# CORRESPONDENCE COVER SHEET
# WASTE PERMITS DIVISION
# TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

Date: April 25, 2019
Facility Name: City of Kingsville Landfill
Permit or Registration No.: MSW 235-C

Nature of Correspondence:
☐ Initial/New
☒ Response/Revision*

*If Response/Revision, please provide previous TCEQ Tracking No.: 23301130, 23458984 and 24040819
(Previous TCEQ Tracking No. can be found in the Subject line of the TCEQ's response letter to your original submittal.)

This cover sheet should accompany all correspondences submitted to the Waste Permits Division and should be affixed to the front of your submittal as a cover page. Please check the appropriate box for the type of correspondence being submitted. For questions regarding this form, please contact the Waste Permits Division at (512) 239-2335.

**Table 1 - Municipal Solid Waste**

| APPLICATIONS | REPORTS and RESPONSES |
|---|---|
| ☐ New Notification | ☐ Closure Report |
| ☐ New Permit (including Subchapter T) | ☐ Groundwater Alternate SRC Demonstration |
| ☐ New Registration (including Subchapter T) | ☐ Groundwater Corrective Action |
| ☒ Major Amendment | ☐ Groundwater Monitoring Report |
| ☐ Minor Amendment | ☐ Groundwater Statistical Evaluation |
| ☐ Limited Scope Major Amendment | ☐ Landfill Gas Corrective Action |
| ☐ Notice Modification | ☐ Landfill Gas Monitoring |
| ☐ Non-Notice Modification | ☐ Liner Evaluation Report |
| ☐ Transfer/Name Change Modification | ☐ Soil Boring Plan |
| ☐ Temporary Authorization | ☐ Special Waste Request |
| ☐ Voluntary Revocation | ☒ Other: 2nd Tech NOD Response |
| ☐ Subchapter T Workplan | |
| ☐ Other: | |

**Table 2 - Industrial & Hazardous Waste**

| APPLICATIONS | REPORTS and RESPONSES |
|---|---|
| ☐ New | ☐ Annual/Biennial Site Activity Report |
| ☐ Renewal | ☐ CfPT Plan/Result |
| ☐ Post-Closure Order | ☐ Closure Certification/Report |
| ☐ Major Amendment | ☐ Construction Certification/Report |
| ☐ Minor Amendment | ☐ CPT Plan/Result |
| ☐ Class 3 Modification | ☐ Extension Request |
| ☐ Class 2 Modification | ☐ Groundwater Monitoring Report |
| ☐ Class 1 ED Modification | ☐ Interim Status Change |
| ☐ Class 1 Modification | ☐ Interim Status Closure Plan |
| ☐ Endorsement | ☐ Soil Core Monitoring Report |
| ☐ Temporary Authorization | ☐ Treatability Study |
| ☐ Voluntary Revocation | ☐ Trial Burn Plan/Result |
| ☐ 335.6 Notification | ☐ Unsaturated Zone Monitoring Report |
| ☐ Other: | ☐ Waste Minimization Report |
| | ☐ Other: |

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April 25, 2019

Ms. Mihaela Chilarescu
Municipal Solid Waste Section
Waste Permits Division (MC 124)
Texas Commission on Environmental Quality
P.O. Box 13087
Austin, TX 78711-3087

Re: City of Kingsville Landfill – Kleberg County
Municipal Solid Waste (MSW) - Permit No. 235C
Permit Amendment Application – Notice of Deficiency
Tracking No. 23301130, 23458984, and 24040819; RN102334570/CN600674246

Dear Ms. Chilarescu,

On behalf of the City of Kingsville and in response to the Texas Commission on Environmental Quality's (TCEQ) March 27, 2019 Notice of Deficiency (NOD) letter, we hereby submit the enclosed response regarding the Permit Amendment Application for the above referenced MSW facility.

We have included our responses to the NOD Items in table format using the file you provided by email (NOD2 Table from 235C_MSW Checklist_Current_20190327.xlsx) on March 28, 2019. A hard copy of the NOD Table of Deficiencies is included in each copy of the response and an electronic version can be provided via email or the TCEQ FTPS upon request.

Where items from the original application have been noted as revised, a redline/strikeout version is included and a replacement copy ("clean copy") of the applicable section or attachment has been provided to allow you to substitute the items in the binders for the originally submitted application.

TXDOT responded to the NORI with a memo, dated April 16, 2019, stating that the facility is subject to the Highway Beautification Act requirements (43 TAC Chapter 21, Subchapter H). The April 16, 2019 memo has been incorporated into the Permit Amendment Application in Part II, Attachment 3–B. We are communicating with TXDOT to determine if the facility is subject to the Highway Beautification Act requirements or not. If it is determined that the facility is subject to the Highway Beautification Act requirements (43 TAC Chapter 21, Subchapter H), the facility will provide screening in accordance with those requirements and as approved by the TXDOT District Engineer for Kleberg County. A statement has been included in Part II, Section 9, page 13 regarding this issue.

Per your March 27, 2019 letter, one (1) original and one (1) copy of the NOD response with applicable application revisions are included and one (1) copy of the NOD response with applicable application revisions has been sent to the TCEQ Corpus Christi Region Office, to the attention of the Waste Section Manager. As noted in the Part I form, the NOD response documents will be posted to a publicly accessible internet web site. If, while reviewing this response, you have any questions or would like additional information, please don't hesitate to contact me.

Sincerely,

HANSON PROFESSIONAL SERVICES INC.

Jon M. Reinhard, P.E.
Project Engineer

cc: Bill Donnell, Kingsville Public Works Director (2 copies)

# Table of Deficiencies

| NOD ID | MRI ID | App. Part | Citation | Location | 2nd NOD Type | NOD Description | NOD Response |
|---|---|---|---|---|---|---|---|
| NT1 | 12 | General | 330.57(d) | Vol. 1, Part I, Page 9 | Incorrect | Provide acurate location of the information in the application. | As per Miki Chilarescu's April 9, 2019 email, by addressing the other comments specifically, this NOD Item will be addressed and no further response is necessary. |
| T2 | 123 | Part I | 305.45(a)(8)(B)(ii) | | Omitted | | Vol 1, Part I, Sec 1.4, pg- 3-5 has been revised to provide a more detailed explanation/definition for the wastes to be accepted at the Kingsville Landfill (i.e.: the characteristics for each special waste, and the definition of MSW). |
| T3 | 126 | Part II | 330.61(b)(1) | Vol 1, Sec 2, pg-3-4 | Omitted | | As per Miki Chilarescu's April 9, 2019 email, after additional clarification the information was located in Vol 1, Part II, Sec 2, pg 3-4 therefore this NOD Item has been addressed and no further response is necessary. |
| T4 | 143 | Part II | 330.61(i)(4) | Vol. 1, Part II, Section 9.2, Page: Part II, pg-13; Part II, Att. 3, Page: Part II, Att. 3A, pg-1-6 & Part II, Att. 3B, pg-1-8 | Incomplete | Provide documentation of coordination with Kleberg County for road maintenance. | Documentation of coordination with Kleberg County for road maintenance is provided in as Part II, Attachment 3-C. |
| NT5 | 198 | Part II | 330.61(d)(9)(D) | Vol 1, Part I, Att 2, Fig I.2-1 | Comment Only | Information located in Vol 1, Part I, Att. 2, Fig. I.2-5. | As per Miki Chilarescu's April 9, 2019 email, this NOD Item has been addressed and no further response is necessary. |
| T6 | 199 | Part II | 330.61(d)(9)(E) | Vol 1, Sec 1.2, pg- 1; Vol 5, Part III, Att 7, Fig III.7-1 | Incomplete | Revise drawings Fig III.1.4. and III.7.1 in Part III, Att. 1 to clearly indicate the maximum waste and final cover elevations or provide a drawing in Part II with these information. | Vol 1, Part II, Sec 1.2, pg- 1 has been revised to remove reference to Fig III.1.4. indicating the maximum waste and final cover elevations. The maximum waste and final cover elevations are clearly indicated on Vol 5, Part III, Att 7, Fig III.7-1. |
| T7 | 277 | Part III | 330.63(b)(2)(D) | Vol 1, Sec 3.2.3, pg- 6 | Inconsistent | Clarify if a liquid waste solidification facility is being proposed, and revise (also Part II, Sec 2, pg. 3-4, and Part IV, Att.5)<br>Revise Figure III.1-2 to depict the solidification facility. | A liquid waste solidification area is proposed. Part II, Sec 2, pg. 3-4 has been revised. Part IV, Att.5 has been revised to include additional information regarding the design and construction of the liquid waste solidification area including Figure IV.5-1 Liquid Waste Solidification Area Construction Details. The Liquid Waste Solidification Area will be installed within an area that is operationally feasible and will periodically be relocated because of general sequence of filling operations. Due to the liquid waste solidification area being relocated periodically Figure III.1-2 was not revised to depict a permanent location. However Figure IV.5-1 was included in Part IV, Attachment 5 to depict the liquid waste solidification area layout and construction details. |
| T8 | 277 | Part III | 330.63(b)(2)(D) | Vol 1, Sec 3.2.3, pg- 6 | Incomplete | Provide construction details for leachate storage tanks and liquid waste solidification facility. | Vol 1, Part III, Section 3.2.3, pg- 6 has been revised to refer to the construction details leachate storage tanks in Part III, Attachment 15, Appendix G, Figure III.15-G-3 and for the liquid waste solidification area in Part IV, Attachment 5, Figure IV.5-1. Part IV, Attachment 5 has been revised to include additional information regarding the design and construction of the liquid waste solidification area including construction details provided as Figure IV.5-1. |
| NT9 | 315 | Part III | 330.63(c)(1)(D)(iv) | Vol 4, Att 6, App 6B.6, 6B.7, 6B.9, 6B.10 & 6B.11; Vol 5, Att 6, App 6B.14, 6B.15 & 6B.18 | Comment Only | Information located in Att. 6, Appx. 6B.19 to 6B.22. | As per Miki Chilarescu's April 9, 2019 email, this NOD Item has been addressed and no further response is necessary. |
| T10 | 353 | Part III | 330.63(d)(4)(E) | Vol 1, Att 2, Fig III.2-1 thru III.2-5 | Ambiguous | Revise Figure III.2-1 to clearly indicate landfill's maximum waste elevation, maximum final cover elevation, and elevation of the deepest excavation. | Figure III.2-1 has been revised to enlarge the contour labels to make them more legible, and a note has been added to clearly indicate the landfill's maximum waste elevation, maximum final cover elevation, and elevation of the deepest excavation. |
| T11 | 356 | Part III | 330.63(d)(4)(E) | Vol 1, Att 2, Fig III.2-1 thru III.2-5 | Ambiguous | Clarify the meaning of each line and revise each section on Figure III.2-2 to Figure III.2-5 to show the top of the waste (existing fill), existing ground, botom of the excavation. Revise the meaning of dotted line for active sectors on Figure III.2-3, Marker 26 Section, and Figure III.2-5, Marker T Section. | Figures III.2-2 to Figure III.2-5 have been revised to clarify the lines representing final grade, top of waste, existing grade, subgrade, and piggyback liner. Revisions to line callouts have been made and additional callouts have been added to provide additional clarification. |
| T12 | 356 | Part III | 330.63(d)(4)(E) | Vol 1, Att 2, Fig III.2-1 thru III.2-5 | Incomplete | Provide cross sections showing gas vents or wells, and groundwater monitoring wells. | Figures III.2-2 to Figure III.2-5 have been revised to show gas probes and groundwater monitoring wells. |
| T13 | 358 | Part III | 330.63(d)(4)(F) | Vol 1, Att 2, Fig III.2-1 thru III.2-5 | Incomplete | Revise Att. 3 to provide details of liners tie-in for piggyback overliner into existing liner in active sectors (Sector 8 to Sector 1), and into new liner in proposed sectors (Sector 8 to Sector 6). | Figure III.3-5 has been added to Part III, Attachment 3 to show details of the Sector 8 piggyback overliner tie-in to Sector 1 (Detail 15) and the Sector 8 piggyback overliner tie-in to Sectors 6/7 (Detail 16). |

# Table of Deficiencies

| NOD ID | MRI ID | App. Part | Citation | Location | 2nd NOD Type | NOD Description | NOD Response |
|---|---|---|---|---|---|---|---|
| T14 | 359 | Part III | 330.63(d)(4)(G) | Vol 5, Att 10 | Incomplete | Provide tables of the required properties for materials to be used for the liner and final cover systems and subgrades. | Vol 5, Part III, Attachment 10 has been revised to add Tables 10-1 to 10-2 and 10-4 to 10-8. Table C.1 (GCL) has been renamed to Table 10-3. |
| T15 | 379 | Part III | 330.335 | Vol 4, Part III, Att. 5 | Incomplete | Provide tables summarizing the input and output data from the HELP runs. | Appendix B.21 Table 1-HELP Model Analysis Alternative Liner Summary has been added to Volume 4, Part III, Attachment 5 and the Contents, Part III, Attachment 5, p.g.-ii has been updated to include Appendix B.21. |
| T16 | 379 | Part III | 330.335 | Vol. 4, Part III, Att. 5 | Incomplete | Provide test data for the final cover over the pre-Subtitle D unit demonstrating that it has the minimum thickness (2 feet) and properties assumed in the alternative overliner design demonstration. | Appendix I, Figure I.1 Pre-Subtitle D Area (Sector 8A and Sector 8B) Final Cover Test Data & Properties has been added to Volume 4, Part III, Attachment 5 and the Contents, Part III, Attachment 5, p.g. -ii has been updated to include Appendix I. |
| T17 | 379 | Part III | 330.335 | Vol. 4, Part III, Att. 5 | Incomplete | Provide Multimed model runs for interim cases when the landfill is only partially filled, and additional model runs with varied inputs to evaluate model sensitivity, along with discussion and tables summarizing input and output data. | MULTIMED model runs for interim cases when the landfill is only partially filled (various waste fill heights) are located in Part III, Attachment 5, Section 4. POINT OF COMPLIANCE DEMONSTRATION RESULTS for both the non-overliner and overliner portion of the landfill. Appendix H MULTIMED Model Sensitivity Analysis, Appendix H.1 MULTIMED Model Sensitivity Analysis Tables, Appendix H.2 HELP Model Input and Output Files for Case 1OL Base Case & Case 1OL Base Case with Liner Defects (4 Defects/Acre), and Appendix H.3 MULTIMED Model Output Files have been added to Volume 4, Part III, Attachment 5. The Contents, Part III, Attachment 5, p.g.-iv has been updated to include Appendices H, H.1, H.2, and H.3. |
| NT18 | 379 | Part III | 330.335 | Vol. 4, Part III, Att. 5, Figs III.5-A.5 through A.8 | Incorrect | Correct the labels and the distance to POC for the cases that do not include overliner. | The labels and the distance to POC for the cases that do not include overliner have been corrected. This affects Figures III.5-A.1 through A.6. It does not affect overliner Figures III.5-A.7 & A.8. |
| NT19 | 379 | Part III | 330.335 | Vol. 4, Part III, Att. 5, Appendix C.4, p. 1 | Incorrect | Correct the information for Cases 3OL and 4OL that indicate pre-Subtitle D waste above the overliner. | Vol 4, Part III, Att. 5, Appendix C.4, p.g.-1 has been corrected to indicate pre-Subtitle D waste is below the overliner. |
| NT20 | 379 | Part III | 330.335 | Vol. 4, Part III, Att. 5, Apendices C.6 and C.7 | Ambiguous | Revise the tables of Multimed aquifer-specific data to clearly reference the information reproduced from exisiting permit 235B in Appendices C.7.1 and C.7.2, and remove the note at the bottom regarding Evangeline Aquifer. | The tables of MULTIMED aquifer-specific data in Part III, Att. 5, Appendices C.6 and C.7 have been corrected to clearly reference the information reproduced from existing permit 235B in Appendices C.7.1 and C.7.2. In addition, the note at the bottom regarding Evangeline Acquifer has been deleted. |
| NT21 | 379 | Part III | 330.335 | Vol. 4, Part III, Att. 5, Figs III.5-D.1 through D.4 | Incorrect | Correct the labels and the distance to POC for the cases that do not include overliner. Correct the DAF values for the non-overliner interim case. | The labels and the distance to POC for the cases that do not include overliner have been corrected. This affects Figures III.5-D.1and D.2. It does not affect overliner Figures III.5-D.3 and D.4. The DAF values for the non-overliner interim and closed landfill conditions have been corrected as shown in the figures and Section 4 Point of Compliance Demonstration Results in Part III, Attachment 5, p.g.-7 and Appendix D, p.g.-1, Calculations of the Dilution Attenuation Factor. The corrections to the distance to POC resulted in slight corrections to the MSW thickness parameters in the HELP Model as shown in corrected Appendices B.3-B.10 used to determine the infiltration rate through the liner for use in MULTIMED as corrected and shown in Part III, Attachment 5, Appendix B.1, p.g.-1, HELP Model/MULTIMED Model-Summary of Cases 1-8 and Appendix B.2, p.g.-1, HELP Model Case Summary. However, this correction did not change the infiltration rate used for the various cases in MULTIMED as shown in Appendix C.3, p.g.-1, MULTIMED Source-Specific Data. These infiltraton rates were used to run new MULTIMED models with the corrected lengths to POC as shown in Appendix F.1 MULTIMED Output for Alternative Liner Interim Case 1-Location 1, Appendix F.2 MULTIMED Output for Alternative Liner Interim Case 2-Location 2, Appendix F.3 MULTIMED Output for Alternative Liner Interim Case 3-Location 3, Appendix F.5 MULTIMED Output for Alternative Liner Closed Case 5-Location 1, Appendix F.6 MULTIMED Output for Alternative Liner Closed Case 6-Location 2, and Appendix F.7 MULTIMED Output for Alternative Liner Closed Case 7-Location 3. Note, new MULTIMED models were not run for Case 4 and Case 8 because the infiltration rate and length to POC did not change. |
| T22 | 381 | Part III | 330.337(b)(1) | Vol 5, Att 10, App E | Incomplete | Provide measurement units for balast thickness calculations in the table on Part III, Att. 10, Appendix E, pg. 6. | Measurement units have been added to the ballast thickness calculations in the table on Part III, Attachment 10, Appendix E, page 6. |
| T23 | 381 | Part III | 330.337(b)(1) | Vol 5, Att 10, App E | Incomplete | Demonstrate that the weight of balast will offset uplift by a facor of safety of 1.2. | A table demonstrating sufficient ballast to offset uplift by the required factor of safety has been added to Part III, Attachment 10, Appendix E on page 7. |
| T24 | 382 | Part III | 330.337(b)(2) | Not Applicable | Incomplete | Demonstrate that the proposed dewatering system will reduce hydrostatic forces by a facor of safety of 1.2. | A demonstration that the proposed dewatering system will reduce hydrostatic forces by a factor of safety of 1.2 has been added to Part III, Attachment 10, Appendix D, Calculation B, page 4. |
| NT25 | 412 | Part III | 330.339(c)(2) | Vol 5, Att 10, Sec 1.1, pg- 1 | Comment Only | Information located in Vol. 5, Part III, Att. 10, Sec. 1.6.2, pg 5. | As per Miki Chilarescu's April 9, 2019 email, this NOD Item has been addressed and no further response is necessary. |

Table of Deficiencies

| NOD ID | MRI ID | App. Part | Citation | Location | 2nd NOD Type | NOD Description | NOD Response |
|---|---|---|---|---|---|---|---|
| NT26 | 476 | Part III | 330.63(e)&(1)(A) | Att 4, App 1, Fig 4.4 & 4.4a, p. 19-20 | Incomplete | Provide hard copies of replacement pages (previewed electronically November 2018) for older reports in which revision-highlighting obscured the content. | Hard copies of replacement pages (previewed electronically November 2018) for the older reports in Part III, Attachment 4, Appendix 1that revision-highlighting obscured the content are provided. |
| NT27 | 477 | Part III | 330.63(e)(1)(B) | Att 4, Table 2-1, p. 6; Att 4, App 1, Fig 4.5, p. 21-23 | Incomplete | In Table 2-1, show the stratigraphic position of the site. | A note has been provided below table 2-1 showing the stratigraphic position of the site. The note reads, "The site overlies the South Texas Eolian Plain Deposits. The hydrogeologic units below the site consist of the Chicot Aquifer within the Lissie Formation followed by the Evangeline Aquifer within the Goliad Sand (Principal Aquifer of the site)." |
| NT28 | 488 | Part III | 330.63(e)(3)(J) | Att 4, App 1: Sec 4.4, p. 37; Fig 4.15, p. 46; App J, p. 584-629 | Incomplete | Provide a figure showing the locations of the water wells listed in Att. 6 to Att. 4. | Figure III.4-6-1 has been provided within Part III, Attachment 4, Attachment 6 showing the locations of the water wells. |
| T29 | 490 | Part III | 330.63(e)(4)(A) | Att 4, App 1, Sec 5.0, p. 48-55; and App 3, Sec 2, p. 4 | Incomplete | Acknowledge in Sec. 1.4 that the drilled locations of borings B-32, 33, 34, 35, and 38 deviated from locations specified in the soil boring plan (March 29, 2016), explain why and how much they deviated, and how the investigator compensated. | "Locations of borings B-32, B-33, B-34, B-35, B-38 and B-40 deviated from locations specified in the soil boring plan due to boring locations being unknowingly moved from original locations during installation. These deviations were identified when the boring locations were surveyed. The distance of boring location deviation varied from approximately 90 feet in B-35 to approximately 440 feet in B-33. With the information obtained during previous subsurface investigations, these discrepancies did not affect the ability to obtain the needed information identified in 30 TAC §330.63(e)(4)(A)." This statement has been added to Sec. 1.4 of Part III, Attachment 4, on page 4. |
| T30 | 491 | Part III | 330.63(e)(4)(B) | Att 4, App 1, Sec 5.0, p. 48-55; Att 4, App 3, Sec 2, p. 4 | Incomplete | Acknowledge in Sec. 1.4 that two borings (B-34 and 40) were not drilled to the depth specified in the soil boring plan, explain why and how short they were from the target elevation, and how the investigator compensated. | "Borings B-34 and B-40 were not drilled to 5 foot below EDE due to the boring locations being unknowingly moved from the original locations during installation. Boring B-34 was 0.64 feet short of 5 foot below EDE and B-40 was 1.31 feet short of 5 foot below EDE. Although these borings were not drilled to the target depth, the information obtained from these borings is useful in characterizing the subsurface conditions at the facility and was used for that purpose. Other borings installed at the site in conjunction with the current subsurface investigation are adequate in meeting the requirements identified in 30 TAC §330.63(e)(4)(B)." This statement has been added to Sec. 1.4 of Part III, Attachment 4, on page 4. |
| T31 | 491 | Part III | 330.63(e)(4)(B) | Att 4, App 1, Sec 5.0, p. 48-55; Att 4, App 3, Sec 2, p. 4 | Inconsistent | Revise logs and cross sections to include the unit identifiers (Body I, II, III, etc.) used in the narrative. | Logs and cross sections have been revised to include unit identifiers used in the narrative. |
| NT32 | 493 | Part III | 330.63(e)(4)(D) | Att 4, App 1, Att K, p. 631-643; Att 4, App 1, Att M, p. 665-700 | Format | Provide legible well reports, and annotate the reports to indicate which wells or borings logs they represent. | More legible well reports have been provided. Reports have been annotated to indicate which wells or boring logs they represent. The majority of the existing monitor wells will be plugged and abandoned, when new monitor wells are installed well reports shall be provided. |
| T33 | 496 | Part III | 330.63(e)(4)(G) | Att 4, App 1, Sec 6.2.2, p. 64-79 | Incomplete | Revise the Hanson cross sections in Exhibit IV of App. 3 to indicate the correlations to the units described in Section 3.3 of the geology report narrative, to distinguish between fill material and the in situ geologic strata, and to show the existing and proposed monitor wells. | Hanson cross sections in Exhibit IV of App. 3 have been revised to indicate the correlations to the units described in section 3.3 of the geology report narrative and to distinguish between fill material and the in situ geologic strata. Existing and proposed monitor wells have not been shown because they are located beyond the limits of cross sections. None of the borings used in the cross sections were converted to monitor wells. |

# Table of Deficiencies

| NOD ID | MRI ID | App. Part | Citation | Location | 2nd NOD Type | NOD Description | NOD Response |
|---|---|---|---|---|---|---|---|
| T34 | 496 | Part III | 330.63(e)(4)(G) | Att 4, App 1, Sec 6.2.2, p. 64-79 | Incomplete | Label all units on cross section B-B' in the FEE geology report. | All units on cross section B-B' in the FEE geology report have been labelled. |
| T35 | 500 | Part III | 330.63(e)(5)(B) | Att 4, App 1, App G, p. 288-400; Att 4, App 3, Ex II, App B, p. 31-59 | Incomplete | Provide a table and discussion detailing which earlier samples and test results are being used as proxies for the borings drilled under the March 2016 SBP. | Tables 4.1 and 4.2 have been provided in Part III, Attachment 4, Appendix 1 beginning on page 92 showing geotechnical testing results by boring. Discussion of the geotechnical laboratory testing has been provided in Part III, Attachment 4, Appendix 1 beginning on page 87. Additional test results have been included in Part III, Attachment 4, Appendix G beginning on page 288. Additional test results are also included in Part III, Attachment 4, Appendix B of Appendix 2 and 3 beginning on pages 22 and 31 in each respective appendix. |
| T36 | 511 | Part III | 330.63(f)(1) | Att 11, App A, Item 1 | Ambiguous | Provide a distinct line for the point of compliance line on Figures III.11-A-1A and 1B. | A distinct line for the point of compliance line on Figures III.11-A-1A and 1B has been provided. |
| T37 | 558 | Part III | 330.403(a) | Att 11, App A, Item 1 | Incomplete | Revise Figure III.11-A-1B to include the date of the groundwater measurements, and the measured groundwater elevation at each well. | Figure III.11-A-1B has been revised to include the date of the groundwater measurements, and the measured groundwater elevation at each existing well. |
| T38 | 559 | Part III | 330.403(a)(1) | Att 11, Sec 3.1, p. 2; Sec. 1.2, p. 1 | Ambiguous | Provide a table detailing which wells "shall be considered upgradient wells until further development of waste sectors occur" and at what stage of landfill development they will become point of compliance wells. | A table detailing which wells "shall be considered upgradient wells until further development of waste sectors occur" and at what stage of landfill development they will become point of compliance wells has been included as Part III, Attachment 11, Appendix A, Table 3, pg-1. |
| NT39 | 576 | Part III | 330.405(b) | Att 11, Sec 5.2 and 5.6 | Incomplete | Indicate that the results of the well headspace screening for methane specified by the sampling plan will be recorded and retained in the operating record. | "Results of the well headspace screening for methane will be recorded and retained in the facility operating record," has been added to Part III, Attachment 11, in section 5.2 on page 3. |
| T40 | 653 | Part III | 330.421(e) | Att 11, Sec 1.2, p. 2 | Incomplete | Provide monitor well installation and construction details on Form TCEQ-10308. | "Monitor well installation and construction details will be provided on form TCEQ-10308, or current appropriate TCEQ reporting form, upon completion," has been added to Part III, Attachment 11, in section 1.2 on page 2. |
| T41 | 684 | Part III | 330.453(d)(1) | Att 5 | Inconsistent | Revise Sec. 9, pg. 14; Att. 3, Fig. III.3-1; Att. 5 Appx. G, pg.1; and Att. 12, Form 20720, pg. 3 for consistency regarding the thickness of subgrade and erosion/protective layers. | Revisions have been made to appropriate sections to ensure consistency regarding the thickness of subgrade and erosion/protective layers. Part III, Site Development Plan, Section 9, page 15 has been revised to include the text "a prepared soil subgrade," in the fourth sentence. Part III, Attachment 3, Figure III.3-1, final cover details have been revised to show the topsoil layer and indicate its thickness as well as identify the prepared subgrade. Part III, Attachment 5, Appendix G, p.g.-1, Section 1.1 Alternative Composite Liner System has been revised to read 25-inch thick erosion layer. Part III, Attachment 12, Form 20720, page 3 has been revised to clarify the prepared soil subgrade. |
| T42 | 684 | Part III | 330.453(d)(1) | Att 5 | Inconsistent | Revise Att. 3, Fig. III.3-1 to show the topsoil layer and indicate its thickness. | Att. 3, Fig. III.3-1 has been revised to show the topsoil layer and indicate its thickness. |
| T43 | 694 | Part III | 330.457(d)(1) | Att 5 | Incomplete | Provide Section 2.5 in Part III, Att. 5, pg 4, as mentioned in NOD1 response, and revise the Contents of Part III, Att. 5 accordingly. | Section 2.5 Alternate Composite Final Cover Design Demonstration as mentioned in NOD1 response has been included in Part III, Attachment 5, p.g.-4. The Contents, Part III, Attachment 5, p.g.i, Section 2 Alternate Liner Demonstration Methods has been revised accordingly. |
| T44 | 695 | Part III | 330.457(d)(2) | Att 5 | Incomplete | See NOD comment T46 above. | Section 2.5 Alternate Composite Final Cover Design Demonstration as mentioned in NOD1 response has been included in Part III, Attachment 5, p.g.-4. The Contents, Part III, Attachment 5, p.g.i, Section 2 Alternate Liner Demonstration Methods has been revised accordingly. |
| T45 | 810 | Part IV | 330.133(a) | Vol 6, Sec 4.6, pg 31-33 | Incomplete | Remove any reference to acceptance of wastes containing free liquids from Part II, Sec. 2, Part IV Sec. 4.2.2 and address inconsistencies regarding acceptance or processing of those wastes throughout the application. (MRI ID 919) | Kingsville Landfill will accept wastes containing free liquids for processing in the Liquid Waste Solidification Area therefore reference to accepting wastes containing free liquids was not removed from Part II, Sec. 2. Part II, Sec. 2 was revised to elaborate on the acceptance of listed wastes for storage, processing and/or disposal. Part IV Sec. 4.2.2 is regarding the wastes prohibited from disposal, wastes containing free liquids will not be disposed of in the Kingsville Landfill. Wastes containing free liquids will be accepted for processing in the Liquid Waste Solidification Area, once the waste if solidified and passes the Paint Filter Test (EPA Method 9095) the waste will be accepted for disposal and placed in the active working face of the landfill. |
| T46 | 833 | Part IV | 330.141(a) | Vol 6, Sec 4.10, pg 35 | Incomplete | Show the location of the utility easement referenced in Sec. 4.10.1. | The overhead powerline easement referenced in Sec. 4.10.1 is shown on Vol 1, Part I, Att 2, Figure I.2-5 & Vol 1, Part III, Att 1, Figure III.1-2. |
| T47 | 851 | Part IV | 330.143(b)(8) | Vol 6, Sec 4.11.7, pg 37 | Ambiguous | Revise to show benchmark coordinates depicted in NAD 83 datum (NAD 83 datum: N 27; 26'; 43.08", W 97; 48'; 56.88") for consistency with Parts I and II. | Vol 6, Part IV, Sec 4.11.7, pg 39 has been revised to include the benchmark coordinates in NAD 83 datum: N 27; 26'; 43.08", W 97; 48'; 56.88". |
| NT48 | 911 | Part IV | 330.171(a) | Vol 6, Sec 4.24, pg 47; Att 3 | Comment Only | Information located in Sec 4.14.3, pg 39, and Att. 3, pg 2.. | As per Miki Chilarescu's April 9, 2019 email, this NOD Item has been addressed and no further response is necessary. |
| NT49 | 919 | Part IV | 330.171(b)(3) | | Comment Only | The operating plan for the liquid waste solidification area is located in Part IV, Att. 5. | As per Miki Chilarescu's April 9, 2019 email, this NOD Item has been addressed and no further response is necessary. |

# THE CITY OF KINGSVILLE LANDFILL

# TCEQ PERMIT MSW 235C

# PERMIT AMENDMENT APPLICATION

# TECH NOD #2 RESPONSE - APRIL 2019

## Volume 1 of 2

## CLEAN COPY

CITY OF KINGSVILLE, KLEBERG COUNTY, TEXAS

For Permitting Purposes Only

STATE OF TEXAS
JON M. REINHARD
64541
LICENSED
PROFESSIONAL ENGINEER

04/25/19

TBPE Firm No. F-417

Prepared by

HANSON
Engineering | Planning | Allied Services

TBPE F-417

HANSON PROJECT NO. 16L0438-0003

THE CITY OF KINGSVILLE LANDFILL

TCEQ PERMIT MSW 235C

# PERMIT AMENDMENT APPLICATION
## Volume 1 of 6

City of Kingsville TEXAS

CITY OF KINGSVILLE, KLEBERG COUNTY, TEXAS

For Permitting Purposes Only

STATE OF TEXAS
JON M. REINHARD
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September 2018
Revision 1 – November 2018
Revision 2 – February 2019
Revision 3 – April 2019

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# THE CITY OF KINGSVILLE LANDFILL

# TCEQ PERMIT MSW 235C

# PERMIT AMENDMENT APPLICATION

City of Kingsville TEXAS

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# VOLUME 1 of 6

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For Pages i - v

## Part II

## Part III Attachments



# VOLUME 2 of 6



# VOLUME 3 of 6



# VOLUME 4 of 6



# VOLUME 5 of 6

# VOLUME 6 of 6



# Part IV

## Part IV Attachments

# THE CITY OF KINGSVILLE LANDFILL

# TCEQ PERMIT MSW 235C

## PERMIT AMENDMENT APPLICATION

## Part I

CITY OF KINGSVILLE, KLEBERG COUNTY, TEXAS

For Permitting Purposes Only

STATE OF TEXAS
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# ATTACHMENTS



For Permitting Purposes Only

STATE OF TEXAS
JON M. REINHARD
64541
LICENSED
PROFESSIONAL ENGINEER

04/25/19

TBPE Firm No. F-417

**Facility Name: City of Kingsville Landfill**
**Permittee/Registrant Name: City of Kingsville**
**MSW Authorization #:235C**
**Initial Submittal Date: September/2018**
**Revision Date: April/2019**

Texas Commission on Environmental Quality

# Part I Form for New Permit/Registration and Amendment Applications for an MSW Facility

## 1. Reason for Submittal

☐ Initial Submittal ☒ Notice of Deficiency (NOD) Response

## 2. Authorization Type

☒ Permit ☐ Registration

## 3. Application Type

☐ New ☒ Major Amendment

☐ Major Amendment (Limited Scope)

## 4. Application Fees

☐ Pay by Check ☒ Online Payment

If paid online, e-Pay Confirmation Number: **Trace Number: 582EA000315158, Voucher Number: 385823, Voucher Number: 385824**

## 5. Application URL

Is the application submitted for Type I Arid Exempt (AE) and/or Type IV AE facility?

☐ Yes ☒ No

If the answer is "No", provide the URL address of a publicly accessible internet web site where the application and all revisions to that application will be posted.
http://**www.cityofkingsville.com/departments/public-works/landfill/landfill-amendment-application/**

## 6. Application Publishing

Party Responsible for Publishing Notice:

☐ Applicant ☐ Agent in Service ☒ Consultant

Contact Name: **Scot Collins, P.G.** Title: **Project Manager**

## Signature Page

I, Jesus A. Garza, City Manager,
(Site Operator (Permittee/Registrant)'s Authorized Signatory) (Title)

certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Signature: ____________ Date: 4/25/19

- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

TO BE COMPLETED BY THE OPERATOR IF THE APPLICATION IS SIGNED BY AN AUTHORIZED REPRESENTATIVE FOR THE OPERATOR

I, Jesus A. Garza, hereby designate William Donnell
(Print or Type Operator Name) (Print or Type Representative Name)

as my representative and hereby authorize said representative to sign any application, submit additional information as may be requested by the Commission; and/or appear for me at any hearing or before the Texas Commission on Environmental Quality in conjunction with this request for a Texas Water Code or Texas Solid Waste Disposal Act permit. I further understand that I am responsible for the contents of this application, for oral statements given by my authorized representative in support of the application, and for compliance with the terms and conditions of any permit which might be issued based upon this application.

Jesus A. Garza
Printed or Typed Name of Operator or Principal Executive Officer

____________
Signature

- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

SUBSCRIBED AND SWORN to before me by the said Jesus A. Garza

On this 25 day of April, 2019

My commission expires on the 22 day of August 2019

Mary Valenzuela
Notary Public in and for

Kleberg County, Texas
(Note: Application Must Bear Signature & Seal of Notary Public)

NOTARY PUBLIC STATE OF TEXAS
MARY VALENZUELA
Notary ID #11847512
My Commission Expires
August 22, 2022

# CITY OF KINGSVILLE LANDFILL

# PART I

# ATTACHMENT 1

# SUPPLEMENTARY TECHNICAL REPORT

THE CITY OF KINGSVILLE LANDFILL

TCEQ PERMIT MSW 235C

# PERMIT AMENDMENT APPLICATION

## Part I

## Attachment 1
## Supplementary Technical Report

CITY OF KINGSVILLE, KLEBERG COUNTY, TEXAS

For Permitting Purposes Only

STATE OF TEXAS
JON M. REINHARD
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## 1.4 Nature of Business and Solid Waste Data

The existing City of Kingsville Landfill serves residences and businesses in Kleberg County and portions of several surrounding counties, including Nueces, Jim Wells, Brooks and Kenedy. This service area is based on current economic conditions. As economic and available landfill disposal capacity change, the landfill may accept waste from areas other than those noted above.

Kingsville Landfill (current MSW Permit No. 235-B) receives approximately 100.46 tons of waste per day for disposal, six days a week (313 days), or 31,444 tons of waste per year for disposal. Types of waste accepted (currently) for disposal include residential and commercial municipal solid waste, including household wastes, brush, construction/demolition waste and special wastes as authorized by the TCEQ. Wastes currently not accepted at the landfill include hazardous wastes, prohibited wastes, radioactive wastes, industrial wastes, some special wastes including batteries and friable asbestos.

Kingsville Landfill (under the new permit amendment) will accept wastes from residential, municipal, commercial and industrial sources. Kingsville Landfill will accept the following types of waste for processing and/or disposal at the landfill:

- **Residential and commercial wastes typical of waste generated by residential and commercial businesses in the area (Municipal Solid Waste):**

  Municipal Solid Waste (MSW) is defined as: Any solid waste resulting from or incidental to municipal, community, commercial, institutional, and recreational activities, including garbage, rubbish, ashes, street cleanings, dead animals, abandoned automobiles, and all other solid waste other than industrial solid waste;

- **Construction and demolition waste:**

  The waste resulting from construction or demolition projects; includes all materials that are directly or indirectly the by-products of construction work or that result from demolition of buildings and other structures, including, but not limited to, paper, cartons, gypsum board, wood, excelsior, rubber, and plastics;

- **Whole and scrap tires for processing:**

  Whole and scrap tires are defined as any tire that can no longer be used for its original intended purpose;

- **Commercial grease and grit trap waste:**

  Grease and grit trap waste is defined as: material collected from a grease interceptor in the sanitary sewer service line of a commercial, institutional, or industrial food service or processing establishment, including the solids resulting from dewatering processes; and grit trap wastes from interceptors placed in the drains prior to entering the sewer system at maintenance and repair shops, automobile service stations, and washes, laundries, and other similar establishments;

- **Liquid wastes for solidification:**

  The liquid wastes accepted for solidification are characterized as/by untreated liquid wastes which typically do not pass the paint filter test including nonhazardous industrial waste and sludges, food and beverage byproducts and other nonhazardous liquids originated from food and beverage processing plants, and other commercial and industrial facilities;

- **Industrial non-hazardous waste:**

  Solid waste resulting from or incidental to any process of industry or manufacturing, mining or agricultural operations, classified as follows:

  - Class 2 Industrial Solid Waste - any individual solid waste or combination of industrial solid wastes that cannot be described as Class 1 or Class 3, as defined in 30 TAC §335.506 (relating to Class 2 waste determination);
  - Class 3 Industrial Solid Waste – any inert and essentially insoluble industrial solid waste, including materials such as rock, brick, glass, dirt, and certain plastics and rubber, etc., that are not readily decomposable as defined in 30 TAC §335.507 (relating to Class 3 waste determination);

- **and;**

- **Other special wastes:**

  Special waste is any solid waste or combination of solid wastes that because of its quantity, concentration, physical or chemical characteristics, or biological properties requires special handling and disposal to protect human health or the environment. Special wastes as defined in 30 TAC §330.3, 30 TAC §330.171, and 30 TAC §330.173 include the following:

  - Municipal hazardous waste from conditionally exempt small-quantity generators that may be exempt from full controls under Chapter 335, Subchapter N (relating to Household Materials Which Could Be Classified as Hazardous Wastes);
  - Class 1 industrial nonhazardous waste;
  - Untreated medical waste;
  - Municipal wastewater treatment plant sludges, other types of domestic sewage treatment plant sludges, and water-supply treatment plant sludges;
  - Septic tank pumpings;
  - Grease and grit trap wastes;
  - Wastes from commercial or industrial wastewater treatment plants; air pollution control facilities; and tanks, drums, or containers used for shipping or storing any material that has been listed as a hazardous constituent in 40 Code of Federal Regulations (CFR) Part 261, Appendix VIII but has not been listed as a commercial chemical product in 40 CFR §261.33(e) or (f);
  - Slaughterhouse wastes;

- Dead animals;
- Drugs, contaminated foods, or contaminated beverages, other than those contained in normal household waste;
- Pesticide (insecticide, herbicide, fungicide, or rodenticide) containers;
- Discarded materials containing asbestos;
- Incinerator ash;
- Soil contaminated by petroleum products, crude oils, or chemicals in concentrations of greater than 1,500 milligrams per kilogram total petroleum hydrocarbons; or contaminated by constituents of concern that exceed the concentrations listed in Table 1 of §335.521(a)(1);
- Used oil;
- Waste from oil, gas, and geothermal activities subject to regulation by the Railroad Commission of Texas when those wastes are to be processed, treated, or disposed of at a solid waste management facility;
- Waste generated outside the boundaries of Texas that contains:
  - any industrial waste;
  - any waste associated with oil, gas, and geothermal exploration, production, or development activities; or
  - any item listed as a special waste in this paragraph;
- Lead acid storage batteries;
- Used-oil filters from internal combustion engines;
- Regulated asbestos-containing material (RACM) as defined in 40 CFR Part 61;
- Nonregulated asbestos-containing material (non-RACM).

Industrial (non-hazardous) and special wastes are accepted and handled in accordance with Part IV – Site Operating Plan.

See Part II, Section 2 for a more detailed breakdown of the quantities, types and characteristics of wastes accepted at the facility.

The life expectancy of the existing permitted sectors is approximately 43 years. The expected rate of solid waste deposition is anticipated to increase at approximately one (1) percent per year (corresponding to the anticipated growth in population) according to information provided by the Texas State Data Center. Based on the anticipated annual growth rate, the expanded facility will last approximately 98 years. See Part II, Section 2.2 and Part III, Section 5.3 for a detailed analysis of the projected life of the expanded site.

The following table provides a summary of the current permitted conditions and proposed permit conditions.

***TABLE 2: PERMIT CONDITION SUMMARY***

| | **CURRENT CONDITIONS** | **PROPOSED CONDITIONS** |
|---|---|---|
| Permitted Area | 120 acres | 176.33 acres |
| Total Permitted Capacity | Type I - 4,993,000 cy<br>Type IV - 820,000 cy<br>5,813,000 cy | 17,994,286 cy |
| Total Remaining Capacity | 1,258,576 tons<br>3,043,714 cy | 6,295,538 tons<br>15,225,000 cy |
| Remaining Projected Site Life | 43 | 98 |
| Maximum Elevation of Final Cover (msl) | 125 | 200 |
| Elevation of Deepest Excavation (msl) | 42.5 | 22.5 |

# 2 FACILITY LOCATION §330.59(b)

## 2.1 Location Description

The City of Kingsville Landfill is located southeast of the City of Kingsville at the northeast corner of the intersection of Farm to Market Road 2619 and East County Road 2130. Kingsville Landfill is outside the City of Kingsville city limits which are approximately 1.45 miles from the northeast corner of the landfill boundary. It however falls within the City of Kingsville's extraterritorial jurisdiction.

## 2.1 Facility Name, Address and Telephone

| | |
|---|---|
| Name: | City of Kingsville Municipal Solid Waste Landfill |
| MSW Permit No: | 235-C |
| Physical Address: | 348 East C.R. 2130<br>Kingsville, TX 78363 |
| Mailing Address: | P.O Box 1458<br>Kingsville, TX 78364 |
| Telephone: | (361) 595-0092 |

## 2.2 Access Routes

The main local public roadways providing access to the facility are East County Road 2130 (E CR 2130), Farm to Market Road 2619 (FM 2619) and Farm to Market Road 1717 (FM 1717). The entrance to the City of Kingsville Landfill is via an existing 24-foot-wide roadway. Refer to Part II, Section 9 - Transportation for more detailed transportation information. Refer to Part I, Attachment 2, Figure I.2-2 - General Highway Map - Kleberg County for the location of the facility in relation to the surrounding roads.

## 2.3 Geographic Coordinates

The latitudinal and longitudinal geographic coordinates of the permanent site benchmark are:
Latitude: N 27° 26' 41.95"
Longitude: W 97° 48' 55.89"
Elevation (above msl): 52.60 feet

# 3 MAPS §330.59(c)

## 3.1 General Location Map §330.59(c)(1)-(2)

The following maps collectively as a group, comply with the rule requirements of §330.59(c)(1)-(2) and §305.45. These general location maps are included in Part I, Attachment 2 - General Location Maps.

Figure I.2-1 – General Location Map
Figure I.2-2 – General Highway Map - Kleberg County (Texas Department of Transportation, General Highway Map for Kleberg County, Texas)
Figure I.2-4 – Aerial Photograph
Figure I.2-5 – Facility Layout

## 3.2 Topographic Map

Figure I.2-3 – General Topographic Map (USGS General Topographic Map for the Ricardo, Texas Quadrant)

## 3.3 Land ownership and Mineral Interests Map

A Land Ownership Map and Land Owners List are included in Part I, Attachment 3. The map and list reflect current property ownership within one-quarter (1/4) mile of the permit boundary and all mineral interest ownership under the facility, as derived from the real property appraisal records as listed on the date that this application was filed. Refer to Figure I.3-1 for location of the properties and Figure I.3-2 for property ownership list. The map and list meet the requirements of 30 TAC §330.59(c)(3), and §281.5. The property ownership list in electronic form is provided in Part I, Attachment 3, Appendix 1, per the requirements of 30 TAC §330.59(c)(3)(B).

Figure I.3-1 – Adjacent Land Ownership Map
Figure I.3-2 – Land Owners List

# 4 CHARACTER OF THE ADJACENT LAND §305.45(a)(6)

The following sections provide an overview of the various land use conditions of the surrounding area.

1) Wind Direction. The nearest reporting station is Corpus Christi, located to the northeast of the landfill site. A wind rose is included as part of Part I, Attachment 2, Figure I.2-1. The wind is predominantly from the southeast.

2) Water Wells. A well search was performed using the Texas Department of Licensing and Regulation's (TDLR) State of Texas Well Report Submission and Retrieval System, developed by the Texas Water Development Board in cooperation with the TDLR and the Texas Water Information Network. Based on this search, one well (Tracking Number 178262) is identified within 500 feet of the City of Kingsville Landfill site. During a site reconnaissance visit, this well was not confirmed to be located at the identified location (near the intersection of CR 2130 and CR 2619) and is believed to be plotted incorrectly based on available data, shown on Part II, Attachment 1, Figure II.1-4.

3) Existing Structures. The number of structures located within 500 feet of the landfill were determined through a visual reconnaissance and review of aerial photography. Approximately four (4) non-habitable structures are located within the 500-foot boundary of the City of Kingsville Landfill. These structures are associated with agricultural activities within the surrounding areas. Within the permitted boundary of the site, there is a scale house, an office building, and a maintenance shop, (see Part I, Attachment 2, Figure I.2-5and Part III, Attachment 1, Figures III.1-2and III.1-14).

4) Special Use areas. A visual reconnaissance and available records search revealed that other than the City of Kingsville Landfill, there are no active disposal facilities located within one mile of the landfill. Surrounding land uses include agriculture (crop land and pasture) with a few remote residences interspaced within the agricultural areas. There are no known licensed day care facilities, hospitals, cemeteries, ponds, or lakes within one mile of the permitted boundary of the landfill.

5) Area Streams. The nearest stream to the City of Kingsville Landfill is the Santa Gertrudis Creek. Santa Gertrudis Creek is located about 3,000 feet to the northeast of the northeast corner of the current site and about 2,000 feet to the northeast of the northeast corner of the proposed easterly expansion. No perennial or intermittent streams are located within 500 feet of the location of the proposed expansion.

6) Airports. The nearest airfield is the non-public-use Kingsville Naval Air Station (NAS-Kingsville) located northeast of the landfill. The north landfill boundary line is approximately 2.73 miles to the end of the nearest runway and falls within the 6 miles jurisdictional limit of the regulatory airport restrictions. NAS-Kingsville personnel have been notified of the proposed development and how it may impact their activities. The Kingsville Naval Air Station has provided notice that the airfield operations will not be adversely affected by the development. A detailed discussion on airports within the proximity of the landfill site can be found in Part II, Section 9.5. as well as correspondence with NAS-Kingsville and the FAA can be found in Part II, Section 9.5.

7) Easements. There is one (1) known aerial electrical line easement within the permitted boundary of the City of Kingsville Landfill.

8) Historic Sites. A review of the Texas Historical Commission's database for a one-mile radius and visual observations indicated that no historic sites are present. A detailed discussion on historic sites within one-mile of the landfill site can be found in Part II, Section 15 as well as applicable correspondence with the Texas Historical Commission can be found in See Part II, Attachment 7.

# 5 PROPERTY OWNER INFORMATION §330.59(d)

## 5.1 Legal Description

The legal description for the City of Kingsville Landfill property boundary and the Kleberg County Clerk's file number are included in Part I, Attachment 4, Appendix 1. The drawing of the property boundary metes and bounds is included in Part I, Attachment 4, Appendix 1.

The legal description for the City of Kingsville Landfill permit boundary and the Kleberg County Clerk's file number are included in Part I, Attachment 4, Appendix 2. The drawing of the permit boundary metes and bounds is included in Part I, Attachment 4, Appendix 2.

## 5.2 Ownership

Kingsville Landfill is owned and operated by the City of Kingsville (City). The facility services residences and businesses within Kleberg County and portions of several surrounding counties, including Nueces, Jim Wells, Brooks and Kenedy.

## 5.3 Property Owner Affidavit

The property owner affidavit for this permit amendment application found in Part I, Attachment 6 meets the requirements of §330.59(d)(2).

# 6 LEGAL AUTHORITY §330.59(e)

The legal authority and status of the applicant has been verified as required by §330.59(e) and §281.5 and is included in Part I, Attachment 5 – Verification of Legal Status. The City of Kingsville owns and operates the City of Kingsville Landfill. No other person or entity owns more than 20 percent of the facility.

# 7 EVIDENCE OF COMPETENCY §330.59(f)

Kingsville Landfill is owned and operated by the City of Kingsville (City). The landfill serves residences and businesses within Kleberg County and portions of surrounding Texas counties. The City has been providing waste disposal since the 1970's and has successfully operated the municipal landfill operation. The City owns and operates the City of Kingsville Citizens Collection Station MSW Registration # 120081, since June 2012. The City does not own and has not operated any other solid waste sites in the last 10 years, in Texas or any other state. It has, to this date, complied with all regulations and requirements set forth by the regulatory agency and most currently, Texas Commission on Environmental Quality (TCEQ). Evidence of Competency for the City of Kingsville Landfill is provided in Part I, Attachment 7.

# 8 APPOINTMENTS §330.59(g)

Part I, Attachment 9 provides documentation that the person signing the application meets the requirements of §305.44 of this title (relating to Signatories to Applications). Article V, Section 31 of the City of Kingsville Charter, establishes that the City Manager is the chief administrative and executive officer of the City. As the City's executive officer, the City Manager has the authority to sign this application and to delegate signatory responsibility related to the permit amendment application.

# 9 OTHER PERMITS AND AUTHORIZATIONS §305.45(a)(7)

Section 11 of the TCEQ Part I Form for New Permit/Registration and Amendment Applications for an MSW Facility (TCEQ-0650) contains the required information relating to additional permits or approvals. The City of Kingsville currently has Standard Air Operating Permit (#3337), Air New Source Registration (#91376), Air New Source Registration (#54070L001) and General Permit to Discharge Under The Texas Pollutant Discharge Elimination System (TPDES) under provisions of Section 402 of the Clean Water Act and Chapter 26 of the Texas Water Code (#TXR05L074).

# 10 APPLICATION FEES §330.59(h)

In accordance with §330.59(h), The City of Kingsville has made payment of $150.00. This fee was paid to TCEQ online via the TCEQ ePay online payment system, the receipt is provided in Part I, Attachment 10.

# THE CITY OF KINGSVILLE LANDFILL

# TCEQ PERMIT MSW 235C

# PERMIT AMENDMENT APPLICATION

# PART II

CITY OF KINGSVILLE, KLEBERG COUNTY, TEXAS

For Permitting Purposes Only

STATE OF TEXAS
JON M. REINHARD
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# 1 EXISTING CONDITIONS SUMMARY §330.61(a)

The City of Kingsville currently operates the City of Kingsville Landfill, which is a Type I and Type IV municipal solid waste facility operating under TCEQ Permit No. 235-B. The landfill is scheduled to cease operation in 2061. The City intends to increase the site life and better utilize the available space at the landfill through the proposed expansion and design modifications.

## 1.1 General Facility Description

The City of Kingsville Landfill (Kingsville Landfill) is located in Kleberg County, Texas, at the northeast corner of the intersection of Farm to Market Road 2619 and County Road 2130. The northern boundary of the property is approximately 2,811 feet from FM 1717, while the eastern boundary is approximately 1,300 feet from N. County Road 1070 (See Part I, Attachment 2, Figure I.2-1 – General Location Map).

The Kingsville Landfill has been in existence since February 1977 and is intended to provide waste disposal for residences and businesses in Kleberg County and surrounding Texas counties. The nearest community is the City of Kingsville, whose city limits are approximately 1.45 miles from the northeast corner of the landfill boundary. The facility has undergone two permit amendments to date allowing it to extend its initial permit boundaries, and increase the permitted maximum elevation (Refer to Part I, Attachment 1, Section 1.2 – Permit History).

The existing Kingsville Landfill includes a scale house, an office building, and a maintenance shop, all enclosed within a perimeter fence. These facilities will continue to be operational for the life of the landfill. No new building or infrastructure improvements will be constructed as part of the proposed permit amendment.

The overall property consists of gently undulating grasslands with limited forest cover. The property generally slopes to the northeast with no major topographic features. The nearest 100-year floodplain is located to the northeast of the site along Santa Gertrudis Creek. There is one (1) known aerial electrical line easement within the permitted facility boundary. Surrounding land use is predominantly agricultural.

## 1.2 Purpose of the Permit Amendment Application

The City of Kingsville proposes to redesign the current City of Kingsville Landfill Permit 235-B, a Type I and Type IV Municipal Solid Waste Facility, in accordance with the Texas Administrative Code Chapter 330: Municipal Solid Waste Regulations. The redesign includes both a vertical and lateral expansion to increase the currently permitted disposal facility from 120-acres to 176.33-acres (121.3 acre waste disposal footprint), and the permitted maximum (final cover) elevation for the facility from 125-feet to 200-feet above MSL (the maximum waste elevation for the facility will be 196.92 feet-msl) as indicated in Part III, Attachment 1, Figure III.7-1. The elevation of the deepest excavation will also be increased 20-feet to an elevation of 22.5 feet-msl

# 2 WASTE ACCEPTANCE PLAN §330.61(b)

## 2.1 Sources and Characteristics of Waste

The operational procedures and redesign described in the Permit Amendment Application, once approved, will allow the facility to accept, store, process and/or dispose of municipal solid waste, construction and/or demolition waste, whole and scrap tires, grease and grit trap waste, liquid waste, industrial waste non-hazardous Class 2 and Class 3 and some special wastes as defined by 30 TAC §330.3, 30 TAC §330.171, and 30 TAC §330.173.

The facility will accept for disposal the following special waste allowable under 30 TAC §330.171: special wastes from health care related facilities, dead animals and/or slaughterhouse waste, non-regulated asbestos-containing materials (non-RACM), empty containers which have been used for pesticides, herbicides, fungicides, or rodenticides, Municipal hazardous waste from a conditionally exempt small quantity generator (CESQG), sludge, grease trap waste, grit trap waste, soil contaminated by petroleum products, crude oils, or chemicals and liquid waste from oilfield activities. Procedures for accepting and processing all special waste are detailed in the Site Operating Plan (Part IV). In the event that the City of Kingsville Landfill elects to accept other special wastes in the future, TCEQ authorization will be sought and procedures for acceptance and processing will be provided. Other materials that will be received for processing and potentially beneficial reuse include scrap tires and unsorted mixed recyclables.

Consistent with 30 TAC §330.15, the City of Kingsville Landfill will not accept for disposal lead acid storage batteries, used motor vehicle oil, used oil filters, refrigerators, freezers, air conditioners or other items containing chlorinated fluorocarbons (CFC), regulated hazardous waste, polychlorinated biphenyls (PCB) waste, radioactive materials, or other wastes prohibited by TCEQ. Friable asbestos-containing materials, and empty containers, as well as industrial hazardous waste, and Non-hazardous Class 1industrial waste will not be accepted for disposal.

The Site Operating Plan in Part IV of the application contains a detailed description of the restrictions pertaining to waste acceptance procedures. The Applicant (City of Kingsville) reserves the right to reject any waste material, including those mentioned above, that contributes a constituent or characteristic that may impact or influence the design or operation of the facility.

## 2.2 Volume and Rate of Disposal

Kingsville Landfill received approximately 31,444 tons of incoming solid waste in 2017. The maximum annual waste acceptance rate is anticipated to increase at approximately one (1) percent per year which corresponds to the anticipated yearly population growth rate for Kleberg County (based on population projections from the Texas State Data Center).

# 9 TRANSPORTATION §330.61(i)

## 9.1 Selected Routes

Vehicles entering the City of Kingsville Landfill include semi-trailers, dump trucks and trailers, and light duty trucks. E County Road 2130 (CR E 2130), Farm to Market Road 1717 (FM 1717), and Farm to Market Road 2169 (FM 2169) will provide access to the site. These routes are asphalt paved and are the same routes currently in use for the City of Kingsville Landfill. The transportation network used to access the landfill is presented as Part II, Attachment 1. Figure II.1-1.

## 9.2 Adequacy of Roads

The privately owned site entrance road is currently a two-lane, 24-foot wide road maintained by the City of Kingsville to ensure access to the facility. The Texas Department of Transportation is responsible for maintaining FM 2169 and FM 1717 while E CR 2130 is maintained by Kleberg County. All roads are adequate for use by vehicles up to the legal maximum of 58,420 pounds, including solid waste collection vehicles entering and exiting the facility. Periodic maintenance of the roads is routinely undertaken by the City and TXDOT as necessary to maintain availability of these routes to the landfill and to ensure that residents and businesses along the routes have continued access. Correspondence with TXDOT regarding the adequacy of roads used to access the facility is included in Part II, Attachment 3. TXDOT responded to the NORI with a memo, dated April 16, 2019, stating that the facility is subject to the Highway Beautification Act requirements (43 TAC Chapter 21, Subchapter H). The April 16, 2019 memo is included with Part II, Attachment 3–B. Further communication with TXDOT is required to determine if the facility is subject to the Highway Beautification Act requirements or not. If it is determined that the facility is subject to the Highway Beautification Act requirements (43 TAC Chapter 21, Subchapter H), the facility will provide screening in accordance with those requirements and as approved by the TXDOT District Engineer for Kleberg County.

## 9.3 Existing Traffic Volumes

All landfill traffic access the facility via the single site entrance road from E County Road 2130 (E CR 2130) and Farm to Market Road 2619 (FM 2619) which is in-turn accessed via Farm to Market Road 1717 (FM 1717). TXDOT records show the Annual Average Daily Traffic (2016 AADT) is approximately 731 on FM 2619 at the nearest traffic count northwest of the landfill and 1,218 on FM 1717 at the traffic count northwest of the landfill (Refer to Part II, Attachment 1. Figure II.1-1. There are no available traffic counts for E CR 2130. Approximately 46 City, commercial, and citizen waste hauling vehicles per day use the City of Kingsville Landfill.

## 9.4 Projected Volume of Vehicular Traffic

The proposed vertical and lateral expansion will not have an impact on vehicular traffic in the area as the rate at which municipal solid waste is received by the facility will not be affected. The traffic volume projection is calculated at the expected annual population growth rate of approximately one (1) percent. Traffic volumes and calculations are presented in the Table 3.

# CITY OF KINGSVILLE LANDFILL

# PART II

# ATTACHMENT 3-B

RESPONSES FROM

TEXAS DEPARTMENT OF TRANSPORTATION (TxDOT)

# MEMO

April 16, 2019

**To:** Gulay Aki, Team Leader
Municipal Solid Waste Permits Section
Waste Permits Division

**From:** Alanna Bettis, P.E., Section Director
Contracts & MMS Support Section
Maintenance Division

DocuSigned by:
Alanna Bettis
652B54A269034EB...

**Subject:** City of Kingsville Landfill – Kleberg County
Municipal Solid Waste – Permit Amendment Application No. 235C
Application Summary for Agency Review
Tracking No. 23301130 and 23458984; RN102334570/CN600674246

---

After review by TxDOT, it was determined that the City of Kingsville Landfill falls within 1,000 feet of FM 2619. Thus, it is subject to regulations of the Highway Beautification Act and Texas Administrative Code, 43 TAC Chapter 21, Subchapter H. The critical elements for review are as follows:

(1) Before any screening is commenced, the plans and specifications therefor shall first be submitted by the owner of the junkyard to, and approved by, the district engineer of the department who serves the county in which such screening is to be placed.

(2) Such screening shall be located outside the highway right-of-way in such manner as not to interfere in any way with traffic along any highway or roadway.

(3) Such screening may be accomplished by means of earthen berms, plantings, fences, walls, or other durable materials provided they are effective in blocking the view of such junkyard or automobile graveyard from the motoring public traveling in a standard size automobile along the main traveled way of the controlled highway. The height and density of such screening shall be such as to effectively block such view at all times.

(4) Such screening shall be so designed and landscaped as to cause the junkyard or automobile graveyard area to be inconspicuous and pleasing to the motoring public in accordance with the purposes of the Highway Beautification Act.

For further assistance please contact Harsh Doshy at 512-416-3185 or at harsh.doshy@txdot.gov.

# CITY OF KINGSVILLE LANDFILL

# PART II

# ATTACHMENT 3-C

# SUBMITTAL TO

# KLEBERG COUNTY (COUNTY)

HANSON
Engineering | Planning | Allied Services

Hanson Professional Services Inc.
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Corpus Christi, TX 78411
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Fax: (361) 814-4401
www.hanson-inc.com

April 8, 2019

Mr. Roy Cantu
Precinct 3 County Commissioner
Kleberg County
433 E. County Road 2310
Riviera, Texas 78379

Re: Coordination Letter for Road Maintenance
City of Kingsville Landfill – Kleberg County
Municipal Solid Waste (MSW) - Permit No. 235C
Permit Amendment for Vertical and Lateral Expansion

Dear Mr. Cantu,

On behalf of the City of Kingsville (City), Hanson Professional Services Inc. has prepared a permit amendment application for a vertical and lateral expansion of the City of Kingsville Municipal Solid Waste Landfill (Kingsville Landfill). The Kingsville Landfill is located southeast of the City of Kingsville, Kleberg County, Texas. The entrance to the landfill is located at 348 East County Road 2130. Other roads used to access the site include Farm to Market Road (FM) 1717 and Farm to Market Road (FM) 2619. The enclosed maps show the access routes and location of the landfill.

This letter is being submitted to document coordination with Kleberg County (County), the agency exercising maintenance responsibility of the public roadway involved (consistent with the requirements of Texas Commission on Environmental Quality (TCEQ) municipal solid waste (MSW). Rule 30 TAC §330.61(i)(4)). We are requesting a written response from the County to acknowledge receipt of this letter and to provide information regarding any traffic or related location restrictions, and any proposed roadway improvements being planned in the vicinity of the site.

## BACKGROUND INFORMATION

- The landfill is an existing facility, currently in operation. The location is shown on attached Figure 1. The landfill entrance/exit is located on East County Road (E CR) 2130. No changes to the existing landfill entrance/exit are planned at this time.
- On a typical day the existing facility generates approximately 65 vehicle trips entering and exiting the landfill via the driveway on E CR 2130. These vehicle counts are based on the facility's scale records, waste receipts, and the typical number of employees and visitors accessing the site on a given day.
- To clarify terminology, please note that the term "expansion" refers to a waste disposal capacity increase of the landfill. Thus, it will allow an extension in site life of the landfill. In terms of expected traffic, the expansion is not expected to trigger any new sources of traffic or sudden increase in traffic – rather, gradual steady growth of existing landfill traffic over time is anticipated.
- Based on existing landfill customer traffic patterns, the main area roads used by waste hauling vehicles coming to and from the landfill are E CR 2130, FM 1717 and FM 2619, shown on the enclosed maps.

- The current site life of the landfill is approximately 46 years. At this time, we estimate that the post-expansion remaining site life of the landfill to be about 100+ years.

We would appreciate your timely review of this information and thank you in advance for your response that provides the above-requested information. If you have any questions or require additional information, you may contact me or Kelly Mayfield at (361) 814-9900.

Sincerely,

HANSON PROFESSIONAL SERVICES INC.

Jon M. Reinhard, P.E.
Project Engineer

Enclosures: General Location Map
TXDOT County Map
2013 Corpus Christi District Traffic Map

cc: Bill Donnell, City of Kingsville Public Works Director
Gary Fuselier, City of Kingsville Landfill Manager

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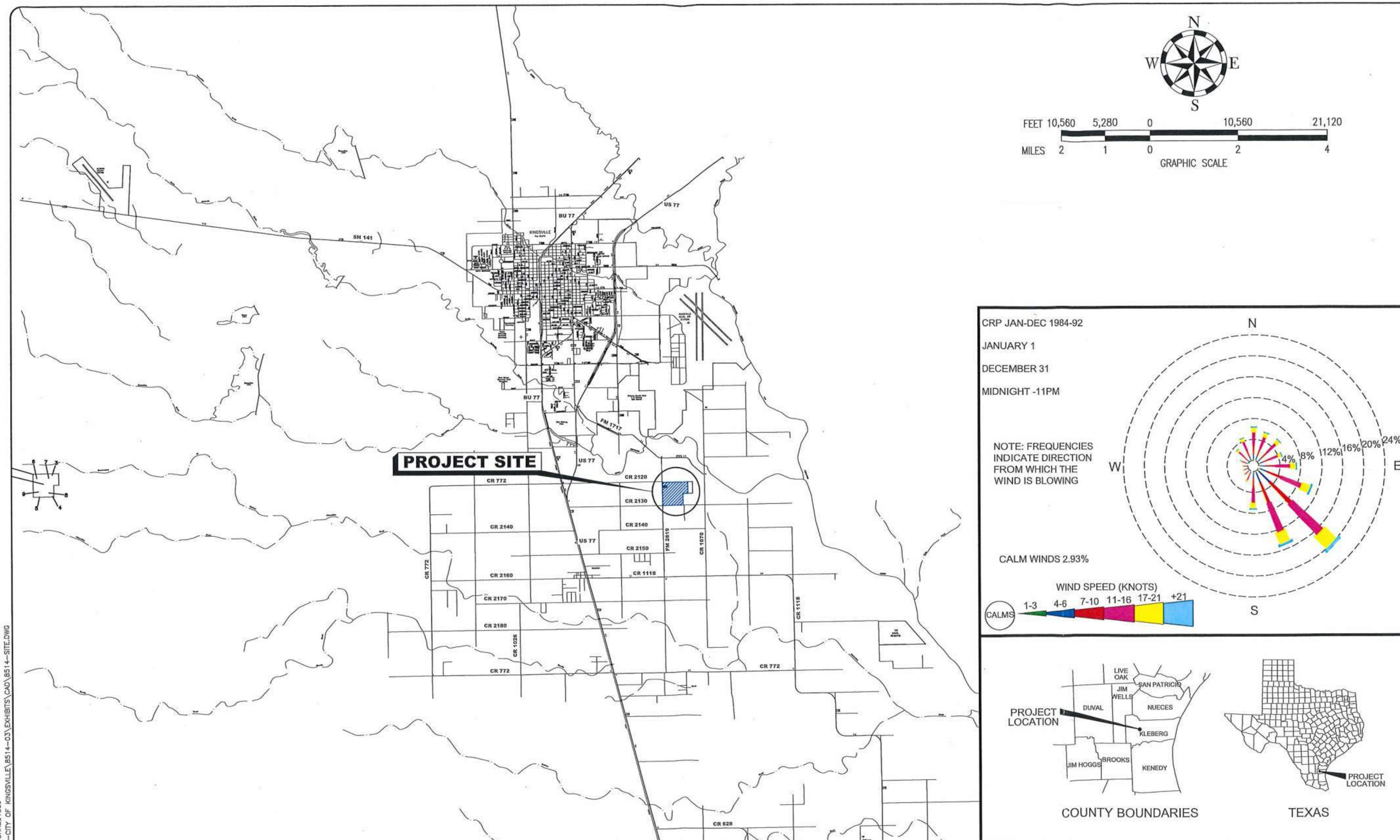


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STATE OF TEXAS
JON M. REINHARD
64541
LICENSED PROFESSIONAL ENGINEER
09/12/18

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| Date | 09/12/2018 |

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| REVIEWED | JMR | 09/12/2018 |

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PART I-ATTACHMENT 2
GENERAL LOCATION MAP
CITY OF KINGSVILLE LANDFILL
MSW PERMIT No. 235-C
KINGSVILLE, TEXAS
KLEBERG COUNTY, TEXAS

FIGURE:
I.2-1

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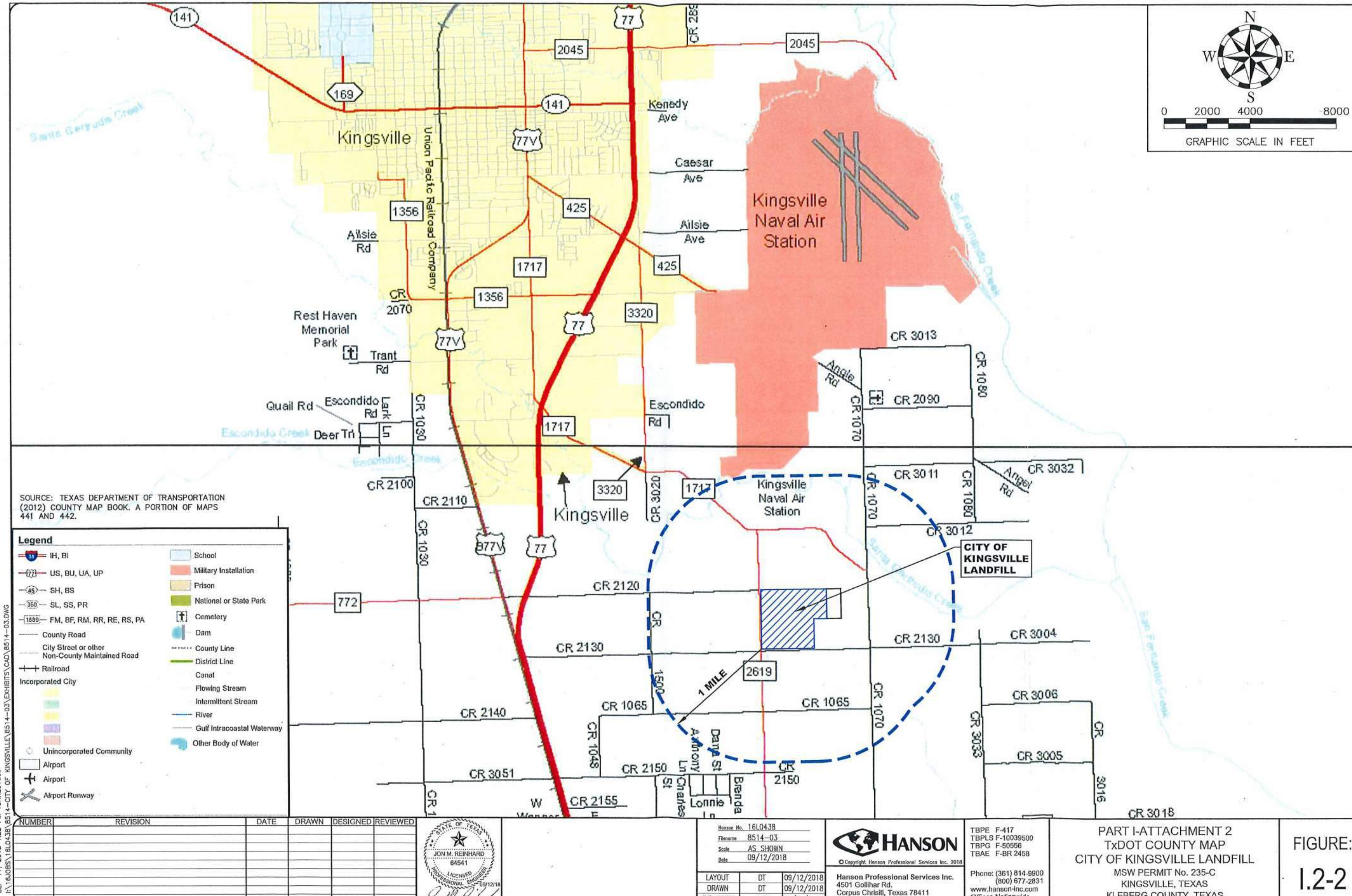

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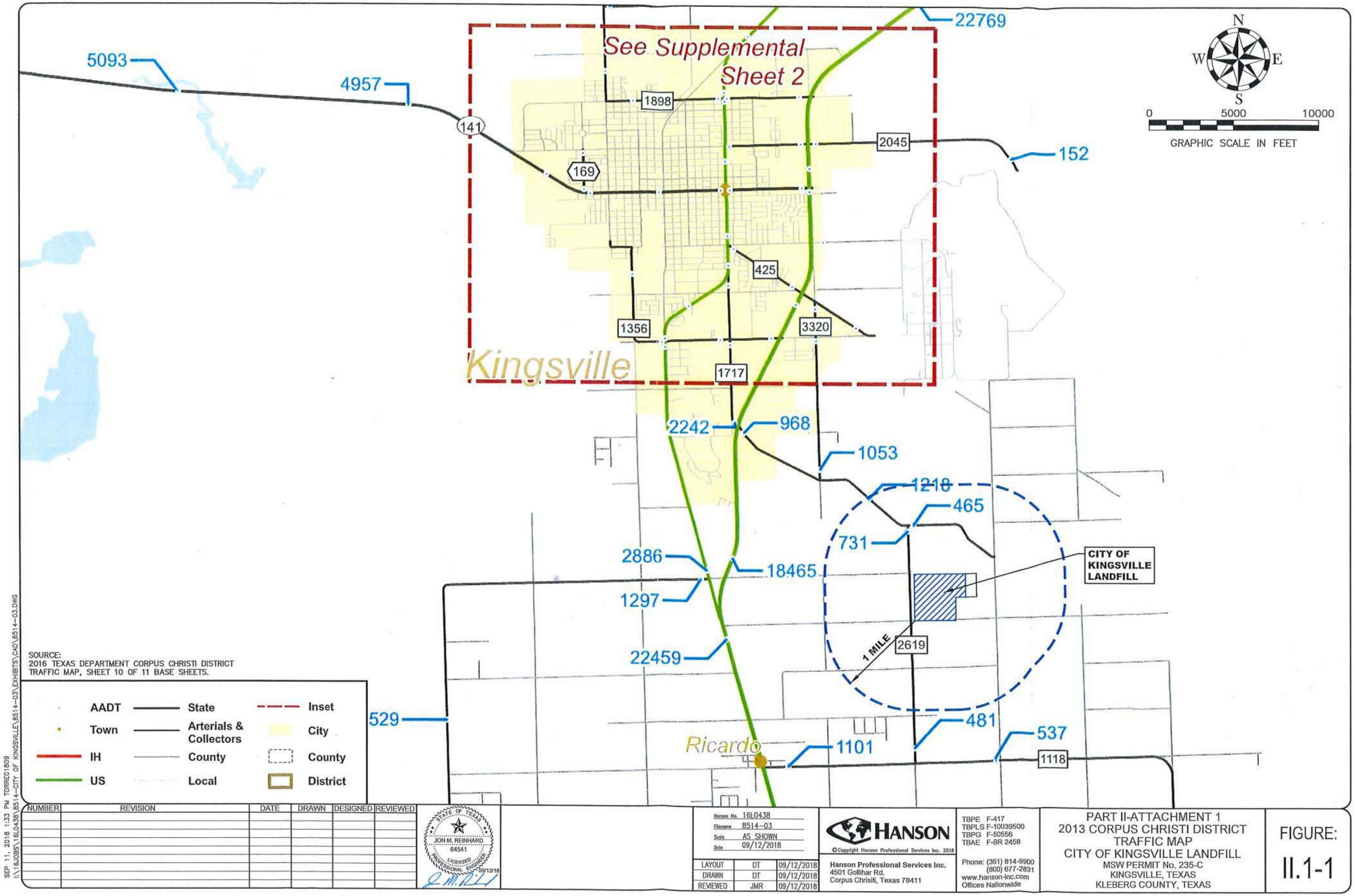

THE CITY OF KINGSVILLE LANDFILL

TCEQ PERMIT MSW 235C

# PERMIT AMENDMENT APPLICATION

# PART III

# SITE DEVELOPMENT PLAN

CITY OF KINGSVILLE, KLEBERG COUNTY, TEXAS

For Permitting Purposes Only

STATE OF TEXAS
JON M. REINHARD
64541
LICENSED
PROFESSIONAL ENGINEER
04/25/19

TBPE Firm No. F-417

September 2018
Revision 1 – November 2018
Revision 2 - February 2019
Revision 3 - April 2019

Prepared by

HANSON
Engineering | Planning | Allied Services

TBPE F-417

HANSON PROJECT NO. 16L0438-000

# CONTENTS



For Permitting Purposes Only
STATE OF TEXAS
JON M. REINHARD
64541
LICENSED
PROFESSIONAL ENGINEER
04/25/19
TBPE Firm No. F-417
For Pages i - ii

# ATTACHMENTS



# LIST OF TABLES



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### 3.2.2 Ventilation and Odor Control Measures

Potential odor sources associated with a landfill can vary considerably and may include the wastes being delivered to the landfill, waste in the open working face, landfill gas, the leachate collection system, or ponded water. Some wastes such as sludge and dead animals are a source of odor upon receipt, while other wastes have the potential for becoming a source of odor by their biodegradable nature. Leachate, liquid that has passed through or emerged from solid waste, may also be a source of odor if not properly handled in a timely manner.

Landfill operation at the site will occur in open areas within the permitted waste disposal footprint, therefore adequate ventilation will be provided. Landfill operators will ensure that odors are kept to a minimum by keeping the size of the working face area to a minimum, identifying any waste streams that require special attention to control odor, proper handling and disposal of leachate in a timely manner, and preventing ponded water. These and other odor control measures are discussed in detail in Part IV – Site Operating Plan.

The site will comply with all the applicable air quality rules and regulations. Accidental fires will be controlled, and open burning of waste will not be permitted.

### 3.2.3 Generalized Construction

Generalized construction details for the landfill are included in Part III, Attachments 1 through 3. Storage and Processing Area Plans, Figure III.1-16 in Part III, Attachment 1, provides details for the White Goods and Metal Recyclables Storage Area and the Tire Storage and Processing Area. Design and operation requirements for the Liquid Waste Solidification Area are included in Part IV- SOP, Attachment 5. Construction details for the liquid waste solidification area are shown on Figure IV.5-1. Details of the leachate management system are included in Part III, Attachment 15. Construction details for the leachate storage tanks are shown on Part III, Attachment 15, Appendix G, Figure III.15-G-3.

