex polyethylene pipe is 800 lb/in$^2$.

Source No. 1

| $S_A$ (psi): | | $Y_s$ (psi): |
|---|---|---|
| 112.6 | < | 800.0 |

Pipe passes wall compressive stress perforation calculations TRUE FS = 7.1

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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
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| Operation w/ CAT 826G Series II Compactor **60 Feet Waste** | | |

Constrained pipe wall buckling (for Driscoplex OD controlled pipe)

$$P_{WC} = \frac{5.65 * \{RB'E' E*[12(DR-1)^3]^{-1}\}^{0.5}}{N}$$ Source 1, Equation 7-5

$P_{WC}$ = allowable constrained buckling pressure (lb/in$^2$)

| | | |
|---|---|---|
| R = buoyancy reduction factor = 1 - 0.33 * (H'/H) | Source 1, Equation 7-34 | |
| H' = groundwater height above pipe (ft) | 0.0 | ft |
| H = cover above pipe (ft) | 67.0 | ft |
| B' = elastic support factor =( 1+ 4*$e^{-0.065H}$ )$^{-1}$ | Source 1, Equation 7-35 | |
| E' = soil reaction modulus (lb/in$^2$) | 3000.0 | lb/in$^2$ for mod comp/crushed rock, 'Source 1, Table 7-7 |
| E = elastic modulus (lb/in$^2$) | 100000.0 | lb/in$^2$ for long term load at 100°F, 'Source 1, Table 5-1 |
| I = moment of inertia = $t^3$ / 12 | 0.0 | in$^4$/in |
| $D_o$ = pipe outer diameter (in) | 8.625 | SDR 11 pipe (Driscopipe) to be used |
| t = pipe wall thickness (in) | 0.784 | SDR 11 pipe (Driscopipe) to be used |
| DR = pipe dimension ratio = $D_o$ / t | 11.0 | SDR 11 pipe (Driscopipe) to be used |
| $D_I$ = pipe inner diameter = $D_o$ - 2t (in) | 7.1 | SDR 11 pipe (Driscopipe) to be used |
| N = safety factor | 2.0 | |

| Cover (ft) | (ft) | (ft) | B' | R | (lb/in$^2$) |
|---|---|---|---|---|---|
| 67.0 | 67 | 0 | 0.95 | 1.00 | 435.54 |

$P_{WC}$ = 435.54 lb/in$^2$

$P_{EFF}$ = 22.52 lb/in$^2$

Pipe passes contrained wall buckling calculations TRUE FS = 19.3

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| **8" Diameter Leachate Collection Lateral** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **60 Feet Waste** | | |

Constrained Pipe Wall Compressive Stress (for Driscoplex OD controlled pipe)

$$S = \frac{P_T D_o}{288t}$$ Source No. 1

S = pipe wall compressive stress ($lb/in^2$)

| | | |
|---|---|---|
| $P_T$ = vertical load applied to pipe w/ perfs ($lb/ft^2$) | 3243.4 | $lb/ft^2$ |
| $D_o$ = pipe outside diameter (in) | 8.63 | SDR 11 pipe (Driscopipe) to be used |
| t = pipe wall thickness (in) | 0.784 | SDR 11 pipe (Driscopipe) to be used |

$$S = \frac{P_T D_o}{288t} = 123.9 \; lb/in^2$$

The recommended, long-term compressive strength ($Y_s$) design value for Driscoplex polyethylene pipe is 800 $lb/in^2$.

Source No. 1

| S (psi): | | $Y_s$ (psi): |
|---|---|---|
| 123.9 | < | 800.0 |

Pipe passes wall compressive stress calculations TRUE

FS = 6.5

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| **8" Diameter Leachate Collection Lateral** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **60 Feet Waste** | | |

Iowa Formula

$\Delta X = \frac{D_L K W_c r^3}{EI + 0.06er^4}$ Source 2, Equation 3.4 Buried Pipe Design, A.P. Moser, Chapter 3

$\Delta X$ = horizontal deflection (in)

$D_L$ = deflection lag factor

K = bedding constant — 0.1 typical value Source 2, Buried Pipe Design, A.P. Moser, Chapter 3

$W_c$ = Marston's load per unit length of pipe (lb/in)

r = mean radius of the pipe (in)

E = modulus of elasticity (lb/in$^2$)

I = moment of inertia of the pipe wall per unit length (in$^3$)

e = modulus of passive resistance fo the side fill (lb/in$^2$(in))

Modified Iowa Formula

$\Delta X = \frac{D_L K W_c r_m^3}{EI + 0.06E'r_m^3}$ Source 2, Equation 3.5 Buried Pipe Design, A.P. Moser, Chapter 3

$\Delta X$ = horizontal deflection (in)

| | | |
|---|---|---|
| $D_L$ = deflection lag factor | 1.0 | Prism Load used |
| Typical Value for Marston Load | 1.5 | |
| Typical Value for Prism Load | 1.0 | |
| K = bedding constant | 0.1 | typical value Buried Pipe Design, A.P. Moser, Chapter 3 |
| $P_T$ = Vertical load on pipe w/ perfs | 22.52 | lb/in$^2$ — 3243 lb/ft$^2$ |
| $W_c$ = Marston's load per unit length of pipe = $P_T$ * $D_o$ (lb/in) | 194.27 | lb/in |
| $D_o$ = pipe outer diameter (in) | 8.63 | SDR 11 pipe (Driscopipe) to be used |
| t = pipe wall thickness (in) | 0.78 | SDR 11 pipe (Driscopipe) to be used |
| $D_I$ = pipe inner diameter = $D_o$-2t (in) | 7.06 | SDR 11 pipe (Driscopipe) to be used |
| $D_m$ = pipe mean diameter = $D_o$ - 1.06t Source 1, Equation 7-27 | 7.79 | SDR 11 pipe (Driscopipe) to be used |
| $r_m$ = mean radius of the pipe (in) | 3.90 | SDR 11 pipe (Driscopipe) to be used |
| E = modulus of elasticity (lb/in$^2$) | 100,000.0 | lb/in2 for long term load at 100oF, 'Source 1, Table 5-1 |
| I = moment of inertia of the pipe wall per unit length | 0.040 | in$^4$/in |
| E' = modulus of soil reaction | 3,000.0 | lb/in$^2$ for moderate compaction and fine grained soils |

$\Delta X = \frac{D_L K W_c r_m^3}{EI + 0.06E'r_m^3} =$ 0.078 inch — Source 2, Equation 3.5 Buried Pipe Design, A.P. Moser, Chapter 3

% Ring Deflection = ($\Delta X/D_m$) x 100 = 1.01% Source 1, Equation 7-31

Ring Bending Strain

$e = \frac{f_D \Delta X 2C}{D_M^2} \times 100$ Source 1, Equation 7-39

e = wall strain (%)

| | | |
|---|---|---|
| $f_D$ = deformation shape factor | 6 | Source 1, non-elliptical shape |
| $D_M$ = mean diameter (in) | | |
| C = outer fiber wall centroid = 0.5 (1.06t) | 0.416 | Source 1, Equation 7-41 |
| $\Delta X$ = ring deflection = $D_X/D_m$ | 0.010 | |

$e = f_D \frac{\Delta X}{D_M} \frac{2C}{D_M} \times 100 =$ 0.6% Source 1, Equation 7-39

The maximum ring bending strain for high performance polyethylene non-pressure pipe is 5.0%

Pipe passes ring bending strain calculations TRUE

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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Collection Lateral** | CHECKED | DATE |
| Operation w/ CAT 826G Series II Compactor **60 Feet Waste** | | |

SOURCES

1.) Attachment - 1 - Chevron Phillips Chemical Company, Bulletin - Book 2 Chapter 5, 2003

2.) Attachment - 2 - Buried Pipe Design, A.P. Moser, Chapter 3

3.) Attachment - 3 - EPA, Lining of Waste Impoundment and Disposal Facilities, SW-870

4.) Attachment - 4 - Driscoplex Pipe Properties

5.) Attachment - 5 - CAT 826G Series II Compactor Data Sheet

6.) Attachment - 6 - CAT D7R Series II Equipment Data Sheet

7.) Attachment - 7 - CAT D6R XW Series II Equipment Data Sheet

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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Collection Lateral** | CHECKED | DATE |
| Operation w/ CAT D7R Series II **40 Feet Waste** | | |

Load on Pipe (Overburden)

Prism Loads, $P_E$ = wH

w = unit weight

H = depth

| | Depth (ft) | Unit Weight ($lb/ft^3$) | $P_E$ ($lb/ft^2$) |
|---|---|---|---|
| Final cover | 0.0 | 115.0 | 0.0 |
| Intermediate cover | 0.0 | 115.0 | 0.0 |
| Waste/cover | 40.0 | 60.0 | 2400.0 |
| Drainage sand | 2.0 | 115.0 | 230.0 |
| Rock (No. 89 & No. 57) | 2.0 | 140.0 | 280.0 |

TOTAL SOIL PRISM LOAD $P_E$: 2910.0 $lb/ft^2$

Total Depth = 44.0 ft

Soil Arching, $P_m = C_D wB$

NOTE: The waste unit weight represents the combined unit weight of waste, daily cover, and moisture.

Pm = vertical soil pressure

B = trench width at pipe crown 6.0 ft

$C_D$ = load coefficient $= \frac{1 - e^{-2Ku'H/B}}{2Ku'}$ Equation 7-3, Source No. 1

e = natural log base number

K = Rankine earth pressure coefficient = $\tan^2(45-0.5*\phi)$

$\phi$ = internal soil friction angle = 27.0 degrees

u' = friction coefficient between backfill and trench sides = tan $\phi$

| Soil Type | Ku' |
|---|---|
| Saturated Clay | 0.110 |
| Ordinary Clay | 0.130 |
| Saturated Top Soil | 0.150 |
| Sand and Gravel | 0.165 |
| Clean Granular Soil | 0.192 |

| | Ku' | $C_D$ | $P_m$ ($lb/ft^2$) |
|---|---|---|---|
| Cover Soil | 0.150 | 0.00 | 0 |
| Int Cover | 0.165 | 0.00 | 0 |
| Waste | 0.191 | 2.41 | 867 |
| Drainage Sand | 0.165 | 0.32 | 217.8 |
| Granular Soil | 0.192 | 0.31 | 262.8 |

TOTAL SOIL ARCHING LOAD $P_M$: 1,348.0 $lb/ft^2$

MODIFIED ARCHING LOAD = $0.6P_M+0.4P_E$: 1,972.79 $lb/ft^2$

OVERBURDEN LOAD: 1,972.79 $lb/ft^2$

Load on Pipe With Equipment Refer to Attachment

Operation w/ CAT D7R Series II 40 Feet Waste

Equipment Weight = 54,573.0 psf

Number of Tracks = 2.0

Track Load = $q_r$ = 27,286.5 psf

Ground contact area/track = 17.3 psf

Length of Track = L = 113.0 in

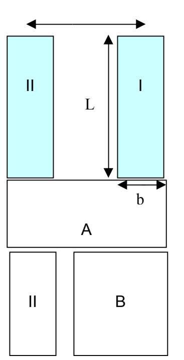
Track Width = b = 22.0 in

Track Gauge = G = 78.0 in

Equipment Width "A" = 113.0 in

Live Load = q*Ic q = track load 1,580.55 psf

Ic = Influence coefficient




| | b (ft) | L (ft) | z (ft) | m = b/z | n = L/z | I* | I** | I |
|---|---|---|---|---|---|---|---|---|
| I | 1.83 | 9.4 | 44.0 | 0.04 | 0.21 | 0.004 | 0.251 | 0.00410 |
| A | 8.33 | 9.4 | 44.0 | 0.19 | 0.21 | 0.018 | 0.256 | 0.01812 |
| B | 6.50 | 9.4 | 44.0 | 0.15 | 0.21 | 0.014 | 0.255 | 0.01429 |

Live $Load_1$ = I + II = $q_I(I_I) + q_A(I_A) - q_B(I_B)$ = 12.53 $lb/ft^2$

$q_I(I_I)$ = 6.48

$q_A(I_A)$ = 28.64

$q_B(I_B)$ = 22.59

Load on Pipe (Equipment) = 12.53 $lb/ft^2$

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| Operation w/ CAT D7R Series II **40 Feet Waste** | | |

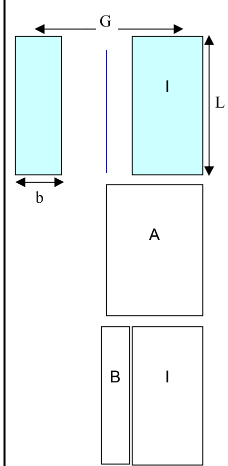
Load on Pipe (Equipment) *Continued*

Live Load = $q*I_c$

$q$ = track load 1580.55 $lb/ft^2$

$I_c$ = Influence coefficient

Alternative 2: Track stradling and parallel to pipe



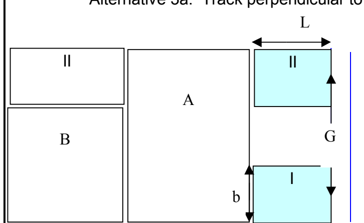

| | b | L | z | m = b/z | n = L/z | I* | I** | I |
|---|---|---|---|---|---|---|---|---|
| A | 4.71 | 9.4 | 44 | 0.11 | 0.21 | 0.010 | 0.253 | 0.01044 |
| B | 2.88 | 9.4 | 44 | 0.07 | 0.21 | 0.006 | 0.252 | 0.00641 |

Live $Load_2$ = 2 * (A - B) = 2 * ($q_AI_A$ - $q_BI_B$) = 12.73 $lb/ft^2$

| | |
|---|---|
| $q_A(I_A)$ = | 16.50 |
| $q_B(I_B)$ = | 10.13 |

Load on Pipe (Equipment) = 12.73 $lb/ft^2$

Alternative 3a: Track perpendicular to pipe




| | b | L | z | m = b/z | n = L/z | I* | I** | I |
|---|---|---|---|---|---|---|---|---|
| I | 1.83 | 9.4 | 44 | 0.04 | 0.21 | 0.004 | 0.251 | 0.00410 |
| A | 9.42 | 9.4 | 44 | 0.21 | 0.21 | 0.020 | 0.256 | 0.02032 |
| B | 7.58 | 9.4 | 44 | 0.17 | 0.21 | 0.017 | 0.255 | 0.01657 |

Live $Load_3$ = I + II = $q_I(I_I)$ + $q_A(I_A)$ - $q_B(I_B)$ = 12.40 $lb/ft^2$

| | |
|---|---|
| $q_I(I_I)$ = | 6.48 |
| $q_A(I_A)$ = | 32.11 |
| $q_B(I_B)$ = | 26.19 |

Load on Pipe (Equipment) = 12.40 $lb/ft^2$

LARGEST EQUIPEMENT LOAD = 12.73 $lb/ft^2$

VERTICAL OVERBURDEN LOAD = 1,972.79 $lb/ft^2$

VERTICAL EQUIPMENT LOAD = 12.73 $lb/ft^2$

TOTAL VERTICAL LOAD APPLIED TO PIPE, $P_T$ = 1,985.53 $lb/ft^2$ = 13.79 $lb/in^2$

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Verify that perforations in the LCRS are adequate for the peak leachate flow.

Use discharge equation:

$Q = (Cd)(Ao)(2gh)^{0.5}$

$C_d$ = coeffiecient of discharge = 0.6 for short tube discharge with fluid/wall separation; conservative value.

$A_o$ = Area of orifice ($\pi D^2/4$)

g = gravitational acceleration (32.3 $ft^2/s$)

h = static head (ft)

Assumptions and Givens:

| | | | |
|---|---|---|---|
| | 1.63 | acres | Phase II Section II south portion |
| | 5.00 | acres | Phase II Section I area |
| 1. No. acres of landfill expansion = | 5.00 | acres | - Use Phase II Section I area in calcs. If LCS pipes can |
| 2. Total length of pipe per expansion = | 2,020.0 | ft | handle this flow they will also handle the flow in the |
| 3. Number of laterals = | 3.0 | | Phase II Section II Expansion south portion which has |
| 4. Total length of pipe per lateral = | 673.3 | ft | less flow. Includes flow from north, center, south, |
| 5. Perforation diameter = | 0.375 | inch | Phase I south sideslope and Phase II Section I area. |
| 6. No. perforations/ft pipe = | 6.0 | perforations/ft of pipe length | |
| 7. Maximum head over pipe = | 1.0 | ft | |
| 8. Per HELP model summary table, $Q_{peak}$ = | 335.56 | gal/min | refer to HELP Model Summary Table |
| 9. Per HELP model summary table, $Q_{peak}$ = | 64,595.3 | cf/day | refer to HELP Model Summary Table |
| 10. Maximum flow/lateral = | 21,531.8 | cf/day/lateral | |
| 11. Maximum leachate flow/ft of pipe = | 31.98 | cf/day/ft of pipe | |

Solution:

$A_o = 0.25(\Pi)(d)^2 =$ 0.00077 $ft^2$

1. Flow per orifice, $Q = (Cd)(Ao)(2gh)^{0.5}$ = 0.0037 $ft^3/s$

2. Flow per ft of pipe = (Q)(# perfs/ft) = 0.02 $ft^3/s$ per ft of pipe

= 1914.47 cf/day/ft of pipe

Conclusion:

Design capacity exceeds estimated generation

1914.47 cf/day/ft of pipe >>> 31.98 cf/day/ft of pipe

Perforations are adequate to handle the maximum leachate flow.

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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
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| Operation w/ CAT D7R Series II **40 Feet Waste** | | |

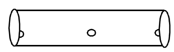
Effective pressure on pipe due to perforations:

$P_{EFF} = \frac{P_T \times 12}{(12 - L_P)}$ Source 3, EPA SW-870, p. 382

$L_P$ = Total accumulated length of perforations in one foot of pipe.

Since each perforation is 0.375 inch diameter and spaced at 6.0 inch on center,

$L_P$ = 1.5 inch



$P_T$ = 13.8 psi

$P_{EFF}$ = 15.8 psi

$P_{EFF}$ = 2269.2 psf

Check actual compressive pressure ($S_A$) per Driscopipe manual:

$S_A$ = 0.5 x (SDR - 1) x P(eff) = 78.8 psi

The recommended, long-term compressive strength ($Y_s$) design value for Driscoplex polyethylene pipe is 800 lb/in$^2$.

Source No. 1

| $S_A$ (psi): | | $Y_s$ (psi): |
|---|---|---|
| 78.8 | < | 800.0 |

Pipe passes wall compressive stress perforation calculations TRUE

FS = 10.2

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| Operation w/ CAT D7R Series II **40 Feet Waste** | | |

Constrained pipe wall buckling (for Driscoplex OD controlled pipe)

$P_{WC} = \frac{5.65 * \{RB'E' E^*[12(DR-1)^3]^{-1}\}^{0.5}}{N}$ Source 1, Equation 7-5

$P_{WC}$ = allowable constrained buckling pressure (lb/in$^2$)

R = buoyancy reduction factor = 1 - 0.33 * (H'/H) Source 1, Equation 7-34

| | | |
|---|---|---|
| H' = groundwater height above pipe (ft) | 0.0 | ft |
| H = cover above pipe (ft) | 44.0 | ft |
| B' = elastic support factor =( 1+ 4*e$^{-0.065H}$ )$^{-1}$ | | Source 1, Equation 7-35 |
| E' = soil reaction modulus (lb/in$^2$) | 3000.0 | lb/in$^2$ for mod comp/crushed rock, 'Source 1, Table 7-7 |
| E = elastic modulus (lb/in$^2$) | 100000.0 | lb/in$^2$ for long term load at 100$^o$F, 'Source 1, Table 5-1 |
| I = moment of inertia = t$^3$ / 12 | 0.0 | in$^4$/in |
| $D_o$ = pipe outer diameter (in) | 8.625 | SDR 11 pipe (Driscopipe) to be used |
| t = pipe wall thickness (in) | 0.784 | SDR 11 pipe (Driscopipe) to be used |
| DR = pipe dimension ratio = $D_o$ / t | 11.0 | SDR 11 pipe (Driscopipe) to be used |
| $D_I$ = pipe inner diameter = $D_o$ - 2t (in) | 7.1 | SDR 11 pipe (Driscopipe) to be used |
| N = safety factor | 2.0 | |

| Cover (ft) | (ft) | (ft) | B' | R | (lb/in$^2$) |
|---|---|---|---|---|---|
| 40.0 | 44 | 0 | 0.81 | 1.00 | 402.82 |

$P_{WC}$ = 402.82 lb/in$^2$

$P_{EFF}$ = 15.76 lb/in$^2$

Pipe passes contrained wall buckling calculations TRUE FS = 25.6

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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
| **8" Diameter Leachate Collection Lateral** | CHECKED | DATE |
| Operation w/ CAT D7R Series II **40 Feet Waste** | | |

Constrained Pipe Wall Compressive Stress (for Driscoplex OD controlled pipe)

$S = \frac{P_T D_o}{288t}$ Source No. 1

S = pipe wall compressive stress ($lb/in^2$)

| | | |
|---|---|---|
| $P_T$ = vertical load applied to pipe w/ perfs ($lb/ft^2$) | 2269.2 | $lb/ft^2$ |
| $D_o$ = pipe outside diameter (in) | 8.63 | SDR 11 pipe (Driscopipe) to be used |
| t = pipe wall thickness (in) | 0.784 | SDR 11 pipe (Driscopipe) to be used |

$S = \frac{P_T D_o}{288t} =$ 86.7 $lb/in^2$

The recommended, long-term compressive strength ($Y_s$) design value for Driscoplex polyethylene pipe is 800 $lb/in^2$.

Source No. 1

| S (psi): | | $Y_s$ (psi): |
|---|---|---|
| 86.7 | < | 800.0 |

Pipe passes wall compressive stress calculations TRUE FS = 9.2

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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
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| Operation w/ CAT D7R Series II **40 Feet Waste** | | |

Iowa Formula

$\Delta X = \dfrac{D_L K W_c r^3}{EI + 0.06er^4}$ Source 2, Equation 3.4 Buried Pipe Design, A.P. Moser, Chapter 3

$\Delta X$ = horizontal deflection (in)

$D_L$ = deflection lag factor

K = bedding constant | 0.1 | typical value Source 2, Buried Pipe Design, A.P. Moser, Chapter 3

$W_c$ = Marston's load per unit length of pipe (lb/in)

r = mean radius of the pipe (in)

E = modulus of elasticity (lb/in$^2$)

I = moment of inertia of the pipe wall per unit length (in$^3$)

e = modulus of passive resistance fo the side fill (lb/in$^2$(in))

Modified Iowa Formula

$\Delta X = \dfrac{D_L K W_c r_m^3}{EI + 0.06E'r_m^3}$ Source 2, Equation 3.5 Buried Pipe Design, A.P. Moser, Chapter 3

$\Delta X$ = horizontal deflection (in)

| | | |
|---|---|---|
| $D_L$ = deflection lag factor | 1.0 | Prism Load used |
| Typical Value for Marston Load | 1.5 | |
| Typical Value for Prism Load | 1.0 | |
| K = bedding constant | 0.1 | typical value Buried Pipe Design, A.P. Moser, Chapter 3 |
| $P_T$ = Vertical load on pipe w/ perfs | 15.76 | lb/in$^2$ ; 2269 lb/ft$^2$ |
| $W_c$ = Marston's load per unit length of pipe = $P_T$ * $D_o$ (lb/in) | 135.91 | lb/in |
| $D_o$ = pipe outer diameter (in) | 8.63 | SDR 11 pipe (Driscopipe) to be used |
| t = pipe wall thickness (in) | 0.78 | SDR 11 pipe (Driscopipe) to be used |
| $D_I$ = pipe inner diameter = $D_o$-2t (in) | 7.06 | SDR 11 pipe (Driscopipe) to be used |
| $D_m$ = pipe mean diameter = $D_o$ - 1.06t Source 1, Equation 7-27 | 7.79 | SDR 11 pipe (Driscopipe) to be used |
| $r_m$ = mean radius of the pipe (in) | 3.90 | SDR 11 pipe (Driscopipe) to be used |
| E = modulus of elasticity (lb/in$^2$) | 100,000.0 | lb/in2 for long term load at 100oF, 'Source 1, Table 5-1 |
| I = moment of inertia of the pipe wall per unit length | 0.040 | in$^4$/in |
| E' = modulus of soil reaction | 3,000.0 | lb/in$^2$ for moderate compaction and fine grained soils |

$\Delta X = \dfrac{D_L K W_c r_m^3}{EI + 0.06E'r_m^3}$ = 0.055 inch — Source 2, Equation 3.5 Buried Pipe Design, A.P. Moser, Chapter 3

% Ring Deflection = ($\Delta X/D_m$) x 100 = 0.70% Source 1, Equation 7-31

Ring Bending Strain

$e = \dfrac{f_D \Delta X 2C}{D_M^2} \times 100$ Source 1, Equation 7-39

e = wall strain (%)

| | | |
|---|---|---|
| $f_D$ = deformation shape factor | 6 | Source 1, non-elliptical shape |
| $D_M$ = mean diameter (in) | | |
| C = outer fiber wall centroid = 0.5 (1.06t) | 0.416 | Source 1, Equation 7-41 |
| $\Delta X$ = ring deflection = $D_X/D_m$ | 0.007 | |

$e = f_D \dfrac{(\Delta X)}{D_M} \dfrac{(2C)}{D_M} \times 100$ = 0.5% Source 1, Equation 7-39

The maximum ring bending strain for high performance polyethylene non-pressure pipe is = 5.0%

Pipe passes ring bending strain calculations TRUE

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| **8" Diameter Leachate Collection Lateral** | CHECKED | DATE |
| Operation w/ CAT D7R Series II **40 Feet Waste** | | |

SOURCES

1.) Attachment - 1 - Chevron Phillips Chemical Company, Bulletin - Book 2 Chapter 5, 2003

2.) Attachment - 2 - Buried Pipe Design, A.P. Moser, Chapter 3

3.) Attachment - 3 - EPA, Lining of Waste Impoundment and Disposal Facilities, SW-870

4.) Attachment - 4 - Driscoplex Pipe Properties

5.) Attachment - 5 - CAT 826G Series II Compactor Data Sheet

6.) Attachment - 6 - CAT D7R Series II Equipment Data Sheet

7.) Attachment - 7 - CAT D6R XW Series II Equipment Data Sheet

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| **8" Diameter Leachate Collection Lateral** | CHECKED | DATE |
| Operation w/ CAT D7R Series II **60 Feet Waste** | | |

Load on Pipe (Overburden)

Prism Loads, $P_E$ = wH

w = unit weight

H = depth

| | Depth (ft) | Unit Weight ($lb/ft^3$) | $P_E$ ($lb/ft^2$) |
|---|---|---|---|
| Final cover | 2.0 | 115.0 | 230.0 |
| Intermediate cover | 1.0 | 115.0 | 115.0 |
| Waste/cover | 60.0 | 60.0 | 3600.0 |
| Drainage sand | 2.0 | 115.0 | 230.0 |
| Rock (No. 89 & No. 57) | 2.0 | 140.0 | 280.0 |

TOTAL SOIL PRISM LOAD $P_E$: 4455.0 $lb/ft^2$

Total Depth = 67.0 ft

Soil Arching, $P_m = C_D wB$

NOTE: The waste unit weight represents the combined unit weight of waste, daily cover, and moisture.

Pm = vertical soil pressure

B = trench width at pipe crown 6.0 ft

$C_D$ = load coefficient $= \frac{1 - e^{-2Ku'H/B}}{2Ku'}$ Equation 7-3, Source No. 1

e = natural log base number

K = Rankine earth pressure coefficient = $\tan^2(45-0.5*\phi)$

$\phi$ = internal soil friction angle = 27.0 degrees

u' = friction coefficient between backfill and trench sides = tan $\phi$

| Soil Type | Ku' |
|---|---|
| Saturated Clay | 0.110 |
| Ordinary Clay | 0.130 |
| Saturated Top Soil | 0.150 |
| Sand and Gravel | 0.165 |
| Clean Granular Soil | 0.192 |

| | Ku' | $C_D$ | $P_m$ ($lb/ft^2$) |
|---|---|---|---|
| Cover Soil | 0.150 | 0.32 | 219 |
| Int Cover | 0.165 | 0.16 | 112 |
| Waste | 0.191 | 2.56 | 920 |
| Drainage Sand | 0.165 | 0.32 | 217.8 |
| Granular Soil | 0.192 | 0.31 | 262.8 |

TOTAL SOIL ARCHING LOAD $P_M$: 1,731.6 $lb/ft^2$

MODIFIED ARCHING LOAD = $0.6P_M+0.4P_E$: 2,820.98 $lb/ft^2$

OVERBURDEN LOAD: 2,820.98 $lb/ft^2$

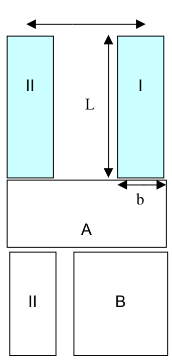
Load on Pipe With Equipment Refer to Attachment

Operation w/ CAT D7R Series II 60 Feet Waste

| | | | | | |
|---|---|---|---|---|---|
| Equipment Weight = | 54,573.0 | psf | Length of Track = L = | 113.0 | in |
| Number of Tracks = | 2.0 | | Track Width = b = | 22.0 | in |
| Track Load = $q_r$ = | 27,286.5 | psf | Track Gauge = G = | 78.0 | in |
| Ground contact area/track = | 17.3 | psf | Equipment Width "A" = | 113.0 | in |

Live Load = q*Ic q = track load 1,580.55 psf

Ic = Influence coefficient




| | b (ft) | L (ft) | z (ft) | m = b/z | n = L/z | I* | I** | I |
|---|---|---|---|---|---|---|---|---|
| I | 1.83 | 9.4 | 67.0 | 0.03 | 0.14 | 0.002 | 0.251 | 0.00181 |
| A | 8.33 | 9.4 | 67.0 | 0.12 | 0.14 | 0.008 | 0.253 | 0.00811 |
| B | 6.50 | 9.4 | 67.0 | 0.10 | 0.14 | 0.006 | 0.252 | 0.00636 |

Live $Load_1$ = I + II = $q_I(I_I) + q_A(I_A) - q_B(I_B)$ = 5.62 $lb/ft^2$

$q_I(I_I)$ = 2.85

$q_A(I_A)$ = 12.82

$q_B(I_B)$ = 10.05

Load on Pipe (Equipment) = 5.62 $lb/ft^2$

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| SUBJECT | BY | DATE |
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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
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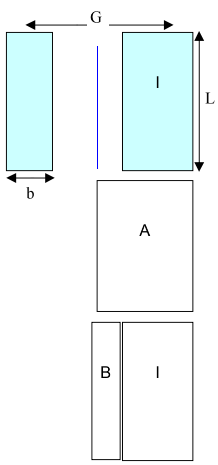
Load on Pipe (Equipment) *Continued*

Live Load = $q*I_c$

$q$ = track load 1580.55 lb/ft$^2$

$I_c$ = Influence coefficient

Alternative 2: Track stradling and parallel to pipe



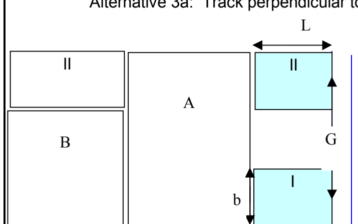

| | b | L | z | m = b/z | n = L/z | I* | I** | I |
|---|---|---|---|---|---|---|---|---|
| A | 4.71 | 9.4 | 67 | 0.07 | 0.14 | 0.005 | 0.252 | 0.00462 |
| B | 2.88 | 9.4 | 67 | 0.04 | 0.14 | 0.003 | 0.251 | 0.00283 |

Live Load$_2$ = 2 * (A - B) = 2 * ($q_A I_A$ - $q_B I_B$) = 5.66 lb/ft$^2$

| | |
|---|---|
| $q_A(I_A)$ = | 7.30 |
| $q_B(I_B)$ = | 4.47 |

Load on Pipe (Equipment) = 5.66 lb/ft$^2$

Alternative 3a: Track perpendicular to pipe




| | b | L | z | m = b/z | n = L/z | I* | I** | I |
|---|---|---|---|---|---|---|---|---|
| I | 1.83 | 9.4 | 67 | 0.03 | 0.14 | 0.002 | 0.251 | 0.00181 |
| A | 9.42 | 9.4 | 67 | 0.14 | 0.14 | 0.009 | 0.253 | 0.00913 |
| B | 7.58 | 9.4 | 67 | 0.11 | 0.14 | 0.007 | 0.252 | 0.00739 |

Live Load$_3$ = I + II = $q_I(I_I)$ + $q_A(I_A)$ - $q_B(I_B)$ = 5.60 lb/ft$^2$

| | |
|---|---|
| $q_I(I_I)$ = | 2.85 |
| $q_A(I_A)$ = | 14.43 |
| $q_B(I_B)$ = | 11.69 |

Load on Pipe (Equipment) = 5.60 lb/ft$^2$

LARGEST EQUIPEMENT LOAD = 5.66 lb/ft$^2$

VERTICAL OVERBURDEN LOAD = 2,820.98 lb/ft$^2$

VERTICAL EQUIPMENT LOAD = 5.66 lb/ft$^2$

TOTAL VERTICAL LOAD APPLIED TO PIPE, $P_T$ = 2,826.65 lb/ft$^2$ = 19.63 lb/in$^2$

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| CLIENT | PROJECT | JOB NO. |
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| SUBJECT | BY | DATE |
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| Pipe Crushing Calculations **RAI No. 1** | SRF | 4/1/13 |
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Verify that perforations in the LCRS are adequate for the peak leachate flow.

Use discharge equation:

$Q = (Cd)(Ao)(2gh)^{0.5}$

$C_d$ = coeffiecient of discharge = 0.6 for short tube discharge with fluid/wall separation; conservative value.

$A_o$ = Area of orifice ($\pi D^2/4$)

g = gravitational acceleration (32.3 $ft^2/s$)

h = static head (ft)

Assumptions and Givens:

| | | | |
|---|---|---|---|
| | 1.63 | acres | Phase II Section II south portion |
| | 5.00 | acres | Phase II Section I area |
| 1. No. acres of landfill expansion = | 5.00 | acres | - Use Phase II Section I area in calcs. If LCS pipes can |
| 2. Total length of pipe per expansion = | 2,020.0 | ft | handle this flow they will also handle the flow in the |
| 3. Number of laterals = | 3.0 | | Phase II Section II Expansion south portion which has |
| 4. Total length of pipe per lateral = | 673.3 | ft | less flow. Includes flow from north, center, south, |
| 5. Perforation diameter = | 0.375 | inch | Phase I south sideslope and Phase II Section I area. |
| 6. No. perforations/ft pipe = | 6.0 | perforations/ft of pipe length | |
| 7. Maximum head over pipe = | 1.0 | ft | |
| 8. Per HELP model summary table, $Q_{peak}$ = | 335.56 | gal/min | refer to HELP Model Summary Table |
| 9. Per HELP model summary table, $Q_{peak}$ = | 64,595.3 | cf/day | refer to HELP Model Summary Table |
| 10. Maximum flow/lateral = | 21,531.8 | cf/day/lateral | |
| 11. Maximum leachate flow/ft of pipe = | 31.98 | cf/day/ft of pipe | |

Solution:

$A_o = 0.25(\Pi)(d)^2 =$ 0.00077 $ft^2$

1. Flow per orifice, $Q = (Cd)(Ao)(2gh)^{0.5}$ = 0.0037 $ft^3/s$

2. Flow per ft of pipe = (Q)(# perfs/ft) = 0.02 $ft^3/s$ per ft of pipe

= 1914.47 cf/day/ft of pipe

Conclusion:

Design capacity exceeds estimated generation

1914.47 cf/day/ft of pipe >>> 31.98 cf/day/ft of pipe

Perforations are adequate to handle the maximum leachate flow.

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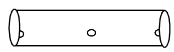
Effective pressure on pipe due to perforations:

$P_{EFF} = \frac{P_T \times 12}{(12-L_P)}$ Source 3, EPA SW-870, p. 382

$L_P$ = Total accumulated length of perforations in one foot of pipe.

Since each perforation is 0.375 inch diameter and spaced at 6.0 inch on center,

$L_P$ = 1.5 inch



$P_T$ = 19.6 psi

$P_{EFF}$ = 22.4 psi

$P_{EFF}$ = 3230.5 psf

Check actual compressive pressure ($S_A$) per Driscopipe manual:

$S_A$ = 0.5 x (SDR - 1) x P(eff) = 112.2 psi

The recommended, long-term compressive strength ($Y_s$) design value for Driscoplex polyethylene pipe is 800 lb/in$^2$.

Source No. 1

| $S_A$ (psi): | | $Y_s$ (psi): |
|---|---|---|
| 112.2 | < | 800.0 |

Pipe passes wall compressive stress perforation calculations TRUE

FS = 7.1

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Constrained pipe wall buckling (for Driscoplex OD controlled pipe)

$P_{WC} = \frac{5.65 * \{RB'E' E*[12(DR-1)^3]^{-1}\}^{0.5}}{N}$ Source 1, Equation 7-5

$P_{WC}$ = allowable constrained buckling pressure (lb/in$^2$)

R = buoyancy reduction factor = 1 - 0.33 * (H'/H) Source 1, Equation 7-34

| | | |
|---|---|---|
| H' = groundwater height above pipe (ft) | 0.0 | ft |
| H = cover above pipe (ft) | 67.0 | ft |
| B' = elastic support factor =( 1+ 4*$e^{-0.065H}$ )$^{-1}$ | | Source 1, Equation 7-35 |
| E' = soil reaction modulus (lb/in$^2$) | 3000.0 | lb/in$^2$ for mod comp/crushed rock, 'Source 1, Table 7-7 |
| E = elastic modulus (lb/in$^2$) | 100000.0 | lb/in$^2$ for long term load at 100$^o$F, 'Source 1, Table 5-1 |
| I = moment of inertia = $t^3$ / 12 | 0.0 | in$^4$/in |
| $D_o$ = pipe outer diameter (in) | 8.625 | SDR 11 pipe (Driscopipe) to be used |
| t = pipe wall thickness (in) | 0.784 | SDR 11 pipe (Driscopipe) to be used |
| DR = pipe dimension ratio = $D_o$ / t | 11.0 | SDR 11 pipe (Driscopipe) to be used |
| $D_I$ = pipe inner diameter = $D_o$ - 2t (in) | 7.1 | SDR 11 pipe (Driscopipe) to be used |
| N = safety factor | 2.0 | |

| Cover (ft) | (ft) | (ft) | B' | R | (lb/in$^2$) |
|---|---|---|---|---|---|
| 60.0 | 67 | 0 | 0.95 | 1.00 | 435.54 |

$P_{WC}$ = 435.54 lb/in$^2$

$P_{EFF}$ = 22.43 lb/in$^2$

Pipe passes contrained wall buckling calculations TRUE FS = 19.4

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| Operation w/ CAT D7R Series II **60 Feet Waste** | | |

Constrained Pipe Wall Compressive Stress (for Driscoplex OD controlled pipe)

$S = \frac{P_T D_o}{288t}$ Source No. 1

S = pipe wall compressive stress (lb/in$^2$)

$P_T$ = vertical load applied to pipe w/ perfs (lb/ft$^2$) 3230.5 lb/ft$^2$

$D_o$ = pipe outside diameter (in) 8.63 SDR 11 pipe (Driscopipe) to be used

t = pipe wall thickness (in) 0.784 SDR 11 pipe (Driscopipe) to be used

$S = \frac{P_T D_o}{288t} =$ 123.4 lb/in$^2$

The recommended, long-term compressive strength ($Y_s$) design value for Driscoplex polyethylene pipe is 800 lb/in$^2$.

Source No. 1

| S (psi): | | $Y_s$ (psi): |
|---|---|---|
| 123.4 | < | 800.0 |

Pipe passes wall compressive stress calculations TRUE FS = 6.5

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Iowa Formula

$\Delta X = \frac{D_L K W_c r^3}{EI + 0.06er^4}$ Source 2, Equation 3.4 Buried Pipe Design, A.P. Moser, Chapter 3

$\Delta X$ = horizontal deflection (in)

$D_L$ = deflection lag factor

K = bedding constant | 0.1 | typical value Source 2, Buried Pipe Design, A.P. Moser, Chapter 3

$W_c$ = Marston's load per unit length of pipe (lb/in)

r = mean radius of the pipe (in)

E = modulus of elasticity ($lb/in^2$)

I = moment of inertia of the pipe wall per unit length ($in^3$)

e = modulus of passive resistance fo the side fill ($lb/in^2(in)$)

Modified Iowa Formula

$\Delta X = \frac{D_L K W_c r_m^3}{EI + 0.06E'r_m^3}$ Source 2, Equation 3.5 Buried Pipe Design, A.P. Moser, Chapter 3

$\Delta X$ = horizontal deflection (in)

| | | Value | |
|---|---|---|---|
| $D_L$ = deflection lag factor | | 1.0 | Prism Load used |
| Typical Value for Marston Load | 1.5 | | |
| Typical Value for Prism Load | 1.0 | | |
| K = bedding constant | | 0.1 | typical value Buried Pipe Design, A.P. Moser, Chapter 3 |
| $P_T$ = Vertical load on pipe w/ perfs | | 22.43 | $lb/in^2$ 3230 $lb/ft^2$ |
| $W_c$ = Marston's load per unit length of pipe = $P_T$ * $D_o$ (lb/in) | | 193.49 | lb/in |
| $D_o$ = pipe outer diameter (in) | | 8.63 | SDR 11 pipe (Driscopipe) to be used |
| t = pipe wall thickness (in) | | 0.78 | SDR 11 pipe (Driscopipe) to be used |
| $D_I$ = pipe inner diameter = $D_o$-2t (in) | | 7.06 | SDR 11 pipe (Driscopipe) to be used |
| $D_m$ = pipe mean diameter = $D_o$ - 1.06t Source 1, Equation 7-27 | | 7.79 | SDR 11 pipe (Driscopipe) to be used |
| $r_m$ = mean radius of the pipe (in) | | 3.90 | SDR 11 pipe (Driscopipe) to be used |
| E = modulus of elasticity ($lb/in^2$) | | 100,000.0 | lb/in2 for long term load at 100oF, 'Source 1, Table 5-1 |
| I = moment of inertia of the pipe wall per unit length | | 0.040 | $in^4/in$ |
| E' = modulus of soil reaction | | 3,000.0 | $lb/in^2$ for moderate compaction and fine grained soils |

$\Delta X = \frac{D_L K W_c r_m^3}{EI + 0.06E'r_m^3}$ = 0.078 inch Source 2, Equation 3.5 Buried Pipe Design, A.P. Moser, Chapter 3

% Ring Deflection = ($\Delta X/D_m$) x 100 = 1.00% Source 1, Equation 7-31

Ring Bending Strain

$e = \frac{f_D \Delta X 2C}{D_M^2} \times 100$ Source 1, Equation 7-39

e = wall strain (%)

| | | |
|---|---|---|
| $f_D$ = deformation shape factor | 6 | Source 1, non-elliptical shape |
| $D_M$ = mean diameter (in) | | |
| C = outer fiber wall centroid = 0.5 (1.06t) | 0.416 | Source 1, Equation 7-41 |
| $\Delta X$ = ring deflection = $D_X/D_m$ | 0.010 | |

$e = f_D(\frac{\Delta X}{D_M})(\frac{2C}{D_M}) \times 100$ = 0.6% Source 1, Equation 7-39

The maximum ring bending strain for high performance polyethylene non-pressure pipe is 5.0%

Pipe passes ring bending strain calculations TRUE

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| Operation w/ CAT D7R Series II **60 Feet Waste** | | |

SOURCES

1.) Attachment - 1 - Chevron Phillips Chemical Company, Bulletin - Book 2 Chapter 5, 2003

2.) Attachment - 2 - Buried Pipe Design, A.P. Moser, Chapter 3

3.) Attachment - 3 - EPA, Lining of Waste Impoundment and Disposal Facilities, SW-870

4.) Attachment - 4 - Driscoplex Pipe Properties

5.) Attachment - 5 - CAT 826G Series II Compactor Data Sheet

6.) Attachment - 6 - CAT D7R Series II Equipment Data Sheet

7.) Attachment - 7 - CAT D6R XW Series II Equipment Data Sheet

# Phase I 8 Inch Perforated ADS Pipe

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|---|---|---|
| Pipe Crushing Calculations Phase I**RAI No. 1** | SRF | 8/31/12 |
| **Existing 8" Diameter ADS Collection System** | CHECKED | DATE |

SOIL ARCH LOAD ($W_{sp}$)

Calculating geostatic load ($P_{sp}$)

$$P_{sp} = \frac{(\gamma_s)(H + 0.11(OD/12))}{144}$$ (Equation 2-2)

= 30.036 psi

Where:

| | | | |
|---|---|---|---|
| $H =$ | 72.0 | ft | burial depth (top of final cover to top of pipe) |
| $\gamma_s =$ | 60.0 | $lb/ft^3$ | unit weight of soil (unit weight of waste/daily cover) |
| $OD =$ | 9.45 | in | outside diameter of pipe (Table 2-4) |

Calculating vertical arching factor (VAF)

$VAF = 0.76 - 0.71 ((S_h - 1.17)/(S_h + 2.92))$ (Equation 2-3)

= 0.89 short term condition
= 0.56 long term condition

| | | | |
|---|---|---|---|
| $S_h = \varphi_s M_s R/(EA)$ | | | hoop stiffness factor |
| = | 0.549 | | short term conditions |
| = | 2.746 | | long term conditions |
| $\varphi_s =$ | 0.9 | | capacity modification factor for soil |
| $M_s =$ | 1,990 | psi | secant constrained soil modulus (Table 2-7) |
| $R =$ | ID/2 + c | | effective radius of pipe |
| | 4.318 | in | |
| $ID =$ | 8.00 | in | inside diameter of pipe |
| $c =$ | 0.318 | in | distance from inside diameter to neutral axis |
| $E =$ | 110,000 | psi | modulus of elasticity of polyethylene, short term conditions |
| = | 22,000 | psi | modulus of elasticity of polyethylene, long term conditions |
| $A =$ | 0.128 | $in^2/in$ | section area |

Soil Arch Load ($W_{sp}$)

$W_{sp} = (P_{sp})(VAF)$ (Equation 2-4)

= 26.64 psi short term conditions
= 16.89 psi long term conditions

HYDROSTATIC LOADS

$$P_w = \frac{\gamma_w (H_g)}{144}$$ (Equation 2-5)

= 4.37 psi

Where:

| | | | |
|---|---|---|---|
| $\gamma_w =$ | 62.4 | pcf | unit weight of water |
| $H_g =$ | 10.1 | ft | height of groundwater above springline of pipe |
| | | | <u>Revised using high groundwater elevation of EL 82.09 feet NGVD</u> |

FOUNDATION LOADS

Pipes are not positioned beneath or near foundations.

**Revised April 1, 3013**

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| Pipe Crushing Calculations Phase I<br>**Existing 8" Diameter ADS Collection System** | SRF | 8/31/12 |
| | CHECKED | DATE |

CALCULATING WALL THRUST ($T_L$)

$T_L = [\eta_{EV}(\gamma_{EV} W_{sp} + \gamma_{WA} P_w) + \eta_{LL}\gamma_{LL} P_l C_l]$ (OD/2) (Equation 2-5)

Where:

| | | | |
|---|---|---|---|
| $W_{sp}$ = | 26.64 | psi | soil arch load, short term conditions (Equation 2-3) |
| = | 16.89 | psi | soil arch load, long term conditions (Equation 2-3) |
| $\eta_{EV}$ = | 1.05 | | load modifier, earth fill (Table 2-13) |
| $\gamma_{EV}$ = | 1.00 | | load factor, vertical earth pressure, Strength Limit I (Table 2-11) |
| = | 1.00 | | load factor, vertical earth pressure, Strength Limit II (Table 2-11) |
| = | 1.00 | | load factor, vertical earth pressure, Service Limit I (Table 2-11) |
| $\gamma_{WA}$ = | 1.00 | | load factor, water load, Strength Limit I (Table 2-11) |
| = | 1.00 | | load factor, water load, Strength Limit II (Table 2-11) |
| = | 1.00 | | load factor, water load, Service Limit I (Table 2-11) |
| $\eta_{LL}$ = | 1.00 | | load modifier, live load (Table 2-13) |
| $\gamma_{LL}$ = | 1.75 | | load factor, live load, Strength Limit I (Table 2-11) |
| = | 1.35 | | load factor, live load, Strength Limit II (Table 2-11) |
| = | 1.00 | | load factor, live load, Service Limit I (Table 2-11) |
| $P_l$ = | 1.00 | psi | live load transferred to pipe negligable per (Table 2-10) |
| $C_l$ = | 0.11 | | live load distribution coefficient |
| = the lesser of $L_w$/OD or 1.0 | | | |
| $L_w$ = | 1.00 | in | live load distribution width at the crown negligable per (Table 2-10) |
| OD = | 9.45 | in | outside diameter of pipe (Table 2-4) |
| $P_w$ = | 4.37 | psi | hydrostatic pressure at springline of pipe (Equation 2-5) |

| $T_L$ | Short Term psi | Long Term psi |
|---|---|---|
| Strength Limit I | 154.75 | 106.39 |
| Strength Limit II | 154.55 | 106.19 |
| Service Limit I | 154.38 | 106.01 |

Tensile Resistance to Thrust ($T_{cr}^{ten}$)

$T_{cr}^{ten}$ = $(F_y)(A)(\phi_p)$ =

| | | | |
|---|---|---|---|
| 384 | psi | short term conditions | (Equation 2-9) |
| 115 | psi | long term conditions | If: $T_{cr}^{ten} \geq T_L$ OK |

Where:

| | | | |
|---|---|---|---|
| $F_y$ = | 3,000 | psi | tensile strength of polyethylene, for short term conditions (Table 2-5) |
| = | 900 | psi | tensile strength of polyethylene, for long term conditions (Table 2-5) |
| A = | 0.128 | $in^2$/in of pipe | |
| $\phi_p$ = | 1.0 | capacity modification factor for pipe (Table 2-11) | |

| CHECK | Short Term | Long Term |
|---|---|---|
| Strength Limit I | $T_{cr}^{ten} > T_L$ **OK** | $T_{cr}^{ten} > T_L$ **OK** |
| Strength Limit II | $T_{cr}^{ten} > T_L$ **OK** | $T_{cr}^{ten} > T_L$ **OK** |

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| Pipe Crushing Calculations Phase I | SRF | 8/31/12 |
| **Existing 8" Diameter ADS Collection System** | CHECKED | DATE |

Compressive Resistance to Thrust ($T_{cr}^{comp}$)

$T_{cr}^{comp} = (F_y)(A_{eff})(\phi_p)$ (Equation 2-10)

If $T_{cr}^{comp} > T_L$ OK
$f_{cr} < F_y$ then $T_{cr}^{comp} = (f_{cr})(A_{eff})(\phi_p)$
see page 5 for $f_{cr}$ calculations

Where:

$F_y$ = 3000 psi tensile strength of polyethylene, for short term conditions (Table 2-5)
= 900 psi tensile strength of polyethylene, for long term conditions (Table 2-5)
$A_{eff}$ = effctive wall area
$\phi_p$ = 1.0 capacity modification factor for pipe (Table 2-12)

| $T_{cr}^{comp}$ | Short Term psi | Long Term psi |
|---|---|---|
| Strength Limit I | 384.00 | 104.77 |
| Strength Limit II | 384.00 | 104.81 |

| CHECK | Short Term | | Long Term | |
|---|---|---|---|---|
| Strength Limit I | $T_{cr}^{comp} > T_L$ | **OK** | $T_{cr}^{comp} > T_L$ | **5633.43** |
| | $f_{cr} < F_y$ | **fcr>Fy** | $f_{cr} < F_y$ | **fcr>Fy** |
| Strength Limit II | $T_{cr}^{comp} > T_L$ | **OK** | $T_{cr}^{comp} > T_L$ | **5633.43** |
| | $f_{cr} < F_y$ | **fcr>Fy** | $f_{cr} < F_y$ | **fcr>Fy** |

EFFECTIVE AREA ($A_{eff}$)

$$A_{eff} = \frac{A_s - \Sigma(1-\rho_i)w_i t_i}{\varpi}$$ (Equation 2-11)

$$\rho_i = \frac{1 - 0.22/\lambda}{\lambda} \leq 1$$ Effective width factor (Equation 2-12)

$\varpi$ = 0.98 in profile pitch (Table 2-11)

$\lambda = (w_i/t_i) \times (\varepsilon/k)^{0.5} > 0.673$ Slenderness factor (Equation 2-13)

Where:

$w_i$ = length of each individual profile element (Table 2-11)
$t_i$ = thickness of each individual profile element (Table 2-11)
k = edge support coefficient, 4.0 for elements with both edges supported

$\varepsilon = T_L / AE$ (Equation 2-11)

Where:

$T_L$ = wall thrust, lb/in
A = 0.128 $in^2$/in of pipe
E = 110,000 modulus of elasticity of polyethylene, short term conditions
E = 22,000 modulus of elasticity of polyethylene, long term conditions

| $\varepsilon$ | Short Term in/in | Long Term in/in |
|---|---|---|
| Strength Limit I | 0.0110 | 0.0378 |
| Strength Limit II | 0.0110 | 0.0377 |
| Service Limit I | 0.0110 | 0.0376 |

| CLIENT | PROJECT | JOB NO. |
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| Pipe Crushing Calculations Phase I | SRF | 8/31/12 |
| **Existing 8" Diameter ADS Collection System** | CHECKED | DATE |

Short Term Strength Limit I

| | $t_i$ | $w_i$ | $w_i/t_i$ | I | $r_i$ |
|---|---|---|---|---|---|
| Crest | 0.049 | 0.365 | 7.449 | 0.673 | 1.000 |
| Web | 0.055 | 0.487 | 8.855 | 0.673 | 1.000 |
| Valley | 0.039 | 0.376 | 9.641 | 0.673 | 1.000 |
| Liner | 0.039 | 0.431 | 11.051 | 0.673 | 1.000 |

$A_{eff}$ = 0.128 $in^2$/in of pipe

Long Term Strength Limit I

| | $t_i$ | $w_i$ | $w_i/t_i$ | I | $r_i$ |
|---|---|---|---|---|---|
| Crest | 0.049 | 0.365 | 7.449 | 0.724 | 0.962 |
| Web | 0.055 | 0.487 | 8.855 | 0.861 | 0.865 |
| Valley | 0.039 | 0.376 | 9.641 | 0.937 | 0.817 |
| Liner | 0.039 | 0.431 | 11.051 | 1.074 | 0.740 |

$A_{eff}$ = 0.116 $in^2$/in of pipe

Short Term Strength Limit II

| | $t_i$ | $w_i$ | $w_i/t_i$ | I | $r_i$ |
|---|---|---|---|---|---|
| Crest | 0.049 | 0.365 | 7.449 | 0.673 | 1.000 |
| Web | 0.055 | 0.487 | 8.855 | 0.673 | 1.000 |
| Valley | 0.039 | 0.376 | 9.641 | 0.673 | 1.000 |
| Liner | 0.039 | 0.431 | 11.051 | 0.673 | 1.000 |

$A_{eff}$ = 0.128 $in^2$/in of pipe

Long Term Strength Limit II

| | $t_i$ | $w_i$ | $w_i/t_i$ | I | $r_i$ |
|---|---|---|---|---|---|
| Crest | 0.049 | 0.365 | 7.449 | 0.723 | 0.962 |
| Web | 0.055 | 0.487 | 8.855 | 0.860 | 0.866 |
| Valley | 0.039 | 0.376 | 9.641 | 0.936 | 0.817 |
| Liner | 0.039 | 0.431 | 11.051 | 1.073 | 0.741 |

$A_{eff}$ = 0.116 $in^2$/in of pipe

Short Term Service Limit I

| | $t_i$ | $w_i$ | $w_i/t_i$ | I | $r_i$ |
|---|---|---|---|---|---|
| Crest | 0.049 | 0.365 | 7.449 | 0.673 | 1.000 |
| Web | 0.055 | 0.487 | 8.855 | 0.673 | 1.000 |
| Valley | 0.039 | 0.376 | 9.641 | 0.673 | 1.000 |
| Liner | 0.039 | 0.431 | 11.051 | 0.673 | 1.000 |

$A_{eff}$ = 0.128 $in^2$/in of pipe

Long Term Service Limit I

| | $t_i$ | $w_i$ | $w_i/t_i$ | I | $r_i$ |
|---|---|---|---|---|---|
| Crest | 0.049 | 0.365 | 7.449 | 0.723 | 0.963 |
| Web | 0.055 | 0.487 | 8.855 | 0.859 | 0.866 |
| Valley | 0.039 | 0.376 | 9.641 | 0.935 | 0.818 |
| Liner | 0.039 | 0.431 | 11.051 | 1.072 | 0.741 |

$A_{eff}$ = 0.116 $in^2$/in of pipe

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| Pipe Crushing Calculations Phase I<br>**Existing 8" Diameter ADS Collection System** | SRF | 8/31/12 |
| | CHECKED | DATE |

BUCKLING

Calculating Critical Bucking Stress ($f_{cr}$)

$$f_{cr} = 9.24(R/A_{eff})[(B'R_w\phi_s M_s(EI/0.149R^3))^{0.5}]$$ (Equation 2-14)

Where:

| | | | |
|---|---|---|---|
| $M_s$ = | 1,990 | psi | secant constrained soil modulus (Table 2-7) |
| R = | ID/2 + c | | effective radius of pipe |
| = | 4.318 | in | |
| ID = | 8 | in | inside diameter of pipe |
| c = | 0.318 | in | distance from inside diameter to neutral axis (Table 2-2) |
| E = | 110,000 | psi | modulus of elasticity of polyethylene, short term condition |
| = | 22,000 | psi | modulus of elasticity of polyethylene, long term condition |
| $A_{eff}$ = | effective area | | |
| I = | 0.0066 | $in^4/in$ | moment of inertia (Table 2-2) |
| $R_w$ = | $1-0.33h_g/H$ | | water bouyancy factor |
| = | 0.954 | ft | |
| H = | 72 | ft | burial depth (top of pipe) |
| $h_g$ = | 10.09 | ft | height of groundwater above crown of pipe |
| $\phi_s$ = | 0.9 | | resistance factor for soil stiffness (Table 2-12) |
| B' = | $1/(1 + 4e^{-0.065H})$ | | nonuniform stress distribution factor |
| = | 0.964 | | |

| | psi | Governing | |
|---|---|---|---|
| Short Term Strength Limit I | 98,412 | Fy | **OK** |
| Long Term Strength Limit I | 48,392 | Fy | **OK** |
| Short Term Strength Limit II | 98,412 | Fy | **OK** |
| Long Term Strength Limit II | 48,375 | Fy | **OK** |

If $f_{cr} > F_y$ OK

Otherwise

$f_{cr} < F_y$ then $T_{cr}^{comp} = (f_{cr})(A_{eff})(\phi_p)$

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Pipe Deflection Due to Bending

$$\Delta = \Delta_c D_m - \frac{T_L D_m}{A_{eff} E \gamma_p} \quad \text{(Equation 2-16)}$$

Where:

$T_L$ = factored wall thrust

| | | | |
|---|---|---|---|
| $\Delta_c$ = | 0.05 | in/in | deflection of pipe, construction induced deflection limit 5% |
| $\gamma_p$ = | 1.95 | | load factor, vertical earth pressure (Table 2-8) |
| $A_{eff}$ = | effective wall area | | |
| E = | 110,000 | psi | short term modulus of elasticity of polyethylene |
| = | 22,000 | psi | long term modulus of elasticity of polyethylene |
| $D_m$ = | ID + 2c | | mean pipe diameter |
| = | 8.64 | in | |
| c = | 0.318 | in | distance from inside diameter to neutral axis (Table 2-2) |

| | D | | Limit of 5% |
|---|---|---|---|
| Short Term Service Limit I | 0.38 | in | 0.43 |
| Long Term Service Limit I | 0.25 | in | 0.43 |

Factored Bending Strain

$$\varepsilon_{bu} = \gamma_B D_f (c_x/R)(\Delta/D_m) \quad \text{(Equation 2-17)}$$

Where:

| | | | |
|---|---|---|---|
| $D_f$ = | 3.3 | | shape factor |
| $\Delta$ = | deflection due to bending, in | | (Equation 2-16) |
| $\gamma_B$ = | 1.5 | | load factor, combined strain |
| R = | ID/2 + $c_x$ | | effective radius of pipe |
| = | 4.407 | in | |
| ID = | 8 | in | inside diameter of pipe |
| OD = | 9.45 | in | outside diameter of pipe |
| $D_{thick}$ = | 0.725 | in | (ID-OD)/2 |
| $c_x$ = | 0.407 | in | distance from neutral axis to extreme fiber, $c_x = D_{thick} - c$ |
| $D_m$ = | ID + 2$c_x$ | | mean pipe diameter |
| = | 8.81 | in | |

| | | | Limit of 5% |
|---|---|---|---|
| $\varepsilon_{bu\ short}$ = | 0.020 | in/in | 0.43 |
| $\varepsilon_{bu\ long}$ = | 0.013 | in/in | 0.43 |

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| **Existing 8" Diameter ADS Collection System** | CHECKED | DATE |

COMBINED STRAIN

Factored Combined Compressive Strain

$\varepsilon_{cu} = \varepsilon_{bu} + (T_L/A_{eff}E_{50})*(\gamma_B/\gamma_P)$ (Equation 2-18)

Where:

$\varepsilon_{bu}$ = factored bending strain, in./in. (Equation 2-17)

$T_L$ = factored wall thrust, lb/in (Equation 2-5, refer to page 2)

$\gamma_P$ = 1.95 load factor, vertical earth pressure (Table 2-11)

$\gamma_B$ = 1.5 load factor, combined strain

$A_{eff}$ = effective wall area

E = 110,000 psi modulus of elasticity of polyethylene, short term conditions

= 22,000 psi modulus of elasticity of polyethylene, long term conditions

Limiting Combined Compressive Strain

$\varepsilon_{cl} = (1.5F_y/E_{50})$ (Equation 2-19) $\varepsilon_{cu} < \varepsilon_{cl}$ OK

= 0.045 in/in Short term

= 0.061 in/in Long term

Where:

$\varepsilon_{cl}$ = limiting combined compressive strain, in./in.

$F_y$ = 3,000 psi Short term tensile strength of polyethylene

= 900 psi Long term tensile strength of polyethylene

E = 110,000 psi Short term modulus of elasticity of polyethylene

= 22,000 psi Long term modulus of elasticity of polyethylene

| $e_{cu}$ | Short Term in/in | Long Term in/in |
|---|---|---|
| Strength Limit I | 0.028 | 0.045 |
| Strength Limit II | 0.028 | 0.045 |

| CHECK | Short Term | Long Term |
|---|---|---|
| Strength Limit I | $e_{cu} < e_{cl}$ **OK** | $e_{cu} < e_{cl}$ **OK** |
| Strength Limit II | $e_{cu} < e_{cl}$ **OK** | $e_{cu} < e_{cl}$ **OK** |

| CLIENT | PROJECT | JOB NO. |
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| Hardee County | Phase II Section II Expansion | 09199033.23 |

| SUBJECT | BY | DATE |
|---|---|---|
| Pipe Crushing Calculations Phase I<br>**Existing 8" Diameter ADS Collection System** | SRF | 8/31/12 |
| | CHECKED | DATE |

COMBINED STRAIN

Factored Combined Tension Strain

$\varepsilon_{tu} = \varepsilon_{bu} + (T_L/A_{eff}E_{50})*(\gamma_B/\gamma_P)$ (Equation 2-20)

Where:

$\varepsilon_{bu}$ = factored bending strain, in./in. (Equation 2-17)

$T_L$ = factored wall thrust, lb/in

$\gamma_P$ = 1.95 load factor, vertical earth pressure

$\gamma_B$ = 1.5 load factor, combined strain

$A_{eff}$ = effective wall area

E = 110,000 psi modulus of elasticity of polyethylene, short term conditions

= 22,000 psi modulus of elasticity of polyethylene, long term conditions

Limiting Combined Tension Strain

$\varepsilon_{tl} = \gamma_B\varepsilon_t$ (Equation 2-21)

= 0.0750 in/in

Where:

$\varepsilon_{tl}$ = limiting combined tension strain, in./in.

$\gamma_B$ = 1.5 load factor, combined strain

$\varepsilon_t$ = 0.05 in/in allowable tensionstrain

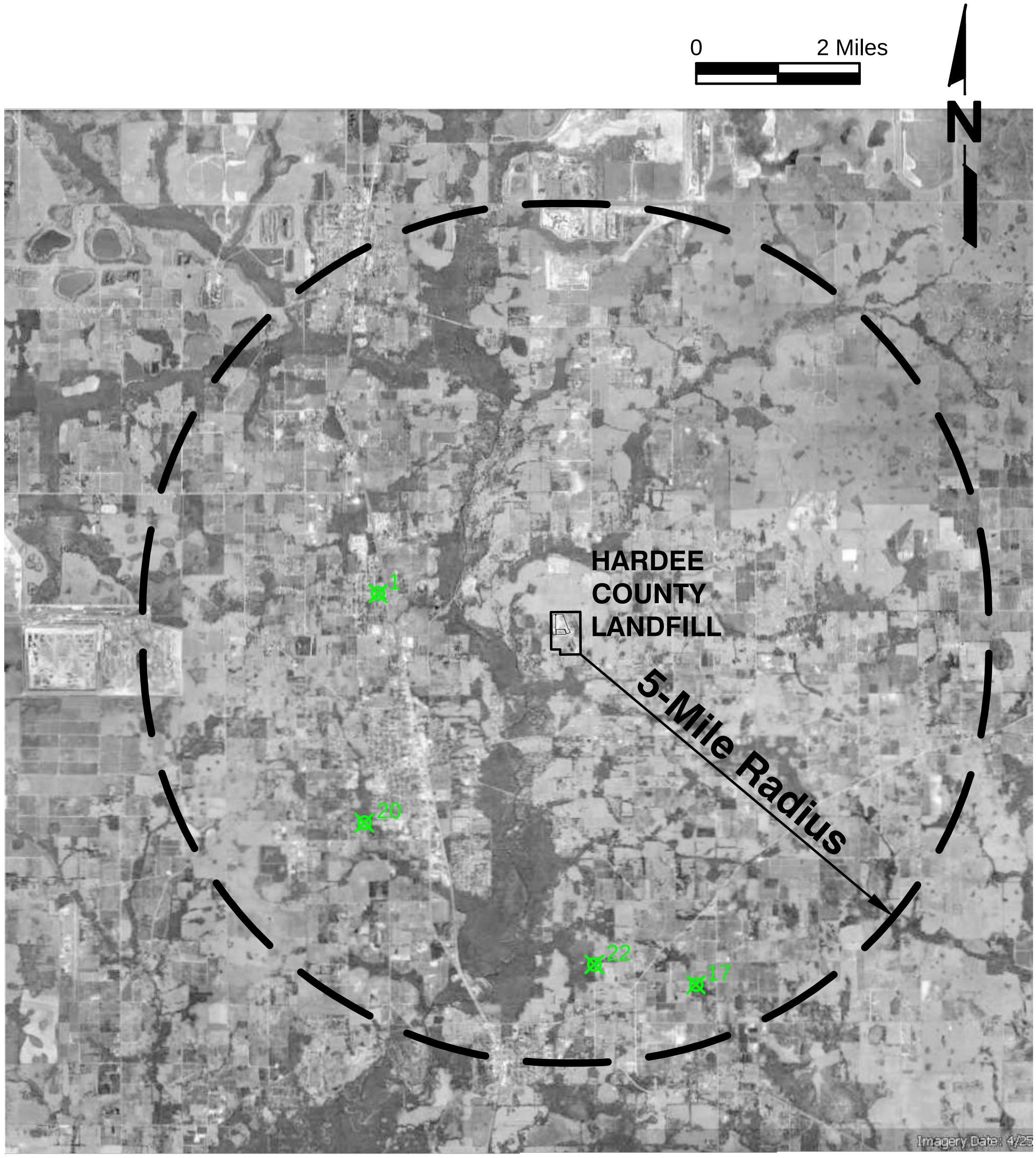
| $\varepsilon_{tu}$ | Short Term in/in | Long Term in/in |
|---|---|---|
| Strength Limit I | 0.0283 | 0.0448 |
| Strength Limit II | 0.0283 | 0.0447 |

| CHECK | Short Term | | Long Term | |
|---|---|---|---|---|
| Strength Limit I | $e_{tu} < e_{tl}$ | **OK** | $e_{tu} < e_{tl}$ | **OK** |
| Strength Limit II | $e_{tu} < e_{tl}$ | **OK** | $e_{tu} < e_{tl}$ | **OK** |

Refer to Attachment 1 - ADS, Inc. Drainage Handbook, ADS, Inc., April 2011

# Attachment U

# Sinkhole Database Location and Figure




LEGEND

17 SINKHOLE LOCATION

1 – 1960
17 – 2002
20 – 2004
22 – 2005

G:\PROJECT\Hardee\09199033.23\Construction\Figures\Hardee Co Airport Location Map.dwg Apr 01, 2013 – 5:28pm Layout Name: Attachment U By: 2378sda

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Figure 1. Sinkhole Location Map, Hardee County Landfill, Hardee County, Florida

| | | | | |
|---|---|---|---|---|
| 1 | 1960 | -81.81914536 | 27.57685539 | |
| 2 | 1989 | -81.67222222 | 27.49583333 | DUNEDIN |
| 3 | 1989 | -81.67222222 | 27.49583333 | DUNEDIN |
| 4 | 1989 | -81.67222222 | 27.49583333 | DUNEDIN |
| 5 | 1989 | -81.67222222 | 27.49583333 | DUNEDIN |
| 6 | 1989 | -81.67222222 | 27.49583333 | DUNEDIN |
| 7 | 1989 | -81.67222222 | 27.49583333 | DUNEDIN |
| 8 | 1989 | -81.67222222 | 27.49583333 | DUNEDIN |
| 9 | 1989 | -81.67222222 | 27.49583333 | DUNEDIN |
| 10 | 1989 | -81.67222222 | 27.49583333 | DUNEDIN |
| 11 | 1989 | -81.67222222 | 27.49583333 | DUNEDIN |
| 12 | 1989 | -81.67222222 | 27.49583333 | DUNEDIN |
| 13 | 1989 | -81.67222222 | 27.49583333 | DUNEDIN |
| 14 | 1989 | -81.67222222 | 27.49583333 | DUNEDIN |
| 15 | 1989 | -81.67222222 | 27.49583333 | DUNEDIN |
| 16 | 1989 | -81.67222222 | 27.49583333 | DUNEDIN |
| 17 | 2002 | -81.75583333 | 27.50722222 | ZOLFO SPRINGS |
| 18 | 2000 | -81.66777778 | 27.47833333 | ZOLFO SPRINGS |
| 19 | 2000 | -81.65055556 | 27.42472222 | ZOLFO SPRINGS |
| 20 | 2004 | -81.82194444 | 27.53611111 | WAUCHULA |
| 21 | 2004 | -81.95805556 | 27.60500000 | BOWLING GREEN |
| 22 | 2005 | -81.77611100 | 27.51083300 | |

# Attachment V

# Settlement Calculation for the Modified LCS Manholes for Phase I

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SHEET 1 OF 1

| CLIENT | PROJECT | JOB NO. |
|---|---|---|
| Hardee County | Phase II Section II Expansion | 09199033.23 |

| SUBJECT | BY | DATE |
|---|---|---|
| Phase I | SRF | 4/1/13 |
| Phase II Section II Expansion | CHECKED | DATE |
| Material Properties | | |

Hardee County Landfill Phase II Section II Expansion

| | | | |
|---|---|---|---|
| Cover Soil = | 115.0 | pcf | Refer to Attachment 6 |
| Cover Soil Saturated = | 120.0 | pcf | |
| Intermediate Soil = | 115.0 | pcf | |
| Intermediate Soil Saturated = | 120.0 | pcf | |
| Waste/Daily = | 60.0 | pcf | |
| Waste/Daily 2 = | 60.0 | pcf | |
| Intermediate Soil 2 = | 115.0 | pcf | |
| Intermediate Soil 2 Saturated = | 120.0 | pcf | |
| Rock = | 140.0 | pcf | |
| Drainage Sand = | 115.0 | pcf | |
| Drainage Sand Saturated = | 120.0 | pcf | |
| Unit Weight of Water, $\gamma_w$ = | 62.4 | pcf | |

Refer to Attachment 7

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SHEET 1 OF 1

| CLIENT | PROJECT | JOB NO. |
|---|---|---|
| Hardee County | Phase II Section II Expansion | 09199033.23 |

| SUBJECT | BY | DATE |
|---|---|---|
| Phase I<br>Settlement Calculations<br>**Settlement of Existing Leachate Collection Pipes and Manholes** | SRF | 4/1/13 |
| | CHECKED | DATE |

| Points | Initial Conditions | | | | Final Conditions | | | |
|---|---|---|---|---|---|---|---|---|
| | Initial Elevation (ft NGVD) | Difference (ft) | Distance (ft) | Slope (%) | Settlement (ft) | Elevation (ft NGVD) | Difference (ft) | Slope (%) |
| A-MH4 | 84.00 | | | | 0.54 | 83.46 | | |
| | | 4.58 | 396.00 | 1.16 | | | 4.56 | 1.15 |
| B-MH5 | 79.42 | | | | 0.52 | 78.90 | | |
| | | 1.14 | 399.00 | 0.29 | | | 1.04 | 0.26 |
| C-MH6 | 78.28 | | | | 0.42 | 77.86 | | |
| | | 2.78 | 160.00 | 1.74 | | | 2.56 | 1.60 |
| D-MH7 | 75.50 | | | | 0.20 | 75.30 | | |

| Points | Initial Conditions | | | | Final Conditions | | | |
|---|---|---|---|---|---|---|---|---|
| | Initial Elevation (ft NGVD) | Difference (ft) | Distance (ft) | Slope (%) | Settlement (ft) | Elevation (ft NGVD) | Difference (ft) | Slope (%) |
| D-MH7 | 75.50 | | | | 0.52 | 74.98 | | |
| | | 1.80 | 378.00 | 0.48 | | | 1.70 | 0.45 |
| E | 73.70 | | | | 0.42 | 73.28 | | |
| | | 1.03 | 368.00 | 0.28 | | | 0.81 | 0.22 |
| F-MH8 | 72.67 | | | | 0.20 | 72.47 | | |

| CLIENT | PROJECT | JOB NO. |
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|---|---|---|
| Phase I<br>Settlement Calculations | SRF | 4/1/13 |
| **Settlement of Existing Leachate Collection Pipes and Manholes** | CHECKED | DATE |

Based on the variability of the soil properties and the range of reasonable values of settlement the estimated settlement at points are the following:

| Location | Foundation Settlement (inches) |
|---|---|
| A-MH4 | 0.18 |
| | |
| B-MH5 | 0.15 |
| | |
| C-MH6 | 0.21 |
| | |
| D-MH7 | 0.21 |
| | |
| E | 0.18 |
| | |
| F-MH8 | 0.09 |

A-MH4 to C-MH6: Existing 8-inch diameter ADS leachate collection pipe from MH4 to MH6.

C-MH6 to F-MH8: Existing 10-inch HDPE leachate collection pipe from MH7 to MH8.

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SHEET 1 OF 1

| CLIENT | PROJECT | JOB NO. |
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| SUBJECT | BY | DATE |
|---|---|---|
| | SRF | 4/1/13 |
| Phase I<br>Settlement Calculations | CHECKED | DATE |

**A-MH4**

| | Soil Type, N | H (ft) | $C_c$ | $C_s$ | $e_o$ | $P_o$ (psf) | ΔP (psf) | Settlement (ft) | |
|---|---|---|---|---|---|---|---|---|---|
| Point 1 | (SP/SP-SM), N~10 | 0.0 | 0.050 | 0.010 | 0.914 | 99.5 | 0.0 | 0.00 | |
| Point 2 | (SP-SM/SM), N>40 | 10.2 | 0.061 | 0.012 | 0.815 | 704.7 | 955.3 | 0.13 | |
| Point 3 | (SP/SP-SM), N~30 | 5.0 | 0.036 | 0.007 | 0.457 | 1399.8 | 955.3 | 0.03 | |
| Point 4 | (CL/CH), N~10 | 5.0 | 0.028 | 0.006 | 0.420 | 1752.7 | 955.3 | 0.02 | |
| Point 5 | (CL/CH), N>40 | 12.0 | 0.008 | 0.002 | 0.333 | 2388.3 | 955.3 | 0.01 | |
| | | | | | | | | 0.18 | ft |
| | | | | | | | | 2.20 | in |

**B-MH5**

| | Soil Type, N | H (ft) | $C_c$ | $C_s$ | $e_o$ | $P_o$ (psf) | ΔP (psf) | Settlement (ft) | |
|---|---|---|---|---|---|---|---|---|---|
| Point 1 | (SP/SP-SM), N~10 | 0.0 | 0.045 | 0.009 | 0.640 | 99.5 | 0.0 | 0.00 | |
| Point 2 | (SP-SM/SM), N>40 | 5.6 | 0.003 | 0.001 | 0.175 | 704.7 | 3042.1 | 0.01 | |
| Point 3 | (SP/SP-SM), N~30 | 5.0 | 0.026 | 0.005 | 0.424 | 1399.8 | 3042.1 | 0.05 | |
| Point 4 | (CL/CH), N~10 | 5.0 | 0.045 | 0.009 | 0.495 | 1752.7 | 3042.1 | 0.07 | |
| Point 5 | (CL/CH), N>40 | 12.0 | 0.008 | 0.002 | 0.333 | 2388.3 | 3042.1 | 0.02 | |
| | | | | | | | | 0.15 | ft |
| | | | | | | | | 1.75 | in |

**C-MH6**

| | Soil Type, N | H (ft) | $C_c$ | $C_s$ | $e_o$ | $P_o$ (psf) | ΔP (psf) | Settlement (ft) | |
|---|---|---|---|---|---|---|---|---|---|
| Point 1 | (SP/SP-SM), N~10 | 0.0 | 0.045 | 0.009 | 0.640 | 176.8 | 0.0 | 0.00 | |
| Point 2 | (SP), N~10 | 1.8 | 0.035 | 0.007 | 0.530 | 514.8 | 3921.0 | 0.04 | |
| Point 3 | (CL/CH), N~10 | 6.0 | 0.045 | 0.009 | 0.495 | 840.5 | 3932.9 | 0.14 | |
| Point 4 | (CL/CH), N>40 | 11.5 | 0.008 | 0.002 | 0.333 | 1491.2 | 3932.9 | 0.04 | |
| | | | | | | | | 0.21 | ft |
| | | | | | | | | 2.53 | in |

**D-MH7**

| | Soil Type, N | H (ft) | $C_c$ | $C_s$ | $e_o$ | $P_o$ (psf) | ΔP (psf) | Settlement (ft) | |
|---|---|---|---|---|---|---|---|---|---|
| Point 1 | (SP/SP-SM), N~10 | 0.0 | 0.045 | 0.009 | 0.640 | 176.8 | 0.0 | 0.00 | |
| Point 2 | (SP), N~10 | 1.8 | 0.035 | 0.007 | 0.530 | 514.8 | 3921.0 | 0.04 | |
| Point 3 | (CL/CH), N~10 | 6.0 | 0.045 | 0.009 | 0.495 | 840.5 | 3932.9 | 0.14 | |
| Point 4 | (CL/CH), N>40 | 11.5 | 0.008 | 0.002 | 0.333 | 1491.2 | 3932.9 | 0.04 | |
| | | | | | | | | 0.21 | ft |
| | | | | | | | | 2.53 | in |

**E**

| | Soil Type, N | H (ft) | $C_c$ | $C_s$ | $e_o$ | $P_o$ (psf) | ΔP (psf) | Settlement (ft) | |
|---|---|---|---|---|---|---|---|---|---|
| Point 1 | (SP), N~5 | 0.0 | 0.050 | 0.010 | 0.91 | 237.9 | 0.0 | 0.00 | |
| Point 2 | (SP/SM), N~5 | 6.8 | 0.061 | 0.012 | 0.81 | 1178.6 | 4467.3 | 0.15 | |
| Point 3 | (SC), N~40 | 6.5 | 0.008 | 0.002 | 0.33 | 1509.8 | 4792.2 | 0.02 | |
| | | | | | | | | 0.18 | ft |
| | | | | | | | | 2.13 | in |

**F-MH8**

| | Soil Type, N | H (ft) | $C_c$ | $C_s$ | $e_o$ | $P_o$ (psf) | ΔP (psf) | Settlement (ft) | |
|---|---|---|---|---|---|---|---|---|---|
| Point 1 | (SP), N~10 | 1.5 | 0.037 | 0.007 | 0.73 | 648.0 | 1937.4 | 0.02 | |
| Point 2 | (CL/CH), N~20 | 6.5 | 0.045 | 0.009 | 0.495 | 1317.7 | 1584.8 | 0.07 | |
| | | | | | | | | 0.09 | ft |
| | | | | | | | | 1.03 | in |

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|---|---|---|
| Phase II Section II Expansion<br>Compression Index Values | SRF | 4/1/13 |
| | CHECKED | DATE |

**SM-SC (silty sands and clayey sands)**

| $D_R$ | SPT N | a | $e_{min}$ | $e_o$ (1) | $C_c$ | $C_s = 1/5\ C_c$ |
|---|---|---|---|---|---|---|
| 5% | 5 | 0.07 | 0.30 | 0.87 | 0.040 | 0.008 |
| 30% | 10 | 0.07 | 0.30 | 0.72 | 0.029 | 0.006 |
| 45% | 20 | 0.07 | 0.30 | 0.63 | 0.023 | 0.005 |
| 50% | 25 | 0.07 | 0.30 | 0.60 | 0.021 | 0.004 |
| 60% | 30 | 0.07 | 0.30 | 0.54 | 0.017 | 0.003 |
| 95% | >40 | 0.07 | 0.30 | 0.33 | 0.002 | 0.000 |

**SP (fine sand to coarse sand)**

| $D_R$ | SPT N | a | $e_{min}$ | $e_o$ (1) | $C_c$ | $C_s = 1/5\ C_c$ |
|---|---|---|---|---|---|---|
| 5% | 5 | 0.07 | 0.20 | 0.91 | 0.050 | 0.010 |
| 30% | 10 | 0.07 | 0.20 | 0.73 | 0.037 | 0.007 |
| 45% | 20 | 0.07 | 0.20 | 0.61 | 0.029 | 0.006 |
| 50% | 25 | 0.07 | 0.20 | 0.58 | 0.026 | 0.005 |
| 60% | 30 | 0.07 | 0.20 | 0.50 | 0.021 | 0.004 |
| 95% | >40 | 0.07 | 0.20 | 0.24 | 0.003 | 0.001 |

**SP-SM (silty sand and gravel)**

| $D_R$ | SPT N | a | $e_{min}$ | $e_o$ (1) | $C_c$ | $C_s = 1/5\ C_c$ |
|---|---|---|---|---|---|---|
| 5% | 5 | 0.09 | 0.14 | 0.81 | 0.061 | 0.012 |
| 30% | 10 | 0.09 | 0.14 | 0.64 | 0.045 | 0.009 |
| 45% | 20 | 0.09 | 0.14 | 0.53 | 0.035 | 0.007 |
| 50% | 25 | 0.09 | 0.14 | 0.50 | 0.032 | 0.006 |
| 60% | 30 | 0.09 | 0.14 | 0.42 | 0.026 | 0.005 |
| 95% | >40 | 0.09 | 0.14 | 0.18 | 0.003 | 0.001 |

**SC (clayey sands)**

| $D_R$ | SPT N | a | $e_{min}$ (2) | $e_o$ (1) | $C_c$ | $C_s = 1/5\ C_c$ |
|---|---|---|---|---|---|---|
| 5% | 5 | 0.23 | 0.30 | 0.56 | 0.059 | 0.012 |
| 30% | 10 | 0.23 | 0.30 | 0.50 | 0.045 | 0.009 |
| 45% | 20 | 0.23 | 0.30 | 0.46 | 0.036 | 0.007 |
| 50% | 25 | 0.23 | 0.30 | 0.45 | 0.033 | 0.007 |
| 60% | 30 | 0.23 | 0.30 | 0.42 | 0.028 | 0.006 |
| 95% | >40 | 0.23 | 0.30 | 0.33 | 0.008 | 0.002 |

**SM (silty sands)**

| $D_R$ | SPT N | a | $e_{min}$ | $e_o$ (1) | $C_c$ | $C_s = 1/5\ C_c$ |
|---|---|---|---|---|---|---|
| 5% | 5 | 0.15 | 0.30 | 0.49 | 0.029 | 0.006 |
| 30% | 10 | 0.15 | 0.30 | 0.45 | 0.022 | 0.004 |
| 45% | 20 | 0.15 | 0.30 | 0.42 | 0.018 | 0.004 |
| 50% | 25 | 0.15 | 0.30 | 0.41 | 0.017 | 0.003 |
| 60% | 30 | 0.15 | 0.30 | 0.39 | 0.014 | 0.003 |
| 95% | >40 | 0.15 | 0.30 | 0.33 | 0.004 | 0.001 |

Notes:

$e_o$ = initial void ratio use equation = $D_R = \frac{e_{max} - e_o}{e_{max} - e_{min}} \times 100$

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| | SRF | 4/1/13 |
| Phase II Section II Expansion<br>Compression Index Values | CHECKED | DATE |

**SW (well graded sands)**

| $D_R$ | SPT N | a | $e_{min}$ | $e_o$ (1) | $C_c$ | $C_s = 1/5\ C_c$ |
|---|---|---|---|---|---|---|
| 5% | 5 | 0.09 | 0.40 | 0.97 | 0.051 | 0.010 |
| 30% | 10 | 0.09 | 0.40 | 0.82 | 0.038 | 0.008 |
| 45% | 20 | 0.09 | 0.40 | 0.73 | 0.030 | 0.006 |
| 50% | 25 | 0.09 | 0.40 | 0.70 | 0.027 | 0.005 |
| 60% | 30 | 0.09 | 0.40 | 0.64 | 0.022 | 0.004 |
| 95% | >40 | 0.09 | 0.40 | 0.43 | 0.003 | 0.001 |

**ML (inorganic silts)**

| $D_R$ | SPT N | a | $e_{min}$ | $e_o$ (1) | $C_c$ | $C_s = 1/5\ C_c$ |
|---|---|---|---|---|---|---|
| 5% | 5 | 0.29 | 0.40 | 1.07 | 0.193 | 0.039 |
| 30% | 10 | 0.29 | 0.40 | 0.89 | 0.142 | 0.028 |
| 45% | 20 | 0.29 | 0.40 | 0.79 | 0.113 | 0.023 |
| 50% | 25 | 0.29 | 0.40 | 0.75 | 0.102 | 0.020 |
| 60% | 30 | 0.29 | 0.40 | 0.68 | 0.081 | 0.016 |
| 95% | >40 | 0.29 | 0.40 | 0.44 | 0.010 | 0.002 |

**Rock**

| $D_R$ | SPT N | a | $e_{min}$ | $e_o$ (1) | $C_c$ | $C_s = 1/5\ C_c$ |
|---|---|---|---|---|---|---|
| 5% | 5 | 0.05 | 0.14 | 0.50 | 0.018 | 0.004 |
| 30% | 10 | 0.05 | 0.14 | 0.45 | 0.015 | 0.003 |
| 45% | 20 | 0.05 | 0.14 | 0.42 | 0.014 | 0.003 |
| 50% | 25 | 0.05 | 0.14 | 0.41 | 0.014 | 0.003 |
| 60% | 30 | 0.05 | 0.14 | 0.39 | 0.013 | 0.003 |
| 95% | >40 | 0.05 | 0.14 | 0.33 | 0.009 | 0.002 |

**Waste**

| $D_R$ | SPT N | a | $e_{min}$ | $e_o$ (1) | $C_c$ | $C_s = 1/5\ C_c$ |
|---|---|---|---|---|---|---|
| 5% | 5 | 0.09 | 0.40 | 1.00 | 0.054 | 0.011 |
| 30% | 10 | 0.09 | 0.40 | 1.00 | 0.054 | 0.011 |
| 45% | 20 | 0.09 | 0.40 | 1.00 | 0.054 | 0.011 |
| 50% | 25 | 0.09 | 0.40 | 0.00 | -0.036 | -0.007 |
| 60% | 30 | 0.09 | 0.40 | 0.00 | -0.036 | -0.007 |
| 95% | >40 | 0.09 | 0.40 | 0.00 | -0.036 | -0.007 |

Notes:

$e_o$ = initial void ratio use equation = $D_R = \frac{e_{max} - e_o}{e_{max} - e_{min}} \times 100$

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**SPT N values 5**

| | | | |
|---|---|---|---|
| Soil Type | SW | Well graded sand | |
| Relative Density ($D_R$) | 0.05 | Target Relative Density | |
| Dry Unit Weight, min. ($\gamma_{min.}$) | 110.0 | pcf | Lindberg Ref. Manual |
| Dry Unit Weight, max. ($\gamma_{max.}$) | 130.0 | pcf | Lindberg Ref. Manual |
| Dry Unit Weight ($\gamma_d$) | 110.8 | pcf | |
| Relative Density ($D_R$) | 0.05 | Computed Relative Density | |
| Void Ratio, max. ($e_{max.}$) | 1.00 | | From Whitman |
| Void Ratio, min. ($e_{min.}$) | 0.40 | | From Whitman |
| Void Ratio, initial ($e_o$) | 0.97 | | |
| Relative Density ($D_R$) | 0.05 | Computed Relative Density | |
| Degree of Saturation | 1 | Pore space fully saturated @ $D_R$ | |
| Specific Gravity of Soil | 2.65 | | |
| Unit Weight of Water ($\gamma_w$) | 62.4 | pcf | |
| Saturated Unit Weight ($\gamma_{sat}$) | 114.66 | pcf | |
| a | 0.09 | | |

**SPT N values 10**

| | | | |
|---|---|---|---|
| Soil Type | SW | Well graded sand | |
| Relative Density ($D_R$) | 0.30 | Target Relative Density | |
| Dry Unit Weight, min. ($\gamma_{min.}$) | 110.0 | pcf | Lindberg Ref. Manual |
| Dry Unit Weight, max. ($\gamma_{max.}$) | 130.0 | pcf | Lindberg Ref. Manual |
| Dry Unit Weight ($\gamma_d$) | 115.4 | pcf | |
| Relative Density ($D_R$) | 0.30 | Computed Relative Density | |
| Void Ratio, max. ($e_{max.}$) | 1.00 | | From Whitman |
| Void Ratio, min. ($e_{min.}$) | 0.40 | | From Whitman |
| Void Ratio, initial ($e_o$) | 0.82 | | |
| Relative Density ($D_R$) | 0.30 | Computed Relative Density | |
| Degree of Saturation | 1 | Pore space fully saturated @ $D_R$ | |
| Specific Gravity of Soil | 2.65 | | |
| Unit Weight of Water ($\gamma_w$) | 62.4 | pcf | |
| Saturated Unit Weight ($\gamma_{sat}$) | 118.97 | pcf | |

**SPT N values 20**

| | | | |
|---|---|---|---|
| Soil Type | SW | Well graded sand | |
| Relative Density ($D_R$) | 0.45 | Target Relative Density | |
| Dry Unit Weight, min. ($\gamma_{min.}$) | 110.0 | pcf | Lindberg Ref. Manual |
| Dry Unit Weight, max. ($\gamma_{max.}$) | 130.0 | pcf | Lindberg Ref. Manual |
| Dry Unit Weight ($\gamma_d$) | 118.2 | pcf | |
| Relative Density ($D_R$) | 0.45 | Computed Relative Density | |
| Void Ratio, max. ($e_{max.}$) | 1.00 | | From Whitman |
| Void Ratio, min. ($e_{min.}$) | 0.40 | | From Whitman |
| Void Ratio, initial ($e_o$) | 0.73 | | |
| Relative Density ($D_R$) | 0.45 | Computed Relative Density | |
| Degree of Saturation | 1 | Pore space fully saturated @ $D_R$ | |
| Specific Gravity of Soil | 2.65 | | |
| Unit Weight of Water ($\gamma_w$) | 62.4 | pcf | |
| Saturated Unit Weight ($\gamma_{sat}$) | 121.91 | pcf | |

**SPT N values 25**

| | | | |
|---|---|---|---|
| Soil Type | SW | Well graded sand | |
| Relative Density ($D_R$) | 0.50 | Target Relative Density | |
| Dry Unit Weight, min. ($\gamma_{min.}$) | 110.0 | pcf | Lindberg Ref. Manual |
| Dry Unit Weight, max. ($\gamma_{max.}$) | 130.0 | pcf | Lindberg Ref. Manual |
| Dry Unit Weight ($\gamma_d$) | 119.2 | pcf | |
| Relative Density ($D_R$) | 0.50 | Computed Relative Density | |
| Void Ratio, max. ($e_{max.}$) | 1.00 | | From Whitman |
| Void Ratio, min. ($e_{min.}$) | 0.40 | | From Whitman |
| Void Ratio, initial ($e_o$) | 0.70 | | |
| Relative Density ($D_R$) | 0.50 | Computed Relative Density | |
| Degree of Saturation | 1 | Pore space fully saturated @ $D_R$ | |
| Specific Gravity of Soil | 2.65 | | |
| Unit Weight of Water ($\gamma_w$) | 62.4 | pcf | |
| Saturated Unit Weight ($\gamma_{sat}$) | 122.96 | pcf | |

**SPT N values 30**

| | | | |
|---|---|---|---|
| Soil Type | SW | Well graded sand | |
| Relative Density ($D_R$) | 0.60 | Target Relative Density | |
| Dry Unit Weight, min. ($\gamma_{min.}$) | 110.0 | pcf | Lindberg Ref. Manual |
| Dry Unit Weight, max. ($\gamma_{max.}$) | 130.0 | pcf | Lindberg Ref. Manual |
| Dry Unit Weight ($\gamma_d$) | 121.1 | pcf | |
| Relative Density ($D_R$) | 0.60 | Computed Relative Density | |
| Void Ratio, max. ($e_{max.}$) | 1.00 | | From Whitman |
| Void Ratio, min. ($e_{min.}$) | 0.40 | | From Whitman |
| Void Ratio, initial ($e_o$) | 0.64 | | |
| Relative Density ($D_R$) | 0.60 | Computed Relative Density | |
| Degree of Saturation | 1 | Pore space fully saturated @ $D_R$ | |
| Specific Gravity of Soil | 2.65 | | |
| Unit Weight of Water ($\gamma_w$) | 62.4 | pcf | |
| Saturated Unit Weight ($\gamma_{sat}$) | 125.18 | pcf | |

**SPT N values greater than 40**

| | | | |
|---|---|---|---|
| Soil Type | SW | Well graded sand | |
| Relative Density ($D_R$) | 0.95 | Target Relative Density | |
| Dry Unit Weight, min. ($\gamma_{min.}$) | 110.0 | pcf | Lindberg Ref. Manual |
| Dry Unit Weight, max. ($\gamma_{max.}$) | 130.0 | pcf | Lindberg Ref. Manual |
| Dry Unit Weight ($\gamma_d$) | 128.8 | pcf | |
| Relative Density ($D_R$) | 0.95 | Computed Relative Density | |
| Void Ratio, max. ($e_{max.}$) | 1.00 | | From Whitman |
| Void Ratio, min. ($e_{min.}$) | 0.40 | | From Whitman |
| Void Ratio, initial ($e_o$) | 0.43 | | |
| Relative Density ($D_R$) | 0.95 | Computed Relative Density | |
| Degree of Saturation | 1 | Pore space fully saturated @ $D_R$ | |
| Specific Gravity of Soil | 2.65 | | |
| Unit Weight of Water ($\gamma_w$) | 62.4 | pcf | |
| Saturated Unit Weight ($\gamma_{sat}$) | 134.40 | pcf | |

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|---|---|---|
| SUBJECT<br><br>Phase II Section II Expansion<br>Estimated Soil Properties | BY<br>SRF<br>CHECKED | DATE<br>4/1/13<br>DATE |

**SPT N values 5**

| | | | |
|---|---|---|---|
| Soil Type | SM/SC | Silty sands and clayey sands | |
| Relative Density ($D_R$) | 0.05 | Target Relative Density | |
| Dry Unit Weight, min. ($\gamma_{min.}$) | 87.0 | pcf | Lindberg Ref. Manual |
| Dry Unit Weight, max. ($\gamma_{max.}$) | 127.0 | pcf | Lindberg Ref. Manual |
| Dry Unit Weight ($\gamma_d$) | 88.5 | pcf | |
| Relative Density ($D_R$) | 0.05 | Computed Relative Density | |
| Void Ratio, max. ($e_{max.}$) | 0.90 | | Lindberg Ref. Manual |
| Void Ratio, min. ($e_{min.}$) | 0.30 | | Lindberg Ref. Manual |
| Void Ratio, initial ($e_o$) | 0.87 | | |
| Relative Density ($D_R$) | 0.05 | Computed Relative Density | |
| Degree of Saturation | 1 | Pore space fully saturated @ $D_R$ | |
| Specific Gravity of Soil | 2.65 | | |
| Unit Weight of Water ($\gamma_w$) | 62.4 | pcf | |
| Saturated Unit Weight ($\gamma_{sat}$) | 117.46 | pcf | |
| a | 0.07 | | |

**SPT N values 10**

| | | | |
|---|---|---|---|
| Soil Type | SM/SC | Silty sands and clayey sands | |
| Relative Density ($D_R$) | 0.30 | Target Relative Density | |
| Dry Unit Weight, min. ($\gamma_{min.}$) | 87.0 | pcf | Lindberg Ref. Manual |
| Dry Unit Weight, max. ($\gamma_{max.}$) | 127.0 | pcf | Lindberg Ref. Manual |
| Dry Unit Weight ($\gamma_d$) | 96.0 | pcf | |
| Relative Density ($D_R$) | 0.30 | Computed Relative Density | |
| Void Ratio, max. ($e_{max.}$) | 0.90 | | Lindberg Ref. Manual |
| Void Ratio, min. ($e_{min.}$) | 0.30 | | Lindberg Ref. Manual |
| Void Ratio, initial ($e_o$) | 0.72 | | |
| Relative Density ($D_R$) | 0.30 | Computed Relative Density | |
| Degree of Saturation | 1 | Pore space fully saturated @ $D_R$ | |
| Specific Gravity of Soil | 2.65 | | |
| Unit Weight of Water ($\gamma_w$) | 62.4 | pcf | |
| Saturated Unit Weight ($\gamma_{sat}$) | 122.26 | pcf | |

**SPT N values 20**

| | | | |
|---|---|---|---|
| Soil Type | SM/SC | Silty sands and clayey sands | |
| Relative Density ($D_R$) | 0.45 | Target Relative Density | |
| Dry Unit Weight, min. ($\gamma_{min.}$) | 87.0 | pcf | Lindberg Ref. Manual |
| Dry Unit Weight, max. ($\gamma_{max.}$) | 127.0 | pcf | Lindberg Ref. Manual |
| Dry Unit Weight ($\gamma_d$) | 101.5 | pcf | |
| Relative Density ($D_R$) | 0.45 | Computed Relative Density | |
| Void Ratio, max. ($e_{max.}$) | 0.90 | | Lindberg Ref. Manual |
| Void Ratio, min. ($e_{min.}$) | 0.30 | | Lindberg Ref. Manual |
| Void Ratio, initial ($e_o$) | 0.63 | | |
| Relative Density ($D_R$) | 0.45 | Computed Relative Density | |
| Degree of Saturation | 1 | Pore space fully saturated @ $D_R$ | |
| Specific Gravity of Soil | 2.65 | | |
| Unit Weight of Water ($\gamma_w$) | 62.4 | pcf | |
| Saturated Unit Weight ($\gamma_{sat}$) | 125.57 | pcf | |

**SPT N values 25**

| | | | |
|---|---|---|---|
| Soil Type | SM/SC | Silty sands and clayey sands | |
| Relative Density ($D_R$) | 0.50 | Target Relative Density | |
| Dry Unit Weight, min. ($\gamma_{min.}$) | 87.0 | pcf | Lindberg Ref. Manual |
| Dry Unit Weight, max. ($\gamma_{max.}$) | 127.0 | pcf | Lindberg Ref. Manual |
| Dry Unit Weight ($\gamma_d$) | 103.4 | pcf | |
| Relative Density ($D_R$) | 0.50 | Computed Relative Density | |
| Void Ratio, max. ($e_{max.}$) | 0.90 | | |
| Void Ratio, min. ($e_{min.}$) | 0.30 | | |
| Void Ratio, initial ($e_o$) | 0.60 | | |
| Relative Density ($D_R$) | 0.50 | Computed Relative Density | |
| Degree of Saturation | 1 | Pore space fully saturated @ $D_R$ | |
| Specific Gravity of Soil | 2.65 | | |
| Unit Weight of Water ($\gamma_w$) | 62.4 | pcf | |
| Saturated Unit Weight ($\gamma_{sat}$) | 126.75 | pcf | |

**SPT N values 30**

| | | | |
|---|---|---|---|
| Soil Type | SM/SC | Silty sands and clayey sands | |
| Relative Density ($D_R$) | 0.60 | Target Relative Density | |
| Dry Unit Weight, min. ($\gamma_{min.}$) | 87.0 | pcf | Lindberg Ref. Manual |
| Dry Unit Weight, max. ($\gamma_{max.}$) | 127.0 | pcf | Lindberg Ref. Manual |
| Dry Unit Weight ($\gamma_d$) | 107.4 | pcf | |
| Relative Density ($D_R$) | 0.60 | Computed Relative Density | |
| Void Ratio, max. ($e_{max.}$) | 0.90 | | |
| Void Ratio, min. ($e_{min.}$) | 0.30 | | |
| Void Ratio, initial ($e_o$) | 0.54 | | |
| Relative Density ($D_R$) | 0.60 | Computed Relative Density | |
| Degree of Saturation | 1 | Pore space fully saturated @ $D_R$ | |
| Specific Gravity of Soil | 2.65 | | |
| Unit Weight of Water ($\gamma_w$) | 62.4 | pcf | |
| Saturated Unit Weight ($\gamma_{sat}$) | 129.26 | pcf | |

**SPT N values greater than 40**

| | | | |
|---|---|---|---|
| Soil Type | SM/SC | Silty sands and clayey sands | |
| Relative Density ($D_R$) | 0.95 | Target Relative Density | |
| Dry Unit Weight, min. ($\gamma_{min.}$) | 87.0 | pcf | Lindberg Ref. Manual |
| Dry Unit Weight, max. ($\gamma_{max.}$) | 127.0 | pcf | Lindberg Ref. Manual |
| Dry Unit Weight ($\gamma_d$) | 124.0 | pcf | |
| Relative Density ($D_R$) | 0.95 | Computed Relative Density | |
| Void Ratio, max. ($e_{max.}$) | 0.90 | | |
| Void Ratio, min. ($e_{min.}$) | 0.30 | | |
| Void Ratio, initial ($e_o$) | 0.33 | | |
| Relative Density ($D_R$) | 0.95 | Computed Relative Density | |
| Degree of Saturation | 1 | Pore space fully saturated @ $D_R$ | |
| Specific Gravity of Soil | 2.65 | | |
| Unit Weight of Water ($\gamma_w$) | 62.4 | pcf | |
| Saturated Unit Weight ($\gamma_{sat}$) | 139.81 | pcf | |

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| Phase II Section II Expansion<br>Estimated Soil Properties | SRF | 4/1/13 |
| | CHECKED | DATE |

**SPT N values 5**

| | | | |
|---|---|---|---|
| Soil Type | ML | Inorganic Silts | |
| Relative Density ($D_R$) | 0.05 | Target Relative Density | |
| Dry Unit Weight, min. ($\gamma_{min.}$) | 95.0 | pcf | Lindberg Ref. Manual |
| Dry Unit Weight, max. ($\gamma_{max.}$) | 120.0 | pcf | Lindberg Ref. Manual |
| Dry Unit Weight ($\gamma_d$) | 96.0 | pcf | |
| Relative Density ($D_R$) | 0.05 | Computed Relative Density | |
| Void Ratio, max. ($e_{max.}$) | 1.10 | | From Whitman |
| Void Ratio, min. ($e_{min.}$) | 0.40 | | From Whitman |
| Void Ratio, initial ($e_o$) | 1.07 | | |
| Relative Density ($D_R$) | 0.05 | Computed Relative Density | |
| Degree of Saturation | 1 | Pore space fully saturated @ $D_R$ | |
| Specific Gravity of Soil | 2.65 | | |
| Unit Weight of Water ($\gamma_w$) | 62.4 | pcf | |
| Saturated Unit Weight ($\gamma_{sat}$) | 112.26 | pcf | |
| a | 0.29 | | |

**SPT N values 10**

| | | | |
|---|---|---|---|
| Soil Type | ML | Inorganic Silts | |
| Relative Density ($D_R$) | 0.30 | Target Relative Density | |
| Dry Unit Weight, min. ($\gamma_{min.}$) | 95.0 | pcf | Lindberg Ref. Manual |
| Dry Unit Weight, max. ($\gamma_{max.}$) | 120.0 | pcf | Lindberg Ref. Manual |
| Dry Unit Weight ($\gamma_d$) | 101.4 | pcf | |
| Relative Density ($D_R$) | 0.30 | Computed Relative Density | |
| Void Ratio, max. ($e_{max.}$) | 1.10 | | From Whitman |
| Void Ratio, min. ($e_{min.}$) | 0.40 | | From Whitman |
| Void Ratio, initial ($e_o$) | 0.89 | | |
| Relative Density ($D_R$) | 0.30 | Computed Relative Density | |
| Degree of Saturation | 1 | Pore space fully saturated @ $D_R$ | |
| Specific Gravity of Soil | 2.65 | | |
| Unit Weight of Water ($\gamma_w$) | 62.4 | pcf | |
| Saturated Unit Weight ($\gamma_{sat}$) | 116.88 | pcf | |

**SPT N values 20**

| | | | |
|---|---|---|---|
| Soil Type | ML | Inorganic Silts | |
| Relative Density ($D_R$) | 0.45 | Target Relative Density | |
| Dry Unit Weight, min. ($\gamma_{min.}$) | 95.0 | pcf | Lindberg Ref. Manual |
| Dry Unit Weight, max. ($\gamma_{max.}$) | 120.0 | pcf | Lindberg Ref. Manual |
| Dry Unit Weight ($\gamma_d$) | 104.8 | pcf | |
| Relative Density ($D_R$) | 0.45 | Computed Relative Density | |
| Void Ratio, max. ($e_{max.}$) | 1.10 | | From Whitman |
| Void Ratio, min. ($e_{min.}$) | 0.40 | | From Whitman |
| Void Ratio, initial ($e_o$) | 0.79 | | |
| Relative Density ($D_R$) | 0.45 | Computed Relative Density | |
| Degree of Saturation | 1 | Pore space fully saturated @ $D_R$ | |
| Specific Gravity of Soil | 2.65 | | |
| Unit Weight of Water ($\gamma_w$) | 62.4 | pcf | |
| Saturated Unit Weight ($\gamma_{sat}$) | 119.98 | pcf | |

**SPT N values 25**

| | | | |
|---|---|---|---|
| Soil Type | ML | Inorganic Silts | |
| Relative Density ($D_R$) | 0.50 | Target Relative Density | |
| Dry Unit Weight, min. ($\gamma_{min.}$) | 95.0 | pcf | Lindberg Ref. Manual |
| Dry Unit Weight, max. ($\gamma_{max.}$) | 120.0 | pcf | Lindberg Ref. Manual |
| Dry Unit Weight ($\gamma_d$) | 106.0 | pcf | |
| Relative Density ($D_R$) | 0.50 | Computed Relative Density | |
| Void Ratio, max. ($e_{max.}$) | 1.10 | | From Whitman |
| Void Ratio, min. ($e_{min.}$) | 0.40 | | From Whitman |
| Void Ratio, initial ($e_o$) | 0.75 | | |
| Relative Density ($D_R$) | 0.50 | Computed Relative Density | |
| Degree of Saturation | 1 | Pore space fully saturated @ $D_R$ | |
| Specific Gravity of Soil | 2.65 | | |
| Unit Weight of Water ($\gamma_w$) | 62.4 | pcf | |
| Saturated Unit Weight ($\gamma_{sat}$) | 121.23 | pcf | |