## 3.3 Sanitation and Water Pollution Control §330.63(b)(3) – (4)

The white goods and metal recyclables storage area and the tire storage and processing area contains waste handling and storage operations but there is no process wastewater produced at these areas or other operations of the landfill. The areas will be built up with an all-weather surface that is graded and bermed to prevent surface water from running into the storage area. In addition to preventing surface water runon into the areas, the berms enclosing the areas will also serve to contain runoff. The areas will be graded to a stormwater collection sump that wil collect and hold runoff from within the area. If runoff is determined to be contaminated it will be collected and transported to the contaminated water evaporation pond or the contaminated water management area.

## 3.4 Endangered Species Protection §330.63(b)(5)

A literature review of threatened or endangered species in Kleberg County was conducted as discussed in Part II, Section 14. The review included both US Fish and Wildlife (USFWS) and Texas Parks and Wildlife Department documentation and their requirements for endangered species assessment and compliance. No potential habitat for federally listed threatened or endangered species or designated critical habitat occurs within the permit area, or the property. And no federally listed threatened or endangered species have been observed on the property. Neither the facility nor its operations will result in the destruction or adverse modification of the critical habitat of threatened or endangered species. If endangered species are encountered during site operations, USFWS and TPWD will be notified.

# 9 CLOSURE PLAN §330.63(h)

Part III, Attachment 12 - Final Closure Plan contains the details of the final cover design, which has been developed to comply with Subchapter K, §330.501 through 330.505 of the TCEQ regulations. A composite cover will be constructed over the entire landfill. The composite cover will overlay a 12-inch thick intermediate cover layer immediately above the top of waste. The composite cover will consist of, from bottom to top, a prepared soil subgrade, a geosynthetic clay liner (GCL), a 40-mil flexible membrane cover, a drainage geocomposite, and a 25-inch thick protective soil erosion layer. The Alternative Liner and Overliner Point of Compliance Demonstrations found in Part III, Attachment 5 includes a demonstration that the GCL material proposed in the final cover design is acceptable.

The initial and primary vegetative cover for the site will include appropriate native grasses. Typical types of grasses include Coastal Bermuda, Buffalo Grass, Texas Grama, Bluestem and Johnson Grass. Winter Rye and Fescue may be used in the cool seasons. The Kleberg County Extension Agent may also be consulted on the use of appropriate grasses and the appropriate planting seasons as cover projects are initiated. The maintenance of grass cover over completed areas is an essential component of erosion control in post closure care.

A demonstration that this specified final cover design will provide effective long term erosional stability is included in Part III, Attachment 6 - FSWDR.

# CITY OF KINGSVILLE LANDFILL

# PART III

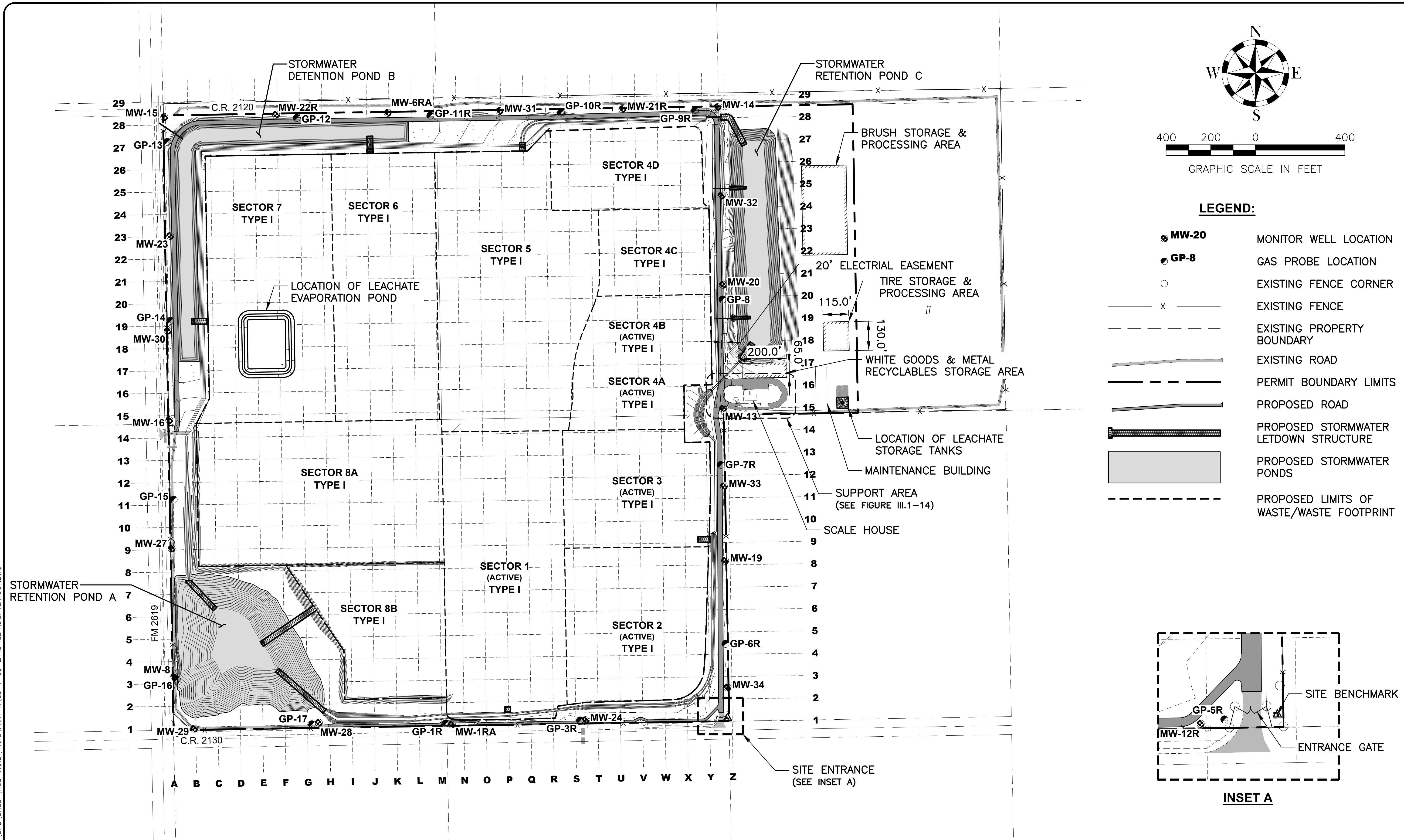
# ATTACHMENT 1

SITE LAYOUT PLANS

For Permitting Purposes Only

STATE OF TEXAS
JON M. REINHARD
64541
LICENSED
PROFESSIONAL ENGINEER
04/25/19

TBPE Firm No. F-417

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STATE OF TEXAS
JON M. REINHARD
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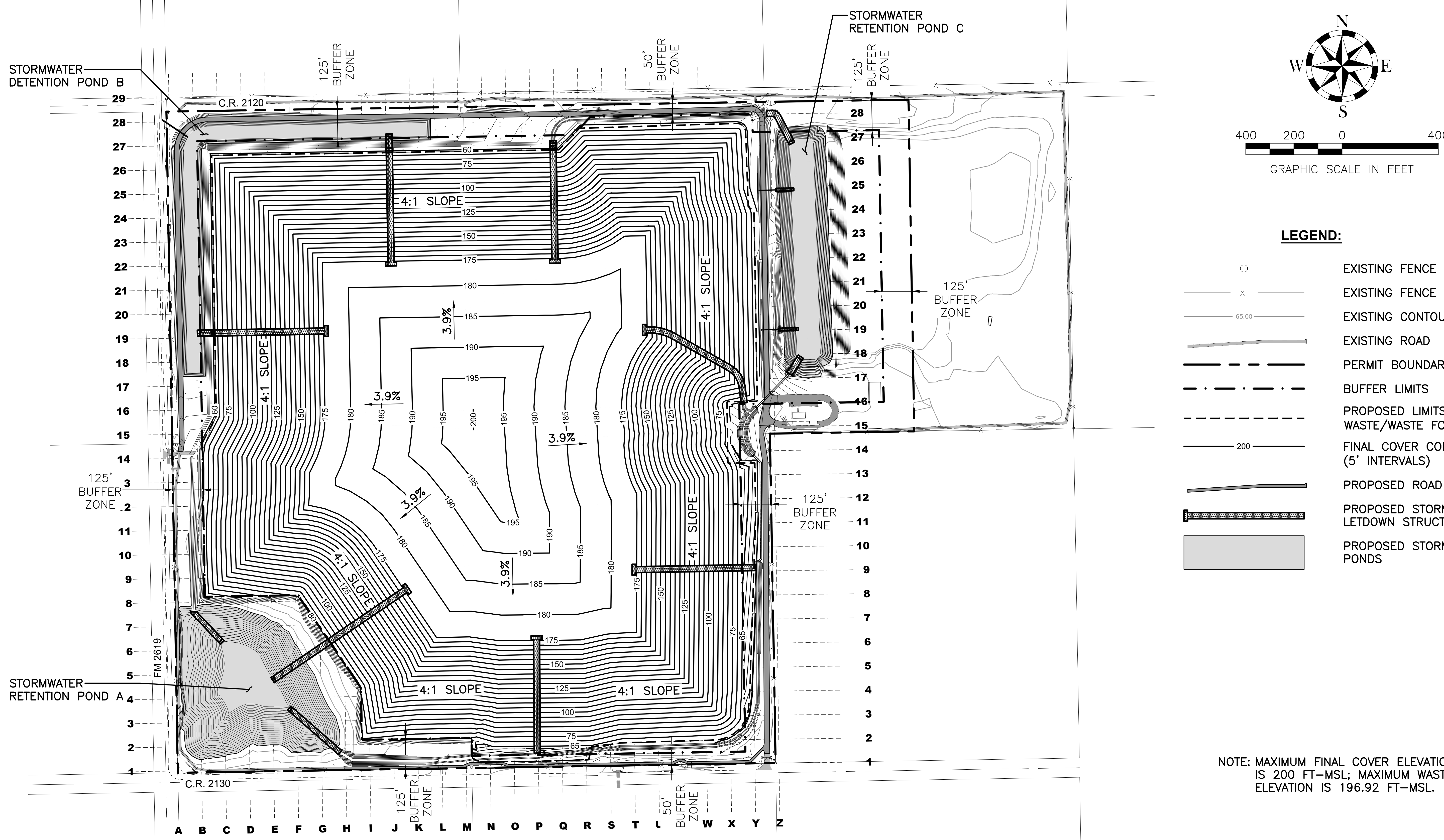
PART III, ATTACHMENT 1
FACILITY LAYOUT
CITY OF KINGSVILLE LANDFILL
MSW PERMIT No. 235-C
KINGSVILLE, TEXAS
KLEBERG COUNTY, TEXAS

FIGURE:
III.1-2




**LEGEND:**

EXISTING FENCE CORNER
EXISTING FENCE
EXISTING CONTOUR
EXISTING ROAD
PERMIT BOUNDARY LIMITS
BUFFER LIMITS
PROPOSED LIMITS OF WASTE/WASTE FOOTPRINT
FINAL COVER CONTOURS (5' INTERVALS)
PROPOSED ROAD
PROPOSED STORMWATER LETDOWN STRUCTURE
PROPOSED STORMWATER PONDS

NOTE: MAXIMUM FINAL COVER ELEVATION IS 200 FT–MSL; MAXIMUM WASTE ELEVATION IS 196.92 FT–MSL.

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PART III, ATTACHMENT 1
LANDFILL COMPLETION PLAN
CITY OF KINGSVILLE LANDFILL
MSW PERMIT No. 235-C
KINGSVILLE, TEXAS
KLEBERG COUNTY, TEXAS

FIGURE:
III.1-4

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# CITY OF KINGSVILLE LANDFILL

## PART III

## ATTACHMENT 2

CROSS-SECTIONS

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JON M. REINHARD
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04/25/19

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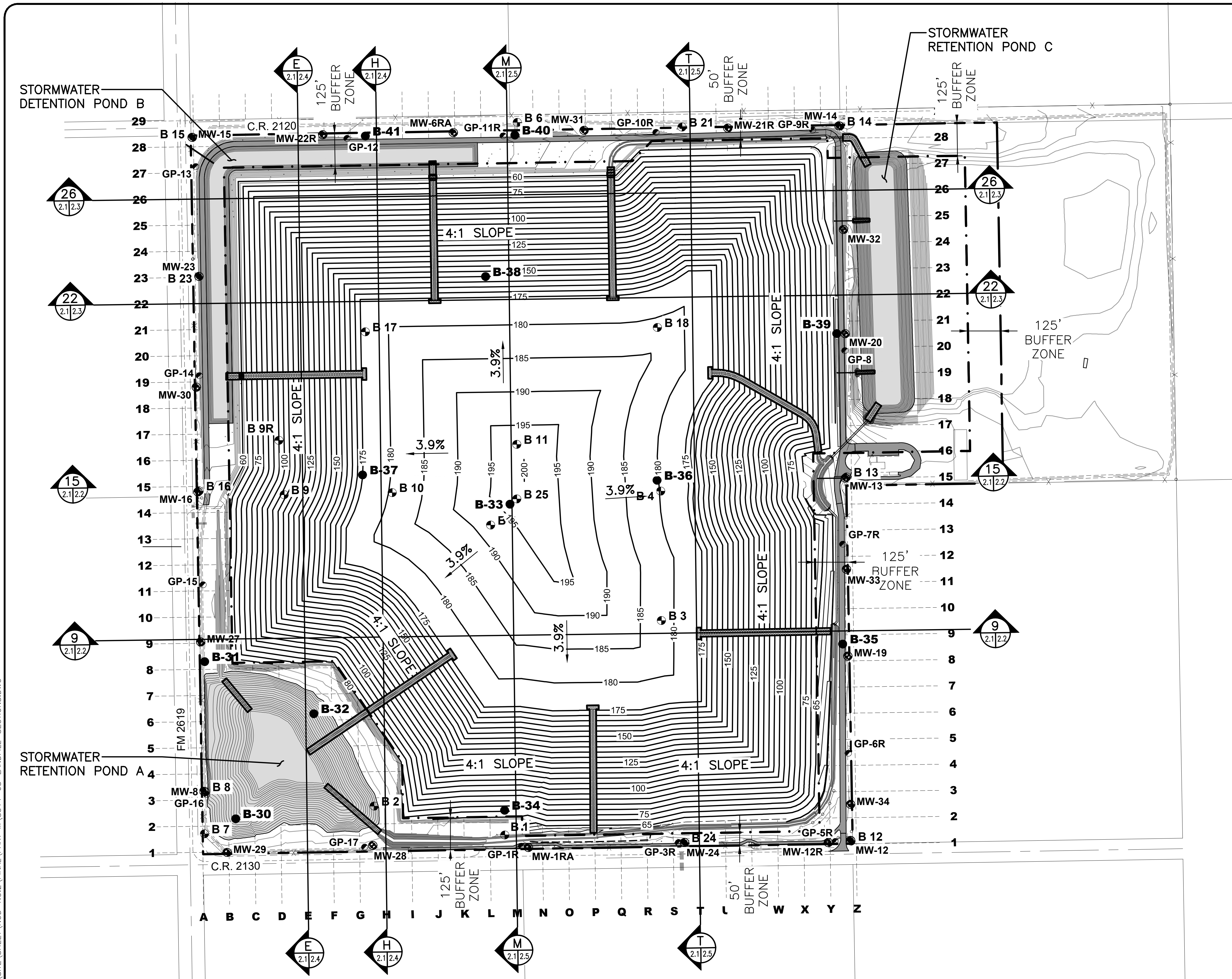


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| | EXISTING ROAD |
| | PERMIT BOUNDARY LIMITS |
| | BUFFER LIMITS |
| — 200 — | FINAL COVER CONTOURS (5' INTERVALS) |
| | PROPOSED ROAD |
| | PROPOSED STORMWATER LETDOWN STRUCTURE |
| | PROPOSED STORMWATER PONDS |
| B 3 | HISTORICAL SOIL BORING |
| B-36 | 2016 SOIL BORING |
| GP-8 | GAS PROBE |
| MW-32 | MONITOR WELL |

NOTE: MAXIMUM FINAL COVER ELEVATION IS 200 FT–MSL; MAXIMUM WASTE ELEVATION IS 196.92 FT–MSL; ELEVATION OF DEEPEST EXCAVATION IS 22.5 FT–MSL.

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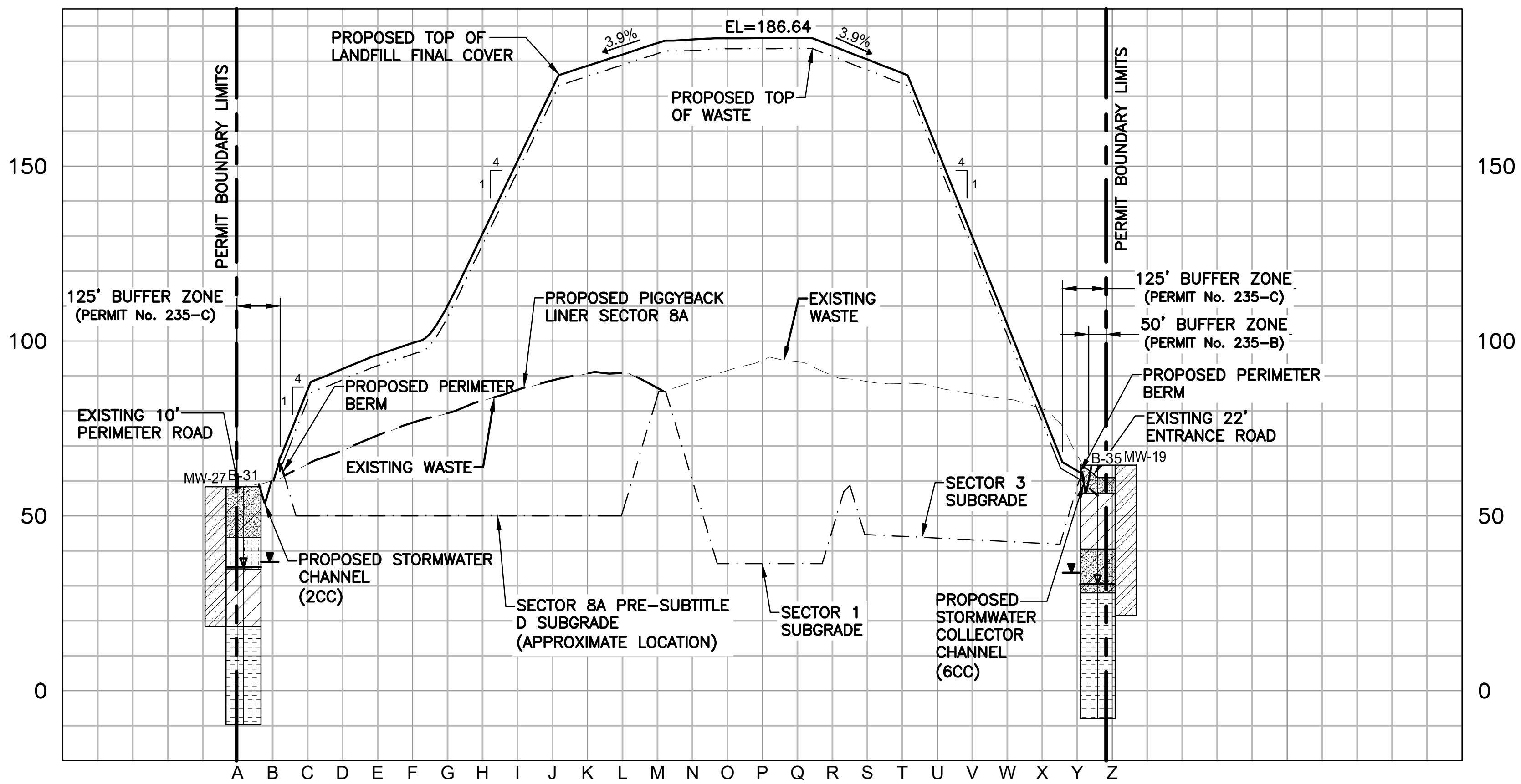
PART III, ATTACHMENT 2
LANDFILL CROSS - SECTION LOCATION PLAN
CITY OF KINGSVILLE LANDFILL
PA. MSW 235-C
KINGSVILLE, TEXAS, KLEBERG COUNTY, TEXAS

FIGURE: III.2-1

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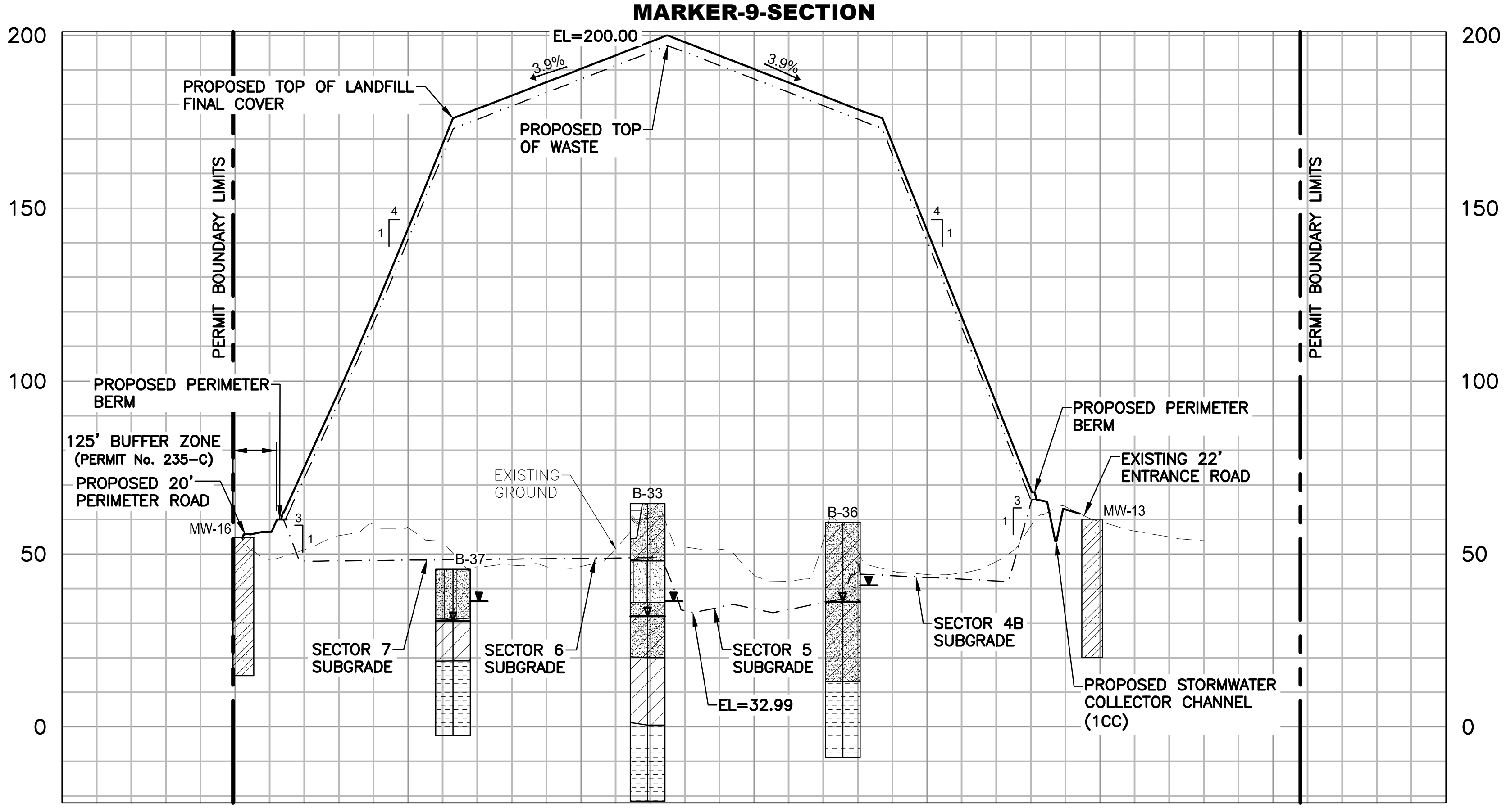


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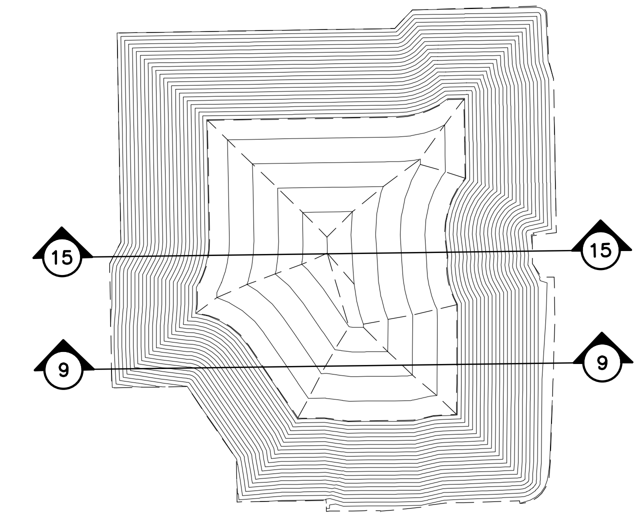


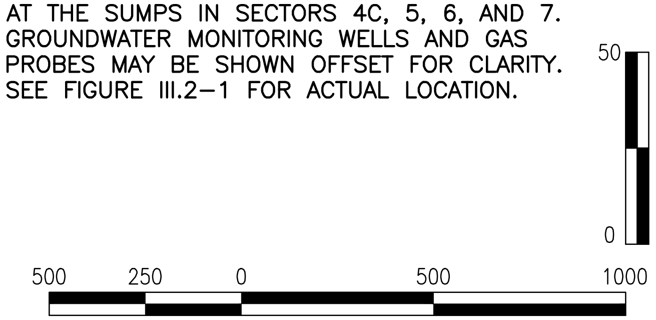

**KEY MAP**

**LEGEND**

- LEAN CLAY, LEAN CLAY WITH SAND, SANDY LEAN SILTY CLAY (CL, CL–ML)
- CLAYEY SAND (SC)
- SILTY SAND, POORLY GRADED SAND WITH SILT (SM, SP–SM)
- FAT CLAY, SANDY FAT CLAY FAT CLAY WITH SAND (CH)
- POORLY GRADED SAND WITH CLAY (SP–SC)
- INITIAL WATER LEVEL
- STATIC WATER LEVEL
- FINAL GRADE
- TOP OF WASTE
- EXISTING GRADE
- SUBGRADE
- PIGGYBACK LINER

NOTES:

1. THE ELEVATION OF THE DEEPEST EXCAVATION WITHIN THE FACILITY IS 22.5 FT–MSL LOCATED AT THE SUMPS IN SECTORS 4C, 5, 6, AND 7.
2. GROUNDWATER MONITORING WELLS AND GAS PROBES MAY BE SHOWN OFFSET FOR CLARITY. SEE FIGURE III.2–1 FOR ACTUAL LOCATION.

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STATE OF TEXAS
JON M. REINHARD
64541
LICENSED PROFESSIONAL ENGINEER
04/23/19

Hanson No. 16L0438
Filename
Scale AS SHOWN
Date 04/23/2019

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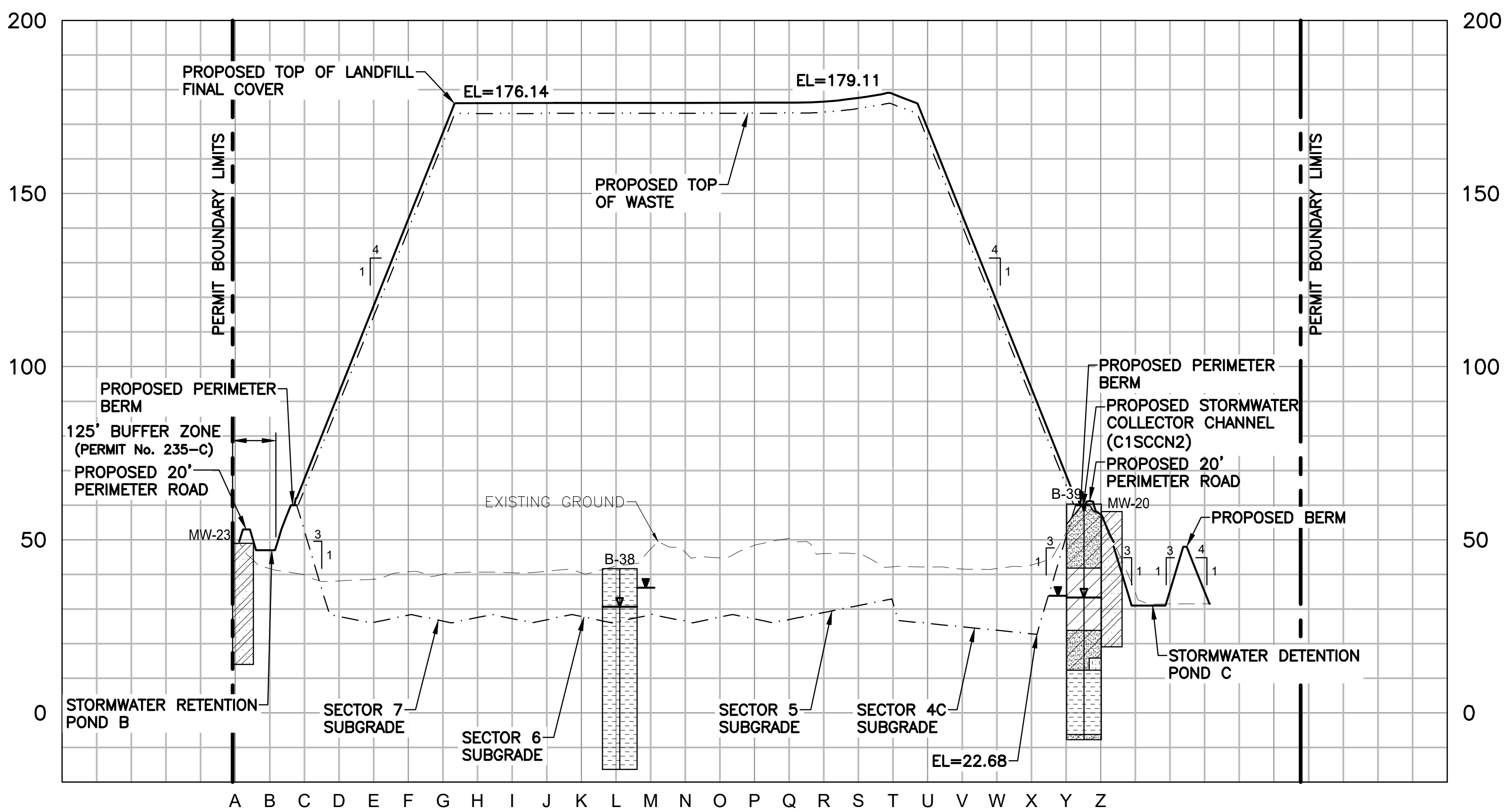
PART III, ATTACHMENT 2
LANDFILL CROSS - SECTIONS 9 & 15
CITY OF KINGSVILLE LANDFILL
MSW PERMIT No. 235-C
KINGSVILLE, TEXAS
KLEBERG COUNTY, TEXAS

FIGURE:
III.2-2

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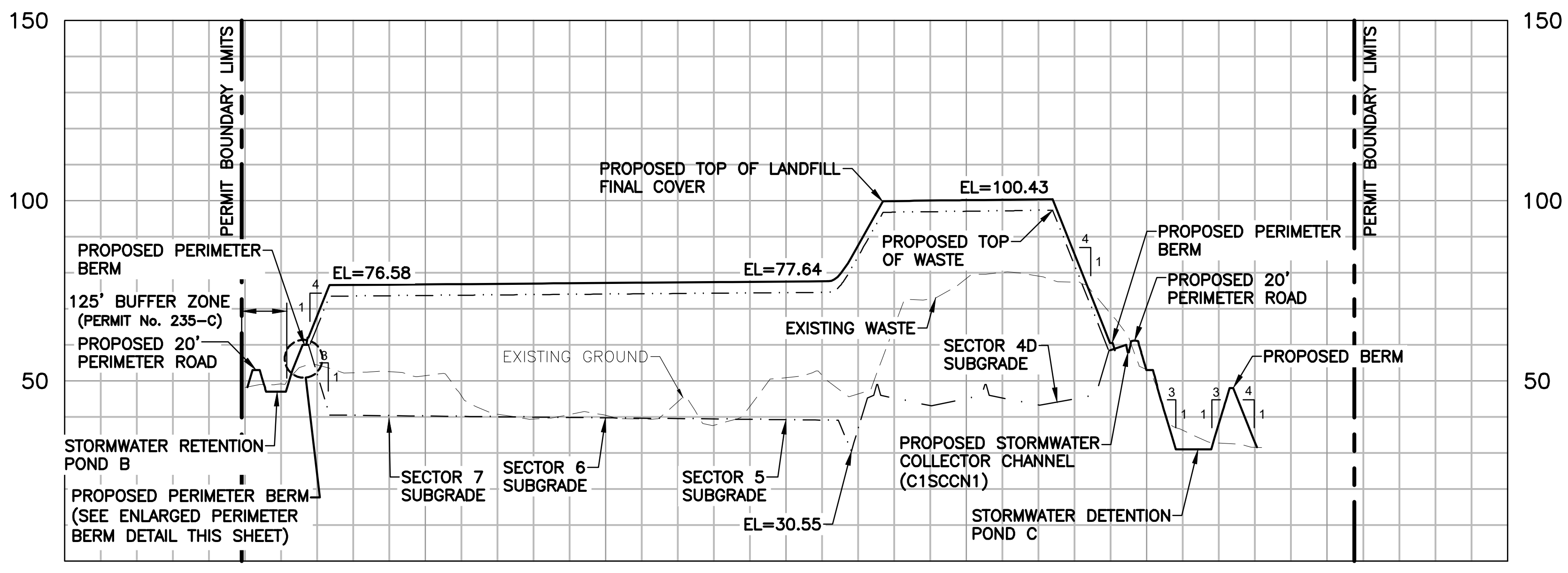


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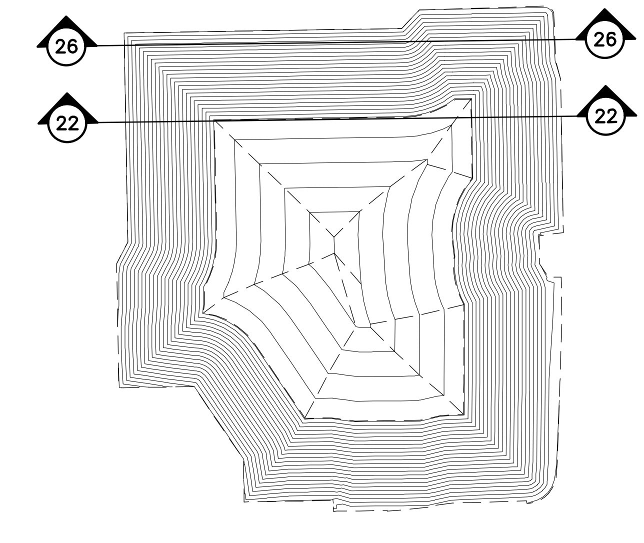


**KEY MAP**

**LEGEND**

| | |
|---|---|
| | LEAN CLAY, LEAN CLAY WITH SAND, SANDY LEAN SILTY CLAY (CL, CL-ML) |
| | CLAYEY SAND (SC) |
| | SILTY SAND, POORLY GRADED SAND WITH SILT (SM, SP-SM) |
| | FAT CLAY, SANDY FAT CLAY FAT CLAY WITH SAND (CH) |
| | POORLY GRADED SAND WITH CLAY (SP-SC) |
| ▽ | INITIAL WATER LEVEL |
| ▼ | STATIC WATER LEVEL |
| | FINAL GRADE |
| | TOP OF WASTE |
| | EXISTING GRADE |
| | SUBGRADE |
| | PIGGYBACK LINER |

NOTES:

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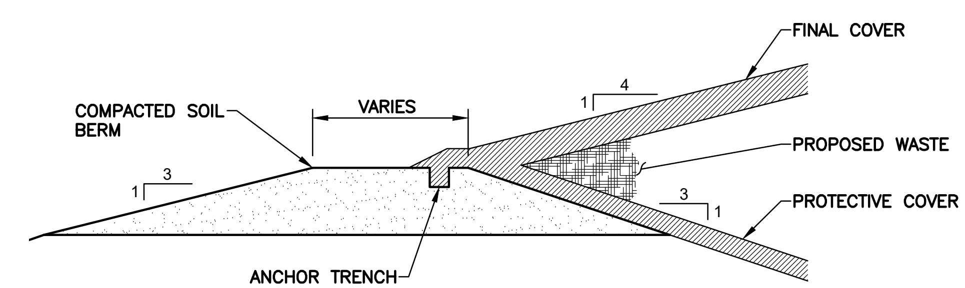
2. GROUNDWATER MONITORING WELLS AND GAS PROBES MAY BE SHOWN OFFSET FOR CLARITY. SEE FIGURE III.2-1 FOR ACTUAL LOCATION.




**PERIMETER BERM - DETAIL (TYP.)**

SCALE: 1" = 20'

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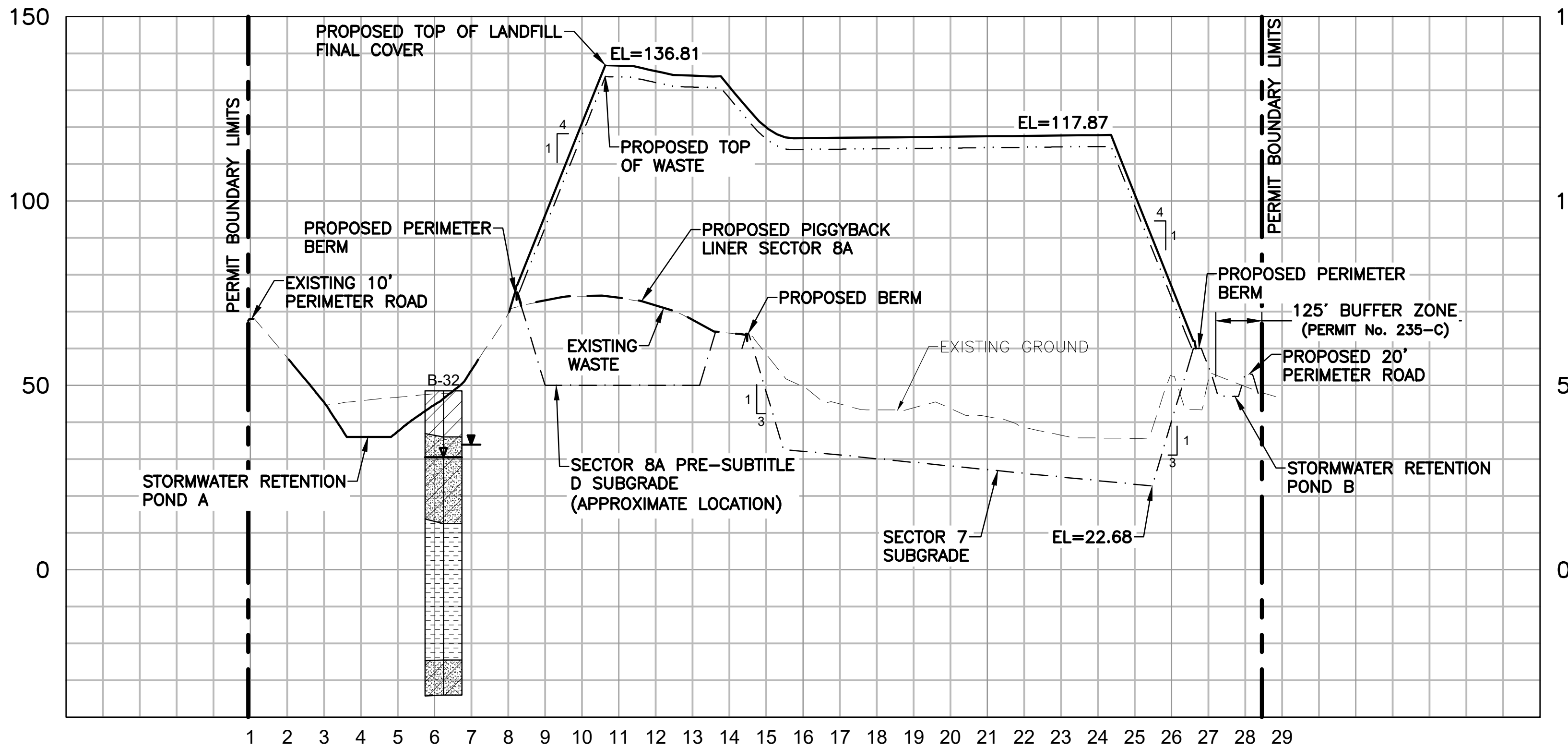
PART III, ATTACHMENT 2
LANDFILL CROSS - SECTIONS 22 & 26
CITY OF KINGSVILLE LANDFILL
MSW PERMIT No. 235-C
KINGSVILLE, TEXAS
KLEBERG COUNTY, TEXAS

FIGURE:
III.2-3

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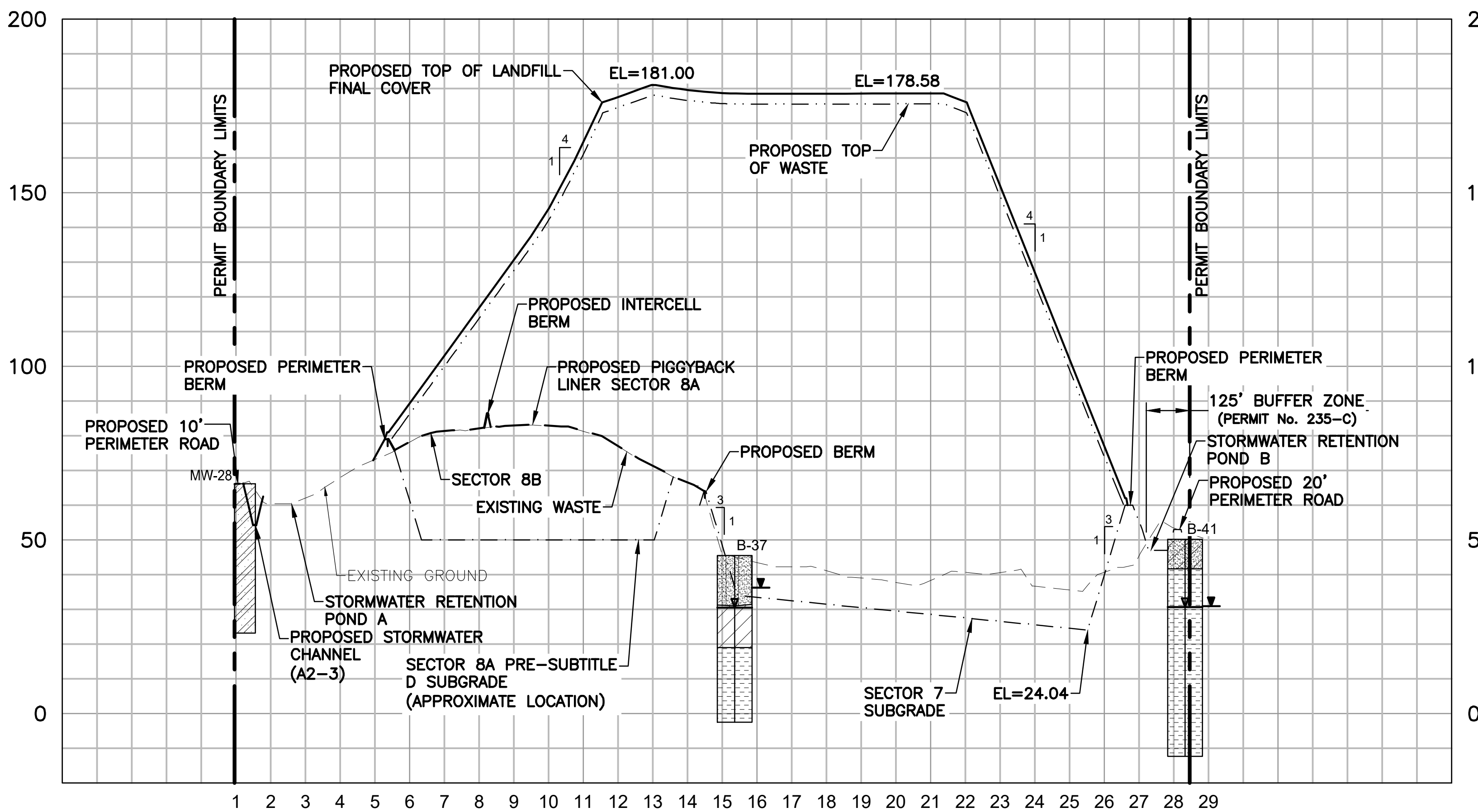


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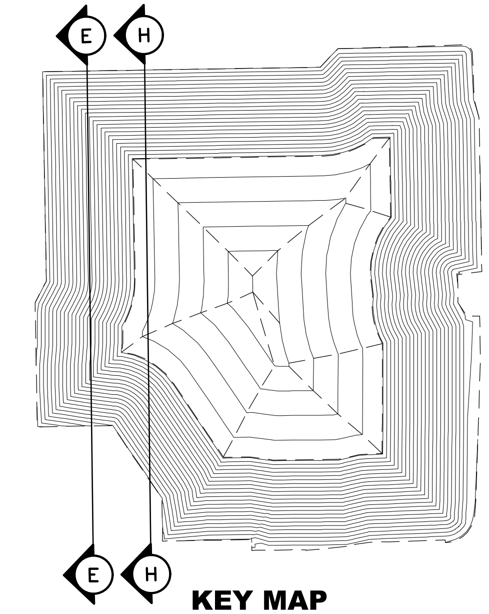

**KEY MAP**

## LEGEND

- LEAN CLAY, LEAN CLAY WITH SAND, SANDY LEAN SILTY CLAY (CL, CL-ML)
- CLAYEY SAND (SC)
- SILTY SAND, POORLY GRADED SAND WITH SILT (SM, SP-SM)
- FAT CLAY, SANDY FAT CLAY FAT CLAY WITH SAND (CH)
- POORLY GRADED SAND WITH CLAY (SP-SC)
- INITIAL WATER LEVEL
- STATIC WATER LEVEL
- FINAL GRADE
- TOP OF WASTE
- EXISTING GRADE
- SUBGRADE
- PIGGYBACK LINER

NOTES:

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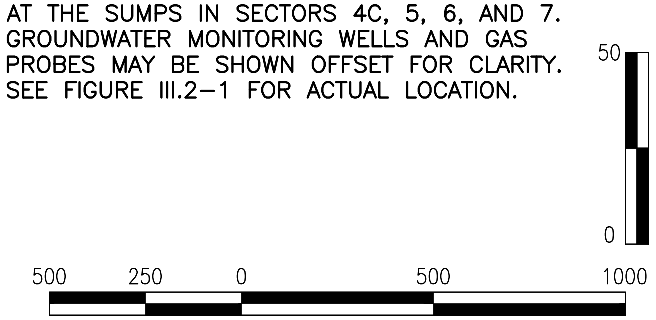


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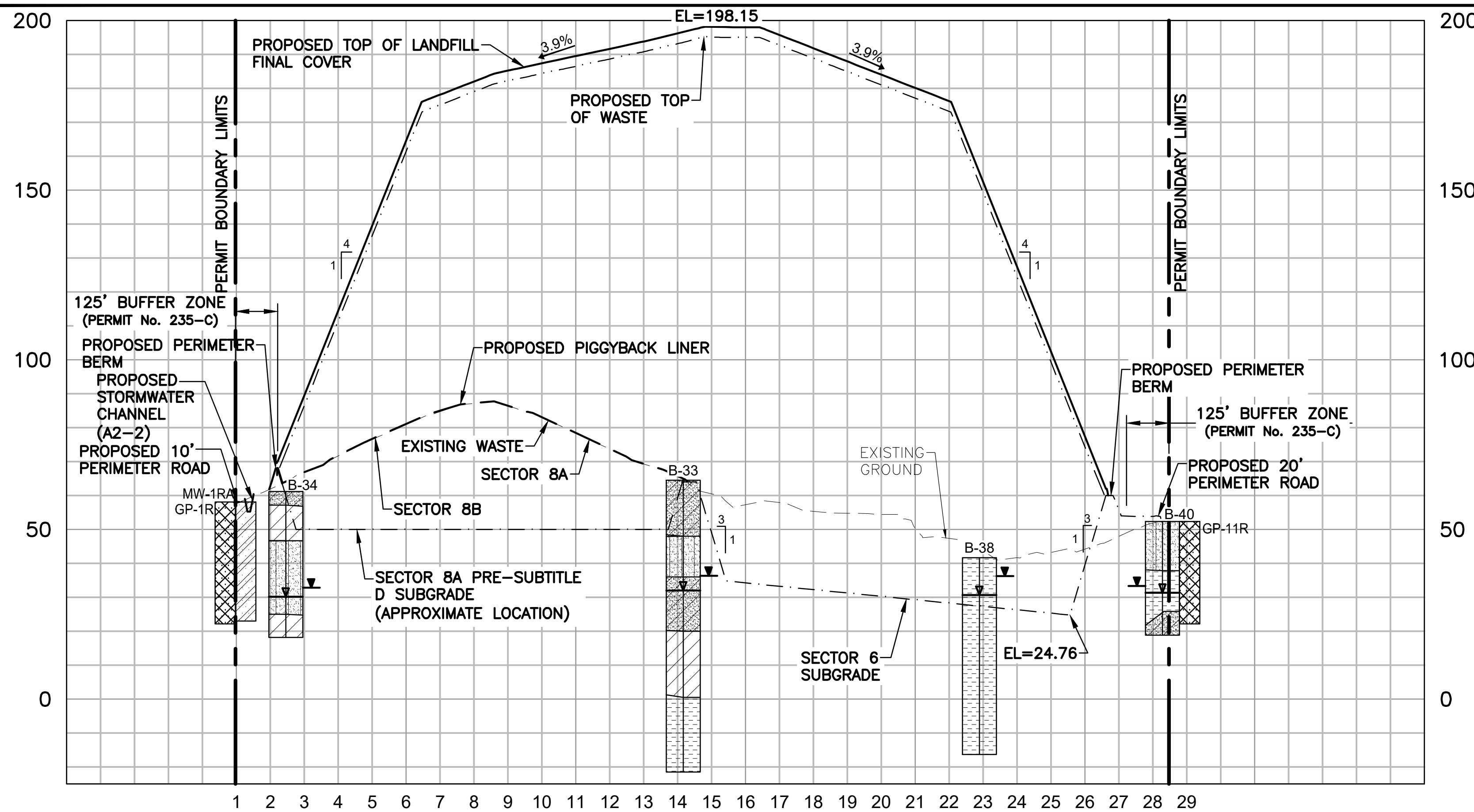
PART III, ATTACHMENT 2
LANDFILL CROSS - SECTIONS E & H
CITY OF KINGSVILLE LANDFILL
MSW PERMIT No. 235-C
KINGSVILLE, TEXAS
KLEBERG COUNTY, TEXAS

FIGURE:
III.2-4

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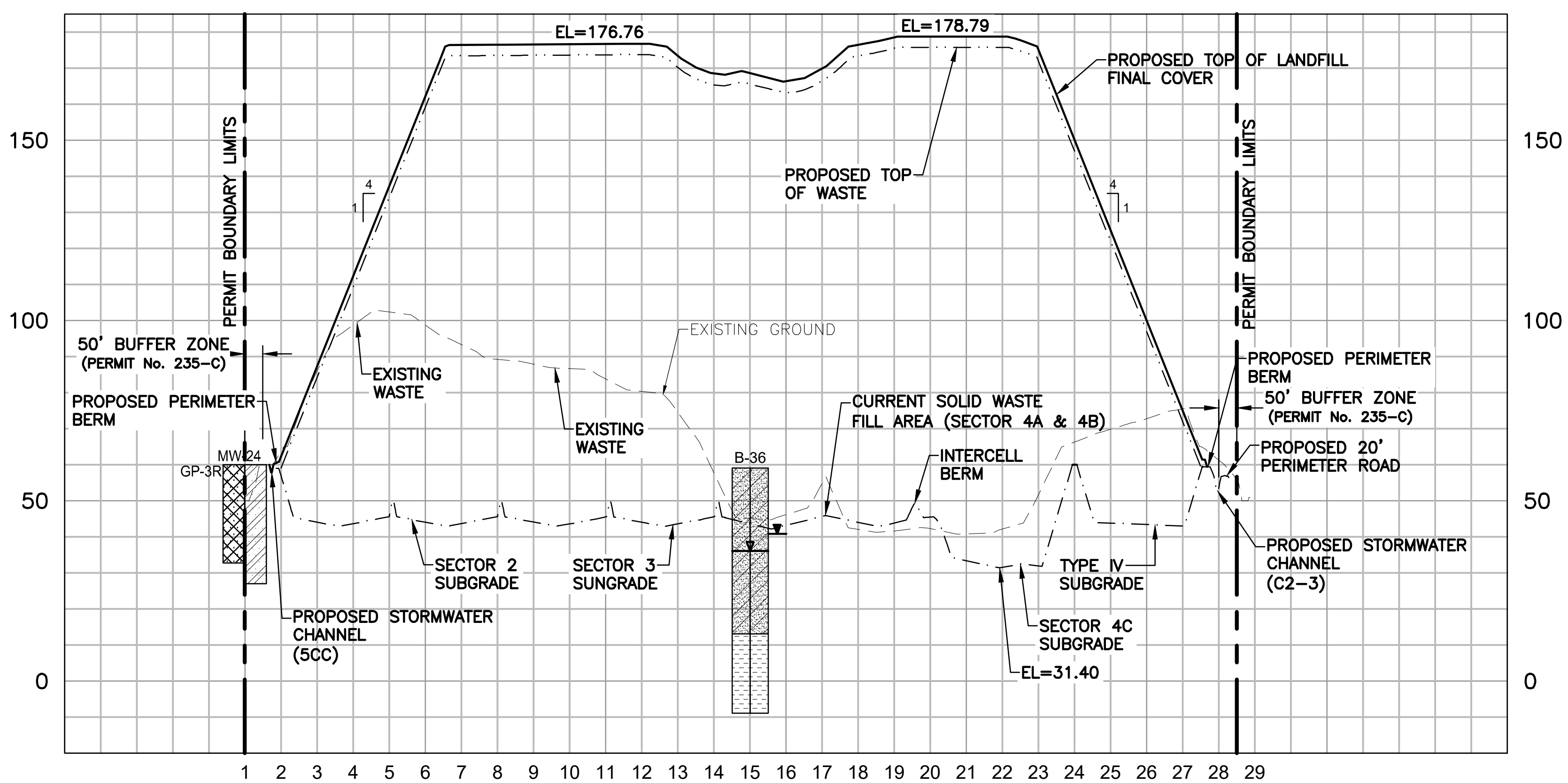


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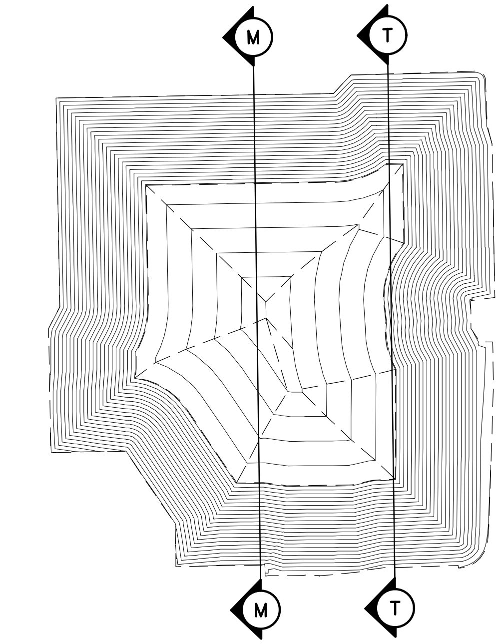

**KEY MAP**

## LEGEND

| | |
|---|---|
| LEAN CLAY, LEAN CLAY WITH SAND, SANDY LEAN SILTY CLAY (CL, CL–ML) | FINAL GRADE |
| CLAYEY SAND (SC) | TOP OF WASTE |
| SILTY SAND, POORLY GRADED SAND WITH SILT (SM, SP–SM) | EXISTING GRADE |
| FAT CLAY, SANDY FAT CLAY FAT CLAY WITH SAND (CH) | SUBGRADE |
| POORLY GRADED SAND WITH CLAY (SP–SC) | PIGGYBACK LINER |
| INITIAL WATER LEVEL | |
| STATIC WATER LEVEL | |

NOTES:

1. THE ELEVATION OF THE DEEPEST EXCAVATION WITHIN THE FACILITY IS 22.5 FT–MSL LOCATED AT THE SUMPS IN SECTORS 4C, 5, 6, AND 7.
2. GROUNDWATER MONITORING WELLS AND GAS PROBES MAY BE SHOWN OFFSET FOR CLARITY. SEE FIGURE III.2–1 FOR ACTUAL LOCATION.

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500 250 0 500 1000

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PART III, ATTACHMENT 2
LANDFILL CROSS - SECTIONS M & T
CITY OF KINGSVILLE LANDFILL
MSW PERMIT No. 235-C
KINGSVILLE, TEXAS
KLEBERG COUNTY, TEXAS

FIGURE:
III.2-5

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# CITY OF KINGSVILLE LANDFILL

# PART III

# ATTACHMENT 3

## WASTE MANAGEMENT UNIT DESIGN DRAWINGS

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JON M. REINHARD
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LICENSED
PROFESSIONAL ENGINEER

04/25/19

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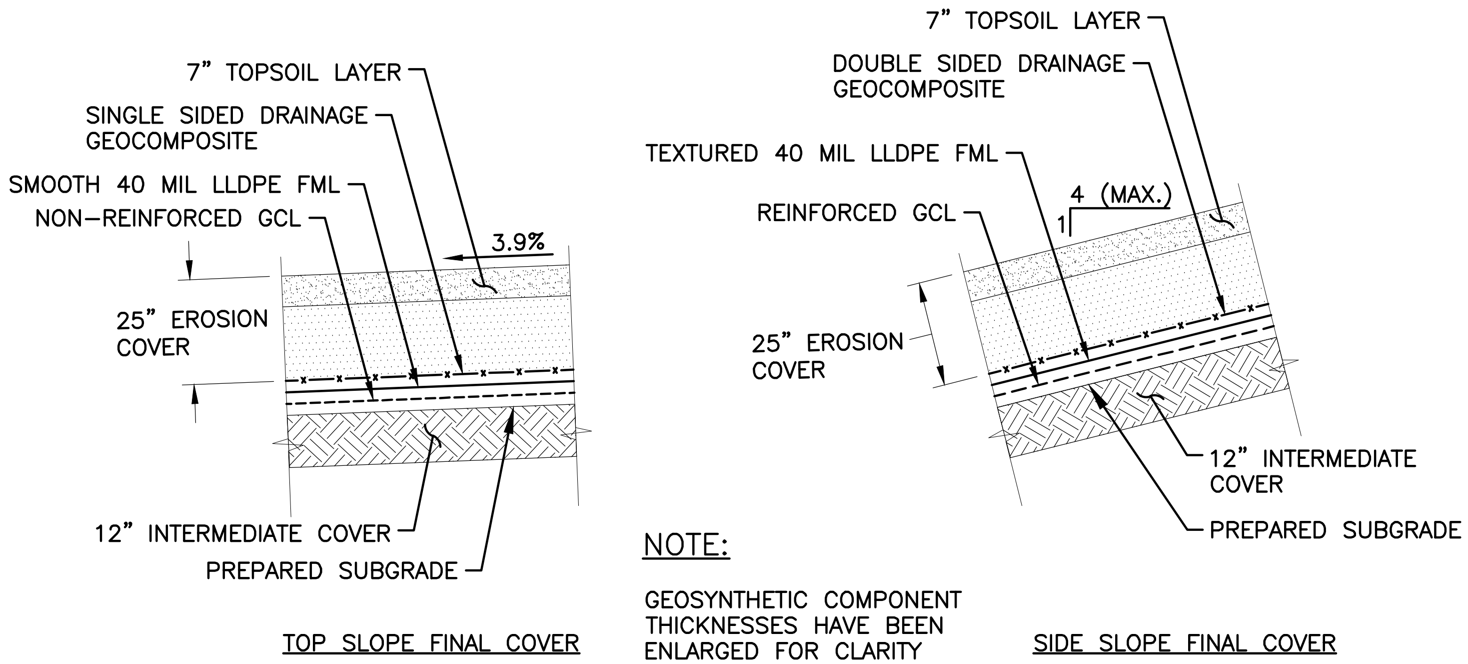
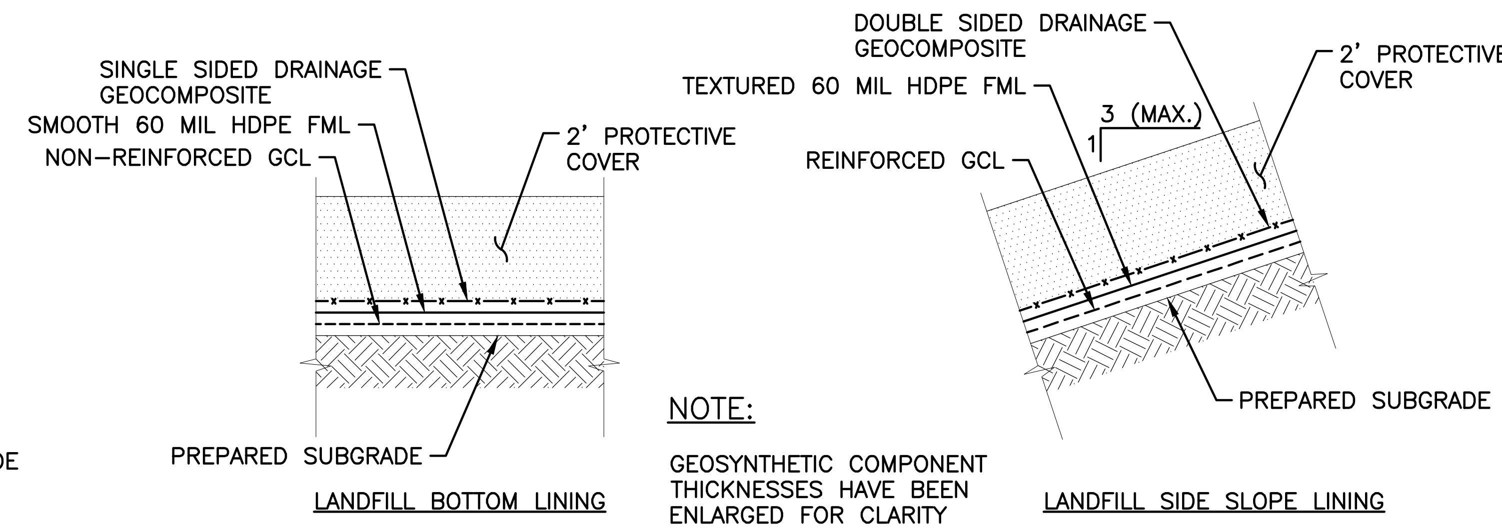



NOTE:

GEOSYNTHETIC COMPONENT THICKNESSES HAVE BEEN ENLARGED FOR CLARITY

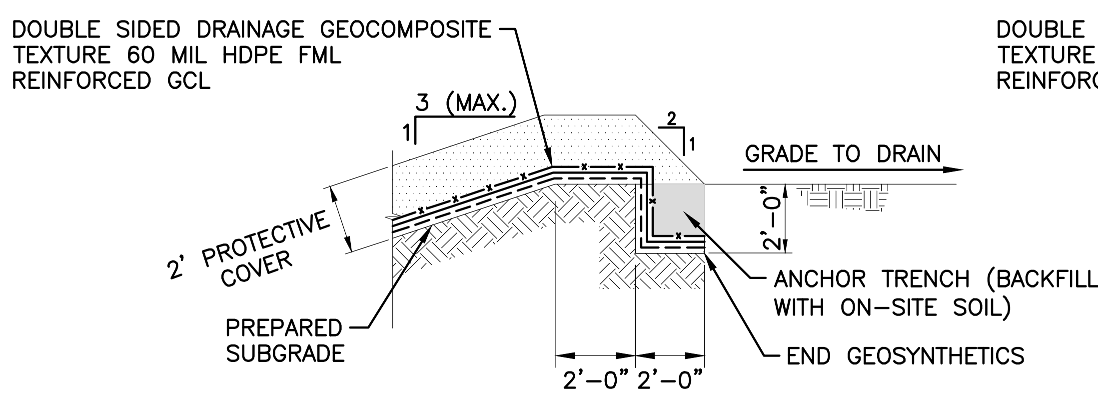
8 — FINAL COVER LINING DETAIL
1 | 1 — SCALE: N.T.S.



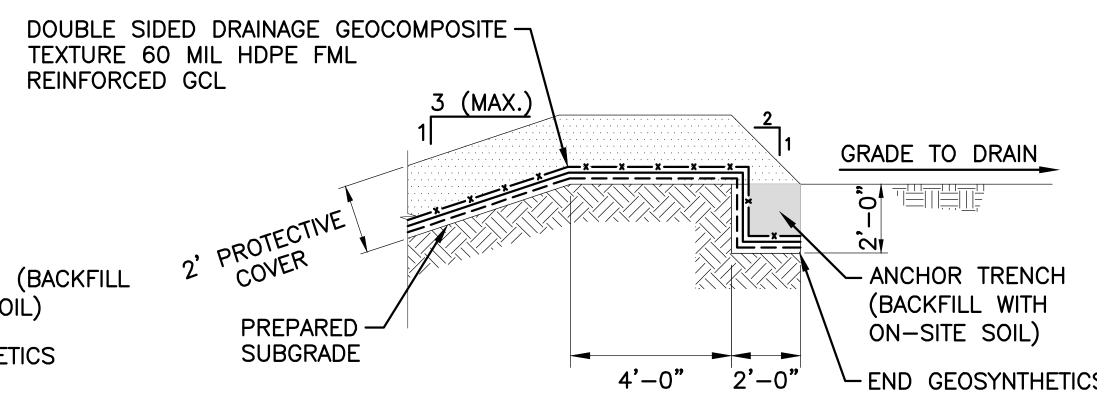

NOTE:

GEOSYNTHETIC COMPONENT THICKNESSES HAVE BEEN ENLARGED FOR CLARITY

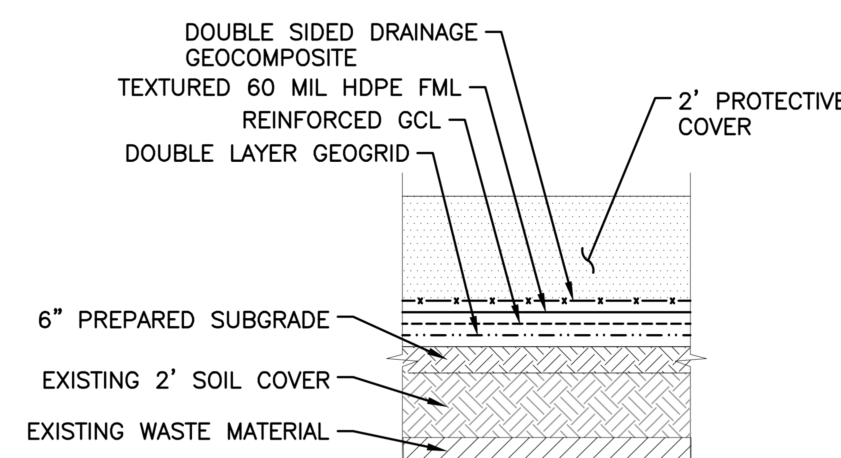
9 — LANDFILL LINING DETAILS
1 | 1 — SCALE: N.T.S.




10 — ANCHOR TRENCH
1 | 1 — SCALE: N.T.S.




11 — ANCHOR TRENCH
1 | 1 — SCALE: N.T.S.




NOTE:

GEOSYNTHETIC COMPONENT THICKNESSES HAVE BEEN ENLARGED FOR CLARITY

12 — PIGGY BACK LINER DETAIL
1 | 1 — SCALE: N.T.S.

NOTE:

1. ALL LINER SYSTEMS DEPICTED ARE ALTERNATIVE LINER SYSTEMS. ALTERNATIVE LINER DEMONSTRATIONS CAN BE FOUND IN PART III, ATTACHMENT 5.

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Hanson No. 16L0438
Filename 8514-03-FLOODPLAIN-MAP
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Date 04/23/2019

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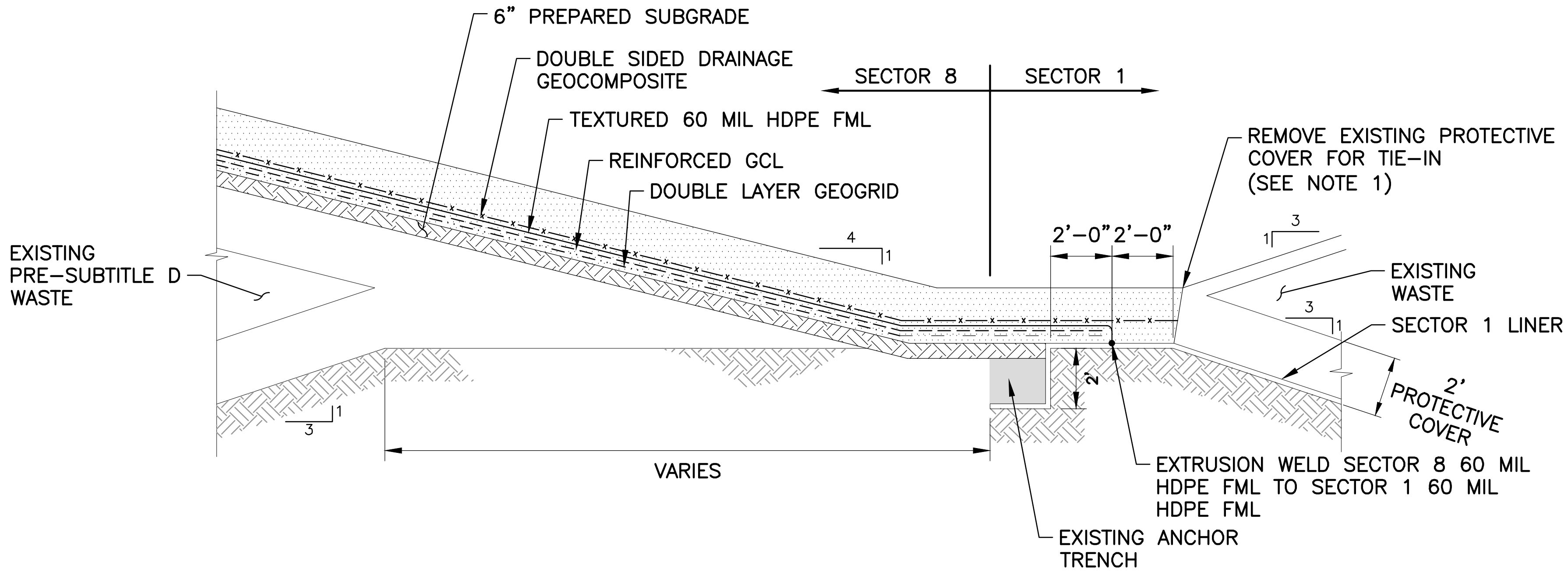
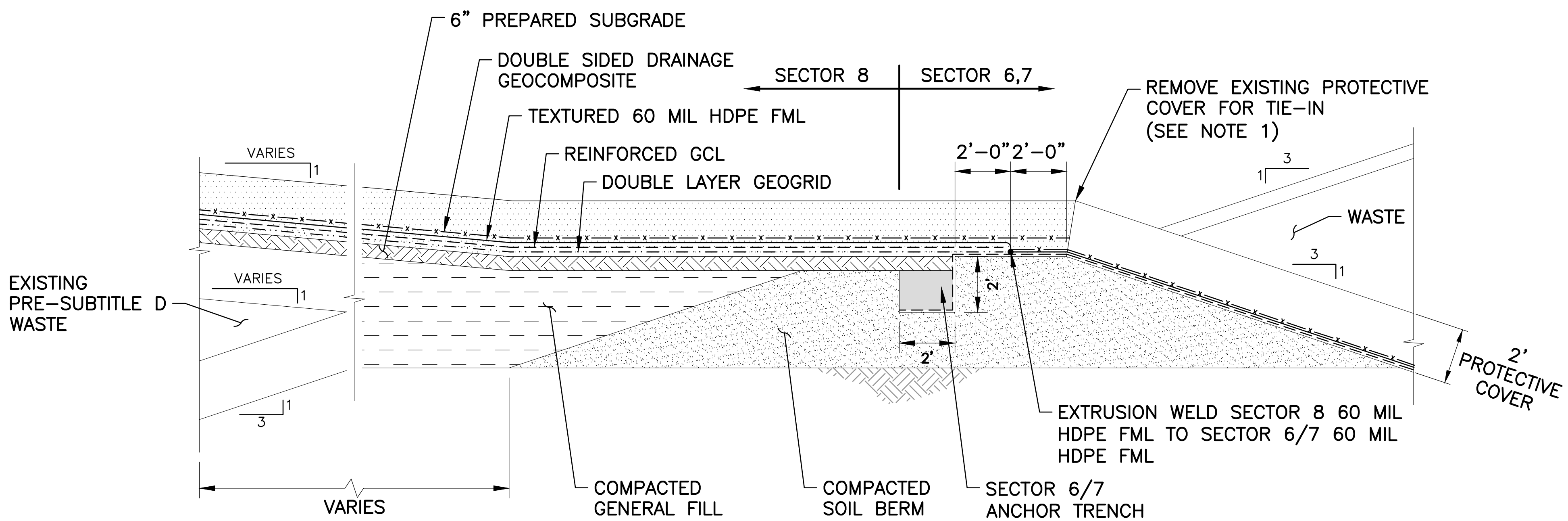
PART III, ATTACHMENT 3
LINER DETAILS
CITY OF KINGSVILLE LANDFILL
MSW PERMIT No. 235-C
KINGSVILLE, TEXAS
KLEBERG COUNTY, TEXAS

FIGURE: III.3-1




15 | 1 | 1 SECTOR 8 PIGGY BACK LINER AND SECTOR 1 LINER TIE–IN DETAIL

SCALE: N.T.S.




16 | 1 | 1 SECTOR 8 PIGGY BACK LINER AND SECTOR 6 & 7 LINER TIE–IN DETAIL

SCALE: N.T.S.

NOTE:

1. REQUIRE LAST 6" OF PROTECTIVE COVER OVER LINER TIE–IN LOCATION TO BE REMOVED BY HAND W/SHOVELS AND/OR BROOMS.
2. ALL LINER SYSTEMS DEPICTED ARE ALTERNATIVE LINER SYSTEMS. ALTERNATIVE LINER DEMONSTRATIONS CAN BE FOUND IN PART III, ATTACHMENT 5.



| NUMBER | REVISION | DATE | DRAWN | DESIGNED | REVIEWED |
|---|---|---|---|---|---|

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PART III, ATTACHMENT 3
PIGGY BACK LINER CONNECTION DETAILS
CITY OF KINGSVILLE LANDFILL
MSW PERMIT No. 235-C
KINGSVILLE, TEXAS
KLEBERG COUNTY, TEXAS

FIGURE: III.3-5

THE CITY OF KINGSVILLE LANDFILL

TCEQ PERMIT MSW 235C

# PERMIT AMENDMENT APPLICATION

## Volume 2 of 6

CITY OF KINGSVILLE, KLEBERG COUNTY, TEXAS

For Permitting Purposes Only

STATE OF TEXAS
JON M. REINHARD
64541
LICENSED
PROFESSIONAL ENGINEER

04/25/19

TBPE Firm No. F-417

September 2018
Revision 1 – November 2018
Revision 2 – February 2019
Revision 3 – April 2019

Prepared by

HANSON
Engineering | Planning | Allied Services

TBPE F-417

HANSON PROJECT NO. 16L0438-0003

# CITY OF KINGSVILLE LANDFILL

# PART III

# ATTACHMENT 4

GEOLOGY REPORT

THE CITY OF KINGSVILLE LANDFILL
TCEQ PERMIT MSW 235C

# PERMIT AMENDMENT APPLICATION
# PART III, ATTACHMENT 4
# GEOLOGY REPORT

CITY OF KINGSVILLE, KLEBERG COUNTY, TEXAS

September 2018
Revision 1 – November 2018
Revision 2 – February 2019
Revision 3 – April 2019

STATE OF TEXAS
TAD A. GASS
GEOLOGY
11496
LICENSED
PROFESSIONAL GEOSCIENTIST

Tad A. Gass
4/24/2019

Prepared by

HANSON
Engineering | Planning | Allied Services
TBPE F-417

HANSON PROJECT NO. 16L0438-0003

# Contents

# APPENDICES

**APPENDIX 1** – FEE GEOLOGY REPORT DATED MAY 29, 1998 AND JUNE 29, 1998, AND REVISED SEPTEMBER 30, 1998, WITH APPENDICES FEE GROUNDWATER CHARACTERIZATION REPORT DATED NOVEMBER 1997, REVISED JUNE 1998 AND SEPTEMBER 1998, WITH APPENDICES

**Appendix 1 Contents**

**Finch Energy and Environmental Services, Inc.**
**Geology Report**

**Appendices**

**Finch Energy and Environmental Services, Inc.**

**Groundwater Characterization Report**



**TABLES**



**FIGURES**

**APPENDICES**



**APPENDIX 2** – TOLUNAY-WONG ENGINEERS, INC. GEOTECHNICAL ENGINEERING STUDY

**Appendix 2 Contents**

**TABLES**



**APPENDICES**



**APPENDIX 3** – HANSON PROFESSIONAL SERVICES, INC. SOIL BORING REPORT

**Appendix 3 Contents**

**EXHIBITS**



# ATTACHMENTS



# LIST OF TABLES



*I:\16jobs\16L0438\8514-City of Kingsville\8514-03\Permit Amendment\NODs\Technical NOD #1\Part III\Part III, Attachment 4\Part III_att4 - Geology Report - R2 Cln.docx*

# 1.0 INTRODUCTION

## 1.1 Project Information

The City of Kingsville Landfill is located approximately 1.45 miles southeast of the City of Kingsville city limits, at the northeast corner of the intersection of Farm to Market Road 2619 and East County Road 2130 as shown on Attachment 1- Location Map (Figure III.4-1-1). The initial facility was permitted by the State of Texas in 1977 (Permit No. 235), and initial filling operations began in February 1977. The original 40 acre landfill is currently closed and is not Subtitle D compliant. The City of Kingsville was authorized a permit amendment for a 40-acre lateral landfill expansion of the site in 1986 (Permit No. 235-A). The approved Permit No. 235-A was developed and Sector 1 received its first load of waste material in March 1992. The City of Kingsville was again authorized a permit amendment in 1999 (Permit No. 235-B). This amendment increased the permitted acreage from 80 acres to approximately 120 acres and a maximum height of final cover of 125 feet-msl. The Kingsville Landfill is currently operating under Permit No. 235-B and subsequent permit modifications and/or authorizations.

The City of Kingsville Landfill is currently comprised of 120 acres. The City of Kingsville wishes to increase the capacity of the landfill site via a vertical and horizontal expansion through a permit amendment. The proposed permit amendment will increase the total permitted area to 176.33 acres. This will be accomplished by incorporating additional acreage to the northeast and southwest of the current permitted boundary. The existing active 108-acre waste disposal area will be expanded to a total of 121.3-acres. Other parts of this permit amendment are to; convert the current Type IV waste sector to accept Type I waste, request approval to process and dispose of liquid wastes and used tires, and to revise the floor contour and final contour plans to incorporate the vertical and horizontal expansion previously discussed.

## 1.2 Scope of Investigation

The purpose of this study is to provide geological and geotechnical data for the design of the city of Kingsville Landfill. The scope of services included reviewing previous subsurface studies, summarizing the engineering properties of the subsurface materials and determining certain geotechnical design criteria such as estimated settlement and future slope stability.

## 1.3 Previous Subsurface Investigations

Previous subsurface investigations were conducted for the City of Kingsville Landfill to characterize subsurface conditions and assist with the development of landfill disposal cell designs. The previous testing and soils exploration work was performed by:

- Finch Energy and Environmental Services, Inc. (FEE)
- and Professional Service Industries, Inc. (PSI).

These reports are included in Appendix 1. A total of 23 soil borings were installed at this site at varying depths and testing intervals during these previous investigations. Finch Energy and Environmental Services, Inc. conducted an investigation of subsurface materials at the Landfill location. Twelve (12) soil borings were installed and sampled. Laboratory tests were performed to determine the engineering properties of the subsurface materials. The report discussed the soils, sediments, and geologic and groundwater conditions encountered by FEE, Inc. during the hydrogeological/geotechnical investigations at the City of Kingsville Landfill. The report also discussed the characteristics of the soil samples collected and tested during the investigation.

As requested by the Texas Natural Resource Conservation Commission (TNRCC) in an NOD letter, Professional Service Industries, Inc. also conducted a subsurface investigation for FEE, Inc. and the City of Kingsville to evaluate the soil and groundwater conditions present at the site and to better define the aquiclude below the landfill site. A total of eleven (11) soil test borings were drilled and laboratory tests were performed to determine the engineering properties of the subsurface materials. This additional study discussed the types of subsurface materials encountered in the test borings and the results of the field and other laboratory tests performed for this site.

## 1.4 Current Subsurface Investigation

As previously identified, the proposed permit boundary for this facility will incorporate 176 acres of land with 128 acres being utilized for waste disposal. In accordance with 30 TAC 330.63 (e)(4)(B), a facility of this size requires 23-26 borings with 13-15 of these borings being installed at least 30 feet below the elevation of deepest excavation (EDE) and the remainder of the borings being installed at least 5 feet below the EDE. Before this subsurface investigation, there were fifteen (15) borings that were installed at least 5 feet below the EDE and four (4) of those borings were installed at least 30 feet below the EDE.

For this investigation, nine (9) soil borings were advanced to a minimum depth of 30 feet below the elevation of the deepest excavation of 22.5 ft and one (1) additional soil boring was advanced to 5 feet below the elevation of the deepest excavation to supplement the existing facility data. The borings were drilled in the locations identified on Attachment 2- Soil Boring Location Map (Figure III.4-2-1). Attachment 2 also identifies the locations of the previously installed soil borings. Attachment 3- Groundwater Contour Map (Figure III.4-3-1) identifies groundwater elevations in addition to the current groundwater monitoring system.

The soil borings for the current subsurface investigation were installed by Tolunay-Wong Engineers, Inc. Representative samples were collected with split-barrel sampling procedures in general accordance with the procedures for "Penetration Test and Split-Barrel Sampling of Soils" (ASTM Designation D-1586) and Standard Practice for Thin-Walled Tube Sampling of Soils for Geotechnical Purposes (ASTM Designation D-1587). Borings were dry-augered using hollow stem augers to advance the boreholes until groundwater was encountered or until the boreholes became unstable and/or collapsed. Wash rotary drilling techniques were used as necessary in order to continue advancing the borings to their required completion depths. No borings collapsed during this investigation. Samples were identified according to boring number and depth, protected against moisture loss, and transported to the laboratory for analysis. After obtaining all required soil samples and groundwater level readings, the soil borings were properly plugged and abandoned in accordance with 16 TAC Chapter 76, Texas Department of Licensing and Regulation (TDLR)-Water Well Drillers and Pump Installers rules. Table 1-1 below identifies specific details for both existing and newly installed soil borings. For this investigation, borings B30 through B41 were installed. These borings were advanced to depths ranging from 33.5 to 86 feet beneath the existing ground surface. Tolunay-Wong Engineers, Inc. prepared a Geotechnical Engineering Study Report that is provided in Appendix 2. Hanson Professional Services also prepared a soil boring report that has been included as Appendix 3.

**Table 1-1**
**Soil Borings**

| Boring Identification | Surface Elevation (ft. AMSL) | Boring Depth (ft. bgs) | Bottom Elevation (ft. AMSL) | ≥5 Feet Below E.D.E? | ≥30 Feet Below E.D.E? |
|---|---|---|---|---|---|
| Finch Energy and Environmental Services, Inc. Borings | | | | | |
| B-1 | 59.25 | 42 | 17.25 | YES | NO |
| B-2 | 52.64 | 27 | 25.64 | NO | NO |
| B-3 | 56.1 | 37 | 19.1 | NO | NO |
| B-4 | 58.01 | 39 | 19.01 | NO | NO |
| B-5 | 60.54 | 48 | 12.54 | YES | NO |
| B-6 | 55.46 | 38 | 17.46 | YES | NO |
| B-7 | 61.05 | 36 | 25.05 | NO | NO |
| B-8 | 59.79 | 43 | 16.79 | YES | NO |
| B-9 | 62.51 | 44 | 18.51 | NO | NO |
| B-9R | 41.41 | 17 | 24.41 | NO | NO |
| B-10 | 49.78 | 29 | 20.78 | NO | NO |
| B-11 | 60.2 | 33 | 27.2 | NO | NO |
| Professional Service Industries, Inc. Borings | | | | | |
| B-12 | 52.38 | 48 | 4.38 | YES | NO |
| B-13 | 59.13 | 50 | 9.13 | YES | NO |
| B-14 | 49.94 | 42 | 7.94 | YES | NO |
| B-15 | 48.39 | 37 | 11.39 | YES | NO |
| B-16 | 55.96 | 47 | 8.96 | YES | NO |
| B-17 | 41.35 | 33 | 8.35 | YES | NO |
| B-18 | 50.04 | 42 | 8.04 | YES | NO |
| B-21 | 52.41 | 84 | -31.59 | YES | YES |
| B-23 | 49.5 | 86 | -36.5 | YES | YES |
| B-24 | 47.38 | 72 | -24.62 | YES | YES |
| B-25 | 61.12 | 88 | -26.88 | YES | YES |
| Tolunay-Wong Engineers, Inc. Borings | | | | | |
| B-30 | 45.99 | 82.5 | -36.51 | YES | YES |
| B-31 | 58.37 | 68 | -9.63 | YES | YES |
| B-32 | 48.46 | 82.5 | -34.04 | YES | YES |
| B-33 | 64.51 | 86 | -21.49 | YES | YES |
| B-34 | 61.14 | 43 | 18.14 | NO | NO |
| B-35 | 64.5 | 72.5 | -8 | YES | YES |
| B-36 | 59.13 | 68 | -8.87 | YES | YES |
| B-37 | 45.52 | 48 | -2.48 | YES | NO |

| Boring Identification | Surface Elevation (ft. AMSL) | Boring Depth (ft. bgs) | Bottom Elevation (ft. AMSL) | ≥5 Feet Below E.D.E? | ≥30 Feet Below E.D.E? |
|---|---|---|---|---|---|
| B-38 | 41.64 | 58 | -16.36 | YES | YES |
| B-39 | 60.26 | 68 | -7.74 | YES | YES |
| B-40 | 52.31 | 33.5 | 18.81 | NO | NO |
| B-41 | 50.2 | 62.5 | -12.3 | YES | YES |

E.D.E.-Elevation of Deepest Excavation (22.5' Above Mean Sea Level (AMSL))

Locations of borings B-32, B-33, B-34, B-35, B-38 and B-40 deviated from locations specified in the soil boring plan due to boring locations being unknowingly moved from original locations during installation. These deviations were identified when the boring locations were surveyed. The distance of boring location deviation varied from approximately 90 feet in B-35 to approximately 440 feet in B-33. With the information obtained during previous subsurface investigations, these discrepancies did not affect the ability to obtain the needed information identified in 30 TAC §330.63(e)(4)(A).

Borings B-34 and B-40 were not drilled to 5 foot below EDE due to the boring locations being unknowingly moved from the original locations during installation. Boring B-34 was 0.64 feet short of 5 foot below EDE and B-40 was 1.31 feet short of 5 foot below EDE. Although these borings were not drilled to the target depth, the information obtained from these borings is useful in characterizing the subsurface conditions at the facility and was used for that purpose. Other borings installed at the site in conjunction with the current subsurface investigation are adequate in meeting the requirements identified in 30 TAC §330.63(e)(4)(B).

# 2.0 REGIONAL INFORMATION

## 2.1 Regional Physiography

As discussed in Finch Energy and Environmental Services' Report (Appendix 1, Section 2.0, Page 11-12), the site of the landfill is located in the part of the Gulf Coastal Plain that has been defined as the Coastal Bend of Texas. The coastal plain is gently, but irregularly, inclined gulfward at about 5 feet or less per mile. In many areas, coastal plain slopes range from 1 to 3 feet per mile, and on the lagoonal wind-tidal flats, slopes are usually less than 1 foot per mile. Elevations within the county range from 0 feet (Gulf of Mexico) to 125 feet above Mean Seal Level (MSL) in the extreme northwestern part. It is characterized as an arid, desert like region where wind (Eolian) erosion and wind transported sediment have determined much of the area's character and distinctiveness. The surface features of the county are broad, dune covered mainland prairies and extensive coastal wind-tidal flats.

Eolian transport of silts and sands has produced the South Texas Eolian System (Sand Sheet). Extensive, hummocky prairies within the South Texas sand sheet are underlain by relic sand dunes and wind-deflated depressions which extend inland from broad wind-tidal flats along the landward margin of Laguna Madre and parts of Baffin Bay.

## 2.2 Regional Stratigraphy

Table 2-1 presents the geologic formations that characterize the regional stratigraphy of Kleberg County.

# ATTACHMENT 4

## Geology Report

For Permitting Purposes Only. Applies to pages of Attachment 4 – Finch Energy & Environmental Services, Inc. Geology Report, sealed by Ray N. Finch, P.E. on 6-26-98 and 9-30-98 altered to provide a clean and legible copy and includes pages: 3, 3.0 Cover Page, 8, 9, 15 - 17,22 - 25, 29 – 30, 33 - 35, 39 - 46, 48 – 60, 60a, 62 - 98, 100 - 101, 104, 108 – 109, D-32 - D-46 and K-1 – K-12. No information or data was altered or changed from the original 6-26-98 and 9-30-98 Geology Report other than text scale corrections on pages 48-60. Bar scales were also added to pages 48-60.

STATE OF TEXAS
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GEOLOGY
11496
LICENSED
PROFESSIONAL GEOSCIENTIST

Tad A. Gass
4/24/2019

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## 2.0 REGIONAL PHYSIOGRAPHY AND TOPOGRAPHY

The Kingsville MSWLF is located within the part of the Gulf Coastal Plain that has been defined as the Coastal Bend of Texas. (See Figure 4.2) The coastal plain is gently, but irregularly, inclined gulfward at about 5 feet or less per mile. In many areas, coastal plain slopes range from 1 to 3 feet per mile, and on the lagoonal wind-tidal flats, slopes are usually less than 1 foot per mile. Elevations within the county range from 0 feet (Gulf of Mexico) to 125 feet above Mean Seal Level (MSL) in the extreme northwestern part. It is characterized as an arid, desert like region where wind (Eolian) erosion and wind-transported sediment have determined much of the area's character and distinctiveness. The surface features of the county are broad, dune covered mainland prairies and extensive coastal wind-tidal flats. The climate is one of low rainfall, high evaporation, and persistent onshore winds.

Eolian transport of silts and sands has produced the South Texas Eolian system (sand sheet). Extensive, hummocky prairies within the South Texas sand sheet are underlain by relic sand dunes and wind-deflated depressions which extend inland from broad wind-tidal flats along the landward margin of Laguna Madre and parts of Baffin Bay.

Live-oak mottes, stands of brushland, and active sand dunes break the widespread sandy prairies of the Kingsville area into many local, discontinuous patches of rangeland. A few small ephemeral streams, that extend coastward across the northern and northwestern parts of the area, discharge into Baffin Bay.

In a broad area southwest of Santa Gertrudis Creek and Cayo del Grullo, mud and sand substrates are veneered by relatively thin airborne silt (loess) deposits that have settled out downwind from the large dune fields southeast of Sarita. The silt, or loess, sheet overlies muddy sediments between U.S. Highway 77 and Cayo del Grullo and sandy and silty deposits west of U.S. Highway 77. (Brown, 1977)

The Santa Gertrudis Creek, located 0.7 miles to the north, trends to the east-southeast 3.25 miles to it's confluence with the San Fernando Creek which then flows southeast to the Cayo del Grullo of Baffin Bay. Jaboncillos Creek, Ebanito Creek and several small unnamed ephemeral streams, are located several miles south of the site. (See Figure 4.3)

Standing water several feet deep is present on the floor of the abandoned caliche mines to the west and southwest. These mines were excavated to a depth of approximately forty feet. This would place the mine floor in proximity to ground water level. The standing water has continued to be present throughout the extended drought period of the past 2-3 years. The USGS topographic map of the area indicates that these pits are considered permanent water bodies. A more complete discussion of the impacts of these local depressions on groundwater is given in Section 6.2.3.

# 3.0 REGIONAL GEOLOGY AND HYDROLOGY

During Pleistocene time, large streams eroded large amounts of sand, gravel, clay, and silt from the upland areas. These clastic sediments were deposited by streams meandering across the nearly featureless coastal plain. Sand beds are lenticular grading rapidly both horizontally and vertically into clay or silt within short distances. These deposits slope to the east at about 25 feet per mile. The thickness of the unit ranges from 100 feet in parts of Jim Wells County where the base of the unit is nearest land surface to approximately 1,400 feet in far eastern Kleberg and Kenedy Counties. The formations consist mostly of very calcareous, slightly carbonaceous, blue and yellow clay, and a few lenticular beds of sand. Many of the sand beds, especially those near the surface, are fine to very fine grained. Calcareous nodules and disseminated caliche are common in the shallow part of the section. The group yields small quantities of slightly to moderately saline water to a few shallow wells used mostly for stock needs in eastern Kleberg and Kenedy Counties. (Shafer, 1973)

The South Texas Eolian system is of Modern, Holocene, and Pleistocene age according to the Environmental Geologic Atlas of the Texas Coastal Zone - Kingsville Area. The landfill site is situated within the Riviera loess sheet to the east of U.S. Highway 77 and southeast of Kingsville. The Riviera loess sheet is characterized as a thin, discontinuous loess sheet composed of airborne silt derived from upwind areas of wind deflation. East of U.S. Highway 77, the loess overlies flat Pleistocene delta-plain deposits composed principally of mud with localized elongate sand and silt bodies (Beaumont Clay). The Riviera loess sheet varies in thickness from a few inches to several feet; locally the loess is absent and Pleistocene deposits are exposed at the surface. The loess and underlying Pleistocene deposits, especially the sands, are extensively calichified. This formation is of minor importance in the site area (Brown, 1977). (See Figure 4.7)

### 3.2.1 Regional Soils

The Environmental Geologic Atlas - Kingsville Area indicates that the soils in the area of the landfill site are of two types: Type II and Type IX. (See Figure 4.7) The predominant soil group is Group IX which is described as clay -sand dunes and dune complexes, active and inactive, sparsely and heavily vegetated respectively. Older vegetated dune complexes have a higher sand and caliche content. Currently active dunes are high in clay content. Type II soil group is defined as dominantly sand, high to very high permeability and drainage, moderate water-holding capacity, low to moderate compressibility and shrink-swell potential. The Atlas also points out in Table 6 that these types of soils may have problems as solid waste disposal areas. However, the use of geosynthetic clay liner as replacement for higher permeability soils addresses this problem.

The Texas Coastal Basins Cooperative River Basin Survey Plate 4-5 indicates that the soils at the landfill site are type 3-V described as Victoria-Orelia-Clareville group. These are described as cracking clay soils; soils with loamy surface layers underlain by cracking clayey layers and soils loamy throughout, some of which are compact beneath the surface layer.

The soil in the area of the landfill site is defined the be Czar-Delfina-Orelia according to the General Soil Map of Kleberg County, Texas prepared by the Soil Conservation Service. This soil group is described as "somewhat poorly to well drained loamy fine sands, fine sandy loams and sandy clay loams that have moderately to very slowly permeable lower layers with low and moderate shrink-swell potentials. This unit consists of about 35 percent Czar soils, 30 percent Delfina soils, 20 percent Orelia soils, and 15 percent other soils. The detailed description of these soils is given in Appendix O. This same source states that the Czar soils have slight limitations for area type sanitary landfills but are so minor they are easily overcome. The Czar soil is good for daily landfill cover. The Delfina soil has the same rating (slight) for area type sanitary landfills as Czar soils. The use of Delfina soil for landfill cover varies from good to fair. The Orelia soil has a moderate rating for area type landfills which means that limitations can be overcome or modified. The Orelia soil has fair use as landfill cover.

Consultation with the local USDA Soil Conversation Office produced a specific aerial photograph soils map of the area. This map defines the caliche pits as just that. The soils surrounding the remainder of the site are of four types: Hidlago fine sandy loam, Racombes sandy clay loam, Runge fine sandy loam, and Willacy fine sandy loam. The description of these soils from the National Soils database at Iowa State University are attached in Appendix O.

The geologic description of the site surface and subsurface described in sections 6 and 8 confirm that the site has a major caliche bearing channel, a discontinuous sand filled channel, and two clay dunes. Thus, the soils description from the Environmental Geologic Atlas, the Kleberg County Soils Map and the local SCS describe the site soils best.

## 3.3 Active Geologic Processes

### 3.3.1 Faults and Faulting

The site is located on the west flank, southwest quadrant, of the Kingsville Dome, an Area of post Late Miocene (<8 m.y.b.p.) uplift which is the largest isolated, positive structure in Kleberg County. The uplift influences an area of approximately 50 square miles. Although origin of the uplift is unknown it is attributed to deep seated diapiric shale or salt movement. The overall paucity of oil and gas production on the Dome is due to late uplift and resulting late trap formation. Possible destruction of any pre Miocene hydrocarbon traps could have also occurred. Past and current oil and gas production has been obtained from sands within the Oligocene age Frio and Miocene age Oakville formations. Productive reservoirs are highly compartmentalized by faulting. Two primary fault zones divide the Dome into quadrants.

a.) Northeast striking regional Frio, down to the coast, growth fault buried below the Oakville formation, and

b.) West-Northwest striking post Miocene Santa Gertrudis Fault zone, down to the South-Southwest with associated, up to the north northeast, relief faults.

An updip projection of the regional Frio growth fault passes below the landfill site at approximate depths of 6,000 to 7,000 feet, but the fault is buried below the Miocene age Oakville formation and therefore does not influence shallower beds. Updip projections of the Santa Gertrudis fault system are located north of and not in the vicinity of the landfill site. Beds as recent as the Goliad sand are influenced by uplift but it is unknown as to whether Santa Gertrudis faulting penetrates this high in the section. It is believed that the Late Miocene uplift and associated Santa Gertrudis faults predate deposition of the Pleistocene Beaumont and Lissie formations. The Pleistocene beds exhibit northeast dip in the landfill site vicinity (Structure Map, Top LT. Olive Green Clay) whereas deeper Miocene and Oligocene beds exhibit west to southwest dips due to uplift.

An evaluation of potential faults or fault zones does not indicate the presence of active faults. Topographic Maps, literature searches, aerial photographs, Petroleum Industry maps and a field survey were used in this evaluation. The field survey combined with topographic maps did not reveal structural damage to buildings, ground scarps, or unusual surface depressions. Changes in drainage or vegetation patterns which are also associated with faulting were not present.

A surface lineament passing through the site was noted on the Physical Properties map in the Kingsville Volume of Environmental Geologic Atlas of the Texas coastal Zone. (See Figure 4.7, Lineament Labeled A) No surface expression of faulting as related to this lineament is noted. Improved copies of Figures 4.8 & 4.9 could not be located.

Electric logs the oil and gas wells drilled in the immediate area are not recorded to

Ground surface. Electronic logs of two uranium wells were located and obtained from URI, Inc.'s Kingsville office. The location of these wells are noted on the Cross section map and subsurface maps submitted with this revised report.

### 3.3.2 Subsidence and Unstable Areas

Site specific soil conditions which might result in differential compaction are not evident. A 2' to 2.5' topsoil and loess cover is present in the current agricultural area and the unmined areas. Below, the topsoil, is a firm to very hard clay. This clay is described as silty, calcified, with caliche, and is uniform in character throughout the site.

A field investigation did not reveal any geologic or geomorphologic features which might affect the soil stability. On site are an office and scale house, and maintenance facilities. Off site (within a one (1) mile radius) are 41 residences and agricultural buildings. All buildings are one-story in design.

An off-site field investigation of the petroleum producing areas did not reveal any major storage, processing or secondary recover facilities which could affect site stability at the surface or at depth.

Subsidence at the site does not appear to be a problem. The settlement analysis in Appendix H indicates a maximum settling of 3.0 inches at the center of the landfill and 1.5 inches at the edges. The maximum stress when the landfill is completely filled is between 1.25 to 1.50 tons per square foot. Unconfined compressive strength is typically 3.0 to 5.0 tons per square foot. Typical strain of less than 1% is encountered when compressive stress is 1.5 tons per square foot. Therefore, subsidence does not appear to be a problem. Some localized sand channels will have to be replaced during construction.

### 3.3.3 Erosion

Based on soil types and character, and topography, erosion does not appear to be a significant factor under "normal conditions" or if design criteria are met and maintained. The soils data found in the references given in Section 3.2.1 above say very little about erosion potential. However, it is obvious that sandy soils will tend to become airborne with sufficient velocity. It is therefore important that the cap for the landfill be immediately covered, compacted and vegetated. The length of the rainfall run-off on slopes has been addressed by breaking up the long runs on the cap with diversionary berms. Thus, active cap cover and maintenance will minimize erosion from the site. However, in a situation of torrential rains associated with tropical storms or hurricanes erosion may be significant in local areas and for a limited time frame.

Although cultivated agricultural lands may tend to undergo some erosion with sandy types of soils, pasture lands or other vegetated soils greatly reduce the potential to erode. The land fill soils for capping will be compacted and/or vegetated of both to minimize erosion. The final cover for the landfill will be well capped and diversionary berms for water flow control on long slopes will be used.

#### 3.3.4 Seismic Impact Zones

Data presented by Algermissen, et al, 1990 suggests a low probability of major seismic activity in the vicinity of the site. (See Figure 4.9)

### 3.4 Wetlands

A representative from the U.S. Army Corps of Engineers has visited the site. The U.S. Army Corps of Engineers has concluded that there are no wetlands on the COK MSWLF site. (See Figure 4.10)

## 4.0 Regional Aquifers

The Evangeline Aquifer is the principal aquifer in the region and is considered one of the most prolific aquifers in the Texas Coastal Plain. The aquifer is composed of at least the Goliad Sand and includes sections of sand in the Fleming Formation. Only in South Texas the base of the Evangeline coincides with the base of the Goliad. The upper boundary of the Evangeline probably follows closely the top of the Goliad Sand where present, but this relationship is somewhat speculative (Muller, 1979). (See Figure 4.11) Ground water flow direction in the Evangeline is in a Northerly direction based on a water level map of the Goliad sand. There are two very significant cones of depression in the Evangeline (Goliad) aquifer located to the northwest of the City of Kingsville MSWLF site. These depressions are primarily due to large groundwater production rates by the City of Kingsville and the Exxon King Ranch Gas Plant. The extent of salt water intrusion from the Gulf of Mexico into the Evangeline (Goliad) aquifer is shown on Figure 4.16.

The Goliad consists of fine to coarse, mostly gray calcareous sand interbedded with sandstone and varicolored clay. Recharge within the site area occurs along the outcrop which is located in western Hidalgo, central-eastern Starr, central Jim Hogg, Duval, southeastern Webb, northeastern Brooks, northern Jim Wells, and extreme northeast Zapata counties, as well as other counties to the north. The maximum width of the outcrop is west of Falfurrias where the Goliad Sand extends for nearly 50 miles at the surface and completely overlaps the underlying Lagarto Clay and Oakville Sandstone and nearly overlaps the Catahoula Tuff (Shafer, 1973). (See Figure 4.12)

The water of the Goliad is under artesian pressure and is yielded to flowing and nonflowing wells. The average coefficient of transmissibility determined during drawdown of the fresh to slightly saline water section of the Goliad Sand in southwestern Kleberg County measured in well no. RR-83-41-803, was about 34,400 gpd per foot. The specific capacity of the well was 17.8 gpm per foot. This was derived from a screened interval of 126 feet near the north boundary of Kenedy and south boundary of Kleberg Counties.

Fresh water of domestic use quality in the Evangeline is found in well developed sands at depths of 500 feet and greater in the MSWLF area. From surface to the fresh water sands in the Evangeline the lithology is predominately a clay described as silty, calcareous, firm to hard with occasionally silty sands.

The regional Chicot aquifer lies approximately 220 feet below ground surface in the vicinity of the MSWLF according to two deep well logs obtained from a local mineral company. (see Section 4.2) The Light Olive Green Clay layer serves as aquiclude between the uppermost aquifer below the landfill site and the Chicot aquifer. The Kleberg County, and specifically the MSWLF, the waters from the Chicot aquifer are generally slightly-saline to saline and yield only marginal quantities of water.

The local unconfined water table aquifer tends to flow in all directions away from the landfill site. The only exception is that for a period of time after excessive rainfall events, groundwater in this local uppermost aquifer tends to flow toward the site from the northwest. This determination is based on water levels recorded in wells completed for use in the current expansion phase. However, the largest gradients for ground water flow are in the northeast and southwest directions. The flow toward the southwest is along a caliche channel which slopes to the southwest toward some lower elevation caliche pits. The flow toward the northeast is toward the Santa Gertrudis creek. However, the ground water tends to flow through some fairly tight clay in that direction. The high point of ground water at the MSWLF site is at least partially a following of the surface topography and influenced by direct recharge from any ponding which is not promptly removed. Attachment 5, Appendix E gives a more thorough analysis of ground water direction and rate of ground water flow.

The initial interpretation, based on available data and monitor well density and location, indicated a predominate flow to the north or west. Completion of monitor and observation wells in the current expansion program indicate a northeast flow direction. Later analysis shows that ground water flows slowly away from MSWLF in all directions. This is based on measurements of the top of the saturated zone as evidence by water levels in wells. The initial flow direction determined by REI when the landfill was started was toward the northeast.

### 4.1 Water Quality

The water quality of the Goliad is highly variable. Chloride contents in the wells sampled ranged from 94 to 9,100 mg/l, exceeding 250 mg/l in 60% of the samples. Sulfate content ranged from 26 to 4,630 mg/l. In Kleberg County, 33% of the samples exceeded 250 mg/l sulfate. Dissolved-solids content ranged from 601 to 49,900 mg/l. Over 75% exceeded 1,000 mg/l dissolved-solids. In summary, ground water that meets most of the quality standards of the U.S. Public Health Service is available from wells less than 1,000 feet deep in the Goliad Sand, Principally in southern Jim Wells County, the western one-half of Kleberg County, and in a few other relatively small areas throughout the report area. Shallow, moderately saline to very saline water overlies the fresh to slightly saline water at most places (Shafer, 1973). (See Figure 4.13)

The Beaumont Clay and Lissie Formation, undifferentiated, (Chicot Aquifer) yields small quantities of slightly to moderately saline water to a few shallow wells used mostly for stock needs in eastern Kleberg and Kenedy Counties. Test wells drilled near Riviera, 15 miles south of Kingsville, in southern Kleberg County show that in this area the shallow sands of the Beaumont and Lissie (Chicot) usually contain very saline water. This group is not considered a supply of useable water because of the highly mineralized water associated with formations in most places. The casings of many wells are cemented through these formations. (Shafer, 1973)

Water held in the Beaumont Clay and Lissie Formation, undifferentiated, (Chicot) is under water-table (unconfined) conditions. There were no recoverable aquifer tests from reference material on this formation as it occurs in the area of the site. This formation is not recognized as a useable source of ground water.

Historical ground water monitoring from in-place monitor wells indicates that the sulfates range approximately from 45 to 500 mg/l, chlorides from approximately 50 to 500 mg/l, and dissolved-solids from approximately 500 to 6,000 mg/l. Values of pH have consistently ranged between 7.00 and 8.00. More detailed analytical data from the ground water monitor wells at the site is given in Table 5.1 in Attachment 5.

## 4.2 Hydraulic Connection

No hydraulic connection was found between the uppermost fluvial-deltaic beds which will host the MSWLF and the deeper Chicot and Evangeline (Goliad) aquifers.

Deep elevations prepared from water well data located in the vicinity show that the Chicot aquifer is located approximately 200 feet below ground surface in the MSWLF vicinity. The data is confirmed by electric logs from two (2) deep uranium tests located on the southeast side and adjacent to the MSWLF acreage block (URI, Inc. well nos. 2001 & 2016). These wells exhibit the top of the main Chicot sand body at depths of 220 & 225' of measured depth, respectively. The top of the deeper Evangeline (Goliad) sands are found at approximately 500' MD. A confining clay, at the base of the fluvial-deltaic section which will host the MSWLF, is indicated in both URI wells to depths of 120' and 130' respectively. In addition, four deep borings (wells 21, 23, 24, 25) at the MSWLF confirm that the "light olive green clay" is ubiquitous under the site with a minimum proven thickness of 38'.

TABLE 4.2.1

| WELL # | ELEVATION (feet) | TOTAL DEPTH (feet) | TOP LT OLIVE GRN CLAY (ft.,+M.S.L.) | FOOTAGE OF CLAY |
|---|---|---|---|---|
| 21 | 52.4 | 84 | +6.4 | 38 |
| 23 | 49.5 | 86 | +13.5 | 38 |
| 24 | 47.4 | 72 | +15.4 | 40 |
| 25 | 61.1 | 88 | +11.1 | 38 |

The "light olive green clay" is the aquiclude for the MSWLF facility.

### 4.3 Recharge

Recharge within a 5 mile radius is from downward percolation of surface water, infiltration from streams. impoundments and water retained in abandoned caliche pits. (Figure 4.14) Flow Through the soils is very slow.

### 4.4 Water Use

A survey of, and for, water wells within a 1 mile radius of the MSWLF site was prepared by Agency Information Consultants (AIC). All known water wells within the survey area produce water for domestic use from the Evangeline Aquifer (Goliad Sand). Thirty one wells were identified in the survey area. (See Figure 4.15) Depth to the top of the perforated or screened interval varies from 524 feet to 726 feet, with an average depth of 621 feet. (See Figure 4.12 & 4.13) There are no known water wells completed in the Chicot aquifer for potable water. There are a few stock wells. The water from the Chicot is mostly very saline. This salinity causes casing corrosion problems with the good fresh water wells in the Goliad aquifer unless they are cemented properly through the Chicot.

seeps, ponds). No seeps were noted on-site.

## 5.3 Drilling and Soil Sampling

F.E.E geologists provided technical oversight of all drilling and sampling activities. This section describes subsurface exploration procedures performed during the hydrogeological/geotechnical investigation activities.

### 5.3.1 Soil Borings

The field portion of this hydrogeological/geotechnical investigation consisted of the drilling and sampling of seven (7) geotechnical borings to assess subsurface hydrogeological and geotechnical conditions of the underlying materials. All soil borings were completed in accordance with the Soil Boring Plan approved by TNRCC in a letter dated June 4, 1997, (see Appendix A).

An original program of 12 borings was proposed and approved, with a stipulation that seven borings be completed initially. Upon completion of the initial seven borings the homogeneity of the sediments was demonstrated. This data was submitted to TNRCC, (see Appendix A), in the form of geological cross sections. Consequently, the remaining five borings were not being required at that time (see Appendix A). Five of these wells were subsequently completed as Monitor Wells. All borings were completed to a depth approximately 10 feet above MSL. Nine other previous soil borings were available to assist in the subsurface investigation. The completions will be discussed in the Ground Water Characterization Section. The location of these borings (as well as previous borings drilled at the site) are presented on Figure 4.17. In April, 1998 four (4) deeper soil borings were completed to better define the aquiclude below the landfill site per TNRCC's NOD letter. These deeper borings were drilled to varying depths between 72 feet and 88 feet below ground surface (BGS), Core samples were taken from these deep borings at two (2) foot intervals.

Professional Services, Inc (PSI), a F.E.E. drilling subcontractor, drilled the borings utilizing 4.25" I.D. hollow-stem auger during July, 1997. The subcontractor advanced the borings until target depths, or specific lithologic zone, were encountered. Borings were completed using a CME-75 Hollow System Auger rig. The CME-75 system uses a 5 foot long core barrel which recovers 3 inch diameter cores from a 10 inch boring.

In one well (completed as MW 16) zone of highly calcified sandy clay was encountered. Drilling time with auger methods was very slow and the interval was drilled using the split spoon. No commercial additives were used in the boring operation.

Water for mixing grout was obtained on site and supplied by the City of Kingsville from a South Texas Water Authority connection. Installation and plugging of the borings were in accordance with current rules and prudent operational procedures. Documentation of this work has been submitted.

Subsurface soil and sediment core samples were collected from each soil boring on a continuous basis to a depth of approximately 30 beet below expected base grades (or approximately 50 feet below ground surface) and on 5-foot centers, thereafter, for lithologic classification and selection of geotechnical laboratory samples for potential analyses. Depths of the borings vary from +4.83 MSL to +11.38 feet MSL with on average of +8.37 feet MSL. The proposed depth of excavation is +40.00 feet MSL. This meets the stipulation of all borings being 5 feet deeper than the deepest excavation and also the 30 feet depth requirement. Core samples were collected using either a split spoon for unconsolidated samples or a 3-inch outside diameter (O.D.) Shelby tube for undisturbed samples of cohesive material. Upon sample retrieval, each core was classified as described in Section 5.3.2 below. Each sample was labeled (at a minimum) with the following information: project name; boring number; and sample depth range.

The geologist or geotechnical engineer sealed the soil core samples with plastic wrap, and plastic bags, then placed them in protective crates for transport to the laboratory. The geologist or geotechnical engineer also sealed the samples of cohesionless materials in plastic bags, and packaged them in protective crates for transport to the laboratory.(Hand drawn field logs will be supplied separately.)

### 5.3.2 Classification and Logging of Soils

The F.E.E., Inc. geologist or geotechnical engineer visually classified the samples in the field in accordance with ASTM D2487 and D2488 (Standard Practice for Description and Identification of Soils, Visual-Manual Procedure) and used field soil borehole forms to record soil classification at each boring location. The borehole forms included additional information such as ground surface elevation, north and east coordinates, surface conditions, ground water elevation, driller's name, and the make of the drilling rig. The geologist or geotechnical engineer later checked the accuracy, consistency, and format. The soil borehole logs prepared as part of this investigation are included within Appendix B.

## 5.4 Piezometer Installation and Development

A total of 7 piezometers (B-12 through B-18) were constructed during the July, 1997 phase of this investigation to evaluate the water-bearing strata underlying the site. All but B-17 and B-18 were converted to groundwater monitoring wells. During the April, 1998 phase of this investigation four more borings (B-21, 23, 24, and 25) were completed. These borings well all grouted upon completion, except 24 which was made into a monitor well. Appendix C includes detailed Piezometer Construction Summaries. The following sections describe piezometer installation and development protocols utilized during the investigation. Texas Water Well Driller's Reports for Borings B-12 through B-18, B-21, B-23, B-24, and B-25 are shown in Appendix K.

### 5.4.1 Piezometer Installation

All piezometers were constructed using new, 2" I.D. (B-17 and B-18) or 4" I.D., Schedule 40, flush-threaded polyvinyl chloride (PVC) well risers, 5 or 10-foot screens, bottom plugs, and fittings. Five piezometers, B-12 through B-16, were converted to groundwater monitoring wells. Later, in April, 1998 soil boring 24 was made into a monitor well. Each piezometer was fitted with a vented top-end cap and all the joints were screwed together with O-rings (no glue was used). centralizers were also installed that were made of inert material compatible with the casing on piezometers. Riser lengths ranged between 2.5 and 3.0 feet above ground surface. The geologist or geotechnical engineer measured each piezometer's screen and riser lengths to the nearest 0.01 foot and recorded all the information pertaining the construction of each piezometer on a Piezometer Construction Summary form prior to installation.

The sand filter pack consisted of washed and pre-graded 20/40 sand (95% minimum silica and visibly free of dust, mica, and organic matter), and extended from the bottom of the borehole to approximately two feet above the screened interval. A one-foot fine sand filter pack seal ("sugar sand", 100% passing the No. 30 sieve and less than 2% passing the No. 200 sieve, and visibly free of clay, mica, and organic matter) followed the 20/40 filter pack to help prevent any intrusion of high pH water associated with the bentonite seal.

A minimum three-foot bentonite seal, utilizing bentonite pellets, immediately followed placement of the sugar sand. Where more than twenty feet of water was present in the borehole, a high solids bentonite slurry was pumped or carefully tremied into place. A one-foot layer of sugar sand was immediately tremied to provide weight during hydration of the bentonite seal and help enhance the expansion of the pellets sideways. Approximately five gallons of clean, potable water was then added and a minimum two-hour hydration time was allowed for the bentonite to hydrate before proceeding further.

A bentonite powder grout consisting of Benseal bentonite, bentonite catalyst, and clean potable water was then mixed by recirculation with a grout pump and tremied via a side-discharge tremie pipe into the annular space from the top of the sugar sand to a depth of five feet below the ground surface upon hydration of the bentonite seal. The bottom tremie pipe had side-discharge exits to avoid washing of the sugar sand and consequent erosion of the bentonite seal. The grout was allowed to settle a minimum of twelve hours. More grout was added, when necessary, to bring the top of the grout to five feet

## 6.0 SITE-SPECIFIC STRATIGRAPHIC CONDITIONS AND SUBSURFACE GEOLOGIC INTERPRETATIONS

This section describes the soils, sediments, geologic and groundwater conditions encountered by F.E.E., Inc. during the Hydrogeological/Geotechnical Investigations at the City of Kingsville, (COK), Municipal Solid Waste Landfill (MSWLF) site as required in 30 TAC § 330.56(d). The section also describes the characteristics of the soil samples collected and tested during the investigation. The locations of all subsurface boring explorations performed for the design of engineered cells, and for the Geological/Geotechnical investigation are shown on Figure 4.17. Subsurface geologic correlations showing stratigraphy and structure beneath the site are presented on the following exhibits included herein;

Cross Section Location Map

Cross Sections A-A’ through I-I’ (9 total) [Note Maximum ground water levels.]

Structure Map – Top “Light Olive Green Clay”

Isopach Map Sand Units I & II

Isopach Map Sand Units III & IV

Information from sample borings at the COK-MSWLF site and electrical logs of uranium test wells which immediately offset the site to the southeast were used in the construction of the geologic maps and cross sections as part of this investigation.

The primary geologic formations exposed at the surface of the site are recent Holocene South Texas Eolian Plain Deposits. The topsoil (approx 0 feet - 20 feet) consists of a clay which is black, silty and contains humic material. This soil is overlain in the extreme northeast corner with a veneer of loess. Sediments encountered in borings at the site are Holocene to Pleistocene in age and consist of clays, silts, sands, and caliches deposited in two (2) separate and distinct environments of deposition. Cross section A-A‘ serves to illustrate these environments of deposition. The cross section traverses the MSWLF site using four (4) deep borings all deep enough to penetrate a minimum thickness of 38’ of a massive, low permeability, light olive green clay (“Light Olive Green Clay”) believed to have been deposited in a marine (estuarian) environment. The interpretation of a marine environment of deposition for this unit is based upon the presence of sand filled burrows in the top surface of the massively bedded clay. The clay also contains sparse pelecypod molds scattered throughout and a single, correlative, thin bedded, pebble conglomerate (rip up clasts) believed to represent a storm deposit.

As noted in Section 4.2 the "Light Olive Green Clay" is the aquiclude for the MSWLF facility. In turn, the "Light Olive Green Clay" is capped by a sheet sand ("Orange sand") possibly 2 to 10' thick across the site of the MSWLF. The "Orange sand" is believed to have been deposited in a near shore or beach environment based on sample descriptions. The sand is extremely well sorted and clean, grains are well rounded and composed of approximately 90% fine quartz grains and 10 % fine multicolored shell fragments giving the overall sand color an orange cast.

Stratigraphy above the "Orange sand", the environment of deposition changes to fluvial-deltaic for the remaining 40 to 50' of section, measured back to surface. These beds are comprised of sands, silts, caliches and clays deposited as superimposed channel sands and clayey dunes or bars. A detailed cross section net was constructed using all sample borings at the MSWLF and four significant sand bodies are believed to be present within the fluvial-deltaic sequence. Locations of these sand bodies are shown on isopach maps included herewith. Bodies I & II, are superimposed, caliche or sand filled channels with Body I having the larger areal extent. Bodies III & IV are interpreted as dunes or bars of limited extent and are comprised of clayey sand. All of the above sand bodies are incised into, or embedded within, a tan, silty clay containing abundant mottles of organic matter.

Taken together, the marine clay section ("Light Olive Green Clay") overlain by fluvial-deltaics section represents a single regressive cycle, with respect to sea level, at the top of the Pleistocene Beaumont formation. The sea level regression was probably caused by an onset of a period of Wisconsan (Stage unknown) glacial ice formation. Bone fragments of large vertebrates and mammoth teeth recovered from the fluvial-deltaic section in nearby areas, i.e. Taylor Ranch, date from approximately 8,000 to 10,000 years B.P. It is believed that the entire fluvial-deltaic section is comprised of Holocene sediments with the Holocene-Pleistocene boundary represented by the top of the "Light Olive Green Clay" or "Orange sand".

The shallow subsurface geological structure at the Kingsville MSWLF site is shown by the Structure Map- Top "Light Olive Green Clay" to be monoclinal dip to the northeast at approximately 20 feet per mile. The horizon was chosen as most representative of structure affecting and underlying the MSWLF site. Any structural mapping on beds above the "Light Olive Green Clay" are less correlative and would reflect local scouring of channel sands causing structural inconsistencies due to stratigraphic variation within the fluvial-deltaic section. Correlations are excellent on the top of the "Light Olive Green Clay" and the surface is most likely to be planar in nature. Some scouring of this surface probably occurs at the extreme southwest corner of the MSWLF site due to the incisement of the overlying Body I, caliche bearing channel.

Deposition of the above sediments postdates uplift of the Kingsville Dome. Pre-lift formations are Miocene and older and exhibit west dip at depth in the vicinity of the MSWLF site. There is no evidence of folding or soft sediment deformation in subsurface boring samples. Some fracture and slump deformation does occur on steeply excavated caliche outcrops.

Quantitative descriptions of the physical characteristics of the investigated sediments are presented in Appendix G, Geochemical Laboratory Test Report and Appendix B, Boring Logs. A qualitative description of the shallow beds which can be correlated across the area as exhibited on cross sections A-A' through I-I' is presented below. The descriptions should aid in the confirmation of interpretations made regarding subsurface structure and environments of deposition of the sand bodies and the clays within and upon which the sand bodies were deposited.

6.0.1 Body I- Caliche Bearing Channel

This is the youngest, most extensive, sand containing body that can be correlated across the site. Body I is internally complex and comprised of a mélange of interbeds of caliche, clays and sands which, in themselves, are noncorrelative. The individual beds within this body appear to be of limited extent, and probably represent braided deposits within a single channel approximately ½ mile in width. The base of this channel is placed at the base of the lowest caliche encountered in the borings at the site. When grouped together, it can be shown via cross section and isopach mapping that the body can obtain a maximum thickness of 40' and, as a whole, cuts downward into underlying beds. Body I was deposited as a channel system which trends in a down dip direction, southwest to northeast, across the MSWLF site. Much of the caliche contained within this body has been previously removed from the site by mining operations.

6.0.2 Body II- sand Filled Channel

Body II was deposited as a channel filled with a homogeneous, well sorted, very fine grained to fine grained, clean, unconsolidated sand. Body II differs from Body I in the simplicity of fill sediment. The preserved length and width of this channel sand is less than one half mile due to truncation and incisement by the overlying channel, Body I. Body II is interpreted as being a channel due to downcutting evident on the cross sections. Maximum preserved thickness of this channel sand in 20' as evidenced in Borings Nos. 10 and 17. Deposition of the Body II channel sand was oriented in a dip direction, southwest to northeast across the site.

6.0.3 Body III- Clayey Sand (Clay Dune)

Sand Body III lies under the eastern edge of the MSWLF site and is composed of a homogeneous, very fine grained, well sorted, clayey sand. Well #13 is the only known penetration of the sand encountering a thickness of 17'. At it's base, the sand appears conformable with the underlying "Orange" sand which is interpreted as a near shore or beach sand. Sand Body III is interpreted as a clay dune based on clay content, sorting and stratgrapghic position within an overall regressive section. Sand Body III could possibly be present in the two URI deep wells but poor sample descriptions of the rotary drilled wells preclude an interpretation and the E-logs obtained were shut off below this shallow interval.

6.0.4 Body IV- Clayey Sand (Clay Dune)

Sand Body IV is believed to be a time and stratigraphic equivalent of Sand Body III, described above, and underlies a portion of the western edge of the MSWLF site. Boring #'s 16 and 23 penetrated 18' and 12' respectively, immediately above the underlying "Orange" sand. Body IV sand is similar in all respects to the homogeneous, very fine grained, well sorted, clayey sand which comprises Body III above. Cross section G-G' (wells 16 and 23) illustrates the top of Sand Body IV as being concave downward with a flat base, indicating deposition as a "buildup" or Clay Dune. Again, sand Body IV appears conformable with the underlying "Orange" which is interpreted as a near shore or beach sand.

Sand Bodies III and IV above are typical of the type IX soil which is comprised of stabilized clay dunes and dune complexes as indicated by the Environmental Atlas.

6.0.5 Sandy Clay Bed

The Sandy Clay Bed was a deposited penecontemporaneous with Bodies I through IV and is comprised of a homogeneous, tan, sandy clay containing abundant decomposed organic material. Thickness of this clay ranges from 40' to 60' under the MSWLF site with the above described Sand Bodies deposited within or adjacent to this clayey interval. The basal contact is abrupt with the underlying "Orange" Sand.

6.0.6 "Orange" Sand

As noted earlier, the "Orange sand" appears to have been deposited in a near shore or beach environment. The sand is extremely well sorted and clean, grains are well rounded and composed of approximately 90% fine quartz grains and 10 % fine multicolored shell fragments giving the overall sand color an orange cast. The thin (< 5'), sheet-like nature of the sand represents a beach environment of short duration developed at the top of the Beaumont clay (Light Olive Green Clay). It is present in all well control of sufficient depth.

6.0.7 "Light Olive Green Clay"

Tops on the "Light Olive Green Clay" are necessary to make the above interpretations of shallower beds in that it is the most definitive, planar marker bed under the MSWLF site. As noted earlier, this massive, low permeability, clay was deposited in a marine environment based upon the presence of sand filled burrows in it's top contact with the overlying "Orange" sand. The clay also contains sparse pelecypod molds scattered throughout and a single, correlative, thin bedded, pebble conglomerate (rip up clasts) believed to represent a storm deposit. This clay is pure and therefore exhibits characteristic low permeabilities with a proven thickness of at least 38'. E-logs from the URI deep uranium wells indicate a much thicker section is present under the site.

## 6.1 Holocene Stratigraphy as related to Groundwater Migration Pathways

Detailed correlation of borings show that the Holocene sediments which will host the proposed City of Kingsville MSWLF were deposited in a fluvial-deltaic environment. The massive "Light Olive Green Clay" which is believed to be Pleistocene age and deposited in a near shore marine environment underlies the section. As noted previously, the clay serves as the aquiclude between the Holocene sediments hosting the MSWLF and the underlying, saline, "Chicot" sand and the even deeper regional "Evangeline" (Goliad) aquifer.

Although excellent vertical separation exists between the Holocene sediments which will host the MSWLF and underlying Pleistocene beds, lateral migration of groundwater occurs within and through the host beds. From a potentiometric standpoint, it is evident from existing monitor well data that migration of groundwater within the Holocene host sediments is occurring in almost all directions away from the MSWLF site, the exception being to the northwest.

From geologic perspective, it is evident that migration of groundwater should occur primarily away from the MSWLF site to the northeast and southwest. Controlling this trend is the presence of the incised channel containing sands, clays and caliche noted on cross sections and maps as Sand Body I. This body, which hosts the thin to massively bedded caliche deposits in the area, strikes northeast and is approximately ½ mile in width. Body I trends directly through both the existing and proposed landfill sites. Other sand bodies in the host section are noted on the cross sections as II, III and IV. Sand body II is, again an incised, sand filled channel with limited areal extent. Sand Body II is truncated along its strike on the northeast and southwest by the overlying Body I. Sand Bodies III and IV are interpreted as being clay dunes or bars of limited areal extent. It should be noted that the entire Holocene section which contains all of the above sand bodies is permeable and therefore all are in communication. Even so, the orientation of Sand Body I should exert an influence on preferential ground water migration to the northeast and southwest and away from the City of Kingsville's MSWLF site.

Note that ground water modeling using site specific data was performed using HELP3 and Multi-Media computer models. The results of these studies are given in Attachment 15, Appendices B & C, and in Attachment 10, Appendices C & D. The HELP3 model is used to estimate liner leakage rates for inputs to the Multi-Media model. The maximum rates were of course encountered for cases with minimum solid waste cover over the bottom liner system. The Multi-Media model used site specific data in the form of the average hydraulic conductivity measured in the wells on site and the average gradient over the entire site, i.e. gradient of $5.19 \times 10^{-3}$ ft/ft to the northeast and hydraulic conductivity of 130 m/yr ($4.12 \times 10^{-4}$ cm/sec).

The primary impact of construction of the lined landfill cells will be the gradual reduction of any groundwater recharge to the uppermost aquifer from surface rainfall. Current recharge from the surface causes some dilution of groundwater and can potentially carry surface contamination to groundwater, as in the case of agricultural or oil and gas materials.

The primary impact of ponds and mined areas within the landfill ·site is dilution caused by surface recharge. This recharge and associated groundwater dilution will be reduced as onsite ponds and mined areas are eliminated as landfill expansion proceeds.

## 6.2 Hydrogeologic Conditions

This section describes groundwater conditions encountered during this investigation. The local groundwater flow regime at the site was determined by the collection of physical data (such as the elevation of the potentiometric surface) and the completion of in-situ hydraulic conductivity (bail) testing from on-site groundwater monitoring points. Depth-to-water measurements were obtained from existing on-site monitor wells and piezometers from August 4, 1997 every 2 weeks to February 18, 1998. Previous data collected from monitor wells during the period from March 29, 1991 through June 25, 1997 are also included. Two additional ground water level measurements are also included for May 18 and June 16, 1998. The depth-to-water measurements were subtracted from a surveyed reference datum (top of PVC casing) to establish a potentiometric surface relative to NGVD. The groundwater elevation data and resultant potentiometric contour maps for each relatively permeable stratum are presented in Attachment 5, Appendices A, B, and C. The water level data measured from soil boring and monitoring well measurements (hydrographs) are included within Appendix D.

The potentiometric contours presented within each map were constructed using the program Surfer (Version 6.04) by interpolation between data points. The primary layer potentiometric contour map from the water level measurement event indicated that ground water appears to flow generally outward from the landfill site in all directions. There are rather strong gradients to the northeast and to the southwest. There is some mounding near the center of the site. The hydraulic gradient was calculated for each of the four quadrants of the landfill site and for the entire site for each monitoring data set over a ten month period form August 4. 1997 through June 16, 1998. These calculations are shown in Attachment 15, Appendix G. The average gradient for the four quadrants over that 10 month period are as follows. The average hydraulic gradient toward the northeast is 7.99 x $10^{-3}$ ft/ft. The average hydraulic gradient toward the southwest is 2.16 x $10^{-3}$ ft/ft. The average hydraulic gradient toward the southeast is 1.44 x $10^{-3}$ ft/ft. The average hydraulic gradient toward the northwest is 3.87 x $10^{-3}$ ft/ft. Note that the gradient in the northwest quadrant actually changed direction over the 10 month period. The average hydraulic gradient and direction over the entire site is 5.19 x $10^{-3}$ ft/ft toward the northeast. This flow gradient and direction is generally consistent with the 9/29/97 and 9/15/97 measuring events and appears to be influenced by Santa Gertrudis Creek located to the north-northeast.

F. E. E., Inc. prepared a hydrograph of existing monitor wells on site using data collected from previous ground water sampling events since May 1991, and data collected during this investigation. Based on the seasonal data for the site collected to date, the potentiometric surface was slightly lower during periods of low precipitation (summer and early fall) and slightly higher during periods of excess precipitation (winter and spring). The hydrograph indicates no significant changes in groundwater elevations since 1991 until the excessive precipitation event of October 8 -12, 1997. (Appendix F).

### 6.2.1 Surface Water Hydrology

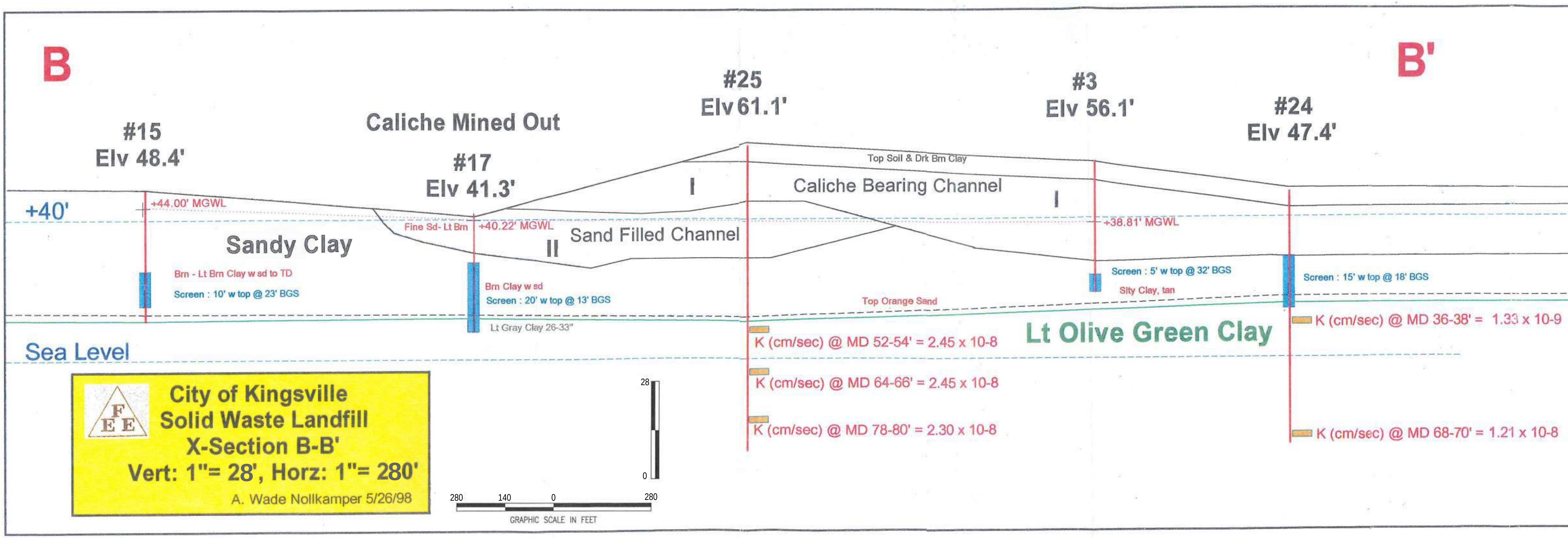
COK MSWLF is located entirely within the Kleberg County Drainage Watershed. All of the soils are characterized by high to very high permeability and drainage which results in significant recharge from surface percolation. The average yearly rainfall total for the Kingsville area is approximately 30 inches, and is more or less evenly distributed throughout the year. However, monthly rainfall totals generally fall below the overall average of four inches per month during the late fall, winter, and spring. Monthly totals for the summer and early fall generally exceed the overall average.

The topography of the watershed is gently sloping. Ground elevations in the Kleberg County Drainage Watershed vary from 125 feet in the extreme northwest to sea level in the East (Gulf of Mexico). Predevelopment ground contours at COK MSWLF varied from approximately 50 to 65 feet NGVD. Ground slope in the area varies from about two feet per mile to 6 feet per mile.

Santa Gertrudis Creek flows from the northwest to the southeast approximately one mile northeast of COK MSWLF before resuming its easterly flow towards Baffin Bay. Surface water runoff from the facility and the vicinity generally follows the easterly down-dip of the surface towards Baffin Bay via Santa Gertrudis Creek east of the site. Uncontaminated surface water from the southern half of the site flows to Santa Gertrudis Creek via drainage ditches to the south of the site, which also crosses the facility's southwest corner. Uncontaminated surface water from the northern half of the site flows to a drainage ditch, which also flows to Santa Gertrudis Creek and ultimately into Baffin Bay.

### 6.2.2 Groundwater Hydrology

Aquifer (slug) tests were performed in piezometers and monitor wells screened in the uppermost aquifer sand unit utilizing both rising head and falling head methodologies where possible. Results of these tests are shown in Attachment 5 as Appendix E, and are included as Appendix E of this Attachment. Based upon these results, the average (geometric mean) horizontal hydraulic conductivity of the uppermost aquifer is approximately 4.1 x 10-4 cm/sec in the subsurface soils above +10' MSL. These results were obtained using bail, or pump, tests and analyzed using the Horslev graphical method. Note that the Horslev method uses the sand filter pack around the monitor well screen rather than the well screen length in this calculation (Fetter, 1988).


B
B'
#15
Elv 48.4'
Caliche Mined Out
#17
Elv 41.3'
#25
Elv 61.1'
#3
Elv 56.1'
#24
Elv 47.4'
Top Soil & Drk Brn Clay
Caliche Bearing Channel
I
I
+40'
+44.00' MGWL
Fine Sd- Lt Brn
+40.22' MGWL
Sand Filled Channel
+38.81' MGWL
Sandy Clay
II
Brn - Lt Brn Clay w sd to TD
Screen : 10' w top @ 23' BGS
Brn Clay w sd
Screen : 20' w top @ 13' BGS
Lt Gray Clay 26-33"
Screen : 5' w top @ 32' BGS
Slty Clay, tan
Screen : 15' w top @ 18' BGS
Top Orange Sand
K (cm/sec) @ MD 52-54' = 2.45 x 10-8
Lt Olive Green Clay
K (cm/sec) @ MD 36-38' = 1.33 x 10-9
Sea Level
K (cm/sec) @ MD 64-66' = 2.45 x 10-8
K (cm/sec) @ MD 78-80' = 2.30 x 10-8
K (cm/sec) @ MD 68-70' = 1.21 x 10-8
City of Kingsville
Solid Waste Landfill
X-Section B-B'
Vert: 1"= 28', Horz: 1"= 280'
A. Wade Nollkamper 5/26/98
28
0
280
140
0
280
GRAPHIC SCALE IN FEET

an equation derived from Darcy's Law,

$V = Ki/n_e$ where: V =velocity (length/time)

K =hydraulic conductivity (length/time)

i =hydraulic gradient (length/length)

$n_e$=effective porosity (decimal)

As calculated from the potentiometric maps of groundwater flow within each stratum (See Attachment 5, Appendix G), the horizontal hydraulic gradient across the site ranges from 1.44 x $10^{-3}$ ft/ft to 7.99 x $10^{-3}$ ft/ft. Horizontal hydraulic conductivity values within each stratum, which are stated above, were obtained from in-situ hydraulic conductivity tests (Appendix E). An effective porosity for a silty clay loam (the predominant lithology screened by piezometers in each stratum) is estimated to be 0.43 (Dean, et. al., 1989). Using these parameters, the horizontal velocity of ground water within uppermost aquifer deposits beneath the site is estimated to range from 0.0033 ft/day to 0.0086 ft/day, or 1.2 ft/year to 3.1 ft/year, respectively.

F.E.E. prepared a hydrograph of existing monitor wells on site using data collected from previous ground water sampling events since May 1991, and data collected during this investigation. Based on the seasonal data for the site collected to date, the potentiometric surface was slightly lower during periods of low precipitation (summer and early fall) and slightly higher during periods of excess precipitation (winter and spring). The hydrograph indicates no significant changes in groundwater elevations since 1991 until the excessive precipitation event of October 8 -12, 1997. (Appendix F).

The COK MSWLF site has several excavations which are adjacent to the currently permitted MSWLF and on the same land for which MSWLF expansion is proposed. These excavations were prepared for two reasons: first, to provide cover soil for the existing MSWLF; second, to prepare the excavations for future MSWLF cells. The net result of these excavations was to provide depressions in the earth's surface which collect ponded water from rainfall events. This ponded water provides recharge to the uppermost, unconfined aquifer by percolation through the unsaturated zone to the ground water table. This recharge causes higher than normal water levels (mounding) below and near these ponds. This is the same result as experienced in the 1968-69 TDWB studies of ponded water on the King Ranch.

The King Ranch study showed that water table water levels were influenced by recharge from ponded water as far as 500 feet from the pond. This was confirmed by both water levels and dilution of total dissolved solids (TDS) in the ground water. The COK MSWLF site experienced similar results after the excessive rainfall events of October 8-12,1997. Unfortunately, this rainfall event was right in the middle of a six month study of water levels being made as part of the permitting process for the expansion of the COK MSWLF. This event requires that the design be modified to protect against such events so that groundwater levels will not rise into bottom liners of the expanded landfill. The proposed design change is to provide pumping capacity for non-active excavations such that ponded water is not allowed to accumulate in excavations after rainfall events. The rainfall in expanded active areas will be handled by the leachate collection system.

In April, May and June, 1998, both the topography and groundwater levels on the landfill site and off-site were mapped. The topographic map and the groundwater contour during the May, 1998 period confirm that the ground water flow from the landfill is leaving the landfill in all directions except to the northwest where groundwater is entering the uppermost aquifer under the landfill. This study shows a very steep gradient to the northeast toward monitor well #14 as indicated previously. However, there is also ground water flow to the southwest toward the caliche pit on the southwest corner of the intersection of FM 2619 and CR 2030. There is also ground water toward the Martin Hamilton caliche pit at the southeast corner of FM 2619 and CR 2030. There is also ground water flow toward the landfill from the northwest corner of the landfill, i.e. monitor well #15. By superimposing the current topographic map onto the current ground water contour, it appears that there is no major disruption of ground water flow due to the local depressions. There does seem to be a small impedance to flow under the low point of the old landfill on the northeast corner of the intersection of FM 2619 and CR 2030. This impedance is indicated by a flattening of the ground water contour in the vicinity of the low area at the southwest corner of the 235 closed landfill, i.e. P& A’d Oil Well. There certainly is recharge from the surface ponding as indicated earlier from the study by Baker of King Ranch ponding studies after Hurricane Beulah.

The May 1998 studies show that there were at that time nine (9) ponds or depressions in the vicinity of the landfill which intersect the ground water table. Eight of these depressions are located in adjacent caliche pits and one is located on site in a former caliche pit which is now inactive. These ponds are shown blue cross hatching on the topographic map in Appendix N. A Surfer ground water contour map using depression water surfaces and ground water monitor well levels was prepared for May 18, 1998. This contour is also shown in Appendix N. The Topographic Map and the Ground Water Contour Map are of the same scale and may be overlain for analysis. The number of ponds or depressions may vary as ground water level varies due to drought or excessive precipitation events. There are also five other ponds or depressions on the landfill site which hold water after rainfall but do not intersect the ground water table. One pond is the excavation where sector 2 is proposed on the southeast corner of the 160 acres. The second pond is about center on the east side of the landfill just north of the service road coming to the current office and weigh station. The third pond (much shallower) is due north of the second pond and also on the east side. The fourth pond is in the same triangular shaped area as the contaminated water evaporation pond but immediately to the north and east. The fifth pond is a long narrow pond immediately south of monitor well #6 at the center of the north side of the landfill. The only pond on site which intersects ground water is in the northwest 40 acre quadrant about the center of the west side and extending about half way across the quadrant. These ponds which do not intersect ground water can be identified on the topographic map in Appendix N by the numbers Pd-1, 2, 3, 4 and 5. These ponds will dry up after pumping or dry conditions.

The uppermost aquifer water table in the vicinity of the landfill site is almost totally supplied by recharge from the surface. This recharge is accelerated by the presence of ponds or depressions as described above which provide a static head through saturated soil. This is explained in the King Ranch ponding study above. The water table in the uppermost aquifer approximately follows the land surface since most of the recharge is from the surface. Since the landfill site is the high point in the area, it also contains the high point in the water table. Ground water tends to flow away from the landfill on all sides except to the northwest during most of the six month test period. However, in the earlier weeks of the test period (August & September, 1997) the ground water gradient was away from the landfill toward the northwest, also. Therefore, the monitor well system will need to monitor the points of compliance on all sides of the landfill site. The steepest ground water gradients are to the northeast and to the southwest. The gradient to the northeast is steep due to stiff clay formation on its way toward Santa Gertrudis creek. The gradient to the southwest is steep due to the caliche channel which rather steeply slopes toward the southwest (relative to the rather flat surrounding terrain).

# 7.0 GROUNDWATER CHARACTERIZATION

# 7.0 GROUNDWATER CHARACTERIZATION

This section describes the historical groundwater conditions that have existed at the City of Kingsville MSWLF site as required in 30 TAC §330.56(e). A delineation of the waste management area, the property boundary, and the proposed locations of all groundwater monitoring wells are shown on Figure 4.17.

## 7.1 Background

Currently a total of five groundwater monitoring wells exist to monitor quality in the uppermost aquifer sands along the perimeter of the currently permitted fill area. A series of sampling and analysis events to characterize the background quality of the groundwater occurred in the third and fourth quarters of 1996, and the first, second, and third quarters of 1997.

Beginning in the third quarter of 1996, the groundwater monitoring requirements included the annual sampling of each well for total organic carbon (TOC), iron, manganese, pH, chloride, potassium, total dissolved solids, and a groundwater elevation measurement. Following establishment of background values, the following additional parameters were sampled: calcium, magnesium, sodium, carbonate, phenolphthalein alkalinity as $CaCO_3$, alkalinity as $CaCO_3$, hardness as $CaCO_3$, bicarbonate, sulphate, specific conductance, anion/cation balance, fluoride, and nitrate (as nitrogen). No known plumes of contamination have been identified as entering the groundwater from the facility.

## 7.2 Groundwater Quality

In order to compare with regional groundwater quality data, relevant analytes were selected from groundwater samples collected from groundwater monitor wells screened within the uppermost aquifer sands at the City of Kingsville MSWLF site. These analytes included pH, manganese (dissolved), iron (dissolved), chlorides, and total dissolved solids (TDS). Groundwater samples collected from the uppermost aquifer sand (MW-1 through MW-11) have reported pH values (field) ranging from 7.08 standard units (s.u.) from MW-4 to 7.66 s.u. from MW-11. Dissolved manganese concentration have ranged from Non-Detect from MW-10 to 0.67 µg/l from MW-3. Dissolved iron concentration have ranged from non-detect (MW-4) to 0.68 µg/l (MW-4). Chloride values have ranged from 66 milligrams per liter (mg/l or parts per million - ppm) from MW-11 to 2600 mg/l from MW-4. TDS concentrations ranged from 1580 mg/l (MW-11) to 5,780 mg/l (MW-4). More complete analytical data from the MSWLF ground water monitor wells is available in Table 5.1 of Attachment 5.

As part of the study performed by Shafer (1973), 272 groundwater samples were collected from water wells in the Kleberg, Kennedy, and Southern Jim Wells County area, ranging in depth from 25 feet below ground surface (ft bgs) to 1,206 ft bgs. Groundwater samples were collected from 1913 to 1969 in order to determine the quality of groundwater supplies in the area. The analyses consisted of dissolved mineral constituents, which determined the fitness of water for industrial, agricultural, and domestic use without reference to the sanitary quality of the sample. A summary list of chemical analyses of groundwater samples collected from the Goliad aquifer in North Central Kleberg County is included within Table 5.2.

In general, the samples were fairly uniform throughout the northwestern portion of Kleberg County. Specific conductance and chloride content generally increased with depth, as a result of brackish or salt water intrusion. The Total Dissolved Solids contents were high and ranged from 894 ppm to 2,000 ppm. Figure 4.16 shows the extent of salt water intrusion from the Gulf of Mexico into the Evangeline (Goliad) aquifer in 1973.

The analytical results of the groundwater samples from the site reported values well within the regional values reported in the studies by Shafer (1973). The highest value for chloride has been reported at 2,600 mg/l, which was within the regional chloride values which ranged from 135 mg/l to 2,700 mg/l. The highest value for TDS has been 5,780 mg/l, well within range of the regional values of 175 mg/l to 21,200 mg/l.

# 8.0 GEOTECHNICAL CHARACTERIZATION

# 8.0 GEOTECHNICAL CHARACTERIZATION

In order to determine the soil characteristics of the shallow soils at the site and to determine the suitability for site soils for liner material as well as evaluate depths, geotechnical laboratory testing of selected soil samples was performed. In accordance with 30 TAC §330.56(d)(5)(B), the following sections present a summary of the geotechnical properties of shallow soils beneath the site.

## 8.1 Geotechnical Laboratory Testing

All soil samples collected during the F.E.E., Inc. July, 1997 investigation were transported to the geotechnical laboratory where tests were performed on selected samples in order to evaluate and further classify the samples. Geotechnical laboratory test results are summarized by boring on Table 4.1 and by stratigraphic unit on Table 4.2. Geotechnical tests were performed on samples by Professional Services, Inc. (PSI), of Corpus Christi, Texas. During the second phase of geotechnical studies at the landfill site in April, 1998, additional samples were taken from four (4) deep borings. These samples were also tested for selected geotechnical parameters at PSI laboratories. The complete geotechnical laboratory test results are presented in Appendix G.

Atterberg Limits (ASTM D-4318), percent passing the No. 200 mesh sieve (ASTM D-1140), and full gradation tests (ASTM D-422) were performed on selected soil samples to determine the index of properties on the subsurface materials. A total of 44 Atterberg Limits and 24 grain size analyses were performed. The index and classification test results are summarized on Tables 4.1 and 4.2, and on the individual boring logs included in Appendix B. Grain size distribution curves are presented in Appendix G.1.

Short-term and long-term bearing strength characteristics and the moisture and density of the soils were evaluated by means of unconfined compression tests (ASTM D-2166), and eleven unconsolidated-undrained three-point triaxial compression tests (ASTM D-2850). The strength test results are summarized on Tables 4.1 and 4.2 and on the boring logs in Appendix B. The individual laboratory strength test results are included in Appendix G.2.

Three consolidation (odometer) tests (ASTM D-2435) were performed on samples obtained from the borings to evaluate the compressibility and rebound characteristics of cohesive materials subjected to varying load conditions. Stress-strain curves plotted using the test data are shown in Appendix G.2. Settlements within the soils underlying the landfill due to the imposed waste load were estimated using the information from these curves.

Horizontal and vertical permeability characteristics of the cohesive soils were evaluated by means of flexible wall permeability tests (ASTM D-5084). Thirteen vertical permeability tests and twelve horizontal permeability tests were performed on samples obtained from the borings. Permeability test results are summarized on Tables 4.1 and 4.2. The individual laboratory permeability test data sheets are presented in Appendix G.4.

## 8.2 Geotechnical Data Evaluation

This section summarizes the results of the geotechnical laboratory testing performed on soil samples collected during the hydrogeological investigation performed by F.E.E., Inc. at the City of Kingsville, Texas (COK) Municipal Solid Waste Landfill (MSWLF) during the month of July, 1997. A discussion of the geotechnical results for each of the stratigraphic units is presented below.

### 8.2.1 Top Soil and dark Brown Clay Unit

Very little geotechnical data was determined from top soil samples.

### 8.2.2 Caliche Bearing Channel (I) Layer

The Caliche Bearing Channel consist of a caliche vein running from the northeast to southwest across the landfill site. The Isopach (Figure 4.29) shows that the thickness varies from 0 to 40 feet thickness across the site. The 40 foot thickness is at the extreme southwest corner. The zero is on the edges of the channel. The channel splits and goes to both sides on monitor wells 18 and 14. The main channel in the new site is approximately 20 feet thick maximum. Much of this layer has already been excavated in the caliche mining process which ceased more than twenty years ago.

The moisture content of this stratum ranged from 8.3 to 11.5 percent with an average of approximately 9.6 percent, and the caliche layer had an average dry density of 81 pounds per cubic foot (pcf). The liquid limits and plasticity indices ranged from 31 to 39 and 13 to 19, respectively, with an average liquid limit and plasticity index of 35 and 16, respectively.

Unconfined compression tests performed on samples from this unit indicate an average cohesion of 5,660 pounds per square foot (psf). Permeability tests performed on samples from this stratum indicated an average horizontal permeability of $3.0 \times 10^{-4}$ cm/sec.

### 8.2.3 Sand Filled Channel (II) Layer

The Sand Filled Channel (II) is a discontinuous layer located below the main caliche bearing channel. Where the caliche has been excavated the Sand Filled Channel is exposed in the vicinity of monitoring well #17. The maximum thickness of the layer of approximately 20 feet occurs in the vicinity of monitor wells #10 and #17. The precise location and shape of this discontinuous unit is shown in Isopach map Figure 4.29. The Sand Filled Channel is composed primarily of SC and SP-SC soils.

The moisture content of this stratum ranged from 18 to 35 percent, with an average of approximately 26 percent. The Sand Filled Channel layer had an average dry density of 82 pcf, and an average wet density of 104 pcf. The liquid limits and plasticity indices ranged from 41 to 58 and non to 33, respectively, with an average liquid limit and plasticity index of 47 and 17, respectively (neglecting the non plasticity index readings).

Cohesion intercept from unconsolidated-undrained triaxial compression tests ranged from 3,100 to 13,000 psf with an average of 8,600 psf. Consolidated-undrained triaxial compression tests were performed on samples from this unit indicating an average effective cohesion of 200 psf and an effective angle of internal friction of 24 degrees. Vertical and horizontal permeability tests performed on samples from this stratum indicated an average vertical and horizontal permeability of $3.0 \times 10^{-5}$ cm/sec and $1.0 \times 10^{-4}$ cm/sec, respectively. Percent passing the No. 200 mesh averaged 40 percent.

8.2.4 Clayey Sand (Clay Dune) (III) Layer

The Clayey Sand (Clay Dune) (III) Layer is present at the extreme eastern side of the landfill site. (See Figure 4.30) It is present below the top soil and sandy clay units below monitor well #13. The Clayey Sand (III) Layer and consists SC, SP-SC and CH soils. The unit is encountered typically between elevations 6 and 26 NGVD. This is a discontinuous clay dune unit. The maximum thickness of the unit is estimated to be about 30 feet. (See Figure 4.26)

Moisture tests were performed on samples from this unit, indicating a water content of 23 percent. The liquid limits and plasticity indices ranged from 56 to 63 and 30 to 48, respectively, with an average liquid limit and plasticity index of 59 and 27, respectively. Permeability tests performed on this layer indicated vertical and horizontal permeabilities of $2.3 \times 10^{-5}$ and $1.75 \times 10^{-5}$ cm/sec, respectively.

8.2.5 Clayey Sand (Clay Dune) (IV) Layer

The Clayey Sand (Clay Dune) (IV) Layer is present under the Caliche Bearing Channel and the Sand Filled Channel and the Sandy Clay unit at the extreme western edge of the landfill site. Section D-D', Figure 4.22, shows the Clay Dune to be of maximum thickness of about 24 feet and centered between monitor wells 16 and 23. The Clayey Sand (IV) Unit consists primarily of SC and SP-SC type soils. Figure 4.30 is the isopach of this formation.

The moisture content of the Clayey Sand (IV) Layer ranged from 19 to 25 percent, with an average of approximately 22 percent. The liquid limits and plasticity indices of this layer averaged 52 to 21, respectively. The percent passing the No. 200 sieve mesh ranged between 30 and 46 percent with an average of 19 percent. Compressive strength of this layer was 5,500 psf. Effective cohesion and angle of internal friction for this layer were 200 psf and 24 degrees, respectively. Vertical permeability was $3.3 \times 10^{-6}$ cm/sec.

8.2.6 Sandy (Silty) Clay Unit

The Sandy (Silty) Clay Unit is the most continuous soil unit above the aquiclude described below. The other discontinuous units (Caliche Bearing Channel, Sand Filled Channel, and two Clay Dunes (III & IV) seem to be located within the Sandy (Silty) Clay Unit. This unit is found in every boring log at the site except 7, 8 and 23. Borings 7 &8 are totally in the Caliche Bearing Channel. Boring 23 penetrates three types of discontinuous units which separate it from the Sandy (Silty) Clay Unit. (See Section D-D', Figure 4.22) The Sandy (Silty) Clay Unit is composed primarily of CH type soils with minor amounts of CL and SC types.

The moisture content of the Sandy (Silty) Clay Unit ranged from 9 to 38 percent with an average moisture content of 23 percent. The Liquid Limit of this soils ranged from 30 to 83% with an average of 60%. The Plasticity Index ranged from 15 to 60% with an average of 39%. The percent passing the No. 200 sieve mesh ranged from 31 to 85% with an average of 60%. Unconfined compressive strength of this soil average 7,680 psf. Effective cohesion and angle of internal friction for this unit were 200 psf and 24 degrees, respectively. The average vertical and horizontal permeabilities were $1.0 \times 10^{-5}$ am/sec and $2.8 \times 10^{-6}$ cm/sec, respectively.

8.2.7 Light Olive Green Clay Confining Layer – Aquiclude

This Light Olive Green Clay Unit was the only truly continuous layer unit at the landfill site. The top of this layer is shown in Figure 4.28 to vary from 5 feet above MSL at the extreme northeast corner of the landfill site to about 17 feet above MSL at the extreme southwest corner of the landfill site where it is slightly truncated by the Caliche Bearing Channel sloping gently towards the southwest. The Unit is at least 38 feet thick at the landfill site. All of the deep borings terminated in this unit. It forms the aquiclude for the local uppermost aquifer in the vicinity of the landfill site.

The moisture content of this soil varied from 18% to 38% and averaged 29%. The average wet and dry densities of this soil are 125 pcf and 98 pcf, respectively. The liquid limit of this soil varied from 51% to 79% and averaged 67%. The Plasticity Index of this soil varied from 25% to 51% and averaged 35%. The average percent passing a number 200 mesh sieve was 81%. The average unconfined compressive strength of this clay was 8,300 psf. The vertical permeability of this clay averaged $3.3 \times 10^{-8}$ cm/sec. The vertical permeability ranged from $1.33 \times 10^{-9}$ m/sec to $6.18 \times 10^{-8}$ cm/sec.