**SPT N values 30**

| | | | |
|---|---|---|---|
| Soil Type | ML | Inorganic Silts | |
| Relative Density ($D_R$) | 0.60 | Target Relative Density | |
| Dry Unit Weight, min. ($\gamma_{min.}$) | 85.0 | pcf | Lindberg Ref. Manual |
| Dry Unit Weight, max. ($\gamma_{max.}$) | 138.0 | pcf | Lindberg Ref. Manual |
| Dry Unit Weight ($\gamma_d$) | 110.4 | pcf | |
| Relative Density ($D_R$) | 0.60 | Computed Relative Density | |
| Void Ratio, max. ($e_{max.}$) | 1.10 | | From Whitman |
| Void Ratio, min. ($e_{min.}$) | 0.40 | | From Whitman |
| Void Ratio, initial ($e_o$) | 0.68 | | |
| Relative Density ($D_R$) | 0.60 | Computed Relative Density | |
| Degree of Saturation | 1 | Pore space fully saturated @ $D_R$ | |
| Specific Gravity of Soil | 2.65 | | |
| Unit Weight of Water ($\gamma_w$) | 62.4 | pcf | |
| Saturated Unit Weight ($\gamma_{sat}$) | 123.69 | pcf | |

**SPT N values greater than 40**

| | | | |
|---|---|---|---|
| Soil Type | ML | Inorganic Silts | |
| Relative Density ($D_R$) | 0.95 | Target Relative Density | |
| Dry Unit Weight, min. ($\gamma_{min.}$) | 95.0 | pcf | Lindberg Ref. Manual |
| Dry Unit Weight, max. ($\gamma_{max.}$) | 120.0 | pcf | Lindberg Ref. Manual |
| Dry Unit Weight ($\gamma_d$) | 118.5 | pcf | |
| Relative Density ($D_R$) | 0.95 | Computed Relative Density | |
| Void Ratio, max. ($e_{max.}$) | 1.10 | | From Whitman |
| Void Ratio, min. ($e_{min.}$) | 0.40 | | From Whitman |
| Void Ratio, initial ($e_o$) | 0.44 | | |
| Relative Density ($D_R$) | 0.95 | Computed Relative Density | |
| Degree of Saturation | 1 | Pore space fully saturated @ $D_R$ | |
| Specific Gravity of Soil | 2.65 | | |
| Unit Weight of Water ($\gamma_w$) | 62.4 | pcf | |
| Saturated Unit Weight ($\gamma_{sat}$) | 134.15 | pcf | |

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**SPT N values 5**

| | | | |
|---|---|---|---|
| Soil Type | SP | Fine Sand to Coarse Sand | |
| Relative Density ($D_R$) | 0.05 | Target Relative Density | |
| Dry Unit Weight, min. ($\gamma_{min.}$) | 85.0 | pcf | Lindberg Ref. Manual |
| Dry Unit Weight, max. ($\gamma_{max.}$) | 138.0 | pcf | Lindberg Ref. Manual |
| Dry Unit Weight ($\gamma_d$) | 86.5 | pcf | |
| Relative Density ($D_R$) | 0.05 | Computed Relative Density | |
| Void Ratio, max. ($e_{max.}$) | 0.95 | | Lindberg Ref. Manual |
| Void Ratio, min. ($e_{min.}$) | 0.20 | | Lindberg Ref. Manual |
| Void Ratio, initial ($e_o$) | 0.91 | | |
| Relative Density ($D_R$) | 0.05 | Computed Relative Density | |
| Degree of Saturation | 1 | Pore space fully saturated @ $D_R$ | |
| Specific Gravity of Soil | 2.65 | | |
| Unit Weight of Water ($\gamma_w$) | 62.4 | pcf | |
| Saturated Unit Weight ($\gamma_{sat}$) | 116.19 | pcf | |
| a | 0.07 | | |

**SPT N values 10**

| | | | |
|---|---|---|---|
| Soil Type | SP | Fine Sand to Coarse Sand | |
| Relative Density ($D_R$) | 0.30 | Target Relative Density | |
| Dry Unit Weight, min. ($\gamma_{min.}$) | 85.0 | pcf | Lindberg Ref. Manual |
| Dry Unit Weight, max. ($\gamma_{max.}$) | 138.0 | pcf | Lindberg Ref. Manual |
| Dry Unit Weight ($\gamma_d$) | 96.0 | pcf | |
| Relative Density ($D_R$) | 0.30 | Computed Relative Density | |
| Void Ratio, max. ($e_{max.}$) | 0.95 | | Lindberg Ref. Manual |
| Void Ratio, min. ($e_{min.}$) | 0.20 | | Lindberg Ref. Manual |
| Void Ratio, initial ($e_o$) | 0.73 | | |
| Relative Density ($D_R$) | 0.3 | Computed Relative Density | |
| Degree of Saturation | 1 | Pore space fully saturated @ $D_R$ | |
| Specific Gravity of Soil | 2.65 | | |
| Unit Weight of Water ($\gamma_w$) | 62.4 | pcf | |
| Saturated Unit Weight ($\gamma_{sat}$) | 121.91 | pcf | |

**SPT N values 20**

| | | | |
|---|---|---|---|
| Soil Type | SP | Fine Sand to Coarse Sand | |
| Relative Density ($D_R$) | 0.45 | Target Relative Density | |
| Dry Unit Weight, min. ($\gamma_{min.}$) | 85.0 | pcf | Lindberg Ref. Manual |
| Dry Unit Weight, max. ($\gamma_{max.}$) | 138.0 | pcf | Lindberg Ref. Manual |
| Dry Unit Weight ($\gamma_d$) | 102.6 | pcf | |
| Relative Density ($D_R$) | 0.45 | Computed Relative Density | |
| Void Ratio, max. ($e_{max.}$) | 0.95 | | Lindberg Ref. Manual |
| Void Ratio, min. ($e_{min.}$) | 0.20 | | Lindberg Ref. Manual |
| Void Ratio, initial ($e_o$) | 0.61 | | |
| Relative Density ($D_R$) | 0.45 | Computed Relative Density | |
| Degree of Saturation | 1 | Pore space fully saturated @ $D_R$ | |
| Specific Gravity of Soil | 2.65 | | |
| Unit Weight of Water ($\gamma_w$) | 62.4 | pcf | |
| Saturated Unit Weight ($\gamma_{sat}$) | 126.35 | pcf | |

**SPT N values 25**

| | | | |
|---|---|---|---|
| Soil Type | SP | Fine Sand to Coarse Sand | |
| Relative Density ($D_R$) | 0.50 | Target Relative Density | |
| Dry Unit Weight, min. ($\gamma_{min.}$) | 85.0 | pcf | Lindberg Ref. Manual |
| Dry Unit Weight, max. ($\gamma_{max.}$) | 138.0 | pcf | Lindberg Ref. Manual |
| Dry Unit Weight ($\gamma_d$) | 105.0 | pcf | |
| Relative Density ($D_R$) | 0.50 | Computed Relative Density | |
| Void Ratio, max. ($e_{max.}$) | 0.95 | | Lindberg Ref. Manual |
| Void Ratio, min. ($e_{min.}$) | 0.20 | | Lindberg Ref. Manual |
| Void Ratio, initial ($e_o$) | 0.58 | | |
| Relative Density ($D_R$) | 0.50 | Computed Relative Density | |
| Degree of Saturation | 1 | Pore space fully saturated @ $D_R$ | |
| Specific Gravity of Soil | 2.65 | | |
| Unit Weight of Water ($\gamma_w$) | 62.4 | pcf | |
| Saturated Unit Weight ($\gamma_{sat}$) | 127.77 | pcf | |

**SPT N values 30**

| | | | |
|---|---|---|---|
| Soil Type | SP | Fine Sand to Coarse Sand | |
| Relative Density ($D_R$) | 0.60 | Target Relative Density | |
| Dry Unit Weight, min. ($\gamma_{min.}$) | 85.0 | pcf | Lindberg Ref. Manual |
| Dry Unit Weight, max. ($\gamma_{max.}$) | 138.0 | pcf | Lindberg Ref. Manual |
| Dry Unit Weight ($\gamma_d$) | 110.4 | pcf | |
| Relative Density ($D_R$) | 0.60 | Computed Relative Density | |
| Void Ratio, max. ($e_{max.}$) | 0.95 | | Lindberg Ref. Manual |
| Void Ratio, min. ($e_{min.}$) | 0.20 | | Lindberg Ref. Manual |
| Void Ratio, initial ($e_o$) | 0.50 | | |
| Relative Density ($D_R$) | 0.60 | Computed Relative Density | |
| Degree of Saturation | 1 | Pore space fully saturated @ $D_R$ | |
| Specific Gravity of Soil | 2.65 | | |
| Unit Weight of Water ($\gamma_w$) | 62.4 | pcf | |
| Saturated Unit Weight ($\gamma_{sat}$) | 131.04 | pcf | |

**SPT N values greater than 40**

| | | | |
|---|---|---|---|
| Soil Type | SP | Fine Sand to Coarse Sand | |
| Relative Density ($D_R$) | 0.95 | Target Relative Density | |
| Dry Unit Weight, min. ($\gamma_{min.}$) | 85.0 | pcf | Lindberg Ref. Manual |
| Dry Unit Weight, max. ($\gamma_{max.}$) | 138.0 | pcf | Lindberg Ref. Manual |
| Dry Unit Weight ($\gamma_d$) | 133.5 | pcf | |
| Relative Density ($D_R$) | 0.95 | Computed Relative Density | |
| Void Ratio, max. ($e_{max.}$) | 0.95 | | Lindberg Ref. Manual |
| Void Ratio, min. ($e_{min.}$) | 0.20 | | Lindberg Ref. Manual |
| Void Ratio, initial ($e_o$) | 0.24 | | |
| Relative Density ($D_R$) | 0.95 | Computed Relative Density | |
| Degree of Saturation | 1 | Pore space fully saturated @ $D_R$ | |
| Specific Gravity of Soil | 2.65 | | |
| Unit Weight of Water ($\gamma_w$) | 62.4 | pcf | |
| Saturated Unit Weight ($\gamma_{sat}$) | 145.43 | pcf | |

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**SPT N values 5**

| | | | |
|---|---|---|---|
| Soil Type | SP/SM | Silty Sand and Gravel | |
| Relative Density ($D_R$) | 0.05 | Target Relative Density | |
| Dry Unit Weight, min. ($\gamma_{min.}$) | 89.0 | pcf | Lindberg Ref. Manual |
| Dry Unit Weight, max. ($\gamma_{max.}$) | 146.0 | pcf | Lindberg Ref. Manual |
| Dry Unit Weight ($\gamma_d$) | 90.6 | pcf | |
| Relative Density ($D_R$) | 0.05 | Computed Relative Density | |
| Void Ratio, max. ($e_{max.}$) | 0.85 | | Lindberg Ref. Manual |
| Void Ratio, min. ($e_{min.}$) | 0.14 | | Lindberg Ref. Manual |
| Void Ratio, initial ($e_o$) | 0.81 | | |
| Relative Density ($D_R$) | 0.05 | Computed Relative Density | |
| Degree of Saturation | 1 | Pore space fully saturated @ $D_R$ | |
| Specific Gravity of Soil | 2.65 | | |
| Unit Weight of Water ($\gamma_w$) | 62.4 | pcf | |
| Saturated Unit Weight ($\gamma_{sat}$) | 119.14 | pcf | |
| a | 0.09 | | |

**SPT N values 10**

| | | | |
|---|---|---|---|
| Soil Type | SP/SM | Silty Sand and Gravel | |
| Relative Density ($D_R$) | 0.30 | Target Relative Density | |
| Dry Unit Weight, min. ($\gamma_{min.}$) | 89.0 | pcf | Lindberg Ref. Manual |
| Dry Unit Weight, max. ($\gamma_{max.}$) | 146.0 | pcf | Lindberg Ref. Manual |
| Dry Unit Weight ($\gamma_d$) | 101.0 | pcf | |
| Relative Density ($D_R$) | 0.30 | Computed Relative Density | |
| Void Ratio, max. ($e_{max.}$) | 0.85 | | Lindberg Ref. Manual |
| Void Ratio, min. ($e_{min.}$) | 0.14 | | Lindberg Ref. Manual |
| Void Ratio, initial ($e_o$) | 0.64 | | |
| Relative Density ($D_R$) | 0.30 | Computed Relative Density | |
| Degree of Saturation | 1 | Pore space fully saturated @ $D_R$ | |
| Specific Gravity of Soil | 2.65 | | |
| Unit Weight of Water ($\gamma_w$) | 62.4 | pcf | |
| Saturated Unit Weight ($\gamma_{sat}$) | 125.18 | pcf | |

**SPT N values 20**

| | | | |
|---|---|---|---|
| Soil Type | SP/SM | Silty Sand and Gravel | |
| Relative Density ($D_R$) | 0.45 | Target Relative Density | |
| Dry Unit Weight, min. ($\gamma_{min.}$) | 89.0 | pcf | Lindberg Ref. Manual |
| Dry Unit Weight, max. ($\gamma_{max.}$) | 146.0 | pcf | Lindberg Ref. Manual |
| Dry Unit Weight ($\gamma_d$) | 108.0 | pcf | |
| Relative Density ($D_R$) | 0.45 | Computed Relative Density | |
| Void Ratio, max. ($e_{max.}$) | 0.85 | | Lindberg Ref. Manual |
| Void Ratio, min. ($e_{min.}$) | 0.14 | | Lindberg Ref. Manual |
| Void Ratio, initial ($e_o$) | 0.53 | | |
| Relative Density ($D_R$) | 0.45 | Computed Relative Density | |
| Degree of Saturation | 1 | Pore space fully saturated @ $D_R$ | |
| Specific Gravity of Soil | 2.65 | | |
| Unit Weight of Water ($\gamma_w$) | 62.4 | pcf | |
| Saturated Unit Weight ($\gamma_{sat}$) | 129.69 | pcf | |

**SPT N values 25**

| | | | |
|---|---|---|---|
| Soil Type | SP/SM | Silty Sand and Gravel | |
| Relative Density ($D_R$) | 0.50 | Target Relative Density | |
| Dry Unit Weight, min. ($\gamma_{min.}$) | 89.0 | pcf | Lindberg Ref. Manual |
| Dry Unit Weight, max. ($\gamma_{max.}$) | 146.0 | pcf | Lindberg Ref. Manual |
| Dry Unit Weight ($\gamma_d$) | 110.5 | pcf | |
| Relative Density ($D_R$) | 0.50 | Computed Relative Density | |
| Void Ratio, max. ($e_{max.}$) | 0.85 | | Lindberg Ref. Manual |
| Void Ratio, min. ($e_{min.}$) | 0.14 | | Lindberg Ref. Manual |
| Void Ratio, initial ($e_o$) | 0.50 | | |
| Relative Density ($D_R$) | 0.50 | Computed Relative Density | |
| Degree of Saturation | 1 | Pore space fully saturated @ $D_R$ | |
| Specific Gravity of Soil | 2.65 | | |
| Unit Weight of Water ($\gamma_w$) | 62.4 | pcf | |
| Saturated Unit Weight ($\gamma_{sat}$) | 131.27 | pcf | |

**SPT N values 30**

| | | | |
|---|---|---|---|
| Soil Type | SP/SM | Silty Sand and Gravel | |
| Relative Density ($D_R$) | 0.60 | Target Relative Density | |
| Dry Unit Weight, min. ($\gamma_{min.}$) | 89.0 | pcf | |
| Dry Unit Weight, max. ($\gamma_{max.}$) | 146.0 | pcf | |
| Dry Unit Weight ($\gamma_d$) | 116.0 | pcf | |
| Relative Density ($D_R$) | 0.60 | Computed Relative Density | |
| Void Ratio, max. ($e_{max.}$) | 0.85 | | Lindberg Ref. Manual |
| Void Ratio, min. ($e_{min.}$) | 0.14 | | Lindberg Ref. Manual |
| Void Ratio, initial ($e_o$) | 0.42 | | |
| Relative Density ($D_R$) | 0.60 | Computed Relative Density | |
| Degree of Saturation | 1 | Pore space fully saturated @ $D_R$ | |
| Specific Gravity of Soil | 2.65 | | |
| Unit Weight of Water ($\gamma_w$) | 62.4 | pcf | |
| Saturated Unit Weight ($\gamma_{sat}$) | 134.70 | pcf | |

**SPT N values greater than 40**

| | | | |
|---|---|---|---|
| Soil Type | SP/SM | Silty Sand and Gravel | |
| Relative Density ($D_R$) | 0.95 | Target Relative Density | |
| Dry Unit Weight, min. ($\gamma_{min.}$) | 89.0 | pcf | |
| Dry Unit Weight, max. ($\gamma_{max.}$) | 146.0 | pcf | |
| Dry Unit Weight ($\gamma_d$) | 141.5 | pcf | |
| Relative Density ($D_R$) | 0.95 | Computed Relative Density | |
| Void Ratio, max. ($e_{max.}$) | 0.85 | | Lindberg Ref. Manual |
| Void Ratio, min. ($e_{min.}$) | 0.14 | | Lindberg Ref. Manual |
| Void Ratio, initial ($e_o$) | 0.18 | | |
| Relative Density ($D_R$) | 0.95 | Computed Relative Density | |
| Degree of Saturation | 1 | Pore space fully saturated @ $D_R$ | |
| Specific Gravity of Soil | 2.65 | | |
| Unit Weight of Water ($\gamma_w$) | 62.4 | pcf | |
| Saturated Unit Weight ($\gamma_{sat}$) | 150.03 | pcf | |

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**SPT N values 5**

| | | | |
|---|---|---|---|
| Soil Type | SC | Clayey Sand | |
| Relative Density ($D_R$) | 0.05 | Target Relative Density | |
| Dry Unit Weight, min. ($\gamma_{min.}$) | 105.0 | pcf | Lindberg Ref. Manual |
| Dry Unit Weight, max. ($\gamma_{max.}$) | 125.0 | pcf | Lindberg Ref. Manual |
| Dry Unit Weight ($\gamma_d$) | 105.8 | pcf | |
| Relative Density ($D_R$) | 0.05 | Computed Relative Density | |
| Void Ratio, max. ($e_{max.}$) | 0.57 | | Lindberg Ref. Manual |
| Void Ratio, min. ($e_{min.}$) | 0.30 | | Lindberg Ref. Manual |
| Void Ratio, initial ($e_o$) | 0.56 | | |
| Relative Density ($D_R$) | 0.04 | Computed Relative Density | |
| Degree of Saturation | 1 | Pore space fully saturated @ $D_R$ | |
| Specific Gravity of Soil | 2.65 | | |
| Unit Weight of Water ($\gamma_w$) | 62.4 | pcf | |
| Saturated Unit Weight ($\gamma_{sat}$) | 128.48 | pcf | |
| a | 0.23 | | |

**SPT N values 10**

| | | | |
|---|---|---|---|
| Soil Type | SC | Clayey Sand | |
| Relative Density ($D_R$) | 0.30 | Target Relative Density | |
| Dry Unit Weight, min. ($\gamma_{min.}$) | 105.0 | pcf | Lindberg Ref. Manual |
| Dry Unit Weight, max. ($\gamma_{max.}$) | 125.0 | pcf | Lindberg Ref. Manual |
| Dry Unit Weight ($\gamma_d$) | 110.3 | pcf | |
| Relative Density ($D_R$) | 0.30 | Computed Relative Density | |
| Void Ratio, max. ($e_{max.}$) | 0.57 | | Lindberg Ref. Manual |
| Void Ratio, min. ($e_{min.}$) | 0.30 | | Lindberg Ref. Manual |
| Void Ratio, initial ($e_o$) | 0.50 | | |
| Relative Density ($D_R$) | 0.28 | Computed Relative Density | |
| Degree of Saturation | 1 | Pore space fully saturated @ $D_R$ | |
| Specific Gravity of Soil | 2.65 | | |
| Unit Weight of Water ($\gamma_w$) | 62.4 | pcf | |
| Saturated Unit Weight ($\gamma_{sat}$) | 131.27 | pcf | |

**SPT N values 20**

| | | | |
|---|---|---|---|
| Soil Type | SC | Clayey Sand | |
| Relative Density ($D_R$) | 0.45 | Target Relative Density | |
| Dry Unit Weight, min. ($\gamma_{min.}$) | 105.0 | pcf | Lindberg Ref. Manual |
| Dry Unit Weight, max. ($\gamma_{max.}$) | 125.0 | pcf | Lindberg Ref. Manual |
| Dry Unit Weight ($\gamma_d$) | 113.2 | pcf | |
| Relative Density ($D_R$) | 0.45 | Computed Relative Density | |
| Void Ratio, max. ($e_{max.}$) | 0.57 | | Lindberg Ref. Manual |
| Void Ratio, min. ($e_{min.}$) | 0.30 | | Lindberg Ref. Manual |
| Void Ratio, initial ($e_o$) | 0.46 | | |
| Relative Density ($D_R$) | 0.42 | Computed Relative Density | |
| Degree of Saturation | 1 | Pore space fully saturated @ $D_R$ | |
| Specific Gravity of Soil | 2.65 | | |
| Unit Weight of Water ($\gamma_w$) | 62.4 | pcf | |
| Saturated Unit Weight ($\gamma_{sat}$) | 133.07 | pcf | |

**SPT N values 25**

| | | | |
|---|---|---|---|
| Soil Type | SC | Clayey Sand | |
| Relative Density ($D_R$) | 0.50 | Target Relative Density | |
| Dry Unit Weight, min. ($\gamma_{min.}$) | 105.0 | pcf | Lindberg Ref. Manual |
| Dry Unit Weight, max. ($\gamma_{max.}$) | 125.0 | pcf | Lindberg Ref. Manual |
| Dry Unit Weight ($\gamma_d$) | 114.2 | pcf | |
| Relative Density ($D_R$) | 0.50 | Computed Relative Density | |
| Void Ratio, max. ($e_{max.}$) | 0.57 | | Lindberg Ref. Manual |
| Void Ratio, min. ($e_{min.}$) | 0.30 | | Lindberg Ref. Manual |
| Void Ratio, initial ($e_o$) | 0.45 | | |
| Relative Density ($D_R$) | 0.46 | Computed Relative Density | |
| Degree of Saturation | 1 | Pore space fully saturated @ $D_R$ | |
| Specific Gravity of Soil | 2.65 | | |
| Unit Weight of Water ($\gamma_w$) | 62.4 | pcf | |
| Saturated Unit Weight ($\gamma_{sat}$) | 133.62 | pcf | |

**SPT N values 30**

| | | | |
|---|---|---|---|
| Soil Type | SC | Clayey Sand | |
| Relative Density ($D_R$) | 0.60 | Target Relative Density | |
| Dry Unit Weight, min. ($\gamma_{min.}$) | 105.0 | pcf | Lindberg Ref. Manual |
| Dry Unit Weight, max. ($\gamma_{max.}$) | 125.0 | pcf | Lindberg Ref. Manual |
| Dry Unit Weight ($\gamma_d$) | 116.2 | pcf | |
| Relative Density ($D_R$) | 0.60 | Computed Relative Density | |
| Void Ratio, max. ($e_{max.}$) | 0.57 | | Lindberg Ref. Manual |
| Void Ratio, min. ($e_{min.}$) | 0.30 | | Lindberg Ref. Manual |
| Void Ratio, initial ($e_o$) | 0.42 | | |
| Relative Density ($D_R$) | 0.56 | Computed Relative Density | |
| Degree of Saturation | 1 | Pore space fully saturated @ $D_R$ | |
| Specific Gravity of Soil | 2.65 | | |
| Unit Weight of Water ($\gamma_w$) | 62.4 | pcf | |
| Saturated Unit Weight ($\gamma_{sat}$) | 134.91 | pcf | |

**SPT N values greater than 40**

| | | | |
|---|---|---|---|
| Soil Type | SC | Clayey Sand | |
| Relative Density ($D_R$) | 0.95 | Target Relative Density | |
| Dry Unit Weight, min. ($\gamma_{min.}$) | 105.0 | pcf | Lindberg Ref. Manual |
| Dry Unit Weight, max. ($\gamma_{max.}$) | 125.0 | pcf | Lindberg Ref. Manual |
| Dry Unit Weight ($\gamma_d$) | 123.8 | pcf | |
| Relative Density ($D_R$) | 0.95 | Computed Relative Density | |
| Void Ratio, max. ($e_{max.}$) | 0.57 | | Lindberg Ref. Manual |
| Void Ratio, min. ($e_{min.}$) | 0.30 | | Lindberg Ref. Manual |
| Void Ratio, initial ($e_o$) | 0.33 | | |
| Relative Density ($D_R$) | 0.88 | Computed Relative Density | |
| Degree of Saturation | 1 | Pore space fully saturated @ $D_R$ | |
| Specific Gravity of Soil | 2.65 | | |
| Unit Weight of Water ($\gamma_w$) | 62.4 | pcf | |
| Saturated Unit Weight ($\gamma_{sat}$) | 139.64 | pcf | |

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**SPT N values 5**

| | | | |
|---|---|---|---|
| Soil Type | SM | Silty Sands | |
| Relative Density ($D_R$) | 0.05 | Target Relative Density | |
| Dry Unit Weight, min. ($\gamma_{min.}$) | 110.0 | pcf | Lindberg Ref. Manual |
| Dry Unit Weight, max. ($\gamma_{max.}$) | 125.0 | pcf | Lindberg Ref. Manual |
| Dry Unit Weight ($\gamma_d$) | 110.6 | pcf | |
| Relative Density ($D_R$) | 0.05 | Computed Relative Density | |
| Void Ratio, max. ($e_{max.}$) | 0.50 | | Lindberg Ref. Manual |
| Void Ratio, min. ($e_{min.}$) | 0.30 | | Lindberg Ref. Manual |
| Void Ratio, initial ($e_o$) | 0.49 | | |
| Relative Density ($D_R$) | 0.05 | Computed Relative Density | |
| Degree of Saturation | 1 | Pore space fully saturated @ $D_R$ | |
| Specific Gravity of Soil | 2.65 | | |
| Unit Weight of Water ($\gamma_w$) | 62.4 | pcf | |
| Saturated Unit Weight ($\gamma_{sat}$) | 131.45 | pcf | |
| a | 0.15 | | |

**SPT N values 10**

| | | | |
|---|---|---|---|
| Soil Type | SM | Silty Sands | |
| Relative Density ($D_R$) | 0.30 | Target Relative Density | |
| Dry Unit Weight, min. ($\gamma_{min.}$) | 110.0 | pcf | Lindberg Ref. Manual |
| Dry Unit Weight, max. ($\gamma_{max.}$) | 125.0 | pcf | Lindberg Ref. Manual |
| Dry Unit Weight ($\gamma_d$) | 114.1 | pcf | |
| Relative Density ($D_R$) | 0.30 | Computed Relative Density | |
| Void Ratio, max. ($e_{max.}$) | 0.50 | | Lindberg Ref. Manual |
| Void Ratio, min. ($e_{min.}$) | 0.30 | | Lindberg Ref. Manual |
| Void Ratio, initial ($e_o$) | 0.45 | | |
| Relative Density ($D_R$) | 0.27 | Computed Relative Density | |
| Degree of Saturation | 1 | Pore space fully saturated @ $D_R$ | |
| Specific Gravity of Soil | 2.65 | | |
| Unit Weight of Water ($\gamma_w$) | 62.4 | pcf | |
| Saturated Unit Weight ($\gamma_{sat}$) | 133.62 | pcf | |

**SPT N values 20**

| | | | |
|---|---|---|---|
| Soil Type | SM | Silty Sands | |
| Relative Density ($D_R$) | 0.45 | Target Relative Density | |
| Dry Unit Weight, min. ($\gamma_{min.}$) | 110.0 | pcf | Lindberg Ref. Manual |
| Dry Unit Weight, max. ($\gamma_{max.}$) | 125.0 | pcf | Lindberg Ref. Manual |
| Dry Unit Weight ($\gamma_d$) | 116.3 | pcf | |
| Relative Density ($D_R$) | 0.45 | Computed Relative Density | |
| Void Ratio, max. ($e_{max.}$) | 0.50 | | Lindberg Ref. Manual |
| Void Ratio, min. ($e_{min.}$) | 0.30 | | Lindberg Ref. Manual |
| Void Ratio, initial ($e_o$) | 0.42 | | |
| Relative Density ($D_R$) | 0.41 | Computed Relative Density | |
| Degree of Saturation | 1 | Pore space fully saturated @ $D_R$ | |
| Specific Gravity of Soil | 2.65 | | |
| Unit Weight of Water ($\gamma_w$) | 62.4 | pcf | |
| Saturated Unit Weight ($\gamma_{sat}$) | 134.96 | pcf | |

**SPT N values 25**

| | | | |
|---|---|---|---|
| Soil Type | SM | Silty Sands | |
| Relative Density ($D_R$) | 0.50 | Target Relative Density | |
| Dry Unit Weight, min. ($\gamma_{min.}$) | 110.0 | pcf | Lindberg Ref. Manual |
| Dry Unit Weight, max. ($\gamma_{max.}$) | 125.0 | pcf | Lindberg Ref. Manual |
| Dry Unit Weight ($\gamma_d$) | 117.0 | pcf | |
| Relative Density ($D_R$) | 0.50 | Computed Relative Density | |
| Void Ratio, max. ($e_{max.}$) | 0.50 | | Lindberg Ref. Manual |
| Void Ratio, min. ($e_{min.}$) | 0.30 | | Lindberg Ref. Manual |
| Void Ratio, initial ($e_o$) | 0.41 | | |
| Relative Density ($D_R$) | 0.45 | Computed Relative Density | |
| Degree of Saturation | 1 | Pore space fully saturated @ $D_R$ | |
| Specific Gravity of Soil | 2.65 | | |
| Unit Weight of Water ($\gamma_w$) | 62.4 | pcf | |
| Saturated Unit Weight ($\gamma_{sat}$) | 135.42 | pcf | |

**SPT N values 30**

| | | | |
|---|---|---|---|
| Soil Type | SM | Silty Sands | |
| Relative Density ($D_R$) | 0.60 | Target Relative Density | |
| Dry Unit Weight, min. ($\gamma_{min.}$) | 110.0 | pcf | Lindberg Ref. Manual |
| Dry Unit Weight, max. ($\gamma_{max.}$) | 125.0 | pcf | Lindberg Ref. Manual |
| Dry Unit Weight ($\gamma_d$) | 118.5 | pcf | |
| Relative Density ($D_R$) | 0.60 | Computed Relative Density | |
| Void Ratio, max. ($e_{max.}$) | 0.50 | | Lindberg Ref. Manual |
| Void Ratio, min. ($e_{min.}$) | 0.30 | | Lindberg Ref. Manual |
| Void Ratio, initial ($e_o$) | 0.39 | | |
| Relative Density ($D_R$) | 0.54 | Computed Relative Density | |
| Degree of Saturation | 1 | Pore space fully saturated @ $D_R$ | |
| Specific Gravity of Soil | 2.65 | | |
| Unit Weight of Water ($\gamma_w$) | 62.4 | pcf | |
| Saturated Unit Weight ($\gamma_{sat}$) | 136.37 | pcf | |

**SPT N values greater than 40**

| | | | |
|---|---|---|---|
| Soil Type | SM | Silty Sands | |
| Relative Density ($D_R$) | 0.95 | Target Relative Density | |
| Dry Unit Weight, min. ($\gamma_{min.}$) | 110.0 | pcf | Lindberg Ref. Manual |
| Dry Unit Weight, max. ($\gamma_{max.}$) | 125.0 | pcf | Lindberg Ref. Manual |
| Dry Unit Weight ($\gamma_d$) | 124.2 | pcf | |
| Relative Density ($D_R$) | 0.95 | Computed Relative Density | |
| Void Ratio, max. ($e_{max.}$) | 0.50 | | Lindberg Ref. Manual |
| Void Ratio, min. ($e_{min.}$) | 0.30 | | Lindberg Ref. Manual |
| Void Ratio, initial ($e_o$) | 0.33 | | |
| Relative Density ($D_R$) | 0.86 | Computed Relative Density | |
| Degree of Saturation | 1 | Pore space fully saturated @ $D_R$ | |
| Specific Gravity of Soil | 2.65 | | |
| Unit Weight of Water ($\gamma_w$) | 62.4 | pcf | |
| Saturated Unit Weight ($\gamma_{sat}$) | 139.87 | pcf | |

SCS ENGINEERS

SHEET 1 OF 1

| CLIENT | PROJECT | JOB NO. |
|---|---|---|
| Hardee County | Phase II Section II Expansion | 09199033.23 |

| SUBJECT | BY | DATE |
|---|---|---|
| Phase II Section II Expansion<br>Estimated Soil Properties | SRF | 4/1/13 |
| | CHECKED | DATE |

**SPT N values 5**

| | | | |
|---|---|---|---|
| Soil Type | No. 57 | Rock | |
| Relative Density ($D_R$) | 0.05 | Target Relative Density | |
| Dry Unit Weight, min. ($\gamma_{min.}$) | 130.0 | pcf | Lindberg Ref. Manual |
| Dry Unit Weight, max. ($\gamma_{max.}$) | 140.0 | pcf | Lindberg Ref. Manual |
| Dry Unit Weight ($\gamma_d$) | 130.5 | pcf | |
| Relative Density ($D_R$) | 0.05 | Computed Relative Density | |
| Void Ratio, max. ($e_{max.}$) | 0.85 | | Lindberg Ref. Manual |
| Void Ratio, min. ($e_{min.}$) | 0.14 | | Lindberg Ref. Manual |
| Void Ratio, initial ($e_o$) | 0.50 | | |
| Relative Density ($D_R$) | 0.50 | Computed Relative Density | |
| Degree of Saturation | 1 | Pore space fully saturated @ $D_R$ | |
| Specific Gravity of Soil | 2.65 | | |
| Unit Weight of Water ($\gamma_w$) | 62.4 | pcf | |
| Saturated Unit Weight ($\gamma_{sat}$) | 131.27 | pcf | |
| a | 0.05 | | |

**SPT N values 10**

| | | | |
|---|---|---|---|
| Soil Type | No. 57 | Rock | |
| Relative Density ($D_R$) | 0.30 | Target Relative Density | |
| Dry Unit Weight, min. ($\gamma_{min.}$) | 130.0 | pcf | Lindberg Ref. Manual |
| Dry Unit Weight, max. ($\gamma_{max.}$) | 140.0 | pcf | Lindberg Ref. Manual |
| Dry Unit Weight ($\gamma_d$) | 132.8 | pcf | |
| Relative Density ($D_R$) | 0.30 | Computed Relative Density | |
| Void Ratio, max. ($e_{max.}$) | 0.85 | | Lindberg Ref. Manual |
| Void Ratio, min. ($e_{min.}$) | 0.14 | | Lindberg Ref. Manual |
| Void Ratio, initial ($e_o$) | 0.45 | | |
| Relative Density ($D_R$) | 0.57 | Computed Relative Density | |
| Degree of Saturation | 1 | Pore space fully saturated @ $D_R$ | |
| Specific Gravity of Soil | 2.65 | | |
| Unit Weight of Water ($\gamma_w$) | 62.4 | pcf | |
| Saturated Unit Weight ($\gamma_{sat}$) | 133.62 | pcf | |

**SPT N values 20**

| | | | |
|---|---|---|---|
| Soil Type | No. 57 | Rock | |
| Relative Density ($D_R$) | 0.45 | Target Relative Density | |
| Dry Unit Weight, min. ($\gamma_{min.}$) | 130.0 | pcf | Lindberg Ref. Manual |
| Dry Unit Weight, max. ($\gamma_{max.}$) | 140.0 | pcf | Lindberg Ref. Manual |
| Dry Unit Weight ($\gamma_d$) | 134.3 | pcf | |
| Relative Density ($D_R$) | 0.45 | Computed Relative Density | |
| Void Ratio, max. ($e_{max.}$) | 0.85 | | Lindberg Ref. Manual |
| Void Ratio, min. ($e_{min.}$) | 0.14 | | Lindberg Ref. Manual |
| Void Ratio, initial ($e_o$) | 0.42 | | |
| Relative Density ($D_R$) | 0.61 | Computed Relative Density | |
| Degree of Saturation | 1 | Pore space fully saturated @ $D_R$ | |
| Specific Gravity of Soil | 2.65 | | |
| Unit Weight of Water ($\gamma_w$) | 62.4 | pcf | |
| Saturated Unit Weight ($\gamma_{sat}$) | 134.96 | pcf | |

**SPT N values 25**

| | | | |
|---|---|---|---|
| Soil Type | No. 57 | Rock | |
| Relative Density ($D_R$) | 0.50 | Target Relative Density | |
| Dry Unit Weight, min. ($\gamma_{min.}$) | 130.0 | pcf | Lindberg Ref. Manual |
| Dry Unit Weight, max. ($\gamma_{max.}$) | 140.0 | pcf | Lindberg Ref. Manual |
| Dry Unit Weight ($\gamma_d$) | 134.8 | pcf | |
| Relative Density ($D_R$) | 0.50 | Computed Relative Density | |
| Void Ratio, max. ($e_{max.}$) | 0.85 | | Lindberg Ref. Manual |
| Void Ratio, min. ($e_{min.}$) | 0.14 | | Lindberg Ref. Manual |
| Void Ratio, initial ($e_o$) | 0.41 | | |
| Relative Density ($D_R$) | 0.62 | Computed Relative Density | |
| Degree of Saturation | 1 | Pore space fully saturated @ $D_R$ | |
| Specific Gravity of Soil | 2.65 | | |
| Unit Weight of Water ($\gamma_w$) | 62.4 | pcf | |
| Saturated Unit Weight ($\gamma_{sat}$) | 135.42 | pcf | |

**SPT N values 30**

| | | | |
|---|---|---|---|
| Soil Type | No. 57 | Rock | |
| Relative Density ($D_R$) | 0.60 | Target Relative Density | |
| Dry Unit Weight, min. ($\gamma_{min.}$) | 130.0 | pcf | Lindberg Ref. Manual |
| Dry Unit Weight, max. ($\gamma_{max.}$) | 140.0 | pcf | Lindberg Ref. Manual |
| Dry Unit Weight ($\gamma_d$) | 135.8 | pcf | |
| Relative Density ($D_R$) | 0.60 | Computed Relative Density | |
| Void Ratio, max. ($e_{max.}$) | 0.85 | | Lindberg Ref. Manual |
| Void Ratio, min. ($e_{min.}$) | 0.14 | | Lindberg Ref. Manual |
| Void Ratio, initial ($e_o$) | 0.39 | | |
| Relative Density ($D_R$) | 0.65 | Computed Relative Density | |
| Degree of Saturation | 1 | Pore space fully saturated @ $D_R$ | |
| Specific Gravity of Soil | 2.65 | | |
| Unit Weight of Water ($\gamma_w$) | 62.4 | pcf | |
| Saturated Unit Weight ($\gamma_{sat}$) | 136.37 | pcf | |

**SPT N values greater than 40**

| | | | |
|---|---|---|---|
| Soil Type | No. 57 | Rock | |
| Relative Density ($D_R$) | 0.95 | Target Relative Density | |
| Dry Unit Weight, min. ($\gamma_{min.}$) | 130.0 | pcf | Lindberg Ref. Manual |
| Dry Unit Weight, max. ($\gamma_{max.}$) | 140.0 | pcf | Lindberg Ref. Manual |
| Dry Unit Weight ($\gamma_d$) | 139.5 | pcf | |
| Relative Density ($D_R$) | 0.95 | Computed Relative Density | |
| Void Ratio, max. ($e_{max.}$) | 0.85 | | Lindberg Ref. Manual |
| Void Ratio, min. ($e_{min.}$) | 0.14 | | Lindberg Ref. Manual |
| Void Ratio, initial ($e_o$) | 0.33 | | |
| Relative Density ($D_R$) | 0.73 | Computed Relative Density | |
| Degree of Saturation | 1 | Pore space fully saturated @ $D_R$ | |
| Specific Gravity of Soil | 2.65 | | |
| Unit Weight of Water ($\gamma_w$) | 62.4 | pcf | |
| Saturated Unit Weight ($\gamma_{sat}$) | 139.87 | pcf | |

SCS ENGINEERS

SHEET 1 OF

| CLIENT | PROJECT | JOB NO. |
|---|---|---|
| Hardee County | Phase II Section II Expansion | 09199033.23 |

| SUBJECT | BY | DATE |
|---|---|---|
| Phase I | SRF | 4/1/13 |
| Settlement Calculations at manholes | CHECKED | DATE |
| Estimated Stress | | |

**A-MH4**

**Initial Stress Conditions**

Use Boring TH-6 PSI 2003

| | | |
|---|---|---|
| Ground Surface | 86.8 | ft |
| Water Table | 78.7 | ft |
| Unit Weight of Water, $\gamma_w$ | 62.4 | pcf |

**Buildout Stress Conditions**

| | | |
|---|---|---|
| Final Closure EL | 96.0 | ft |
| Top Intermediate Cover EL | 94.0 | ft |
| Bottom Intermediate Cover EL | 93.0 | ft |
| Top Drainage Sand EL | 86.0 | ft |
| Bottom Drainage Sand EL | 84.0 | ft |
| Depth | 12.0 | ft |
| Water Table | 78.7 | ft |

| | | | | | | |
|---|---|---|---|---|---|---|
| Cover Soil | 2.0 | ft | 115.0 | pcf | 230.0 | psf |
| Intermediate Soil | 1.0 | ft | 115.0 | pcf | 115.0 | psf |
| Waste/Daily | 7.0 | ft | 60.0 | pcf | 420.0 | psf |
| Drainage Sand | 2.0 | ft | 115.0 | pcf | 230.0 | psf |
| Depth | 12.0 | ft | Total Bottom Stress | | 995.0 | psf |

| | Initial Conditions | | | | | Final Conditions | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Soil Layers** | **Layer Elevation (ft)** | **Thickness (ft)** | **Point Elevation (ft)** | **Unit Weight γ (pcf)** | **Stress σ' (psf)** | **Soil Layers** | **Thickness (ft)** | **Point Elevation (ft)** | **Unit Weight γ (pcf)** | **After Cell Excavation (psf)** | **Waste/Soil (psf)** | **Final Stress (psf)** | **Change in Stress (psf)** |
| | | | | | | | | | | | 995.0 | | |
| Point 1 | 86.8 | 2.0 | 85.8 | 101.0 | 99.5 | Point 1 | 0.0 | 0.0 | 101.0 | 0.0 | | 0.0 | 0.0 |
| (SP/SP-SM), N~10 | 84.8 | | | 125.2 | 222.8 | (SP/SP-SM), N~10 | | 0.0 | 125.2 | 0.0 | | 0.0 | 0.0 |
| | | | | 62.8 | | | | | 62.8 | | | | |
| Point 2 | 84.8 | 11.0 | 79.3 | 141.5 | 704.7 | Point 2 | 10.2 | 79.3 | 141.5 | 665.1 | | 1660.1 | 955.3 |
| (SP-SM/SM), N>40 | 73.8 | | | 150.0 | 1219.0 | (SP-SM/SM), N>40 | | 73.8 | 150.0 | 1179.3 | | 2174.3 | 955.3 |
| | | | | 87.6 | | | | | 87.6 | | | | |
| Point 3 | 73.8 | 5.0 | 71.3 | 116.0 | 1399.8 | Point 3 | 5.0 | 71.3 | 116.0 | 1360.1 | | 2355.1 | 955.3 |
| (SP/SP-SM), N~30 | 68.8 | | | 134.7 | 1580.5 | (SP/SP-SM), N~30 | | 68.8 | 134.7 | 1540.8 | | 2535.8 | 955.3 |
| | | | | 72.3 | | | | | 72.3 | | | | |
| Point 4 | 68.8 | 5.0 | 66.3 | 110.3 | 1752.7 | Point 4 | 5.0 | 66.3 | 110.3 | 1713.0 | | 2708.0 | 955.3 |
| (CL/CH), N~10 | 63.8 | | | 131.3 | 1924.9 | (CL/CH), N~10 | | 63.8 | 131.3 | 1885.2 | | 2880.2 | 955.3 |
| | | | | 68.9 | | | | | 68.9 | | | | |
| Point 5 | 63.8 | 12.0 | 57.8 | 123.8 | 2388.3 | Point 5 | 12.0 | 57.8 | 123.8 | 2348.6 | | 3343.6 | 955.3 |
| (CL/CH), N>40 | 51.8 | | | 139.6 | 2851.7 | (CL/CH), N>40 | | 51.8 | 139.6 | 2812.1 | | 3807.1 | 955.3 |
| | | | | 77.2 | | | | | 77.2 | | | | |

Note:

CL/CH used SC for weight

Used for MH-4

SCS ENGINEERS

SHEET 2 OF

| CLIENT | PROJECT | JOB NO. |
|---|---|---|
| Hardee County | Phase II Section II Expansion | 09199033.23 |

| SUBJECT | BY | DATE |
|---|---|---|
| Phase I | SRF | 4/1/13 |
| Settlement Calculations at manholes | CHECKED | DATE |
| Estimated Stress | | |

**B-MH5**

**Initial Stress Conditions**

Use Boring TH-6 PSI 2003

| | | |
|---|---|---|
| Ground Surface | 86.8 | ft |
| Water Table | 78.7 | ft |
| Unit Weight of Water, $\gamma_w$ | 62.4 | pcf |

**Buildout Stress Conditions**

| | | |
|---|---|---|
| Final Closure EL | 137.0 | ft |
| Top Intermediate Cover EL | 135.0 | ft |
| Bottom Intermediate Cover EL | 134.0 | ft |
| Top Drainage Sand EL | 81.4 | ft |
| Bottom Drainage Sand EL | 79.4 | ft |
| Depth | 57.6 | ft |
| Water Table | 78.7 | ft |

| | | | | | | |
|---|---|---|---|---|---|---|
| Cover Soil | 2.0 | ft | 115.0 | pcf | 230.0 | psf |
| Intermediate Soil | 1.0 | ft | 115.0 | pcf | 115.0 | psf |
| Waste/Daily | 52.6 | ft | 60.0 | pcf | 3154.8 | psf |
| Drainage Sand | 2.0 | ft | 115.0 | pcf | 230.0 | psf |
| Depth | 57.6 | ft | Total Bottom Stress | | 3729.8 | psf |

| | Initial Conditions | | | | | Final Conditions | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Soil Layers | Layer Elevation (ft) | Thickness (ft) | Point Elevation (ft) | Unit Weight γ (pcf) | Stress σ' (psf) | Soil Layers | Thickness (ft) | Point Elevation (ft) | Unit Weight γ (pcf) | After Cell Excavation (psf) | Waste/Soil (psf) | Final Stress (psf) | Change in Stress (psf) |
| | | | | | | | | | | | 3729.8 | | |
| Point 1 | 86.8 | 2.0 | 85.8 | 101.0 | 99.5 | Point 1 | 0.0 | 0.0 | 101.0 | 0.0 | | 0.0 | 0.0 |
| (SP/SP-SM), N~10 | 84.8 | | | 125.2 | 222.8 | (SP/SP-SM), N~10 | | 0.0 | 125.2 | 0.0 | | 0.0 | 0.0 |
| | | | | 62.8 | | | | | 62.8 | | | | |
| Point 2 | 84.8 | 11.0 | 79.3 | 141.5 | 704.7 | Point 2 | 5.6 | 79.3 | 141.5 | 17.0 | | 3746.8 | 3042.1 |
| (SP-SM/SM), N>40 | 73.8 | | | 150.0 | 1219.0 | (SP-SM/SM), N>40 | | 73.8 | 150.0 | 531.2 | | 4261.0 | 3042.1 |
| | | | | 87.6 | | | | | 87.6 | | | | |
| Point 3 | 73.8 | 5.0 | 71.3 | 116.0 | 1399.8 | Point 3 | 5.0 | 71.3 | 116.0 | 712.0 | | 4441.8 | 3042.1 |
| (SP/SP-SM), N~30 | 68.8 | | | 134.7 | 1580.5 | (SP/SP-SM), N~30 | | 68.8 | 134.7 | 892.8 | | 4622.6 | 3042.1 |
| | | | | 72.3 | | | | | 72.3 | | | | |
| Point 4 | 68.8 | 5.0 | 66.3 | 110.3 | 1752.7 | Point 4 | 5.0 | 66.3 | 110.3 | 1064.9 | | 4794.7 | 3042.1 |
| (CL/CH), N~10 | 63.8 | | | 131.3 | 1924.9 | (CL/CH), N~10 | | 63.8 | 131.3 | 1237.1 | | 4966.9 | 3042.1 |
| | | | | 68.9 | | | | | 68.9 | | | | |
| Point 5 | 63.8 | 12.0 | 57.8 | 123.8 | 2388.3 | Point 5 | 12.0 | 57.8 | 123.8 | 1700.5 | | 5430.3 | 3042.1 |
| (CL/CH), N>40 | 51.8 | | | 139.6 | 2851.7 | (CL/CH), N>40 | | 51.8 | 139.6 | 2164.0 | | 5893.8 | 3042.1 |
| | | | | 77.2 | | | | | 77.2 | | | | |

Note:

CL/CH used SC for weight

Used for MH-5

SCS ENGINEERS

SHEET 3 OF

| CLIENT | PROJECT | JOB NO. |
|---|---|---|
| Hardee County | Phase II Section II Expansion | 09199033.23 |

| SUBJECT | BY | DATE |
|---|---|---|
| Phase I | SRF | 4/1/13 |
| Settlement Calculations at manholes | CHECKED | DATE |
| Estimated Stress | | |

**C-MH6**

**Initial Stress Conditions**

Use Boring TB-1 PSI 1997

| | | |
|---|---|---|
| Ground Surface | 84.0 | ft |
| Water Table | 78.7 | ft |
| Unit Weight of Water, $\gamma_w$ | 62.4 | pcf |

**Buildout Stress Conditions**

| | | |
|---|---|---|
| Final Closure EL | 147.0 | ft |
| Top Intermediate Cover EL | 145.0 | ft |
| Bottom Intermediate Cover EL | 144.0 | ft |
| Top Drainage Sand EL | 80.3 | ft |
| Bottom Drainage Sand EL | 78.3 | ft |
| Depth | 68.7 | ft |
| Water Table | 78.7 | ft |

| | | | | | | |
|---|---|---|---|---|---|---|
| Cover Soil | 2.0 | ft | 115.0 | pcf | 230.0 | psf |
| Intermediate Soil | 1.0 | ft | 115.0 | pcf | 115.0 | psf |
| Waste/Daily | 63.7 | ft | 60.0 | pcf | 3823.2 | psf |
| Drainage Sand | 2.0 | ft | 115.0 | pcf | 230.0 | psf |
| Depth | 68.7 | ft | Total Bottom Stress | | 4398.2 | psf |

| | Initial Conditions | | | | | Final Conditions | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Soil Layers** | **Layer Elevation (ft)** | **Thickness (ft)** | **Point Elevation (ft)** | **Unit Weight γ (pcf)** | **Stress σ' (psf)** | **Soil Layers** | **Thickness (ft)** | **Point Elevation (ft)** | **Unit Weight γ (pcf)** | **After Cell Excavation (psf)** | **Waste/Soil (psf)** | **Final Stress (psf)** | **Change in Stress (psf)** |
| | | | | | | | | | | | 4398.2 | | |
| Point 1 | 84.0 | 3.5 | 82.3 | 101.0 | 176.8 | Point 1 | 0.0 | 0.0 | 101.0 | 0.0 | | 0.0 | 0.0 |
| (SP/SP-SM), N~10 | 80.5 | | | 125.2 | 395.8 | (SP/SP-SM), N~10 | | 0.0 | 125.2 | 0.0 | | 0.0 | 0.0 |
| | | | | 62.8 | | | | | 62.8 | | | | |
| Point 2 | 80.5 | 4.0 | 78.5 | 96.0 | 514.8 | Point 2 | 1.8 | 77.4 | 96.0 | 37.6 | | 4435.8 | 3921.0 |
| (SP), N~10 | 76.5 | | | 121.9 | 633.9 | (SP), N~10 | | 76.5 | 121.9 | 168.6 | | 4566.8 | 3932.9 |
| | | | | 59.5 | | | | | 59.5 | | | | |
| Point 3 | 76.5 | 6.0 | 73.5 | 110.3 | 840.5 | Point 3 | 6.0 | 73.5 | 110.3 | 375.2 | | 4773.4 | 3932.9 |
| (CL/CH), N~10 | 70.5 | | | 131.3 | 1047.1 | (CL/CH), N~10 | | 70.5 | 131.3 | 581.8 | | 4980.0 | 3932.9 |
| | | | | 68.9 | | | | | 68.9 | | | | |
| Point 4 | 70.5 | 11.5 | 64.8 | 123.8 | 1491.2 | Point 4 | 11.5 | 64.8 | 123.8 | 1025.9 | | 5424.1 | 3932.9 |
| (CL/CH), N>40 | 59.0 | | | 139.6 | 1935.3 | (CL/CH), N>40 | | 59.0 | 139.6 | 1470.0 | | 5868.2 | 3932.9 |
| | | | | 77.2 | | | | | 77.2 | | | | |

Note:
CL/CH used SC for weight
Used for MH-6

SCS ENGINEERS

SHEET 4 OF

| CLIENT | PROJECT | JOB NO. |
|---|---|---|
| Hardee County | Phase II Section II Expansion | 09199033.23 |

| SUBJECT | BY | DATE |
|---|---|---|
| Phase I | SRF | 4/1/13 |
| Settlement Calculations at manholes | CHECKED | DATE |
| Estimated Stress | | |

**D-MH7**

**Initial Stress Conditions**

Use Boring TB-1 PSI 1997

| | | |
|---|---|---|
| Ground Surface | 84.0 | ft |
| Water Table | 78.7 | ft |
| Unit Weight of Water, $\gamma_w$ | 62.4 | pcf |

**Buildout Stress Conditions**

| | | |
|---|---|---|
| Final Closure EL | 147.0 | ft |
| Top Intermediate Cover EL | 145.0 | ft |
| Bottom Intermediate Cover EL | 144.0 | ft |
| Top Drainage Sand EL | 77.5 | ft |
| Bottom Drainage Sand EL | 75.5 | ft |
| Depth | 71.5 | ft |
| Water Table | 78.7 | ft |

| | | | | | | |
|---|---|---|---|---|---|---|
| Cover Soil | 2.0 | ft | 115.0 | pcf | 230.0 | psf |
| Intermediate Soil | 1.0 | ft | 115.0 | pcf | 115.0 | psf |
| Waste/Daily | 66.5 | ft | 60.0 | pcf | 3990.0 | psf |
| Drainage Sand | 2.0 | ft | 115.0 | pcf | 230.0 | psf |
| Depth | 71.5 | ft | Total Bottom Stress | | 4565.0 | psf |

| | Initial Conditions | | | | | Final Conditions | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Soil Layers | Layer Elevation (ft) | Thickness (ft) | Point Elevation (ft) | Unit Weight γ (pcf) | Stress σ' (psf) | Soil Layers | Thickness (ft) | Point Elevation (ft) | Unit Weight γ (pcf) | After Cell Excavation (psf) | Waste/Soil (psf) | Final Stress (psf) | Change in Stress (psf) |
| | | | | | | | | | | | 4565.0 | | |
| Point 1 | 84.0 | 3.5 | 82.3 | 101.0 | 176.8 | Point 1 | 0.0 | 0.0 | 101.0 | 0.0 | | 0.0 | 0.0 |
| (SP/SP-SM), N~10 | 80.5 | | | 125.2 | 395.8 | (SP/SP-SM), N~10 | | 0.0 | 125.2 | 0.0 | | 0.0 | 0.0 |
| | | | | 62.8 | | | | | 62.8 | | | | |
| Point 2 | 80.5 | 4.0 | 78.5 | 96.0 | 514.8 | Point 2 | 0.0 | 0.0 | 96.0 | 4376.6 | | 8941.6 | 0.0 |
| (SP), N~10 | 76.5 | | | 121.9 | 633.9 | (SP), N~10 | | 76.5 | 121.9 | 4507.5 | | 9072.5 | 0.0 |
| | | | | 59.5 | | | | | 59.5 | | | | |
| Point 3 | 76.5 | 6.0 | 73.5 | 110.3 | 840.5 | Point 3 | 5.0 | 73.5 | 110.3 | 4714.1 | | 9279.1 | 8438.6 |
| (CL/CH), N~10 | 70.5 | | | 131.3 | 1047.1 | (CL/CH), N~10 | | 70.5 | 131.3 | 4920.7 | | 9485.7 | 8438.6 |
| | | | | 68.9 | | | | | 68.9 | | | | |
| Point 4 | 70.5 | 11.5 | 64.8 | 123.8 | 1491.2 | Point 4 | 11.5 | 64.8 | 123.8 | 5364.9 | | 9929.9 | 8438.6 |
| (CL/CH), N>40 | 59.0 | | | 139.6 | 1935.3 | (CL/CH), N>40 | | 59.0 | 139.6 | 5809.0 | | 10374.0 | 8438.6 |
| | | | | 77.2 | | | | | 77.2 | | | | |

Note:
CL/CH used SC for weight
Used for MH-7

SCS ENGINEERS

SHEET 5 OF

| CLIENT | PROJECT | JOB NO. |
|---|---|---|
| Hardee County | Phase II Section II Expansion | 09199033.23 |

| SUBJECT | BY | DATE |
|---|---|---|
| Phase I | SRF | 4/1/13 |
| Settlement Calculations at manholes | CHECKED | DATE |
| Estimated Stress | | |

E

**Initial Stress Conditions**

Use Boring TB-2 PSI March 1997

| | | |
|---|---|---|
| Ground Surface | 86.4 | ft |
| Water Table | 78.8 | ft |
| Unit Weight of Water, $\gamma_w$ | 62.4 | pcf |

**Buildout Stress Conditions**

| | | |
|---|---|---|
| Final Closure EL | 160.0 | ft |
| Top Intermediate Cover EL | 158.0 | ft |
| Bottom Intermediate Cover EL | 157.0 | ft |
| Top Drainage Sand EL | 75.7 | ft |
| Bottom Drainage Sand EL | 73.7 | ft |
| Depth | 86.3 | ft |
| Water Table | 78.8 | ft |

| | | | |
|---|---|---|---|
| Cover Soil | 2.0 ft | 115.0 pcf | 230.0 psf |
| Intermediate Soil | 1.0 ft | 115.0 pcf | 115.0 psf |
| Waste/Daily | 81.3 ft | 60.0 pcf | 4878.0 psf |
| Drainage Sand | 2.0 ft | 115.0 pcf | 230.0 psf |
| Depth | 86.3 ft | Total Bottom Stress | 5453.0 psf |

`

| | Initial Conditions | | | | | Final Conditions | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Soil Layers | Layer Elevation (ft) | Thickness (ft) | Point Elevation (ft) | Unit Weight γ (pcf) | Stress σ' (psf) | Soil Layers | Thickness (ft) | Point Elevation (ft) | Unit Weight γ (pcf) | After Cell Excavation (psf) | Waste/Soil (psf) | Final Stress (psf) | Change in Stress (psf) |
| | | | | | | | | | | | 5453.0 | | |
| Point 1 | 86.4 | 5.5 | 83.7 | 86.5 | 237.9 | Point 1 | 0.0 | 0.0 | 86.5 | 0.0 | | 0.0 | 0.0 |
| (SP), N~5 | 80.9 | | | 116.2 | 544.4 | (SP), N~5 | | 0.0 | 116.2 | 0.0 | | 0.0 | 0.0 |
| | | | | 53.8 | | | | | 53.8 | | | | |
| Point 2 | 80.9 | 14.0 | 73.9 | 90.6 | 1178.6 | Point 2 | 6.8 | 70.3 | 90.6 | 192.9 | | 5645.9 | 4467.3 |
| (SP/SM), N~5 | 66.9 | | | 119.1 | 1812.8 | (SP/SM), N~5 | | 66.9 | 119.1 | 598.0 | | 6051.0 | 4238.2 |
| | | | | 56.7 | | | | | 56.7 | | | | |
| Point 3 | 66.9 | 6.5 | 63.7 | 123.8 | 1509.8 | Point 3 | 6.5 | 63.7 | 123.8 | 849.0 | | 6302.0 | 4792.2 |
| (SC), N~40 | 60.4 | | | 139.6 | 1760.8 | (SC), N~40 | | 60.4 | 139.6 | 1100.1 | | 6553.1 | 4792.2 |
| | | | | 77.2 | | | | | 77.2 | | | | |

Note:

CL/CH used SC for weight

SCS ENGINEERS

SHEET 6 OF

| CLIENT | PROJECT | JOB NO. |
|---|---|---|
| Hardee County | Phase II Section II Expansion | 09199033.23 |

| SUBJECT | BY | DATE |
|---|---|---|
| Phase I | SRF | 4/1/13 |
| Settlement Calculations at manholes | CHECKED | DATE |
| Estimated Stress | | |

**F-MH8**

**Initial Stress Conditions**

Use Boring TB-04 PSI 1997

| | | |
|---|---|---|
| Ground Surface | 84.7 | ft |
| Water Table | 76.9 | ft |
| Unit Weight of Water, $\gamma_w$ | 62.4 | pcf |

**Buildout Stress Conditions**

| | | |
|---|---|---|
| Final Closure EL | 110.0 | ft |
| Top Intermediate Cover EL | 108.0 | ft |
| Bottom Intermediate Cover EL | 107.0 | ft |
| Top Drainage Sand EL | 74.7 | ft |
| Bottom Drainage Sand EL | 72.7 | ft |
| Depth | 37.3 | ft |
| Water Table | 76.9 | ft |

| | | | | | | |
|---|---|---|---|---|---|---|
| Cover Soil | 2.0 | ft | 115.0 | pcf | 230.0 | psf |
| Intermediate Soil | 1.0 | ft | 115.0 | pcf | 115.0 | psf |
| Waste/Daily | 32.3 | ft | 60.0 | pcf | 1939.8 | psf |
| Drainage Sand | 2.0 | ft | 115.0 | pcf | 230.0 | psf |
| Depth | 37.3 | ft | Total Bottom Stress | | 2514.8 | psf |

`

| | Initial Conditions | | | | | Final Conditions | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Soil Layers** | **Layer Elevation (ft)** | **Thickness (ft)** | **Point Elevation (ft)** | **Unit Weight γ (pcf)** | **Stress σ' (psf)** | **Soil Layers** | **Thickness (ft)** | **Point Elevation (ft)** | **Unit Weight γ (pcf)** | **After Cell Excavation (psf)** | **Waste/Soil (psf)** | **Final Stress (psf)** | **Change in Stress (psf)** |
| | | | | | | | | | | | 2514.8 | | |
| Point 1 | 84.7 | 13.5 | 78.0 | 96.0 | 648.0 | Point 1 | 1.5 | 71.9 | 96.0 | 70.6 | | 2585.4 | 1937.4 |
| (SP), N~10 | 71.2 | | | 121.9 | 1088.0 | (SP), N~10 | | 71.2 | 121.9 | 158.0 | | 2672.8 | 1584.8 |
| | | | | 59.5 | | | | | 59.5 | | | | |
| Point 2 | 71.2 | 6.5 | 68.0 | 113.2 | 1317.7 | Point 2 | 6.5 | 68.0 | 113.2 | 387.7 | | 2902.5 | 1584.8 |
| (CL/CH), N~20 | 64.7 | | | 133.1 | 1547.4 | (CL/CH), N~20 | | 64.7 | 133.1 | 617.4 | | 3132.2 | 1584.8 |
| | | | | 70.7 | | | | | 70.7 | | | | |

Note:
CL/CH used SC for weight
Used for settlement for flow into MH-8

# Attachment W

- Revised Slope Stability Summary Table

- Slope Stability Analysis during Construction Phase II Section II Adjacent to Phase I Circular Analysis With and Without Equipment Loading
- Slope Stability Analysis during Construction Phase II Section II Adjacent to Phase I Block-Type Analysis With and Without Equipment Loading

- Slope Stability Analysis during Construction Phase II Section II Adjacent to Phase II Section I Circular Analysis With and Without Equipment Loading
- Slope Stability Analysis during Construction Phase II Section II Adjacent to Phase II Section I Block-Type Analysis With and Without Equipment Loading

- Slope Stability Analysis Phase II Section II Final Buildout Circular Analysis With and Without Equipment Loading
- Slope Stability Analysis Phase II Section II Final Buildout Block-Type Analysis With and Without Equipment Loading

- Slope Stability Analysis Phase II Section I East Sideslope Circular Analysis With and Without Equipment Loading
- Slope Stability Analysis Phase II Section I East Sideslope Block-Type Analysis With and Without Equipment Loading

# Slope Stability Analysis Summary Table

SCS ENGINEERS

SHEET 1 OF 1

| CLIENT | PROJECT | JOB NO. |
|---|---|---|
| Hardee County | Phase II Section II Expansion | 09199033.23 |

| SUBJECT | BY | DATE |
|---|---|---|
| | SRF | 8/31/12 |
| | CHECKED | DATE |
| Slope Stability Summary | | |

| Slope Stability Analysis Location | Calculation Location | Circular Mode No Load | Block Mode No Load | Circular Mode With Load | Block Mode With Load |
|---|---|---|---|---|---|
| Phase II Section II - East/West Section During Construction Phase I to Final Buildout | Attachment I-8 | 1.6 | ~~1.7~~ 1.6 | 1.6 | ~~1.7~~ 1.6 |
| Phase II Section II - East/West Section During Construction Phase II Section I to Highest Sequence Buildout | Attachment I-9 | ~~2.1~~ 1.9 | ~~2.6~~ 2.5 | ~~2.0~~ 1.8 | 2.1 |
| [2]Phase II Section II - East/West Section Final Buildout Phase I to Final Buildout | Attachment I-10 | 1.7 | 1.7 | ~~1.7~~ 1.6 | ~~1.7~~ 1.6 |
| Phase II Section I - East/West Section Height Increase Phase II Section I to Final Buildout | Attachment I-11 | 1.7 | 2.3 | 1.7 | 2.2 |
| [1]Phase II Section I - North/South Section Height Increase Phase II Section I to Final Buildout | Attachment I-12 | 1.7 | 2.6 | 1.7 | 2.6 |

Notes:

(1) - No changes per RAI No. 1 based on revised estimated seasonal high groundwater elevation due to existing groundwater interceptor system located within the Phase II Section I area.

(2) - Slope stability calculations revised assuming at the far western end the groundwater would be at the revised EL 82.09 feet NGVD after the installation of the groundwater interceptor system within the south portion of the Phase II Section II Expansion.

Slope stability calculations revised to present the current estimated seasonal high groundwater elevation for the Phase II Section II Expansion of EL 82.09 feet NGVD.

**Revised April 1, 2013**

# Slope Stability Analysis during Construction Phase II Section II Adjacent to Phase I

## Circular Analysis With and Without Equipment Loading

# Phase II Section II Expansion RAI No. 1 Phase I West Slope During Construction

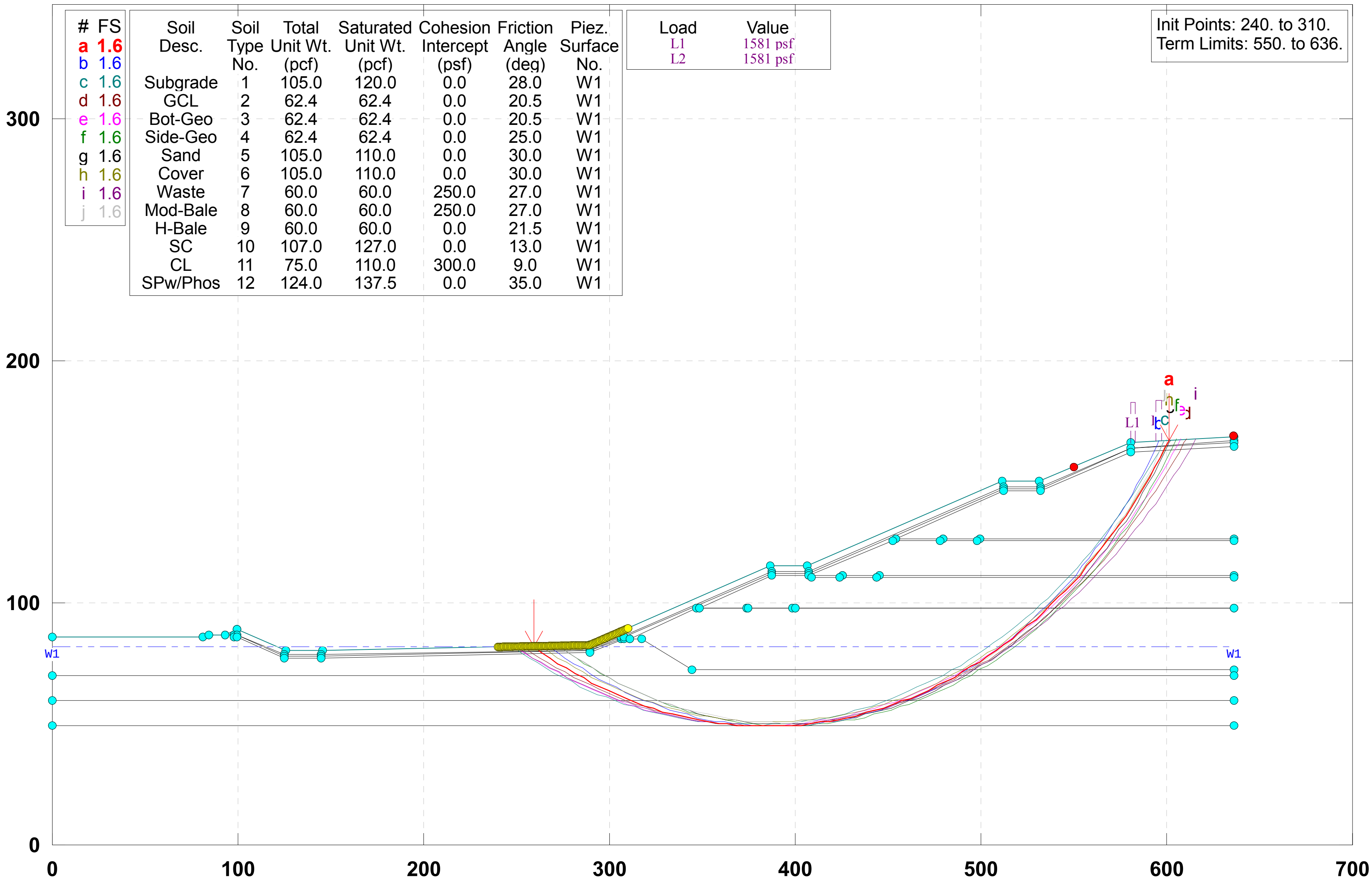
C:\1\HARDEE~1.1\4HARDE~1.1\EWCILO~1\EWSECCIL.PL2 Run By: Shane R. Fischer, P.E. 03/31/13 5:23AM

| # | FS |
|---|---|
| a | 1.6 |
| b | 1.6 |
| c | 1.6 |
| d | 1.6 |
| e | 1.6 |
| f | 1.6 |
| g | 1.6 |
| h | 1.6 |
| i | 1.6 |
| j | 1.6 |

| Soil Desc. | Soil Type No. | Total Unit Wt. (pcf) | Saturated Unit Wt. (pcf) | Cohesion Intercept (psf) | Friction Angle (deg) | Piez. Surface No. |
|---|---|---|---|---|---|---|
| Subgrade | 1 | 105.0 | 120.0 | 0.0 | 28.0 | W1 |
| GCL | 2 | 62.4 | 62.4 | 0.0 | 20.5 | W1 |
| Bot-Geo | 3 | 62.4 | 62.4 | 0.0 | 20.5 | W1 |
| Side-Geo | 4 | 62.4 | 62.4 | 0.0 | 25.0 | W1 |
| Sand | 5 | 105.0 | 110.0 | 0.0 | 30.0 | W1 |
| Cover | 6 | 105.0 | 110.0 | 0.0 | 30.0 | W1 |
| Waste | 7 | 60.0 | 60.0 | 250.0 | 27.0 | W1 |
| Mod-Bale | 8 | 60.0 | 60.0 | 250.0 | 27.0 | W1 |
| H-Bale | 9 | 60.0 | 60.0 | 0.0 | 21.5 | W1 |
| SC | 10 | 107.0 | 127.0 | 0.0 | 13.0 | W1 |
| CL | 11 | 75.0 | 110.0 | 300.0 | 9.0 | W1 |
| SPw/Phos | 12 | 124.0 | 137.5 | 0.0 | 35.0 | W1 |

| Load | Value |
|---|---|
| L1 | 1581 psf |
| L2 | 1581 psf |

Init Points: 240. to 310.
Term Limits: 550. to 636.




PCSTABL5M/si FSmin=1.6

Safety Factors Are Calculated By The Modified Bishop Method

SCS ENGINEERS

**** PCSTABL5M ****

by

Purdue University

--Slope Stability Analysis--

Simplified Janbu, Simplified Bishop

or Spencer`s Method of Slices

Run Date: 03/31/13
Time of Run: 5:23AM
Run By: Shane R. Fischer, P.E.
Input Data Filename: C:ewseccil.
Output Filename: C:ewseccil.OUT
Unit: ENGLISH
Plotted Output Filename: C:ewseccil.PLT
PROBLEM DESCRIPTION Phase II Section II Expansion RAI No. 1
Phase I West Slope During Construction

BOUNDARY COORDINATES
14 Top Boundaries
87 Total Boundaries

| Boundary No. | X-Left (ft) | Y-Left (ft) | X-Right (ft) | Y-Right (ft) | Soil Type Below Bnd |
|---|---|---|---|---|---|
| 1 | .00 | 86.00 | 81.46 | 86.00 | 1 |
| 2 | 81.46 | 86.00 | 84.47 | 87.00 | 1 |
| 3 | 84.47 | 87.00 | 93.14 | 87.00 | 1 |
| 4 | 93.14 | 87.00 | 99.14 | 89.00 | 6 |
| 5 | 99.14 | 89.00 | 99.79 | 89.00 | 6 |
| 6 | 99.79 | 89.00 | 125.29 | 80.50 | 6 |
| 7 | 125.29 | 80.50 | 145.29 | 80.50 | 6 |
| 8 | 145.29 | 80.50 | 289.16 | 82.49 | 6 |
| 9 | 289.16 | 82.49 | 386.69 | 115.00 | 6 |
| 10 | 386.69 | 115.00 | 406.69 | 115.00 | 6 |
| 11 | 406.69 | 115.00 | 511.69 | 150.00 | 6 |
| 12 | 511.69 | 150.00 | 531.69 | 150.00 | 6 |
| 13 | 531.69 | 150.00 | 580.29 | 166.20 | 6 |
| 14 | 580.29 | 166.20 | 636.29 | 169.00 | 6 |
| 15 | 93.14 | 87.00 | 97.46 | 87.00 | 1 |
| 16 | 97.46 | 87.00 | 99.46 | 87.00 | 3 |
| 17 | 99.46 | 87.00 | 124.96 | 78.50 | 3 |
| 18 | 124.96 | 78.50 | 144.96 | 78.50 | 3 |
| 19 | 144.96 | 78.50 | 289.51 | 80.50 | 3 |
| 20 | 289.51 | 80.50 | 306.09 | 86.02 | 3 |
| 21 | 306.09 | 86.02 | 387.01 | 113.00 | 4 |
| 22 | 387.01 | 113.00 | 407.01 | 113.00 | 4 |
| 23 | 407.01 | 113.00 | 512.01 | 148.00 | 4 |
| 24 | 512.01 | 148.00 | 532.01 | 148.00 | 4 |
| 25 | 532.01 | 148.00 | 580.29 | 164.09 | 4 |
| 26 | 580.29 | 164.09 | 636.29 | 166.89 | 4 |
| 27 | 97.46 | 86.53 | 99.30 | 86.53 | 2 |
| 28 | 99.30 | 86.53 | 124.99 | 78.00 | 2 |
| 29 | 124.99 | 78.00 | 144.99 | 78.00 | 2 |
| 30 | 144.99 | 78.00 | 289.59 | 80.00 | 2 |
| 31 | 289.59 | 80.00 | 305.93 | 85.44 | 2 |
| 32 | 305.93 | 85.44 | 306.09 | 86.02 | 4 |
| 33 | 305.93 | 85.44 | 307.91 | 86.10 | 2 |
| 34 | 307.91 | 86.10 | 387.09 | 112.50 | 5 |
| 35 | 387.09 | 112.50 | 407.09 | 112.50 | 5 |
| 36 | 407.09 | 112.50 | 512.09 | 147.50 | 5 |
| 37 | 512.09 | 147.50 | 532.09 | 147.50 | 5 |
| 38 | 532.09 | 147.50 | 580.38 | 163.59 | 5 |
| 39 | 580.38 | 163.59 | 636.29 | 166.39 | 5 |
| 40 | 97.46 | 86.03 | 99.22 | 86.03 | 1 |
| 41 | 99.22 | 86.03 | 124.91 | 77.50 | 1 |
| 42 | 124.91 | 77.50 | 144.99 | 77.50 | 1 |
| 43 | 144.99 | 77.50 | 289.68 | 79.50 | 1 |
| 44 | 289.68 | 79.50 | 307.67 | 85.50 | 1 |
| 45 | 307.67 | 85.50 | 307.91 | 86.10 | 6 |
| 46 | 307.67 | 85.50 | 310.84 | 85.50 | 1 |
| 47 | 310.84 | 85.50 | 346.84 | 97.50 | 8 |
| 48 | 346.84 | 97.50 | 348.34 | 98.00 | 8 |
| 49 | 348.34 | 98.00 | 387.34 | 111.00 | 8 |
| 50 | 387.34 | 111.00 | 407.34 | 111.00 | 8 |

| | | | | | |
|---|---|---|---|---|---|
| 51 | 407.34 | 111.00 | 452.34 | 126.00 | 5 |
| 52 | 452.34 | 126.00 | 453.84 | 126.50 | 8 |
| 53 | 453.84 | 126.50 | 512.34 | 146.00 | 7 |
| 54 | 512.34 | 146.00 | 532.34 | 146.00 | 7 |
| 55 | 532.34 | 146.00 | 580.29 | 161.98 | 7 |
| 56 | 580.29 | 161.98 | 636.29 | 164.78 | 7 |
| 57 | 453.84 | 126.50 | 479.80 | 126.50 | 8 |
| 58 | 479.80 | 126.50 | 499.68 | 126.50 | 9 |
| 59 | 499.68 | 126.50 | 636.29 | 126.50 | 8 |
| 60 | 452.34 | 126.00 | 478.05 | 126.00 | 8 |
| 61 | 478.05 | 126.00 | 479.80 | 126.50 | 9 |
| 62 | 478.05 | 126.00 | 498.18 | 126.00 | 8 |
| 63 | 498.18 | 126.00 | 499.68 | 126.50 | 8 |
| 64 | 498.18 | 126.00 | 636.29 | 126.00 | 8 |
| 65 | 407.34 | 111.00 | 425.29 | 111.00 | 8 |
| 66 | 425.29 | 111.00 | 445.17 | 111.00 | 9 |
| 67 | 445.17 | 111.00 | 636.29 | 111.00 | 8 |
| 68 | 407.34 | 111.00 | 408.84 | 110.50 | 8 |
| 69 | 408.84 | 110.50 | 423.54 | 110.50 | 8 |
| 70 | 423.54 | 110.50 | 425.29 | 111.00 | 9 |
| 71 | 423.54 | 110.50 | 443.67 | 110.50 | 8 |
| 72 | 443.67 | 110.50 | 445.17 | 111.00 | 8 |
| 73 | 443.67 | 110.50 | 636.29 | 110.50 | 8 |
| 74 | 348.34 | 98.00 | 374.93 | 98.00 | 8 |
| 75 | 374.93 | 98.00 | 399.93 | 98.00 | 9 |
| 76 | 399.93 | 98.00 | 636.29 | 98.00 | 8 |
| 77 | 346.84 | 97.50 | 373.43 | 97.50 | 8 |
| 78 | 373.43 | 97.50 | 374.93 | 98.00 | 9 |
| 79 | 373.43 | 97.50 | 398.43 | 97.50 | 8 |
| 80 | 398.43 | 97.50 | 399.93 | 98.00 | 8 |
| 81 | 398.43 | 97.50 | 636.29 | 97.50 | 8 |
| 82 | 310.84 | 85.50 | 317.52 | 85.50 | 1 |
| 83 | 317.52 | 85.50 | 344.52 | 72.00 | 1 |
| 84 | 344.52 | 72.00 | 636.29 | 72.00 | 1 |
| 85 | .00 | 70.00 | 636.29 | 70.00 | 10 |
| 86 | .00 | 60.00 | 636.29 | 60.00 | 11 |
| 87 | .00 | 49.00 | 636.29 | 49.00 | 12 |

ISOTROPIC SOIL PARAMETERS

12 Type(s) of Soil

| Soil Type No. | Total Unit Wt. (pcf) | Saturated Unit Wt. (pcf) | Cohesion Intercept (psf) | Friction Angle (deg) | Pore Pressure Param. | Pressure Constant (psf) | Piez. Surface No. |
|---|---|---|---|---|---|---|---|
| 1 | 105.0 | 120.0 | .0 | 28.0 | .00 | .0 | 1 |
| 2 | 62.4 | 62.4 | .0 | 20.5 | .00 | .0 | 1 |
| 3 | 62.4 | 62.4 | .0 | 20.5 | .00 | .0 | 1 |
| 4 | 62.4 | 62.4 | .0 | 25.0 | .00 | .0 | 1 |
| 5 | 105.0 | 110.0 | .0 | 30.0 | .00 | .0 | 1 |
| 6 | 105.0 | 110.0 | .0 | 30.0 | .00 | .0 | 1 |
| 7 | 60.0 | 60.0 | 250.0 | 27.0 | .00 | .0 | 1 |
| 8 | 60.0 | 60.0 | 250.0 | 27.0 | .00 | .0 | 1 |
| 9 | 60.0 | 60.0 | .0 | 21.5 | .00 | .0 | 1 |
| 10 | 107.0 | 127.0 | .0 | 13.0 | .00 | .0 | 1 |
| 11 | 75.0 | 110.0 | 300.0 | 9.0 | .00 | .0 | 1 |
| 12 | 124.0 | 137.5 | .0 | 35.0 | .00 | .0 | 1 |

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

Unit Weight of Water = 62.40

Piezometric Surface No. 1 Specified by 2 Coordinate Points

| Point No. | X-Water (ft) | Y-Water (ft) |
|---|---|---|
| 1 | .00 | 82.09 |
| 2 | 636.29 | 82.09 |

BOUNDARY LOAD(S)

2 Load(s) Specified

| Load No. | X-Left (ft) | X-Right (ft) | Intensity (psf) | Deflection (deg) |
|---|---|---|---|---|
| 1 | 580.29 | 583.25 | 1581.0 | .0 |
| 2 | 594.24 | 597.21 | 1581.0 | .0 |

NOTE - Intensity Is Specified As A Uniformly Distributed
Force Acting On A Horizontally Projected Surface.

A Critical Failure Surface Searching Method, Using A Random

Technique For Generating Circular Surfaces, Has Been Specified.
5000 Trial Surfaces Have Been Generated.
50 Surfaces Initiate From Each Of100 Points Equally Spaced
Along The Ground Surface Between X = 240.00 ft.
and X = 310.00 ft.
Each Surface Terminates Between X = 550.00 ft.
and X = 636.00 ft.
Unless Further Limitations Were Imposed, The Minimum Elevation
At Which A Surface Extends Is Y = .00 ft.
5.00 ft. Line Segments Define Each Trial Failure Surface.
Following Are Displayed The Ten Most Critical Of The Trial
Failure Surfaces Examined. They Are Ordered - Most Critical
First.
* * Safety Factors Are Calculated By The Modified Bishop Method * *
Failure Surface Specified By 79 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 259.09 | 82.07 |
| 2 | 263.47 | 79.66 |
| 3 | 267.90 | 77.33 |
| 4 | 272.37 | 75.09 |
| 5 | 276.88 | 72.94 |
| 6 | 281.43 | 70.88 |
| 7 | 286.03 | 68.90 |
| 8 | 290.66 | 67.01 |
| 9 | 295.32 | 65.22 |
| 10 | 300.02 | 63.51 |
| 11 | 304.76 | 61.90 |
| 12 | 309.52 | 60.38 |
| 13 | 314.31 | 58.96 |
| 14 | 319.13 | 57.62 |
| 15 | 323.98 | 56.39 |
| 16 | 328.84 | 55.24 |
| 17 | 333.73 | 54.19 |
| 18 | 338.64 | 53.24 |
| 19 | 343.57 | 52.38 |
| 20 | 348.51 | 51.62 |
| 21 | 353.46 | 50.95 |
| 22 | 358.43 | 50.39 |
| 23 | 363.41 | 49.91 |
| 24 | 368.39 | 49.54 |
| 25 | 373.39 | 49.26 |
| 26 | 378.38 | 49.08 |
| 27 | 383.38 | 49.00 |
| 28 | 388.38 | 49.01 |
| 29 | 393.38 | 49.13 |
| 30 | 398.38 | 49.34 |
| 31 | 403.37 | 49.64 |
| 32 | 408.35 | 50.05 |
| 33 | 413.33 | 50.55 |
| 34 | 418.29 | 51.15 |
| 35 | 423.24 | 51.84 |
| 36 | 428.18 | 52.63 |
| 37 | 433.10 | 53.52 |
| 38 | 438.00 | 54.50 |
| 39 | 442.88 | 55.58 |
| 40 | 447.74 | 56.75 |
| 41 | 452.58 | 58.02 |
| 42 | 457.39 | 59.38 |
| 43 | 462.18 | 60.83 |
| 44 | 466.93 | 62.38 |
| 45 | 471.65 | 64.02 |
| 46 | 476.34 | 65.75 |
| 47 | 481.00 | 67.58 |
| 48 | 485.62 | 69.49 |
| 49 | 490.20 | 71.49 |
| 50 | 494.74 | 73.59 |
| 51 | 499.24 | 75.76 |
| 52 | 503.70 | 78.03 |
| 53 | 508.11 | 80.39 |

| | | |
|---|---|---|
| 54 | 512.48 | 82.82 |
| 55 | 516.79 | 85.35 |
| 56 | 521.06 | 87.96 |
| 57 | 525.27 | 90.64 |
| 58 | 529.43 | 93.42 |
| 59 | 533.54 | 96.27 |
| 60 | 537.59 | 99.20 |
| 61 | 541.58 | 102.21 |
| 62 | 545.52 | 105.30 |
| 63 | 549.39 | 108.46 |
| 64 | 553.20 | 111.70 |
| 65 | 556.95 | 115.01 |
| 66 | 560.63 | 118.39 |
| 67 | 564.24 | 121.85 |
| 68 | 567.79 | 125.37 |
| 69 | 571.27 | 128.97 |
| 70 | 574.67 | 132.63 |
| 71 | 578.01 | 136.35 |
| 72 | 581.27 | 140.14 |
| 73 | 584.45 | 143.99 |
| 74 | 587.56 | 147.91 |
| 75 | 590.60 | 151.88 |
| 76 | 593.55 | 155.92 |
| 77 | 596.43 | 160.01 |
| 78 | 599.23 | 164.15 |
| 79 | 601.23 | 167.25 |

Circle Center At X = 385.1 ; Y = 305.6 and Radius, 256.6

*** 1.560 ***

Individual data on the 151 slices

| Slice No. | Width (ft) | Weight (lbs) | Water Force Top (lbs) | Water Force Bot (lbs) | Tie Force Norm (lbs) | Tie Force Tan (lbs) | Earthquake Force Hor (lbs) | Earthquake Force Ver (lbs) | Surcharge Load (lbs) |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 3.5 | 387.3 | .0 | 248.8 | .0 | .0 | .0 | .0 | .0 |
| 2 | .8 | 198.5 | .0 | 132.6 | .0 | .0 | .0 | .0 | .0 |
| 3 | .0 | 10.3 | .0 | 7.1 | .0 | .0 | .0 | .0 | .0 |
| 4 | .9 | 247.0 | .0 | 176.4 | .0 | .0 | .0 | .0 | .0 |
| 5 | 3.5 | 1359.7 | .0 | 937.4 | .0 | .0 | .0 | .0 | .0 |
| 6 | 4.5 | 2875.2 | .0 | 1833.5 | .0 | .0 | .0 | .0 | .0 |
| 7 | 4.5 | 4124.7 | .0 | 2518.9 | .0 | .0 | .0 | .0 | .0 |
| 8 | 4.6 | 5347.4 | .0 | 3176.9 | .0 | .0 | .0 | .0 | .0 |
| 9 | 2.0 | 2758.9 | .0 | 1610.5 | .0 | .0 | .0 | .0 | .0 |
| 10 | 2.6 | 3791.5 | .0 | 2196.7 | .0 | .0 | .0 | .0 | .0 |
| 11 | 3.1 | 5132.7 | .0 | 2920.6 | .0 | .0 | .0 | .0 | .0 |
| 12 | .4 | 607.7 | .0 | 342.8 | .0 | .0 | .0 | .0 | .0 |
| 13 | .1 | 140.3 | .0 | 78.8 | .0 | .0 | .0 | .0 | .0 |
| 14 | .1 | 158.4 | .0 | 88.9 | .0 | .0 | .0 | .0 | .0 |
| 15 | 1.0 | 1764.5 | .0 | 978.5 | .0 | .0 | .0 | .0 | .0 |
| 16 | 3.6 | 7294.8 | .0 | 3828.0 | .0 | .0 | .0 | .0 | .0 |
| 17 | 1.0 | 2296.1 | .0 | 1155.9 | .0 | .0 | .0 | .0 | .0 |
| 18 | .5 | 1244.4 | .0 | 613.8 | .0 | .0 | .0 | .0 | .0 |
| 19 | 1.6 | 3747.9 | .0 | 1817.7 | .0 | .0 | .0 | .0 | .0 |
| 20 | 2.6 | 6566.7 | .0 | 3098.2 | .0 | .0 | .0 | .0 | .0 |
| 21 | 4.7 | 13428.4 | .0 | 6047.0 | .0 | .0 | .0 | .0 | .0 |
| 22 | 1.2 | 3599.0 | .0 | 1566.1 | .0 | .0 | .0 | .0 | .0 |
| 23 | .2 | 498.8 | .0 | 215.8 | .0 | .0 | .0 | .0 | .0 |
| 24 | 1.6 | 5028.9 | .0 | 2159.3 | .0 | .0 | .0 | .0 | .0 |
| 25 | .2 | 783.0 | .0 | 332.5 | .0 | .0 | .0 | .0 | .0 |
| 26 | 1.6 | 5382.9 | .0 | 2261.9 | .0 | .0 | .0 | .0 | .0 |
| 27 | 1.3 | 4440.0 | .0 | 1834.2 | .0 | .0 | .0 | .0 | .0 |
| 28 | .0 | 117.2 | .0 | 48.2 | .0 | .0 | .0 | .0 | .0 |
| 29 | 3.5 | 12471.4 | .0 | 5112.7 | .0 | .0 | .0 | .0 | .0 |
| 30 | 3.2 | 12075.1 | .0 | 4896.5 | .0 | .0 | .0 | .0 | .0 |
| 31 | 1.6 | 6231.8 | .0 | 2529.0 | .0 | .0 | .0 | .0 | .0 |
| 32 | 4.8 | 19145.0 | .0 | 7826.7 | .0 | .0 | .0 | .0 | .0 |
| 33 | .4 | 1465.1 | .0 | 601.7 | .0 | .0 | .0 | .0 | .0 |
| 34 | 4.5 | 18274.4 | .0 | 7596.7 | .0 | .0 | .0 | .0 | .0 |
| 35 | 4.9 | 20177.9 | .0 | 8540.5 | .0 | .0 | .0 | .0 | .0 |
| 36 | 4.9 | 20558.5 | .0 | 8852.9 | .0 | .0 | .0 | .0 | .0 |
| 37 | 4.9 | 20880.9 | .0 | 9135.5 | .0 | .0 | .0 | .0 | .0 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 38 | 1.0 | 4070.3 | .0 | 1794.6 | .0 | .0 | .0 | .0 | .0 |
| 39 | 2.3 | 10001.7 | .0 | 4399.5 | .0 | .0 | .0 | .0 | .0 |
| 40 | 1.5 | 6572.5 | .0 | 2872.4 | .0 | .0 | .0 | .0 | .0 |
| 41 | .2 | 738.1 | .0 | 321.7 | .0 | .0 | .0 | .0 | .0 |
| 42 | 5.0 | 22308.4 | .0 | 9610.7 | .0 | .0 | .0 | .0 | .0 |
| 43 | 5.0 | 23192.6 | .0 | 9803.2 | .0 | .0 | .0 | .0 | .0 |
| 44 | 5.0 | 24019.7 | .0 | 9965.4 | .0 | .0 | .0 | .0 | .0 |
| 45 | 5.0 | 24788.3 | .0 | 10097.4 | .0 | .0 | .0 | .0 | .0 |
| 46 | 5.0 | 25496.9 | .0 | 10199.1 | .0 | .0 | .0 | .0 | .0 |
| 47 | .0 | 225.4 | .0 | 89.3 | .0 | .0 | .0 | .0 | .0 |
| 48 | 1.5 | 7787.2 | .0 | 3077.4 | .0 | .0 | .0 | .0 | .0 |
| 49 | 3.5 | 18131.9 | .0 | 7103.7 | .0 | .0 | .0 | .0 | .0 |
| 50 | 5.0 | 26530.4 | .0 | 10235.1 | .0 | .0 | .0 | .0 | .0 |
| 51 | .0 | 199.4 | .0 | 76.3 | .0 | .0 | .0 | .0 | .0 |
| 52 | .2 | 1111.6 | .0 | 424.8 | .0 | .0 | .0 | .0 | .0 |
| 53 | 3.1 | 16860.6 | .0 | 6403.7 | .0 | .0 | .0 | .0 | .0 |
| 54 | .3 | 1748.5 | .0 | 660.6 | .0 | .0 | .0 | .0 | .0 |
| 55 | .1 | 436.8 | .0 | 165.1 | .0 | .0 | .0 | .0 | .0 |
| 56 | .3 | 1364.8 | .0 | 516.0 | .0 | .0 | .0 | .0 | .0 |
| 57 | 1.0 | 5689.1 | .0 | 2151.7 | .0 | .0 | .0 | .0 | .0 |
| 58 | 5.0 | 27248.0 | .0 | 10302.2 | .0 | .0 | .0 | .0 | .0 |
| 59 | 5.0 | 27142.5 | .0 | 10251.9 | .0 | .0 | .0 | .0 | .0 |
| 60 | .1 | 288.2 | .0 | 108.9 | .0 | .0 | .0 | .0 | .0 |
| 61 | 1.5 | 8124.5 | .0 | 3066.9 | .0 | .0 | .0 | .0 | .0 |
| 62 | 3.4 | 18560.7 | .0 | 6995.6 | .0 | .0 | .0 | .0 | .0 |
| 63 | 3.3 | 17852.9 | .0 | 6721.3 | .0 | .0 | .0 | .0 | .0 |
| 64 | .3 | 1716.0 | .0 | 644.4 | .0 | .0 | .0 | .0 | .0 |
| 65 | .1 | 429.3 | .0 | 161.0 | .0 | .0 | .0 | .0 | .0 |
| 66 | .3 | 1342.7 | .0 | 503.0 | .0 | .0 | .0 | .0 | .0 |
| 67 | 1.0 | 5446.9 | .0 | 2030.8 | .0 | .0 | .0 | .0 | .0 |
| 68 | .5 | 2643.5 | .0 | 981.8 | .0 | .0 | .0 | .0 | .0 |
| 69 | 4.5 | 24519.3 | .0 | 8937.4 | .0 | .0 | .0 | .0 | .0 |
| 70 | 5.0 | 27667.6 | .0 | 9747.8 | .0 | .0 | .0 | .0 | .0 |
| 71 | 5.0 | 28104.8 | .0 | 9546.2 | .0 | .0 | .0 | .0 | .0 |
| 72 | .3 | 1709.5 | .0 | 570.2 | .0 | .0 | .0 | .0 | .0 |
| 73 | 1.8 | 10053.4 | .0 | 3324.6 | .0 | .0 | .0 | .0 | .0 |
| 74 | 2.9 | 16710.8 | .0 | 5419.8 | .0 | .0 | .0 | .0 | .0 |
| 75 | 4.9 | 28774.2 | .0 | 9052.8 | .0 | .0 | .0 | .0 | .0 |
| 76 | 4.9 | 29006.3 | .0 | 8761.1 | .0 | .0 | .0 | .0 | .0 |
| 77 | 4.9 | 29170.2 | .0 | 8439.7 | .0 | .0 | .0 | .0 | .0 |
| 78 | .8 | 4717.9 | .0 | 1332.5 | .0 | .0 | .0 | .0 | .0 |
| 79 | 1.5 | 9020.5 | .0 | 2517.0 | .0 | .0 | .0 | .0 | .0 |
| 80 | 2.6 | 15527.9 | .0 | 4239.1 | .0 | .0 | .0 | .0 | .0 |
| 81 | 4.6 | 27829.0 | .0 | 7332.5 | .0 | .0 | .0 | .0 | .0 |
| 82 | .2 | 1302.4 | .0 | 375.4 | .0 | .0 | .0 | .0 | .0 |
| 83 | 1.3 | 6778.6 | .0 | 1950.1 | .0 | .0 | .0 | .0 | .0 |
| 84 | 3.6 | 19039.4 | .0 | 5347.8 | .0 | .0 | .0 | .0 | .0 |
| 85 | 2.0 | 10854.5 | .0 | 2977.6 | .0 | .0 | .0 | .0 | .0 |
| 86 | 2.7 | 14514.8 | .0 | 3881.0 | .0 | .0 | .0 | .0 | .0 |
| 87 | 4.8 | 24771.8 | .0 | 6390.1 | .0 | .0 | .0 | .0 | .0 |
| 88 | 4.7 | 24101.5 | .0 | 5892.8 | .0 | .0 | .0 | .0 | .0 |
| 89 | 4.7 | 23371.2 | .0 | 5366.8 | .0 | .0 | .0 | .0 | .0 |
| 90 | 1.7 | 8346.7 | .0 | 1828.7 | .0 | .0 | .0 | .0 | .0 |
| 91 | 1.8 | 8475.0 | .0 | 1797.2 | .0 | .0 | .0 | .0 | .0 |
| 92 | 1.2 | 5761.1 | .0 | 1186.4 | .0 | .0 | .0 | .0 | .0 |
| 93 | 4.6 | 21738.8 | .0 | 4229.5 | .0 | .0 | .0 | .0 | .0 |
| 94 | 1.2 | 5372.0 | .0 | 979.7 | .0 | .0 | .0 | .0 | .0 |
| 95 | 3.4 | 15487.4 | .0 | 2638.9 | .0 | .0 | .0 | .0 | .0 |
| 96 | 1.1 | 4904.4 | .0 | 781.6 | .0 | .0 | .0 | .0 | .0 |
| 97 | 3.4 | 15233.6 | .0 | 2198.2 | .0 | .0 | .0 | .0 | .0 |
| 98 | 3.4 | 15116.1 | .0 | 1828.5 | .0 | .0 | .0 | .0 | .0 |
| 99 | 1.1 | 4651.0 | .0 | 484.9 | .0 | .0 | .0 | .0 | .0 |
| 100 | .4 | 1911.8 | .0 | 190.3 | .0 | .0 | .0 | .0 | .0 |
| 101 | 4.0 | 17469.7 | .0 | 1429.5 | .0 | .0 | .0 | .0 | .0 |
| 102 | 4.4 | 18965.4 | .0 | 899.0 | .0 | .0 | .0 | .0 | .0 |
| 103 | 3.1 | 12970.8 | .0 | 185.8 | .0 | .0 | .0 | .0 | .0 |
| 104 | .5 | 2236.2 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 105 | .3 | 1349.3 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 106 | .1 | 336.7 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 107 | .2 | 1049.7 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 108 | .1 | 567.4 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 109 | 4.3 | 17755.9 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 110 | 4.3 | 16893.6 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 111 | 4.2 | 16019.4 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 112 | 4.2 | 15135.5 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 113 | 2.3 | 7908.4 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 114 | .3 | 1106.8 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 115 | .1 | 276.6 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 116 | .2 | 863.6 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 117 | 1.2 | 4135.5 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 118 | 1.7 | 5801.0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 119 | .7 | 2335.3 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 120 | 1.7 | 5557.8 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 121 | 4.0 | 13107.8 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 122 | 3.9 | 12505.2 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 123 | 3.9 | 11887.9 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 124 | 2.4 | 7146.9 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 125 | .6 | 1723.9 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 126 | .8 | 2386.7 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 127 | 3.7 | 10615.9 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 128 | 3.7 | 9965.2 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 129 | 3.6 | 9306.9 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 130 | 3.5 | 8643.2 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 131 | .6 | 1429.7 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 132 | .5 | 1127.9 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 133 | 2.4 | 5418.3 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 134 | 3.4 | 7307.0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 135 | 3.3 | 6638.6 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 136 | 2.3 | 4238.9 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 137 | .1 | 161.6 | .0 | .0 | .0 | .0 | .0 | .0 | 142.2 |
| 138 | .9 | 1565.0 | .0 | .0 | .0 | .0 | .0 | .0 | 1402.3 |
| 139 | 2.0 | 3303.5 | .0 | .0 | .0 | .0 | .0 | .0 | 3135.2 |
| 140 | 1.2 | 1871.7 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 141 | 3.1 | 4356.8 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 142 | 3.0 | 3559.2 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 143 | 3.0 | 2784.2 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 144 | .7 | 546.2 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 145 | 2.2 | 1487.7 | .0 | .0 | .0 | .0 | .0 | .0 | 3465.3 |
| 146 | .8 | 432.0 | .0 | .0 | .0 | .0 | .0 | .0 | 1230.3 |
| 147 | 1.2 | 549.3 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 148 | .9 | 305.3 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 149 | .3 | 70.1 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 150 | .3 | 79.8 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 151 | 1.4 | 156.2 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |

Failure Surface Specified By 77 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 267.58 | 82.19 |
| 2 | 271.91 | 79.70 |
| 3 | 276.30 | 77.30 |
| 4 | 280.74 | 75.00 |
| 5 | 285.22 | 72.78 |
| 6 | 289.75 | 70.66 |
| 7 | 294.32 | 68.64 |
| 8 | 298.93 | 66.71 |
| 9 | 303.58 | 64.88 |
| 10 | 308.27 | 63.14 |
| 11 | 313.00 | 61.51 |
| 12 | 317.76 | 59.97 |
| 13 | 322.54 | 58.53 |
| 14 | 327.36 | 57.19 |
| 15 | 332.21 | 55.95 |
| 16 | 337.07 | 54.81 |
| 17 | 341.97 | 53.78 |
| 18 | 346.88 | 52.84 |
| 19 | 351.81 | 52.01 |
| 20 | 356.76 | 51.28 |
| 21 | 361.72 | 50.66 |
| 22 | 366.69 | 50.14 |
| 23 | 371.67 | 49.72 |

| | | |
|---|---|---|
| 24 | 376.66 | 49.41 |
| 25 | 381.66 | 49.20 |
| 26 | 386.66 | 49.09 |
| 27 | 391.66 | 49.09 |
| 28 | 396.65 | 49.19 |
| 29 | 401.65 | 49.40 |
| 30 | 406.64 | 49.71 |
| 31 | 411.62 | 50.12 |
| 32 | 416.60 | 50.64 |
| 33 | 421.56 | 51.26 |
| 34 | 426.51 | 51.99 |
| 35 | 431.44 | 52.81 |
| 36 | 436.35 | 53.74 |
| 37 | 441.24 | 54.78 |
| 38 | 446.11 | 55.91 |
| 39 | 450.96 | 57.14 |
| 40 | 455.77 | 58.48 |
| 41 | 460.56 | 59.92 |
| 42 | 465.32 | 61.45 |
| 43 | 470.05 | 63.09 |
| 44 | 474.74 | 64.82 |
| 45 | 479.39 | 66.65 |
| 46 | 484.01 | 68.57 |
| 47 | 488.58 | 70.59 |
| 48 | 493.11 | 72.71 |
| 49 | 497.59 | 74.92 |
| 50 | 502.03 | 77.22 |
| 51 | 506.42 | 79.62 |
| 52 | 510.76 | 82.10 |
| 53 | 515.04 | 84.68 |
| 54 | 519.28 | 87.35 |
| 55 | 523.45 | 90.10 |
| 56 | 527.57 | 92.94 |
| 57 | 531.62 | 95.86 |
| 58 | 535.62 | 98.87 |
| 59 | 539.55 | 101.96 |
| 60 | 543.41 | 105.13 |
| 61 | 547.21 | 108.38 |
| 62 | 550.94 | 111.71 |
| 63 | 554.60 | 115.11 |
| 64 | 558.19 | 118.60 |
| 65 | 561.71 | 122.15 |
| 66 | 565.15 | 125.78 |
| 67 | 568.51 | 129.48 |
| 68 | 571.80 | 133.25 |
| 69 | 575.01 | 137.08 |
| 70 | 578.13 | 140.98 |
| 71 | 581.18 | 144.95 |
| 72 | 584.14 | 148.98 |
| 73 | 587.01 | 153.07 |
| 74 | 589.81 | 157.22 |
| 75 | 592.51 | 161.42 |
| 76 | 595.13 | 165.68 |
| 77 | 595.88 | 166.98 |

Circle Center At X = 389.2 ; Y = 289.1 and Radius, 240.1

*** 1.567 ***

Failure Surface Specified By 81 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 247.78 | 81.92 |
| 2 | 252.20 | 79.58 |
| 3 | 256.67 | 77.33 |
| 4 | 261.17 | 75.17 |
| 5 | 265.72 | 73.08 |
| 6 | 270.30 | 71.08 |
| 7 | 274.92 | 69.17 |
| 8 | 279.57 | 67.34 |
| 9 | 284.26 | 65.60 |
| 10 | 288.98 | 63.94 |
| 11 | 293.73 | 62.38 |

| | | |
|---|---|---|
| 12 | 298.50 | 60.90 |
| 13 | 303.30 | 59.51 |
| 14 | 308.13 | 58.21 |
| 15 | 312.98 | 57.00 |
| 16 | 317.86 | 55.87 |
| 17 | 322.75 | 54.84 |
| 18 | 327.66 | 53.90 |
| 19 | 332.59 | 53.05 |
| 20 | 337.53 | 52.29 |
| 21 | 342.48 | 51.63 |
| 22 | 347.45 | 51.05 |
| 23 | 352.43 | 50.57 |
| 24 | 357.41 | 50.18 |
| 25 | 362.40 | 49.88 |
| 26 | 367.40 | 49.68 |
| 27 | 372.40 | 49.56 |
| 28 | 377.40 | 49.54 |
| 29 | 382.40 | 49.62 |
| 30 | 387.39 | 49.78 |
| 31 | 392.39 | 50.04 |
| 32 | 397.38 | 50.39 |
| 33 | 402.36 | 50.83 |
| 34 | 407.33 | 51.36 |
| 35 | 412.29 | 51.99 |
| 36 | 417.24 | 52.71 |
| 37 | 422.17 | 53.51 |
| 38 | 427.09 | 54.42 |
| 39 | 431.99 | 55.41 |
| 40 | 436.87 | 56.49 |
| 41 | 441.73 | 57.66 |
| 42 | 446.57 | 58.92 |
| 43 | 451.38 | 60.27 |
| 44 | 456.17 | 61.71 |
| 45 | 460.93 | 63.24 |
| 46 | 465.66 | 64.86 |
| 47 | 470.37 | 66.56 |
| 48 | 475.03 | 68.35 |
| 49 | 479.67 | 70.23 |
| 50 | 484.27 | 72.19 |
| 51 | 488.83 | 74.23 |
| 52 | 493.35 | 76.37 |
| 53 | 497.84 | 78.58 |
| 54 | 502.28 | 80.88 |
| 55 | 506.68 | 83.25 |
| 56 | 511.03 | 85.71 |
| 57 | 515.34 | 88.25 |
| 58 | 519.60 | 90.87 |
| 59 | 523.81 | 93.57 |
| 60 | 527.96 | 96.34 |
| 61 | 532.07 | 99.20 |
| 62 | 536.13 | 102.12 |
| 63 | 540.12 | 105.12 |
| 64 | 544.07 | 108.20 |
| 65 | 547.95 | 111.35 |
| 66 | 551.78 | 114.56 |
| 67 | 555.54 | 117.85 |
| 68 | 559.25 | 121.21 |
| 69 | 562.89 | 124.64 |
| 70 | 566.47 | 128.13 |
| 71 | 569.98 | 131.69 |
| 72 | 573.43 | 135.31 |
| 73 | 576.80 | 139.00 |
| 74 | 580.11 | 142.75 |
| 75 | 583.35 | 146.56 |
| 76 | 586.52 | 150.42 |
| 77 | 589.62 | 154.35 |
| 78 | 592.64 | 158.33 |
| 79 | 595.59 | 162.37 |
| 80 | 598.46 | 166.46 |
| 81 | 598.92 | 167.13 |