Table 4.1

**SUMMARY OF GEOTECHNICAL TESTING RESULTS BY BORING**

*City of Kingsville MSWLF, Permit 235 B*

*Kingsville, Texas*

| Boring No. Ground El. (ft MSL) | Sample Number | Depth (ft bgs) | USCS | Water Content (%) | Wet Density (pcf) | Dry Density (pcf) | Liquid Limit (%) | Plastic Index (%) | #200 Sieve (%) | Permeability Vertical (cm/sec) | Permeability Horizontal (cm/sec) | Other Tests Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| B-12 | S1 | 0-2 | CL | 7.2 | | | | | | | | |
| 52.38 | S2 | | | | | | | | | | | |
| | S3 | 5-7 | CL | 14.1 | | | | | 60 | | | |
| | S4 | 7-8 | CL | 13.6 | 127.53 | 112.3 | 41 | 28 | | | | (1) 200 (2) 26 (3) 3.4 |
| | S5 | | | | | | | | | | | |
| | S6 | 14-19 | SC | 19.1 | 121.84 | 102.3 | 51 | 28 | 48 | | | (3) 1.7 |
| | S7 | 19-24 | SC | 23.6 | 118.76 | 96.1 | 48 | 26 | 33 | | | (3) 2.4 |
| | S8 | | | | | | | | | | | |
| | S9 | 29-34 | CH | 24.7 | | | 53 | 29 | | | | |
| | S10 | 34-36 | CH | 23.2 | | | 51 | 24 | | | | |
| | S11 | 36-41 | CH | 25.2 | | | | | 51 | | | |
| | S12 | | | | | | | | | | | |
| | S13 | 46-47 | CH | 29 | | | | | | | | |
| | S14 | 47-48 | CH | 30.2 | | | 59 | 25 | | | | (1) 200 (2) 26 (3) 6.5 |
| B-13 | S1 | 0-2 | | | | | | | | | | |
| 59.13 | S2 | 2-4 | CL | | | | 30 | 12 | | | 0.0001 | |
| | S3 | 5-8 | CL | 8 | 108.79 | 100.7 | | | 62 | 5.80E-06 | | |
| | S4 | 8-10 | CL | 9.4 | | | 43 | 26 | 66 | | | |
| | S5 | | | | | | | | | | | |
| | S6 | 15-20 | CH | | | | 59 | 36 | | | | |
| | S7 | 20-25 | CH | 21.3 | | | 59 | 29 | | | | |
| | S8 | 25-26 | CH | 21.3 | 114.94 | 94.8 | | | | 3.40E-07 | 5E-06 | |
| | S9 | 26-27 | CH | 21.6 | 123.27 | 101.4 | 63 | 29 | | | | (3) 2.3 |
| | S10 | 27-30 | SC | 18.6 | | | | | 48 | | | |
| | S11 | 30-35 | SC | 23.9 | 116.5 | 94 | 59 | 28 | 46 | | | (3) 3.2 |
| | S12 | 35-36 | SC | 20.3 | 112.63 | 93.6 | | | | 0.00046 | 3E-05 | |
| | S13 | 37-40 | | | | | | | | | | |
| | S14 | 40-45 | SC | 26.9 | 112.92 | 96.9 | 56 | 24 | | | | (3) 0.38 |
| | S15 | 45-46 | SPSC | 24.7 | | | | | 30 | | | |
| | S16 | 48-49 | SPSC | 26.7 | | | | NON | | | | |

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*1 Effective Cohesion (psf)*
*2 Effective Angle of Internal Friction (degrees)*
*3 Unconfined Compressive Strength (tsf)*

Table 4.1 (cont'd)

**SUMMARY OF GEOTECHNICAL TESTING RESULTS BY BORING**

*City of Kingsville MSWLF, Permit 235 B*

*Kingsville, Texas*

| Boring No. Ground El. (ft MSL) | Sample Number | Depth (ft bgs) | USCS | Water Content (%) | Wet Density (pcf) | Dry Density (pcf) | Liquid Limit (%) | Plastic Index (%) | #200 Sieve (%) | Permeability Vertical (cm/sec) | Permeability Horizontal (cm/sec) | Other Tests Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| B-14 | S1 | 0-2 | | | | | | | | | | |
| 49.94 | S2 | 5-10 | CL | 11.5 | 116.69 | 104.7 | 44 | 26 | 56 | | | |
| | S3 | 10-11 | CL | 14.4 | 113.11 | 95.1 | | | 53 | | 5E-07 | (1) 200 (2) 26 (3) 4.0 |
| | S4 | 11-15 | CH | 19 | 113.11 | 95.1 | 63 | 37 | | | 5E-07 | |
| | S5 | 15-20 | CH | 22.2 | | | | | | | | |
| | S6 | 20-25 | CH | 24.8 | 108.57 | 86.99 | 58 | 33 | | 6.90E-05 | | |
| | S7 | 25-30 | SC | 28.5 | | | | | 46 | | | |
| | S8 | 30-33 | CL | 29.3 | 114.2 | 88.3 | 50 | 27 | 66 | | | |
| | S9 | 33-34 | CH | 25.7 | 123.66 | 98.54 | 61 | 33 | | 1.20E-07 | | |
| | S10 | 34-35 | | | | | | | | | | (1) 200 (2) 24 (3) 3.0 |
| | S11 | 35-37 | CH | 26 | 104.29 | 82.1 | 64 | 37 | 85 | | | |
| | S12 | 39-40 | CL | 29.5 | | | 41 | 15 | | | | |
| B-15 | S1 | 0-2 | | | | | | | | | | |
| 48.39 | S2 | 5-10 | SC | 12.3 | 126.4 | 112.6 | 30 | 19 | 47 | | | |
| | S3 | 10-12 | CL | 11.6 | | | | | 51 | | | |
| | S4 | 12-13 | CH | 12.9 | 113.38 | 100.4 | | | | | | (1) 200 (2) 21 (3) 1.55 |
| | S5 | 13-14 | CH | 15.3 | | | 68 | 46 | 55 | 3E-07 | | |
| | S6 | 14-16 | CH | 15.3 | 97.04 | 84.2 | 79 | 56 | | | | |
| | S7 | 16-19 | CH | 15.3 | | | 79 | 56 | 65 | | | |
| | S8 | 19-22 | CH | 21.2 | | | 83 | 60 | | | | |
| | S9 | | | | | | | | | | | |
| | S10 | 23-24 | CH | 20.1 | | | | | | 2.40E-07 | | (3) 1.56 |
| | S11 | 24-25 | CH | 21.3 | 121.79 | 100 | 50 | 32 | 53 | | | (1) 200 (2) 24 (3) 1.53 |
| | S12 | | | | | | | | | | | |
| | S13 | 25-28 | CH | 26.5 | | | 52 | 35 | 58 | | | |
| | S14 | 28-29 | CH | 29 | | | | | | | | |

*1 Effective Cohesion (psf)*
*2 Effective Angle of Internal Friction (degrees)*
*3 Unconfined Compressive Strength (tsf)*

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Table 4.1 (cont'd)

**SUMMARY OF GEOTECHNICAL TESTING RESULTS BY BORING**

*City of Kingsville MSWLF, Permit 235 B*

*Kingsville, Texas*

| Boring No. Ground El. (ft MSL) | Sample Number | Depth (ft bgs) | USCS | Water Content (%) | Wet Density (pcf) | Dry Density (pcf) | Liquid Limit (%) | Plastic Index (%) | #200 Sieve (%) | Permeability Vertical (cm/sec) | Permeability Horizontal (cm/sec) | Other Tests Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| B-16 | S1 | 0-2 | CL | | | | | | | | | |
| 55.96 | S2 | 3-5 | | 9.3 | 114.66 | 104.9 | | | | | | (1) 200 (2) 26 (3) 2.9 |
| | S3 | 5-10 | SC | 11.6 | | | 45 | 23 | 31 | | | |
| | S4 | | | | | | | | | | | |
| | S5 | | | | | | | | | | | |
| | S6 | | | | | | | | | | | |
| | S7 | | | | | | | | | | | |
| | S8 | 16-18 | SP-SC | 27.3 | | | | NON | 22 | | | |
| | S9 | 18-20 | SP-SC | 22.3 | | | 43 | 13 | 24 | | | |
| | S10 | | | | | | | | | | | |
| | S11 | | | | | | | | | | | |
| | S12 | | | | | | | | | | | |
| | S13 | | | | | | | | | | | |
| | S14 | 26-29 | SC | 24.5 | | | 50 | 29 | 30 | | | |
| | S15 | | | | | | | | | | | |
| | S16 | | | | | | | | | | | |
| | S17 | 33-35 | SC | 19.4 | | | 41 | 24 | 46 | 1.20E-05 | | |
| | S18 | 35-37 | SC | 21 | | | | | | 4E-06 | | |
| | S19 | | | | | | | | | | | |
| | S20 | | | | | | | | | | | |
| | S21 | | | | | | | | | | | |
| | S22 | | | | | | | | | | | |
| | S23 | 45-47 | CH | 30.6 | 110.03 | 84.3 | 79 | 51 | 83 | | | |

*1 Effective Cohesion (psf)*
*2 Effective Angle of Internal Friction (degrees)*
*3 Unconfined Compressive Strength (tsf)*

Table 4.1 (cont'd)

**SUMMARY OF GEOTECHNICAL TESTING RESULTS BY BORING**

*City of Kingsville MSWLF, Permit 235 B*

*Kingsville, Texas*

| Boring No. Ground El. (ft MSL) | Sample Number | Depth (ft bgs) | USCS | Water Content (%) | Wet Density (pcf) | Dry Density (pcf) | Liquid Limit (%) | Plastic Index (%) | #200 Sieve (%) | Permeability Vertical (cm/sec) | Permeability Horizontal (cm/sec) | Other Tests Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| B-17 | S1 | | | | | | | | | | | |
| 41.35 | S2 | 2-5 | SP-SC | 21.6 | | | | NON | | | | |
| | S3 | 5-8 | SP-SC | 35 | | | | | 25 | | | |
| | S4 | 8-9 | SP-SC | 31.4 | 85.07 | 64.6 | | NON | | 0.0001 | 3E-05 | |
| | S5 | 9-10 | CL | 32 | | | 41 | 19 | 66 | | | |
| | S6 | | | | | | | | | | | |
| | S7 | | | | | | | | | | | |
| | S8 | 17-18 | CH | 31.5 | 95.09 | 82.7 | 66 | 46 | | | | |
| | S9 | | | | | | | | | | | |
| | S10 | | | | | | | | | | | |
| | S11 | | | | | | | | | | | |
| | S12 | 24-29 | CH | 38 | 108.86 | 78.9 | 74 | 52 | 83 | | | |
| | S13 | | | | | | | | | | | |
| | S14 | 31-32 | CH | 23 | | | | | | | | |
| | S15 | 32-33 | CH | | 115.38 | 93.8 | 62 | 41 | | 6.70E-07 | | (1) 200 (2) 24 (3) 2.27 |
| B-18 | S1 | 0-2 | | | | | | | | | | |
| 50.04 | S2 | 3-5 | | | | | | | | | | |
| | S3 | 5-9 | CH | 15.2 | 97.82 | 84.9 | 59 | 44 | 60 | | | |
| | S4 | 9-10 | CL | 14.8 | 127.25 | 110.8 | | | | | | (1) 200 (2) 21 (3) 5.4 |
| | S5 | 10-15 | CH | 18.3 | | | | | 45 | | | |
| | S6 | | | | | | | | | | | |
| | S7 | 12-18 | CH | 23.8 | 122.97 | 99.3 | 58 | 33 | 57 | | | (1) 200 (2) 24 (3) 4.91 |
| | S8 | | | | | | | | | | | |
| | S9 | | | | | | | | | | | |
| | S10 | 24-29 | CH | 26.5 | | | 66 | 47 | 78 | | | |
| | S11 | 29-30 | CH | 31.9 | | | | | | 0.0023 | | |
| | S12 | | | | | | | | | | | |
| | S13 | | | | | | | | | | | |
| | S14 | 34-39 | CH | 34.9 | | | 73 | 48 | 81 | | | |
| | S15 | 39-42 | CH | 31.1 | 106.75 | 81.4 | | | | | | (1) 200 (2) 24 (3) 1.57 |

1 Effective Cohesion (psf)
2 Effective Angle of Internal Friction (degrees)
3 Unconfined Compressive Strength (tsf)

Table 4.1 (cont'd)
## SUMMARY OF GEOTECHNICAL TESTING RESULTS BY BORING
*City of Kingsville MSWLF, Permit 235 B*
*Kingsville, Texas*

| Boring No. Ground El. (ft MSL) | Sample Number | Depth (ft bgs) | USCS | Water Content (%) | Wet Density (pcf) | Dry Density (pcf) | Liquid Limit (%) | Plastic Index (%) | #200 Sieve (%) | Permeability Vertical (cm/sec) | Permeability Horizontal (cm/sec) | Other Tests Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| B-21 | S1 | 1-2 | | | | | | | | | | |
| 52.41 | S2 | 2-4 | | | | | | | | | | (3) 4.5 |
| | S3 | 4-6 | | | | | | | | | | (3) 4.5 |
| | S4 | 6-8 | | | | | | | | | | (3) 4.5 |
| | S5 | 8-10 | | | | | | | | | | (3) 4.5 |
| | S6 | 10-12 | | | | | | | | | | (3) 4.5 |
| | S7 | 12-14 | | | | | | | | | | (3) 4.5 |
| | S8 | 14-16 | | | | | | | | | | (3) 4.5 |
| | S9 | 16-18 | | | | | | | | | | (3) 4.5 |
| | S10 | 18-20 | | | | | | | | | | (3) 2.3 |
| | S11 | 20-22 | | | | | | | | | | (3) 2.3 |
| | S12 | 22-24 | | | | | | | | | | (3) 3.5 |
| | S13 | 24-26 | | | | | | | | | | (3) 4.5 |
| | S14 | 26-28 | | | | | | | | | | (3) 4.5 |
| | S15 | 28-30 | | | | | | | | | | (3) 4.5 |
| | S16 | 30-32 | | | | | | | | | | (3) 4.5 |
| | S17 | 32-34 | | | | | | | | | | |
| | S18 | 34-36 | | | | | | | | | | |
| | S19 | 36-38 | | | | | | | | | | |
| | S20 | 38-40 | | | | | | | | | | (3) 4.3 |
| | S21 | 40-42 | | | | | | | | | | |
| | S22 | 42-44 | | | | | | | | | | |
| | S23 | 44-46 | | | | | | | | | | |
| | S24 | 46-48 | | | | | | | | | | (3) 4.5 |
| | S25 | 48-50 | | | | | | | | | | (3) 4.0 |
| | S26 | 50-52 | | 37.8 | | | 75 | 40 | 95 | $1.99 \times 10^{-9}$ | | (3) 4.5 |
| | S27 | 52-54 | | | | | | | | | | (3) 4.5 |
| | S28 | 54-56 | | | | | | | | | | (3) 4.5 |
| | S29 | 56-58 | | | | | | | | | | (3) 4.5 |
| | S30 | 58-60 | | | | | | | | | | (3) 3.8 |
| | S31 | 60-62 | | | | | | | | | | (3) 4.5 |

*1 Effective Cohesion (psf)*
*2 Effective Angle of Internal Friction (degrees)*
*3 Unconfined Compressive Strength (tsf)*

Revision 1

Table 4.1 (cont'd)
**SUMMARY OF GEOTECHNICAL TESTING RESULTS BY BORING**
*City of Kingsville MSWLF, Permit 235 B*
*Kingsville, Texas*

| Boring No. Ground El. (ft MSL) | Sample Number | Depth (ft bgs) | USCS | Water Content (%) | Wet Density (pcf) | Dry Density (pcf) | Liquid Limit (%) | Plastic Index (%) | #200 Sieve (%) | Permeability | | Other Tests Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | Vertical (cm/sec) | Horizontal (cm/sec) | |
| B-21 | S32 | 62-64 | | 27.7 | | | 51 | 25 | 86 | $3.00 \times 10^{-8}$ | | (3) 4.5 |
| 52.41 | S33 | 64-66 | | | | | | | | | | (3) 4.5 |
| (cont'd.) | S34 | 66-68 | | | | | | | | | | (3) 4.5 |
| | S35 | 68-70 | | | | | | | | | | (3) 4.5 |
| | S36 | 70-72 | | | | | | | | | | (3) 2.5 |
| | S37 | 72-74 | | | | | | | | | | (3) 3.5 |
| | S38 | 74-76 | | | | | | | | | | (3) 2.8 |
| | S39 | 76-78 | | | | | | | | | | (3) 3.0 |
| | S40 | 78-80 | | 24.6 | | | 62 | 33 | 78 | $1.56 \times 10^{-8}$ | | (3) 4.0 |
| | S41 | 80-82 | | | | | | | | | | (3) 4.5 |
| | S42 | 82-84 | | | | | | | | | | (3) 4.5 |
| | | | | | | | | | | | | |
| B-23 | S1 | 1-2 | | | | | | | | | | |
| 49.5 | S2 | 2-4 | | | | | | | | | | (3) 4.5 |
| | S3 | 4-6 | | | | | | | | | | (3) 4.5 |
| | S4 | 6-8 | | | | | | | | | | (3) 2.0 |
| | S5 | 8-10 | | | | | | | | | | (3) 0.8 |
| | S6 | 10-12 | | | | | | | | | | (3) 0.5 |
| | S7 | 12-14 | | | | | | | | | | |
| | S8 | 14-16 | | | | | | | | | | |
| | S9 | 16-18 | | | | | | | | | | |
| | S10 | 18-20 | | | | | | | | | | |
| | S11 | 20-22 | | | | | | | | | | |
| | S12 | 22-24 | | | | | | | | | | (3) 2.0 |
| | S13 | 24-26 | | | | | | | | | | (3) 2.3 |
| | S14 | 26-28 | | | | | | | | | | |
| | S15 | 28-30 | | | | | | | | | | |
| | S16 | 30-32 | | | | | | | | | | (3) 4.5 |
| | S17 | 32-34 | | | | | | | | | | |
| | S18 | 34-36 | | | | | | | | | | (3) 3.0 |
| | S19 | 36-38 | | 36.9 | | | 73 | 37 | 88 | $4.4 \times 10^{-8}$ | | (3) 3.8 |

*1 Effective Cohesion (psf)*
*2 Effective Angle of Internal Friction (degrees)*
*3 Unconfined Compressive Strength (tsf)*

Revision 1

Table 4.1 (cont'd)

## SUMMARY OF GEOTECHNICAL TESTING RESULTS BY BORING

*City of Kingsville MSWLF, Permit 235 B*

*Kingsville, Texas*

| Boring No. Ground El. (ft MSL) | Sample Number | Depth (ft bgs) | USCS | Water Content (%) | Wet Density (pcf) | Dry Density (pcf) | Liquid Limit (%) | Plastic Index (%) | #200 Sieve (%) | Permeability | | Other Tests Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | Vertical (cm/sec) | Horizontal (cm/sec) | |
| B-23 | S20 | 38-40 | | | | | | | | | | (3) 4.3 |
| 52.41 | S21 | 40-42 | | | | | | | | | | (3) 4.5 |
| (cont'd.) | S22 | 42-44 | | | | | | | | | | (3) 4.5 |
| | S23 | 44-46 | | | | | | | | | | (3) 4.5 |
| | S24 | 46-48 | | | | | | | | $1.6 \times 10^{-8}$ | | (3) 4.5 |
| | S25 | 48-50 | | | | | | | | | | (3) 3.0 |
| | S26 | 50-52 | | | | | | | | | | (3) 4.0 |
| | S27 | 52-54 | | | | | | | | | | (3) 4.5 |
| | S28 | 54-56 | | | | | | | | | | (3) 4.3 |
| | S29 | 56-58 | | | | | | | | | | (3) 4.5 |
| | S30 | 58-60 | | 27.7 | | | 62 | 32 | 80 | | | (3) 4.5 |
| | S31 | 60-62 | | | | | | | | | | (3) 4.5 |
| | S32 | 62-64 | | | | | | | | | | (3) 4.5 |
| | S33 | 64-66 | | | | | | | | | | (3) 4.5 |
| | S34 | 66-68 | | 24.3 | | | 59 | 31 | 76 | $3.80 \times 10^{-8}$ | | (3) 2.8 |
| | S35 | 68-70 | | | | | | | | | | (3) 4.0 |
| | S36 | 70-72 | | | | | | | | | | (3) 3.3 |
| | S37 | 72-74 | | | | | | | | | | (3) 2.5 |
| | S38 | 74-76 | | | | | | | | | | (3) 4.3 |
| | S39 | 76-78 | | | | | | | | | | |
| | S40 | 78-80 | | | | | | | | | | |
| | S41 | 80-82 | | | | | | | | | | (3) 4.5 |
| | S42 | 82-84 | | | | | | | | | | (3) 4.5 |
| | | | | | | | | | | | | |
| B-24 | S1 | 1-2 | | | | | | | | | | (3) 4.5 |
| 47.38 | S2 | 2-4 | | | | | | | | | | (3) 4.5 |
| | S3 | 4-6 | | | | | | | | | | (3) 4.5 |
| | S4 | 6-8 | | | | | | | | | | (3) 3.0 |
| | S5 | 8-10 | | | | | | | | | | |
| | S6 | 10-12 | | | | | | | | | | |
| | S7 | 12-14 | | | | | | | | | | |

*1 Effective Cohesion (psf)*
*2 Effective Angle of Internal Friction (degrees)*
*3 Unconfined Compressive Strength (tsf)*

Revision 1

Table 4.1 (cont'd)

**SUMMARY OF GEOTECHNICAL TESTING RESULTS BY BORING**

*City of Kingsville MSWLF, Permit 235 B*

*Kingsville, Texas*

| Boring No. Ground El. (ft MSL) | Sample Number | Depth (ft bgs) | USCS | Water Content (%) | Wet Density (pcf) | Dry Density (pcf) | Liquid Limit (%) | Plastic Index (%) | #200 Sieve (%) | Permeability | | Other Tests Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | Vertical (cm/sec) | Horizontal (cm/sec) | |
| B-24 | S8 | 14-16 | | | | | | | | | | |
| 47.38 | S9 | 16-18 | | | | | | | | | | |
| (cont'd.) | S10 | 18-20 | | | | | | | | | | |
| | S11 | 20-22 | | | | | | | | | | (3) 4.5 |
| | S12 | 22-24 | | | | | | | | | | (3) 4.3 |
| | S13 | 24-26 | | | | | | | | | | (3) 4.5 |
| | S14 | 26-28 | | | | | | | | | | (3) 4.5 |
| | S15 | 28-30 | | | | | | | | | | (3) 4.5 |
| | S16 | 30-32 | | | | | | | | | | |
| | S17 | 32-34 | | 36.4 | | | 79 | 38 | 80 | $8.30x10^{-7}$ | | |
| | S18 | 34-36 | | | | | | | | | | (3) 4.3 |
| | S19 | 36-38 | | | | | | | | $1.33x10^{-9}$ | | (3) 4.5 |
| | S20 | 38-40 | | | | | | | | | | (3) 4.5 |
| | S21 | 40-42 | | | | | | | | | | (3) 4.5 |
| | S22 | 42-44 | | | | | | | | | | (3) 4.5 |
| | S23 | 44-46 | | | | | | | | | | (3) 3.5 |
| | S24 | 46-48 | | | | | | | | | | (3) 4.5 |
| | S25 | 48-50 | | | | | | | | | | (3) 4.5 |
| | S26 | 50-52 | | 27.7 | | | 71 | 36 | 68 | $3.28x10^{-9}$ | | (3) 4.5 |
| | S27 | 52-54 | | | | | | | | | | (3) 4.5 |
| | S28 | 54-56 | | | | | | | | | | (3) 4.5 |
| | S29 | 56-58 | | | | | | | | | | (3) 2.3 |
| | S30 | 58-60 | | | | | | | | | | (3) 4.5 |
| | S31 | 60-62 | | | | | | | | | | (3) 4.3 |
| | S32 | 62-64 | | | | | | | | | | (3) 1.8 |
| | S33 | 64-66 | | | | | | | | | | (3) 4.5 |
| | S34 | 66-68 | | 17.7 | | | 50 | 30 | 66 | $6.00x10^{-7}$ | | (3) 4.5 |
| | S35 | 68-70 | | | | | | | | $1.21x10^{-8}$ | | (3) 3.5 |
| | S36 | 70-72 | | | | | | | | | | (3) 3.0 |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |

*1 Effective Cohesion (psf)*
*2 Effective Angle of Internal Friction (degrees)*
*3 Unconfined Compressive Strength (tsf)*

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Table 4.1 (cont'd)

**SUMMARY OF GEOTECHNICAL TESTING RESULTS BY BORING**

*City of Kingsville MSWLF, Permit 235 B*

*Kingsville, Texas*

| Boring No. Ground El. (ft MSL) | Sample Number | Depth (ft bgs) | USCS | Water Content (%) | Wet Density (pcf) | Dry Density (pcf) | Liquid Limit (%) | Plastic Index (%) | #200 Sieve (%) | Permeability | | Other Tests Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | Vertical (cm/sec) | Horizontal (cm/sec) | |
| B-25 | S1 | 1-2 | | | | | | | | | | (3) 4.5 |
| 61.12 | S2 | 2-4 | | | | | | | | | | |
| | S3 | 4-6 | | | | | | | | | | (3) 4.5 |
| | S4 | 6-8 | | | | | | | | | | |
| | S5 | 8-10 | | | | | | | | | | |
| | S6 | 10-12 | | | | | | | | | | |
| | S7 | 12-14 | | | | | | | | | | |
| | S8 | 14-16 | | | | | | | | | | |
| | S9 | 16-18 | | | | | | | | | | |
| | S10 | 18-20 | | | | | | | | | | |
| | S11 | 20-22 | | | | | | | | | | |
| | S12 | 22-24 | | | | | | | | | | |
| | S13 | 24-26 | | | | | | | | | | |
| | S14 | 26-28 | | | | | | | | | | |
| | S15 | 28-30 | | | | | | | | | | |
| | S16 | 30-32 | | | | | | | | | | |
| | S17 | 32-34 | | | | | | | | | | (3) 3.8 |
| | S18 | 34-36 | | | | | | | | | | |
| | S19 | 36-38 | | | | | | | | | | (3) 2.8 |
| | S20 | 38-40 | | | | | | | | | | (3) 8.3 |
| | S21 | 40-42 | | | | | | | | | | (3) 2.5 |
| | S22 | 42-44 | | | | | | | | | | (3) 4.3 |
| | S23 | 44-46 | | | | | | | | | | (3) 4.3 |
| | S24 | 46-48 | | | | | | | | | | (3) 3.3 |
| | S25 | 48-50 | | | | | | | | | | |
| | S26 | 50-52 | | | | | | | | | | (3) 3.0 |
| | S27 | 52-54 | | 31.8 | | | 77 | 43 | 87 | $2.45 \times 10^{-8}$ | | (3) 4.5 |
| | S28 | 54-56 | | | | | | | | | | (3) 4.5 |
| | S29 | 56-58 | | | | | | | | | | (3) 4.5 |
| | S30 | 58-60 | | | | | | | | | | (3) 4.5 |
| | S31 | 60-62 | | | | | | | | | | (3) 4.5 |

*1 Effective Cohesion (psf)*
*2 Effective Angle of Internal Friction (degrees)*
*3 Unconfined Compressive Strength (tsf)*

Revision 1

Table 4.1 (cont'd)

**SUMMARY OF GEOTECHNICAL TESTING RESULTS BY BORING**

*City of Kingsville MSWLF, Permit 235 B*

*Kingsville, Texas*

| Boring No. Ground El. (ft MSL) | Sample Number | Depth (ft bgs) | USCS | Water Content (%) | Wet Density (pcf) | Dry Density (pcf) | Liquid Limit (%) | Plastic Index (%) | #200 Sieve (%) | Permeability | | Other Tests Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | Vertical (cm/sec) | Horizontal (cm/sec) | |
| B-25 | S32 | 62-64 | | | | | | | | | | (3) 4.5 |
| 61.12 | S33 | 64-66 | | 30.5 | | | 77 | 39 | 92 | $2.30 \times 10^{-8}$ | | (3) 4.5 |
| (cont'd.) | S34 | 66-68 | | | | | | | | | | (3) 4.5 |
| | S35 | 68-70 | | | | | | | | | | (3) 4.5 |
| | S36 | 70-72 | | | | | | | | | | (3) 4.5 |
| | S37 | 72-74 | | | | | | | | | | (3) 4.5 |
| | S38 | 74-76 | | | | | | | | | | (3) 4.5 |
| | S39 | 76-78 | | | | | | | | | | (3) 4.5 |
| | S40 | 78-80 | | 20.5 | | | 58 | 31 | 83 | $6.18 \times 10^{-9}$ | | (3) 4.5 |
| | S41 | 80-82 | | | | | | | | | | (3) 4.5 |
| | S42 | 82-84 | | | | | | | | | | (3) 4.5 |
| | S43 | 84-86 | | | | | | | | | | (3) 4.5 |

*1 Effective Cohesion (psf)*
*2 Effective Angle of Internal Friction (degrees)*
*3 Unconfined Compressive Strength (tsf)*

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Table 4.2
# SUMMARY OF GEOTECHNICAL TESTING RESULTS BY STRATIGRAPHIC UNIT
*City of Kingsville MSWLF, Permit 235 B*
*Kingsville, Texas*

| Boring No. Ground El. (ft MSL) | Sample Number | Depth (ft bgs) | USCS | Water Content (%) | Wet Density (pcf) | Dry Density (pcf) | Liquid Limit (%) | Plastic Index (%) | #200 Sieve (%) | Permeability | | Other Tests Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | Vertical (cm/sec) | Horizontal (cm/sec) | |
| **Top Soil (Dark Brown Clay) Unit** | | | | | | | | | | | | |
| B-1 | S-1 | 0-1 | | | | | | | | | | |
| | S-2 | 1-2 | | | | | | | | | | |
| | S-3 | 2-3 | | 8.3 | | | 34 | 17 | | | | |
| | S-4 | 3-4 | | | | | | | | | | |
| | S-5 | 4-6 | | | | | | | | | | |
| B-2 | S-1 | 1-2 | | | | | | | | | | |
| | S-2 | 4-5 | | | | | | | | | | (3) 4.5 |
| B-4 | S-1 | 1-3 | | | | | | | | | | (3) 4.5 |
| | S-2 | 3-5 | | | | | | | | | | (3) 4.5 |
| B-5 | S-1 | 1-3 | | | | | | | | | | |
| | S-2 | 3-5 | | | | | | | | | | |
| B-10 | S-1 | 0-1 | | | | | | | | | | |
| | S-2 | 1-2 | | | | | | | | | | |
| B-11 | S-1 | 0-5 | | | | | | | | | | |
| B-12 | S-1 | 0-2 | | | | | | | | | | |
| | S-2 | 2-3 | | | | | | | | | $1.6x10^{-4}$ | |
| | S-3 | 5-7 | | | | | | | | | | |
| | S-4 | 7-8 | | | | | | | | | | |
| | S-5 | 9-15 | | | | | | | | | $2.0x10^{-4}$ | |
| B-13 | S-1 | 0-2 | | | | | | | | $5.8x10^{-6}$ | $1.0x10^{-4}$ | |
| | S-2 | 2-4 | | | | | | | | | | |
| | S-3 | 5-8 | | | | | | | | | | |
| | S-4 | 8-10 | | | | | | | | | | |
| | S-5 | 10-15 | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |

*1 Effective Cohesion (psf)*
*2 Effective Angle of Internal Friction (degrees)*
*3 Unconfined Compressive Strength (tsf)*

Table 4.2 (cont'd)

**SUMMARY OF GEOTECHNICAL TESTING RESULTS BY STRATIGRAPHIC UNIT**

*City of Kingsville MSWLF, Permit 235 B*

*Kingsville, Texas*

| Boring No. Ground El. (ft MSL) | Sample Number | Depth (ft bgs) | USCS | Water Content (%) | Wet Density (pcf) | Dry Density (pcf) | Liquid Limit (%) | Plastic Index (%) | #200 Sieve (%) | Permeability | | Other Tests Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | Vertical (cm/sec) | Horizontal (cm/sec) | |
| **Top Soil (Dark Brown Clay) Unit** | | | | | | | | | | | | |
| B-14 | S-1 | 0-2 | | | | | | | | | | |
| | S-2 | 5-10 | | | | | | | | | | |
| | S-3 | 10-11 | | | | | | | | | | |
| B-18 | S-1 | 0-2 | | | | | | | | | | |
| | S-2 | 2-5 | | | | | | | | | $1.0x10^{-4}$ | |
| | S-3 | 5-9 | | | | | | | | | | |
| | S-4 | 9-10 | | | | | | | | | | |
| B-21 | S-1 | 0-2 | | | | | | | | | | |
| | S-2 | 2-4 | | | | | | | | | | |
| B-24 | S-1 | 0-2 | | | | | | | | | | |
| | S-2 | 2-4 | | | | | | | | | | |
| | S-3 | 4-6 | | | | | | | | | | |
| B-25 | S-1 | 0-2 | | | | | | | | | | |
| | S-2 | 2-4 | | | | | | | | | | |
| | S-3 | 4-6 | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| Average: | | | | 8.3 | | | 34 | 17 | | $5.8x10^{-6}$ | $1.4x10^{-4}$ | (3) 4.5 |

*1 Effective Cohesion (psf)*
*2 Effective Angle of Internal Friction (degrees)*
*3 Unconfined Compressive Strength (tsf)*

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Table 4.2 (cont'd.)

**SUMMARY OF GEOTECHNICAL TESTING RESULTS BY STRATIGRAPHIC UNIT**

*City of Kingsville MSWLF, Permit 235 B*

*Kingsville, Texas*

| Boring No. Ground El. (ft MSL) | Sample Number | Depth (ft bgs) | USCS | Water Content (%) | Wet Density (pcf) | Dry Density (pcf) | Liquid Limit (%) | Plastic Index (%) | #200 Sieve (%) | Permeability | | Other Tests Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | Vertical (cm/sec) | Horizontal (cm/sec) | |
| **Caliche Bearing Channel (I) Unit** | | | | | | | | | | | | |
| B-1 | S-6 | 6.5-7.0 | | | | | | | | | | |
| | S-7 | 7.0-8.5 | | 9.1 | | | 31 | 13 | | | | |
| | S-8 | 8.5-10.5 | | | | | | | | | | |
| | S-9 | 10.5-12 | | | | | | | | | | |
| | S-10 | 12-13 | | 8.3 | | | 39 | 19 | | | | |
| | S-11 | 14-15 | | | | | | | | | | |
| | S-12 | 20-21 | | | | | | | | | | |
| | S-13 | 23-24 | | | | | | | | | | |
| | S-14 | 24-25 | | | | | | | | | | |
| | S-15 | 30-31 | | | | | | | | | | |
| B-2 | S-3 | 8-10 | | | | | | | | | | (3) 4.5 |
| | S-4 | 13-15 | | | | | | | | | | |
| B-3 | S-1 | 8-10 | | | | | | | | | | |
| | S-2 | 14-16 | | | | | | | | | | |
| B-4 | S-3 | 8-10 | | | | | | | | | | (3) 4.5 |
| | S-4 | 12.5-14.5 | | | | | | | | | | |
| | S-5 | 18-19 | | | | | | | | | | |
| | S-6 | 23-25 | | | | | | | | | | |
| B-5 | S-3 | 8-9 | | | | | | | | | | |
| | S-4 | 13-15 | | | | | | | | | | |
| | S-5 | 18-20 | | | | | | | | | | |
| | S-6 | 23-25 | | | | | | | | | | |
| | S-7 | 29-30 | | 11.5 | | 81 | 35 | 16 | | | $3.0 \times 10^{-4}$ | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |

*1 Effective Cohesion (psf)*
*2 Effective Angle of Internal Friction (degrees)*
*3 Unconfined Compressive Strength (tsf)*

Revision 1

Table 4.2 (cont'd.)

**SUMMARY OF GEOTECHNICAL TESTING RESULTS BY STRATIGRAPHIC UNIT**

*City of Kingsville MSWLF, Permit 235 B*

*Kingsville, Texas*

| Boring No. Ground El. (ft MSL) | Sample Number | Depth (ft bgs) | USCS | Water Content (%) | Wet Density (pcf) | Dry Density (pcf) | Liquid Limit (%) | Plastic Index (%) | #200 Sieve (%) | Permeability Vertical (cm/sec) | Permeability Horizontal (cm/sec) | Other Tests Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Caliche Bearing Channel (I) Unit** | | | | | | | | | | | | |
| B-6 | S-1 | 3-5 | | | | | | | | | | |
| | S-2 | 7-9 | | | | | | | | | | |
| | S-3 | 12-14 | | | | | | | | | | |
| | S-4 | 17.5-19.5 | | | | | | | | | | |
| | S-5 | 23.5-25.5 | | | | | | | | | | |
| | S-6 | 28-30 | | | | | | | | | | |
| B-8 | S-1 | 0-8 | | | | | | | | | | |
| | S-2 | 8-18 | | | | | | | | | | |
| | S-3 | 18-24 | | | | | | | | | | |
| | S-4 | 24-28 | | | | | | | | | | |
| | S-5 | 28-30 | | | | | | | | | | |
| | S-6 | 31-36 | | | | | | | | | | |
| | S-7 | 36-43 | | | | | | | | | | |
| B-9 | S-1 | 0-10 | | | | | | | | | | |
| | S-2 | 10-20 | | | | | | | | | | |
| B-11 | S-2 | 5-10 | | | | | | | | | | |
| | S-3 | 10-15 | | | | | | | | | | |
| B-21 | S-3 | 4-6 | | | | | | | | | | (3) 4.5 |
| | S-4 | 6-8 | | | | | | | | | | (3) 4.5 |
| | S-5 | 8-10 | | | | | | | | | | (3) 4.5 |
| | S-6 | 10-12 | | | | | | | | | | (3) 4.5 |
| | S-7 | 12-14 | | | | | | | | | | (3) 4.5 |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |

*1 Effective Cohesion (psf)*
*2 Effective Angle of Internal Friction (degrees)*
*3 Unconfined Compressive Strength (tsf)*

Revision 1

Table 4.2 (cont'd.)

**SUMMARY OF GEOTECHNICAL TESTING RESULTS BY STRATIGRAPHIC UNIT**

*City of Kingsville MSWLF, Permit 235 B*

*Kingsville, Texas*

| Boring No. Ground El. (ft MSL) | Sample Number | Depth (ft bgs) | USCS | Water Content (%) | Wet Density (pcf) | Dry Density (pcf) | Liquid Limit (%) | Plastic Index (%) | #200 Sieve (%) | Permeability | | Other Tests Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | Vertical (cm/sec) | Horizontal (cm/sec) | |
| **Caliche Bearing Channel (I) Unit** | | | | | | | | | | | | |
| B-23 | S-1 | 0-2 | | | | | | | | | | |
| | S-2 | 2-4 | | | | | | | | | | (3) 4.5 |
| | S-3 | 4-6 | | | | | | | | | | (3) 4.5 |
| | S-4 | 6-8 | | | | | | | | | | (3) 2.0 |
| | S-5 | 8-10 | | | | | | | | | | (3) 0.8 |
| | S-6 | 10-12 | | | | | | | | | | (3) 0.5 |
| | S-7 | 12-14 | | | | | | | | | | |
| | S-8 | 14-16 | | | | | | | | | | (3) 3.0 |
| B-24 | S-4 | 6-8 | | | | | | | | | | |
| | S-5 | 8-10 | | | | | | | | | | |
| | S-6 | 10-12 | | | | | | | | | | |
| | S-7 | 12-14 | | | | | | | | | | |
| | S-8 | 14-16 | | | | | | | | | | |
| | S-9 | 16-18 | | | | | | | | | | |
| | S-10 | 18-20 | | | | | | | | | | |
| B-25 | S-4 | 6-8 | | | | | | | | | | |
| | S-5 | 8-10 | | | | | | | | | | |
| | S-6 | 10-12 | | | | | | | | | | |
| | S-7 | 12-14 | | | | | | | | | | |
| | S-8 | 14-16 | | | | | | | | | | |
| | S-9 | 16-18 | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| Average: | | | | 9.63 | | 81 | 35 | 16 | | | $3.0 \times 10^{-4}$ | (3) 2.83 |

*1 Effective Cohesion (psf)*
*2 Effective Angle of Internal Friction (degrees)*
*3 Unconfined Compressive Strength (tsf)*

Revision 1

Table 4.2 (cont'd)

**SUMMARY OF GEOTECHNICAL TESTING RESULTS BY STRATIGRAPHIC UNIT**

*City of Kingsville MSWLF, Permit 235 B*

*Kingsville, Texas*

| Boring No. Ground El. (ft MSL) | Sample Number | Depth (ft bgs) | USCS | Water Content (%) | Wet Density (pcf) | Dry Density (pcf) | Liquid Limit (%) | Plastic Index (%) | #200 Sieve (%) | Permeability Vertical (cm/sec) | Permeability Horizontal (cm/sec) | Other Tests Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Sand Filled Channel (II) Unit** | | | | | | | | | | | | |
| B-9 | S-2 | 10-20 | | | | | | | | | | |
| | S-3 | 20-28 | | | | | | | | | | |
| | S-4 | 28-36 | | | | | | | | | | |
| B-9R | S-1 | 5-7 | | | | | | | | | | |
| B-10 | S-3 | 2-11 | | | | | | | | | | |
| B-11 | S-4 | 15-20 | | | | | | | | | | |
| | S-5 | 22-24 | | | | | | | | | | |
| | S-6 | 26-28 | | | | | | | | | | |
| | S-7 | 31-34 | | | | | | | | | | |
| B-16 | S-4 | 10-11 | | | | | | | | | | |
| | S-5 | 11-12 | | | | | | | | | | |
| | S-6 | 12-14 | | | | | | | | | | |
| | S-7 | 14-16 | | | | | | | | | | |
| | S-8 | 16-18 | SP-SC | 27.3 | | | | NON | 22 | | | |
| | S-9 | 18-20 | SP-SC | 22.3 | | | 43 | 13 | 24 | | | |
| B-17 | S-1 | 0-2 | | | | | | | | | | |
| | S-2 | 2-5 | SP-SC | 21.6 | | | | NON | | | | |
| | S-3 | 5-8 | SP-SC | 35 | | | | | 25 | | | |
| | S-4 | 8-9 | SP-SC | 31.4 | 85.07 | 64.6 | | NON | | 0.0001 | $3x10^{-5}$ | |
| | S-5 | 9-10 | CL | 32 | | | 41 | 19 | 66 | | | |

*1 Effective Cohesion (psf)*
*2 Effective Angle of Internal Friction (degrees)*
*3 Unconfined Compressive Strength (tsf)*

Table 4.2 (cont'd)

## SUMMARY OF GEOTECHNICAL TESTING RESULTS BY STRATIGRAPHIC UNIT

*City of Kingsville MSWLF, Permit 235 B*
*Kingsville, Texas*

| Boring No. Ground El. (ft MSL) | Sample Number | Depth (ft bgs) | USCS | Water Content (%) | Wet Density (pcf) | Dry Density (pcf) | Liquid Limit (%) | Plastic Index (%) | #200 Sieve (%) | Permeability Vertical (cm/sec) | Permeability Horizontal (cm/sec) | Other Tests Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Sand Filled Channel (II) Unit** | | | | | | | | | | | | |
| B-18 | S-5 | 11-15 | CH | 18.3 | | | | | 45 | | | |
| | S-6 | 15-17 | | | | | | | | | | |
| | S-7 | 17-18 | CH | 23.8 | 122.97 | 99.3 | 58 | 33 | 57 | | | (1) 200 (2) 24 (3) 4.91 |
| B-21 | S-8 | 14-16 | | | | | | | | | | (3) 4.5 |
| | S-9 | 16-18 | | | | | | | | | | (3) 4.5 |
| B-23 | S-9 | 16-18 | | | | | | | | | | |
| | S-10 | 18-20 | | | | | | | | | | |
| B-25 | S-9 | 16-18 | | | | | | | | | | |
| | S-10 | 18-20 | | | | | | | | | | |
| | S-11 | 20-22 | | | | | | | | | | |
| | S-12 | 22-24 | | | | | | | | | | |
| | S-13 | 24-26 | | | | | | | | | | |
| | S-14 | 26-28 | | | | | | | | | | |
| | S-15 | 28-30 | | | | | | | | | | |
| | S-16 | 30-32 | | | | | | | | | | |
| | S-17 | 32-34 | | | | | | | | | | (3) 4.5 |
| Average: | | | | 26.46 | 104.02 | 81.95 | 47.3 | 17.3 | 39.8 | 0.0001 | $3x10^{-5}$ | (1) 200 (2) 24 (3) 4.6 |

*1 Effective Cohesion (psf)*
*2 Effective Angle of Internal Friction (degrees)*
*3 Unconfined Compressive Strength (tsf)*

Table 4.2 (cont'd)

**SUMMARY OF GEOTECHNICAL TESTING RESULTS BY STRATIGRAPHIC UNIT**

*City of Kingsville MSWLF, Permit 235 B*

*Kingsville, Texas*

| Boring No. Ground El. (ft MSL) | Sample Number | Depth (ft bgs) | USCS | Water Content (%) | Wet Density (pcf) | Dry Density (pcf) | Liquid Limit (%) | Plastic Index (%) | #200 Sieve (%) | Permeability Vertical (cm/sec) | Permeability Horizontal (cm/sec) | Other Tests Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Clayey Sand (Clay Dune) (III) Unit** | | | | | | | | | | | | |
| B-13 | S-9 | 26-27 | CH | 21.6 | 123.97 | 101.4 | 63 | 29 | | $3.4\times10^{-7}$ | $5.0\times10^{-6}$ | (3)2.3 |
| | S-10 | 27-30 | SC | 18.6 | | | | | 48 | | | |
| | S-11 | 31-35 | SC | 23.9 | 116.5 | 94 | 59 | 28 | 46 | | | (3) 3.2 |
| | S-12 | 35-36 | SC | 20.3 | 112.63 | 93.6 | | | | $4.6\times10^{-5}$ | $3\times10^{-5}$ | |
| | S-13 | 37-40 | | | | | | | | | | |
| | S-14 | 40-45 | SC | 26.9 | 112.92 | 96.9 | 56 | 24 | | | | (3) 0.38 |
| | S-15 | 45-46 | SPSC | 24.7 | | | | | 30 | | | |
| | S-16 | 48-49 | SPSC | 26.7 | | | | NON | | | | |
| B-21 | S-17 | 32-34 | | | | | | | | | | |
| | S-18 | 34-36 | | | | | | | | | | |
| | S-19 | 36-38 | | | | | | | | | | |
| | S-20 | 38-40 | | | | | | | | | | (3) 4.3 |
| | S-21 | 40-42 | | | | | | | | | | |
| | S-22 | 42-44 | | | | | | | | | | |
| | S-23 | 44-46 | | | | | | | | | | |
| Average: | | | | 23.24 | 111.51 | 96.48 | 59.3 | 27 | 41.3 | $2.3\times10^{-5}$ | $1.75\times10^{-5}$ | (3) 3.27 |

*1 Effective Cohesion (psf)*
*2 Effective Angle of Internal Friction (degrees)*
*3 Unconfined Compressive Strength (tsf)*

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Table 4.2 (cont'd)

## SUMMARY OF GEOTECHNICAL TESTING RESULTS BY STRATIGRAPHIC UNIT

*City of Kingsville MSWLF, Permit 235 B*

*Kingsville, Texas*

| Boring No. Ground El. (ft MSL) | Sample Number | Depth (ft bgs) | USCS | Water Content (%) | Wet Density (pcf) | Dry Density (pcf) | Liquid Limit (%) | Plastic Index (%) | #200 Sieve (%) | Permeability | | Other Tests Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | Vertical (cm/sec) | Horizontal (cm/sec) | |
| **Clayey Sand (Clay Dune) (IV) Unit** | | | | | | | | | | | | |
| B-16 | S-9 | 18-20 | Sp-SC | 22.3 | | | 43 | 13 | 24 | | | |
| | S-10 | 20-22 | | | | | | | | | | |
| | S-11 | 23-24 | | | | | | | | | | |
| | S-12 | 24-25 | | | | | | | | | | |
| | S-13 | 25-26 | | | | | | | | | | |
| | S-14 | 26-29 | SC | 24.5 | | | 50 | 29 | 30 | | | |
| | S-15 | 29-31 | | | | | | | | | | |
| | S-16 | 31-33 | | | | | | | | | | |
| | S-17 | 33-35 | SC | 19.4 | | | 41 | 24 | 46 | $1.2x10^{-5}$ | | |
| | S-18 | 35-37 | SC | 21 | | | | | | $4x10^{-6}$ | | |
| | S-19 | 37-39 | | | | | | | | | | |
| | S-20 | 39-41 | | | | | | | | | | |
| | S-21 | 41-43 | | | | | | | | | | |
| B-23 | S-11 | 20-22 | | | | | | | | | | |
| | S-12 | 22-24 | | | | | | | | | | (3) 2.0 |
| | S-13 | 24-26 | | | | | | | | | | (3) 2.3 |
| | S-14 | 26-28 | | | | | | | | | | |
| | S-15 | 28-30 | | | | | | | | | | |
| | S-16 | 30-32 | | | | | | | | | | (3) 4.5 |
| | S-17 | 32-34 | | | | | | | | | | |
| | S-18 | 34-36 | | | | | | | | | | (3) 3.0 |
| Average: | | | | 21.8 | 116.5 | 96.48 | 52 | 21.13 | 18.83 | $3.3x10^{-6}$ | | (3) 2.75 |

*1 Effective Cohesion (psf)*
*2 Effective Angle of Internal Friction (degrees)*
*3 Unconfined Compressive Strength (tsf)*

Table 4.2 (cont'd)

## SUMMARY OF GEOTECHNICAL TESTING RESULTS BY STRATIGRAPHIC UNIT

*City of Kingsville MSWLF, Permit 235 B*

*Kingsville, Texas*

| Boring No. Ground El. (ft MSL) | Sample Number | Depth (ft bgs) | USCS | Water Content (%) | Wet Density (pcf) | Dry Density (pcf) | Liquid Limit (%) | Plastic Index (%) | #200 Sieve (%) | Permeability | | Other Tests Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | Vertical (cm/sec) | Horizontal (cm/sec) | |
| **Sandy (Silty) Clay Unit** | | | | | | | | | | | | |
| B-1 | S-17 | 35-36 | | | | | | | | | | |
| | S-18 | 40-41 | | | | | | | | | | |
| B-2 | S-6 | 23-25 | | 8.3 | | 99 | | | | | | |
| | S-7 | 25-27 | | | | | | | | $5.6 \times 10^{-6}$ | | (3) 4.5 |
| B-3 | S-3 | 29-31 | | | | | | | | | | |
| | S-4 | 32-34 | | | | | | | | | | |
| B-4 | S-7 | 28-30 | | | | | | | | | | |
| | S8 | 33-35 | | | | | | | | | | |
| | S-9 | 38-40 | | | | | | | | | | |
| B-5 | S-8 | 33-35 | | | | | | | | | | (3) 4.2 |
| | S-9 | 38-40 | | | | | | | | | | |
| | S-10 | 46-48 | | | | | | | | | | |
| B-6 | S-7 | 33-35 | | | | | | | | | | |
| | S-8 | 38-40 | | | | | | | | | | |
| B-9 | S-5 | 36-48 | | | | | | | | | | |
| B-9R | S-2 | 10-12 | | | | | | | | | | |
| | S-3 | 15-17 | | | | | | | | | | |
| B-10 | S-4 | 11-12 | | | | | | | | | | |
| | S-5 | 13-14 | | | | | | | | | | |
| | S-6 | 14-15 | | | | | | | | | | |
| | S-7 | 15-16 | | | | | | | | | | |
| | S-8 | 17-19 | | | | | | | | | | |
| | S-9 | 19-29 | | | | | | | | | | |

*1 Effective Cohesion (psf)*
*2 Effective Angle of Internal Friction (degrees)*
*3 Unconfined Compressive Strength (tsf)*

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Table 4.2 (cont'd)

**SUMMARY OF GEOTECHNICAL TESTING RESULTS BY STRATIGRAPHIC UNIT**

*City of Kingsville MSWLF, Permit 235 B*

*Kingsville, Texas*

| Boring No. Ground El. (ft MSL) | Sample Number | Depth (ft bgs) | USCS | Water Content (%) | Wet Density (pcf) | Dry Density (pcf) | Liquid Limit (%) | Plastic Index (%) | #200 Sieve (%) | Permeability Vertical (cm/sec) | Permeability Horizontal (cm/sec) | Other Tests Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Sandy (Silty) Clay Unit** | | | | | | | | | | | | |
| B-11 | S-7 | 31-35 | | | | | | | | | | |
| | S-8 | 36-40 | | | | | | | | | | |
| | S-9 | 41-45 | | | | | | | | | | |
| | S-10 | 46-48 | | | | | | | | | | |
| B-12 | S-6 | 14-19 | SC | 19.1 | 121.84 | 102.3 | 51 | 28 | 48 | | | (3) 1.7 |
| | S-7 | 19-24 | SC | 23.6 | 118.76 | 96.1 | 48 | 26 | 33 | | | (3) 2.4 |
| | S-8 | 24-29 | CH | | | | | | | | | |
| | S-9 | 29-34 | CH | 24.7 | | | 53 | 29 | | | | |
| | S-10 | 34-36 | CH | 23.2 | | | 51 | 24 | | | | |
| | S-11 | 36-39 | CH | 25.2 | | | | | 51 | | | |
| B-13 | S-6 | 15-20 | CH | | | | 59 | 36 | | | | |
| | S-7 | 20-25 | CH | 21.3 | | | 59 | 29 | | | | |
| | S-8 | 25-26 | CH | 21.3 | 114.94 | 94.8 | | | | $3.4x10^{-7}$ | $5x10^{-6}$ | |
| B-14 | S-4 | 11-15 | CH | 19 | 113.11 | 95.1 | 63 | 37 | | | $5x10^{-7}$ | |
| | S-5 | 15-20 | CH | 22.2 | | | | | | | | |
| | S-6 | 20-25 | CH | 24.8 | 108.57 | 86.99 | 58 | 33 | | $6.9x10^{-5}$ | | |
| | S-7 | 25-30 | SC | 28.5 | | | | | 46 | | | |
| | S-8 | 30-33 | CL | 29.3 | 114.2 | 88.3 | 50 | 27 | 66 | | | |
| | S-9 | 33-34 | CH | 25.7 | 123.66 | 98.64 | 61 | 33 | | $1.2x10^{-7}$ | | |
| | S-10 | 34-35 | | | | | | | | | | |
| | S-11 | 35-37 | CH | 26 | 104.29 | 82.1 | 64 | 37 | 85 | | | |
| | S-12 | 39-40 | CL | 29.5 | | | 41 | 15 | | | | |

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*1 Effective Cohesion (psf)*
*2 Effective Angle of Internal Friction (degrees)*
*3 Unconfined Compressive Strength (tsf)*

Table 4.2 (cont'd)

**SUMMARY OF GEOTECHNICAL TESTING RESULTS BY STRATIGRAPHIC UNIT**

*City of Kingsville MSWLF, Permit 235 B*

*Kingsville, Texas*

| Boring No. Ground El. (ft MSL) | Sample Number | Depth (ft bgs) | USCS | Water Content (%) | Wet Density (pcf) | Dry Density (pcf) | Liquid Limit (%) | Plastic Index (%) | #200 Sieve (%) | Permeability Vertical (cm/sec) | Permeability Horizontal (cm/sec) | Other Tests Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Sandy (Silty) Clay Unit** | | | | | | | | | | | | |
| B-15 | S-1 | 0-2 | | | | | | | | | | |
| | S-2 | 5-10 | SC | 12.3 | 126.4 | 112.6 | 30 | 19 | 47 | | | |
| | S-3 | 10-12 | CL | 11.6 | | | | | 51 | | | |
| | S-4 | 12-13 | CH | 12.9 | 113.38 | 100.4 | | | | | | (1) 200 (2) 21 (3) 1.55 |
| | S-5 | 13-14 | CH | 15.3 | | | 68 | 46 | 55 | $3x10^{-7}$ | | |
| | S-6 | 14-16 | CH | 15.3 | 97.04 | 84.2 | 79 | 56 | | | | |
| | S-7 | 16-19 | CH | 15.3 | | | 79 | 56 | 65 | | | |
| | S-8 | 19-22 | CH | 21.2 | | | 83 | 60 | | | | |
| | S-9 | 22-23 | | | | | | | | | | |
| | S-10 | 23-24 | CH | 20.1 | | | | | | $2.4x10^{-7}$ | | (3) 1.56 |
| | S-11 | 24-25 | CH | 21.3 | 121.79 | 100 | 50 | 32 | 53 | | | (1) 200 (2) 24 (3) 1.53 |
| | S-12 | 25-28 | CH | 26.5 | | | 52 | 35 | 58 | | | |
| | S-13 | 28-29 | CH | 29 | | | | | | | | |
| | S-14 | 29-31 | | | | | | | | | | |
| | S-15 | 31-37 | | | | | | | | | | |
| B-16 | S-1 | 0-2 | CL | | | | | | | | | |
| | S-2 | 3-5 | | 9.3 | 114.66 | 104.9 | | | | | | (1) 200 (2) 24 (3) 2.9 |
| | S-3 | 5-8 | SC | 11.6 | | | 45 | 23 | 31 | | | |
| B-17 | S-6 | 10-15 | | | | | | | | | | |
| | S-7 | 15-17 | | | | | | | | | | |
| | S-8 | 17-18 | CL | 31.5 | 95.09 | 82.7 | 66 | 46 | | | | |
| | S-9 | 19-22 | | | | | | | | | | |
| | S-10 | 22-23 | | | | | | | | | | |
| | S-11 | 23-24 | | | | | | | | | | |
| | S-12 | 24-29 | CH | 38 | 108.86 | 78.9 | 74 | 52 | 83 | | | |

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*1 Effective Cohesion (psf)*
*2 Effective Angle of Internal Friction (degrees)*
*3 Unconfined Compressive Strength (tsf)*

Table 4.2 (cont'd)

**SUMMARY OF GEOTECHNICAL TESTING RESULTS BY STRATIGRAPHIC UNIT**

*City of Kingsville MSWLF, Permit 235 B*

*Kingsville, Texas*

| Boring No. Ground El. (ft MSL) | Sample Number | Depth (ft bgs) | USCS | Water Content (%) | Wet Density (pcf) | Dry Density (pcf) | Liquid Limit (%) | Plastic Index (%) | #200 Sieve (%) | Permeability Vertical (cm/sec) | Permeability Horizontal (cm/sec) | Other Tests Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Sandy (Silty) Clay Unit** | | | | | | | | | | | | |
| B-18 | S-8 | 19-21 | | | | | | | | | | |
| | S-9 | 21-23 | | | | | | | | | | |
| | S-10 | 24-29 | CH | 26.5 | | | 66 | 47 | 78 | | | |
| | S-11 | 29-30 | CH | 31.9 | | | | | | $2.3 \times 10^{-7}$ | | |
| | S-12 | 30-31 | | | | | | | | | | |
| | S-13 | 31-34 | | | | | | | | | | |
| | S-14 | 34-39 | CL | 34.9 | | | 73 | 48 | 81 | | | |
| | S-15 | 39-42 | CH | 31.1 | 106.75 | 81.4 | | | | | | (1) 200 (2) 24 (3) 1.57 |
| S-21 | S-10 | 18-20 | | | | | | | | | | (3) 2.3 |
| | S-11 | 20-22 | | | | | | | | | | (3) 2.3 |
| | S-12 | 22-24 | | | | | | | | | | (3) 3.5 |
| | S-13 | 24-26 | | | | | | | | | | (3) 4.5 |
| | S-14 | 26-28 | | | | | | | | | | (3) 4.5 |
| | S-15 | 28-30 | | | | | | | | | | (3) 4.5 |
| | S-16 | 30-32 | | | | | | | | | | (3) 4.5 |
| B-24 | S-11 | 20-22 | | | | | | | | | | (3) 4.5 |
| | S-12 | 22-24 | | | | | | | | | | (3) 4.3 |
| | S-13 | 4-26 | | | | | | | | | | (3) 4.5 |
| | S-14 | 26-28 | | | | | | | | | | (3) 4.5 |
| | S-15 | 28-30 | | | | | | | | | | (3) 4.5 |
| | S-16 | 30-32 | | | | | | | | | | |
| | S-17 | 32-34 | | 36.4 | | | 79 | 38 | 80 | $8.3 \times 10^{-7}$ | | |
| | | | | | | | | | | | | |

*1 Effective Cohesion (psf)*
*2 Effective Angle of Internal Friction (degrees)*
*3 Unconfined Compressive Strength (tsf)*

Table 4.2 (cont'd)

**SUMMARY OF GEOTECHNICAL TESTING RESULTS BY STRATIGRAPHIC UNIT**

*City of Kingsville MSWLF, Permit 235 B*

*Kingsville, Texas*

| Boring No. Ground El. (ft MSL) | Sample Number | Depth (ft bgs) | USCS | Water Content (%) | Wet Density (pcf) | Dry Density (pcf) | Liquid Limit (%) | Plastic Index (%) | #200 Sieve (%) | Permeability | | Other Tests Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | Vertical (cm/sec) | Horizontal (cm/sec) | |
| **Sandy (Silty) Clay Unit** | | | | | | | | | | | | |
| B-25 | S-17 | 32-34 | | | | | | | | | | (3) 3.8 |
| | S-18 | 34-36 | | | | | | | | | | |
| | S-19 | 36-38 | | | | | | | | | | (3) 2.8 |
| | S-20 | 38-40 | | | | | | | | | | (3) 3.8 |
| | S-21 | 40-42 | | | | | | | | | | (3) 2.5 |
| | S-22 | 42-44 | | | | | | | | | | (3) 4.3 |
| | S-23 | 44-46 | | | | | | | | | | (3) 4.3 |
| | S-24 | 46-48 | | | | | | | | | | (3) 3.3 |
| | S-25 | 48-50 | | | | | | | | | | |
| | S-26 | 50-52 | | | | | | | | | | (3) 3.0 |
| Average: | | | | 23.3 | 112.7 | 93.1 | 60.1 | 39.1 | 59.5 | $1.02 \times 10^{-5}$ | $2.75 \times 10^{-6}$ | (1) 200 (2) 24 (3) 3.84 |

*1 Effective Cohesion (psf)*
*2 Effective Angle of Internal Friction (degrees)*
*3 Unconfined Compressive Strength (tsf)*

Table 4.2 (cont'd)

**SUMMARY OF GEOTECHNICAL TESTING RESULTS BY STRATIGRAPHIC UNIT**

*City of Kingsville MSWLF, Permit 235 B*

*Kingsville, Texas*

| Boring No. Ground El. (ft MSL) | Sample Number | Depth (ft bgs) | USCS | Water Content (%) | Wet Density (pcf) | Dry Density (pcf) | Liquid Limit (%) | Plastic Index (%) | #200 Sieve (%) | Permeability Vertical (cm/sec) | Permeability Horizontal (cm/sec) | Other Tests Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Light Olive Green Clay (Aquiclude) Unit** | | | | | | | | | | | | |
| B-12 | S-12 | 41-46 | | | | | | | | | | |
| | S-13 | 46-47 | | 29 | | | | | | | | |
| | S-14 | 47-48 | | 30.2 | | | 59 | 25 | | | | |
| B-16 | S-21 | 41-43 | | | | | | | | | | |
| | S-22 | 43-45 | | | | | | | | | | |
| | S-23 | 45-47 | | 30.6 | | | 79 | 51 | 83 | | | |
| B-17 | S-13 | 29-31 | | | | | | | | | | |
| | S-14 | 31-32 | | 23 | | | | | | | | |
| | S-15 | 32-33 | | | | | | | | | | (3) 2.27 |
| B-21 | S-24 | 46-48 | | | | | | | | | | (3) 4.5 |
| | S-25 | 48-50 | | | | | | | | | | (3) 4.0 |
| | S-26 | 50-52 | | 37.8 | | | 75 | 40 | 95 | $1.99 \times 10^{-9}$ | | (3) 4.5 |
| | S-27 | 52-54 | | | | | | | | | | (3) 4.5 |
| | S-28 | 54-56 | | | | | | | | | | (3) 4.5 |
| | S-29 | 56-58 | | | | | | | | | | (3) 4.5 |
| | S-30 | 58-60 | | | | | | | | | | (3) 3.8 |
| | S-31 | 60-62 | | | | | | | | | | (3) 4.5 |
| | S-32 | 62-64 | | 27.7 | | | 51 | 25 | 86 | $3 \times 10^{-8}$ | | (3) 4.5 |
| | S-33 | 64-66 | | | 119.8 | 94.2 | | | | | | (3) 4.5 |
| | S-34 | 66-68 | | | | | | | | | | (3) 4.5 |
| | S-35 | 68-70 | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |

*1 Effective Cohesion (psf)*
*2 Effective Angle of Internal Friction (degrees)*
*3 Unconfined Compressive Strength (tsf)*

Table 4.2 (cont'd)

## SUMMARY OF GEOTECHNICAL TESTING RESULTS BY STRATIGRAPHIC UNIT

*City of Kingsville MSWLF, Permit 235 B*

*Kingsville, Texas*

| Boring No. Ground El. (ft MSL) | Sample Number | Depth (ft bgs) | USCS | Water Content (%) | Wet Density (pcf) | Dry Density (pcf) | Liquid Limit (%) | Plastic Index (%) | #200 Sieve (%) | Permeability Vertical (cm/sec) | Permeability Horizontal (cm/sec) | Other Tests Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Light Olive Green Clay (Aquiclude) Unit** | | | | | | | | | | | | |
| B-21 | S-36 | 70-72 | | | | | | | | | | (3) 2.5 |
| | S-37 | 72-74 | | | | | | | | | | (3) 3.5 |
| | S-38 | 74-76 | | | | | | | | | | (3) 2.8 |
| | S-39 | 76-78 | | | | | | | | | | (3) 3.0 |
| | S-40 | 78-80 | | 24.6 | | | 62 | 33 | 78 | $1.56 \times 10^{-8}$ | | (3) 4.0 |
| | S-41 | 80-82 | | | | | | | | | | (3) 4.5 |
| | S-42 | 82-84 | | | | | | | | | | (3) 4.5 |
| B-23 | S-19 | 36-38 | | 36.9 | | | 73 | 37 | 88 | $4.4 \times 10^{-8}$ | | (3) 3.8 |
| | S-20 | 38-40 | | | | | | | | | | (3) 4.3 |
| | S-21 | 40-42 | | | | | | | | | | (3) 4.5 |
| | S-22 | 42-44 | | | | | | | | | | (3) 4.5 |
| | S-23 | 44-46 | | | | | | | | | | (3) 4.5 |
| | S-24 | 46-48 | | | | | | | | $1.6 \times 10^{-8}$ | | (3) 4.5 |
| | S-25 | 48-50 | | | | | | | | | | (3) 3.0 |
| | S-26 | 50-52 | | | | | | | | | | (3) 4.0 |
| | S-27 | 52-54 | | | | | | | | | | (3) 4.5 |
| | S-28 | 54-56 | | | | | | | | | | (3) 4.3 |
| | S-29 | 56-58 | | | | | | | | | | (3) 4.5 |
| | S-30 | 58-60 | | 27.7 | | | 62 | 32 | 80 | | | (3) 4.5 |
| | S-31 | 60-62 | | | | | | | | | | (3) 4.5 |
| | S-32 | 62-64 | | | | | | | | | | (3) 4.5 |
| | S-33 | 64-66 | | | | | | | | | | (3) 4.5 |
| | S-34 | 66-68 | | 24.3 | | | 59 | 31 | 76 | $3.8 \times 10^{-8}$ | | (3) 2.8 |
| | S-35 | 68-70 | | | | | | | | | | (3) 4.0 |

*1 Effective Cohesion (psf)*
*2 Effective Angle of Internal Friction (degrees)*
*3 Unconfined Compressive Strength (tsf)*

Table 4.2 (cont'd)
**SUMMARY OF GEOTECHNICAL TESTING RESULTS BY STRATIGRAPHIC UNIT**
*City of Kingsville MSWLF, Permit 235 B*
*Kingsville, Texas*

| Boring No. Ground El. (ft MSL) | Sample Number | Depth (ft bgs) | USCS | Water Content (%) | Wet Density (pcf) | Dry Density (pcf) | Liquid Limit (%) | Plastic Index (%) | #200 Sieve (%) | Permeability Vertical (cm/sec) | Permeability Horizontal (cm/sec) | Other Tests Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Light Olive Green Clay (Aquiclude) Unit** | | | | | | | | | | | | |
| B-23 | S-36 | 70-72 | | | | | | | | | | (3) 3.3 |
| | S-37 | 72-74 | | | | | | | | | | (3) 2.5 |
| | S-38 | 74-76 | | | | | | | | | | (3) 4.3 |
| | S-39 | 76-78 | | | | | | | | | | |
| | S-40 | 78-80 | | | | | | | | | | |
| | S-41 | 80-82 | | | | | | | | | | |
| | S-42 | 82-84 | | | 125.8 | 105.3 | | | | | | (3) 4.5 |
| | S-43 | 84-86 | | | | | | | | | | (3) 4.5 |
| B-24 | S-17 | 32-34 | | 36.4 | | | 79 | 38 | 80 | | | |
| | S-18 | 34-36 | | | | | | | | | | (3) 4.3 |
| | S-19 | 36-38 | | | | | | | | $1.33 \times 10^{-9}$ | | (3) 4.5 |
| | S-20 | 38-40 | | | | | | | | | | (3) 4.5 |
| | S-21 | 40-42 | | | | | | | | | | (3) 4.5 |
| | S-22 | 42-44 | | | | | | | | | | (3) 4.5 |
| | S-23 | 44-46 | | | | | | | | | | (3) 3.5 |
| | S-24 | 46-48 | | | | | | | | | | (3) 4.5 |
| | S-25 | 48-50 | | | | | | | | | | (3) 4.5 |
| | S-26 | 50-52 | | 27.7 | | | 71 | 36 | 68 | $3.28 \times 10^{-9}$ | | (3) 4.5 |
| | S-27 | 52-54 | | | 114.5 | 86.2 | | | | | | (3) 4.5 |
| | S-28 | 54-56 | | | | | | | | | | (3) 4.5 |
| | S-29 | 56-58 | | | | | | | | | | (3) 2.3 |
| | S-30 | 58-60 | | | | | | | | | | (3) 4.5 |
| | | | | | | | | | | | | |

*1 Effective Cohesion (psf)*
*2 Effective Angle of Internal Friction (degrees)*
*3 Unconfined Compressive Strength (tsf)*

Table 4.2 (cont'd)

## SUMMARY OF GEOTECHNICAL TESTING RESULTS BY STRATIGRAPHIC UNIT

*City of Kingsville MSWLF, Permit 235 B*
*Kingsville, Texas*

| Boring No. Ground El. (ft MSL) | Sample Number | Depth (ft bgs) | USCS | Water Content (%) | Wet Density (pcf) | Dry Density (pcf) | Liquid Limit (%) | Plastic Index (%) | #200 Sieve (%) | Permeability Vertical (cm/sec) | Permeability Horizontal (cm/sec) | Other Tests Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Light Olive Green Clay (Aquiclude) Unit** | | | | | | | | | | | | |
| B-24 | S-31 | 60-62 | | | | | | | | | | (3) 4.3 |
| | S-32 | 62-64 | | | | | | | | | | (3) 1.8 |
| | S-33 | 64-66 | | | | | | | | | | (3) 4.5 |
| | S-34 | 66-68 | | 17.7 | | | 50 | 30 | 66 | | | (3) 4.5 |
| | S-35 | 68-70 | | | | | | | | $1.21 \times 10^{-8}$ | | (3) 3.5 |
| | S-36 | 70-72 | | | | | | | | | | (3) 3.0 |
| B-25 | S-27 | 52-54 | | 31.8 | | | 77 | 43 | 87 | $2.45 \times 10^{-8}$ | | (3) 4.5 |
| | S-28 | 54-56 | | | | | | | | | | (3) 4.5 |
| | S-29 | 56-58 | | | | | | | | | | (3) 4.5 |
| | S-30 | 58-60 | | | 139 | 104.3 | | | | | | (3) 4.5 |
| | S-31 | 60-62 | | | | | | | | | | (3) 4.5 |
| | S-32 | 62-64 | | | | | | | | | | (3) 4.5 |
| | S-33 | 64-66 | | 30.5 | | | 77 | 39 | 92 | $2.3 \times 10^{-8}$ | | (3) 4.5 |
| | S-34 | 66-68 | | | | | | | | | | (3) 4.5 |
| | S-35 | 68-70 | | | | | | | | | | (3) 4.5 |
| | S-36 | 70-72 | | | | | | | | | | (3) 4.5 |
| | S-37 | 72-74 | | | | | | | | | | (3) 4.5 |
| | S-38 | 74-76 | | | | | | | | | | (3) 4.5 |
| | S-39 | 76-78 | | | | | | | | | | (3) 4.5 |
| | S-40 | 78-80 | | 20.5 | | | 58 | 31 | 68 | $6.18 \times 10^{-8}$ | | (3) 4.5 |
| | S-41 | 80-82 | | | | | | | | | | (3) 4.5 |
| | S-42 | 82-84 | | | | | | | | | | (3) 4.5 |
| | S-43 | 84-86 | | | | | | | | | | (3) 4.5 |
| | S-44 | 86-88 | | | | | | | | | | (3) 4.5 |
| | | | | | | | | | | | | |
| Average: | | | | 28.53 | 124.78 | 97.5 | 66.57 | 35.07 | 80.54 | $3.31 \times 10^{-8}$ | | (3) 4.15 |

*1 Effective Cohesion (psf)*
*2 Effective Angle of Internal Friction (degrees)*
*3 Unconfined Compressive Strength (tsf)*

(elevation 60 NGVD) and proceeding up at a 4H:1V slope to elevation 119 feet NGVD, then along a 6 percent slope to a maximum peak elevation of 125 feet NGVD. After determining the maximum landfill height and side slopes, hundreds of trial failure surfaces were generated to verify the slope stability. The assumptions made for the slope stability analyses are as follows:

1) The potentiometric head will be one and one half feet below the elevation of the top of the protective soil cover above the sumps. (The Protective Soil cover above the sump is 42.5' MSL; GW level is 410' MSL)

2) The landfill will slope approximately two percent along the base. The slope stability analyses was performed assuming a flat bottom.

3) A two-foot compacted cohesive soil liner (covered by synthetic geoclay liner) with a cohesion intercept of 200 psf and a total density of 112 pcf will be placed along the excavation sideslopes and over the bottom of the landfill.

4) A textured (double-sided) 60-mil HDPE geomembrane will be placed over the compacted cohesive soil liner along the base and sideslopes of new landfill cells 2 through 7. An angle of internal friction of 20 degrees was assumed for the soil/HDPE geomembrane interface.

5) The granular drainage blanket for the leachate collection system was conservatively assumed to have a similar strength characteristics as the solid waste.

6) Various resources were investigated to determine geotechnical design strength values for the solid waste. A significant amount of research has been conducted since 1988 on the subject of slope stability modeling techniques for waste fills. Based on these resources, F.E.E., Inc. used an average total density of 32 pcf, a cohesion intercept of 1000 psf , and an angle of internal friction of 20 degrees for the solid waste.

7) The final cover load was not included in the analyses since it's contribution to the driving force will be negligible.

8) The minimum allowable factor of safety will be 2.0 for static loading conditions.

9) Based on excavation depths, the relatively strong underlying in-situ soils, and the low interface friction angle of the cohesive soil/smooth HDPE liner, the most critical failure will be a block-type failure along the compacted cohesive soil/smooth HDPE geomembrane interface located in the existing landfill area.

10) The perimeter levee fill was assumed to have the same geotechnical properties as

as the compacted cohesive soil liner.

8.3.1.2 Open Cut Excavation Slopes

Slope stability analyses were performed on temporary open cut excavations from crest of perimeter levee elevation 60 feet NGVD to average base grade elevation 40 feet NGVD at both 4H:1V and 3H:1V sideslopes. The 3H:1V was selected. The cross sections consist of a typical open cut excavation. A perimeter levee was included in the model. The excavation sideslopes were analyzed using short-term soil strength properties based on the sampling and testing of soils underlying the landfill area. A long-term strength analysis was not performed since the excavation will be backfilled with refuse prior to the development of long-term strength characteristics. Minimum factor of safety of 2.55 was calculated for circular-type failure surfaces, respectively. Both exceed the minimum design factor of safety requirement of 2.0 for static loading conditions. The open cut excavation slope stability calculations are presented in Appendix H.1.

8.3.2 Settlement Analysis

The settlement analysis was performed by Mr Ralph N. Lewis of Professional Services, Inc. (PSI). His calculations show that conservatively the final landfill cover will settle 3.0 inches at the center and 1.5 inches at the edge of the landfill. The settlement calculations are shown in Appendix H.2

8.3.3 Perforated Pipe

The maximum anticipated deflection of the leachate collection system pipe due to the loads imposed by the waste overburden was analyzed using the Driscopipe Design Manual and Spangler's modified formula. The sections where pipes are under maximum loading conditions were analyzed for the six-inch diameter, SDR 17 HDPE or Schedule 80 PVC perforated collection lines that are located in trenches along the floor of the landfill. The results of the calculations indicated an estimated maximum deflection of approximately 1.0 percent (0.064 inches) for the six-inch diameter collection lines under maximum loading conditions. These deflections are within the maximum allowable cross-sectional deflection of 4.2 percent for HDPE, as recommended by Driscopipe and 5.0 percent for PVC, as recommended by American Water Works Association. The perforated pipe deflection calculations are presented in Appendix H.3.

8.3.4 Liner Puncture Resistance

The puncture resistance of the protective geotextile fabric wrapped around the gravel in the leachate collection system was analyzed. The most critical case for puncture will occur when the drainage sand is placed over the geotextile. During placement of the

#### 8.4.2 Composite Liner System

In accordance with the requirements of the 30TAC §330.200, the liner system to be installed in cells 2 through 7 will consist of a minimum one -foot thick compacted soil liner with a hydraulic conductivity of $1x10^{-5}$ cm/sec or less, overlain by a GeoClay synthetic liner, overlain by a 60-mil HDPE liner. This composite liner system will be installed over the entire floor and sideslope areas of the cells. A plan view of the completed liner system (base grades) is shown on Figures 15.2 through 15. 7 of Attachment 15. The composite liner system (compacted cohesive soil and flexible membrane liner) shall be constructed using the guidelines of the Soils and Liner Quality Control Plan presented as Attachment 10 of the Site Development Plan (Part III).

#### 8.4.3 Leachate Collection System

The design of the leachate collection system (LSC) for new cells within the landfill includes two-foot deep leachate collection trenches designed to collect leachate from a granular drainage layer on each side of the cell. The floor area on each side of the leachate collection pipe is sloped toward the pipe at a minimum grade of two percent. The leachate collection trenches will contain perforated, six-inch diameter SDR-17 HDPE or Schedule 80 PVC pipe surrounded by gravel. Filter geotextile will completely surround the gravel to prevent clogging of the leachate collection pipes.

A cross section through the collection trench and LCS pipe detail is shown on Figures 15.9 and 15.10 of Attachment 15. The gravel-filled collection trench is sloped on a minimum one half percent slope toward a LCS sump, located at the outer edge of the cells. A one-foot thick granular drainage layer, with a minimum permeability of $6x10^{-3}$ cm/sec, overlies the geomembrane liner and LCS trenches. A one-foot thick protective cover layer, with a minimum permeability of $1x10^{-4}$ cm/sec, will overlie the granular drainage blanket to provide protection for the LCS. Two feet of protective cover will overlie the geocomposite drainage layer if utilized in place of the granular drainage layer (see Figure 15.11).

#### 8.4.4 Landfill Closure System

The final cover design and placement will be in accordance with the final closure plan requirements. The thickness and design of the final cover are given in Attachment 12. This design is based upon the design of a combination synthetic Geoclay and 60 mil HDPE Flexible Membrane bottom liner. The final cover system is comprised of, from the bottom up, 18 inches of compacted ·earthen material with a hydraulic conductivity of $1x10^{-5}$ cm/sec or less, a flexible membrane liner, a geonet/geotextile drainage layer, and 18 inches of protective soil cover, of which the uppermost 6 inches will be soil capable of supporting native vegetation. Six inches of permeable soil (hydraulic conductivity ≥

of 72 to 88 feet below ground surface (BGS). One of these borings (No. 24) was converted into a monitor well and plugged back to the top of the aquiclude clay.