Circle Center At X = 376.0 ; Y = 319.6 and Radius, 270.1
*** 1.568 ***
Failure Surface Specified By 82 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 253.43 | 82.00 |
| 2 | 257.86 | 79.67 |
| 3 | 262.33 | 77.43 |
| 4 | 266.84 | 75.28 |
| 5 | 271.39 | 73.20 |
| 6 | 275.98 | 71.20 |
| 7 | 280.60 | 69.29 |
| 8 | 285.25 | 67.47 |
| 9 | 289.94 | 65.72 |
| 10 | 294.66 | 64.07 |
| 11 | 299.40 | 62.50 |
| 12 | 304.18 | 61.01 |
| 13 | 308.98 | 59.61 |
| 14 | 313.80 | 58.30 |
| 15 | 318.65 | 57.08 |
| 16 | 323.52 | 55.94 |
| 17 | 328.41 | 54.89 |
| 18 | 333.31 | 53.93 |
| 19 | 338.24 | 53.06 |
| 20 | 343.18 | 52.28 |
| 21 | 348.13 | 51.59 |
| 22 | 353.09 | 50.99 |
| 23 | 358.07 | 50.48 |
| 24 | 363.05 | 50.06 |
| 25 | 368.04 | 49.73 |
| 26 | 373.03 | 49.49 |
| 27 | 378.03 | 49.34 |
| 28 | 383.03 | 49.28 |
| 29 | 388.03 | 49.31 |
| 30 | 393.03 | 49.43 |
| 31 | 398.02 | 49.64 |
| 32 | 403.01 | 49.94 |
| 33 | 408.00 | 50.34 |
| 34 | 412.98 | 50.82 |
| 35 | 417.94 | 51.39 |
| 36 | 422.90 | 52.06 |
| 37 | 427.84 | 52.81 |
| 38 | 432.77 | 53.65 |
| 39 | 437.68 | 54.58 |
| 40 | 442.58 | 55.60 |
| 41 | 447.45 | 56.71 |
| 42 | 452.31 | 57.90 |
| 43 | 457.14 | 59.19 |
| 44 | 461.95 | 60.56 |
| 45 | 466.73 | 62.02 |
| 46 | 471.49 | 63.56 |
| 47 | 476.21 | 65.19 |
| 48 | 480.91 | 66.91 |
| 49 | 485.57 | 68.71 |
| 50 | 490.21 | 70.59 |
| 51 | 494.80 | 72.56 |
| 52 | 499.36 | 74.61 |
| 53 | 503.88 | 76.75 |
| 54 | 508.37 | 78.96 |
| 55 | 512.81 | 81.26 |
| 56 | 517.21 | 83.63 |
| 57 | 521.56 | 86.09 |
| 58 | 525.88 | 88.62 |
| 59 | 530.14 | 91.23 |
| 60 | 534.36 | 93.92 |
| 61 | 538.52 | 96.68 |
| 62 | 542.64 | 99.52 |
| 63 | 546.70 | 102.43 |
| 64 | 550.71 | 105.42 |
| 65 | 554.67 | 108.48 |

| | | |
|---|---|---|
| 66 | 558.57 | 111.61 |
| 67 | 562.41 | 114.81 |
| 68 | 566.19 | 118.07 |
| 69 | 569.92 | 121.41 |
| 70 | 573.58 | 124.81 |
| 71 | 577.18 | 128.28 |
| 72 | 580.72 | 131.82 |
| 73 | 584.19 | 135.41 |
| 74 | 587.60 | 139.07 |
| 75 | 590.94 | 142.79 |
| 76 | 594.21 | 146.57 |
| 77 | 597.42 | 150.41 |
| 78 | 600.55 | 154.31 |
| 79 | 603.61 | 158.26 |
| 80 | 606.60 | 162.27 |
| 81 | 609.52 | 166.33 |
| 82 | 610.48 | 167.71 |

Circle Center At X =  383.8 ; Y =  325.4  and Radius,  276.1
*** 1.568 ***

Failure Surface Specified By 82 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 249.19 | 81.94 |
| 2 | 253.63 | 79.63 |
| 3 | 258.11 | 77.40 |
| 4 | 262.62 | 75.26 |
| 5 | 267.18 | 73.19 |
| 6 | 271.77 | 71.21 |
| 7 | 276.39 | 69.31 |
| 8 | 281.05 | 67.49 |
| 9 | 285.74 | 65.76 |
| 10 | 290.46 | 64.11 |
| 11 | 295.21 | 62.55 |
| 12 | 299.98 | 61.07 |
| 13 | 304.79 | 59.68 |
| 14 | 309.61 | 58.37 |
| 15 | 314.46 | 57.15 |
| 16 | 319.33 | 56.02 |
| 17 | 324.22 | 54.98 |
| 18 | 329.13 | 54.02 |
| 19 | 334.05 | 53.15 |
| 20 | 338.99 | 52.37 |
| 21 | 343.94 | 51.68 |
| 22 | 348.91 | 51.08 |
| 23 | 353.88 | 50.56 |
| 24 | 358.86 | 50.14 |
| 25 | 363.85 | 49.81 |
| 26 | 368.85 | 49.56 |
| 27 | 373.84 | 49.41 |
| 28 | 378.84 | 49.34 |
| 29 | 383.84 | 49.36 |
| 30 | 388.84 | 49.48 |
| 31 | 393.84 | 49.68 |
| 32 | 398.83 | 49.97 |
| 33 | 403.81 | 50.36 |
| 34 | 408.79 | 50.83 |
| 35 | 413.76 | 51.39 |
| 36 | 418.72 | 52.04 |
| 37 | 423.66 | 52.78 |
| 38 | 428.59 | 53.61 |
| 39 | 433.51 | 54.52 |
| 40 | 438.41 | 55.53 |
| 41 | 443.29 | 56.62 |
| 42 | 448.15 | 57.80 |
| 43 | 452.98 | 59.06 |
| 44 | 457.80 | 60.41 |
| 45 | 462.59 | 61.85 |
| 46 | 467.35 | 63.38 |
| 47 | 472.08 | 64.99 |
| 48 | 476.79 | 66.68 |

| | | |
|---|---|---|
| 49 | 481.46 | 68.46 |
| 50 | 486.10 | 70.32 |
| 51 | 490.71 | 72.27 |
| 52 | 495.28 | 74.29 |
| 53 | 499.81 | 76.40 |
| 54 | 504.31 | 78.59 |
| 55 | 508.76 | 80.86 |
| 56 | 513.17 | 83.21 |
| 57 | 517.54 | 85.64 |
| 58 | 521.87 | 88.15 |
| 59 | 526.15 | 90.73 |
| 60 | 530.39 | 93.39 |
| 61 | 534.57 | 96.12 |
| 62 | 538.71 | 98.93 |
| 63 | 542.79 | 101.82 |
| 64 | 546.82 | 104.77 |
| 65 | 550.80 | 107.80 |
| 66 | 554.73 | 110.90 |
| 67 | 558.59 | 114.07 |
| 68 | 562.40 | 117.31 |
| 69 | 566.15 | 120.61 |
| 70 | 569.85 | 123.99 |
| 71 | 573.48 | 127.43 |
| 72 | 577.04 | 130.93 |
| 73 | 580.55 | 134.49 |
| 74 | 583.99 | 138.12 |
| 75 | 587.36 | 141.81 |
| 76 | 590.67 | 145.56 |
| 77 | 593.91 | 149.37 |
| 78 | 597.08 | 153.24 |
| 79 | 600.18 | 157.16 |
| 80 | 603.21 | 161.14 |
| 81 | 606.17 | 165.17 |
| 82 | 607.88 | 167.58 |

Circle Center At X = 380.0 ; Y = 328.0 and Radius, 278.7

*** 1.569 ***

Failure Surface Specified By 77 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 273.23 | 82.27 |
| 2 | 277.58 | 79.80 |
| 3 | 281.98 | 77.43 |
| 4 | 286.43 | 75.14 |
| 5 | 290.92 | 72.95 |
| 6 | 295.46 | 70.85 |
| 7 | 300.04 | 68.84 |
| 8 | 304.66 | 66.93 |
| 9 | 309.32 | 65.11 |
| 10 | 314.01 | 63.39 |
| 11 | 318.74 | 61.76 |
| 12 | 323.50 | 60.23 |
| 13 | 328.29 | 58.80 |
| 14 | 333.11 | 57.47 |
| 15 | 337.95 | 56.23 |
| 16 | 342.82 | 55.10 |
| 17 | 347.71 | 54.06 |
| 18 | 352.63 | 53.13 |
| 19 | 357.56 | 52.29 |
| 20 | 362.50 | 51.56 |
| 21 | 367.46 | 50.93 |
| 22 | 372.43 | 50.40 |
| 23 | 377.42 | 49.97 |
| 24 | 382.40 | 49.64 |
| 25 | 387.40 | 49.42 |
| 26 | 392.40 | 49.30 |
| 27 | 397.40 | 49.28 |
| 28 | 402.40 | 49.36 |
| 29 | 407.39 | 49.55 |
| 30 | 412.39 | 49.83 |
| 31 | 417.37 | 50.22 |

| | | |
|---|---|---|
| 32 | 422.35 | 50.71 |
| 33 | 427.31 | 51.31 |
| 34 | 432.26 | 52.00 |
| 35 | 437.20 | 52.80 |
| 36 | 442.12 | 53.69 |
| 37 | 447.02 | 54.69 |
| 38 | 451.90 | 55.79 |
| 39 | 456.75 | 56.99 |
| 40 | 461.58 | 58.28 |
| 41 | 466.38 | 59.68 |
| 42 | 471.15 | 61.17 |
| 43 | 475.89 | 62.76 |
| 44 | 480.60 | 64.44 |
| 45 | 485.27 | 66.23 |
| 46 | 489.91 | 68.10 |
| 47 | 494.50 | 70.08 |
| 48 | 499.05 | 72.14 |
| 49 | 503.56 | 74.30 |
| 50 | 508.03 | 76.55 |
| 51 | 512.45 | 78.89 |
| 52 | 516.82 | 81.32 |
| 53 | 521.13 | 83.84 |
| 54 | 525.40 | 86.45 |
| 55 | 529.61 | 89.15 |
| 56 | 533.77 | 91.93 |
| 57 | 537.87 | 94.79 |
| 58 | 541.90 | 97.74 |
| 59 | 545.88 | 100.77 |
| 60 | 549.80 | 103.88 |
| 61 | 553.65 | 107.07 |
| 62 | 557.43 | 110.34 |
| 63 | 561.15 | 113.68 |
| 64 | 564.79 | 117.10 |
| 65 | 568.37 | 120.60 |
| 66 | 571.87 | 124.17 |
| 67 | 575.30 | 127.80 |
| 68 | 578.66 | 131.51 |
| 69 | 581.94 | 135.29 |
| 70 | 585.14 | 139.13 |
| 71 | 588.26 | 143.03 |
| 72 | 591.30 | 147.00 |
| 73 | 594.26 | 151.03 |
| 74 | 597.13 | 155.12 |
| 75 | 599.93 | 159.27 |
| 76 | 602.63 | 163.48 |
| 77 | 605.07 | 167.44 |

Circle Center At X =  395.8 ; Y =  293.6  and Radius,  244.3

*** 1.570 ***

Failure Surface Specified By 77 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 273.23 | 82.27 |
| 2 | 277.59 | 79.82 |
| 3 | 282.00 | 77.46 |
| 4 | 286.45 | 75.19 |
| 5 | 290.95 | 73.01 |
| 6 | 295.50 | 70.92 |
| 7 | 300.08 | 68.93 |
| 8 | 304.71 | 67.04 |
| 9 | 309.38 | 65.24 |
| 10 | 314.08 | 63.53 |
| 11 | 318.81 | 61.93 |
| 12 | 323.58 | 60.42 |
| 13 | 328.38 | 59.01 |
| 14 | 333.20 | 57.70 |
| 15 | 338.05 | 56.49 |
| 16 | 342.93 | 55.38 |
| 17 | 347.82 | 54.37 |
| 18 | 352.74 | 53.46 |
| 19 | 357.68 | 52.65 |

| | | |
|---|---|---|
| 20 | 362.63 | 51.95 |
| 21 | 367.59 | 51.34 |
| 22 | 372.56 | 50.84 |
| 23 | 377.55 | 50.45 |
| 24 | 382.54 | 50.15 |
| 25 | 387.54 | 49.96 |
| 26 | 392.54 | 49.87 |
| 27 | 397.54 | 49.88 |
| 28 | 402.53 | 50.00 |
| 29 | 407.53 | 50.22 |
| 30 | 412.52 | 50.54 |
| 31 | 417.50 | 50.97 |
| 32 | 422.47 | 51.50 |
| 33 | 427.43 | 52.13 |
| 34 | 432.38 | 52.86 |
| 35 | 437.31 | 53.69 |
| 36 | 442.22 | 54.63 |
| 37 | 447.11 | 55.67 |
| 38 | 451.98 | 56.80 |
| 39 | 456.82 | 58.04 |
| 40 | 461.64 | 59.38 |
| 41 | 466.43 | 60.81 |
| 42 | 471.19 | 62.35 |
| 43 | 475.92 | 63.98 |
| 44 | 480.61 | 65.71 |
| 45 | 485.26 | 67.54 |
| 46 | 489.88 | 69.46 |
| 47 | 494.45 | 71.47 |
| 48 | 498.99 | 73.58 |
| 49 | 503.48 | 75.78 |
| 50 | 507.92 | 78.08 |
| 51 | 512.31 | 80.47 |
| 52 | 516.66 | 82.94 |
| 53 | 520.95 | 85.51 |
| 54 | 525.19 | 88.16 |
| 55 | 529.37 | 90.90 |
| 56 | 533.49 | 93.72 |
| 57 | 537.56 | 96.63 |
| 58 | 541.57 | 99.63 |
| 59 | 545.51 | 102.70 |
| 60 | 549.39 | 105.86 |
| 61 | 553.20 | 109.09 |
| 62 | 556.95 | 112.40 |
| 63 | 560.62 | 115.79 |
| 64 | 564.23 | 119.26 |
| 65 | 567.76 | 122.80 |
| 66 | 571.22 | 126.40 |
| 67 | 574.60 | 130.09 |
| 68 | 577.91 | 133.83 |
| 69 | 581.14 | 137.65 |
| 70 | 584.29 | 141.53 |
| 71 | 587.36 | 145.48 |
| 72 | 590.35 | 149.49 |
| 73 | 593.26 | 153.56 |
| 74 | 596.08 | 157.69 |
| 75 | 598.81 | 161.87 |
| 76 | 601.46 | 166.11 |
| 77 | 602.16 | 167.29 |

Circle Center At X = 394.4 ; Y = 292.4 and Radius, 242.6

*** 1.573 ***

Failure Surface Specified By 78 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 263.33 | 82.13 |
| 2 | 267.75 | 79.79 |
| 3 | 272.21 | 77.53 |
| 4 | 276.71 | 75.35 |
| 5 | 281.26 | 73.27 |
| 6 | 285.84 | 71.27 |
| 7 | 290.46 | 69.36 |

| | | |
|---|---|---|
| 8 | 295.12 | 67.55 |
| 9 | 299.81 | 65.82 |
| 10 | 304.54 | 64.18 |
| 11 | 309.29 | 62.64 |
| 12 | 314.08 | 61.19 |
| 13 | 318.89 | 59.84 |
| 14 | 323.73 | 58.57 |
| 15 | 328.59 | 57.40 |
| 16 | 333.47 | 56.33 |
| 17 | 338.38 | 55.35 |
| 18 | 343.30 | 54.47 |
| 19 | 348.24 | 53.68 |
| 20 | 353.19 | 52.99 |
| 21 | 358.15 | 52.40 |
| 22 | 363.13 | 51.90 |
| 23 | 368.11 | 51.50 |
| 24 | 373.10 | 51.19 |
| 25 | 378.10 | 50.99 |
| 26 | 383.10 | 50.88 |
| 27 | 388.10 | 50.86 |
| 28 | 393.10 | 50.95 |
| 29 | 398.09 | 51.13 |
| 30 | 403.09 | 51.41 |
| 31 | 408.07 | 51.78 |
| 32 | 413.05 | 52.25 |
| 33 | 418.02 | 52.82 |
| 34 | 422.97 | 53.49 |
| 35 | 427.91 | 54.25 |
| 36 | 432.84 | 55.11 |
| 37 | 437.75 | 56.06 |
| 38 | 442.64 | 57.11 |
| 39 | 447.50 | 58.25 |
| 40 | 452.35 | 59.49 |
| 41 | 457.17 | 60.82 |
| 42 | 461.96 | 62.25 |
| 43 | 466.73 | 63.76 |
| 44 | 471.46 | 65.38 |
| 45 | 476.16 | 67.08 |
| 46 | 480.83 | 68.87 |
| 47 | 485.46 | 70.75 |
| 48 | 490.05 | 72.73 |
| 49 | 494.61 | 74.79 |
| 50 | 499.12 | 76.94 |
| 51 | 503.59 | 79.18 |
| 52 | 508.02 | 81.50 |
| 53 | 512.40 | 83.91 |
| 54 | 516.74 | 86.40 |
| 55 | 521.02 | 88.98 |
| 56 | 525.25 | 91.64 |
| 57 | 529.43 | 94.39 |
| 58 | 533.56 | 97.21 |
| 59 | 537.63 | 100.11 |
| 60 | 541.65 | 103.09 |
| 61 | 545.60 | 106.15 |
| 62 | 549.49 | 109.29 |
| 63 | 553.33 | 112.50 |
| 64 | 557.10 | 115.78 |
| 65 | 560.80 | 119.14 |
| 66 | 564.44 | 122.57 |
| 67 | 568.02 | 126.07 |
| 68 | 571.52 | 129.63 |
| 69 | 574.95 | 133.27 |
| 70 | 578.31 | 136.97 |
| 71 | 581.60 | 140.73 |
| 72 | 584.82 | 144.56 |
| 73 | 587.96 | 148.45 |
| 74 | 591.03 | 152.40 |
| 75 | 594.01 | 156.41 |
| 76 | 596.92 | 160.48 |
| 77 | 599.75 | 164.60 |

| | | |
|---|---|---|
| 78 | 601.50 | 167.26 |

Circle Center At X = 386.3 ; Y = 308.0 and Radius, 257.2
*** 1.574 ***
Failure Surface Specified By 83 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 249.90 | 81.95 |
| 2 | 254.35 | 79.67 |
| 3 | 258.84 | 77.46 |
| 4 | 263.36 | 75.34 |
| 5 | 267.93 | 73.29 |
| 6 | 272.52 | 71.33 |
| 7 | 277.16 | 69.44 |
| 8 | 281.82 | 67.64 |
| 9 | 286.51 | 65.92 |
| 10 | 291.24 | 64.28 |
| 11 | 295.99 | 62.72 |
| 12 | 300.76 | 61.24 |
| 13 | 305.57 | 59.85 |
| 14 | 310.39 | 58.54 |
| 15 | 315.24 | 57.32 |
| 16 | 320.11 | 56.18 |
| 17 | 325.00 | 55.12 |
| 18 | 329.90 | 54.15 |
| 19 | 334.82 | 53.27 |
| 20 | 339.76 | 52.47 |
| 21 | 344.71 | 51.76 |
| 22 | 349.67 | 51.13 |
| 23 | 354.64 | 50.59 |
| 24 | 359.62 | 50.14 |
| 25 | 364.60 | 49.77 |
| 26 | 369.60 | 49.49 |
| 27 | 374.59 | 49.30 |
| 28 | 379.59 | 49.19 |
| 29 | 384.59 | 49.18 |
| 30 | 389.59 | 49.24 |
| 31 | 394.59 | 49.40 |
| 32 | 399.58 | 49.64 |
| 33 | 404.57 | 49.97 |
| 34 | 409.55 | 50.39 |
| 35 | 414.53 | 50.89 |
| 36 | 419.49 | 51.48 |
| 37 | 424.45 | 52.15 |
| 38 | 429.39 | 52.91 |
| 39 | 434.32 | 53.76 |
| 40 | 439.23 | 54.69 |
| 41 | 444.13 | 55.71 |
| 42 | 449.00 | 56.81 |
| 43 | 453.86 | 58.00 |
| 44 | 458.69 | 59.27 |
| 45 | 463.51 | 60.63 |
| 46 | 468.30 | 62.07 |
| 47 | 473.06 | 63.59 |
| 48 | 477.79 | 65.20 |
| 49 | 482.50 | 66.88 |
| 50 | 487.18 | 68.65 |
| 51 | 491.82 | 70.50 |
| 52 | 496.43 | 72.43 |
| 53 | 501.01 | 74.45 |
| 54 | 505.55 | 76.54 |
| 55 | 510.06 | 78.70 |
| 56 | 514.53 | 80.95 |
| 57 | 518.95 | 83.28 |
| 58 | 523.34 | 85.68 |
| 59 | 527.68 | 88.15 |
| 60 | 531.98 | 90.70 |
| 61 | 536.24 | 93.33 |
| 62 | 540.45 | 96.03 |
| 63 | 544.61 | 98.80 |
| 64 | 548.72 | 101.65 |

| | | |
|---|---|---|
| 65 | 552.78 | 104.56 |
| 66 | 556.79 | 107.55 |
| 67 | 560.75 | 110.61 |
| 68 | 564.65 | 113.73 |
| 69 | 568.50 | 116.92 |
| 70 | 572.29 | 120.18 |
| 71 | 576.03 | 123.50 |
| 72 | 579.71 | 126.89 |
| 73 | 583.32 | 130.34 |
| 74 | 586.88 | 133.86 |
| 75 | 590.38 | 137.43 |
| 76 | 593.81 | 141.07 |
| 77 | 597.18 | 144.76 |
| 78 | 600.48 | 148.51 |
| 79 | 603.72 | 152.32 |
| 80 | 606.89 | 156.19 |
| 81 | 610.00 | 160.11 |
| 82 | 613.03 | 164.08 |
| 83 | 615.91 | 167.98 |

Circle Center At X =  383.2 ; Y =  336.5  and Radius,  287.4
*** 1.575 ***
Failure Surface Specified By 76 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 273.23 | 82.27 |
| 2 | 277.60 | 79.83 |
| 3 | 282.01 | 77.48 |
| 4 | 286.47 | 75.23 |
| 5 | 290.98 | 73.07 |
| 6 | 295.54 | 71.00 |
| 7 | 300.13 | 69.02 |
| 8 | 304.76 | 67.15 |
| 9 | 309.44 | 65.37 |
| 10 | 314.14 | 63.68 |
| 11 | 318.89 | 62.10 |
| 12 | 323.66 | 60.61 |
| 13 | 328.46 | 59.22 |
| 14 | 333.30 | 57.94 |
| 15 | 338.15 | 56.75 |
| 16 | 343.03 | 55.67 |
| 17 | 347.94 | 54.68 |
| 18 | 352.86 | 53.80 |
| 19 | 357.80 | 53.02 |
| 20 | 362.75 | 52.34 |
| 21 | 367.72 | 51.77 |
| 22 | 372.69 | 51.30 |
| 23 | 377.68 | 50.93 |
| 24 | 382.67 | 50.67 |
| 25 | 387.67 | 50.51 |
| 26 | 392.67 | 50.46 |
| 27 | 397.67 | 50.50 |
| 28 | 402.67 | 50.66 |
| 29 | 407.66 | 50.91 |
| 30 | 412.65 | 51.27 |
| 31 | 417.63 | 51.73 |
| 32 | 422.60 | 52.30 |
| 33 | 427.55 | 52.97 |
| 34 | 432.49 | 53.74 |
| 35 | 437.41 | 54.62 |
| 36 | 442.32 | 55.59 |
| 37 | 447.20 | 56.67 |
| 38 | 452.06 | 57.85 |
| 39 | 456.89 | 59.13 |
| 40 | 461.70 | 60.51 |
| 41 | 466.47 | 61.99 |
| 42 | 471.22 | 63.57 |
| 43 | 475.93 | 65.24 |
| 44 | 480.60 | 67.02 |
| 45 | 485.24 | 68.89 |
| 46 | 489.84 | 70.85 |

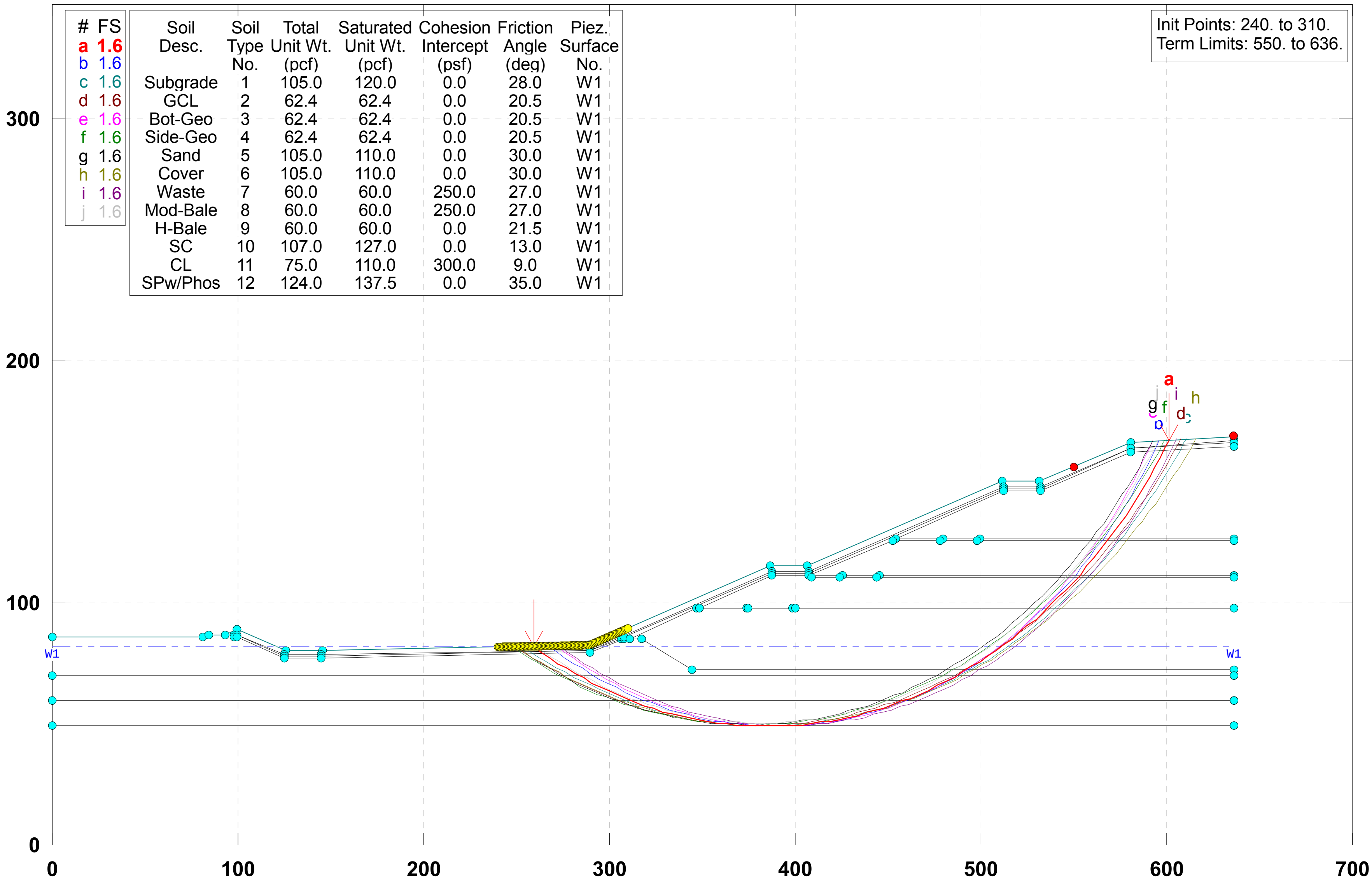
| | | |
|---|---|---|
| 47 | 494.39 | 72.91 |
| 48 | 498.90 | 75.07 |
| 49 | 503.37 | 77.32 |
| 50 | 507.79 | 79.66 |
| 51 | 512.16 | 82.09 |
| 52 | 516.47 | 84.61 |
| 53 | 520.74 | 87.23 |
| 54 | 524.95 | 89.93 |
| 55 | 529.10 | 92.71 |
| 56 | 533.19 | 95.58 |
| 57 | 537.22 | 98.54 |
| 58 | 541.19 | 101.58 |
| 59 | 545.10 | 104.70 |
| 60 | 548.94 | 107.90 |
| 61 | 552.71 | 111.18 |
| 62 | 556.42 | 114.54 |
| 63 | 560.05 | 117.98 |
| 64 | 563.61 | 121.49 |
| 65 | 567.10 | 125.07 |
| 66 | 570.51 | 128.72 |
| 67 | 573.85 | 132.45 |
| 68 | 577.11 | 136.24 |
| 69 | 580.29 | 140.10 |
| 70 | 583.39 | 144.02 |
| 71 | 586.40 | 148.01 |
| 72 | 589.33 | 152.06 |
| 73 | 592.18 | 156.17 |
| 74 | 594.94 | 160.34 |
| 75 | 597.62 | 164.56 |
| 76 | 599.18 | 167.14 |

Circle Center At X = 392.8 ; Y = 291.2 and Radius, 240.8

*** 1.577 ***

# Phase II Section II Expansion RAI No. 1 Phase I West Slope During Construction

C:\1\HARDEE~1.1\4HARDE~1.1\EWCI\EWSECCI.PL2 Run By: Shane R. Fischer, P.E. 03/31/13 5:20AM




| Soil Desc. | Soil Type No. | Total Unit Wt. (pcf) | Saturated Unit Wt. (pcf) | Cohesion Intercept (psf) | Friction Angle (deg) | Piez. Surface No. |
|---|---|---|---|---|---|---|
| Subgrade | 1 | 105.0 | 120.0 | 0.0 | 28.0 | W1 |
| GCL | 2 | 62.4 | 62.4 | 0.0 | 20.5 | W1 |
| Bot-Geo | 3 | 62.4 | 62.4 | 0.0 | 20.5 | W1 |
| Side-Geo | 4 | 62.4 | 62.4 | 0.0 | 20.5 | W1 |
| Sand | 5 | 105.0 | 110.0 | 0.0 | 30.0 | W1 |
| Cover | 6 | 105.0 | 110.0 | 0.0 | 30.0 | W1 |
| Waste | 7 | 60.0 | 60.0 | 250.0 | 27.0 | W1 |
| Mod-Bale | 8 | 60.0 | 60.0 | 250.0 | 27.0 | W1 |
| H-Bale | 9 | 60.0 | 60.0 | 0.0 | 21.5 | W1 |
| SC | 10 | 107.0 | 127.0 | 0.0 | 13.0 | W1 |
| CL | 11 | 75.0 | 110.0 | 300.0 | 9.0 | W1 |
| SPw/Phos | 12 | 124.0 | 137.5 | 0.0 | 35.0 | W1 |

**PCSTABL5M/si FSmin=1.6**

**Safety Factors Are Calculated By The Modified Bishop Method**

SCS ENGINEERS

**** PCSTABL5M ****
by
Purdue University
--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer`s Method of Slices

Run Date: 03/31/13
Time of Run: 5:20AM
Run By: Shane R. Fischer, P.E.
Input Data Filename: C:ewsecci.
Output Filename: C:ewsecci.OUT
Unit: ENGLISH
Plotted Output Filename: C:ewsecci.PLT
PROBLEM DESCRIPTION Phase II Section II Expansion RAI No. 1
Phase I West Slope During Construction

BOUNDARY COORDINATES
14 Top Boundaries
87 Total Boundaries

| Boundary No. | X-Left (ft) | Y-Left (ft) | X-Right (ft) | Y-Right (ft) | Soil Type Below Bnd |
|---|---|---|---|---|---|
| 1 | .00 | 86.00 | 81.46 | 86.00 | 1 |
| 2 | 81.46 | 86.00 | 84.47 | 87.00 | 1 |
| 3 | 84.47 | 87.00 | 93.14 | 87.00 | 1 |
| 4 | 93.14 | 87.00 | 99.14 | 89.00 | 6 |
| 5 | 99.14 | 89.00 | 99.79 | 89.00 | 6 |
| 6 | 99.79 | 89.00 | 125.29 | 80.50 | 6 |
| 7 | 125.29 | 80.50 | 145.29 | 80.50 | 6 |
| 8 | 145.29 | 80.50 | 289.16 | 82.49 | 6 |
| 9 | 289.16 | 82.49 | 386.69 | 115.00 | 6 |
| 10 | 386.69 | 115.00 | 406.69 | 115.00 | 6 |
| 11 | 406.69 | 115.00 | 511.69 | 150.00 | 6 |
| 12 | 511.69 | 150.00 | 531.69 | 150.00 | 6 |
| 13 | 531.69 | 150.00 | 580.29 | 166.20 | 6 |
| 14 | 580.29 | 166.20 | 636.29 | 169.00 | 6 |
| 15 | 93.14 | 87.00 | 97.46 | 87.00 | 1 |
| 16 | 97.46 | 87.00 | 99.46 | 87.00 | 3 |
| 17 | 99.46 | 87.00 | 124.96 | 78.50 | 3 |
| 18 | 124.96 | 78.50 | 144.96 | 78.50 | 3 |
| 19 | 144.96 | 78.50 | 289.51 | 80.50 | 3 |
| 20 | 289.51 | 80.50 | 306.09 | 86.02 | 3 |
| 21 | 306.09 | 86.02 | 387.01 | 113.00 | 4 |
| 22 | 387.01 | 113.00 | 407.01 | 113.00 | 4 |
| 23 | 407.01 | 113.00 | 512.01 | 148.00 | 4 |
| 24 | 512.01 | 148.00 | 532.01 | 148.00 | 4 |
| 25 | 532.01 | 148.00 | 580.29 | 164.09 | 4 |
| 26 | 580.29 | 164.09 | 636.29 | 166.89 | 4 |
| 27 | 97.46 | 86.53 | 99.30 | 86.53 | 2 |
| 28 | 99.30 | 86.53 | 124.99 | 78.00 | 2 |
| 29 | 124.99 | 78.00 | 144.99 | 78.00 | 2 |
| 30 | 144.99 | 78.00 | 289.59 | 80.00 | 2 |
| 31 | 289.59 | 80.00 | 305.93 | 85.44 | 2 |
| 32 | 305.93 | 85.44 | 306.09 | 86.02 | 4 |
| 33 | 305.93 | 85.44 | 307.91 | 86.10 | 2 |
| 34 | 307.91 | 86.10 | 387.09 | 112.50 | 5 |
| 35 | 387.09 | 112.50 | 407.09 | 112.50 | 5 |
| 36 | 407.09 | 112.50 | 512.09 | 147.50 | 5 |
| 37 | 512.09 | 147.50 | 532.09 | 147.50 | 5 |
| 38 | 532.09 | 147.50 | 580.38 | 163.59 | 5 |
| 39 | 580.38 | 163.59 | 636.29 | 166.39 | 5 |
| 40 | 97.46 | 86.03 | 99.22 | 86.03 | 1 |
| 41 | 99.22 | 86.03 | 124.91 | 77.50 | 1 |
| 42 | 124.91 | 77.50 | 144.99 | 77.50 | 1 |
| 43 | 144.99 | 77.50 | 289.68 | 79.50 | 1 |
| 44 | 289.68 | 79.50 | 307.67 | 85.50 | 1 |
| 45 | 307.67 | 85.50 | 307.91 | 86.10 | 6 |
| 46 | 307.67 | 85.50 | 310.84 | 85.50 | 1 |
| 47 | 310.84 | 85.50 | 346.84 | 97.50 | 8 |
| 48 | 346.84 | 97.50 | 348.34 | 98.00 | 8 |
| 49 | 348.34 | 98.00 | 387.34 | 111.00 | 8 |
| 50 | 387.34 | 111.00 | 407.34 | 111.00 | 8 |

| | | | | | |
|---|---|---|---|---|---|
| 51 | 407.34 | 111.00 | 452.34 | 126.00 | 5 |
| 52 | 452.34 | 126.00 | 453.84 | 126.50 | 8 |
| 53 | 453.84 | 126.50 | 512.34 | 146.00 | 7 |
| 54 | 512.34 | 146.00 | 532.34 | 146.00 | 7 |
| 55 | 532.34 | 146.00 | 580.29 | 161.98 | 7 |
| 56 | 580.29 | 161.98 | 636.29 | 164.78 | 7 |
| 57 | 453.84 | 126.50 | 479.80 | 126.50 | 8 |
| 58 | 479.80 | 126.50 | 499.68 | 126.50 | 9 |
| 59 | 499.68 | 126.50 | 636.29 | 126.50 | 8 |
| 60 | 452.34 | 126.00 | 478.05 | 126.00 | 8 |
| 61 | 478.05 | 126.00 | 479.80 | 126.50 | 9 |
| 62 | 478.05 | 126.00 | 498.18 | 126.00 | 8 |
| 63 | 498.18 | 126.00 | 499.68 | 126.50 | 8 |
| 64 | 498.18 | 126.00 | 636.29 | 126.00 | 8 |
| 65 | 407.34 | 111.00 | 425.29 | 111.00 | 8 |
| 66 | 425.29 | 111.00 | 445.17 | 111.00 | 9 |
| 67 | 445.17 | 111.00 | 636.29 | 111.00 | 8 |
| 68 | 407.34 | 111.00 | 408.84 | 110.50 | 8 |
| 69 | 408.84 | 110.50 | 423.54 | 110.50 | 8 |
| 70 | 423.54 | 110.50 | 425.29 | 111.00 | 9 |
| 71 | 423.54 | 110.50 | 443.67 | 110.50 | 8 |
| 72 | 443.67 | 110.50 | 445.17 | 111.00 | 8 |
| 73 | 443.67 | 110.50 | 636.29 | 110.50 | 8 |
| 74 | 348.34 | 98.00 | 374.93 | 98.00 | 8 |
| 75 | 374.93 | 98.00 | 399.93 | 98.00 | 9 |
| 76 | 399.93 | 98.00 | 636.29 | 98.00 | 8 |
| 77 | 346.84 | 97.50 | 373.43 | 97.50 | 8 |
| 78 | 373.43 | 97.50 | 374.93 | 98.00 | 9 |
| 79 | 373.43 | 97.50 | 398.43 | 97.50 | 8 |
| 80 | 398.43 | 97.50 | 399.93 | 98.00 | 8 |
| 81 | 398.43 | 97.50 | 636.29 | 97.50 | 8 |
| 82 | 310.84 | 85.50 | 317.52 | 85.50 | 1 |
| 83 | 317.52 | 85.50 | 344.52 | 72.00 | 1 |
| 84 | 344.52 | 72.00 | 636.29 | 72.00 | 1 |
| 85 | .00 | 70.00 | 636.29 | 70.00 | 10 |
| 86 | .00 | 60.00 | 636.29 | 60.00 | 11 |
| 87 | .00 | 49.00 | 636.29 | 49.00 | 12 |

ISOTROPIC SOIL PARAMETERS

12 Type(s) of Soil

| Soil Type No. | Total Unit Wt. (pcf) | Saturated Unit Wt. (pcf) | Cohesion Intercept (psf) | Friction Angle (deg) | Pore Pressure Param. | Pressure Constant (psf) | Piez. Surface No. |
|---|---|---|---|---|---|---|---|
| 1 | 105.0 | 120.0 | .0 | 28.0 | .00 | .0 | 1 |
| 2 | 62.4 | 62.4 | .0 | 20.5 | .00 | .0 | 1 |
| 3 | 62.4 | 62.4 | .0 | 20.5 | .00 | .0 | 1 |
| 4 | 62.4 | 62.4 | .0 | 20.5 | .00 | .0 | 1 |
| 5 | 105.0 | 110.0 | .0 | 30.0 | .00 | .0 | 1 |
| 6 | 105.0 | 110.0 | .0 | 30.0 | .00 | .0 | 1 |
| 7 | 60.0 | 60.0 | 250.0 | 27.0 | .00 | .0 | 1 |
| 8 | 60.0 | 60.0 | 250.0 | 27.0 | .00 | .0 | 1 |
| 9 | 60.0 | 60.0 | .0 | 21.5 | .00 | .0 | 1 |
| 10 | 107.0 | 127.0 | .0 | 13.0 | .00 | .0 | 1 |
| 11 | 75.0 | 110.0 | 300.0 | 9.0 | .00 | .0 | 1 |
| 12 | 124.0 | 137.5 | .0 | 35.0 | .00 | .0 | 1 |

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

Unit Weight of Water = 62.40

Piezometric Surface No. 1 Specified by 2 Coordinate Points

| Point No. | X-Water (ft) | Y-Water (ft) |
|---|---|---|
| 1 | .00 | 82.09 |
| 2 | 636.29 | 82.09 |

BOUNDARY LOAD(S)

1 Load(s) Specified

| Load No. | X-Left (ft) | X-Right (ft) | Intensity (psf) | Deflection (deg) |
|---|---|---|---|---|
| 1 | 626.80 | 636.29 | 1581.0 | .0 |

NOTE - Intensity Is Specified As A Uniformly Distributed
Force Acting On A Horizontally Projected Surface.

SURCHARGE BOUNDARY LOAD DATA HAS BEEN SUPPRESSED

A Critical Failure Surface Searching Method, Using A Random

Technique For Generating Circular Surfaces, Has Been Specified.
5000 Trial Surfaces Have Been Generated.
50 Surfaces Initiate From Each Of100 Points Equally Spaced
Along The Ground Surface Between X = 240.00 ft.
and X = 310.00 ft.
Each Surface Terminates Between X = 550.00 ft.
and X = 636.00 ft.
Unless Further Limitations Were Imposed, The Minimum Elevation
At Which A Surface Extends Is Y = .00 ft.
5.00 ft. Line Segments Define Each Trial Failure Surface.
Following Are Displayed The Ten Most Critical Of The Trial
Failure Surfaces Examined. They Are Ordered - Most Critical
First.
* * Safety Factors Are Calculated By The Modified Bishop Method * *
Failure Surface Specified By 79 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 259.09 | 82.07 |
| 2 | 263.47 | 79.66 |
| 3 | 267.90 | 77.33 |
| 4 | 272.37 | 75.09 |
| 5 | 276.88 | 72.94 |
| 6 | 281.43 | 70.88 |
| 7 | 286.03 | 68.90 |
| 8 | 290.66 | 67.01 |
| 9 | 295.32 | 65.22 |
| 10 | 300.02 | 63.51 |
| 11 | 304.76 | 61.90 |
| 12 | 309.52 | 60.38 |
| 13 | 314.31 | 58.96 |
| 14 | 319.13 | 57.62 |
| 15 | 323.98 | 56.39 |
| 16 | 328.84 | 55.24 |
| 17 | 333.73 | 54.19 |
| 18 | 338.64 | 53.24 |
| 19 | 343.57 | 52.38 |
| 20 | 348.51 | 51.62 |
| 21 | 353.46 | 50.95 |
| 22 | 358.43 | 50.39 |
| 23 | 363.41 | 49.91 |
| 24 | 368.39 | 49.54 |
| 25 | 373.39 | 49.26 |
| 26 | 378.38 | 49.08 |
| 27 | 383.38 | 49.00 |
| 28 | 388.38 | 49.01 |
| 29 | 393.38 | 49.13 |
| 30 | 398.38 | 49.34 |
| 31 | 403.37 | 49.64 |
| 32 | 408.35 | 50.05 |
| 33 | 413.33 | 50.55 |
| 34 | 418.29 | 51.15 |
| 35 | 423.24 | 51.84 |
| 36 | 428.18 | 52.63 |
| 37 | 433.10 | 53.52 |
| 38 | 438.00 | 54.50 |
| 39 | 442.88 | 55.58 |
| 40 | 447.74 | 56.75 |
| 41 | 452.58 | 58.02 |
| 42 | 457.39 | 59.38 |
| 43 | 462.18 | 60.83 |
| 44 | 466.93 | 62.38 |
| 45 | 471.65 | 64.02 |
| 46 | 476.34 | 65.75 |
| 47 | 481.00 | 67.58 |
| 48 | 485.62 | 69.49 |
| 49 | 490.20 | 71.49 |
| 50 | 494.74 | 73.59 |
| 51 | 499.24 | 75.76 |
| 52 | 503.70 | 78.03 |
| 53 | 508.11 | 80.39 |

| | | |
|---|---|---|
| 54 | 512.48 | 82.82 |
| 55 | 516.79 | 85.35 |
| 56 | 521.06 | 87.96 |
| 57 | 525.27 | 90.64 |
| 58 | 529.43 | 93.42 |
| 59 | 533.54 | 96.27 |
| 60 | 537.59 | 99.20 |
| 61 | 541.58 | 102.21 |
| 62 | 545.52 | 105.30 |
| 63 | 549.39 | 108.46 |
| 64 | 553.20 | 111.70 |
| 65 | 556.95 | 115.01 |
| 66 | 560.63 | 118.39 |
| 67 | 564.24 | 121.85 |
| 68 | 567.79 | 125.37 |
| 69 | 571.27 | 128.97 |
| 70 | 574.67 | 132.63 |
| 71 | 578.01 | 136.35 |
| 72 | 581.27 | 140.14 |
| 73 | 584.45 | 143.99 |
| 74 | 587.56 | 147.91 |
| 75 | 590.60 | 151.88 |
| 76 | 593.55 | 155.92 |
| 77 | 596.43 | 160.01 |
| 78 | 599.23 | 164.15 |
| 79 | 601.23 | 167.25 |

Circle Center At X = 385.1 ; Y = 305.6 and Radius, 256.6

*** 1.590 ***

Individual data on the 148 slices

| Slice No. | Width (ft) | Weight (lbs) | Water Force Top (lbs) | Water Force Bot (lbs) | Tie Force Norm (lbs) | Tie Force Tan (lbs) | Earthquake Force Hor (lbs) | Earthquake Force Ver (lbs) | Surcharge Load (lbs) |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 3.5 | 387.3 | .0 | 248.8 | .0 | .0 | .0 | .0 | .0 |
| 2 | .8 | 198.5 | .0 | 132.6 | .0 | .0 | .0 | .0 | .0 |
| 3 | .0 | 10.3 | .0 | 7.1 | .0 | .0 | .0 | .0 | .0 |
| 4 | .9 | 247.0 | .0 | 176.4 | .0 | .0 | .0 | .0 | .0 |
| 5 | 3.5 | 1359.7 | .0 | 937.4 | .0 | .0 | .0 | .0 | .0 |
| 6 | 4.5 | 2875.2 | .0 | 1833.5 | .0 | .0 | .0 | .0 | .0 |
| 7 | 4.5 | 4124.7 | .0 | 2518.9 | .0 | .0 | .0 | .0 | .0 |
| 8 | 4.6 | 5347.4 | .0 | 3176.9 | .0 | .0 | .0 | .0 | .0 |
| 9 | 2.0 | 2758.9 | .0 | 1610.5 | .0 | .0 | .0 | .0 | .0 |
| 10 | 2.6 | 3791.5 | .0 | 2196.7 | .0 | .0 | .0 | .0 | .0 |
| 11 | 3.1 | 5132.7 | .0 | 2920.6 | .0 | .0 | .0 | .0 | .0 |
| 12 | .4 | 607.7 | .0 | 342.8 | .0 | .0 | .0 | .0 | .0 |
| 13 | .1 | 140.3 | .0 | 78.8 | .0 | .0 | .0 | .0 | .0 |
| 14 | .1 | 158.4 | .0 | 88.9 | .0 | .0 | .0 | .0 | .0 |
| 15 | 1.0 | 1764.5 | .0 | 978.5 | .0 | .0 | .0 | .0 | .0 |
| 16 | 3.6 | 7294.8 | .0 | 3828.0 | .0 | .0 | .0 | .0 | .0 |
| 17 | 1.0 | 2296.1 | .0 | 1155.9 | .0 | .0 | .0 | .0 | .0 |
| 18 | .5 | 1244.4 | .0 | 613.8 | .0 | .0 | .0 | .0 | .0 |
| 19 | 1.6 | 3747.9 | .0 | 1817.7 | .0 | .0 | .0 | .0 | .0 |
| 20 | 2.6 | 6566.7 | .0 | 3098.2 | .0 | .0 | .0 | .0 | .0 |
| 21 | 4.7 | 13428.4 | .0 | 6047.0 | .0 | .0 | .0 | .0 | .0 |
| 22 | 1.2 | 3599.0 | .0 | 1566.1 | .0 | .0 | .0 | .0 | .0 |
| 23 | .2 | 498.8 | .0 | 215.8 | .0 | .0 | .0 | .0 | .0 |
| 24 | 1.6 | 5028.9 | .0 | 2159.3 | .0 | .0 | .0 | .0 | .0 |
| 25 | .2 | 783.0 | .0 | 332.5 | .0 | .0 | .0 | .0 | .0 |
| 26 | 1.6 | 5382.9 | .0 | 2261.9 | .0 | .0 | .0 | .0 | .0 |
| 27 | 1.3 | 4440.0 | .0 | 1834.2 | .0 | .0 | .0 | .0 | .0 |
| 28 | .0 | 117.2 | .0 | 48.2 | .0 | .0 | .0 | .0 | .0 |
| 29 | 3.5 | 12471.4 | .0 | 5112.7 | .0 | .0 | .0 | .0 | .0 |
| 30 | 3.2 | 12075.1 | .0 | 4896.5 | .0 | .0 | .0 | .0 | .0 |
| 31 | 1.6 | 6231.8 | .0 | 2529.0 | .0 | .0 | .0 | .0 | .0 |
| 32 | 4.8 | 19145.0 | .0 | 7826.7 | .0 | .0 | .0 | .0 | .0 |
| 33 | .4 | 1465.1 | .0 | 601.7 | .0 | .0 | .0 | .0 | .0 |
| 34 | 4.5 | 18274.4 | .0 | 7596.7 | .0 | .0 | .0 | .0 | .0 |
| 35 | 4.9 | 20177.9 | .0 | 8540.5 | .0 | .0 | .0 | .0 | .0 |
| 36 | 4.9 | 20558.5 | .0 | 8852.9 | .0 | .0 | .0 | .0 | .0 |
| 37 | 4.9 | 20880.9 | .0 | 9135.5 | .0 | .0 | .0 | .0 | .0 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 38 | 1.0 | 4070.3 | .0 | 1794.6 | .0 | .0 | .0 | .0 | .0 |
| 39 | 2.3 | 10001.7 | .0 | 4399.5 | .0 | .0 | .0 | .0 | .0 |
| 40 | 1.5 | 6572.5 | .0 | 2872.4 | .0 | .0 | .0 | .0 | .0 |
| 41 | .2 | 738.1 | .0 | 321.7 | .0 | .0 | .0 | .0 | .0 |
| 42 | 5.0 | 22308.4 | .0 | 9610.7 | .0 | .0 | .0 | .0 | .0 |
| 43 | 5.0 | 23192.6 | .0 | 9803.2 | .0 | .0 | .0 | .0 | .0 |
| 44 | 5.0 | 24019.7 | .0 | 9965.4 | .0 | .0 | .0 | .0 | .0 |
| 45 | 5.0 | 24788.3 | .0 | 10097.4 | .0 | .0 | .0 | .0 | .0 |
| 46 | 5.0 | 25496.9 | .0 | 10199.1 | .0 | .0 | .0 | .0 | .0 |
| 47 | .0 | 225.4 | .0 | 89.3 | .0 | .0 | .0 | .0 | .0 |
| 48 | 1.5 | 7787.2 | .0 | 3077.4 | .0 | .0 | .0 | .0 | .0 |
| 49 | 3.5 | 18131.9 | .0 | 7103.7 | .0 | .0 | .0 | .0 | .0 |
| 50 | 5.0 | 26530.4 | .0 | 10235.1 | .0 | .0 | .0 | .0 | .0 |
| 51 | .0 | 199.4 | .0 | 76.3 | .0 | .0 | .0 | .0 | .0 |
| 52 | .2 | 1111.6 | .0 | 424.8 | .0 | .0 | .0 | .0 | .0 |
| 53 | 3.1 | 16860.6 | .0 | 6403.7 | .0 | .0 | .0 | .0 | .0 |
| 54 | .3 | 1748.5 | .0 | 660.6 | .0 | .0 | .0 | .0 | .0 |
| 55 | .1 | 436.8 | .0 | 165.1 | .0 | .0 | .0 | .0 | .0 |
| 56 | .3 | 1364.8 | .0 | 516.0 | .0 | .0 | .0 | .0 | .0 |
| 57 | 1.0 | 5689.1 | .0 | 2151.7 | .0 | .0 | .0 | .0 | .0 |
| 58 | 5.0 | 27248.0 | .0 | 10302.2 | .0 | .0 | .0 | .0 | .0 |
| 59 | 5.0 | 27142.5 | .0 | 10251.9 | .0 | .0 | .0 | .0 | .0 |
| 60 | .1 | 288.2 | .0 | 108.9 | .0 | .0 | .0 | .0 | .0 |
| 61 | 1.5 | 8124.5 | .0 | 3066.9 | .0 | .0 | .0 | .0 | .0 |
| 62 | 3.4 | 18560.7 | .0 | 6995.6 | .0 | .0 | .0 | .0 | .0 |
| 63 | 3.3 | 17852.9 | .0 | 6721.3 | .0 | .0 | .0 | .0 | .0 |
| 64 | .3 | 1716.0 | .0 | 644.4 | .0 | .0 | .0 | .0 | .0 |
| 65 | .1 | 429.3 | .0 | 161.0 | .0 | .0 | .0 | .0 | .0 |
| 66 | .3 | 1342.7 | .0 | 503.0 | .0 | .0 | .0 | .0 | .0 |
| 67 | 1.0 | 5446.9 | .0 | 2030.8 | .0 | .0 | .0 | .0 | .0 |
| 68 | .5 | 2643.5 | .0 | 981.8 | .0 | .0 | .0 | .0 | .0 |
| 69 | 4.5 | 24519.3 | .0 | 8937.4 | .0 | .0 | .0 | .0 | .0 |
| 70 | 5.0 | 27667.6 | .0 | 9747.8 | .0 | .0 | .0 | .0 | .0 |
| 71 | 5.0 | 28104.8 | .0 | 9546.2 | .0 | .0 | .0 | .0 | .0 |
| 72 | .3 | 1709.5 | .0 | 570.2 | .0 | .0 | .0 | .0 | .0 |
| 73 | 1.8 | 10053.4 | .0 | 3324.6 | .0 | .0 | .0 | .0 | .0 |
| 74 | 2.9 | 16710.8 | .0 | 5419.8 | .0 | .0 | .0 | .0 | .0 |
| 75 | 4.9 | 28774.2 | .0 | 9052.8 | .0 | .0 | .0 | .0 | .0 |
| 76 | 4.9 | 29006.3 | .0 | 8761.1 | .0 | .0 | .0 | .0 | .0 |
| 77 | 4.9 | 29170.2 | .0 | 8439.7 | .0 | .0 | .0 | .0 | .0 |
| 78 | .8 | 4717.9 | .0 | 1332.5 | .0 | .0 | .0 | .0 | .0 |
| 79 | 1.5 | 9020.5 | .0 | 2517.0 | .0 | .0 | .0 | .0 | .0 |
| 80 | 2.6 | 15527.9 | .0 | 4239.1 | .0 | .0 | .0 | .0 | .0 |
| 81 | 4.6 | 27829.0 | .0 | 7332.5 | .0 | .0 | .0 | .0 | .0 |
| 82 | .2 | 1302.4 | .0 | 375.4 | .0 | .0 | .0 | .0 | .0 |
| 83 | 1.3 | 6778.6 | .0 | 1950.1 | .0 | .0 | .0 | .0 | .0 |
| 84 | 3.6 | 19039.4 | .0 | 5347.8 | .0 | .0 | .0 | .0 | .0 |
| 85 | 2.0 | 10854.5 | .0 | 2977.6 | .0 | .0 | .0 | .0 | .0 |
| 86 | 2.7 | 14514.8 | .0 | 3881.0 | .0 | .0 | .0 | .0 | .0 |
| 87 | 4.8 | 24771.8 | .0 | 6390.1 | .0 | .0 | .0 | .0 | .0 |
| 88 | 4.7 | 24101.5 | .0 | 5892.8 | .0 | .0 | .0 | .0 | .0 |
| 89 | 4.7 | 23371.2 | .0 | 5366.8 | .0 | .0 | .0 | .0 | .0 |
| 90 | 1.7 | 8346.7 | .0 | 1828.7 | .0 | .0 | .0 | .0 | .0 |
| 91 | 1.8 | 8475.0 | .0 | 1797.2 | .0 | .0 | .0 | .0 | .0 |
| 92 | 1.2 | 5761.1 | .0 | 1186.4 | .0 | .0 | .0 | .0 | .0 |
| 93 | 4.6 | 21738.8 | .0 | 4229.5 | .0 | .0 | .0 | .0 | .0 |
| 94 | 1.2 | 5372.0 | .0 | 979.7 | .0 | .0 | .0 | .0 | .0 |
| 95 | 3.4 | 15487.4 | .0 | 2638.9 | .0 | .0 | .0 | .0 | .0 |
| 96 | 1.1 | 4904.4 | .0 | 781.6 | .0 | .0 | .0 | .0 | .0 |
| 97 | 3.4 | 15233.6 | .0 | 2198.2 | .0 | .0 | .0 | .0 | .0 |
| 98 | 3.4 | 15116.1 | .0 | 1828.5 | .0 | .0 | .0 | .0 | .0 |
| 99 | 1.1 | 4651.0 | .0 | 484.9 | .0 | .0 | .0 | .0 | .0 |
| 100 | .4 | 1911.8 | .0 | 190.3 | .0 | .0 | .0 | .0 | .0 |
| 101 | 4.0 | 17469.7 | .0 | 1429.5 | .0 | .0 | .0 | .0 | .0 |
| 102 | 4.4 | 18965.4 | .0 | 899.0 | .0 | .0 | .0 | .0 | .0 |
| 103 | 3.1 | 12970.8 | .0 | 185.8 | .0 | .0 | .0 | .0 | .0 |
| 104 | .5 | 2236.2 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 105 | .3 | 1349.3 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 106 | .1 | 336.7 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 107 | .2 | 1049.7 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 108 | .1 | 567.4 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 109 | 4.3 | 17755.9 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 110 | 4.3 | 16893.6 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 111 | 4.2 | 16019.4 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 112 | 4.2 | 15135.5 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 113 | 2.3 | 7908.4 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 114 | .3 | 1106.8 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 115 | .1 | 276.6 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 116 | .2 | 863.6 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 117 | 1.2 | 4135.5 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 118 | 1.7 | 5801.0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 119 | .7 | 2335.3 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 120 | 1.7 | 5557.8 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 121 | 4.0 | 13107.8 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 122 | 3.9 | 12505.2 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 123 | 3.9 | 11887.9 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 124 | 2.4 | 7146.9 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 125 | .6 | 1723.9 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 126 | .8 | 2386.7 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 127 | 3.7 | 10615.9 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 128 | 3.7 | 9965.2 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 129 | 3.6 | 9306.9 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 130 | 3.5 | 8643.2 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 131 | .6 | 1429.7 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 132 | .5 | 1127.9 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 133 | 2.4 | 5418.3 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 134 | 3.4 | 7307.0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 135 | 3.3 | 6638.6 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 136 | 2.3 | 4238.9 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 137 | .1 | 161.6 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 138 | .9 | 1565.0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 139 | 3.2 | 5175.2 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 140 | 3.1 | 4356.8 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 141 | 3.0 | 3559.2 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 142 | 3.0 | 2784.2 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 143 | 2.9 | 2033.9 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 144 | 1.9 | 981.4 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 145 | .9 | 305.3 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 146 | .3 | 70.1 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 147 | .3 | 79.8 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 148 | 1.4 | 156.2 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |

Failure Surface Specified By 77 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 267.58 | 82.19 |
| 2 | 271.91 | 79.70 |
| 3 | 276.30 | 77.30 |
| 4 | 280.74 | 75.00 |
| 5 | 285.22 | 72.78 |
| 6 | 289.75 | 70.66 |
| 7 | 294.32 | 68.64 |
| 8 | 298.93 | 66.71 |
| 9 | 303.58 | 64.88 |
| 10 | 308.27 | 63.14 |
| 11 | 313.00 | 61.51 |
| 12 | 317.76 | 59.97 |
| 13 | 322.54 | 58.53 |
| 14 | 327.36 | 57.19 |
| 15 | 332.21 | 55.95 |
| 16 | 337.07 | 54.81 |
| 17 | 341.97 | 53.78 |
| 18 | 346.88 | 52.84 |
| 19 | 351.81 | 52.01 |
| 20 | 356.76 | 51.28 |
| 21 | 361.72 | 50.66 |
| 22 | 366.69 | 50.14 |
| 23 | 371.67 | 49.72 |
| 24 | 376.66 | 49.41 |
| 25 | 381.66 | 49.20 |
| 26 | 386.66 | 49.09 |

| | | |
|---|---|---|
| 27 | 391.66 | 49.09 |
| 28 | 396.65 | 49.19 |
| 29 | 401.65 | 49.40 |
| 30 | 406.64 | 49.71 |
| 31 | 411.62 | 50.12 |
| 32 | 416.60 | 50.64 |
| 33 | 421.56 | 51.26 |
| 34 | 426.51 | 51.99 |
| 35 | 431.44 | 52.81 |
| 36 | 436.35 | 53.74 |
| 37 | 441.24 | 54.78 |
| 38 | 446.11 | 55.91 |
| 39 | 450.96 | 57.14 |
| 40 | 455.77 | 58.48 |
| 41 | 460.56 | 59.92 |
| 42 | 465.32 | 61.45 |
| 43 | 470.05 | 63.09 |
| 44 | 474.74 | 64.82 |
| 45 | 479.39 | 66.65 |
| 46 | 484.01 | 68.57 |
| 47 | 488.58 | 70.59 |
| 48 | 493.11 | 72.71 |
| 49 | 497.59 | 74.92 |
| 50 | 502.03 | 77.22 |
| 51 | 506.42 | 79.62 |
| 52 | 510.76 | 82.10 |
| 53 | 515.04 | 84.68 |
| 54 | 519.28 | 87.35 |
| 55 | 523.45 | 90.10 |
| 56 | 527.57 | 92.94 |
| 57 | 531.62 | 95.86 |
| 58 | 535.62 | 98.87 |
| 59 | 539.55 | 101.96 |
| 60 | 543.41 | 105.13 |
| 61 | 547.21 | 108.38 |
| 62 | 550.94 | 111.71 |
| 63 | 554.60 | 115.11 |
| 64 | 558.19 | 118.60 |
| 65 | 561.71 | 122.15 |
| 66 | 565.15 | 125.78 |
| 67 | 568.51 | 129.48 |
| 68 | 571.80 | 133.25 |
| 69 | 575.01 | 137.08 |
| 70 | 578.13 | 140.98 |
| 71 | 581.18 | 144.95 |
| 72 | 584.14 | 148.98 |
| 73 | 587.01 | 153.07 |
| 74 | 589.81 | 157.22 |
| 75 | 592.51 | 161.42 |
| 76 | 595.13 | 165.68 |
| 77 | 595.88 | 166.98 |

Circle Center At X =  389.2 ; Y =  289.1  and Radius,  240.1

***     1.592   ***

Failure Surface Specified By 82 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 253.43 | 82.00 |
| 2 | 257.86 | 79.67 |
| 3 | 262.33 | 77.43 |
| 4 | 266.84 | 75.28 |
| 5 | 271.39 | 73.20 |
| 6 | 275.98 | 71.20 |
| 7 | 280.60 | 69.29 |
| 8 | 285.25 | 67.47 |
| 9 | 289.94 | 65.72 |
| 10 | 294.66 | 64.07 |
| 11 | 299.40 | 62.50 |
| 12 | 304.18 | 61.01 |
| 13 | 308.98 | 59.61 |
| 14 | 313.80 | 58.30 |

| | | |
|---|---|---|
| 15 | 318.65 | 57.08 |
| 16 | 323.52 | 55.94 |
| 17 | 328.41 | 54.89 |
| 18 | 333.31 | 53.93 |
| 19 | 338.24 | 53.06 |
| 20 | 343.18 | 52.28 |
| 21 | 348.13 | 51.59 |
| 22 | 353.09 | 50.99 |
| 23 | 358.07 | 50.48 |
| 24 | 363.05 | 50.06 |
| 25 | 368.04 | 49.73 |
| 26 | 373.03 | 49.49 |
| 27 | 378.03 | 49.34 |
| 28 | 383.03 | 49.28 |
| 29 | 388.03 | 49.31 |
| 30 | 393.03 | 49.43 |
| 31 | 398.02 | 49.64 |
| 32 | 403.01 | 49.94 |
| 33 | 408.00 | 50.34 |
| 34 | 412.98 | 50.82 |
| 35 | 417.94 | 51.39 |
| 36 | 422.90 | 52.06 |
| 37 | 427.84 | 52.81 |
| 38 | 432.77 | 53.65 |
| 39 | 437.68 | 54.58 |
| 40 | 442.58 | 55.60 |
| 41 | 447.45 | 56.71 |
| 42 | 452.31 | 57.90 |
| 43 | 457.14 | 59.19 |
| 44 | 461.95 | 60.56 |
| 45 | 466.73 | 62.02 |
| 46 | 471.49 | 63.56 |
| 47 | 476.21 | 65.19 |
| 48 | 480.91 | 66.91 |
| 49 | 485.57 | 68.71 |
| 50 | 490.21 | 70.59 |
| 51 | 494.80 | 72.56 |
| 52 | 499.36 | 74.61 |
| 53 | 503.88 | 76.75 |
| 54 | 508.37 | 78.96 |
| 55 | 512.81 | 81.26 |
| 56 | 517.21 | 83.63 |
| 57 | 521.56 | 86.09 |
| 58 | 525.88 | 88.62 |
| 59 | 530.14 | 91.23 |
| 60 | 534.36 | 93.92 |
| 61 | 538.52 | 96.68 |
| 62 | 542.64 | 99.52 |
| 63 | 546.70 | 102.43 |
| 64 | 550.71 | 105.42 |
| 65 | 554.67 | 108.48 |
| 66 | 558.57 | 111.61 |
| 67 | 562.41 | 114.81 |
| 68 | 566.19 | 118.07 |
| 69 | 569.92 | 121.41 |
| 70 | 573.58 | 124.81 |
| 71 | 577.18 | 128.28 |
| 72 | 580.72 | 131.82 |
| 73 | 584.19 | 135.41 |
| 74 | 587.60 | 139.07 |
| 75 | 590.94 | 142.79 |
| 76 | 594.21 | 146.57 |
| 77 | 597.42 | 150.41 |
| 78 | 600.55 | 154.31 |
| 79 | 603.61 | 158.26 |
| 80 | 606.60 | 162.27 |
| 81 | 609.52 | 166.33 |
| 82 | 610.48 | 167.71 |

Circle Center At X =  383.8 ; Y =  325.4  and Radius,  276.1

*** 1.595 ***

Failure Surface Specified By 82 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 249.19 | 81.94 |
| 2 | 253.63 | 79.63 |
| 3 | 258.11 | 77.40 |
| 4 | 262.62 | 75.26 |
| 5 | 267.18 | 73.19 |
| 6 | 271.77 | 71.21 |
| 7 | 276.39 | 69.31 |
| 8 | 281.05 | 67.49 |
| 9 | 285.74 | 65.76 |
| 10 | 290.46 | 64.11 |
| 11 | 295.21 | 62.55 |
| 12 | 299.98 | 61.07 |
| 13 | 304.79 | 59.68 |
| 14 | 309.61 | 58.37 |
| 15 | 314.46 | 57.15 |
| 16 | 319.33 | 56.02 |
| 17 | 324.22 | 54.98 |
| 18 | 329.13 | 54.02 |
| 19 | 334.05 | 53.15 |
| 20 | 338.99 | 52.37 |
| 21 | 343.94 | 51.68 |
| 22 | 348.91 | 51.08 |
| 23 | 353.88 | 50.56 |
| 24 | 358.86 | 50.14 |
| 25 | 363.85 | 49.81 |
| 26 | 368.85 | 49.56 |
| 27 | 373.84 | 49.41 |
| 28 | 378.84 | 49.34 |
| 29 | 383.84 | 49.36 |
| 30 | 388.84 | 49.48 |
| 31 | 393.84 | 49.68 |
| 32 | 398.83 | 49.97 |
| 33 | 403.81 | 50.36 |
| 34 | 408.79 | 50.83 |
| 35 | 413.76 | 51.39 |
| 36 | 418.72 | 52.04 |
| 37 | 423.66 | 52.78 |
| 38 | 428.59 | 53.61 |
| 39 | 433.51 | 54.52 |
| 40 | 438.41 | 55.53 |
| 41 | 443.29 | 56.62 |
| 42 | 448.15 | 57.80 |
| 43 | 452.98 | 59.06 |
| 44 | 457.80 | 60.41 |
| 45 | 462.59 | 61.85 |
| 46 | 467.35 | 63.38 |
| 47 | 472.08 | 64.99 |
| 48 | 476.79 | 66.68 |
| 49 | 481.46 | 68.46 |
| 50 | 486.10 | 70.32 |
| 51 | 490.71 | 72.27 |
| 52 | 495.28 | 74.29 |
| 53 | 499.81 | 76.40 |
| 54 | 504.31 | 78.59 |
| 55 | 508.76 | 80.86 |
| 56 | 513.17 | 83.21 |
| 57 | 517.54 | 85.64 |
| 58 | 521.87 | 88.15 |
| 59 | 526.15 | 90.73 |
| 60 | 530.39 | 93.39 |
| 61 | 534.57 | 96.12 |
| 62 | 538.71 | 98.93 |
| 63 | 542.79 | 101.82 |
| 64 | 546.82 | 104.77 |
| 65 | 550.80 | 107.80 |
| 66 | 554.73 | 110.90 |
| 67 | 558.59 | 114.07 |

| | | |
|---|---|---|
| 68 | 562.40 | 117.31 |
| 69 | 566.15 | 120.61 |
| 70 | 569.85 | 123.99 |
| 71 | 573.48 | 127.43 |
| 72 | 577.04 | 130.93 |
| 73 | 580.55 | 134.49 |
| 74 | 583.99 | 138.12 |
| 75 | 587.36 | 141.81 |
| 76 | 590.67 | 145.56 |
| 77 | 593.91 | 149.37 |
| 78 | 597.08 | 153.24 |
| 79 | 600.18 | 157.16 |
| 80 | 603.21 | 161.14 |
| 81 | 606.17 | 165.17 |
| 82 | 607.88 | 167.58 |

Circle Center At X =  380.0 ; Y =  328.0  and Radius,  278.7
*** 1.597 ***
Failure Surface Specified By 75 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 271.82 | 82.25 |
| 2 | 276.13 | 79.71 |
| 3 | 280.49 | 77.27 |
| 4 | 284.90 | 74.92 |
| 5 | 289.37 | 72.67 |
| 6 | 293.88 | 70.51 |
| 7 | 298.44 | 68.45 |
| 8 | 303.04 | 66.50 |
| 9 | 307.68 | 64.64 |
| 10 | 312.36 | 62.88 |
| 11 | 317.08 | 61.23 |
| 12 | 321.83 | 59.67 |
| 13 | 326.62 | 58.23 |
| 14 | 331.43 | 56.88 |
| 15 | 336.28 | 55.64 |
| 16 | 341.14 | 54.51 |
| 17 | 346.04 | 53.48 |
| 18 | 350.95 | 52.55 |
| 19 | 355.88 | 51.74 |
| 20 | 360.83 | 51.03 |
| 21 | 365.80 | 50.43 |
| 22 | 370.77 | 49.93 |
| 23 | 375.76 | 49.55 |
| 24 | 380.75 | 49.27 |
| 25 | 385.75 | 49.10 |
| 26 | 390.75 | 49.04 |
| 27 | 395.75 | 49.09 |
| 28 | 400.75 | 49.24 |
| 29 | 405.74 | 49.51 |
| 30 | 410.72 | 49.88 |
| 31 | 415.70 | 50.36 |
| 32 | 420.67 | 50.95 |
| 33 | 425.62 | 51.64 |
| 34 | 430.55 | 52.44 |
| 35 | 435.47 | 53.35 |
| 36 | 440.37 | 54.37 |
| 37 | 445.24 | 55.49 |
| 38 | 450.09 | 56.72 |
| 39 | 454.90 | 58.05 |
| 40 | 459.69 | 59.48 |
| 41 | 464.45 | 61.02 |
| 42 | 469.17 | 62.66 |
| 43 | 473.86 | 64.41 |
| 44 | 478.51 | 66.25 |
| 45 | 483.11 | 68.20 |
| 46 | 487.68 | 70.24 |
| 47 | 492.19 | 72.39 |
| 48 | 496.66 | 74.63 |
| 49 | 501.08 | 76.96 |
| 50 | 505.45 | 79.39 |

| | | |
|---|---|---|
| 51 | 509.77 | 81.92 |
| 52 | 514.03 | 84.54 |
| 53 | 518.23 | 87.25 |
| 54 | 522.37 | 90.05 |
| 55 | 526.45 | 92.94 |
| 56 | 530.47 | 95.92 |
| 57 | 534.42 | 98.98 |
| 58 | 538.30 | 102.13 |
| 59 | 542.12 | 105.36 |
| 60 | 545.86 | 108.68 |
| 61 | 549.53 | 112.07 |
| 62 | 553.13 | 115.55 |
| 63 | 556.65 | 119.10 |
| 64 | 560.09 | 122.72 |
| 65 | 563.45 | 126.42 |
| 66 | 566.74 | 130.20 |
| 67 | 569.94 | 134.04 |
| 68 | 573.05 | 137.95 |
| 69 | 576.08 | 141.93 |
| 70 | 579.02 | 145.97 |
| 71 | 581.88 | 150.07 |
| 72 | 584.65 | 154.24 |
| 73 | 587.32 | 158.46 |
| 74 | 589.90 | 162.74 |
| 75 | 592.23 | 166.80 |

Circle Center At X =  391.1 ; Y =  279.7  and Radius,  230.7

*** 1.597 ***

Failure Surface Specified By 81 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 247.78 | 81.92 |
| 2 | 252.20 | 79.58 |
| 3 | 256.67 | 77.33 |
| 4 | 261.17 | 75.17 |
| 5 | 265.72 | 73.08 |
| 6 | 270.30 | 71.08 |
| 7 | 274.92 | 69.17 |
| 8 | 279.57 | 67.34 |
| 9 | 284.26 | 65.60 |
| 10 | 288.98 | 63.94 |
| 11 | 293.73 | 62.38 |
| 12 | 298.50 | 60.90 |
| 13 | 303.30 | 59.51 |
| 14 | 308.13 | 58.21 |
| 15 | 312.98 | 57.00 |
| 16 | 317.86 | 55.87 |
| 17 | 322.75 | 54.84 |
| 18 | 327.66 | 53.90 |
| 19 | 332.59 | 53.05 |
| 20 | 337.53 | 52.29 |
| 21 | 342.48 | 51.63 |
| 22 | 347.45 | 51.05 |
| 23 | 352.43 | 50.57 |
| 24 | 357.41 | 50.18 |
| 25 | 362.40 | 49.88 |
| 26 | 367.40 | 49.68 |
| 27 | 372.40 | 49.56 |
| 28 | 377.40 | 49.54 |
| 29 | 382.40 | 49.62 |
| 30 | 387.39 | 49.78 |
| 31 | 392.39 | 50.04 |
| 32 | 397.38 | 50.39 |
| 33 | 402.36 | 50.83 |
| 34 | 407.33 | 51.36 |
| 35 | 412.29 | 51.99 |
| 36 | 417.24 | 52.71 |
| 37 | 422.17 | 53.51 |
| 38 | 427.09 | 54.42 |
| 39 | 431.99 | 55.41 |
| 40 | 436.87 | 56.49 |

| | | |
|---|---|---|
| 41 | 441.73 | 57.66 |
| 42 | 446.57 | 58.92 |
| 43 | 451.38 | 60.27 |
| 44 | 456.17 | 61.71 |
| 45 | 460.93 | 63.24 |
| 46 | 465.66 | 64.86 |
| 47 | 470.37 | 66.56 |
| 48 | 475.03 | 68.35 |
| 49 | 479.67 | 70.23 |
| 50 | 484.27 | 72.19 |
| 51 | 488.83 | 74.23 |
| 52 | 493.35 | 76.37 |
| 53 | 497.84 | 78.58 |
| 54 | 502.28 | 80.88 |
| 55 | 506.68 | 83.25 |
| 56 | 511.03 | 85.71 |
| 57 | 515.34 | 88.25 |
| 58 | 519.60 | 90.87 |
| 59 | 523.81 | 93.57 |
| 60 | 527.96 | 96.34 |
| 61 | 532.07 | 99.20 |
| 62 | 536.13 | 102.12 |
| 63 | 540.12 | 105.12 |
| 64 | 544.07 | 108.20 |
| 65 | 547.95 | 111.35 |
| 66 | 551.78 | 114.56 |
| 67 | 555.54 | 117.85 |
| 68 | 559.25 | 121.21 |
| 69 | 562.89 | 124.64 |
| 70 | 566.47 | 128.13 |
| 71 | 569.98 | 131.69 |
| 72 | 573.43 | 135.31 |
| 73 | 576.80 | 139.00 |
| 74 | 580.11 | 142.75 |
| 75 | 583.35 | 146.56 |
| 76 | 586.52 | 150.42 |
| 77 | 589.62 | 154.35 |
| 78 | 592.64 | 158.33 |
| 79 | 595.59 | 162.37 |
| 80 | 598.46 | 166.46 |
| 81 | 598.92 | 167.13 |

Circle Center At X =  376.0 ; Y =  319.6  and Radius,  270.1

*** 1.598 ***

Failure Surface Specified By 79 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 249.90 | 81.95 |
| 2 | 254.30 | 79.57 |
| 3 | 258.75 | 77.29 |
| 4 | 263.24 | 75.09 |
| 5 | 267.77 | 72.97 |
| 6 | 272.34 | 70.95 |
| 7 | 276.95 | 69.01 |
| 8 | 281.59 | 67.16 |
| 9 | 286.27 | 65.40 |
| 10 | 290.99 | 63.73 |
| 11 | 295.73 | 62.15 |
| 12 | 300.51 | 60.67 |
| 13 | 305.31 | 59.27 |
| 14 | 310.13 | 57.97 |
| 15 | 314.99 | 56.76 |
| 16 | 319.86 | 55.65 |
| 17 | 324.76 | 54.63 |
| 18 | 329.67 | 53.70 |
| 19 | 334.60 | 52.87 |
| 20 | 339.55 | 52.14 |
| 21 | 344.50 | 51.50 |
| 22 | 349.47 | 50.95 |
| 23 | 354.45 | 50.50 |
| 24 | 359.44 | 50.15 |

| | | |
|---|---|---|
| 25 | 364.44 | 49.89 |
| 26 | 369.43 | 49.73 |
| 27 | 374.43 | 49.67 |
| 28 | 379.43 | 49.70 |
| 29 | 384.43 | 49.83 |
| 30 | 389.43 | 50.05 |
| 31 | 394.42 | 50.37 |
| 32 | 399.40 | 50.79 |
| 33 | 404.37 | 51.30 |
| 34 | 409.33 | 51.91 |
| 35 | 414.28 | 52.62 |
| 36 | 419.22 | 53.42 |
| 37 | 424.14 | 54.31 |
| 38 | 429.04 | 55.30 |
| 39 | 433.92 | 56.38 |
| 40 | 438.78 | 57.56 |
| 41 | 443.62 | 58.83 |
| 42 | 448.43 | 60.19 |
| 43 | 453.21 | 61.65 |
| 44 | 457.97 | 63.19 |
| 45 | 462.69 | 64.83 |
| 46 | 467.38 | 66.56 |
| 47 | 472.04 | 68.38 |
| 48 | 476.66 | 70.29 |
| 49 | 481.24 | 72.29 |
| 50 | 485.79 | 74.37 |
| 51 | 490.29 | 76.54 |
| 52 | 494.75 | 78.80 |
| 53 | 499.17 | 81.15 |
| 54 | 503.54 | 83.57 |
| 55 | 507.86 | 86.09 |
| 56 | 512.14 | 88.68 |
| 57 | 516.36 | 91.36 |
| 58 | 520.53 | 94.12 |
| 59 | 524.65 | 96.95 |
| 60 | 528.71 | 99.87 |
| 61 | 532.71 | 102.86 |
| 62 | 536.66 | 105.94 |
| 63 | 540.55 | 109.08 |
| 64 | 544.37 | 112.30 |
| 65 | 548.13 | 115.60 |
| 66 | 551.83 | 118.96 |
| 67 | 555.46 | 122.40 |
| 68 | 559.03 | 125.90 |
| 69 | 562.53 | 129.48 |
| 70 | 565.95 | 133.11 |
| 71 | 569.31 | 136.82 |
| 72 | 572.60 | 140.59 |
| 73 | 575.81 | 144.42 |
| 74 | 578.95 | 148.31 |
| 75 | 582.01 | 152.27 |
| 76 | 584.99 | 156.28 |
| 77 | 587.90 | 160.35 |
| 78 | 590.73 | 164.47 |
| 79 | 592.26 | 166.80 |

Circle Center At X =  375.3 ; Y =  309.3  and Radius,  259.6

*** 1.598 ***

Failure Surface Specified By 83 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 249.90 | 81.95 |
| 2 | 254.35 | 79.67 |
| 3 | 258.84 | 77.46 |
| 4 | 263.36 | 75.34 |
| 5 | 267.93 | 73.29 |
| 6 | 272.52 | 71.33 |
| 7 | 277.16 | 69.44 |
| 8 | 281.82 | 67.64 |
| 9 | 286.51 | 65.92 |
| 10 | 291.24 | 64.28 |

| | | |
|---|---|---|
| 11 | 295.99 | 62.72 |
| 12 | 300.76 | 61.24 |
| 13 | 305.57 | 59.85 |
| 14 | 310.39 | 58.54 |
| 15 | 315.24 | 57.32 |
| 16 | 320.11 | 56.18 |
| 17 | 325.00 | 55.12 |
| 18 | 329.90 | 54.15 |
| 19 | 334.82 | 53.27 |
| 20 | 339.76 | 52.47 |
| 21 | 344.71 | 51.76 |
| 22 | 349.67 | 51.13 |
| 23 | 354.64 | 50.59 |
| 24 | 359.62 | 50.14 |
| 25 | 364.60 | 49.77 |
| 26 | 369.60 | 49.49 |
| 27 | 374.59 | 49.30 |
| 28 | 379.59 | 49.19 |
| 29 | 384.59 | 49.18 |
| 30 | 389.59 | 49.24 |
| 31 | 394.59 | 49.40 |
| 32 | 399.58 | 49.64 |
| 33 | 404.57 | 49.97 |
| 34 | 409.55 | 50.39 |
| 35 | 414.53 | 50.89 |
| 36 | 419.49 | 51.48 |
| 37 | 424.45 | 52.15 |
| 38 | 429.39 | 52.91 |
| 39 | 434.32 | 53.76 |
| 40 | 439.23 | 54.69 |
| 41 | 444.13 | 55.71 |
| 42 | 449.00 | 56.81 |
| 43 | 453.86 | 58.00 |
| 44 | 458.69 | 59.27 |
| 45 | 463.51 | 60.63 |
| 46 | 468.30 | 62.07 |
| 47 | 473.06 | 63.59 |
| 48 | 477.79 | 65.20 |
| 49 | 482.50 | 66.88 |
| 50 | 487.18 | 68.65 |
| 51 | 491.82 | 70.50 |
| 52 | 496.43 | 72.43 |
| 53 | 501.01 | 74.45 |
| 54 | 505.55 | 76.54 |
| 55 | 510.06 | 78.70 |
| 56 | 514.53 | 80.95 |
| 57 | 518.95 | 83.28 |
| 58 | 523.34 | 85.68 |
| 59 | 527.68 | 88.15 |
| 60 | 531.98 | 90.70 |
| 61 | 536.24 | 93.33 |
| 62 | 540.45 | 96.03 |
| 63 | 544.61 | 98.80 |
| 64 | 548.72 | 101.65 |
| 65 | 552.78 | 104.56 |
| 66 | 556.79 | 107.55 |
| 67 | 560.75 | 110.61 |
| 68 | 564.65 | 113.73 |
| 69 | 568.50 | 116.92 |
| 70 | 572.29 | 120.18 |
| 71 | 576.03 | 123.50 |
| 72 | 579.71 | 126.89 |
| 73 | 583.32 | 130.34 |
| 74 | 586.88 | 133.86 |
| 75 | 590.38 | 137.43 |
| 76 | 593.81 | 141.07 |
| 77 | 597.18 | 144.76 |
| 78 | 600.48 | 148.51 |
| 79 | 603.72 | 152.32 |
| 80 | 606.89 | 156.19 |

| | | |
|---|---|---|
| 81 | 610.00 | 160.11 |
| 82 | 613.03 | 164.08 |
| 83 | 615.91 | 167.98 |

Circle Center At X =  383.2 ; Y =  336.5  and Radius,  287.4

***   1.600   ***

Failure Surface Specified By 77 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 273.23 | 82.27 |
| 2 | 277.58 | 79.80 |
| 3 | 281.98 | 77.43 |
| 4 | 286.43 | 75.14 |
| 5 | 290.92 | 72.95 |
| 6 | 295.46 | 70.85 |
| 7 | 300.04 | 68.84 |
| 8 | 304.66 | 66.93 |
| 9 | 309.32 | 65.11 |
| 10 | 314.01 | 63.39 |
| 11 | 318.74 | 61.76 |
| 12 | 323.50 | 60.23 |
| 13 | 328.29 | 58.80 |
| 14 | 333.11 | 57.47 |
| 15 | 337.95 | 56.23 |
| 16 | 342.82 | 55.10 |
| 17 | 347.71 | 54.06 |
| 18 | 352.63 | 53.13 |
| 19 | 357.56 | 52.29 |
| 20 | 362.50 | 51.56 |
| 21 | 367.46 | 50.93 |
| 22 | 372.43 | 50.40 |
| 23 | 377.42 | 49.97 |
| 24 | 382.40 | 49.64 |
| 25 | 387.40 | 49.42 |
| 26 | 392.40 | 49.30 |
| 27 | 397.40 | 49.28 |
| 28 | 402.40 | 49.36 |
| 29 | 407.39 | 49.55 |
| 30 | 412.39 | 49.83 |
| 31 | 417.37 | 50.22 |
| 32 | 422.35 | 50.71 |
| 33 | 427.31 | 51.31 |
| 34 | 432.26 | 52.00 |
| 35 | 437.20 | 52.80 |
| 36 | 442.12 | 53.69 |
| 37 | 447.02 | 54.69 |
| 38 | 451.90 | 55.79 |
| 39 | 456.75 | 56.99 |
| 40 | 461.58 | 58.28 |
| 41 | 466.38 | 59.68 |
| 42 | 471.15 | 61.17 |
| 43 | 475.89 | 62.76 |
| 44 | 480.60 | 64.44 |
| 45 | 485.27 | 66.23 |
| 46 | 489.91 | 68.10 |
| 47 | 494.50 | 70.08 |
| 48 | 499.05 | 72.14 |
| 49 | 503.56 | 74.30 |
| 50 | 508.03 | 76.55 |
| 51 | 512.45 | 78.89 |
| 52 | 516.82 | 81.32 |
| 53 | 521.13 | 83.84 |
| 54 | 525.40 | 86.45 |
| 55 | 529.61 | 89.15 |
| 56 | 533.77 | 91.93 |
| 57 | 537.87 | 94.79 |
| 58 | 541.90 | 97.74 |
| 59 | 545.88 | 100.77 |
| 60 | 549.80 | 103.88 |
| 61 | 553.65 | 107.07 |
| 62 | 557.43 | 110.34 |

| | | |
|---|---|---|
| 63 | 561.15 | 113.68 |
| 64 | 564.79 | 117.10 |
| 65 | 568.37 | 120.60 |
| 66 | 571.87 | 124.17 |
| 67 | 575.30 | 127.80 |
| 68 | 578.66 | 131.51 |
| 69 | 581.94 | 135.29 |
| 70 | 585.14 | 139.13 |
| 71 | 588.26 | 143.03 |
| 72 | 591.30 | 147.00 |
| 73 | 594.26 | 151.03 |
| 74 | 597.13 | 155.12 |
| 75 | 599.93 | 159.27 |
| 76 | 602.63 | 163.48 |
| 77 | 605.07 | 167.44 |

Circle Center At X = 395.8 ; Y = 293.6 and Radius, 244.3

*** 1.600 ***

Failure Surface Specified By 78 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 260.51 | 82.09 |
| 2 | 264.90 | 79.71 |
| 3 | 269.34 | 77.41 |
| 4 | 273.83 | 75.20 |
| 5 | 278.35 | 73.08 |
| 6 | 282.92 | 71.05 |
| 7 | 287.53 | 69.11 |
| 8 | 292.18 | 67.26 |
| 9 | 296.86 | 65.51 |
| 10 | 301.58 | 63.85 |
| 11 | 306.33 | 62.28 |
| 12 | 311.10 | 60.81 |
| 13 | 315.91 | 59.43 |
| 14 | 320.74 | 58.15 |
| 15 | 325.60 | 56.97 |
| 16 | 330.48 | 55.88 |
| 17 | 335.38 | 54.89 |
| 18 | 340.30 | 54.00 |
| 19 | 345.24 | 53.20 |
| 20 | 350.19 | 52.50 |
| 21 | 355.15 | 51.91 |
| 22 | 360.13 | 51.41 |
| 23 | 365.11 | 51.01 |
| 24 | 370.10 | 50.70 |
| 25 | 375.10 | 50.50 |
| 26 | 380.10 | 50.40 |
| 27 | 385.10 | 50.39 |
| 28 | 390.10 | 50.49 |
| 29 | 395.09 | 50.68 |
| 30 | 400.08 | 50.98 |
| 31 | 405.07 | 51.37 |
| 32 | 410.04 | 51.86 |
| 33 | 415.01 | 52.45 |
| 34 | 419.96 | 53.14 |
| 35 | 424.90 | 53.93 |
| 36 | 429.82 | 54.81 |
| 37 | 434.72 | 55.80 |
| 38 | 439.61 | 56.88 |
| 39 | 444.46 | 58.05 |
| 40 | 449.30 | 59.33 |
| 41 | 454.11 | 60.70 |
| 42 | 458.89 | 62.16 |
| 43 | 463.64 | 63.72 |
| 44 | 468.36 | 65.37 |
| 45 | 473.04 | 67.12 |
| 46 | 477.69 | 68.96 |
| 47 | 482.31 | 70.89 |
| 48 | 486.88 | 72.91 |
| 49 | 491.41 | 75.02 |
| 50 | 495.90 | 77.23 |

| | | |
|---|---|---|
| 51 | 500.34 | 79.52 |
| 52 | 504.74 | 81.90 |
| 53 | 509.09 | 84.36 |
| 54 | 513.39 | 86.91 |
| 55 | 517.64 | 89.55 |
| 56 | 521.83 | 92.27 |
| 57 | 525.97 | 95.07 |
| 58 | 530.06 | 97.96 |
| 59 | 534.08 | 100.92 |
| 60 | 538.05 | 103.97 |
| 61 | 541.95 | 107.09 |
| 62 | 545.80 | 110.29 |
| 63 | 549.57 | 113.57 |
| 64 | 553.28 | 116.92 |
| 65 | 556.93 | 120.34 |
| 66 | 560.50 | 123.84 |
| 67 | 564.01 | 127.40 |
| 68 | 567.44 | 131.04 |
| 69 | 570.81 | 134.74 |
| 70 | 574.09 | 138.51 |
| 71 | 577.30 | 142.34 |
| 72 | 580.44 | 146.23 |
| 73 | 583.49 | 150.19 |
| 74 | 586.47 | 154.21 |
| 75 | 589.37 | 158.28 |
| 76 | 592.18 | 162.41 |
| 77 | 594.92 | 166.60 |
| 78 | 595.13 | 166.94 |

Circle Center At X =  382.8 ; Y =  302.1  and Radius,  251.7

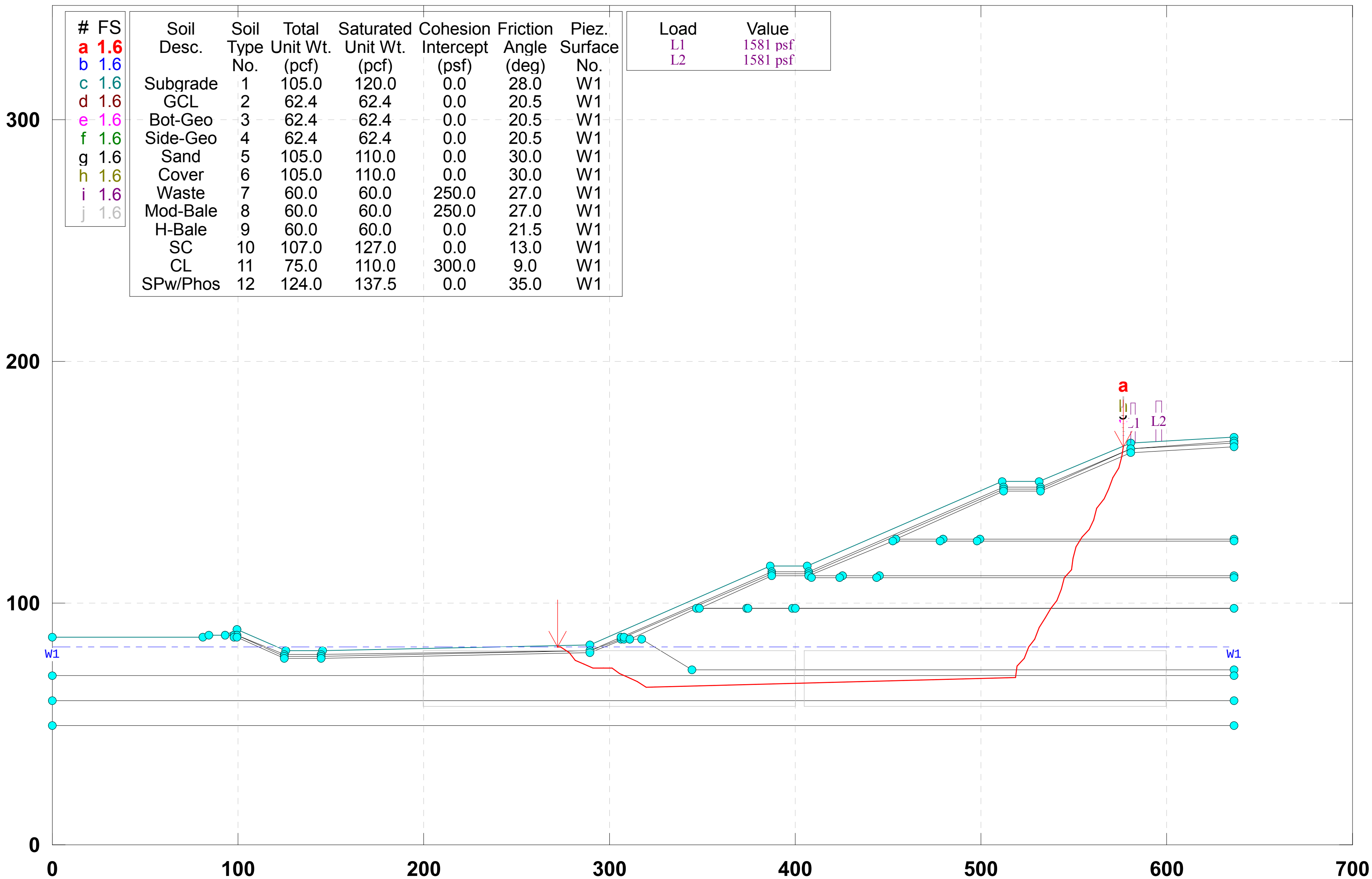
*** 1.600 ***

# Slope Stability Analysis during Construction Phase II Section II Adjacent to Phase I

## Block-Type Analysis With and Without Equipment Loading

# Phase II Section II Expansion RAI No.1 Phase I West Slope During Construction

C:\1\HARDEE~1.1\4HARDE~1.1\EWBLLO~1\EWSECBLL.PL2   Run By: Shane R. Fischer, P.E.   03/31/13   5:18AM




| # | FS |
|---|---|
| a | 1.6 |
| b | 1.6 |
| c | 1.6 |
| d | 1.6 |
| e | 1.6 |
| f | 1.6 |
| g | 1.6 |
| h | 1.6 |
| i | 1.6 |
| j | 1.6 |

| Soil Desc. | Soil Type No. | Total Unit Wt. (pcf) | Saturated Unit Wt. (pcf) | Cohesion Intercept (psf) | Friction Angle (deg) | Piez. Surface No. |
|---|---|---|---|---|---|---|
| Subgrade | 1 | 105.0 | 120.0 | 0.0 | 28.0 | W1 |
| GCL | 2 | 62.4 | 62.4 | 0.0 | 20.5 | W1 |
| Bot-Geo | 3 | 62.4 | 62.4 | 0.0 | 20.5 | W1 |
| Side-Geo | 4 | 62.4 | 62.4 | 0.0 | 20.5 | W1 |
| Sand | 5 | 105.0 | 110.0 | 0.0 | 30.0 | W1 |
| Cover | 6 | 105.0 | 110.0 | 0.0 | 30.0 | W1 |
| Waste | 7 | 60.0 | 60.0 | 250.0 | 27.0 | W1 |
| Mod-Bale | 8 | 60.0 | 60.0 | 250.0 | 27.0 | W1 |
| H-Bale | 9 | 60.0 | 60.0 | 0.0 | 21.5 | W1 |
| SC | 10 | 107.0 | 127.0 | 0.0 | 13.0 | W1 |
| CL | 11 | 75.0 | 110.0 | 300.0 | 9.0 | W1 |
| SPw/Phos | 12 | 124.0 | 137.5 | 0.0 | 35.0 | W1 |

| Load | Value |
|---|---|
| L1 | 1581 psf |
| L2 | 1581 psf |

**PCSTABL5M/si FSmin=1.6**

**Safety Factors Are Calculated By The Modified Janbu Method**

SCS ENGINEERS

**** PCSTABL5M ****
by
Purdue University
--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer`s Method of Slices

Run Date: 03/31/13
Time of Run: 5:18AM
Run By: Shane R. Fischer, P.E.
Input Data Filename: C:ewsecbll.
Output Filename: C:ewsecbll.OUT
Unit: ENGLISH
Plotted Output Filename: C:ewsecbll.PLT
PROBLEM DESCRIPTION Phase II Section II Expansion RAI No.1
Phase I West Slope During Construction

BOUNDARY COORDINATES
14 Top Boundaries
87 Total Boundaries

| Boundary No. | X-Left (ft) | Y-Left (ft) | X-Right (ft) | Y-Right (ft) | Soil Type Below Bnd |
|---|---|---|---|---|---|
| 1 | .00 | 86.00 | 81.46 | 86.00 | 1 |
| 2 | 81.46 | 86.00 | 84.47 | 87.00 | 1 |
| 3 | 84.47 | 87.00 | 93.14 | 87.00 | 1 |
| 4 | 93.14 | 87.00 | 99.14 | 89.00 | 6 |
| 5 | 99.14 | 89.00 | 99.79 | 89.00 | 6 |
| 6 | 99.79 | 89.00 | 125.29 | 80.50 | 6 |
| 7 | 125.29 | 80.50 | 145.29 | 80.50 | 6 |
| 8 | 145.29 | 80.50 | 289.16 | 82.49 | 6 |
| 9 | 289.16 | 82.49 | 386.69 | 115.00 | 6 |
| 10 | 386.69 | 115.00 | 406.69 | 115.00 | 6 |
| 11 | 406.69 | 115.00 | 511.69 | 150.00 | 6 |
| 12 | 511.69 | 150.00 | 531.69 | 150.00 | 6 |
| 13 | 531.69 | 150.00 | 580.29 | 166.20 | 6 |
| 14 | 580.29 | 166.20 | 636.29 | 169.00 | 6 |
| 15 | 93.14 | 87.00 | 97.46 | 87.00 | 1 |
| 16 | 97.46 | 87.00 | 99.46 | 87.00 | 3 |
| 17 | 99.46 | 87.00 | 124.96 | 78.50 | 3 |
| 18 | 124.96 | 78.50 | 144.96 | 78.50 | 3 |
| 19 | 144.96 | 78.50 | 289.51 | 80.50 | 3 |
| 20 | 289.51 | 80.50 | 306.09 | 86.02 | 3 |
| 21 | 306.09 | 86.02 | 387.01 | 113.00 | 4 |
| 22 | 387.01 | 113.00 | 407.01 | 113.00 | 4 |
| 23 | 407.01 | 113.00 | 512.01 | 148.00 | 4 |
| 24 | 512.01 | 148.00 | 532.01 | 148.00 | 4 |
| 25 | 532.01 | 148.00 | 580.29 | 164.09 | 4 |
| 26 | 580.29 | 164.09 | 636.29 | 166.89 | 4 |
| 27 | 97.46 | 86.53 | 99.30 | 86.53 | 2 |
| 28 | 99.30 | 86.53 | 124.99 | 78.00 | 2 |
| 29 | 124.99 | 78.00 | 144.99 | 78.00 | 2 |
| 30 | 144.99 | 78.00 | 289.59 | 80.00 | 2 |
| 31 | 289.59 | 80.00 | 305.93 | 85.44 | 2 |
| 32 | 305.93 | 85.44 | 306.09 | 86.02 | 4 |
| 33 | 305.93 | 85.44 | 307.91 | 86.10 | 2 |
| 34 | 307.91 | 86.10 | 387.09 | 112.50 | 5 |
| 35 | 387.09 | 112.50 | 407.09 | 112.50 | 5 |
| 36 | 407.09 | 112.50 | 512.09 | 147.50 | 5 |
| 37 | 512.09 | 147.50 | 532.09 | 147.50 | 5 |
| 38 | 532.09 | 147.50 | 580.38 | 163.59 | 5 |
| 39 | 580.38 | 163.59 | 636.29 | 166.39 | 5 |
| 40 | 97.46 | 86.03 | 99.22 | 86.03 | 1 |
| 41 | 99.22 | 86.03 | 124.91 | 77.50 | 1 |
| 42 | 124.91 | 77.50 | 144.99 | 77.50 | 1 |
| 43 | 144.99 | 77.50 | 289.68 | 79.50 | 1 |
| 44 | 289.68 | 79.50 | 307.67 | 85.50 | 1 |
| 45 | 307.67 | 85.50 | 307.91 | 86.10 | 6 |
| 46 | 307.67 | 85.50 | 310.84 | 85.50 | 1 |
| 47 | 310.84 | 85.50 | 346.84 | 97.50 | 8 |
| 48 | 346.84 | 97.50 | 348.34 | 98.00 | 8 |
| 49 | 348.34 | 98.00 | 387.34 | 111.00 | 8 |
| 50 | 387.34 | 111.00 | 407.34 | 111.00 | 8 |

| | | | | | |
|---|---|---|---|---|---|
| 51 | 407.34 | 111.00 | 452.34 | 126.00 | 5 |
| 52 | 452.34 | 126.00 | 453.84 | 126.50 | 8 |
| 53 | 453.84 | 126.50 | 512.34 | 146.00 | 7 |
| 54 | 512.34 | 146.00 | 532.34 | 146.00 | 7 |
| 55 | 532.34 | 146.00 | 580.29 | 161.98 | 7 |
| 56 | 580.29 | 161.98 | 636.29 | 164.78 | 7 |
| 57 | 453.84 | 126.50 | 479.80 | 126.50 | 8 |
| 58 | 479.80 | 126.50 | 499.68 | 126.50 | 9 |
| 59 | 499.68 | 126.50 | 636.29 | 126.50 | 8 |
| 60 | 452.34 | 126.00 | 478.05 | 126.00 | 8 |
| 61 | 478.05 | 126.00 | 479.80 | 126.50 | 9 |
| 62 | 478.05 | 126.00 | 498.18 | 126.00 | 8 |
| 63 | 498.18 | 126.00 | 499.68 | 126.50 | 8 |
| 64 | 498.18 | 126.00 | 636.29 | 126.00 | 8 |
| 65 | 407.34 | 111.00 | 425.29 | 111.00 | 8 |
| 66 | 425.29 | 111.00 | 445.17 | 111.00 | 9 |
| 67 | 445.17 | 111.00 | 636.29 | 111.00 | 8 |
| 68 | 407.34 | 111.00 | 408.84 | 110.50 | 8 |
| 69 | 408.84 | 110.50 | 423.54 | 110.50 | 8 |
| 70 | 423.54 | 110.50 | 425.29 | 111.00 | 9 |
| 71 | 423.54 | 110.50 | 443.67 | 110.50 | 8 |
| 72 | 443.67 | 110.50 | 445.17 | 111.00 | 8 |
| 73 | 443.67 | 110.50 | 636.29 | 110.50 | 8 |
| 74 | 348.34 | 98.00 | 374.93 | 98.00 | 8 |
| 75 | 374.93 | 98.00 | 399.93 | 98.00 | 9 |
| 76 | 399.93 | 98.00 | 636.29 | 98.00 | 8 |
| 77 | 346.84 | 97.50 | 373.43 | 97.50 | 8 |
| 78 | 373.43 | 97.50 | 374.93 | 98.00 | 9 |
| 79 | 373.43 | 97.50 | 398.43 | 97.50 | 8 |
| 80 | 398.43 | 97.50 | 399.93 | 98.00 | 8 |
| 81 | 398.43 | 97.50 | 636.29 | 97.50 | 8 |
| 82 | 310.84 | 85.50 | 317.52 | 85.50 | 1 |
| 83 | 317.52 | 85.50 | 344.52 | 72.00 | 1 |
| 84 | 344.52 | 72.00 | 636.29 | 72.00 | 1 |
| 85 | .00 | 70.00 | 636.29 | 70.00 | 10 |
| 86 | .00 | 60.00 | 636.29 | 60.00 | 11 |
| 87 | .00 | 49.00 | 636.29 | 49.00 | 12 |

ISOTROPIC SOIL PARAMETERS

12 Type(s) of Soil

| Soil Type No. | Total Unit Wt. (pcf) | Saturated Unit Wt. (pcf) | Cohesion Intercept (psf) | Friction Angle (deg) | Pore Pressure Param. | Pressure Constant (psf) | Piez. Surface No. |
|---|---|---|---|---|---|---|---|
| 1 | 105.0 | 120.0 | .0 | 28.0 | .00 | .0 | 1 |
| 2 | 62.4 | 62.4 | .0 | 20.5 | .00 | .0 | 1 |
| 3 | 62.4 | 62.4 | .0 | 20.5 | .00 | .0 | 1 |
| 4 | 62.4 | 62.4 | .0 | 20.5 | .00 | .0 | 1 |
| 5 | 105.0 | 110.0 | .0 | 30.0 | .00 | .0 | 1 |
| 6 | 105.0 | 110.0 | .0 | 30.0 | .00 | .0 | 1 |
| 7 | 60.0 | 60.0 | 250.0 | 27.0 | .00 | .0 | 1 |
| 8 | 60.0 | 60.0 | 250.0 | 27.0 | .00 | .0 | 1 |
| 9 | 60.0 | 60.0 | .0 | 21.5 | .00 | .0 | 1 |
| 10 | 107.0 | 127.0 | .0 | 13.0 | .00 | .0 | 1 |
| 11 | 75.0 | 110.0 | 300.0 | 9.0 | .00 | .0 | 1 |
| 12 | 124.0 | 137.5 | .0 | 35.0 | .00 | .0 | 1 |

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

Unit Weight of Water = 62.40

Piezometric Surface No. 1 Specified by 2 Coordinate Points

| Point No. | X-Water (ft) | Y-Water (ft) |
|---|---|---|
| 1 | .00 | 82.09 |
| 2 | 636.29 | 82.09 |

BOUNDARY LOAD(S)

2 Load(s) Specified

| Load No. | X-Left (ft) | X-Right (ft) | Intensity (psf) | Deflection (deg) |
|---|---|---|---|---|
| 1 | 580.29 | 583.25 | 1581.0 | .0 |
| 2 | 594.24 | 597.21 | 1581.0 | .0 |

NOTE - Intensity Is Specified As A Uniformly Distributed
Force Acting On A Horizontally Projected Surface.

A Critical Failure Surface Searching Method, Using A Random

Technique For Generating Sliding Block Surfaces, Has Been Specified.
1000 Trial Surfaces Have Been Generated.
2 Boxes Specified For Generation Of Central Block Base
Length Of Line Segments For Active And Passive Portions Of Sliding Block Is 5.0

| Box No. | X-Left (ft) | Y-Left (ft) | X-Right (ft) | Y-Right (ft) | Height (ft) |
|---|---|---|---|---|---|
| 1 | 200.00 | 69.00 | 400.00 | 69.00 | 23.00 |
| 2 | 405.00 | 69.00 | 600.00 | 69.00 | 23.00 |

Following Are Displayed The Ten Most Critical Of The Trial Failure Surfaces Examined. They Are Ordered - Most Critical First.

* * Safety Factors Are Calculated By The Modified Janbu Method * *

Failure Surface Specified By 36 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 272.15 | 82.25 |
| 2 | 273.54 | 81.78 |
| 3 | 278.05 | 79.62 |
| 4 | 281.67 | 76.17 |
| 5 | 286.49 | 74.82 |
| 6 | 291.33 | 73.56 |
| 7 | 296.33 | 73.45 |
| 8 | 301.32 | 73.28 |
| 9 | 305.70 | 70.86 |
| 10 | 310.26 | 68.81 |
| 11 | 315.06 | 67.41 |
| 12 | 319.67 | 65.47 |
| 13 | 518.53 | 68.92 |
| 14 | 519.44 | 73.84 |
| 15 | 522.97 | 77.38 |
| 16 | 525.53 | 81.67 |
| 17 | 528.89 | 85.38 |
| 18 | 531.47 | 89.66 |
| 19 | 534.67 | 93.50 |
| 20 | 537.60 | 97.55 |
| 21 | 541.13 | 101.09 |
| 22 | 543.57 | 105.46 |
| 23 | 544.94 | 110.26 |
| 24 | 548.46 | 113.82 |
| 25 | 549.44 | 118.72 |
| 26 | 551.18 | 123.41 |
| 27 | 554.61 | 127.04 |
| 28 | 558.05 | 130.67 |
| 29 | 560.85 | 134.81 |
| 30 | 562.55 | 139.51 |
| 31 | 565.91 | 143.22 |
| 32 | 568.60 | 147.43 |
| 33 | 570.71 | 151.97 |
| 34 | 573.86 | 155.85 |
| 35 | 575.67 | 160.51 |
| 36 | 576.64 | 164.98 |

*** 1.635 ***

Individual data on the 100 slices

| Slice No. | Width (ft) | Weight (lbs) | Water Force Top (lbs) | Water Force Bot (lbs) | Tie Force Norm (lbs) | Tie Force Tan (lbs) | Earthquake Force Hor (lbs) | Earthquake Force Ver (lbs) | Surcharge Load (lbs) |
|---|---|---|---|---|---|---|---|---|---|
| 1 | .5 | 4.4 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 2 | .9 | 32.5 | .0 | 9.3 | .0 | .0 | .0 | .0 | .0 |
| 3 | 3.0 | 413.2 | .0 | 218.8 | .0 | .0 | .0 | .0 | .0 |
| 4 | 1.0 | 237.5 | .0 | 141.4 | .0 | .0 | .0 | .0 | .0 |
| 5 | .5 | 115.8 | .0 | 73.9 | .0 | .0 | .0 | .0 | .0 |
| 6 | .3 | 78.4 | .0 | 64.8 | .0 | .0 | .0 | .0 | .0 |
| 7 | 3.3 | 1579.3 | .0 | 1244.3 | .0 | .0 | .0 | .0 | .0 |
| 8 | 4.8 | 3618.5 | .0 | 2057.8 | .0 | .0 | .0 | .0 | .0 |
| 9 | 2.7 | 2353.4 | .0 | 1312.9 | .0 | .0 | .0 | .0 | .0 |
| 10 | .4 | 327.5 | .0 | 180.8 | .0 | .0 | .0 | .0 | .0 |
| 11 | .1 | 75.9 | .0 | 41.6 | .0 | .0 | .0 | .0 | .0 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 12 | .1 | 85.8 | .0 | 46.9 | .0 | .0 | .0 | .0 | .0 |
| 13 | 1.6 | 1668.5 | .0 | 882.6 | .0 | .0 | .0 | .0 | .0 |
| 14 | 3.0 | 3348.3 | .0 | 1581.6 | .0 | .0 | .0 | .0 | .0 |
| 15 | 1.6 | 1939.6 | .0 | 850.6 | .0 | .0 | .0 | .0 | .0 |
| 16 | .5 | 580.9 | .0 | 246.6 | .0 | .0 | .0 | .0 | .0 |
| 17 | 1.1 | 1461.3 | .0 | 605.9 | .0 | .0 | .0 | .0 | .0 |
| 18 | 3.9 | 5443.6 | .0 | 2116.0 | .0 | .0 | .0 | .0 | .0 |
| 19 | 4.4 | 7443.7 | .0 | 3124.8 | .0 | .0 | .0 | .0 | .0 |
| 20 | .2 | 449.6 | .0 | 179.5 | .0 | .0 | .0 | .0 | .0 |
| 21 | .2 | 312.2 | .0 | 124.5 | .0 | .0 | .0 | .0 | .0 |
| 22 | 1.5 | 3090.6 | .0 | 1226.3 | .0 | .0 | .0 | .0 | .0 |
| 23 | .1 | 114.7 | .0 | 45.3 | .0 | .0 | .0 | .0 | .0 |
| 24 | .2 | 509.1 | .0 | 199.9 | .0 | .0 | .0 | .0 | .0 |
| 25 | 2.3 | 5282.3 | .0 | 2047.4 | .0 | .0 | .0 | .0 | .0 |
| 26 | .6 | 1390.6 | .0 | 507.5 | .0 | .0 | .0 | .0 | .0 |
| 27 | 4.2 | 10632.3 | .0 | 3854.7 | .0 | .0 | .0 | .0 | .0 |
| 28 | 2.5 | 6736.2 | .0 | 2535.3 | .0 | .0 | .0 | .0 | .0 |
| 29 | 2.1 | 6174.7 | .0 | 2347.5 | .0 | .0 | .0 | .0 | .0 |
| 30 | 4.7 | 13656.1 | .0 | 4836.1 | .0 | .0 | .0 | .0 | .0 |
| 31 | 20.2 | 56248.3 | .0 | 20606.4 | .0 | .0 | .0 | .0 | .0 |
| 32 | 2.3 | 6228.9 | .0 | 2340.8 | .0 | .0 | .0 | .0 | .0 |
| 33 | 1.5 | 4078.3 | .0 | 1510.3 | .0 | .0 | .0 | .0 | .0 |
| 34 | 25.1 | 74153.0 | .0 | 24902.0 | .0 | .0 | .0 | .0 | .0 |
| 35 | 1.5 | 4788.2 | .0 | 1467.2 | .0 | .0 | .0 | .0 | .0 |
| 36 | 11.8 | 38926.9 | .0 | 11418.3 | .0 | .0 | .0 | .0 | .0 |
| 37 | .3 | 1091.9 | .0 | 308.6 | .0 | .0 | .0 | .0 | .0 |
| 38 | .1 | 272.7 | .0 | 77.1 | .0 | .0 | .0 | .0 | .0 |
| 39 | .3 | 851.7 | .0 | 241.0 | .0 | .0 | .0 | .0 | .0 |
| 40 | 11.1 | 37622.9 | .0 | 10622.9 | .0 | .0 | .0 | .0 | .0 |
| 41 | 1.5 | 5068.0 | .0 | 1426.6 | .0 | .0 | .0 | .0 | .0 |
| 42 | 6.8 | 22778.2 | .0 | 6399.0 | .0 | .0 | .0 | .0 | .0 |
| 43 | .3 | 1077.6 | .0 | 301.7 | .0 | .0 | .0 | .0 | .0 |
| 44 | .1 | 269.8 | .0 | 75.4 | .0 | .0 | .0 | .0 | .0 |
| 45 | .3 | 844.5 | .0 | 235.6 | .0 | .0 | .0 | .0 | .0 |
| 46 | 1.5 | 5110.3 | .0 | 1412.1 | .0 | .0 | .0 | .0 | .0 |
| 47 | 14.7 | 53986.7 | .0 | 13710.2 | .0 | .0 | .0 | .0 | .0 |
| 48 | 1.8 | 6899.1 | .0 | 1616.6 | .0 | .0 | .0 | .0 | .0 |
| 49 | 18.4 | 78527.5 | .0 | 16778.7 | .0 | .0 | .0 | .0 | .0 |
| 50 | 1.5 | 6897.7 | .0 | 1353.2 | .0 | .0 | .0 | .0 | .0 |
| 51 | 7.2 | 33990.3 | .0 | 6434.6 | .0 | .0 | .0 | .0 | .0 |
| 52 | 1.5 | 6294.8 | .0 | 1339.1 | .0 | .0 | .0 | .0 | .0 |
| 53 | 24.2 | 107138.0 | .0 | 21276.5 | .0 | .0 | .0 | .0 | .0 |
| 54 | 1.8 | 8148.7 | .0 | 1513.4 | .0 | .0 | .0 | .0 | .0 |
| 55 | 18.4 | 88876.9 | .0 | 15694.6 | .0 | .0 | .0 | .0 | .0 |
| 56 | 1.5 | 7518.7 | .0 | 1264.7 | .0 | .0 | .0 | .0 | .0 |
| 57 | 12.0 | 61643.3 | .0 | 10038.4 | .0 | .0 | .0 | .0 | .0 |
| 58 | .3 | 1675.8 | .0 | 265.3 | .0 | .0 | .0 | .0 | .0 |
| 59 | .1 | 418.8 | .0 | 66.3 | .0 | .0 | .0 | .0 | .0 |
| 60 | .2 | 1307.6 | .0 | 207.1 | .0 | .0 | .0 | .0 | .0 |
| 61 | 6.2 | 32338.0 | .0 | 5110.0 | .0 | .0 | .0 | .0 | .0 |
| 62 | .2 | 1023.9 | .0 | 865.4 | .0 | .0 | .0 | .0 | .0 |
| 63 | .4 | 1826.5 | .0 | 1407.2 | .0 | .0 | .0 | .0 | .0 |
| 64 | .3 | 1619.0 | .0 | 1069.2 | .0 | .0 | .0 | .0 | .0 |
| 65 | 3.5 | 16312.9 | .0 | 2022.3 | .0 | .0 | .0 | .0 | .0 |
| 66 | 2.6 | 11236.7 | .0 | 799.9 | .0 | .0 | .0 | .0 | .0 |
| 67 | .4 | 1603.6 | .0 | 7.3 | .0 | .0 | .0 | .0 | .0 |
| 68 | 3.0 | 12320.7 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 69 | 2.6 | 10101.7 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 70 | .2 | 827.0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 71 | .3 | 1202.4 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 72 | .1 | 300.0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 73 | .2 | 935.5 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 74 | 2.3 | 8576.6 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 75 | 2.9 | 10190.7 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 76 | .0 | 128.9 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 77 | .4 | 1531.0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 78 | 3.1 | 10342.8 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 79 | 2.4 | 7758.5 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 80 | 1.4 | 4050.2 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 81 | .2 | 657.0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 82 | .5 | 1386.2 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 83 | 2.8 | 7619.4 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 84 | 1.0 | 2484.5 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 85 | 1.7 | 3950.7 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 86 | 2.5 | 5144.7 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 87 | .5 | 962.4 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 88 | .5 | 1030.3 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 89 | 3.4 | 6636.9 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 90 | 2.8 | 4921.8 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 91 | 1.7 | 2611.6 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 92 | 3.4 | 4493.3 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 93 | 2.7 | 3117.5 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 94 | 2.1 | 1989.7 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 95 | 3.1 | 2345.9 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 96 | 1.8 | 963.4 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 97 | .0 | 12.5 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 98 | .4 | 118.0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 99 | .1 | 29.4 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 100 | .5 | 54.6 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |

Failure Surface Specified By 36 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 272.15 | 82.25 |
| 2 | 273.54 | 81.78 |
| 3 | 278.05 | 79.62 |
| 4 | 281.67 | 76.17 |
| 5 | 286.49 | 74.82 |
| 6 | 291.33 | 73.56 |
| 7 | 296.33 | 73.45 |
| 8 | 301.32 | 73.28 |
| 9 | 305.70 | 70.86 |
| 10 | 310.26 | 68.81 |
| 11 | 315.06 | 67.41 |
| 12 | 319.67 | 65.47 |
| 13 | 518.53 | 68.92 |
| 14 | 519.44 | 73.84 |
| 15 | 522.97 | 77.38 |
| 16 | 525.53 | 81.67 |
| 17 | 528.89 | 85.38 |
| 18 | 531.47 | 89.66 |
| 19 | 534.67 | 93.50 |
| 20 | 537.60 | 97.55 |
| 21 | 541.13 | 101.09 |
| 22 | 543.57 | 105.46 |
| 23 | 544.94 | 110.26 |
| 24 | 548.46 | 113.82 |
| 25 | 549.44 | 118.72 |
| 26 | 551.18 | 123.41 |
| 27 | 554.61 | 127.04 |
| 28 | 558.05 | 130.67 |
| 29 | 560.85 | 134.81 |
| 30 | 562.55 | 139.51 |
| 31 | 565.91 | 143.22 |
| 32 | 568.60 | 147.43 |
| 33 | 570.71 | 151.97 |
| 34 | 573.86 | 155.85 |
| 35 | 575.67 | 160.51 |
| 36 | 576.64 | 164.98 |

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Failure Surface Specified By 36 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 272.15 | 82.25 |
| 2 | 273.54 | 81.78 |
| 3 | 278.05 | 79.62 |
| 4 | 281.67 | 76.17 |
| 5 | 286.49 | 74.82 |
| 6 | 291.33 | 73.56 |
| 7 | 296.33 | 73.45 |
| 8 | 301.32 | 73.28 |

| | | |
|---|---|---|
| 9 | 305.70 | 70.86 |
| 10 | 310.26 | 68.81 |
| 11 | 315.06 | 67.41 |
| 12 | 319.67 | 65.47 |
| 13 | 518.53 | 68.92 |
| 14 | 519.44 | 73.84 |
| 15 | 522.97 | 77.38 |
| 16 | 525.53 | 81.67 |
| 17 | 528.89 | 85.38 |
| 18 | 531.47 | 89.66 |
| 19 | 534.67 | 93.50 |
| 20 | 537.60 | 97.55 |
| 21 | 541.13 | 101.09 |
| 22 | 543.57 | 105.46 |
| 23 | 544.94 | 110.26 |
| 24 | 548.46 | 113.82 |
| 25 | 549.44 | 118.72 |
| 26 | 551.18 | 123.41 |
| 27 | 554.61 | 127.04 |
| 28 | 558.05 | 130.67 |
| 29 | 560.85 | 134.81 |
| 30 | 562.55 | 139.51 |
| 31 | 565.91 | 143.22 |
| 32 | 568.60 | 147.43 |
| 33 | 570.71 | 151.97 |
| 34 | 573.86 | 155.85 |
| 35 | 575.67 | 160.51 |
| 36 | 576.64 | 164.98 |

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Failure Surface Specified By 36 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 272.15 | 82.25 |
| 2 | 273.54 | 81.78 |
| 3 | 278.05 | 79.62 |
| 4 | 281.67 | 76.17 |
| 5 | 286.49 | 74.82 |
| 6 | 291.33 | 73.56 |
| 7 | 296.33 | 73.45 |
| 8 | 301.32 | 73.28 |
| 9 | 305.70 | 70.86 |
| 10 | 310.26 | 68.81 |
| 11 | 315.06 | 67.41 |
| 12 | 319.67 | 65.47 |
| 13 | 518.53 | 68.92 |
| 14 | 519.44 | 73.84 |
| 15 | 522.97 | 77.38 |
| 16 | 525.53 | 81.67 |
| 17 | 528.89 | 85.38 |
| 18 | 531.47 | 89.66 |
| 19 | 534.67 | 93.50 |
| 20 | 537.60 | 97.55 |
| 21 | 541.13 | 101.09 |
| 22 | 543.57 | 105.46 |
| 23 | 544.94 | 110.26 |
| 24 | 548.46 | 113.82 |
| 25 | 549.44 | 118.72 |
| 26 | 551.18 | 123.41 |
| 27 | 554.61 | 127.04 |
| 28 | 558.05 | 130.67 |
| 29 | 560.85 | 134.81 |
| 30 | 562.55 | 139.51 |
| 31 | 565.91 | 143.22 |
| 32 | 568.60 | 147.43 |
| 33 | 570.71 | 151.97 |
| 34 | 573.86 | 155.85 |
| 35 | 575.67 | 160.51 |
| 36 | 576.64 | 164.98 |

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Failure Surface Specified By 36 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 272.15 | 82.25 |
| 2 | 273.54 | 81.78 |
| 3 | 278.05 | 79.62 |
| 4 | 281.67 | 76.17 |
| 5 | 286.49 | 74.82 |
| 6 | 291.33 | 73.56 |
| 7 | 296.33 | 73.45 |
| 8 | 301.32 | 73.28 |
| 9 | 305.70 | 70.86 |
| 10 | 310.26 | 68.81 |
| 11 | 315.06 | 67.41 |
| 12 | 319.67 | 65.47 |
| 13 | 518.53 | 68.92 |
| 14 | 519.44 | 73.84 |
| 15 | 522.97 | 77.38 |
| 16 | 525.53 | 81.67 |
| 17 | 528.89 | 85.38 |
| 18 | 531.47 | 89.66 |
| 19 | 534.67 | 93.50 |
| 20 | 537.60 | 97.55 |
| 21 | 541.13 | 101.09 |
| 22 | 543.57 | 105.46 |
| 23 | 544.94 | 110.26 |
| 24 | 548.46 | 113.82 |
| 25 | 549.44 | 118.72 |
| 26 | 551.18 | 123.41 |
| 27 | 554.61 | 127.04 |
| 28 | 558.05 | 130.67 |
| 29 | 560.85 | 134.81 |
| 30 | 562.55 | 139.51 |
| 31 | 565.91 | 143.22 |
| 32 | 568.60 | 147.43 |
| 33 | 570.71 | 151.97 |
| 34 | 573.86 | 155.85 |
| 35 | 575.67 | 160.51 |
| 36 | 576.64 | 164.98 |

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Failure Surface Specified By 36 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 272.15 | 82.25 |
| 2 | 273.54 | 81.78 |
| 3 | 278.05 | 79.62 |
| 4 | 281.67 | 76.17 |
| 5 | 286.49 | 74.82 |
| 6 | 291.33 | 73.56 |
| 7 | 296.33 | 73.45 |
| 8 | 301.32 | 73.28 |
| 9 | 305.70 | 70.86 |
| 10 | 310.26 | 68.81 |
| 11 | 315.06 | 67.41 |
| 12 | 319.67 | 65.47 |
| 13 | 518.53 | 68.92 |
| 14 | 519.44 | 73.84 |
| 15 | 522.97 | 77.38 |
| 16 | 525.53 | 81.67 |
| 17 | 528.89 | 85.38 |
| 18 | 531.47 | 89.66 |
| 19 | 534.67 | 93.50 |
| 20 | 537.60 | 97.55 |
| 21 | 541.13 | 101.09 |
| 22 | 543.57 | 105.46 |
| 23 | 544.94 | 110.26 |
| 24 | 548.46 | 113.82 |
| 25 | 549.44 | 118.72 |
| 26 | 551.18 | 123.41 |
| 27 | 554.61 | 127.04 |
| 28 | 558.05 | 130.67 |

| | | |
|---|---|---|
| 29 | 560.85 | 134.81 |
| 30 | 562.55 | 139.51 |
| 31 | 565.91 | 143.22 |
| 32 | 568.60 | 147.43 |
| 33 | 570.71 | 151.97 |
| 34 | 573.86 | 155.85 |
| 35 | 575.67 | 160.51 |
| 36 | 576.64 | 164.98 |

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Failure Surface Specified By 36 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 272.15 | 82.25 |
| 2 | 273.54 | 81.78 |
| 3 | 278.05 | 79.62 |
| 4 | 281.67 | 76.17 |
| 5 | 286.49 | 74.82 |
| 6 | 291.33 | 73.56 |
| 7 | 296.33 | 73.45 |
| 8 | 301.32 | 73.28 |
| 9 | 305.70 | 70.86 |
| 10 | 310.26 | 68.81 |
| 11 | 315.06 | 67.41 |
| 12 | 319.67 | 65.47 |
| 13 | 518.53 | 68.92 |
| 14 | 519.44 | 73.84 |
| 15 | 522.97 | 77.38 |
| 16 | 525.53 | 81.67 |
| 17 | 528.89 | 85.38 |
| 18 | 531.47 | 89.66 |
| 19 | 534.67 | 93.50 |
| 20 | 537.60 | 97.55 |
| 21 | 541.13 | 101.09 |
| 22 | 543.57 | 105.46 |
| 23 | 544.94 | 110.26 |
| 24 | 548.46 | 113.82 |
| 25 | 549.44 | 118.72 |
| 26 | 551.18 | 123.41 |
| 27 | 554.61 | 127.04 |
| 28 | 558.05 | 130.67 |
| 29 | 560.85 | 134.81 |
| 30 | 562.55 | 139.51 |
| 31 | 565.91 | 143.22 |
| 32 | 568.60 | 147.43 |
| 33 | 570.71 | 151.97 |
| 34 | 573.86 | 155.85 |
| 35 | 575.67 | 160.51 |
| 36 | 576.64 | 164.98 |

*** 1.635 ***

Failure Surface Specified By 36 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 272.15 | 82.25 |
| 2 | 273.54 | 81.78 |
| 3 | 278.05 | 79.62 |
| 4 | 281.67 | 76.17 |
| 5 | 286.49 | 74.82 |
| 6 | 291.33 | 73.56 |
| 7 | 296.33 | 73.45 |
| 8 | 301.32 | 73.28 |
| 9 | 305.70 | 70.86 |
| 10 | 310.26 | 68.81 |
| 11 | 315.06 | 67.41 |
| 12 | 319.67 | 65.47 |
| 13 | 518.53 | 68.92 |
| 14 | 519.44 | 73.84 |
| 15 | 522.97 | 77.38 |
| 16 | 525.53 | 81.67 |
| 17 | 528.89 | 85.38 |
| 18 | 531.47 | 89.66 |

| | | |
|---|---|---|
| 19 | 534.67 | 93.50 |
| 20 | 537.60 | 97.55 |
| 21 | 541.13 | 101.09 |
| 22 | 543.57 | 105.46 |
| 23 | 544.94 | 110.26 |
| 24 | 548.46 | 113.82 |
| 25 | 549.44 | 118.72 |
| 26 | 551.18 | 123.41 |
| 27 | 554.61 | 127.04 |
| 28 | 558.05 | 130.67 |
| 29 | 560.85 | 134.81 |
| 30 | 562.55 | 139.51 |
| 31 | 565.91 | 143.22 |
| 32 | 568.60 | 147.43 |
| 33 | 570.71 | 151.97 |
| 34 | 573.86 | 155.85 |
| 35 | 575.67 | 160.51 |
| 36 | 576.64 | 164.98 |

*** 1.635 ***

Failure Surface Specified By 36 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 272.15 | 82.25 |
| 2 | 273.54 | 81.78 |
| 3 | 278.05 | 79.62 |
| 4 | 281.67 | 76.17 |
| 5 | 286.49 | 74.82 |
| 6 | 291.33 | 73.56 |
| 7 | 296.33 | 73.45 |
| 8 | 301.32 | 73.28 |
| 9 | 305.70 | 70.86 |
| 10 | 310.26 | 68.81 |
| 11 | 315.06 | 67.41 |
| 12 | 319.67 | 65.47 |
| 13 | 518.53 | 68.92 |
| 14 | 519.44 | 73.84 |
| 15 | 522.97 | 77.38 |
| 16 | 525.53 | 81.67 |
| 17 | 528.89 | 85.38 |
| 18 | 531.47 | 89.66 |
| 19 | 534.67 | 93.50 |
| 20 | 537.60 | 97.55 |
| 21 | 541.13 | 101.09 |
| 22 | 543.57 | 105.46 |
| 23 | 544.94 | 110.26 |
| 24 | 548.46 | 113.82 |
| 25 | 549.44 | 118.72 |
| 26 | 551.18 | 123.41 |
| 27 | 554.61 | 127.04 |
| 28 | 558.05 | 130.67 |
| 29 | 560.85 | 134.81 |
| 30 | 562.55 | 139.51 |
| 31 | 565.91 | 143.22 |
| 32 | 568.60 | 147.43 |
| 33 | 570.71 | 151.97 |
| 34 | 573.86 | 155.85 |
| 35 | 575.67 | 160.51 |
| 36 | 576.64 | 164.98 |

*** 1.635 ***

Failure Surface Specified By 36 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 272.15 | 82.25 |
| 2 | 273.54 | 81.78 |
| 3 | 278.05 | 79.62 |
| 4 | 281.67 | 76.17 |
| 5 | 286.49 | 74.82 |
| 6 | 291.33 | 73.56 |
| 7 | 296.33 | 73.45 |
| 8 | 301.32 | 73.28 |

| | | |
|---|---|---|
| 9 | 305.70 | 70.86 |
| 10 | 310.26 | 68.81 |
| 11 | 315.06 | 67.41 |
| 12 | 319.67 | 65.47 |
| 13 | 518.53 | 68.92 |
| 14 | 519.44 | 73.84 |
| 15 | 522.97 | 77.38 |
| 16 | 525.53 | 81.67 |
| 17 | 528.89 | 85.38 |
| 18 | 531.47 | 89.66 |
| 19 | 534.67 | 93.50 |
| 20 | 537.60 | 97.55 |
| 21 | 541.13 | 101.09 |
| 22 | 543.57 | 105.46 |
| 23 | 544.94 | 110.26 |
| 24 | 548.46 | 113.82 |
| 25 | 549.44 | 118.72 |
| 26 | 551.18 | 123.41 |
| 27 | 554.61 | 127.04 |
| 28 | 558.05 | 130.67 |
| 29 | 560.85 | 134.81 |
| 30 | 562.55 | 139.51 |
| 31 | 565.91 | 143.22 |
| 32 | 568.60 | 147.43 |
| 33 | 570.71 | 151.97 |
| 34 | 573.86 | 155.85 |
| 35 | 575.67 | 160.51 |
| 36 | 576.64 | 164.98 |

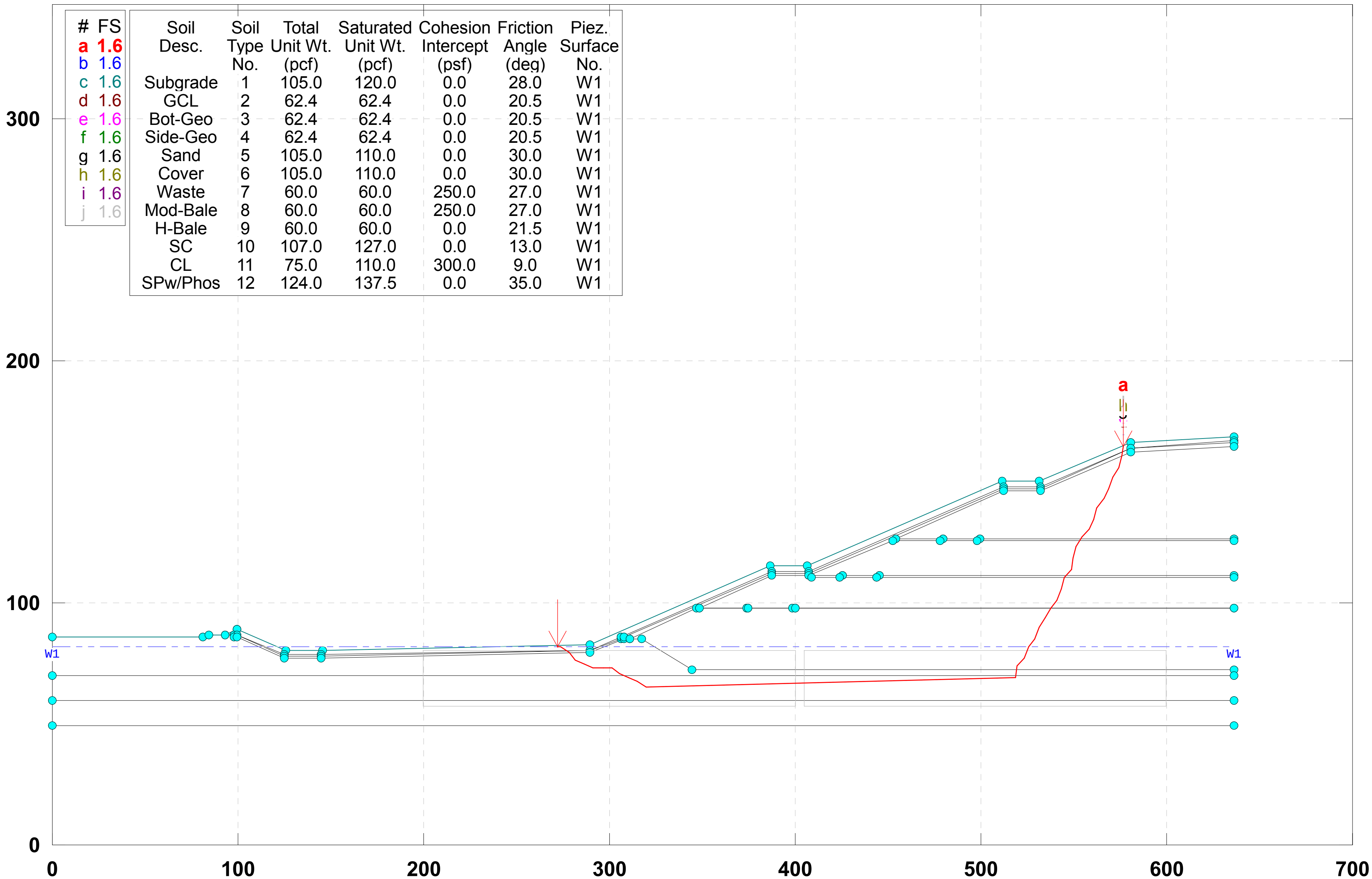
*** 1.635 ***

# Phase II Section II Expansion RAI No. 1 Phase I West Slope During Construction

C:\1\HARDEE~1.1\4HARDE~1.1\EWBL\EWSECBLA.PL2 Run By: Shane R. Fischer, P.E. 03/31/13 5:10AM

| # | FS |
|---|---|
| a | 1.6 |
| b | 1.6 |
| c | 1.6 |
| d | 1.6 |
| e | 1.6 |
| f | 1.6 |
| g | 1.6 |
| h | 1.6 |
| i | 1.6 |
| j | 1.6 |

| Soil Desc. | Soil Type No. | Total Unit Wt. (pcf) | Saturated Unit Wt. (pcf) | Cohesion Intercept (psf) | Friction Angle (deg) | Piez. Surface No. |
|---|---|---|---|---|---|---|
| Subgrade | 1 | 105.0 | 120.0 | 0.0 | 28.0 | W1 |
| GCL | 2 | 62.4 | 62.4 | 0.0 | 20.5 | W1 |
| Bot-Geo | 3 | 62.4 | 62.4 | 0.0 | 20.5 | W1 |
| Side-Geo | 4 | 62.4 | 62.4 | 0.0 | 20.5 | W1 |
| Sand | 5 | 105.0 | 110.0 | 0.0 | 30.0 | W1 |
| Cover | 6 | 105.0 | 110.0 | 0.0 | 30.0 | W1 |
| Waste | 7 | 60.0 | 60.0 | 250.0 | 27.0 | W1 |
| Mod-Bale | 8 | 60.0 | 60.0 | 250.0 | 27.0 | W1 |
| H-Bale | 9 | 60.0 | 60.0 | 0.0 | 21.5 | W1 |
| SC | 10 | 107.0 | 127.0 | 0.0 | 13.0 | W1 |
| CL | 11 | 75.0 | 110.0 | 300.0 | 9.0 | W1 |
| SPw/Phos | 12 | 124.0 | 137.5 | 0.0 | 35.0 | W1 |




PCSTABL5M/si FSmin=1.6

Safety Factors Are Calculated By The Modified Janbu Method

SCS ENGINEERS

**** PCSTABL5M ****
by
Purdue University
--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer`s Method of Slices

Run Date: 03/31/13
Time of Run: 5:10AM
Run By: Shane R. Fischer, P.E.
Input Data Filename: C:ewsecbla.
Output Filename: C:ewsecbla.OUT
Unit: ENGLISH
Plotted Output Filename: C:ewsecbla.PLT
PROBLEM DESCRIPTION Phase II Section II Expansion RAI No. 1
Phase I West Slope During Construction

BOUNDARY COORDINATES
14 Top Boundaries
87 Total Boundaries

| Boundary No. | X-Left (ft) | Y-Left (ft) | X-Right (ft) | Y-Right (ft) | Soil Type Below Bnd |
|---|---|---|---|---|---|
| 1 | .00 | 86.00 | 81.46 | 86.00 | 1 |
| 2 | 81.46 | 86.00 | 84.47 | 87.00 | 1 |
| 3 | 84.47 | 87.00 | 93.14 | 87.00 | 1 |
| 4 | 93.14 | 87.00 | 99.14 | 89.00 | 6 |
| 5 | 99.14 | 89.00 | 99.79 | 89.00 | 6 |
| 6 | 99.79 | 89.00 | 125.29 | 80.50 | 6 |
| 7 | 125.29 | 80.50 | 145.29 | 80.50 | 6 |
| 8 | 145.29 | 80.50 | 289.16 | 82.49 | 6 |
| 9 | 289.16 | 82.49 | 386.69 | 115.00 | 6 |
| 10 | 386.69 | 115.00 | 406.69 | 115.00 | 6 |
| 11 | 406.69 | 115.00 | 511.69 | 150.00 | 6 |
| 12 | 511.69 | 150.00 | 531.69 | 150.00 | 6 |
| 13 | 531.69 | 150.00 | 580.29 | 166.20 | 6 |
| 14 | 580.29 | 166.20 | 636.29 | 169.00 | 6 |
| 15 | 93.14 | 87.00 | 97.46 | 87.00 | 1 |
| 16 | 97.46 | 87.00 | 99.46 | 87.00 | 3 |
| 17 | 99.46 | 87.00 | 124.96 | 78.50 | 3 |
| 18 | 124.96 | 78.50 | 144.96 | 78.50 | 3 |
| 19 | 144.96 | 78.50 | 289.51 | 80.50 | 3 |
| 20 | 289.51 | 80.50 | 306.09 | 86.02 | 3 |
| 21 | 306.09 | 86.02 | 387.01 | 113.00 | 4 |
| 22 | 387.01 | 113.00 | 407.01 | 113.00 | 4 |
| 23 | 407.01 | 113.00 | 512.01 | 148.00 | 4 |
| 24 | 512.01 | 148.00 | 532.01 | 148.00 | 4 |
| 25 | 532.01 | 148.00 | 580.29 | 164.09 | 4 |
| 26 | 580.29 | 164.09 | 636.29 | 166.89 | 4 |
| 27 | 97.46 | 86.53 | 99.30 | 86.53 | 2 |
| 28 | 99.30 | 86.53 | 124.99 | 78.00 | 2 |
| 29 | 124.99 | 78.00 | 144.99 | 78.00 | 2 |
| 30 | 144.99 | 78.00 | 289.59 | 80.00 | 2 |
| 31 | 289.59 | 80.00 | 305.93 | 85.44 | 2 |
| 32 | 305.93 | 85.44 | 306.09 | 86.02 | 4 |
| 33 | 305.93 | 85.44 | 307.91 | 86.10 | 2 |
| 34 | 307.91 | 86.10 | 387.09 | 112.50 | 5 |
| 35 | 387.09 | 112.50 | 407.09 | 112.50 | 5 |
| 36 | 407.09 | 112.50 | 512.09 | 147.50 | 5 |
| 37 | 512.09 | 147.50 | 532.09 | 147.50 | 5 |
| 38 | 532.09 | 147.50 | 580.38 | 163.59 | 5 |
| 39 | 580.38 | 163.59 | 636.29 | 166.39 | 5 |
| 40 | 97.46 | 86.03 | 99.22 | 86.03 | 1 |
| 41 | 99.22 | 86.03 | 124.91 | 77.50 | 1 |
| 42 | 124.91 | 77.50 | 144.99 | 77.50 | 1 |
| 43 | 144.99 | 77.50 | 289.68 | 79.50 | 1 |
| 44 | 289.68 | 79.50 | 307.67 | 85.50 | 1 |
| 45 | 307.67 | 85.50 | 307.91 | 86.10 | 6 |
| 46 | 307.67 | 85.50 | 310.84 | 85.50 | 1 |
| 47 | 310.84 | 85.50 | 346.84 | 97.50 | 8 |
| 48 | 346.84 | 97.50 | 348.34 | 98.00 | 8 |
| 49 | 348.34 | 98.00 | 387.34 | 111.00 | 8 |
| 50 | 387.34 | 111.00 | 407.34 | 111.00 | 8 |

| | | | | | |
|---|---|---|---|---|---|
| 51 | 407.34 | 111.00 | 452.34 | 126.00 | 5 |
| 52 | 452.34 | 126.00 | 453.84 | 126.50 | 8 |
| 53 | 453.84 | 126.50 | 512.34 | 146.00 | 7 |
| 54 | 512.34 | 146.00 | 532.34 | 146.00 | 7 |
| 55 | 532.34 | 146.00 | 580.29 | 161.98 | 7 |
| 56 | 580.29 | 161.98 | 636.29 | 164.78 | 7 |
| 57 | 453.84 | 126.50 | 479.80 | 126.50 | 8 |
| 58 | 479.80 | 126.50 | 499.68 | 126.50 | 9 |
| 59 | 499.68 | 126.50 | 636.29 | 126.50 | 8 |
| 60 | 452.34 | 126.00 | 478.05 | 126.00 | 8 |
| 61 | 478.05 | 126.00 | 479.80 | 126.50 | 9 |
| 62 | 478.05 | 126.00 | 498.18 | 126.00 | 8 |
| 63 | 498.18 | 126.00 | 499.68 | 126.50 | 8 |
| 64 | 498.18 | 126.00 | 636.29 | 126.00 | 8 |
| 65 | 407.34 | 111.00 | 425.29 | 111.00 | 8 |
| 66 | 425.29 | 111.00 | 445.17 | 111.00 | 9 |
| 67 | 445.17 | 111.00 | 636.29 | 111.00 | 8 |
| 68 | 407.34 | 111.00 | 408.84 | 110.50 | 8 |
| 69 | 408.84 | 110.50 | 423.54 | 110.50 | 8 |
| 70 | 423.54 | 110.50 | 425.29 | 111.00 | 9 |
| 71 | 423.54 | 110.50 | 443.67 | 110.50 | 8 |
| 72 | 443.67 | 110.50 | 445.17 | 111.00 | 8 |
| 73 | 443.67 | 110.50 | 636.29 | 110.50 | 8 |
| 74 | 348.34 | 98.00 | 374.93 | 98.00 | 8 |
| 75 | 374.93 | 98.00 | 399.93 | 98.00 | 9 |
| 76 | 399.93 | 98.00 | 636.29 | 98.00 | 8 |
| 77 | 346.84 | 97.50 | 373.43 | 97.50 | 8 |
| 78 | 373.43 | 97.50 | 374.93 | 98.00 | 9 |
| 79 | 373.43 | 97.50 | 398.43 | 97.50 | 8 |
| 80 | 398.43 | 97.50 | 399.93 | 98.00 | 8 |
| 81 | 398.43 | 97.50 | 636.29 | 97.50 | 8 |
| 82 | 310.84 | 85.50 | 317.52 | 85.50 | 1 |
| 83 | 317.52 | 85.50 | 344.52 | 72.00 | 1 |
| 84 | 344.52 | 72.00 | 636.29 | 72.00 | 1 |
| 85 | .00 | 70.00 | 636.29 | 70.00 | 10 |
| 86 | .00 | 60.00 | 636.29 | 60.00 | 11 |
| 87 | .00 | 49.00 | 636.29 | 49.00 | 12 |

ISOTROPIC SOIL PARAMETERS

12 Type(s) of Soil

| Soil Type No. | Total Unit Wt. (pcf) | Saturated Unit Wt. (pcf) | Cohesion Intercept (psf) | Friction Angle (deg) | Pore Pressure Param. | Pressure Constant (psf) | Piez. Surface No. |
|---|---|---|---|---|---|---|---|
| 1 | 105.0 | 120.0 | .0 | 28.0 | .00 | .0 | 1 |
| 2 | 62.4 | 62.4 | .0 | 20.5 | .00 | .0 | 1 |
| 3 | 62.4 | 62.4 | .0 | 20.5 | .00 | .0 | 1 |
| 4 | 62.4 | 62.4 | .0 | 20.5 | .00 | .0 | 1 |
| 5 | 105.0 | 110.0 | .0 | 30.0 | .00 | .0 | 1 |
| 6 | 105.0 | 110.0 | .0 | 30.0 | .00 | .0 | 1 |
| 7 | 60.0 | 60.0 | 250.0 | 27.0 | .00 | .0 | 1 |
| 8 | 60.0 | 60.0 | 250.0 | 27.0 | .00 | .0 | 1 |
| 9 | 60.0 | 60.0 | .0 | 21.5 | .00 | .0 | 1 |
| 10 | 107.0 | 127.0 | .0 | 13.0 | .00 | .0 | 1 |
| 11 | 75.0 | 110.0 | 300.0 | 9.0 | .00 | .0 | 1 |
| 12 | 124.0 | 137.5 | .0 | 35.0 | .00 | .0 | 1 |

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

Unit Weight of Water =  62.40

Piezometric Surface No.  1 Specified by  2 Coordinate Points

| Point No. | X-Water (ft) | Y-Water (ft) |
|---|---|---|
| 1 | .00 | 82.09 |
| 2 | 636.29 | 82.09 |

BOUNDARY LOAD(S)

2 Load(s) Specified

| Load No. | X-Left (ft) | X-Right (ft) | Intensity (psf) | Deflection (deg) |
|---|---|---|---|---|
| 1 | 580.29 | 583.25 | 1581.0 | .0 |
| 2 | 594.24 | 597.21 | 1581.0 | .0 |

NOTE - Intensity Is Specified As A Uniformly Distributed
Force Acting On A Horizontally Projected Surface.

SURCHARGE BOUNDARY LOAD DATA HAS BEEN SUPPRESSED

A Critical Failure Surface Searching Method, Using A Random Technique For Generating Sliding Block Surfaces, Has Been Specified.

1000 Trial Surfaces Have Been Generated.

2 Boxes Specified For Generation Of Central Block Base

Length Of Line Segments For Active And Passive Portions Of Sliding Block Is 5.0

| Box No. | X-Left (ft) | Y-Left (ft) | X-Right (ft) | Y-Right (ft) | Height (ft) |
|---|---|---|---|---|---|
| 1 | 200.00 | 69.00 | 400.00 | 69.00 | 23.00 |
| 2 | 405.00 | 69.00 | 600.00 | 69.00 | 23.00 |

Following Are Displayed The Ten Most Critical Of The Trial Failure Surfaces Examined. They Are Ordered - Most Critical First.

* * Safety Factors Are Calculated By The Modified Janbu Method * *

Failure Surface Specified By 36 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 272.15 | 82.25 |
| 2 | 273.54 | 81.78 |
| 3 | 278.05 | 79.62 |
| 4 | 281.67 | 76.17 |
| 5 | 286.49 | 74.82 |
| 6 | 291.33 | 73.56 |
| 7 | 296.33 | 73.45 |
| 8 | 301.32 | 73.28 |
| 9 | 305.70 | 70.86 |
| 10 | 310.26 | 68.81 |
| 11 | 315.06 | 67.41 |
| 12 | 319.67 | 65.47 |
| 13 | 518.53 | 68.92 |
| 14 | 519.44 | 73.84 |
| 15 | 522.97 | 77.38 |
| 16 | 525.53 | 81.67 |
| 17 | 528.89 | 85.38 |
| 18 | 531.47 | 89.66 |
| 19 | 534.67 | 93.50 |
| 20 | 537.60 | 97.55 |
| 21 | 541.13 | 101.09 |
| 22 | 543.57 | 105.46 |
| 23 | 544.94 | 110.26 |
| 24 | 548.46 | 113.82 |
| 25 | 549.44 | 118.72 |
| 26 | 551.18 | 123.41 |
| 27 | 554.61 | 127.04 |
| 28 | 558.05 | 130.67 |
| 29 | 560.85 | 134.81 |
| 30 | 562.55 | 139.51 |
| 31 | 565.91 | 143.22 |
| 32 | 568.60 | 147.43 |
| 33 | 570.71 | 151.97 |
| 34 | 573.86 | 155.85 |
| 35 | 575.67 | 160.51 |
| 36 | 576.64 | 164.98 |

*** 1.635 ***

Individual data on the 100 slices

| Slice No. | Width (ft) | Weight (lbs) | Water Force Top (lbs) | Water Force Bot (lbs) | Tie Force Norm (lbs) | Tie Force Tan (lbs) | Earthquake Force Hor (lbs) | Earthquake Force Ver (lbs) | Surcharge Load (lbs) |
|---|---|---|---|---|---|---|---|---|---|
| 1 | .5 | 4.4 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 2 | .9 | 32.5 | .0 | 9.3 | .0 | .0 | .0 | .0 | .0 |
| 3 | 3.0 | 413.2 | .0 | 218.8 | .0 | .0 | .0 | .0 | .0 |
| 4 | 1.0 | 237.5 | .0 | 141.4 | .0 | .0 | .0 | .0 | .0 |
| 5 | .5 | 115.8 | .0 | 73.9 | .0 | .0 | .0 | .0 | .0 |
| 6 | .3 | 78.4 | .0 | 64.8 | .0 | .0 | .0 | .0 | .0 |
| 7 | 3.3 | 1579.3 | .0 | 1244.3 | .0 | .0 | .0 | .0 | .0 |
| 8 | 4.8 | 3618.5 | .0 | 2057.8 | .0 | .0 | .0 | .0 | .0 |
| 9 | 2.7 | 2353.4 | .0 | 1312.9 | .0 | .0 | .0 | .0 | .0 |
| 10 | .4 | 327.5 | .0 | 180.8 | .0 | .0 | .0 | .0 | .0 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 11 | .1 | 75.9 | .0 | 41.6 | .0 | .0 | .0 | .0 | .0 |
| 12 | .1 | 85.8 | .0 | 46.9 | .0 | .0 | .0 | .0 | .0 |
| 13 | 1.6 | 1668.5 | .0 | 882.6 | .0 | .0 | .0 | .0 | .0 |
| 14 | 3.0 | 3348.3 | .0 | 1581.6 | .0 | .0 | .0 | .0 | .0 |
| 15 | 1.6 | 1939.6 | .0 | 850.6 | .0 | .0 | .0 | .0 | .0 |
| 16 | .5 | 580.9 | .0 | 246.6 | .0 | .0 | .0 | .0 | .0 |
| 17 | 1.1 | 1461.3 | .0 | 605.9 | .0 | .0 | .0 | .0 | .0 |
| 18 | 3.9 | 5443.6 | .0 | 2116.0 | .0 | .0 | .0 | .0 | .0 |
| 19 | 4.4 | 7443.7 | .0 | 3124.8 | .0 | .0 | .0 | .0 | .0 |
| 20 | .2 | 449.6 | .0 | 179.5 | .0 | .0 | .0 | .0 | .0 |
| 21 | .2 | 312.2 | .0 | 124.5 | .0 | .0 | .0 | .0 | .0 |
| 22 | 1.5 | 3090.6 | .0 | 1226.3 | .0 | .0 | .0 | .0 | .0 |
| 23 | .1 | 114.7 | .0 | 45.3 | .0 | .0 | .0 | .0 | .0 |
| 24 | .2 | 509.1 | .0 | 199.9 | .0 | .0 | .0 | .0 | .0 |
| 25 | 2.3 | 5282.3 | .0 | 2047.4 | .0 | .0 | .0 | .0 | .0 |
| 26 | .6 | 1390.6 | .0 | 507.5 | .0 | .0 | .0 | .0 | .0 |
| 27 | 4.2 | 10632.3 | .0 | 3854.7 | .0 | .0 | .0 | .0 | .0 |
| 28 | 2.5 | 6736.2 | .0 | 2535.3 | .0 | .0 | .0 | .0 | .0 |
| 29 | 2.1 | 6174.7 | .0 | 2347.5 | .0 | .0 | .0 | .0 | .0 |
| 30 | 4.7 | 13656.1 | .0 | 4836.1 | .0 | .0 | .0 | .0 | .0 |
| 31 | 20.2 | 56248.3 | .0 | 20606.4 | .0 | .0 | .0 | .0 | .0 |
| 32 | 2.3 | 6228.9 | .0 | 2340.8 | .0 | .0 | .0 | .0 | .0 |
| 33 | 1.5 | 4078.3 | .0 | 1510.3 | .0 | .0 | .0 | .0 | .0 |
| 34 | 25.1 | 74153.0 | .0 | 24902.0 | .0 | .0 | .0 | .0 | .0 |
| 35 | 1.5 | 4788.2 | .0 | 1467.2 | .0 | .0 | .0 | .0 | .0 |
| 36 | 11.8 | 38926.9 | .0 | 11418.3 | .0 | .0 | .0 | .0 | .0 |
| 37 | .3 | 1091.9 | .0 | 308.6 | .0 | .0 | .0 | .0 | .0 |
| 38 | .1 | 272.7 | .0 | 77.1 | .0 | .0 | .0 | .0 | .0 |
| 39 | .3 | 851.7 | .0 | 241.0 | .0 | .0 | .0 | .0 | .0 |
| 40 | 11.1 | 37622.9 | .0 | 10622.9 | .0 | .0 | .0 | .0 | .0 |
| 41 | 1.5 | 5068.0 | .0 | 1426.6 | .0 | .0 | .0 | .0 | .0 |
| 42 | 6.8 | 22778.2 | .0 | 6399.0 | .0 | .0 | .0 | .0 | .0 |
| 43 | .3 | 1077.6 | .0 | 301.7 | .0 | .0 | .0 | .0 | .0 |
| 44 | .1 | 269.8 | .0 | 75.4 | .0 | .0 | .0 | .0 | .0 |
| 45 | .3 | 844.5 | .0 | 235.6 | .0 | .0 | .0 | .0 | .0 |
| 46 | 1.5 | 5110.3 | .0 | 1412.1 | .0 | .0 | .0 | .0 | .0 |
| 47 | 14.7 | 53986.7 | .0 | 13710.2 | .0 | .0 | .0 | .0 | .0 |
| 48 | 1.8 | 6899.1 | .0 | 1616.6 | .0 | .0 | .0 | .0 | .0 |
| 49 | 18.4 | 78527.5 | .0 | 16778.7 | .0 | .0 | .0 | .0 | .0 |
| 50 | 1.5 | 6897.7 | .0 | 1353.2 | .0 | .0 | .0 | .0 | .0 |
| 51 | 7.2 | 33990.3 | .0 | 6434.6 | .0 | .0 | .0 | .0 | .0 |
| 52 | 1.5 | 6294.8 | .0 | 1339.1 | .0 | .0 | .0 | .0 | .0 |
| 53 | 24.2 | 107138.0 | .0 | 21276.5 | .0 | .0 | .0 | .0 | .0 |
| 54 | 1.8 | 8148.7 | .0 | 1513.4 | .0 | .0 | .0 | .0 | .0 |
| 55 | 18.4 | 88876.9 | .0 | 15694.6 | .0 | .0 | .0 | .0 | .0 |
| 56 | 1.5 | 7518.7 | .0 | 1264.7 | .0 | .0 | .0 | .0 | .0 |
| 57 | 12.0 | 61643.3 | .0 | 10038.4 | .0 | .0 | .0 | .0 | .0 |
| 58 | .3 | 1675.8 | .0 | 265.3 | .0 | .0 | .0 | .0 | .0 |
| 59 | .1 | 418.8 | .0 | 66.3 | .0 | .0 | .0 | .0 | .0 |
| 60 | .2 | 1307.6 | .0 | 207.1 | .0 | .0 | .0 | .0 | .0 |
| 61 | 6.2 | 32338.0 | .0 | 5110.0 | .0 | .0 | .0 | .0 | .0 |
| 62 | .2 | 1023.9 | .0 | 865.4 | .0 | .0 | .0 | .0 | .0 |
| 63 | .4 | 1826.5 | .0 | 1407.2 | .0 | .0 | .0 | .0 | .0 |
| 64 | .3 | 1619.0 | .0 | 1069.2 | .0 | .0 | .0 | .0 | .0 |
| 65 | 3.5 | 16312.9 | .0 | 2022.3 | .0 | .0 | .0 | .0 | .0 |
| 66 | 2.6 | 11236.7 | .0 | 799.9 | .0 | .0 | .0 | .0 | .0 |
| 67 | .4 | 1603.6 | .0 | 7.3 | .0 | .0 | .0 | .0 | .0 |
| 68 | 3.0 | 12320.7 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 69 | 2.6 | 10101.7 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 70 | .2 | 827.0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 71 | .3 | 1202.4 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 72 | .1 | 300.0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 73 | .2 | 935.5 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 74 | 2.3 | 8576.6 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 75 | 2.9 | 10190.7 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 76 | .0 | 128.9 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 77 | .4 | 1531.0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 78 | 3.1 | 10342.8 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 79 | 2.4 | 7758.5 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 80 | 1.4 | 4050.2 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 81 | .2 | 657.0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 82 | .5 | 1386.2 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 83 | 2.8 | 7619.4 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 84 | 1.0 | 2484.5 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 85 | 1.7 | 3950.7 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 86 | 2.5 | 5144.7 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 87 | .5 | 962.4 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 88 | .5 | 1030.3 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 89 | 3.4 | 6636.9 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 90 | 2.8 | 4921.8 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 91 | 1.7 | 2611.6 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 92 | 3.4 | 4493.3 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 93 | 2.7 | 3117.5 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 94 | 2.1 | 1989.7 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 95 | 3.1 | 2345.9 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 96 | 1.8 | 963.4 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 97 | .0 | 12.5 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 98 | .4 | 118.0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 99 | .1 | 29.4 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 100 | .5 | 54.6 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |

Failure Surface Specified By 36 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 272.15 | 82.25 |
| 2 | 273.54 | 81.78 |
| 3 | 278.05 | 79.62 |
| 4 | 281.67 | 76.17 |
| 5 | 286.49 | 74.82 |
| 6 | 291.33 | 73.56 |
| 7 | 296.33 | 73.45 |
| 8 | 301.32 | 73.28 |
| 9 | 305.70 | 70.86 |
| 10 | 310.26 | 68.81 |
| 11 | 315.06 | 67.41 |
| 12 | 319.67 | 65.47 |
| 13 | 518.53 | 68.92 |
| 14 | 519.44 | 73.84 |
| 15 | 522.97 | 77.38 |
| 16 | 525.53 | 81.67 |
| 17 | 528.89 | 85.38 |
| 18 | 531.47 | 89.66 |
| 19 | 534.67 | 93.50 |
| 20 | 537.60 | 97.55 |
| 21 | 541.13 | 101.09 |
| 22 | 543.57 | 105.46 |
| 23 | 544.94 | 110.26 |
| 24 | 548.46 | 113.82 |
| 25 | 549.44 | 118.72 |
| 26 | 551.18 | 123.41 |
| 27 | 554.61 | 127.04 |
| 28 | 558.05 | 130.67 |
| 29 | 560.85 | 134.81 |
| 30 | 562.55 | 139.51 |
| 31 | 565.91 | 143.22 |
| 32 | 568.60 | 147.43 |
| 33 | 570.71 | 151.97 |
| 34 | 573.86 | 155.85 |
| 35 | 575.67 | 160.51 |
| 36 | 576.64 | 164.98 |

*** 1.635 ***

Failure Surface Specified By 36 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 272.15 | 82.25 |
| 2 | 273.54 | 81.78 |
| 3 | 278.05 | 79.62 |
| 4 | 281.67 | 76.17 |
| 5 | 286.49 | 74.82 |
| 6 | 291.33 | 73.56 |
| 7 | 296.33 | 73.45 |

| | | |
|---|---|---|
| 8 | 301.32 | 73.28 |
| 9 | 305.70 | 70.86 |
| 10 | 310.26 | 68.81 |
| 11 | 315.06 | 67.41 |
| 12 | 319.67 | 65.47 |
| 13 | 518.53 | 68.92 |
| 14 | 519.44 | 73.84 |
| 15 | 522.97 | 77.38 |
| 16 | 525.53 | 81.67 |
| 17 | 528.89 | 85.38 |
| 18 | 531.47 | 89.66 |
| 19 | 534.67 | 93.50 |
| 20 | 537.60 | 97.55 |
| 21 | 541.13 | 101.09 |
| 22 | 543.57 | 105.46 |
| 23 | 544.94 | 110.26 |
| 24 | 548.46 | 113.82 |
| 25 | 549.44 | 118.72 |
| 26 | 551.18 | 123.41 |
| 27 | 554.61 | 127.04 |
| 28 | 558.05 | 130.67 |
| 29 | 560.85 | 134.81 |
| 30 | 562.55 | 139.51 |
| 31 | 565.91 | 143.22 |
| 32 | 568.60 | 147.43 |
| 33 | 570.71 | 151.97 |
| 34 | 573.86 | 155.85 |
| 35 | 575.67 | 160.51 |
| 36 | 576.64 | 164.98 |

*** 1.635 ***

Failure Surface Specified By 36 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 272.15 | 82.25 |
| 2 | 273.54 | 81.78 |
| 3 | 278.05 | 79.62 |
| 4 | 281.67 | 76.17 |
| 5 | 286.49 | 74.82 |
| 6 | 291.33 | 73.56 |
| 7 | 296.33 | 73.45 |
| 8 | 301.32 | 73.28 |
| 9 | 305.70 | 70.86 |
| 10 | 310.26 | 68.81 |
| 11 | 315.06 | 67.41 |
| 12 | 319.67 | 65.47 |
| 13 | 518.53 | 68.92 |
| 14 | 519.44 | 73.84 |
| 15 | 522.97 | 77.38 |
| 16 | 525.53 | 81.67 |
| 17 | 528.89 | 85.38 |
| 18 | 531.47 | 89.66 |
| 19 | 534.67 | 93.50 |
| 20 | 537.60 | 97.55 |
| 21 | 541.13 | 101.09 |
| 22 | 543.57 | 105.46 |
| 23 | 544.94 | 110.26 |
| 24 | 548.46 | 113.82 |
| 25 | 549.44 | 118.72 |
| 26 | 551.18 | 123.41 |
| 27 | 554.61 | 127.04 |
| 28 | 558.05 | 130.67 |
| 29 | 560.85 | 134.81 |
| 30 | 562.55 | 139.51 |
| 31 | 565.91 | 143.22 |
| 32 | 568.60 | 147.43 |
| 33 | 570.71 | 151.97 |
| 34 | 573.86 | 155.85 |
| 35 | 575.67 | 160.51 |
| 36 | 576.64 | 164.98 |

*** 1.635 ***

Failure Surface Specified By 36 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 272.15 | 82.25 |
| 2 | 273.54 | 81.78 |
| 3 | 278.05 | 79.62 |
| 4 | 281.67 | 76.17 |
| 5 | 286.49 | 74.82 |
| 6 | 291.33 | 73.56 |
| 7 | 296.33 | 73.45 |
| 8 | 301.32 | 73.28 |
| 9 | 305.70 | 70.86 |
| 10 | 310.26 | 68.81 |
| 11 | 315.06 | 67.41 |
| 12 | 319.67 | 65.47 |
| 13 | 518.53 | 68.92 |
| 14 | 519.44 | 73.84 |
| 15 | 522.97 | 77.38 |
| 16 | 525.53 | 81.67 |
| 17 | 528.89 | 85.38 |
| 18 | 531.47 | 89.66 |
| 19 | 534.67 | 93.50 |
| 20 | 537.60 | 97.55 |
| 21 | 541.13 | 101.09 |
| 22 | 543.57 | 105.46 |
| 23 | 544.94 | 110.26 |
| 24 | 548.46 | 113.82 |
| 25 | 549.44 | 118.72 |
| 26 | 551.18 | 123.41 |
| 27 | 554.61 | 127.04 |
| 28 | 558.05 | 130.67 |
| 29 | 560.85 | 134.81 |
| 30 | 562.55 | 139.51 |
| 31 | 565.91 | 143.22 |
| 32 | 568.60 | 147.43 |
| 33 | 570.71 | 151.97 |
| 34 | 573.86 | 155.85 |
| 35 | 575.67 | 160.51 |
| 36 | 576.64 | 164.98 |

*** 1.635 ***

Failure Surface Specified By 36 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 272.15 | 82.25 |
| 2 | 273.54 | 81.78 |
| 3 | 278.05 | 79.62 |
| 4 | 281.67 | 76.17 |
| 5 | 286.49 | 74.82 |
| 6 | 291.33 | 73.56 |
| 7 | 296.33 | 73.45 |
| 8 | 301.32 | 73.28 |
| 9 | 305.70 | 70.86 |
| 10 | 310.26 | 68.81 |
| 11 | 315.06 | 67.41 |
| 12 | 319.67 | 65.47 |
| 13 | 518.53 | 68.92 |
| 14 | 519.44 | 73.84 |
| 15 | 522.97 | 77.38 |
| 16 | 525.53 | 81.67 |
| 17 | 528.89 | 85.38 |
| 18 | 531.47 | 89.66 |
| 19 | 534.67 | 93.50 |
| 20 | 537.60 | 97.55 |
| 21 | 541.13 | 101.09 |
| 22 | 543.57 | 105.46 |
| 23 | 544.94 | 110.26 |
| 24 | 548.46 | 113.82 |
| 25 | 549.44 | 118.72 |
| 26 | 551.18 | 123.41 |
| 27 | 554.61 | 127.04 |

| | | |
|---|---|---|
| 28 | 558.05 | 130.67 |
| 29 | 560.85 | 134.81 |
| 30 | 562.55 | 139.51 |
| 31 | 565.91 | 143.22 |
| 32 | 568.60 | 147.43 |
| 33 | 570.71 | 151.97 |
| 34 | 573.86 | 155.85 |
| 35 | 575.67 | 160.51 |
| 36 | 576.64 | 164.98 |

*** 1.635 ***

Failure Surface Specified By 36 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 272.15 | 82.25 |
| 2 | 273.54 | 81.78 |
| 3 | 278.05 | 79.62 |
| 4 | 281.67 | 76.17 |
| 5 | 286.49 | 74.82 |
| 6 | 291.33 | 73.56 |
| 7 | 296.33 | 73.45 |
| 8 | 301.32 | 73.28 |
| 9 | 305.70 | 70.86 |
| 10 | 310.26 | 68.81 |
| 11 | 315.06 | 67.41 |
| 12 | 319.67 | 65.47 |
| 13 | 518.53 | 68.92 |
| 14 | 519.44 | 73.84 |
| 15 | 522.97 | 77.38 |
| 16 | 525.53 | 81.67 |
| 17 | 528.89 | 85.38 |
| 18 | 531.47 | 89.66 |
| 19 | 534.67 | 93.50 |
| 20 | 537.60 | 97.55 |
| 21 | 541.13 | 101.09 |
| 22 | 543.57 | 105.46 |
| 23 | 544.94 | 110.26 |
| 24 | 548.46 | 113.82 |
| 25 | 549.44 | 118.72 |
| 26 | 551.18 | 123.41 |
| 27 | 554.61 | 127.04 |
| 28 | 558.05 | 130.67 |
| 29 | 560.85 | 134.81 |
| 30 | 562.55 | 139.51 |
| 31 | 565.91 | 143.22 |
| 32 | 568.60 | 147.43 |
| 33 | 570.71 | 151.97 |
| 34 | 573.86 | 155.85 |
| 35 | 575.67 | 160.51 |
| 36 | 576.64 | 164.98 |

*** 1.635 ***

Failure Surface Specified By 36 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 272.15 | 82.25 |
| 2 | 273.54 | 81.78 |
| 3 | 278.05 | 79.62 |
| 4 | 281.67 | 76.17 |
| 5 | 286.49 | 74.82 |
| 6 | 291.33 | 73.56 |
| 7 | 296.33 | 73.45 |
| 8 | 301.32 | 73.28 |
| 9 | 305.70 | 70.86 |
| 10 | 310.26 | 68.81 |
| 11 | 315.06 | 67.41 |
| 12 | 319.67 | 65.47 |
| 13 | 518.53 | 68.92 |
| 14 | 519.44 | 73.84 |
| 15 | 522.97 | 77.38 |
| 16 | 525.53 | 81.67 |
| 17 | 528.89 | 85.38 |

| | | |
|---|---|---|
| 18 | 531.47 | 89.66 |
| 19 | 534.67 | 93.50 |
| 20 | 537.60 | 97.55 |
| 21 | 541.13 | 101.09 |
| 22 | 543.57 | 105.46 |
| 23 | 544.94 | 110.26 |
| 24 | 548.46 | 113.82 |
| 25 | 549.44 | 118.72 |
| 26 | 551.18 | 123.41 |
| 27 | 554.61 | 127.04 |
| 28 | 558.05 | 130.67 |
| 29 | 560.85 | 134.81 |
| 30 | 562.55 | 139.51 |
| 31 | 565.91 | 143.22 |
| 32 | 568.60 | 147.43 |
| 33 | 570.71 | 151.97 |
| 34 | 573.86 | 155.85 |
| 35 | 575.67 | 160.51 |
| 36 | 576.64 | 164.98 |

*** 1.635 ***

Failure Surface Specified By 36 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 272.15 | 82.25 |
| 2 | 273.54 | 81.78 |
| 3 | 278.05 | 79.62 |
| 4 | 281.67 | 76.17 |
| 5 | 286.49 | 74.82 |
| 6 | 291.33 | 73.56 |
| 7 | 296.33 | 73.45 |
| 8 | 301.32 | 73.28 |
| 9 | 305.70 | 70.86 |
| 10 | 310.26 | 68.81 |
| 11 | 315.06 | 67.41 |
| 12 | 319.67 | 65.47 |
| 13 | 518.53 | 68.92 |
| 14 | 519.44 | 73.84 |
| 15 | 522.97 | 77.38 |
| 16 | 525.53 | 81.67 |
| 17 | 528.89 | 85.38 |
| 18 | 531.47 | 89.66 |
| 19 | 534.67 | 93.50 |
| 20 | 537.60 | 97.55 |
| 21 | 541.13 | 101.09 |
| 22 | 543.57 | 105.46 |
| 23 | 544.94 | 110.26 |
| 24 | 548.46 | 113.82 |
| 25 | 549.44 | 118.72 |
| 26 | 551.18 | 123.41 |
| 27 | 554.61 | 127.04 |
| 28 | 558.05 | 130.67 |
| 29 | 560.85 | 134.81 |
| 30 | 562.55 | 139.51 |
| 31 | 565.91 | 143.22 |
| 32 | 568.60 | 147.43 |
| 33 | 570.71 | 151.97 |
| 34 | 573.86 | 155.85 |
| 35 | 575.67 | 160.51 |
| 36 | 576.64 | 164.98 |

*** 1.635 ***

Failure Surface Specified By 36 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 272.15 | 82.25 |
| 2 | 273.54 | 81.78 |
| 3 | 278.05 | 79.62 |
| 4 | 281.67 | 76.17 |
| 5 | 286.49 | 74.82 |
| 6 | 291.33 | 73.56 |
| 7 | 296.33 | 73.45 |

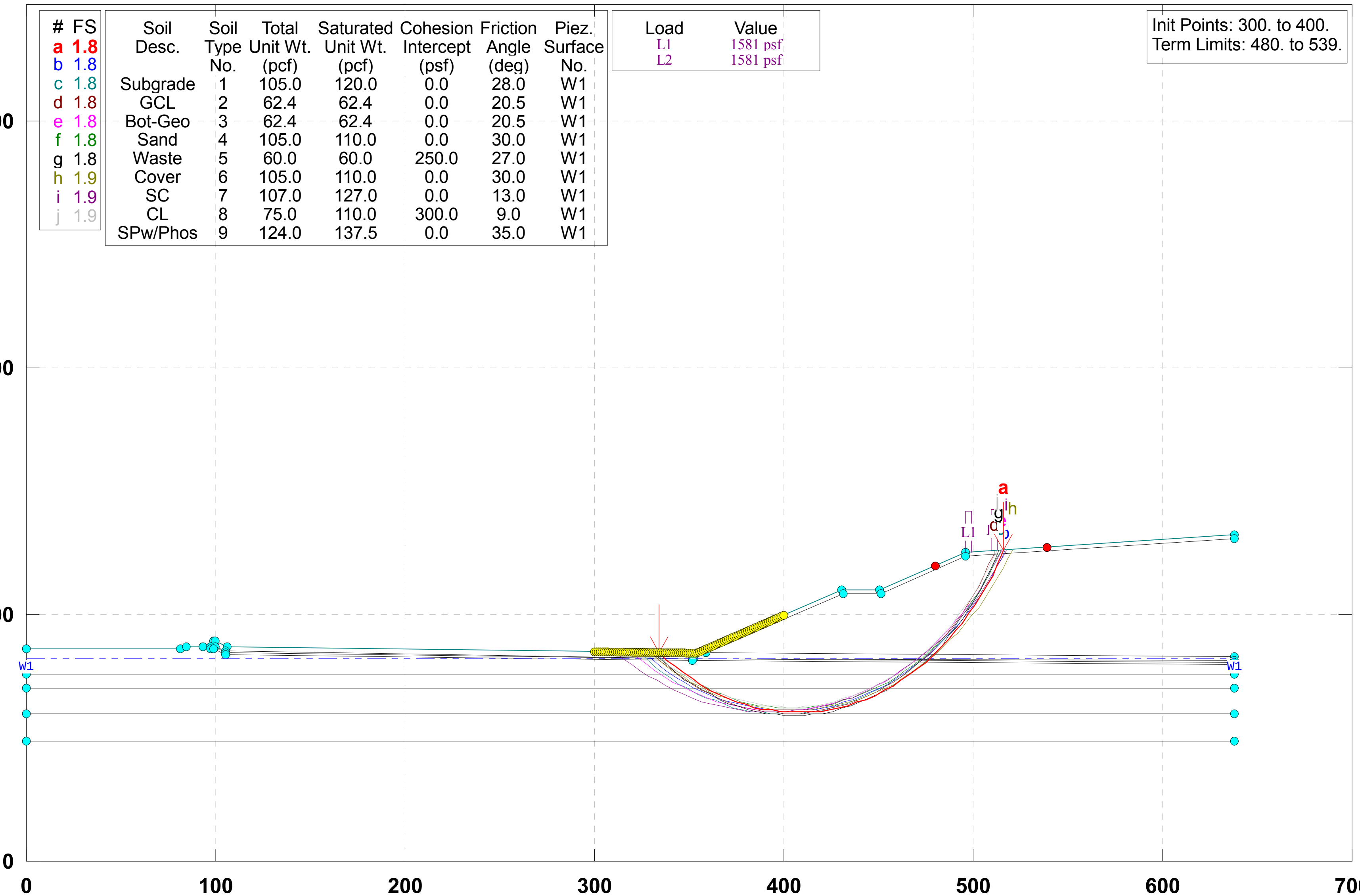
| | | |
|---|---|---|
| 8 | 301.32 | 73.28 |
| 9 | 305.70 | 70.86 |
| 10 | 310.26 | 68.81 |
| 11 | 315.06 | 67.41 |
| 12 | 319.67 | 65.47 |
| 13 | 518.53 | 68.92 |
| 14 | 519.44 | 73.84 |
| 15 | 522.97 | 77.38 |
| 16 | 525.53 | 81.67 |
| 17 | 528.89 | 85.38 |
| 18 | 531.47 | 89.66 |
| 19 | 534.67 | 93.50 |
| 20 | 537.60 | 97.55 |
| 21 | 541.13 | 101.09 |
| 22 | 543.57 | 105.46 |
| 23 | 544.94 | 110.26 |
| 24 | 548.46 | 113.82 |
| 25 | 549.44 | 118.72 |
| 26 | 551.18 | 123.41 |
| 27 | 554.61 | 127.04 |
| 28 | 558.05 | 130.67 |
| 29 | 560.85 | 134.81 |
| 30 | 562.55 | 139.51 |
| 31 | 565.91 | 143.22 |
| 32 | 568.60 | 147.43 |
| 33 | 570.71 | 151.97 |
| 34 | 573.86 | 155.85 |
| 35 | 575.67 | 160.51 |
| 36 | 576.64 | 164.98 |
| *** | 1.635 | *** |

# Slope Stability Analysis during Construction
# Phase II Section II Adjacent to Phase II Section I

## Circular Analysis With and Without Equipment Loading

# Phase II Section I RAI No. 1 West Slope During Expansion Construction

C:\1\HARDEE~1.1\2HARDE~1.1\EWCILO~1\EWSECCIL.PL2 Run By: Shane R. Fischer, P.E. 03/31/13 5:38AM




**PCSTABL5M/si FSmin=1.8**

**Safety Factors Are Calculated By The Modified Bishop Method**

**** PCSTABL5M ****
by
Purdue University
--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer`s Method of Slices

Run Date: 03/31/13
Time of Run: 5:38AM
Run By: Shane R. Fischer, P.E.
Input Data Filename: C:ewseccil.
Output Filename: C:ewseccil.OUT
Unit: ENGLISH
Plotted Output Filename: C:ewseccil.PLT
PROBLEM DESCRIPTION Phase II Section I RAI No. 1
West Slope During Expansion Construction

BOUNDARY COORDINATES
11 Top Boundaries
38 Total Boundaries

| Boundary No. | X-Left (ft) | Y-Left (ft) | X-Right (ft) | Y-Right (ft) | Soil Type Below Bnd |
|---|---|---|---|---|---|
| 1 | .00 | 86.00 | 81.46 | 86.00 | 1 |
| 2 | 81.46 | 86.00 | 84.46 | 87.00 | 1 |
| 3 | 84.46 | 87.00 | 93.14 | 87.00 | 1 |
| 4 | 93.14 | 87.00 | 99.14 | 89.00 | 4 |
| 5 | 99.14 | 89.00 | 99.79 | 89.00 | 4 |
| 6 | 99.79 | 89.00 | 105.80 | 86.99 | 4 |
| 7 | 105.80 | 86.99 | 354.00 | 84.35 | 4 |
| 8 | 354.00 | 84.35 | 430.93 | 110.00 | 6 |
| 9 | 430.93 | 110.00 | 450.93 | 110.00 | 6 |
| 10 | 450.93 | 110.00 | 495.93 | 125.00 | 6 |
| 11 | 495.93 | 125.00 | 637.93 | 132.10 | 6 |
| 12 | 93.14 | 87.00 | 96.95 | 87.00 | 1 |
| 13 | 96.95 | 87.00 | 97.46 | 87.00 | 2 |
| 14 | 97.46 | 87.00 | 99.46 | 87.00 | 3 |
| 15 | 99.46 | 87.00 | 105.46 | 85.00 | 3 |
| 16 | 105.46 | 85.00 | 352.75 | 82.35 | 3 |
| 17 | 352.75 | 82.35 | 358.68 | 84.33 | 4 |
| 18 | 358.68 | 84.33 | 431.18 | 108.50 | 5 |
| 19 | 431.18 | 108.50 | 451.18 | 108.50 | 5 |
| 20 | 451.18 | 108.50 | 496.21 | 123.51 | 5 |
| 21 | 496.21 | 123.51 | 637.93 | 130.59 | 5 |
| 22 | 97.46 | 87.00 | 97.57 | 86.53 | 2 |
| 23 | 97.57 | 86.53 | 99.30 | 86.53 | 2 |
| 24 | 99.30 | 86.53 | 105.41 | 84.50 | 2 |
| 25 | 105.41 | 84.50 | 351.28 | 81.86 | 2 |
| 26 | 351.28 | 81.86 | 352.75 | 82.35 | 2 |
| 27 | 358.68 | 84.33 | 637.93 | 83.10 | 4 |
| 28 | 352.75 | 82.35 | 637.93 | 81.10 | 3 |
| 29 | 351.28 | 81.86 | 637.93 | 80.60 | 2 |
| 30 | 96.95 | 87.00 | 97.17 | 86.03 | 1 |
| 31 | 97.17 | 86.03 | 99.22 | 86.03 | 1 |
| 32 | 99.22 | 86.03 | 105.33 | 84.00 | 1 |
| 33 | 105.33 | 84.00 | 351.28 | 81.36 | 1 |
| 34 | 351.28 | 81.36 | 637.93 | 80.10 | 1 |
| 35 | .00 | 76.00 | 637.93 | 76.00 | 1 |
| 36 | .00 | 70.00 | 637.93 | 70.00 | 7 |
| 37 | .00 | 60.00 | 637.93 | 60.00 | 8 |
| 38 | .00 | 49.00 | 637.93 | 49.00 | 9 |

ISOTROPIC SOIL PARAMETERS
9 Type(s) of Soil

| Soil Type No. | Total Unit Wt. (pcf) | Saturated Unit Wt. (pcf) | Cohesion Intercept (psf) | Friction Angle (deg) | Pore Pressure Param. | Pressure Constant (psf) | Piez. Surface No. |
|---|---|---|---|---|---|---|---|
| 1 | 105.0 | 120.0 | .0 | 28.0 | .00 | .0 | 1 |
| 2 | 62.4 | 62.4 | .0 | 20.5 | .00 | .0 | 1 |
| 3 | 62.4 | 62.4 | .0 | 20.5 | .00 | .0 | 1 |
| 4 | 105.0 | 110.0 | .0 | 30.0 | .00 | .0 | 1 |
| 5 | 60.0 | 60.0 | 250.0 | 27.0 | .00 | .0 | 1 |
| 6 | 105.0 | 110.0 | .0 | 30.0 | .00 | .0 | 1 |
| 7 | 107.0 | 127.0 | .0 | 13.0 | .00 | .0 | 1 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 8 | 75.0 | 110.0 | 300.0 | 9.0 | .00 | .0 | 1 |
| 9 | 124.0 | 137.5 | .0 | 35.0 | .00 | .0 | 1 |

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED
Unit Weight of Water = 62.40
Piezometric Surface No. 1 Specified by 2 Coordinate Points

| Point No. | X-Water (ft) | Y-Water (ft) |
|---|---|---|
| 1 | .00 | 82.09 |
| 2 | 637.93 | 82.09 |

BOUNDARY LOAD(S)
2 Load(s) Specified

| Load No. | X-Left (ft) | X-Right (ft) | Intensity (psf) | Deflection (deg) |
|---|---|---|---|---|
| 1 | 495.93 | 498.90 | 1581.0 | .0 |
| 2 | 509.89 | 512.85 | 1581.0 | .0 |

NOTE - Intensity Is Specified As A Uniformly Distributed
Force Acting On A Horizontally Projected Surface.
A Critical Failure Surface Searching Method, Using A Random
Technique For Generating Circular Surfaces, Has Been Specified.
5000 Trial Surfaces Have Been Generated.
50 Surfaces Initiate From Each Of100 Points Equally Spaced
Along The Ground Surface Between X = 300.00 ft.
and X = 400.00 ft.
Each Surface Terminates Between X = 480.00 ft.
and X = 539.00 ft.
Unless Further Limitations Were Imposed, The Minimum Elevation
At Which A Surface Extends Is Y = .00 ft.
5.00 ft. Line Segments Define Each Trial Failure Surface.
Following Are Displayed The Ten Most Critical Of The Trial
Failure Surfaces Examined. They Are Ordered - Most Critical
First.
* * Safety Factors Are Calculated By The Modified Bishop Method * *
Failure Surface Specified By 44 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 334.34 | 84.56 |
| 2 | 338.41 | 81.65 |
| 3 | 342.59 | 78.91 |
| 4 | 346.89 | 76.35 |
| 5 | 351.28 | 73.96 |
| 6 | 355.77 | 71.75 |
| 7 | 360.34 | 69.73 |
| 8 | 364.99 | 67.90 |
| 9 | 369.71 | 66.26 |
| 10 | 374.50 | 64.81 |
| 11 | 379.34 | 63.56 |
| 12 | 384.23 | 62.51 |
| 13 | 389.16 | 61.66 |
| 14 | 394.12 | 61.02 |
| 15 | 399.10 | 60.58 |
| 16 | 404.09 | 60.34 |
| 17 | 409.09 | 60.30 |
| 18 | 414.09 | 60.47 |
| 19 | 419.07 | 60.85 |
| 20 | 424.04 | 61.42 |
| 21 | 428.98 | 62.20 |
| 22 | 433.88 | 63.19 |
| 23 | 438.74 | 64.37 |
| 24 | 443.55 | 65.75 |
| 25 | 448.29 | 67.32 |
| 26 | 452.97 | 69.09 |
| 27 | 457.57 | 71.05 |
| 28 | 462.09 | 73.19 |
| 29 | 466.51 | 75.52 |
| 30 | 470.84 | 78.03 |
| 31 | 475.06 | 80.71 |
| 32 | 479.17 | 83.56 |
| 33 | 483.15 | 86.58 |
| 34 | 487.01 | 89.75 |
| 35 | 490.74 | 93.09 |

| | | |
|---|---|---|
| 36 | 494.33 | 96.57 |
| 37 | 497.77 | 100.20 |
| 38 | 501.06 | 103.96 |
| 39 | 504.19 | 107.86 |
| 40 | 507.17 | 111.88 |
| 41 | 509.97 | 116.02 |
| 42 | 512.60 | 120.27 |
| 43 | 515.06 | 124.62 |
| 44 | 515.76 | 125.99 |

Circle Center At X = 407.4 ; Y = 182.5 and Radius, 122.2

*** 1.829 ***

Individual data on the 72 slices

| Slice No. | Width (ft) | Weight (lbs) | Water Force Top (lbs) | Water Force Bot (lbs) | Tie Force Norm (lbs) | Tie Force Tan (lbs) | Earthquake Force Hor (lbs) | Earthquake Force Ver (lbs) | Surcharge Load (lbs) |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 2.9 | 301.8 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 2 | .6 | 133.9 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 3 | .1 | 29.1 | .0 | .4 | .0 | .0 | .0 | .0 | .0 |
| 4 | .5 | 125.0 | .0 | 9.9 | .0 | .0 | .0 | .0 | .0 |
| 5 | .2 | 63.9 | .0 | 9.1 | .0 | .0 | .0 | .0 | .0 |
| 6 | 3.9 | 1682.9 | .0 | 555.1 | .0 | .0 | .0 | .0 | .0 |
| 7 | 4.3 | 3133.8 | .0 | 1391.9 | .0 | .0 | .0 | .0 | .0 |
| 8 | .6 | 573.9 | .0 | 267.5 | .0 | .0 | .0 | .0 | .0 |
| 9 | 3.8 | 3915.2 | .0 | 1897.2 | .0 | .0 | .0 | .0 | .0 |
| 10 | .0 | 1.8 | .0 | .9 | .0 | .0 | .0 | .0 | .0 |
| 11 | .7 | 815.9 | .0 | 398.3 | .0 | .0 | .0 | .0 | .0 |
| 12 | .8 | 955.7 | .0 | 469.9 | .0 | .0 | .0 | .0 | .0 |
| 13 | 1.3 | 1605.0 | .0 | 796.5 | .0 | .0 | .0 | .0 | .0 |
| 14 | 1.8 | 2476.9 | .0 | 1215.8 | .0 | .0 | .0 | .0 | .0 |
| 15 | 2.9 | 4705.0 | .0 | 2183.8 | .0 | .0 | .0 | .0 | .0 |
| 16 | 1.0 | 1867.3 | .0 | 848.4 | .0 | .0 | .0 | .0 | .0 |
| 17 | .6 | 1123.5 | .0 | 508.7 | .0 | .0 | .0 | .0 | .0 |
| 18 | 4.7 | 9431.4 | .0 | 4142.0 | .0 | .0 | .0 | .0 | .0 |
| 19 | 4.7 | 11054.1 | .0 | 4683.7 | .0 | .0 | .0 | .0 | .0 |
| 20 | 4.8 | 12589.2 | .0 | 5165.2 | .0 | .0 | .0 | .0 | .0 |
| 21 | 4.8 | 14022.8 | .0 | 5585.5 | .0 | .0 | .0 | .0 | .0 |
| 22 | 4.9 | 15342.0 | .0 | 5944.1 | .0 | .0 | .0 | .0 | .0 |
| 23 | 4.9 | 16535.4 | .0 | 6240.2 | .0 | .0 | .0 | .0 | .0 |
| 24 | 5.0 | 17592.7 | .0 | 6473.5 | .0 | .0 | .0 | .0 | .0 |
| 25 | 5.0 | 18504.9 | .0 | 6643.5 | .0 | .0 | .0 | .0 | .0 |
| 26 | 5.0 | 19265.0 | .0 | 6749.9 | .0 | .0 | .0 | .0 | .0 |
| 27 | 5.0 | 19866.6 | .0 | 6792.6 | .0 | .0 | .0 | .0 | .0 |
| 28 | 3.0 | 12056.6 | .0 | 4042.4 | .0 | .0 | .0 | .0 | .0 |
| 29 | 2.0 | 8249.2 | .0 | 2729.0 | .0 | .0 | .0 | .0 | .0 |
| 30 | 5.0 | 20579.9 | .0 | 6686.5 | .0 | .0 | .0 | .0 | .0 |
| 31 | 5.0 | 20687.7 | .0 | 6538.0 | .0 | .0 | .0 | .0 | .0 |
| 32 | 4.9 | 20629.2 | .0 | 6326.0 | .0 | .0 | .0 | .0 | .0 |
| 33 | 2.0 | 8137.7 | .0 | 2444.9 | .0 | .0 | .0 | .0 | .0 |
| 34 | .3 | 1040.0 | .0 | 309.8 | .0 | .0 | .0 | .0 | .0 |
| 35 | 2.7 | 11131.0 | .0 | 3296.4 | .0 | .0 | .0 | .0 | .0 |
| 36 | 4.9 | 19482.1 | .0 | 5713.5 | .0 | .0 | .0 | .0 | .0 |
| 37 | 4.8 | 18484.6 | .0 | 5313.9 | .0 | .0 | .0 | .0 | .0 |
| 38 | 4.7 | 17356.2 | .0 | 4853.0 | .0 | .0 | .0 | .0 | .0 |
| 39 | 2.6 | 9217.9 | .0 | 2511.7 | .0 | .0 | .0 | .0 | .0 |
| 40 | .3 | 857.0 | .0 | 228.8 | .0 | .0 | .0 | .0 | .0 |
| 41 | 1.8 | 6081.8 | .0 | 1591.0 | .0 | .0 | .0 | .0 | .0 |
| 42 | 2.1 | 7133.9 | .0 | 1817.5 | .0 | .0 | .0 | .0 | .0 |
| 43 | 2.5 | 8043.4 | .0 | 1932.8 | .0 | .0 | .0 | .0 | .0 |
| 44 | 4.5 | 14188.9 | .0 | 3110.4 | .0 | .0 | .0 | .0 | .0 |
| 45 | 4.4 | 13105.1 | .0 | 2412.9 | .0 | .0 | .0 | .0 | .0 |
| 46 | .8 | 2356.9 | .0 | 378.2 | .0 | .0 | .0 | .0 | .0 |
| 47 | 3.5 | 9574.6 | .0 | 1280.6 | .0 | .0 | .0 | .0 | .0 |
| 48 | 4.2 | 10681.5 | .0 | 849.6 | .0 | .0 | .0 | .0 | .0 |
| 49 | .2 | 373.1 | .0 | 15.6 | .0 | .0 | .0 | .0 | .0 |
| 50 | .7 | 1712.9 | .0 | 55.8 | .0 | .0 | .0 | .0 | .0 |
| 51 | .7 | 1694.1 | .0 | 28.7 | .0 | .0 | .0 | .0 | .0 |
| 52 | .4 | 960.9 | .0 | 4.4 | .0 | .0 | .0 | .0 | .0 |
| 53 | 2.1 | 4844.5 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 54 | .3 | 701.5 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 55 | 3.7 | 7959.0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 56 | 3.9 | 7969.0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 57 | 3.7 | 7248.8 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 58 | 3.6 | 6506.3 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 59 | 1.6 | 2741.7 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 60 | .3 | 466.4 | .0 | .0 | .0 | .0 | .0 | .0 | 442.7 |
| 61 | 1.6 | 2507.4 | .0 | .0 | .0 | .0 | .0 | .0 | 2464.8 |
| 62 | 1.1 | 1723.9 | .0 | .0 | .0 | .0 | .0 | .0 | 1788.0 |
| 63 | 2.2 | 3059.0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 64 | 3.1 | 3865.1 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 65 | 3.0 | 2986.7 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 66 | 2.7 | 2103.6 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 67 | .1 | 52.9 | .0 | .0 | .0 | .0 | .0 | .0 | 128.2 |
| 68 | 2.6 | 1383.3 | .0 | .0 | .0 | .0 | .0 | .0 | 4163.4 |
| 69 | .2 | 95.5 | .0 | .0 | .0 | .0 | .0 | .0 | 388.1 |
| 70 | 2.1 | 564.6 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 71 | .1 | 14.7 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 72 | .7 | 49.1 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |

Failure Surface Specified By 45 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 326.26 | 84.65 |
| 2 | 330.43 | 81.88 |
| 3 | 334.70 | 79.28 |
| 4 | 339.06 | 76.83 |
| 5 | 343.51 | 74.56 |
| 6 | 348.04 | 72.44 |
| 7 | 352.65 | 70.51 |
| 8 | 357.33 | 68.74 |
| 9 | 362.07 | 67.15 |
| 10 | 366.87 | 65.74 |
| 11 | 371.71 | 64.51 |
| 12 | 376.60 | 63.46 |
| 13 | 381.53 | 62.60 |
| 14 | 386.48 | 61.92 |
| 15 | 391.46 | 61.43 |
| 16 | 396.45 | 61.12 |
| 17 | 401.45 | 61.00 |
| 18 | 406.45 | 61.07 |
| 19 | 411.44 | 61.33 |
| 20 | 416.42 | 61.77 |
| 21 | 421.38 | 62.40 |
| 22 | 426.31 | 63.21 |
| 23 | 431.21 | 64.21 |
| 24 | 436.07 | 65.39 |
| 25 | 440.88 | 66.75 |
| 26 | 445.64 | 68.29 |
| 27 | 450.34 | 70.01 |
| 28 | 454.96 | 71.90 |
| 29 | 459.52 | 73.97 |
| 30 | 463.99 | 76.20 |
| 31 | 468.38 | 78.60 |
| 32 | 472.67 | 81.16 |
| 33 | 476.87 | 83.88 |
| 34 | 480.96 | 86.76 |
| 35 | 484.94 | 89.78 |
| 36 | 488.80 | 92.96 |
| 37 | 492.54 | 96.27 |
| 38 | 496.16 | 99.73 |
| 39 | 499.64 | 103.31 |
| 40 | 502.99 | 107.03 |
| 41 | 506.20 | 110.86 |
| 42 | 509.25 | 114.82 |
| 43 | 512.16 | 118.89 |
| 44 | 514.92 | 123.06 |
| 45 | 516.73 | 126.04 |

Circle Center At X = 402.1 ; Y = 194.5 and Radius, 133.5

*** 1.830 ***

Failure Surface Specified By 46 Coordinate Points

Point X-Surf Y-Surf

| No. | (ft) | (ft) |
|---|---|---|
| 1 | 323.23 | 84.68 |
| 2 | 327.34 | 81.83 |
| 3 | 331.55 | 79.13 |
| 4 | 335.86 | 76.60 |
| 5 | 340.27 | 74.23 |
| 6 | 344.76 | 72.04 |
| 7 | 349.33 | 70.01 |
| 8 | 353.98 | 68.17 |
| 9 | 358.69 | 66.49 |
| 10 | 363.46 | 65.00 |
| 11 | 368.29 | 63.70 |
| 12 | 373.16 | 62.57 |
| 13 | 378.07 | 61.64 |
| 14 | 383.02 | 60.89 |
| 15 | 387.99 | 60.33 |
| 16 | 392.97 | 59.95 |
| 17 | 397.97 | 59.77 |
| 18 | 402.97 | 59.78 |
| 19 | 407.96 | 59.98 |
| 20 | 412.95 | 60.37 |
| 21 | 417.92 | 60.95 |
| 22 | 422.86 | 61.71 |
| 23 | 427.76 | 62.67 |
| 24 | 432.63 | 63.80 |
| 25 | 437.45 | 65.13 |
| 26 | 442.22 | 66.63 |
| 27 | 446.93 | 68.32 |
| 28 | 451.57 | 70.19 |
| 29 | 456.13 | 72.22 |
| 30 | 460.62 | 74.44 |
| 31 | 465.02 | 76.82 |
| 32 | 469.32 | 79.36 |
| 33 | 473.52 | 82.07 |
| 34 | 477.62 | 84.94 |
| 35 | 481.61 | 87.96 |
| 36 | 485.47 | 91.12 |
| 37 | 489.22 | 94.44 |
| 38 | 492.83 | 97.89 |
| 39 | 496.31 | 101.48 |
| 40 | 499.66 | 105.20 |
| 41 | 502.86 | 109.04 |
| 42 | 505.91 | 113.00 |
| 43 | 508.80 | 117.08 |
| 44 | 511.54 | 121.26 |
| 45 | 514.12 | 125.54 |
| 46 | 514.33 | 125.92 |

Circle Center At X = 400.2 ; Y = 191.2 and Radius, 131.4

*** 1.835 ***

Failure Surface Specified By 44 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 330.30 | 84.60 |
| 2 | 334.35 | 81.67 |
| 3 | 338.52 | 78.90 |
| 4 | 342.79 | 76.31 |
| 5 | 347.17 | 73.90 |
| 6 | 351.65 | 71.67 |
| 7 | 356.21 | 69.62 |
| 8 | 360.85 | 67.77 |
| 9 | 365.57 | 66.10 |
| 10 | 370.35 | 64.64 |
| 11 | 375.19 | 63.37 |
| 12 | 380.07 | 62.30 |
| 13 | 384.99 | 61.43 |
| 14 | 389.95 | 60.77 |
| 15 | 394.93 | 60.31 |
| 16 | 399.92 | 60.06 |
| 17 | 404.92 | 60.01 |
| 18 | 409.92 | 60.17 |

| | | |
|---|---|---|
| 19 | 414.91 | 60.53 |
| 20 | 419.87 | 61.10 |
| 21 | 424.81 | 61.87 |
| 22 | 429.72 | 62.85 |
| 23 | 434.58 | 64.03 |
| 24 | 439.38 | 65.40 |
| 25 | 444.13 | 66.98 |
| 26 | 448.81 | 68.74 |
| 27 | 453.41 | 70.70 |
| 28 | 457.92 | 72.85 |
| 29 | 462.35 | 75.18 |
| 30 | 466.67 | 77.69 |
| 31 | 470.89 | 80.37 |
| 32 | 474.99 | 83.23 |
| 33 | 478.98 | 86.25 |
| 34 | 482.83 | 89.44 |
| 35 | 486.55 | 92.78 |
| 36 | 490.13 | 96.27 |
| 37 | 493.56 | 99.90 |
| 38 | 496.84 | 103.68 |
| 39 | 499.96 | 107.58 |
| 40 | 502.92 | 111.61 |
| 41 | 505.71 | 115.76 |
| 42 | 508.33 | 120.02 |
| 43 | 510.77 | 124.39 |
| 44 | 511.47 | 125.78 |

Circle Center At X =  403.6 ; Y =  181.4  and Radius,  121.4

*** 1.837 ***

Failure Surface Specified By 46 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 319.19 | 84.72 |
| 2 | 323.40 | 82.02 |
| 3 | 327.70 | 79.47 |
| 4 | 332.09 | 77.08 |
| 5 | 336.57 | 74.84 |
| 6 | 341.12 | 72.77 |
| 7 | 345.74 | 70.86 |
| 8 | 350.42 | 69.12 |
| 9 | 355.17 | 67.54 |
| 10 | 359.97 | 66.13 |
| 11 | 364.81 | 64.90 |
| 12 | 369.70 | 63.84 |
| 13 | 374.62 | 62.95 |
| 14 | 379.57 | 62.24 |
| 15 | 384.54 | 61.71 |
| 16 | 389.53 | 61.36 |
| 17 | 394.52 | 61.18 |
| 18 | 399.52 | 61.18 |
| 19 | 404.52 | 61.36 |
| 20 | 409.51 | 61.72 |
| 21 | 414.48 | 62.25 |
| 22 | 419.43 | 62.97 |
| 23 | 424.35 | 63.85 |
| 24 | 429.23 | 64.92 |
| 25 | 434.08 | 66.15 |
| 26 | 438.88 | 67.56 |
| 27 | 443.62 | 69.14 |
| 28 | 448.30 | 70.89 |
| 29 | 452.92 | 72.80 |
| 30 | 457.47 | 74.88 |
| 31 | 461.94 | 77.11 |
| 32 | 466.33 | 79.51 |
| 33 | 470.63 | 82.06 |
| 34 | 474.84 | 84.76 |
| 35 | 478.95 | 87.61 |
| 36 | 482.95 | 90.61 |
| 37 | 486.85 | 93.74 |
| 38 | 490.63 | 97.01 |
| 39 | 494.29 | 100.42 |

| | | |
|---|---|---|
| 40 | 497.83 | 103.95 |
| 41 | 501.24 | 107.61 |
| 42 | 504.51 | 111.39 |
| 43 | 507.65 | 115.28 |
| 44 | 510.65 | 119.28 |
| 45 | 513.51 | 123.39 |
| 46 | 515.16 | 125.96 |

Circle Center At X = 397.0 ; Y = 201.3 and Radius, 140.2

*** 1.837 ***

Failure Surface Specified By 44 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 331.31 | 84.59 |
| 2 | 335.49 | 81.84 |
| 3 | 339.77 | 79.25 |
| 4 | 344.14 | 76.83 |
| 5 | 348.61 | 74.59 |
| 6 | 353.16 | 72.52 |
| 7 | 357.79 | 70.63 |
| 8 | 362.49 | 68.92 |
| 9 | 367.25 | 67.40 |
| 10 | 372.07 | 66.07 |
| 11 | 376.94 | 64.92 |
| 12 | 381.85 | 63.97 |
| 13 | 386.79 | 63.20 |
| 14 | 391.76 | 62.64 |
| 15 | 396.74 | 62.26 |
| 16 | 401.74 | 62.08 |
| 17 | 406.74 | 62.10 |
| 18 | 411.74 | 62.31 |
| 19 | 416.72 | 62.72 |
| 20 | 421.68 | 63.32 |
| 21 | 426.62 | 64.12 |
| 22 | 431.52 | 65.11 |
| 23 | 436.38 | 66.28 |
| 24 | 441.19 | 67.65 |
| 25 | 445.94 | 69.21 |
| 26 | 450.63 | 70.94 |
| 27 | 455.25 | 72.87 |
| 28 | 459.78 | 74.96 |
| 29 | 464.24 | 77.24 |
| 30 | 468.60 | 79.69 |
| 31 | 472.86 | 82.30 |
| 32 | 477.01 | 85.08 |
| 33 | 481.06 | 88.03 |
| 34 | 484.98 | 91.12 |
| 35 | 488.78 | 94.37 |
| 36 | 492.45 | 97.76 |
| 37 | 495.99 | 101.30 |
| 38 | 499.39 | 104.97 |
| 39 | 502.64 | 108.77 |
| 40 | 505.73 | 112.69 |
| 41 | 508.68 | 116.73 |
| 42 | 511.46 | 120.89 |
| 43 | 514.08 | 125.15 |
| 44 | 514.52 | 125.93 |

Circle Center At X = 403.8 ; Y = 190.0 and Radius, 127.9

*** 1.844 ***

Failure Surface Specified By 44 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 331.31 | 84.59 |
| 2 | 335.32 | 81.60 |
| 3 | 339.45 | 78.79 |
| 4 | 343.70 | 76.14 |
| 5 | 348.05 | 73.68 |
| 6 | 352.49 | 71.39 |
| 7 | 357.03 | 69.29 |
| 8 | 361.65 | 67.39 |
| 9 | 366.35 | 65.67 |

| | | |
|---|---|---|
| 10 | 371.11 | 64.15 |
| 11 | 375.94 | 62.83 |
| 12 | 380.81 | 61.71 |
| 13 | 385.73 | 60.79 |
| 14 | 390.67 | 60.08 |
| 15 | 395.65 | 59.57 |
| 16 | 400.64 | 59.27 |
| 17 | 405.64 | 59.18 |
| 18 | 410.64 | 59.29 |
| 19 | 415.63 | 59.61 |
| 20 | 420.60 | 60.14 |
| 21 | 425.55 | 60.87 |
| 22 | 430.46 | 61.81 |
| 23 | 435.33 | 62.95 |
| 24 | 440.14 | 64.29 |
| 25 | 444.90 | 65.82 |
| 26 | 449.59 | 67.56 |
| 27 | 454.20 | 69.48 |
| 28 | 458.73 | 71.60 |
| 29 | 463.17 | 73.90 |
| 30 | 467.51 | 76.38 |
| 31 | 471.75 | 79.05 |
| 32 | 475.87 | 81.88 |
| 33 | 479.86 | 84.88 |
| 34 | 483.73 | 88.05 |
| 35 | 487.47 | 91.37 |
| 36 | 491.07 | 94.84 |
| 37 | 494.51 | 98.47 |
| 38 | 497.81 | 102.23 |
| 39 | 500.95 | 106.12 |
| 40 | 503.92 | 110.14 |
| 41 | 506.72 | 114.28 |
| 42 | 509.35 | 118.53 |
| 43 | 511.81 | 122.89 |
| 44 | 513.32 | 125.87 |

Circle Center At X =  405.4 ; Y =  179.9  and Radius,  120.7

*** 1.848 ***

Failure Surface Specified By 45 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 329.29 | 84.61 |
| 2 | 333.48 | 81.88 |
| 3 | 337.77 | 79.30 |
| 4 | 342.14 | 76.89 |
| 5 | 346.61 | 74.64 |
| 6 | 351.15 | 72.55 |
| 7 | 355.77 | 70.64 |
| 8 | 360.46 | 68.89 |
| 9 | 365.20 | 67.32 |
| 10 | 370.01 | 65.93 |
| 11 | 374.86 | 64.72 |
| 12 | 379.75 | 63.68 |
| 13 | 384.68 | 62.83 |
| 14 | 389.63 | 62.16 |
| 15 | 394.61 | 61.67 |
| 16 | 399.60 | 61.37 |
| 17 | 404.60 | 61.26 |
| 18 | 409.60 | 61.32 |
| 19 | 414.59 | 61.58 |
| 20 | 419.57 | 62.01 |
| 21 | 424.53 | 62.64 |
| 22 | 429.47 | 63.44 |
| 23 | 434.37 | 64.43 |
| 24 | 439.23 | 65.59 |
| 25 | 444.05 | 66.94 |
| 26 | 448.81 | 68.46 |
| 27 | 453.51 | 70.16 |
| 28 | 458.15 | 72.03 |
| 29 | 462.71 | 74.07 |
| 30 | 467.20 | 76.28 |

| | | |
|---|---|---|
| 31 | 471.60 | 78.65 |
| 32 | 475.91 | 81.19 |
| 33 | 480.12 | 83.88 |
| 34 | 484.23 | 86.73 |
| 35 | 488.24 | 89.72 |
| 36 | 492.13 | 92.86 |
| 37 | 495.90 | 96.15 |
| 38 | 499.54 | 99.57 |
| 39 | 503.06 | 103.12 |
| 40 | 506.45 | 106.80 |
| 41 | 509.69 | 110.60 |
| 42 | 512.79 | 114.52 |
| 43 | 515.75 | 118.56 |
| 44 | 518.56 | 122.70 |
| 45 | 520.77 | 126.24 |

Circle Center At X =  405.3 ; Y =  196.4  and Radius,  135.2
*** 1.850 ***

Failure Surface Specified By 48 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 311.11 | 84.81 |
| 2 | 315.35 | 82.15 |
| 3 | 319.67 | 79.64 |
| 4 | 324.07 | 77.27 |
| 5 | 328.55 | 75.04 |
| 6 | 333.10 | 72.97 |
| 7 | 337.72 | 71.05 |
| 8 | 342.40 | 69.28 |
| 9 | 347.13 | 67.67 |
| 10 | 351.91 | 66.22 |
| 11 | 356.74 | 64.93 |
| 12 | 361.61 | 63.80 |
| 13 | 366.52 | 62.83 |
| 14 | 371.45 | 62.02 |
| 15 | 376.41 | 61.38 |
| 16 | 381.39 | 60.90 |
| 17 | 386.38 | 60.59 |
| 18 | 391.38 | 60.45 |
| 19 | 396.38 | 60.47 |
| 20 | 401.37 | 60.65 |
| 21 | 406.36 | 61.00 |
| 22 | 411.34 | 61.52 |
| 23 | 416.29 | 62.20 |
| 24 | 421.22 | 63.05 |
| 25 | 426.11 | 64.05 |
| 26 | 430.98 | 65.23 |
| 27 | 435.79 | 66.56 |
| 28 | 440.57 | 68.05 |
| 29 | 445.29 | 69.69 |
| 30 | 449.95 | 71.50 |
| 31 | 454.55 | 73.45 |
| 32 | 459.09 | 75.56 |
| 33 | 463.55 | 77.82 |
| 34 | 467.93 | 80.22 |
| 35 | 472.23 | 82.77 |
| 36 | 476.45 | 85.46 |
| 37 | 480.57 | 88.29 |
| 38 | 484.60 | 91.26 |
| 39 | 488.52 | 94.35 |
| 40 | 492.35 | 97.58 |
| 41 | 496.06 | 100.92 |
| 42 | 499.66 | 104.39 |
| 43 | 503.14 | 107.98 |
| 44 | 506.50 | 111.68 |
| 45 | 509.74 | 115.49 |
| 46 | 512.85 | 119.41 |
| 47 | 515.82 | 123.43 |
| 48 | 517.66 | 126.09 |

Circle Center At X =  393.3 ; Y =  211.1  and Radius,  150.7
*** 1.852 ***

Failure Surface Specified By 43 Coordinate Points

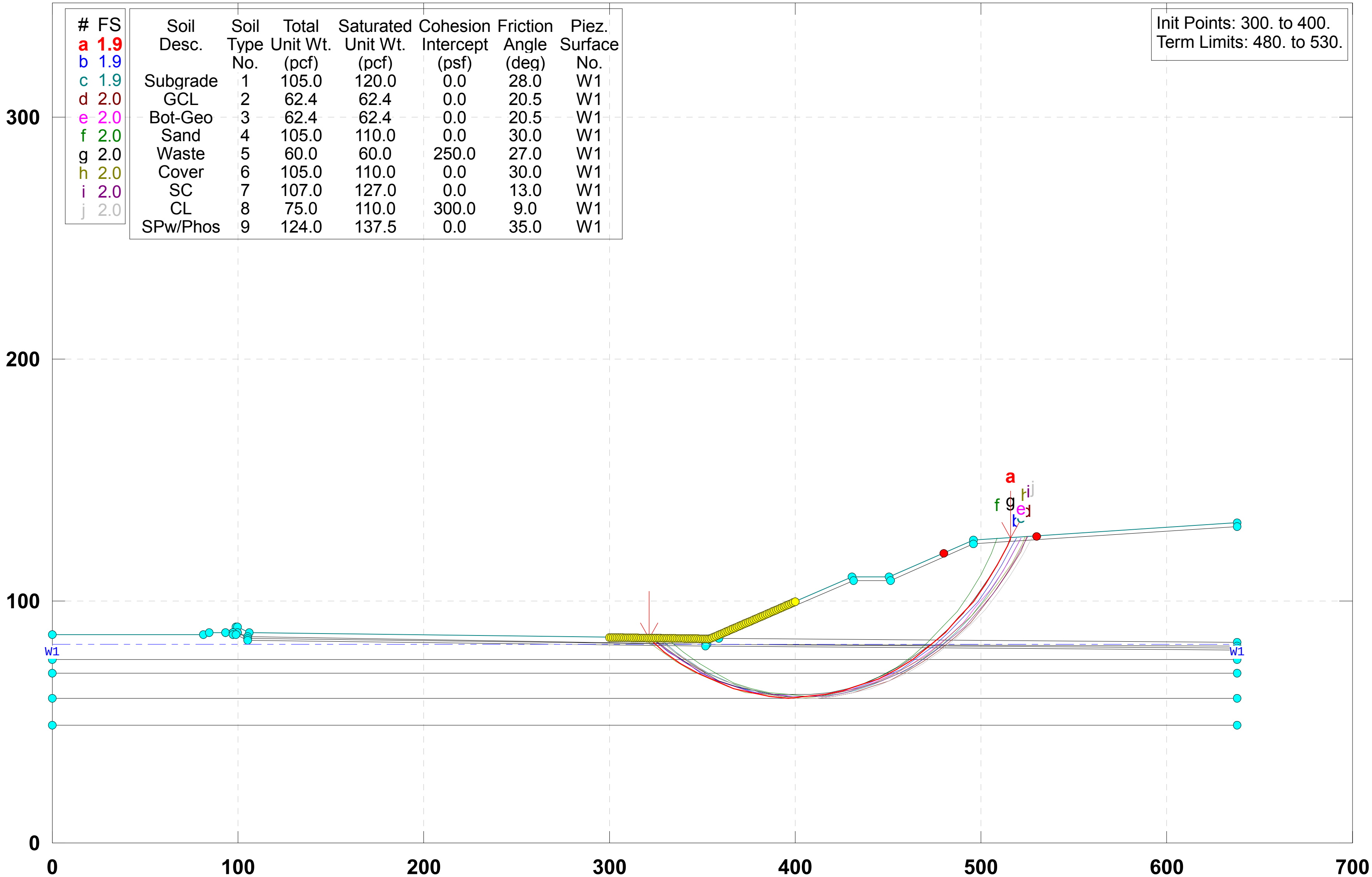
| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 331.31 | 84.59 |
| 2 | 335.49 | 81.85 |
| 3 | 339.78 | 79.28 |
| 4 | 344.17 | 76.87 |
| 5 | 348.64 | 74.64 |
| 6 | 353.20 | 72.59 |
| 7 | 357.84 | 70.73 |
| 8 | 362.55 | 69.04 |
| 9 | 367.32 | 67.55 |
| 10 | 372.15 | 66.24 |
| 11 | 377.02 | 65.13 |
| 12 | 381.93 | 64.21 |
| 13 | 386.88 | 63.48 |
| 14 | 391.85 | 62.95 |
| 15 | 396.84 | 62.62 |
| 16 | 401.84 | 62.48 |
| 17 | 406.84 | 62.54 |
| 18 | 411.83 | 62.80 |
| 19 | 416.81 | 63.25 |
| 20 | 421.77 | 63.91 |
| 21 | 426.70 | 64.75 |
| 22 | 431.59 | 65.80 |
| 23 | 436.43 | 67.03 |
| 24 | 441.23 | 68.45 |
| 25 | 445.96 | 70.07 |
| 26 | 450.62 | 71.86 |
| 27 | 455.22 | 73.84 |
| 28 | 459.72 | 76.00 |
| 29 | 464.15 | 78.34 |
| 30 | 468.47 | 80.85 |
| 31 | 472.69 | 83.53 |
| 32 | 476.80 | 86.37 |
| 33 | 480.80 | 89.38 |
| 34 | 484.68 | 92.54 |
| 35 | 488.43 | 95.85 |
| 36 | 492.04 | 99.30 |
| 37 | 495.51 | 102.90 |
| 38 | 498.84 | 106.63 |
| 39 | 502.02 | 110.48 |
| 40 | 505.05 | 114.46 |
| 41 | 507.92 | 118.56 |
| 42 | 510.62 | 122.77 |
| 43 | 512.41 | 125.82 |