Ten (10) of the seventeen (17) monitor wells which exist at the time of this permit application are completed in or within one foot of the Light Olive Green Clay aquiclude. These ten wells include all of the wells drilled for this permit application (MW-12 through MW-18 and MW-24). Monitor well #1 is also within one foot of the aquiclude. Seven wells terminate within at least eight feet above the aquiclude. Monitor well #6 will eventually have to be moved about 45 feet south of its current location to remove it from CR 2040 right-of-way. Any wells deepened will be terminated in the aquiclude clay. The rest of the wells should be maintained but not plugged and abandoned. They will be useful for water level information. Monitor wells# 10 or #11 could be deepened by the time sector 5 becomes active as they can serve as exterior well to the active landfill. If #10 is chosen to be deepened, it should be moved south about 20 feet and out of the active area when sector 6 is activated.

As discussed in section 6.1, all of the fluvial-deltaic sand bodies above the light olive green clay aquiclude are in communication with each other. These units essentially act as one body from a hydrogeologic standpoint. The caliche bearing channel running northeast to southwest is the primary avenue for pollutant migration as indicated by the rather steep gradients in those two directions. However, the groundwater flows away from the landfill in all directions except to the northwest, currently. There were some earlier dates in which the ground water flowed toward the northwest also. Thus, the point of compliance must be around the entire landfill site. The ground water flow to the northeast (MW #14) is strongly influenced by the clay environment surrounding that well and possibly by the clay dune (III) on top of the aquiclude clay at the northwest corner of the site.

Since this is an unconfined aquifer, there is direct recharge from the surface by percolation through the soil. Ponding in the area will create hydrostatic head to accelerate this recharge process. As discussed in section 6.3.2, there are a significant number of ponds in the area of the landfill. There are fourteen potential ponds in the area of the landfill. Nine of these are permanent ponds in which the ground water intersects the surface. One of these is in the northwest quadrant of the landfill. The other eight are off site. In addition, there are five depressions on the landfill site which will hold water after extensive rainfall, but which do not intersect with the ground water table. The plan for this permit is to properly fill and compact the pond on site which intersects the ground water table, and to obtain pumps to rapidly remove water from the temporary ponds outside of the waste area to surface drainage to minimize infiltration. This is shown in Attachment 15. Both of these will serve to drastically reduce the water level in this uppermost unconfined aquifer.

Background values have been established for this MSWLF site as from the six quarters of background data from MW-1, 3, 4, 10, and 11 for permit

235-A. That data has been submitted. Present data suggest a groundwater flow direction away from the landfill site in all directions except to the northwest. Therefore, the points of compliance for the water table aquifer will be located on all sides of the MSWLF site as indicated above. It may be necessary periodically to alter the use of northwest perimeter monitor wells depending on the direction of ground water flow. The drainage ditch on FM 2619 next to MW #15 should be deepened and lined in order to minimize the infiltration on of water removed from the landfill site and pumped into surface drainage.

At the present time (235-A), this is a single unit facility. The proposed new landfill (235-B) is comprised of several sectors which will be activated in various stages of operation (i.e. closure, active, and proposed expansion).

The construction and operation of the new landfill should have a minimal impact on ground water flow with the possible exception of the extreme northwest corner. This may also be prevented by removing ponded water in depressions to surface water and by lining the ditch next to MW# 15 as described above.

The current monitor well network for Cell 1 includes existing monitor wells MW-1, 3, 4, 10, & 11. New monitor wells will be activated and the new monitor well network certified as each individual cell is activated. These certifications will be submitted to the Executive Director as required in TAC regulations. Monitor Well Site Survey data is shown in Appendix M.

The Monitor Wells have been completed as specified in TAC 330.242 specifications. The certification for these new monitor wells is given in Appendix M. Monitor wells will be constructed following ASTM guidelines. A schematic for proposed monitor wells in included as Appendix I.

As previously discussed, the Light Olive Green Clay layer in this report is the aquiclude beneath the uppermost aquifer at the site. It is, therefore, proposed that the groundwater monitoring for City of Kingsville MSWLF monitor the local uppermost aquifer as bounded by the Light Olive Green Clay. Proposed groundwater monitoring well locations, which comprise a network designed to monitor groundwater quality around the permitted landfill and expansion area, are shown on Figure 5.2 in Attachment 5. Point of compliance wells are also shown on this figure. Recommended elevations for well screens along with approximate horizontal survey coordinates at each proposed location are summarized in Table 5.3 and Table

5.6 in Attachment 5.

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As required by §330.231(e)(3), the Executive Director will be notified in writing of any changes in the direction and rate of groundwater flow that may require the installation of additional monitor wells. Any additional monitor wells installed will be addressed in a modification to the Site Development Plan.

The site groundwater monitoring network will be sampled for constituents listed in the Groundwater Sampling and Analysis Plan (GWSAP), presented as Attachment 11 of Part III. The development of background values for each constituent, and the sampling, analysis and statistical comparison procedures to be utilized in evaluation of groundwater monitoring data, are also addressed in the GWSAP.

### 9.3 Landfill Design

The information presented within this report was used in developing a geotechnical characterization of the site for utilization in the landfill design process.The characterization was used in the foundation analysis of the landfill design as related to slope stability, settlement, and constructability. The information presented in Section 7.0 "Geotechnical Characterization" and Appendix H "Engineering Design Calculation and Analysis" is provided in accordance with 30 TAC §330.203(d), to the executive director as demonstration of the foundation evaluation for the design presented within the Permit Amendment Application.

*City of Kingsville, TX Landfill - TNRCC MSW Permit #235-A*

**Ground Water Monitor Well #1**
**Measured Total Depth is 41.67 ft from top of PVC**
**All Measures from Top of PVC Well Pipe**
**Elevation** Top PVC 61.867 Feet, MSL**

| | Date | Depth to Water feet | Elevation of water feet,MSL | Comments |
|---|---|---|---|---|
| | 03-29-91 | 35.6 | 26.27 | |
| | 07-30-91 | 34.5 | 27.37 | |
| | 08-08-91 | 34.69 | 27.18 | |
| | 04-14-92 | 36.88 | 24.99 | |
| | 08-11-92 | 30.02 | 31.85 | |
| | 09-28-92 | 30.6 | 31.27 | |
| | 04-05-93 | 28.61 | 33.26 | |
| * | 03-14-94 | 31.4 | 30.47 | |
| * | 05-10-95 | 29.02 | 32.85 | |
| | 07-11-96 | 29 | 32.87 | |
| | 12-23-96 | 29.85 | 32.02 | |
| | 03-20-97 | 30.53 | 31.34 | |
| | 06-25-97 | 27.79 | 34.08 | |
| | 08-04-97 | 27.67 | 34.2 | |
| | 08-18-97 | 22.94 | 38.93 | |
| | 09-02-97 | 35.64 | 26.23 | |
| | 09-15-97 | 28.28 | 33.59 | |
| | 09-29-97 | 28.39 | 33.48 | |
| | 10-16-97 | 28.57 | 33.3 | |
| | 10-28-97 | 27.5 | 34.37 | |
| | 11-10-97 | 27.1 | 34.77 | |
| | 11-24-97 | 26.69 | 35.17 | |
| | 12-08-97 | 26.36 | 35.5 | |
| | 12-22-97 | 26.19 | 35.67 | |
| | 01-05-98 | 26.05 | 35.81 | |
| | 01-20-98 | 25.88 | 35.98 | |
| | 02-02-98 | 25.92 | 35.94 | |
| | 02-18-98 | 25.67 | 36.19 | |
| | 05-18-98 | 25.21 | 36.65 | |
| | 06-16-98 | 25.54 | 36.32 | |

* City of Kingsville was responsible for the measurements during this period. (used plopper)

** All top of PVC casing elevation have been corrected to McCumber elevation survey of 07-29-97.

*City of Kingsville, TX Landfill - TNRCC MSW Permit #235-A*

**Ground Water Monitor Well #3**
**Measured Total Depth is 37.75 ft from top of PVC**
**All Measures from Top of PVC Well Pipe**
**Elevation** Top PVC 59.173 Feet, MSL**

| | Date | Depth to Water feet | Elevation of water feet | Comments |
|---|---|---|---|---|
| | 03-29-91 | 25.59 | 33.58 | |
| | 07-30-91 | 26.69 | 32.48 | |
| | 08-08-91 | 26.86 | 32.31 | |
| | 04-14-92 | 26.75 | 32.42 | |
| | 08-11-92 | 25.54 | 33.63 | |
| | 09-28-92 | 25.7 | 33.47 | |
| | 04-05-93 | 27.02 | 32.15 | |
| * | 03-14-94 | 26 | 33.17 | |
| * | 05-10-95 | 22.98 | 36.19 | |
| | 07-11-96 | 22 | 37.17 | |
| | 12-23-96 | 26.03 | 33.14 | |
| | 03-20-97 | 27.08 | 32.09 | |
| | 06-25-97 | 22.11 | 37.06 | |
| | 08-04-97 | 22.83 | 36.34 | |
| | 08-18-97 | 23.26 | 35.91 | |
| | 09-02-97 | 23.63 | 35.54 | |
| | 09-15-97 | 23.79 | 35.38 | |
| | 09-29-97 | 23.9 | 35.27 | |
| | 10-16-97 | 22.31 | 36.86 | |
| | 10-28-97 | 21.89 | 37.28 | |
| | 11-10-97 | 21.2 | 37.97 | |
| | 11-24-97 | 20.6 | 38.57 | |
| | 12-08-97 | 20.36 | 38.81 | |
| | 12-22-97 | 20.48 | 38.69 | |
| | 01-05-98 | 20.65 | 38.52 | |
| | 01-20-98 | 20.73 | 38.44 | |
| | 02-02-98 | 21 | 38.17 | |
| | 02-22-98 | 20.43 | 38.74 | |
| | 05-18-98 | 21.04 | 38.13 | |
| | 06-16-98 | 21.58 | 37.59 | |

*The City of Kingsville (COK) was responsible for depth measurements during this period. (used plopper)

** All top of PVC casing elevations have been corrected to McCumber elevation survey of 07-29-97.

*City of Kingsville, TX Landfill - TNRCC MSW Permit #235-A*

**Ground Water Monitor Well #4**
**Measured Total Depth is 40.32 ft from top of PVC**
**All Measures from Top of PVC Well Pipe**
**Elevation** Top PVC 60.125 Feet, MSL**

| | Date | Depth to Water feet | Elevation of water feet*** | Comments |
|---|---|---|---|---|
| | 03-29-91 | 23.98 | 35.15 | |
| | 07-30-91 | 23.77 | 35.36 | |
| | 08-08-91 | 24.56 | 34.57 | |
| | 04-14-92 | 27.39 | 31.74 | |
| | 08-11-92 | 26.79 | 32.34 | |
| | 09-28-92 | 30.4 | 28.73 | |
| | 04-05-93 | 30.11 | 29.02 | |
| * | 03-14-94 | 28 | 31.13 | |
| * | 05-10-95 | 25.02 | 34.11 | |
| | 07-11-96 | 26.13 | 33 | |
| | 12-23-96 | 26.32 | 32.81 | |
| | 03-20-97 | 27.33 | 31.8 | |
| | 06-25-97 | 22.28 | 36.85 | |
| | 08-04-97 | 24.24 | 35.89 | |
| | 08-18-97 | 24.76 | 35.37 | |
| | 09-02-97 | 25.04 | 35.09 | |
| | 09-15-97 | 23.84 | 36.29 | |
| | 09-29-97 | 24.6 | 35.53 | |
| | 10-16-97 | 23.16 | 36.97 | |
| | 10-28-97 | 21.81 | 38.32 | |
| | 11-10-97 | 22.19 | 37.94 | |
| | 11-24-97 | 20.65 | 39.47 | |
| | 12-08-97 | 20.52 | 39.60 | |
| | 12-22-97 | 20.73 | 39.39 | |
| | 01-05-98 | 20.99 | 39.13 | |
| | 01-20-98 | 21.24 | 38.88 | |
| | 02-02-98 | 21.52 | 38.60 | |
| | 02-18-98 | 20.72 | 39.40 | |
| | 05-18-98 | 21.96 | 38.16 | |
| | 06-16-98 | 22.69 | 37.43 | |

*The City of Kingsville (COK) was responsible for depth measurements during this period. (used plopper)

** All top of PVC casing elevations have been corrected to McCumber elevation survey of 07-29-97.

*** One foot has been subtracted from the calculated water depth for MW #4, due to the addition of a 12.00" extension to the top of the well casing between the time of measurement of depth to water and the time of the McCumber elevation survey.

*City of Kingsville, TX Landfill - TNRCC MSW Permit #235-A*

**Ground Water Monitor Well #6**
**Measured Total Depth is 39.15 ft from top of PVC**
**All Measures from Top of PVC Well Pipe**
**Elevation** Top PVC 56.604 Feet, MSL**

| | Date | Depth to Water feet | Elevation of water feet | Comments |
|---|---|---|---|---|
| | 03-29-91 | 21.35 | 35.25 | |
| | 07-30-91 | 22.02 | 34.58 | |
| | 08-08-91 | 21.44 | 35.16 | |
| | 04-14-92 | 21.92 | 34.68 | |
| | 08-11-92 | 25.25 | 31.35 | |
| | 09-28-92 | 27 | 29.6 | |
| | 04-05-93 | 27.11 | 29.49 | |
| * | 03-14-94 | 25.25 | 31.35 | |
| * | 05-10-95 | Not | measured | |
| | 07-11-96 | 26.29 | 30.31 | |
| | 12-23-96 | 28.19 | 28.41 | |
| | 03-20-97 | 28.06 | 28.54 | |
| | 06-25-97 | Not | measured | |
| | 08-04-97 | 23.31 | 33.29 | |
| | 08-18-97 | 24.01 | 32.59 | |
| | 09-02-97 | 24.53 | 32.07 | |
| | 09-15-97 | 24.69 | 31.91 | |
| | 09-29-97 | 24.48 | 32.12 | |
| | 10-16-97 | 17.74 | 38.86 | |
| | 10-28-97 | 17.59 | 39.01 | |
| | 11-10-97 | 18.3 | 38.3 | |
| | 11-24-97 | 18.23 | 38.37 | |
| | 12-08-97 | 18.35 | 38.25 | |
| | 12-22-97 | 19.11 | 37.49 | |
| | 01-05-98 | 19.42 | 37.18 | |
| | 01-20-98 | 19.55 | 37.05 | |
| | 02-02-98 | 19.11 | 37.49 | |
| | 02-18-98 | 18.64 | 37.96 | |
| | 05-18-98 | 19.30 | 37.30 | |
| | 06-16-98 | 20.38 | 36.22 | |

*The City of Kingsville (COK) was responsible for depth measurements during this period. (used plopper)

** All top of PVC casing elevations have been corrected to McCumber elevation survey of 07-29-97.

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*City of Kingsville, TX Landfill - TNRCC MSW Permit #235-A*

**Ground Water Monitor Well #8**
**Measured Total Depth is 43.65 ft from top of PVC**
**All Measures from Top of PVC Well Pipe**
**Elevation** Top PVC 61.178 Feet, MSL**

| | Date | Depth to Water feet | Elevation of water feet | Comments |
|---|---|---|---|---|
| | 03-29-91 | Not | Drill'd | |
| | 07-30-91 | 27.67 | 33.51 | |
| | 08-08-91 | 27.5 | 33.68 | |
| | 04-14-92 | 26.77 | 34.41 | |
| | 08-11-92 | 27.52 | 33.66 | |
| | 09-28-92 | 28.3 | 32.88 | |
| | 04-05-93 | 29.17 | 32.01 | |
| * | 03-14-94 | 28.1 | 33.08 | |
| * | 05-10-95 | 28.46 | 32.72 | |
| | 07-11-96 | 29.4 | 31.78 | |
| | 12-23-96 | 30.38 | 30.8 | |
| | 03-20-97 | 30.22 | 30.96 | |
| | 06-25-97 | Not | Measured | |
| | 08-04-97 | 27.37 | 33.81 | |
| | 08-18-97 | 35.36 | 25.82 | |
| | 09-02-97 | 35.76 | 25.42 | |
| | 09-15-97 | 28.42 | 32.76 | |
| | 09-29-97 | 28.14 | 33.04 | |
| | 10-16-97 | 22.07 | 39.11 | |
| | 10-28-97 | 22.74 | 38.44 | |
| | 11-10-97 | 22.73 | 38.45 | |
| | 11-24-97 | 23.06 | 38.11 | |
| | 12-08-97 | 23.83 | 37.34 | |
| | 12-22-97 | 24.38 | 36.79 | |
| | 01-05-98 | 24.72 | 36.45 | |
| | 01-20-98 | 24.91 | 36.26 | |
| | 02-02-98 | 24.72 | 36.45 | |
| | 02-18-98 | 23.14 | 38.03 | |
| | 05-18-98 | 25.19 | 35.98 | |
| | 06-16-98 | 25.89 | 35.28 | |

*The City of Kingsville (COK) was responsible for depth measurements during this period. (used plopper)

** All top of PVC casing elevations have been corrected to McCumber elevation survey of 07-29-97.

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*City of Kingsville, TX Landfill - TNRCC MSW Permit #235-A*

**Ground Water Monitor Well #9R**
**Measured Total Depth is 18.29 ft from top of PVC**
**All Measures from Top of PVC Well Pipe**
**Elevation** Top PVC 44.849 Feet, MSL**

| Date | Depth to Water feet | Elevation of water feet | Comments |
|---|---|---|---|
| 03-29-91 | Not | Drill'd | |
| 07-30-91 | Not | Drill'd | |
| 08-08-91 | Not | Drill'd | |
| 04-14-92 | Not | Drill'd | |
| 08-11-92 | Not | Drill'd | |
| 09-28-92 | Not | Drill'd | |
| 04-05-93 | Not | Drill'd | |
| 03-14-94 | Not | Drill'd | |
| 05-10-95 | Not | Drill'd | |
| 07-11-96 | 12.57 | 32.28 | |
| 12-23-96 | 14.02 | 30.83 | |
| 03-20-97 | 13.76 | 31.09 | |
| 06-25-97 | Not | Measured | |
| 08-04-97 | 10.49 | 34.36 | |
| 08-18-97 | 10.56 | 34.29 | |
| 09-02-97 | 10.45 | 34.4 | |
| 09-15-97 | 10.43 | 34.42 | |
| 09-29-97 | 9.85 | 35 | |
| 10-16-97 | 9.85 | 35 | |
| 10-28-97 | 9.85 | 35 | |
| 11-10-97 | 9.85 | 35 | |
| 11-24-97 | 6.10 | 38.74 | |
| 12-08-97 | 6.35 | 38.49 | |
| 12-22-97 | 6.60 | 38.24 | |
| 01-05-98 | 6.93 | 37.91 | |
| 01-20-98 | 7.35 | 37.49 | |
| 02-02-98 | 6.24 | 38.60 | |
| 02-18-98 | 6.23 | 38.61 | |
| 05-18-98 | 7.93 | 36.91 | |
| 06-16-98 | 8.65 | 36.19 | |

** All top of PVC casing elevations have been corrected to McCumber elevation survey of 07-29-97.

*City of Kingsville, TX Landfill - TNRCC MSW Permit #235-A*

**Ground Water Monitor Well #10**
**Measured Total Depth is 31.48 ft from top of PVC**
**All Measures from Top of PVC Well Pipe**
**Elevation*** Top PVC 52.684 Feet, MSL**

| | Date | Depth to Water feet | Elevation of water feet | Comments |
|---|---|---|---|---|
| | 03-29-91 | Not | Drill'd | |
| | 07-30-91 | Not | Drill'd | |
| | 08-08-91 | Not | Drill'd | |
| | 04-14-92 | 18.49 | 34.19 | |
| | 08-11-92 | 16.59 | 36.09 | |
| | 09-28-92 | 18.9 | 33.78 | |
| | 04-05-93 | 17.76 | 34.92 | |
| * | 03-14-94 | 17.5 | 35.18 | |
| * | 05-10-95 | 19.02 | 33.66 | |
| ** | 07-11-96 | 19.36 | 33.32 | |
| | 12-23-96 | 20.91 | 31.77 | |
| | 03-20-97 | 21.33 | 31.35 | |
| | 06-25-97 | 17.35 | 35.33 | |
| | 08-04-97 | 18.16 | 34.52 | |
| | 08-18-97 | 18.16 | 34.52 | |
| | 09-02-97 | 18.31 | 34.37 | |
| | 09-15-97 | 18.32 | 34.36 | |
| | 09-29-97 | 18.26 | 34.42 | |
| | 10-16-97 | 16.56 | 36.12 | |
| | 10-28-97 | 15.58 | 37.1 | |
| | 11-10-97 | 15.35 | 37.33 | |
| | 11-24-97 | 15.01 | 37.67 | |
| | 12-08-97 | 15.06 | 37.62 | |
| | 12-22-97 | 15.19 | 37.49 | |
| | 01-05-98 | 15.24 | 37.44 | |
| | 01-20-98 | 15.25 | 37.43 | |
| | 02-02-98 | 15.23 | 37.45 | |
| | 02-18-98 | 14.70 | 37.98 | |
| | 05-18-98 | 15.18 | 37.50 | |
| | 06-16-98 | 15.58 | 37.10 | |

*The City of Kingsville (COK) was responsible for depth measurements during this period. (used plopper)

** Due to surface water infiltration, a riser was installed and a taller casing protector was added. Three (3) foot was added to the "Top of PVC" datum point.

*** All top of PVC casings have been corrected to McCumber elevation survey of 07-29-97.

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*City of Kingsville, TX Landfill - TNRCC MSW Permit #235-A*

**Ground Water Monitor Well #11**
**Measured Total Depth is 35.21 ft from top of PVC**
**All Measures from Top of PVC Well Pipe**
**Elevation** Top PVC 62.401 Feet, MSL**

| Date | Depth to Water feet | Elevation of water feet | Comments |
|---|---|---|---|
| 03-29-91 | Not | Drill'd | |
| 07-30-91 | Not | Drill'd | |
| 08-08-91 | Not | Drill'd | |
| 04-14-92 | Not | Drill'd | |
| 08-11-92 | Not | Drill'd | |
| 09-28-92 | Not | Drill'd | |
| 04-05-93 | Not | Drill'd | |
| 03-14-94 | Not | Drill'd | |
| 05-10-95 | Not | Drill'd | |
| 07-11-96 | 28.77 | 33.63 | |
| 12-23-96 | 30.2 | 32.2 | |
| 03-20-97 | 30.69 | 31.71 | |
| 06-25-97 | 26.03 | 36.37 | |
| 08-04-97 | 27.1 | 35.3 | |
| 08-18-97 | 27.31 | 35.09 | |
| 09-02-97 | 27.45 | 34.95 | |
| 09-15-97 | 27.35 | 35.05 | |
| 09-29-97 | 27 | 35.4 | |
| 10-16-97 | 23.76 | 38.64 | |
| 10-18-97 | 22.25 | 40.15 | |
| 11-10-97 | 21.92 | 40.48 | |
| 11-24-97 | 21.72 | 40.68 | |
| 12-08-97 | 22.23 | 40.17 | |
| 12-22-97 | 22.69 | 39.71 | |
| 01-05-98 | 22.99 | 39.41 | |
| 01-20-98 | 23.22 | 39.18 | |
| 02-02-98 | 23.02 | 39.38 | |
| 02-18-98 | 22.22 | 40.18 | |
| 05-18-98 | 24.02 | 38.38 | |
| 06-16-98 | 24.90 | 37.50 | |

** All top of PVC casing elevations have been corrected to McCumber elevation survey of 07-29-97.

*City of Kingsville, TX Landfill - TNRCC MSW Permit #235*

**Ground Water Monitor Well #12**
**Elevation** Top PVC 54.879 Feet, MSL**

| Date | Depth to Water feet | Elevation of water feet | Comments |
|---|---|---|---|
| 03-29-91 | Not | Drill'd | |
| 07-30-91 | Not | Drill'd | |
| 08-08-91 | Not | Drill'd | |
| 04-14-92 | Not | Drill'd | |
| 08-11-92 | Not | Drill'd | |
| 09-28-92 | Not | Drill'd | |
| 04-05-93 | Not | Drill'd | |
| 03-14-94 | Not | Drill'd | |
| 05-10-95 | Not | Drill'd | |
| 07-11-96 | Not | Drill'd | |
| 12-23-96 | Not | Drill'd | |
| 03-20-97 | Not | Drill'd | |
| 06-25-97 | Not | Drill'd | |
| 08-04-97 | 20.97 | 33.91 | |
| 08-18-97 | 21.42 | 33.46 | |
| 09-02-97 | 21.82 | 33.06 | |
| 09-15-97 | 22.01 | 32.87 | |
| 09-29-97 | 22.09 | 32.79 | |
| 10-16-97 | 19.58 | 35.3 | |
| 10-28-97 | 19.61 | 35.27 | |
| 11-10-97 | 19.34 | 35.54 | |
| 11-24-97 | 18.65 | 36.22 | |
| 12-08-97 | 18.51 | 36.36 | |
| 12-22-97 | 18.54 | 36.33 | |
| 01-05-98 | 18.51 | 36.36 | |
| 01-20-98 | 18.49 | 36.38 | |
| 02-02-98 | 18.42 | 36.45 | |
| 02-18-98 | 17.81 | 37.06 | |
| 05-18-98 | 18.09 | 36.78 | |
| 06-16-98 | 18.82 | 36.05 | |

** All top of PVC casing elevations have been corrected to McCumber elevation survey of 07-29-97.

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**Ground Water Monitor Well #13**
**Elevation** Top PVC 62.096 Feet, MSL**

| Date | Depth to Water feet | Elevation of water feet | Comments |
|---|---|---|---|
| 03-29-91 | Not | Drill'd | |
| 07-30-91 | Not | Drill'd | |
| 08-08-91 | Not | Drill'd | |
| 04-14-92 | Not | Drill'd | |
| 08-11-92 | Not | Drill'd | |
| 09-28-92 | Not | Drill'd | |
| 04-05-93 | Not | Drill'd | |
| 03-14-94 | Not | Drill'd | |
| 05-10-95 | Not | Drill'd | |
| 07-11-96 | Not | Drill'd | |
| 12-23-96 | Not | Drill'd | |
| 03-20-97 | Not | Drill'd | |
| 06-25-97 | Not | Drill'd | |
| 08-04-97 | 28.86 | 33.24 | |
| 08-18-97 | 29.15 | 32.95 | |
| 09-02-97 | 29.16 | 32.94 | |
| 09-15-97 | 29.33 | 32.77 | |
| 09-29-97 | 29.26 | 32.84 | |
| 10-16-97 | 28.53 | 33.57 | |
| 10-28-98 | 27.55 | 34.55 | |
| 11-10-97 | 27.12 | 34.98 | |
| 11-24-97 | 26.68 | 35.41 | |
| 12-08-97 | 26.49 | 35.60 | |
| 12-22-97 | 26.61 | 35.48 | |
| 01-05-98 | 26.71 | 35.38 | |
| 01-20-98 | 26.81 | 35.28 | |
| 02-02-98 | 27.17 | 34.92 | |
| 02-18-98 | 26.62 | 35.47 | |
| 05-18-98 | 26.62 | 35.47 | |
| 06-16-98 | 27.10 | 34.99 | |

** All top of PVC casing elevations have been corrected to McCumber elevation survey of 07-29-97.

*City of Kingsville, TX Landfill - TNRCC MSW Permit #235*

**Ground Water Monitor Well #14**
**Elevation** Top PVC 52.677 Feet, MSL**

| Date | Depth to Water feet | Elevation of water feet | Comments |
|---|---|---|---|
| 03-29-91 | Not | Drill'd | |
| 07-30-91 | Not | Drill'd | |
| 08-08-91 | Not | Drill'd | |
| 04-14-92 | Not | Drill'd | |
| 08-11-92 | Not | Drill'd | |
| 09-28-92 | Not | Drill'd | |
| 04-05-93 | Not | Drill'd | |
| 03-14-94 | Not | Drill'd | |
| 05-10-95 | Not | Drill'd | |
| 07-11-96 | Not | Drill'd | |
| 12-23-96 | Not | Drill'd | |
| 03-20-97 | Not | Drill'd | |
| 06-25-97 | Not | Drill'd | |
| 08-04-97 | 25.65 | 27.03 | |
| 08-18-97 | 25.88 | 26.8 | |
| 09-02-97 | 26.05 | 26.63 | |
| 09-15-97 | 25.95 | 26.73 | |
| 09-29-97 | 25.77 | 26.91 | |
| 10-16-97 | 25.46 | 27.22 | |
| 10-28-97 | 25.08 | 27.6 | |
| 11-10-97 | 24.66 | 28.02 | |
| 11-24-97 | 24.25 | 28.42 | |
| 12-08-97 | 23.89 | 28.78 | |
| 12-22-97 | 23.64 | 29.03 | |
| 01-05-98 | 23.63 | 29.04 | |
| 01-20-98 | 23.37 | 29.30 | |
| 02-02-98 | 23.51 | 29.16 | |
| 02-18-98 | 23.10 | 29.57 | |
| 05-18-98 | 22.52 | 30.15 | |
| 06-16-98 | 22.67 | 30.00 | |

** All top of PVC casing elevations have been corrected to McCumber elevation survey of 07-29-97.

*City of Kingsville, TX Landfill - TNRCC MSW Permit #235*

**Ground Water Monitor Well #15**

**Elevation** Top PVC 51.624 Feet, MSL**

| Date | Depth to Water feet | Elevation of water feet | Comments |
|---|---|---|---|
| 03-29-91 | Not | Drill'd | |
| 07-30-91 | Not | Drill'd | |
| 08-08-91 | Not | Drill'd | |
| 04-14-92 | Not | Drill'd | |
| 08-11-92 | Not | Drill'd | |
| 09-28-92 | Not | Drill'd | |
| 04-05-93 | Not | Drill'd | |
| 03-14-94 | Not | Drill'd | |
| 05-10-95 | Not | Drill'd | |
| 07-11-96 | Not | Drill'd | |
| 12-23-96 | Not | Drill'd | |
| 03-20-97 | Not | Drill'd | |
| 06-25-97 | Not | Drill'd | |
| 08-04-97 | 17.47 | 34.15 | |
| 08-18-97 | 18.17 | 33.45 | |
| 09-02-97 | 18.47 | 33.15 | |
| 09-15-97 | 18.68 | 32.94 | |
| 09-29-97 | 18.65 | 32.97 | |
| 10-16-97 | 10.19 | 41.43 | |
| 10-28-97 | 10.16 | 41.46 | |
| 11-10-97 | 8.14 | 43.48 | |
| 11-24-97 | 8.19 | 43.43 | |
| 12-08-97 | 7.62 | 44.00 | |
| 12-22-97 | 9.05 | 42.57 | |
| 01-05-98 | 9.89 | 41.73 | |
| 01-20-98 | 10.54 | 41.08 | |
| 02-02-98 | 9.54 | 42.08 | |
| 02-18-98 | 8.91 | 42.91 | |
| 05-18-98 | 11.98 | 39.64 | |
| 06-16-98 | 13.16 | 38.46 | |

** All top of PVC casing elevations have been corrected to McCumber elevation survey of 07-29-97.

City of Kingsville, TX Landfill - TNRCC MSW Permit #235

**Ground Water Monitor Well #16**

**Elevation** Top PVC 58.839 Feet, MSL**

| Date | Depth to Water feet | Elevation of water feet | Comments |
|---|---|---|---|
| 03-29-91 | Not | Drill'd | |
| 07-30-91 | Not | Drill'd | |
| 08-08-91 | Not | Drill'd | |
| 04-14-92 | Not | Drill'd | |
| 08-11-92 | Not | Drill'd | |
| 09-28-92 | Not | Drill'd | |
| 04-05-93 | Not | Drill'd | |
| 03-14-94 | Not | Drill'd | |
| 05-10-95 | Not | Drill'd | |
| 07-11-96 | Not | Drill'd | |
| 12-23-96 | Not | Drill'd | |
| 03-20-97 | Not | Drill'd | |
| 06-25-97 | Not | Drill'd | |
| 08-04-97 | 24.21 | 34.63 | |
| 08-18-97 | 24.63 | 34.21 | |
| 09-02-97 | 24.94 | 33.9 | |
| 09-15-97 | 24.95 | 33.89 | |
| 09-29-97 | 24.81 | 34.03 | |
| 10-16-97 | 23.32 | 35.52 | |
| 10-28-97 | 22.75 | 36.09 | |
| 11-10-97 | 22.46 | 36.38 | |
| 11-24-97 | 21.94 | 36.89 | |
| 12-08-97 | 21.70 | 37.13 | |
| 12-22-97 | 21.71 | 37.12 | |
| 01-05-98 | 21.66 | 37.17 | |
| 01-20-98 | 21.67 | 37.16 | |
| 02-02-98 | 21.74 | 37.09 | |
| 02-18-98 | 21.28 | 37.55 | |
| 05-18-98 | 21.62 | 37.21 | |
| 06-16-98 | 22.27 | 36.56 | |

** All top of PVC casing elevations have been corrected to McCumber elevation survey of 07-29-97.

*City of Kingsville, TX Landfill - TNRCC MSW Permit #235*

**Ground Water Monitor Well #17**

**Elevation** Top PVC 43.868 Feet, MSL**

| Date | Depth to Water feet | Elevation of water feet | Comments |
|---|---|---|---|
| 03-29-91 | Not | Drill'd | |
| 07-30-91 | Not | Drill'd | |
| 08-08-91 | Not | Drill'd | |
| 04-14-92 | Not | Drill'd | |
| 08-11-92 | Not | Drill'd | |
| 09-28-92 | Not | Drill'd | |
| 04-05-93 | Not | Drill'd | |
| 03-14-94 | Not | Drill'd | |
| 05-10-95 | Not | Drill'd | |
| 07-11-96 | Not | Drill'd | |
| 12-23-96 | Not | Drill'd | |
| 03-20-97 | Not | Drill'd | |
| 06-25-97 | Not | Drill'd | |
| 08-04-97 | 9.33 | 34.54 | |
| 08-18-97 | 9.69 | 34.18 | |
| 09-02-97 | 9.92 | 33.95 | |
| 09-15-97 | 9.68 | 34.19 | |
| 09-29-97 | 8.99 | 34.88 | |
| 10-16-97 | 4.28 | 39.59 | |
| 10-28-97 | 4.44 | 39.43 | |
| 11-10-97 | 3.64 | 40.23 | |
| 11-24-97 | 4.01 | 39.85 | |
| 12-08-97 | 4.45 | 39.41 | |
| 12-22-97 | 4.91 | 38.95 | |
| 01-05-98 | 5.58 | 38.28 | |
| 01-20-98 | 6.13 | 37.73 | |
| 02-02-98 | 3.82 | 40.04 | |
| 02-18-98 | 4.37 | 39.49 | |
| 05-18-98 | 6.40 | 37.46 | |
| 06-16-98 | 7.40 | 36.46 | |

** All top of PVC casing elevations have been corrected to McCumber elevation survey of 07-29-97.

D-45

*City of Kingsville, TX Landfill - TNRCC MSW Permit #235*

**Ground Water Monitor Well #18**

**Elevation** Top PVC 52.438 Feet, MSL**

| Date | Depth to Water feet | Elevation of water feet | Comments |
|---|---|---|---|
| 03-29-91 | Not | Drill'd | |
| 07-30-91 | Not | Drill'd | |
| 08-08-91 | Not | Drill'd | |
| 04-14-92 | Not | Drill'd | |
| 08-11-92 | Not | Drill'd | |
| 09-28-92 | Not | Drill'd | |
| 04-05-93 | Not | Drill'd | |
| 03-14-94 | Not | Drill'd | |
| 05-10-95 | Not | Drill'd | |
| 07-11-96 | Not | Drill'd | |
| 12-23-96 | Not | Drill'd | |
| 03-20-97 | Not | Drill'd | |
| 06-25-97 | Not | Drill'd | |
| 08-04-97 | 18.61 | 33.83 | |
| 08-18-97 | 18.47 | 33.97 | |
| 09-02-97 | 18.92 | 33.52 | |
| 09-15-97 | 18.78 | 33.66 | |
| 09-29-97 | 18.71 | 33.73 | |
| 10-16-97 | 16.65 | 35.79 | |
| 10-28-97 | 15.8 | 36.64 | |
| 11-10-97 | 15.14 | 37.3 | |
| 11-24-97 | 14.62 | 37.81 | |
| 12-08-97 | 14.25 | 38.18 | |
| 12-22-97 | 14.48 | 37.95 | |
| 01-05-98 | 14.67 | 37.76 | |
| 01-20-98 | 14.88 | 37.55 | |
| 02-02-98 | 15.16 | 37.27 | |
| 02-18-98 | 14.23 | 38.20 | |
| 05-18-98 | 15.09 | 37.34 | |
| 06-16-98 | 15.92 | 36.51 | |

** All top of PVC casing elevations have been corrected to McCumber elevation survey of 07-29-97.

# THE CITY OF KINGSVILLE LANDFILL

# TCEQ PERMIT MSW 235C

## PERMIT AMENDMENT APPLICATION

## Volume 3 of 6

CITY OF KINGSVILLE, KLEBERG COUNTY, TEXAS

For Permitting Purposes Only

STATE OF TEXAS
JON M. REINHARD
64541
LICENSED
PROFESSIONAL ENGINEER
04/25/19

TBPE Firm No. F-417

September 2018
Revision 1 – November 2018
Revision 2 – February 2019
Revision 3 – April 2019

Prepared by

HANSON
Engineering | Planning | Allied Services

TBPE F-417

HANSON PROJECT NO. 16L0438-0003

K-1
MW-12

Send original copy by certified return receipt requested m[illegible] TNRCC, MC 177, P.O. Box 13087, Austin, TX 787[illegible]

**ATTENTION OWNER:** *Confidentiality Privilege Notice on on reverse side of Well Owner's copy (pink)*

# State of Texas
# WELL REPORT

**Texas Water Well Drillers Advisory Council**
MC 177
P.O. Box 13087
Austin, TX 78711-3087
512-239-0530

1) OWNER City of Kingsville (Name) ADDRESS P.O Box 1458 Kingsville TX 78363 (Street or RFD) (City) (State) (Zip)

2) ADDRESS OF WELL: County Kleberg Kingsville Landfill Kingsville TX (Street, RFD or other) (City) (State) (Zip) GRID # 83-34-4

3) TYPE OF WORK (Check): ☑ New Well ☐ Deepening ☐ Reconditioning ☐ Plugging

4) PROPOSED USE (Check): ☑ Monitor ☐ Environmental Soil Boring ☐ Domestic ☐ Industrial ☐ Irrigation ☐ Injection ☐ Public Supply ☐ De-watering ☐ Testwell
If Public Supply well, were plans submitted to the TNRCC? ☐ Yes ☐ No

5) MW-12 (SB-12)

6) WELL LOG:
Date Drilling:
Started 7-7 1997
Completed 7-7 1997

DIAMETER OF HOLE

| Dia. (in.) | From (ft.) | To (ft.) |
|---|---|---|
| 12.0 | Surface | 45.0 |
| | | |

7) DRILLING METHOD (Check): ☐ Driven ☐ Air Rotary ☐ Mud Rotary ☑ Bored ☐ Air Hammer ☐ Cable Tool ☐ Jetted ☐ Other

| From (ft.) | To (ft.) | Description and color of formation material |
|---|---|---|
| | | See attached logs |

(Use reverse side of Well Owner's copy, if necessary)

8) Borehole Completion (Check): ☐ Open Hole ☐ Straight Wall ☐ Underreamed ☐ Gravel Packed ☑ Other 16/30 Silica
If Gravel Packed give interval ... from 35.0 ft. to 23.0 ft.

CASING, BLANK PIPE, AND WELL SCREEN DATA:

| Dia. (in.) | New or Used | Steel, Plastic, etc. Perf., Slotted, etc. Screen Mfg., if commercial | Setting (ft.) From | Setting (ft.) To | Gage Casing Screen |
|---|---|---|---|---|---|
| 4 | N | PVC Screen Mfg. TRI-LOC | 35.0 | 25.0 | .010 |
| 4 | N | PVC Riser | 25.0 | +2.5 | |

9) CEMENTING DATA [Rule 338.44(1)]
Cemented from 21.0 ft. to 0.0 ft. No. of sacks used 50
___ ft. to ___ ft. No. of sacks used ___
Method used
Cemented by PSI Inc.
Distance to septic system field lines or other concentrated contamination ___ ft.
Method of verification of above distance

13) TYPE PUMP: N/A
☐ Turbine ☐ Jet ☐ Submersible ☐ Cylinder
☐ Other
Depth to pump bowls, cylinder, jet, etc., ___ ft.

10) SURFACE COMPLETION
☑ Specified Surface Slab Installed [Rule 338.44(2)(A)]
☐ Specified Steel Sleeve Installed [Rule 338.44(3)(A)]
☐ Pitless Adapter Used [Rule 338.44(3)(b)]
☐ Approved Alternative Procedure Used [Rule 338.71]

14) WELL TESTS: N/A
Type test: ☐ Pump ☐ Bailer ☐ Jetted ☐ Estimated
Yield: ___ gpm with ___ ft. drawdown after ___ hrs.

11) WATER LEVEL: N/A
Static level ___ ft. below land surface Date ___
Artesian flow ___ gpm. Date ___

15) WATER QUALITY:
Did you knowingly penetrate any strata which contained undesirable constituents?
☐ Yes ☑ No If yes, submit "REPORT OF UNDESIRABLE WATER"
Type of water? ___ Depth of strata ___
Was a chemical analysis made? ☐ Yes ☐ No

12) PACKERS:

| | Type | Depth |
|---|---|---|
| Bentonite Pellets | 1/4" | 23.0-21.0 |

I hereby certify that this well was drilled by me (or under my supervision) and that each and all of the statements herein are true to the best of my knowledge and belief. I understand that failure to complete items 1 thru 15 will result in the log(s) being returned for completion and resubmittal.

COMPANY NAME PSI Inc. (Type or print) WELL DRILLER'S LICENSE NO. 4694-M

ADDRESS [illegible] (Street or RFD) Corpus Christi (City) TX (State) 78416 (Zip)

(Signed) [illegible] (Licensed Well Driller) (Signed) ___ (Registered Driller Trainee)

Please attach electric log, chemical analysis, and other pertinent information, if available.

K-2
MW-13

Send original copy by certified return receipt requested mail to TNRCC, MC 177, P.O. Box 13087, Austin, TX 787

ATTENTION OWNER: *Confidentiality Privilege Notice on on reverse side of Well Owner's copy (pink)*

# State of Texas WELL REPORT

Texas Water Well Drillers Advisory Council
MC 177
P.O. Box 13087
Austin, TX 78711-3087
512-239-0530

1) OWNER City of Kingsville (Name) ADDRESS P.O. Box 1458 Kingsville TX 78363 (Street or RFD) (City) (State) (Zip)

2) ADDRESS OF WELL: County Kleberg Kingsville Landfill Kingsville TX (Street, RFD or other) (City) (State) (Zip) GRID # 83-34-4

3) TYPE OF WORK (Check): ☑ New Well ☐ Deepening ☐ Reconditioning ☐ Plugging

4) PROPOSED USE (Check): ☑ Monitor ☐ Environmental Soil Boring ☐ Domestic ☐ Industrial ☐ Irrigation ☐ Injection ☐ Public Supply ☐ De-watering ☐ Testwell
If Public Supply well, were plans submitted to the TNRCC? ☐ Yes ☐ No

5) MW-13 (SB-13)

6) WELL LOG:
Date Drilling:
Started 7-25 19 97
Completed 7-25 19 97

| DIAMETER OF HOLE | | |
|---|---|---|
| Dia. (in.) | From (ft.) | To (ft.) |
| 8.0 | Surface | 50.0 |

7) DRILLING METHOD (Check): ☐ Driven ☐ Air Rotary ☐ Mud Rotary ☑ Bored ☐ Air Hammer ☐ Cable Tool ☐ Jetted ☐ Other

| From (ft.) | To (ft.) | Description and color of formation material |
|---|---|---|
| | | See attached log |

(Use reverse side of Well Owner's copy, if necessary)

8) Borehole Completion (Check): ☐ Open Hole ☐ Straight Wall ☐ Underreamed ☐ Gravel Packed ☑ Other 16/30 Silica
If Gravel Packed give interval ... from 40.0 ft. to 28.0 ft.

CASING, BLANK PIPE, AND WELL SCREEN DATA:

| Dia. (in.) | New or Used | Steel, Plastic, etc. Perf., Slotted, etc. Screen Mfg., if commercial | Setting (ft.) From | Setting (ft.) To | Gage Casting Screen |
|---|---|---|---|---|---|
| 4 | N | PVC Screen mfg. TRI-LOC | 40.0 | 50.0 | .010 |
| 4 | N | PVC Riser | 30.0 | +2.5 | |

9) CEMENTING DATA [Rule 338.44(1)]
Cemented from 26.0 ft. to 0.0 ft. No. of sacks used 50
ft. to ft. No. of sacks used
Method used
Cemented by PSI Inc.
Distance to septic system field lines or other concentrated contamination ____ ft.
Method of verification of above distance

13) TYPE PUMP: N/A
☐ Turbine ☐ Jet ☐ Submersible ☐ Cylinder ☐ Other
Depth to pump bowls, cylinder, jet, etc., ____ ft.

10) SURFACE COMPLETION
☑ Specified Surface Slab Installed [Rule 338.44(2)(A)]
☐ Specified Steel Sleeve Installed [Rule 338.44(3)(A)]
☐ Pitless Adapter Used [Rule 338.44(3)(b)]
☐ Approved Alternative Procedure Used [Rule 338.71]

14) WELL TESTS: N/A
Type test: ☐ Pump ☐ Bailer ☐ Jetted ☐ Estimated
Yield: ____ gpm with ____ ft. drawdown after ____ hrs.

11) WATER LEVEL: N/A
Static level ____ ft. below land surface Date
Artesian flow ____ gpm. Date

15) WATER QUALITY:
Did you knowingly penetrate any strata which contained undesirable constituents?
☐ Yes ☑ No If yes, submit "REPORT OF UNDESIRABLE WATER"
Type of water? Depth of strata
Was a chemical analysis made? ☐ Yes ☐ No

12) PACKERS: Type Depth
Bentonite Pellets 1/4" 28.0 - 26.0

I hereby certify that this well was drilled by me (or under my supervision) and that each and all of the statements herein are true to the best of my knowledge and belief. I understand that failure to complete items 1 thru 15 will result in the log(s) being returned for completion and resubmittal.

COMPANY NAME PSI Inc. (Type or print) WELL DRILLER'S LICENSE NO. 4694-M

ADDRESS 5520 (Street or RFD) Corpus Christi (City) TX (State) 78416 (Zip)

(Signed) [signature] (Licensed Well Driller) (Signed) (Registered Driller Trainee)

Please attach electric log, chemical analysis, and other pertinent information, if available.

K-2
MW-13

*Please use black ink.*
File WHITE COPY with:
TNRCC
P.O. Box 13087, MC 177
Austin, TX 78711-3087
512-239-0530

## State of Texas
## PLUGGING REPORT

(This form must be completed and filed with the TNRCC within 30 days following the date the well is plugged as required by current statutory law.)

Texas Water Well Drillers Advisory Council
P.O. Box 13087
Austin, TX 78711-3087
512-239-0530

### A. WELL IDENTIFICATION AND LOCATION DATA

1) OWNER City of Kingsville (Name) ADDRESS P.O. Box 1458 (Street or RFD) Kingsville (City) TX (State) 78363 (Zip)

2) ADDRESS OF WELL: County Kleberg Kingsville Landfill (Street, RFD or other) Kingsville (City) TX (State) (Zip) GRID # 83-30-4

3) OWNER'S WELL NO: MW-13

4) WELL TYPE (Check): ☐ Water ☑ Monitor ☐ Injection ☐ De-watering

5)

Driller, Pump Installer, or Landowner performing the plugging operations **must** locate and identify the location of the well within a specific grid on a full scale-gridded County map available from the TNRCC/Installers Certification Program. The location of the well should be denoted within the grid by placing a corresponding dot in the grid to the right. The legal description section below is optional.

☐ LEGAL DESCRIPTION: n/a

Section No. ______ Block No. ______ Township ______

Abstract No. ______ Survey Name ______

Distance and direction from two intersecting section lines or survey lines: ______

N

### B. HISTORICAL DATA ON WELL TO BE PLUGGED (if available)

6) Driller Craig Scherer License No. 4694-M City Corpus Christi

7) Drilled 7-8 19 97 8) Diameter of hole 10.0 inches; 9) Total depth of well 40.0 feet.

### C. CURRENT PLUGGING DATA

10) Date well plugged 7-28 ,19 97

11) Sketch of well: Using space at right, show method of plugging the well including all casing and cemented intervals.

Monitor well was filled and well pressure grouted from bottom to surface.

12) Name of Driller/Pump Installer actually performing the plugging operations
Craig Scherer

License number 4694-M

13) Casing and cementing data relative to the plugging operations:

| DIAMETER (inches) | CASING LEFT IN WELL FROM (feet) | TO (feet) |
|---|---|---|
| | 0.0 | 0.0 |
| | | |
| | | |

| CEMENT PLUG(S) PLACED IN WELL FROM (feet) | TO (feet) | SACK(S) OF CEMENT USED |
|---|---|---|
| 40.0 | 0.0 | 10.0 |
| | | |
| | | |
| | | |
| | | |

### D. VALIDATION OF INFORMATION INCLUDED IN FORM

I hereby certify that this well was plugged by me (or under my supervision) and that each and all of the statements herein are true to the best of my knowledge and belief. I understand that failure to complete items 1 thru 13 will result in the report(s) being returned for completion and resubmittal.

Company or Individual's Name (*type or print*) PSI Inc

Address: Street or RFD 610 S.P.I.D. City Corpus Christi State TX Zip 78416

Signatures: Craig Scherer 8-13-97
Licensed Driller/Pump Installer Date

______ Owner of Well ______ Date

______ Trainee/Apprentice ______ Date

*White - TNRCC Yellow - Well Owner Pink - Licensed Well Driller/Pump Installer*

K-4
MW-14

Send original copy by certified return receipt requested to TNRCC, MC 177, P.O. Box 13087, Austin, TX 787__-__7

**ATTENTION OWNER:** *Confidentiality Privilege Notice on on reverse side of Well Owner's copy (pink)*

# State of Texas
# WELL REPORT

**Texas Water Well Drillers Advisory Council**
MC 177
P.O. Box 13087
Austin, TX 78711-3087
512-239-0530

1) OWNER: City of Kingsville (Name) ADDRESS: P.O. Box 1458 (Street or RFD) Kingsville (City) TX (State) 78363 (Zip)

2) ADDRESS OF WELL: County: Kleberg; Kingsville Landfill (Street, RFD or other) Kingsville (City) TX (State) (Zip) GRID # 83-34-4

3) TYPE OF WORK (Check): ☑ New Well ☐ Deepening ☐ Reconditioning ☐ Plugging

4) PROPOSED USE (Check): ☑ Monitor ☐ Environmental Soil Boring ☐ Domestic ☐ Industrial ☐ Irrigation ☐ Injection ☐ Public Supply ☐ De-watering ☐ Testwell
If Public Supply well, were plans submitted to the TNRCC? ☐ Yes ☐ No

5) MW-14 (SS-14)

6) WELL LOG:
Date Drilling:
Started 7-8 1997
Completed 7-8 1997

DIAMETER OF HOLE

| Dia. (in.) | From (ft.) | To (ft.) |
|---|---|---|
| 8.0 | Surface | 42.0 |

7) DRILLING METHOD (Check): ☐ Driven ☐ Air Rotary ☐ Mud Rotary ☑ Bored ☐ Air Hammer ☐ Cable Tool ☐ Jetted ☐ Other

| From (ft.) | To (ft.) | Description and color of formation material |
|---|---|---|
| | | See attached logs |

*(Use reverse side of Well Owner's copy, if necessary)*

8) Borehole Completion (Check): ☐ Open Hole ☐ Straight Wall ☐ Underreamed ☐ Gravel Packed ☑ Other 16/30 Silica
If Gravel Packed give interval ... from 35.0 ft. to 23.0 ft.

CASING, BLANK PIPE, AND WELL SCREEN DATA:

| Dia (in.) | New or Used | Steel, Plastic, etc. Perf., Slotted, etc. Screen Mfg., if commercial | Setting (ft.) From | Setting (ft.) To | Gage Casting Screen |
|---|---|---|---|---|---|
| 4 | N | PVC Screen Mfg. TRI-LOC | 35.0 | 25.0 | .010 |
| 4 | N | PVC Riser | 25.0 | +2.5 | |

9) CEMENTING DATA [Rule 338.44(1)]
Cemented from 21.0 ft. to 0.0 ft. No. of sacks used 5
______ ft. to ______ ft. No. of sacks used ______
Method used ______
Cemented by PSI Inc.
Distance to septic system field lines or other concentrated contamination ______ ft.
Method of verification of above distance ______

13) TYPE PUMP: N/A
☐ Turbine ☐ Jet ☐ Submersible ☐ Cylinder ☐ Other ______
Depth to pump bowls, cylinder, jet, etc., ______ ft.

10) SURFACE COMPLETION
☑ Specified Surface Slab Installed [Rule 338.44(2)(A)]
☐ Specified Steel Sleeve Installed [Rule 338.44(3)(A)]
☐ Pitless Adapter Used [Rule 338.44(3)(b)]
☐ Approved Alternative Procedure Used [Rule 338.71]

14) WELL TESTS: N/A
Type test: ☐ Pump ☐ Bailer ☐ Jetted ☐ Estimated
Yield: ______ gpm with ______ ft. drawdown after ______ hrs.

11) WATER LEVEL: N/A
Static level ______ ft. below land surface Date ______
Artesian flow ______ gpm. Date ______

15) WATER QUALITY:
Did you knowingly penetrate any strata which contained undesirable constituents?
☐ Yes ☑ No If yes, submit "REPORT OF UNDESIRABLE WATER"
Type of water? ______ Depth of strata ______
Was a chemical analysis made? ☐ Yes ☐ No

12) PACKERS:

| | Type | Depth |
|---|---|---|
| Bentonite Pellets | 1G | 23.0-21.0 |

I hereby certify that this well was drilled by me (or under my supervision) and that each and all of the statements herein are true to the best of my knowledge and belief. I understand that failure to complete items 1 thru 15 will result in the log(s) being returned for completion and resubmittal.

COMPANY NAME PSI Inc. (Type or print) WELL DRILLER'S LICENSE NO. 4694-M

ADDRESS 810 Sotol (Street or RFD) Corpus Christi (City) TX (State) 78416 (Zip)

(Signed) [signature] (Licensed Well Driller) (Signed) ______ (Registered Driller Trainee)

**Please attach electric log, chemical analysis, and other pertinent information, if available.**

WELL OWNER

K-5
MW-15

Send original copy by certified return receipt requested TNRCC, MC 177, P.O. Box 13087, Austin, TX 78 7

ATTENTION OWNER: Confidentiality Privilege Notice on on reverse side of Well Owner's copy (pink)

# State of Texas WELL REPORT

Texas Water Well Drillers Advisory Council
MC 177
P.O. Box 13087
Austin, TX 78711-3087
512-239-0530

1) OWNER City of Kingsville (Name) ADDRESS PO Box 1458 Kingsville TX 78363 (Street or RFD) (City) (State) (Zip)

2) ADDRESS OF WELL: County Kleberg Kingsville Landfill Kingsville TX (Street, RFD or other) (City) (State) (Zip) GRID # 83-34-4

3) TYPE OF WORK (Check): ☑ New Well ☐ Deepening ☐ Reconditioning ☐ Plugging

4) PROPOSED USE (Check): ☑ Monitor ☐ Environmental Soil Boring ☐ Domestic ☐ Industrial ☐ Irrigation ☐ Injection ☐ Public Supply ☐ De-watering ☐ Testwell
If Public Supply well, were plans submitted to the TNRCC? ☐ Yes ☐ No

5) MW-15 (SS-15)

6) WELL LOG:
Date Drilling:
Started 7-8 19 97
Completed 7-8 19 97

| DIAMETER OF HOLE | | |
|---|---|---|
| Dia. (in.) | From (ft.) | To (ft.) |
| 11.0 | Surface | 37.0 |

7) DRILLING METHOD (Check): ☐ Driven ☐ Air Rotary ☐ Mud Rotary ☑ Bored ☐ Air Hammer ☐ Cable Tool ☐ Jetted ☐ Other

| From (ft.) | To (ft.) | Description and color of formation material |
|---|---|---|
| | | see attached logs |

(Use reverse side of Well Owner's copy, if necessary)

8) Borehole Completion (Check): ☐ Open Hole ☐ Straight Wall ☐ Underreamed ☐ Gravel Packed ☑ Other 16/30 Silica
If Gravel Packed give interval ... from 33.0 ft. to 21.0 ft.

CASING, BLANK PIPE, AND WELL SCREEN DATA:

| Dia. (in.) | New or Used | Steel, Plastic, etc. Perf., Slotted, etc. Screen Mfg., if commercial | Setting (ft.) From | Setting (ft.) To | Gage Casting Screen |
|---|---|---|---|---|---|
| 4 | N | PVC Screen, Mfg. TRI-LOC | 33.0 | 23.0 | .010 |
| 4 | N | PVC Riser | 23.0 | +2.5 | |

9) CEMENTING DATA [Rule 338.44(1)]
Cemented from 19.0 ft. to 0.0 ft. No. of sacks used 5.0
ft. to ft. No. of sacks used
Method used
Cemented by FSI, Inc.
Distance to septic system field lines or other concentrated contamination ft.
Method of verification of above distance

13) TYPE PUMP: N/A
☐ Turbine ☐ Jet ☐ Submersible ☐ Cylinder
☐ Other
Depth to pump bowls, cylinder, jet, etc. ft.

10) SURFACE COMPLETION
☑ Specified Surface Slab Installed [Rule 338.44(2)(A)]
☐ Specified Steel Sleeve Installed [Rule 338.44(3)(A)]
☐ Pitless Adapter Used [Rule 338.44(3)(b)]
☐ Approved Alternative Procedure Used [Rule 338.71]

14) WELL TESTS: N/A
Type test: ☐ Pump ☐ Bailer ☐ Jetted ☐ Estimated
Yield gpm with ft. drawdown after hrs.

11) WATER LEVEL: N/A
Static level ft. below land surface Date
Artesian flow gpm. Date

15) WATER QUALITY:
Did you knowingly penetrate any strata which contained undesirable constituents?
☐ Yes ☑ No If yes, submit "REPORT OF UNDESIRABLE WATER"
Type of water? Depth of strata
Was a chemical analysis made? ☐ Yes ☐ No

12) PACKERS:

| | Type | Depth |
|---|---|---|
| Bentonite Pellets | 3/8" | 21.0-19.0 |

I hereby certify that this well was drilled by me (or under my supervision) and that each and all of the statements herein are true to the best of my knowledge and belief. I understand that failure to complete items 1 thru 15 will result in the log(s) being returned for completion and resubmittal.

COMPANY NAME FSI, Inc. (Type or print) WELL DRILLER'S LICENSE NO. 4290 M

ADDRESS FSI (Street or RFD) Corpus Christi (City) TX (State) 784 (Zip)

(Signed) [signature] (Licensed Well Driller) (Signed) (Registered Driller Trainee)

Please attach electric log, chemical analysis, and other pertinent information, if available.

TNRCC-0199 Rev.

Send original copy by certified return receipt requested m... TNRCC, MC 177, P.O. Box 13087, Austin, TX 787...7

K-6
MW-16

**ATTENTION OWNER:** *Confidentiality Privilege Notice on on reverse side of Well Owner's copy (pink)*

# State of Texas WELL REPORT

Texas Water Well Drillers Advisory Council
MC 177
P.O. Box 13087
Austin, TX 78711-3087
512-239-0530

1) OWNER City of Kingsville (Name) ADDRESS P.O. Box 1458 Kingsville TX 78363 (Street or RFD) (City) (State) (Zip)

2) ADDRESS OF WELL: County Kleberg Kingsville Landfill Kingsville TX (Street, RFD or other) (City) (State) (Zip) GRID # 83-34-4

3) TYPE OF WORK (Check): ☑ New Well ☐ Deepening ☐ Reconditioning ☐ Plugging

4) PROPOSED USE (Check): ☑ Monitor ☐ Environmental Soil Boring ☐ Domestic ☐ Industrial ☐ Irrigation ☐ Injection ☐ Public Supply ☐ De-watering ☐ Testwell
If Public Supply well, were plans submitted to the TNRCC? ☐ Yes ☐ No

5) MW-16 (SB-16)

6) WELL LOG:
Date Drilling:
Started 7-10 19 97
Completed 7-10 19 97

DIAMETER OF HOLE

| Dia. (in.) | From (ft.) | To (ft.) |
|---|---|---|
| 10.0 | Surface | 47.0 |
| | | |

7) DRILLING METHOD (Check): ☐ Driven ☐ Air Rotary ☐ Mud Rotary ☑ Bored ☐ Air Hammer ☐ Cable Tool ☐ Jetted ☐ Other ______

| From (ft.) | To (ft.) | Description and color of formation material |
|---|---|---|
| See attached logs | | |

(Use reverse side of Well Owner's copy, if necessary)

8) Borehole Completion (Check): ☐ Open Hole ☐ Straight Wall ☐ Underreamed ☐ Gravel Packed ☑ Other 16/30 Silica
If Gravel Packed give interval ... from 40.0 ft. to 28.0 ft.

CASING, BLANK PIPE, AND WELL SCREEN DATA:

| Dia. (in.) | New or Used | Steel, Plastic, etc. Perf., Slotted, etc. Screen Mfg., if commercial | Setting (ft.) From | Setting (ft.) To | Gage Casting Screen |
|---|---|---|---|---|---|
| 4 | N | PVC Screen MFL. TRI-LOC | 40.0 | 30.0 | .010 |
| 4 | N | PVC Riser | 0.0 | +2.5 | |

9) CEMENTING DATA [Rule 338.44(1)]
Cemented from 26.0 ft. to 0.0 ft. No. of sacks used 7.0
______ ft. to ______ ft. No. of sacks used ______
Method used ______
Cemented by FSI Inc.
Distance to septic system field lines or other concentrated contamination ____ ft.
Method of verification of above distance ______

10) SURFACE COMPLETION
☑ Specified Surface Slab Installed [Rule 338.44(2)(A)]
☐ Specified Steel Sleeve Installed [Rule 338.44(3)(A)]
☐ Pitless Adapter Used [Rule 338.44(3)(b)]
☐ Approved Alternative Procedure Used [Rule 338.71]

11) WATER LEVEL: N/A
Static level ______ ft. below land surface Date ______
Artesian flow ______ gpm. Date ______

12) PACKERS: Type Depth
Bentonite Pellets 1/2" 28.0-26.0

13) TYPE PUMP: N/A
☐ Turbine ☐ Jet ☐ Submersible ☐ Cylinder
☐ Other ______
Depth to pump bowls, cylinder, jet, etc., ______ ft.

14) WELL TESTS: N/A
Type test: ☐ Pump ☐ Bailer ☐ Jetted ☐ Estimated
Yield: ______ gpm with ______ ft. drawdown after ______ hrs.

15) WATER QUALITY:
Did you knowingly penetrate any strata which contained undesirable constituents?
☐ Yes ☑ No If yes, submit "REPORT OF UNDESIRABLE WATER"
Type of water? ______ Depth of strata ______
Was a chemical analysis made? ☐ Yes ☐ No

I hereby certify that this well was drilled by me (or under my supervision) and that each and all of the statements herein are true to the best of my knowledge and belief. I understand that failure to complete items 1 thru 15 will result in the log(s) being returned for completion and resubmittal.

COMPANY NAME FSI Inc (Type or print) WELL DRILLER'S LICENSE NO. 4694-M

ADDRESS 910 S-ID (Street or RFD) Corpus Christi (City) TX (State) 78416 (Zip)

(Signed) Craig [signature] (Licensed Well Driller) (Signed) ______ (Registered Driller Trainee)

Please attach electric log, chemical analysis, and other pertinent information, if available.

K-7
MW-17

Send original copy by certified return receipt requested to TNRCC, MC 177, P.O. Box 13087, Austin, TX 78711-3087

**ATTENTION OWNER:** *Confidentiality Privilege Notice on on reverse side of Well Owner's copy (pink)*

# State of Texas
# WELL REPORT

Texas Water Well Drillers Advisory Council
MC 177
P.O. Box 13087
Austin, TX 78711-3087
512-239-0530

1) OWNER City of Kingsville (Name) ADDRESS P.O. Box 1458 Kingsville TX 78363 (Street or RFD) (City) (State) (Zip)

2) ADDRESS OF WELL: County Kleberg Kingsville Landfill Kingsville TX (Street, RFD or other) (City) (State) (Zip) GRID # 83-34-4

3) TYPE OF WORK (Check): ☑ New Well ☐ Deepening ☐ Reconditioning ☐ Plugging

4) PROPOSED USE (Check): ☑ Monitor ☐ Environmental Soil Boring ☐ Domestic ☐ Industrial ☐ Irrigation ☐ Injection ☐ Public Supply ☐ De-watering ☐ Testwell
If Public Supply well, were plans submitted to the TNRCC? ☐ Yes ☐ No

5) MW-17 (83-17)

6) WELL LOG:
Date Drilling:
Started 7-9 19 97
Completed 7-9 19 97

DIAMETER OF HOLE

| Dia. (in.) | From (ft.) | To (ft.) |
|---|---|---|
| 8.0 | Surface | 33.0 |

7) DRILLING METHOD (Check): ☐ Driven ☐ Air Rotary ☐ Mud Rotary ☑ Bored ☐ Air Hammer ☐ Cable Tool ☐ Jetted ☐ Other

| From (ft.) | To (ft.) | Description and color of formation material |
|---|---|---|
| | | See attached logs |

*(Use reverse side of Well Owner's copy, if necessary)*

8) Borehole Completion (Check): ☐ Open Hole ☐ Straight Wall ☐ Underreamed ☐ Gravel Packed ☑ Other 16/30 Silica
If Gravel Packed give interval ... from 33.0 ft. to 10.0 ft.

CASING, BLANK PIPE, AND WELL SCREEN DATA:

| Dia. (in.) | New or Used | Steel, Plastic, etc. Perf., Slotted, etc. Screen Mfg., if commercial | Setting (ft.) From | Setting (ft.) To | Gage Casting Screen |
|---|---|---|---|---|---|
| 2 | N | PVC Screen | 33.0 | 13.0 | .010 |
| | | MFG. TRI-LOC | | | |
| 2 | N | PVC Riser | 13.0 | +2.0 | |

9) CEMENTING DATA [Rule 338.44(1)]
Cemented from 8.0 ft. to 0.0 ft. No. of sacks used 1.0
ft. to ft. No. of sacks used
Method used
Cemented by PSI Inc
Distance to septic system field lines or other concentrated contamination ___ ft.
Method of verification of above distance

13) TYPE PUMP: N/A
☐ Turbine ☐ Jet ☐ Submersible ☐ Cylinder
☐ Other
Depth to pump bowls, cylinder, jet, etc., ___ ft.

10) SURFACE COMPLETION
☑ Specified Surface Slab Installed [Rule 338.44(2)(A)]
☐ Specified Steel Sleeve Installed [Rule 338.44(3)(A)]
☐ Pitless Adapter Used [Rule 338.44(3)(b)]
☐ Approved Alternative Procedure Used [Rule 338.71]

14) WELL TESTS: N/A
Type test: ☐ Pump ☐ Bailer ☐ Jetted ☐ Estimated
Yield: ___ gpm with ___ ft. drawdown after ___ hrs.

11) WATER LEVEL: N/A
Static level ___ ft. below land surface Date ___
Artesian flow ___ gpm. Date ___

15) WATER QUALITY:
Did you knowingly penetrate any strata which contained undesirable constituents?
☐ Yes ☑ No If yes, submit "REPORT OF UNDESIRABLE WATER"
Type of water? ___ Depth of strata ___
Was a chemical analysis made? ☐ Yes ☐ No

12) PACKERS:

| | Type | Depth |
|---|---|---|
| Bentonite Pellets | 1/2 | 10.0-8.0 |

I hereby certify that this well was drilled by me (or under my supervision) and that each and all of the statements herein are true to the best of my knowledge and belief. I understand that failure to complete items 1 thru 15 will result in the log(s) being returned for completion and resubmittal.

COMPANY NAME PSI Inc (Type or print) WELL DRILLER'S LICENSE NO. 4694-M

ADDRESS RIO [illegible] Corpus Christi TX 78416 (Street or RFD) (City) (State) (Zip)

(Signed) [signature] (Licensed Well Driller) (Signed) ___ (Registered Driller Trainee)

Please attach electric log, chemical analysis, and other pertinent information, if available.

TNRCC-0199 (Rev. 05-21-96)

K-8
MW-18

Send original copy by certified return receipt requested to TNRCC, MC 177, P.O. Box 13087, Austin, TX 78711-3087

**ATTENTION OWNER:** *Confidentiality Privilege Notice on on reverse side of Well Owner's copy (pink)*

# State of Texas WELL REPORT

Texas Water Well Drillers Advisory Council
MC 177
P.O. Box 13087
Austin, TX 78711-3087
512-239-0530

1) OWNER City of Kingsville (Name) ADDRESS P.O. Box 1458 Kingsville TX 78363 (Street or RFD) (City) (State) (Zip)

2) ADDRESS OF WELL: County Kleberg Kingsville Landfill Kingsville TX (Street, RFD or other) (City) (State) (Zip) GRID # 83-34-4

3) TYPE OF WORK (Check): ☑ New Well ☐ Deepening ☐ Reconditioning ☐ Plugging

4) PROPOSED USE (Check): ☑ Monitor ☐ Environmental Soil Boring ☐ Domestic ☐ Industrial ☐ Irrigation ☐ Injection ☐ Public Supply ☐ De-watering ☐ Testwell
If Public Supply well, were plans submitted to the TNRCC? ☐ Yes ☐ No

5) MW-18 (SB-18)

6) WELL LOG:
Date Drilling:
Started 7-9 1997
Completed 7-9 1997

| DIAMETER OF HOLE | | |
|---|---|---|
| Dia. (in.) | From (ft.) | To (ft.) |
| 8.0 | Surface | 42.0 |

7) DRILLING METHOD (Check): ☐ Driven ☐ Air Rotary ☐ Mud Rotary ☑ Bored ☐ Air Hammer ☐ Cable Tool ☐ Jetted ☐ Other ____

N

| From (ft.) | To (ft.) | Description and color of formation material |
|---|---|---|
| | | See attached logs |

(Use reverse side of Well Owner's copy, if necessary)

8) Borehole Completion (Check): ☐ Open Hole ☐ Straight Wall ☐ Underreamed ☐ Gravel Packed ☑ Other 16/30 Silica
If Gravel Packed give interval ... from 42.0 ft. to 19.0 ft.

CASING, BLANK PIPE, AND WELL SCREEN DATA:

| Dia. (in.) | New or Used | Steel, Plastic, etc. Perf., Slotted, etc. Screen Mfg., if commercial | Setting (ft.) From | Setting (ft.) To | Gage Casting Screen |
|---|---|---|---|---|---|
| 2 | N | PVC Screen | 42.0 | 22.0 | .010 |
| | | MFG. TRI-LOC | | | |
| 2 | N | PVC Riser | | | |

9) CEMENTING DATA [Rule 338.44(1)]
Cemented from 17.0 ft. to 3.0 ft. No. of sacks used 3.0
____ ft. to ____ ft. No. of sacks used ____
Method used ____
Cemented by PSI Inc
Distance to septic system field lines or other concentrated contamination ____ ft.
Method of verification of above distance ____

13) TYPE PUMP: N/A
☐ Turbine ☐ Jet ☐ Submersible ☐ Cylinder
☐ Other ____
Depth to pump bowls, cylinder, jet, etc., ____ ft.

10) SURFACE COMPLETION
☑ Specified Surface Slab Installed [Rule 338.44(2)(A)]
☐ Specified Steel Sleeve Installed [Rule 338.44(3)(A)]
☐ Pitless Adapter Used [Rule 338.44(3)(b)]
☐ Approved Alternative Procedure Used [Rule 338.71]

14) WELL TESTS: N/A
Type test: ☐ Pump ☐ Bailer ☐ Jetted ☐ Estimated
Yield: ____ gpm with ____ ft. drawdown after ____ hrs.

11) WATER LEVEL: N/A
Static level ____ ft. below land surface Date ____
Artesian flow ____ gpm. Date ____

15) WATER QUALITY:
Did you knowingly penetrate any strata which contained undesirable constituents?
☐ Yes ☑ No If yes, submit "REPORT OF UNDESIRABLE WATER"
Type of water? ____ Depth of strata ____
Was a chemical analysis made? ☐ Yes ☐ No

| 12) PACKERS: | Type | Depth |
|---|---|---|
| Bentonite Pellets | 1/2" | 19.0 - 17.0 |

I hereby certify that this well was drilled by me (or under my supervision) and that each and all of the statements herein are true to the best of my knowledge and belief. I understand that failure to complete items 1 thru 15 will result in the log(s) being returned for completion and resubmittal.

COMPANY NAME PSI Inc (Type or print) WELL DRILLER'S LICENSE NO. 4694-M

ADDRESS 810 (PTD) Corpus Christi TX 78416 (Street or RFD) (City) (State) (Zip)

(Signed) [signature] (Licensed Well Driller) (Signed) ____ (Registered Driller Trainee)

Please attach electric log, chemical analysis, and other pertinent information, if available.

K-9
MW-21

Send original copy by certified return receipt requested mail to: TNRCC, MC 177, P.O. Box 13087, Austin, TX 78711-3087

ATTENTION OWNER: *Confidentiality Privilege Notice on on reverse side of Well Owner's copy (pink)*

# State of Texas WELL REPORT

Texas Water Well Drillers Advisory Council
MC 177
P.O. Box 13087
Austin, TX 78711-3087
512-239-0530

1) OWNER City of Kingsville (Name) ADDRESS P.O. Box 1458 (Street or RFD) Kingsville (City) Texas (State) 78363 (Zip)

2) ADDRESS OF WELL: County Kleberg Kingsville Landfill (Street, RFD or other) Kingsville (City) Texas (State) (Zip) GRID # 83-34-4

3) TYPE OF WORK (Check): [x] New Well [ ] Deepening [ ] Reconditioning [x] Plugging

4) PROPOSED USE (Check): [ ] Monitor [x] Environmental Soil Boring [ ] Domestic [ ] Industrial [ ] Irrigation [ ] Injection [ ] Public Supply [ ] De-watering [ ] Testwell
If Public Supply well, were plans submitted to the TNRCC? [ ] Yes [ ] No

5)

6) WELL LOG:
Date Drilling:
Started 4-27 19 98
Completed 4-27 19 98

DIAMETER OF HOLE

| Dia. (in.) | From (ft.) | To (ft.) |
|---|---|---|
| 6.0 | Surface | 84.0 |
| | | |

7) DRILLING METHOD (Check): [ ] Driven [ ] Air Rotary [ ] Mud Rotary [x] Bored [ ] Air Hammer [ ] Cable Tool [ ] Jetted [ ] Other

N

| From (ft.) | To (ft.) | Description and color of formation material |
|---|---|---|
| see attached log MW-21 | | |

*(Use reverse side of Well Owner's copy, if necessary)*

8) Borehole Completion (Check): [ ] Open Hole [ ] Straight Wall [ ] Underreamed [ ] Gravel Packed [x] Other grout
If Gravel Packed give interval ... from ____ ft. to ____ ft.

CASING, BLANK PIPE, AND WELL SCREEN DATA: N/A

| Dia. (in.) | New or Used | Steel, Plastic, etc. Perf., Slotted, etc. Screen Mfg., if commercial | Setting (ft.) From | To | Gage Casting Screen |
|---|---|---|---|---|---|
| | | | | | |

9) CEMENTING DATA [Rule 338.44(1)]
Cemented from 84.0 ft. to 0.0 ft. No. of sacks used 12.5
____ ft. to ____ ft. No. of sacks used ____
Method used mixed with 5% bentonite
Cemented by PSI Inc.
Distance to septic system field lines or other concentrated contamination ____ ft.
Method of verification of above distance ____

10) SURFACE COMPLETION N/A
[ ] Specified Surface Slab Installed [Rule 338.44(2)(A)]
[ ] Specified Steel Sleeve Installed [Rule 338.44(3)(A)]
[ ] Pitless Adapter Used [Rule 338.44(3)(b)]
[ ] Approved Alternative Procedure Used [Rule 338.71]

11) WATER LEVEL: N/AS
Static level ____ ft. below land surface Date ____
Artesian flow ____ gpm. Date ____

12) PACKERS: N/A Type Depth

13) TYPE PUMP: N/A
[ ] Turbine [ ] Jet [ ] Submersible [ ] Cylinder
[ ] Other ____
Depth to pump bowls, cylinder, jet, etc., ____ ft.

14) WELL TESTS: N/A
Type test: [ ] Pump [ ] Bailer [ ] Jetted [ ] Estimated
Yield: ____ gpm with ____ ft. drawdown after ____ hrs.

15) WATER QUALITY:
Did you knowingly penetrate any strata which contained undesirable constituents?
[ ] Yes [x] No If yes, submit "REPORT OF UNDESIRABLE WATER"
Type of water? ____ Depth of strata ____
Was a chemical analysis made? [ ] Yes [ ] No

I hereby certify that this well was drilled by me (or under my supervision) and that each and all of the statements herein are true to the best of my knowledge and belief. I understand that failure to complete items 1 thru 15 will result in the log(s) being returned for completion and resubmittal.

COMPANY NAME PSI Inc. (Type or print) WELL DRILLER'S LICENSE NO. 4694-M

ADDRESS 810 SPID (Street or RFD) Corpus Christi (City) Texas (State) 78416 (Zip)

(Signed) Craig Sikema (Licensed Well Driller) (Signed) ____ (Registered Driller Trainee)

**Please attach electric log, chemical analysis, and other pertinent information, if available.**

TNRCC-0199 (Rev. 05-21-96)

K-10
MW-23

Send original copy by certified return receipt requested mail to: TNRCC, MC 177, P.O. Box 13087, Austin, TX 78711-3087

ATTENTION OWNER: *Confidentiality Privilege Notice on on reverse side of Well Owner's copy (pink)*

# State of Texas WELL REPORT

Texas Water Well Drillers Advisory Council
MC 177
P.O. Box 13087
Austin, TX 78711-3087
512-239-0530

1) OWNER Kingsville City of (Name) ADDRESS P.O. Box 1458 (Street or RFD) Kingsville (City) Texas (State) 78363 (Zip)

2) ADDRESS OF WELL: County Kleberg Kingsville Landfill (Street, RFD or other) Kingsville (City) Texas (State) (Zip) GRID # 83-34-4

3) TYPE OF WORK (Check): ☒ New Well ☐ Deepening ☐ Reconditioning ☒ Plugging

4) PROPOSED USE (Check): ☐ Monitor ☒ Environmental Soil Boring ☐ Domestic ☐ Industrial ☐ Irrigation ☐ Injection ☐ Public Supply ☐ De-watering ☐ Testwell
If Public Supply well, were plans submitted to the TNRCC? ☐ Yes ☐ No

5)

6) WELL LOG:
Date Drilling:
Started 4-24 19 98
Completed 4-24 19 95

DIAMETER OF HOLE

| Dia. (in.) | From (ft.) | To (ft.) |
|---|---|---|
| 6.0 | Surface | 86.0 |
| | | |

7) DRILLING METHOD (Check): ☐ Driven ☐ Air Rotary ☐ Mud Rotary ☒ Bored ☐ Air Hammer ☐ Cable Tool ☐ Jetted ☐ Other

N

| From (ft.) | To (ft.) | Description and color of formation material |
|---|---|---|
| see attached log | | MW-23 |

*(Use reverse side of Well Owner's copy, if necessary)*

8) Borehole Completion (Check): ☐ Open Hole ☐ Straight Wall ☐ Underreamed ☐ Gravel Packed ☒ Other grout
If Gravel Packed give interval ... from ____ ft. to ____ ft.

CASING, BLANK PIPE, AND WELL SCREEN DATA: N/A

| Dia. (in.) | New or Used | Steel, Plastic, etc. Perf., Slotted, etc. Screen Mfg., if commercial | Setting (ft.) From | Setting (ft.) To | Gage Casting Screen |
|---|---|---|---|---|---|
| | | | | | |

9) CEMENTING DATA [Rule 338.44(1)]
Cemented from 86.0 ft. to 0.0 ft. No. of sacks used 12.5
ft. to ____ ft. No. of sacks used ____
Method used -mixed with 5% bentonite
Cemented by PSI Inc.
Distance to septic system field lines or other concentrated contamination ____ ft.
Method of verification of above distance ____

13) TYPE PUMP: N/A
☐ Turbine ☐ Jet ☐ Submersible ☐ Cylinder
☐ Other ____
Depth to pump bowls, cylinder, jet, etc., ____ ft.

10) SURFACE COMPLETION N/A
☐ Specified Surface Slab Installed [Rule 338.44(2)(A)]
☐ Specified Steel Sleeve Installed [Rule 338.44(3)(A)]
☐ Pitless Adapter Used [Rule 338.44(3)(b)]
☐ Approved Alternative Procedure Used [Rule 338.71]

14) WELL TESTS: N/A
Type test: ☐ Pump ☐ Bailer ☐ Jetted ☐ Estimated
Yield: ____ gpm with ____ ft. drawdown after ____ hrs.

11) WATER LEVEL: N/A
Static level ____ ft. below land surface Date ____
Artesian flow ____ gpm. Date ____

15) WATER QUALITY:
Did you knowingly penetrate any strata which contained undesirable constituents?
☐ Yes ☒ No If yes, submit "REPORT OF UNDESIRABLE WATER"
Type of water? ____ Depth of strata ____
Was a chemical analysis made? ☐ Yes ☐ No

12) PACKERS: N/A Type Depth

I hereby certify that this well was drilled by me (or under my supervision) and that each and all of the statements herein are true to the best of my knowledge and belief. I understand that failure to complete items 1 thru 15 will result in the log(s) being returned for completion and resubmittal.

COMPANY NAME PSI INc. (Type or print) WELL DRILLER'S LICENSE NO. 4694-M

ADDRESS 810 SPID (Street or RFD) Corpus Christi (City) Texas (State) 78416 (Zip)

(Signed) [signature] (Licensed Well Driller) (Signed) ____ (Registered Driller Trainee)

**Please attach electric log, chemical analysis, and other pertinent information, if available.**

TNRCC-0199 (Rev. 05-21-96)

K-11
MW-24

Send original copy by certified return receipt requested mail to: TNRCC, MC 177, P.O. Box 13087, Austin, TX 78711-3087

ATTENTION OWNER: *Confidentiality Privilege Notice on on reverse side of Well Owner's copy (pink)*

# State of Texas
# WELL REPORT

Texas Water Well Drillers Advisory Council
MC 177
P.O. Box 13087
Austin, TX 78711-3087
512-239-0530

1) OWNER City of Kingsville (Name) ADDRESS P.O. Box 1458 (Street or RFD) Kingsville (City) Texas (State) 78363 (Zip)

2) ADDRESS OF WELL: County Kleberg Kingsville Landfill (Street, RFD or other) Kingsville (City) Texas (State) (Zip) GRID # 83-34-4

3) TYPE OF WORK (Check): ☒ New Well ☐ Deepening ☐ Reconditioning ☐ Plugging

4) PROPOSED USE (Check): ☒ Monitor ☐ Environmental Soil Boring ☐ Domestic ☐ Industrial ☐ Irrigation ☐ Injection ☐ Public Supply ☐ De-watering ☐ Testwell
If Public Supply well, were plans submitted to the TNRCC? ☐ Yes ☐ No

5)

6) WELL LOG:
Date Drilling:
Started 4-28 19 98
Completed 4-29 19 98

| DIAMETER OF HOLE | | |
|---|---|---|
| Dia. (in.) | From (ft.) | To (ft.) |
| 6.0 | Surface | 72.0 |
| 11.0 | | 33.0 |

7) DRILLING METHOD (Check): ☐ Driven ☐ Air Rotary ☐ Mud Rotary ☒ Bored ☐ Air Hammer ☐ Cable Tool ☐ Jetted ☐ Other

| From (ft.) | To (ft.) | Description and color of formation material |
|---|---|---|
| see attached log | | MW-24 |

(Use reverse side of Well Owner's copy, if necessary)

8) Borehole Completion (Check): ☐ Open Hole ☐ Straight Wall ☐ Underreamed ☐ Gravel Packed ☒ Other 16/30 silica sand
If Gravel Packed give interval ... from 33.0 ft. to 16.0 ft.

CASING, BLANK PIPE, AND WELL SCREEN DATA:

| Dia. (in.) | New or Used | Steel, Plastic, etc. Perf., Slotted, etc. Screen Mfg., if commercial | Setting (ft.) From | Setting (ft.) To | Gage Casting Screen |
|---|---|---|---|---|---|
| 4 | N | Pvc screen Mfg. National Wells Supply | 33.0 | 18.0 | .010 |
| 4 | N | Pvc riser | 18.0, | +2.5 | |

9) CEMENTING DATA [Rule 338.44(1)]
Cemented from 72.0 ft. to 33.0 ft. No. of sacks used 6.0
14.0 ft. to 0.0 ft. No. of sacks used 1.5
Method used mixed with 5% bentonite
Cemented by PSI INc.
Distance to septic system field lines or other concentrated contamination ____ ft.
Method of verification of above distance ____

10) SURFACE COMPLETION
☒ Specified Surface Slab Installed [Rule 338.44(2)(A)]
☐ Specified Steel Sleeve Installed [Rule 338.44(3)(A)]
☐ Pitless Adapter Used [Rule 338.44(3)(b)]
☐ Approved Alternative Procedure Used [Rule 338.71]

11) WATER LEVEL: N/A
Static level ____ ft. below land surface Date ____
Artesian flow ____ gpm. Date ____

12) PACKERS:

| | Type | Depth |
|---|---|---|
| bentonite pellets | ½" | 16'-14' |

13) TYPE PUMP: N/A
☐ Turbine ☐ Jet ☐ Submersible ☐ Cylinder ☐ Other ____
Depth to pump bowls, cylinder, jet, etc., ____ ft.

14) WELL TESTS: N/A
Type test: ☐ Pump ☐ Bailer ☐ Jetted ☐ Estimated
Yield: ____ gpm with ____ ft. drawdown after ____ hrs.

15) WATER QUALITY:
Did you knowingly penetrate any strata which contained undesirable constituents?
☐ Yes XX No If yes, submit "REPORT OF UNDESIRABLE WATER"
Type of water? ____ Depth of strata ____
Was a chemical analysis made? ☐ Yes ☐ No

I hereby certify that this well was drilled by me (or under my supervision) and that each and all of the statements herein are true to the best of my knowledge and belief. I understand that failure to complete items 1 thru 15 will result in the log(s) being returned for completion and resubmittal.

COMPANY NAME PSI Inc. (Type or print) WELL DRILLER'S LICENSE NO. 4694-M

ADDRESS 810 SPID (Street or RFD) Corpus Christi (City) Texas (State) 78416 (Zip)

(Signed) Craig Scher (Licensed Well Driller) (Signed) ____ (Registered Driller Trainee)

Please attach electric log, chemical analysis, and other pertinent information, if available.

K-12
MW-25

Send original copy by certified return receipt requested mail to: **TNRCC, MC 177, P.O. Box 13087, Austin, TX 78711-3087**

**ATTENTION OWNER:** *Confidentiality Privilege Notice on on reverse side of Well Owner's copy (pink)*

# State of Texas
# WELL REPORT

**Texas Water Well Drillers Advisory Council**
**MC 177**
**P.O. Box 13087**
**Austin, TX 78711-3087**
**512-239-0530**

1) OWNER City of Kingsville (Name) ADDRESS P.O. Box 1458 (Street or RFD) Kingsville (City) Texas (State) 78363 (Zip)

2) ADDRESS OF WELL: County Kleberg Kingsville Landfill (Street, RFD or other) Kingsville (City) Texas (State) (Zip) GRID # 83-34-4

3) TYPE OF WORK (Check): ☒ New Well ☐ Deepening ☐ Reconditioning ☒ Plugging

4) PROPOSED USE (Check): ☐ Monitor ☒ Environmental Soil Boring ☐ Domestic ☐ Industrial ☐ Irrigation ☐ Injection ☐ Public Supply ☐ De-watering ☐ Testwell
If Public Supply well, were plans submitted to the TNRCC? ☐ Yes ☐ No

5)

6) WELL LOG:
Date Drilling:
Started 4-29 19 98
Completed 4029 19 98

DIAMETER OF HOLE

| Dia. (in.) | From (ft.) | To (ft.) |
|---|---|---|
| 6.0 | Surface | 86.0 |
| | | |

7) DRILLING METHOD (Check): ☐ Driven ☐ Air Rotary ☐ Mud Rotary ☒ Bored ☐ Air Hammer ☐ Cable Tool ☐ Jetted ☐ Other ____

N

| From (ft.) | To (ft.) | Description and color of formation material |
|---|---|---|
| see attached log | | MW-25 |

(Use reverse side of Well Owner's copy, if necessary)

8) Borehole Completion (Check): ☐ Open Hole ☐ Straight Wall ☐ Underreamed ☐ Gravel Packed ☒ Other grout
If Gravel Packed give interval ... from ____ ft. to ____ ft.

CASING, BLANK PIPE, AND WELL SCREEN DATA: N/A

| Dia. (in.) | New or Used | Steel, Plastic, etc. Perf., Slotted, etc. Screen Mfg., if commercial | Setting (ft.) From | To | Gage Casting Screen |
|---|---|---|---|---|---|
| | | | | | |

9) CEMENTING DATA [Rule 338.44(1)]
Cemented from 86.0 ft. to 0.0 ft. No. of sacks used 13.0
____ ft. to ____ ft. No. of sacks used ____
Method used mixed with 5% bentonite
Cemented by PSI Inc.
Distance to septic system field lines or other concentrated contamination ____ ft.
Method of verification of above distance ____

13) TYPE PUMP: N/A
☐ Turbine ☐ Jet ☐ Submersible ☐ Cylinder
☐ Other ____
Depth to pump bowls, cylinder, jet, etc., ____ ft.

10) SURFACE COMPLETION N/A
☐ Specified Surface Slab Installed [Rule 338.44(2)(A)]
☐ Specified Steel Sleeve Installed [Rule 338.44(3)(A)]
☐ Pitless Adapter Used [Rule 338.44(3)(b)]
☐ Approved Alternative Procedure Used [Rule 338.71]

14) WELL TESTS: N/A
Type test: ☐ Pump ☐ Bailer ☐ Jetted ☐ Estimated
Yield: ____ gpm with ____ ft. drawdown after ____ hrs.

11) WATER LEVEL: N/A
Static level ____ ft. below land surface Date ____
Artesian flow ____ gpm. Date ____

15) WATER QUALITY:
Did you knowingly penetrate any strata which contained undesirable constituents?
☐ Yes ☒ No If yes, submit "REPORT OF UNDESIRABLE WATER"
Type of water? ____ Depth of strata ____
Was a chemical analysis made? ☐ Yes ☐ No

12) PACKERS: N/A Type Depth

I hereby certify that this well was drilled by me (or under my supervision) and that each and all of the statements herein are true to the best of my knowledge and belief. I understand that failure to complete items 1 thru 15 will result in the log(s) being returned for completion and resubmittal.

COMPANY NAME PSI Inc. (Type or print) WELL DRILLER'S LICENSE NO. 4694-M

ADDRESS 810 SPID (Street or RFD) Corpus Christit (City) Texas (State) 78415 (Zip)

(Signed) [signature] (Licensed Well Driller) (Signed) ____ (Registered Driller Trainee)

**Please attach electric log, chemical analysis, and other pertinent information, if available.**

# ATTACHMENT 5

## Groundwater Characterization Report

For Permitting Purposes Only. Applies to pages of Attachment 5 – Finch Energy & Environmental Services, Inc. Groundwater Characterization Report, sealed by Ray N. Finch, P.E. on 6-26-98 and 9-30-98 altered to provide a clean and legible copy and includes pages: ii, 1, 3 - 8, 10, 34 and B-1 - B-15. No information or data was altered or changed from the original 6-26-98 and 9-30-98 Groundwater Characterization Report.

STATE OF TEXAS
TAD A. GASS
GEOLOGY
11496
LICENSED
PROFESSIONAL GEOSCIENTIST

11/16/2018

Finch Energy & Environmental Services, Inc.
P.O. Box 73/1204 W. King, Kingsville, TX 78364
Phone: (512) 592-9810 Fax: (512) 592-5552

## FIGURES



## APPENDICES



STATE OF TEXAS
RAY N. FINCH
30926
REGISTERED
PROFESSIONAL ENGINEER
9-30-98

*THIS DOCUMENT IS ISSUED FOR PERMITTING PURPOSES ONLY.*
*INCLUDING PAGES 1 THROUGH 51 AND APPENDICES.*

Revision 2 - September 1998

# 1.0 GROUNDWATER CHARACTERIZATION

This section describes the historical groundwater conditions that have existed at the City of Kingsville MSWLF site as required in 30 TAC §330.56(e). A delineation of the waste management area, the property boundary, the proposed "point of compliance" and the proposed locations of all groundwater monitoring wells are shown on Figure 5.2.

## 1.1 Background

Currently, five (5) from a total of eight (8) active groundwater monitoring wells are being used to monitor quality in the uppermost aquifer sands along the perimeter of the currently permitted fill area. A series of sampling and analysis events to characterize the background quality of the groundwater occurred in the third and fourth quarters of 1996, and the first, second, third and fourth quarters of 1997. The detection monitoring program has been in place since 1985.

Beginning in the third quarter of 1996, the groundwater monitoring requirements included the annual sampling of each well for nine (9) metals, forty seven (47) volatile organic compounds (VOCs), nine (9) water parameters and three (3) field measured parameters. The metals analyzed were arsenic, barium, cadmium, chromium, lead, mercury, selenium, iron, and manganese. The VOCs analyzed have been non-detectable. pH, specific conductance and temperature are field measured parameters. A groundwater elevation measurement is made at each sampling event. The following additional water parameters were sampled: calcium, magnesium, sodium, potassium, alkalinity as CaCO3, sulphate, chloride, total dissolved solids (TDS) and ammonia nitrogen. For a complete listing of the sampled parameters, please consult the Groundwater Sampling and Analysis Plan included as Attachment 11.

No known plumes of contamination have been identified as entering the groundwater from the facility. Levels of arsenic, barium, and selenium have been detected in the ground water at the MSWLF. The arsenic detected is most likely due to the past use of defoliant on the surrounding cotton fields. This should probably decrease with the cease of use of arsenic based defoliant and the rmoval of cotton fields for the site expansion. The barium levels can most likely be attributed to the past use of drilling muds present on the facility site (four plugged and abandoned wells). The barium levels should decrease with time and are well below the MCLs. Selenium is a naturally occurring metal most likely found in the soil present on the site. No other known reason for the levels of selenium found is apparent.

# 2.0 HYDROGEOLOGIC CONDITIONS

## 2.1 Uppermost Aquifer

Eleven new borings were completed to obtain basic data necessary to complete a Soil Characterization. Six of these wells were subsequently completed as Monitor Wells. Nine other previous soil borings were available to assist in the subsurface investigation. The completions will be discussed in the Ground Water Characterization Section. The first seven borings were completed to a depth approximately 10 feet above Mean Sea Level (MSL). The second four borings were completed to depths varying from 72 feet to 88 feet below ground surface (bgs). A generalized description of the sediments encountered follows.

The section describes the characteristics of the soil samples collected and tested during the investigation. The locations of all subsurface boring explorations performed for the design of engineered cells, and for the Geological/Geotechnical investigation are shown on Figure 5.16.. Subsurface geologic correlations showing stratigraphy and structure beneath the site are presented on the following exhibits included herein; Figures 5.3 through 5.15. These figures include a Cross Section Location Map, Geologic Cross sections A-A' through I-I' (9 total), [Note Maximum ground water levels.], A Structure Map of the Top "Light Olive Green Clay", Isopach Map Sand Units I & II, and Isopach Map Sand Units III & IV.

The primary geologic formations exposed at the surface of the site are recent Holocene South Texas Eolian Plain Deposits. The topsoil (approx 0 feet - 20 feet) consists of a clay which is black, silty and contains humic material. This soil is overlain in the extreme northeast corner with a veneer of loess. Sediments encountered in borings at the site are Holocene to Pleistocene in age and consist of clays, silts, sands, and caliches deposited in two (2) separate and distinct environments of deposition. Cross section A – A' serves to illustrate theses environments of deposition. The cross section traverses the MSWLF site using four (4) deep borings all deep enough to penetrate a minimum thickness of 38' of a massive, low permeability, light olive green clay ("Light Olive Green Clay") believed to have been deposited in a marine (estuarian) environment.

The "Light Olive Green Clay" is the aquiclude for the MSWLF facility. In turn, the "Light Olive Green Clay" is capped by a sheet sand ("Orange sand") possibly 2 to 10' thick across the site of the MSWLF. Stratigraphically above the "Orange sand", the environment of deposition changes to fluvial-deltaic for the remaining 40 to 50' of section, measured back to surface. These beds are comprised of sands, silts, caliches and clays deposited as superimposed channel sands and clayey dunes or bars. A detailed cross section net was constructed using all sample borings at the MSWLF and four significant sand bodies are believed to be present within the fluvial-deltaic sequence. Location of these sand bodies are shown on isopach maps included herewith. Bodies I & II are superimposed, caliche or sand filled channels with Body I having the larger areal extent. Bodies III & IV are interpreted as dunes or bars of limited extent and are comprised of clayey sand. All of the above sand bodies are incised into, or embedded within, a tan, silty clay containing abundant mottles of organic matter.

Taken together, the marine clay section (“Light Olive Green Clay”) overlain by fluvial-deltaics section represents a single regressive cycle, with respect to sea level, at the top of the Pleistocene Beaumont formation. It is believed that the entire fluvial-deltaic section is comprised of Holocene sediments with Holocene – Pleistocene boundary represented by the top of the “Light Olive Green Clay” or “Orange sand”.

The shallow subsurface geological structure at the Kingsville MSWLF site is shown by the Structure Map- Top “Light Olive Green Clay” to be monoclinal dip to the northeast at approximately 20 feet per mile. The horizon was chosen as most representative of structure affecting and underlying the MSWLF site. Any structural mapping on beds above the “Light Olive Green Clay” are less correlative and would reflect local scouring of channel sands causing structural inconsistencies due to stratigraphic variation within the fluvial-deltaic section. Correlations are excellent on the top of the “Light Olive Green Clay” and the surface is the most likely to be planar in nature. Some scouring of this surface probably occurs at the extreme southwest corner of the MSWLF site due to the incisement of the overlying Body I, caliche bearing channel.

Deposition of the above sediments postdates uplift of the Kingsville Dome.

## 2.2 Aquiclude

Detailed correlation of borings show that the Holocene sediments which will host the proposed City Kingsville MSWLF were deposited in a fluvial-deltaic environment. The massive “Light Olive Green Clay” which is believed to be of Pleistocene age and deposited in a near shore marine environment underlies the section. As noted previously, the clay serves as the aquiclude between the Holocene sediments hosting the MSWLF and the underlying, saline, “Chicot” sand and the even deeper regional “Evangeline” (Goliad) aquifer.

Although excellent vertical separation exists between the Holocene sediments which will host the MSWLF and underlying Pleistocene beds, lateral migration of groundwater occurs within the through the host beds. From a potentiometric standpoint, it is evident from existing monitor well data that migration of groundwater with the Holocene host sediments is occurring in almost all directions away from the MSWLF site, the exception being the northwest.

From a geologic perspective, it is evident that migration of groundwater should occur primarily away from the MSWLF site to the northeast and southwest. Controlling this trend is the presence of the incised channel containing sands, clays and caliche noted on cross sections and maps as Sand Body I. This body, which hosts the thin to massively bedded caliche deposits in the area, strikes northeast and is approximately ½ mile in width. Body I trends directly through both the existing and proposed landfill sites. Other sand bodies in the host section are noted on the cross sections as II, III and IV. Sand body II is, again an incised, sand filled channel with limited areal extent. Sand Body II is truncated along its strike on the northeast and southwest by the overlying Body I. Sand Bodies III and IV are interpreted as being clay dunes or bars of limited areal extent. It should be noted that the entire Holocene section which contains all of the above sand bodies is permeable and therefore all are in communication. Even so, the orientation of Sand Body I should exert an influence on preferential ground water migration to the northeast and southwest and away from the City of Kingsville's MSWLF site.

Note that ground water modeling using site specific data was performed using HELP3 and Multi-Media computer models. The results of these studies are given in Attachment 15, Appendices B & C, and in Attachment 10, Appendices C & D.

## 2.3 Groundwater Flow Direction and Rate

### 2.3.1 Basis

The local groundwater flow regime at the site was determined by the collection of physical data (such as the elevation of the potentiometric surface) and the completion of in-situ hydraulic conductivity (slug) testing from on-site groundwater monitoring points. Depth-to-water measurements were obtained from existing on-site monitor wells and piezometers on June 16, May 18, February 18, February 2, January 20, January 5, 1998; December 22, December 8, November 24, November 10, October 24, October 16, September 29, September 15, August 15, and August 4, 1997; and December 23, 1996, May 10, 1995, March 14, 1994 and April 5, 1993. The depth-to-water measurements were subtracted from a surveyed reference datum (top of PVC casing) to establish a potentiometric surface relative to 1929 National Geodetic Vertical Datum (NGVD). The groundwater elevation data and resultant potentiometric contour maps for the uppermost permeable stratum are presented in Appendices A, B & C. The water level data measured from soil boring and monitoring well measurements are presented in Appendix B and in Table 5.4.

Analysis of the ground water level data over the period past ten months indicate that the ground water flow tends to leave the MSWLG site in all directions expect the northwest. However, prior to the major rainfall event ground water actually flowed toward the northwest also. The table below determined from the data referred to above gives the following summary of average values of ground water direction, gradient and flow rate.

| Landfill Quadrant | Direction degrees | Gradient ft/ft | Flow Rate ft/yr | Well Used No. | Hydr. Cond. Cm/sec |
|---|---|---|---|---|---|
| N/E | 36 | 0.00799 | 1.200 | 6, 14, 13 | 0.000127 |
| S/E | 257.3 | 0.00144 | 3.124 | 1, 12, 13 | 0.000724 |
| S/W | 204.3 | 0.00216 | 1.503 | 1, 8, 16 | 0.000674 |
| N/W | 202.6 | 0.00387 | 2.137 | 6, 15, 16 | 0.000531 |

From the above table it can be shown that the flow is predominantly away from the MSWLF along the axis of the caliche bearing channel (I). The flow from the Northeast quadrant flows on average at 36 degrees or to the north-northeast with a relatively strong gradient of 0.008 ft/ft. However, the flow rate is fairly low (1.2 ft/yr) due to the relatively lower permeability. On the other hand, the direction from the southwest quadrant is at 204 degrees or south-southwest. The gradient is above ¼ as large, but the flow rate is slightly larger (1.5 ft/yr) due to the higher permeability. The unexpected conclusion from this study is that, on average, both the northwest quadrant and the southeast quadrant flow toward the southwest and along the caliche bearing channel axis. The Southwest quadrant average direction of flow is 257 degrees or west- southwest. The Northeast quadrant average direction is 203 degrees of south-southwest. In other words, both are being pulled into the flow along the Caliche bearing channel. At this point it is important to mention the ponding effect study of on-site and off-site ponds in the area. The off-site contour map shows that the gradient becomes much stronger to the southwest and the deeper caliche pits after it passes under the cross roads of CR-2030 and FM-2619. Thus, even though the strongest gradient on-site is to the northeast, the greatest rate of flow is to the southwest. The northwest and southeast quadrants actually change flow directions depending on the rate of recharge from the surface of from the loss of water through evapotranspiration during drouth periods. Even though these flows are relatively greater to the southwest, all of the flow rates are very low, i,e, a few feet per year. Graphs of daily versus average flow rates are given in Appendix G as are the tabulated calculations for directions, gradients and flow rates.

F.E.E., Inc prepared a hydrograph of existing monitor wells on site using data collected from previous ground water sampling events since March 1991, and data collected during this investigation. Based on the seasonal data from the site collected to date, the potentiometric surface was slightly lower during periods of low precipitation (summer and early fall) and slightly higher during periods of excess precipitation (winter and spring). Given the minimal seasonal fluctuations, the horizontal gradients and flow directions for the uppermost aquifer are more strongly influence by excessive rainfall events (October 11 & 12, 1997 and September 14 & 15, 1967. The hydrograph indicated no significant changes in groundwater elevations since 1991 until recent excessive rainfall events during the period of October 8 through 12, 1997. (Appendix D), [See Section 2.3.4]

### 2.3.2 Evaluation of Horizontal Hydraulic Gradients

Aquifer (bail) tests were performed in piezometers and monitor wells screened in the uppermost groundwater aquifer utilizing falling head methodology. Results of these tests are presented in Appendix E. Based upon these results, the average (geometric mean) horizontal hydraulic conductivity of the uppermost aquifer is approximately 4.12 x $10^{-4}$ cm/sec (1.17 ft/day). The In-Situ hydraulic conductivities for MW's 12,14 and 15 were used in the flow studies for the S/E, N/E and N/W quadrants, respectively. An average of MW-16 and MW-12 was used for the hydraulic conductivity for the S/W quadrant.

The horizontal flow velocity of ground water within each stratum can be estimated using an equation derived from Darcy's Law,

$V=(Ki/n_e)$, where: V=velocity (length/time);

K=Hydraulic conductivity (length/time);

i=hydraulic gradient (length/length); and,

$n_e$=effective porosity (decimal).

As calculated from the potentiometric maps of groundwater flow within each stratum (See Appendix G), the horizontal hydraulic gradient across the site ranges from 1.44 x $10^{-3}$ to 7.99 x $10^{-3}$ ft/ft horizontal hydraulic conductivity values within each stratum, which are stated above, were obtained from in-situ hydraulic conductivity tests (Appendix E). An effective porosity for a silty clay loam (the predominant lithology screened by piezometers in each stratum) is estimated to be 0.43 (Dean, et. al., 1989). Using these parameters, the horizontal velocity of ground water within the uppermost aquifer deposits beneath the site is estimated to range from 0.0033 ft/day to 1.0086 ft/day, or 1.2 ft/year to 3.1 ft/year, respectively.

### 2.3.3 Evaluation of Vertical Hydraulic Gradients

No hydraulic connection was found between uppermost local aquifer (separated by the Light Olive Green Clay aquiclude) and the Chicot Aquifer . (Beaumont Clay, Beaumont Clay-Lissie Formation). The deepest borings did not reach the bottom of the Chicot aquifer. However, the deepest borings did locate the Light Olive Green Clay aquiclude which has a minimum thickness of 38' of low permeability clay (3.31x$10^{-8}$cm/sec) below the uppermost local aquifer., Deeper information was obtained from deeper well logs (URI)and from water well data in the vicinity (AIC Survey). These elevations show that the bottom of the Chicot aquifer is located approximately 200 feet below ground surface in the MSLWF vicinity. These elevation further show that there is at least 38' and probably 140' of a low permeability clay between the uppermost aquifer at the landfill site and the Chicot aquifer. Further there is 200' to 300' of shale /clay below the Chicot aquifer before reaching the Evangeline (Goliad) aquifer. The light Olive Green Clay described above and in Attachment 4 is the aquiclude for the MSWLF facility. There are no water wells in the area with screens set above 524 feet below ground surface. Further, TAC Rule 33.56(d)(S)(A)(ii) states that "Aquifers more than 300 feet below the lowest excavation and where the estimated travel for constituents to the aquifer are in excess of 30 years plus the estimated life of the site, need not be identified by borings." This is the case for the COK MSWLF.

### 2.3.4 Relationship of Ponded Water to Water Table

During the six day period from September 19 through September 25, 1967 massive amount of rainfall fell in South Texas which exceeded annual average rainfall (30 inches). This large rainfall resulted in numerous ponds of water in the relatively flat South Texas area. A joint study of the relationship of this ponded water to groundwater levels in the uppermost, unconfined aquifer was made jointly by the United States Geological Survey and the Texas Water Development Board, (TDWB, #138, December, 1971). This date is relevant to water levels below the City of Kingsville, Texas (COK) Municipal Solid Waste Landfill (MSWLF) site.

The King Ranch site was most representative of the COK MSWLF site. It had water in ponds well above the normal water level in the uppermost aquifer. The massive rainfall from Hurricane Beulah (15 inches) resulted in water table levels continuing to rise below and around the pond for a period of eight months after these above normal rainfall events. The COK MSWLF had a similar large rainfall event during the period October 8 through 12, 1997.

The COK MSWLF site has several excavations which are adjacent to the currently permitted MSWLF and on the same land for which MSWLF expansion is proposed. These excavations were prepared for two reasons: first to provide cover soil for the existing MSWLF; second, to prepare the excavations for future MSWLF cells. The net result of these excavations was to provide depressions in the earth's surface which collect ponded water from rainfall events. This ponded water provides recharge to the uppermost, confined aquifer by percolation through the unsaturated zone to the around water table. This recharge causes higher than normal water levels (mounding) below and near these ponds. This the same result as experienced in the 1968-69 TDWB studies of ponded water on the King Ranch.

# 3.0 GROUNDWATER MONITORING PROGRAM

## 3.1 Proposed Monitoring Well Network

As previously discussed, the uppermost aquifer beneath the site is confined by the Light Olive Green Clay aquiclude located at 5 to 15 foot above MSL below the landfill. This clay extends at least 38 feet and probably 140 feet below the uppermost aquifer. It is, therefore, proposed that the groundwater monitoring system monitor the uppermost aquifer above the Light Olive Green Clay aquiclude. Proposed groundwater monitoring well locations, which comprise a network designed to monitor groundwater quality around the permitted landfill and expansion area, are shown on Figure 5.2. Monitor wells should have their screens located within one foot or less of the aquiclude clay. Recommended elevations for well screens along with approximate horizontal survey coordinates at each proposed location are summarized in Table 5.6.

Based upon an understanding of the local ground water regime and site stratigraphy, the site groundwater monitoring network will monitor the uppermost aquifer separated from below by the Light Olive Green Clay aquiclude. The monitor well network completed within the uppermost aquifer will ultimately be comprised of a total of twenty four (24) monitor wells. Monitor well locations are illustrated on Figure 5.2. A ground water monitor well sequencing table showing required installation and removal times is shown in Table 5.7.

As required by TAC §330.231(e)(3), the Executive Director will be notified in writing of any changes in the direction and rate of groundwater flow that my require the installation of additional monitor wells. Any additional monitor wells installed will be addressed in a modification to the Site Development Plan.

## 3.2 Groundwater Sampling and Analysis

A detailed plan and engineering report describing the proposed groundwater monitoring program is presented in Attachment 11 of Part III, Groundwater Sampling and Analysis Plan (GWSAP). The goal of the GWSAP is to establish consistent sampling and analysis procedures that ensure monitoring results are representative of groundwater quality at the background and down gradient monitoring well locations. The procedures in the GWSAP are considered applicable for all groundwater wells included in the administratively approved monitoring network.

The site groundwater monitoring network will be sampled for constituents listed in the GWSAP. As discussed the GWSAP, semi-annual sampling of groundwater within the Chicot unit will ensure that samples are independent. The development of background values for each constituent, and the sampling, analysis and statistical comparison

# TABLE 5.6
## SUMMARY OF PROPOSED GROUND WATER MONITOR WELLS

| Monitor Well # | Total Depth (ft,bgs) | Ground Elev (ft, MSL) | TOC Elevation (ft, MSL) | Depth to GW (ft,bgs) | Screen Depth (ft,bgs) | Screen Elev (ft, MSL) | Filter Pack (ft,bgs) | Up/Down Gradient | Status |
|---|---|---|---|---|---|---|---|---|---|
| MW-1 | 42.00 | 59.249 | 61.87 | 31.00 | 32.00 | 27.25 | 28.00 | D(POC) | A |
| MW-2 | | | | | | | | | P&A |
| MW-3 | 37.00 | 56.096 | 59.17 | 27.70 | 32.00 | 24.10 | 20.00 | D(POC) | A |
| MW-4 | 39.00 | 58.008 | 60.13 | 31.20 | 34.00 | 24.01 | 25.00 | D | A |
| MW-5 | | | | | | | | | P&A |
| MW-6 | 38.00 | 55.456 | 56.60 | 29.10 | 33.00 | 22.46 | 28.00 | D | A |
| MW-7 | | | | | | | | | P&A |
| 34 MW-8 | 43.00 | 59.787 | 61.18 | 32.02 | 33.00 | 26.79 | 26.00 | D | A |
| MW-9 | | | | | | | | | P&A |
| MW-9R | 17.00 | 41.411 | 44.85 | 9.60 | 7.00 | 34.41 | 6.00 | D | A |
| MW-10 | 29.00 | 49.78 | 52.68 | 19.50 | 19.00 | 30.78 | 16.00 | D | A |
| MW-11 | 33.00 | 60.197 | 62.40 | 26.30 | 17.50 | 42.70 | 16.00 | D | A |
| MW-12 | 48.00 | 52.375 | 54.88 | 17.30 | 25.00 | 27.38 | 23.00 | D(POC) | A |
| MW-13 | 50.00 | 59.131 | 62.10 | 24.00 | 30.00 | 29.13 | 29 | D(POC) | A |
| MW-14 | 42.00 | 49.938 | 52.68 | 22.00 | 25.00 | 24.94 | 23.50 | D | A |
| MW-15 | 37.00 | 48.386 | 51.62 | 12.00 | 22.50 | 25.89 | 21.00 | D | A |
| MW-16 | 47.00 | 55.958 | 58.84 | 19.00 | 30.00 | 25.96 | 29.00 | D | A |
| MW-17 | 33.00 | 41.345 | 43.87 | 7.00 | 12.50 | 28.85 | 10.00 | D | A |
| MW-18 | 42.00 | 50.039 | 52.44 | 15.00 | 22.00 | 28.04 | 19.00 | D | A |
| MW-24 | 33.00 | 47.380 | 49.580 | 12.58 | 18.00 | 29.38 | 18.00 | D | A |

Note: These POC designated wells are for Sector 2 only - the first sector to be activated.

Revision 1

*City of Kingsville, TX Landfill - TNRCC MSW Permit #235-A*

**Ground Water Monitor Well #1**
**Measured Total Depth is 41.67 ft from top of PVC**
**All Measures from Top of PVC Well Pipe**
**Elevation** Top PVC 61.867 Feet, MSL**

| | Date | Depth to Water feet | Elevation of water feet,MSL | Comments |
|---|---|---|---|---|
| | 03-29-91 | 35.6 | 26.27 | |
| | 07-30-91 | 34.5 | 27.37 | |
| | 08-08-91 | 34.69 | 27.18 | |
| | 04-14-92 | 36.88 | 24.99 | |
| | 08-11-92 | 30.02 | 31.85 | |
| | 09-28-92 | 30.6 | 31.27 | |
| | 04-05-93 | 28.61 | 33.26 | |
| * | 03-14-94 | 31.4 | 30.47 | |
| * | 05-10-95 | 29.02 | 32.85 | |
| | 07-11-96 | 29 | 32.87 | |
| | 12-23-96 | 29.85 | 32.02 | |
| | 03-20-97 | 30.53 | 31.34 | |
| | 06-25-97 | 27.79 | 34.08 | |
| | 08-04-97 | 27.67 | 34.2 | |
| | 08-18-97 | 22.94 | 38.93 | |
| | 09-02-97 | 35.64 | 26.23 | |
| | 09-15-97 | 28.28 | 33.59 | |
| | 09-29-97 | 28.39 | 33.48 | |
| | 10-16-97 | 28.57 | 33.3 | |
| | 10-28-97 | 27.5 | 34.37 | |
| | 11-10-97 | 27.1 | 34.77 | |
| | 11-24-97 | 26.69 | 35.17 | |
| | 12-08-97 | 26.36 | 35.5 | |
| | 12-22-97 | 26.19 | 35.67 | |
| | 01-05-98 | 26.05 | 35.81 | |
| | 01-20-98 | 25.88 | 35.98 | |
| | 02-02-98 | 25.92 | 35.94 | |
| | 02-18-98 | 25.67 | 36.19 | |
| | 05-18-98 | 25.21 | 36.65 | |
| | 06-16-98 | 25.54 | 36.32 | |

* City of Kingsville was responsible for the measurements during this period. (used plopper)

** All top of PVC casing elevation have been corrected to McCumber elevation survey of 07-29-97.

B-1

*City of Kingsville, TX Landfill - TNRCC MSW Permit #235-A*

**Ground Water Monitor Well #3**
**Measured Total Depth is 37.75 ft from top of PVC**
**All Measures from Top of PVC Well Pipe**
**Elevation** Top PVC 59.173 Feet, MSL**

| | Date | Depth to Water feet | Elevation of water feet | Comments |
|---|---|---|---|---|
| | 03-29-91 | 25.59 | 33.58 | |
| | 07-30-91 | 26.69 | 32.48 | |
| | 08-08-91 | 26.86 | 32.31 | |
| | 04-14-92 | 26.75 | 32.42 | |
| | 08-11-92 | 25.54 | 33.63 | |
| | 09-28-92 | 25.7 | 33.47 | |
| | 04-05-93 | 27.02 | 32.15 | |
| * | 03-14-94 | 26 | 33.17 | |
| * | 05-10-95 | 22.98 | 36.19 | |
| | 07-11-96 | 22 | 37.17 | |
| | 12-23-96 | 26.03 | 33.14 | |
| | 03-20-97 | 27.08 | 32.09 | |
| | 06-25-97 | 22.11 | 37.06 | |
| | 08-04-97 | 22.83 | 36.34 | |
| | 08-18-97 | 23.26 | 35.91 | |
| | 09-02-97 | 23.63 | 35.54 | |
| | 09-15-97 | 23.79 | 35.38 | |
| | 09-29-97 | 23.9 | 35.27 | |
| | 10-16-97 | 22.31 | 36.86 | |
| | 10-28-97 | 21.89 | 37.28 | |
| | 11-10-97 | 21.2 | 37.97 | |
| | 11-24-97 | 20.6 | 38.57 | |
| | 12-08-97 | 20.36 | 38.81 | |
| | 12-22-97 | 20.48 | 38.69 | |
| | 01-05-98 | 20.65 | 38.52 | |
| | 01-20-98 | 20.73 | 38.44 | |
| | 02-02-98 | 21 | 38.17 | |
| | 02-22-98 | 20.43 | 38.74 | |
| | 05-18-98 | 21.04 | 38.13 | |
| | 06-16-98 | 21.58 | 37.59 | |

*The City of Kingsville (COK) was responsible for depth measurements during this period. (used plopper)

** All top of PVC casing elevations have been corrected to McCumber elevation survey of 07-29-97.

B-2

*City of Kingsville, TX Landfill - TNRCC MSW Permit #235-A*

**Ground Water Monitor Well #4**
**Measured Total Depth is 40.32 ft from top of PVC**
**All Measures from Top of PVC Well Pipe**
**Elevation** Top PVC 60.125 Feet, MSL**

| | Date | Depth to Water feet | Elevation of water feet*** | Comments |
|---|---|---|---|---|
| | 03-29-91 | 23.98 | 35.15 | |
| | 07-30-91 | 23.77 | 35.36 | |
| | 08-08-91 | 24.56 | 34.57 | |
| | 04-14-92 | 27.39 | 31.74 | |
| | 08-11-92 | 26.79 | 32.34 | |
| | 09-28-92 | 30.4 | 28.73 | |
| | 04-05-93 | 30.11 | 29.02 | |
| * | 03-14-94 | 28 | 31.13 | |
| * | 05-10-95 | 25.02 | 34.11 | |
| | 07-11-96 | 26.13 | 33 | |
| | 12-23-96 | 26.32 | 32.81 | |
| | 03-20-97 | 27.33 | 31.8 | |
| | 06-25-97 | 22.28 | 36.85 | |
| | 08-04-97 | 24.24 | 35.89 | |
| | 08-18-97 | 24.76 | 35.37 | |
| | 09-02-97 | 25.04 | 35.09 | |
| | 09-15-97 | 23.84 | 36.29 | |
| | 09-29-97 | 24.6 | 35.53 | |
| | 10-16-97 | 23.16 | 36.97 | |
| | 10-28-97 | 21.81 | 38.32 | |
| | 11-10-97 | 22.19 | 37.94 | |
| | 11-24-97 | 20.65 | 39.47 | |
| | 12-08-97 | 20.52 | 39.60 | |
| | 12-22-97 | 20.73 | 39.39 | |
| | 01-05-98 | 20.99 | 39.13 | |
| | 01-20-98 | 21.24 | 38.88 | |
| | 02-02-98 | 21.52 | 38.60 | |
| | 02-18-98 | 20.72 | 39.40 | |
| | 05-18-98 | 21.96 | 38.16 | |
| | 06-16-98 | 22.69 | 37.43 | |

*The City of Kingsville (COK) was responsible for depth measurements during this period. (used plopper)

** All top of PVC casing elevations have been corrected to McCumber elevation survey of 07-29-97.

*** One foot has been subtracted from the calculated water depth for MW #4, due to the addition of a 12.00" extension to the top of the well casing between the time of measurement of depth to water and the time of the McCumber elevation survey.

*City of Kingsville, TX Landfill - TNRCC MSW Permit #235-A*

**Ground Water Monitor Well #6**
**Measured Total Depth is 39.15 ft from top of PVC**
**All Measures from Top of PVC Well Pipe**
**Elevation** Top PVC 56.604 Feet, MSL**

| | Date | Depth to Water feet | Elevation of water feet | Comments |
|---|---|---|---|---|
| | 03-29-91 | 21.35 | 35.25 | |
| | 07-30-91 | 22.02 | 34.58 | |
| | 08-08-91 | 21.44 | 35.16 | |
| | 04-14-92 | 21.92 | 34.68 | |
| | 08-11-92 | 25.25 | 31.35 | |
| | 09-28-92 | 27 | 29.6 | |
| | 04-05-93 | 27.11 | 29.49 | |
| * | 03-14-94 | 25.25 | 31.35 | |
| * | 05-10-95 | Not | measured | |
| | 07-11-96 | 26.29 | 30.31 | |
| | 12-23-96 | 28.19 | 28.41 | |
| | 03-20-97 | 28.06 | 28.54 | |
| | 06-25-97 | Not | measured | |
| | 08-04-97 | 23.31 | 33.29 | |
| | 08-18-97 | 24.01 | 32.59 | |
| | 09-02-97 | 24.53 | 32.07 | |
| | 09-15-97 | 24.69 | 31.91 | |
| | 09-29-97 | 24.48 | 32.12 | |
| | 10-16-97 | 17.74 | 38.86 | |
| | 10-28-97 | 17.59 | 39.01 | |
| | 11-10-97 | 18.3 | 38.3 | |
| | 11-24-97 | 18.23 | 38.37 | |
| | 12-08-97 | 18.35 | 38.25 | |
| | 12-22-97 | 19.11 | 37.49 | |
| | 01-05-98 | 19.42 | 37.18 | |
| | 01-20-98 | 19.55 | 37.05 | |
| | 02-02-98 | 19.11 | 37.49 | |
| | 02-18-98 | 18.64 | 37.96 | |
| | 05-18-98 | 19.30 | 37.30 | |
| | 06-16-98 | 20.38 | 36.22 | |

*The City of Kingsville (COK) was responsible for depth measurements during this period. (used plopper)

** All top of PVC casing elevations have been corrected to McCumber elevation survey of 07-29-97.

B-4

*City of Kingsville, TX Landfill - TNRCC MSW Permit #235-A*

**Ground Water Monitor Well #8**
**Measured Total Depth is 43.65 ft from top of PVC**
**All Measures from Top of PVC Well Pipe**
**Elevation** Top PVC 61.178 Feet, MSL**

| | Date | Depth to Water feet | Elevation of water feet | Comments |
|---|---|---|---|---|
| | 03-29-91 | Not | Drill'd | |
| | 07-30-91 | 27.67 | 33.51 | |
| | 08-08-91 | 27.5 | 33.68 | |
| | 04-14-92 | 26.77 | 34.41 | |
| | 08-11-92 | 27.52 | 33.66 | |
| | 09-28-92 | 28.3 | 32.88 | |
| | 04-05-93 | 29.17 | 32.01 | |
| * | 03-14-94 | 28.1 | 33.08 | |
| * | 05-10-95 | 28.46 | 32.72 | |
| | 07-11-96 | 29.4 | 31.78 | |
| | 12-23-96 | 30.38 | 30.8 | |
| | 03-20-97 | 30.22 | 30.96 | |
| | 06-25-97 | Not | Measured | |
| | 08-04-97 | 27.37 | 33.81 | |
| | 08-18-97 | 35.36 | 25.82 | |
| | 09-02-97 | 35.76 | 25.42 | |
| | 09-15-97 | 28.42 | 32.76 | |
| | 09-29-97 | 28.14 | 33.04 | |
| | 10-16-97 | 22.07 | 39.11 | |
| | 10-28-97 | 22.74 | 38.44 | |
| | 11-10-97 | 22.73 | 38.45 | |
| | 11-24-97 | 23.06 | 38.11 | |
| | 12-08-97 | 23.83 | 37.34 | |
| | 12-22-97 | 24.38 | 36.79 | |
| | 01-05-98 | 24.72 | 36.45 | |
| | 01-20-98 | 24.91 | 36.26 | |
| | 02-02-98 | 24.72 | 36.45 | |
| | 02-18-98 | 23.14 | 38.03 | |
| | 05-18-98 | 25.19 | 35.98 | |
| | 06-16-98 | 25.89 | 35.28 | |

*The City of Kingsville (COK) was responsible for depth measurements during this period. (used plopper)

** All top of PVC casing elevations have been corrected to McCumber elevation survey of 07-29-97.

B-5

*City of Kingsville, TX Landfill - TNRCC MSW Permit #235-A*

**Ground Water Monitor Well #9R**
**Measured Total Depth is 18.29 ft from top of PVC**
**All Measures from Top of PVC Well Pipe**
**Elevation** Top PVC 44.849 Feet, MSL**

| Date | Depth to Water feet | Elevation of water feet | Comments |
|---|---|---|---|
| 03-29-91 | Not | Drill'd | |
| 07-30-91 | Not | Drill'd | |
| 08-08-91 | Not | Drill'd | |
| 04-14-92 | Not | Drill'd | |
| 08-11-92 | Not | Drill'd | |
| 09-28-92 | Not | Drill'd | |
| 04-05-93 | Not | Drill'd | |
| 03-14-94 | Not | Drill'd | |
| 05-10-95 | Not | Drill'd | |
| 07-11-96 | 12.57 | 32.28 | |
| 12-23-96 | 14.02 | 30.83 | |
| 03-20-97 | 13.76 | 31.09 | |
| 06-25-97 | Not | Measured | |
| 08-04-97 | 10.49 | 34.36 | |
| 08-18-97 | 10.56 | 34.29 | |
| 09-02-97 | 10.45 | 34.4 | |
| 09-15-97 | 10.43 | 34.42 | |
| 09-29-97 | 9.85 | 35 | |
| 10-16-97 | 9.85 | 35 | |
| 10-28-97 | 9.85 | 35 | |
| 11-10-97 | 9.85 | 35 | |
| 11-24-97 | 6.10 | 38.74 | |
| 12-08-97 | 6.35 | 38.49 | |
| 12-22-97 | 6.60 | 38.24 | |
| 01-05-98 | 6.93 | 37.91 | |
| 01-20-98 | 7.35 | 37.49 | |
| 02-02-98 | 6.24 | 38.60 | |
| 02-18-98 | 6.23 | 38.61 | |
| 05-18-98 | 7.93 | 36.91 | |
| 06-16-98 | 8.65 | 36.19 | |

** All top of PVC casing elevations have been corrected to McCumber elevation survey of 07-29-97.

B-6

City of Kingsville, TX Landfill - TNRCC MSW Permit #235-A

**Ground Water Monitor #10**
**Measured Total Depth is 31.48 ft from top of PVC**
**All Measures from Top of PVC Well Pipe**
**Elevation*** Top PVC 52.684 Feet, MSL**

| | Date | Depth to Water feet | Elevation of water feet | Comments |
|---|---|---|---|---|
| | 03-29-91 | Not | Drill'd | |
| | 07-30-91 | Not | Drill'd | |
| | 08-08-91 | Not | Drill'd | |
| | 04-14-92 | 18.49 | 34.19 | |
| | 08-11-92 | 16.59 | 36.09 | |
| | 09-28-92 | 18.9 | 33.78 | |
| | 04-05-93 | 17.76 | 34.92 | |
| * | 03-14-94 | 17.5 | 35.18 | |
| * | 05-10-95 | 19.02 | 33.66 | |
| ** | 07-11-96 | 19.36 | 33.32 | |
| | 12-23-96 | 20.91 | 31.77 | |
| | 03-20-97 | 21.33 | 31.35 | |
| | 06-25-97 | 17.35 | 35.33 | |
| | 08-04-97 | 18.16 | 34.52 | |
| | 08-18-97 | 18.16 | 34.52 | |
| | 09-02-97 | 18.31 | 34.37 | |
| | 09-15-97 | 18.32 | 34.36 | |
| | 09-29-97 | 18.26 | 34.42 | |
| | 10-16-97 | 16.56 | 36.12 | |
| | 10-28-97 | 15.58 | 37.1 | |
| | 11-10-97 | 15.35 | 37.33 | |
| | 11-24-97 | 15.01 | 37.67 | |
| | 12-08-97 | 15.06 | 37.62 | |
| | 12-22-97 | 15.19 | 37.49 | |
| | 01-05-98 | 15.24 | 37.44 | |
| | 01-20-98 | 15.25 | 37.43 | |
| | 02-02-98 | 15.23 | 37.45 | |
| | 02-18-98 | 14.70 | 37.98 | |
| | 05-18-98 | 15.18 | 37.50 | |
| | 06-16-98 | 15.58 | 37.10 | |

*The City of Kingsville (COK) was responsible for depth measurements during this period. (used plopper)

** Due to surface water infiltration, a riser was installed and a taller casing protector was added. Three (3) foot was added to the "Top of PVC" datum point.

*** All top of PVC casings have been corrected to McCumber elevation survey of 07-29-97.

B-7

*City of Kingsville, TX Landfill - TNRCC MSW Permit #235-A*

**Ground Water Monitor Well #11**
**Measured Total Depth is 35.21 ft from top of PVC**
**All Measures from Top of PVC Well Pipe**
**Elevation** Top PVC 62.401 Feet, MSL**

| Date | Depth to Water feet | Elevation of water feet | Comments |
|---|---|---|---|
| 03-29-91 | Not | Drill'd | |
| 07-30-91 | Not | Drill'd | |
| 08-08-91 | Not | Drill'd | |
| 04-14-92 | Not | Drill'd | |
| 08-11-92 | Not | Drill'd | |
| 09-28-92 | Not | Drill'd | |
| 04-05-93 | Not | Drill'd | |
| 03-14-94 | Not | Drill'd | |
| 05-10-95 | Not | Drill'd | |
| 07-11-96 | 28.77 | 33.63 | |
| 12-23-96 | 30.2 | 32.2 | |
| 03-20-97 | 30.69 | 31.71 | |
| 06-25-97 | 26.03 | 36.37 | |
| 08-04-97 | 27.1 | 35.3 | |
| 08-18-97 | 27.31 | 35.09 | |
| 09-02-97 | 27.45 | 34.95 | |
| 09-15-97 | 27.35 | 35.05 | |
| 09-29-97 | 27 | 35.4 | |
| 10-16-97 | 23.76 | 38.64 | |
| 10-18-97 | 22.25 | 40.15 | |
| 11-10-97 | 21.92 | 40.48 | |
| 11-24-97 | 21.72 | 40.68 | |
| 12-08-97 | 22.23 | 40.17 | |
| 12-22-97 | 22.69 | 39.71 | |
| 01-05-98 | 22.99 | 39.41 | |
| 01-20-98 | 23.22 | 39.18 | |
| 02-02-98 | 23.02 | 39.38 | |
| 02-18-98 | 22.22 | 40.18 | |
| 05-18-98 | 24.02 | 38.38 | |
| 06-16-98 | 24.90 | 37.50 | |

** All top of PVC casing elevations have been corrected to McCumber elevation survey of 07-29-97.

B-8

*City of Kingsville, TX Landfill - TNRCC MSW Permit #235*

**Ground Water Monitor Well #12**
**Elevation** Top PVC 54.879 Feet, MSL**

| Date | Depth to Water feet | Elevation of water feet | Comments |
|---|---|---|---|
| 03-29-91 | Not | Drill'd | |
| 07-30-91 | Not | Drill'd | |
| 08-08-91 | Not | Drill'd | |
| 04-14-92 | Not | Drill'd | |
| 08-11-92 | Not | Drill'd | |
| 09-28-92 | Not | Drill'd | |
| 04-05-93 | Not | Drill'd | |
| 03-14-94 | Not | Drill'd | |
| 05-10-95 | Not | Drill'd | |
| 07-11-96 | Not | Drill'd | |
| 12-23-96 | Not | Drill'd | |
| 03-20-97 | Not | Drill'd | |
| 06-25-97 | Not | Drill'd | |
| 08-04-97 | 20.97 | 33.91 | |
| 08-18-97 | 21.42 | 33.46 | |
| 09-02-97 | 21.82 | 33.06 | |
| 09-15-97 | 22.01 | 32.87 | |
| 09-29-97 | 22.09 | 32.79 | |
| 10-16-97 | 19.58 | 35.3 | |
| 10-28-97 | 19.61 | 35.27 | |
| 11-10-97 | 19.34 | 35.54 | |
| 11-24-97 | 18.65 | 36.22 | |
| 12-08-97 | 18.51 | 36.36 | |
| 12-22-97 | 18.54 | 36.33 | |
| 01-05-98 | 18.51 | 36.36 | |
| 01-20-98 | 18.49 | 36.38 | |
| 02-02-98 | 18.42 | 36.45 | |
| 02-18-98 | 17.81 | 37.06 | |
| 05-18-98 | 18.09 | 36.78 | |
| 06-16-98 | 18.82 | 36.05 | |

** All top of PVC casing elevations have been corrected to McCumber elevation survey of 07-29-97.

City of Kingsville, TX Landfill - TNRCC MSW Permit #235

**Ground Water Monitor Well #13**
**Elevation** Top PVC 62.096 Feet, MSL**

| Date | Depth to Water feet | Elevation of water feet | Comments |
|---|---|---|---|
| 03-29-91 | Not | Drill'd | |
| 07-30-91 | Not | Drill'd | |
| 08-08-91 | Not | Drill'd | |
| 04-14-92 | Not | Drill'd | |
| 08-11-92 | Not | Drill'd | |
| 09-28-92 | Not | Drill'd | |
| 04-05-93 | Not | Drill'd | |
| 03-14-94 | Not | Drill'd | |
| 05-10-95 | Not | Drill'd | |
| 07-11-96 | Not | Drill'd | |
| 12-23-96 | Not | Drill'd | |
| 03-20-97 | Not | Drill'd | |
| 06-25-97 | Not | Drill'd | |
| 08-04-97 | 28.86 | 33.24 | |
| 08-18-97 | 29.15 | 32.95 | |
| 09-02-97 | 29.16 | 32.94 | |
| 09-15-97 | 29.33 | 32.77 | |
| 09-29-97 | 29.26 | 32.84 | |
| 10-16-97 | 28.53 | 33.57 | |
| 10-28-98 | 27.55 | 34.55 | |
| 11-10-97 | 27.12 | 34.98 | |
| 11-24-97 | 26.68 | 35.41 | |
| 12-08-97 | 26.49 | 35.60 | |
| 12-22-97 | 26.61 | 35.48 | |
| 01-05-98 | 26.71 | 35.38 | |
| 01-20-98 | 26.81 | 35.28 | |
| 02-02-98 | 27.17 | 34.92 | |
| 02-18-98 | 26.62 | 35.47 | |
| 05-18-98 | 26.62 | 35.47 | |
| 06-16-98 | 27.10 | 34.99 | |

** All top of PVC casing elevations have been corrected to McCumber elevation survey of 07-29-97.

City of Kingsville, TX Landfill - TNRCC MSW Permit #235

## Ground Water Monitor Well #14

**Elevation** Top PVC 52.677 Feet, MSL**

| Date | Depth to Water feet | Elevation of water feet | Comments |
|---|---|---|---|
| 03-29-91 | Not | Drill'd | |
| 07-30-91 | Not | Drill'd | |
| 08-08-91 | Not | Drill'd | |
| 04-14-92 | Not | Drill'd | |
| 08-11-92 | Not | Drill'd | |
| 09-28-92 | Not | Drill'd | |
| 04-05-93 | Not | Drill'd | |
| 03-14-94 | Not | Drill'd | |
| 05-10-95 | Not | Drill'd | |
| 07-11-96 | Not | Drill'd | |
| 12-23-96 | Not | Drill'd | |
| 03-20-97 | Not | Drill'd | |
| 06-25-97 | Not | Drill'd | |
| 08-04-97 | 25.65 | 27.03 | |
| 08-18-97 | 25.88 | 26.8 | |
| 09-02-97 | 26.05 | 26.63 | |
| 09-15-97 | 25.95 | 26.73 | |
| 09-29-97 | 25.77 | 26.91 | |
| 10-16-97 | 25.46 | 27.22 | |
| 10-28-97 | 25.08 | 27.6 | |
| 11-10-97 | 24.66 | 28.02 | |
| 11-24-97 | 24.25 | 28.42 | |
| 12-08-97 | 23.89 | 28.78 | |
| 12-22-97 | 23.64 | 29.03 | |
| 01-05-98 | 23.63 | 29.04 | |
| 01-20-98 | 23.37 | 29.30 | |
| 02-02-98 | 23.51 | 29.16 | |
| 02-18-98 | 23.10 | 29.57 | |
| 05-18-98 | 22.52 | 30.15 | |
| 06-16-98 | 22.67 | 30.00 | |

** All top of PVC casing elevations have been corrected to McCumber elevation survey of 07-29-97.

*City of Kingsville, TX Landfill - TNRCC MSW Permit #235*

**Ground Water Monitor Well #15**

**Elevation** Top PVC 51.624 Feet, MSL**

| Date | Depth to Water feet | Elevation of water feet | Comments |
|---|---|---|---|
| 03-29-91 | Not | Drill'd | |
| 07-30-91 | Not | Drill'd | |
| 08-08-91 | Not | Drill'd | |
| 04-14-92 | Not | Drill'd | |
| 08-11-92 | Not | Drill'd | |
| 09-28-92 | Not | Drill'd | |
| 04-05-93 | Not | Drill'd | |
| 03-14-94 | Not | Drill'd | |
| 05-10-95 | Not | Drill'd | |
| 07-11-96 | Not | Drill'd | |
| 12-23-96 | Not | Drill'd | |
| 03-20-97 | Not | Drill'd | |
| 06-25-97 | Not | Drill'd | |
| 08-04-97 | 17.47 | 34.15 | |
| 08-18-97 | 18.17 | 33.45 | |
| 09-02-97 | 18.47 | 33.15 | |
| 09-15-97 | 18.68 | 32.94 | |
| 09-29-97 | 18.65 | 32.97 | |
| 10-16-97 | 10.19 | 41.43 | |
| 10-28-97 | 10.16 | 41.46 | |
| 11-10-97 | 8.14 | 43.48 | |
| 11-24-97 | 8.19 | 43.43 | |
| 12-08-97 | 7.62 | 44.00 | |
| 12-22-97 | 9.05 | 42.57 | |
| 01-05-98 | 9.89 | 41.73 | |
| 01-20-98 | 10.54 | 41.08 | |
| 02-02-98 | 9.54 | 42.08 | |
| 02-18-98 | 8.91 | 42.91 | |
| 05-18-98 | 11.98 | 39.64 | |
| 06-16-98 | 13.16 | 38.46 | |

** All top of PVC casing elevations have been corrected to McCumber elevation survey of 07-29-97.

*City of Kingsville, TX Landfill - TNRCC MSW Permit #235*

**Ground Water Monitor Well #16**

**Elevation** Top PVC 58.839 Feet, MSL**

| Date | Depth to Water feet | Elevation of water feet | Comments |
|---|---|---|---|
| 03-29-91 | Not | Drill'd | |
| 07-30-91 | Not | Drill'd | |
| 08-08-91 | Not | Drill'd | |
| 04-14-92 | Not | Drill'd | |
| 08-11-92 | Not | Drill'd | |
| 09-28-92 | Not | Drill'd | |
| 04-05-93 | Not | Drill'd | |
| 03-14-94 | Not | Drill'd | |
| 05-10-95 | Not | Drill'd | |
| 07-11-96 | Not | Drill'd | |
| 12-23-96 | Not | Drill'd | |
| 03-20-97 | Not | Drill'd | |
| 06-25-97 | Not | Drill'd | |
| 08-04-97 | 24.21 | 34.63 | |
| 08-18-97 | 24.63 | 34.21 | |
| 09-02-97 | 24.94 | 33.9 | |
| 09-15-97 | 24.95 | 33.89 | |
| 09-29-97 | 24.81 | 34.03 | |
| 10-16-97 | 23.32 | 35.52 | |
| 10-28-97 | 22.75 | 36.09 | |
| 11-10-97 | 22.46 | 36.38 | |
| 11-24-97 | 21.94 | 36.89 | |
| 12-08-97 | 21.70 | 37.13 | |
| 12-22-97 | 21.71 | 37.12 | |
| 01-05-98 | 21.66 | 37.17 | |
| 01-20-98 | 21.67 | 37.16 | |
| 02-02-98 | 21.74 | 37.09 | |
| 02-18-98 | 21.28 | 37.55 | |
| 05-18-98 | 21.62 | 37.21 | |
| 06-16-98 | 22.27 | 36.56 | |

** All top of PVC casing elevations have been corrected to McCumber elevation survey of 07-29-97.

B-13

*City of Kingsville, TX Landfill - TNRCC MSW Permit #235*

**Ground Water Monitor Well #17**
**Elevation** Top PVC 43.868 Feet, MSL**

| Date | Depth to Water feet | Elevation of water feet | Comments |
|---|---|---|---|
| 03-29-91 | Not | Drill'd | |
| 07-30-91 | Not | Drill'd | |
| 08-08-91 | Not | Drill'd | |
| 04-14-92 | Not | Drill'd | |
| 08-11-92 | Not | Drill'd | |
| 09-28-92 | Not | Drill'd | |
| 04-05-93 | Not | Drill'd | |
| 03-14-94 | Not | Drill'd | |
| 05-10-95 | Not | Drill'd | |
| 07-11-96 | Not | Drill'd | |
| 12-23-96 | Not | Drill'd | |
| 03-20-97 | Not | Drill'd | |
| 06-25-97 | Not | Drill'd | |
| 08-04-97 | 9.33 | 34.54 | |
| 08-18-97 | 9.69 | 34.18 | |
| 09-02-97 | 9.92 | 33.95 | |
| 09-15-97 | 9.68 | 34.19 | |
| 09-29-97 | 8.99 | 34.88 | |
| 10-16-97 | 4.28 | 39.59 | |
| 10-28-97 | 4.44 | 39.43 | |
| 11-10-97 | 3.64 | 40.23 | |
| 11-24-97 | 4.01 | 39.85 | |
| 12-08-97 | 4.45 | 39.41 | |
| 12-22-97 | 4.91 | 38.95 | |
| 01-05-98 | 5.58 | 38.28 | |
| 01-20-98 | 6.13 | 37.73 | |
| 02-02-98 | 3.82 | 40.04 | |
| 02-18-98 | 4.37 | 39.49 | |
| 05-18-98 | 6.40 | 37.46 | |
| 06-16-98 | 7.40 | 36.46 | |

** All top of PVC casing elevations have been corrected to McCumber elevation survey of 07-29-97.

*City of Kingsville, TX Landfill - TNRCC MSW Permit #235*

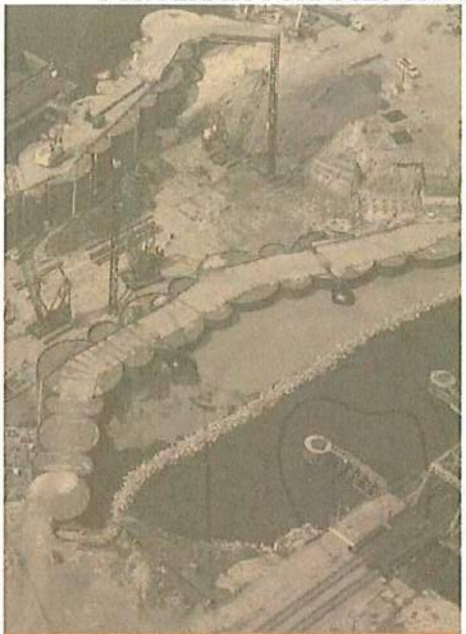
**Ground Water Monitor Well #18**

**Elevation** Top PVC 52.438 Feet, MSL**

| Date | Depth to Water feet | Elevation of water feet | Comments |
|---|---|---|---|
| 03-29-91 | Not | Drill'd | |
| 07-30-91 | Not | Drill'd | |
| 08-08-91 | Not | Drill'd | |
| 04-14-92 | Not | Drill'd | |
| 08-11-92 | Not | Drill'd | |
| 09-28-92 | Not | Drill'd | |
| 04-05-93 | Not | Drill'd | |
| 03-14-94 | Not | Drill'd | |
| 05-10-95 | Not | Drill'd | |
| 07-11-96 | Not | Drill'd | |
| 12-23-96 | Not | Drill'd | |
| 03-20-97 | Not | Drill'd | |
| 06-25-97 | Not | Drill'd | |
| 08-04-97 | 18.61 | 33.83 | |
| 08-18-97 | 18.47 | 33.97 | |
| 09-02-97 | 18.92 | 33.52 | |
| 09-15-97 | 18.78 | 33.66 | |
| 09-29-97 | 18.71 | 33.73 | |
| 10-16-97 | 16.65 | 35.79 | |
| 10-28-97 | 15.8 | 36.64 | |
| 11-10-97 | 15.14 | 37.3 | |
| 11-24-97 | 14.62 | 37.81 | |
| 12-08-97 | 14.25 | 38.18 | |
| 12-22-97 | 14.48 | 37.95 | |
| 01-05-98 | 14.67 | 37.76 | |
| 01-20-98 | 14.88 | 37.55 | |
| 02-02-98 | 15.16 | 37.27 | |
| 02-18-98 | 14.23 | 38:20 | |
| 05-18-98 | 15.09 | 37.34 | |
| 06-16-98 | 15.92 | 36.51 | |

** All top of PVC casing elevations have been corrected to McCumber elevation survey of 07-29-97.

FOR PERMIT PURPOSES ONLY



# Tolunay-Wong Engineers, Inc.

## GEOTECHNICAL ENGINEERING STUDY
## CITY OF KINGSVILLE MUNICIPAL SOLID WASTE LANDFILL EXPANSION
## KINGSVILLE, TEXAS

For Permitting Purposes Only. Applies to boring logs in Appendix B of Tolunay-Wong Engineers, Inc. Geotechnical Engineering Study, City of Kingsville Municipal Solid Waste Landfill Expansion, Kingsville, Texas – Report No. 12788R1, sealed by Don R. Rokohl, P.E. on 8-30-18 altered to provide text showing surface elevations, the elevations of all contacts between soil and rock layers, and unit identifiers in the soil boring logs. No information or data was altered or changed from the original report other than the addition of text showing these elevations and unit identifiers in Appendix B.

*Prepared for:*

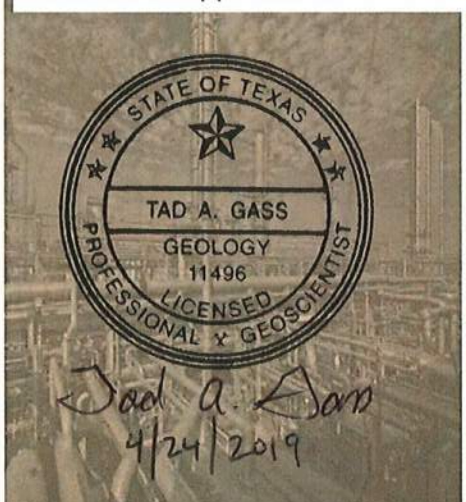
**Naismith/Hanson**
**Corpus Christi, Texas**

*Prepared by:*

**Tolunay-Wong Engineers, Inc.**
**826 South Padre Island Drive**
**Corpus Christi, Texas 78416**

**August 30, 2018**

**Project No. 16.53.042 / Report No. 12788R1**



STATE OF TEXAS
TAD A. GASS
GEOLOGY
11496
LICENSED
PROFESSIONAL GEOSCIENTIST

Tad A. Gass
4/24/2019

*GEOTECHNICAL ENGINEERING, DEEP FOUNDATIONS TESTING, ENVIRONMENTAL SERVICES, CONSTRUCTION MATERIALS TESTING*

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*WWW.TWEINC.COM*

# LOG OF BORING B-30

PROJECT: City of Kingsville
Municipal Solid Waste Landfill
Aerial Expansion

CLIENT: Naismith Engineering, Inc.

COORDINATES: N 27° 26' 44.0"
W 97° 49' 23.1"
SURFACE ELEVATION: 45.99' AMSL
DRILLING METHOD:
Dry Augered: 0-ft. to 82.5-ft.
Wash Bored: -- to --

| DEPTH (ft) | MATERIAL DESCRIPTION | (P) POCKET PEN (tsf) (T) TORVANE (psf) | STD. PENETRATION TEST (blows/ft) | MOISTURE CONTENT (%) | DRY UNIT WEIGHT (pcf) | LIQUID LIMIT (%) | PLASTICITY INDEX (%) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi) | PASSING #200 SIEVE (%) | OTHER TESTS PERFORMED |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | Dense to very dense tan and gray CLAYEY SAND (SC) with gypsum crystals | | 11/6" 23/6" 50/5" | 16 | | 42 | 17 | | | | 37 | |
| 5 | -color changes to tan with ferrous staining | | 34/6" 50/3" | | | | | | | | | |
| | -with sand partings | | 13/6" 50/3" | | | | | | | | | |
| 10 | | | | | | | | | | | | |
| | | | 7/6" 12/6" 20/6" | 35 | | | | | | | 33 | |
| 15 | -color changes to reddish tan and light gray | | 6/6" 15/6" 20/6" | | | | | | | | | |
| 20 | 25.49' AMSL | | | | | | | | | | | |
| | Very stiff to hard reddish tan and light gray FAT CLAY (CH) with gypsum crystals<br>LIGHT OLIVE GREEN TO GRAY CLAY | | 10/6" 17/6" 26/6" | | | | | | | | | |
| 25 | -color changes to reddish tan and tan | | 10/6" 18/6" 30/6" | 25 | | 50 | 28 | | | | 92 | |
| | -color changes to tan and reddish brown | | 8/6" 11/6" 16/6" | | | | | | | | | |
| 30 | | | | | | | | | | | | |
| | -color changes to tan and gray | | 8/6" 12/6" 18/6" | | | | | | | | | |
| 35 | | | | | | | | | | | | |

COMPLETION DEPTH: 82.5 ft
DATE BORING STARTED: 07/22/2016
DATE BORING COMPLETED: 07/23/2016
LOGGER: J. Gonzalez
PROJECT NO.: 16.53.042

REMARKS: Free water was encounterd at an approximate depth of 21' below existing grade during drilling operations. After a 10 to 15-minute waiting period, water was at a depth of 10'-6". At the completion of the boring, the open bore-hole was backfilled with cement-bentonite grout.

Page 1 of 3

TOLUNAY-WONG ENGINEERS, INC.

# LOG OF BORING B-30

PROJECT: City of Kingsville
Municipal Solid Waste Landfill
Aerial Expansion

CLIENT: Naismith Engineering, Inc.

COORDINATES: N 27° 26' 44.0"
W 97° 49' 23.1"
SURFACE ELEVATION: 45.99' AMSL
DRILLING METHOD:
Dry Augered: 0-ft. to 82.5-ft.
Wash Bored: -- to --

| DEPTH (ft) | MATERIAL DESCRIPTION | (P) POCKET PEN (tsf) (T) TORVANE (psf) | STD. PENETRATION TEST (blows/ft) | MOISTURE CONTENT (%) | DRY UNIT WEIGHT (pcf) | LIQUID LIMIT (%) | PLASTICITY INDEX (%) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi) | PASSING #200 SIEVE (%) | OTHER TESTS PERFORMED |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 35 | Very stiff to hard reddish tan and tan FAT CLAY (CH) with gypsum crystals and ferrous stains | | | | | | | | | | | |
| | LIGHT OLIVE GREEN TO GRAY CLAY | | 10/6" 17/6" 21/6" | 30 | | | | | | | 90 | |
| 40 | -color changes to tan and reddish brown | | 9/6" 14/6" 21/6" | | | | | | | | | |
| 45 | | | 13/6" 19/6" 29/6" | | | | | | | | | |
| | -becomes sandy 48' to 52' | | 8/6" 11/6" 13/6" | 30 | | | | | | | 70 | |
| 50 | -color changes to tan and becomes slickensided | (P) 4.50+ | | 23 | 100 | 71 | 51 | | | | 87 | |
| 55 | | (P) 4.50+ | | | | | | | | | | |
| 60 | | (P) 4.50+ | | | | | | | | | | |
| 65 | -becomes sandy and color changes to tan and gray | (P) 4.50+ | | 26 | 97 | 54 | 30 | 1.75 | 3 | | 69 | |
| 70 | -color changes to tan and reddish brown with trace calcareous nodules | (P) 3.00 | | | | | | | | | | |

COMPLETION DEPTH: 82.5 ft
DATE BORING STARTED: 07/22/2016
DATE BORING COMPLETED: 07/23/2016
LOGGER: J. Gonzalez
PROJECT NO.: 16.53.042

REMARKS: Free water was encounterd at an approximate depth of 21' below existing grade during drilling operations. After a 10 to 15-minute waiting period, water was at a depth of 10'-6". At the completion of the boring, the open bore-hole was backfilled with cement-bentonite grout.

Page 2 of 3

TOLUNAY-WONG ENGINEERS, INC.

# LOG OF BORING B-31

PROJECT: City of Kingsville
Municipal Solid Waste Landfill
Aerial Expansion

CLIENT: Naismith Engineering, Inc.

COORDINATES: N 27° 26' 50.1"
W 97° 49' 24.3"
SURFACE ELEVATION: 58.37' AMSL
DRILLING METHOD:
Dry Augered: 0-ft. to 68-ft.
Wash Bored: -- to --

| DEPTH (ft) | MATERIAL DESCRIPTION | (P) POCKET PEN (tsf) (T) TORVANE (psf) | STD. PENETRATION TEST (blows/ft) | MOISTURE CONTENT (%) | DRY UNIT WEIGHT (pcf) | LIQUID LIMIT (%) | PLASTICITY INDEX (%) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi) | PASSING #200 SIEVE (%) | OTHER TESTS PERFORMED |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | Medium dense to very dense gray CLAYEY SAND (SC) BODY I | | 4/6" 5/6" 7/6" | | | | | | | | | |
| | -with calcareous nodules and sand pockets | | 10/6" 22/6" 18/6" | | | | | | | | | |
| 5 | | | 4/6" 5/6" 6/6" | 11 | | | | | | | 46 | |
| | | | 5/6" 6/6" 8/6" | | | | | | | | | |
| | | | 6/6" 8/6" 12/6" | | | | | | | | | |
| 10 | -with cemented sand layers | | 8/6" 27/6" 29/6" | 27 | | | | | | | 22 | |
| | -color changes to tan | | 18/6" 32/6" 39/6" | | | | | | | | | |
| | 43.87' AMSL | | | | | | | | | | | |
| 15 | Very dense tan POORLY GRADED SAND with CLAY (SP-SC) and sand partings BODY IV | | 36/6" 50/5" | | | | | | | | | |
| | | | 12/6" 50/5" | 15 | | | | | | | 9 | |
| | | | 45/6" 50/5" | | | | | | | | | |
| 20 | | | 35/6" 50/4" | | | | | | | | | |
| | | | 17/6" 26/6" 50/5" | | | | | | | | | |
| | | | 17/6" 38/6" 38/6" | | | | | | | | | |
| | 34.87' AMSL | | | | | | | | | | | |
| | Hard reddish tan and light gray SANDY LEAN SILTY CLAY (CL-ML) with sand partings | | 13/6" 20/6" 31/6" | | | | | | | | | |
| 25 | | | 23/6" 34/6" 50/4" | 26 | | 29 | 7 | | | | 66 | |
| | | | 12/6" 17/6" 50/5" | | | | | | | | | |
| | -color changes to reddish tan and tan with ferrous stains | | 13/6" 32/6" 50/5" | | | | | | | | | |
| 30 | | | 7/6" 36/6" 39/6" | | | | | | | | | |
| | | | 10/6" 21/6" 36/6" | | | | | | | | | |
| | | | 10/6" 18/6" 35/6" | 25 | | | | | | | 62 | |
| 35 | | | | | | | | | | | | |

COMPLETION DEPTH: 68 ft
DATE BORING STARTED: 07/20/2016
DATE BORING COMPLETED: 07/21/2016
LOGGER: J. Gonzalez
PROJECT NO.: 16.53.042

REMARKS: Free water was encounterd at an approximate depth of 23' below existing grade during drilling operations. After a 10 to 15-minute waiting period, water was at a depth of 21'-6". At the completion of the boring, the open bore-hole was backfilled with cement-bentonite grout.

Page 1 of 2

TOLUNAY-WONG ENGINEERS, INC.

# LOG OF BORING B-31

PROJECT: City of Kingsville
Municipal Solid Waste Landfill
Aerial Expansion

CLIENT: Naismith Engineering, Inc.

COORDINATES: N 27° 26' 50.1"
W 97° 49' 24.3"
SURFACE ELEVATION: 58.37' AMSL
DRILLING METHOD:
Dry Augered: 0-ft. to 68-ft.
Wash Bored: -- to --

| DEPTH (ft) | MATERIAL DESCRIPTION | (P) POCKET PEN (tsf) (T) TORVANE (psf) | STD. PENETRATION TEST (blows/ft) | MOISTURE CONTENT (%) | DRY UNIT WEIGHT (pcf) | LIQUID LIMIT (%) | PLASTICITY INDEX (%) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi) | PASSING #200 SIEVE (%) | OTHER TESTS PERFORMED |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 35 | Hard reddish tan and tan SANDY LEAN CLAY (CL) with ferrous stains and laminated sands | | 17/6" 25/6" 35/6" 17/6" 13/6" 19/6" 7/6" 16/6" 17/6" | | | | | | | | | |
| | 18.87' AMSL | | | | | | | | | | | |
| 40 | Very stiff to hard reddish tan and tan FAT CLAY with SAND (CH) and ferrous stains | | 3/6" 7/6" 10/6" 9/6" 20/6" 27/6" | 37 | | 59 | 36 | | | | 76 | |
| | LIGHT OLIVE GREEN TO GRAY CLAY | | 5/6" 14/6" 17/6" 10/6" 18/6" 21/6" | | | | | | | | | |
| 45 | -with trace gypsum crystals and ferrous stains | | 18/6" 23/6" 30/6" 6/6" 20/6" 21/6" | 30 | | | | | | | 83 | |
| 50 | | | 9/6" 17/6" 19/6" 9/6" 18/6" 23/6" 11/6" 23/6" 26/6" | | | | | | | | | |
| | -with calcareous nodules and ferrous stains | (P) 4.50+ | | 32 | 91 | 83 | 50 | 4.14 | 2 | | 87 | |
| 55 | | (P) 4.50+ | | | | | | | | | | |
| | | (P) 4.50+ | | | | | | | | | | |
| | | (P) 4.50+ | | 34 | 87 | | | 2.88 | 2 | | 83 | |
| 60 | -with trace gypsum crystals and ferrous stains | (P) 4.50+ | | | | | | | | | | |
| | | (P) 4.50+ | | | | | | | | | | |
| 65 | | (P) 4.50+ | | | | | | | | | | |
| | -9.63' AMSL | (P) 4.50+ | | | | | | | | | | |
| | Bottom @ 68' | | | | | | | | | | | |
| 70 | | | | | | | | | | | | |

COMPLETION DEPTH: 68 ft
DATE BORING STARTED: 07/20/2016
DATE BORING COMPLETED: 07/21/2016
LOGGER: J. Gonzalez
PROJECT NO.: 16.53.042

REMARKS: Free water was encounterd at an approximate depth of 23' below existing grade during drilling operations. After a 10 to 15-minute waiting period, water was at a depth of 21'-6". At the completion of the boring, the open bore-hole was backfilled with cement-bentonite grout.