Circle Center At X = 402.8 ; Y = 189.0 and Radius, 126.6

*** 1.857 ***

# Phase II Section I RAI No. 1 West Slope During Expansion Construction

C:\1\HARDEE~1.1\2HARDE~1.1\EWCI\EWSECCI.PL2   Run By: Shane R. Fischer, P.E.   03/31/13   5:35AM




| # | FS |
|---|---|
| a | 1.9 |
| b | 1.9 |
| c | 1.9 |
| d | 2.0 |
| e | 2.0 |
| f | 2.0 |
| g | 2.0 |
| h | 2.0 |
| i | 2.0 |
| j | 2.0 |

| Soil Desc. | Soil Type No. | Total Unit Wt. (pcf) | Saturated Unit Wt. (pcf) | Cohesion Intercept (psf) | Friction Angle (deg) | Piez. Surface No. |
|---|---|---|---|---|---|---|
| Subgrade | 1 | 105.0 | 120.0 | 0.0 | 28.0 | W1 |
| GCL | 2 | 62.4 | 62.4 | 0.0 | 20.5 | W1 |
| Bot-Geo | 3 | 62.4 | 62.4 | 0.0 | 20.5 | W1 |
| Sand | 4 | 105.0 | 110.0 | 0.0 | 30.0 | W1 |
| Waste | 5 | 60.0 | 60.0 | 250.0 | 27.0 | W1 |
| Cover | 6 | 105.0 | 110.0 | 0.0 | 30.0 | W1 |
| SC | 7 | 107.0 | 127.0 | 0.0 | 13.0 | W1 |
| CL | 8 | 75.0 | 110.0 | 300.0 | 9.0 | W1 |
| SPw/Phos | 9 | 124.0 | 137.5 | 0.0 | 35.0 | W1 |

**PCSTABL5M/si FSmin=1.9**

**Safety Factors Are Calculated By The Modified Bishop Method**

SCS ENGINEERS

**** PCSTABL5M ****
by
Purdue University
--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer`s Method of Slices

Run Date: 03/31/13
Time of Run: 5:35AM
Run By: Shane R. Fischer, P.E.
Input Data Filename: C:ewsecci.
Output Filename: C:ewsecci.OUT
Unit: ENGLISH
Plotted Output Filename: C:ewsecci.PLT
PROBLEM DESCRIPTION Phase II Section I RAI No. 1
West Slope During Expansion Construction

BOUNDARY COORDINATES
11 Top Boundaries
38 Total Boundaries

| Boundary No. | X-Left (ft) | Y-Left (ft) | X-Right (ft) | Y-Right (ft) | Soil Type Below Bnd |
|---|---|---|---|---|---|
| 1 | .00 | 86.00 | 81.46 | 86.00 | 1 |
| 2 | 81.46 | 86.00 | 84.46 | 87.00 | 1 |
| 3 | 84.46 | 87.00 | 93.14 | 87.00 | 1 |
| 4 | 93.14 | 87.00 | 99.14 | 89.00 | 4 |
| 5 | 99.14 | 89.00 | 99.79 | 89.00 | 4 |
| 6 | 99.79 | 89.00 | 105.80 | 86.99 | 4 |
| 7 | 105.80 | 86.99 | 354.00 | 84.35 | 4 |
| 8 | 354.00 | 84.35 | 430.93 | 110.00 | 6 |
| 9 | 430.93 | 110.00 | 450.93 | 110.00 | 6 |
| 10 | 450.93 | 110.00 | 495.93 | 125.00 | 6 |
| 11 | 495.93 | 125.00 | 637.93 | 132.10 | 6 |
| 12 | 93.14 | 87.00 | 96.95 | 87.00 | 1 |
| 13 | 96.95 | 87.00 | 97.46 | 87.00 | 2 |
| 14 | 97.46 | 87.00 | 99.46 | 87.00 | 3 |
| 15 | 99.46 | 87.00 | 105.46 | 85.00 | 3 |
| 16 | 105.46 | 85.00 | 352.75 | 82.35 | 3 |
| 17 | 352.75 | 82.35 | 358.68 | 84.33 | 4 |
| 18 | 358.68 | 84.33 | 431.18 | 108.50 | 5 |
| 19 | 431.18 | 108.50 | 451.18 | 108.50 | 5 |
| 20 | 451.18 | 108.50 | 496.21 | 123.51 | 5 |
| 21 | 496.21 | 123.51 | 637.93 | 130.59 | 5 |
| 22 | 97.46 | 87.00 | 97.57 | 86.53 | 2 |
| 23 | 97.57 | 86.53 | 99.30 | 86.53 | 2 |
| 24 | 99.30 | 86.53 | 105.41 | 84.50 | 2 |
| 25 | 105.41 | 84.50 | 351.28 | 81.86 | 2 |
| 26 | 351.28 | 81.86 | 352.75 | 82.35 | 2 |
| 27 | 358.68 | 84.33 | 637.93 | 83.10 | 4 |
| 28 | 352.75 | 82.35 | 637.93 | 81.10 | 3 |
| 29 | 351.28 | 81.86 | 637.93 | 80.60 | 2 |
| 30 | 96.95 | 87.00 | 97.17 | 86.03 | 1 |
| 31 | 97.17 | 86.03 | 99.22 | 86.03 | 1 |
| 32 | 99.22 | 86.03 | 105.33 | 84.00 | 1 |
| 33 | 105.33 | 84.00 | 351.28 | 81.36 | 1 |
| 34 | 351.28 | 81.36 | 637.93 | 80.10 | 1 |
| 35 | .00 | 76.00 | 637.93 | 76.00 | 1 |
| 36 | .00 | 70.00 | 637.93 | 70.00 | 7 |
| 37 | .00 | 60.00 | 637.93 | 60.00 | 8 |
| 38 | .00 | 49.00 | 637.93 | 49.00 | 9 |

ISOTROPIC SOIL PARAMETERS
9 Type(s) of Soil

| Soil Type No. | Total Unit Wt. (pcf) | Saturated Unit Wt. (pcf) | Cohesion Intercept (psf) | Friction Angle (deg) | Pore Pressure Param. | Pressure Constant (psf) | Piez. Surface No. |
|---|---|---|---|---|---|---|---|
| 1 | 105.0 | 120.0 | .0 | 28.0 | .00 | .0 | 1 |
| 2 | 62.4 | 62.4 | .0 | 20.5 | .00 | .0 | 1 |
| 3 | 62.4 | 62.4 | .0 | 20.5 | .00 | .0 | 1 |
| 4 | 105.0 | 110.0 | .0 | 30.0 | .00 | .0 | 1 |
| 5 | 60.0 | 60.0 | 250.0 | 27.0 | .00 | .0 | 1 |
| 6 | 105.0 | 110.0 | .0 | 30.0 | .00 | .0 | 1 |
| 7 | 107.0 | 127.0 | .0 | 13.0 | .00 | .0 | 1 |

```
    8    75.0    110.0     300.0      9.0     .00        .0      1
    9   124.0    137.5        .0     35.0     .00        .0      1
  1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED
  Unit Weight of Water =  62.40
  Piezometric Surface No.  1 Specified by  2 Coordinate Points
    Point      X-Water     Y-Water
     No.         (ft)        (ft)
      1           .00       82.09
      2        637.93       82.09
 BOUNDARY LOAD(S)
      2 Load(s) Specified
  Load        X-Left      X-Right     Intensity     Deflection
   No.         (ft)         (ft)      (psf)       (deg)
    1         495.93       498.90       1581.0           .0
    2         509.89       512.85       1581.0           .0
  NOTE - Intensity Is Specified As A Uniformly Distributed
         Force Acting On A Horizontally Projected Surface.
  SURCHARGE BOUNDARY LOAD DATA HAS BEEN SUPPRESSED
  A Critical Failure Surface Searching Method, Using A Random
  Technique For Generating Circular Surfaces, Has Been Specified.
 5000 Trial Surfaces Have Been Generated.
   50 Surfaces Initiate From Each Of100 Points Equally Spaced
  Along The Ground Surface Between  X = 300.00 ft.
                               and  X = 400.00 ft.
  Each Surface Terminates Between   X = 480.00 ft.
                              and   X = 530.00 ft.
  Unless Further Limitations Were Imposed, The Minimum Elevation
  At Which A Surface Extends Is  Y =   .00 ft.
  10.00 ft. Line Segments Define Each Trial Failure Surface.
  Following Are Displayed The Ten Most Critical Of The Trial
        Failure Surfaces Examined.  They Are Ordered - Most Critical
        First.
        * * Safety Factors Are Calculated By The Modified Bishop Method * *
        Failure Surface Specified By 24 Coordinate Points
          Point      X-Surf      Y-Surf
           No.        (ft)        (ft)
            1        321.21       84.70
            2        329.61       79.28
            3        338.39       74.48
            4        347.49       70.35
            5        356.88       66.89
            6        366.49       64.12
            7        376.28       62.07
            8        386.19       60.74
            9        396.17       60.14
           10        406.17       60.28
           11        416.13       61.14
           12        426.00       62.73
           13        435.73       65.05
           14        445.27       68.06
           15        454.55       71.77
           16        463.54       76.15
           17        472.19       81.18
           18        480.44       86.82
           19        488.26       93.06
           20        495.60       99.85
           21        502.43      107.16
           22        508.70      114.95
           23        514.38      123.17
           24        516.04      126.01
        Circle Center At X =  399.3 ; Y =  196.4  and Radius,  136.3
              ***     1.939   ***
             Individual data on the    50  slices
                       Water  Water     Tie     Tie     Earthquake
                       Force  Force    Force   Force       Force   Surcharge
Slice  Width   Weight    Top    Bot     Norm     Tan     Hor     Ver    Load
 No.    (ft)    (lbs)  (lbs)  (lbs)   (lbs)   (lbs)  (lbs)   (lbs)   (lbs)
  1      3.2    334.5     .0      .0       .0      .0      .0      .0      .0
  2       .8    180.6     .0      .0       .0      .0      .0      .0      .0
  3       .1     19.0     .0      .0       .0      .0      .0      .0      .0
```

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 4 | .7 | 184.5 | .0 | 12.1 | .0 | .0 | .0 | .0 | .0 |
| 5 | 3.7 | 1507.2 | .0 | 443.6 | .0 | .0 | .0 | .0 | .0 |
| 6 | .2 | 137.5 | .0 | 50.3 | .0 | .0 | .0 | .0 | .0 |
| 7 | 5.8 | 4329.2 | .0 | 1848.4 | .0 | .0 | .0 | .0 | .0 |
| 8 | 2.8 | 2852.3 | .0 | 1352.8 | .0 | .0 | .0 | .0 | .0 |
| 9 | 9.1 | 12366.1 | .0 | 6037.8 | .0 | .0 | .0 | .0 | .0 |
| 10 | .9 | 1518.6 | .0 | 742.6 | .0 | .0 | .0 | .0 | .0 |
| 11 | 2.8 | 4858.5 | .0 | 2389.5 | .0 | .0 | .0 | .0 | .0 |
| 12 | .7 | 1232.7 | .0 | 608.8 | .0 | .0 | .0 | .0 | .0 |
| 13 | .8 | 1419.9 | .0 | 702.3 | .0 | .0 | .0 | .0 | .0 |
| 14 | 1.3 | 2333.4 | .0 | 1156.6 | .0 | .0 | .0 | .0 | .0 |
| 15 | 2.9 | 5792.2 | .0 | 2808.1 | .0 | .0 | .0 | .0 | .0 |
| 16 | 1.8 | 3956.2 | .0 | 1809.6 | .0 | .0 | .0 | .0 | .0 |
| 17 | 7.8 | 19356.4 | .0 | 8539.7 | .0 | .0 | .0 | .0 | .0 |
| 18 | 9.8 | 28632.1 | .0 | 11851.3 | .0 | .0 | .0 | .0 | .0 |
| 19 | 9.9 | 33049.6 | .0 | 12906.0 | .0 | .0 | .0 | .0 | .0 |
| 20 | 10.0 | 36468.0 | .0 | 13507.7 | .0 | .0 | .0 | .0 | .0 |
| 21 | 10.0 | 38798.7 | .0 | 13653.1 | .0 | .0 | .0 | .0 | .0 |
| 22 | 5.9 | 23581.2 | .0 | 7967.7 | .0 | .0 | .0 | .0 | .0 |
| 23 | 4.1 | 16406.9 | .0 | 5373.9 | .0 | .0 | .0 | .0 | .0 |
| 24 | 9.9 | 40020.0 | .0 | 12574.7 | .0 | .0 | .0 | .0 | .0 |
| 25 | 4.9 | 19829.1 | .0 | 5931.5 | .0 | .0 | .0 | .0 | .0 |
| 26 | .3 | 998.3 | .0 | 291.1 | .0 | .0 | .0 | .0 | .0 |
| 27 | 4.6 | 17836.4 | .0 | 5133.9 | .0 | .0 | .0 | .0 | .0 |
| 28 | 9.5 | 34857.8 | .0 | 9693.7 | .0 | .0 | .0 | .0 | .0 |
| 29 | 4.8 | 16192.6 | .0 | 4253.6 | .0 | .0 | .0 | .0 | .0 |
| 30 | .8 | 2608.7 | .0 | 654.0 | .0 | .0 | .0 | .0 | .0 |
| 31 | .3 | 793.9 | .0 | 196.8 | .0 | .0 | .0 | .0 | .0 |
| 32 | 3.4 | 10544.8 | .0 | 2490.8 | .0 | .0 | .0 | .0 | .0 |
| 33 | 8.7 | 25269.4 | .0 | 4942.8 | .0 | .0 | .0 | .0 | .0 |
| 34 | .3 | 847.9 | .0 | 129.3 | .0 | .0 | .0 | .0 | .0 |
| 35 | 8.1 | 20370.5 | .0 | 2091.6 | .0 | .0 | .0 | .0 | .0 |
| 36 | .6 | 1379.1 | .0 | 46.5 | .0 | .0 | .0 | .0 | .0 |
| 37 | .2 | 513.0 | .0 | 14.0 | .0 | .0 | .0 | .0 | .0 |
| 38 | .7 | 1668.1 | .0 | 28.2 | .0 | .0 | .0 | .0 | .0 |
| 39 | .4 | 895.0 | .0 | 4.0 | .0 | .0 | .0 | .0 | .0 |
| 40 | 2.5 | 5568.8 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 41 | 4.4 | 9230.3 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 42 | 7.8 | 15194.8 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 43 | 7.3 | 12511.0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 44 | .3 | 512.3 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 45 | .3 | 433.8 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 46 | 6.2 | 8382.2 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 47 | 6.3 | 5853.5 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 48 | 5.7 | 2676.2 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 49 | .8 | 147.0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 50 | .9 | 71.9 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |

Failure Surface Specified By 24 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 323.23 | 84.68 |
| 2 | 331.68 | 79.32 |
| 3 | 340.48 | 74.58 |
| 4 | 349.61 | 70.50 |
| 5 | 359.01 | 67.08 |
| 6 | 368.63 | 64.36 |
| 7 | 378.42 | 62.33 |
| 8 | 388.34 | 61.02 |
| 9 | 398.32 | 60.43 |
| 10 | 408.32 | 60.57 |
| 11 | 418.28 | 61.42 |
| 12 | 428.16 | 63.00 |
| 13 | 437.89 | 65.28 |
| 14 | 447.44 | 68.27 |
| 15 | 456.74 | 71.93 |
| 16 | 465.76 | 76.26 |
| 17 | 474.43 | 81.23 |
| 18 | 482.73 | 86.81 |
| 19 | 490.60 | 92.98 |
| 20 | 498.00 | 99.70 |

| | | |
|---|---|---|
| 21 | 504.90 | 106.94 |
| 22 | 511.26 | 114.66 |
| 23 | 517.04 | 122.82 |
| 24 | 519.06 | 126.16 |

Circle Center At X = 401.4 ; Y = 198.4 and Radius, 138.1
*** 1.946 ***

Failure Surface Specified By 24 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 327.27 | 84.63 |
| 2 | 335.69 | 79.23 |
| 3 | 344.48 | 74.46 |
| 4 | 353.59 | 70.34 |
| 5 | 362.98 | 66.91 |
| 6 | 372.60 | 64.17 |
| 7 | 382.39 | 62.15 |
| 8 | 392.31 | 60.85 |
| 9 | 402.29 | 60.29 |
| 10 | 412.29 | 60.46 |
| 11 | 422.25 | 61.36 |
| 12 | 432.12 | 62.99 |
| 13 | 441.84 | 65.34 |
| 14 | 451.36 | 68.39 |
| 15 | 460.63 | 72.14 |
| 16 | 469.60 | 76.56 |
| 17 | 478.22 | 81.62 |
| 18 | 486.45 | 87.31 |
| 19 | 494.24 | 93.58 |
| 20 | 501.55 | 100.41 |
| 21 | 508.33 | 107.75 |
| 22 | 514.56 | 115.57 |
| 23 | 520.20 | 123.83 |
| 24 | 521.62 | 126.28 |

Circle Center At X = 405.0 ; Y = 196.3 and Radius, 136.0
*** 1.948 ***

Failure Surface Specified By 24 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 326.26 | 84.65 |
| 2 | 334.70 | 79.28 |
| 3 | 343.50 | 74.53 |
| 4 | 352.62 | 70.42 |
| 5 | 362.01 | 66.97 |
| 6 | 371.61 | 64.20 |
| 7 | 381.39 | 62.11 |
| 8 | 391.30 | 60.73 |
| 9 | 401.27 | 60.05 |
| 10 | 411.27 | 60.09 |
| 11 | 421.25 | 60.84 |
| 12 | 431.14 | 62.29 |
| 13 | 440.90 | 64.45 |
| 14 | 450.49 | 67.29 |
| 15 | 459.85 | 70.81 |
| 16 | 468.94 | 74.99 |
| 17 | 477.70 | 79.80 |
| 18 | 486.10 | 85.23 |
| 19 | 494.10 | 91.23 |
| 20 | 501.64 | 97.80 |
| 21 | 508.71 | 104.88 |
| 22 | 515.24 | 112.44 |
| 23 | 521.23 | 120.46 |
| 24 | 525.08 | 126.46 |

Circle Center At X = 405.7 ; Y = 200.3 and Radius, 140.3
*** 1.950 ***

Failure Surface Specified By 24 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 322.22 | 84.69 |
| 2 | 330.71 | 79.39 |
| 3 | 339.54 | 74.71 |

| | | |
|---|---|---|
| 4 | 348.68 | 70.65 |
| 5 | 358.08 | 67.25 |
| 6 | 367.70 | 64.51 |
| 7 | 377.49 | 62.46 |
| 8 | 387.40 | 61.10 |
| 9 | 397.37 | 60.44 |
| 10 | 407.37 | 60.48 |
| 11 | 417.35 | 61.22 |
| 12 | 427.24 | 62.66 |
| 13 | 437.01 | 64.79 |
| 14 | 446.61 | 67.60 |
| 15 | 455.99 | 71.08 |
| 16 | 465.09 | 75.21 |
| 17 | 473.89 | 79.96 |
| 18 | 482.33 | 85.33 |
| 19 | 490.37 | 91.27 |
| 20 | 497.98 | 97.76 |
| 21 | 505.11 | 104.77 |
| 22 | 511.74 | 112.26 |
| 23 | 517.82 | 120.20 |
| 24 | 521.84 | 126.30 |

Circle Center At X = 401.8 ; Y = 202.6 and Radius, 142.3

*** 1.951 ***

Failure Surface Specified By 22 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 331.31 | 84.59 |
| 2 | 339.57 | 78.95 |
| 3 | 348.27 | 74.01 |
| 4 | 357.35 | 69.83 |
| 5 | 366.75 | 66.41 |
| 6 | 376.40 | 63.80 |
| 7 | 386.24 | 62.01 |
| 8 | 396.19 | 61.05 |
| 9 | 406.19 | 60.93 |
| 10 | 416.17 | 61.64 |
| 11 | 426.05 | 63.19 |
| 12 | 435.76 | 65.56 |
| 13 | 445.24 | 68.74 |
| 14 | 454.42 | 72.70 |
| 15 | 463.24 | 77.42 |
| 16 | 471.63 | 82.86 |
| 17 | 479.54 | 88.98 |
| 18 | 486.90 | 95.75 |
| 19 | 493.67 | 103.11 |
| 20 | 499.80 | 111.01 |
| 21 | 505.25 | 119.39 |
| 22 | 508.59 | 125.63 |

Circle Center At X = 402.6 ; Y = 179.9 and Radius, 119.1

*** 1.951 ***

Failure Surface Specified By 24 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 323.23 | 84.68 |
| 2 | 331.70 | 79.36 |
| 3 | 340.54 | 74.68 |
| 4 | 349.70 | 70.66 |
| 5 | 359.12 | 67.32 |
| 6 | 368.77 | 64.68 |
| 7 | 378.58 | 62.75 |
| 8 | 388.51 | 61.55 |
| 9 | 398.50 | 61.07 |
| 10 | 408.49 | 61.33 |
| 11 | 418.44 | 62.31 |
| 12 | 428.30 | 64.03 |
| 13 | 438.00 | 66.46 |
| 14 | 447.49 | 69.59 |
| 15 | 456.73 | 73.41 |
| 16 | 465.67 | 77.90 |
| 17 | 474.26 | 83.02 |

| | | |
|---|---|---|
| 18 | 482.44 | 88.76 |
| 19 | 490.19 | 95.09 |
| 20 | 497.45 | 101.97 |
| 21 | 504.19 | 109.35 |
| 22 | 510.37 | 117.22 |
| 23 | 515.96 | 125.51 |
| 24 | 516.25 | 126.02 |

Circle Center At X =  400.0 ; Y =  197.6  and Radius,  136.5

*** 1.952 ***

Failure Surface Specified By 25 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 318.18 | 84.73 |
| 2 | 326.71 | 79.50 |
| 3 | 335.56 | 74.86 |
| 4 | 344.71 | 70.82 |
| 5 | 354.11 | 67.40 |
| 6 | 363.71 | 64.62 |
| 7 | 373.48 | 62.49 |
| 8 | 383.37 | 61.02 |
| 9 | 393.34 | 60.21 |
| 10 | 403.34 | 60.08 |
| 11 | 413.33 | 60.62 |
| 12 | 423.25 | 61.82 |
| 13 | 433.08 | 63.69 |
| 14 | 442.75 | 66.21 |
| 15 | 452.24 | 69.38 |
| 16 | 461.49 | 73.17 |
| 17 | 470.47 | 77.58 |
| 18 | 479.13 | 82.58 |
| 19 | 487.44 | 88.15 |
| 20 | 495.35 | 94.26 |
| 21 | 502.84 | 100.89 |
| 22 | 509.86 | 108.01 |
| 23 | 516.39 | 115.58 |
| 24 | 522.40 | 123.57 |
| 25 | 524.26 | 126.42 |

Circle Center At X =  400.3 ; Y =  209.1  and Radius,  149.1

*** 1.953 ***

Failure Surface Specified By 25 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 322.22 | 84.69 |
| 2 | 330.73 | 79.44 |
| 3 | 339.58 | 74.78 |
| 4 | 348.73 | 70.74 |
| 5 | 358.13 | 67.34 |
| 6 | 367.75 | 64.58 |
| 7 | 377.53 | 62.50 |
| 8 | 387.43 | 61.09 |
| 9 | 397.40 | 60.35 |
| 10 | 407.40 | 60.31 |
| 11 | 417.38 | 60.95 |
| 12 | 427.29 | 62.27 |
| 13 | 437.09 | 64.27 |
| 14 | 446.73 | 66.93 |
| 15 | 456.16 | 70.25 |
| 16 | 465.35 | 74.20 |
| 17 | 474.24 | 78.78 |
| 18 | 482.80 | 83.95 |
| 19 | 490.98 | 89.70 |
| 20 | 498.75 | 95.99 |
| 21 | 506.07 | 102.80 |
| 22 | 512.91 | 110.10 |
| 23 | 519.23 | 117.85 |
| 24 | 525.01 | 126.01 |
| 25 | 525.29 | 126.47 |

Circle Center At X =  403.1 ; Y =  206.2  and Radius,  145.9

*** 1.954 ***

Failure Surface Specified By 24 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 326.26 | 84.65 |
| 2 | 334.73 | 79.32 |
| 3 | 343.55 | 74.61 |
| 4 | 352.67 | 70.52 |
| 5 | 362.06 | 67.07 |
| 6 | 371.67 | 64.29 |
| 7 | 381.44 | 62.19 |
| 8 | 391.34 | 60.77 |
| 9 | 401.32 | 60.05 |
| 10 | 411.32 | 60.02 |
| 11 | 421.29 | 60.69 |
| 12 | 431.20 | 62.06 |
| 13 | 440.99 | 64.11 |
| 14 | 450.61 | 66.85 |
| 15 | 460.01 | 70.24 |
| 16 | 469.16 | 74.29 |
| 17 | 478.00 | 78.96 |
| 18 | 486.49 | 84.24 |
| 19 | 494.60 | 90.09 |
| 20 | 502.27 | 96.50 |
| 21 | 509.48 | 103.43 |
| 22 | 516.19 | 110.84 |
| 23 | 522.37 | 118.71 |
| 24 | 527.72 | 126.59 |

Circle Center At X = 406.7 ; Y = 203.2 and Radius, 143.2

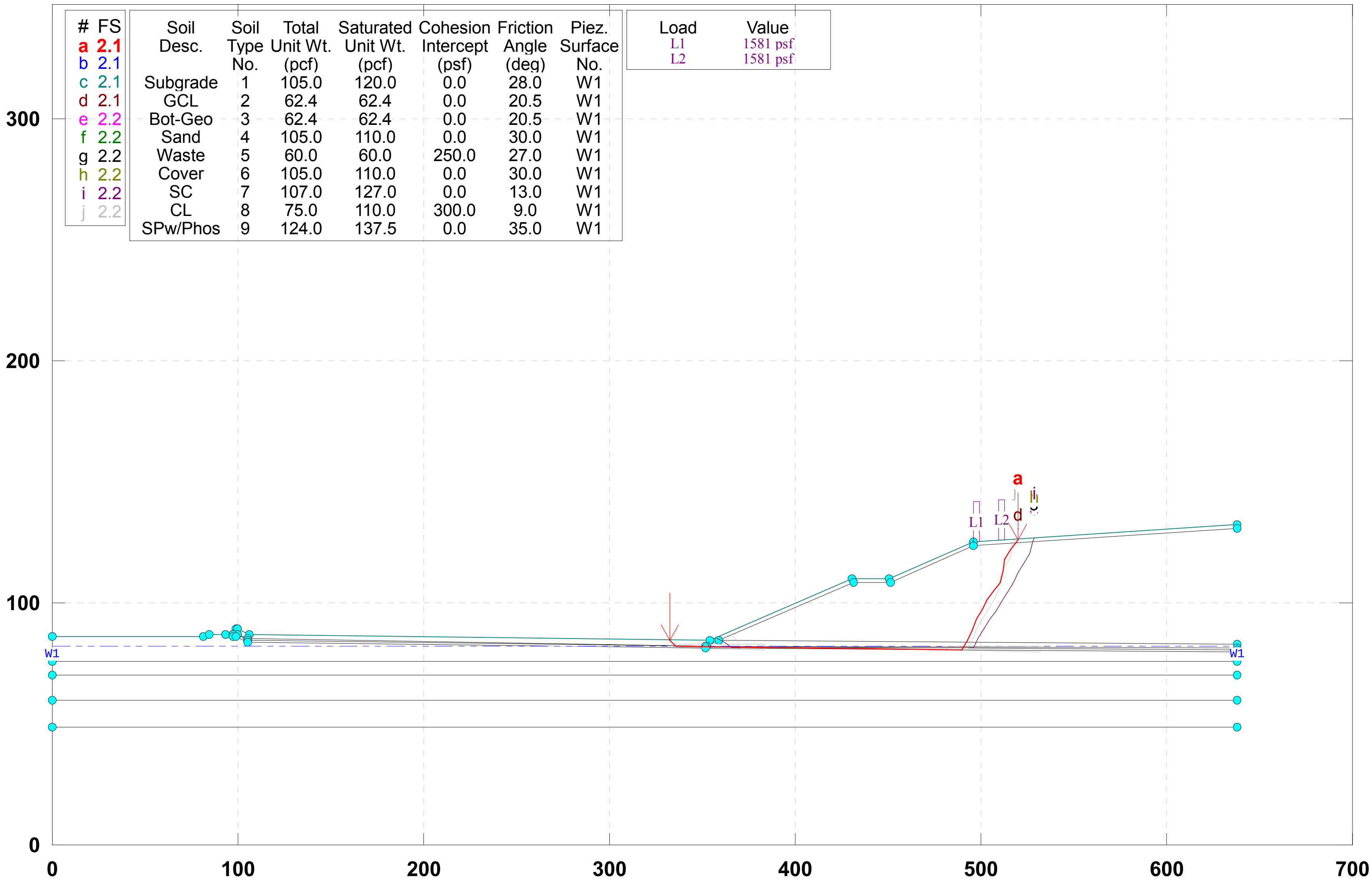
*** 1.954 ***

# Slope Stability Analysis during Construction
# Phase II Section II Adjacent to Phase II Section I

## Block-Type Analysis With and Without Equipment Loading

# Phase II Section I RAI No. 1 West Slope During Expansion Construction

C:\1\HARDEE~1.1\2HARDE~1.1\EWBLLO~1\EWSECBLL.PL2 Run By: Shane R. Fischer, P.E. 03/31/13 5:33AM




PCSTABL5M/si FSmin=2.1

Safety Factors Are Calculated By The Modified Janbu Method

SCS ENGINEERS

**** PCSTABL5M ****
by
Purdue University
--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer`s Method of Slices

Run Date: 03/31/13
Time of Run: 5:33AM
Run By: Shane R. Fischer, P.E.
Input Data Filename: C:ewsecbll.
Output Filename: C:ewsecbll.OUT
Unit: ENGLISH
Plotted Output Filename: C:ewsecbll.PLT
PROBLEM DESCRIPTION Phase II Section I RAI No. 1
West Slope During Expansion Construction

BOUNDARY COORDINATES
11 Top Boundaries
38 Total Boundaries

| Boundary No. | X-Left (ft) | Y-Left (ft) | X-Right (ft) | Y-Right (ft) | Soil Type Below Bnd |
|---|---|---|---|---|---|
| 1 | .00 | 86.00 | 81.46 | 86.00 | 1 |
| 2 | 81.46 | 86.00 | 84.46 | 87.00 | 1 |
| 3 | 84.46 | 87.00 | 93.14 | 87.00 | 1 |
| 4 | 93.14 | 87.00 | 99.14 | 89.00 | 4 |
| 5 | 99.14 | 89.00 | 99.79 | 89.00 | 4 |
| 6 | 99.79 | 89.00 | 105.80 | 86.99 | 4 |
| 7 | 105.80 | 86.99 | 354.00 | 84.35 | 4 |
| 8 | 354.00 | 84.35 | 430.93 | 110.00 | 6 |
| 9 | 430.93 | 110.00 | 450.93 | 110.00 | 6 |
| 10 | 450.93 | 110.00 | 495.93 | 125.00 | 6 |
| 11 | 495.93 | 125.00 | 637.93 | 132.10 | 6 |
| 12 | 93.14 | 87.00 | 96.95 | 87.00 | 1 |
| 13 | 96.95 | 87.00 | 97.46 | 87.00 | 2 |
| 14 | 97.46 | 87.00 | 99.46 | 87.00 | 3 |
| 15 | 99.46 | 87.00 | 105.46 | 85.00 | 3 |
| 16 | 105.46 | 85.00 | 352.75 | 82.35 | 3 |
| 17 | 352.75 | 82.35 | 358.68 | 84.33 | 4 |
| 18 | 358.68 | 84.33 | 431.18 | 108.50 | 5 |
| 19 | 431.18 | 108.50 | 451.18 | 108.50 | 5 |
| 20 | 451.18 | 108.50 | 496.21 | 123.51 | 5 |
| 21 | 496.21 | 123.51 | 637.93 | 130.59 | 5 |
| 22 | 97.46 | 87.00 | 97.57 | 86.53 | 2 |
| 23 | 97.57 | 86.53 | 99.30 | 86.53 | 2 |
| 24 | 99.30 | 86.53 | 105.41 | 84.50 | 2 |
| 25 | 105.41 | 84.50 | 351.28 | 81.86 | 2 |
| 26 | 351.28 | 81.86 | 352.75 | 82.35 | 2 |
| 27 | 358.68 | 84.33 | 637.93 | 83.10 | 4 |
| 28 | 352.75 | 82.35 | 637.93 | 81.10 | 3 |
| 29 | 351.28 | 81.86 | 637.93 | 80.60 | 2 |
| 30 | 96.95 | 87.00 | 97.17 | 86.03 | 1 |
| 31 | 97.17 | 86.03 | 99.22 | 86.03 | 1 |
| 32 | 99.22 | 86.03 | 105.33 | 84.00 | 1 |
| 33 | 105.33 | 84.00 | 351.28 | 81.36 | 1 |
| 34 | 351.28 | 81.36 | 637.93 | 80.10 | 1 |
| 35 | .00 | 76.00 | 637.93 | 76.00 | 1 |
| 36 | .00 | 70.00 | 637.93 | 70.00 | 7 |
| 37 | .00 | 60.00 | 637.93 | 60.00 | 8 |
| 38 | .00 | 49.00 | 637.93 | 49.00 | 9 |

ISOTROPIC SOIL PARAMETERS
9 Type(s) of Soil

| Soil Type No. | Total Unit Wt. (pcf) | Saturated Unit Wt. (pcf) | Cohesion Intercept (psf) | Friction Angle (deg) | Pore Pressure Param. | Pressure Constant (psf) | Piez. Surface No. |
|---|---|---|---|---|---|---|---|
| 1 | 105.0 | 120.0 | .0 | 28.0 | .00 | .0 | 1 |
| 2 | 62.4 | 62.4 | .0 | 20.5 | .00 | .0 | 1 |
| 3 | 62.4 | 62.4 | .0 | 20.5 | .00 | .0 | 1 |
| 4 | 105.0 | 110.0 | .0 | 30.0 | .00 | .0 | 1 |
| 5 | 60.0 | 60.0 | 250.0 | 27.0 | .00 | .0 | 1 |
| 6 | 105.0 | 110.0 | .0 | 30.0 | .00 | .0 | 1 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 7 | 107.0 | 127.0 | .0 | 13.0 | .00 | .0 | 1 |
| 8 | 75.0 | 110.0 | 300.0 | 9.0 | .00 | .0 | 1 |
| 9 | 124.0 | 137.5 | .0 | 35.0 | .00 | .0 | 1 |

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED
Unit Weight of Water = 62.40
Piezometric Surface No. 1 Specified by 2 Coordinate Points

| Point No. | X-Water (ft) | Y-Water (ft) |
|---|---|---|
| 1 | .00 | 82.09 |
| 2 | 637.93 | 82.09 |

BOUNDARY LOAD(S)
2 Load(s) Specified

| Load No. | X-Left (ft) | X-Right (ft) | Intensity (psf) | Deflection (deg) |
|---|---|---|---|---|
| 1 | 495.93 | 498.90 | 1581.0 | .0 |
| 2 | 509.89 | 512.85 | 1581.0 | .0 |

NOTE - Intensity Is Specified As A Uniformly Distributed
Force Acting On A Horizontally Projected Surface.
A Critical Failure Surface Searching Method, Using A Random
Technique For Generating Sliding Block Surfaces, Has Been
Specified.
1000 Trial Surfaces Have Been Generated.
2 Boxes Specified For Generation Of Central Block Base
Length Of Line Segments For Active And Passive Portions Of
Sliding Block Is 5.0

| Box No. | X-Left (ft) | Y-Left (ft) | X-Right (ft) | Y-Right (ft) | Height (ft) |
|---|---|---|---|---|---|
| 1 | 333.66 | 82.05 | 383.66 | 81.72 | 2.00 |
| 2 | 482.02 | 81.29 | 532.02 | 81.07 | 2.00 |

Following Are Displayed The Ten Most Critical Of The Trial
Failure Surfaces Examined. They Are Ordered - Most Critical
First.
* * Safety Factors Are Calculated By The Modified Janbu Method * *
Failure Surface Specified By 15 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 332.47 | 84.58 |
| 2 | 335.72 | 82.34 |
| 3 | 489.33 | 80.76 |
| 4 | 492.73 | 84.43 |
| 5 | 495.45 | 88.62 |
| 6 | 497.62 | 93.12 |
| 7 | 500.49 | 97.21 |
| 8 | 503.56 | 101.16 |
| 9 | 506.82 | 104.95 |
| 10 | 510.35 | 108.49 |
| 11 | 512.02 | 113.21 |
| 12 | 512.50 | 118.18 |
| 13 | 515.82 | 121.92 |
| 14 | 519.28 | 125.53 |
| 15 | 519.94 | 126.20 |

*** 2.085 ***

Individual data on the 36 slices

| Slice No. | Width (ft) | Weight (lbs) | Water Force Top (lbs) | Water Force Bot (lbs) | Tie Force Norm (lbs) | Tie Force Tan (lbs) | Earthquake Force Hor (lbs) | Earthquake Force Ver (lbs) | Surcharge Load (lbs) |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 3.0 | 313.3 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 2 | .3 | 62.3 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 3 | 16.5 | 3680.1 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 4 | .5 | 121.5 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 5 | 1.3 | 278.6 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 6 | 4.7 | 1434.8 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 7 | 1.2 | 462.8 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 8 | 45.4 | 40087.0 | .0 | 662.0 | .0 | .0 | .0 | .0 | .0 |
| 9 | 6.8 | 9707.7 | .0 | 214.0 | .0 | .0 | .0 | .0 | .0 |
| 10 | 18.9 | 31819.9 | .0 | 746.7 | .0 | .0 | .0 | .0 | .0 |
| 11 | .3 | 470.0 | .0 | 11.4 | .0 | .0 | .0 | .0 | .0 |
| 12 | 19.8 | 37224.1 | .0 | 1029.9 | .0 | .0 | .0 | .0 | .0 |
| 13 | .3 | 473.9 | .0 | 14.6 | .0 | .0 | .0 | .0 | .0 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 14 | 38.1 | 87515.8 | .0 | 2704.5 | .0 | .0 | .0 | .0 | .0 |
| 15 | .5 | 1224.1 | .0 | 45.6 | .0 | .0 | .0 | .0 | .0 |
| 16 | .5 | 1220.8 | .0 | 24.9 | .0 | .0 | .0 | .0 | .0 |
| 17 | .3 | 834.7 | .0 | 5.0 | .0 | .0 | .0 | .0 | .0 |
| 18 | 1.5 | 3891.5 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 19 | .6 | 1554.0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 20 | 2.7 | 6381.6 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 21 | .5 | 1063.3 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 22 | .3 | 609.2 | .0 | .0 | .0 | .0 | .0 | .0 | 442.7 |
| 23 | 1.4 | 2915.4 | .0 | .0 | .0 | .0 | .0 | .0 | 2225.6 |
| 24 | 1.3 | 2477.9 | .0 | .0 | .0 | .0 | .0 | .0 | 2027.2 |
| 25 | 1.6 | 2890.0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 26 | 3.1 | 5014.0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 27 | 3.3 | 4605.9 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 28 | 3.1 | 3728.5 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 29 | .5 | 515.4 | .0 | .0 | .0 | .0 | .0 | .0 | 731.1 |
| 30 | 1.7 | 1604.5 | .0 | .0 | .0 | .0 | .0 | .0 | 2635.7 |
| 31 | .5 | 323.2 | .0 | .0 | .0 | .0 | .0 | .0 | 757.0 |
| 32 | .4 | 181.1 | .0 | .0 | .0 | .0 | .0 | .0 | 555.9 |
| 33 | 3.0 | 1212.5 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 34 | 2.6 | 606.7 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 35 | .9 | 98.2 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 36 | .7 | 21.9 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |

Failure Surface Specified By 15 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 332.47 | 84.58 |
| 2 | 335.72 | 82.34 |
| 3 | 489.33 | 80.76 |
| 4 | 492.73 | 84.43 |
| 5 | 495.45 | 88.62 |
| 6 | 497.62 | 93.12 |
| 7 | 500.49 | 97.21 |
| 8 | 503.56 | 101.16 |
| 9 | 506.82 | 104.95 |
| 10 | 510.35 | 108.49 |
| 11 | 512.02 | 113.21 |
| 12 | 512.50 | 118.18 |
| 13 | 515.82 | 121.92 |
| 14 | 519.28 | 125.53 |
| 15 | 519.94 | 126.20 |

*** 2.085 ***

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| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 332.47 | 84.58 |
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| 3 | 489.33 | 80.76 |
| 4 | 492.73 | 84.43 |
| 5 | 495.45 | 88.62 |
| 6 | 497.62 | 93.12 |
| 7 | 500.49 | 97.21 |
| 8 | 503.56 | 101.16 |
| 9 | 506.82 | 104.95 |
| 10 | 510.35 | 108.49 |
| 11 | 512.02 | 113.21 |
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*** 2.085 ***

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| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 332.47 | 84.58 |
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| 3 | 489.33 | 80.76 |
| 4 | 492.73 | 84.43 |
| 5 | 495.45 | 88.62 |
| 6 | 497.62 | 93.12 |

| | | |
|---|---|---|
| 7 | 500.49 | 97.21 |
| 8 | 503.56 | 101.16 |
| 9 | 506.82 | 104.95 |
| 10 | 510.35 | 108.49 |
| 11 | 512.02 | 113.21 |
| 12 | 512.50 | 118.18 |
| 13 | 515.82 | 121.92 |
| 14 | 519.28 | 125.53 |
| 15 | 519.94 | 126.20 |

*** 2.085 ***

Failure Surface Specified By 16 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 358.06 | 85.70 |
| 2 | 361.88 | 83.74 |
| 3 | 366.41 | 81.62 |
| 4 | 495.99 | 80.98 |
| 5 | 498.66 | 85.20 |
| 6 | 501.42 | 89.37 |
| 7 | 504.61 | 93.23 |
| 8 | 508.11 | 96.79 |
| 9 | 511.33 | 100.62 |
| 10 | 514.69 | 104.32 |
| 11 | 517.62 | 108.38 |
| 12 | 520.23 | 112.64 |
| 13 | 523.21 | 116.65 |
| 14 | 526.40 | 120.50 |
| 15 | 528.20 | 125.17 |
| 16 | 528.75 | 126.64 |

*** 2.204 ***

Failure Surface Specified By 16 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 358.06 | 85.70 |
| 2 | 361.88 | 83.74 |
| 3 | 366.41 | 81.62 |
| 4 | 495.99 | 80.98 |
| 5 | 498.66 | 85.20 |
| 6 | 501.42 | 89.37 |
| 7 | 504.61 | 93.23 |
| 8 | 508.11 | 96.79 |
| 9 | 511.33 | 100.62 |
| 10 | 514.69 | 104.32 |
| 11 | 517.62 | 108.38 |
| 12 | 520.23 | 112.64 |
| 13 | 523.21 | 116.65 |
| 14 | 526.40 | 120.50 |
| 15 | 528.20 | 125.17 |
| 16 | 528.75 | 126.64 |

*** 2.204 ***

Failure Surface Specified By 16 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 358.06 | 85.70 |
| 2 | 361.88 | 83.74 |
| 3 | 366.41 | 81.62 |
| 4 | 495.99 | 80.98 |
| 5 | 498.66 | 85.20 |
| 6 | 501.42 | 89.37 |
| 7 | 504.61 | 93.23 |
| 8 | 508.11 | 96.79 |
| 9 | 511.33 | 100.62 |
| 10 | 514.69 | 104.32 |
| 11 | 517.62 | 108.38 |
| 12 | 520.23 | 112.64 |
| 13 | 523.21 | 116.65 |
| 14 | 526.40 | 120.50 |
| 15 | 528.20 | 125.17 |
| 16 | 528.75 | 126.64 |

*** 2.204 ***

Failure Surface Specified By 16 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 358.06 | 85.70 |
| 2 | 361.88 | 83.74 |
| 3 | 366.41 | 81.62 |
| 4 | 495.99 | 80.98 |
| 5 | 498.66 | 85.20 |
| 6 | 501.42 | 89.37 |
| 7 | 504.61 | 93.23 |
| 8 | 508.11 | 96.79 |
| 9 | 511.33 | 100.62 |
| 10 | 514.69 | 104.32 |
| 11 | 517.62 | 108.38 |
| 12 | 520.23 | 112.64 |
| 13 | 523.21 | 116.65 |
| 14 | 526.40 | 120.50 |
| 15 | 528.20 | 125.17 |
| 16 | 528.75 | 126.64 |

*** 2.204 ***

Failure Surface Specified By 16 Coordinate Points

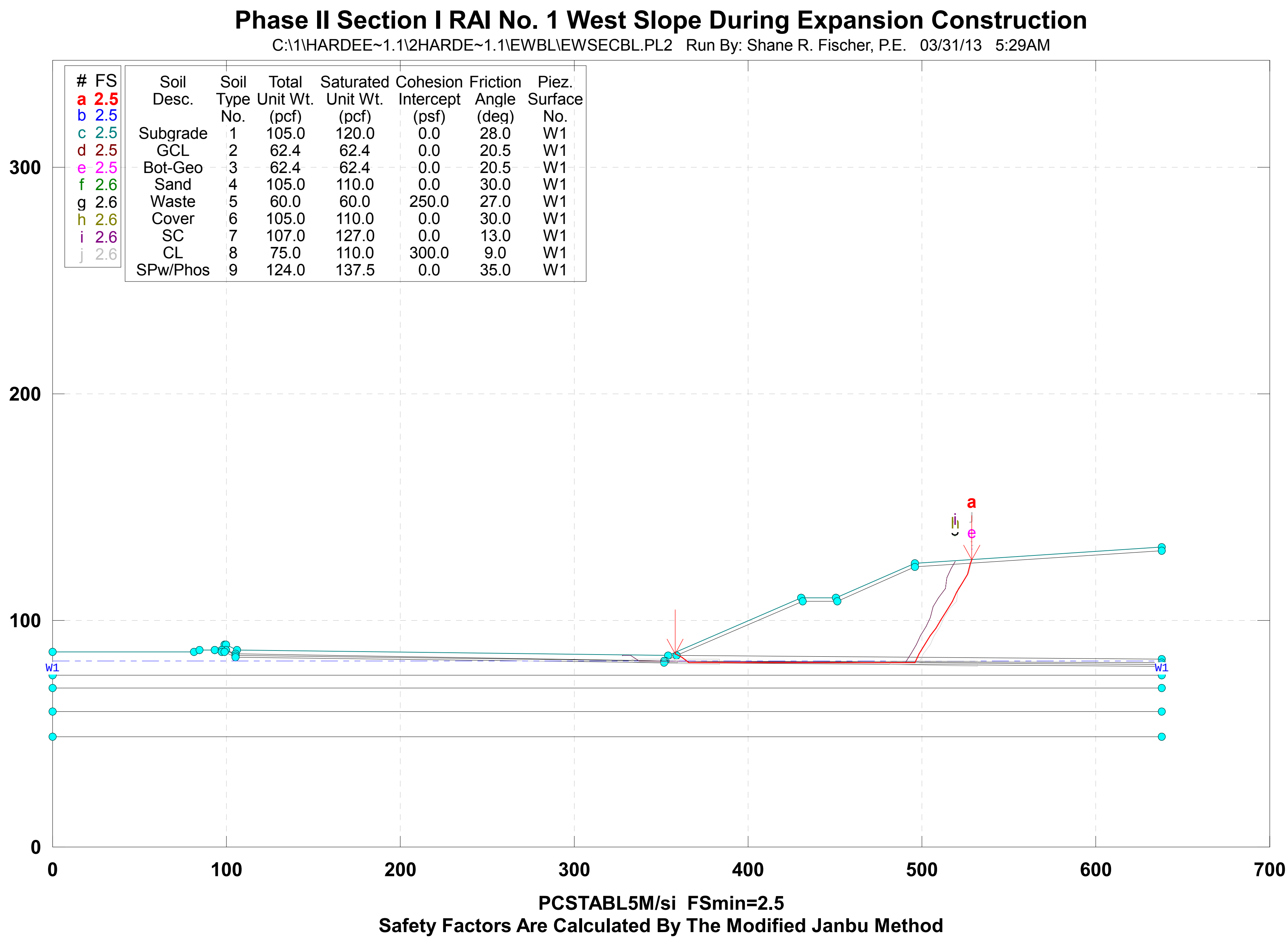
| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 358.06 | 85.70 |
| 2 | 361.88 | 83.74 |
| 3 | 366.41 | 81.62 |
| 4 | 495.99 | 80.98 |
| 5 | 498.66 | 85.20 |
| 6 | 501.42 | 89.37 |
| 7 | 504.61 | 93.23 |
| 8 | 508.11 | 96.79 |
| 9 | 511.33 | 100.62 |
| 10 | 514.69 | 104.32 |
| 11 | 517.62 | 108.38 |
| 12 | 520.23 | 112.64 |
| 13 | 523.21 | 116.65 |
| 14 | 526.40 | 120.50 |
| 15 | 528.20 | 125.17 |
| 16 | 528.75 | 126.64 |

*** 2.204 ***

Failure Surface Specified By 15 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 364.08 | 87.71 |
| 2 | 367.26 | 85.11 |
| 3 | 370.90 | 81.68 |
| 4 | 492.67 | 81.01 |
| 5 | 495.73 | 84.97 |
| 6 | 497.66 | 89.58 |
| 7 | 500.91 | 93.38 |
| 8 | 503.64 | 97.57 |
| 9 | 507.12 | 101.16 |
| 10 | 509.38 | 105.62 |
| 11 | 510.43 | 110.51 |
| 12 | 512.60 | 115.01 |
| 13 | 516.05 | 118.63 |
| 14 | 516.65 | 123.60 |
| 15 | 518.12 | 126.11 |

*** 2.204 ***




SCS ENGINEERS

**** PCSTABL5M ****

by

Purdue University

--Slope Stability Analysis--

Simplified Janbu, Simplified Bishop

or Spencer`s Method of Slices

Run Date: 03/31/13

Time of Run: 5:29AM

Run By: Shane R. Fischer, P.E.

Input Data Filename: C:ewsecbl.

Output Filename: C:ewsecbl.OUT

Unit: ENGLISH

Plotted Output Filename: C:ewsecbl.PLT

PROBLEM DESCRIPTION Phase II Section I RAI No. 1
West Slope During Expansion Construction

BOUNDARY COORDINATES

11 Top Boundaries

38 Total Boundaries

| Boundary No. | X-Left (ft) | Y-Left (ft) | X-Right (ft) | Y-Right (ft) | Soil Type Below Bnd |
|---|---|---|---|---|---|
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| 4 | 93.14 | 87.00 | 99.14 | 89.00 | 4 |
| 5 | 99.14 | 89.00 | 99.79 | 89.00 | 4 |
| 6 | 99.79 | 89.00 | 105.80 | 86.99 | 4 |
| 7 | 105.80 | 86.99 | 354.00 | 84.35 | 4 |
| 8 | 354.00 | 84.35 | 430.93 | 110.00 | 6 |
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| 10 | 450.93 | 110.00 | 495.93 | 125.00 | 6 |
| 11 | 495.93 | 125.00 | 637.93 | 132.10 | 6 |
| 12 | 93.14 | 87.00 | 96.95 | 87.00 | 1 |
| 13 | 96.95 | 87.00 | 97.46 | 87.00 | 2 |
| 14 | 97.46 | 87.00 | 99.46 | 87.00 | 3 |
| 15 | 99.46 | 87.00 | 105.46 | 85.00 | 3 |
| 16 | 105.46 | 85.00 | 352.75 | 82.35 | 3 |
| 17 | 352.75 | 82.35 | 358.68 | 84.33 | 4 |
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| 20 | 451.18 | 108.50 | 496.21 | 123.51 | 5 |
| 21 | 496.21 | 123.51 | 637.93 | 130.59 | 5 |
| 22 | 97.46 | 87.00 | 97.57 | 86.53 | 2 |
| 23 | 97.57 | 86.53 | 99.30 | 86.53 | 2 |
| 24 | 99.30 | 86.53 | 105.41 | 84.50 | 2 |
| 25 | 105.41 | 84.50 | 351.28 | 81.86 | 2 |
| 26 | 351.28 | 81.86 | 352.75 | 82.35 | 2 |
| 27 | 358.68 | 84.33 | 637.93 | 83.10 | 4 |
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| 29 | 351.28 | 81.86 | 637.93 | 80.60 | 2 |
| 30 | 96.95 | 87.00 | 97.17 | 86.03 | 1 |
| 31 | 97.17 | 86.03 | 99.22 | 86.03 | 1 |
| 32 | 99.22 | 86.03 | 105.33 | 84.00 | 1 |
| 33 | 105.33 | 84.00 | 351.28 | 81.36 | 1 |
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ISOTROPIC SOIL PARAMETERS

9 Type(s) of Soil

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|---|---|---|---|---|---|---|---|
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| 2 | 62.4 | 62.4 | .0 | 20.5 | .00 | .0 | 1 |
| 3 | 62.4 | 62.4 | .0 | 20.5 | .00 | .0 | 1 |
| 4 | 105.0 | 110.0 | .0 | 30.0 | .00 | .0 | 1 |
| 5 | 60.0 | 60.0 | 250.0 | 27.0 | .00 | .0 | 1 |
| 6 | 105.0 | 110.0 | .0 | 30.0 | .00 | .0 | 1 |
| 7 | 107.0 | 127.0 | .0 | 13.0 | .00 | .0 | 1 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 8 | 75.0 | 110.0 | 300.0 | 9.0 | .00 | .0 | 1 |
| 9 | 124.0 | 137.5 | .0 | 35.0 | .00 | .0 | 1 |

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED
Unit Weight of Water = 62.40
Piezometric Surface No. 1 Specified by 2 Coordinate Points

| Point No. | X-Water (ft) | Y-Water (ft) |
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SURCHARGE BOUNDARY LOAD DATA HAS BEEN SUPPRESSED
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Length Of Line Segments For Active And Passive Portions Of
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Failure Surface Specified By 16 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 358.06 | 85.70 |
| 2 | 361.88 | 83.74 |
| 3 | 366.41 | 81.62 |
| 4 | 495.99 | 80.98 |
| 5 | 498.66 | 85.20 |
| 6 | 501.42 | 89.37 |
| 7 | 504.61 | 93.23 |
| 8 | 508.11 | 96.79 |
| 9 | 511.33 | 100.62 |
| 10 | 514.69 | 104.32 |
| 11 | 517.62 | 108.38 |
| 12 | 520.23 | 112.64 |
| 13 | 523.21 | 116.65 |
| 14 | 526.40 | 120.50 |
| 15 | 528.20 | 125.17 |
| 16 | 528.75 | 126.64 |

*** 2.522 ***

Individual data on the 32 slices

| Slice No. | Width (ft) | Weight (lbs) | Water Force Top (lbs) | Water Force Bot (lbs) | Tie Force Norm (lbs) | Tie Force Tan (lbs) | Earthquake Force Hor (lbs) | Earthquake Force Ver (lbs) | Surcharge Load (lbs) |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 1.9 | 154.7 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 2 | .8 | 154.5 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 3 | 1.1 | 280.8 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 4 | 3.1 | 1229.5 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 5 | .4 | 227.4 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 6 | .6 | 341.4 | .0 | 6.4 | .0 | .0 | .0 | .0 | .0 |
| 7 | .4 | 206.2 | .0 | 9.5 | .0 | .0 | .0 | .0 | .0 |
| 8 | 45.7 | 47413.2 | .0 | 1651.6 | .0 | .0 | .0 | .0 | .0 |
| 9 | 18.9 | 31945.7 | .0 | 872.4 | .0 | .0 | .0 | .0 | .0 |
| 10 | .3 | 470.9 | .0 | 12.3 | .0 | .0 | .0 | .0 | .0 |
| 11 | 19.8 | 37228.6 | .0 | 1034.3 | .0 | .0 | .0 | .0 | .0 |
| 12 | .3 | 473.1 | .0 | 13.9 | .0 | .0 | .0 | .0 | .0 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 13 | 44.8 | 105240.5 | .0 | 2798.3 | .0 | .0 | .0 | .0 | .0 |
| 14 | .1 | 179.6 | .0 | 4.5 | .0 | .0 | .0 | .0 | .0 |
| 15 | .2 | 437.2 | .0 | 18.1 | .0 | .0 | .0 | .0 | .0 |
| 16 | .1 | 166.5 | .0 | 5.7 | .0 | .0 | .0 | .0 | .0 |
| 17 | .3 | 702.8 | .0 | 16.9 | .0 | .0 | .0 | .0 | .0 |
| 18 | .2 | 638.9 | .0 | 5.0 | .0 | .0 | .0 | .0 | .0 |
| 19 | 1.0 | 2704.4 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 20 | .9 | 2351.1 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 21 | 2.8 | 6466.8 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 22 | 3.2 | 6719.1 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 23 | 3.5 | 6662.5 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 24 | 3.2 | 5425.1 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 25 | 3.4 | 4946.1 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 26 | 2.9 | 3646.4 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 27 | 2.6 | 2624.8 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 28 | 3.0 | 2291.3 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 29 | 3.2 | 1719.6 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 30 | 1.8 | 520.7 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 31 | .0 | 3.7 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 32 | .6 | 42.2 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |

Failure Surface Specified By 16 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 358.06 | 85.70 |
| 2 | 361.88 | 83.74 |
| 3 | 366.41 | 81.62 |
| 4 | 495.99 | 80.98 |
| 5 | 498.66 | 85.20 |
| 6 | 501.42 | 89.37 |
| 7 | 504.61 | 93.23 |
| 8 | 508.11 | 96.79 |
| 9 | 511.33 | 100.62 |
| 10 | 514.69 | 104.32 |
| 11 | 517.62 | 108.38 |
| 12 | 520.23 | 112.64 |
| 13 | 523.21 | 116.65 |
| 14 | 526.40 | 120.50 |
| 15 | 528.20 | 125.17 |
| 16 | 528.75 | 126.64 |

*** 2.522 ***

Failure Surface Specified By 16 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 358.06 | 85.70 |
| 2 | 361.88 | 83.74 |
| 3 | 366.41 | 81.62 |
| 4 | 495.99 | 80.98 |
| 5 | 498.66 | 85.20 |
| 6 | 501.42 | 89.37 |
| 7 | 504.61 | 93.23 |
| 8 | 508.11 | 96.79 |
| 9 | 511.33 | 100.62 |
| 10 | 514.69 | 104.32 |
| 11 | 517.62 | 108.38 |
| 12 | 520.23 | 112.64 |
| 13 | 523.21 | 116.65 |
| 14 | 526.40 | 120.50 |
| 15 | 528.20 | 125.17 |
| 16 | 528.75 | 126.64 |

*** 2.522 ***

Failure Surface Specified By 16 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 358.06 | 85.70 |
| 2 | 361.88 | 83.74 |
| 3 | 366.41 | 81.62 |
| 4 | 495.99 | 80.98 |
| 5 | 498.66 | 85.20 |
| 6 | 501.42 | 89.37 |
| 7 | 504.61 | 93.23 |

| | | |
|---|---|---|
| 8 | 508.11 | 96.79 |
| 9 | 511.33 | 100.62 |
| 10 | 514.69 | 104.32 |
| 11 | 517.62 | 108.38 |
| 12 | 520.23 | 112.64 |
| 13 | 523.21 | 116.65 |
| 14 | 526.40 | 120.50 |
| 15 | 528.20 | 125.17 |
| 16 | 528.75 | 126.64 |
| *** | 2.522 | *** |

Failure Surface Specified By 16 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 358.06 | 85.70 |
| 2 | 361.88 | 83.74 |
| 3 | 366.41 | 81.62 |
| 4 | 495.99 | 80.98 |
| 5 | 498.66 | 85.20 |
| 6 | 501.42 | 89.37 |
| 7 | 504.61 | 93.23 |
| 8 | 508.11 | 96.79 |
| 9 | 511.33 | 100.62 |
| 10 | 514.69 | 104.32 |
| 11 | 517.62 | 108.38 |
| 12 | 520.23 | 112.64 |
| 13 | 523.21 | 116.65 |
| 14 | 526.40 | 120.50 |
| 15 | 528.20 | 125.17 |
| 16 | 528.75 | 126.64 |
| *** | 2.522 | *** |

Failure Surface Specified By 16 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 327.49 | 84.63 |
| 2 | 327.89 | 84.41 |
| 3 | 332.89 | 84.29 |
| 4 | 337.56 | 82.52 |
| 5 | 490.68 | 81.07 |
| 6 | 493.62 | 85.11 |
| 7 | 496.75 | 89.01 |
| 8 | 499.46 | 93.21 |
| 9 | 502.55 | 97.14 |
| 10 | 504.68 | 101.67 |
| 11 | 506.38 | 106.37 |
| 12 | 509.89 | 109.93 |
| 13 | 513.19 | 113.69 |
| 14 | 514.59 | 118.49 |
| 15 | 516.98 | 122.88 |
| 16 | 519.26 | 126.17 |
| *** | 2.571 | *** |

Failure Surface Specified By 16 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 327.49 | 84.63 |
| 2 | 327.89 | 84.41 |
| 3 | 332.89 | 84.29 |
| 4 | 337.56 | 82.52 |
| 5 | 490.68 | 81.07 |
| 6 | 493.62 | 85.11 |
| 7 | 496.75 | 89.01 |
| 8 | 499.46 | 93.21 |
| 9 | 502.55 | 97.14 |
| 10 | 504.68 | 101.67 |
| 11 | 506.38 | 106.37 |
| 12 | 509.89 | 109.93 |
| 13 | 513.19 | 113.69 |
| 14 | 514.59 | 118.49 |
| 15 | 516.98 | 122.88 |
| 16 | 519.26 | 126.17 |
| *** | 2.571 | *** |

Failure Surface Specified By 16 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 327.49 | 84.63 |
| 2 | 327.89 | 84.41 |
| 3 | 332.89 | 84.29 |
| 4 | 337.56 | 82.52 |
| 5 | 490.68 | 81.07 |
| 6 | 493.62 | 85.11 |
| 7 | 496.75 | 89.01 |
| 8 | 499.46 | 93.21 |
| 9 | 502.55 | 97.14 |
| 10 | 504.68 | 101.67 |
| 11 | 506.38 | 106.37 |
| 12 | 509.89 | 109.93 |
| 13 | 513.19 | 113.69 |
| 14 | 514.59 | 118.49 |
| 15 | 516.98 | 122.88 |
| 16 | 519.26 | 126.17 |

*** 2.571 ***

Failure Surface Specified By 16 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 327.49 | 84.63 |
| 2 | 327.89 | 84.41 |
| 3 | 332.89 | 84.29 |
| 4 | 337.56 | 82.52 |
| 5 | 490.68 | 81.07 |
| 6 | 493.62 | 85.11 |
| 7 | 496.75 | 89.01 |
| 8 | 499.46 | 93.21 |
| 9 | 502.55 | 97.14 |
| 10 | 504.68 | 101.67 |
| 11 | 506.38 | 106.37 |
| 12 | 509.89 | 109.93 |
| 13 | 513.19 | 113.69 |
| 14 | 514.59 | 118.49 |
| 15 | 516.98 | 122.88 |
| 16 | 519.26 | 126.17 |

*** 2.571 ***

Failure Surface Specified By 16 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 354.56 | 84.54 |
| 2 | 355.13 | 84.38 |
| 3 | 359.26 | 81.55 |
| 4 | 498.02 | 81.36 |
| 5 | 500.89 | 85.46 |
| 6 | 504.37 | 89.04 |
| 7 | 507.14 | 93.21 |
| 8 | 510.23 | 97.14 |
| 9 | 512.85 | 101.40 |
| 10 | 516.30 | 105.02 |
| 11 | 519.54 | 108.83 |
| 12 | 520.70 | 113.69 |
| 13 | 524.00 | 117.45 |
| 14 | 526.90 | 121.52 |
| 15 | 528.95 | 126.08 |
| 16 | 529.04 | 126.66 |

*** 2.573 ***

# Slope Stability Analysis
# Phase II Section II Final Buildout

## Circular Analysis With and Without Equipment Loading

# Phase II Section II Expansion RAI No. 1 West Slope Operation

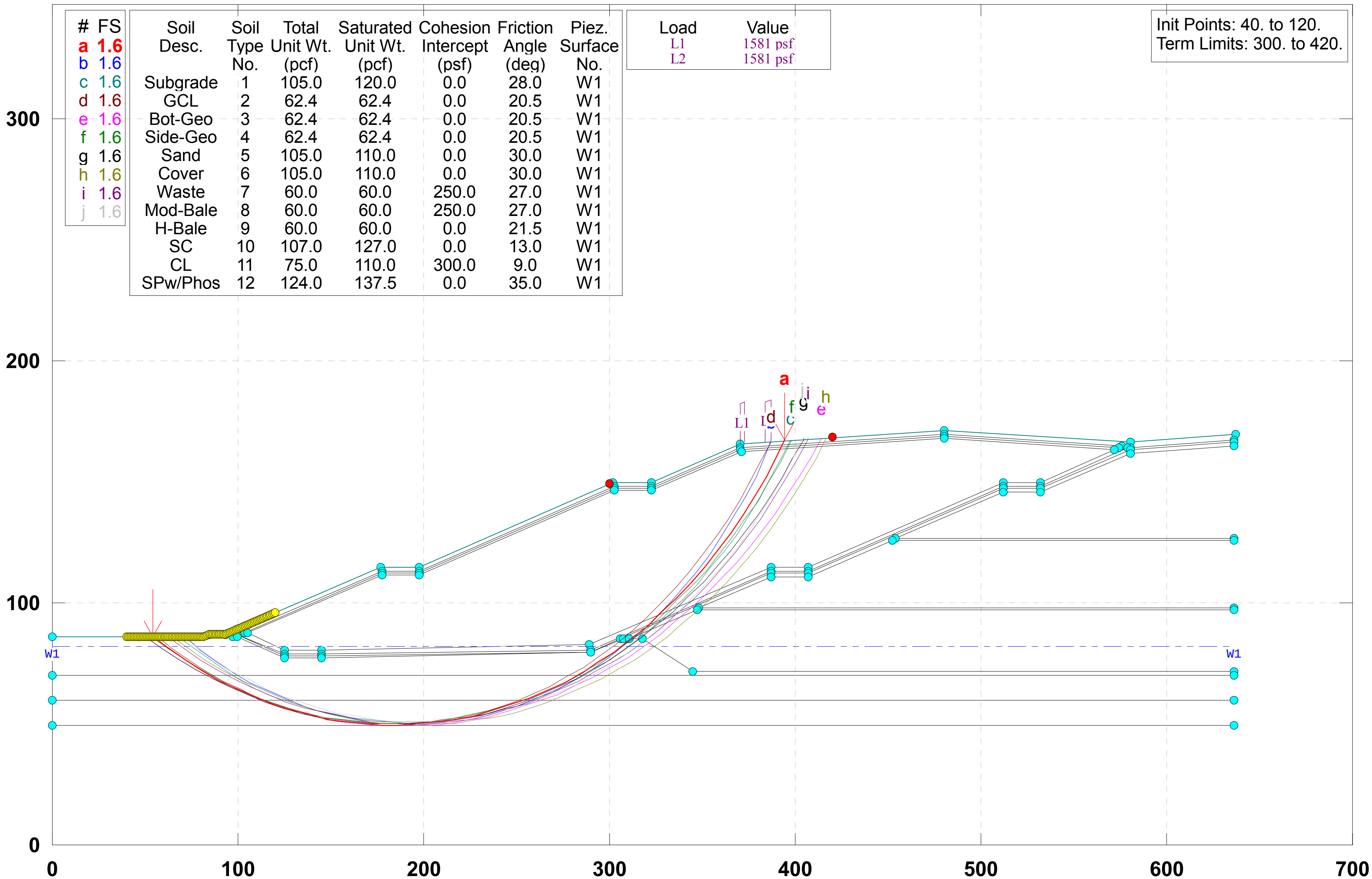
C:\1\HARDEE~1.1\5HARDE~1.1\EWCILO~1\EWSECCIL.PL2 Run By: Shane R. Fischer, P.E. 03/31/13 5:03AM

| # | FS |
|---|---|
| a | 1.6 |
| b | 1.6 |
| c | 1.6 |
| d | 1.6 |
| e | 1.6 |
| f | 1.6 |
| g | 1.6 |
| h | 1.6 |
| i | 1.6 |
| j | 1.6 |

| Soil Desc. | Soil Type No. | Total Unit Wt. (pcf) | Saturated Unit Wt. (pcf) | Cohesion Intercept (psf) | Friction Angle (deg) | Piez. Surface No. |
|---|---|---|---|---|---|---|
| Subgrade | 1 | 105.0 | 120.0 | 0.0 | 28.0 | W1 |
| GCL | 2 | 62.4 | 62.4 | 0.0 | 20.5 | W1 |
| Bot-Geo | 3 | 62.4 | 62.4 | 0.0 | 20.5 | W1 |
| Side-Geo | 4 | 62.4 | 62.4 | 0.0 | 20.5 | W1 |
| Sand | 5 | 105.0 | 110.0 | 0.0 | 30.0 | W1 |
| Cover | 6 | 105.0 | 110.0 | 0.0 | 30.0 | W1 |
| Waste | 7 | 60.0 | 60.0 | 250.0 | 27.0 | W1 |
| Mod-Bale | 8 | 60.0 | 60.0 | 250.0 | 27.0 | W1 |
| H-Bale | 9 | 60.0 | 60.0 | 0.0 | 21.5 | W1 |
| SC | 10 | 107.0 | 127.0 | 0.0 | 13.0 | W1 |
| CL | 11 | 75.0 | 110.0 | 300.0 | 9.0 | W1 |
| SPw/Phos | 12 | 124.0 | 137.5 | 0.0 | 35.0 | W1 |

| Load | Value |
|---|---|
| L1 | 1581 psf |
| L2 | 1581 psf |

Init Points: 40. to 120.
Term Limits: 300. to 420.




PCSTABL5M/si FSmin=1.6

**Safety Factors Are Calculated By The Modified Bishop Method**

SCS ENGINEERS

**** PCSTABL5M ****
by
Purdue University
--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer`s Method of Slices

Run Date: 03/31/13
Time of Run: 5:03AM
Run By: Shane R. Fischer, P.E.
Input Data Filename: C:ewseccil.
Output Filename: C:ewseccil.OUT
Unit: ENGLISH
Plotted Output Filename: C:ewseccil.PLT
PROBLEM DESCRIPTION Phase II Section II Expansion RAI No. 1
West Slope Operation

BOUNDARY COORDINATES
12 Top Boundaries
96 Total Boundaries

| Boundary No. | X-Left (ft) | Y-Left (ft) | X-Right (ft) | Y-Right (ft) | Soil Type Below Bnd |
|---|---|---|---|---|---|
| 1 | .00 | 86.00 | 81.46 | 86.00 | 1 |
| 2 | 81.46 | 86.00 | 84.47 | 87.00 | 1 |
| 3 | 84.47 | 87.00 | 93.14 | 87.00 | 1 |
| 4 | 93.14 | 87.00 | 99.46 | 89.10 | 5 |
| 5 | 99.46 | 89.10 | 177.14 | 115.00 | 6 |
| 6 | 177.14 | 115.00 | 197.14 | 115.00 | 6 |
| 7 | 197.14 | 115.00 | 302.14 | 150.00 | 6 |
| 8 | 302.14 | 150.00 | 322.14 | 150.00 | 6 |
| 9 | 322.14 | 150.00 | 370.14 | 166.00 | 6 |
| 10 | 370.14 | 166.00 | 480.14 | 171.50 | 6 |
| 11 | 480.14 | 171.50 | 580.29 | 166.20 | 6 |
| 12 | 580.29 | 166.20 | 637.10 | 169.27 | 6 |
| 13 | 99.46 | 89.10 | 102.62 | 88.05 | 5 |
| 14 | 102.62 | 88.05 | 177.46 | 113.00 | 4 |
| 15 | 177.46 | 113.00 | 197.46 | 113.00 | 4 |
| 16 | 197.46 | 113.00 | 302.46 | 148.00 | 4 |
| 17 | 302.46 | 148.00 | 322.46 | 148.00 | 4 |
| 18 | 322.46 | 148.00 | 370.51 | 164.01 | 4 |
| 19 | 370.51 | 164.01 | 480.14 | 169.49 | 4 |
| 20 | 480.14 | 169.49 | 575.83 | 164.71 | 4 |
| 21 | 575.83 | 164.71 | 580.29 | 164.09 | 4 |
| 22 | 580.29 | 164.09 | 636.29 | 166.89 | 4 |
| 23 | 102.62 | 88.05 | 103.41 | 87.79 | 5 |
| 24 | 103.41 | 87.79 | 177.54 | 112.50 | 6 |
| 25 | 177.54 | 112.50 | 197.54 | 112.50 | 6 |
| 26 | 197.54 | 112.50 | 302.54 | 147.50 | 6 |
| 27 | 302.54 | 147.50 | 322.54 | 147.50 | 6 |
| 28 | 322.54 | 147.50 | 370.60 | 163.52 | 6 |
| 29 | 370.60 | 163.52 | 480.10 | 168.99 | 6 |
| 30 | 480.10 | 168.99 | 574.50 | 164.27 | 6 |
| 31 | 574.50 | 164.27 | 579.21 | 163.73 | 6 |
| 32 | 579.21 | 163.73 | 580.38 | 163.59 | 4 |
| 33 | 580.38 | 163.59 | 636.29 | 166.39 | 6 |
| 34 | 103.41 | 87.79 | 105.00 | 87.26 | 5 |
| 35 | 105.00 | 87.26 | 177.70 | 111.50 | 7 |
| 36 | 177.70 | 111.50 | 197.70 | 111.50 | 7 |
| 37 | 197.70 | 111.50 | 302.70 | 146.50 | 7 |
| 38 | 302.70 | 146.50 | 322.70 | 146.50 | 7 |
| 39 | 322.70 | 146.50 | 370.79 | 162.52 | 7 |
| 40 | 370.79 | 162.52 | 480.14 | 167.99 | 7 |
| 41 | 480.14 | 167.99 | 571.91 | 163.40 | 7 |
| 42 | 571.91 | 163.40 | 579.21 | 163.73 | 5 |
| 43 | 105.00 | 87.26 | 125.29 | 80.50 | 5 |
| 44 | 125.29 | 80.50 | 145.29 | 80.50 | 5 |
| 45 | 145.29 | 80.50 | 289.16 | 82.49 | 5 |
| 46 | 289.16 | 82.49 | 386.69 | 115.00 | 5 |
| 47 | 386.69 | 115.00 | 406.69 | 115.00 | 5 |
| 48 | 406.69 | 115.00 | 511.69 | 150.00 | 5 |
| 49 | 511.69 | 150.00 | 531.69 | 150.00 | 5 |
| 50 | 531.69 | 150.00 | 571.91 | 163.40 | 5 |

| | | | | | |
|---|---|---|---|---|---|
| 51 | 93.14 | 87.00 | 97.46 | 87.00 | 1 |
| 52 | 97.46 | 87.00 | 99.46 | 87.00 | 3 |
| 53 | 99.46 | 87.00 | 124.96 | 78.50 | 3 |
| 54 | 124.96 | 78.50 | 144.96 | 78.50 | 3 |
| 55 | 144.96 | 78.50 | 289.51 | 80.50 | 3 |
| 56 | 289.51 | 80.50 | 387.01 | 113.00 | 3 |
| 57 | 387.01 | 113.00 | 407.01 | 113.00 | 3 |
| 58 | 407.01 | 113.00 | 512.01 | 148.00 | 3 |
| 59 | 512.01 | 148.00 | 532.01 | 148.00 | 3 |
| 60 | 532.01 | 148.00 | 579.21 | 163.73 | 3 |
| 61 | 97.46 | 86.53 | 99.30 | 86.53 | 2 |
| 62 | 99.30 | 86.53 | 124.99 | 78.00 | 2 |
| 63 | 124.99 | 78.00 | 144.99 | 78.00 | 3 |
| 64 | 144.99 | 78.00 | 289.59 | 80.00 | 3 |
| 65 | 289.59 | 80.00 | 305.93 | 85.44 | 3 |
| 66 | 305.93 | 85.44 | 387.09 | 112.50 | 6 |
| 67 | 387.09 | 112.50 | 407.09 | 112.50 | 6 |
| 68 | 407.09 | 112.50 | 512.09 | 147.50 | 6 |
| 69 | 512.09 | 147.50 | 532.09 | 147.50 | 6 |
| 70 | 532.09 | 147.50 | 580.38 | 163.59 | 6 |
| 71 | 97.46 | 86.03 | 99.22 | 86.03 | 1 |
| 72 | 99.22 | 86.03 | 124.91 | 77.50 | 1 |
| 73 | 124.91 | 77.50 | 144.99 | 77.50 | 1 |
| 74 | 144.99 | 77.50 | 289.68 | 79.50 | 1 |
| 75 | 289.68 | 79.50 | 307.67 | 85.50 | 1 |
| 76 | 307.67 | 85.50 | 310.84 | 85.50 | 1 |
| 77 | 310.84 | 85.50 | 346.84 | 97.50 | 8 |
| 78 | 346.84 | 97.50 | 348.34 | 98.00 | 8 |
| 79 | 348.34 | 98.00 | 387.34 | 111.00 | 8 |
| 80 | 387.34 | 111.00 | 407.34 | 111.00 | 8 |
| 81 | 407.34 | 111.00 | 452.34 | 126.00 | 8 |
| 82 | 452.34 | 126.00 | 453.84 | 126.50 | 8 |
| 83 | 453.84 | 126.50 | 512.34 | 146.00 | 7 |
| 84 | 512.34 | 146.00 | 532.34 | 146.00 | 7 |
| 85 | 532.34 | 146.00 | 580.29 | 161.98 | 7 |
| 86 | 580.29 | 161.98 | 636.29 | 164.78 | 7 |
| 87 | 453.84 | 126.50 | 636.29 | 126.60 | 8 |
| 88 | 452.34 | 126.00 | 636.29 | 126.00 | 7 |
| 89 | 348.34 | 98.00 | 636.29 | 98.00 | 8 |
| 90 | 346.84 | 97.50 | 636.29 | 97.50 | 7 |
| 91 | 310.84 | 85.50 | 317.52 | 85.50 | 1 |
| 92 | 317.52 | 85.50 | 344.52 | 72.00 | 1 |
| 93 | 344.52 | 72.00 | 636.29 | 72.00 | 1 |
| 94 | .00 | 70.00 | 636.29 | 70.00 | 10 |
| 95 | .00 | 60.00 | 636.29 | 60.00 | 11 |
| 96 | .00 | 49.00 | 636.29 | 49.00 | 12 |

ISOTROPIC SOIL PARAMETERS

12 Type(s) of Soil

| Soil Type No. | Total Unit Wt. (pcf) | Saturated Unit Wt. (pcf) | Cohesion Intercept (psf) | Friction Angle (deg) | Pore Pressure Param. | Pressure Constant (psf) | Piez. Surface No. |
|---|---|---|---|---|---|---|---|
| 1 | 105.0 | 120.0 | .0 | 28.0 | .00 | .0 | 1 |
| 2 | 62.4 | 62.4 | .0 | 20.5 | .00 | .0 | 1 |
| 3 | 62.4 | 62.4 | .0 | 20.5 | .00 | .0 | 1 |
| 4 | 62.4 | 62.4 | .0 | 20.5 | .00 | .0 | 1 |
| 5 | 105.0 | 110.0 | .0 | 30.0 | .00 | .0 | 1 |
| 6 | 105.0 | 110.0 | .0 | 30.0 | .00 | .0 | 1 |
| 7 | 60.0 | 60.0 | 250.0 | 27.0 | .00 | .0 | 1 |
| 8 | 60.0 | 60.0 | 250.0 | 27.0 | .00 | .0 | 1 |
| 9 | 60.0 | 60.0 | .0 | 21.5 | .00 | .0 | 1 |
| 10 | 107.0 | 127.0 | .0 | 13.0 | .00 | .0 | 1 |
| 11 | 75.0 | 110.0 | 300.0 | 9.0 | .00 | .0 | 1 |
| 12 | 124.0 | 137.5 | .0 | 35.0 | .00 | .0 | 1 |

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

Unit Weight of Water =  62.40

Piezometric Surface No.  1 Specified by  2 Coordinate Points

| Point No. | X-Water (ft) | Y-Water (ft) |
|---|---|---|
| 1 | .00 | 82.09 |
| 2 | 636.29 | 82.09 |

BOUNDARY LOAD(S)

2 Load(s) Specified

| Load No. | X-Left (ft) | X-Right (ft) | Intensity (psf) | Deflection (deg) |
|---|---|---|---|---|
| 1 | 370.14 | 373.10 | 1581.0 | .0 |
| 2 | 384.09 | 387.06 | 1581.0 | .0 |

NOTE - Intensity Is Specified As A Uniformly Distributed Force Acting On A Horizontally Projected Surface.

A Critical Failure Surface Searching Method, Using A Random Technique For Generating Circular Surfaces, Has Been Specified.

5000 Trial Surfaces Have Been Generated.

50 Surfaces Initiate From Each Of100 Points Equally Spaced Along The Ground Surface Between X = 40.00 ft. and X = 120.00 ft.

Each Surface Terminates Between X = 300.00 ft. and X = 420.00 ft.

Unless Further Limitations Were Imposed, The Minimum Elevation At Which A Surface Extends Is Y = .00 ft.

10.00 ft. Line Segments Define Each Trial Failure Surface.

Following Are Displayed The Ten Most Critical Of The Trial Failure Surfaces Examined. They Are Ordered - Most Critical First.

* * Safety Factors Are Calculated By The Modified Bishop Method * *

Failure Surface Specified By 40 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 54.55 | 86.00 |
| 2 | 63.18 | 80.95 |
| 3 | 72.00 | 76.25 |
| 4 | 81.01 | 71.91 |
| 5 | 90.19 | 67.94 |
| 6 | 99.52 | 64.34 |
| 7 | 108.99 | 61.12 |
| 8 | 118.58 | 58.29 |
| 9 | 128.28 | 55.85 |
| 10 | 138.07 | 53.80 |
| 11 | 147.93 | 52.15 |
| 12 | 157.85 | 50.91 |
| 13 | 167.81 | 50.06 |
| 14 | 177.80 | 49.61 |
| 15 | 187.80 | 49.58 |
| 16 | 197.80 | 49.94 |
| 17 | 207.77 | 50.71 |
| 18 | 217.70 | 51.88 |
| 19 | 227.57 | 53.45 |
| 20 | 237.38 | 55.42 |
| 21 | 247.09 | 57.79 |
| 22 | 256.71 | 60.54 |
| 23 | 266.20 | 63.69 |
| 24 | 275.56 | 67.21 |
| 25 | 284.77 | 71.11 |
| 26 | 293.81 | 75.38 |
| 27 | 302.67 | 80.01 |
| 28 | 311.34 | 84.99 |
| 29 | 319.80 | 90.33 |
| 30 | 328.04 | 96.00 |
| 31 | 336.04 | 101.99 |
| 32 | 343.80 | 108.31 |
| 33 | 351.29 | 114.93 |
| 34 | 358.50 | 121.86 |
| 35 | 365.43 | 129.07 |
| 36 | 372.07 | 136.55 |
| 37 | 378.39 | 144.29 |
| 38 | 384.40 | 152.29 |
| 39 | 390.08 | 160.52 |
| 40 | 394.31 | 167.21 |

Circle Center At X = 183.8 ; Y = 296.7 and Radius, 247.2

*** 1.636 ***

Individual data on the 108 slices

Water Water Tie Tie Earthquake

| Slice No. | Width (ft) | Weight (lbs) | Force Top (lbs) | Force Bot (lbs) | Force Norm (lbs) | Force Tan (lbs) | Force Hor (lbs) | Force Ver (lbs) | Surcharge Load (lbs) |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 6.7 | 1370.7 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 2 | 2.0 | 935.2 | .0 | 80.7 | .0 | .0 | .0 | .0 | .0 |
| 3 | 8.8 | 7323.5 | .0 | 2179.6 | .0 | .0 | .0 | .0 | .0 |
| 4 | 9.0 | 12361.5 | .0 | 4999.8 | .0 | .0 | .0 | .0 | .0 |
| 5 | .4 | 737.0 | .0 | 313.3 | .0 | .0 | .0 | .0 | .0 |
| 6 | 3.0 | 5376.8 | .0 | 2256.8 | .0 | .0 | .0 | .0 | .0 |
| 7 | 1.0 | 1846.6 | .0 | 768.5 | .0 | .0 | .0 | .0 | .0 |
| 8 | 4.8 | 10000.8 | .0 | 4254.1 | .0 | .0 | .0 | .0 | .0 |
| 9 | 3.0 | 6788.3 | .0 | 2905.1 | .0 | .0 | .0 | .0 | .0 |
| 10 | 4.3 | 11033.1 | .0 | 4658.1 | .0 | .0 | .0 | .0 | .0 |
| 11 | 1.8 | 4870.8 | .0 | 2035.7 | .0 | .0 | .0 | .0 | .0 |
| 12 | .1 | 227.6 | .0 | 94.4 | .0 | .0 | .0 | .0 | .0 |
| 13 | .2 | 456.4 | .0 | 189.3 | .0 | .0 | .0 | .0 | .0 |
| 14 | .1 | 171.8 | .0 | 71.2 | .0 | .0 | .0 | .0 | .0 |
| 15 | 3.1 | 9251.2 | .0 | 3733.8 | .0 | .0 | .0 | .0 | .0 |
| 16 | .8 | 2469.0 | .0 | 986.0 | .0 | .0 | .0 | .0 | .0 |
| 17 | 1.6 | 5099.4 | .0 | 2026.7 | .0 | .0 | .0 | .0 | .0 |
| 18 | 4.0 | 13423.6 | .0 | 5333.2 | .0 | .0 | .0 | .0 | .0 |
| 19 | 2.1 | 7354.9 | .0 | 2903.7 | .0 | .0 | .0 | .0 | .0 |
| 20 | 1.6 | 5678.6 | .0 | 2251.4 | .0 | .0 | .0 | .0 | .0 |
| 21 | .1 | 437.3 | .0 | 173.8 | .0 | .0 | .0 | .0 | .0 |
| 22 | 1.4 | 5081.6 | .0 | 2026.4 | .0 | .0 | .0 | .0 | .0 |
| 23 | 4.4 | 16397.3 | .0 | 6611.3 | .0 | .0 | .0 | .0 | .0 |
| 24 | 1.9 | 7441.5 | .0 | 2998.5 | .0 | .0 | .0 | .0 | .0 |
| 25 | 4.4 | 17256.8 | .0 | 7020.3 | .0 | .0 | .0 | .0 | .0 |
| 26 | .0 | 199.5 | .0 | 81.7 | .0 | .0 | .0 | .0 | .0 |
| 27 | .0 | 119.8 | .0 | 49.0 | .0 | .0 | .0 | .0 | .0 |
| 28 | .3 | 1199.3 | .0 | 491.3 | .0 | .0 | .0 | .0 | .0 |
| 29 | 3.0 | 12167.6 | .0 | 4970.8 | .0 | .0 | .0 | .0 | .0 |
| 30 | 9.8 | 42631.2 | .0 | 17011.9 | .0 | .0 | .0 | .0 | .0 |
| 31 | 6.9 | 32393.3 | .0 | 12590.2 | .0 | .0 | .0 | .0 | .0 |
| 32 | .0 | 144.9 | .0 | 55.9 | .0 | .0 | .0 | .0 | .0 |
| 33 | .3 | 1451.3 | .0 | 559.3 | .0 | .0 | .0 | .0 | .0 |
| 34 | 2.6 | 12914.0 | .0 | 4959.7 | .0 | .0 | .0 | .0 | .0 |
| 35 | 9.9 | 50787.2 | .0 | 19069.6 | .0 | .0 | .0 | .0 | .0 |
| 36 | 10.0 | 54217.0 | .0 | 19723.6 | .0 | .0 | .0 | .0 | .0 |
| 37 | 9.3 | 53266.4 | .0 | 18779.9 | .0 | .0 | .0 | .0 | .0 |
| 38 | .3 | 1865.5 | .0 | 648.6 | .0 | .0 | .0 | .0 | .0 |
| 39 | .1 | 466.3 | .0 | 162.2 | .0 | .0 | .0 | .0 | .0 |
| 40 | .2 | 932.5 | .0 | 324.5 | .0 | .0 | .0 | .0 | .0 |
| 41 | .1 | 606.5 | .0 | 211.1 | .0 | .0 | .0 | .0 | .0 |
| 42 | 10.0 | 58342.3 | .0 | 20276.9 | .0 | .0 | .0 | .0 | .0 |
| 43 | 9.3 | 54388.6 | .0 | 18855.1 | .0 | .0 | .0 | .0 | .0 |
| 44 | .3 | 1861.0 | .0 | 642.7 | .0 | .0 | .0 | .0 | .0 |
| 45 | .1 | 465.7 | .0 | 160.7 | .0 | .0 | .0 | .0 | .0 |
| 46 | .2 | 932.0 | .0 | 321.3 | .0 | .0 | .0 | .0 | .0 |
| 47 | .1 | 567.2 | .0 | 195.4 | .0 | .0 | .0 | .0 | .0 |
| 48 | 10.0 | 58731.9 | .0 | 19821.2 | .0 | .0 | .0 | .0 | .0 |
| 49 | 9.9 | 59499.2 | .0 | 19215.8 | .0 | .0 | .0 | .0 | .0 |
| 50 | 9.9 | 59713.5 | .0 | 18359.8 | .0 | .0 | .0 | .0 | .0 |
| 51 | 9.8 | 59379.5 | .0 | 17254.5 | .0 | .0 | .0 | .0 | .0 |
| 52 | 9.7 | 58507.0 | .0 | 15901.9 | .0 | .0 | .0 | .0 | .0 |
| 53 | 7.7 | 45902.9 | .0 | 11613.7 | .0 | .0 | .0 | .0 | .0 |
| 54 | 1.9 | 11199.1 | .0 | 2690.5 | .0 | .0 | .0 | .0 | .0 |
| 55 | 3.5 | 20646.6 | .0 | 4868.3 | .0 | .0 | .0 | .0 | .0 |
| 56 | 6.0 | 34222.2 | .0 | 7595.6 | .0 | .0 | .0 | .0 | .0 |
| 57 | 9.4 | 51959.5 | .0 | 10384.0 | .0 | .0 | .0 | .0 | .0 |
| 58 | 6.6 | 35020.4 | .0 | 6018.9 | .0 | .0 | .0 | .0 | .0 |
| 59 | 2.6 | 13550.0 | .0 | 2049.2 | .0 | .0 | .0 | .0 | .0 |
| 60 | 4.4 | 22181.5 | .0 | 3013.4 | .0 | .0 | .0 | .0 | .0 |
| 61 | .4 | 1738.8 | .0 | 213.1 | .0 | .0 | .0 | .0 | .0 |
| 62 | .1 | 396.9 | .0 | 48.1 | .0 | .0 | .0 | .0 | .0 |
| 63 | .1 | 446.3 | .0 | 53.9 | .0 | .0 | .0 | .0 | .0 |
| 64 | 4.1 | 20325.8 | .0 | 2191.1 | .0 | .0 | .0 | .0 | .0 |
| 65 | .5 | 2286.0 | .0 | 217.5 | .0 | .0 | .0 | .0 | .0 |
| 66 | 1.6 | 7704.7 | .0 | 676.5 | .0 | .0 | .0 | .0 | .0 |
| 67 | 1.6 | 7601.1 | .0 | 580.5 | .0 | .0 | .0 | .0 | .0 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 68 | 4.7 | 22223.2 | .0 | 1185.3 | .0 | .0 | .0 | .0 | .0 |
| 69 | .3 | 1490.8 | .0 | 51.3 | .0 | .0 | .0 | .0 | .0 |
| 70 | .1 | 371.8 | .0 | 12.2 | .0 | .0 | .0 | .0 | .0 |
| 71 | .1 | 624.0 | .0 | 20.0 | .0 | .0 | .0 | .0 | .0 |
| 72 | .0 | 118.4 | .0 | 3.8 | .0 | .0 | .0 | .0 | .0 |
| 73 | 3.2 | 14689.0 | .0 | 264.4 | .0 | .0 | .0 | .0 | .0 |
| 74 | .4 | 1622.6 | .0 | 2.7 | .0 | .0 | .0 | .0 | .0 |
| 75 | 1.4 | 6103.8 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 76 | 3.2 | 13721.7 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 77 | .5 | 2134.5 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 78 | .8 | 3369.1 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 79 | 1.5 | 6076.4 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 80 | 5.3 | 21161.0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 81 | .9 | 3361.0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 82 | .8 | 2905.6 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 83 | 1.6 | 5868.4 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 84 | .3 | 1179.5 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 85 | .1 | 294.6 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 86 | .2 | 588.5 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 87 | 3.8 | 13717.1 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 88 | 1.5 | 5404.8 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 89 | 8.0 | 27221.2 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 90 | 7.8 | 24732.2 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 91 | 7.5 | 22131.5 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 92 | 7.2 | 19451.2 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 93 | 6.9 | 16724.0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 94 | 4.7 | 10137.4 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 95 | .4 | 750.1 | .0 | .0 | .0 | .0 | .0 | .0 | 585.0 |
| 96 | .1 | 180.9 | .0 | .0 | .0 | .0 | .0 | .0 | 142.3 |
| 97 | .2 | 380.0 | .0 | .0 | .0 | .0 | .0 | .0 | 300.4 |
| 98 | 1.3 | 2492.1 | .0 | .0 | .0 | .0 | .0 | .0 | 2019.3 |
| 99 | 1.0 | 1934.8 | .0 | .0 | .0 | .0 | .0 | .0 | 1632.8 |
| 100 | 5.3 | 8736.8 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 101 | 5.7 | 7094.0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 102 | .3 | 315.0 | .0 | .0 | .0 | .0 | .0 | .0 | 490.9 |
| 103 | 2.7 | 2369.2 | .0 | .0 | .0 | .0 | .0 | .0 | 4204.6 |
| 104 | 3.0 | 1970.2 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 105 | 1.9 | 845.2 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 106 | .7 | 193.9 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 107 | .3 | 73.1 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 108 | 1.3 | 138.2 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |

Failure Surface Specified By 38 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 71.52 | 86.00 |
| 2 | 79.99 | 80.69 |
| 3 | 88.70 | 75.77 |
| 4 | 97.62 | 71.26 |
| 5 | 106.74 | 67.15 |
| 6 | 116.03 | 63.46 |
| 7 | 125.48 | 60.19 |
| 8 | 135.07 | 57.36 |
| 9 | 144.78 | 54.97 |
| 10 | 154.59 | 53.02 |
| 11 | 164.48 | 51.51 |
| 12 | 174.42 | 50.46 |
| 13 | 184.40 | 49.86 |
| 14 | 194.40 | 49.71 |
| 15 | 204.40 | 50.02 |
| 16 | 214.37 | 50.78 |
| 17 | 224.29 | 51.99 |
| 18 | 234.16 | 53.65 |
| 19 | 243.93 | 55.76 |
| 20 | 253.60 | 58.30 |
| 21 | 263.15 | 61.29 |
| 22 | 272.54 | 64.70 |
| 23 | 281.78 | 68.54 |
| 24 | 290.83 | 72.79 |
| 25 | 299.68 | 77.45 |
| 26 | 308.31 | 82.51 |

| | | |
|---|---|---|
| 27 | 316.70 | 87.95 |
| 28 | 324.83 | 93.77 |
| 29 | 332.69 | 99.95 |
| 30 | 340.26 | 106.48 |
| 31 | 347.53 | 113.35 |
| 32 | 354.48 | 120.54 |
| 33 | 361.10 | 128.03 |
| 34 | 367.37 | 135.83 |
| 35 | 373.28 | 143.89 |
| 36 | 378.81 | 152.22 |
| 37 | 383.97 | 160.79 |
| 38 | 387.25 | 166.86 |

Circle Center At X =  192.6 ; Y =  269.9  and Radius,  220.2

*** 1.638 ***

Failure Surface Specified By 39 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 67.48 | 86.00 |
| 2 | 76.09 | 80.92 |
| 3 | 84.91 | 76.21 |
| 4 | 93.92 | 71.88 |
| 5 | 103.11 | 67.92 |
| 6 | 112.45 | 64.36 |
| 7 | 121.94 | 61.19 |
| 8 | 131.55 | 58.43 |
| 9 | 141.26 | 56.07 |
| 10 | 151.07 | 54.12 |
| 11 | 160.95 | 52.58 |
| 12 | 170.89 | 51.47 |
| 13 | 180.87 | 50.77 |
| 14 | 190.86 | 50.49 |
| 15 | 200.86 | 50.63 |
| 16 | 210.85 | 51.20 |
| 17 | 220.80 | 52.18 |
| 18 | 230.70 | 53.58 |
| 19 | 240.53 | 55.39 |
| 20 | 250.28 | 57.62 |
| 21 | 259.93 | 60.26 |
| 22 | 269.46 | 63.30 |
| 23 | 278.85 | 66.73 |
| 24 | 288.09 | 70.56 |
| 25 | 297.15 | 74.77 |
| 26 | 306.04 | 79.37 |
| 27 | 314.72 | 84.33 |
| 28 | 323.19 | 89.65 |
| 29 | 331.42 | 95.32 |
| 30 | 339.41 | 101.33 |
| 31 | 347.14 | 107.68 |
| 32 | 354.60 | 114.34 |
| 33 | 361.77 | 121.31 |
| 34 | 368.64 | 128.58 |
| 35 | 375.19 | 136.13 |
| 36 | 381.43 | 143.95 |
| 37 | 387.33 | 152.02 |
| 38 | 392.88 | 160.34 |
| 39 | 397.15 | 167.35 |

Circle Center At X =  192.5 ; Y =  288.2  and Radius,  237.7

*** 1.640 ***

Failure Surface Specified By 39 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 56.16 | 86.00 |
| 2 | 64.75 | 80.88 |
| 3 | 73.55 | 76.12 |
| 4 | 82.53 | 71.74 |
| 5 | 91.70 | 67.74 |
| 6 | 101.02 | 64.12 |
| 7 | 110.49 | 60.91 |
| 8 | 120.09 | 58.09 |
| 9 | 129.79 | 55.69 |

| | | |
|---|---|---|
| 10 | 139.59 | 53.69 |
| 11 | 149.47 | 52.11 |
| 12 | 159.40 | 50.94 |
| 13 | 169.37 | 50.19 |
| 14 | 179.37 | 49.86 |
| 15 | 189.36 | 49.96 |
| 16 | 199.35 | 50.47 |
| 17 | 209.31 | 51.41 |
| 18 | 219.22 | 52.76 |
| 19 | 229.06 | 54.53 |
| 20 | 238.82 | 56.71 |
| 21 | 248.48 | 59.30 |
| 22 | 258.02 | 62.30 |
| 23 | 267.42 | 65.69 |
| 24 | 276.68 | 69.48 |
| 25 | 285.77 | 73.65 |
| 26 | 294.67 | 78.20 |
| 27 | 303.38 | 83.13 |
| 28 | 311.86 | 88.41 |
| 29 | 320.12 | 94.05 |
| 30 | 328.14 | 100.03 |
| 31 | 335.90 | 106.34 |
| 32 | 343.38 | 112.97 |
| 33 | 350.58 | 119.91 |
| 34 | 357.48 | 127.15 |
| 35 | 364.07 | 134.67 |
| 36 | 370.33 | 142.47 |
| 37 | 376.27 | 150.52 |
| 38 | 381.85 | 158.81 |
| 39 | 386.78 | 166.83 |

Circle Center At X = 182.1 ; Y = 287.4 and Radius, 237.5

*** 1.643 ***

Failure Surface Specified By 42 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 50.51 | 86.00 |
| 2 | 59.25 | 81.14 |
| 3 | 68.16 | 76.60 |
| 4 | 77.23 | 72.40 |
| 5 | 86.45 | 68.52 |
| 6 | 95.80 | 64.99 |
| 7 | 105.28 | 61.80 |
| 8 | 114.87 | 58.95 |
| 9 | 124.55 | 56.46 |
| 10 | 134.32 | 54.33 |
| 11 | 144.16 | 52.55 |
| 12 | 154.06 | 51.14 |
| 13 | 164.01 | 50.08 |
| 14 | 173.98 | 49.39 |
| 15 | 183.98 | 49.07 |
| 16 | 193.98 | 49.11 |
| 17 | 203.97 | 49.51 |
| 18 | 213.94 | 50.28 |
| 19 | 223.87 | 51.42 |
| 20 | 233.76 | 52.91 |
| 21 | 243.59 | 54.77 |
| 22 | 253.34 | 56.98 |
| 23 | 263.01 | 59.55 |
| 24 | 272.57 | 62.47 |
| 25 | 282.02 | 65.74 |
| 26 | 291.35 | 69.35 |
| 27 | 300.53 | 73.30 |
| 28 | 309.57 | 77.58 |
| 29 | 318.45 | 82.18 |
| 30 | 327.15 | 87.11 |
| 31 | 335.66 | 92.36 |
| 32 | 343.98 | 97.91 |
| 33 | 352.09 | 103.76 |
| 34 | 359.98 | 109.90 |
| 35 | 367.64 | 116.33 |

| | | |
|---|---|---|
| 36 | 375.06 | 123.03 |
| 37 | 382.23 | 130.00 |
| 38 | 389.14 | 137.23 |
| 39 | 395.79 | 144.70 |
| 40 | 402.15 | 152.42 |
| 41 | 408.23 | 160.36 |
| 42 | 413.78 | 168.18 |

Circle Center At X = 187.9 ; Y = 322.8 and Radius, 273.8

*** 1.643 ***

Failure Surface Specified By 41 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 53.74 | 86.00 |
| 2 | 62.42 | 81.04 |
| 3 | 71.30 | 76.43 |
| 4 | 80.35 | 72.18 |
| 5 | 89.56 | 68.28 |
| 6 | 98.91 | 64.75 |
| 7 | 108.40 | 61.59 |
| 8 | 118.00 | 58.80 |
| 9 | 127.71 | 56.40 |
| 10 | 137.50 | 54.38 |
| 11 | 147.37 | 52.74 |
| 12 | 157.29 | 51.50 |
| 13 | 167.25 | 50.64 |
| 14 | 177.24 | 50.18 |
| 15 | 187.24 | 50.12 |
| 16 | 197.24 | 50.45 |
| 17 | 207.21 | 51.17 |
| 18 | 217.15 | 52.28 |
| 19 | 227.04 | 53.78 |
| 20 | 236.86 | 55.67 |
| 21 | 246.59 | 57.95 |
| 22 | 256.23 | 60.60 |
| 23 | 265.76 | 63.64 |
| 24 | 275.16 | 67.04 |
| 25 | 284.43 | 70.82 |
| 26 | 293.53 | 74.95 |
| 27 | 302.46 | 79.45 |
| 28 | 311.22 | 84.29 |
| 29 | 319.77 | 89.47 |
| 30 | 328.11 | 94.98 |
| 31 | 336.23 | 100.82 |
| 32 | 344.12 | 106.97 |
| 33 | 351.75 | 113.42 |
| 34 | 359.13 | 120.18 |
| 35 | 366.23 | 127.22 |
| 36 | 373.05 | 134.53 |
| 37 | 379.58 | 142.10 |
| 38 | 385.81 | 149.93 |
| 39 | 391.72 | 157.99 |
| 40 | 397.31 | 166.29 |
| 41 | 397.99 | 167.39 |

Circle Center At X = 183.9 ; Y = 304.1 and Radius, 254.0

*** 1.643 ***

Failure Surface Specified By 42 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 50.51 | 86.00 |
| 2 | 59.23 | 81.12 |
| 3 | 68.14 | 76.57 |
| 4 | 77.21 | 72.36 |
| 5 | 86.43 | 68.50 |
| 6 | 95.80 | 64.99 |
| 7 | 105.29 | 61.83 |
| 8 | 114.89 | 59.03 |
| 9 | 124.59 | 56.60 |
| 10 | 134.37 | 54.54 |
| 11 | 144.23 | 52.85 |
| 12 | 154.14 | 51.53 |

| | | |
|---|---|---|
| 13 | 164.10 | 50.59 |
| 14 | 174.08 | 50.02 |
| 15 | 184.08 | 49.83 |
| 16 | 194.08 | 50.02 |
| 17 | 204.06 | 50.58 |
| 18 | 214.02 | 51.53 |
| 19 | 223.93 | 52.84 |
| 20 | 233.78 | 54.54 |
| 21 | 243.57 | 56.60 |
| 22 | 253.27 | 59.03 |
| 23 | 262.87 | 61.82 |
| 24 | 272.36 | 64.98 |
| 25 | 281.72 | 68.49 |
| 26 | 290.95 | 72.35 |
| 27 | 300.02 | 76.56 |
| 28 | 308.92 | 81.11 |
| 29 | 317.65 | 85.99 |
| 30 | 326.19 | 91.20 |
| 31 | 334.52 | 96.72 |
| 32 | 342.65 | 102.56 |
| 33 | 350.54 | 108.70 |
| 34 | 358.20 | 115.13 |
| 35 | 365.60 | 121.85 |
| 36 | 372.75 | 128.84 |
| 37 | 379.63 | 136.10 |
| 38 | 386.23 | 143.61 |
| 39 | 392.55 | 151.36 |
| 40 | 398.56 | 159.35 |
| 41 | 404.27 | 167.56 |
| 42 | 404.37 | 167.71 |

Circle Center At X = 184.1 ; Y = 314.6 and Radius, 264.8

*** 1.645 ***

Failure Surface Specified By 41 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 64.24 | 86.00 |
| 2 | 72.95 | 81.09 |
| 3 | 81.85 | 76.51 |
| 4 | 90.91 | 72.28 |
| 5 | 100.12 | 68.39 |
| 6 | 109.48 | 64.86 |
| 7 | 118.96 | 61.69 |
| 8 | 128.56 | 58.88 |
| 9 | 138.26 | 56.45 |
| 10 | 148.04 | 54.38 |
| 11 | 157.89 | 52.68 |
| 12 | 167.81 | 51.37 |
| 13 | 177.76 | 50.43 |
| 14 | 187.75 | 49.87 |
| 15 | 197.75 | 49.69 |
| 16 | 207.74 | 49.90 |
| 17 | 217.73 | 50.48 |
| 18 | 227.68 | 51.45 |
| 19 | 237.59 | 52.79 |
| 20 | 247.44 | 54.51 |
| 21 | 257.22 | 56.61 |
| 22 | 266.91 | 59.08 |
| 23 | 276.50 | 61.91 |
| 24 | 285.97 | 65.11 |
| 25 | 295.32 | 68.67 |
| 26 | 304.52 | 72.58 |
| 27 | 313.57 | 76.83 |
| 28 | 322.45 | 81.43 |
| 29 | 331.15 | 86.37 |
| 30 | 339.65 | 91.63 |
| 31 | 347.95 | 97.22 |
| 32 | 356.02 | 103.11 |
| 33 | 363.87 | 109.31 |
| 34 | 371.47 | 115.81 |
| 35 | 378.83 | 122.59 |

| | | |
|---|---|---|
| 36 | 385.91 | 129.64 |
| 37 | 392.73 | 136.96 |
| 38 | 399.26 | 144.53 |
| 39 | 405.49 | 152.35 |
| 40 | 411.43 | 160.40 |
| 41 | 416.82 | 168.33 |