Page 2 of 2

TOLUNAY-WONG ENGINEERS, INC.

# LOG OF BORING B-32

PROJECT: City of Kingsville Municipal Solid Waste Landfill Aerial Expansion
CLIENT: Naismith Engineering, Inc.

COORDINATES: N 27° 26' 49.7" W 97° 49' 17.0"
SURFACE ELEVATION: 48.46' AMSL
DRILLING METHOD:
Dry Augered: 0-ft. to 82.5-ft.
Wash Bored: -- to --

| DEPTH (ft) | MATERIAL DESCRIPTION | (P) POCKET PEN (tsf) (T) TORVANE (psf) | STD. PENETRATION TEST (blows/ft) | MOISTURE CONTENT (%) | DRY UNIT WEIGHT (pcf) | LIQUID LIMIT (%) | PLASTICITY INDEX (%) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi) | PASSING #200 SIEVE (%) | OTHER TESTS PERFORMED |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 35 | Medium dense to dense reddish tan and gray CLAYEY SAND (SC) with gypsum crystals 12.46' AMSL | | | | | | | | | | | |
| | Very stiff to hard tan FAT CLAY with SAND (CH), slickensided, with calcareous nodules | (P) 4.50+ | | 29 | 89 | | | | | | 79 | |
| | LIGHT OLIVE GREEN TO GRAY CLAY | | | | | | | | | | | |
| 40 | | | | | | | | | | | | |
| | -color changes to tan and reddish brown with gypsum crystals and ferrous stains | | 8/6" 12/6" 15/6" | | | | | | | | | |
| 45 | -color changes to tan, gray, and reddish brown | (P) 4.50+ | | | | | | | | | | |
| 50 | -color changes to tan and reddish brown | | 4/6" 9/6" 10/6" | 30 | | 73 | 51 | | | | 82 | |
| | | (P) 4.50+ | | | | | | | | | | |
| 55 | | | | | | | | | | | | |
| | -color changes to tan and gray | (P) 4.50+ | | | | | | | | | | |
| 60 | | | | | | | | | | | | |
| | | (P) 4.50+ | | 26 | 94 | | | 0.61 | 2 | | 81 | |
| 65 | -color changes to tan, red, and brown | (P) 4.00 | | | | | | | | | | |
| | -color changes to tan and gray | (P) 4.50+ | | | | | | | | | | |
| 70 | | | | | | | | | | | | |

COMPLETION DEPTH: 82.5 ft
DATE BORING STARTED: 07/27/2016
DATE BORING COMPLETED: 07/28/2016
LOGGER: J. Gonzalez
PROJECT NO.: 16.53.042

REMARKS: Free water was encounterd at an approximate depth of 18' below existing grade during drilling operations. After a 10 to 15-minute waiting period, water was at a depth of 14'-7". At the completion of the boring, the open bore-hole was backfilled with cement-bentonite grout.

Page 2 of 3

TOLUNAY-WONG ENGINEERS, INC.

# LOG OF BORING B-32

PROJECT: City of Kingsville Municipal Solid Waste Landfill Aerial Expansion
CLIENT: Naismith Engineering, Inc.

COORDINATES: N 27° 26' 49.7" W 97° 49' 17.0"
SURFACE ELEVATION: 48.46' AMSL
DRILLING METHOD:
Dry Augered: 0-ft. to 82.5-ft.
Wash Bored: -- to --

| DEPTH (ft) | MATERIAL DESCRIPTION | (P) POCKET PEN (tsf) (T) TORVANE (psf) | STD. PENETRATION TEST (blows/ft) | MOISTURE CONTENT (%) | DRY UNIT WEIGHT (pcf) | LIQUID LIMIT (%) | PLASTICITY INDEX (%) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi) | PASSING #200 SIEVE (%) | OTHER TESTS PERFORMED |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 70 | Very stiff to hard tan and gray FAT CLAY with SAND (CH), slickensided with gypsum crystals and calcareous nodules LIGHT OLIVE GREEN TO GRAY CLAY -24.54' AMSL | | | | | | | | | | | |
| | Medium dense to dense tan CLAYEY SAND (SC) with calcareous nodules | (P) 0.75 | | 21 | | 24 | 8 | | | | 24 | |
| 75 | | | | | | | | | | | | |
| | -with gypsum crystals and ferrous stains | | 5/6" 10/6" 13/6" | | | | | | | | | |
| 80 | | | 13/6" 20/6" 20/6" | | | | | | | | | |
| | -34.04' AMSL | | | | | | | | | | | |
| | Bottom @ 82.5' | | | | | | | | | | | |
| 85 | | | | | | | | | | | | |
| 90 | | | | | | | | | | | | |
| 95 | | | | | | | | | | | | |
| 100 | | | | | | | | | | | | |
| 105 | | | | | | | | | | | | |

COMPLETION DEPTH: 82.5 ft
DATE BORING STARTED: 07/27/2016
DATE BORING COMPLETED: 07/28/2016
LOGGER: J. Gonzalez
PROJECT NO.: 16.53.042

REMARKS: Free water was encounterd at an approximate depth of 18' below existing grade during drilling operations. After a 10 to 15-minute waiting period, water was at a depth of 14'-7". At the completion of the boring, the open bore-hole was backfilled with cement-bentonite grout.

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TOLUNAY-WONG ENGINEERS, INC.

# LOG OF BORING B-33

PROJECT: City of Kingsville Municipal Solid Waste Landfill Aerial Expansion

CLIENT: Naismith Engineering, Inc.

COORDINATES: N 27° 26' 55.9" W 97° 49' 11.3"
SURFACE ELEVATION: 64.51' AMSL
DRILLING METHOD:
Dry Augered: 0-ft. to 86-ft.
Wash Bored: -- to --

| DEPTH (ft) | MATERIAL DESCRIPTION | (P) POCKET PEN (tsf) (T) TORVANE (psf) | STD. PENETRATION TEST (blows/ft) | MOISTURE CONTENT (%) | DRY UNIT WEIGHT (pcf) | LIQUID LIMIT (%) | PLASTICITY INDEX (%) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi) | PASSING #200 SIEVE (%) | OTHER TESTS PERFORMED |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | Medium dense to very dense tan CLAYEY SAND (SC) with gypsum crystals BODY I | | 2/6" 7/6" 9/6" | | | | | | | | | |
| 5 | -color changes to dark gray and gray with trace gravel | | 7/6" 11/6" 9/6" | 16 | | | | | | | 47 | |
| 10 | -color changes to tan and light gray sand partings | | 27/6" 50/6" | | | | | | | | | |
| | -color changes to tan and white with trace caliche | | 50/5" | | | | | | | | | |
| 15 | 48.01' AMSL | | | | | | | | | | | |
| | Dense to very dense tan and white POORLY GRADED SAND with SILT (SP-SM), and trace caliche BODY II | | 17/6" 48/6" 50/3" | 11 | | 35 | 8 | | | | 12 | |
| 20 | | | 17/6" 21/6" 27/6" | | | | | | | | | |
| 25 | -color changes to light gray and tan with gypsum crystals and ferrous stains | | 15/6" 17/6" 32/6" | | | | | | | | | |
| | 36.01' AMSL | | | | | | | | | | | |
| 30 | Medium dense to dense gray and white CLAYEY SAND (SC) with gypsum crystals | | 14/6" 22/6" 26/6" | 42 | | | | | | | 20 | |
| | -color changes to tan | | 13/6" 21/6" 22/6" | | | | | | | | | |
| 35 | | | | | | | | | | | | |

COMPLETION DEPTH: 86 ft
DATE BORING STARTED: 08/05/2016
DATE BORING COMPLETED: 08/05/2016
LOGGER: J. Gonzalez
PROJECT NO.: 16.53.042

REMARKS: Free water was encounterd at an approximate depth of 32'-6" below existing grade during drilling operations. After a 10 to 15-minute waiting period, water was at a depth of 28'-2". At the completion of the boring, the open bore-hole was backfilled with cement-bentonite grout.

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TOLUNAY-WONG ENGINEERS, INC.

# LOG OF BORING B-33

PROJECT: City of Kingsville Municipal Solid Waste Landfill Aerial Expansion

CLIENT: Naismith Engineering, Inc.

COORDINATES: N 27° 26' 55.9" W 97° 49' 11.3"
SURFACE ELEVATION: 64.51' AMSL
DRILLING METHOD:
Dry Augered: 0-ft. to 86-ft.
Wash Bored: -- to --

| DEPTH (ft) | MATERIAL DESCRIPTION | (P) POCKET PEN (tsf) (T) TORVANE (psf) | STD. PENETRATION TEST (blows/ft) | MOISTURE CONTENT (%) | DRY UNIT WEIGHT (pcf) | LIQUID LIMIT (%) | PLASTICITY INDEX (%) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi) | PASSING #200 SIEVE (%) | OTHER TESTS PERFORMED |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 35 | Medium dense to dense reddish tan CLAYEY SAND (SC) with gypsum crystals and ferrous stains | | 6/6" 9/6" 12/6" | | | | | | | | | |
| 40 | -color changes to tan and reddish tan | | 8/6" 16/6" 18/6" | | | | | | | | | |
| | 20.01' AMSL | | | | | | | | | | | |
| 45 | Stiff to very stiff reddish tan LEAN CLAY with SAND (CL), slickensided, with ferrous stains<br>SANDY SILTY CLAY BED | | 9/6" 12/6" 18/6" | 29 | | 43 | 24 | | | | 79 | |
| | -color changes to reddish tan and tan with gypsum crystals | | 5/6" 6/6" 9/6" | | | | | | | | | |
| 50 | 12.51' AMSL | | | | | | | | | | | |
| | Stiff to very stiff LEAN CLAY (CL), slickensided, with ferrous stains<br>SANDY SILTY CLAY BED | (P) 2.00 | | 40 | 79 | | | 1.06 | 3 | | 96 | |
| 55 | -color changes to reddish brown and tan with gypsum crystals | (P) 3.50 | | | | | | | | | | |
| 60 | | (P) 4.00 | | 34 | 87 | | | | | | | |
| | -0.51' AMSL | | | | | | | | | | | |
| 65 | Very stiff to hard tan FAT CLAY (CH), slickensided, with gypsum crystals and ferrous stains<br>LIGHT OLIVE GREEN TO GRAY CLAY | (P) 4.50+ | | 32 | 42 | 64 | 33 | 2.57 | 2 | | 95 | |
| | -color changes to tan and reddish brown | | 7/6" 12/6" 14/6" | | | | | | | | | |
| 70 | | | | | | | | | | | | |

COMPLETION DEPTH: 86 ft
DATE BORING STARTED: 08/05/2016
DATE BORING COMPLETED: 08/05/2016
LOGGER: J. Gonzalez
PROJECT NO.: 16.53.042

REMARKS: Free water was encounterd at an approximate depth of 32'-6" below existing grade during drilling operations. After a 10 to 15-minute waiting period, water was at a depth of 28'-2". At the completion of the boring, the open bore-hole was backfilled with cement-bentonite grout.

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TOLUNAY-WONG ENGINEERS, INC.

# LOG OF BORING B-33

PROJECT: City of Kingsville
Municipal Solid Waste Landfill
Aerial Expansion

CLIENT: Naismith Engineering, Inc.

COORDINATES: N 27° 26' 55.9" W 97° 49' 11.3"
SURFACE ELEVATION: 64.51' AMSL
DRILLING METHOD:
Dry Augered: 0-ft. to 86-ft.
Wash Bored: -- to --

| DEPTH (ft) | MATERIAL DESCRIPTION | (P) POCKET PEN (tsf) (T) TORVANE (psf) | STD. PENETRATION TEST (blows/ft) | MOISTURE CONTENT (%) | DRY UNIT WEIGHT (pcf) | LIQUID LIMIT (%) | PLASTICITY INDEX (%) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi) | PASSING #200 SIEVE (%) | OTHER TESTS PERFORMED |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 70 | Very stiff to hard tan and reddish brown FAT CLAY (CH), slickensided, with gypsum crystals and ferrous stains LIGHT OLIVE GREEN TO GRAY CLAY | (P) 4.50+ | | | | | | | | | | |
| | -color changes to tan and light gray | | | | | | | | | | | |
| 75 | -with layers of calcareous nodules | | 9/6" 10/6" 21/6" | | | | | | | | | |
| | -15.49' AMSL | | | | | | | | | | | |
| 80 | Very stiff to hard tan FAT CLAY with SAND (CH) with gypsum crystals and ferrous stains LIGHT OLIVE GREEN TO GRAY CLAY | (P) 4.50+ | | 18 | 106 | | | 3.57 | 3 | | 77 | |
| | -color changes to tan and white | (P) 4.50+ | | | | | | | | | | |
| 85 | -21.49' AMSL | | | | | | | | | | | |
| | Bottom @ 86' | | | | | | | | | | | |
| 90 | | | | | | | | | | | | |
| 95 | | | | | | | | | | | | |
| 100 | | | | | | | | | | | | |
| 105 | | | | | | | | | | | | |

COMPLETION DEPTH: 86 ft
DATE BORING STARTED: 08/05/2016
DATE BORING COMPLETED: 08/05/2016
LOGGER: J. Gonzalez
PROJECT NO.: 16.53.042

REMARKS: Free water was encounterd at an approximate depth of 32'-6" below existing grade during drilling operations. After a 10 to 15-minute waiting period, water was at a depth of 28'-2". At the completion of the boring, the open bore-hole was backfilled with cement-bentonite grout.

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TOLUNAY-WONG ENGINEERS, INC.

# LOG OF BORING B-34

PROJECT: City of Kingsville
Municipal Solid Waste Landfill
Aerial Expansion

CLIENT: Naismith Engineering, Inc.

COORDINATES: N 27° 26' 43.4"
W 97° 49' 11.4"
SURFACE ELEVATION: 61.14' AMSL
DRILLING METHOD:
Dry Augered: 0 ft. to 30 ft.
Wash Bored: 30 ft. to 43 ft.

| DEPTH (ft) | MATERIAL DESCRIPTION | (P) POCKET PEN (tsf) (T) TORVANE (psf) | STD. PENETRATION TEST (blows/ft) | MOISTURE CONTENT (%) | DRY UNIT WEIGHT (pcf) | LIQUID LIMIT (%) | PLASTICITY INDEX (%) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi) | PASSING #200 SIEVE (%) | OTHER TESTS PERFORMED |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | Medium dense dark gray, gray, and light gray CLAYEY SAND (SC) with trace of organics | | 2/6" 5/6" 6/6" | | | | | | | | | |
| | | (P) 4.50+ | | 15 | 112 | | | 2.53 | 6 | | 42 | |
| | 57.14' AMSL | | | | | | | | | | | |
| | Very stiff to hard gray and light gray SANDY LEAN SILTY CLAY (CL-ML) with calcareous nodules | (P) 4.50+ | | 15 | 115 | 21 | 7 | | | | 59 | |
| 5 | | (P) 4.50+ | | 14 | 114 | | | 6.13 | 4 | | 62 | |
| | -color changes to light gray | | | | | | | | | | | |
| | -color changes to light gray and tan | | 4/6" 12/6" 16/6" | | | | | | | | | |
| 10 | -color changes to white and light gray | | 11/6" 18/6" 16/6" | | | | | | | | | |
| | -becomes stiff | | 5/6" 6/6" 8/6" | | | | | | | | | |
| | 46.64' AMSL | | | | | | | | | | | |
| 15 | Medium dense to dense white and light gray SILTY SAND (SM) with calcareous nodules BODY II | | 4/6" 6/6" 8/6" | 17 | | 38 | 7 | | | | 31 | |
| | -color changes to light gray and tan with ferrous stains | | 4/6" 10/6" 19/6" | | | | | | | | | |
| | | | 23/6" 50/5" | | | | | | | | | |
| 20 | | | 23/6" 50/4" | | | | | | | | | |
| | -color changes to light gray | | 27/6" 35/6" 50/4" | 22 | | | | | | | 25 | |
| 25 | | | 5/6" 37/6" 45/6" | | | | | | | | | |
| | | | 20/6" 39/6" 37/6" | | | | | | | | | |
| | -becomes medium dense | | 8/6" 12/6" 9/6" | 26 | | 39 | 2 | | | | 28 | |
| 30 | | | 4/6" 12/6" 10/6" | 33 | | | | | | | 39 | |
| | | | 5/6" 6/6" 10/6" | | | | | | | | | |
| 35 | -color changes to tan and marine green | | 3/6" | | | | | | | | | |

COMPLETION DEPTH: 43 ft
DATE BORING STARTED: 06/22/2016
DATE BORING COMPLETED: 06/22/2016
LOGGER: J. Garcia
PROJECT NO.: 16.53.042

REMARKS: Free water was encounterd at an approximate depth of 31' below existing grade during drilling operations. After a 10 to 15-minute waiting period, water was at a depth of 28'-4". At the completion of the boring, the open bore-hole was backfilled with cement-bentonite grout.

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TOLUNAY-WONG ENGINEERS, INC.

# LOG OF BORING B-34

PROJECT: City of Kingsville Municipal Solid Waste Landfill Aerial Expansion

CLIENT: Naismith Engineering, Inc.

COORDINATES: N 27° 26' 43.4" W 97° 49' 11.4"
SURFACE ELEVATION: 61.14' AMSL
DRILLING METHOD:
Dry Augered: 0 ft. to 30 ft.
Wash Bored: 30 ft. to 43 ft.

| DEPTH (ft) | MATERIAL DESCRIPTION | (P) POCKET PEN (tsf) (T) TORVANE (psf) | STD. PENETRATION TEST (blows/ft) | MOISTURE CONTENT (%) | DRY UNIT WEIGHT (pcf) | LIQUID LIMIT (%) | PLASTICITY INDEX (%) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi) | PASSING #200 SIEVE (%) | OTHER TESTS PERFORMED |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 35 | Medium dense tan and marine green SILTY SAND (SM) with sand lenses and trace organics 25.14' AMSL | | 8/6" 13/6" | | | | | | | | | |
| | Hard tan and light gray LEAN CLAY (CL) | (P) 4.50+ | | | | | | | | | | |
| | SANDY SILTY CLAY BED | (P) 4.50+ | | 30 | 91 | 40 | 17 | 0.93 | 1 | | 91 | |
| 40 | | (P) 4.50+ | | | | | | | | | | |
| | 18.14' AMSL | (P) 4.50+ | | | | | | | | | | |
| | Bottom @ 43' | | | | | | | | | | | |
| 45 | | | | | | | | | | | | |
| 50 | | | | | | | | | | | | |
| 55 | | | | | | | | | | | | |
| 60 | | | | | | | | | | | | |
| 65 | | | | | | | | | | | | |
| 70 | | | | | | | | | | | | |

COMPLETION DEPTH: 43 ft
DATE BORING STARTED: 06/22/2016
DATE BORING COMPLETED: 06/22/2016
LOGGER: J. Garcia
PROJECT NO.: 16.53.042

REMARKS: Free water was encounterd at an approximate depth of 31' below existing grade during drilling operations. After a 10 to 15-minute waiting period, water was at a depth of 28'-4". At the completion of the boring, the open bore-hole was backfilled with cement-bentonite grout.

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TOLUNAY-WONG ENGINEERS, INC.

# LOG OF BORING B-35

PROJECT: City of Kingsville Municipal Solid Waste Landfill Aerial Expansion

CLIENT: Naismith Engineering, Inc.

COORDINATES: N 27° 26' 50.5" W 97° 48' 57.2"
SURFACE ELEVATION: 64.50' AMSL
DRILLING METHOD:
Dry Augered: 0-ft. to 72.5-ft.
Wash Bored: -- to --

| DEPTH (ft) | MATERIAL DESCRIPTION | (P) POCKET PEN (tsf) (T) TORVANE (psf) | STD. PENETRATION TEST (blows/ft) | MOISTURE CONTENT (%) | DRY UNIT WEIGHT (pcf) | LIQUID LIMIT (%) | PLASTICITY INDEX (%) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi) | PASSING #200 SIEVE (%) | OTHER TESTS PERFORMED |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | Medium dense tan and brown CLAYEY SAND (SC) with trace caliche | | 5/6" 8/6" 7/6" | | | | | | | | | |
| 5 | -color changes to reddish brown with ferrous stains | | 5/6" 8/6" 5/6" | 12 | | 31 | 17 | | | | 38 | |
| | 56.50' AMSL | | | | | | | | | | | |
| | Very stiff to hard reddish tan SANDY LEAN CLAY (CL) with gypsum crystals | (P) 4.50+ | | 14 | 117 | | | 2.22 | 3 | | 52 | |
| 10 | | | | | | | | | | | | |
| | -color changes to reddish tan and tan with ferrous stains | | 5/6" 10/6" 12/6" | | | | | | | | | |
| 15 | -color changes to reddish tan | (P) 4.50+ | | 17 | 109 | 42 | 25 | | | | | |
| 20 | -color changes to reddish tan and tan | (P) 4.50+ | | | | | | | | | | |
| | 40.50' AMSL | | | | | | | | | | | |
| 25 | Medium dense to dense reddish tan and tan CLAYEY SAND (SC) with gypsum crystals and ferrous stains<br>BODY III | (P) 4.50+ | | 17 | 104 | | | 1.29 | 3 | | 40 | |
| 30 | -color changes to reddish tan | | 4/6" 7/6" 9/6" | | | | | | | | | |
| | | | 8/6" 13/6" 20/6" | | | | | | | | | |
| 35 | | | | | | | | | | | | |

COMPLETION DEPTH: 72.5 ft
DATE BORING STARTED: 07/29/2016
DATE BORING COMPLETED: 07/29/2016
LOGGER: J. Gonzalez
PROJECT NO.: 16.53.042

REMARKS: Free water was encounterd at an approximate depth of 34' below existing grade during drilling operations. After a 10 to 15-minute waiting period, water was at a depth of 30'-9". At the completion of the boring, the open bore-hole was backfilled with cement-bentonite grout.

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TOLUNAY-WONG ENGINEERS, INC.

# LOG OF BORING B-35

PROJECT: City of Kingsville
Municipal Solid Waste Landfill
Aerial Expansion

CLIENT: Naismith Engineering, Inc.

COORDINATES: N 27° 26' 50.5"
W 97° 48' 57.2"
SURFACE ELEVATION: 64.50' AMSL
DRILLING METHOD:
Dry Augered: 0-ft. to 72.5-ft.
Wash Bored: -- to --

| DEPTH (ft) | MATERIAL DESCRIPTION | (P) POCKET PEN (tsf) (T) TORVANE (psf) | STD. PENETRATION TEST (blows/ft) | MOISTURE CONTENT (%) | DRY UNIT WEIGHT (pcf) | LIQUID LIMIT (%) | PLASTICITY INDEX (%) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi) | PASSING #200 SIEVE (%) | OTHER TESTS PERFORMED |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 35 | 28.00' AMSL<br>Medium dense to dense reddish tan and tan CLAYEY SAND (SC) with gypsum crystals and ferrous stains | | | | | | | | | | | |
| | Hard tan and light gray FAT CLAY with SAND (CH), gypsum crystals, and ferrous stains<br>LIGHT OLIVE GREEN TO GRAY CLAY | | 17/6"<br>26/6"<br>30/6" | 25 | | 109 | 72 | | | | 77 | |
| 40 | | | | | | | | | | | | |
| | -color changes to tan and reddish brown | | 8/6"<br>15/6"<br>24/6" | | | | | | | | | |
| 45 | -with sand partings | | 10/6"<br>16/6"<br>16/6" | | | | | | | | | |
| | 16.00' AMSL<br>Stiff to hard reddish brown and tan FAT CLAY (CH) with gypsum crystals and ferrous stains<br>LIGHT OLIVE GREEN TO GRAY CLAY | | 4/6"<br>7/6"<br>10/6" | 34 | | | | | | | 96 | |
| 50 | | | | | | | | | | | | |
| | -becomes slickensided with sand layers | (P) 2.00 | | | | | | | | | | |
| 55 | | | | | | | | | | | | |
| | -color changes to tan | | 4/6"<br>7/6"<br>10/6" | | | | | | | | | |
| 60 | | (P) 3.75 | | 33 | 89 | 90 | 67 | 3.88 | 4 | | 89 | |
| | | (P) 4.25 | | | | | | | | | | |
| 65 | | | | | | | | | | | | |
| | -color changes to tan and reddish brown | (P) 4.50+ | | | | | | | | | | |
| 70 | | | | | | | | | | | | |

COMPLETION DEPTH: 72.5 ft
DATE BORING STARTED: 07/29/2016
DATE BORING COMPLETED: 07/29/2016
LOGGER: J. Gonzalez
PROJECT NO.: 16.53.042

REMARKS: Free water was encounterd at an approximate depth of 34' below existing grade during drilling operations. After a 10 to 15-minute waiting period, water was at a depth of 30'-9". At the completion of the boring, the open bore-hole was backfilled with cement-bentonite grout.

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TOLUNAY-WONG ENGINEERS, INC.

# LOG OF BORING B-36

PROJECT: City of Kingsville
Municipal Solid Waste Landfill
Aerial Expansion

CLIENT: Naismith Engineering, Inc.

COORDINATES: N 27° 26' 56.8"
W 97° 49' 04.9"
SURFACE ELEVATION: 59.13' AMSL
DRILLING METHOD:
Dry Augered: 0-ft. to 22-ft.
Wash Bored: 22-ft. to 68-ft.

| DEPTH (ft) | MATERIAL DESCRIPTION | (P) POCKET PEN (tsf) (T) TORVANE (psf) | STD. PENETRATION TEST (blows/ft) | MOISTURE CONTENT (%) | DRY UNIT WEIGHT (pcf) | LIQUID LIMIT (%) | PLASTICITY INDEX (%) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi) | PASSING #200 SIEVE (%) | OTHER TESTS PERFORMED |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | Loose to medium dense dark gray and gray CLAYEY SAND (SC) BODY I | | | | | | | | | | | |
| | -with calcareous nodules | | 18/6" 20/6" 21/6" | 10 | | | | | | | 36 | |
| 5 | | | | | | | | | | | | |
| | -color changes to light gray and tan | | 4/6" 5/6" 5/6" | | | | | | | | | |
| 10 | -color changes to tan | | 4/6" 5/6" 6/6" | 12 | | 47 | 28 | | | | 44 | |
| 15 | | | 2/6" 4/6" 6/6" | | | | | | | | | |
| | -color changes to light gray with ferrous stains | | 4/6" 10/6" 14/6" | | | | | | | | | |
| 20 | | | | | | | | | | | | |
| | -becomes very dense and color changes to light gray and tan | | 15/6" 24/6" 50/6" | 25 | | | | | | | 32 | |
| 25 | | | 12/6" 14/6" 15/6" | | | | | | | | | |
| 30 | -becomes dense | | 5/6" 17/6" 27/6" | | | | | | | | | |
| 35 | | | 4/6" | | | | | | | | | |

COMPLETION DEPTH: 68 ft
DATE BORING STARTED: 06/24/2016
DATE BORING COMPLETED: 06/24/2016
LOGGER: J. Garcia
PROJECT NO.: 16.53.042

REMARKS: Free water was encounterd at an approximate depth of 23' below existing grade during drilling operations. After a 10 to 15-minute waiting period, water was at a depth of 18'-3". At the completion of the boring, the open bore-hole was backfilled with cement-bentonite grout.

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TOLUNAY-WONG ENGINEERS, INC.

# LOG OF BORING B-36

PROJECT: City of Kingsville
Municipal Solid Waste Landfill
Aerial Expansion

CLIENT: Naismith Engineering, Inc.

COORDINATES: N 27° 26' 56.8"
W 97° 49' 04.9"
SURFACE ELEVATION: 59.13' AMSL
DRILLING METHOD:
Dry Augered: 0-ft. to 22-ft.
Wash Bored: 22-ft. to 68-ft.

| DEPTH (ft) | MATERIAL DESCRIPTION | (P) POCKET PEN (tsf) (T) TORVANE (psf) | STD. PENETRATION TEST (blows/ft) | MOISTURE CONTENT (%) | DRY UNIT WEIGHT (pcf) | LIQUID LIMIT (%) | PLASTICITY INDEX (%) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi) | PASSING #200 SIEVE (%) | OTHER TESTS PERFORMED |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 35 | Medium dense light gray and tan CLAYEY SAND (SC) BODY I | | 7/6" 8/6" | | | | | | | | | |
| | -with sand seams, calcareous nodules, and ferrous staining | | 6/6" 10/6" 13/6" | 21 | | 47 | 30 | | | | 35 | |
| 40 | | | | | | | | | | | | |
| | -color changes to reddish brown and light gray | | 4/6" 8/6" 10/6" | | | | | | | | | |
| 45 | 13.13' AMSL | | | | | | | | | | | |
| | Stiff to very stiff reddish brown and light gray FAT CLAY (CH), slickensided, with ferrous staining LIGHT OLIVE GREEN TO GRAY CLAY | (P) 4.50+ | | | | | | | | | | |
| 50 | | | | | | | | | | | | |
| | -with sand seams and calcareous nodules | | 4/6" 6/6" 8/6" | 42 | | | | | | | 96 | |
| 55 | -color changes to light gray with sand layers | | 11/6" 12/6" 14/6" | | | | | | | | | |
| | -becomes hard | | 11/6" 21/6" 26/6" | 37 | | 70 | 44 | | | | 94 | |
| 60 | | | | | | | | | | | | |
| | | | 7/6" 8/6" 9/6" | | | | | | | | | |
| 65 | | | | | | | | | | | | |
| | -color changes to brown yellow, reddish brown, and light gray -8.87' AMSL | | 7/6" 10/6" 10/6" | | | | | | | | | |
| | Bottom @ 68' | | | | | | | | | | | |
| 70 | | | | | | | | | | | | |

COMPLETION DEPTH: 68 ft
DATE BORING STARTED: 06/24/2016
DATE BORING COMPLETED: 06/24/2016
LOGGER: J. Garcia
PROJECT NO.: 16.53.042

REMARKS: Free water was encounterd at an approximate depth of 23' below existing grade during drilling operations. After a 10 to 15-minute waiting period, water was at a depth of 18'-3". At the completion of the boring, the open bore-hole was backfilled with cement-bentonite grout.

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TOLUNAY-WONG ENGINEERS, INC.

# LOG OF BORING B-37

PROJECT: City of Kingsville
Municipal Solid Waste Landfill
Aerial Expansion

CLIENT: Naismith Engineering, Inc.

COORDINATES: N 27° 26' 57.1"
W 97° 49' 17.6"
SURFACE ELEVATION: 45.52' AMSL
DRILLING METHOD:
Dry Augered: 0-ft. to 12-ft.
Wash Bored: 12-ft. to 48-ft.

| DEPTH (ft) | SAMPLE TYPE | SYMBOL/USCS | MATERIAL DESCRIPTION | (P) POCKET PEN (tsf) (T) TORVANE (psf) | STD. PENETRATION TEST (blows/ft) | MOISTURE CONTENT (%) | DRY UNIT WEIGHT (pcf) | LIQUID LIMIT (%) | PLASTICITY INDEX (%) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi) | PASSING #200 SIEVE (%) | OTHER TESTS PERFORMED |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | | Very dense light gray and tan SILTY SAND (SM)<br>BODY II | | | | | | | | | | | |
| | | | -with ferrous staining | | 6/6"<br>16/6"<br>50/5" | | | | | | | | | |
| 5 | | | | | 11/6"<br>50/5" | 20 | | 33 | 9 | | | | 20 | |
| 10 | | | -with calcareous nodules | | 23/6"<br>37/6"<br>50/6" | | | | | | | | | |
| | | | 31.02' AMSL | | | | | | | | | | | |
| 15 | | | Very stiff to hard tan and light tan SANDY LEAN SILTY CLAY (CL-ML)<br>SANDY SILTY CLAY BED | | 6/6"<br>7/6"<br>10/6" | 31 | | | | | | | 52 | |
| 20 | | | -color changes to tan and light gray with ferrous staining | | 9/6"<br>17/6"<br>27/6" | | | | | | | | | |
| | | | | | 7/6"<br>12/6"<br>13/6" | | | | | | | | | |
| 25 | | | 19.02' AMSL | | | | | | | | | | | |
| | | | Stiff to very stiff reddish brown and light gray FAT CLAY (CH) with calcareous nodules and ferrous staining<br>LIGHT OLIVE GREEN TO GRAY CLAY | | 4/6"<br>5/6"<br>9/6" | 33 | | 56 | 39 | | | | 99 | |
| 30 | | | -color changes to light gray with sand layers | | 5/6"<br>7/6"<br>12/6" | | | | | | | | | |
| 35 | | | | | 5/6" | 34 | | | | | | | 86 | |

COMPLETION DEPTH: 48 ft
DATE BORING STARTED: 06/24/2016
DATE BORING COMPLETED: 06/25/2016
LOGGER: J. Garcia
PROJECT NO.: 16.53.042

REMARKS: Free water was encounterd at an approximate depth of 15' below existing grade during drilling operations. After a 10 to 15-minute waiting period, water was at a depth of 9'-3". At the completion of the boring, the open bore-hole was backfilled with cement-bentonite grout.

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TOLUNAY-WONG ENGINEERS, INC.

# LOG OF BORING B-37

PROJECT: City of Kingsville Municipal Solid Waste Landfill Aerial Expansion

CLIENT: Naismith Engineering, Inc.

COORDINATES: N 27° 26' 57.1" W 97° 49' 17.6"
SURFACE ELEVATION: 45.52' AMSL
DRILLING METHOD:
Dry Augered: 0-ft. to 12-ft.
Wash Bored: 12-ft. to 48-ft.

| DEPTH (ft) | MATERIAL DESCRIPTION | (P) POCKET PEN (tsf) (T) TORVANE (psf) | STD. PENETRATION TEST (blows/ft) | MOISTURE CONTENT (%) | DRY UNIT WEIGHT (pcf) | LIQUID LIMIT (%) | PLASTICITY INDEX (%) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi) | PASSING #200 SIEVE (%) | OTHER TESTS PERFORMED |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 35 | Stiff to very stiff light gray and brownish tan FAT CLAY (CH) with sand seams, calcareous nodules, and ferrous staining<br>LIGHT OLIVE GREEN TO GRAY CLAY | | 7/6" 12/6" | | | | | | | | | |
| | | | 4/6" 5/6" 7/6" | | | | | | | | | |
| 40 | -color changes to light gray and reddish brown | | 6/6" 6/6" 9/6" | | | | | | | | | |
| 45 | -color changes to light gray | | 4/6" 5/6" 9/6" | 35 | | 80 | 51 | | | | 86 | |
| | -2.48' AMSL<br>Bottom @ 48' | | | | | | | | | | | |
| 50 | | | | | | | | | | | | |
| 55 | | | | | | | | | | | | |
| 60 | | | | | | | | | | | | |
| 65 | | | | | | | | | | | | |
| 70 | | | | | | | | | | | | |

COMPLETION DEPTH: 48 ft
DATE BORING STARTED: 06/24/2016
DATE BORING COMPLETED: 06/25/2016
LOGGER: J. Garcia
PROJECT NO.: 16.53.042

REMARKS: Free water was encounterd at an approximate depth of 15' below existing grade during drilling operations. After a 10 to 15-minute waiting period, water was at a depth of 9'-3". At the completion of the boring, the open bore-hole was backfilled with cement-bentonite grout.

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TOLUNAY-WONG ENGINEERS, INC.

# LOG OF BORING B-38

PROJECT: City of Kingsville Municipal Solid Waste Landfill Aerial Expansion

CLIENT: Naismith Engineering, Inc.

COORDINATES: N 27° 27' 03.76" W 97° 49' 12.19"
SURFACE ELEVATION: 41.64' AMSL
DRILLING METHOD:
Dry Augered: 0 ft. to 10 ft.
Wash Bored: 10 ft. to 58 ft.

| DEPTH (ft) | MATERIAL DESCRIPTION | (P) POCKET PEN (tsf) (T) TORVANE (psf) | STD. PENETRATION TEST (blows/ft) | MOISTURE CONTENT (%) | DRY UNIT WEIGHT (pcf) | LIQUID LIMIT (%) | PLASTICITY INDEX (%) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi) | PASSING #200 SIEVE (%) | OTHER TESTS PERFORMED |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 35 | Very stiff to hard reddish brown and light gray SANDY FAT CLAY (CH) with sand seams and layers | (P) 4.50+ | 8/6" 10/6" | | | | | | | | | |
| | 3.64' AMSL | | | | | | | | | | | |
| | Stiff to hard light gray FAT CLAY (CH), slickensided, with calcareous nodules and ferrous stains | (P) 4.50+ | | 42 | 78 | 100 | 72 | 2.95 | 2 | | 93 | |
| 40 | -color changes to reddish brown and light gray | (P) 4.50+ | | | | | | | | | | |
| | LIGHT OLIVE GREEN TO GRAY CLAY | (P) 4.50+ | | | | | | | | | | |
| 45 | -color changes to tannish brown and light gray with trace organics | (P) 4.50+ | | | | | | | | | | |
| | -color changes to light gray | | 5/6" 6/6" 8/6" | | | | | | | | | |
| | | (P) 4.50+ | | 30 | 91 | | | 2.14 | 3 | | 87 | |
| 50 | | | 6/6" 7/6" 7/6" | | | | | | | | | |
| | | | 4/6" 5/6" 8/6" | | | | | | | | | |
| 55 | -color changes to tannish brown and light gray | | 5/6" 7/6" 9/6" | | | | | | | | | |
| | -color changes to light gray | | 6/6" 7/6" 9/6" | | | | | | | | | |
| | -16.36' AMSL | | | | | | | | | | | |
| | Bottom @ 58' | | | | | | | | | | | |
| 60 | | | | | | | | | | | | |
| 65 | | | | | | | | | | | | |
| 70 | | | | | | | | | | | | |

COMPLETION DEPTH: 58 ft
DATE BORING STARTED: 06/23/2016
DATE BORING COMPLETED: 06/23/2016
LOGGER: J. Garcia
PROJECT NO.: 16.53.042

REMARKS: Free water was encounterd at an approximate depth of 11' below existing grade during drilling operations. After a 10 to 15-minute waiting period, water was at a depth of 5'-5". At the completion of the boring, the open bore-hole was backfilled with cement-bentonite grout.

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TOLUNAY-WONG ENGINEERS, INC.

# LOG OF BORING B-39

PROJECT: City of Kingsville
Municipal Solid Waste Landfill
Aerial Expansion

CLIENT: Naismith Engineering, Inc.

COORDINATES: N 27° 27' 01.3"
W 97° 48' 57.3"
SURFACE ELEVATION: 60.26' AMSL
DRILLING METHOD:
Dry Augered: 0 ft. to 26 ft.
Wash Bored: 26 ft. to 68 ft.

| DEPTH (ft) | MATERIAL DESCRIPTION | (P) POCKET PEN (tsf) (T) TORVANE (psf) | STD. PENETRATION TEST (blows/ft) | MOISTURE CONTENT (%) | DRY UNIT WEIGHT (pcf) | LIQUID LIMIT (%) | PLASTICITY INDEX (%) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi) | PASSING #200 SIEVE (%) | OTHER TESTS PERFORMED |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | Medium dense to dense tan and light gray CLAYEY SAND FILL with trace gravel BODY I | | 8/6" 9/6" 6/6" | 18 | | | | | | | 33 | |
| | -color changes to brown | | 40/6" 27/6" 19/6" | | | | | | | | | |
| | 55.76' AMSL | | | | | | | | | | | |
| 5 | Medium dense to dense brown and reddish brown CLAYEY SAND (SC) BODY I | | 6/6" 7/6" 8/6" | | | | | | | | | |
| | -color changes to tan and gray with calcareous nodules | | 4/6" 5/6" 6/6" | | | | | | | | | |
| | | | 5/6" 6/6" 8/6" | 11 | | 36 | 20 | | | | 49 | |
| 10 | -color changes to tan and light gray | | 4/6" 6/6" 7/6" | | | | | | | | | |
| | -color changes to light gray | | 7/6" 8/6" 11/6" | | | | | | | | | |
| 15 | -color changes to light gray and tan with ferrous stains | | 6/6" 12/6" 19/6" | | | | | | | | | |
| | -color changes to light gray | | 11/6" 19/6" 22/6" | | | | | | | | | |
| | 41.76' AMSL | | | | | | | | | | | |
| | Stiff to hard light gray SANDY LEAN CLAY (CL) with calcareous nodules and ferrous stains | | 3/6" 4/6" 5/6" | 19 | | | | | | | 65 | |
| 20 | | | 6/6" 9/6" 13/6" | | | | | | | | | |
| | | | 8/6" 11/6" 20/6" | | | | | | | | | |
| 25 | -color changes to light tan and light gray | (P) 4.50+ | | | | | | | | | | |
| | -color changes to light gray | (P) 4.00 | | | | | | | | | | |
| | | | 7/6" 11/6" 13/6" | | | | | | | | | |
| 30 | -color changes to light gray and tan | (P) 4.50+ | | 19 | 102 | | | 1.14 | 7 | | 50 | |
| | | | 12/6" 16/6" 20/6" | | | | | | | | | |
| 35 | | | 8/6" | | | | | | | | | |

COMPLETION DEPTH: 68 ft
DATE BORING STARTED: 06/20/2016
DATE BORING COMPLETED: 06/24/2016
LOGGER: J. Garcia
PROJECT NO.: 16.53.042

REMARKS: Free water was encounterd at an approximate depth of 27' below existing grade during drilling operations. After a 10 to 15-minute waiting period, water was at a depth of 26'-6". At the completion of the boring, the open bore-hole was backfilled with cement-bentonite grout.

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TOLUNAY-WONG ENGINEERS, INC.

# LOG OF BORING B-39

PROJECT: City of Kingsville Municipal Solid Waste Landfill Aerial Expansion

CLIENT: Naismith Engineering, Inc.

COORDINATES: N 27° 27' 01.3" W 97° 48' 57.3"
SURFACE ELEVATION: 60.26' AMSL
DRILLING METHOD:
Dry Augered: 0 ft. to 26 ft.
Wash Bored: 26 ft. to 68 ft.

| DEPTH (ft) | MATERIAL DESCRIPTION | (P) POCKET PEN (tsf) (T) TORVANE (psf) | STD. PENETRATION TEST (blows/ft) | MOISTURE CONTENT (%) | DRY UNIT WEIGHT (pcf) | LIQUID LIMIT (%) | PLASTICITY INDEX (%) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi) | PASSING #200 SIEVE (%) | OTHER TESTS PERFORMED |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 35 | Stiff to hard light gray and tan SANDY LEAN CLAY (CL) with ferrous stains 23.76' AMSL | | 12/6" 16/6" | | | | | | | | | |
| | Medium dense to dense light gray CLAYEY SAND (SC) with ferrous stains BODY III | | 7/6" 8/6" 11/6" | | | | | | | | | |
| | | | 6/6" 11/6" 12/6" | | | | | | | | | |
| 40 | | | 7/6" 10/6" 13/6" | 25 | | 69 | 51 | | | | 45 | |
| | 15.76' AMSL | | 13/6" 19/6" 21/6" | | | | | | | | | |
| 45 | Dense light gray POORLY GRADED SAND with CLAY (SP- SC) | | 12/6" 21/6" 20/6" | | | | | | | | | |
| | 12.26' AMSL | | 11/6" 16/6" 16/6" | | | | | | | | | |
| | Hard reddish brown and light gray FAT CLAY with SAND (CH) LIGHT OLIVE GREEN TO GRAY CLAY | (P) 4.50+ | | | | | | | | | | |
| 50 | | (P) 4.50+ | | 28 | 93 | | | 0.85 | 1 | | 72 | |
| | -becomes slickensided with calcareous nodules | (P) 4.50+ | | | | | | | | | | |
| | -with ferrous stains | (P) 4.50+ | | | | | | | | | | |
| 55 | | (P) 4.50+ | | | | | | | | | | |
| | | (P) 4.50+ | | | | | | | | | | |
| 60 | | (P) 4.50+ | | | | | | | | | | |
| | -becomes stiff | | 7/6" 7/6" 7/6" | | | | | | | | | |
| 65 | -6.24' AMSL | | | | | | | | | | | |
| | Medium dense light gray CLAYEY SAND (SC) with calcareous nodules and ferrous stains -7.74' AMSL | | 6/6" 10/6" 13/6" | 20 | 102 | 61 | 45 | 1.91 | 5 | | 46 | |
| | Bottom @ 68' | | | | | | | | | | | |
| 70 | | | | | | | | | | | | |

COMPLETION DEPTH: 68 ft
DATE BORING STARTED: 06/20/2016
DATE BORING COMPLETED: 06/24/2016
LOGGER: J. Garcia
PROJECT NO.: 16.53.042

REMARKS: Free water was encounterd at an approximate depth of 27' below existing grade during drilling operations. After a 10 to 15-minute waiting period, water was at a depth of 26'-6". At the completion of the boring, the open bore-hole was backfilled with cement-bentonite grout.

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TOLUNAY-WONG ENGINEERS, INC.

# LOG OF BORING B-40

PROJECT: City of Kingsville
Municipal Solid Waste Landfill
Aerial Expansion

CLIENT: Naismith Engineering, Inc.

COORDINATES: N 27° 27' 09.97"
W 97° 49' 11.18"
SURFACE ELEVATION: 52.31' AMSL
DRILLING METHOD:
Dry Augered: 0 ft. to 22 ft.
Wash Bored: 22 ft. to 33.75 ft.

| DEPTH (ft) | MATERIAL DESCRIPTION | (P) POCKET PEN (tsf) (T) TORVANE (psf) | STD. PENETRATION TEST (blows/ft) | MOISTURE CONTENT (%) | DRY UNIT WEIGHT (pcf) | LIQUID LIMIT (%) | PLASTICITY INDEX (%) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi) | PASSING #200 SIEVE (%) | OTHER TESTS PERFORMED |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | Loose to very dense light gray and gray SILTY SAND (SM) with trace caliche BODY II | | 4/6" 4/6" 6/6" | | | | | | | | | |
| | -color changes to light gray and tan with ferrous stains | | 5/6" 7/6" 11/6" | 16 | | 35 | 10 | | | | 31 | |
| 5 | | | 7/6" 17/6" 17/6" | | | | | | | | | |
| | -color changes to light gray with calcareous nodules | | 12/6" 21/6" 34/6" | | | | | | | | | |
| | -color changes to light gray and white | | 12/6" 27/6" 50/3" | 18 | | | | | | | 34 | |
| 10 | -color changes to white | | 15/6" 50/3" | | | | | | | | | |
| | -color changes to light gray and white | | 25/6" 50/4" | | | | | | | | | |
| | 37.81' AMSL | | | | | | | | | | | |
| 15 | Hard light gray FAT CLAY with SAND (CH), calcareous nodules, and ferrous stains | | 7/6" 26/6" 50/5" | 22 | | 70 | 41 | | | | 80 | |
| | | | 5/6" 17/6" 28/6" | | | | | | | | | |
| | | | 10/6" 30/6" 35/6" | | | | | | | | | |
| 20 | 31.81' AMSL | | | | | | | | | | | |
| | Hard light gray SANDY FAT CLAY (CH) with calcareous nodules and ferrous stains | | 9/6" 25/6" 35/6" | 31 | | | | | | | 59 | |
| | | | 16/6" 32/6" 50/5" | | | | | | | | | |
| 25 | | | 16/6" 31/6" 50/5" | | | | | | | | | |
| | 25.81' AMSL | | | | | | | | | | | |
| | Dense to very dense light gray CLAYEY SAND (SC) with calcareous nodules | | 8/6" 18/6" 27/6" | 30 | | 53 | 32 | | | | 49 | |
| 30 | | | 6/6" 18/6" 50/6" | | | | | | | | | |
| | | | 6/6" 20/6" 50/5" | | | | | | | | | |
| | 18.81' AMSL | | 3/6" 40/6" 50/3" | 16 | | | | | | | 30 | |
| | Bottom @ 33.5' | | | | | | | | | | | |
| 35 | | | | | | | | | | | | |

COMPLETION DEPTH: 33.5 ft
DATE BORING STARTED: 06/21/2016
DATE BORING COMPLETED: 06/22/2016
LOGGER: J. Garcia
PROJECT NO.: 16.53.042

REMARKS: Free water was encounterd at an approximate depth of 21' below existing grade during drilling operations. After a 10 to 15-minute waiting period, water was at a depth of 19'. At the completion of the boring, the open bore-hole was backfilled with cement-bentonite grout.

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TOLUNAY-WONG ENGINEERS, INC.

# LOG OF BORING B-41

PROJECT: City of Kingsville Municipal Solid Waste Landfill Aerial Expansion

CLIENT: Naismith Engineering, Inc.

COORDINATES: N 27° 27' 09.8" W 97° 49' 17.4"
SURFACE ELEVATION: 50.20' AMSL
DRILLING METHOD:
Dry Augered: 0-ft. to 62.5-ft.
Wash Bored: -- to --

| DEPTH (ft) | MATERIAL DESCRIPTION | (P) POCKET PEN (tsf) (T) TORVANE (psf) | STD. PENETRATION TEST (blows/ft) | MOISTURE CONTENT (%) | DRY UNIT WEIGHT (pcf) | LIQUID LIMIT (%) | PLASTICITY INDEX (%) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi) | PASSING #200 SIEVE (%) | OTHER TESTS PERFORMED |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | Loose to medium dense gray CLAYEY SAND (SC) with calcareous nodules BODY I | | 4/6" 5/6" 5/6" | 8 | | | | | | | 35 | |
| 5 | -color changes to light gray | | 4/6" 5/6" 6/6" | | | | | | | | | |
| | 41.70' AMSL | | | | | | | | | | | |
| | Stiff to very stiff gray SANDY FAT CLAY (CH) LIGHT OLIVE GREEN TO GRAY CLAY | | 5/6" 8/6" 11/6" | 20 | | 78 | 52 | | | | 64 | |
| 10 | | | | | | | | | | | | |
| | -becomes hard and color changes to brown with interbedded sand seams | | 9/6" 17/6" 25/6" | | | | | | | | | |
| 15 | | | | | | | | | | | | |
| | -color changes to brown and tan | | 7/6" 12/6" 14/6" | | | | | | | | | |
| 20 | -color changes to tan with sand layers | | 3/6" 4/6" 6/6" | 36 | | | | | | | 64 | |
| 25 | -color changes to brown with sand partings | | 5/6" 4/6" 6/6" | | | | | | | | | |
| | -color changes to brown and tan | | 6/6" 7/6" 8/6" | 31 | | 52 | 30 | | | | 51 | |
| 30 | | | | | | | | | | | | |
| | | | 4/6" 6/6" 6/6" | | | | | | | | | |
| 35 | | | | | | | | | | | | |

COMPLETION DEPTH: 62.5 ft
DATE BORING STARTED: 07/20/2016
DATE BORING COMPLETED: 07/20/2016
LOGGER: M. Anderson
PROJECT NO.: 16.53.042

REMARKS: Free water was encounterd at an approximate depth of 19'-6" below existing grade during drilling operations. After a 10 to 15-minute waiting period, water was at a depth of 19'-3". At the completion of the boring, the open bore-hole was backfilled with cement-bentonite grout.

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TOLUNAY-WONG ENGINEERS, INC.

# LOG OF BORING B-41

PROJECT: City of Kingsville
Municipal Solid Waste Landfill
Aerial Expansion

CLIENT: Naismith Engineering, Inc.

COORDINATES: N 27° 27' 09.8"
W 97° 49' 17.4"
SURFACE ELEVATION: 50.20' AMSL
DRILLING METHOD:
Dry Augered: 0-ft. to 62.5-ft.
Wash Bored: -- to --

| DEPTH (ft) | MATERIAL DESCRIPTION | (P) POCKET PEN (tsf) (T) TORVANE (psf) | STD. PENETRATION TEST (blows/ft) | MOISTURE CONTENT (%) | DRY UNIT WEIGHT (pcf) | LIQUID LIMIT (%) | PLASTICITY INDEX (%) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi) | PASSING #200 SIEVE (%) | OTHER TESTS PERFORMED |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 35 | Stiff to very stiff gray SANDY FAT CLAY (CH) 14.20' AMSL | | | | | | | | | | | |
| | Very stiff brown FAT CLAY with SAND (CH) | (P) 3.25 | | 27 | 92 | | | | | | 77 | |
| | LIGHT OLIVE GREEN TO GRAY CLAY | | | | | | | | | | | |
| 40 | -color changes to brown and tan | | 6/6" 13/6" 11/6" | | | | | | | | | |
| 45 | | | 4/6" 9/6" 14/6" | | | | | | | | | |
| | | | 6/6" 8/6" 9/6" | 35 | | 97 | 75 | | | | 84 | |
| 50 | -color changes to brown and gray | | 7/6" 9/6" 12/6" | | | | | | | | | |
| 55 | -color changes to gray | (P) 4.50+ | | | | | | | | | | |
| 60 | | (P) 3.50 | | | | | | | | | | |
| | -12.30' AMSL | | | | | | | | | | | |
| | Bottom @ 62.5' | | | | | | | | | | | |
| 65 | | | | | | | | | | | | |
| 70 | | | | | | | | | | | | |

COMPLETION DEPTH: 62.5 ft
DATE BORING STARTED: 07/20/2016
DATE BORING COMPLETED: 07/20/2016
LOGGER: M. Anderson
PROJECT NO.: 16.53.042

REMARKS: Free water was encounterd at an approximate depth of 19'-6" below existing grade during drilling operations. After a 10 to 15-minute waiting period, water was at a depth of 19'-3". At the completion of the boring, the open bore-hole was backfilled with cement-bentonite grout.

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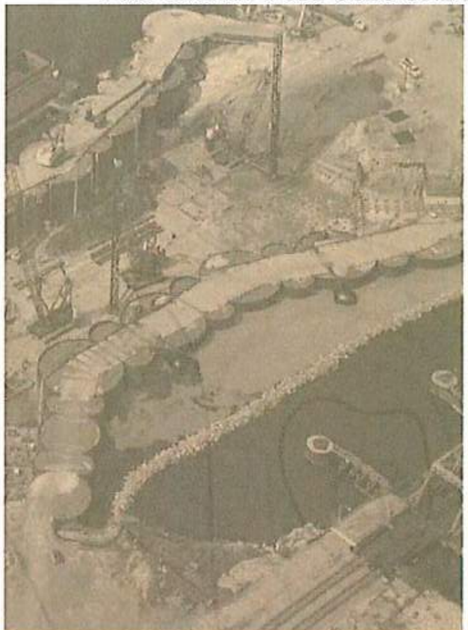
TOLUNAY-WONG ENGINEERS, INC.

FOR PERMIT PURPOSES ONLY



# Tolunay-Wong Engineers, Inc.

**GEOTECHNICAL ENGINEERING STUDY**
**CITY OF KINGSVILLE MUNICIPAL SOLID WASTE LANDFILL EXPANSION**
**KINGSVILLE, TEXAS**

For Permitting Purposes Only. Applies to boring logs in Appendix B of Tolunay-Wong Engineers, Inc. Geotechnical Engineering Study, City of Kingsville Municipal Solid Waste Landfill Expansion, Kingsville, Texas – Report No. 12788R1, sealed by Don R. Rokohl, P.E. on 8-30-18 altered to provide text showing surface elevations, the elevations of all contacts between soil and rock layers, and unit identifiers in the soil boring logs. No information or data was altered or changed from the original report other than the addition of text showing these elevations and unit identifiers in Appendix B.

*Prepared for:*

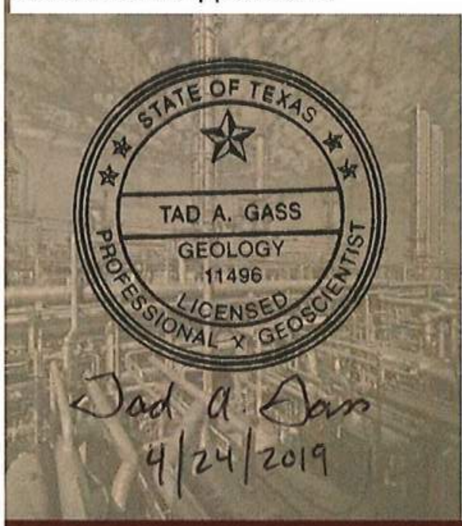
**Naismith/Hanson**
**Corpus Christi, Texas**

*Prepared by:*

**Tolunay-Wong Engineers, Inc.**
**826 South Padre Island Drive**
**Corpus Christi, Texas 78416**

**August 30, 2018**

**Project No. 16.53.042 / Report No. 12788R1**




*GEOTECHNICAL ENGINEERING, DEEP FOUNDATIONS TESTING, ENVIRONMENTAL SERVICES, CONSTRUCTION MATERIALS TESTING*

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# LOG OF BORING B-30

PROJECT: City of Kingsville Municipal Solid Waste Landfill Aerial Expansion
CLIENT: Naismith Engineering, Inc.

COORDINATES: N 27° 26' 44.0" W 97° 49' 23.1"
SURFACE ELEVATION: 45.99' AMSL
DRILLING METHOD:
Dry Augered: 0-ft. to 82.5-ft.
Wash Bored: -- to --

| DEPTH (ft) | MATERIAL DESCRIPTION | (P) POCKET PEN (tsf) (T) TORVANE (psf) | STD. PENETRATION TEST (blows/ft) | MOISTURE CONTENT (%) | DRY UNIT WEIGHT (pcf) | LIQUID LIMIT (%) | PLASTICITY INDEX (%) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi) | PASSING #200 SIEVE (%) | OTHER TESTS PERFORMED |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | Dense to very dense tan and gray CLAYEY SAND (SC) with gypsum crystals | | 11/6" 23/6" 50/5" | 16 | | 42 | 17 | | | | 37 | |
| 5 | -color changes to tan with ferrous staining | | 34/6" 50/3" | | | | | | | | | |
| | -with sand partings | | 13/6" 50/3" | | | | | | | | | |
| 10 | | | | | | | | | | | | |
| | | | 7/6" 12/6" 20/6" | 35 | | | | | | | 33 | |
| 15 | | | | | | | | | | | | |
| | -color changes to reddish tan and light gray | | 6/6" 15/6" 20/6" | | | | | | | | | |
| 20 | 25.49' AMSL | | | | | | | | | | | |
| | Very stiff to hard reddish tan and light gray FAT CLAY (CH) with gypsum crystals<br>LIGHT OLIVE GREEN TO GRAY CLAY | | 10/6" 17/6" 26/6" | | | | | | | | | |
| 25 | -color changes to reddish tan and tan | | 10/6" 18/6" 30/6" | 25 | | 50 | 28 | | | | 92 | |
| | -color changes to tan and reddish brown | | 8/6" 11/6" 16/6" | | | | | | | | | |
| 30 | | | | | | | | | | | | |
| | -color changes to tan and gray | | 8/6" 12/6" 18/6" | | | | | | | | | |
| 35 | | | | | | | | | | | | |

COMPLETION DEPTH: 82.5 ft
DATE BORING STARTED: 07/22/2016
DATE BORING COMPLETED: 07/23/2016
LOGGER: J. Gonzalez
PROJECT NO.: 16.53.042

REMARKS: Free water was encounterd at an approximate depth of 21' below existing grade during drilling operations. After a 10 to 15-minute waiting period, water was at a depth of 10'-6". At the completion of the boring, the open bore-hole was backfilled with cement-bentonite grout.

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TOLUNAY-WONG ENGINEERS, INC.

# LOG OF BORING B-30

PROJECT: City of Kingsville
Municipal Solid Waste Landfill
Aerial Expansion

CLIENT: Naismith Engineering, Inc.

COORDINATES: N 27° 26' 44.0"
W 97° 49' 23.1"
SURFACE ELEVATION: 45.99' AMSL
DRILLING METHOD:
Dry Augered: 0-ft. to 82.5-ft.
Wash Bored: -- to --

| DEPTH (ft) | MATERIAL DESCRIPTION | (P) POCKET PEN (tsf) (T) TORVANE (psf) | STD. PENETRATION TEST (blows/ft) | MOISTURE CONTENT (%) | DRY UNIT WEIGHT (pcf) | LIQUID LIMIT (%) | PLASTICITY INDEX (%) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi) | PASSING #200 SIEVE (%) | OTHER TESTS PERFORMED |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 35 | Very stiff to hard reddish tan and tan FAT CLAY (CH) with gypsum crystals and ferrous stains | | | | | | | | | | | |
| | LIGHT OLIVE GREEN TO GRAY CLAY | | 10/6" 17/6" 21/6" | 30 | | | | | | | 90 | |
| 40 | -color changes to tan and reddish brown | | 9/6" 14/6" 21/6" | | | | | | | | | |
| 45 | | | 13/6" 19/6" 29/6" | | | | | | | | | |
| | -becomes sandy 48' to 52' | | 8/6" 11/6" 13/6" | 30 | | | | | | | 70 | |
| 50 | -color changes to tan and becomes slickensided | (P) 4.50+ | | 23 | 100 | 71 | 51 | | | | 87 | |
| 55 | | (P) 4.50+ | | | | | | | | | | |
| 60 | | (P) 4.50+ | | | | | | | | | | |
| 65 | -becomes sandy and color changes to tan and gray | (P) 4.50+ | | 26 | 97 | 54 | 30 | 1.75 | 3 | | 69 | |
| 70 | -color changes to tan and reddish brown with trace calcareous nodules | (P) 3.00 | | | | | | | | | | |

COMPLETION DEPTH: 82.5 ft
DATE BORING STARTED: 07/22/2016
DATE BORING COMPLETED: 07/23/2016
LOGGER: J. Gonzalez
PROJECT NO.: 16.53.042

REMARKS: Free water was encounterd at an approximate depth of 21' below existing grade during drilling operations. After a 10 to 15-minute waiting period, water was at a depth of 10'-6". At the completion of the boring, the open bore-hole was backfilled with cement-bentonite grout.

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TOLUNAY-WONG ENGINEERS, INC.

# LOG OF BORING B-31

PROJECT: City of Kingsville
Municipal Solid Waste Landfill
Aerial Expansion

CLIENT: Naismith Engineering, Inc.

COORDINATES: N 27° 26' 50.1"
W 97° 49' 24.3"
SURFACE ELEVATION: 58.37' AMSL
DRILLING METHOD:
Dry Augered: 0-ft. to 68-ft.
Wash Bored: -- to --

| DEPTH (ft) | MATERIAL DESCRIPTION | (P) POCKET PEN (tsf) (T) TORVANE (psf) | STD. PENETRATION TEST (blows/ft) | MOISTURE CONTENT (%) | DRY UNIT WEIGHT (pcf) | LIQUID LIMIT (%) | PLASTICITY INDEX (%) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi) | PASSING #200 SIEVE (%) | OTHER TESTS PERFORMED |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | Medium dense to very dense gray CLAYEY SAND (SC) BODY I | | 4/6" 5/6" 7/6" | | | | | | | | | |
| | -with calcareous nodules and sand pockets | | 10/6" 22/6" 18/6" | | | | | | | | | |
| 5 | | | 4/6" 5/6" 6/6" | 11 | | | | | | | 46 | |
| | | | 5/6" 6/6" 8/6" | | | | | | | | | |
| | | | 6/6" 8/6" 12/6" | | | | | | | | | |
| 10 | -with cemented sand layers | | 8/6" 27/6" 29/6" | 27 | | | | | | | 22 | |
| | -color changes to tan | | 18/6" 32/6" 39/6" | | | | | | | | | |
| | 43.87' AMSL | | | | | | | | | | | |
| 15 | Very dense tan POORLY GRADED SAND with CLAY (SP-SC) and sand partings BODY IV | | 36/6" 50/5" | | | | | | | | | |
| | | | 12/6" 50/5" | 15 | | | | | | | 9 | |
| | | | 45/6" 50/5" | | | | | | | | | |
| 20 | | | 35/6" 50/4" | | | | | | | | | |
| | | | 17/6" 26/6" 50/5" | | | | | | | | | |
| | 34.87' AMSL | | 17/6" 38/6" 38/6" | | | | | | | | | |
| 25 | Hard reddish tan and light gray SANDY LEAN SILTY CLAY (CL-ML) with sand partings | | 13/6" 20/6" 31/6" | | | | | | | | | |
| | | | 23/6" 34/6" 50/4" | 26 | | 29 | 7 | | | | 66 | |
| | | | 12/6" 17/6" 50/5" | | | | | | | | | |
| 30 | -color changes to reddish tan and tan with ferrous stains | | 13/6" 32/6" 50/5" | | | | | | | | | |
| | | | 7/6" 36/6" 39/6" | | | | | | | | | |
| | | | 10/6" 21/6" 36/6" | | | | | | | | | |
| 35 | | | 10/6" 18/6" 35/6" | 25 | | | | | | | 62 | |

COMPLETION DEPTH: 68 ft
DATE BORING STARTED: 07/20/2016
DATE BORING COMPLETED: 07/21/2016
LOGGER: J. Gonzalez
PROJECT NO.: 16.53.042

REMARKS: Free water was encounterd at an approximate depth of 23' below existing grade during drilling operations. After a 10 to 15-minute waiting period, water was at a depth of 21'-6". At the completion of the boring, the open bore-hole was backfilled with cement-bentonite grout.

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TOLUNAY-WONG ENGINEERS, INC.

# LOG OF BORING B-31

PROJECT: City of Kingsville
Municipal Solid Waste Landfill
Aerial Expansion

CLIENT: Naismith Engineering, Inc.

COORDINATES: N 27° 26' 50.1"
W 97° 49' 24.3"
SURFACE ELEVATION: 58.37' AMSL
DRILLING METHOD:
Dry Augered: 0-ft. to 68-ft.
Wash Bored: -- to --

| DEPTH (ft) | MATERIAL DESCRIPTION | (P) POCKET PEN (tsf) (T) TORVANE (psf) | STD. PENETRATION TEST (blows/ft) | MOISTURE CONTENT (%) | DRY UNIT WEIGHT (pcf) | LIQUID LIMIT (%) | PLASTICITY INDEX (%) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi) | PASSING #200 SIEVE (%) | OTHER TESTS PERFORMED |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 35 | Hard reddish tan and tan SANDY LEAN CLAY (CL) with ferrous stains and laminated sands | | 17/6" 25/6" 35/6" 17/6" 13/6" 19/6" 7/6" 16/6" 17/6" | | | | | | | | | |
| | 18.87' AMSL | | | | | | | | | | | |
| 40 | Very stiff to hard reddish tan and tan FAT CLAY with SAND (CH) and ferrous stains LIGHT OLIVE GREEN TO GRAY CLAY | | 3/6" 7/6" 10/6" 9/6" 20/6" 27/6" | 37 | | 59 | 36 | | | | 76 | |
| | | | 5/6" 14/6" 17/6" 10/6" 18/6" | | | | | | | | | |
| 45 | -with trace gypsum crystals and ferrous stains | | 21/6" 18/6" 23/6" 30/6" 6/6" 20/6" 21/6" | | | | | | | | | |
| | | | 9/6" | 30 | | | | | | | 83 | |
| 50 | | | 17/6" 19/6" 9/6" 18/6" 23/6" 11/6" 23/6" 26/6" | | | | | | | | | |
| | -with calcareous nodules and ferrous stains | (P) 4.50+ | | 32 | 91 | 83 | 50 | 4.14 | 2 | | 87 | |
| 55 | | (P) 4.50+ | | | | | | | | | | |
| | | (P) 4.50+ | | | | | | | | | | |
| | | (P) 4.50+ | | 34 | 87 | | | 2.88 | 2 | | 83 | |
| 60 | -with trace gypsum crystals and ferrous stains | (P) 4.50+ | | | | | | | | | | |
| | | (P) 4.50+ | | | | | | | | | | |
| 65 | | (P) 4.50+ | | | | | | | | | | |
| | -9.63' AMSL | (P) 4.50+ | | | | | | | | | | |
| | Bottom @ 68' | | | | | | | | | | | |
| 70 | | | | | | | | | | | | |

COMPLETION DEPTH: 68 ft
DATE BORING STARTED: 07/20/2016
DATE BORING COMPLETED: 07/21/2016
LOGGER: J. Gonzalez
PROJECT NO.: 16.53.042

REMARKS: Free water was encounterd at an approximate depth of 23' below existing grade during drilling operations. After a 10 to 15-minute waiting period, water was at a depth of 21'-6". At the completion of the boring, the open bore-hole was backfilled with cement-bentonite grout.

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TOLUNAY-WONG ENGINEERS, INC.

# LOG OF BORING B-32

PROJECT: City of Kingsville
Municipal Solid Waste Landfill
Aerial Expansion

CLIENT: Naismith Engineering, Inc.

COORDINATES: N 27° 26' 49.7"
W 97° 49' 17.0"
SURFACE ELEVATION: 48.46' AMSL
DRILLING METHOD:
Dry Augered: 0-ft. to 82.5-ft.
Wash Bored: -- to --

| DEPTH (ft) | MATERIAL DESCRIPTION | (P) POCKET PEN (tsf) (T) TORVANE (psf) | STD. PENETRATION TEST (blows/ft) | MOISTURE CONTENT (%) | DRY UNIT WEIGHT (pcf) | LIQUID LIMIT (%) | PLASTICITY INDEX (%) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi) | PASSING #200 SIEVE (%) | OTHER TESTS PERFORMED |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 35 | Medium dense to dense reddish tan and gray CLAYEY SAND (SC) with gypsum crystals 12.46' AMSL | | | | | | | | | | | |
| | Very stiff to hard tan FAT CLAY with SAND (CH), slickensided, with calcareous nodules<br>LIGHT OLIVE GREEN TO GRAY CLAY | (P) 4.50+ | | 29 | 89 | | | | | | 79 | |
| 40 | | | | | | | | | | | | |
| | -color changes to tan and reddish brown with gypsum crystals and ferrous stains | | 8/6"<br>12/6"<br>15/6" | | | | | | | | | |
| 45 | -color changes to tan, gray, and reddish brown | (P) 4.50+ | | | | | | | | | | |
| 50 | -color changes to tan and reddish brown | | 4/6"<br>9/6"<br>10/6" | 30 | | 73 | 51 | | | | 82 | |
| | | (P) 4.50+ | | | | | | | | | | |
| 55 | | | | | | | | | | | | |
| | -color changes to tan and gray | (P) 4.50+ | | | | | | | | | | |
| 60 | | (P) 4.50+ | | 26 | 94 | | | 0.61 | 2 | | 81 | |
| 65 | -color changes to tan, red, and brown | (P) 4.00 | | | | | | | | | | |
| | -color changes to tan and gray | (P) 4.50+ | | | | | | | | | | |
| 70 | | | | | | | | | | | | |

COMPLETION DEPTH: 82.5 ft
DATE BORING STARTED: 07/27/2016
DATE BORING COMPLETED: 07/28/2016
LOGGER: J. Gonzalez
PROJECT NO.: 16.53.042

REMARKS: Free water was encounterd at an approximate depth of 18' below existing grade during drilling operations. After a 10 to 15-minute waiting period, water was at a depth of 14'-7". At the completion of the boring, the open bore-hole was backfilled with cement-bentonite grout.

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TOLUNAY-WONG ENGINEERS, INC.

# LOG OF BORING B-32

PROJECT: City of Kingsville Municipal Solid Waste Landfill Aerial Expansion
CLIENT: Naismith Engineering, Inc.

COORDINATES: N 27° 26' 49.7" W 97° 49' 17.0"
SURFACE ELEVATION: 48.46' AMSL
DRILLING METHOD:
Dry Augered: 0-ft. to 82.5-ft.
Wash Bored: -- to --

| DEPTH (ft) | MATERIAL DESCRIPTION | (P) POCKET PEN (tsf) (T) TORVANE (psf) | STD. PENETRATION TEST (blows/ft) | MOISTURE CONTENT (%) | DRY UNIT WEIGHT (pcf) | LIQUID LIMIT (%) | PLASTICITY INDEX (%) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi) | PASSING #200 SIEVE (%) | OTHER TESTS PERFORMED |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 70 | Very stiff to hard tan and gray FAT CLAY with SAND (CH), slickensided with gypsum crystals and calcareous nodules LIGHT OLIVE GREEN TO GRAY CLAY -24.54' AMSL | | | | | | | | | | | |
| | Medium dense to dense tan CLAYEY SAND (SC) with calcareous nodules | (P) 0.75 | | 21 | | 24 | 8 | | | | 24 | |
| 75 | | | | | | | | | | | | |
| | -with gypsum crystals and ferrous stains | | 5/6" 10/6" 13/6" | | | | | | | | | |
| 80 | | | 13/6" 20/6" 20/6" | | | | | | | | | |
| | -34.04' AMSL | | | | | | | | | | | |
| | Bottom @ 82.5' | | | | | | | | | | | |
| 85 | | | | | | | | | | | | |
| 90 | | | | | | | | | | | | |
| 95 | | | | | | | | | | | | |
| 100 | | | | | | | | | | | | |
| 105 | | | | | | | | | | | | |

COMPLETION DEPTH: 82.5 ft
DATE BORING STARTED: 07/27/2016
DATE BORING COMPLETED: 07/28/2016
LOGGER: J. Gonzalez
PROJECT NO.: 16.53.042

REMARKS: Free water was encounterd at an approximate depth of 18' below existing grade during drilling operations. After a 10 to 15-minute waiting period, water was at a depth of 14'-7". At the completion of the boring, the open bore-hole was backfilled with cement-bentonite grout.

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TOLUNAY-WONG ENGINEERS, INC.

# LOG OF BORING B-33

PROJECT: City of Kingsville
Municipal Solid Waste Landfill
Aerial Expansion

CLIENT: Naismith Engineering, Inc.

COORDINATES: N 27° 26' 55.9"
W 97° 49' 11.3"
SURFACE ELEVATION: 64.51' AMSL
DRILLING METHOD:
Dry Augered: 0-ft. to 86-ft.
Wash Bored: -- to --

| DEPTH (ft) | MATERIAL DESCRIPTION | (P) POCKET PEN (tsf) (T) TORVANE (psf) | STD. PENETRATION TEST (blows/ft) | MOISTURE CONTENT (%) | DRY UNIT WEIGHT (pcf) | LIQUID LIMIT (%) | PLASTICITY INDEX (%) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi) | PASSING #200 SIEVE (%) | OTHER TESTS PERFORMED |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | Medium dense to very dense tan CLAYEY SAND (SC) with gypsum crystals BODY I | | 2/6" 7/6" 9/6" | | | | | | | | | |
| 5 | -color changes to dark gray and gray with trace gravel | | 7/6" 11/6" 9/6" | 16 | | | | | | | 47 | |
| | -color changes to tan and light gray sand partings | | 27/6" 50/6" | | | | | | | | | |
| 10 | | | | | | | | | | | | |
| | -color changes to tan and white with trace caliche | | 50/5" | | | | | | | | | |
| 15 | 48.01' AMSL | | | | | | | | | | | |
| | Dense to very dense tan and white POORLY GRADED SAND with SILT (SP-SM), and trace caliche BODY II | | 17/6" 48/6" 50/3" | 11 | | 35 | 8 | | | | 12 | |
| 20 | | | 17/6" 21/6" 27/6" | | | | | | | | | |
| 25 | -color changes to light gray and tan with gypsum crystals and ferrous stains | | 15/6" 17/6" 32/6" | | | | | | | | | |
| | 36.01' AMSL | | | | | | | | | | | |
| 30 | Medium dense to dense gray and white CLAYEY SAND (SC) with gypsum crystals | | 14/6" 22/6" 26/6" | 42 | | | | | | | 20 | |
| | -color changes to tan | | 13/6" 21/6" 22/6" | | | | | | | | | |
| 35 | | | | | | | | | | | | |

COMPLETION DEPTH: 86 ft
DATE BORING STARTED: 08/05/2016
DATE BORING COMPLETED: 08/05/2016
LOGGER: J. Gonzalez
PROJECT NO.: 16.53.042

REMARKS: Free water was encounterd at an approximate depth of 32'-6" below existing grade during drilling operations. After a 10 to 15-minute waiting period, water was at a depth of 28'-2". At the completion of the boring, the open bore-hole was backfilled with cement-bentonite grout.

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TOLUNAY-WONG ENGINEERS, INC.

# LOG OF BORING B-33

PROJECT: City of Kingsville Municipal Solid Waste Landfill Aerial Expansion

CLIENT: Naismith Engineering, Inc.

COORDINATES: N 27° 26' 55.9" W 97° 49' 11.3"
SURFACE ELEVATION: 64.51' AMSL
DRILLING METHOD:
Dry Augered: 0-ft. to 86-ft.
Wash Bored: -- to --

| DEPTH (ft) | MATERIAL DESCRIPTION | (P) POCKET PEN (tsf) (T) TORVANE (psf) | STD. PENETRATION TEST (blows/ft) | MOISTURE CONTENT (%) | DRY UNIT WEIGHT (pcf) | LIQUID LIMIT (%) | PLASTICITY INDEX (%) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi) | PASSING #200 SIEVE (%) | OTHER TESTS PERFORMED |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 35 | Medium dense to dense reddish tan CLAYEY SAND (SC) with gypsum crystals and ferrous stains | | | | | | | | | | | |
| | | | 6/6" 9/6" 12/6" | | | | | | | | | |
| 40 | -color changes to tan and reddish tan | | 8/6" 16/6" 18/6" | | | | | | | | | |
| | 20.01' AMSL | | | | | | | | | | | |
| 45 | Stiff to very stiff reddish tan LEAN CLAY with SAND (CL), slickensided, with ferrous stains SANDY SILTY CLAY BED | | 9/6" 12/6" 18/6" | 29 | | 43 | 24 | | | | 79 | |
| | -color changes to reddish tan and tan with gypsum crystals | | 5/6" 6/6" 9/6" | | | | | | | | | |
| 50 | 12.51' AMSL | | | | | | | | | | | |
| | Stiff to very stiff LEAN CLAY (CL), slickensided, with ferrous stains SANDY SILTY CLAY BED | (P) 2.00 | | 40 | 79 | | | 1.06 | 3 | | 96 | |
| 55 | -color changes to reddish brown and tan with gypsum crystals | (P) 3.50 | | | | | | | | | | |
| 60 | | (P) 4.00 | | 34 | 87 | | | | | | | |
| | -0.51' AMSL | | | | | | | | | | | |
| 65 | Very stiff to hard tan FAT CLAY (CH), slickensided, with gypsum crystals and ferrous stains LIGHT OLIVE GREEN TO GRAY CLAY | (P) 4.50+ | | 32 | 42 | 64 | 33 | 2.57 | 2 | | 95 | |
| | -color changes to tan and reddish brown | | 7/6" 12/6" 14/6" | | | | | | | | | |
| 70 | | | | | | | | | | | | |

COMPLETION DEPTH: 86 ft
DATE BORING STARTED: 08/05/2016
DATE BORING COMPLETED: 08/05/2016
LOGGER: J. Gonzalez
PROJECT NO.: 16.53.042

REMARKS: Free water was encounterd at an approximate depth of 32'-6" below existing grade during drilling operations. After a 10 to 15-minute waiting period, water was at a depth of 28'-2". At the completion of the boring, the open bore-hole was backfilled with cement-bentonite grout.