Circle Center At X = 197.4 ; Y = 312.0 and Radius, 262.3
*** 1.646 ***
Failure Surface Specified By 41 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 61.82 | 86.00 |
| 2 | 70.53 | 81.09 |
| 3 | 79.43 | 76.53 |
| 4 | 88.50 | 72.32 |
| 5 | 97.73 | 68.46 |
| 6 | 107.10 | 64.97 |
| 7 | 116.60 | 61.85 |
| 8 | 126.21 | 59.10 |
| 9 | 135.93 | 56.73 |
| 10 | 145.73 | 54.74 |
| 11 | 155.60 | 53.14 |
| 12 | 165.52 | 51.92 |
| 13 | 175.49 | 51.09 |
| 14 | 185.48 | 50.65 |
| 15 | 195.48 | 50.60 |
| 16 | 205.47 | 50.95 |
| 17 | 215.45 | 51.68 |
| 18 | 225.38 | 52.80 |
| 19 | 235.27 | 54.31 |
| 20 | 245.09 | 56.20 |
| 21 | 254.83 | 58.48 |
| 22 | 264.47 | 61.14 |
| 23 | 274.00 | 64.17 |
| 24 | 283.40 | 67.57 |
| 25 | 292.66 | 71.33 |
| 26 | 301.77 | 75.46 |
| 27 | 310.72 | 79.94 |
| 28 | 319.48 | 84.76 |
| 29 | 328.04 | 89.92 |
| 30 | 336.40 | 95.41 |
| 31 | 344.53 | 101.23 |
| 32 | 352.43 | 107.36 |
| 33 | 360.09 | 113.79 |
| 34 | 367.49 | 120.52 |
| 35 | 374.62 | 127.53 |
| 36 | 381.47 | 134.81 |
| 37 | 388.03 | 142.36 |
| 38 | 394.29 | 150.16 |
| 39 | 400.25 | 158.19 |
| 40 | 405.88 | 166.45 |
| 41 | 406.74 | 167.83 |

Circle Center At X = 191.7 ; Y = 306.4 and Radius, 255.9
*** 1.647 ***
Failure Surface Specified By 40 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 69.90 | 86.00 |
| 2 | 78.56 | 80.99 |
| 3 | 87.41 | 76.35 |
| 4 | 96.45 | 72.07 |
| 5 | 105.66 | 68.17 |
| 6 | 115.02 | 64.65 |
| 7 | 124.51 | 61.52 |
| 8 | 134.13 | 58.78 |
| 9 | 143.85 | 56.44 |
| 10 | 153.66 | 54.50 |
| 11 | 163.55 | 52.96 |
| 12 | 173.48 | 51.84 |
| 13 | 183.46 | 51.12 |

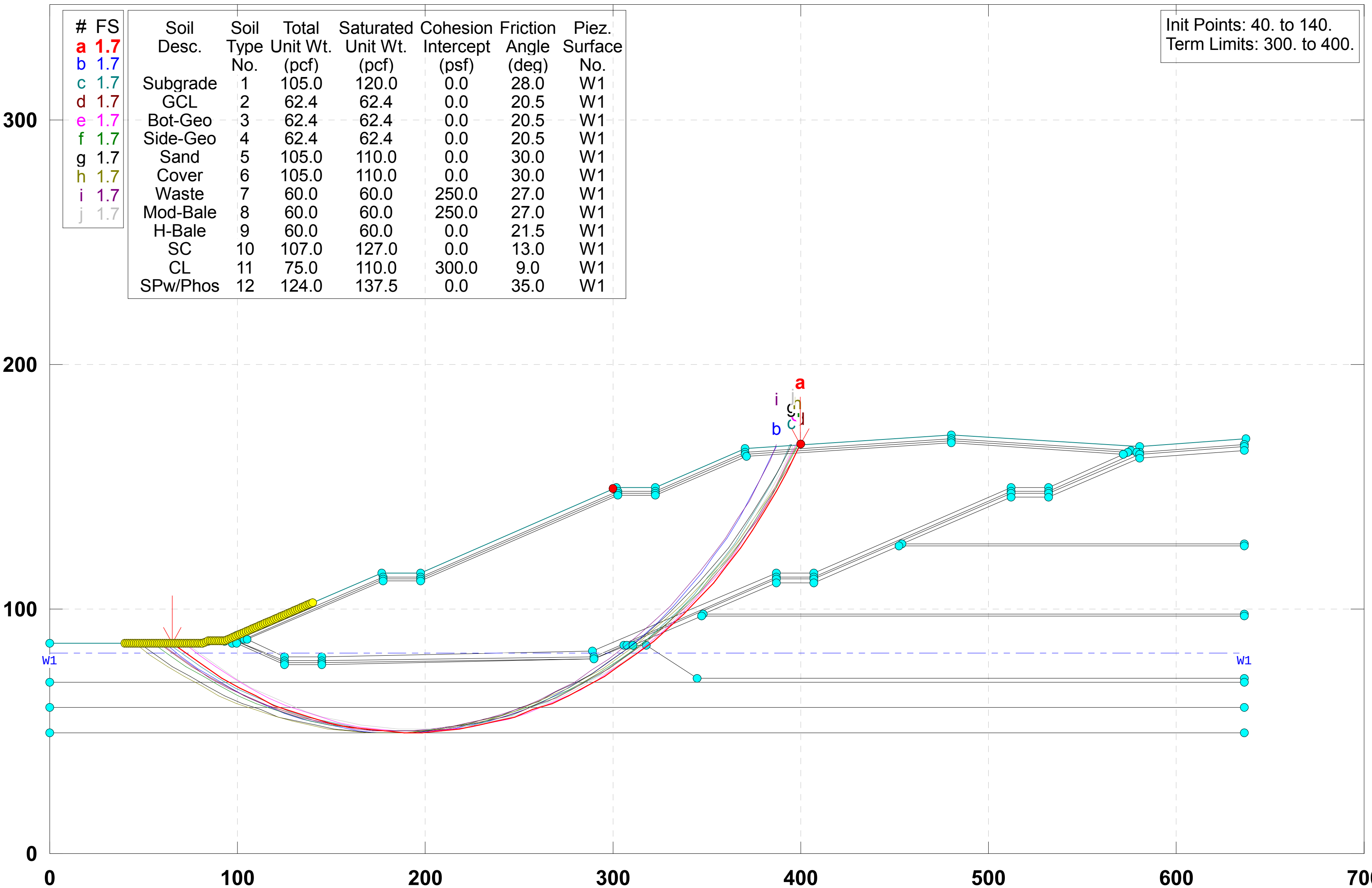
| | | |
|---|---|---|
| 14 | 193.45 | 50.82 |
| 15 | 203.45 | 50.93 |
| 16 | 213.44 | 51.44 |
| 17 | 223.40 | 52.37 |
| 18 | 233.31 | 53.71 |
| 19 | 243.15 | 55.45 |
| 20 | 252.92 | 57.60 |
| 21 | 262.59 | 60.15 |
| 22 | 272.15 | 63.09 |
| 23 | 281.57 | 66.43 |
| 24 | 290.86 | 70.14 |
| 25 | 299.98 | 74.24 |
| 26 | 308.92 | 78.71 |
| 27 | 317.68 | 83.55 |
| 28 | 326.23 | 88.74 |
| 29 | 334.55 | 94.27 |
| 30 | 342.64 | 100.15 |
| 31 | 350.49 | 106.35 |
| 32 | 358.07 | 112.87 |
| 33 | 365.38 | 119.70 |
| 34 | 372.40 | 126.82 |
| 35 | 379.12 | 134.23 |
| 36 | 385.53 | 141.90 |
| 37 | 391.62 | 149.83 |
| 38 | 397.38 | 158.01 |
| 39 | 402.79 | 166.42 |
| 40 | 403.53 | 167.67 |

Circle Center At X =  195.9 ; Y =  293.8  and Radius,  243.0

*** 1.647 ***

# Phase II Section II Expansion RAI No. 1 West Slope Operation

C:\1\HARDEE~1.1\5HARDE~1.1\EWCI\EWSECCI.PL2 Run By: Shane R. Fischer, P.E. 03/31/13 5:00AM




| Soil Desc. | Soil Type No. | Total Unit Wt. (pcf) | Saturated Unit Wt. (pcf) | Cohesion Intercept (psf) | Friction Angle (deg) | Piez. Surface No. |
|---|---|---|---|---|---|---|
| Subgrade | 1 | 105.0 | 120.0 | 0.0 | 28.0 | W1 |
| GCL | 2 | 62.4 | 62.4 | 0.0 | 20.5 | W1 |
| Bot-Geo | 3 | 62.4 | 62.4 | 0.0 | 20.5 | W1 |
| Side-Geo | 4 | 62.4 | 62.4 | 0.0 | 20.5 | W1 |
| Sand | 5 | 105.0 | 110.0 | 0.0 | 30.0 | W1 |
| Cover | 6 | 105.0 | 110.0 | 0.0 | 30.0 | W1 |
| Waste | 7 | 60.0 | 60.0 | 250.0 | 27.0 | W1 |
| Mod-Bale | 8 | 60.0 | 60.0 | 250.0 | 27.0 | W1 |
| H-Bale | 9 | 60.0 | 60.0 | 0.0 | 21.5 | W1 |
| SC | 10 | 107.0 | 127.0 | 0.0 | 13.0 | W1 |
| CL | 11 | 75.0 | 110.0 | 300.0 | 9.0 | W1 |
| SPw/Phos | 12 | 124.0 | 137.5 | 0.0 | 35.0 | W1 |

**PCSTABL5M/si FSmin=1.7**

**Safety Factors Are Calculated By The Modified Bishop Method**

SCS ENGINEERS

**** PCSTABL5M ****
by
Purdue University
--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer`s Method of Slices

Run Date: 03/31/13
Time of Run: 5:00AM
Run By: Shane R. Fischer, P.E.
Input Data Filename: C:ewsecci.
Output Filename: C:ewsecci.OUT
Unit: ENGLISH
Plotted Output Filename: C:ewsecci.PLT
PROBLEM DESCRIPTION Phase II Section II Expansion RAI No. 1
West Slope Operation

BOUNDARY COORDINATES
12 Top Boundaries
96 Total Boundaries

| Boundary No. | X-Left (ft) | Y-Left (ft) | X-Right (ft) | Y-Right (ft) | Soil Type Below Bnd |
|---|---|---|---|---|---|
| 1 | .00 | 86.00 | 81.46 | 86.00 | 1 |
| 2 | 81.46 | 86.00 | 84.47 | 87.00 | 1 |
| 3 | 84.47 | 87.00 | 93.14 | 87.00 | 1 |
| 4 | 93.14 | 87.00 | 99.46 | 89.10 | 5 |
| 5 | 99.46 | 89.10 | 177.14 | 115.00 | 6 |
| 6 | 177.14 | 115.00 | 197.14 | 115.00 | 6 |
| 7 | 197.14 | 115.00 | 302.14 | 150.00 | 6 |
| 8 | 302.14 | 150.00 | 322.14 | 150.00 | 6 |
| 9 | 322.14 | 150.00 | 370.14 | 166.00 | 6 |
| 10 | 370.14 | 166.00 | 480.14 | 171.50 | 6 |
| 11 | 480.14 | 171.50 | 580.29 | 166.20 | 6 |
| 12 | 580.29 | 166.20 | 637.10 | 169.27 | 6 |
| 13 | 99.46 | 89.10 | 102.62 | 88.05 | 5 |
| 14 | 102.62 | 88.05 | 177.46 | 113.00 | 4 |
| 15 | 177.46 | 113.00 | 197.46 | 113.00 | 4 |
| 16 | 197.46 | 113.00 | 302.46 | 148.00 | 4 |
| 17 | 302.46 | 148.00 | 322.46 | 148.00 | 4 |
| 18 | 322.46 | 148.00 | 370.51 | 164.01 | 4 |
| 19 | 370.51 | 164.01 | 480.14 | 169.49 | 4 |
| 20 | 480.14 | 169.49 | 575.83 | 164.71 | 4 |
| 21 | 575.83 | 164.71 | 580.29 | 164.09 | 4 |
| 22 | 580.29 | 164.09 | 636.29 | 166.89 | 4 |
| 23 | 102.62 | 88.05 | 103.41 | 87.79 | 5 |
| 24 | 103.41 | 87.79 | 177.54 | 112.50 | 6 |
| 25 | 177.54 | 112.50 | 197.54 | 112.50 | 6 |
| 26 | 197.54 | 112.50 | 302.54 | 147.50 | 6 |
| 27 | 302.54 | 147.50 | 322.54 | 147.50 | 6 |
| 28 | 322.54 | 147.50 | 370.60 | 163.52 | 6 |
| 29 | 370.60 | 163.52 | 480.10 | 168.99 | 6 |
| 30 | 480.10 | 168.99 | 574.50 | 164.27 | 6 |
| 31 | 574.50 | 164.27 | 579.21 | 163.73 | 6 |
| 32 | 579.21 | 163.73 | 580.38 | 163.59 | 4 |
| 33 | 580.38 | 163.59 | 636.29 | 166.39 | 6 |
| 34 | 103.41 | 87.79 | 105.00 | 87.26 | 5 |
| 35 | 105.00 | 87.26 | 177.70 | 111.50 | 7 |
| 36 | 177.70 | 111.50 | 197.70 | 111.50 | 7 |
| 37 | 197.70 | 111.50 | 302.70 | 146.50 | 7 |
| 38 | 302.70 | 146.50 | 322.70 | 146.50 | 7 |
| 39 | 322.70 | 146.50 | 370.79 | 162.52 | 7 |
| 40 | 370.79 | 162.52 | 480.14 | 167.99 | 7 |
| 41 | 480.14 | 167.99 | 571.91 | 163.40 | 7 |
| 42 | 571.91 | 163.40 | 579.21 | 163.73 | 5 |
| 43 | 105.00 | 87.26 | 125.29 | 80.50 | 5 |
| 44 | 125.29 | 80.50 | 145.29 | 80.50 | 5 |
| 45 | 145.29 | 80.50 | 289.16 | 82.49 | 5 |
| 46 | 289.16 | 82.49 | 386.69 | 115.00 | 5 |
| 47 | 386.69 | 115.00 | 406.69 | 115.00 | 5 |
| 48 | 406.69 | 115.00 | 511.69 | 150.00 | 5 |
| 49 | 511.69 | 150.00 | 531.69 | 150.00 | 5 |
| 50 | 531.69 | 150.00 | 571.91 | 163.40 | 5 |

| | | | | | |
|---|---|---|---|---|---|
| 51 | 93.14 | 87.00 | 97.46 | 87.00 | 1 |
| 52 | 97.46 | 87.00 | 99.46 | 87.00 | 3 |
| 53 | 99.46 | 87.00 | 124.96 | 78.50 | 3 |
| 54 | 124.96 | 78.50 | 144.96 | 78.50 | 3 |
| 55 | 144.96 | 78.50 | 289.51 | 80.50 | 3 |
| 56 | 289.51 | 80.50 | 387.01 | 113.00 | 3 |
| 57 | 387.01 | 113.00 | 407.01 | 113.00 | 3 |
| 58 | 407.01 | 113.00 | 512.01 | 148.00 | 3 |
| 59 | 512.01 | 148.00 | 532.01 | 148.00 | 3 |
| 60 | 532.01 | 148.00 | 579.21 | 163.73 | 3 |
| 61 | 97.46 | 86.53 | 99.30 | 86.53 | 2 |
| 62 | 99.30 | 86.53 | 124.99 | 78.00 | 2 |
| 63 | 124.99 | 78.00 | 144.99 | 78.00 | 3 |
| 64 | 144.99 | 78.00 | 289.59 | 80.00 | 3 |
| 65 | 289.59 | 80.00 | 305.93 | 85.44 | 3 |
| 66 | 305.93 | 85.44 | 387.09 | 112.50 | 6 |
| 67 | 387.09 | 112.50 | 407.09 | 112.50 | 6 |
| 68 | 407.09 | 112.50 | 512.09 | 147.50 | 6 |
| 69 | 512.09 | 147.50 | 532.09 | 147.50 | 6 |
| 70 | 532.09 | 147.50 | 580.38 | 163.59 | 6 |
| 71 | 97.46 | 86.03 | 99.22 | 86.03 | 1 |
| 72 | 99.22 | 86.03 | 124.91 | 77.50 | 1 |
| 73 | 124.91 | 77.50 | 144.99 | 77.50 | 1 |
| 74 | 144.99 | 77.50 | 289.68 | 79.50 | 1 |
| 75 | 289.68 | 79.50 | 307.67 | 85.50 | 1 |
| 76 | 307.67 | 85.50 | 310.84 | 85.50 | 1 |
| 77 | 310.84 | 85.50 | 346.84 | 97.50 | 8 |
| 78 | 346.84 | 97.50 | 348.34 | 98.00 | 8 |
| 79 | 348.34 | 98.00 | 387.34 | 111.00 | 8 |
| 80 | 387.34 | 111.00 | 407.34 | 111.00 | 8 |
| 81 | 407.34 | 111.00 | 452.34 | 126.00 | 8 |
| 82 | 452.34 | 126.00 | 453.84 | 126.50 | 8 |
| 83 | 453.84 | 126.50 | 512.34 | 146.00 | 7 |
| 84 | 512.34 | 146.00 | 532.34 | 146.00 | 7 |
| 85 | 532.34 | 146.00 | 580.29 | 161.98 | 7 |
| 86 | 580.29 | 161.98 | 636.29 | 164.78 | 7 |
| 87 | 453.84 | 126.50 | 636.29 | 126.60 | 8 |
| 88 | 452.34 | 126.00 | 636.29 | 126.00 | 7 |
| 89 | 348.34 | 98.00 | 636.29 | 98.00 | 8 |
| 90 | 346.84 | 97.50 | 636.29 | 97.50 | 7 |
| 91 | 310.84 | 85.50 | 317.52 | 85.50 | 1 |
| 92 | 317.52 | 85.50 | 344.52 | 72.00 | 1 |
| 93 | 344.52 | 72.00 | 636.29 | 72.00 | 1 |
| 94 | .00 | 70.00 | 636.29 | 70.00 | 10 |
| 95 | .00 | 60.00 | 636.29 | 60.00 | 11 |
| 96 | .00 | 49.00 | 636.29 | 49.00 | 12 |

ISOTROPIC SOIL PARAMETERS

12 Type(s) of Soil

| Soil Type No. | Total Unit Wt. (pcf) | Saturated Unit Wt. (pcf) | Cohesion Intercept (psf) | Friction Angle (deg) | Pore Pressure Param. | Pressure Constant (psf) | Piez. Surface No. |
|---|---|---|---|---|---|---|---|
| 1 | 105.0 | 120.0 | .0 | 28.0 | .00 | .0 | 1 |
| 2 | 62.4 | 62.4 | .0 | 20.5 | .00 | .0 | 1 |
| 3 | 62.4 | 62.4 | .0 | 20.5 | .00 | .0 | 1 |
| 4 | 62.4 | 62.4 | .0 | 20.5 | .00 | .0 | 1 |
| 5 | 105.0 | 110.0 | .0 | 30.0 | .00 | .0 | 1 |
| 6 | 105.0 | 110.0 | .0 | 30.0 | .00 | .0 | 1 |
| 7 | 60.0 | 60.0 | 250.0 | 27.0 | .00 | .0 | 1 |
| 8 | 60.0 | 60.0 | 250.0 | 27.0 | .00 | .0 | 1 |
| 9 | 60.0 | 60.0 | .0 | 21.5 | .00 | .0 | 1 |
| 10 | 107.0 | 127.0 | .0 | 13.0 | .00 | .0 | 1 |
| 11 | 75.0 | 110.0 | 300.0 | 9.0 | .00 | .0 | 1 |
| 12 | 124.0 | 137.5 | .0 | 35.0 | .00 | .0 | 1 |

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

Unit Weight of Water = 62.40

Piezometric Surface No. 1 Specified by 2 Coordinate Points

| Point No. | X-Water (ft) | Y-Water (ft) |
|---|---|---|
| 1 | .00 | 82.09 |
| 2 | 636.29 | 82.09 |

BOUNDARY LOAD(S)
2 Load(s) Specified

| Load No. | X-Left (ft) | X-Right (ft) | Intensity (psf) | Deflection (deg) |
|---|---|---|---|---|
| 1 | 370.14 | 373.10 | 1581.0 | .0 |
| 2 | 384.09 | 387.06 | 1581.0 | .0 |

NOTE - Intensity Is Specified As A Uniformly Distributed Force Acting On A Horizontally Projected Surface.
SURCHARGE BOUNDARY LOAD DATA HAS BEEN SUPPRESSED
A Critical Failure Surface Searching Method, Using A Random Technique For Generating Circular Surfaces, Has Been Specified.
5000 Trial Surfaces Have Been Generated.
50 Surfaces Initiate From Each Of100 Points Equally Spaced
Along The Ground Surface Between X = 40.00 ft.
and X = 140.00 ft.
Each Surface Terminates Between X = 300.00 ft.
and X = 400.00 ft.
Unless Further Limitations Were Imposed, The Minimum Elevation
At Which A Surface Extends Is Y = .00 ft.
10.00 ft. Line Segments Define Each Trial Failure Surface.
Following Are Displayed The Ten Most Critical Of The Trial Failure Surfaces Examined. They Are Ordered - Most Critical First.
* * Safety Factors Are Calculated By The Modified Bishop Method * *
Failure Surface Specified By 40 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 65.25 | 86.00 |
| 2 | 73.85 | 80.89 |
| 3 | 82.65 | 76.14 |
| 4 | 91.64 | 71.76 |
| 5 | 100.80 | 67.76 |
| 6 | 110.13 | 64.14 |
| 7 | 119.59 | 60.92 |
| 8 | 129.18 | 58.09 |
| 9 | 138.88 | 55.65 |
| 10 | 148.68 | 53.63 |
| 11 | 158.54 | 52.01 |
| 12 | 168.47 | 50.80 |
| 13 | 178.44 | 50.01 |
| 14 | 188.43 | 49.63 |
| 15 | 198.43 | 49.67 |
| 16 | 208.42 | 50.12 |
| 17 | 218.38 | 50.98 |
| 18 | 228.30 | 52.26 |
| 19 | 238.16 | 53.95 |
| 20 | 247.94 | 56.05 |
| 21 | 257.62 | 58.55 |
| 22 | 267.19 | 61.45 |
| 23 | 276.63 | 64.75 |
| 24 | 285.93 | 68.43 |
| 25 | 295.06 | 72.50 |
| 26 | 304.02 | 76.94 |
| 27 | 312.79 | 81.75 |
| 28 | 321.35 | 86.92 |
| 29 | 329.68 | 92.45 |
| 30 | 337.78 | 98.31 |
| 31 | 345.63 | 104.51 |
| 32 | 353.22 | 111.02 |
| 33 | 360.53 | 117.85 |
| 34 | 367.55 | 124.97 |
| 35 | 374.26 | 132.38 |
| 36 | 380.67 | 140.06 |
| 37 | 386.75 | 148.00 |
| 38 | 392.49 | 156.18 |
| 39 | 397.89 | 164.60 |
| 40 | 399.57 | 167.47 |

Circle Center At X = 192.5 ; Y = 290.3 and Radius, 240.7
*** 1.662 ***
Individual data on the 106 slices

| Slice No. | Width (ft) | Weight (lbs) | Water Force Top (lbs) | Water Force Bot (lbs) | Tie Force Norm (lbs) | Tie Force Tan (lbs) | Earthquake Force Hor (lbs) | Earthquake Force Ver (lbs) | Surcharge Load (lbs) |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 6.6 | 1350.3 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 2 | 2.0 | 973.7 | .0 | 87.9 | .0 | .0 | .0 | .0 | .0 |
| 3 | 7.6 | 6095.2 | .0 | 1755.1 | .0 | .0 | .0 | .0 | .0 |
| 4 | 1.2 | 1316.7 | .0 | 474.7 | .0 | .0 | .0 | .0 | .0 |
| 5 | 1.8 | 2276.3 | .0 | 807.3 | .0 | .0 | .0 | .0 | .0 |
| 6 | 7.2 | 11079.5 | .0 | 4270.2 | .0 | .0 | .0 | .0 | .0 |
| 7 | 1.5 | 2690.2 | .0 | 1087.8 | .0 | .0 | .0 | .0 | .0 |
| 8 | 2.5 | 4937.4 | .0 | 1994.8 | .0 | .0 | .0 | .0 | .0 |
| 9 | 1.8 | 3801.7 | .0 | 1512.7 | .0 | .0 | .0 | .0 | .0 |
| 10 | 1.8 | 3967.0 | .0 | 1588.0 | .0 | .0 | .0 | .0 | .0 |
| 11 | .1 | 186.9 | .0 | 74.4 | .0 | .0 | .0 | .0 | .0 |
| 12 | .2 | 375.3 | .0 | 149.3 | .0 | .0 | .0 | .0 | .0 |
| 13 | 1.3 | 3244.6 | .0 | 1285.1 | .0 | .0 | .0 | .0 | .0 |
| 14 | 1.8 | 4628.7 | .0 | 1783.5 | .0 | .0 | .0 | .0 | .0 |
| 15 | .8 | 2092.6 | .0 | 803.0 | .0 | .0 | .0 | .0 | .0 |
| 16 | 1.6 | 4353.4 | .0 | 1665.3 | .0 | .0 | .0 | .0 | .0 |
| 17 | 5.1 | 15097.5 | .0 | 5817.6 | .0 | .0 | .0 | .0 | .0 |
| 18 | 1.0 | 2978.5 | .0 | 1144.5 | .0 | .0 | .0 | .0 | .0 |
| 19 | 1.6 | 5018.5 | .0 | 1938.7 | .0 | .0 | .0 | .0 | .0 |
| 20 | 1.5 | 4905.8 | .0 | 1908.7 | .0 | .0 | .0 | .0 | .0 |
| 21 | 5.4 | 18295.0 | .0 | 7213.1 | .0 | .0 | .0 | .0 | .0 |
| 22 | .9 | 3262.8 | .0 | 1282.9 | .0 | .0 | .0 | .0 | .0 |
| 23 | 2.2 | 7817.3 | .0 | 3087.9 | .0 | .0 | .0 | .0 | .0 |
| 24 | 2.2 | 8101.7 | .0 | 3226.3 | .0 | .0 | .0 | .0 | .0 |
| 25 | .0 | 185.0 | .0 | 74.0 | .0 | .0 | .0 | .0 | .0 |
| 26 | .0 | 111.0 | .0 | 44.4 | .0 | .0 | .0 | .0 | .0 |
| 27 | .3 | 1112.2 | .0 | 445.2 | .0 | .0 | .0 | .0 | .0 |
| 28 | 3.9 | 14852.3 | .0 | 5934.7 | .0 | .0 | .0 | .0 | .0 |
| 29 | 9.7 | 40234.9 | .0 | 15737.5 | .0 | .0 | .0 | .0 | .0 |
| 30 | 6.1 | 27398.5 | .0 | 10480.3 | .0 | .0 | .0 | .0 | .0 |
| 31 | .0 | 139.2 | .0 | 52.9 | .0 | .0 | .0 | .0 | .0 |
| 32 | .3 | 1393.9 | .0 | 530.1 | .0 | .0 | .0 | .0 | .0 |
| 33 | 3.4 | 16002.0 | .0 | 6064.8 | .0 | .0 | .0 | .0 | .0 |
| 34 | 9.9 | 49262.7 | .0 | 18265.2 | .0 | .0 | .0 | .0 | .0 |
| 35 | 9.9 | 53144.7 | .0 | 19146.6 | .0 | .0 | .0 | .0 | .0 |
| 36 | 8.7 | 48995.3 | .0 | 17165.9 | .0 | .0 | .0 | .0 | .0 |
| 37 | .3 | 1849.2 | .0 | 640.8 | .0 | .0 | .0 | .0 | .0 |
| 38 | .1 | 462.3 | .0 | 160.3 | .0 | .0 | .0 | .0 | .0 |
| 39 | .2 | 924.6 | .0 | 320.7 | .0 | .0 | .0 | .0 | .0 |
| 40 | .7 | 4273.9 | .0 | 1483.1 | .0 | .0 | .0 | .0 | .0 |
| 41 | 10.0 | 58059.0 | .0 | 20136.6 | .0 | .0 | .0 | .0 | .0 |
| 42 | 8.7 | 50828.0 | .0 | 17629.5 | .0 | .0 | .0 | .0 | .0 |
| 43 | .3 | 1870.2 | .0 | 647.5 | .0 | .0 | .0 | .0 | .0 |
| 44 | .1 | 468.1 | .0 | 161.9 | .0 | .0 | .0 | .0 | .0 |
| 45 | .2 | 936.8 | .0 | 323.8 | .0 | .0 | .0 | .0 | .0 |
| 46 | .7 | 4293.1 | .0 | 1481.0 | .0 | .0 | .0 | .0 | .0 |
| 47 | 10.0 | 59456.5 | .0 | 20091.6 | .0 | .0 | .0 | .0 | .0 |
| 48 | 10.0 | 60642.3 | .0 | 19680.7 | .0 | .0 | .0 | .0 | .0 |
| 49 | 9.9 | 61255.1 | .0 | 19011.7 | .0 | .0 | .0 | .0 | .0 |
| 50 | 9.9 | 61295.4 | .0 | 18085.8 | .0 | .0 | .0 | .0 | .0 |
| 51 | 9.8 | 60769.7 | .0 | 16904.5 | .0 | .0 | .0 | .0 | .0 |
| 52 | 9.7 | 59689.9 | .0 | 15469.9 | .0 | .0 | .0 | .0 | .0 |
| 53 | 2.6 | 16029.7 | .0 | 3957.8 | .0 | .0 | .0 | .0 | .0 |
| 54 | 2.2 | 13161.5 | .0 | 3163.3 | .0 | .0 | .0 | .0 | .0 |
| 55 | 4.8 | 28821.9 | .0 | 6663.3 | .0 | .0 | .0 | .0 | .0 |
| 56 | 9.4 | 55439.5 | .0 | 11851.1 | .0 | .0 | .0 | .0 | .0 |
| 57 | 9.3 | 52275.6 | .0 | 9673.2 | .0 | .0 | .0 | .0 | .0 |
| 58 | 3.2 | 17554.3 | .0 | 2858.4 | .0 | .0 | .0 | .0 | .0 |
| 59 | .3 | 1559.4 | .0 | 241.2 | .0 | .0 | .0 | .0 | .0 |
| 60 | .1 | 318.8 | .0 | 49.0 | .0 | .0 | .0 | .0 | .0 |
| 61 | .1 | 428.8 | .0 | 65.8 | .0 | .0 | .0 | .0 | .0 |
| 62 | .1 | 482.2 | .0 | 73.8 | .0 | .0 | .0 | .0 | .0 |
| 63 | 4.6 | 24482.6 | .0 | 3444.9 | .0 | .0 | .0 | .0 | .0 |
| 64 | .8 | 4126.7 | .0 | 521.1 | .0 | .0 | .0 | .0 | .0 |
| 65 | .8 | 4249.4 | .0 | 527.6 | .0 | .0 | .0 | .0 | .0 |
| 66 | 1.6 | 8278.2 | .0 | 967.3 | .0 | .0 | .0 | .0 | .0 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 67 | 4.7 | 24284.1 | .0 | 2368.9 | .0 | .0 | .0 | .0 | .0 |
| 68 | .3 | 1633.8 | .0 | 133.8 | .0 | .0 | .0 | .0 | .0 |
| 69 | .1 | 407.7 | .0 | 32.9 | .0 | .0 | .0 | .0 | .0 |
| 70 | .2 | 814.1 | .0 | 65.1 | .0 | .0 | .0 | .0 | .0 |
| 71 | 1.3 | 6670.0 | .0 | 503.4 | .0 | .0 | .0 | .0 | .0 |
| 72 | 1.9 | 9505.3 | .0 | 628.7 | .0 | .0 | .0 | .0 | .0 |
| 73 | 1.7 | 8535.4 | .0 | 448.6 | .0 | .0 | .0 | .0 | .0 |
| 74 | 3.2 | 15154.1 | .0 | 513.3 | .0 | .0 | .0 | .0 | .0 |
| 75 | 1.9 | 9021.7 | .0 | 120.6 | .0 | .0 | .0 | .0 | .0 |
| 76 | .6 | 2536.1 | .0 | 6.8 | .0 | .0 | .0 | .0 | .0 |
| 77 | 4.2 | 18372.6 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 78 | .8 | 3397.2 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 79 | 3.0 | 12520.3 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 80 | .8 | 3236.9 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 81 | .3 | 1297.7 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 82 | .1 | 324.4 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 83 | .2 | 648.5 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 84 | 5.0 | 19845.0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 85 | 2.0 | 7937.8 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 86 | 2.3 | 8964.2 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 87 | 1.4 | 5131.0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 88 | 4.4 | 16143.0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 89 | .8 | 3016.4 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 90 | 7.0 | 24078.4 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 91 | 7.6 | 24455.7 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 92 | 7.3 | 21726.9 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 93 | 7.0 | 18935.3 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 94 | 2.6 | 6468.3 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 95 | .4 | 895.6 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 96 | .1 | 216.3 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 97 | .2 | 454.8 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 98 | 3.5 | 7909.5 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 99 | 6.4 | 12462.4 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 100 | 6.1 | 9096.0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 101 | 5.7 | 5917.8 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 102 | 4.9 | 2807.3 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 103 | .5 | 148.2 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 104 | .2 | 44.2 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 105 | .3 | 67.5 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 106 | 1.2 | 127.6 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |

Failure Surface Specified By 39 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 61.21 | 86.00 |
| 2 | 69.73 | 80.76 |
| 3 | 78.46 | 75.89 |
| 4 | 87.40 | 71.40 |
| 5 | 96.53 | 67.31 |
| 6 | 105.82 | 63.62 |
| 7 | 115.26 | 60.34 |
| 8 | 124.84 | 57.47 |
| 9 | 134.54 | 55.02 |
| 10 | 144.33 | 52.99 |
| 11 | 154.20 | 51.39 |
| 12 | 164.13 | 50.22 |
| 13 | 174.11 | 49.48 |
| 14 | 184.10 | 49.18 |
| 15 | 194.10 | 49.31 |
| 16 | 204.08 | 49.87 |
| 17 | 214.03 | 50.87 |
| 18 | 223.93 | 52.30 |
| 19 | 233.76 | 54.16 |
| 20 | 243.49 | 56.44 |
| 21 | 253.12 | 59.15 |
| 22 | 262.62 | 62.27 |
| 23 | 271.98 | 65.80 |
| 24 | 281.17 | 69.73 |
| 25 | 290.19 | 74.06 |
| 26 | 299.00 | 78.78 |
| 27 | 307.61 | 83.87 |

| | | |
|---|---|---|
| 28 | 315.98 | 89.34 |
| 29 | 324.11 | 95.16 |
| 30 | 331.98 | 101.33 |
| 31 | 339.58 | 107.84 |
| 32 | 346.88 | 114.67 |
| 33 | 353.88 | 121.81 |
| 34 | 360.56 | 129.25 |
| 35 | 366.92 | 136.97 |
| 36 | 372.93 | 144.96 |
| 37 | 378.59 | 153.21 |
| 38 | 383.88 | 161.69 |
| 39 | 386.79 | 166.83 |

Circle Center At X =  186.1 ; Y =  279.3  and Radius,  230.1
*** 1.665 ***

Failure Surface Specified By 40 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 63.23 | 86.00 |
| 2 | 71.83 | 80.89 |
| 3 | 80.64 | 76.15 |
| 4 | 89.63 | 71.78 |
| 5 | 98.80 | 67.80 |
| 6 | 108.13 | 64.20 |
| 7 | 117.60 | 60.99 |
| 8 | 127.20 | 58.19 |
| 9 | 136.91 | 55.79 |
| 10 | 146.71 | 53.79 |
| 11 | 156.58 | 52.21 |
| 12 | 166.52 | 51.05 |
| 13 | 176.49 | 50.30 |
| 14 | 186.48 | 49.97 |
| 15 | 196.48 | 50.06 |
| 16 | 206.47 | 50.57 |
| 17 | 216.43 | 51.50 |
| 18 | 226.34 | 52.85 |
| 19 | 236.18 | 54.60 |
| 20 | 245.94 | 56.77 |
| 21 | 255.60 | 59.35 |
| 22 | 265.15 | 62.33 |
| 23 | 274.56 | 65.70 |
| 24 | 283.83 | 69.47 |
| 25 | 292.92 | 73.62 |
| 26 | 301.84 | 78.15 |
| 27 | 310.56 | 83.05 |
| 28 | 319.06 | 88.31 |
| 29 | 327.34 | 93.93 |
| 30 | 335.37 | 99.88 |
| 31 | 343.15 | 106.17 |
| 32 | 350.66 | 112.77 |
| 33 | 357.88 | 119.69 |
| 34 | 364.81 | 126.90 |
| 35 | 371.43 | 134.39 |
| 36 | 377.73 | 142.16 |
| 37 | 383.69 | 150.18 |
| 38 | 389.32 | 158.45 |
| 39 | 394.60 | 166.95 |
| 40 | 394.76 | 167.23 |

Circle Center At X =  189.3 ; Y =  288.5  and Radius,  238.6
*** 1.667 ***

Failure Surface Specified By 40 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 58.18 | 86.00 |
| 2 | 66.85 | 81.01 |
| 3 | 75.71 | 76.37 |
| 4 | 84.75 | 72.09 |
| 5 | 93.95 | 68.18 |
| 6 | 103.30 | 64.63 |
| 7 | 112.78 | 61.46 |
| 8 | 122.38 | 58.67 |

| | | |
|---|---|---|
| 9 | 132.09 | 56.26 |
| 10 | 141.89 | 54.25 |
| 11 | 151.75 | 52.63 |
| 12 | 161.68 | 51.40 |
| 13 | 171.64 | 50.57 |
| 14 | 181.63 | 50.14 |
| 15 | 191.63 | 50.11 |
| 16 | 201.63 | 50.47 |
| 17 | 211.60 | 51.24 |
| 18 | 221.53 | 52.40 |
| 19 | 231.41 | 53.96 |
| 20 | 241.22 | 55.91 |
| 21 | 250.94 | 58.25 |
| 22 | 260.56 | 60.98 |
| 23 | 270.06 | 64.08 |
| 24 | 279.44 | 67.57 |
| 25 | 288.66 | 71.43 |
| 26 | 297.73 | 75.65 |
| 27 | 306.62 | 80.23 |
| 28 | 315.32 | 85.16 |
| 29 | 323.81 | 90.44 |
| 30 | 332.09 | 96.04 |
| 31 | 340.14 | 101.98 |
| 32 | 347.94 | 108.23 |
| 33 | 355.49 | 114.79 |
| 34 | 362.77 | 121.65 |
| 35 | 369.77 | 128.79 |
| 36 | 376.49 | 136.20 |
| 37 | 382.90 | 143.87 |
| 38 | 388.99 | 151.80 |
| 39 | 394.77 | 159.96 |
| 40 | 399.65 | 167.48 |

Circle Center At X = 187.4 ; Y = 300.5 and Radius, 250.5

*** 1.669 ***

Failure Surface Specified By 39 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 71.31 | 86.00 |
| 2 | 79.88 | 80.85 |
| 3 | 88.67 | 76.06 |
| 4 | 97.65 | 71.66 |
| 5 | 106.81 | 67.66 |
| 6 | 116.13 | 64.04 |
| 7 | 125.60 | 60.84 |
| 8 | 135.21 | 58.04 |
| 9 | 144.92 | 55.66 |
| 10 | 154.72 | 53.70 |
| 11 | 164.60 | 52.16 |
| 12 | 174.54 | 51.05 |
| 13 | 184.52 | 50.37 |
| 14 | 194.52 | 50.12 |
| 15 | 204.51 | 50.29 |
| 16 | 214.50 | 50.90 |
| 17 | 224.44 | 51.94 |
| 18 | 234.34 | 53.40 |
| 19 | 244.16 | 55.29 |
| 20 | 253.89 | 57.59 |
| 21 | 263.51 | 60.32 |
| 22 | 273.00 | 63.45 |
| 23 | 282.36 | 66.99 |
| 24 | 291.55 | 70.93 |
| 25 | 300.56 | 75.26 |
| 26 | 309.38 | 79.98 |
| 27 | 317.99 | 85.07 |
| 28 | 326.37 | 90.52 |
| 29 | 334.51 | 96.34 |
| 30 | 342.39 | 102.49 |
| 31 | 350.00 | 108.98 |
| 32 | 357.32 | 115.79 |
| 33 | 364.34 | 122.91 |

| | | |
|---|---|---|
| 34 | 371.05 | 130.32 |
| 35 | 377.44 | 138.02 |
| 36 | 383.49 | 145.98 |
| 37 | 389.19 | 154.20 |
| 38 | 394.53 | 162.65 |
| 39 | 397.23 | 167.35 |

Circle Center At X =  195.4 ; Y =  282.6  and Radius,  232.5

*** 1.670 ***

Failure Surface Specified By 41 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 55.15 | 86.00 |
| 2 | 63.83 | 81.04 |
| 3 | 72.70 | 76.42 |
| 4 | 81.75 | 72.16 |
| 5 | 90.96 | 68.25 |
| 6 | 100.31 | 64.72 |
| 7 | 109.80 | 61.55 |
| 8 | 119.40 | 58.76 |
| 9 | 129.10 | 56.35 |
| 10 | 138.90 | 54.33 |
| 11 | 148.76 | 52.70 |
| 12 | 158.69 | 51.45 |
| 13 | 168.65 | 50.60 |
| 14 | 178.64 | 50.14 |
| 15 | 188.64 | 50.07 |
| 16 | 198.63 | 50.40 |
| 17 | 208.61 | 51.12 |
| 18 | 218.54 | 52.24 |
| 19 | 228.43 | 53.74 |
| 20 | 238.25 | 55.64 |
| 21 | 247.99 | 57.92 |
| 22 | 257.62 | 60.58 |
| 23 | 267.15 | 63.63 |
| 24 | 276.55 | 67.04 |
| 25 | 285.81 | 70.82 |
| 26 | 294.91 | 74.97 |
| 27 | 303.84 | 79.47 |
| 28 | 312.58 | 84.31 |
| 29 | 321.13 | 89.50 |
| 30 | 329.47 | 95.03 |
| 31 | 337.58 | 100.87 |
| 32 | 345.46 | 107.04 |
| 33 | 353.08 | 113.51 |
| 34 | 360.45 | 120.27 |
| 35 | 367.54 | 127.32 |
| 36 | 374.35 | 134.64 |
| 37 | 380.86 | 142.23 |
| 38 | 387.08 | 150.07 |
| 39 | 392.97 | 158.14 |
| 40 | 398.55 | 166.44 |
| 41 | 399.17 | 167.45 |

Circle Center At X =  185.3 ; Y =  303.6  and Radius,  253.5

*** 1.671 ***

Failure Surface Specified By 41 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 48.08 | 86.00 |
| 2 | 56.75 | 81.02 |
| 3 | 65.61 | 76.37 |
| 4 | 74.64 | 72.08 |
| 5 | 83.83 | 68.15 |
| 6 | 93.17 | 64.57 |
| 7 | 102.65 | 61.37 |
| 8 | 112.24 | 58.54 |
| 9 | 121.93 | 56.09 |
| 10 | 131.71 | 54.01 |
| 11 | 141.57 | 52.32 |
| 12 | 151.49 | 51.02 |
| 13 | 161.44 | 50.11 |

| | | |
|---|---|---|
| 14 | 171.43 | 49.59 |
| 15 | 181.43 | 49.46 |
| 16 | 191.43 | 49.71 |
| 17 | 201.40 | 50.37 |
| 18 | 211.35 | 51.41 |
| 19 | 221.25 | 52.83 |
| 20 | 231.08 | 54.65 |
| 21 | 240.84 | 56.85 |
| 22 | 250.50 | 59.43 |
| 23 | 260.05 | 62.38 |
| 24 | 269.48 | 65.71 |
| 25 | 278.78 | 69.40 |
| 26 | 287.92 | 73.45 |
| 27 | 296.90 | 77.86 |
| 28 | 305.69 | 82.61 |
| 29 | 314.30 | 87.71 |
| 30 | 322.70 | 93.14 |
| 31 | 330.88 | 98.89 |
| 32 | 338.82 | 104.96 |
| 33 | 346.53 | 111.33 |
| 34 | 353.98 | 118.00 |
| 35 | 361.16 | 124.96 |
| 36 | 368.07 | 132.19 |
| 37 | 374.68 | 139.69 |
| 38 | 381.00 | 147.44 |
| 39 | 387.01 | 155.43 |
| 40 | 392.71 | 163.65 |
| 41 | 394.99 | 167.24 |

Circle Center At X = 179.8 ; Y = 305.0 and Radius, 255.6

*** 1.674 ***

Failure Surface Specified By 42 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 45.05 | 86.00 |
| 2 | 53.75 | 81.06 |
| 3 | 62.63 | 76.46 |
| 4 | 71.67 | 72.20 |
| 5 | 80.87 | 68.28 |
| 6 | 90.22 | 64.72 |
| 7 | 99.69 | 61.52 |
| 8 | 109.28 | 58.68 |
| 9 | 118.97 | 56.21 |
| 10 | 128.75 | 54.10 |
| 11 | 138.59 | 52.37 |
| 12 | 148.50 | 51.02 |
| 13 | 158.45 | 50.05 |
| 14 | 168.44 | 49.45 |
| 15 | 178.43 | 49.23 |
| 16 | 188.43 | 49.40 |
| 17 | 198.42 | 49.94 |
| 18 | 208.38 | 50.87 |
| 19 | 218.29 | 52.17 |
| 20 | 228.15 | 53.85 |
| 21 | 237.94 | 55.90 |
| 22 | 247.64 | 58.33 |
| 23 | 257.24 | 61.12 |
| 24 | 266.73 | 64.27 |
| 25 | 276.09 | 67.79 |
| 26 | 285.31 | 71.65 |
| 27 | 294.38 | 75.87 |
| 28 | 303.28 | 80.43 |
| 29 | 312.00 | 85.32 |
| 30 | 320.53 | 90.54 |
| 31 | 328.86 | 96.08 |
| 32 | 336.96 | 101.94 |
| 33 | 344.84 | 108.09 |
| 34 | 352.48 | 114.55 |
| 35 | 359.87 | 121.29 |
| 36 | 366.99 | 128.30 |
| 37 | 373.85 | 135.59 |

| | | |
|---|---|---|
| 38 | 380.42 | 143.12 |
| 39 | 386.70 | 150.91 |
| 40 | 392.68 | 158.92 |
| 41 | 398.35 | 167.16 |
| 42 | 398.51 | 167.42 |

Circle Center At X = 179.1 ; Y = 312.0 and Radius, 262.8

*** 1.674 ***

Failure Surface Specified By 39 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 59.19 | 86.00 |
| 2 | 67.78 | 80.87 |
| 3 | 76.57 | 76.12 |
| 4 | 85.56 | 71.74 |
| 5 | 94.73 | 67.74 |
| 6 | 104.06 | 64.14 |
| 7 | 113.54 | 60.95 |
| 8 | 123.14 | 58.15 |
| 9 | 132.85 | 55.77 |
| 10 | 142.66 | 53.80 |
| 11 | 152.53 | 52.25 |
| 12 | 162.47 | 51.12 |
| 13 | 172.45 | 50.42 |
| 14 | 182.44 | 50.14 |
| 15 | 192.44 | 50.29 |
| 16 | 202.42 | 50.86 |
| 17 | 212.38 | 51.85 |
| 18 | 222.27 | 53.27 |
| 19 | 232.10 | 55.11 |
| 20 | 241.85 | 57.36 |
| 21 | 251.49 | 60.03 |
| 22 | 261.00 | 63.10 |
| 23 | 270.38 | 66.57 |
| 24 | 279.60 | 70.44 |
| 25 | 288.65 | 74.70 |
| 26 | 297.51 | 79.34 |
| 27 | 306.16 | 84.35 |
| 28 | 314.59 | 89.73 |
| 29 | 322.79 | 95.46 |
| 30 | 330.73 | 101.53 |
| 31 | 338.41 | 107.93 |
| 32 | 345.81 | 114.66 |
| 33 | 352.92 | 121.69 |
| 34 | 359.72 | 129.02 |
| 35 | 366.21 | 136.64 |
| 36 | 372.36 | 144.52 |
| 37 | 378.18 | 152.65 |
| 38 | 383.64 | 161.03 |
| 39 | 387.09 | 166.85 |

Circle Center At X = 184.0 ; Y = 285.3 and Radius, 235.1

*** 1.677 ***

Failure Surface Specified By 39 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 72.32 | 86.00 |
| 2 | 80.91 | 80.87 |
| 3 | 89.70 | 76.12 |
| 4 | 98.70 | 71.75 |
| 5 | 107.87 | 67.77 |
| 6 | 117.21 | 64.19 |
| 7 | 126.70 | 61.02 |
| 8 | 136.31 | 58.27 |
| 9 | 146.03 | 55.93 |
| 10 | 155.85 | 54.01 |
| 11 | 165.74 | 52.52 |
| 12 | 175.68 | 51.46 |
| 13 | 185.66 | 50.83 |
| 14 | 195.66 | 50.64 |
| 15 | 205.66 | 50.87 |
| 16 | 215.63 | 51.54 |

| | | |
|---|---|---|
| 17 | 225.57 | 52.64 |
| 18 | 235.46 | 54.16 |
| 19 | 245.26 | 56.11 |
| 20 | 254.98 | 58.49 |
| 21 | 264.58 | 61.28 |
| 22 | 274.05 | 64.49 |
| 23 | 283.38 | 68.10 |
| 24 | 292.54 | 72.11 |
| 25 | 301.52 | 76.51 |
| 26 | 310.30 | 81.30 |
| 27 | 318.86 | 86.46 |
| 28 | 327.19 | 91.99 |
| 29 | 335.28 | 97.87 |
| 30 | 343.10 | 104.10 |
| 31 | 350.65 | 110.66 |
| 32 | 357.91 | 117.54 |
| 33 | 364.86 | 124.72 |
| 34 | 371.50 | 132.21 |
| 35 | 377.81 | 139.97 |
| 36 | 383.77 | 147.99 |
| 37 | 389.38 | 156.27 |
| 38 | 394.63 | 164.78 |
| 39 | 396.04 | 167.29 |

Circle Center At X =  195.2 ; Y =  281.9  and Radius,  231.2

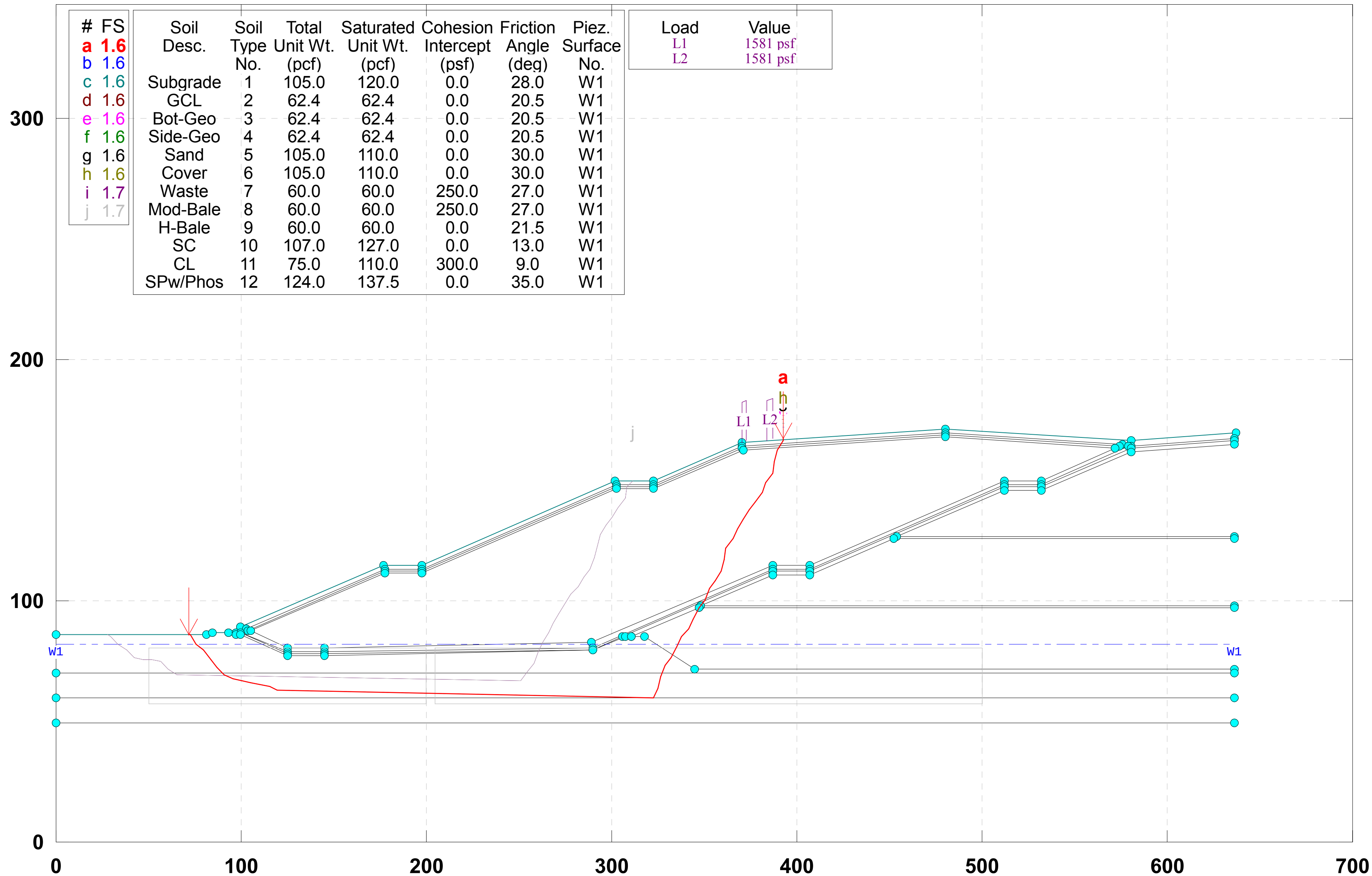
*** 1.677 ***

# Slope Stability Analysis
# Phase II Section II Final Buildout

## Block-Type Analysis With and Without Equipment Loading

## Phase II Section II Expansion RAI No. 1 West Slope Operation

C:\1\HARDEE~1.1\5HARDE~1.1\EWBLLO~1\EWSECBLL.PL2 Run By: Shane R. Fischer, P.E. 03/31/13 4:46AM




PCSTABL5M/si FSmin=1.6

Safety Factors Are Calculated By The Modified Janbu Method

SCS ENGINEERS

**** PCSTABL5M ****

by

Purdue University

--Slope Stability Analysis--

Simplified Janbu, Simplified Bishop

or Spencer`s Method of Slices

Run Date: 03/31/13

Time of Run: 4:46AM

Run By: Shane R. Fischer, P.E.

Input Data Filename: C:ewsecbll.

Output Filename: C:ewsecbll.OUT

Unit: ENGLISH

Plotted Output Filename: C:ewsecbll.PLT

PROBLEM DESCRIPTION Phase II Section II Expansion RAI No. 1
West Slope Operation

BOUNDARY COORDINATES

12 Top Boundaries

96 Total Boundaries

| Boundary No. | X-Left (ft) | Y-Left (ft) | X-Right (ft) | Y-Right (ft) | Soil Type Below Bnd |
|---|---|---|---|---|---|
| 1 | .00 | 86.00 | 81.46 | 86.00 | 1 |
| 2 | 81.46 | 86.00 | 84.47 | 87.00 | 1 |
| 3 | 84.47 | 87.00 | 93.14 | 87.00 | 1 |
| 4 | 93.14 | 87.00 | 99.46 | 89.10 | 5 |
| 5 | 99.46 | 89.10 | 177.14 | 115.00 | 6 |
| 6 | 177.14 | 115.00 | 197.14 | 115.00 | 6 |
| 7 | 197.14 | 115.00 | 302.14 | 150.00 | 6 |
| 8 | 302.14 | 150.00 | 322.14 | 150.00 | 6 |
| 9 | 322.14 | 150.00 | 370.14 | 166.00 | 6 |
| 10 | 370.14 | 166.00 | 480.14 | 171.50 | 6 |
| 11 | 480.14 | 171.50 | 580.29 | 166.20 | 6 |
| 12 | 580.29 | 166.20 | 637.10 | 169.27 | 6 |
| 13 | 99.46 | 89.10 | 102.62 | 88.05 | 5 |
| 14 | 102.62 | 88.05 | 177.46 | 113.00 | 4 |
| 15 | 177.46 | 113.00 | 197.46 | 113.00 | 4 |
| 16 | 197.46 | 113.00 | 302.46 | 148.00 | 4 |
| 17 | 302.46 | 148.00 | 322.46 | 148.00 | 4 |
| 18 | 322.46 | 148.00 | 370.51 | 164.01 | 4 |
| 19 | 370.51 | 164.01 | 480.14 | 169.49 | 4 |
| 20 | 480.14 | 169.49 | 575.83 | 164.71 | 4 |
| 21 | 575.83 | 164.71 | 580.29 | 164.09 | 4 |
| 22 | 580.29 | 164.09 | 636.29 | 166.89 | 4 |
| 23 | 102.62 | 88.05 | 103.41 | 87.79 | 5 |
| 24 | 103.41 | 87.79 | 177.54 | 112.50 | 6 |
| 25 | 177.54 | 112.50 | 197.54 | 112.50 | 6 |
| 26 | 197.54 | 112.50 | 302.54 | 147.50 | 6 |
| 27 | 302.54 | 147.50 | 322.54 | 147.50 | 6 |
| 28 | 322.54 | 147.50 | 370.60 | 163.52 | 6 |
| 29 | 370.60 | 163.52 | 480.10 | 168.99 | 6 |
| 30 | 480.10 | 168.99 | 574.50 | 164.27 | 6 |
| 31 | 574.50 | 164.27 | 579.21 | 163.73 | 6 |
| 32 | 579.21 | 163.73 | 580.38 | 163.59 | 4 |
| 33 | 580.38 | 163.59 | 636.29 | 166.39 | 6 |
| 34 | 103.41 | 87.79 | 105.00 | 87.26 | 5 |
| 35 | 105.00 | 87.26 | 177.70 | 111.50 | 7 |
| 36 | 177.70 | 111.50 | 197.70 | 111.50 | 7 |
| 37 | 197.70 | 111.50 | 302.70 | 146.50 | 7 |
| 38 | 302.70 | 146.50 | 322.70 | 146.50 | 7 |
| 39 | 322.70 | 146.50 | 370.79 | 162.52 | 7 |
| 40 | 370.79 | 162.52 | 480.14 | 167.99 | 7 |
| 41 | 480.14 | 167.99 | 571.91 | 163.40 | 7 |
| 42 | 571.91 | 163.40 | 579.21 | 163.73 | 5 |
| 43 | 105.00 | 87.26 | 125.29 | 80.50 | 5 |
| 44 | 125.29 | 80.50 | 145.29 | 80.50 | 5 |
| 45 | 145.29 | 80.50 | 289.16 | 82.49 | 5 |
| 46 | 289.16 | 82.49 | 386.69 | 115.00 | 5 |
| 47 | 386.69 | 115.00 | 406.69 | 115.00 | 5 |
| 48 | 406.69 | 115.00 | 511.69 | 150.00 | 5 |
| 49 | 511.69 | 150.00 | 531.69 | 150.00 | 5 |
| 50 | 531.69 | 150.00 | 571.91 | 163.40 | 5 |

| | | | | | |
|---|---|---|---|---|---|
| 51 | 93.14 | 87.00 | 97.46 | 87.00 | 1 |
| 52 | 97.46 | 87.00 | 99.46 | 87.00 | 3 |
| 53 | 99.46 | 87.00 | 124.96 | 78.50 | 3 |
| 54 | 124.96 | 78.50 | 144.96 | 78.50 | 3 |
| 55 | 144.96 | 78.50 | 289.51 | 80.50 | 3 |
| 56 | 289.51 | 80.50 | 387.01 | 113.00 | 3 |
| 57 | 387.01 | 113.00 | 407.01 | 113.00 | 3 |
| 58 | 407.01 | 113.00 | 512.01 | 148.00 | 3 |
| 59 | 512.01 | 148.00 | 532.01 | 148.00 | 3 |
| 60 | 532.01 | 148.00 | 579.21 | 163.73 | 3 |
| 61 | 97.46 | 86.53 | 99.30 | 86.53 | 2 |
| 62 | 99.30 | 86.53 | 124.99 | 78.00 | 2 |
| 63 | 124.99 | 78.00 | 144.99 | 78.00 | 3 |
| 64 | 144.99 | 78.00 | 289.59 | 80.00 | 3 |
| 65 | 289.59 | 80.00 | 305.93 | 85.44 | 3 |
| 66 | 305.93 | 85.44 | 387.09 | 112.50 | 6 |
| 67 | 387.09 | 112.50 | 407.09 | 112.50 | 6 |
| 68 | 407.09 | 112.50 | 512.09 | 147.50 | 6 |
| 69 | 512.09 | 147.50 | 532.09 | 147.50 | 6 |
| 70 | 532.09 | 147.50 | 580.38 | 163.59 | 6 |
| 71 | 97.46 | 86.03 | 99.22 | 86.03 | 1 |
| 72 | 99.22 | 86.03 | 124.91 | 77.50 | 1 |
| 73 | 124.91 | 77.50 | 144.99 | 77.50 | 1 |
| 74 | 144.99 | 77.50 | 289.68 | 79.50 | 1 |
| 75 | 289.68 | 79.50 | 307.67 | 85.50 | 1 |
| 76 | 307.67 | 85.50 | 310.84 | 85.50 | 1 |
| 77 | 310.84 | 85.50 | 346.84 | 97.50 | 8 |
| 78 | 346.84 | 97.50 | 348.34 | 98.00 | 8 |
| 79 | 348.34 | 98.00 | 387.34 | 111.00 | 8 |
| 80 | 387.34 | 111.00 | 407.34 | 111.00 | 8 |
| 81 | 407.34 | 111.00 | 452.34 | 126.00 | 8 |
| 82 | 452.34 | 126.00 | 453.84 | 126.50 | 8 |
| 83 | 453.84 | 126.50 | 512.34 | 146.00 | 7 |
| 84 | 512.34 | 146.00 | 532.34 | 146.00 | 7 |
| 85 | 532.34 | 146.00 | 580.29 | 161.98 | 7 |
| 86 | 580.29 | 161.98 | 636.29 | 164.78 | 7 |
| 87 | 453.84 | 126.50 | 636.29 | 126.60 | 8 |
| 88 | 452.34 | 126.00 | 636.29 | 126.00 | 7 |
| 89 | 348.34 | 98.00 | 636.29 | 98.00 | 8 |
| 90 | 346.84 | 97.50 | 636.29 | 97.50 | 7 |
| 91 | 310.84 | 85.50 | 317.52 | 85.50 | 1 |
| 92 | 317.52 | 85.50 | 344.52 | 72.00 | 1 |
| 93 | 344.52 | 72.00 | 636.29 | 72.00 | 1 |
| 94 | .00 | 70.00 | 636.29 | 70.00 | 10 |
| 95 | .00 | 60.00 | 636.29 | 60.00 | 11 |
| 96 | .00 | 49.00 | 636.29 | 49.00 | 12 |

ISOTROPIC SOIL PARAMETERS

12 Type(s) of Soil

| Soil Type No. | Total Unit Wt. (pcf) | Saturated Unit Wt. (pcf) | Cohesion Intercept (psf) | Friction Angle (deg) | Pore Pressure Param. | Pressure Constant (psf) | Piez. Surface No. |
|---|---|---|---|---|---|---|---|
| 1 | 105.0 | 120.0 | .0 | 28.0 | .00 | .0 | 1 |
| 2 | 62.4 | 62.4 | .0 | 20.5 | .00 | .0 | 1 |
| 3 | 62.4 | 62.4 | .0 | 20.5 | .00 | .0 | 1 |
| 4 | 62.4 | 62.4 | .0 | 20.5 | .00 | .0 | 1 |
| 5 | 105.0 | 110.0 | .0 | 30.0 | .00 | .0 | 1 |
| 6 | 105.0 | 110.0 | .0 | 30.0 | .00 | .0 | 1 |
| 7 | 60.0 | 60.0 | 250.0 | 27.0 | .00 | .0 | 1 |
| 8 | 60.0 | 60.0 | 250.0 | 27.0 | .00 | .0 | 1 |
| 9 | 60.0 | 60.0 | .0 | 21.5 | .00 | .0 | 1 |
| 10 | 107.0 | 127.0 | .0 | 13.0 | .00 | .0 | 1 |
| 11 | 75.0 | 110.0 | 300.0 | 9.0 | .00 | .0 | 1 |
| 12 | 124.0 | 137.5 | .0 | 35.0 | .00 | .0 | 1 |

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

Unit Weight of Water = 62.40

Piezometric Surface No. 1 Specified by 2 Coordinate Points

| Point No. | X-Water (ft) | Y-Water (ft) |
|---|---|---|
| 1 | .00 | 82.09 |
| 2 | 636.29 | 82.09 |

BOUNDARY LOAD(S)
2 Load(s) Specified

| Load No. | X-Left (ft) | X-Right (ft) | Intensity (psf) | Deflection (deg) |
|---|---|---|---|---|
| 1 | 370.14 | 373.10 | 1581.0 | .0 |
| 2 | 384.09 | 387.06 | 1581.0 | .0 |

NOTE - Intensity Is Specified As A Uniformly Distributed Force Acting On A Horizontally Projected Surface.

A Critical Failure Surface Searching Method, Using A Random Technique For Generating Sliding Block Surfaces, Has Been Specified.

1000 Trial Surfaces Have Been Generated.

2 Boxes Specified For Generation Of Central Block Base

Length Of Line Segments For Active And Passive Portions Of Sliding Block Is 5.0

| Box No. | X-Left (ft) | Y-Left (ft) | X-Right (ft) | Y-Right (ft) | Height (ft) |
|---|---|---|---|---|---|
| 1 | 50.00 | 69.00 | 200.00 | 69.00 | 23.00 |
| 2 | 205.00 | 69.00 | 500.00 | 69.00 | 23.00 |

Following Are Displayed The Ten Most Critical Of The Trial Failure Surfaces Examined. They Are Ordered - Most Critical First.

* * Safety Factors Are Calculated By The Modified Janbu Method * *

Failure Surface Specified By 41 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 71.79 | 86.00 |
| 2 | 72.25 | 85.82 |
| 3 | 75.83 | 82.32 |
| 4 | 79.94 | 79.48 |
| 5 | 83.47 | 75.94 |
| 6 | 87.11 | 72.51 |
| 7 | 90.69 | 69.02 |
| 8 | 95.46 | 67.53 |
| 9 | 100.45 | 67.19 |
| 10 | 105.39 | 66.44 |
| 11 | 110.19 | 65.04 |
| 12 | 115.18 | 64.65 |
| 13 | 119.75 | 62.63 |
| 14 | 322.45 | 59.52 |
| 15 | 324.72 | 63.98 |
| 16 | 326.22 | 68.74 |
| 17 | 328.88 | 72.98 |
| 18 | 332.25 | 76.67 |
| 19 | 334.88 | 80.92 |
| 20 | 337.83 | 84.96 |
| 21 | 341.32 | 88.54 |
| 22 | 344.14 | 92.67 |
| 23 | 346.92 | 96.83 |
| 24 | 350.32 | 100.49 |
| 25 | 352.58 | 104.95 |
| 26 | 355.98 | 108.62 |
| 27 | 359.33 | 112.33 |
| 28 | 360.42 | 117.21 |
| 29 | 361.71 | 122.04 |
| 30 | 365.14 | 125.67 |
| 31 | 367.75 | 129.94 |
| 32 | 371.26 | 133.50 |
| 33 | 374.27 | 137.49 |
| 34 | 377.75 | 141.09 |
| 35 | 381.22 | 144.68 |
| 36 | 383.22 | 149.27 |
| 37 | 386.64 | 152.91 |
| 38 | 387.86 | 157.76 |
| 39 | 389.30 | 162.54 |
| 40 | 392.37 | 166.50 |
| 41 | 392.46 | 167.12 |

*** 1.626 ***

Individual data on the 113 slices

Water Water Tie Tie Earthquake

| Slice No. | Width (ft) | Weight (lbs) | Force Top (lbs) | Force Bot (lbs) | Force Norm (lbs) | Force Tan (lbs) | Force Hor (lbs) | Force Ver (lbs) | Surcharge Load (lbs) |
|---|---|---|---|---|---|---|---|---|---|
| 1 | .5 | 4.3 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 2 | 3.6 | 723.1 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 3 | .3 | 134.8 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 4 | 3.8 | 2139.5 | .0 | 374.1 | .0 | .0 | .0 | .0 | .0 |
| 5 | 1.5 | 1243.1 | .0 | 453.8 | .0 | .0 | .0 | .0 | .0 |
| 6 | 2.0 | 2138.6 | .0 | 912.9 | .0 | .0 | .0 | .0 | .0 |
| 7 | 1.0 | 1289.1 | .0 | 565.9 | .0 | .0 | .0 | .0 | .0 |
| 8 | 2.6 | 4003.8 | .0 | 1886.9 | .0 | .0 | .0 | .0 | .0 |
| 9 | 2.6 | 4674.1 | .0 | 2432.6 | .0 | .0 | .0 | .0 | .0 |
| 10 | 1.0 | 2033.6 | .0 | 1100.0 | .0 | .0 | .0 | .0 | .0 |
| 11 | 2.5 | 5242.9 | .0 | 2155.4 | .0 | .0 | .0 | .0 | .0 |
| 12 | 2.3 | 5280.3 | .0 | 2155.0 | .0 | .0 | .0 | .0 | .0 |
| 13 | 2.0 | 4806.3 | .0 | 1828.9 | .0 | .0 | .0 | .0 | .0 |
| 14 | 1.8 | 4304.0 | .0 | 1624.8 | .0 | .0 | .0 | .0 | .0 |
| 15 | .1 | 198.8 | .0 | 74.2 | .0 | .0 | .0 | .0 | .0 |
| 16 | .2 | 398.2 | .0 | 148.4 | .0 | .0 | .0 | .0 | .0 |
| 17 | 1.0 | 2486.5 | .0 | 920.4 | .0 | .0 | .0 | .0 | .0 |
| 18 | 2.2 | 5628.3 | .0 | 2064.0 | .0 | .0 | .0 | .0 | .0 |
| 19 | .8 | 2103.3 | .0 | 762.5 | .0 | .0 | .0 | .0 | .0 |
| 20 | 1.6 | 4318.2 | .0 | 1552.6 | .0 | .0 | .0 | .0 | .0 |
| 21 | .4 | 1087.1 | .0 | 387.8 | .0 | .0 | .0 | .0 | .0 |
| 22 | 4.8 | 13775.1 | .0 | 5101.7 | .0 | .0 | .0 | .0 | .0 |
| 23 | .9 | 2656.4 | .0 | 954.2 | .0 | .0 | .0 | .0 | .0 |
| 24 | 1.6 | 4744.7 | .0 | 1705.7 | .0 | .0 | .0 | .0 | .0 |
| 25 | 1.5 | 4565.2 | .0 | 1644.2 | .0 | .0 | .0 | .0 | .0 |
| 26 | 1.0 | 2986.2 | .0 | 1076.8 | .0 | .0 | .0 | .0 | .0 |
| 27 | 4.6 | 14453.0 | .0 | 5756.7 | .0 | .0 | .0 | .0 | .0 |
| 28 | .8 | 2514.0 | .0 | 927.6 | .0 | .0 | .0 | .0 | .0 |
| 29 | 4.4 | 14486.4 | .0 | 5346.5 | .0 | .0 | .0 | .0 | .0 |
| 30 | .0 | 165.1 | .0 | 61.0 | .0 | .0 | .0 | .0 | .0 |
| 31 | .0 | 99.1 | .0 | 36.6 | .0 | .0 | .0 | .0 | .0 |
| 32 | .3 | 991.4 | .0 | 365.9 | .0 | .0 | .0 | .0 | .0 |
| 33 | 19.7 | 69263.5 | .0 | 24176.6 | .0 | .0 | .0 | .0 | .0 |
| 34 | .0 | 112.1 | .0 | 37.2 | .0 | .0 | .0 | .0 | .0 |
| 35 | .3 | 1122.3 | .0 | 371.6 | .0 | .0 | .0 | .0 | .0 |
| 36 | 31.9 | 130815.3 | .0 | 39943.1 | .0 | .0 | .0 | .0 | .0 |
| 37 | .3 | 1429.7 | .0 | 406.2 | .0 | .0 | .0 | .0 | .0 |
| 38 | .1 | 357.3 | .0 | 101.6 | .0 | .0 | .0 | .0 | .0 |
| 39 | .2 | 714.5 | .0 | 203.2 | .0 | .0 | .0 | .0 | .0 |
| 40 | 19.4 | 87311.2 | .0 | 24867.6 | .0 | .0 | .0 | .0 | .0 |
| 41 | .3 | 1447.8 | .0 | 412.4 | .0 | .0 | .0 | .0 | .0 |
| 42 | .1 | 362.5 | .0 | 103.1 | .0 | .0 | .0 | .0 | .0 |
| 43 | .2 | 725.7 | .0 | 206.2 | .0 | .0 | .0 | .0 | .0 |
| 44 | 62.5 | 328380.0 | .0 | 82491.4 | .0 | .0 | .0 | .0 | .0 |
| 45 | 28.9 | 181937.3 | .0 | 39410.6 | .0 | .0 | .0 | .0 | .0 |
| 46 | .4 | 2319.2 | .0 | 481.9 | .0 | .0 | .0 | .0 | .0 |
| 47 | .1 | 530.6 | .0 | 110.1 | .0 | .0 | .0 | .0 | .0 |
| 48 | .1 | 597.2 | .0 | 123.9 | .0 | .0 | .0 | .0 | .0 |
| 49 | 1.5 | 9991.3 | .0 | 2065.0 | .0 | .0 | .0 | .0 | .0 |
| 50 | 3.1 | 20961.0 | .0 | 4280.0 | .0 | .0 | .0 | .0 | .0 |
| 51 | 1.6 | 10881.9 | .0 | 2194.7 | .0 | .0 | .0 | .0 | .0 |
| 52 | 1.6 | 10919.8 | .0 | 2183.7 | .0 | .0 | .0 | .0 | .0 |
| 53 | 4.7 | 33043.5 | .0 | 6510.2 | .0 | .0 | .0 | .0 | .0 |
| 54 | .3 | 2280.0 | .0 | 444.5 | .0 | .0 | .0 | .0 | .0 |
| 55 | .1 | 570.2 | .0 | 111.2 | .0 | .0 | .0 | .0 | .0 |
| 56 | .2 | 1140.4 | .0 | 222.3 | .0 | .0 | .0 | .0 | .0 |
| 57 | 3.2 | 23107.9 | .0 | 4493.4 | .0 | .0 | .0 | .0 | .0 |
| 58 | 1.7 | 12559.2 | .0 | 2424.8 | .0 | .0 | .0 | .0 | .0 |
| 59 | 3.2 | 23010.4 | .0 | 4425.0 | .0 | .0 | .0 | .0 | .0 |
| 60 | 6.7 | 48703.4 | .0 | 9356.1 | .0 | .0 | .0 | .0 | .0 |
| 61 | 4.6 | 33488.4 | .0 | 6495.8 | .0 | .0 | .0 | .0 | .0 |
| 62 | .3 | 2225.8 | .0 | 435.2 | .0 | .0 | .0 | .0 | .0 |
| 63 | .0 | 78.9 | .0 | 34.0 | .0 | .0 | .0 | .0 | .0 |
| 64 | .1 | 575.6 | .0 | 247.4 | .0 | .0 | .0 | .0 | .0 |
| 65 | .2 | 1098.6 | .0 | 468.9 | .0 | .0 | .0 | .0 | .0 |
| 66 | .0 | 48.5 | .0 | 20.6 | .0 | .0 | .0 | .0 | .0 |
| 67 | 1.6 | 11390.8 | .0 | 4618.0 | .0 | .0 | .0 | .0 | .0 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 68 | .4 | 2519.4 | .0 | 957.7 | .0 | .0 | .0 | .0 | .0 |
| 69 | 1.5 | 9520.9 | .0 | 4907.6 | .0 | .0 | .0 | .0 | .0 |
| 70 | .8 | 4679.6 | .0 | 1176.2 | .0 | .0 | .0 | .0 | .0 |
| 71 | 1.9 | 10598.5 | .0 | 2326.9 | .0 | .0 | .0 | .0 | .0 |
| 72 | 3.4 | 17664.3 | .0 | 2266.6 | .0 | .0 | .0 | .0 | .0 |
| 73 | .7 | 3411.3 | .0 | 398.5 | .0 | .0 | .0 | .0 | .0 |
| 74 | 1.9 | 9286.4 | .0 | 629.0 | .0 | .0 | .0 | .0 | .0 |
| 75 | .9 | 3989.3 | .0 | 52.7 | .0 | .0 | .0 | .0 | .0 |
| 76 | 2.1 | 9616.6 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 77 | 3.5 | 15558.7 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 78 | 2.8 | 12055.9 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 79 | 2.7 | 11079.8 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 80 | .1 | 315.5 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 81 | .6 | 2488.4 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 82 | .3 | 1249.6 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 83 | 2.1 | 8228.1 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 84 | .3 | 1274.2 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 85 | .2 | 641.1 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 86 | 1.3 | 4685.7 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 87 | .8 | 2815.2 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 88 | 3.4 | 11474.7 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 89 | 3.4 | 10826.3 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 90 | 1.1 | 3275.6 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 91 | 1.3 | 3542.7 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 92 | 3.4 | 8715.9 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 93 | 2.6 | 6141.8 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 94 | 2.4 | 5294.5 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 95 | .4 | 795.1 | .0 | .0 | .0 | .0 | .0 | .0 | 585.0 |
| 96 | .1 | 192.0 | .0 | .0 | .0 | .0 | .0 | .0 | 142.3 |
| 97 | .2 | 403.6 | .0 | .0 | .0 | .0 | .0 | .0 | 300.4 |
| 98 | .5 | 984.7 | .0 | .0 | .0 | .0 | .0 | .0 | 740.0 |
| 99 | 1.8 | 3720.2 | .0 | .0 | .0 | .0 | .0 | .0 | 2912.1 |
| 100 | 1.2 | 2223.0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 101 | 3.5 | 6112.6 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 102 | 3.5 | 5392.3 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 103 | 2.0 | 2623.6 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 104 | .9 | 1008.3 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 105 | 2.6 | 2677.4 | .0 | .0 | .0 | .0 | .0 | .0 | 4033.3 |
| 106 | .4 | 386.4 | .0 | .0 | .0 | .0 | .0 | .0 | 662.3 |
| 107 | .8 | 620.4 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 108 | 1.4 | 786.3 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 109 | .7 | 272.3 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 110 | .8 | 239.5 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 111 | .4 | 90.3 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 112 | 1.1 | 154.8 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 113 | .1 | 3.1 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |

Failure Surface Specified By 41 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 71.79 | 86.00 |
| 2 | 72.25 | 85.82 |
| 3 | 75.83 | 82.32 |
| 4 | 79.94 | 79.48 |
| 5 | 83.47 | 75.94 |
| 6 | 87.11 | 72.51 |
| 7 | 90.69 | 69.02 |
| 8 | 95.46 | 67.53 |
| 9 | 100.45 | 67.19 |
| 10 | 105.39 | 66.44 |
| 11 | 110.19 | 65.04 |
| 12 | 115.18 | 64.65 |
| 13 | 119.75 | 62.63 |
| 14 | 322.45 | 59.52 |
| 15 | 324.72 | 63.98 |
| 16 | 326.22 | 68.74 |
| 17 | 328.88 | 72.98 |
| 18 | 332.25 | 76.67 |
| 19 | 334.88 | 80.92 |
| 20 | 337.83 | 84.96 |
| 21 | 341.32 | 88.54 |

| | | |
|---|---|---|
| 22 | 344.14 | 92.67 |
| 23 | 346.92 | 96.83 |
| 24 | 350.32 | 100.49 |
| 25 | 352.58 | 104.95 |
| 26 | 355.98 | 108.62 |
| 27 | 359.33 | 112.33 |
| 28 | 360.42 | 117.21 |
| 29 | 361.71 | 122.04 |
| 30 | 365.14 | 125.67 |
| 31 | 367.75 | 129.94 |
| 32 | 371.26 | 133.50 |
| 33 | 374.27 | 137.49 |
| 34 | 377.75 | 141.09 |
| 35 | 381.22 | 144.68 |
| 36 | 383.22 | 149.27 |
| 37 | 386.64 | 152.91 |
| 38 | 387.86 | 157.76 |
| 39 | 389.30 | 162.54 |
| 40 | 392.37 | 166.50 |
| 41 | 392.46 | 167.12 |

*** 1.626 ***

Failure Surface Specified By 41 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 71.79 | 86.00 |
| 2 | 72.25 | 85.82 |
| 3 | 75.83 | 82.32 |
| 4 | 79.94 | 79.48 |
| 5 | 83.47 | 75.94 |
| 6 | 87.11 | 72.51 |
| 7 | 90.69 | 69.02 |
| 8 | 95.46 | 67.53 |
| 9 | 100.45 | 67.19 |
| 10 | 105.39 | 66.44 |
| 11 | 110.19 | 65.04 |
| 12 | 115.18 | 64.65 |
| 13 | 119.75 | 62.63 |
| 14 | 322.45 | 59.52 |
| 15 | 324.72 | 63.98 |
| 16 | 326.22 | 68.74 |
| 17 | 328.88 | 72.98 |
| 18 | 332.25 | 76.67 |
| 19 | 334.88 | 80.92 |
| 20 | 337.83 | 84.96 |
| 21 | 341.32 | 88.54 |
| 22 | 344.14 | 92.67 |
| 23 | 346.92 | 96.83 |
| 24 | 350.32 | 100.49 |
| 25 | 352.58 | 104.95 |
| 26 | 355.98 | 108.62 |
| 27 | 359.33 | 112.33 |
| 28 | 360.42 | 117.21 |
| 29 | 361.71 | 122.04 |
| 30 | 365.14 | 125.67 |
| 31 | 367.75 | 129.94 |
| 32 | 371.26 | 133.50 |
| 33 | 374.27 | 137.49 |
| 34 | 377.75 | 141.09 |
| 35 | 381.22 | 144.68 |
| 36 | 383.22 | 149.27 |
| 37 | 386.64 | 152.91 |
| 38 | 387.86 | 157.76 |
| 39 | 389.30 | 162.54 |
| 40 | 392.37 | 166.50 |
| 41 | 392.46 | 167.12 |

*** 1.626 ***

Failure Surface Specified By 41 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 71.79 | 86.00 |

| | | |
|---|---|---|
| 2 | 72.25 | 85.82 |
| 3 | 75.83 | 82.32 |
| 4 | 79.94 | 79.48 |
| 5 | 83.47 | 75.94 |
| 6 | 87.11 | 72.51 |
| 7 | 90.69 | 69.02 |
| 8 | 95.46 | 67.53 |
| 9 | 100.45 | 67.19 |
| 10 | 105.39 | 66.44 |
| 11 | 110.19 | 65.04 |
| 12 | 115.18 | 64.65 |
| 13 | 119.75 | 62.63 |
| 14 | 322.45 | 59.52 |
| 15 | 324.72 | 63.98 |
| 16 | 326.22 | 68.74 |
| 17 | 328.88 | 72.98 |
| 18 | 332.25 | 76.67 |
| 19 | 334.88 | 80.92 |
| 20 | 337.83 | 84.96 |
| 21 | 341.32 | 88.54 |
| 22 | 344.14 | 92.67 |
| 23 | 346.92 | 96.83 |
| 24 | 350.32 | 100.49 |
| 25 | 352.58 | 104.95 |
| 26 | 355.98 | 108.62 |
| 27 | 359.33 | 112.33 |
| 28 | 360.42 | 117.21 |
| 29 | 361.71 | 122.04 |
| 30 | 365.14 | 125.67 |
| 31 | 367.75 | 129.94 |
| 32 | 371.26 | 133.50 |
| 33 | 374.27 | 137.49 |
| 34 | 377.75 | 141.09 |
| 35 | 381.22 | 144.68 |
| 36 | 383.22 | 149.27 |
| 37 | 386.64 | 152.91 |
| 38 | 387.86 | 157.76 |
| 39 | 389.30 | 162.54 |
| 40 | 392.37 | 166.50 |
| 41 | 392.46 | 167.12 |

*** 1.626 ***

Failure Surface Specified By 41 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 71.79 | 86.00 |
| 2 | 72.25 | 85.82 |
| 3 | 75.83 | 82.32 |
| 4 | 79.94 | 79.48 |
| 5 | 83.47 | 75.94 |
| 6 | 87.11 | 72.51 |
| 7 | 90.69 | 69.02 |
| 8 | 95.46 | 67.53 |
| 9 | 100.45 | 67.19 |
| 10 | 105.39 | 66.44 |
| 11 | 110.19 | 65.04 |
| 12 | 115.18 | 64.65 |
| 13 | 119.75 | 62.63 |
| 14 | 322.45 | 59.52 |
| 15 | 324.72 | 63.98 |
| 16 | 326.22 | 68.74 |
| 17 | 328.88 | 72.98 |
| 18 | 332.25 | 76.67 |
| 19 | 334.88 | 80.92 |
| 20 | 337.83 | 84.96 |
| 21 | 341.32 | 88.54 |
| 22 | 344.14 | 92.67 |
| 23 | 346.92 | 96.83 |
| 24 | 350.32 | 100.49 |
| 25 | 352.58 | 104.95 |
| 26 | 355.98 | 108.62 |

```
    27        359.33      112.33
    28        360.42      117.21
    29        361.71      122.04
    30        365.14      125.67
    31        367.75      129.94
    32        371.26      133.50
    33        374.27      137.49
    34        377.75      141.09
    35        381.22      144.68
    36        383.22      149.27
    37        386.64      152.91
    38        387.86      157.76
    39        389.30      162.54
    40        392.37      166.50
    41        392.46      167.12
       ***     1.626   ***
Failure Surface Specified By 41 Coordinate Points
  Point      X-Surf      Y-Surf
   No.        (ft)        (ft)
     1         71.79       86.00
     2         72.25       85.82
     3         75.83       82.32
     4         79.94       79.48
     5         83.47       75.94
     6         87.11       72.51
     7         90.69       69.02
     8         95.46       67.53
     9        100.45       67.19
    10        105.39       66.44
    11        110.19       65.04
    12        115.18       64.65
    13        119.75       62.63
    14        322.45       59.52
    15        324.72       63.98
    16        326.22       68.74
    17        328.88       72.98
    18        332.25       76.67
    19        334.88       80.92
    20        337.83       84.96
    21        341.32       88.54
    22        344.14       92.67
    23        346.92       96.83
    24        350.32      100.49
    25        352.58      104.95
    26        355.98      108.62
    27        359.33      112.33
    28        360.42      117.21
    29        361.71      122.04
    30        365.14      125.67
    31        367.75      129.94
    32        371.26      133.50
    33        374.27      137.49
    34        377.75      141.09
    35        381.22      144.68
    36        383.22      149.27
    37        386.64      152.91
    38        387.86      157.76
    39        389.30      162.54
    40        392.37      166.50
    41        392.46      167.12
       ***     1.626   ***
Failure Surface Specified By 41 Coordinate Points
  Point      X-Surf      Y-Surf
   No.        (ft)        (ft)
     1         71.79       86.00
     2         72.25       85.82
     3         75.83       82.32
     4         79.94       79.48
     5         83.47       75.94
     6         87.11       72.51
```

| | | |
|---|---|---|
| 7 | 90.69 | 69.02 |
| 8 | 95.46 | 67.53 |
| 9 | 100.45 | 67.19 |
| 10 | 105.39 | 66.44 |
| 11 | 110.19 | 65.04 |
| 12 | 115.18 | 64.65 |
| 13 | 119.75 | 62.63 |
| 14 | 322.45 | 59.52 |
| 15 | 324.72 | 63.98 |
| 16 | 326.22 | 68.74 |
| 17 | 328.88 | 72.98 |
| 18 | 332.25 | 76.67 |
| 19 | 334.88 | 80.92 |
| 20 | 337.83 | 84.96 |
| 21 | 341.32 | 88.54 |
| 22 | 344.14 | 92.67 |
| 23 | 346.92 | 96.83 |
| 24 | 350.32 | 100.49 |
| 25 | 352.58 | 104.95 |
| 26 | 355.98 | 108.62 |
| 27 | 359.33 | 112.33 |
| 28 | 360.42 | 117.21 |
| 29 | 361.71 | 122.04 |
| 30 | 365.14 | 125.67 |
| 31 | 367.75 | 129.94 |
| 32 | 371.26 | 133.50 |
| 33 | 374.27 | 137.49 |
| 34 | 377.75 | 141.09 |
| 35 | 381.22 | 144.68 |
| 36 | 383.22 | 149.27 |
| 37 | 386.64 | 152.91 |
| 38 | 387.86 | 157.76 |
| 39 | 389.30 | 162.54 |
| 40 | 392.37 | 166.50 |
| 41 | 392.46 | 167.12 |

*** 1.626 ***

Failure Surface Specified By 41 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 71.79 | 86.00 |
| 2 | 72.25 | 85.82 |
| 3 | 75.83 | 82.32 |
| 4 | 79.94 | 79.48 |
| 5 | 83.47 | 75.94 |
| 6 | 87.11 | 72.51 |
| 7 | 90.69 | 69.02 |
| 8 | 95.46 | 67.53 |
| 9 | 100.45 | 67.19 |
| 10 | 105.39 | 66.44 |
| 11 | 110.19 | 65.04 |
| 12 | 115.18 | 64.65 |
| 13 | 119.75 | 62.63 |
| 14 | 322.45 | 59.52 |
| 15 | 324.72 | 63.98 |
| 16 | 326.22 | 68.74 |
| 17 | 328.88 | 72.98 |
| 18 | 332.25 | 76.67 |
| 19 | 334.88 | 80.92 |
| 20 | 337.83 | 84.96 |
| 21 | 341.32 | 88.54 |
| 22 | 344.14 | 92.67 |
| 23 | 346.92 | 96.83 |
| 24 | 350.32 | 100.49 |
| 25 | 352.58 | 104.95 |
| 26 | 355.98 | 108.62 |
| 27 | 359.33 | 112.33 |
| 28 | 360.42 | 117.21 |
| 29 | 361.71 | 122.04 |
| 30 | 365.14 | 125.67 |
| 31 | 367.75 | 129.94 |

| | | |
|---|---|---|
| 32 | 371.26 | 133.50 |
| 33 | 374.27 | 137.49 |
| 34 | 377.75 | 141.09 |
| 35 | 381.22 | 144.68 |
| 36 | 383.22 | 149.27 |
| 37 | 386.64 | 152.91 |
| 38 | 387.86 | 157.76 |
| 39 | 389.30 | 162.54 |
| 40 | 392.37 | 166.50 |
| 41 | 392.46 | 167.12 |

*** 1.626 ***

Failure Surface Specified By 32 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 27.94 | 86.00 |
| 2 | 29.50 | 85.14 |
| 3 | 33.68 | 82.39 |
| 4 | 38.04 | 79.95 |
| 5 | 41.94 | 76.82 |
| 6 | 46.84 | 75.83 |
| 7 | 51.84 | 75.82 |
| 8 | 56.68 | 74.55 |
| 9 | 60.66 | 71.53 |
| 10 | 65.08 | 69.18 |
| 11 | 251.22 | 66.93 |
| 12 | 254.71 | 70.51 |
| 13 | 258.10 | 74.18 |
| 14 | 260.09 | 78.77 |
| 15 | 262.64 | 83.07 |
| 16 | 265.64 | 87.07 |
| 17 | 268.52 | 91.15 |
| 18 | 271.81 | 94.92 |
| 19 | 274.53 | 99.12 |
| 20 | 278.06 | 102.66 |
| 21 | 281.58 | 106.20 |
| 22 | 285.10 | 109.75 |
| 23 | 288.52 | 113.40 |
| 24 | 290.64 | 117.93 |
| 25 | 292.18 | 122.69 |
| 26 | 293.74 | 127.44 |
| 27 | 296.87 | 131.34 |
| 28 | 300.37 | 134.91 |
| 29 | 303.56 | 138.76 |
| 30 | 307.04 | 142.35 |
| 31 | 308.55 | 147.12 |
| 32 | 311.39 | 150.00 |

*** 1.736 ***

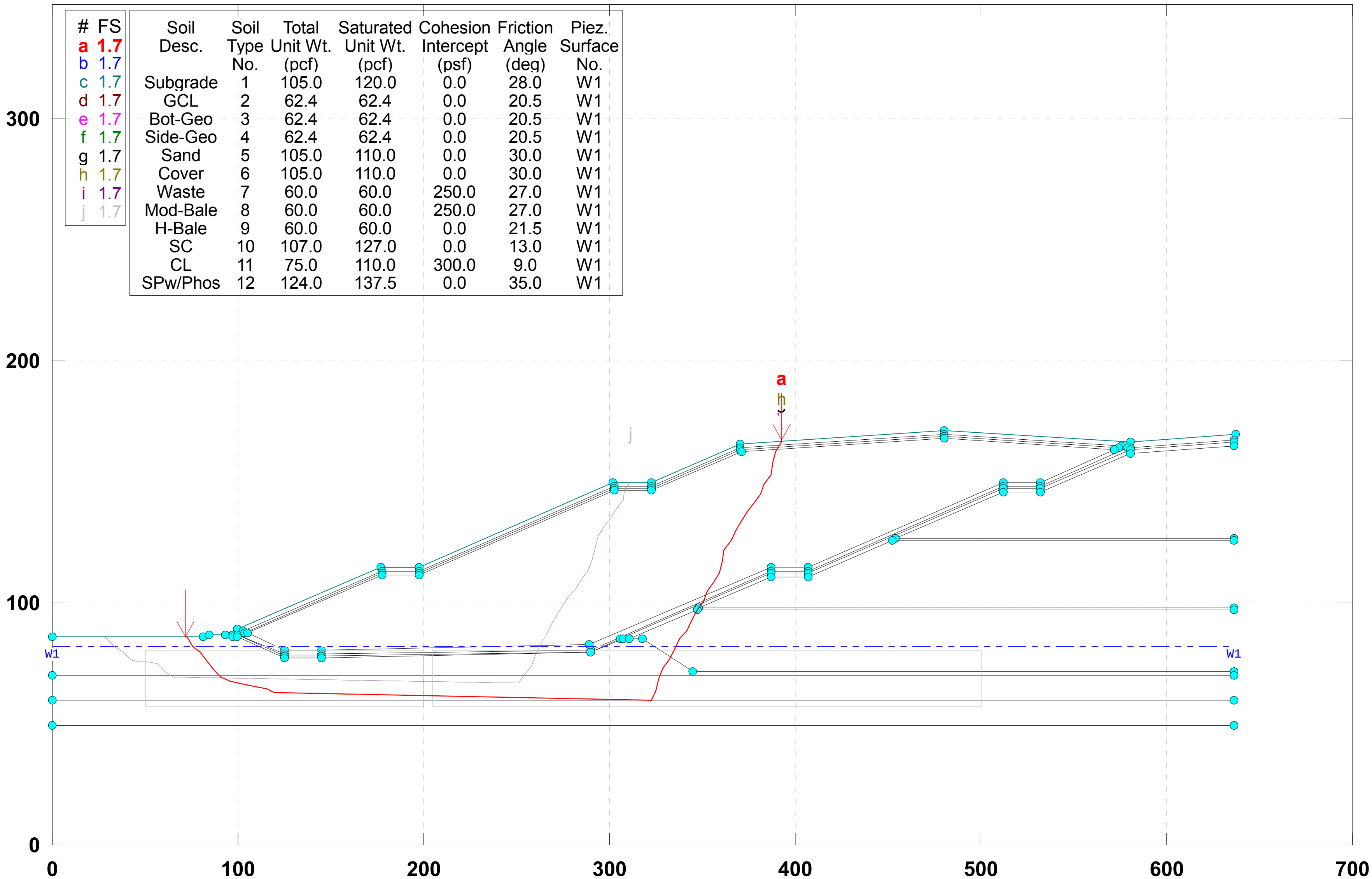
Failure Surface Specified By 32 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 27.94 | 86.00 |
| 2 | 29.50 | 85.14 |
| 3 | 33.68 | 82.39 |
| 4 | 38.04 | 79.95 |
| 5 | 41.94 | 76.82 |
| 6 | 46.84 | 75.83 |
| 7 | 51.84 | 75.82 |
| 8 | 56.68 | 74.55 |
| 9 | 60.66 | 71.53 |
| 10 | 65.08 | 69.18 |
| 11 | 251.22 | 66.93 |
| 12 | 254.71 | 70.51 |
| 13 | 258.10 | 74.18 |
| 14 | 260.09 | 78.77 |
| 15 | 262.64 | 83.07 |
| 16 | 265.64 | 87.07 |
| 17 | 268.52 | 91.15 |
| 18 | 271.81 | 94.92 |
| 19 | 274.53 | 99.12 |
| 20 | 278.06 | 102.66 |

| | | |
|---|---|---|
| 21 | 281.58 | 106.20 |
| 22 | 285.10 | 109.75 |
| 23 | 288.52 | 113.40 |
| 24 | 290.64 | 117.93 |
| 25 | 292.18 | 122.69 |
| 26 | 293.74 | 127.44 |
| 27 | 296.87 | 131.34 |
| 28 | 300.37 | 134.91 |
| 29 | 303.56 | 138.76 |
| 30 | 307.04 | 142.35 |
| 31 | 308.55 | 147.12 |
| 32 | 311.39 | 150.00 |
| *** | 1.736 | *** |

# Phase II Section II Expansion RAI No. 1 West Slope Operation

C:\1\HARDEE~1.1\5HARDE~1.1\EWBL\EWSECBLA.PL2 Run By: Shane R. Fischer, P.E. 03/31/13 4:56AM




| Soil Desc. | Soil Type No. | Total Unit Wt. (pcf) | Saturated Unit Wt. (pcf) | Cohesion Intercept (psf) | Friction Angle (deg) | Piez. Surface No. |
|---|---|---|---|---|---|---|
| Subgrade | 1 | 105.0 | 120.0 | 0.0 | 28.0 | W1 |
| GCL | 2 | 62.4 | 62.4 | 0.0 | 20.5 | W1 |
| Bot-Geo | 3 | 62.4 | 62.4 | 0.0 | 20.5 | W1 |
| Side-Geo | 4 | 62.4 | 62.4 | 0.0 | 20.5 | W1 |
| Sand | 5 | 105.0 | 110.0 | 0.0 | 30.0 | W1 |
| Cover | 6 | 105.0 | 110.0 | 0.0 | 30.0 | W1 |
| Waste | 7 | 60.0 | 60.0 | 250.0 | 27.0 | W1 |
| Mod-Bale | 8 | 60.0 | 60.0 | 250.0 | 27.0 | W1 |
| H-Bale | 9 | 60.0 | 60.0 | 0.0 | 21.5 | W1 |
| SC | 10 | 107.0 | 127.0 | 0.0 | 13.0 | W1 |
| CL | 11 | 75.0 | 110.0 | 300.0 | 9.0 | W1 |
| SPw/Phos | 12 | 124.0 | 137.5 | 0.0 | 35.0 | W1 |

**PCSTABL5M/si FSmin=1.7**

**Safety Factors Are Calculated By The Modified Janbu Method**

SCS ENGINEERS

**** PCSTABL5M ****
by
Purdue University
--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer`s Method of Slices

Run Date: 03/31/13
Time of Run: 4:56AM
Run By: Shane R. Fischer, P.E.
Input Data Filename: C:ewsecbla.
Output Filename: C:ewsecbla.OUT
Unit: ENGLISH
Plotted Output Filename: C:ewsecbla.PLT
PROBLEM DESCRIPTION Phase II Section II Expansion RAI No. 1
West Slope Operation

BOUNDARY COORDINATES
12 Top Boundaries
96 Total Boundaries

| Boundary No. | X-Left (ft) | Y-Left (ft) | X-Right (ft) | Y-Right (ft) | Soil Type Below Bnd |
|---|---|---|---|---|---|
| 1 | .00 | 86.00 | 81.46 | 86.00 | 1 |
| 2 | 81.46 | 86.00 | 84.47 | 87.00 | 1 |
| 3 | 84.47 | 87.00 | 93.14 | 87.00 | 1 |
| 4 | 93.14 | 87.00 | 99.46 | 89.10 | 5 |
| 5 | 99.46 | 89.10 | 177.14 | 115.00 | 6 |
| 6 | 177.14 | 115.00 | 197.14 | 115.00 | 6 |
| 7 | 197.14 | 115.00 | 302.14 | 150.00 | 6 |
| 8 | 302.14 | 150.00 | 322.14 | 150.00 | 6 |
| 9 | 322.14 | 150.00 | 370.14 | 166.00 | 6 |
| 10 | 370.14 | 166.00 | 480.14 | 171.50 | 6 |
| 11 | 480.14 | 171.50 | 580.29 | 166.20 | 6 |
| 12 | 580.29 | 166.20 | 637.10 | 169.27 | 6 |
| 13 | 99.46 | 89.10 | 102.62 | 88.05 | 5 |
| 14 | 102.62 | 88.05 | 177.46 | 113.00 | 4 |
| 15 | 177.46 | 113.00 | 197.46 | 113.00 | 4 |
| 16 | 197.46 | 113.00 | 302.46 | 148.00 | 4 |
| 17 | 302.46 | 148.00 | 322.46 | 148.00 | 4 |
| 18 | 322.46 | 148.00 | 370.51 | 164.01 | 4 |
| 19 | 370.51 | 164.01 | 480.14 | 169.49 | 4 |
| 20 | 480.14 | 169.49 | 575.83 | 164.71 | 4 |
| 21 | 575.83 | 164.71 | 580.29 | 164.09 | 4 |
| 22 | 580.29 | 164.09 | 636.29 | 166.89 | 4 |
| 23 | 102.62 | 88.05 | 103.41 | 87.79 | 5 |
| 24 | 103.41 | 87.79 | 177.54 | 112.50 | 6 |
| 25 | 177.54 | 112.50 | 197.54 | 112.50 | 6 |
| 26 | 197.54 | 112.50 | 302.54 | 147.50 | 6 |
| 27 | 302.54 | 147.50 | 322.54 | 147.50 | 6 |
| 28 | 322.54 | 147.50 | 370.60 | 163.52 | 6 |
| 29 | 370.60 | 163.52 | 480.10 | 168.99 | 6 |
| 30 | 480.10 | 168.99 | 574.50 | 164.27 | 6 |
| 31 | 574.50 | 164.27 | 579.21 | 163.73 | 6 |
| 32 | 579.21 | 163.73 | 580.38 | 163.59 | 4 |
| 33 | 580.38 | 163.59 | 636.29 | 166.39 | 6 |
| 34 | 103.41 | 87.79 | 105.00 | 87.26 | 5 |
| 35 | 105.00 | 87.26 | 177.70 | 111.50 | 7 |
| 36 | 177.70 | 111.50 | 197.70 | 111.50 | 7 |
| 37 | 197.70 | 111.50 | 302.70 | 146.50 | 7 |
| 38 | 302.70 | 146.50 | 322.70 | 146.50 | 7 |
| 39 | 322.70 | 146.50 | 370.79 | 162.52 | 7 |
| 40 | 370.79 | 162.52 | 480.14 | 167.99 | 7 |
| 41 | 480.14 | 167.99 | 571.91 | 163.40 | 7 |
| 42 | 571.91 | 163.40 | 579.21 | 163.73 | 5 |
| 43 | 105.00 | 87.26 | 125.29 | 80.50 | 5 |
| 44 | 125.29 | 80.50 | 145.29 | 80.50 | 5 |
| 45 | 145.29 | 80.50 | 289.16 | 82.49 | 5 |
| 46 | 289.16 | 82.49 | 386.69 | 115.00 | 5 |
| 47 | 386.69 | 115.00 | 406.69 | 115.00 | 5 |
| 48 | 406.69 | 115.00 | 511.69 | 150.00 | 5 |
| 49 | 511.69 | 150.00 | 531.69 | 150.00 | 5 |
| 50 | 531.69 | 150.00 | 571.91 | 163.40 | 5 |

| | | | | | |
|---|---|---|---|---|---|
| 51 | 93.14 | 87.00 | 97.46 | 87.00 | 1 |
| 52 | 97.46 | 87.00 | 99.46 | 87.00 | 3 |
| 53 | 99.46 | 87.00 | 124.96 | 78.50 | 3 |
| 54 | 124.96 | 78.50 | 144.96 | 78.50 | 3 |
| 55 | 144.96 | 78.50 | 289.51 | 80.50 | 3 |
| 56 | 289.51 | 80.50 | 387.01 | 113.00 | 3 |
| 57 | 387.01 | 113.00 | 407.01 | 113.00 | 3 |
| 58 | 407.01 | 113.00 | 512.01 | 148.00 | 3 |
| 59 | 512.01 | 148.00 | 532.01 | 148.00 | 3 |
| 60 | 532.01 | 148.00 | 579.21 | 163.73 | 3 |
| 61 | 97.46 | 86.53 | 99.30 | 86.53 | 2 |
| 62 | 99.30 | 86.53 | 124.99 | 78.00 | 2 |
| 63 | 124.99 | 78.00 | 144.99 | 78.00 | 3 |
| 64 | 144.99 | 78.00 | 289.59 | 80.00 | 3 |
| 65 | 289.59 | 80.00 | 305.93 | 85.44 | 3 |
| 66 | 305.93 | 85.44 | 387.09 | 112.50 | 6 |
| 67 | 387.09 | 112.50 | 407.09 | 112.50 | 6 |
| 68 | 407.09 | 112.50 | 512.09 | 147.50 | 6 |
| 69 | 512.09 | 147.50 | 532.09 | 147.50 | 6 |
| 70 | 532.09 | 147.50 | 580.38 | 163.59 | 6 |
| 71 | 97.46 | 86.03 | 99.22 | 86.03 | 1 |
| 72 | 99.22 | 86.03 | 124.91 | 77.50 | 1 |
| 73 | 124.91 | 77.50 | 144.99 | 77.50 | 1 |
| 74 | 144.99 | 77.50 | 289.68 | 79.50 | 1 |
| 75 | 289.68 | 79.50 | 307.67 | 85.50 | 1 |
| 76 | 307.67 | 85.50 | 310.84 | 85.50 | 1 |
| 77 | 310.84 | 85.50 | 346.84 | 97.50 | 8 |
| 78 | 346.84 | 97.50 | 348.34 | 98.00 | 8 |
| 79 | 348.34 | 98.00 | 387.34 | 111.00 | 8 |
| 80 | 387.34 | 111.00 | 407.34 | 111.00 | 8 |
| 81 | 407.34 | 111.00 | 452.34 | 126.00 | 8 |
| 82 | 452.34 | 126.00 | 453.84 | 126.50 | 8 |
| 83 | 453.84 | 126.50 | 512.34 | 146.00 | 7 |
| 84 | 512.34 | 146.00 | 532.34 | 146.00 | 7 |
| 85 | 532.34 | 146.00 | 580.29 | 161.98 | 7 |
| 86 | 580.29 | 161.98 | 636.29 | 164.78 | 7 |
| 87 | 453.84 | 126.50 | 636.29 | 126.60 | 8 |
| 88 | 452.34 | 126.00 | 636.29 | 126.00 | 7 |
| 89 | 348.34 | 98.00 | 636.29 | 98.00 | 8 |
| 90 | 346.84 | 97.50 | 636.29 | 97.50 | 7 |
| 91 | 310.84 | 85.50 | 317.52 | 85.50 | 1 |
| 92 | 317.52 | 85.50 | 344.52 | 72.00 | 1 |
| 93 | 344.52 | 72.00 | 636.29 | 72.00 | 1 |
| 94 | .00 | 70.00 | 636.29 | 70.00 | 10 |
| 95 | .00 | 60.00 | 636.29 | 60.00 | 11 |
| 96 | .00 | 49.00 | 636.29 | 49.00 | 12 |

ISOTROPIC SOIL PARAMETERS

12 Type(s) of Soil

| Soil Type No. | Total Unit Wt. (pcf) | Saturated Unit Wt. (pcf) | Cohesion Intercept (psf) | Friction Angle (deg) | Pore Pressure Param. | Pressure Constant (psf) | Piez. Surface No. |
|---|---|---|---|---|---|---|---|
| 1 | 105.0 | 120.0 | .0 | 28.0 | .00 | .0 | 1 |
| 2 | 62.4 | 62.4 | .0 | 20.5 | .00 | .0 | 1 |
| 3 | 62.4 | 62.4 | .0 | 20.5 | .00 | .0 | 1 |
| 4 | 62.4 | 62.4 | .0 | 20.5 | .00 | .0 | 1 |
| 5 | 105.0 | 110.0 | .0 | 30.0 | .00 | .0 | 1 |
| 6 | 105.0 | 110.0 | .0 | 30.0 | .00 | .0 | 1 |
| 7 | 60.0 | 60.0 | 250.0 | 27.0 | .00 | .0 | 1 |
| 8 | 60.0 | 60.0 | 250.0 | 27.0 | .00 | .0 | 1 |
| 9 | 60.0 | 60.0 | .0 | 21.5 | .00 | .0 | 1 |
| 10 | 107.0 | 127.0 | .0 | 13.0 | .00 | .0 | 1 |
| 11 | 75.0 | 110.0 | 300.0 | 9.0 | .00 | .0 | 1 |
| 12 | 124.0 | 137.5 | .0 | 35.0 | .00 | .0 | 1 |

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

Unit Weight of Water = 62.40

Piezometric Surface No. 1 Specified by 2 Coordinate Points

| Point No. | X-Water (ft) | Y-Water (ft) |
|---|---|---|
| 1 | .00 | 82.09 |
| 2 | 636.29 | 82.09 |

BOUNDARY LOAD(S)

2 Load(s) Specified

| Load No. | X-Left (ft) | X-Right (ft) | Intensity (psf) | Deflection (deg) |
|---|---|---|---|---|
| 1 | 370.14 | 373.10 | 1581.0 | .0 |
| 2 | 384.09 | 387.06 | 1581.0 | .0 |

NOTE - Intensity Is Specified As A Uniformly Distributed Force Acting On A Horizontally Projected Surface.

SURCHARGE BOUNDARY LOAD DATA HAS BEEN SUPPRESSED

A Critical Failure Surface Searching Method, Using A Random Technique For Generating Sliding Block Surfaces, Has Been Specified.

1000 Trial Surfaces Have Been Generated.

2 Boxes Specified For Generation Of Central Block Base

Length Of Line Segments For Active And Passive Portions Of Sliding Block Is 5.0

| Box No. | X-Left (ft) | Y-Left (ft) | X-Right (ft) | Y-Right (ft) | Height (ft) |
|---|---|---|---|---|---|
| 1 | 50.00 | 69.00 | 200.00 | 69.00 | 23.00 |
| 2 | 205.00 | 69.00 | 500.00 | 69.00 | 23.00 |

Following Are Displayed The Ten Most Critical Of The Trial Failure Surfaces Examined. They Are Ordered - Most Critical First.

* * Safety Factors Are Calculated By The Modified Janbu Method * *

Failure Surface Specified By 41 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 71.79 | 86.00 |
| 2 | 72.25 | 85.82 |
| 3 | 75.83 | 82.32 |
| 4 | 79.94 | 79.48 |
| 5 | 83.47 | 75.94 |
| 6 | 87.11 | 72.51 |
| 7 | 90.69 | 69.02 |
| 8 | 95.46 | 67.53 |
| 9 | 100.45 | 67.19 |
| 10 | 105.39 | 66.44 |
| 11 | 110.19 | 65.04 |
| 12 | 115.18 | 64.65 |
| 13 | 119.75 | 62.63 |
| 14 | 322.45 | 59.52 |
| 15 | 324.72 | 63.98 |
| 16 | 326.22 | 68.74 |
| 17 | 328.88 | 72.98 |
| 18 | 332.25 | 76.67 |
| 19 | 334.88 | 80.92 |
| 20 | 337.83 | 84.96 |
| 21 | 341.32 | 88.54 |
| 22 | 344.14 | 92.67 |
| 23 | 346.92 | 96.83 |
| 24 | 350.32 | 100.49 |
| 25 | 352.58 | 104.95 |
| 26 | 355.98 | 108.62 |
| 27 | 359.33 | 112.33 |
| 28 | 360.42 | 117.21 |
| 29 | 361.71 | 122.04 |
| 30 | 365.14 | 125.67 |
| 31 | 367.75 | 129.94 |
| 32 | 371.26 | 133.50 |
| 33 | 374.27 | 137.49 |
| 34 | 377.75 | 141.09 |
| 35 | 381.22 | 144.68 |
| 36 | 383.22 | 149.27 |
| 37 | 386.64 | 152.91 |
| 38 | 387.86 | 157.76 |
| 39 | 389.30 | 162.54 |
| 40 | 392.37 | 166.50 |
| 41 | 392.46 | 167.12 |

*** 1.669 ***

Individual data on the 110 slices

| Slice No. | Width (ft) | Weight (lbs) | Water Force Top (lbs) | Water Force Bot (lbs) | Tie Force Norm (lbs) | Tie Force Tan (lbs) | Earthquake Force Hor (lbs) | Earthquake Force Ver (lbs) | Surcharge Load (lbs) |
|---|---|---|---|---|---|---|---|---|---|
| 1 | .5 | 4.3 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 2 | 3.6 | 723.1 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 3 | .3 | 134.8 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 4 | 3.8 | 2139.5 | .0 | 374.1 | .0 | .0 | .0 | .0 | .0 |
| 5 | 1.5 | 1243.1 | .0 | 453.8 | .0 | .0 | .0 | .0 | .0 |
| 6 | 2.0 | 2138.6 | .0 | 912.9 | .0 | .0 | .0 | .0 | .0 |
| 7 | 1.0 | 1289.1 | .0 | 565.9 | .0 | .0 | .0 | .0 | .0 |
| 8 | 2.6 | 4003.8 | .0 | 1886.9 | .0 | .0 | .0 | .0 | .0 |
| 9 | 2.6 | 4674.1 | .0 | 2432.6 | .0 | .0 | .0 | .0 | .0 |
| 10 | 1.0 | 2033.6 | .0 | 1100.0 | .0 | .0 | .0 | .0 | .0 |
| 11 | 2.5 | 5242.9 | .0 | 2155.4 | .0 | .0 | .0 | .0 | .0 |
| 12 | 2.3 | 5280.3 | .0 | 2155.0 | .0 | .0 | .0 | .0 | .0 |
| 13 | 2.0 | 4806.3 | .0 | 1828.9 | .0 | .0 | .0 | .0 | .0 |
| 14 | 1.8 | 4304.0 | .0 | 1624.8 | .0 | .0 | .0 | .0 | .0 |
| 15 | .1 | 198.8 | .0 | 74.2 | .0 | .0 | .0 | .0 | .0 |
| 16 | .2 | 398.2 | .0 | 148.4 | .0 | .0 | .0 | .0 | .0 |
| 17 | 1.0 | 2486.5 | .0 | 920.4 | .0 | .0 | .0 | .0 | .0 |
| 18 | 2.2 | 5628.3 | .0 | 2064.0 | .0 | .0 | .0 | .0 | .0 |
| 19 | .8 | 2103.3 | .0 | 762.5 | .0 | .0 | .0 | .0 | .0 |
| 20 | 1.6 | 4318.2 | .0 | 1552.6 | .0 | .0 | .0 | .0 | .0 |
| 21 | .4 | 1087.1 | .0 | 387.8 | .0 | .0 | .0 | .0 | .0 |
| 22 | 4.8 | 13775.1 | .0 | 5101.7 | .0 | .0 | .0 | .0 | .0 |
| 23 | .9 | 2656.4 | .0 | 954.2 | .0 | .0 | .0 | .0 | .0 |
| 24 | 1.6 | 4744.7 | .0 | 1705.7 | .0 | .0 | .0 | .0 | .0 |
| 25 | 1.5 | 4565.2 | .0 | 1644.2 | .0 | .0 | .0 | .0 | .0 |
| 26 | 1.0 | 2986.2 | .0 | 1076.8 | .0 | .0 | .0 | .0 | .0 |
| 27 | 4.6 | 14453.0 | .0 | 5756.7 | .0 | .0 | .0 | .0 | .0 |
| 28 | .8 | 2514.0 | .0 | 927.6 | .0 | .0 | .0 | .0 | .0 |
| 29 | 4.4 | 14486.4 | .0 | 5346.5 | .0 | .0 | .0 | .0 | .0 |
| 30 | .0 | 165.1 | .0 | 61.0 | .0 | .0 | .0 | .0 | .0 |
| 31 | .0 | 99.1 | .0 | 36.6 | .0 | .0 | .0 | .0 | .0 |
| 32 | .3 | 991.4 | .0 | 365.9 | .0 | .0 | .0 | .0 | .0 |
| 33 | 19.7 | 69263.5 | .0 | 24176.6 | .0 | .0 | .0 | .0 | .0 |
| 34 | .0 | 112.1 | .0 | 37.2 | .0 | .0 | .0 | .0 | .0 |
| 35 | .3 | 1122.3 | .0 | 371.6 | .0 | .0 | .0 | .0 | .0 |
| 36 | 31.9 | 130815.3 | .0 | 39943.1 | .0 | .0 | .0 | .0 | .0 |
| 37 | .3 | 1429.7 | .0 | 406.2 | .0 | .0 | .0 | .0 | .0 |
| 38 | .1 | 357.3 | .0 | 101.6 | .0 | .0 | .0 | .0 | .0 |
| 39 | .2 | 714.5 | .0 | 203.2 | .0 | .0 | .0 | .0 | .0 |
| 40 | 19.4 | 87311.2 | .0 | 24867.6 | .0 | .0 | .0 | .0 | .0 |
| 41 | .3 | 1447.8 | .0 | 412.4 | .0 | .0 | .0 | .0 | .0 |
| 42 | .1 | 362.5 | .0 | 103.1 | .0 | .0 | .0 | .0 | .0 |
| 43 | .2 | 725.7 | .0 | 206.2 | .0 | .0 | .0 | .0 | .0 |
| 44 | 62.5 | 328380.0 | .0 | 82491.4 | .0 | .0 | .0 | .0 | .0 |
| 45 | 28.9 | 181937.3 | .0 | 39410.6 | .0 | .0 | .0 | .0 | .0 |
| 46 | .4 | 2319.2 | .0 | 481.9 | .0 | .0 | .0 | .0 | .0 |
| 47 | .1 | 530.6 | .0 | 110.1 | .0 | .0 | .0 | .0 | .0 |
| 48 | .1 | 597.2 | .0 | 123.9 | .0 | .0 | .0 | .0 | .0 |
| 49 | 1.5 | 9991.3 | .0 | 2065.0 | .0 | .0 | .0 | .0 | .0 |
| 50 | 3.1 | 20961.0 | .0 | 4280.0 | .0 | .0 | .0 | .0 | .0 |
| 51 | 1.6 | 10881.9 | .0 | 2194.7 | .0 | .0 | .0 | .0 | .0 |
| 52 | 1.6 | 10919.8 | .0 | 2183.7 | .0 | .0 | .0 | .0 | .0 |
| 53 | 4.7 | 33043.5 | .0 | 6510.2 | .0 | .0 | .0 | .0 | .0 |
| 54 | .3 | 2280.0 | .0 | 444.5 | .0 | .0 | .0 | .0 | .0 |
| 55 | .1 | 570.2 | .0 | 111.2 | .0 | .0 | .0 | .0 | .0 |
| 56 | .2 | 1140.4 | .0 | 222.3 | .0 | .0 | .0 | .0 | .0 |
| 57 | 3.2 | 23107.9 | .0 | 4493.4 | .0 | .0 | .0 | .0 | .0 |
| 58 | 1.7 | 12559.2 | .0 | 2424.8 | .0 | .0 | .0 | .0 | .0 |
| 59 | 3.2 | 23010.4 | .0 | 4425.0 | .0 | .0 | .0 | .0 | .0 |
| 60 | 6.7 | 48703.4 | .0 | 9356.1 | .0 | .0 | .0 | .0 | .0 |
| 61 | 4.6 | 33488.4 | .0 | 6495.8 | .0 | .0 | .0 | .0 | .0 |
| 62 | .3 | 2225.8 | .0 | 435.2 | .0 | .0 | .0 | .0 | .0 |
| 63 | .0 | 78.9 | .0 | 34.0 | .0 | .0 | .0 | .0 | .0 |
| 64 | .1 | 575.6 | .0 | 247.4 | .0 | .0 | .0 | .0 | .0 |
| 65 | .2 | 1098.6 | .0 | 468.9 | .0 | .0 | .0 | .0 | .0 |
| 66 | .0 | 48.5 | .0 | 20.6 | .0 | .0 | .0 | .0 | .0 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 67 | 1.6 | 11390.8 | .0 | 4618.0 | .0 | .0 | .0 | .0 | .0 |
| 68 | .4 | 2519.4 | .0 | 957.7 | .0 | .0 | .0 | .0 | .0 |
| 69 | 1.5 | 9520.9 | .0 | 4907.6 | .0 | .0 | .0 | .0 | .0 |
| 70 | .8 | 4679.6 | .0 | 1176.2 | .0 | .0 | .0 | .0 | .0 |
| 71 | 1.9 | 10598.5 | .0 | 2326.9 | .0 | .0 | .0 | .0 | .0 |
| 72 | 3.4 | 17664.3 | .0 | 2266.6 | .0 | .0 | .0 | .0 | .0 |
| 73 | .7 | 3411.3 | .0 | 398.5 | .0 | .0 | .0 | .0 | .0 |
| 74 | 1.9 | 9286.4 | .0 | 629.0 | .0 | .0 | .0 | .0 | .0 |
| 75 | .9 | 3989.3 | .0 | 52.7 | .0 | .0 | .0 | .0 | .0 |
| 76 | 2.1 | 9616.6 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 77 | 3.5 | 15558.7 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 78 | 2.8 | 12055.9 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 79 | 2.7 | 11079.8 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 80 | .1 | 315.5 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 81 | .6 | 2488.4 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 82 | .3 | 1249.6 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 83 | 2.1 | 8228.1 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 84 | .3 | 1274.2 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 85 | .2 | 641.1 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 86 | 1.3 | 4685.7 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 87 | .8 | 2815.2 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 88 | 3.4 | 11474.7 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 89 | 3.4 | 10826.3 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 90 | 1.1 | 3275.6 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 91 | 1.3 | 3542.7 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 92 | 3.4 | 8715.9 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 93 | 2.6 | 6141.8 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 94 | 2.4 | 5294.5 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 95 | .4 | 795.1 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 96 | .1 | 192.0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 97 | .2 | 403.6 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 98 | .5 | 984.7 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 99 | 3.0 | 5943.2 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 100 | 3.5 | 6112.6 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 101 | 3.5 | 5392.3 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 102 | 2.0 | 2623.6 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 103 | 3.4 | 3685.6 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 104 | 1.2 | 1006.8 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 105 | 1.4 | 786.3 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 106 | .7 | 272.3 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 107 | .8 | 239.5 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 108 | .4 | 90.3 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 109 | 1.1 | 154.8 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 110 | .1 | 3.1 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |

Failure Surface Specified By 41 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 71.79 | 86.00 |
| 2 | 72.25 | 85.82 |
| 3 | 75.83 | 82.32 |
| 4 | 79.94 | 79.48 |
| 5 | 83.47 | 75.94 |
| 6 | 87.11 | 72.51 |
| 7 | 90.69 | 69.02 |
| 8 | 95.46 | 67.53 |
| 9 | 100.45 | 67.19 |
| 10 | 105.39 | 66.44 |
| 11 | 110.19 | 65.04 |
| 12 | 115.18 | 64.65 |
| 13 | 119.75 | 62.63 |
| 14 | 322.45 | 59.52 |
| 15 | 324.72 | 63.98 |
| 16 | 326.22 | 68.74 |
| 17 | 328.88 | 72.98 |
| 18 | 332.25 | 76.67 |
| 19 | 334.88 | 80.92 |
| 20 | 337.83 | 84.96 |
| 21 | 341.32 | 88.54 |
| 22 | 344.14 | 92.67 |
| 23 | 346.92 | 96.83 |

```
    24         350.32      100.49
    25         352.58      104.95
    26         355.98      108.62
    27         359.33      112.33
    28         360.42      117.21
    29         361.71      122.04
    30         365.14      125.67
    31         367.75      129.94
    32         371.26      133.50
    33         374.27      137.49
    34         377.75      141.09
    35         381.22      144.68
    36         383.22      149.27
    37         386.64      152.91
    38         387.86      157.76
    39         389.30      162.54
    40         392.37      166.50
    41         392.46      167.12
       ***      1.669   ***
Failure Surface Specified By 41 Coordinate Points
  Point      X-Surf      Y-Surf
    No.        (ft)        (ft)
     1         71.79       86.00
     2         72.25       85.82
     3         75.83       82.32
     4         79.94       79.48
     5         83.47       75.94
     6         87.11       72.51
     7         90.69       69.02
     8         95.46       67.53
     9        100.45       67.19
    10        105.39       66.44
    11        110.19       65.04
    12        115.18       64.65
    13        119.75       62.63
    14        322.45       59.52
    15        324.72       63.98
    16        326.22       68.74
    17        328.88       72.98
    18        332.25       76.67
    19        334.88       80.92
    20        337.83       84.96
    21        341.32       88.54
    22        344.14       92.67
    23        346.92       96.83
    24        350.32      100.49
    25        352.58      104.95
    26        355.98      108.62
    27        359.33      112.33
    28        360.42      117.21
    29        361.71      122.04
    30        365.14      125.67
    31        367.75      129.94
    32        371.26      133.50
    33        374.27      137.49
    34        377.75      141.09
    35        381.22      144.68
    36        383.22      149.27
    37        386.64      152.91
    38        387.86      157.76
    39        389.30      162.54
    40        392.37      166.50
    41        392.46      167.12
       ***      1.669   ***
Failure Surface Specified By 41 Coordinate Points
  Point      X-Surf      Y-Surf
    No.        (ft)        (ft)
     1         71.79       86.00
     2         72.25       85.82
     3         75.83       82.32
```

| | | |
|---|---|---|
| 4 | 79.94 | 79.48 |
| 5 | 83.47 | 75.94 |
| 6 | 87.11 | 72.51 |
| 7 | 90.69 | 69.02 |
| 8 | 95.46 | 67.53 |
| 9 | 100.45 | 67.19 |
| 10 | 105.39 | 66.44 |
| 11 | 110.19 | 65.04 |
| 12 | 115.18 | 64.65 |
| 13 | 119.75 | 62.63 |
| 14 | 322.45 | 59.52 |
| 15 | 324.72 | 63.98 |
| 16 | 326.22 | 68.74 |
| 17 | 328.88 | 72.98 |
| 18 | 332.25 | 76.67 |
| 19 | 334.88 | 80.92 |
| 20 | 337.83 | 84.96 |
| 21 | 341.32 | 88.54 |
| 22 | 344.14 | 92.67 |
| 23 | 346.92 | 96.83 |
| 24 | 350.32 | 100.49 |
| 25 | 352.58 | 104.95 |
| 26 | 355.98 | 108.62 |
| 27 | 359.33 | 112.33 |
| 28 | 360.42 | 117.21 |
| 29 | 361.71 | 122.04 |
| 30 | 365.14 | 125.67 |
| 31 | 367.75 | 129.94 |
| 32 | 371.26 | 133.50 |
| 33 | 374.27 | 137.49 |
| 34 | 377.75 | 141.09 |
| 35 | 381.22 | 144.68 |
| 36 | 383.22 | 149.27 |
| 37 | 386.64 | 152.91 |
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| 10 | 105.39 | 66.44 |
| 11 | 110.19 | 65.04 |
| 12 | 115.18 | 64.65 |
| 13 | 119.75 | 62.63 |
| 14 | 322.45 | 59.52 |
| 15 | 324.72 | 63.98 |
| 16 | 326.22 | 68.74 |
| 17 | 328.88 | 72.98 |
| 18 | 332.25 | 76.67 |
| 19 | 334.88 | 80.92 |
| 20 | 337.83 | 84.96 |
| 21 | 341.32 | 88.54 |
| 22 | 344.14 | 92.67 |
| 23 | 346.92 | 96.83 |
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| 25 | 352.58 | 104.95 |
| 26 | 355.98 | 108.62 |
| 27 | 359.33 | 112.33 |
| 28 | 360.42 | 117.21 |

| | | |
|---|---|---|
| 29 | 361.71 | 122.04 |
| 30 | 365.14 | 125.67 |
| 31 | 367.75 | 129.94 |
| 32 | 371.26 | 133.50 |
| 33 | 374.27 | 137.49 |
| 34 | 377.75 | 141.09 |
| 35 | 381.22 | 144.68 |
| 36 | 383.22 | 149.27 |
| 37 | 386.64 | 152.91 |
| 38 | 387.86 | 157.76 |
| 39 | 389.30 | 162.54 |
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| 12 | 115.18 | 64.65 |
| 13 | 119.75 | 62.63 |
| 14 | 322.45 | 59.52 |
| 15 | 324.72 | 63.98 |
| 16 | 326.22 | 68.74 |
| 17 | 328.88 | 72.98 |
| 18 | 332.25 | 76.67 |
| 19 | 334.88 | 80.92 |
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| 21 | 341.32 | 88.54 |
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| 23 | 346.92 | 96.83 |
| 24 | 350.32 | 100.49 |
| 25 | 352.58 | 104.95 |
| 26 | 355.98 | 108.62 |
| 27 | 359.33 | 112.33 |
| 28 | 360.42 | 117.21 |
| 29 | 361.71 | 122.04 |
| 30 | 365.14 | 125.67 |
| 31 | 367.75 | 129.94 |
| 32 | 371.26 | 133.50 |
| 33 | 374.27 | 137.49 |
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| 35 | 381.22 | 144.68 |
| 36 | 383.22 | 149.27 |
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| 5 | 83.47 | 75.94 |
| 6 | 87.11 | 72.51 |
| 7 | 90.69 | 69.02 |
| 8 | 95.46 | 67.53 |

| | | |
|---|---|---|
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| 12 | 115.18 | 64.65 |
| 13 | 119.75 | 62.63 |
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| 29 | 361.71 | 122.04 |
| 30 | 365.14 | 125.67 |
| 31 | 367.75 | 129.94 |
| 32 | 371.26 | 133.50 |
| 33 | 374.27 | 137.49 |
| 34 | 377.75 | 141.09 |
| 35 | 381.22 | 144.68 |
| 36 | 383.22 | 149.27 |
| 37 | 386.64 | 152.91 |
| 38 | 387.86 | 157.76 |
| 39 | 389.30 | 162.54 |
| 40 | 392.37 | 166.50 |
| 41 | 392.46 | 167.12 |

*** 1.669 ***

Failure Surface Specified By 41 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 71.79 | 86.00 |
| 2 | 72.25 | 85.82 |
| 3 | 75.83 | 82.32 |
| 4 | 79.94 | 79.48 |
| 5 | 83.47 | 75.94 |
| 6 | 87.11 | 72.51 |
| 7 | 90.69 | 69.02 |
| 8 | 95.46 | 67.53 |
| 9 | 100.45 | 67.19 |
| 10 | 105.39 | 66.44 |
| 11 | 110.19 | 65.04 |
| 12 | 115.18 | 64.65 |
| 13 | 119.75 | 62.63 |
| 14 | 322.45 | 59.52 |
| 15 | 324.72 | 63.98 |
| 16 | 326.22 | 68.74 |
| 17 | 328.88 | 72.98 |
| 18 | 332.25 | 76.67 |
| 19 | 334.88 | 80.92 |
| 20 | 337.83 | 84.96 |
| 21 | 341.32 | 88.54 |
| 22 | 344.14 | 92.67 |
| 23 | 346.92 | 96.83 |
| 24 | 350.32 | 100.49 |
| 25 | 352.58 | 104.95 |
| 26 | 355.98 | 108.62 |
| 27 | 359.33 | 112.33 |
| 28 | 360.42 | 117.21 |
| 29 | 361.71 | 122.04 |
| 30 | 365.14 | 125.67 |
| 31 | 367.75 | 129.94 |
| 32 | 371.26 | 133.50 |
| 33 | 374.27 | 137.49 |

| | | |
|---|---|---|
| 34 | 377.75 | 141.09 |
| 35 | 381.22 | 144.68 |
| 36 | 383.22 | 149.27 |
| 37 | 386.64 | 152.91 |
| 38 | 387.86 | 157.76 |
| 39 | 389.30 | 162.54 |
| 40 | 392.37 | 166.50 |
| 41 | 392.46 | 167.12 |

*** 1.669 ***

Failure Surface Specified By 32 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 27.94 | 86.00 |
| 2 | 29.50 | 85.14 |
| 3 | 33.68 | 82.39 |
| 4 | 38.04 | 79.95 |
| 5 | 41.94 | 76.82 |
| 6 | 46.84 | 75.83 |
| 7 | 51.84 | 75.82 |
| 8 | 56.68 | 74.55 |
| 9 | 60.66 | 71.53 |
| 10 | 65.08 | 69.18 |
| 11 | 251.22 | 66.93 |
| 12 | 254.71 | 70.51 |
| 13 | 258.10 | 74.18 |
| 14 | 260.09 | 78.77 |
| 15 | 262.64 | 83.07 |
| 16 | 265.64 | 87.07 |
| 17 | 268.52 | 91.15 |
| 18 | 271.81 | 94.92 |
| 19 | 274.53 | 99.12 |
| 20 | 278.06 | 102.66 |
| 21 | 281.58 | 106.20 |
| 22 | 285.10 | 109.75 |
| 23 | 288.52 | 113.40 |
| 24 | 290.64 | 117.93 |
| 25 | 292.18 | 122.69 |
| 26 | 293.74 | 127.44 |
| 27 | 296.87 | 131.34 |
| 28 | 300.37 | 134.91 |
| 29 | 303.56 | 138.76 |
| 30 | 307.04 | 142.35 |
| 31 | 308.55 | 147.12 |
| 32 | 311.39 | 150.00 |

*** 1.736 ***

Failure Surface Specified By 32 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 27.94 | 86.00 |
| 2 | 29.50 | 85.14 |
| 3 | 33.68 | 82.39 |
| 4 | 38.04 | 79.95 |
| 5 | 41.94 | 76.82 |
| 6 | 46.84 | 75.83 |
| 7 | 51.84 | 75.82 |
| 8 | 56.68 | 74.55 |
| 9 | 60.66 | 71.53 |
| 10 | 65.08 | 69.18 |
| 11 | 251.22 | 66.93 |
| 12 | 254.71 | 70.51 |
| 13 | 258.10 | 74.18 |
| 14 | 260.09 | 78.77 |
| 15 | 262.64 | 83.07 |
| 16 | 265.64 | 87.07 |
| 17 | 268.52 | 91.15 |
| 18 | 271.81 | 94.92 |
| 19 | 274.53 | 99.12 |
| 20 | 278.06 | 102.66 |
| 21 | 281.58 | 106.20 |
| 22 | 285.10 | 109.75 |

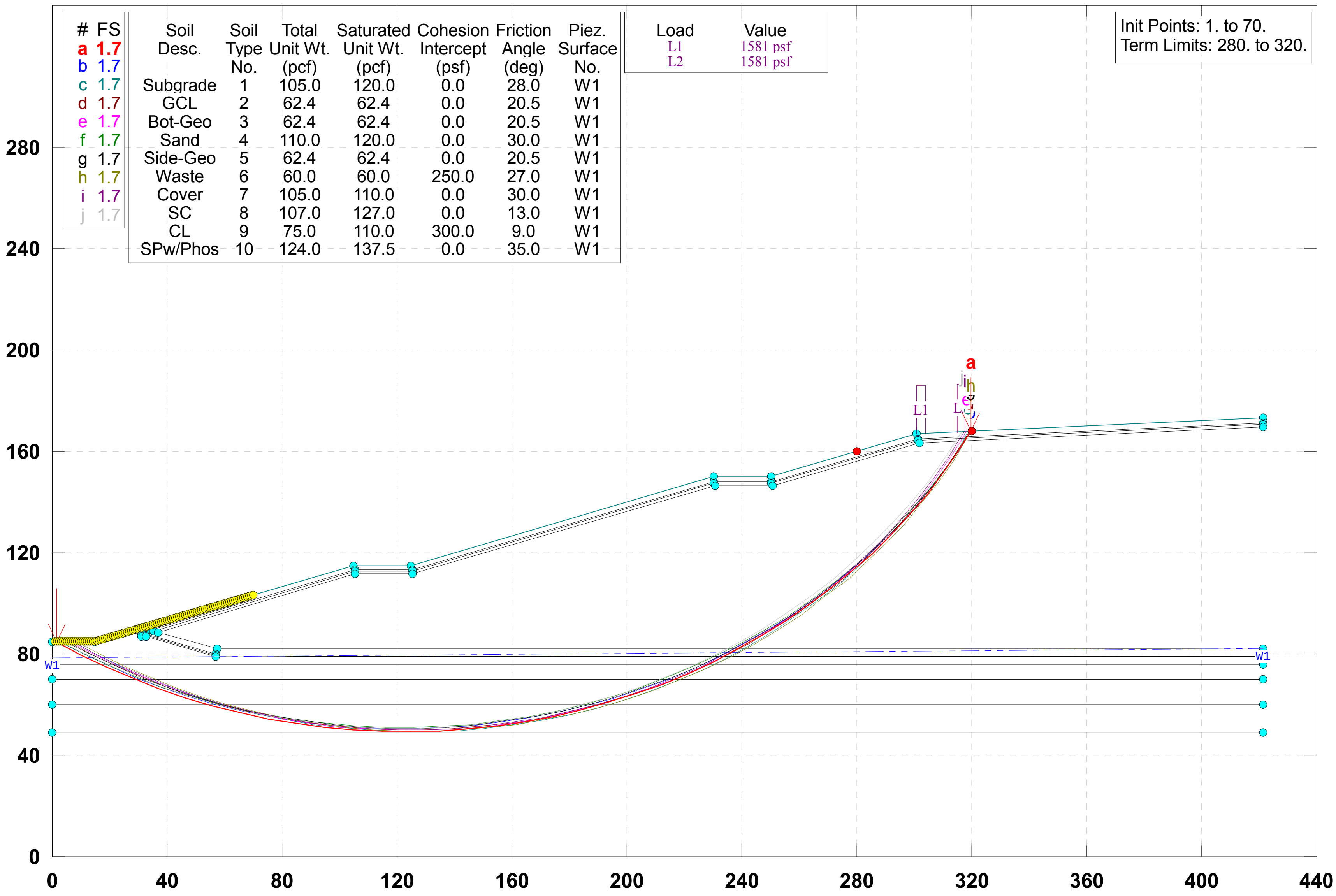
| | | |
|---|---|---|
| 23 | 288.52 | 113.40 |
| 24 | 290.64 | 117.93 |
| 25 | 292.18 | 122.69 |
| 26 | 293.74 | 127.44 |
| 27 | 296.87 | 131.34 |
| 28 | 300.37 | 134.91 |
| 29 | 303.56 | 138.76 |
| 30 | 307.04 | 142.35 |
| 31 | 308.55 | 147.12 |
| 32 | 311.39 | 150.00 |
| *** | 1.736 | *** |

# Slope Stability Analysis
# Phase II Section I East Final Buildout

## Circular Analysis With and Without Equipment Loading

## Hardee Landfill Phase II Section I RAI 1Height Increase East Slope Operation

C:\1\HARDEE~1.1\1HARDE~1.1\EWCILO~1\EWSECCIL.PL2   Run By: Shane R. Fischer, P.E.   03/31/13   7:01AM




**PCSTABL5M/si FSmin=1.7**

**Safety Factors Are Calculated By The Modified Bishop Method**

SCS ENGINEERS

**** PCSTABL5M ****
by
Purdue University
--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer`s Method of Slices

Run Date: 03/31/13
Time of Run: 7:01AM
Run By: Shane R. Fischer, P.E.
Input Data Filename: C:ewseccil.
Output Filename: C:ewseccil.OUT
Unit: ENGLISH
Plotted Output Filename: C:ewseccil.PLT
PROBLEM DESCRIPTION Hardee Landfill Phase II Section I RAI 1
Height Increase East Slope Operation

BOUNDARY COORDINATES
9 Top Boundaries
46 Total Boundaries

| Boundary No. | X-Left (ft) | Y-Left (ft) | X-Right (ft) | Y-Right (ft) | Soil Type Below Bnd |
|---|---|---|---|---|---|
| 1 | .00 | 85.00 | 15.00 | 85.00 | 1 |
| 2 | 15.00 | 85.00 | 24.00 | 88.00 | 1 |
| 3 | 24.00 | 88.00 | 31.58 | 90.52 | 4 |
| 4 | 31.58 | 90.52 | 105.00 | 115.00 | 7 |
| 5 | 105.00 | 115.00 | 125.00 | 115.00 | 7 |
| 6 | 125.00 | 115.00 | 230.00 | 150.00 | 7 |
| 7 | 230.00 | 150.00 | 250.00 | 150.00 | 7 |
| 8 | 250.00 | 150.00 | 300.95 | 166.98 | 7 |
| 9 | 300.95 | 166.98 | 421.22 | 173.20 | 7 |
| 10 | 31.58 | 90.52 | 34.74 | 89.47 | 4 |
| 11 | 34.74 | 89.47 | 105.32 | 113.00 | 5 |
| 12 | 105.32 | 113.00 | 125.32 | 113.00 | 5 |
| 13 | 125.32 | 113.00 | 230.32 | 148.00 | 5 |
| 14 | 230.32 | 148.00 | 250.32 | 148.00 | 5 |
| 15 | 250.32 | 148.00 | 301.32 | 165.00 | 5 |
| 16 | 301.32 | 165.00 | 421.32 | 171.00 | 5 |
| 17 | 34.74 | 89.47 | 35.53 | 89.20 | 4 |
| 18 | 35.53 | 89.20 | 105.40 | 112.50 | 7 |
| 19 | 105.40 | 112.50 | 125.40 | 112.50 | 7 |
| 20 | 125.40 | 112.50 | 230.40 | 147.50 | 7 |
| 21 | 230.40 | 147.50 | 250.40 | 147.50 | 7 |
| 22 | 250.40 | 147.50 | 301.41 | 164.50 | 7 |
| 23 | 301.41 | 164.50 | 421.34 | 170.50 | 7 |
| 24 | 35.53 | 89.20 | 37.11 | 88.68 | 4 |
| 25 | 37.11 | 88.68 | 105.56 | 111.50 | 6 |
| 26 | 105.56 | 111.50 | 125.56 | 111.50 | 6 |
| 27 | 125.56 | 111.50 | 230.56 | 146.50 | 6 |
| 28 | 230.56 | 146.50 | 250.56 | 146.50 | 6 |
| 29 | 250.56 | 146.50 | 301.60 | 163.51 | 6 |
| 30 | 301.60 | 163.51 | 421.39 | 169.50 | 6 |
| 31 | 37.11 | 88.68 | 57.16 | 82.00 | 4 |
| 32 | 57.16 | 82.00 | 421.32 | 82.00 | 4 |
| 33 | 24.00 | 88.00 | 30.83 | 88.00 | 3 |
| 34 | 30.83 | 88.00 | 32.83 | 88.00 | 3 |
| 35 | 32.83 | 88.00 | 56.83 | 80.00 | 3 |
| 36 | 56.83 | 80.00 | 421.32 | 80.00 | 3 |
| 37 | 30.83 | 87.53 | 32.67 | 87.53 | 2 |
| 38 | 32.67 | 87.53 | 56.86 | 79.50 | 2 |
| 39 | 56.86 | 79.50 | 421.32 | 79.50 | 2 |
| 40 | 30.83 | 87.03 | 32.59 | 87.03 | 1 |
| 41 | 32.59 | 87.03 | 56.77 | 79.00 | 1 |
| 42 | 56.77 | 79.00 | 421.32 | 79.00 | 1 |
| 43 | .00 | 76.00 | 421.32 | 76.00 | 1 |
| 44 | .00 | 70.00 | 421.32 | 70.00 | 8 |
| 45 | .00 | 60.00 | 421.32 | 60.00 | 9 |
| 46 | .00 | 49.00 | 421.32 | 49.00 | 10 |

ISOTROPIC SOIL PARAMETERS
10 Type(s) of Soil

| Soil Type | Total Unit Wt. | Saturated Unit Wt. | Cohesion Intercept | Friction Angle | Pore Pressure | Pressure Constant | Piez. Surface |
|---|---|---|---|---|---|---|---|

| No. | (pcf) | (pcf) | (psf) | (deg) | Param. | (psf) | No. |
|---|---|---|---|---|---|---|---|
| 1 | 105.0 | 120.0 | .0 | 28.0 | .00 | .0 | 1 |
| 2 | 62.4 | 62.4 | .0 | 20.5 | .00 | .0 | 1 |
| 3 | 62.4 | 62.4 | .0 | 20.5 | .00 | .0 | 1 |
| 4 | 110.0 | 120.0 | .0 | 30.0 | .00 | .0 | 1 |
| 5 | 62.4 | 62.4 | .0 | 20.5 | .00 | .0 | 1 |
| 6 | 60.0 | 60.0 | 250.0 | 27.0 | .00 | .0 | 1 |
| 7 | 105.0 | 110.0 | .0 | 30.0 | .00 | .0 | 1 |
| 8 | 107.0 | 127.0 | .0 | 13.0 | .00 | .0 | 1 |
| 9 | 75.0 | 110.0 | 300.0 | 9.0 | .00 | .0 | 1 |
| 10 | 124.0 | 137.5 | .0 | 35.0 | .00 | .0 | 1 |

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED
Unit Weight of Water = 62.40
Piezometric Surface No. 1 Specified by 2 Coordinate Points

| Point No. | X-Water (ft) | Y-Water (ft) |
|---|---|---|
| 1 | .00 | 78.50 |
| 2 | 421.32 | 82.09 |

BOUNDARY LOAD(S)
2 Load(s) Specified

| Load No. | X-Left (ft) | X-Right (ft) | Intensity (psf) | Deflection (deg) |
|---|---|---|---|---|
| 1 | 300.95 | 303.91 | 1581.0 | .0 |
| 2 | 314.90 | 317.87 | 1581.0 | .0 |

NOTE - Intensity Is Specified As A Uniformly Distributed
Force Acting On A Horizontally Projected Surface.
A Critical Failure Surface Searching Method, Using A Random
Technique For Generating Circular Surfaces, Has Been Specified.
5000 Trial Surfaces Have Been Generated.
50 Surfaces Initiate From Each Of100 Points Equally Spaced
Along The Ground Surface Between X = 1.00 ft.
and X = 70.00 ft.
Each Surface Terminates Between X = 280.00 ft.
and X = 320.00 ft.
Unless Further Limitations Were Imposed, The Minimum Elevation
At Which A Surface Extends Is Y = .00 ft.
10.00 ft. Line Segments Define Each Trial Failure Surface.
Following Are Displayed The Ten Most Critical Of The Trial
Failure Surfaces Examined. They Are Ordered - Most Critical
First.
* * Safety Factors Are Calculated By The Modified Bishop Method * *
Failure Surface Specified By 38 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 1.70 | 85.00 |
| 2 | 10.22 | 79.77 |
| 3 | 18.97 | 74.93 |
| 4 | 27.93 | 70.49 |
| 5 | 37.08 | 66.45 |
| 6 | 46.40 | 62.83 |
| 7 | 55.88 | 59.63 |
| 8 | 65.48 | 56.85 |
| 9 | 75.20 | 54.51 |
| 10 | 85.02 | 52.60 |
| 11 | 94.91 | 51.14 |
| 12 | 104.86 | 50.12 |
| 13 | 114.84 | 49.55 |
| 14 | 124.84 | 49.42 |
| 15 | 134.84 | 49.74 |
| 16 | 144.81 | 50.51 |
| 17 | 154.73 | 51.73 |
| 18 | 164.60 | 53.39 |
| 19 | 174.37 | 55.48 |
| 20 | 184.05 | 58.02 |
| 21 | 193.60 | 60.98 |
| 22 | 203.01 | 64.37 |
| 23 | 212.25 | 68.18 |
| 24 | 221.32 | 72.39 |
| 25 | 230.19 | 77.01 |
| 26 | 238.85 | 82.02 |

| | | |
|---|---|---|
| 27 | 247.27 | 87.41 |
| 28 | 255.44 | 93.18 |
| 29 | 263.34 | 99.30 |
| 30 | 270.97 | 105.77 |
| 31 | 278.29 | 112.58 |
| 32 | 285.31 | 119.71 |
| 33 | 291.99 | 127.15 |
| 34 | 298.34 | 134.87 |
| 35 | 304.34 | 142.88 |
| 36 | 309.97 | 151.14 |
| 37 | 315.22 | 159.65 |
| 38 | 319.86 | 167.96 |

Circle Center At X =  122.6 ; Y =  272.7  and Radius,  223.3

*** 1.669 ***

Individual data on the 92 slices

| Slice No. | Width (ft) | Weight (lbs) | Water Force Top (lbs) | Water Force Bot (lbs) | Tie Force Norm (lbs) | Tie Force Tan (lbs) | Earthquake Force Hor (lbs) | Earthquake Force Ver (lbs) | Surcharge Load (lbs) |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 8.5 | 2339.3 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 2 | 2.1 | 1289.2 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 3 | 2.7 | 2024.7 | .0 | 142.1 | .0 | .0 | .0 | .0 | .0 |
| 4 | 2.0 | 1949.4 | .0 | 302.2 | .0 | .0 | .0 | .0 | .0 |
| 5 | 1.9 | 2224.3 | .0 | 437.9 | .0 | .0 | .0 | .0 | .0 |
| 6 | 5.0 | 7487.4 | .0 | 1748.6 | .0 | .0 | .0 | .0 | .0 |
| 7 | 3.9 | 5367.3 | .0 | 1987.2 | .0 | .0 | .0 | .0 | .0 |
| 8 | 1.1 | 1785.3 | .0 | 645.2 | .0 | .0 | .0 | .0 | .0 |
| 9 | 1.8 | 3096.5 | .0 | 1113.0 | .0 | .0 | .0 | .0 | .0 |
| 10 | .8 | 1773.5 | .0 | 497.1 | .0 | .0 | .0 | .0 | .0 |
| 11 | 1.0 | 2469.1 | .0 | 696.7 | .0 | .0 | .0 | .0 | .0 |
| 12 | .1 | 199.4 | .0 | 56.5 | .0 | .0 | .0 | .0 | .0 |
| 13 | .2 | 400.3 | .0 | 113.6 | .0 | .0 | .0 | .0 | .0 |
| 14 | 1.9 | 4956.6 | .0 | 1417.2 | .0 | .0 | .0 | .0 | .0 |
| 15 | .8 | 2138.4 | .0 | 618.9 | .0 | .0 | .0 | .0 | .0 |
| 16 | 1.6 | 4348.1 | .0 | 1271.3 | .0 | .0 | .0 | .0 | .0 |
| 17 | .0 | 81.5 | .0 | 23.5 | .0 | .0 | .0 | .0 | .0 |
| 18 | 9.3 | 29075.3 | .0 | 8845.4 | .0 | .0 | .0 | .0 | .0 |
| 19 | 8.4 | 30003.1 | .0 | 9658.0 | .0 | .0 | .0 | .0 | .0 |
| 20 | 1.1 | 4197.9 | .0 | 1390.7 | .0 | .0 | .0 | .0 | .0 |
| 21 | .9 | 3444.1 | .0 | 1132.3 | .0 | .0 | .0 | .0 | .0 |
| 22 | .1 | 232.0 | .0 | 76.5 | .0 | .0 | .0 | .0 | .0 |
| 23 | .0 | 116.1 | .0 | 38.3 | .0 | .0 | .0 | .0 | .0 |
| 24 | .3 | 1162.4 | .0 | 383.6 | .0 | .0 | .0 | .0 | .0 |
| 25 | 1.5 | 5956.7 | .0 | 1969.9 | .0 | .0 | .0 | .0 | .0 |
| 26 | 6.8 | 28129.8 | .0 | 9364.2 | .0 | .0 | .0 | .0 | .0 |
| 27 | 9.7 | 44112.1 | .0 | 14612.9 | .0 | .0 | .0 | .0 | .0 |
| 28 | 9.8 | 48756.4 | .0 | 15990.1 | .0 | .0 | .0 | .0 | .0 |
| 29 | 9.9 | 52914.9 | .0 | 17093.6 | .0 | .0 | .0 | .0 | .0 |
| 30 | 9.9 | 56545.9 | .0 | 17921.1 | .0 | .0 | .0 | .0 | .0 |
| 31 | .1 | 812.0 | .0 | 254.4 | .0 | .0 | .0 | .0 | .0 |
| 32 | .3 | 1869.5 | .0 | 585.9 | .0 | .0 | .0 | .0 | .0 |
| 33 | .1 | 467.3 | .0 | 146.5 | .0 | .0 | .0 | .0 | .0 |
| 34 | .2 | 934.4 | .0 | 293.1 | .0 | .0 | .0 | .0 | .0 |
| 35 | 9.3 | 54491.6 | .0 | 17191.1 | .0 | .0 | .0 | .0 | .0 |
| 36 | 2.5 | 14838.1 | .0 | 4701.4 | .0 | .0 | .0 | .0 | .0 |
| 37 | 7.5 | 44210.1 | .0 | 14040.7 | .0 | .0 | .0 | .0 | .0 |
| 38 | .2 | 923.6 | .0 | 294.0 | .0 | .0 | .0 | .0 | .0 |
| 39 | .3 | 1893.3 | .0 | 602.0 | .0 | .0 | .0 | .0 | .0 |
| 40 | .1 | 473.8 | .0 | 150.5 | .0 | .0 | .0 | .0 | .0 |
| 41 | .2 | 948.1 | .0 | 300.9 | .0 | .0 | .0 | .0 | .0 |
| 42 | 9.3 | 55712.8 | .0 | 17386.5 | .0 | .0 | .0 | .0 | .0 |
| 43 | 10.0 | 61200.0 | .0 | 18446.5 | .0 | .0 | .0 | .0 | .0 |
| 44 | 9.9 | 61819.0 | .0 | 17880.4 | .0 | .0 | .0 | .0 | .0 |
| 45 | 9.9 | 61811.5 | .0 | 17036.7 | .0 | .0 | .0 | .0 | .0 |
| 46 | 9.8 | 61184.9 | .0 | 15917.2 | .0 | .0 | .0 | .0 | .0 |
| 47 | 1.7 | 10378.7 | .0 | 2609.0 | .0 | .0 | .0 | .0 | .0 |
| 48 | 8.0 | 49577.5 | .0 | 11915.0 | .0 | .0 | .0 | .0 | .0 |
| 49 | 6.4 | 39043.9 | .0 | 8802.5 | .0 | .0 | .0 | .0 | .0 |
| 50 | 3.2 | 19079.1 | .0 | 4057.5 | .0 | .0 | .0 | .0 | .0 |
| 51 | 9.4 | 55359.6 | .0 | 10928.6 | .0 | .0 | .0 | .0 | .0 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 52 | 9.2 | 51919.3 | .0 | 8733.5 | .0 | .0 | .0 | .0 | .0 |
| 53 | 3.9 | 21143.3 | .0 | 3033.8 | .0 | .0 | .0 | .0 | .0 |
| 54 | 5.1 | 26858.9 | .0 | 3245.5 | .0 | .0 | .0 | .0 | .0 |
| 55 | 6.9 | 34524.4 | .0 | 3031.8 | .0 | .0 | .0 | .0 | .0 |
| 56 | 1.7 | 8390.7 | .0 | 491.7 | .0 | .0 | .0 | .0 | .0 |
| 57 | .2 | 910.8 | .0 | 47.2 | .0 | .0 | .0 | .0 | .0 |
| 58 | .1 | 608.8 | .0 | 31.6 | .0 | .0 | .0 | .0 | .0 |
| 59 | .1 | 378.6 | .0 | 19.3 | .0 | .0 | .0 | .0 | .0 |
| 60 | .2 | 755.7 | .0 | 37.9 | .0 | .0 | .0 | .0 | .0 |
| 61 | 3.1 | 14145.0 | .0 | 523.4 | .0 | .0 | .0 | .0 | .0 |
| 62 | .9 | 3875.8 | .0 | 77.5 | .0 | .0 | .0 | .0 | .0 |
| 63 | .9 | 3848.9 | .0 | 46.8 | .0 | .0 | .0 | .0 | .0 |
| 64 | .9 | 3907.7 | .0 | 16.1 | .0 | .0 | .0 | .0 | .0 |
| 65 | 2.6 | 11038.9 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 66 | .0 | 151.0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 67 | 8.4 | 34132.5 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 68 | 2.7 | 10477.2 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 69 | .3 | 1207.9 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 70 | .1 | 301.7 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 71 | .2 | 603.4 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 72 | 4.9 | 18127.6 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 73 | 7.9 | 28116.7 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 74 | 7.6 | 25415.9 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 75 | 7.3 | 22600.7 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 76 | 7.0 | 19711.2 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 77 | 6.7 | 16788.9 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 78 | 6.3 | 13876.3 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 79 | 2.6 | 5060.0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 80 | .4 | 682.4 | .0 | .0 | .0 | .0 | .0 | .0 | 585.0 |
| 81 | .1 | 164.2 | .0 | .0 | .0 | .0 | .0 | .0 | 142.3 |
| 82 | .2 | 344.3 | .0 | .0 | .0 | .0 | .0 | .0 | 300.4 |
| 83 | 2.3 | 3961.2 | .0 | .0 | .0 | .0 | .0 | .0 | 3652.1 |
| 84 | .4 | 686.1 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 85 | 5.6 | 7626.0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 86 | 4.9 | 4358.2 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 87 | .3 | 205.8 | .0 | .0 | .0 | .0 | .0 | .0 | 511.0 |
| 88 | 2.6 | 1265.3 | .0 | .0 | .0 | .0 | .0 | .0 | 4120.8 |
| 89 | .0 | 13.9 | .0 | .0 | .0 | .0 | .0 | .0 | 63.7 |
| 90 | .5 | 156.3 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 91 | .3 | 66.1 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 92 | 1.2 | 124.1 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |

Failure Surface Specified By 38 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 2.39 | 85.00 |
| 2 | 10.98 | 79.87 |
| 3 | 19.78 | 75.12 |
| 4 | 28.78 | 70.77 |
| 5 | 37.97 | 66.82 |
| 6 | 47.32 | 63.28 |
| 7 | 56.82 | 60.16 |
| 8 | 66.45 | 57.47 |
| 9 | 76.20 | 55.21 |
| 10 | 86.03 | 53.38 |
| 11 | 95.93 | 51.99 |
| 12 | 105.88 | 51.05 |
| 13 | 115.87 | 50.54 |
| 14 | 125.87 | 50.48 |
| 15 | 135.86 | 50.87 |
| 16 | 145.83 | 51.69 |
| 17 | 155.75 | 52.96 |
| 18 | 165.60 | 54.67 |
| 19 | 175.37 | 56.81 |
| 20 | 185.03 | 59.39 |
| 21 | 194.57 | 62.39 |
| 22 | 203.97 | 65.81 |
| 23 | 213.20 | 69.65 |
| 24 | 222.26 | 73.89 |
| 25 | 231.12 | 78.53 |
| 26 | 239.76 | 83.56 |

| | | |
|---|---|---|
| 27 | 248.17 | 88.97 |
| 28 | 256.33 | 94.75 |
| 29 | 264.23 | 100.88 |
| 30 | 271.85 | 107.36 |
| 31 | 279.17 | 114.17 |
| 32 | 286.18 | 121.30 |
| 33 | 292.87 | 128.73 |
| 34 | 299.23 | 136.45 |
| 35 | 305.23 | 144.45 |
| 36 | 310.87 | 152.71 |
| 37 | 316.14 | 161.20 |
| 38 | 319.93 | 167.96 |

Circle Center At X = 122.2 ; Y = 275.5 and Radius, 225.1

*** 1.678 ***

Failure Surface Specified By 38 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 7.27 | 85.00 |
| 2 | 15.74 | 79.69 |
| 3 | 24.45 | 74.77 |
| 4 | 33.38 | 70.26 |
| 5 | 42.50 | 66.17 |
| 6 | 51.81 | 62.51 |
| 7 | 61.27 | 59.28 |
| 8 | 70.88 | 56.50 |
| 9 | 80.60 | 54.16 |
| 10 | 90.42 | 52.27 |
| 11 | 100.32 | 50.84 |
| 12 | 110.27 | 49.88 |
| 13 | 120.26 | 49.37 |
| 14 | 130.26 | 49.33 |
| 15 | 140.25 | 49.75 |
| 16 | 150.21 | 50.63 |
| 17 | 160.12 | 51.97 |
| 18 | 169.96 | 53.77 |
| 19 | 179.70 | 56.03 |
| 20 | 189.33 | 58.73 |
| 21 | 198.82 | 61.87 |
| 22 | 208.16 | 65.46 |
| 23 | 217.32 | 69.47 |
| 24 | 226.28 | 73.90 |
| 25 | 235.03 | 78.74 |
| 26 | 243.55 | 83.98 |
| 27 | 251.81 | 89.61 |
| 28 | 259.81 | 95.62 |
| 29 | 267.52 | 101.99 |
| 30 | 274.92 | 108.71 |
| 31 | 282.01 | 115.76 |
| 32 | 288.76 | 123.14 |
| 33 | 295.16 | 130.82 |
| 34 | 301.20 | 138.79 |
| 35 | 306.86 | 147.04 |
| 36 | 312.14 | 155.53 |
| 37 | 317.02 | 164.26 |
| 38 | 318.84 | 167.91 |

Circle Center At X = 126.2 ; Y = 265.0 and Radius, 215.8

*** 1.679 ***

Failure Surface Specified By 38 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 5.88 | 85.00 |
| 2 | 14.41 | 79.78 |
| 3 | 23.16 | 74.94 |
| 4 | 32.13 | 70.52 |
| 5 | 41.29 | 66.50 |
| 6 | 50.62 | 62.91 |
| 7 | 60.11 | 59.75 |
| 8 | 69.73 | 57.02 |
| 9 | 79.46 | 54.73 |
| 10 | 89.29 | 52.89 |

| | | |
|---|---|---|
| 11 | 99.19 | 51.50 |
| 12 | 109.15 | 50.56 |
| 13 | 119.14 | 50.08 |
| 14 | 129.14 | 50.05 |
| 15 | 139.13 | 50.48 |
| 16 | 149.09 | 51.36 |
| 17 | 159.00 | 52.70 |
| 18 | 168.84 | 54.48 |
| 19 | 178.59 | 56.71 |
| 20 | 188.22 | 59.39 |
| 21 | 197.73 | 62.50 |
| 22 | 207.08 | 66.04 |
| 23 | 216.26 | 70.00 |
| 24 | 225.25 | 74.38 |
| 25 | 234.04 | 79.16 |
| 26 | 242.59 | 84.33 |
| 27 | 250.90 | 89.89 |
| 28 | 258.95 | 95.83 |
| 29 | 266.72 | 102.12 |
| 30 | 274.20 | 108.76 |
| 31 | 281.36 | 115.74 |
| 32 | 288.20 | 123.04 |
| 33 | 294.70 | 130.63 |
| 34 | 300.85 | 138.52 |
| 35 | 306.63 | 146.68 |
| 36 | 312.04 | 155.09 |
| 37 | 317.05 | 163.75 |
| 38 | 319.23 | 167.93 |

Circle Center At X = 124.7 ; Y = 269.3 and Radius, 219.3

*** 1.681 ***

Failure Surface Specified By 38 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 6.58 | 85.00 |
| 2 | 15.08 | 79.73 |
| 3 | 23.81 | 74.86 |
| 4 | 32.76 | 70.40 |
| 5 | 41.90 | 66.35 |
| 6 | 51.23 | 62.73 |
| 7 | 60.71 | 59.55 |
| 8 | 70.32 | 56.80 |
| 9 | 80.05 | 54.51 |
| 10 | 89.88 | 52.66 |
| 11 | 99.78 | 51.27 |
| 12 | 109.74 | 50.33 |
| 13 | 119.73 | 49.86 |
| 14 | 129.73 | 49.85 |
| 15 | 139.72 | 50.30 |
| 16 | 149.68 | 51.21 |
| 17 | 159.58 | 52.57 |
| 18 | 169.42 | 54.40 |
| 19 | 179.15 | 56.67 |
| 20 | 188.78 | 59.39 |
| 21 | 198.26 | 62.56 |
| 22 | 207.59 | 66.15 |
| 23 | 216.75 | 70.17 |
| 24 | 225.71 | 74.62 |
| 25 | 234.45 | 79.47 |
| 26 | 242.97 | 84.71 |
| 27 | 251.23 | 90.35 |
| 28 | 259.22 | 96.36 |
| 29 | 266.93 | 102.73 |
| 30 | 274.33 | 109.45 |
| 31 | 281.42 | 116.50 |
| 32 | 288.17 | 123.88 |
| 33 | 294.58 | 131.56 |
| 34 | 300.63 | 139.52 |
| 35 | 306.30 | 147.76 |
| 36 | 311.59 | 156.25 |
| 37 | 316.48 | 164.97 |

| | | |
|---|---|---|
| 38 | 317.92 | 167.86 |

Circle Center At X = 125.0 ; Y = 266.5 and Radius, 216.7
*** 1.682 ***
Failure Surface Specified By 38 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 2.39 | 85.00 |
| 2 | 11.01 | 79.92 |
| 3 | 19.83 | 75.22 |
| 4 | 28.86 | 70.91 |
| 5 | 38.07 | 67.01 |
| 6 | 47.44 | 63.52 |
| 7 | 56.95 | 60.45 |
| 8 | 66.60 | 57.80 |
| 9 | 76.35 | 55.58 |
| 10 | 86.19 | 53.79 |
| 11 | 96.09 | 52.44 |
| 12 | 106.05 | 51.53 |
| 13 | 116.04 | 51.06 |
| 14 | 126.04 | 51.03 |
| 15 | 136.03 | 51.45 |
| 16 | 146.00 | 52.30 |
| 17 | 155.91 | 53.60 |
| 18 | 165.76 | 55.33 |
| 19 | 175.52 | 57.50 |
| 20 | 185.18 | 60.09 |
| 21 | 194.71 | 63.11 |
| 22 | 204.10 | 66.55 |
| 23 | 213.33 | 70.40 |
| 24 | 222.38 | 74.65 |
| 25 | 231.24 | 79.30 |
| 26 | 239.88 | 84.34 |
| 27 | 248.28 | 89.75 |
| 28 | 256.44 | 95.53 |
| 29 | 264.34 | 101.67 |
| 30 | 271.96 | 108.15 |
| 31 | 279.28 | 114.96 |
| 32 | 286.30 | 122.08 |
| 33 | 292.99 | 129.51 |
| 34 | 299.35 | 137.23 |
| 35 | 305.36 | 145.22 |
| 36 | 311.01 | 153.47 |
| 37 | 316.30 | 161.96 |
| 38 | 319.66 | 167.95 |

Circle Center At X = 121.7 ; Y = 277.1 and Radius, 226.1
*** 1.683 ***
Failure Surface Specified By 38 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 4.49 | 85.00 |
| 2 | 13.07 | 79.87 |
| 3 | 21.87 | 75.13 |
| 4 | 30.88 | 70.78 |
| 5 | 40.07 | 66.85 |
| 6 | 49.43 | 63.33 |
| 7 | 58.94 | 60.23 |
| 8 | 68.58 | 57.56 |
| 9 | 78.33 | 55.33 |
| 10 | 88.17 | 53.54 |
| 11 | 98.07 | 52.19 |
| 12 | 108.03 | 51.28 |
| 13 | 118.02 | 50.83 |
| 14 | 128.02 | 50.82 |
| 15 | 138.01 | 51.25 |
| 16 | 147.97 | 52.14 |
| 17 | 157.88 | 53.47 |
| 18 | 167.73 | 55.24 |
| 19 | 177.48 | 57.46 |
| 20 | 187.12 | 60.10 |
| 21 | 196.64 | 63.18 |

| | | |
|---|---|---|
| 22 | 206.00 | 66.68 |
| 23 | 215.20 | 70.60 |
| 24 | 224.22 | 74.92 |
| 25 | 233.03 | 79.65 |
| 26 | 241.63 | 84.76 |
| 27 | 249.98 | 90.26 |
| 28 | 258.08 | 96.12 |
| 29 | 265.91 | 102.34 |
| 30 | 273.45 | 108.91 |
| 31 | 280.70 | 115.80 |
| 32 | 287.62 | 123.02 |
| 33 | 294.22 | 130.54 |
| 34 | 300.47 | 138.34 |
| 35 | 306.36 | 146.42 |
| 36 | 311.89 | 154.75 |
| 37 | 317.04 | 163.33 |
| 38 | 319.53 | 167.94 |

Circle Center At X = 123.2 ; Y = 273.8 and Radius, 223.0

*** 1.685 ***

Failure Surface Specified By 38 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 8.67 | 85.00 |
| 2 | 17.15 | 79.71 |
| 3 | 25.87 | 74.81 |
| 4 | 34.81 | 70.32 |
| 5 | 43.94 | 66.25 |
| 6 | 53.25 | 62.61 |
| 7 | 62.73 | 59.40 |
| 8 | 72.34 | 56.64 |
| 9 | 82.06 | 54.32 |
| 10 | 91.89 | 52.46 |
| 11 | 101.79 | 51.05 |
| 12 | 111.74 | 50.10 |
| 13 | 121.73 | 49.61 |
| 14 | 131.73 | 49.59 |
| 15 | 141.72 | 50.03 |
| 16 | 151.68 | 50.93 |
| 17 | 161.59 | 52.29 |
| 18 | 171.42 | 54.11 |
| 19 | 181.16 | 56.38 |
| 20 | 190.78 | 59.11 |
| 21 | 200.27 | 62.27 |
| 22 | 209.60 | 65.87 |
| 23 | 218.75 | 69.89 |
| 24 | 227.71 | 74.34 |
| 25 | 236.45 | 79.19 |
| 26 | 244.96 | 84.45 |
| 27 | 253.22 | 90.09 |
| 28 | 261.20 | 96.11 |
| 29 | 268.90 | 102.50 |
| 30 | 276.29 | 109.23 |
| 31 | 283.37 | 116.30 |
| 32 | 290.11 | 123.68 |
| 33 | 296.50 | 131.37 |
| 34 | 302.53 | 139.35 |
| 35 | 308.18 | 147.60 |
| 36 | 313.44 | 156.10 |
| 37 | 318.31 | 164.84 |
| 38 | 319.86 | 167.96 |

Circle Center At X = 127.2 ; Y = 265.4 and Radius, 215.9

*** 1.685 ***

Failure Surface Specified By 38 Coordinate Points

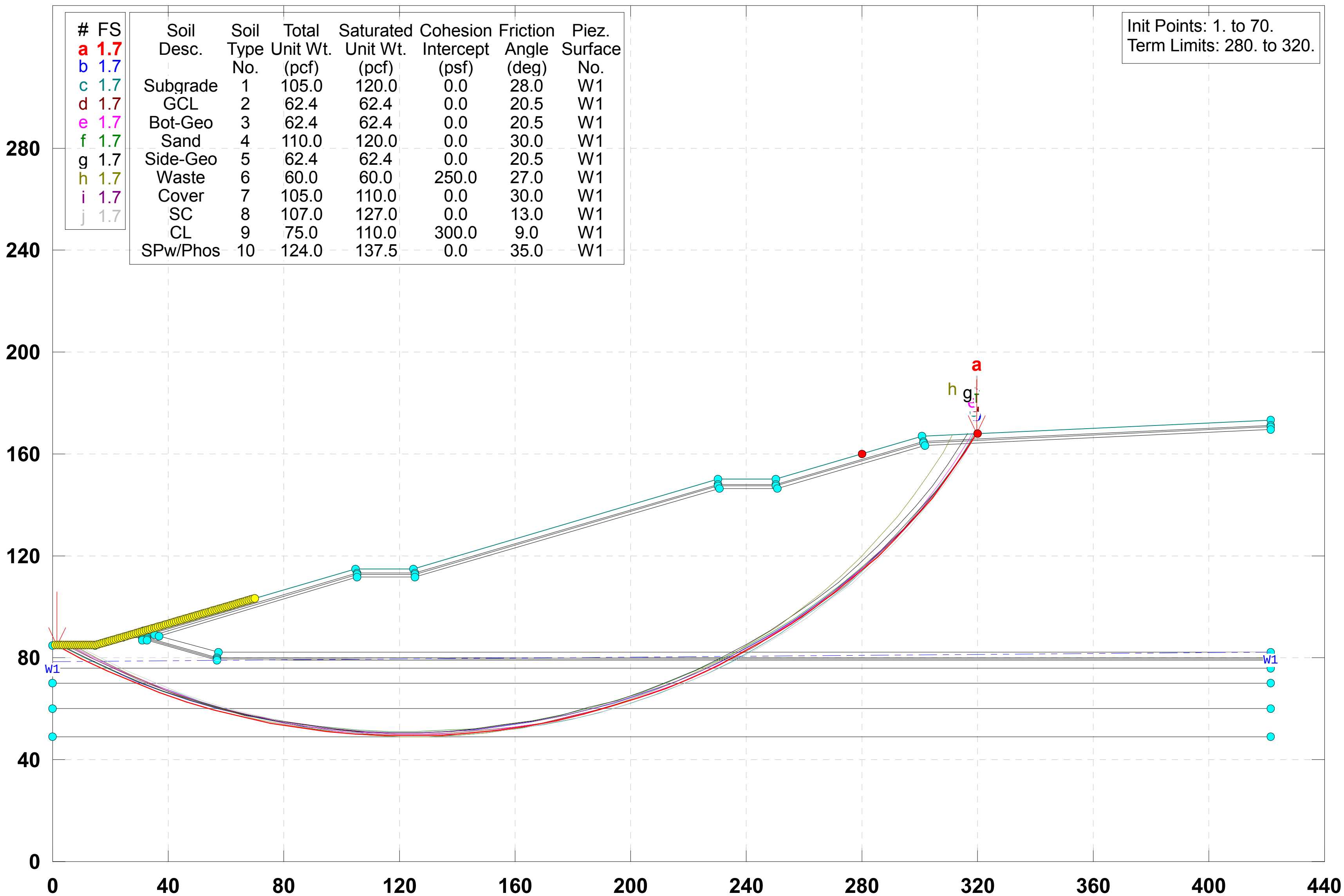
| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 7.27 | 85.00 |
| 2 | 15.79 | 79.76 |
| 3 | 24.53 | 74.91 |
| 4 | 33.50 | 70.47 |
| 5 | 42.65 | 66.46 |

```
     6         51.99       62.87
     7         61.48       59.71
     8         71.10       57.00
     9         80.84       54.74
    10         90.68       52.92
    11        100.59       51.57
    12        110.55       50.67
    13        120.54       50.24
    14        130.54       50.26
    15        140.52       50.75
    16        150.48       51.71
    17        160.38       53.12
    18        170.20       54.98
    19        179.93       57.30
    20        189.54       60.07
    21        199.01       63.27
    22        208.33       66.91
    23        217.46       70.98
    24        226.40       75.47
    25        235.12       80.36
    26        243.60       85.65
    27        251.84       91.33
    28        259.80       97.38
    29        267.47      103.80
    30        274.84      110.56
    31        281.88      117.65
    32        288.59      125.07
    33        294.95      132.78
    34        300.95      140.78
    35        306.57      149.05
    36        311.81      157.58
    37        316.64      166.33
    38        317.38      167.83
Circle Center At X =  124.9 ; Y =  266.4  and Radius,  216.2
      ***     1.691   ***
Failure Surface Specified By 38 Coordinate Points
  Point      X-Surf      Y-Surf
   No.        (ft)        (ft)
     1          3.09       85.00
     2         11.66       79.85
     3         20.46       75.09
     4         29.46       70.73
     5         38.65       66.79
     6         48.01       63.26
     7         57.51       60.16
     8         67.15       57.50
     9         76.90       55.27
    10         86.74       53.48
    11         96.65       52.14
    12        106.61       51.25
    13        116.60       50.81
    14        126.60       50.82
    15        136.59       51.29
    16        146.55       52.20
    17        156.45       53.57
    18        166.29       55.38
    19        176.03       57.63
    20        185.66       60.32
    21        195.16       63.44
    22        204.51       66.99
    23        213.69       70.96
    24        222.68       75.34
    25        231.46       80.12
    26        240.02       85.29
    27        248.34       90.84
    28        256.40       96.77
    29        264.18      103.05
    30        271.67      109.67
    31        278.85      116.63
    32        285.71      123.91
```

```
   33        292.23      131.49
   34        298.41      139.35
   35        304.22      147.49
   36        309.66      155.88
   37        314.72      164.51
   38        316.44      167.78
Circle Center At X =  121.3 ; Y =  271.9  and Radius,  221.2
      ***     1.691   ***
           Y            A     X     I     S            F     T
            .00     52.67    105.35    158.02    210.70    263.37
X       .00 +--------*+*-**W*---+---------+---------+---------+
            -             13
            -            13*.
            -          .13..*
            -         ..1...*.
            -        ..13.....
      52.67 +       ..13..*....
            -      ...1....*...
            -      ...2.........
            -     ...16.........
            -    ....1.........
            -    ....1...........
A    105.35 +    ....1..........**
            -   ....12...........
            -   ....12..........**
            -   ....12...........
            -   ....31............
            -   .....2............
X    158.02 +   .....1.............
            -   .....16............
            -    ....81............
            -    .....1.............
            -     ....31............
            -     .....16............
I    210.70 +      ....31............
            -      .....31............
            -       .....31...........*
            -        .....31...........
            -         .....31.........*
            -          .....31.........*.
S    263.37 +           .....315.........
            -             ....813.........
            -              .....121........
            -                .....216......
            -                   ....319...**/1
            -                      ...1315..1/
     316.04 +                         ..41212/2
F    368.72 +
T    421.39 +       * * ****               **
```

# Hardee Landfill Phase II Section I RAI 1Height Increase East Slope Operation

C:\1\HARDEE~1.1\1HARDE~1.1\EWCI\EWSECCI.PL2 Run By: Shane R. Fischer, P.E. 03/31/13 6:58AM




| # | FS |
|---|---|
| a | 1.7 |
| b | 1.7 |
| c | 1.7 |
| d | 1.7 |
| e | 1.7 |
| f | 1.7 |
| g | 1.7 |
| h | 1.7 |
| i | 1.7 |
| j | 1.7 |

| Soil Desc. | Soil Type No. | Total Unit Wt. (pcf) | Saturated Unit Wt. (pcf) | Cohesion Intercept (psf) | Friction Angle (deg) | Piez. Surface No. |
|---|---|---|---|---|---|---|
| Subgrade | 1 | 105.0 | 120.0 | 0.0 | 28.0 | W1 |
| GCL | 2 | 62.4 | 62.4 | 0.0 | 20.5 | W1 |
| Bot-Geo | 3 | 62.4 | 62.4 | 0.0 | 20.5 | W1 |
| Sand | 4 | 110.0 | 120.0 | 0.0 | 30.0 | W1 |
| Side-Geo | 5 | 62.4 | 62.4 | 0.0 | 20.5 | W1 |
| Waste | 6 | 60.0 | 60.0 | 250.0 | 27.0 | W1 |
| Cover | 7 | 105.0 | 110.0 | 0.0 | 30.0 | W1 |
| SC | 8 | 107.0 | 127.0 | 0.0 | 13.0 | W1 |
| CL | 9 | 75.0 | 110.0 | 300.0 | 9.0 | W1 |
| SPw/Phos | 10 | 124.0 | 137.5 | 0.0 | 35.0 | W1 |

**PCSTABL5M/si FSmin=1.7**

**Safety Factors Are Calculated By The Modified Bishop Method**

SCS ENGINEERS

**** PCSTABL5M ****

by

Purdue University

--Slope Stability Analysis--

Simplified Janbu, Simplified Bishop

or Spencer`s Method of Slices

Run Date: 03/31/13
Time of Run: 6:58AM
Run By: Shane R. Fischer, P.E.
Input Data Filename: C:ewsecci.
Output Filename: C:ewsecci.OUT
Unit: ENGLISH
Plotted Output Filename: C:ewsecci.PLT
PROBLEM DESCRIPTION Hardee Landfill Phase II Section I RAI 1
Height Increase East Slope Operation

BOUNDARY COORDINATES
9 Top Boundaries
46 Total Boundaries

| Boundary No. | X-Left (ft) | Y-Left (ft) | X-Right (ft) | Y-Right (ft) | Soil Type Below Bnd |
|---|---|---|---|---|---|
| 1 | .00 | 85.00 | 15.00 | 85.00 | 1 |
| 2 | 15.00 | 85.00 | 24.00 | 88.00 | 1 |
| 3 | 24.00 | 88.00 | 31.58 | 90.52 | 4 |
| 4 | 31.58 | 90.52 | 105.00 | 115.00 | 7 |
| 5 | 105.00 | 115.00 | 125.00 | 115.00 | 7 |
| 6 | 125.00 | 115.00 | 230.00 | 150.00 | 7 |
| 7 | 230.00 | 150.00 | 250.00 | 150.00 | 7 |
| 8 | 250.00 | 150.00 | 300.95 | 166.98 | 7 |
| 9 | 300.95 | 166.98 | 421.22 | 173.20 | 7 |
| 10 | 31.58 | 90.52 | 34.74 | 89.47 | 4 |
| 11 | 34.74 | 89.47 | 105.32 | 113.00 | 5 |
| 12 | 105.32 | 113.00 | 125.32 | 113.00 | 5 |
| 13 | 125.32 | 113.00 | 230.32 | 148.00 | 5 |
| 14 | 230.32 | 148.00 | 250.32 | 148.00 | 5 |
| 15 | 250.32 | 148.00 | 301.32 | 165.00 | 5 |
| 16 | 301.32 | 165.00 | 421.32 | 171.00 | 5 |
| 17 | 34.74 | 89.47 | 35.53 | 89.20 | 4 |
| 18 | 35.53 | 89.20 | 105.40 | 112.50 | 7 |
| 19 | 105.40 | 112.50 | 125.40 | 112.50 | 7 |
| 20 | 125.40 | 112.50 | 230.40 | 147.50 | 7 |
| 21 | 230.40 | 147.50 | 250.40 | 147.50 | 7 |
| 22 | 250.40 | 147.50 | 301.41 | 164.50 | 7 |
| 23 | 301.41 | 164.50 | 421.34 | 170.50 | 7 |
| 24 | 35.53 | 89.20 | 37.11 | 88.68 | 4 |
| 25 | 37.11 | 88.68 | 105.56 | 111.50 | 6 |
| 26 | 105.56 | 111.50 | 125.56 | 111.50 | 6 |
| 27 | 125.56 | 111.50 | 230.56 | 146.50 | 6 |
| 28 | 230.56 | 146.50 | 250.56 | 146.50 | 6 |
| 29 | 250.56 | 146.50 | 301.60 | 163.51 | 6 |
| 30 | 301.60 | 163.51 | 421.39 | 169.50 | 6 |
| 31 | 37.11 | 88.68 | 57.16 | 82.00 | 4 |
| 32 | 57.16 | 82.00 | 421.32 | 82.00 | 4 |
| 33 | 24.00 | 88.00 | 30.83 | 88.00 | 3 |
| 34 | 30.83 | 88.00 | 32.83 | 88.00 | 3 |
| 35 | 32.83 | 88.00 | 56.83 | 80.00 | 3 |
| 36 | 56.83 | 80.00 | 421.32 | 80.00 | 3 |
| 37 | 30.83 | 87.53 | 32.67 | 87.53 | 2 |
| 38 | 32.67 | 87.53 | 56.86 | 79.50 | 2 |
| 39 | 56.86 | 79.50 | 421.32 | 79.50 | 2 |
| 40 | 30.83 | 87.03 | 32.59 | 87.03 | 1 |
| 41 | 32.59 | 87.03 | 56.77 | 79.00 | 1 |
| 42 | 56.77 | 79.00 | 421.32 | 79.00 | 1 |
| 43 | .00 | 76.00 | 421.32 | 76.00 | 1 |
| 44 | .00 | 70.00 | 421.32 | 70.00 | 8 |
| 45 | .00 | 60.00 | 421.32 | 60.00 | 9 |
| 46 | .00 | 49.00 | 421.32 | 49.00 | 10 |

ISOTROPIC SOIL PARAMETERS
10 Type(s) of Soil

| Soil Type | Total Unit Wt. | Saturated Unit Wt. | Cohesion Intercept | Friction Angle | Pore Pressure | Pressure Constant | Piez. Surface |
|---|---|---|---|---|---|---|---|

| No. | (pcf) | (pcf) | (psf) | (deg) | Param. | (psf) | No. |
|---|---|---|---|---|---|---|---|
| 1 | 105.0 | 120.0 | .0 | 28.0 | .00 | .0 | 1 |
| 2 | 62.4 | 62.4 | .0 | 20.5 | .00 | .0 | 1 |
| 3 | 62.4 | 62.4 | .0 | 20.5 | .00 | .0 | 1 |
| 4 | 110.0 | 120.0 | .0 | 30.0 | .00 | .0 | 1 |
| 5 | 62.4 | 62.4 | .0 | 20.5 | .00 | .0 | 1 |
| 6 | 60.0 | 60.0 | 250.0 | 27.0 | .00 | .0 | 1 |
| 7 | 105.0 | 110.0 | .0 | 30.0 | .00 | .0 | 1 |
| 8 | 107.0 | 127.0 | .0 | 13.0 | .00 | .0 | 1 |
| 9 | 75.0 | 110.0 | 300.0 | 9.0 | .00 | .0 | 1 |
| 10 | 124.0 | 137.5 | .0 | 35.0 | .00 | .0 | 1 |

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED
Unit Weight of Water = 62.40
Piezometric Surface No. 1 Specified by 2 Coordinate Points

| Point No. | X-Water (ft) | Y-Water (ft) |
|---|---|---|
| 1 | .00 | 78.50 |
| 2 | 421.32 | 82.09 |

BOUNDARY LOAD(S)
2 Load(s) Specified

| Load No. | X-Left (ft) | X-Right (ft) | Intensity (psf) | Deflection (deg) |
|---|---|---|---|---|
| 1 | 300.95 | 303.91 | 1581.0 | .0 |
| 2 | 314.90 | 317.87 | 1581.0 | .0 |

NOTE - Intensity Is Specified As A Uniformly Distributed
Force Acting On A Horizontally Projected Surface.
SURCHARGE BOUNDARY LOAD DATA HAS BEEN SUPPRESSED
A Critical Failure Surface Searching Method, Using A Random
Technique For Generating Circular Surfaces, Has Been Specified.
5000 Trial Surfaces Have Been Generated.
50 Surfaces Initiate From Each Of100 Points Equally Spaced
Along The Ground Surface Between X = 1.00 ft.
and X = 70.00 ft.
Each Surface Terminates Between X = 280.00 ft.
and X = 320.00 ft.
Unless Further Limitations Were Imposed, The Minimum Elevation
At Which A Surface Extends Is Y = .00 ft.
10.00 ft. Line Segments Define Each Trial Failure Surface.
Following Are Displayed The Ten Most Critical Of The Trial
Failure Surfaces Examined. They Are Ordered - Most Critical
First.
* * Safety Factors Are Calculated By The Modified Bishop Method * *
Failure Surface Specified By 38 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 1.70 | 85.00 |
| 2 | 10.22 | 79.77 |
| 3 | 18.97 | 74.93 |
| 4 | 27.93 | 70.49 |
| 5 | 37.08 | 66.45 |
| 6 | 46.40 | 62.83 |
| 7 | 55.88 | 59.63 |
| 8 | 65.48 | 56.85 |
| 9 | 75.20 | 54.51 |
| 10 | 85.02 | 52.60 |
| 11 | 94.91 | 51.14 |
| 12 | 104.86 | 50.12 |
| 13 | 114.84 | 49.55 |
| 14 | 124.84 | 49.42 |
| 15 | 134.84 | 49.74 |
| 16 | 144.81 | 50.51 |
| 17 | 154.73 | 51.73 |
| 18 | 164.60 | 53.39 |
| 19 | 174.37 | 55.48 |
| 20 | 184.05 | 58.02 |
| 21 | 193.60 | 60.98 |
| 22 | 203.01 | 64.37 |
| 23 | 212.25 | 68.18 |
| 24 | 221.32 | 72.39 |
| 25 | 230.19 | 77.01 |

| | | |
|---|---|---|
| 26 | 238.85 | 82.02 |
| 27 | 247.27 | 87.41 |
| 28 | 255.44 | 93.18 |
| 29 | 263.34 | 99.30 |
| 30 | 270.97 | 105.77 |
| 31 | 278.29 | 112.58 |
| 32 | 285.31 | 119.71 |
| 33 | 291.99 | 127.15 |
| 34 | 298.34 | 134.87 |
| 35 | 304.34 | 142.88 |
| 36 | 309.97 | 151.14 |
| 37 | 315.22 | 159.65 |
| 38 | 319.86 | 167.96 |

Circle Center At X = 122.6 ; Y = 272.7 and Radius, 223.3

*** 1.704 ***

Individual data on the 89 slices

| Slice No. | Width (ft) | Weight (lbs) | Water Force Top (lbs) | Water Force Bot (lbs) | Tie Force Norm (lbs) | Tie Force Tan (lbs) | Earthquake Force Hor (lbs) | Earthquake Force Ver (lbs) | Surcharge Load (lbs) |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 8.5 | 2339.3 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 2 | 2.1 | 1289.2 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 3 | 2.7 | 2024.7 | .0 | 142.1 | .0 | .0 | .0 | .0 | .0 |
| 4 | 2.0 | 1949.4 | .0 | 302.2 | .0 | .0 | .0 | .0 | .0 |
| 5 | 1.9 | 2224.3 | .0 | 437.9 | .0 | .0 | .0 | .0 | .0 |
| 6 | 5.0 | 7487.4 | .0 | 1748.6 | .0 | .0 | .0 | .0 | .0 |
| 7 | 3.9 | 5367.3 | .0 | 1987.2 | .0 | .0 | .0 | .0 | .0 |
| 8 | 1.1 | 1785.3 | .0 | 645.2 | .0 | .0 | .0 | .0 | .0 |
| 9 | 1.8 | 3096.5 | .0 | 1113.0 | .0 | .0 | .0 | .0 | .0 |
| 10 | .8 | 1773.5 | .0 | 497.1 | .0 | .0 | .0 | .0 | .0 |
| 11 | 1.0 | 2469.1 | .0 | 696.7 | .0 | .0 | .0 | .0 | .0 |
| 12 | .1 | 199.4 | .0 | 56.5 | .0 | .0 | .0 | .0 | .0 |
| 13 | .2 | 400.3 | .0 | 113.6 | .0 | .0 | .0 | .0 | .0 |
| 14 | 1.9 | 4956.6 | .0 | 1417.2 | .0 | .0 | .0 | .0 | .0 |
| 15 | .8 | 2138.4 | .0 | 618.9 | .0 | .0 | .0 | .0 | .0 |
| 16 | 1.6 | 4348.1 | .0 | 1271.3 | .0 | .0 | .0 | .0 | .0 |
| 17 | .0 | 81.5 | .0 | 23.5 | .0 | .0 | .0 | .0 | .0 |
| 18 | 9.3 | 29075.3 | .0 | 8845.4 | .0 | .0 | .0 | .0 | .0 |
| 19 | 8.4 | 30003.1 | .0 | 9658.0 | .0 | .0 | .0 | .0 | .0 |
| 20 | 1.1 | 4197.9 | .0 | 1390.7 | .0 | .0 | .0 | .0 | .0 |
| 21 | .9 | 3444.1 | .0 | 1132.3 | .0 | .0 | .0 | .0 | .0 |
| 22 | .1 | 232.0 | .0 | 76.5 | .0 | .0 | .0 | .0 | .0 |
| 23 | .0 | 116.1 | .0 | 38.3 | .0 | .0 | .0 | .0 | .0 |
| 24 | .3 | 1162.4 | .0 | 383.6 | .0 | .0 | .0 | .0 | .0 |
| 25 | 1.5 | 5956.7 | .0 | 1969.9 | .0 | .0 | .0 | .0 | .0 |
| 26 | 6.8 | 28129.8 | .0 | 9364.2 | .0 | .0 | .0 | .0 | .0 |
| 27 | 9.7 | 44112.1 | .0 | 14612.9 | .0 | .0 | .0 | .0 | .0 |
| 28 | 9.8 | 48756.4 | .0 | 15990.1 | .0 | .0 | .0 | .0 | .0 |
| 29 | 9.9 | 52914.9 | .0 | 17093.6 | .0 | .0 | .0 | .0 | .0 |
| 30 | 9.9 | 56545.9 | .0 | 17921.1 | .0 | .0 | .0 | .0 | .0 |
| 31 | .1 | 812.0 | .0 | 254.4 | .0 | .0 | .0 | .0 | .0 |
| 32 | .3 | 1869.5 | .0 | 585.9 | .0 | .0 | .0 | .0 | .0 |
| 33 | .1 | 467.3 | .0 | 146.5 | .0 | .0 | .0 | .0 | .0 |
| 34 | .2 | 934.4 | .0 | 293.1 | .0 | .0 | .0 | .0 | .0 |
| 35 | 9.3 | 54491.6 | .0 | 17191.1 | .0 | .0 | .0 | .0 | .0 |
| 36 | 2.5 | 14838.1 | .0 | 4701.4 | .0 | .0 | .0 | .0 | .0 |
| 37 | 7.5 | 44210.1 | .0 | 14040.7 | .0 | .0 | .0 | .0 | .0 |
| 38 | .2 | 923.6 | .0 | 294.0 | .0 | .0 | .0 | .0 | .0 |
| 39 | .3 | 1893.3 | .0 | 602.0 | .0 | .0 | .0 | .0 | .0 |
| 40 | .1 | 473.8 | .0 | 150.5 | .0 | .0 | .0 | .0 | .0 |
| 41 | .2 | 948.1 | .0 | 300.9 | .0 | .0 | .0 | .0 | .0 |
| 42 | 9.3 | 55712.8 | .0 | 17386.5 | .0 | .0 | .0 | .0 | .0 |
| 43 | 10.0 | 61200.0 | .0 | 18446.5 | .0 | .0 | .0 | .0 | .0 |
| 44 | 9.9 | 61819.0 | .0 | 17880.4 | .0 | .0 | .0 | .0 | .0 |
| 45 | 9.9 | 61811.5 | .0 | 17036.7 | .0 | .0 | .0 | .0 | .0 |
| 46 | 9.8 | 61184.9 | .0 | 15917.2 | .0 | .0 | .0 | .0 | .0 |
| 47 | 1.7 | 10378.7 | .0 | 2609.0 | .0 | .0 | .0 | .0 | .0 |
| 48 | 8.0 | 49577.5 | .0 | 11915.0 | .0 | .0 | .0 | .0 | .0 |
| 49 | 6.4 | 39043.9 | .0 | 8802.5 | .0 | .0 | .0 | .0 | .0 |
| 50 | 3.2 | 19079.1 | .0 | 4057.5 | .0 | .0 | .0 | .0 | .0 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 51 | 9.4 | 55359.6 | .0 | 10928.6 | .0 | .0 | .0 | .0 | .0 |
| 52 | 9.2 | 51919.3 | .0 | 8733.5 | .0 | .0 | .0 | .0 | .0 |
| 53 | 3.9 | 21143.3 | .0 | 3033.8 | .0 | .0 | .0 | .0 | .0 |
| 54 | 5.1 | 26858.9 | .0 | 3245.5 | .0 | .0 | .0 | .0 | .0 |
| 55 | 6.9 | 34524.4 | .0 | 3031.8 | .0 | .0 | .0 | .0 | .0 |
| 56 | 1.7 | 8390.7 | .0 | 491.7 | .0 | .0 | .0 | .0 | .0 |
| 57 | .2 | 910.8 | .0 | 47.2 | .0 | .0 | .0 | .0 | .0 |
| 58 | .1 | 608.8 | .0 | 31.6 | .0 | .0 | .0 | .0 | .0 |
| 59 | .1 | 378.6 | .0 | 19.3 | .0 | .0 | .0 | .0 | .0 |
| 60 | .2 | 755.7 | .0 | 37.9 | .0 | .0 | .0 | .0 | .0 |
| 61 | 3.1 | 14145.0 | .0 | 523.4 | .0 | .0 | .0 | .0 | .0 |
| 62 | .9 | 3875.8 | .0 | 77.5 | .0 | .0 | .0 | .0 | .0 |
| 63 | .9 | 3848.9 | .0 | 46.8 | .0 | .0 | .0 | .0 | .0 |
| 64 | .9 | 3907.7 | .0 | 16.1 | .0 | .0 | .0 | .0 | .0 |
| 65 | 2.6 | 11038.9 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 66 | .0 | 151.0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 67 | 8.4 | 34132.5 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 68 | 2.7 | 10477.2 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 69 | .3 | 1207.9 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 70 | .1 | 301.7 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 71 | .2 | 603.4 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 72 | 4.9 | 18127.6 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 73 | 7.9 | 28116.7 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 74 | 7.6 | 25415.9 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 75 | 7.3 | 22600.7 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 76 | 7.0 | 19711.2 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 77 | 6.7 | 16788.9 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 78 | 6.3 | 13876.3 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 79 | 2.6 | 5060.0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 80 | .4 | 682.4 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 81 | .1 | 164.2 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 82 | .2 | 344.3 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 83 | 2.7 | 4647.2 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 84 | 5.6 | 7626.0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 85 | 5.3 | 4564.1 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 86 | 2.6 | 1265.3 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 87 | .6 | 170.2 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 88 | .3 | 66.1 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 89 | 1.2 | 124.1 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |

Failure Surface Specified By 38 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 2.39 | 85.00 |
| 2 | 10.98 | 79.87 |
| 3 | 19.78 | 75.12 |
| 4 | 28.78 | 70.77 |
| 5 | 37.97 | 66.82 |
| 6 | 47.32 | 63.28 |
| 7 | 56.82 | 60.16 |
| 8 | 66.45 | 57.47 |
| 9 | 76.20 | 55.21 |
| 10 | 86.03 | 53.38 |
| 11 | 95.93 | 51.99 |
| 12 | 105.88 | 51.05 |
| 13 | 115.87 | 50.54 |
| 14 | 125.87 | 50.48 |
| 15 | 135.86 | 50.87 |
| 16 | 145.83 | 51.69 |
| 17 | 155.75 | 52.96 |
| 18 | 165.60 | 54.67 |
| 19 | 175.37 | 56.81 |
| 20 | 185.03 | 59.39 |
| 21 | 194.57 | 62.39 |
| 22 | 203.97 | 65.81 |
| 23 | 213.20 | 69.65 |
| 24 | 222.26 | 73.89 |
| 25 | 231.12 | 78.53 |
| 26 | 239.76 | 83.56 |
| 27 | 248.17 | 88.97 |
| 28 | 256.33 | 94.75 |

| | | |
|---|---|---|
| 29 | 264.23 | 100.88 |
| 30 | 271.85 | 107.36 |
| 31 | 279.17 | 114.17 |
| 32 | 286.18 | 121.30 |
| 33 | 292.87 | 128.73 |
| 34 | 299.23 | 136.45 |
| 35 | 305.23 | 144.45 |
| 36 | 310.87 | 152.71 |
| 37 | 316.14 | 161.20 |
| 38 | 319.93 | 167.96 |

Circle Center At X =  122.2 ; Y =  275.5  and Radius,  225.1

*** 1.714 ***

Failure Surface Specified By 38 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 7.27 | 85.00 |
| 2 | 15.74 | 79.69 |
| 3 | 24.45 | 74.77 |
| 4 | 33.38 | 70.26 |
| 5 | 42.50 | 66.17 |
| 6 | 51.81 | 62.51 |
| 7 | 61.27 | 59.28 |
| 8 | 70.88 | 56.50 |
| 9 | 80.60 | 54.16 |
| 10 | 90.42 | 52.27 |
| 11 | 100.32 | 50.84 |
| 12 | 110.27 | 49.88 |
| 13 | 120.26 | 49.37 |
| 14 | 130.26 | 49.33 |
| 15 | 140.25 | 49.75 |
| 16 | 150.21 | 50.63 |
| 17 | 160.12 | 51.97 |
| 18 | 169.96 | 53.77 |
| 19 | 179.70 | 56.03 |
| 20 | 189.33 | 58.73 |
| 21 | 198.82 | 61.87 |
| 22 | 208.16 | 65.46 |
| 23 | 217.32 | 69.47 |
| 24 | 226.28 | 73.90 |
| 25 | 235.03 | 78.74 |
| 26 | 243.55 | 83.98 |
| 27 | 251.81 | 89.61 |
| 28 | 259.81 | 95.62 |
| 29 | 267.52 | 101.99 |
| 30 | 274.92 | 108.71 |
| 31 | 282.01 | 115.76 |
| 32 | 288.76 | 123.14 |
| 33 | 295.16 | 130.82 |
| 34 | 301.20 | 138.79 |
| 35 | 306.86 | 147.04 |
| 36 | 312.14 | 155.53 |
| 37 | 317.02 | 164.26 |
| 38 | 318.84 | 167.91 |

Circle Center At X =  126.2 ; Y =  265.0  and Radius,  215.8

*** 1.716 ***

Failure Surface Specified By 38 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 5.88 | 85.00 |
| 2 | 14.41 | 79.78 |
| 3 | 23.16 | 74.94 |
| 4 | 32.13 | 70.52 |
| 5 | 41.29 | 66.50 |
| 6 | 50.62 | 62.91 |
| 7 | 60.11 | 59.75 |
| 8 | 69.73 | 57.02 |
| 9 | 79.46 | 54.73 |
| 10 | 89.29 | 52.89 |
| 11 | 99.19 | 51.50 |
| 12 | 109.15 | 50.56 |

| | | |
|---|---|---|
| 13 | 119.14 | 50.08 |
| 14 | 129.14 | 50.05 |
| 15 | 139.13 | 50.48 |
| 16 | 149.09 | 51.36 |
| 17 | 159.00 | 52.70 |
| 18 | 168.84 | 54.48 |
| 19 | 178.59 | 56.71 |
| 20 | 188.22 | 59.39 |
| 21 | 197.73 | 62.50 |
| 22 | 207.08 | 66.04 |
| 23 | 216.26 | 70.00 |
| 24 | 225.25 | 74.38 |
| 25 | 234.04 | 79.16 |
| 26 | 242.59 | 84.33 |
| 27 | 250.90 | 89.89 |
| 28 | 258.95 | 95.83 |
| 29 | 266.72 | 102.12 |
| 30 | 274.20 | 108.76 |
| 31 | 281.36 | 115.74 |
| 32 | 288.20 | 123.04 |
| 33 | 294.70 | 130.63 |
| 34 | 300.85 | 138.52 |
| 35 | 306.63 | 146.68 |
| 36 | 312.04 | 155.09 |
| 37 | 317.05 | 163.75 |
| 38 | 319.23 | 167.93 |

Circle Center At X = 124.7 ; Y = 269.3 and Radius, 219.3

*** 1.718 ***

Failure Surface Specified By 38 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 6.58 | 85.00 |
| 2 | 15.08 | 79.73 |
| 3 | 23.81 | 74.86 |
| 4 | 32.76 | 70.40 |
| 5 | 41.90 | 66.35 |
| 6 | 51.23 | 62.73 |
| 7 | 60.71 | 59.55 |
| 8 | 70.32 | 56.80 |
| 9 | 80.05 | 54.51 |
| 10 | 89.88 | 52.66 |
| 11 | 99.78 | 51.27 |
| 12 | 109.74 | 50.33 |
| 13 | 119.73 | 49.86 |
| 14 | 129.73 | 49.85 |
| 15 | 139.72 | 50.30 |
| 16 | 149.68 | 51.21 |
| 17 | 159.58 | 52.57 |
| 18 | 169.42 | 54.40 |
| 19 | 179.15 | 56.67 |
| 20 | 188.78 | 59.39 |
| 21 | 198.26 | 62.56 |
| 22 | 207.59 | 66.15 |
| 23 | 216.75 | 70.17 |
| 24 | 225.71 | 74.62 |
| 25 | 234.45 | 79.47 |
| 26 | 242.97 | 84.71 |
| 27 | 251.23 | 90.35 |
| 28 | 259.22 | 96.36 |
| 29 | 266.93 | 102.73 |
| 30 | 274.33 | 109.45 |
| 31 | 281.42 | 116.50 |
| 32 | 288.17 | 123.88 |
| 33 | 294.58 | 131.56 |
| 34 | 300.63 | 139.52 |
| 35 | 306.30 | 147.76 |
| 36 | 311.59 | 156.25 |
| 37 | 316.48 | 164.97 |
| 38 | 317.92 | 167.86 |

Circle Center At X = 125.0 ; Y = 266.5 and Radius, 216.7

*** 1.719 ***

Failure Surface Specified By 38 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 2.39 | 85.00 |
| 2 | 11.01 | 79.92 |
| 3 | 19.83 | 75.22 |
| 4 | 28.86 | 70.91 |
| 5 | 38.07 | 67.01 |
| 6 | 47.44 | 63.52 |
| 7 | 56.95 | 60.45 |
| 8 | 66.60 | 57.80 |
| 9 | 76.35 | 55.58 |
| 10 | 86.19 | 53.79 |
| 11 | 96.09 | 52.44 |
| 12 | 106.05 | 51.53 |
| 13 | 116.04 | 51.06 |
| 14 | 126.04 | 51.03 |
| 15 | 136.03 | 51.45 |
| 16 | 146.00 | 52.30 |
| 17 | 155.91 | 53.60 |
| 18 | 165.76 | 55.33 |
| 19 | 175.52 | 57.50 |
| 20 | 185.18 | 60.09 |
| 21 | 194.71 | 63.11 |
| 22 | 204.10 | 66.55 |
| 23 | 213.33 | 70.40 |
| 24 | 222.38 | 74.65 |
| 25 | 231.24 | 79.30 |
| 26 | 239.88 | 84.34 |
| 27 | 248.28 | 89.75 |
| 28 | 256.44 | 95.53 |
| 29 | 264.34 | 101.67 |
| 30 | 271.96 | 108.15 |
| 31 | 279.28 | 114.96 |
| 32 | 286.30 | 122.08 |
| 33 | 292.99 | 129.51 |
| 34 | 299.35 | 137.23 |
| 35 | 305.36 | 145.22 |
| 36 | 311.01 | 153.47 |
| 37 | 316.30 | 161.96 |
| 38 | 319.66 | 167.95 |

Circle Center At X = 121.7 ; Y = 277.1 and Radius, 226.1

*** 1.719 ***

Failure Surface Specified By 38 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 3.09 | 85.00 |
| 2 | 11.66 | 79.85 |
| 3 | 20.46 | 75.09 |
| 4 | 29.46 | 70.73 |
| 5 | 38.65 | 66.79 |
| 6 | 48.01 | 63.26 |
| 7 | 57.51 | 60.16 |
| 8 | 67.15 | 57.50 |
| 9 | 76.90 | 55.27 |
| 10 | 86.74 | 53.48 |
| 11 | 96.65 | 52.14 |
| 12 | 106.61 | 51.25 |
| 13 | 116.60 | 50.81 |
| 14 | 126.60 | 50.82 |
| 15 | 136.59 | 51.29 |
| 16 | 146.55 | 52.20 |
| 17 | 156.45 | 53.57 |
| 18 | 166.29 | 55.38 |
| 19 | 176.03 | 57.63 |
| 20 | 185.66 | 60.32 |
| 21 | 195.16 | 63.44 |
| 22 | 204.51 | 66.99 |
| 23 | 213.69 | 70.96 |

| | | |
|---|---|---|
| 24 | 222.68 | 75.34 |
| 25 | 231.46 | 80.12 |
| 26 | 240.02 | 85.29 |
| 27 | 248.34 | 90.84 |
| 28 | 256.40 | 96.77 |
| 29 | 264.18 | 103.05 |
| 30 | 271.67 | 109.67 |
| 31 | 278.85 | 116.63 |
| 32 | 285.71 | 123.91 |
| 33 | 292.23 | 131.49 |
| 34 | 298.41 | 139.35 |
| 35 | 304.22 | 147.49 |
| 36 | 309.66 | 155.88 |
| 37 | 314.72 | 164.51 |
| 38 | 316.44 | 167.78 |

Circle Center At X =  121.3 ; Y =  271.9  and Radius,  221.2
*** 1.719 ***

Failure Surface Specified By 37 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 7.27 | 85.00 |
| 2 | 15.68 | 79.58 |
| 3 | 24.34 | 74.58 |
| 4 | 33.22 | 69.99 |
| 5 | 42.32 | 65.84 |
| 6 | 51.61 | 62.13 |
| 7 | 61.06 | 58.88 |
| 8 | 70.66 | 56.08 |
| 9 | 80.39 | 53.75 |
| 10 | 90.21 | 51.89 |
| 11 | 100.12 | 50.51 |
| 12 | 110.08 | 49.60 |
| 13 | 120.07 | 49.18 |
| 14 | 130.07 | 49.23 |
| 15 | 140.05 | 49.77 |
| 16 | 150.00 | 50.79 |
| 17 | 159.89 | 52.29 |
| 18 | 169.69 | 54.26 |
| 19 | 179.39 | 56.70 |
| 20 | 188.96 | 59.61 |
| 21 | 198.38 | 62.97 |
| 22 | 207.62 | 66.78 |
| 23 | 216.67 | 71.03 |
| 24 | 225.51 | 75.72 |
| 25 | 234.11 | 80.82 |
| 26 | 242.45 | 86.34 |
| 27 | 250.52 | 92.24 |
| 28 | 258.29 | 98.53 |
| 29 | 265.75 | 105.19 |
| 30 | 272.89 | 112.20 |
| 31 | 279.67 | 119.54 |
| 32 | 286.10 | 127.21 |
| 33 | 292.15 | 135.17 |
| 34 | 297.80 | 143.42 |
| 35 | 303.06 | 151.92 |
| 36 | 307.90 | 160.68 |
| 37 | 311.26 | 167.51 |

Circle Center At X =  123.9 ; Y =  256.7  and Radius,  207.6
*** 1.721 ***

Failure Surface Specified By 38 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 4.49 | 85.00 |
| 2 | 13.07 | 79.87 |
| 3 | 21.87 | 75.13 |
| 4 | 30.88 | 70.78 |
| 5 | 40.07 | 66.85 |
| 6 | 49.43 | 63.33 |
| 7 | 58.94 | 60.23 |
| 8 | 68.58 | 57.56 |

| | | |
|---|---|---|
| 9 | 78.33 | 55.33 |
| 10 | 88.17 | 53.54 |
| 11 | 98.07 | 52.19 |
| 12 | 108.03 | 51.28 |
| 13 | 118.02 | 50.83 |
| 14 | 128.02 | 50.82 |
| 15 | 138.01 | 51.25 |
| 16 | 147.97 | 52.14 |
| 17 | 157.88 | 53.47 |
| 18 | 167.73 | 55.24 |
| 19 | 177.48 | 57.46 |
| 20 | 187.12 | 60.10 |
| 21 | 196.64 | 63.18 |
| 22 | 206.00 | 66.68 |
| 23 | 215.20 | 70.60 |
| 24 | 224.22 | 74.92 |
| 25 | 233.03 | 79.65 |
| 26 | 241.63 | 84.76 |
| 27 | 249.98 | 90.26 |
| 28 | 258.08 | 96.12 |
| 29 | 265.91 | 102.34 |
| 30 | 273.45 | 108.91 |
| 31 | 280.70 | 115.80 |
| 32 | 287.62 | 123.02 |
| 33 | 294.22 | 130.54 |
| 34 | 300.47 | 138.34 |
| 35 | 306.36 | 146.42 |
| 36 | 311.89 | 154.75 |
| 37 | 317.04 | 163.33 |
| 38 | 319.53 | 167.94 |

Circle Center At X =  123.2 ; Y =  273.8  and Radius,  223.0

*** 1.721 ***

Failure Surface Specified By 38 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 8.67 | 85.00 |
| 2 | 17.15 | 79.71 |
| 3 | 25.87 | 74.81 |
| 4 | 34.81 | 70.32 |
| 5 | 43.94 | 66.25 |
| 6 | 53.25 | 62.61 |
| 7 | 62.73 | 59.40 |
| 8 | 72.34 | 56.64 |
| 9 | 82.06 | 54.32 |
| 10 | 91.89 | 52.46 |
| 11 | 101.79 | 51.05 |
| 12 | 111.74 | 50.10 |
| 13 | 121.73 | 49.61 |
| 14 | 131.73 | 49.59 |
| 15 | 141.72 | 50.03 |
| 16 | 151.68 | 50.93 |
| 17 | 161.59 | 52.29 |
| 18 | 171.42 | 54.11 |
| 19 | 181.16 | 56.38 |
| 20 | 190.78 | 59.11 |
| 21 | 200.27 | 62.27 |
| 22 | 209.60 | 65.87 |
| 23 | 218.75 | 69.89 |
| 24 | 227.71 | 74.34 |
| 25 | 236.45 | 79.19 |
| 26 | 244.96 | 84.45 |
| 27 | 253.22 | 90.09 |
| 28 | 261.20 | 96.11 |
| 29 | 268.90 | 102.50 |
| 30 | 276.29 | 109.23 |
| 31 | 283.37 | 116.30 |
| 32 | 290.11 | 123.68 |
| 33 | 296.50 | 131.37 |
| 34 | 302.53 | 139.35 |
| 35 | 308.18 | 147.60 |

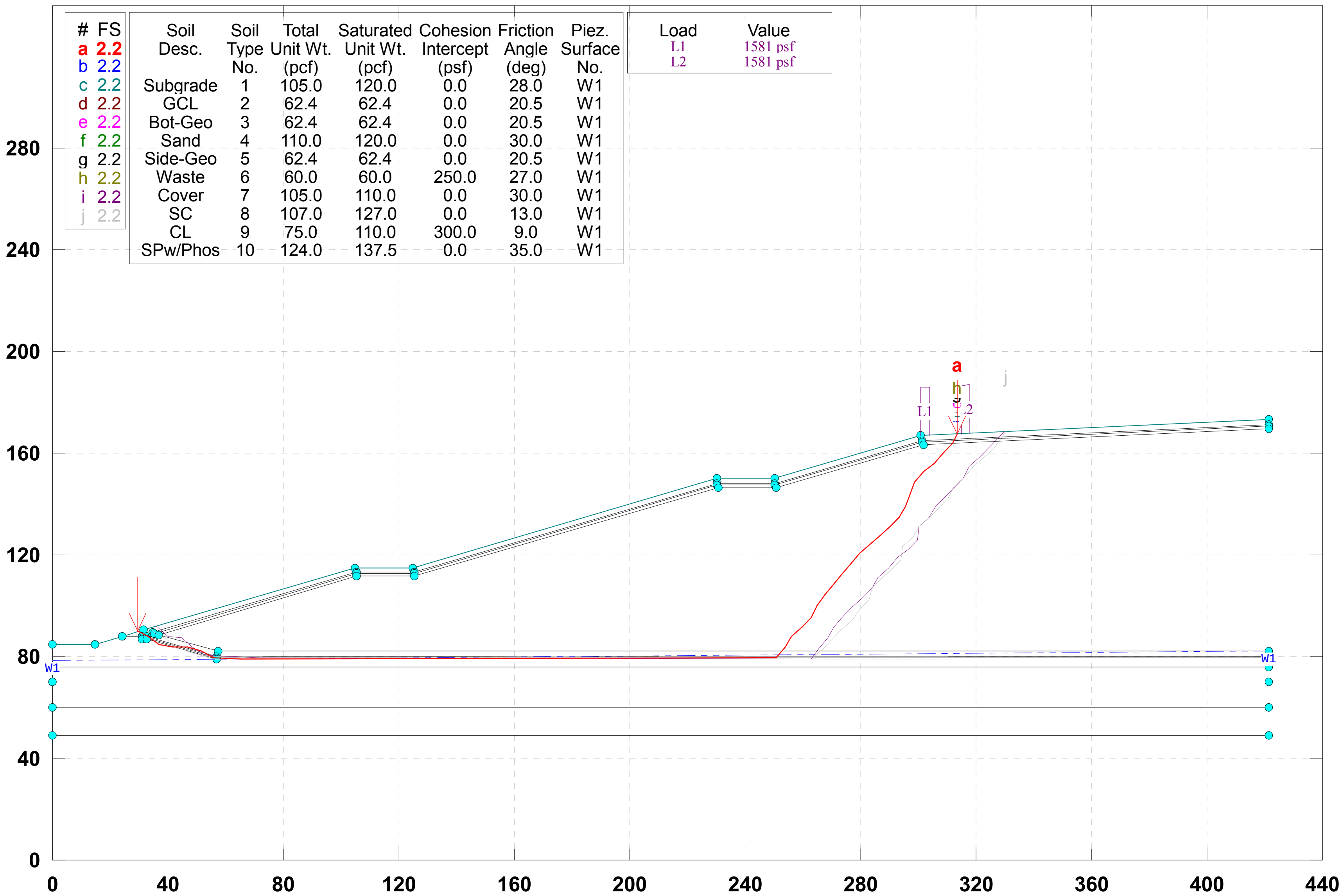
```
   36        313.44      156.10
   37        318.31      164.84
   38        319.86      167.96
Circle Center At X =  127.2 ; Y =  265.4  and Radius,  215.9
      ***     1.722   ***
          Y            A     X     I     S            F     T
           .00     52.67    105.35    158.02    210.70    263.37
X      .00 +--------*+*-**W*---+---------+---------+---------+
           -             13
           -            13*.
           -          .13..*
           -         ..1...*.
           -        ..13.....
     52.67 +       ..13..*....
           -      ...1....*...
           -      ...2.........
           -     ...16.........
           -    ....1.........
           -    ....1..........
A   105.35 +    ....1..........**
           -   ....12...........
           -   ....12..........**
           -   ....12...........
           -   ....31............
           -   .....2............
X   158.02 +   .....1.............
           -   .....16............
           -    ....01............
           -    .....1.............
           -     ....31............
           -     .....16............
I   210.70 +      ....31............
           -      .....31............
           -       .....31...........*
           -        .....31...........
           -         .....31.........*
           -          .....318........*.
S   263.37 +           .....315.........
           -             ....013.........
           -              .....121........
           -                .....2168.....
           -                   ....318...**
           -                      ...131588
    316.04 +                         ..4121
F   368.72 +
T   421.39 +        * * ****               **
```

# Slope Stability Analysis
# Phase II Section I East Final Buildout

# Block Analysis With and Without Equipment Loading

# Hardee Landfill Phase II Section I RAI 1Height Increase East Slope Operation

C:\1\HARDEE~1.1\1HARDE~1.1\EWBLLO~1\EWSECBLL.PL2 Run By: Shane R. Fischer, P.E. 03/31/13 6:53AM




| # | FS |
|---|---|
| a | 2.2 |
| b | 2.2 |
| c | 2.2 |
| d | 2.2 |
| e | 2.2 |
| f | 2.2 |
| g | 2.2 |
| h | 2.2 |
| i | 2.2 |
| j | 2.2 |

| Soil Desc. | Soil Type No. | Total Unit Wt. (pcf) | Saturated Unit Wt. (pcf) | Cohesion Intercept (psf) | Friction Angle (deg) | Piez. Surface No. |
|---|---|---|---|---|---|---|
| Subgrade | 1 | 105.0 | 120.0 | 0.0 | 28.0 | W1 |
| GCL | 2 | 62.4 | 62.4 | 0.0 | 20.5 | W1 |
| Bot-Geo | 3 | 62.4 | 62.4 | 0.0 | 20.5 | W1 |
| Sand | 4 | 110.0 | 120.0 | 0.0 | 30.0 | W1 |
| Side-Geo | 5 | 62.4 | 62.4 | 0.0 | 20.5 | W1 |
| Waste | 6 | 60.0 | 60.0 | 250.0 | 27.0 | W1 |
| Cover | 7 | 105.0 | 110.0 | 0.0 | 30.0 | W1 |
| SC | 8 | 107.0 | 127.0 | 0.0 | 13.0 | W1 |
| CL | 9 | 75.0 | 110.0 | 300.0 | 9.0 | W1 |
| SPw/Phos | 10 | 124.0 | 137.5 | 0.0 | 35.0 | W1 |

| Load | Value |
|---|---|
| L1 | 1581 psf |
| L2 | 1581 psf |

**PCSTABL5M/si FSmin=2.2**

**Safety Factors Are Calculated By The Modified Janbu Method**

SCS ENGINEERS

**** PCSTABL5M ****
by
Purdue University
--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer`s Method of Slices

Run Date: 03/31/13
Time of Run: 6:53AM
Run By: Shane R. Fischer, P.E.
Input Data Filename: C:ewsecbll.
Output Filename: C:ewsecbll.OUT
Unit: ENGLISH
Plotted Output Filename: C:ewsecbll.PLT
PROBLEM DESCRIPTION Hardee Landfill Phase II Section I RAI 1
Height Increase East Slope Operation

BOUNDARY COORDINATES
9 Top Boundaries
46 Total Boundaries

| Boundary No. | X-Left (ft) | Y-Left (ft) | X-Right (ft) | Y-Right (ft) | Soil Type Below Bnd |
|---|---|---|---|---|---|
| 1 | .00 | 85.00 | 15.00 | 85.00 | 1 |
| 2 | 15.00 | 85.00 | 24.00 | 88.00 | 1 |
| 3 | 24.00 | 88.00 | 31.58 | 90.52 | 4 |
| 4 | 31.58 | 90.52 | 105.00 | 115.00 | 7 |
| 5 | 105.00 | 115.00 | 125.00 | 115.00 | 7 |
| 6 | 125.00 | 115.00 | 230.00 | 150.00 | 7 |
| 7 | 230.00 | 150.00 | 250.00 | 150.00 | 7 |
| 8 | 250.00 | 150.00 | 300.95 | 166.98 | 7 |
| 9 | 300.95 | 166.98 | 421.22 | 173.20 | 7 |
| 10 | 31.58 | 90.52 | 34.74 | 89.47 | 4 |
| 11 | 34.74 | 89.47 | 105.32 | 113.00 | 5 |
| 12 | 105.32 | 113.00 | 125.32 | 113.00 | 5 |
| 13 | 125.32 | 113.00 | 230.32 | 148.00 | 5 |
| 14 | 230.32 | 148.00 | 250.32 | 148.00 | 5 |
| 15 | 250.32 | 148.00 | 301.32 | 165.00 | 5 |
| 16 | 301.32 | 165.00 | 421.32 | 171.00 | 5 |
| 17 | 34.74 | 89.47 | 35.53 | 89.20 | 4 |
| 18 | 35.53 | 89.20 | 105.40 | 112.50 | 7 |
| 19 | 105.40 | 112.50 | 125.40 | 112.50 | 7 |
| 20 | 125.40 | 112.50 | 230.40 | 147.50 | 7 |
| 21 | 230.40 | 147.50 | 250.40 | 147.50 | 7 |
| 22 | 250.40 | 147.50 | 301.41 | 164.50 | 7 |
| 23 | 301.41 | 164.50 | 421.34 | 170.50 | 7 |
| 24 | 35.53 | 89.20 | 37.11 | 88.68 | 4 |
| 25 | 37.11 | 88.68 | 105.56 | 111.50 | 6 |
| 26 | 105.56 | 111.50 | 125.56 | 111.50 | 6 |
| 27 | 125.56 | 111.50 | 230.56 | 146.50 | 6 |
| 28 | 230.56 | 146.50 | 250.56 | 146.50 | 6 |
| 29 | 250.56 | 146.50 | 301.60 | 163.51 | 6 |
| 30 | 301.60 | 163.51 | 421.39 | 169.50 | 6 |
| 31 | 37.11 | 88.68 | 57.16 | 82.00 | 4 |
| 32 | 57.16 | 82.00 | 421.32 | 82.00 | 4 |
| 33 | 24.00 | 88.00 | 30.83 | 88.00 | 3 |
| 34 | 30.83 | 88.00 | 32.83 | 88.00 | 3 |
| 35 | 32.83 | 88.00 | 56.83 | 80.00 | 3 |
| 36 | 56.83 | 80.00 | 421.32 | 80.00 | 3 |
| 37 | 30.83 | 87.53 | 32.67 | 87.53 | 2 |
| 38 | 32.67 | 87.53 | 56.86 | 79.50 | 2 |
| 39 | 56.86 | 79.50 | 421.32 | 79.50 | 2 |
| 40 | 30.83 | 87.03 | 32.59 | 87.03 | 1 |
| 41 | 32.59 | 87.03 | 56.77 | 79.00 | 1 |
| 42 | 56.77 | 79.00 | 421.32 | 79.00 | 1 |
| 43 | .00 | 76.00 | 421.32 | 76.00 | 1 |
| 44 | .00 | 70.00 | 421.32 | 70.00 | 8 |
| 45 | .00 | 60.00 | 421.32 | 60.00 | 9 |
| 46 | .00 | 49.00 | 421.32 | 49.00 | 10 |

ISOTROPIC SOIL PARAMETERS
10 Type(s) of Soil

| Soil Type | Total Unit Wt. | Saturated Unit Wt. | Cohesion Intercept | Friction Angle | Pore Pressure | Pressure Constant | Piez. Surface |
|---|---|---|---|---|---|---|---|

| No. | (pcf) | (pcf) | (psf) | (deg) | Param. | (psf) | No. |
|---|---|---|---|---|---|---|---|
| 1 | 105.0 | 120.0 | .0 | 28.0 | .00 | .0 | 1 |
| 2 | 62.4 | 62.4 | .0 | 20.5 | .00 | .0 | 1 |
| 3 | 62.4 | 62.4 | .0 | 20.5 | .00 | .0 | 1 |
| 4 | 110.0 | 120.0 | .0 | 30.0 | .00 | .0 | 1 |
| 5 | 62.4 | 62.4 | .0 | 20.5 | .00 | .0 | 1 |
| 6 | 60.0 | 60.0 | 250.0 | 27.0 | .00 | .0 | 1 |
| 7 | 105.0 | 110.0 | .0 | 30.0 | .00 | .0 | 1 |
| 8 | 107.0 | 127.0 | .0 | 13.0 | .00 | .0 | 1 |
| 9 | 75.0 | 110.0 | 300.0 | 9.0 | .00 | .0 | 1 |
| 10 | 124.0 | 137.5 | .0 | 35.0 | .00 | .0 | 1 |

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED
Unit Weight of Water = 62.40
Piezometric Surface No. 1 Specified by 2 Coordinate Points

| Point No. | X-Water (ft) | Y-Water (ft) |
|---|---|---|
| 1 | .00 | 78.50 |
| 2 | 421.32 | 82.09 |

BOUNDARY LOAD(S)
2 Load(s) Specified

| Load No. | X-Left (ft) | X-Right (ft) | Intensity (psf) | Deflection (deg) |
|---|---|---|---|---|
| 1 | 300.95 | 303.91 | 1581.0 | .0 |
| 2 | 314.90 | 317.87 | 1581.0 | .0 |

NOTE - Intensity Is Specified As A Uniformly Distributed
Force Acting On A Horizontally Projected Surface.
A Critical Failure Surface Searching Method, Using A Random
Technique For Generating Sliding Block Surfaces, Has Been
Specified.
1000 Trial Surfaces Have Been Generated.
3 Boxes Specified For Generation Of Central Block Base
Length Of Line Segments For Active And Passive Portions Of
Sliding Block Is 5.0

| Box No. | X-Left (ft) | Y-Left (ft) | X-Right (ft) | Y-Right (ft) | Height (ft) |
|---|---|---|---|---|---|
| 1 | 46.24 | 83.01 | 55.74 | 79.87 | 1.20 |
| 2 | 57.83 | 79.50 | 72.83 | 79.50 | 1.20 |
| 3 | 210.00 | 79.50 | 310.00 | 79.50 | 1.20 |

Following Are Displayed The Ten Most Critical Of The Trial
Failure Surfaces Examined. They Are Ordered - Most Critical
First.
* * Safety Factors Are Calculated By The Modified Janbu Method * *
Failure Surface Specified By 31 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 29.49 | 89.83 |
| 2 | 33.05 | 87.83 |
| 3 | 36.95 | 84.71 |
| 4 | 41.85 | 83.72 |
| 5 | 46.85 | 83.71 |
| 6 | 51.69 | 82.43 |
| 7 | 55.67 | 79.41 |
| 8 | 65.45 | 79.09 |
| 9 | 250.99 | 79.64 |
| 10 | 253.73 | 83.82 |
| 11 | 256.15 | 88.19 |
| 12 | 259.64 | 91.77 |
| 13 | 263.03 | 95.44 |
| 14 | 265.02 | 100.03 |
| 15 | 267.57 | 104.33 |
| 16 | 270.57 | 108.34 |
| 17 | 273.45 | 112.42 |
| 18 | 276.74 | 116.19 |
| 19 | 279.46 | 120.39 |
| 20 | 282.99 | 123.92 |
| 21 | 286.51 | 127.47 |
| 22 | 290.04 | 131.02 |
| 23 | 293.45 | 134.67 |
| 24 | 295.57 | 139.20 |
| 25 | 297.11 | 143.96 |

| | | |
|---|---|---|
| 26 | 298.67 | 148.71 |
| 27 | 301.80 | 152.61 |
| 28 | 305.30 | 156.18 |
| 29 | 308.49 | 160.03 |
| 30 | 311.97 | 163.62 |
| 31 | 313.24 | 167.62 |

*** 2.184 ***

Individual data on the 77 slices

| Slice No. | Width (ft) | Weight (lbs) | Water Force Top (lbs) | Water Force Bot (lbs) | Tie Force Norm (lbs) | Tie Force Tan (lbs) | Earthquake Force Hor (lbs) | Earthquake Force Ver (lbs) | Surcharge Load (lbs) |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 2.1 | 214.2 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 2 | 1.2 | 305.9 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 3 | .1 | 24.4 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 4 | .2 | 73.1 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 5 | .9 | 352.8 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 6 | .8 | 363.3 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 7 | .3 | 180.3 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 8 | .4 | 244.8 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 9 | 1.4 | 934.0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 10 | .2 | 118.4 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 11 | 4.7 | 3856.1 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 12 | .7 | 627.5 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 13 | 1.6 | 1431.2 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 14 | 1.5 | 1416.5 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 15 | 1.2 | 1085.5 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 16 | 4.8 | 4940.8 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 17 | 1.7 | 1988.3 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 18 | 1.2 | 1492.5 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 19 | 1.1 | 1537.7 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 20 | 1.2 | 1634.5 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 21 | .0 | 42.7 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 22 | .3 | 427.5 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 23 | 8.3 | 12578.9 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 24 | 5.5 | 9076.7 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 25 | 34.1 | 70062.4 | .0 | 201.4 | .0 | .0 | .0 | .0 | .0 |
| 26 | .3 | 765.0 | .0 | 3.8 | .0 | .0 | .0 | .0 | .0 |
| 27 | .1 | 191.1 | .0 | 1.0 | .0 | .0 | .0 | .0 | .0 |
| 28 | .2 | 381.9 | .0 | 1.9 | .0 | .0 | .0 | .0 | .0 |
| 29 | 11.8 | 28136.9 | .0 | 165.9 | .0 | .0 | .0 | .0 | .0 |
| 30 | 7.6 | 18205.9 | .0 | 133.1 | .0 | .0 | .0 | .0 | .0 |
| 31 | .3 | 764.1 | .0 | 6.0 | .0 | .0 | .0 | .0 | .0 |
| 32 | .1 | 191.5 | .0 | 1.5 | .0 | .0 | .0 | .0 | .0 |
| 33 | .2 | 383.6 | .0 | 3.0 | .0 | .0 | .0 | .0 | .0 |
| 34 | 50.5 | 146418.3 | .0 | 1398.0 | .0 | .0 | .0 | .0 | .0 |
| 35 | 28.3 | 104373.2 | .0 | 1172.1 | .0 | .0 | .0 | .0 | .0 |
| 36 | 25.6 | 108103.3 | .0 | 1299.1 | .0 | .0 | .0 | .0 | .0 |
| 37 | .3 | 1431.1 | .0 | 17.7 | .0 | .0 | .0 | .0 | .0 |
| 38 | .1 | 357.5 | .0 | 4.4 | .0 | .0 | .0 | .0 | .0 |
| 39 | .2 | 715.0 | .0 | 8.9 | .0 | .0 | .0 | .0 | .0 |
| 40 | 19.4 | 86823.5 | .0 | 1141.4 | .0 | .0 | .0 | .0 | .0 |
| 41 | .3 | 1430.7 | .0 | 19.9 | .0 | .0 | .0 | .0 | .0 |
| 42 | .1 | 358.1 | .0 | 5.0 | .0 | .0 | .0 | .0 | .0 |
| 43 | .2 | 717.0 | .0 | 10.0 | .0 | .0 | .0 | .0 | .0 |
| 44 | .4 | 1907.8 | .0 | 26.5 | .0 | .0 | .0 | .0 | .0 |
| 45 | .2 | 1066.3 | .0 | 22.2 | .0 | .0 | .0 | .0 | .0 |
| 46 | .4 | 1880.3 | .0 | 15.4 | .0 | .0 | .0 | .0 | .0 |
| 47 | .9 | 3868.0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 48 | 1.2 | 5052.5 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 49 | 2.4 | 9873.1 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 50 | 3.5 | 13623.5 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 51 | 3.4 | 12737.9 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 52 | 2.0 | 7081.8 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 53 | 2.5 | 8500.8 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 54 | 3.0 | 9426.2 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 55 | 2.9 | 8546.1 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 56 | 3.3 | 9149.8 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 57 | 2.7 | 7092.1 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 58 | 3.5 | 8617.9 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 59 | 3.5 | 8091.7 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 60 | 3.5 | 7583.6 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 61 | 3.4 | 6861.3 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 62 | 2.1 | 3844.2 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 63 | 1.5 | 2422.7 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 64 | 1.6 | 2067.1 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 65 | 2.3 | 2578.1 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 66 | .4 | 389.7 | .0 | .0 | .0 | .0 | .0 | .0 | 585.0 |
| 67 | .1 | 93.1 | .0 | .0 | .0 | .0 | .0 | .0 | 142.3 |
| 68 | .2 | 194.4 | .0 | .0 | .0 | .0 | .0 | .0 | 300.4 |
| 69 | .2 | 197.6 | .0 | .0 | .0 | .0 | .0 | .0 | 309.9 |
| 70 | 2.1 | 1986.7 | .0 | .0 | .0 | .0 | .0 | .0 | 3342.2 |
| 71 | 1.4 | 1165.2 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 72 | 3.2 | 2193.6 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 73 | 3.5 | 1653.1 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 74 | .1 | 47.7 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 75 | .3 | 95.4 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 76 | .2 | 37.0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 77 | .7 | 69.0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |

Failure Surface Specified By 31 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 29.49 | 89.83 |
| 2 | 33.05 | 87.83 |
| 3 | 36.95 | 84.71 |
| 4 | 41.85 | 83.72 |
| 5 | 46.85 | 83.71 |
| 6 | 51.69 | 82.43 |
| 7 | 55.67 | 79.41 |
| 8 | 65.45 | 79.09 |
| 9 | 250.99 | 79.64 |
| 10 | 253.73 | 83.82 |
| 11 | 256.15 | 88.19 |
| 12 | 259.64 | 91.77 |
| 13 | 263.03 | 95.44 |
| 14 | 265.02 | 100.03 |
| 15 | 267.57 | 104.33 |
| 16 | 270.57 | 108.34 |
| 17 | 273.45 | 112.42 |
| 18 | 276.74 | 116.19 |
| 19 | 279.46 | 120.39 |
| 20 | 282.99 | 123.92 |
| 21 | 286.51 | 127.47 |
| 22 | 290.04 | 131.02 |
| 23 | 293.45 | 134.67 |
| 24 | 295.57 | 139.20 |
| 25 | 297.11 | 143.96 |
| 26 | 298.67 | 148.71 |
| 27 | 301.80 | 152.61 |
| 28 | 305.30 | 156.18 |
| 29 | 308.49 | 160.03 |
| 30 | 311.97 | 163.62 |
| 31 | 313.24 | 167.62 |

*** 2.184 ***

Failure Surface Specified By 31 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 29.49 | 89.83 |
| 2 | 33.05 | 87.83 |
| 3 | 36.95 | 84.71 |
| 4 | 41.85 | 83.72 |
| 5 | 46.85 | 83.71 |
| 6 | 51.69 | 82.43 |
| 7 | 55.67 | 79.41 |
| 8 | 65.45 | 79.09 |
| 9 | 250.99 | 79.64 |
| 10 | 253.73 | 83.82 |
| 11 | 256.15 | 88.19 |
| 12 | 259.64 | 91.77 |
| 13 | 263.03 | 95.44 |

| | | |
|---|---|---|
| 14 | 265.02 | 100.03 |
| 15 | 267.57 | 104.33 |
| 16 | 270.57 | 108.34 |
| 17 | 273.45 | 112.42 |
| 18 | 276.74 | 116.19 |
| 19 | 279.46 | 120.39 |
| 20 | 282.99 | 123.92 |
| 21 | 286.51 | 127.47 |
| 22 | 290.04 | 131.02 |
| 23 | 293.45 | 134.67 |
| 24 | 295.57 | 139.20 |
| 25 | 297.11 | 143.96 |
| 26 | 298.67 | 148.71 |
| 27 | 301.80 | 152.61 |
| 28 | 305.30 | 156.18 |
| 29 | 308.49 | 160.03 |
| 30 | 311.97 | 163.62 |
| 31 | 313.24 | 167.62 |

*** 2.184 ***

Failure Surface Specified By 31 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 29.49 | 89.83 |
| 2 | 33.05 | 87.83 |
| 3 | 36.95 | 84.71 |
| 4 | 41.85 | 83.72 |
| 5 | 46.85 | 83.71 |
| 6 | 51.69 | 82.43 |
| 7 | 55.67 | 79.41 |
| 8 | 65.45 | 79.09 |
| 9 | 250.99 | 79.64 |
| 10 | 253.73 | 83.82 |
| 11 | 256.15 | 88.19 |
| 12 | 259.64 | 91.77 |
| 13 | 263.03 | 95.44 |
| 14 | 265.02 | 100.03 |
| 15 | 267.57 | 104.33 |
| 16 | 270.57 | 108.34 |
| 17 | 273.45 | 112.42 |
| 18 | 276.74 | 116.19 |
| 19 | 279.46 | 120.39 |
| 20 | 282.99 | 123.92 |
| 21 | 286.51 | 127.47 |
| 22 | 290.04 | 131.02 |
| 23 | 293.45 | 134.67 |
| 24 | 295.57 | 139.20 |
| 25 | 297.11 | 143.96 |
| 26 | 298.67 | 148.71 |
| 27 | 301.80 | 152.61 |
| 28 | 305.30 | 156.18 |
| 29 | 308.49 | 160.03 |
| 30 | 311.97 | 163.62 |
| 31 | 313.24 | 167.62 |

*** 2.184 ***

Failure Surface Specified By 31 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 29.49 | 89.83 |
| 2 | 33.05 | 87.83 |
| 3 | 36.95 | 84.71 |
| 4 | 41.85 | 83.72 |
| 5 | 46.85 | 83.71 |
| 6 | 51.69 | 82.43 |
| 7 | 55.67 | 79.41 |
| 8 | 65.45 | 79.09 |
| 9 | 250.99 | 79.64 |
| 10 | 253.73 | 83.82 |
| 11 | 256.15 | 88.19 |
| 12 | 259.64 | 91.77 |
| 13 | 263.03 | 95.44 |

| | | |
|---|---|---|
| 14 | 265.02 | 100.03 |
| 15 | 267.57 | 104.33 |
| 16 | 270.57 | 108.34 |
| 17 | 273.45 | 112.42 |
| 18 | 276.74 | 116.19 |
| 19 | 279.46 | 120.39 |
| 20 | 282.99 | 123.92 |
| 21 | 286.51 | 127.47 |
| 22 | 290.04 | 131.02 |
| 23 | 293.45 | 134.67 |
| 24 | 295.57 | 139.20 |
| 25 | 297.11 | 143.96 |
| 26 | 298.67 | 148.71 |
| 27 | 301.80 | 152.61 |
| 28 | 305.30 | 156.18 |
| 29 | 308.49 | 160.03 |
| 30 | 311.97 | 163.62 |
| 31 | 313.24 | 167.62 |
| *** | 2.184 | *** |

Failure Surface Specified By 31 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 29.49 | 89.83 |
| 2 | 33.05 | 87.83 |
| 3 | 36.95 | 84.71 |
| 4 | 41.85 | 83.72 |
| 5 | 46.85 | 83.71 |
| 6 | 51.69 | 82.43 |
| 7 | 55.67 | 79.41 |
| 8 | 65.45 | 79.09 |
| 9 | 250.99 | 79.64 |
| 10 | 253.73 | 83.82 |
| 11 | 256.15 | 88.19 |
| 12 | 259.64 | 91.77 |
| 13 | 263.03 | 95.44 |
| 14 | 265.02 | 100.03 |
| 15 | 267.57 | 104.33 |
| 16 | 270.57 | 108.34 |
| 17 | 273.45 | 112.42 |
| 18 | 276.74 | 116.19 |
| 19 | 279.46 | 120.39 |
| 20 | 282.99 | 123.92 |
| 21 | 286.51 | 127.47 |
| 22 | 290.04 | 131.02 |
| 23 | 293.45 | 134.67 |
| 24 | 295.57 | 139.20 |
| 25 | 297.11 | 143.96 |
| 26 | 298.67 | 148.71 |
| 27 | 301.80 | 152.61 |
| 28 | 305.30 | 156.18 |
| 29 | 308.49 | 160.03 |
| 30 | 311.97 | 163.62 |
| 31 | 313.24 | 167.62 |
| *** | 2.184 | *** |

Failure Surface Specified By 31 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 29.49 | 89.83 |
| 2 | 33.05 | 87.83 |
| 3 | 36.95 | 84.71 |
| 4 | 41.85 | 83.72 |
| 5 | 46.85 | 83.71 |
| 6 | 51.69 | 82.43 |
| 7 | 55.67 | 79.41 |
| 8 | 65.45 | 79.09 |
| 9 | 250.99 | 79.64 |
| 10 | 253.73 | 83.82 |
| 11 | 256.15 | 88.19 |
| 12 | 259.64 | 91.77 |
| 13 | 263.03 | 95.44 |

| | | |
|---|---|---|
| 14 | 265.02 | 100.03 |
| 15 | 267.57 | 104.33 |
| 16 | 270.57 | 108.34 |
| 17 | 273.45 | 112.42 |
| 18 | 276.74 | 116.19 |
| 19 | 279.46 | 120.39 |
| 20 | 282.99 | 123.92 |
| 21 | 286.51 | 127.47 |
| 22 | 290.04 | 131.02 |
| 23 | 293.45 | 134.67 |
| 24 | 295.57 | 139.20 |
| 25 | 297.11 | 143.96 |
| 26 | 298.67 | 148.71 |
| 27 | 301.80 | 152.61 |
| 28 | 305.30 | 156.18 |
| 29 | 308.49 | 160.03 |
| 30 | 311.97 | 163.62 |
| 31 | 313.24 | 167.62 |

*** 2.184 ***

Failure Surface Specified By 31 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 29.49 | 89.83 |
| 2 | 33.05 | 87.83 |
| 3 | 36.95 | 84.71 |
| 4 | 41.85 | 83.72 |
| 5 | 46.85 | 83.71 |
| 6 | 51.69 | 82.43 |
| 7 | 55.67 | 79.41 |
| 8 | 65.45 | 79.09 |
| 9 | 250.99 | 79.64 |
| 10 | 253.73 | 83.82 |
| 11 | 256.15 | 88.19 |
| 12 | 259.64 | 91.77 |
| 13 | 263.03 | 95.44 |
| 14 | 265.02 | 100.03 |
| 15 | 267.57 | 104.33 |
| 16 | 270.57 | 108.34 |
| 17 | 273.45 | 112.42 |
| 18 | 276.74 | 116.19 |
| 19 | 279.46 | 120.39 |
| 20 | 282.99 | 123.92 |
| 21 | 286.51 | 127.47 |
| 22 | 290.04 | 131.02 |
| 23 | 293.45 | 134.67 |
| 24 | 295.57 | 139.20 |
| 25 | 297.11 | 143.96 |
| 26 | 298.67 | 148.71 |
| 27 | 301.80 | 152.61 |
| 28 | 305.30 | 156.18 |
| 29 | 308.49 | 160.03 |
| 30 | 311.97 | 163.62 |
| 31 | 313.24 | 167.62 |

*** 2.184 ***

Failure Surface Specified By 31 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 35.82 | 91.93 |
| 2 | 36.48 | 91.55 |
| 3 | 40.07 | 88.06 |
| 4 | 45.00 | 87.23 |
| 5 | 48.65 | 83.81 |
| 6 | 52.46 | 80.57 |
| 7 | 71.65 | 79.58 |
| 8 | 262.83 | 79.21 |
| 9 | 265.56 | 83.39 |
| 10 | 268.41 | 87.50 |
| 11 | 270.98 | 91.79 |
| 12 | 273.93 | 95.83 |
| 13 | 277.30 | 99.52 |

| | | |
|---|---|---|
| 14 | 280.83 | 103.07 |
| 15 | 284.14 | 106.81 |
| 16 | 286.25 | 111.35 |
| 17 | 289.73 | 114.94 |
| 18 | 292.87 | 118.83 |
| 19 | 296.39 | 122.37 |
| 20 | 299.93 | 125.91 |
| 21 | 300.19 | 130.90 |
| 22 | 303.65 | 134.51 |
| 23 | 306.00 | 138.92 |
| 24 | 309.42 | 142.56 |
| 25 | 312.32 | 146.64 |
| 26 | 315.75 | 150.28 |
| 27 | 317.56 | 154.94 |
| 28 | 321.10 | 158.47 |
| 29 | 324.21 | 162.39 |
| 30 | 327.62 | 166.04 |
| 31 | 330.00 | 168.48 |

*** 2.204 ***

Failure Surface Specified By 31 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 33.46 | 91.15 |
| 2 | 35.34 | 89.46 |
| 3 | 39.48 | 86.67 |
| 4 | 43.04 | 83.15 |
| 5 | 48.04 | 82.89 |
| 6 | 52.39 | 80.43 |
| 7 | 64.72 | 79.45 |
| 8 | 263.29 | 79.68 |
| 9 | 266.81 | 83.24 |
| 10 | 270.33 | 86.79 |
| 11 | 273.56 | 90.60 |
| 12 | 276.94 | 94.28 |
| 13 | 279.52 | 98.57 |
| 14 | 282.92 | 102.24 |
| 15 | 283.77 | 107.16 |
| 16 | 287.13 | 110.87 |
| 17 | 290.60 | 114.46 |
| 18 | 293.89 | 118.23 |
| 19 | 294.42 | 123.20 |
| 20 | 297.95 | 126.75 |
| 21 | 300.41 | 131.10 |
| 22 | 303.94 | 134.64 |
| 23 | 307.35 | 138.30 |
| 24 | 310.34 | 142.31 |
| 25 | 312.57 | 146.78 |
| 26 | 315.98 | 150.44 |
| 27 | 318.84 | 154.54 |
| 28 | 322.35 | 158.10 |
| 29 | 325.88 | 161.64 |
| 30 | 328.50 | 165.90 |
| 31 | 330.32 | 168.50 |

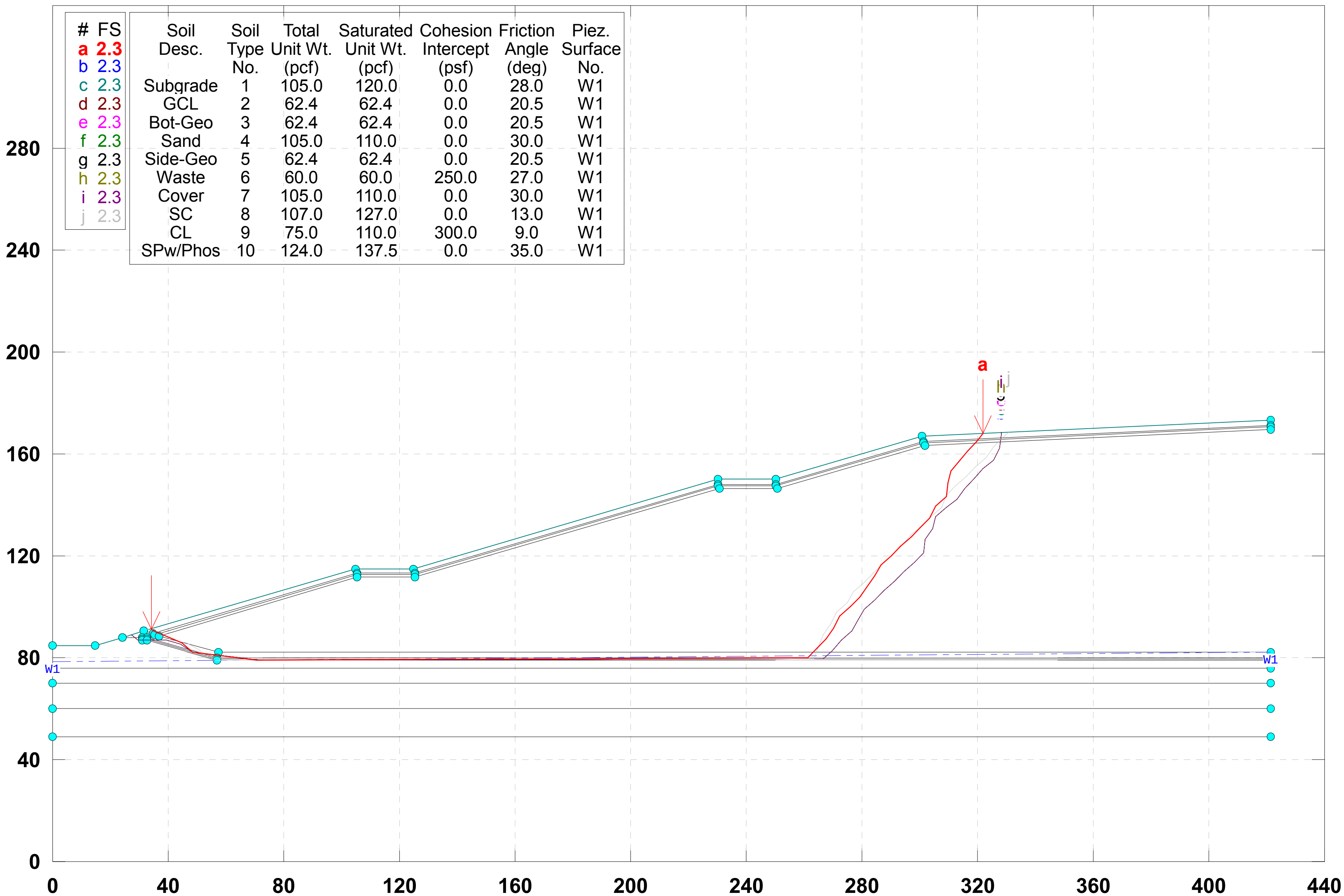
*** 2.206 ***

```
           Y            A     X     I     S            F     T
            .00      52.67    105.35    158.02    210.70    263.37
X       .00 +--------*+*-**W*---+---------+---------+---------+
            -               *
            -               .*
            -               1*.
            -              .19.
      52.67 +              *1
            -              1*
            -              9
A    105.35 +                    **
            -                    **
X    158.02 +
I    210.70 +              .....
            -              .......
            -              ...........  *
```

```
                -              ..............
                -              .............*
                -              111..........*.
S     263.37 +              991111..........
                -              .099..1.........
                -              ...099.111.......
                -              ......999111.....
                -              ........9991111.**/1
                -              ...........99..1..1/
      316.04 +               ............99.112/2
                -                 ............999
                -                   ............9
                -                       .........
                -                          ......
                -                             ...
F     368.72 +                                 .
T     421.39 +        * * ****                 **
```

# Hardee Landfill Phase II Section I RAI 1Height Increase East Slope Operation

C:\1\HARDEE~1.1\1HARDE~1.1\EWBL\EWSECBL.PL2  Run By: Shane R. Fischer, P.E.  03/31/13  6:49AM




| # | FS |
|---|---|
| a | 2.3 |
| b | 2.3 |
| c | 2.3 |
| d | 2.3 |
| e | 2.3 |
| f | 2.3 |
| g | 2.3 |
| h | 2.3 |
| i | 2.3 |
| j | 2.3 |

| Soil Desc. | Soil Type No. | Total Unit Wt. (pcf) | Saturated Unit Wt. (pcf) | Cohesion Intercept (psf) | Friction Angle (deg) | Piez. Surface No. |
|---|---|---|---|---|---|---|
| Subgrade | 1 | 105.0 | 120.0 | 0.0 | 28.0 | W1 |
| GCL | 2 | 62.4 | 62.4 | 0.0 | 20.5 | W1 |
| Bot-Geo | 3 | 62.4 | 62.4 | 0.0 | 20.5 | W1 |
| Sand | 4 | 105.0 | 110.0 | 0.0 | 30.0 | W1 |
| Side-Geo | 5 | 62.4 | 62.4 | 0.0 | 20.5 | W1 |
| Waste | 6 | 60.0 | 60.0 | 250.0 | 27.0 | W1 |
| Cover | 7 | 105.0 | 110.0 | 0.0 | 30.0 | W1 |
| SC | 8 | 107.0 | 127.0 | 0.0 | 13.0 | W1 |
| CL | 9 | 75.0 | 110.0 | 300.0 | 9.0 | W1 |
| SPw/Phos | 10 | 124.0 | 137.5 | 0.0 | 35.0 | W1 |

**PCSTABL5M/si FSmin=2.3**

**Safety Factors Are Calculated By The Modified Janbu Method for the case of First.**

SCS ENGINEERS

**** PCSTABL5M ****
by
Purdue University
--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer`s Method of Slices

Run Date: 03/31/13
Time of Run: 6:49AM
Run By: Shane R. Fischer, P.E.
Input Data Filename: C:ewsecbl.
Output Filename: C:ewsecbl.OUT
Unit: ENGLISH
Plotted Output Filename: C:ewsecbl.PLT
PROBLEM DESCRIPTION Hardee Landfill Phase II Section I RAI 1
Height Increase East Slope Operation

BOUNDARY COORDINATES
9 Top Boundaries
46 Total Boundaries

| Boundary No. | X-Left (ft) | Y-Left (ft) | X-Right (ft) | Y-Right (ft) | Soil Type Below Bnd |
|---|---|---|---|---|---|
| 1 | .00 | 85.00 | 15.00 | 85.00 | 1 |
| 2 | 15.00 | 85.00 | 24.00 | 88.00 | 1 |
| 3 | 24.00 | 88.00 | 31.58 | 90.52 | 4 |
| 4 | 31.58 | 90.52 | 105.00 | 115.00 | 7 |
| 5 | 105.00 | 115.00 | 125.00 | 115.00 | 7 |
| 6 | 125.00 | 115.00 | 230.00 | 150.00 | 7 |
| 7 | 230.00 | 150.00 | 250.00 | 150.00 | 7 |
| 8 | 250.00 | 150.00 | 300.95 | 166.98 | 7 |
| 9 | 300.95 | 166.98 | 421.22 | 173.20 | 7 |
| 10 | 31.58 | 90.52 | 34.74 | 89.47 | 4 |
| 11 | 34.74 | 89.47 | 105.32 | 113.00 | 5 |
| 12 | 105.32 | 113.00 | 125.32 | 113.00 | 5 |
| 13 | 125.32 | 113.00 | 230.32 | 148.00 | 5 |
| 14 | 230.32 | 148.00 | 250.32 | 148.00 | 5 |
| 15 | 250.32 | 148.00 | 301.32 | 165.00 | 5 |
| 16 | 301.32 | 165.00 | 421.32 | 171.00 | 5 |
| 17 | 34.74 | 89.47 | 35.53 | 89.20 | 4 |
| 18 | 35.53 | 89.20 | 105.40 | 112.50 | 7 |
| 19 | 105.40 | 112.50 | 125.40 | 112.50 | 7 |
| 20 | 125.40 | 112.50 | 230.40 | 147.50 | 7 |
| 21 | 230.40 | 147.50 | 250.40 | 147.50 | 7 |
| 22 | 250.40 | 147.50 | 301.41 | 164.50 | 7 |
| 23 | 301.41 | 164.50 | 421.34 | 170.50 | 7 |
| 24 | 35.53 | 89.20 | 37.11 | 88.68 | 4 |
| 25 | 37.11 | 88.68 | 105.56 | 111.50 | 6 |
| 26 | 105.56 | 111.50 | 125.56 | 111.50 | 6 |
| 27 | 125.56 | 111.50 | 230.56 | 146.50 | 6 |
| 28 | 230.56 | 146.50 | 250.56 | 146.50 | 6 |
| 29 | 250.56 | 146.50 | 301.60 | 163.51 | 6 |
| 30 | 301.60 | 163.51 | 421.39 | 169.50 | 6 |
| 31 | 37.11 | 88.68 | 57.16 | 82.00 | 4 |
| 32 | 57.16 | 82.00 | 421.32 | 82.00 | 4 |
| 33 | 24.00 | 88.00 | 30.83 | 88.00 | 3 |
| 34 | 30.83 | 88.00 | 32.83 | 88.00 | 3 |
| 35 | 32.83 | 88.00 | 56.83 | 80.00 | 3 |
| 36 | 56.83 | 80.00 | 421.32 | 80.00 | 3 |
| 37 | 30.83 | 87.53 | 32.67 | 87.53 | 2 |
| 38 | 32.67 | 87.53 | 56.86 | 79.50 | 2 |
| 39 | 56.86 | 79.50 | 421.32 | 79.50 | 2 |
| 40 | 30.83 | 87.03 | 32.59 | 87.03 | 1 |
| 41 | 32.59 | 87.03 | 56.77 | 79.00 | 1 |
| 42 | 56.77 | 79.00 | 421.32 | 79.00 | 1 |
| 43 | .00 | 76.00 | 421.32 | 76.00 | 1 |
| 44 | .00 | 70.00 | 421.32 | 70.00 | 8 |
| 45 | .00 | 60.00 | 421.32 | 60.00 | 9 |
| 46 | .00 | 49.00 | 421.32 | 49.00 | 10 |

ISOTROPIC SOIL PARAMETERS
10 Type(s) of Soil

| Soil Type | Total Unit Wt. | Saturated Unit Wt. | Cohesion Intercept | Friction Angle | Pore Pressure | Pressure Constant | Piez. Surface |
|---|---|---|---|---|---|---|---|

| No. | (pcf) | (pcf) | (psf) | (deg) | Param. | (psf) | No. |
|---|---|---|---|---|---|---|---|
| 1 | 105.0 | 120.0 | .0 | 28.0 | .00 | .0 | 1 |
| 2 | 62.4 | 62.4 | .0 | 20.5 | .00 | .0 | 1 |
| 3 | 62.4 | 62.4 | .0 | 20.5 | .00 | .0 | 1 |
| 4 | 105.0 | 110.0 | .0 | 30.0 | .00 | .0 | 1 |
| 5 | 62.4 | 62.4 | .0 | 20.5 | .00 | .0 | 1 |
| 6 | 60.0 | 60.0 | 250.0 | 27.0 | .00 | .0 | 1 |
| 7 | 105.0 | 110.0 | .0 | 30.0 | .00 | .0 | 1 |
| 8 | 107.0 | 127.0 | .0 | 13.0 | .00 | .0 | 1 |
| 9 | 75.0 | 110.0 | 300.0 | 9.0 | .00 | .0 | 1 |
| 10 | 124.0 | 137.5 | .0 | 35.0 | .00 | .0 | 1 |

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED
Unit Weight of Water = 62.40
Piezometric Surface No. 1 Specified by 2 Coordinate Points

| Point No. | X-Water (ft) | Y-Water (ft) |
|---|---|---|
| 1 | .00 | 78.50 |
| 2 | 421.32 | 82.09 |

BOUNDARY LOAD(S)
2 Load(s) Specified

| Load No. | X-Left (ft) | X-Right (ft) | Intensity (psf) | Deflection (deg) |
|---|---|---|---|---|
| 1 | 300.95 | 303.91 | 1581.0 | .0 |
| 2 | 314.90 | 317.87 | 1581.0 | .0 |

NOTE - Intensity Is Specified As A Uniformly Distributed
Force Acting On A Horizontally Projected Surface.
SURCHARGE BOUNDARY LOAD DATA HAS BEEN SUPPRESSED
A Critical Failure Surface Searching Method, Using A Random
Technique For Generating Sliding Block Surfaces, Has Been
Specified.
1000 Trial Surfaces Have Been Generated.
3 Boxes Specified For Generation Of Central Block Base
Length Of Line Segments For Active And Passive Portions Of
Sliding Block Is 5.0

| Box No. | X-Left (ft) | Y-Left (ft) | X-Right (ft) | Y-Right (ft) | Height (ft) |
|---|---|---|---|---|---|
| 1 | 46.24 | 83.01 | 55.74 | 79.87 | 1.20 |
| 2 | 57.83 | 79.50 | 72.83 | 79.50 | 1.20 |
| 3 | 250.00 | 79.50 | 347.87 | 79.50 | 1.20 |

Following Are Displayed The Ten Most Critical Of The Trial
Failure Surfaces Examined. They Are Ordered - Most Critical
First.
* * Safety Factors Are Calculated By The Modified Janbu Method * *
Failure Surface Specified By 29 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 34.01 | 91.33 |
| 2 | 36.06 | 90.27 |
| 3 | 40.45 | 87.89 |
| 4 | 44.90 | 85.60 |
| 5 | 48.45 | 82.08 |
| 6 | 70.78 | 79.00 |
| 7 | 261.22 | 79.82 |
| 8 | 264.53 | 83.58 |
| 9 | 267.38 | 87.68 |
| 10 | 270.30 | 91.74 |
| 11 | 272.48 | 96.24 |
| 12 | 275.88 | 99.91 |
| 13 | 279.02 | 103.80 |
| 14 | 282.04 | 107.78 |
| 15 | 284.45 | 112.16 |
| 16 | 286.69 | 116.64 |
| 17 | 290.21 | 120.18 |
| 18 | 293.59 | 123.87 |
| 19 | 296.99 | 127.54 |
| 20 | 300.27 | 131.31 |
| 21 | 303.56 | 135.08 |
| 22 | 305.68 | 139.60 |
| 23 | 309.02 | 143.33 |
| 24 | 309.51 | 148.30 |

| | | |
|---|---|---|
| 25 | 310.71 | 153.15 |
| 26 | 313.64 | 157.21 |
| 27 | 316.49 | 161.31 |
| 28 | 319.75 | 165.11 |
| 29 | 322.01 | 168.07 |

*** 2.258 ***

Individual data on the 71 slices

| Slice No. | Width (ft) | Weight (lbs) | Water Force Top (lbs) | Water Force Bot (lbs) | Tie Force Norm (lbs) | Tie Force Tan (lbs) | Earthquake Force Hor (lbs) | Earthquake Force Ver (lbs) | Surcharge Load (lbs) |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 2.0 | 186.9 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 2 | .4 | 83.3 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 3 | .6 | 144.6 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 4 | 1.2 | 369.5 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 5 | 2.2 | 917.7 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 6 | 1.8 | 925.2 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 7 | 2.7 | 1735.2 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 8 | 2.5 | 2130.7 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 9 | .8 | 785.4 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 10 | .3 | 337.1 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 11 | 1.1 | 1174.8 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 12 | 2.6 | 2946.9 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 13 | 5.1 | 6261.6 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 14 | 6.4 | 8856.1 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 15 | 3.6 | 5620.0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 16 | 2.9 | 4804.1 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 17 | .7 | 1190.0 | .0 | 2.3 | .0 | .0 | .0 | .0 | .0 |
| 18 | .0 | 60.1 | .0 | .2 | .0 | .0 | .0 | .0 | .0 |
| 19 | 1.1 | 1921.6 | .0 | 7.7 | .0 | .0 | .0 | .0 | .0 |
| 20 | 33.1 | 68202.5 | .0 | 375.1 | .0 | .0 | .0 | .0 | .0 |
| 21 | .3 | 763.0 | .0 | 5.0 | .0 | .0 | .0 | .0 | .0 |
| 22 | .1 | 190.6 | .0 | 1.3 | .0 | .0 | .0 | .0 | .0 |
| 23 | .2 | 380.9 | .0 | 2.5 | .0 | .0 | .0 | .0 | .0 |
| 24 | 11.8 | 28057.3 | .0 | 204.3 | .0 | .0 | .0 | .0 | .0 |
| 25 | 7.6 | 18147.9 | .0 | 151.6 | .0 | .0 | .0 | .0 | .0 |
| 26 | .3 | 761.5 | .0 | 6.7 | .0 | .0 | .0 | .0 | .0 |
| 27 | .1 | 190.9 | .0 | 1.7 | .0 | .0 | .0 | .0 | .0 |
| 28 | .2 | 382.3 | .0 | 3.4 | .0 | .0 | .0 | .0 | .0 |
| 29 | 50.5 | 145906.0 | .0 | 1390.4 | .0 | .0 | .0 | .0 | .0 |
| 30 | 10.7 | 37407.0 | .0 | 380.0 | .0 | .0 | .0 | .0 | .0 |
| 31 | 43.3 | 174215.8 | .0 | 1839.0 | .0 | .0 | .0 | .0 | .0 |
| 32 | .3 | 1424.9 | .0 | 15.4 | .0 | .0 | .0 | .0 | .0 |
| 33 | .1 | 356.0 | .0 | 3.9 | .0 | .0 | .0 | .0 | .0 |
| 34 | .2 | 711.9 | .0 | 7.7 | .0 | .0 | .0 | .0 | .0 |
| 35 | 19.4 | 86422.4 | .0 | 987.8 | .0 | .0 | .0 | .0 | .0 |
| 36 | .3 | 1423.7 | .0 | 17.1 | .0 | .0 | .0 | .0 | .0 |
| 37 | .1 | 356.4 | .0 | 4.3 | .0 | .0 | .0 | .0 | .0 |
| 38 | .2 | 713.4 | .0 | 8.6 | .0 | .0 | .0 | .0 | .0 |
| 39 | 10.7 | 48704.4 | .0 | 585.2 | .0 | .0 | .0 | .0 | .0 |
| 40 | .2 | 723.2 | .0 | 11.9 | .0 | .0 | .0 | .0 | .0 |
| 41 | .6 | 2990.3 | .0 | 22.2 | .0 | .0 | .0 | .0 | .0 |
| 42 | 1.1 | 5073.0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 43 | 1.4 | 6182.3 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 44 | 2.9 | 12345.6 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 45 | 2.9 | 12049.2 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 46 | 2.2 | 8594.4 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 47 | 3.4 | 12720.8 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 48 | 3.1 | 11234.4 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 49 | 3.0 | 10296.2 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 50 | 2.4 | 7740.8 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 51 | 2.2 | 6680.2 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 52 | 3.5 | 9898.4 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 53 | 3.4 | 8983.8 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 54 | 3.4 | 8521.5 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 55 | 3.3 | 7719.9 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 56 | .7 | 1521.9 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 57 | .4 | 822.4 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 58 | .1 | 198.5 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 59 | .2 | 417.0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 60 | 2.0 | 4154.2 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 61 | 2.1 | 4089.9 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 62 | 3.3 | 5637.2 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 63 | .5 | 701.3 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 64 | 1.2 | 1370.4 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 65 | 2.9 | 2571.8 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 66 | 2.9 | 1839.5 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 67 | 2.6 | 1155.6 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 68 | .6 | 193.9 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 69 | .2 | 64.5 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 70 | .4 | 91.6 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| 71 | 1.6 | 172.2 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |

Failure Surface Specified By 31 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 27.35 | 89.11 |
| 2 | 29.46 | 87.01 |
| 3 | 34.45 | 86.78 |
| 4 | 39.45 | 86.67 |
| 5 | 44.27 | 85.33 |
| 6 | 48.20 | 82.24 |
| 7 | 72.37 | 79.04 |
| 8 | 266.29 | 79.32 |
| 9 | 269.82 | 82.86 |
| 10 | 272.85 | 86.84 |
| 11 | 276.38 | 90.38 |
| 12 | 278.40 | 94.95 |
| 13 | 280.89 | 99.29 |
| 14 | 284.31 | 102.94 |
| 15 | 287.70 | 106.61 |
| 16 | 291.23 | 110.15 |
| 17 | 294.69 | 113.76 |
| 18 | 298.20 | 117.33 |
| 19 | 301.35 | 121.20 |
| 20 | 301.97 | 126.17 |
| 21 | 304.61 | 130.41 |
| 22 | 305.64 | 135.30 |
| 23 | 309.10 | 138.92 |
| 24 | 312.63 | 142.45 |
| 25 | 315.52 | 146.53 |
| 26 | 318.92 | 150.21 |
| 27 | 321.99 | 154.15 |
| 28 | 325.50 | 157.71 |
| 29 | 327.52 | 162.29 |
| 30 | 327.91 | 167.27 |
| 31 | 328.23 | 168.39 |

*** 2.276 ***

Failure Surface Specified By 31 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 27.35 | 89.11 |
| 2 | 29.46 | 87.01 |
| 3 | 34.45 | 86.78 |
| 4 | 39.45 | 86.67 |
| 5 | 44.27 | 85.33 |
| 6 | 48.20 | 82.24 |
| 7 | 72.37 | 79.04 |
| 8 | 266.29 | 79.32 |
| 9 | 269.82 | 82.86 |
| 10 | 272.85 | 86.84 |
| 11 | 276.38 | 90.38 |
| 12 | 278.40 | 94.95 |
| 13 | 280.89 | 99.29 |
| 14 | 284.31 | 102.94 |
| 15 | 287.70 | 106.61 |
| 16 | 291.23 | 110.15 |
| 17 | 294.69 | 113.76 |
| 18 | 298.20 | 117.33 |
| 19 | 301.35 | 121.20 |
| 20 | 301.97 | 126.17 |

| | | |
|---|---|---|
| 21 | 304.61 | 130.41 |
| 22 | 305.64 | 135.30 |
| 23 | 309.10 | 138.92 |
| 24 | 312.63 | 142.45 |
| 25 | 315.52 | 146.53 |
| 26 | 318.92 | 150.21 |
| 27 | 321.99 | 154.15 |
| 28 | 325.50 | 157.71 |
| 29 | 327.52 | 162.29 |
| 30 | 327.91 | 167.27 |
| 31 | 328.23 | 168.39 |

*** 2.276 ***

Failure Surface Specified By 31 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 27.35 | 89.11 |
| 2 | 29.46 | 87.01 |
| 3 | 34.45 | 86.78 |
| 4 | 39.45 | 86.67 |
| 5 | 44.27 | 85.33 |
| 6 | 48.20 | 82.24 |
| 7 | 72.37 | 79.04 |
| 8 | 266.29 | 79.32 |
| 9 | 269.82 | 82.86 |
| 10 | 272.85 | 86.84 |
| 11 | 276.38 | 90.38 |
| 12 | 278.40 | 94.95 |
| 13 | 280.89 | 99.29 |
| 14 | 284.31 | 102.94 |
| 15 | 287.70 | 106.61 |
| 16 | 291.23 | 110.15 |
| 17 | 294.69 | 113.76 |
| 18 | 298.20 | 117.33 |
| 19 | 301.35 | 121.20 |
| 20 | 301.97 | 126.17 |
| 21 | 304.61 | 130.41 |
| 22 | 305.64 | 135.30 |
| 23 | 309.10 | 138.92 |
| 24 | 312.63 | 142.45 |
| 25 | 315.52 | 146.53 |
| 26 | 318.92 | 150.21 |
| 27 | 321.99 | 154.15 |
| 28 | 325.50 | 157.71 |
| 29 | 327.52 | 162.29 |
| 30 | 327.91 | 167.27 |
| 31 | 328.23 | 168.39 |

*** 2.276 ***

Failure Surface Specified By 31 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 27.35 | 89.11 |
| 2 | 29.46 | 87.01 |
| 3 | 34.45 | 86.78 |
| 4 | 39.45 | 86.67 |
| 5 | 44.27 | 85.33 |
| 6 | 48.20 | 82.24 |
| 7 | 72.37 | 79.04 |
| 8 | 266.29 | 79.32 |
| 9 | 269.82 | 82.86 |
| 10 | 272.85 | 86.84 |
| 11 | 276.38 | 90.38 |
| 12 | 278.40 | 94.95 |
| 13 | 280.89 | 99.29 |
| 14 | 284.31 | 102.94 |
| 15 | 287.70 | 106.61 |
| 16 | 291.23 | 110.15 |
| 17 | 294.69 | 113.76 |
| 18 | 298.20 | 117.33 |
| 19 | 301.35 | 121.20 |
| 20 | 301.97 | 126.17 |

| | | |
|---|---|---|
| 21 | 304.61 | 130.41 |
| 22 | 305.64 | 135.30 |
| 23 | 309.10 | 138.92 |
| 24 | 312.63 | 142.45 |
| 25 | 315.52 | 146.53 |
| 26 | 318.92 | 150.21 |
| 27 | 321.99 | 154.15 |
| 28 | 325.50 | 157.71 |
| 29 | 327.52 | 162.29 |
| 30 | 327.91 | 167.27 |
| 31 | 328.23 | 168.39 |

*** 2.276 ***

Failure Surface Specified By 31 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 27.35 | 89.11 |
| 2 | 29.46 | 87.01 |
| 3 | 34.45 | 86.78 |
| 4 | 39.45 | 86.67 |
| 5 | 44.27 | 85.33 |
| 6 | 48.20 | 82.24 |
| 7 | 72.37 | 79.04 |
| 8 | 266.29 | 79.32 |
| 9 | 269.82 | 82.86 |
| 10 | 272.85 | 86.84 |
| 11 | 276.38 | 90.38 |
| 12 | 278.40 | 94.95 |
| 13 | 280.89 | 99.29 |
| 14 | 284.31 | 102.94 |
| 15 | 287.70 | 106.61 |
| 16 | 291.23 | 110.15 |
| 17 | 294.69 | 113.76 |
| 18 | 298.20 | 117.33 |
| 19 | 301.35 | 121.20 |
| 20 | 301.97 | 126.17 |
| 21 | 304.61 | 130.41 |
| 22 | 305.64 | 135.30 |
| 23 | 309.10 | 138.92 |
| 24 | 312.63 | 142.45 |
| 25 | 315.52 | 146.53 |
| 26 | 318.92 | 150.21 |
| 27 | 321.99 | 154.15 |
| 28 | 325.50 | 157.71 |
| 29 | 327.52 | 162.29 |
| 30 | 327.91 | 167.27 |
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*** 2.276 ***

Failure Surface Specified By 31 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 27.35 | 89.11 |
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| 3 | 34.45 | 86.78 |
| 4 | 39.45 | 86.67 |
| 5 | 44.27 | 85.33 |
| 6 | 48.20 | 82.24 |
| 7 | 72.37 | 79.04 |
| 8 | 266.29 | 79.32 |
| 9 | 269.82 | 82.86 |
| 10 | 272.85 | 86.84 |
| 11 | 276.38 | 90.38 |
| 12 | 278.40 | 94.95 |
| 13 | 280.89 | 99.29 |
| 14 | 284.31 | 102.94 |
| 15 | 287.70 | 106.61 |
| 16 | 291.23 | 110.15 |
| 17 | 294.69 | 113.76 |
| 18 | 298.20 | 117.33 |
| 19 | 301.35 | 121.20 |
| 20 | 301.97 | 126.17 |

| | | |
|---|---|---|
| 21 | 304.61 | 130.41 |
| 22 | 305.64 | 135.30 |
| 23 | 309.10 | 138.92 |
| 24 | 312.63 | 142.45 |
| 25 | 315.52 | 146.53 |
| 26 | 318.92 | 150.21 |
| 27 | 321.99 | 154.15 |
| 28 | 325.50 | 157.71 |
| 29 | 327.52 | 162.29 |
| 30 | 327.91 | 167.27 |
| 31 | 328.23 | 168.39 |

*** 2.276 ***

Failure Surface Specified By 31 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 27.35 | 89.11 |
| 2 | 29.46 | 87.01 |
| 3 | 34.45 | 86.78 |
| 4 | 39.45 | 86.67 |
| 5 | 44.27 | 85.33 |
| 6 | 48.20 | 82.24 |
| 7 | 72.37 | 79.04 |
| 8 | 266.29 | 79.32 |
| 9 | 269.82 | 82.86 |
| 10 | 272.85 | 86.84 |
| 11 | 276.38 | 90.38 |
| 12 | 278.40 | 94.95 |
| 13 | 280.89 | 99.29 |
| 14 | 284.31 | 102.94 |
| 15 | 287.70 | 106.61 |
| 16 | 291.23 | 110.15 |
| 17 | 294.69 | 113.76 |
| 18 | 298.20 | 117.33 |
| 19 | 301.35 | 121.20 |
| 20 | 301.97 | 126.17 |
| 21 | 304.61 | 130.41 |
| 22 | 305.64 | 135.30 |
| 23 | 309.10 | 138.92 |
| 24 | 312.63 | 142.45 |
| 25 | 315.52 | 146.53 |
| 26 | 318.92 | 150.21 |
| 27 | 321.99 | 154.15 |
| 28 | 325.50 | 157.71 |
| 29 | 327.52 | 162.29 |
| 30 | 327.91 | 167.27 |
| 31 | 328.23 | 168.39 |

*** 2.276 ***

Failure Surface Specified By 31 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 27.35 | 89.11 |
| 2 | 29.46 | 87.01 |
| 3 | 34.45 | 86.78 |
| 4 | 39.45 | 86.67 |
| 5 | 44.27 | 85.33 |
| 6 | 48.20 | 82.24 |
| 7 | 72.37 | 79.04 |
| 8 | 266.29 | 79.32 |
| 9 | 269.82 | 82.86 |
| 10 | 272.85 | 86.84 |
| 11 | 276.38 | 90.38 |
| 12 | 278.40 | 94.95 |
| 13 | 280.89 | 99.29 |
| 14 | 284.31 | 102.94 |
| 15 | 287.70 | 106.61 |
| 16 | 291.23 | 110.15 |
| 17 | 294.69 | 113.76 |
| 18 | 298.20 | 117.33 |
| 19 | 301.35 | 121.20 |
| 20 | 301.97 | 126.17 |

| | | |
|---|---|---|
| 21 | 304.61 | 130.41 |
| 22 | 305.64 | 135.30 |
| 23 | 309.10 | 138.92 |
| 24 | 312.63 | 142.45 |
| 25 | 315.52 | 146.53 |
| 26 | 318.92 | 150.21 |
| 27 | 321.99 | 154.15 |
| 28 | 325.50 | 157.71 |
| 29 | 327.52 | 162.29 |
| 30 | 327.91 | 167.27 |
| 31 | 328.23 | 168.39 |
| *** | 2.276 | *** |

Failure Surface Specified By 31 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 32.75 | 90.91 |
| 2 | 37.66 | 90.21 |
| 3 | 41.28 | 86.77 |
| 4 | 46.19 | 85.80 |
| 5 | 50.49 | 83.26 |
| 6 | 54.12 | 79.82 |
| 7 | 69.21 | 79.74 |
| 8 | 263.45 | 79.63 |
| 9 | 264.89 | 84.41 |
| 10 | 266.47 | 89.16 |
| 11 | 269.27 | 93.30 |
| 12 | 271.35 | 97.85 |
| 13 | 274.84 | 101.43 |
| 14 | 277.28 | 105.79 |
| 15 | 280.58 | 109.55 |
| 16 | 283.95 | 113.24 |
| 17 | 287.19 | 117.05 |
| 18 | 290.70 | 120.61 |
| 19 | 293.94 | 124.41 |
| 20 | 297.12 | 128.28 |
| 21 | 300.61 | 131.86 |
| 22 | 304.15 | 135.39 |
| 23 | 307.36 | 139.22 |
| 24 | 308.98 | 143.95 |
| 25 | 312.28 | 147.71 |
| 26 | 315.79 | 151.27 |
| 27 | 319.31 | 154.82 |
| 28 | 322.71 | 158.49 |
| 29 | 325.27 | 162.78 |
| 30 | 328.78 | 166.35 |
| 31 | 330.63 | 168.51 |
| *** | 2.293 | *** |

```
           Y            A     X     I     S            F     T
            .00     52.67    105.35    158.02    210.70    263.37
X       .00 +--------*+*-**W*---+---------+---------+---------+
            -              *
            -              .*
            -              2*.
            -             .11.
      52.67 +             *1
            -             .*
            -             1
A    105.35 +                   **
            -                   **
X    158.02 +
I    210.70 +
            -                         *
            -                         *
            -             ....        *
S    263.37 +             111....
            -             .2111.....
            -             ...2211.......
            -             .....22111.......
            -             .......2211.....**
            -             ..........21111...
```

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     316.04 +              ............22211.
            -              ..............2221
            -              .................0
            -              ..................
            -              ..................
            -                 ................
F    368.72 +                   ..............
            -                      ...........
            -                         ........
            -                           ......
            -                             ....
T    421.39 +        * * ****               **
```

# Attachment X

# Revised Financial Assurance

| | |
|---|---|
| DEP Form # | 62-701.900(28) |
| Form Title | Closure Cost Estimating Form for Solid Waste Facilities |
| Effective Date | January 6, 2010 |
| Incorporated in Rule 62-701.630(3), F.A.C. | |

# Florida Department of Environmental Protection

Bob Martinez Center
2600 Blair Stone Road
Tallahassee, Florida 32399-2400

## CLOSURE COST ESTIMATING FORM FOR SOLID WASTE FACILITIES

Date of DEP Approval: ______________

### I. GENERAL INFORMATION:

Facility Name: Hardee County Landfill    WACS ID: SWD/25/40612
Permit Application or Consent Order No.: 38414-011-SO/01    Expiration Date: 5/12/2013
Facility Address: 685 Airport Road, Wauchula, FL 33873
Permittee or Owner/Operator: Hardee County
Mailing Address: 685 Airport Road, Wauchula, FL 33873

Latitude: 27° 34' 17" N    Longitude: 81° 46' 58" W
Coordinate Method: USGS Mapping    Datum: NAD 83/90 West Zone of the State Plane Coordinate
Collected by: Shane Fischer    Company/Affiliation: SCS Engineers

Solid Waste Disposal Units Included in Estimate:

| Phase / Cell | Acres | Date Unit Began Accepting Waste | Active Life of Unit From Date of Initial Receipt of Waste | If active: Remaining life of unit | If closed: Date last waste receeived | If closed: Official date of closing |
|---|---|---|---|---|---|---|
| Phase I | 12.31 | NA | NA | NA | October 26, 2010 | 01/03/12 |
| Phase II Section I | 6.29 | May 1, 2008 | 07/01/14 | 23 months | NA | NA |
| Phase II Section II | 6.20 | To Be Determined | 02/01/37 | NA | NA | NA |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |

Total disposal unit acreage included in this estimate.    Closure: 12.49    Long-Term Care: 24.80

Facility Type: X Class I ____ Class III ____ C&D Debris Disposal
(Check all that apply) ____ Other ____________

### II. TYPE OF FINANCIAL ASSURANCE DOCUMENT (Check Type)

____ Letter of Credit *    ____ Insurance Certificate    X Escrow Account

____ Performance Bond *    ____ Financial Test    ____ Form 28 (FA Deferral)

____ Guarantee Bond *    ____ Trust Fund Agreement

* - Indicates mechanisms that require the use of a Standby Trust Fund Agreement

| Northwest District | Northeast District | Central District | Southwest District | South District | Southeast District |
|---|---|---|---|---|---|
| 160 Governmental Center | 7825 Baymeadows Way, Ste. B200 | 3319 Maguire Blvd., Ste. 232 | 13501 N. Telecom Pky | 2295 Victoria Ave., Ste. 364 | 400 North Congress Ave., Suite 200 |
| Pensacola, FL 32502-5794 | Jacksonville, FL 32256-7590 | Orlando, FL 32803-3767 | Temple Terrace, FL 33637 | Fort Myers, FL 33901-3881 | West Palm Beach, FL 33401 |
| 850-595-8360 | 904-807-3300 | 407-894-7555 | 813-632-7600 | 239-332-6975 | 561-681-6600 |

## III. ESTIMATE ADJUSTMENT

40 CFR Part 264 Subpart H as adopted by reference in Rule 62-701.630, Florida Administrative Code (F.A.C.) sets forth the meth of annual cost estimate adjustment. Cost estimates may be adjusted by using an inflation factor or by recalculating the maximum of closure in current dollars. Select one of the methods of cost estimate adjustment below.

_____ **(a) Inflation Factor Adjustment** _X_ **(b) Recalculated or New Cost Estimates**

Inflation adjustment using an inflation factor may only be made when a Department approved closure cost estimate exists and no changes have occurred in the facility operation which would necessitate modification to the closure plan. The inflation factor is dei from the most recent Implicit Price Deflator for Gross National Product published by the U.S. Department of Commerce in its surve Current Business. The inflation factor is the result of dividing the latest published annual Deflator yby the Deflator for the previous The inflation factor may also be obtained from the Solid Waste website www.dep.state.fl.us/waste/categories/swfr or call the Financial Coordinator at (850)-245-8706.

This adjustment is based on the Department approved closing cost estimate dated: ____________

| Latest Department Approved **Closing Cost** Estimate: | | Current Year Inflation Factor, **e.g. 1.02** | | Inflation Adjusted Closing Cost Estimate: |
|---|---|---|---|---|
| | x | | = | $0.00 |

This adjustment is based on the Department approved long-term care cost estimate dated: ____________

| Latest Department Approved Annual **Long-Term Care** Cost Estimate: | | Current Year Inflation Factor, **e.g. 1.02** | | Inflation Adjusted Annual Long-Term Care Cost Estimate |
|---|---|---|---|---|
| | x | | = | $0.00 |

Number of Years of Long Term Care Remaining: x ____________

**Inflation Adjusted Long-Term Care Cost Estimate:** = $0.00

**Signature by:** _____ **Owner/Operator** _X_ **Engineer** (check what applies)

[signature]
Signature

4041 Park Oaks Blvd., Suite 100
Address

Shane R. Fischer, P.E., Project Manager
Name & Title

Tampa, Florida 33610
City, State, Zip Code

4/1/13
Date

sfischer@scsengineers.com
E-Mail Address

(813) 621-0080
Telephone Number

**IV. ESTIMATED CLOSING COST (check what applies)**

__X__ **Recalculated Cost Estimate** ______ **New Facility Cost Estimate**

Notes:
1. Cost estimates for the time period when the extent and manner of landfill operation makes closing most expensive
2. Cost estimate must be certified by a professional engineer
3. Cost estimates based on third party suppliers of material, equipment and labor at fair market value
4. In some cases, a price quote in support of individual item estimates may be required

| Description | Unit | Number of Units | Cost / Unit | Total Cost |
|---|---|---|---|---|
| **1. Proposed Monitoring Wells** | **(Do not include wells already in existence.)** | | | |
| | EA | 0.00 | $0.00 | $0 |
| | | | Subtotal Proposed Monitoring Wells: | $0 |
| **2. Slope and Fill (bedding layer between waste and barrier layer):** | | | | |
| Excavation | CY | 12,172 | $0.55 | $6,695 |
| Placement and Spreading | CY | 24,344 | $10.25 | $249,526 |
| Compaction | CY | 24,344 | $0.75 | $18,258 |
| Off Site Material | CY | 24,344 | $10.25 | $249,526 |
| Delivery | CY | 0 | $0.00 | $0 |
| | | | Subtotal Slope and Fill: | $524,005 |
| **3. Cover Material (Barrier Layer):** | | | | |
| Off-Site Clay | CY | 0.00 | $0.00 | $0 |
| Synthetics - 40 mil | SY | 76,685 | $3.24 | $248,459 |
| Synthetics - GCL | SY | 0.00 | $0.00 | $0 |
| Synthetics - Composite | SY | 76,685 | $5.67 | $434,804 |
| Synthetics - Other (explain) | | 0.00 | $0.00 | $0 |
| | | | Subtotal Cover Material: | $683,263 |
| **4. Top Soil Cover:** | | | | |
| Off-Site Material | CY | 48,689 | $10.25 | $499,062 |
| Delivery | CY | 48,689 | $0.00 | $0 |
| Spread | CY | 48,689 | $0.00 | $0 |
| | | | Subtotal Top Soil Cover : | $499,062 |
| **5. Vegetative Layer** | | | | |
| Sodding | SY | 73,033 | $1.53 | $111,740 |
| Hydroseeding | AC | 0.00 | $0.00 | $0 |
| Fertilizer | AC | 0.00 | $0.00 | $0 |
| Mulch | AC | 0.00 | $0.00 | $0 |
| Other (explain) | | 0 | $0.00 | $0 |
| | | | Subtotal Vegetative Layer: | $111,740 |
| **6. Stormwater Control System:** | | | | |
| Earthwork | CY | 0 | $0.00 | $0 |
| Grading | SY | 0 | $0.00 | $0 |
| Piping | LF | 1,080 | $32.27 | $34,852 |
| Ditches | LF | 0 | $0.00 | $0 |
| Berms | LF | 0 | $0.00 | $0 |
| Control Structures | EA | 4 | $2,000.00 | $8,000 |
| Other (explain) | EA | 1 | $2,000.00 | $2,000 |
| Discharge Structure | | | Subtotal Stormwater Control System: | $44,852 |

| Description | Unit | Number of Units | Cost / Unit | Total Cost |
|---|---|---|---|---|
| **7. Passive Gas Control** | | | | |
| Wells | EA | 15 | $4,750.00 | $71,250 |
| Pipe and Fittings | LF | 0 | $0.00 | $0 |
| Monitoring Probes | EA | 0 | $0.00 | $0 |
| NSPS/Title V requirements | LS | 0 | $0.00 | $0 |
| | | | Subtotal Passive Gas Control: | $71,250 |
| **8. Active Gas Extraction Control** | | | | |
| Traps | EA | 0 | $0.00 | $0 |
| Sumps | | 0 | $0.00 | $0 |
| Flare Assembly | EA | 0 | $0.00 | $0 |
| Flame Arrestor | EA | 0 | $0.00 | $0 |
| Mist Eliminator | EA | 0 | $0.00 | $0 |
| Flow Meter | EA | 0 | $0.00 | $0 |
| Blowers | EA | 0 | $0.00 | $0 |
| Collection System | LF | 0 | $0.00 | $0 |
| Other (explain) | | 0 | $0.00 | $0 |
| | | | Subtotal Active Gas Extraction: | $0 |
| **9. Security System** | | | | |
| Fencing | LF | 0 | $0.00 | $0 |
| Gate(s) | EA | 0 | $0.00 | $0 |
| Sign(s) | EA | 0 | $0.00 | $0 |
| | | | Subtotal Security System: | $0 |
| **10. Engineering:** | | | | |
| Closure Plan Report | LS | 1 | $133,753 | $133,753 |
| Certified Engineering Drawings | LS | 1 | $25,471 | $25,471 |
| NSPS/Title V Air Permit | LS | 0 | $0.00 | $0 |
| Final Survey | LS | 1 | $15,204 | $15,204 |
| Certification of Closure | LS | 1 | $25,331 | $25,331 |
| Other (explain) | LS | 1 | $17,788 | $17,788 |
| (Bidding Services) | | | Subtotal Engineering: | $217,547 |

| Description | Hours | Cost / Hour | Hours | Cost / Hour | Total Cost |
|---|---|---|---|---|---|
| **11. Professional Services** | | | | | |
| | Contract Management | | Quality Assurance | | |
| P.E. Supervisor | 64 | $195 | 16 | $195 | $15,600 |
| On-Site Engineer | 200 | $145 | 100 | $145 | $43,500 |
| Office Engineer | 40 | $115 | 120 | $115 | $18,400 |
| On-site Technician | 240 | $88 | 960 | $88 | $105,600 |
| Other (Admin. Cost) | 40 | $60 | 40 | $60 | $4,800 |
| Reimbursables | NA | $2,018 | NA | $34,030 | $36,048 |

| Description | Unit | Number of Units | Cost / Unit | Total Cost |
|---|---|---|---|---|
| Quality Assurance Testing | LS | 1 | $14,000 | $14,000.00 |
| | | | Subtotal Professional Services: | $237,948 |

| | |
|---|---|
| **Subtotal of 1-11 Above:** | $2,389,668 |
| **12. Contingency** 10% of Subtotal of 1-11 Above | 10% |
| Subtotal Contingency: | $238,967 |
| **Estimated Closing Cost Subtotal:** | $2,628,630 |

| **Description** | **Total Cost** |
|---|---|
| **13. Site Specific Costs** | |
| Mobilization (10% of Sub-total 1-11) | $238,970 |
| Waste Tire Facility | $617 |
| Materials Recovery Facility | $46,525 |
| Special Wastes | $0 |
| Leachate Management System Modification | $0 |
| Other (Household Hazardous Waste Building) | $7,603 |
| | |
| Subtotal Site Specific Costs: | $293,720 |
| **TOTAL ESTIMATED CLOSING COSTS ($):** | $2,922,350 |

## V. ANNUAL COST FOR LONG-TERM CARE

See 62-701.600(1)a.1., 62-701.620(1), 62-701.630(3)a. and 62-701.730(11)b. F.A.C. for required term length. For landfills certified closed and Department accepted, enter the remaining long-term care length as "Other" and provide years remaining.

(Check Term Length) ______ 5 years ______ 20 years __X__ 30 years ______ Other,______ Years

Notes: 1. Cost estimates must be certified by a professional engineer.
2. Cost estimates based on third party suppliers of material, equipment and labor at fair market value.
3. In some cases, a price quote in support of individual item estimates may be required.

**All items must be addressed.** Attach a detailed explanation for all entries left blank.

| Description | Sampling Frequency (Events/Year) | Number of Wells | (Cost/Well) / Event | Annual Cost |
|---|---|---|---|---|
| **1. Groundwater Monitoring [62-701.510(6), and (8)(a)]** | | | | |
| Monthly | 12 | 0 | $0.00 | $0 |
| Quarterly | 4 | 0 | $0.00 | $0 |
| Semi-Annually | 2 | 9 | $600.00 | $10,800 |
| Annually | 1 | 0 | $0.00 | $0 |
| | | | Subtotal Groundwater Monitoring: | $10,800 |
| **2. Surface Water Monitoring [62-701.510(4), and (8)(b)]** | | | | |
| Monthly | 12 | 0 | 0 | $0 |
| Quarterly | 4 | 0 | 0.00 | $0 |
| Semi-Annually | 2 | 1 | 650 | $1,300 |
| Annually | 1 | 0 | 0.00 | $0 |
| | | | Subtotal Surface Water Monitoring: | $1,300 |
| **3. Gas Monitoring [62-701.400(10)]** | | | | |
| Monthly | 12 | 0 | $0.00 | $0.00 |
| Quarterly | 4 | 15 | $57.00 | $3,420 |
| Semi-Annually | 2 | 0 | $0.00 | $0.00 |
| Annually | 1 | 0 | $0.00 | $0.00 |
| | | | Subtotal Gas Monitoring: | $3,420 |
| **4. Leachate Monitoring [62-701.510(5), (6)(b) and 62-701.510(8)c]** | | | | |
| Monthly | 12 | 0 | $0.00 | $0.00 |
| Quarterly | 4 | 0 | $0.00 | $0 |
| Semi-Annually | 2 | 0 | $0.00 | $0.00 |
| Annually | 1 | 1 | $967 | $967 |
| Other (explain) ______ | 0 | 0 | $0.00 | $0.00 |
| | | | Subtotal Leachate Monitoring: | $967 |

| Description | Unit | Number of Units/Year | Cost / Unit | Annual Cost |
|---|---|---|---|---|
| **5. Leachate Collection/Treatment Systems Maintenance** | | | | |
| Maintenance | | | | |
| Collection Pipes | LF | 16,290.0 | $0.46 | $7,493 |
| Sumps, Traps | EA | 0 | $0.00 | $0.00 |
| Lift Stations | EA | 0 | $0.00 | $0 |
| Cleaning | LS | 0.0 | $0.00 | $0.00 |
| Tanks | EA | 2 | $500.00 | $1,000 |

| Description | Unit | Number of Units/Year | Cost / Unit | Annual Cost |
|---|---|---|---|---|
| **5. (Continued)** | | | | |
| Impoundments | | | | |
| Liner Repair | SY | 0 | $0.00 | $0 |
| Sludge Removal | CY | 0 | $0.00 | $0 |
| Aeration Systems | | | | |
| Floating Aerators | EA | 0 | $0.00 | $0 |
| Spray Aerators | EA | 0 | $0.00 | $0 |
| Disposal | | | | |
| Off-site (Includes transportation & disposal) | LS | 1 | $280,000.00 | $280,000 |
| | Subtotal Leachate Collection /Treatment System Maintenance: | | | $288,493 |
| **6. Groundwater Monitoring Well Maintenance** | | | | |
| Monitoring Wells | LF | 30 | $13.33 | $400 |
| Replacement | EA | 0.2 | $2,000.00 | $400 |
| Abandonment | EA | 9.0 | $25.00 | $225.00 |
| | Subtotal Groundwater Monitoring Well Maintenance: | | | $1,025 |
| **7. Gas System Maintenance** | | | | |
| Piping, Vents | LF | 10 | $95.00 | $950 |
| Blowers | EA | 0 | $0.00 | $0.00 |
| Flaring Units | EA | 0 | $0.00 | $0 |
| Meters, Valves | EA | 0 | $0.00 | $0.00 |
| Compressors | EA | 0 | $0.00 | $0.00 |
| Flame Arrestors | EA | 0 | $0.00 | $0.00 |
| Replace Monitoring Probes | LS | 1 | $775.00 | $775.00 |
| | Subtotal Gas System Maintenance: | | | $1,725 |
| **8. Landscape Maintenance** | | | | |
| Mowing | AC | 99.2 | $27.88 | $2,770 |
| Fertilizer | AC | 0 | $0.00 | $0 |
| | Subtotal Landscape Maintenance: | | | $2,770 |
| **9. Erosion Control and Cover Maintenance** | | | | |
| Sodding | SY | 1,210 | $1.53 | $1,851 |
| Regrading | AC | 1 | $2,000 | $2,000 |
| Liner Repair | SY | 200 | $3.69 | $738 |
| Clay | CY | 0 | $0.00 | $0.00 |
| | Subtotal Erosion Control and Cover Maintenance: | | | $4,589 |
| **10. Storm Water Management System Maintenance** | | | | |
| Conveyance Maintenance | LS | 1 | $2,150 | $2,150 |
| | Subtotal Storm Water Management System Maintenance: | | | $2,150 |
| **11. Security System Maintenance** | | | | |
| Fences | LS | 1 | $810.00 | $810 |
| Gate(s) | EA | 1 | $515.00 | $515 |
| Sign(s) | EA | 0 | $0.00 | $0 |
| | Subtotal Security System: | | | $1,325 |

| Description | Unit | Number of Units/Year | Cost / Unit | Annual Cost |
|---|---|---|---|---|
| **12. Utilities** | LS | 1 | 500 | $500 |
| | | | Subtotal Utilities: | $500 |
| **13. Leachate Collection/Treatment Systems Operation** | | | | |
| P.E. Supervisor | HR | 24 | $195.00 | $4,680 |
| On-Site Engineer | HR | 0 | $0.00 | $0 |
| Office Engineer | HR | 0 | $0.00 | $0.00 |
| On-Site Technicial | HR | 48 | $95.00 | $4,560 |
| Materials | LS | 0 | $0.00 | $0 |
| | | | Subtotal Leachate Collection/Treatment Systems Operation: | $9,240 |
| **14. Administrative** | | | | |
| P.E. Supervisor | HR | 12 | $195.00 | $2,340 |
| On-Site Engineer | HR | 0 | $0.00 | $0 |
| Office Engineer | HR | 0 | $0.00 | $0.00 |
| On-Site Technicial | HR | 48 | $88.00 | $4,224 |
| Other (consulting) | LS | 0 | $0.00 | $0 |
| | | | Subtotal Administrative: | $6,564 |
| **15. Contingency** | 5% % of Subtotal of 1-14 Above | | | $334,394 |
| | | | Subtotal Contingency: | $16,720 |

| Description | Unit | Number of Units/Year | Cost / Unit | Annual Cost |
|---|---|---|---|---|
| **16. Site Specific Costs** | | | | |
| NA | 0 | 0 | 0 | $0 |
| NA | 0 | 0 | 0 | $0 |
| NA | 0 | 0 | 0 | $0 |
| | | | Subtotal Site Specific Costs: | $0 |

**ANNUAL LONG-TERM CARE COST ($/Year): $351,588**

Number of Years of Long-Term Care: 30

**TOTAL LONG-TERM CARE COST ($): $10,547,648**

### VI. CERTIFICATION BY ENGINEER

This is to certify that the Cost Estimates pertaining to the engineering features of the this solid waste management facility have been examined by me and found to conform to engineering principals applicable to such facilities. In my professional judgement, the Cost Estimates are a true, correct and complete representation of the financial liabilities for closing and/or long-term care of the facility and comply with the requirements of Rule 62-701.630 F.A.C. and all other Department of Environmental Protection rules, and statutes of the State of Florida. It is understood that the Cost Estimates shall be submitted to the Department annually, revised or adjusted as required by Rule 62-701.630(4), F.A.C.

Signature

SCS Engineers, 4041 Park Oaks Blvd. Suite 100
Mailing Address

Shane R. Fischer, P.E., Project Manager
Name & Title (please type)

Tampa, Florida 33610
City, State, Zip Code

4/1/13
Date

sfischer@scsengineers.com
E-Mail Address

58026
Florida Registration Number
(please affix seal)

(813) 621-0080
Telephone Number

### VII. SIGNATURE BY OWNER/OPERATOR

Teresa Carver
Signature of Applicant

685 Airport Road
Mailing Address

Teresa Carver, Solid Waste Director
Name & Title (please type)

Wauchula, Florida 33873
City, State, Zip Code

teresa.carver@hardeecounty.net
E-Mail Address (if available)

(863) 773-5089
Telephone Number

# Attachment Y

## Revised Figure 1 Potable Wells Inventory and Table 1 SWFWMD Well Construction Permits

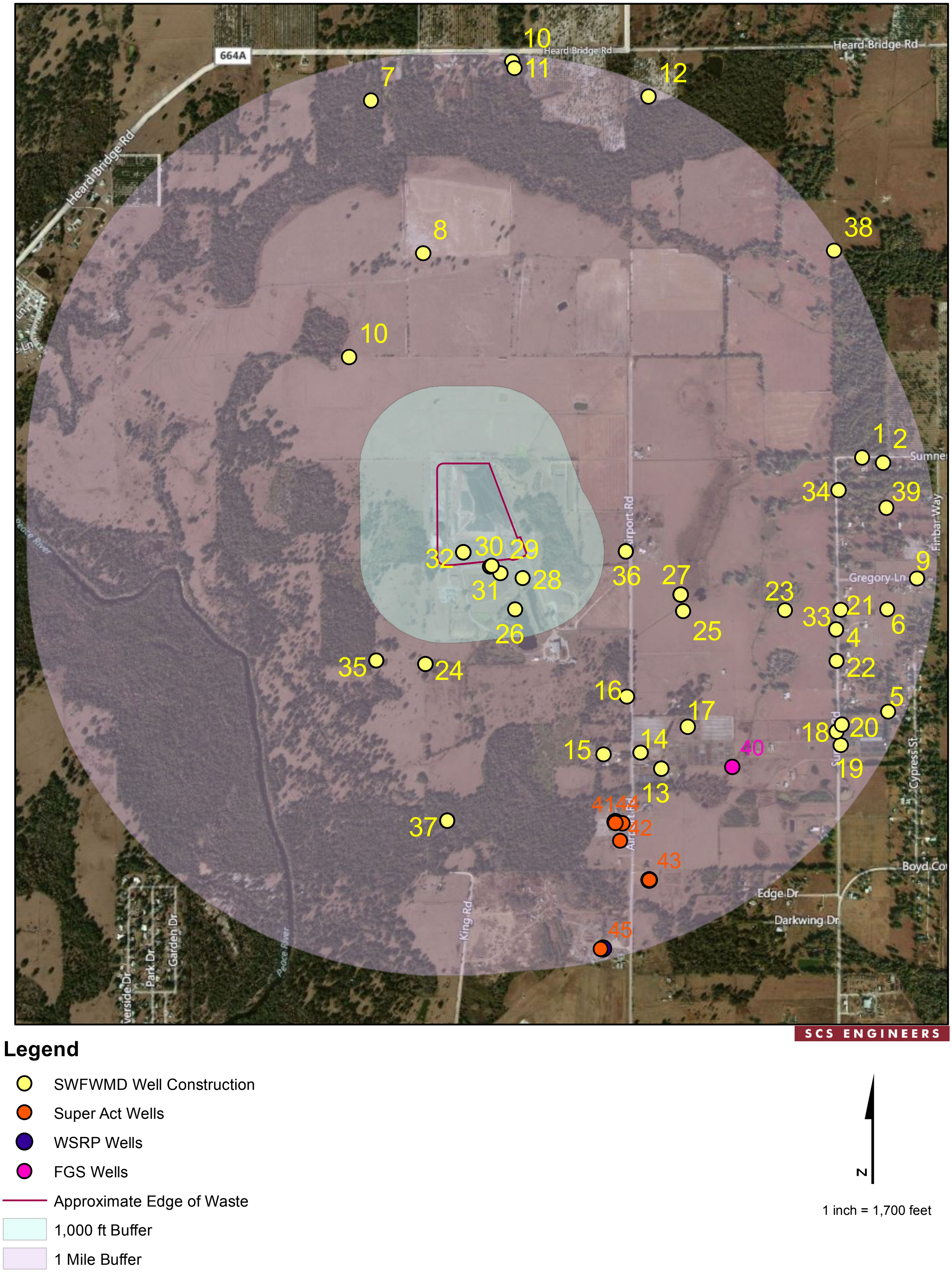


Figure 1. Well Inventory, Hardee County Landfill, Hardee County, Florida.

Table 1. SWFWMD Well Construction Permits, Hardee County Landfill, Hardee County, Florida.

| Map ID | Construction Permit Number | Well Use | Well Depth | Owner | Address | Lattitude | Longitude |
|---|---|---|---|---|---|---|---|
| 1 | 631797 | DOMESTIC | 157 | JOYCE LYERLY | 1028 SUMNER ROAD | 27 34 23.69 | 81 46 02.82 |
| 2 | 760217 | DOMESTIC | 220 | RUBEN SALAS | 1044 SUMNER RD | 27 34 23.00 | 81 45 59.80 |
| 4 | 412499 | DOMESTIC | 0 | DRAKE, GEORGE W | 11214 NORTH SUMMER ROAD | 27 33 57.73 | 81 46 06.48 |
| 5 | 545871 | DOMESTIC | 203 | MANUEL HERRERA | 126 CYPRESS STREET | 27 33 51.27 | 81 45 59.14 |
| 6 | 414023 | DOMESTIC | 220 | DRAKE, GEORGE | 1342 HWY S 17 | 27 34 04.27 | 81 45 59.23 |
| 7 | 680065 | DOMESTIC | 138 | WILLIAM E DAVIS | 1992 HEARN BRIDGE RD | 27 35 09.20 | 81 47 12.87 |
| 8 | 601175 | DOMESTIC | 180 | MARK SCHUMANN | 1998 HEARD BRIDGE RD | 27 34 49.74 | 81 47 05.44 |
| 9 | 647646 | DOMESTIC | 280 | GREGORY MORGAN | 2598 GREGORY LN | 27 34 08.21 | 81 45 54.99 |
| 10 | 783932 | MONITOR | 24 | SOUTH FT MEADE PARTNERSHIP L P | 2612 HEARD BRIDGE RD | 27 34 36.57 | 81 47 16.06 |
| 10 | 805156 | PLUGGED | 130 | SOUTH FT MEADE PARTNERSHIP L P | 2612 HEARD BRIDGE RD | 27 35 14.13 | 81 46 52.67 |
| 11 | 802184 | DOMESTIC | 190 | SOUTH FT MEADE PARTNERSHIP L P | 2660 HEARD BRIDGE RD | 27 35 13.30 | 81 46 52.40 |
| 12 | 637224 | DOMESTIC | 132 | CARGILL FERTILIZER INC | 2894 HEARD BRIDGE ROAD | 27 34 49.97 | 81 46 06.73 |
| 13 | 760114 | IRRIGATION | 220 | NICK MIRANDA | 498 AIRPORT RD | 27 33 44.10 | 81 46 31.60 |
| 13 | 659635 | DOMESTIC | 200 | CARL & MARYJANE SISSOMS | 498 AIRPORT RD | 27 33 57.73 | 81 46 06.48 |
| 14 | 673367 | IRRIGATION | 200 | NICK MIRANDA | 510 AIRPORT RD | 27 33 57.73 | 81 46 06.48 |
| 14 | 685705 | IRRIGATION | 220 | NICK MIRANDA | 510 AIRPORT ROAD | 27 33 57.73 | 81 46 06.48 |
| 15 | 806217 | DOMESTIC | 200 | FIELD JASON C & | 515 AIRPORT RD | 27 33 45.90 | 81 46 39.80 |
| 16 | 586779 | IRRIGATION | 173 | GENE FIELD | 515 AIRPORT RD | 27 33 53.26 | 81 46 36.47 |
| 17 | 809297 | IRRIGATION - AGRICULTURAL | 220 | ARAUJO DAVID | 520 AIRPORT RD | 27 33 49.43 | 81 46 27.80 |
| 18 | 731418 | DOMESTIC | 220 | ROBERT & JOY ROBERTS | 543 SUMMER ROAD | 27 33 57.73 | 81 46 06.48 |
| 19 | 753985 | IRRIGATION | 200 | IGNACIO LUCATERO | 552 SUMNER RD | 27 33 48.77 | 81 46 06.49 |
| 20 | 656331 | DOMESTIC | 170 | LARRY FIEGLE | 555 SUMMER RD | 27 33 57.73 | 81 46 06.48 |
| 21 | 643154 | DOMESTIC | 160 | BOBBY AND ESTER BRAGG | 671 SUMNER RD | 27 34 01.80 | 81 46 06.52 |
| 22 | 418987 | DOMESTIC | 235 | BURNETT, HENRY P | RT 2 | 27 33 57.73 | 81 46 06.48 |
| 23 | 366380 | DOMESTIC | 210 | HINES, HOWARD | RT 2 LOT 09 | 27 34 04.19 | 81 46 13.82 |
| 24 | 435610 | MONITOR | 20 | HARDEE COUNTY REGIONAL SANITARY LANDFILL | AIRPORT RD | 27 33 57.46 | 81 47 05.26 |
| 24 | 435611 | MONITOR | 18 | HARDEE COUNTY REGIONAL SANITARY LANDFILL | AIRPORT RD | 27 33 57.46 | 81 47 05.26 |
| 24 | 435612 | MONITOR | 21 | HARDEE COUNTY REGIONAL SANITARY LANDFILL | AIRPORT RD | 27 33 57.46 | 81 47 05.26 |
| 24 | 435613 | MONITOR | 21 | HARDEE COUNTY REGIONAL SANITARY LANDFILL | AIRPORT RD | 27 33 57.46 | 81 47 05.26 |
| 24 | 384054 | MONITOR | 15 | HARDEE COUNTY REGIONAL SANITARY LANDFILL | AIRPORT RD | 27 33 57.46 | 81 47 05.26 |
| 24 | 384055 | MONITOR | 11 | HARDEE COUNTY REGIONAL SANITARY LANDFILL | AIRPORT RD | 27 33 57.46 | 81 47 05.26 |
| 24 | 384056 | MONITOR | 11 | HARDEE COUNTY REGIONAL SANITARY LANDFILL | AIRPORT RD | 27 33 57.46 | 81 47 05.26 |
| 24 | 384468 | INDUSTRIAL | 200 | HARDEE COUNTY REGIONAL SANITARY LANDFILL | AIRPORT RD | 27 33 57.46 | 81 47 05.26 |
| 24 | 510327 | PUBLIC SUPPLY | 197 | HARDEE COUNTY REGIONAL SANITARY LANDFILL | AIRPORT RD | 27 33 57.46 | 81 47 05.26 |
| 25 | 554873 | MONITOR | 15 | HARDEE COUNTY SOLID WASTE RECYCLING CENTER | 685 AIRPORT RD | 27 34 04.11 | 81 46 28.41 |
| 25 | 554873 | MONITOR | 15 | HARDEE COUNTY SOLID WASTE RECYCLING CENTER | 685 AIRPORT RD | 27 34 04.11 | 81 46 28.41 |
| 25 | 554873 | MONITOR | 15 | HARDEE COUNTY SOLID WASTE RECYCLING CENTER | 685 AIRPORT RD | 27 34 04.11 | 81 46 28.41 |
| 25 | 554873 | MONITOR | 15 | HARDEE COUNTY SOLID WASTE RECYCLING CENTER | 685 AIRPORT RD | 27 34 04.11 | 81 46 28.41 |
| 26 | 758080 | MONITOR | 8 | HARDEE COUNTY REGIONAL SANITARY LANDFILL | 685 AIRPORT RD | 27 34 04.38 | 81 46 52.36 |
| 26 | 758080 | MONITOR | 8 | HARDEE COUNTY REGIONAL SANITARY LANDFILL | 685 AIRPORT RD | 27 34 04.38 | 81 46 52.36 |
| 27 | 808434 | PLUGGED | 19 | SOUTH FT MEADE PARTNERSHIP L P | 685 AIRPORT RD | 27 34 06.28 | 81 46 28.79 |
| 27 | 808434 | PLUGGED | 16 | SOUTH FT MEADE PARTNERSHIP L P | 685 AIRPORT RD | 27 34 06.28 | 81 46 28.79 |
| 27 | 808434 | PLUGGED | 17 | SOUTH FT MEADE PARTNERSHIP L P | 685 AIRPORT RD | 27 34 06.28 | 81 46 28.79 |
| 27 | 808434 | PLUGGED | 0 | SOUTH FT MEADE PARTNERSHIP L P | 685 AIRPORT RD | 27 34 06.28 | 81 46 28.79 |
| 27 | 808434 | PLUGGED | 0 | SOUTH FT MEADE PARTNERSHIP L P | 685 AIRPORT RD | 27 34 06.28 | 81 46 28.79 |
| 27 | 808434 | PLUGGED | 0 | SOUTH FT MEADE PARTNERSHIP L P | 685 AIRPORT RD | 27 34 06.28 | 81 46 28.79 |
| 27 | 808434 | PLUGGED | 0 | SOUTH FT MEADE PARTNERSHIP L P | 685 AIRPORT RD | 27 34 06.28 | 81 46 28.79 |
| 27 | 808434 | PLUGGED | 0 | SOUTH FT MEADE PARTNERSHIP L P | 685 AIRPORT RD | 27 34 06.28 | 81 46 28.79 |

| Map ID | Construction Permit Number | Well Use | Well Depth | Owner | Address | Lattitude | Longitude |
|---|---|---|---|---|---|---|---|
| 28 | 758079 | MONITOR | 12 | HARDEE COUNTY REGIONAL SANITARY LANDFILL | 685 AIRPORT RD | 27 34 08.39 | 81 46 51.30 |
| 28 | 758079 | MONITOR | 12 | HARDEE COUNTY REGIONAL SANITARY LANDFILL | 685 AIRPORT RD | 27 34 08.39 | 81 46 51.30 |
| 29 | 758074 | MONITOR | 17 | HARDEE COUNTY REGIONAL SANITARY LANDFILL | 685 AIRPORT RD | 27 34 09.01 | 81 46 54.55 |
| 30 | 770272 | MONITOR | 20 | HARDEE CO BOCC | 685 AIRPORT RD | 27 34 09.80 | 81 46 55.96 |
| 30 | 770272 | MONITOR | 20 | HARDEE CO BOCC | 685 AIRPORT RD | 27 34 09.80 | 81 46 55.96 |
| 31 | 770274 | PLUGGED | 12 | HARDEE CO BOCC | 685 AIRPORT RD | 27 34 09.96 | 81 46 55.73 |
| 31 | 770274 | PLUGGED | 12 | HARDEE CO BOCC | 685 AIRPORT RD | 27 34 09.96 | 81 46 55.73 |
| 32 | 758082 | TEST | 12 | HARDEE COUNTY REGIONAL SANITARY LANDFILL | 685 AIRPORT RD | 27 34 11.71 | 81 46 59.78 |
| 32 | 758082 | TEST | 12 | HARDEE COUNTY REGIONAL SANITARY LANDFILL | 685 AIRPORT RD | 27 34 11.71 | 81 46 59.78 |
| 32 | 758082 | TEST | 12 | HARDEE COUNTY REGIONAL SANITARY LANDFILL | 685 AIRPORT RD | 27 34 11.71 | 81 46 59.78 |
| 32 | 758082 | TEST | 12 | HARDEE COUNTY REGIONAL SANITARY LANDFILL | 685 AIRPORT RD | 27 34 11.71 | 81 46 59.78 |
| 32 | 758082 | TEST | 12 | HARDEE COUNTY REGIONAL SANITARY LANDFILL | 685 AIRPORT RD | 27 34 11.71 | 81 46 59.78 |
| 32 | 758082 | TEST | 12 | HARDEE COUNTY REGIONAL SANITARY LANDFILL | 685 AIRPORT RD | 27 34 11.71 | 81 46 59.78 |
| 32 | 758082 | TEST | 12 | HARDEE COUNTY REGIONAL SANITARY LANDFILL | 685 AIRPORT RD | 27 34 11.71 | 81 46 59.78 |
| 33 | 622889 | DOMESTIC | 220 | BILL HODGE | 754 SUMMER ROAD | 27 33 57.73 | 81 46 06.48 |
| 34 | 637035 | DOMESTIC | 200 | JACK KERNS | 918 SUMMER ROAD | 27 33 57.73 | 81 46 06.48 |
| 35 | 804173 | MONITOR | 25 | MOSAIC FERTILIZER LLC | AIRPORT RD | 27 33 57.92 | 81 47 12.25 |
| 35 | 804173 | MONITOR | 25 | MOSAIC FERTILIZER LLC | AIRPORT RD | 27 33 57.92 | 81 47 12.25 |
| 35 | 804173 | MONITOR | 25 | MOSAIC FERTILIZER LLC | AIRPORT RD | 27 33 57.92 | 81 47 12.25 |
| 35 | 804173 | MONITOR | 25 | MOSAIC FERTILIZER LLC | AIRPORT RD | 27 33 57.92 | 81 47 12.25 |
| 35 | 804173 | MONITOR | 25 | MOSAIC FERTILIZER LLC | AIRPORT RD | 27 33 57.92 | 81 47 12.25 |
| 35 | 804173 | MONITOR | 25 | MOSAIC FERTILIZER LLC | AIRPORT RD | 27 33 57.92 | 81 47 12.25 |
| 35 | 804173 | MONITOR | 25 | MOSAIC FERTILIZER LLC | AIRPORT RD | 27 33 57.92 | 81 47 12.25 |
| 35 | 804173 | MONITOR | 25 | MOSAIC FERTILIZER LLC | AIRPORT RD | 27 33 57.92 | 81 47 12.25 |
| 36 | 599468 | MONITOR | 0 | HARDEE CO BOCC | 685 AIRPORT RD | 27 34 11.78 | 81 46 36.59 |
| 36 | 627535 | PLUGGED | 10 | HARDEE COUNTY SOLID WASTE RECYCLING CENTER | 685 AIRPORT RD | 27 34 11.78 | 81 46 36.59 |
| 36 | 737393 | IRRIGATION | 280 | HARDEE COUNTY SOLID WASTE RECYCLING CENTER | 685 AIRPORT RD | 27 34 11.78 | 81 46 36.59 |
| 36 | 738035 | PLUGGED | 13 | HARDEE CO | 685 AIRPORT RD, WAUCHULA | 27 34 11.78 | 81 46 36.59 |
| 36 | 738035 | PLUGGED | 13 | HARDEE CO | 685 AIRPORT RD, WAUCHULA | 27 34 11.78 | 81 46 36.59 |
| 36 | 738034 | PLUGGED | 14 | HARDEE CO | 685 AIRPORT RD, WAUCHULA | 27 34 11.78 | 81 46 36.59 |
| 36 | 738034 | PLUGGED | 14 | HARDEE CO | 685 AIRPORT RD, WAUCHULA | 27 34 11.78 | 81 46 36.59 |
| 36 | 738034 | PLUGGED | 14 | HARDEE CO | 685 AIRPORT RD, WAUCHULA | 27 34 11.78 | 81 46 36.59 |
| 36 | 738034 | PLUGGED | 15 | HARDEE CO | 685 AIRPORT RD, WAUCHULA | 27 34 11.78 | 81 46 36.59 |
| 36 | 738034 | PLUGGED | 14 | HARDEE CO | 685 AIRPORT RD, WAUCHULA | 27 34 11.78 | 81 46 36.59 |
| 36 | 738036 | PLUGGED | 96 | HARDEE CO | 685 AIRPORT RD, WAUCHULA | 27 34 11.78 | 81 46 36.59 |
| 37 | 804174 | MONITOR | 25 | MOSAIC FERTILIZER LLC | AIRPORT RD | 27 33 37.53 | 81 47 02.16 |
| 37 | 804174 | MONITOR | 0 | MOSAIC FERTILIZER LLC | AIRPORT RD | 27 33 37.53 | 81 47 02.16 |
| 37 | 804174 | MONITOR | 0 | MOSAIC FERTILIZER LLC | AIRPORT RD | 27 33 37.53 | 81 47 02.16 |
| 37 | 804174 | MONITOR | 0 | MOSAIC FERTILIZER LLC | AIRPORT RD | 27 33 37.53 | 81 47 02.16 |
| 37 | 804174 | MONITOR | 0 | MOSAIC FERTILIZER LLC | AIRPORT RD | 27 33 37.53 | 81 47 02.16 |
| 37 | 804174 | MONITOR | 0 | MOSAIC FERTILIZER LLC | AIRPORT RD | 27 33 37.53 | 81 47 02.16 |
| 37 | 804174 | MONITOR | 0 | MOSAIC FERTILIZER LLC | AIRPORT RD | 27 33 37.53 | 81 47 02.16 |
| 37 | 804174 | MONITOR | 0 | MOSAIC FERTILIZER LLC | AIRPORT RD | 27 33 37.53 | 81 47 02.16 |
| 38 | 605132 | PLUGGED | 80 | CARGILL FERTILIZER INC | BOYD COWART ROAD | 27 34 49.97 | 81 46 06.73 |
| 39 | 377003 | DOMESTIC | 200 | J.B. PARKER | RT 1, BOX 200 | 27 34 17.27 | 81 45 59.32 |

Notes:

1. Well information obtained from the SWFWMD Well Construction Permits website.

**Table 2. Department of Health Listed Wells, Hardee County Landfill, Hardee County, Florida.**

| Map ID | FLUWID | STATUS | Casing Mat | Longitude | Latitude | Diameter | Permit Nar | Comment | Sanitary Se | Name | Address | Zip Code | City | WSRP ID | Action | POTABLE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 41 | AAE3543 | ACTIVE | PVC | -81.77699 | 27.56031 | 2 | Carls Recyc | Around Ca | Yes | BRENDA H | 425 AIRPO | 33873 | WAUCHULA | | | POTABLE |
| 42 | AAE3544 | ACTIVE | Galvanized | -81.77707 | 27.55970 | 2 | Carls Recyc | Around Ca | Yes | REBA M. R | 407 AIRPO | 33873 | WAUCHULA | | | POTABLE |
| 43 | AAG9900 | ACTIVE | Galvanized | -81.77592 | 27.55831 | 4 | Carls Recyc | Around Ca | Yes | ANDREW R | 348 AIRPO | 33873 | WAUCHUL | 250025101 | UNFILTERE | POTABLE |
| 44 | AAG9901 | ACTIVE | PVC | -81.77726 | 27.56034 | 2 | Carls Recyc | Around Ca | Yes | FLOYD CHA | 445 AIRPO | 33873 | WAUCHUL | 250025001 | UNFILTERE | POTABLE |
| 45 | AAG9930 | ACTIVE | PVC | -81.77786 | 27.55587 | 2 | Carls Recyc | Around Ca | Yes | CARL'S REC | 249 AIRPO | 33873 | WAUCHUL | 250024801 | NEW WELL | POTABLE |

Notes:

1. Well information obtained from the DOH Super Act Well listing. This information can be downloaded at http://www.doh.state.fl.us/environment/water/petroleum/saindex.html

**Table 3. Florida Geologic Survey Wells, Hardee County Landfill, Hardee County, Florida.**

| MAP ID | Well Number | Latitude | LONG_DEG | WELL_NAME | WELL_USE | OWNER_DRLR | TOTALDEPTH |
|---|---|---|---|---|---|---|---|
| 40 | 9070 | 27 33 43.14 | 81 46 22.14 | F-182/182A / HORC CT # 3 T.M. Carlton | Stratigraphic Test | Humble Oil | 830 |

**Table 4. Water Supply Restoration Program (WSRP) Wells, Hardee County Landfill, Hardee County, Florida.**

| Map ID | Florida ID | Well ID | Address | City | Longitude | Latitude | Well Depth |
|---|---|---|---|---|---|---|---|
| 43 | AAG9901 | 250025001 | 445 AIRPORT RD | WAUCHULA | 81 46 33.31 | 27 33 29.87 | 30 |
| 44 | AAG9900 | 250025101 | 348 AIRPORT RD | WAUCHULA | 81 46 38.15 | 27 33 37.32 | 265 |
| 45 | AAG9930 | 250024801 | 249 AIRPORT ROAD | WAUCHULA | 81 46 39.97 | 27 33 21.21 | 0 |