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TOLUNAY-WONG ENGINEERS, INC.

# LOG OF BORING B-33

PROJECT: City of Kingsville Municipal Solid Waste Landfill Aerial Expansion

CLIENT: Naismith Engineering, Inc.

COORDINATES: N 27° 26' 55.9" W 97° 49' 11.3"
SURFACE ELEVATION: 64.51' AMSL
DRILLING METHOD:
Dry Augered: 0-ft. to 86-ft.
Wash Bored: -- to --

| DEPTH (ft) | MATERIAL DESCRIPTION | (P) POCKET PEN (tsf) (T) TORVANE (psf) | STD. PENETRATION TEST (blows/ft) | MOISTURE CONTENT (%) | DRY UNIT WEIGHT (pcf) | LIQUID LIMIT (%) | PLASTICITY INDEX (%) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi) | PASSING #200 SIEVE (%) | OTHER TESTS PERFORMED |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 70 | Very stiff to hard tan and reddish brown FAT CLAY (CH), slickensided, with gypsum crystals and ferrous stains LIGHT OLIVE GREEN TO GRAY CLAY | (P) 4.50+ | | | | | | | | | | |
| | -color changes to tan and light gray | | | | | | | | | | | |
| 75 | -with layers of calcareous nodules | | 9/6" 10/6" 21/6" | | | | | | | | | |
| | -15.49' AMSL | | | | | | | | | | | |
| 80 | Very stiff to hard tan FAT CLAY with SAND (CH) with gypsum crystals and ferrous stains LIGHT OLIVE GREEN TO GRAY CLAY | (P) 4.50+ | | 18 | 106 | | | 3.57 | 3 | | 77 | |
| | -color changes to tan and white | (P) 4.50+ | | | | | | | | | | |
| 85 | -21.49' AMSL | | | | | | | | | | | |
| | Bottom @ 86' | | | | | | | | | | | |
| 90 | | | | | | | | | | | | |
| 95 | | | | | | | | | | | | |
| 100 | | | | | | | | | | | | |
| 105 | | | | | | | | | | | | |

COMPLETION DEPTH: 86 ft
DATE BORING STARTED: 08/05/2016
DATE BORING COMPLETED: 08/05/2016
LOGGER: J. Gonzalez
PROJECT NO.: 16.53.042

REMARKS: Free water was encounterd at an approximate depth of 32'-6" below existing grade during drilling operations. After a 10 to 15-minute waiting period, water was at a depth of 28'-2". At the completion of the boring, the open bore-hole was backfilled with cement-bentonite grout.

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TOLUNAY-WONG ENGINEERS, INC.

# LOG OF BORING B-34

PROJECT: City of Kingsville
Municipal Solid Waste Landfill
Aerial Expansion

CLIENT: Naismith Engineering, Inc.

COORDINATES: N 27° 26' 43.4"
W 97° 49' 11.4"
SURFACE ELEVATION: 61.14' AMSL
DRILLING METHOD:
Dry Augered: 0 ft. to 30 ft.
Wash Bored: 30 ft. to 43 ft.

| DEPTH (ft) | SAMPLE TYPE | SYMBOL/USCS | MATERIAL DESCRIPTION | (P) POCKET PEN (tsf) (T) TORVANE (psf) | STD. PENETRATION TEST (blows/ft) | MOISTURE CONTENT (%) | DRY UNIT WEIGHT (pcf) | LIQUID LIMIT (%) | PLASTICITY INDEX (%) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi) | PASSING #200 SIEVE (%) | OTHER TESTS PERFORMED |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | | Medium dense dark gray, gray, and light gray CLAYEY SAND (SC) with trace of organics | | 2/6" 5/6" 6/6" | | | | | | | | | |
| | | | | (P) 4.50+ | | 15 | 112 | | | 2.53 | 6 | | 42 | |
| | | | 57.14' AMSL | | | | | | | | | | | |
| | | | Very stiff to hard gray and light gray SANDY LEAN SILTY CLAY (CL-ML) with calcareous nodules | (P) 4.50+ | | 15 | 115 | 21 | 7 | | | | 59 | |
| 5 | | | | (P) 4.50+ | | 14 | 114 | | | 6.13 | 4 | | 62 | |
| | | | -color changes to light gray | | | | | | | | | | | |
| | | | -color changes to light gray and tan | | 4/6" 12/6" 16/6" | | | | | | | | | |
| 10 | | | -color changes to white and light gray | | 11/6" 18/6" 16/6" | | | | | | | | | |
| | | | -becomes stiff | | 5/6" 6/6" 8/6" | | | | | | | | | |
| | | | 46.64' AMSL | | | | | | | | | | | |
| 15 | | | Medium dense to dense white and light gray SILTY SAND (SM) with calcareous nodules BODY II | | 4/6" 6/6" 8/6" | 17 | | 38 | 7 | | | | 31 | |
| | | | -color changes to light gray and tan with ferrous stains | | 4/6" 10/6" 19/6" | | | | | | | | | |
| | | | | | 23/6" 50/5" | | | | | | | | | |
| 20 | | | | | 23/6" 50/4" | | | | | | | | | |
| | | | -color changes to light gray | | 27/6" 35/6" 50/4" | 22 | | | | | | | 25 | |
| 25 | | | | | 5/6" 37/6" 45/6" | | | | | | | | | |
| | | | | | 20/6" 39/6" 37/6" | | | | | | | | | |
| | | | -becomes medium dense | | 8/6" 12/6" 9/6" | 26 | | 39 | 2 | | | | 28 | |
| 30 | | | | | 4/6" 12/6" 10/6" | 33 | | | | | | | 39 | |
| | | | | | 5/6" 6/6" 10/6" | | | | | | | | | |
| 35 | | | -color changes to tan and marine green | | 3/6" | | | | | | | | | |

COMPLETION DEPTH: 43 ft
DATE BORING STARTED: 06/22/2016
DATE BORING COMPLETED: 06/22/2016
LOGGER: J. Garcia
PROJECT NO.: 16.53.042

REMARKS: Free water was encounterd at an approximate depth of 31' below existing grade during drilling operations. After a 10 to 15-minute waiting period, water was at a depth of 28'-4". At the completion of the boring, the open bore-hole was backfilled with cement-bentonite grout.

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TOLUNAY-WONG ENGINEERS, INC.

# LOG OF BORING B-34

PROJECT: City of Kingsville
Municipal Solid Waste Landfill
Aerial Expansion

CLIENT: Naismith Engineering, Inc.

COORDINATES: N 27° 26' 43.4"
W 97° 49' 11.4"
SURFACE ELEVATION: 61.14' AMSL
DRILLING METHOD:
Dry Augered: 0 ft. to 30 ft.
Wash Bored: 30 ft. to 43 ft.

| DEPTH (ft) | MATERIAL DESCRIPTION | (P) POCKET PEN (tsf) (T) TORVANE (psf) | STD. PENETRATION TEST (blows/ft) | MOISTURE CONTENT (%) | DRY UNIT WEIGHT (pcf) | LIQUID LIMIT (%) | PLASTICITY INDEX (%) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi) | PASSING #200 SIEVE (%) | OTHER TESTS PERFORMED |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 35 | Medium dense tan and marine green SILTY SAND (SM) with sand lenses and trace organics 25.14' AMSL | | 8/6" 13/6" | | | | | | | | | |
| | Hard tan and light gray LEAN CLAY (CL) | (P) 4.50+ | | | | | | | | | | |
| | SANDY SILTY CLAY BED | (P) 4.50+ | | 30 | 91 | 40 | 17 | 0.93 | 1 | | 91 | |
| 40 | | (P) 4.50+ | | | | | | | | | | |
| | 18.14' AMSL | (P) 4.50+ | | | | | | | | | | |
| | Bottom @ 43' | | | | | | | | | | | |
| 45 | | | | | | | | | | | | |
| 50 | | | | | | | | | | | | |
| 55 | | | | | | | | | | | | |
| 60 | | | | | | | | | | | | |
| 65 | | | | | | | | | | | | |
| 70 | | | | | | | | | | | | |

COMPLETION DEPTH: 43 ft
DATE BORING STARTED: 06/22/2016
DATE BORING COMPLETED: 06/22/2016
LOGGER: J. Garcia
PROJECT NO.: 16.53.042

REMARKS: Free water was encounterd at an approximate depth of 31' below existing grade during drilling operations. After a 10 to 15-minute waiting period, water was at a depth of 28'-4". At the completion of the boring, the open bore-hole was backfilled with cement-bentonite grout.

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TOLUNAY-WONG ENGINEERS, INC.

# LOG OF BORING B-35

PROJECT: City of Kingsville
Municipal Solid Waste Landfill
Aerial Expansion

CLIENT: Naismith Engineering, Inc.

COORDINATES: N 27° 26' 50.5"
W 97° 48' 57.2"
SURFACE ELEVATION: 64.50' AMSL
DRILLING METHOD:
Dry Augered: 0-ft. to 72.5-ft.
Wash Bored: -- to --

| DEPTH (ft) | MATERIAL DESCRIPTION | (P) POCKET PEN (tsf) (T) TORVANE (psf) | STD. PENETRATION TEST (blows/ft) | MOISTURE CONTENT (%) | DRY UNIT WEIGHT (pcf) | LIQUID LIMIT (%) | PLASTICITY INDEX (%) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi) | PASSING #200 SIEVE (%) | OTHER TESTS PERFORMED |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | Medium dense tan and brown CLAYEY SAND (SC) with trace caliche | | 5/6" 8/6" 7/6" | | | | | | | | | |
| 5 | -color changes to reddish brown with ferrous stains | | 5/6" 8/6" 5/6" | 12 | | 31 | 17 | | | | 38 | |
| | 56.50' AMSL | | | | | | | | | | | |
| 10 | Very stiff to hard reddish tan SANDY LEAN CLAY (CL) with gypsum crystals | (P) 4.50+ | | 14 | 117 | | | 2.22 | 3 | | 52 | |
| | -color changes to reddish tan and tan with ferrous stains | | 5/6" 10/6" 12/6" | | | | | | | | | |
| 15 | -color changes to reddish tan | (P) 4.50+ | | 17 | 109 | 42 | 25 | | | | | |
| 20 | -color changes to reddish tan and tan | (P) 4.50+ | | | | | | | | | | |
| | 40.50' AMSL | | | | | | | | | | | |
| 25 | Medium dense to dense reddish tan and tan CLAYEY SAND (SC) with gypsum crystals and ferrous stains<br>BODY III | (P) 4.50+ | | 17 | 104 | | | 1.29 | 3 | | 40 | |
| 30 | -color changes to reddish tan | | 4/6" 7/6" 9/6" | | | | | | | | | |
| | | | 8/6" 13/6" 20/6" | | | | | | | | | |
| 35 | | | | | | | | | | | | |

COMPLETION DEPTH: 72.5 ft
DATE BORING STARTED: 07/29/2016
DATE BORING COMPLETED: 07/29/2016
LOGGER: J. Gonzalez
PROJECT NO.: 16.53.042

REMARKS: Free water was encounterd at an approximate depth of 34' below existing grade during drilling operations. After a 10 to 15-minute waiting period, water was at a depth of 30'-9". At the completion of the boring, the open bore-hole was backfilled with cement-bentonite grout.

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TOLUNAY-WONG ENGINEERS, INC.

# LOG OF BORING B-35

PROJECT: City of Kingsville Municipal Solid Waste Landfill Aerial Expansion

CLIENT: Naismith Engineering, Inc.

COORDINATES: N 27° 26' 50.5" W 97° 48' 57.2"
SURFACE ELEVATION: 64.50' AMSL
DRILLING METHOD:
Dry Augered: 0-ft. to 72.5-ft.
Wash Bored: -- to --

| DEPTH (ft) | MATERIAL DESCRIPTION | (P) POCKET PEN (tsf) (T) TORVANE (psf) | STD. PENETRATION TEST (blows/ft) | MOISTURE CONTENT (%) | DRY UNIT WEIGHT (pcf) | LIQUID LIMIT (%) | PLASTICITY INDEX (%) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi) | PASSING #200 SIEVE (%) | OTHER TESTS PERFORMED |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 35 | 28.00' AMSL Medium dense to dense reddish tan and tan CLAYEY SAND (SC) with gypsum crystals and ferrous stains | | | | | | | | | | | |
| | Hard tan and light gray FAT CLAY with SAND (CH), gypsum crystals, and ferrous stains LIGHT OLIVE GREEN TO GRAY CLAY | | 17/6" 26/6" 30/6" | 25 | | 109 | 72 | | | | 77 | |
| 40 | -color changes to tan and reddish brown | | 8/6" 15/6" 24/6" | | | | | | | | | |
| 45 | -with sand partings | | 10/6" 16/6" 16/6" | | | | | | | | | |
| | 16.00' AMSL Stiff to hard reddish brown and tan FAT CLAY (CH) with gypsum crystals and ferrous stains LIGHT OLIVE GREEN TO GRAY CLAY | | 4/6" 7/6" 10/6" | 34 | | | | | | | 96 | |
| 50 | -becomes slickensided with sand layers | (P) 2.00 | | | | | | | | | | |
| 55 | -color changes to tan | | 4/6" 7/6" 10/6" | | | | | | | | | |
| 60 | | (P) 3.75 | | 33 | 89 | 90 | 67 | 3.88 | 4 | | 89 | |
| 65 | | (P) 4.25 | | | | | | | | | | |
| 70 | -color changes to tan and reddish brown | (P) 4.50+ | | | | | | | | | | |

COMPLETION DEPTH: 72.5 ft
DATE BORING STARTED: 07/29/2016
DATE BORING COMPLETED: 07/29/2016
LOGGER: J. Gonzalez
PROJECT NO.: 16.53.042

REMARKS: Free water was encounterd at an approximate depth of 34' below existing grade during drilling operations. After a 10 to 15-minute waiting period, water was at a depth of 30'-9". At the completion of the boring, the open bore-hole was backfilled with cement-bentonite grout.

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TOLUNAY-WONG ENGINEERS, INC.

# LOG OF BORING B-36

PROJECT: City of Kingsville Municipal Solid Waste Landfill Aerial Expansion

CLIENT: Naismith Engineering, Inc.

COORDINATES: N 27° 26' 56.8" W 97° 49' 04.9"
SURFACE ELEVATION: 59.13' AMSL
DRILLING METHOD:
Dry Augered: 0-ft. to 22-ft.
Wash Bored: 22-ft. to 68-ft.

| DEPTH (ft) | MATERIAL DESCRIPTION | (P) POCKET PEN (tsf) (T) TORVANE (psf) | STD. PENETRATION TEST (blows/ft) | MOISTURE CONTENT (%) | DRY UNIT WEIGHT (pcf) | LIQUID LIMIT (%) | PLASTICITY INDEX (%) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi) | PASSING #200 SIEVE (%) | OTHER TESTS PERFORMED |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | Loose to medium dense dark gray and gray CLAYEY SAND (SC) BODY I | | | | | | | | | | | |
| | -with calcareous nodules | | 18/6" 20/6" 21/6" | 10 | | | | | | | 36 | |
| 5 | -color changes to light gray and tan | | 4/6" 5/6" 5/6" | | | | | | | | | |
| 10 | -color changes to tan | | 4/6" 5/6" 6/6" | 12 | | 47 | 28 | | | | 44 | |
| 15 | | | 2/6" 4/6" 6/6" | | | | | | | | | |
| | -color changes to light gray with ferrous stains | | 4/6" 10/6" 14/6" | | | | | | | | | |
| 20 | -becomes very dense and color changes to light gray and tan | | 15/6" 24/6" 50/6" | 25 | | | | | | | 32 | |
| 25 | | | 12/6" 14/6" 15/6" | | | | | | | | | |
| 30 | -becomes dense | | 5/6" 17/6" 27/6" | | | | | | | | | |
| 35 | | | 4/6" | | | | | | | | | |

COMPLETION DEPTH: 68 ft
DATE BORING STARTED: 06/24/2016
DATE BORING COMPLETED: 06/24/2016
LOGGER: J. Garcia
PROJECT NO.: 16.53.042

REMARKS: Free water was encounterd at an approximate depth of 23' below existing grade during drilling operations. After a 10 to 15-minute waiting period, water was at a depth of 18'-3". At the completion of the boring, the open bore-hole was backfilled with cement-bentonite grout.

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TOLUNAY-WONG ENGINEERS, INC.

# LOG OF BORING B-36

PROJECT: City of Kingsville Municipal Solid Waste Landfill Aerial Expansion
CLIENT: Naismith Engineering, Inc.

COORDINATES: N 27° 26' 56.8" W 97° 49' 04.9"
SURFACE ELEVATION: 59.13' AMSL
DRILLING METHOD:
Dry Augered: 0-ft. to 22-ft.
Wash Bored: 22-ft. to 68-ft.

| DEPTH (ft) | MATERIAL DESCRIPTION | (P) POCKET PEN (tsf) (T) TORVANE (psf) | STD. PENETRATION TEST (blows/ft) | MOISTURE CONTENT (%) | DRY UNIT WEIGHT (pcf) | LIQUID LIMIT (%) | PLASTICITY INDEX (%) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi) | PASSING #200 SIEVE (%) | OTHER TESTS PERFORMED |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 35 | Medium dense light gray and tan CLAYEY SAND (SC) BODY I | | 7/6" 8/6" | | | | | | | | | |
| | -with sand seams, calcareous nodules, and ferrous staining | | 6/6" 10/6" 13/6" | 21 | | 47 | 30 | | | | 35 | |
| 40 | | | | | | | | | | | | |
| | -color changes to reddish brown and light gray | | 4/6" 8/6" 10/6" | | | | | | | | | |
| 45 | 13.13' AMSL | | | | | | | | | | | |
| | Stiff to very stiff reddish brown and light gray FAT CLAY (CH), slickensided, with ferrous staining LIGHT OLIVE GREEN TO GRAY CLAY | (P) 4.50+ | | | | | | | | | | |
| 50 | | | | | | | | | | | | |
| | -with sand seams and calcareous nodules | | 4/6" 6/6" 8/6" | 42 | | | | | | | 96 | |
| 55 | -color changes to light gray with sand layers | | 11/6" 12/6" 14/6" | | | | | | | | | |
| | -becomes hard | | 11/6" 21/6" 26/6" | 37 | | 70 | 44 | | | | 94 | |
| 60 | | | | | | | | | | | | |
| | | | 7/6" 8/6" 9/6" | | | | | | | | | |
| 65 | | | | | | | | | | | | |
| | -color changes to brown yellow, reddish brown, and light gray -8.87' AMSL | | 7/6" 10/6" 10/6" | | | | | | | | | |
| | Bottom @ 68' | | | | | | | | | | | |
| 70 | | | | | | | | | | | | |

COMPLETION DEPTH: 68 ft
DATE BORING STARTED: 06/24/2016
DATE BORING COMPLETED: 06/24/2016
LOGGER: J. Garcia
PROJECT NO.: 16.53.042

REMARKS: Free water was encounterd at an approximate depth of 23' below existing grade during drilling operations. After a 10 to 15-minute waiting period, water was at a depth of 18'-3". At the completion of the boring, the open bore-hole was backfilled with cement-bentonite grout.

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TOLUNAY-WONG ENGINEERS, INC.

# LOG OF BORING B-37

PROJECT: City of Kingsville
Municipal Solid Waste Landfill
Aerial Expansion

CLIENT: Naismith Engineering, Inc.

COORDINATES: N 27° 26' 57.1"
W 97° 49' 17.6"
SURFACE ELEVATION: 45.52' AMSL
DRILLING METHOD:
Dry Augered: 0-ft. to 12-ft.
Wash Bored: 12-ft. to 48-ft.

| DEPTH (ft) | MATERIAL DESCRIPTION | (P) POCKET PEN (tsf) (T) TORVANE (psf) | STD. PENETRATION TEST (blows/ft) | MOISTURE CONTENT (%) | DRY UNIT WEIGHT (pcf) | LIQUID LIMIT (%) | PLASTICITY INDEX (%) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi) | PASSING #200 SIEVE (%) | OTHER TESTS PERFORMED |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | Very dense light gray and tan SILTY SAND (SM)<br>BODY II | | | | | | | | | | | |
| | -with ferrous staining | | 6/6"<br>16/6"<br>50/5" | | | | | | | | | |
| 5 | | | | | | | | | | | | |
| | | | 11/6"<br>50/5" | 20 | | 33 | 9 | | | | 20 | |
| 10 | -with calcareous nodules | | 23/6"<br>37/6"<br>50/6" | | | | | | | | | |
| | 31.02' AMSL | | | | | | | | | | | |
| 15 | Very stiff to hard tan and light tan SANDY LEAN SILTY CLAY (CL-ML)<br>SANDY SILTY CLAY BED | | 6/6"<br>7/6"<br>10/6" | 31 | | | | | | | 52 | |
| | -color changes to tan and light gray with ferrous staining | | 9/6"<br>17/6"<br>27/6" | | | | | | | | | |
| 20 | | | | | | | | | | | | |
| | | | 7/6"<br>12/6"<br>13/6" | | | | | | | | | |
| 25 | 19.02' AMSL | | | | | | | | | | | |
| | Stiff to very stiff reddish brown and light gray FAT CLAY (CH) with calcareous nodules and ferrous staining<br>LIGHT OLIVE GREEN TO GRAY CLAY | | 4/6"<br>5/6"<br>9/6" | 33 | | 56 | 39 | | | | 99 | |
| 30 | -color changes to light gray with sand layers | | 5/6"<br>7/6"<br>12/6" | | | | | | | | | |
| 35 | | | 5/6" | 34 | | | | | | | 86 | |

COMPLETION DEPTH: 48 ft
DATE BORING STARTED: 06/24/2016
DATE BORING COMPLETED: 06/25/2016
LOGGER: J. Garcia
PROJECT NO.: 16.53.042

REMARKS: Free water was encounterd at an approximate depth of 15' below existing grade during drilling operations. After a 10 to 15-minute waiting period, water was at a depth of 9'-3". At the completion of the boring, the open bore-hole was backfilled with cement-bentonite grout.

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TOLUNAY-WONG ENGINEERS, INC.

# LOG OF BORING B-37

PROJECT: City of Kingsville Municipal Solid Waste Landfill Aerial Expansion

CLIENT: Naismith Engineering, Inc.

COORDINATES: N 27° 26' 57.1" W 97° 49' 17.6"
SURFACE ELEVATION: 45.52' AMSL
DRILLING METHOD:
Dry Augered: 0-ft. to 12-ft.
Wash Bored: 12-ft. to 48-ft.

| DEPTH (ft) | MATERIAL DESCRIPTION | (P) POCKET PEN (tsf) (T) TORVANE (psf) | STD. PENETRATION TEST (blows/ft) | MOISTURE CONTENT (%) | DRY UNIT WEIGHT (pcf) | LIQUID LIMIT (%) | PLASTICITY INDEX (%) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi) | PASSING #200 SIEVE (%) | OTHER TESTS PERFORMED |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 35 | Stiff to very stiff light gray and brownish tan FAT CLAY (CH) with sand seams, calcareous nodules, and ferrous staining<br>LIGHT OLIVE GREEN TO GRAY CLAY | | 7/6" 12/6" | | | | | | | | | |
| 40 | | | 4/6" 5/6" 7/6" | | | | | | | | | |
| | -color changes to light gray and reddish brown | | 6/6" 6/6" 9/6" | | | | | | | | | |
| 45 | -color changes to light gray<br>-2.48' AMSL | | 4/6" 5/6" 9/6" | 35 | | 80 | 51 | | | | 86 | |
| | Bottom @ 48' | | | | | | | | | | | |
| 50 | | | | | | | | | | | | |
| 55 | | | | | | | | | | | | |
| 60 | | | | | | | | | | | | |
| 65 | | | | | | | | | | | | |
| 70 | | | | | | | | | | | | |

COMPLETION DEPTH: 48 ft
DATE BORING STARTED: 06/24/2016
DATE BORING COMPLETED: 06/25/2016
LOGGER: J. Garcia
PROJECT NO.: 16.53.042

REMARKS: Free water was encounterd at an approximate depth of 15' below existing grade during drilling operations. After a 10 to 15-minute waiting period, water was at a depth of 9'-3". At the completion of the boring, the open bore-hole was backfilled with cement-bentonite grout.

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TOLUNAY-WONG ENGINEERS, INC.

# LOG OF BORING B-38

PROJECT: City of Kingsville Municipal Solid Waste Landfill Aerial Expansion

CLIENT: Naismith Engineering, Inc.

COORDINATES: N 27° 27' 03.76" W 97° 49' 12.19"
SURFACE ELEVATION: 41.64' AMSL
DRILLING METHOD:
Dry Augered: 0 ft. to 10 ft.
Wash Bored: 10 ft. to 58 ft.

| DEPTH (ft) | MATERIAL DESCRIPTION | (P) POCKET PEN (tsf) (T) TORVANE (psf) | STD. PENETRATION TEST (blows/ft) | MOISTURE CONTENT (%) | DRY UNIT WEIGHT (pcf) | LIQUID LIMIT (%) | PLASTICITY INDEX (%) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi) | PASSING #200 SIEVE (%) | OTHER TESTS PERFORMED |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 35 | Very stiff to hard reddish brown and light gray SANDY FAT CLAY (CH) with sand seams and layers | (P) 4.50+ | 8/6" 10/6" | | | | | | | | | |
| | 3.64' AMSL | | | | | | | | | | | |
| | Stiff to hard light gray FAT CLAY (CH), slickensided, with calcareous nodules and ferrous stains | (P) 4.50+ | | 42 | 78 | 100 | 72 | 2.95 | 2 | | 93 | |
| 40 | -color changes to reddish brown and light gray | (P) 4.50+ | | | | | | | | | | |
| | LIGHT OLIVE GREEN TO GRAY CLAY | | | | | | | | | | | |
| | | (P) 4.50+ | | | | | | | | | | |
| | -color changes to tannish brown and light gray with trace organics | (P) 4.50+ | | | | | | | | | | |
| 45 | -color changes to light gray | | 5/6" 6/6" 8/6" | | | | | | | | | |
| | | (P) 4.50+ | | 30 | 91 | | | 2.14 | 3 | | 87 | |
| 50 | | | 6/6" 7/6" 7/6" | | | | | | | | | |
| | | | 4/6" 5/6" 8/6" | | | | | | | | | |
| 55 | -color changes to tannish brown and light gray | | 5/6" 7/6" 9/6" | | | | | | | | | |
| | -color changes to light gray | | 6/6" 7/6" 9/6" | | | | | | | | | |
| | -16.36' AMSL | | | | | | | | | | | |
| | Bottom @ 58' | | | | | | | | | | | |
| 60 | | | | | | | | | | | | |
| 65 | | | | | | | | | | | | |
| 70 | | | | | | | | | | | | |

COMPLETION DEPTH: 58 ft
DATE BORING STARTED: 06/23/2016
DATE BORING COMPLETED: 06/23/2016
LOGGER: J. Garcia
PROJECT NO.: 16.53.042

REMARKS: Free water was encounterd at an approximate depth of 11' below existing grade during drilling operations. After a 10 to 15-minute waiting period, water was at a depth of 5'-5". At the completion of the boring, the open bore-hole was backfilled with cement-bentonite grout.

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TOLUNAY-WONG ENGINEERS, INC.

# LOG OF BORING B-39

PROJECT: City of Kingsville
Municipal Solid Waste Landfill
Aerial Expansion

CLIENT: Naismith Engineering, Inc.

COORDINATES: N 27° 27' 01.3"
W 97° 48' 57.3"
SURFACE ELEVATION: 60.26' AMSL
DRILLING METHOD:
Dry Augered: 0 ft. to 26 ft.
Wash Bored: 26 ft. to 68 ft.

| DEPTH (ft) | MATERIAL DESCRIPTION | (P) POCKET PEN (tsf) (T) TORVANE (psf) | STD. PENETRATION TEST (blows/ft) | MOISTURE CONTENT (%) | DRY UNIT WEIGHT (pcf) | LIQUID LIMIT (%) | PLASTICITY INDEX (%) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi) | PASSING #200 SIEVE (%) | OTHER TESTS PERFORMED |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | Medium dense to dense tan and light gray CLAYEY SAND FILL with trace gravel BODY I | | 8/6" 9/6" 6/6" | 18 | | | | | | | 33 | |
| | -color changes to brown | | 40/6" 27/6" 19/6" | | | | | | | | | |
| | 55.76' AMSL | | | | | | | | | | | |
| 5 | Medium dense to dense brown and reddish brown CLAYEY SAND (SC) BODY I | | 6/6" 7/6" 8/6" | | | | | | | | | |
| | -color changes to tan and gray with calcareous nodules | | 4/6" 5/6" 6/6" | | | | | | | | | |
| | | | 5/6" 6/6" 8/6" | 11 | | 36 | 20 | | | | 49 | |
| 10 | -color changes to tan and light gray | | 4/6" 6/6" 7/6" | | | | | | | | | |
| | -color changes to light gray | | 7/6" 8/6" 11/6" | | | | | | | | | |
| 15 | -color changes to light gray and tan with ferrous stains | | 6/6" 12/6" 19/6" | | | | | | | | | |
| | -color changes to light gray | | 11/6" 19/6" 22/6" | | | | | | | | | |
| | 41.76' AMSL | | | | | | | | | | | |
| 20 | Stiff to hard light gray SANDY LEAN CLAY (CL) with calcareous nodules and ferrous stains | | 3/6" 4/6" 5/6" | 19 | | | | | | | 65 | |
| | | | 6/6" 9/6" 13/6" | | | | | | | | | |
| | | | 8/6" 11/6" 20/6" | | | | | | | | | |
| 25 | -color changes to light tan and light gray | (P) 4.50+ | | | | | | | | | | |
| | -color changes to light gray | (P) 4.00 | | | | | | | | | | |
| | | | 7/6" 11/6" 13/6" | | | | | | | | | |
| 30 | -color changes to light gray and tan | (P) 4.50+ | | 19 | 102 | | | 1.14 | 7 | | 50 | |
| | | | 12/6" 16/6" 20/6" | | | | | | | | | |
| 35 | | | 8/6" | | | | | | | | | |

COMPLETION DEPTH: 68 ft
DATE BORING STARTED: 06/20/2016
DATE BORING COMPLETED: 06/24/2016
LOGGER: J. Garcia
PROJECT NO.: 16.53.042

REMARKS: Free water was encounterd at an approximate depth of 27' below existing grade during drilling operations. After a 10 to 15-minute waiting period, water was at a depth of 26'-6". At the completion of the boring, the open bore-hole was backfilled with cement-bentonite grout.

Page 1 of 2

TOLUNAY-WONG ENGINEERS, INC.

# LOG OF BORING B-39

PROJECT: City of Kingsville Municipal Solid Waste Landfill Aerial Expansion

CLIENT: Naismith Engineering, Inc.

COORDINATES: N 27° 27' 01.3" W 97° 48' 57.3"
SURFACE ELEVATION: 60.26' AMSL
DRILLING METHOD:
Dry Augered: 0 ft. to 26 ft.
Wash Bored: 26 ft. to 68 ft.

| DEPTH (ft) | MATERIAL DESCRIPTION | (P) POCKET PEN (tsf) (T) TORVANE (psf) | STD. PENETRATION TEST (blows/ft) | MOISTURE CONTENT (%) | DRY UNIT WEIGHT (pcf) | LIQUID LIMIT (%) | PLASTICITY INDEX (%) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi) | PASSING #200 SIEVE (%) | OTHER TESTS PERFORMED |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 35 | Stiff to hard light gray and tan SANDY LEAN CLAY (CL) with ferrous stains 23.76' AMSL | | 12/6" 16/6" | | | | | | | | | |
| | Medium dense to dense light gray CLAYEY SAND (SC) with ferrous stains BODY III | | 7/6" 8/6" 11/6" | | | | | | | | | |
| | | | 6/6" 11/6" 12/6" | | | | | | | | | |
| 40 | | | 7/6" 10/6" 13/6" | 25 | | 69 | 51 | | | | 45 | |
| | 15.76' AMSL | | 13/6" 19/6" 21/6" | | | | | | | | | |
| 45 | Dense light gray POORLY GRADED SAND with CLAY (SP- SC) | | 12/6" 21/6" 20/6" | | | | | | | | | |
| | 12.26' AMSL | | 11/6" 16/6" 16/6" | | | | | | | | | |
| | Hard reddish brown and light gray FAT CLAY with SAND (CH) LIGHT OLIVE GREEN TO GRAY CLAY | (P) 4.50+ | | | | | | | | | | |
| 50 | | (P) 4.50+ | | 28 | 93 | | | 0.85 | 1 | | 72 | |
| | -becomes slickensided with calcareous nodules | (P) 4.50+ | | | | | | | | | | |
| | -with ferrous stains | (P) 4.50+ | | | | | | | | | | |
| 55 | | (P) 4.50+ | | | | | | | | | | |
| | | (P) 4.50+ | | | | | | | | | | |
| 60 | | (P) 4.50+ | | | | | | | | | | |
| | -becomes stiff | | 7/6" 7/6" 7/6" | | | | | | | | | |
| 65 | -6.24' AMSL | | | | | | | | | | | |
| | Medium dense light gray CLAYEY SAND (SC) with calcareous nodules and ferrous stains -7.74' AMSL | | 6/6" 10/6" 13/6" | 20 | 102 | 61 | 45 | 1.91 | 5 | | 46 | |
| | Bottom @ 68' | | | | | | | | | | | |
| 70 | | | | | | | | | | | | |

COMPLETION DEPTH: 68 ft
DATE BORING STARTED: 06/20/2016
DATE BORING COMPLETED: 06/24/2016
LOGGER: J. Garcia
PROJECT NO.: 16.53.042

REMARKS: Free water was encounterd at an approximate depth of 27' below existing grade during drilling operations. After a 10 to 15-minute waiting period, water was at a depth of 26'-6". At the completion of the boring, the open bore-hole was backfilled with cement-bentonite grout.

Page 2 of 2

TOLUNAY-WONG ENGINEERS, INC.

# LOG OF BORING B-40

PROJECT: City of Kingsville
Municipal Solid Waste Landfill
Aerial Expansion

CLIENT: Naismith Engineering, Inc.

COORDINATES: N 27° 27' 09.97"
W 97° 49' 11.18"
SURFACE ELEVATION: 52.31' AMSL
DRILLING METHOD:
Dry Augered: 0 ft. to 22 ft.
Wash Bored: 22 ft. to 33.75 ft.

| DEPTH (ft) | SAMPLE TYPE | SYMBOL/USCS | MATERIAL DESCRIPTION | (P) POCKET PEN (tsf) (T) TORVANE (psf) | STD. PENETRATION TEST (blows/ft) | MOISTURE CONTENT (%) | DRY UNIT WEIGHT (pcf) | LIQUID LIMIT (%) | PLASTICITY INDEX (%) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi) | PASSING #200 SIEVE (%) | OTHER TESTS PERFORMED |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | | Loose to very dense light gray and gray SILTY SAND (SM) with trace caliche BODY II | | 4/6" 4/6" 6/6" | | | | | | | | | |
| | | | -color changes to light gray and tan with ferrous stains | | 5/6" 7/6" 11/6" | 16 | | 35 | 10 | | | | 31 | |
| 5 | | | | | 7/6" 17/6" 17/6" | | | | | | | | | |
| | | | -color changes to light gray with calcareous nodules | | 12/6" 21/6" 34/6" | | | | | | | | | |
| | | | -color changes to light gray and white | | 12/6" 27/6" 50/3" | 18 | | | | | | | 34 | |
| 10 | | | -color changes to white | | 15/6" 50/3" | | | | | | | | | |
| | | | -color changes to light gray and white | | 25/6" 50/4" | | | | | | | | | |
| | | | 37.81' AMSL | | | | | | | | | | | |
| 15 | | | Hard light gray FAT CLAY with SAND (CH), calcareous nodules, and ferrous stains | | 7/6" 26/6" 50/5" | 22 | | 70 | 41 | | | | 80 | |
| | | | | | 5/6" 17/6" 28/6" | | | | | | | | | |
| | | | | | 10/6" 30/6" 35/6" | | | | | | | | | |
| 20 | | | 31.81' AMSL | | | | | | | | | | | |
| | | | Hard light gray SANDY FAT CLAY (CH) with calcareous nodules and ferrous stains | | 9/6" 25/6" 35/6" | 31 | | | | | | | 59 | |
| | | | | | 16/6" 32/6" 50/5" | | | | | | | | | |
| 25 | | | | | 16/6" 31/6" 50/5" | | | | | | | | | |
| | | | 25.81' AMSL | | | | | | | | | | | |
| | | | Dense to very dense light gray CLAYEY SAND (SC) with calcareous nodules | | 8/6" 18/6" 27/6" | 30 | | 53 | 32 | | | | 49 | |
| 30 | | | | | 6/6" 18/6" 50/6" | | | | | | | | | |
| | | | | | 6/6" 20/6" 50/5" | | | | | | | | | |
| | | | 18.81' AMSL | | 3/6" 40/6" 50/3" | 16 | | | | | | | 30 | |
| | | | Bottom @ 33.5' | | | | | | | | | | | |
| 35 | | | | | | | | | | | | | | |

COMPLETION DEPTH: 33.5 ft
DATE BORING STARTED: 06/21/2016
DATE BORING COMPLETED: 06/22/2016
LOGGER: J. Garcia
PROJECT NO.: 16.53.042

REMARKS: Free water was encounterd at an approximate depth of 21' below existing grade during drilling operations. After a 10 to 15-minute waiting period, water was at a depth of 19'. At the completion of the boring, the open bore-hole was backfilled with cement-bentonite grout.

Page 1 of 1

TOLUNAY-WONG ENGINEERS, INC.

# LOG OF BORING B-41

PROJECT: City of Kingsville
Municipal Solid Waste Landfill
Aerial Expansion

CLIENT: Naismith Engineering, Inc.

COORDINATES: N 27° 27' 09.8"
W 97° 49' 17.4"
SURFACE ELEVATION: 50.20' AMSL
DRILLING METHOD:
Dry Augered: 0-ft. to 62.5-ft.
Wash Bored: -- to --

| DEPTH (ft) | MATERIAL DESCRIPTION | (P) POCKET PEN (tsf) (T) TORVANE (psf) | STD. PENETRATION TEST (blows/ft) | MOISTURE CONTENT (%) | DRY UNIT WEIGHT (pcf) | LIQUID LIMIT (%) | PLASTICITY INDEX (%) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi) | PASSING #200 SIEVE (%) | OTHER TESTS PERFORMED |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | Loose to medium dense gray CLAYEY SAND (SC) with calcareous nodules BODY I | | 4/6" 5/6" 5/6" | 8 | | | | | | | 35 | |
| 5 | -color changes to light gray | | 4/6" 5/6" 6/6" | | | | | | | | | |
| | 41.70' AMSL | | | | | | | | | | | |
| | Stiff to very stiff gray SANDY FAT CLAY (CH) LIGHT OLIVE GREEN TO GRAY CLAY | | 5/6" 8/6" 11/6" | 20 | | 78 | 52 | | | | 64 | |
| 10 | | | | | | | | | | | | |
| | -becomes hard and color changes to brown with interbedded sand seams | | 9/6" 17/6" 25/6" | | | | | | | | | |
| 15 | | | | | | | | | | | | |
| | -color changes to brown and tan | | 7/6" 12/6" 14/6" | | | | | | | | | |
| 20 | -color changes to tan with sand layers | | 3/6" 4/6" 6/6" | 36 | | | | | | | 64 | |
| 25 | -color changes to brown with sand partings | | 5/6" 4/6" 6/6" | | | | | | | | | |
| | -color changes to brown and tan | | 6/6" 7/6" 8/6" | 31 | | 52 | 30 | | | | 51 | |
| 30 | | | | | | | | | | | | |
| | | | 4/6" 6/6" 6/6" | | | | | | | | | |
| 35 | | | | | | | | | | | | |

COMPLETION DEPTH: 62.5 ft
DATE BORING STARTED: 07/20/2016
DATE BORING COMPLETED: 07/20/2016
LOGGER: M. Anderson
PROJECT NO.: 16.53.042

REMARKS: Free water was encounterd at an approximate depth of 19'-6" below existing grade during drilling operations. After a 10 to 15-minute waiting period, water was at a depth of 19'-3". At the completion of the boring, the open bore-hole was backfilled with cement-bentonite grout.

Page 1 of 2

TOLUNAY-WONG ENGINEERS, INC.

# LOG OF BORING B-41

PROJECT: City of Kingsville
Municipal Solid Waste Landfill
Aerial Expansion

CLIENT: Naismith Engineering, Inc.

COORDINATES: N 27° 27' 09.8"
W 97° 49' 17.4"
SURFACE ELEVATION: 50.20' AMSL
DRILLING METHOD:
Dry Augered: 0-ft. to 62.5-ft.
Wash Bored: -- to --

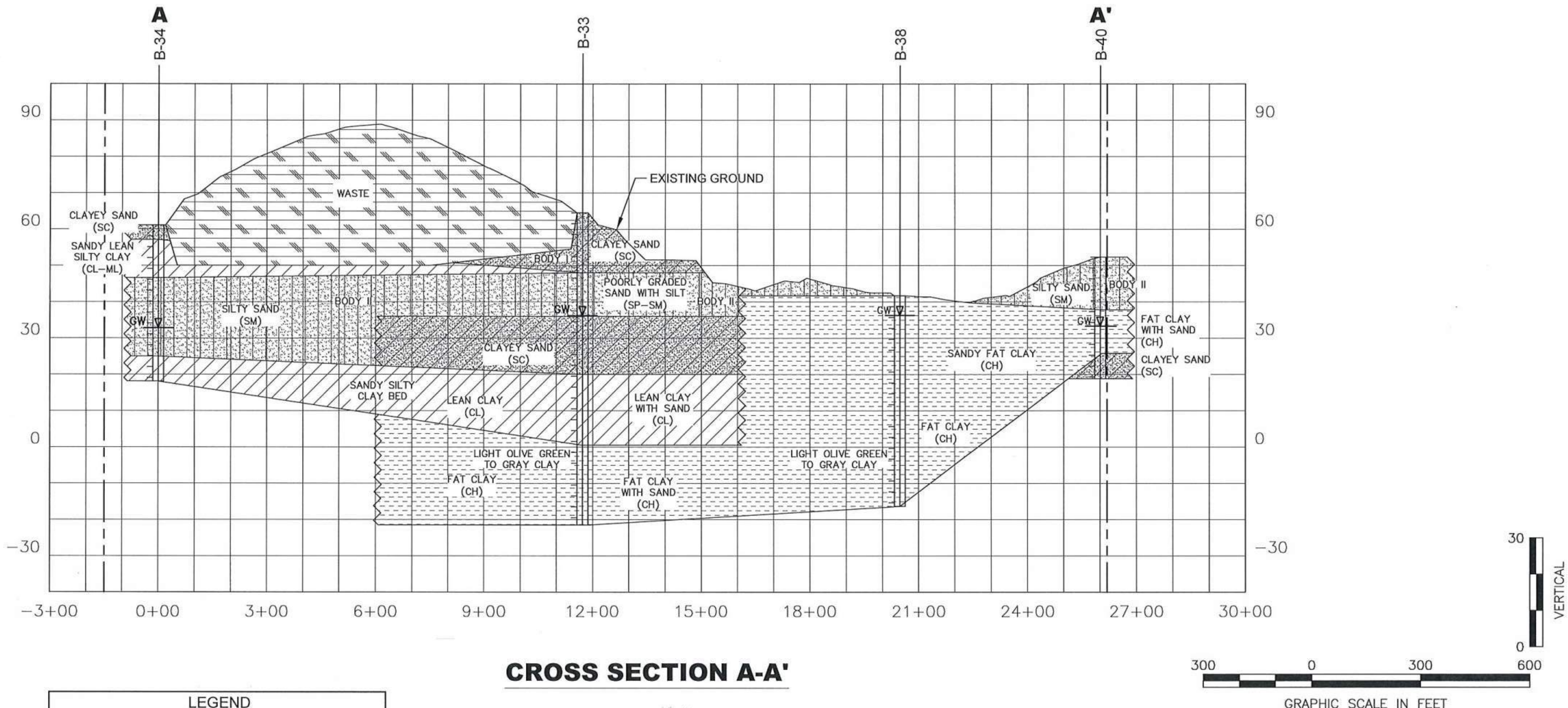
| DEPTH (ft) | MATERIAL DESCRIPTION | (P) POCKET PEN (tsf) (T) TORVANE (psf) | STD. PENETRATION TEST (blows/ft) | MOISTURE CONTENT (%) | DRY UNIT WEIGHT (pcf) | LIQUID LIMIT (%) | PLASTICITY INDEX (%) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi) | PASSING #200 SIEVE (%) | OTHER TESTS PERFORMED |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 35 | 14.20' AMSL<br>Stiff to very stiff gray SANDY FAT CLAY (CH) | | | | | | | | | | | |
| | Very stiff brown FAT CLAY with SAND (CH)<br>LIGHT OLIVE GREEN TO GRAY CLAY | (P) 3.25 | | 27 | 92 | | | | | | 77 | |
| 40 | -color changes to brown and tan | | 6/6" 13/6" 11/6" | | | | | | | | | |
| 45 | | | 4/6" 9/6" 14/6" | | | | | | | | | |
| | | | 6/6" 8/6" 9/6" | 35 | | 97 | 75 | | | | 84 | |
| 50 | -color changes to brown and gray | | 7/6" 9/6" 12/6" | | | | | | | | | |
| 55 | -color changes to gray | (P) 4.50+ | | | | | | | | | | |
| 60 | | (P) 3.50 | | | | | | | | | | |
| | -12.30' AMSL<br>Bottom @ 62.5' | | | | | | | | | | | |
| 65 | | | | | | | | | | | | |
| 70 | | | | | | | | | | | | |

COMPLETION DEPTH: 62.5 ft
DATE BORING STARTED: 07/20/2016
DATE BORING COMPLETED: 07/20/2016
LOGGER: M. Anderson
PROJECT NO.: 16.53.042

REMARKS: Free water was encounterd at an approximate depth of 19'-6" below existing grade during drilling operations. After a 10 to 15-minute waiting period, water was at a depth of 19'-3". At the completion of the boring, the open bore-hole was backfilled with cement-bentonite grout.

Page 2 of 2

TOLUNAY-WONG ENGINEERS, INC.




## CROSS SECTION A-A'

### LEGEND

| | |
|---|---|
| | WASTE |
| | LEAN CLAY, LEAN CLAY WITH SAND, SANDY LEAN SILTY CLAY (CL, CL-ML) |
| | CLAYEY SAND (SC) |
| | SILTY SAND, POORLY GRADED SAND WITH SILT (SM, SP-SM) |
| | FAT CLAY, SANDY FAT CLAY FAT CLAY WITH SAND (CH) |
| ▽ | GROUND WATER AFTER EQUILIBRIUM (GW) |
| — — — | PERMIT BOUNDARY |

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CITY OF KINGSVILLE LANDFILL

SOIL BORING REPORT
CROSS SECTION A-A'
KLEBERG COUNTY, TEXAS

16L0438

EXHIBIT IV

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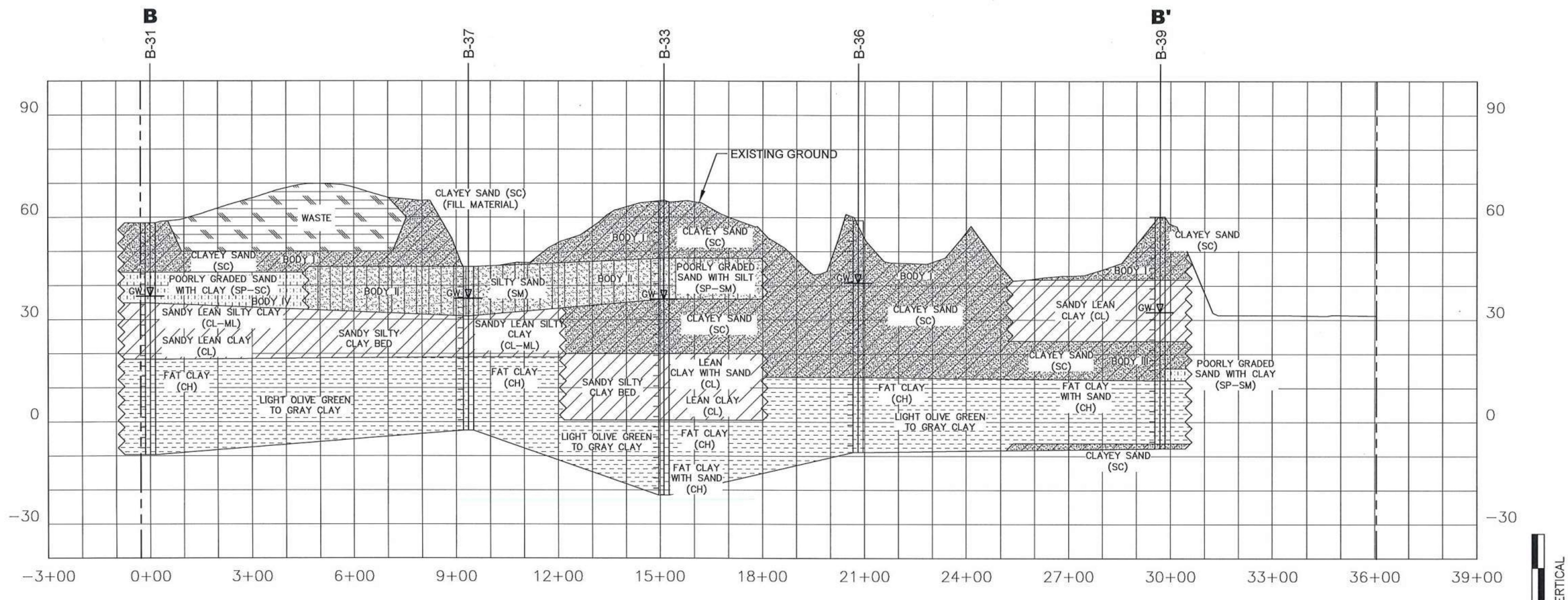


## CROSS SECTION B-B'

### LEGEND

| | |
|---|---|
| | WASTE |
| | LEAN CLAY, LEAN CLAY WITH SAND, SANDY LEAN SILTY CLAY (CL, CL-ML) |
| | CLAYEY SAND (SC) |
| | SILTY SAND, POORLY GRADED SAND WITH SILT (SM, SP-SM) |
| | FAT CLAY, SANDY FAT CLAY FAT CLAY WITH SAND (CH) |
| | POORLY GRADED SAND WITH CLAY (SP-SC) |
| ▽ | GROUND WATER AFTER EQUILIBRIUM (GW) |
| — — — | PERMIT BOUNDARY |

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CITY OF KINGSVILLE LANDFILL

SOIL BORING REPORT
CROSS SECTION B-B'
KLEBERG COUNTY, TEXAS

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# CROSS SECTION C-C'

**LEGEND**

- WASTE
- LEAN CLAY, LEAN CLAY WITH SAND, SANDY LEAN SILTY CLAY (CL, CL-ML)
- CLAYEY SAND (SC)
- SILTY SAND, POORLY GRADED SAND WITH SILT (SM, SP-SM)
- FAT CLAY, SANDY FAT CLAY (CH)
- GROUND WATER AFTER EQUILIBRIUM (GW)
- PERMIT BOUNDARY

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CROSS SECTION C-C'
KLEBERG COUNTY, TEXAS

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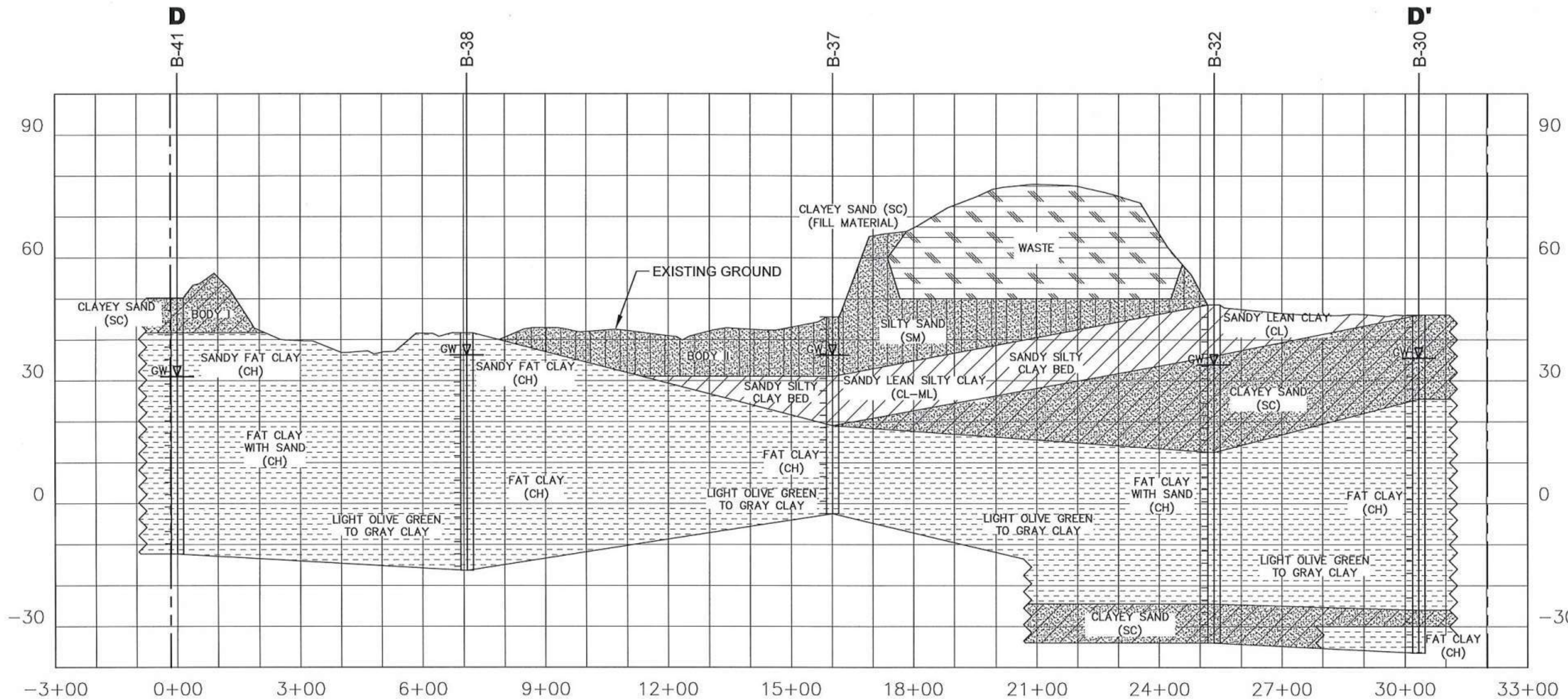


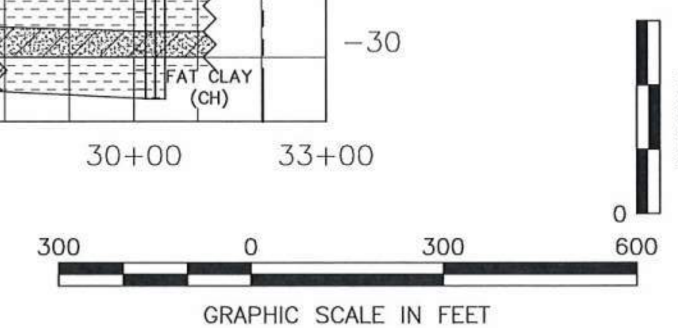


## CROSS SECTION D-D'

LEGEND

| | |
|---|---|
| | WASTE |
| | LEAN CLAY, LEAN CLAY WITH SAND, SANDY LEAN SILTY CLAY (CL, CL−ML) |
| | CLAYEY SAND (SC) |
| | SILTY SAND, POORLY GRADED SAND WITH SILT (SM, SP−SM) |
| | FAT CLAY, SANDY FAT CLAY (CH) |
| ▽ | GROUND WATER AFTER EQUILIBRIUM (GW) |
| — — — | PERMIT BOUNDARY |


Tad A. Gass
4/24/2019



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CITY OF KINGSVILLE LANDFILL

SOIL BORING REPORT
CROSS SECTION D-D'
KLEBERG COUNTY, TEXAS

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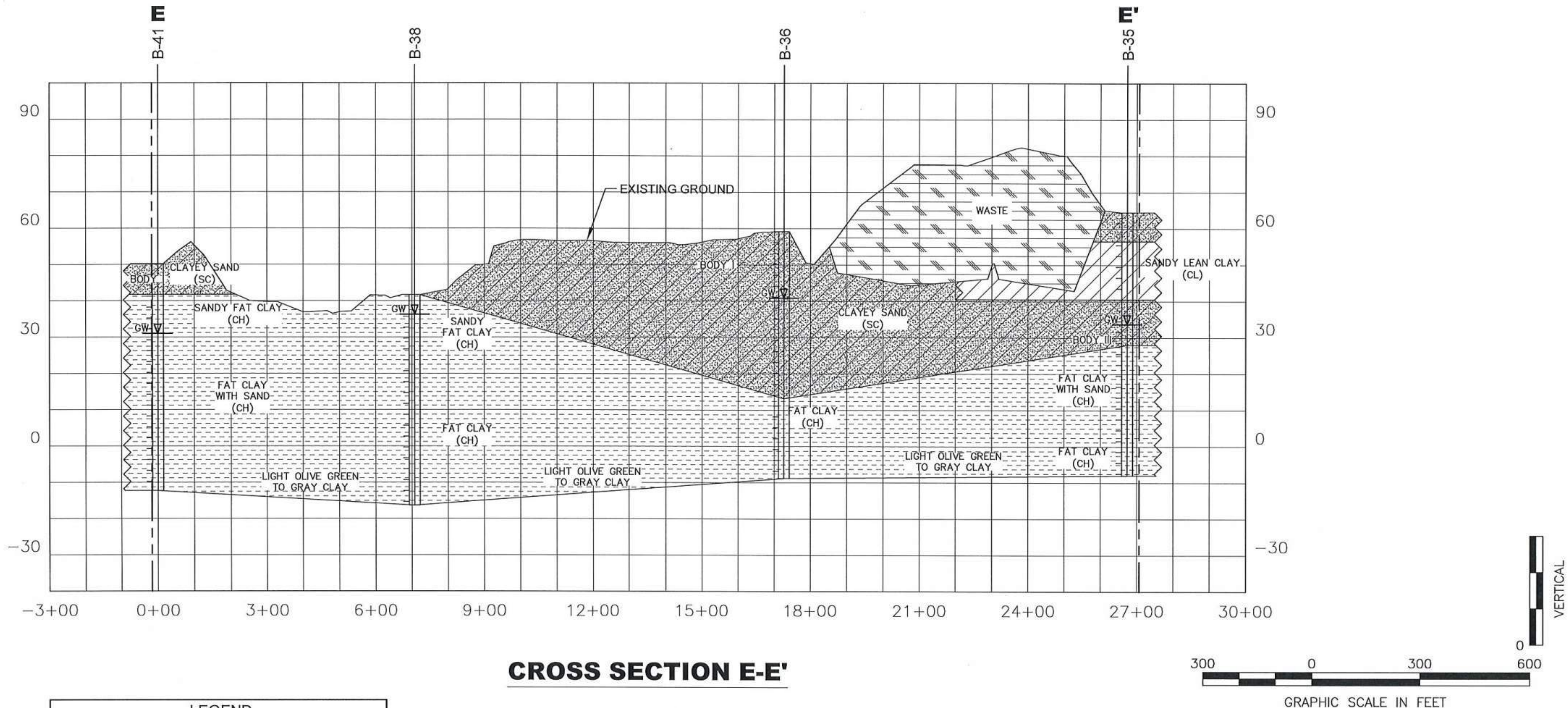


## CROSS SECTION E-E'

### LEGEND

- WASTE
- LEAN CLAY, LEAN CLAY WITH SAND, SANDY LEAN SILTY CLAY (CL, CL-ML)
- CLAYEY SAND (SC)
- FAT CLAY, SANDY FAT CLAY (CH)
- GROUND WATER AFTER EQUILIBRIUM (GW)
- PERMIT BOUNDARY

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CITY OF KINGSVILLE LANDFILL

SOIL BORING REPORT
CROSS SECTION E-E'
KLEBERG COUNTY, TEXAS

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# CITY OF KINGSVILLE LANDFILL

# PART III, ATTACHMENT 4

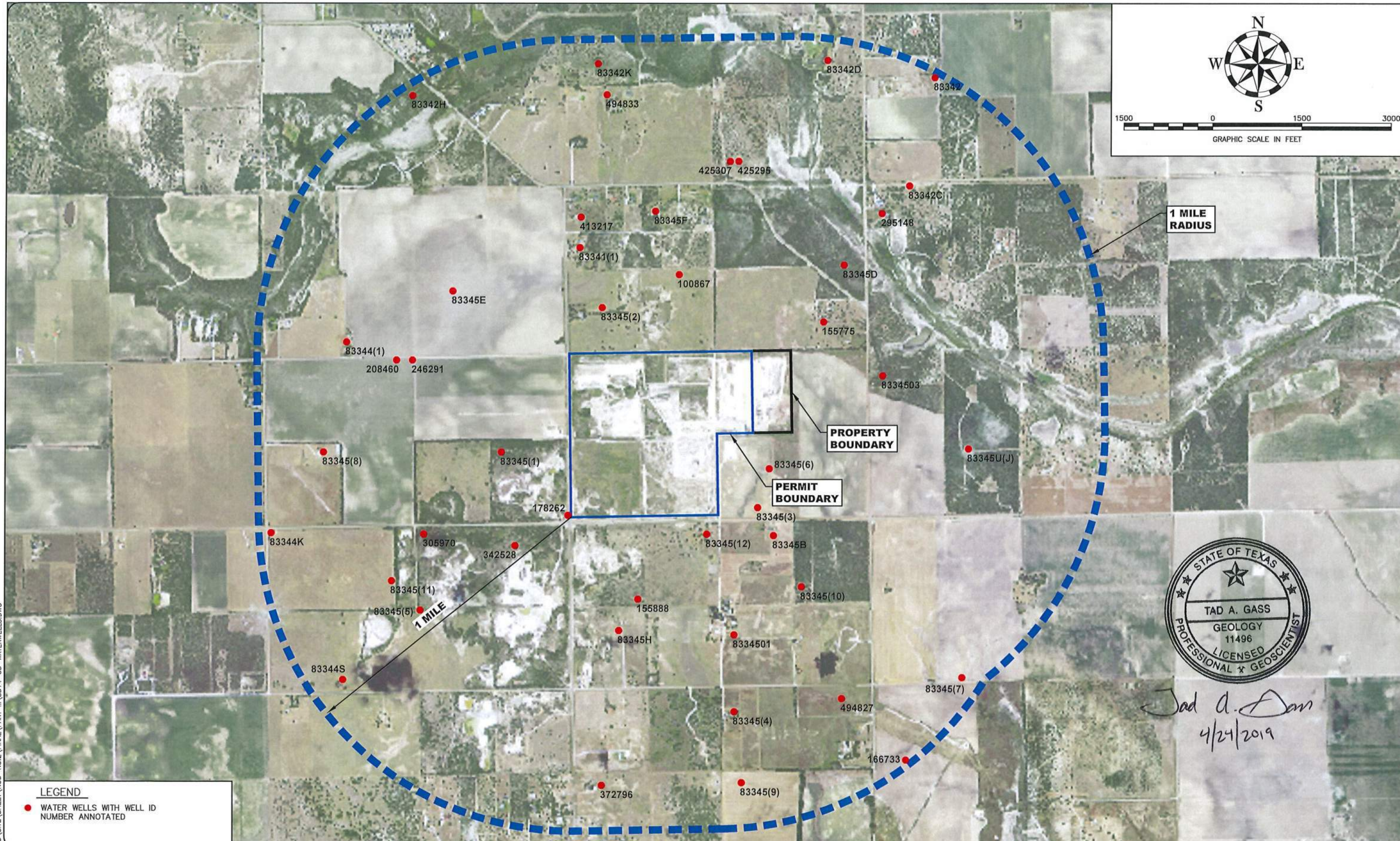
# ATTACHMENT 6

WATER WELL SURVEY DATA

# Water Well Survey Data Table

| Well ID | Figure 4.15 ID | Well Use | Aquifer | Well Depth (Ft.) | Approximate Distance from Site |
|---|---|---|---|---|---|
| **Wells Identified by FEE** | | | | | |
| 83-34-501 | 501 | Domestic | Evangeline Aquifer (Goliad Sand) | 631 | ~0.6 Miles South |
| 83-34-503 | 503 | N/A | Aquifer Code Is Not Applicable to this Well | 6131 | ~ 0.8 Miles Northeast |
| 83-34-2C | 2C | Domestic | *Evangeline Aquifer (Goliad Sand) | 618 | ~0.9 Miles Northeast |
| 83-34-2D | 2D | Other | *Evangeline Aquifer (Goliad Sand) | 556 | ~0.9 Miles Northeast |
| 83-34-2H | 2H | Domestic | *Evangeline Aquifer (Goliad Sand) | 618 | ~0.9 Mile Northwest |
| 83-34-2K | 2K | Domestic | *Evangeline Aquifer (Goliad Sand) | 591 | ~0.9 Miles Northwest |
| 83-34-2K | 2K | Domestic | *Evangeline Aquifer (Goliad Sand) | 668 | ~0.9 Miles Northwest |
| 83-34-4K | 4K | Domestic | *Evangeline Aquifer (Goliad Sand) | 692 | ~0.9 Miles Southwest |
| 83-34-4S | 4S | Domestic | *Evangeline Aquifer (Goliad Sand) | 640 | ~0.8 Miles Southwest |
| 83-34-5B | 5B | Domestic | *Evangeline Aquifer (Goliad Sand) | 631 | ~0.4 Miles Southeast |
| 83-34-5D | 5D | Domestic | *Evangeline Aquifer (Goliad Sand) | 642 | ~0.7 Miles Northeast |
| 83-34-5E | 5E | Domestic | *Evangeline Aquifer (Goliad Sand) | 612 | ~0.5 Miles Northwest |
| 83-34-5F | 5F | Domestic | *Evangeline Aquifer (Goliad Sand) | 727 | ~0.5 Miles North |
| 83-34-5G | 5G | Domestic | *Evangeline Aquifer (Goliad Sand) | 763 | ~0.9 Miles Southwest |
| 83-34-5H | 5H | Domestic | *Evangeline Aquifer (Goliad Sand) | 687 | ~0.5 Miles South |
| 83-34-5U | 5J | Domestic | *Evangeline Aquifer (Goliad Sand) | 640 | ~ 0.7 Miles Northeast |
| 83-34-1 | 1(1) | Irrigation | *Evangeline Aquifer (Goliad Sand) | 642 | ~0.5 Miles Northwest |
| 83-34-2 | 2(1) | Domestic | *Evangeline Aquifer (Goliad Sand) | 540 | ~1.0 Miles Northeast |
| 83-34-4 | 4(1) | Domestic | *Evangeline Aquifer (Goliad Sand) | 630 | ~0.7 Miles Northwest |
| 83-34-5 | 5(1) | Domestic | *Evangeline Aquifer (Goliad Sand) | 573 | ~0.3 Miles Southwest |
| 83-34-5 | 5(2) | Domestic | *Evangeline Aquifer (Goliad Sand) | 630 | ~0.4 Miles Northwest |
| 83-34-5 | 5(3) | Domestic | *Evangeline Aquifer (Goliad Sand) | 662 | ~0.3 Miles Southeast |
| 83-34-5 | 5(4) | Domestic | *Evangeline Aquifer (Goliad Sand) | 652 | ~0.5 Miles Southeast |
| 83-34-5 | 5(5) | Domestic | *Evangeline Aquifer (Goliad Sand) | 661 | ~0.7 Miles Southwest |
| 83-34-5 | 5(6) | Domestic | *Evangeline Aquifer (Goliad Sand) | 729 | ~0.3 Miles East |
| 83-34-5 | 5(7) | Supply | *Evangeline Aquifer (Goliad Sand) | 720 | ~0.9 Miles Southeast |
| 83-34-5 | 5(8) | Industrial | *Evangeline Aquifer (Goliad Sand) | 801 | ~0.5 Miles West |
| 83-34-5 | 5(9) | Domestic | *Evangeline Aquifer (Goliad Sand) | 645 | ~0.8 Miles Southwest |
| 83-34-5 | 5(10) | Domestic | *Evangeline Aquifer (Goliad Sand) | 656 | ~0.5 Miles Southeast |
| 83-34-5 | 5(11) | Domestic | *Evangeline Aquifer (Goliad Sand) | 663 | ~0.7 Miles Southwest |
| 83-34-5 | 5(12) | Domestic | *Evangeline Aquifer (Goliad Sand) | 612 | ~0.3 Miles Southeast |
| **Additional Wells Identified by Hanson Professional Services** | | | | | |
| **Tracking #** | **Owner Well #** | **Well Use** | **Aquifer** | **Well Depth (Ft.)** | **Approximate Distance from Site** |
| 155775 | No Data | Domestic | *Evangeline Aquifer (Goliad Sand) | 600 | ~0.7 Miles Northeast |
| 100867 | NOLLKINPER #2 | Rig Supply | *Evangeline Aquifer (Goliad Sand) | 640 | ~0.6 Miles Northeast |
| 425307 | 2 | Stock | *Evangeline Aquifer (Goliad Sand) | 650 | ~0.9 Miles Northeast |
| 425295 | 1 | Domestic | *Evangeline Aquifer (Goliad Sand) | 650 | ~0.9 Miles Northeast |
| 494827 | FLAMINGO #1 | Rig Supply | *Evangeline Aquifer (Goliad Sand) | 600 | ~1.0 Miles Southeast |
| 372796 | 1 | Domestic | *Evangeline Aquifer (Goliad Sand) | 660 | ~1.0 Miles Southwest |
| 155888 | No Data | Industrial | *Evangeline Aquifer (Goliad Sand) | 580 | ~0.5 Miles Southwest |
| 305970 | No Data | Industrial | *Evangeline Aquifer (Goliad Sand) | 608 | ~0.8 Miles Southwest |
| 342528 | No Data | Domestic | *Evangeline Aquifer (Goliad Sand) | 645 | ~0.5 Miles Southwest |
| 178262 | No Data | Domestic | *Evangeline Aquifer (Goliad Sand) | 595 | ~0.2 Miles Southwest |
| 208460 | No Data | Domestic | *Evangeline Aquifer (Goliad Sand) | 596 | ~0.8 Milles Northwest |
| 246291 | No Data | Domestic | *Evangeline Aquifer (Goliad Sand) | 560 | ~0.8 Milles Northwest |
| 413217 | No Data | Domestic | *Evangeline Aquifer (Goliad Sand) | 622 | ~0.8 Milles Northwest |
| 295148 | No Data | Domestic | *Evangeline Aquifer (Goliad Sand) | 600 | ~0.5 Milles Northeast |
| 8334503 | No Data | Oil or Gas | Aquifer Code Is Not Applicable to this Well | 6131 | ~0.3 Milles East |
| 166733 | No Data | Industrial | *Evangeline Aquifer (Goliad Sand) | 612 | ~1.0 Miles Southeast |
| 494833 | No Data | Stock | *Evangeline Aquifer (Goliad Sand) | 560 | ~0.9 Miles Northwest |
| 8334501 | No Data | Domestic | Evangeline Aquifer (Goliad Sand) | 631 | ~0.4 Milles South |
| 190906 | No Data | Domestic | *Evangeline Aquifer (Goliad Sand) | 648 | ~1.0 Miles Southwest |

***Aquifer Based on Total Depth of Well and Screening Interval**

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PART III-ATTACHMENT 4, ATTACHMENT 6
WATER WELLS
WITHIN 1 MILE
CITY OF KINGSVILLE LANDFILL
MSW PERMIT No. 235-C
KINGSVILLE, TEXAS
KLEBERG COUNTY, TEXAS

FIGURE:
III.4-6-1

THE CITY OF KINGSVILLE LANDFILL

TCEQ PERMIT MSW 235C

# PERMIT AMENDMENT APPLICATION

## Volume 4 of 6

CITY OF KINGSVILLE, KLEBERG COUNTY, TEXAS

For Permitting Purposes Only

STATE OF TEXAS
JON M. REINHARD
64541
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PROFESSIONAL ENGINEER

04/25/19

TBPE Firm No. F-417

September 2018
Revision 1 – November 2018
Revision 2 – February 2019
Revision 3 – April 2019

Prepared by

HANSON
Engineering | Planning | Allied Services

TBPE F-417

HANSON PROJECT NO. 16L0438-0003

# CITY OF KINGSVILLE LANDFILL

# PART III

# ATTACHMENT 5

ALTERNATIVE LINER AND OVERLINER

POINT OF COMPLIANCE DEMONSTRATIONS

# ATTACHMENT 5

# ALTERNATIVE LINER AND OVERLINER DESIGN AND POINT OF COMPLIANCE DEMONSTRATIONS

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04/24/19

Jose C. Garza, P.E.

TBPE Firm No. F-417

## CONTENTS

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Jose C. Garza, P.E.
TBPE Firm No. 417
For Pages i - iv

Appendices C.7.1 through C.7.11. The upper clay (light olive green clay) is ubiquitous under the site with a minimum proven thickness of 38 feet thick, the Chicot Aquifer is approximately 220 feet below ground surface, and the Evangeline Aquifer is approximately 500 feet below ground surface. The light olive green clay layer serves as aquiclude between the uppermost acquifer below the landfill site and the Chicot acquifer. To provide a conservative assumption given the bottom of the landfill and the groundwater, the percolation through the alternate liner and overliner system was assumed to be conveyed directly to the upper strata and therefore travel time, dilution, and attenuation are not accounted for in this analysis for upper soils.

## 2.4 SLOPE STABILITY ANALYSIS

The alternative liner and overliner system were analyzed for slope stability by performing two dimensional, effective stress slope stability analyses for the final, closed geometry, using the computer program SLIDE. The slope stability calculations are presented in Part III Attachment 4, Appendix 2-Section 7 WASTE MASS STABILITY and Appendix F: Graphical Representation of Mass Stability Analyses Results.

## 2.5 ALTERNATE COMPOSITE FINAL COVER DESIGN DEMONSTRATION

The alternate composite final cover design demonstration will demonstrate that the use of a geosynthetic clay liner (GCL) will provide equivalent infiltration and protection from wind and water erosion as the conventional composite final cover defined in 30 TAC §330.457 (d)(1) & (d)(2). The design demonstration is shown in Appendix G.

# 4 POINT OF COMPLIANCE DEMONSTRATION RESULTS

The HELP and MULTIMED models were used to evaluate the proposed design of the alternative liner and overliner system by estimating constituent concentrations at the POC for the landfill cases discussed in Section 2.3. The percolation rates obtained from the HELP Model cases included in Appendix C.3 and Appendix C.4 were used as input for the MULTIMED model to determine the DAF. Conservatively, the constituent concentrations at the base of the landfill liner and at the POC were used to calculate the DAF.

A summary of the calculated DAF is presented below and in Appendix D.

| Location | Interim Case DAF | Closed Case DAF |
|---|---|---|
| Alternative Liner Location 1 | 40,833 | 102,301 |
| Alternative Liner Location 2 | 68,446 | 239,750 |
| Alternative Liner Location 3 | 137,381 | 481,231 |
| Alternative Liner Location 4 | 286,533 | 1,003,814 |

| Location | Interim Case DAF | Closed Case DAF |
|---|---|---|
| Overliner Location 1 | 18,797 | 65,833 |
| Overliner Location 2 | 77,640 | 232,450 |
| Overliner Location 3 | 158,253 | 473,934 |
| Overliner Location 4 | 615,385 | 1,842,639 |

The results demonstrate that the proposed alternative liner design and overliner design meets or exceeds the requirements of Title 30 TAC §330.331(a)(1). The DAF calculated by the use of HELP and MULTIMED are well in excess of the 260 minimum criterion. The actual DAFs are expected to be substantially higher than the DAFs predicted by this modeling demonstration because the model input was conservatively estimated as discussed in previous sections of this report.

# APPENDIX A
# POINT OF COMPLIANCE FIGURES

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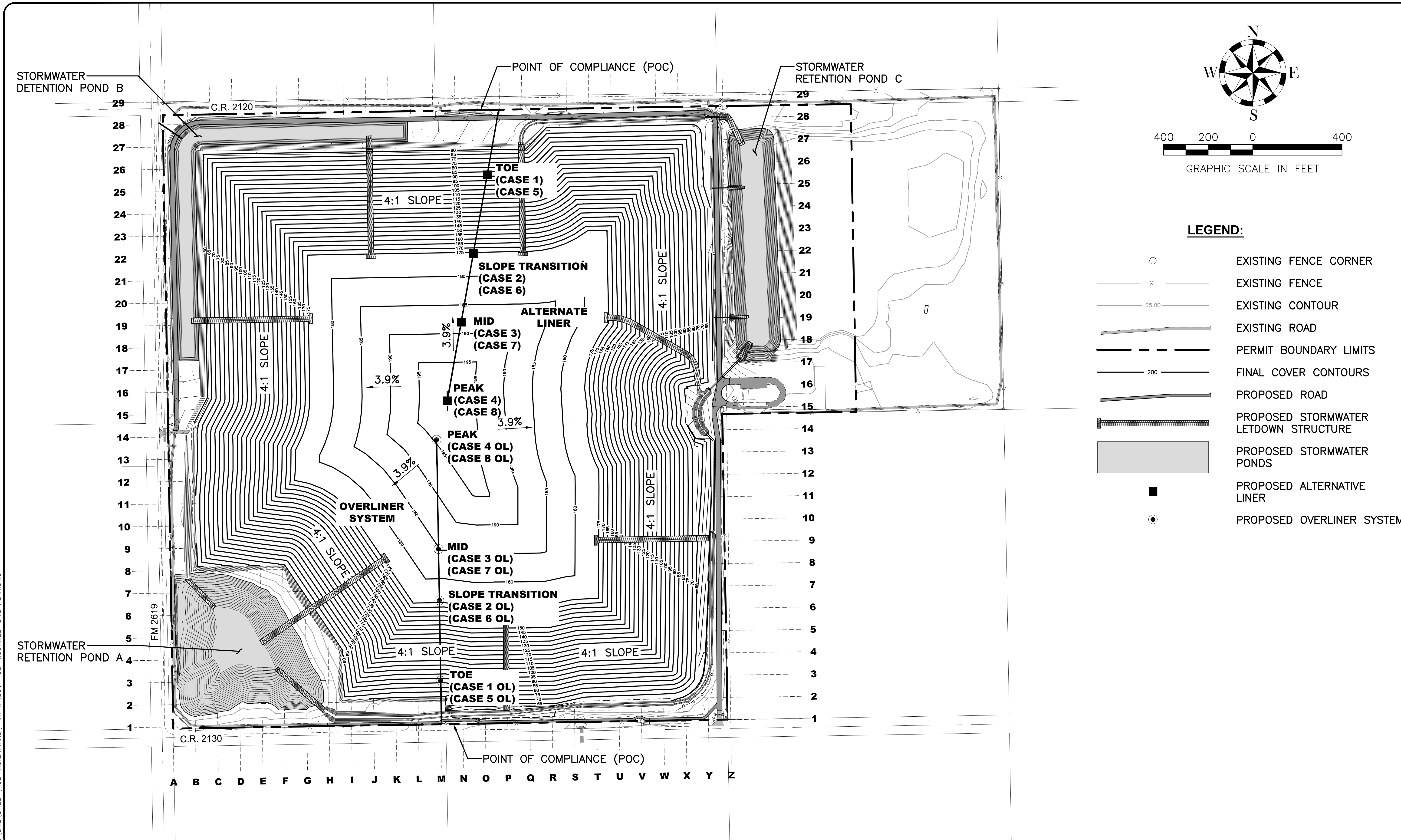


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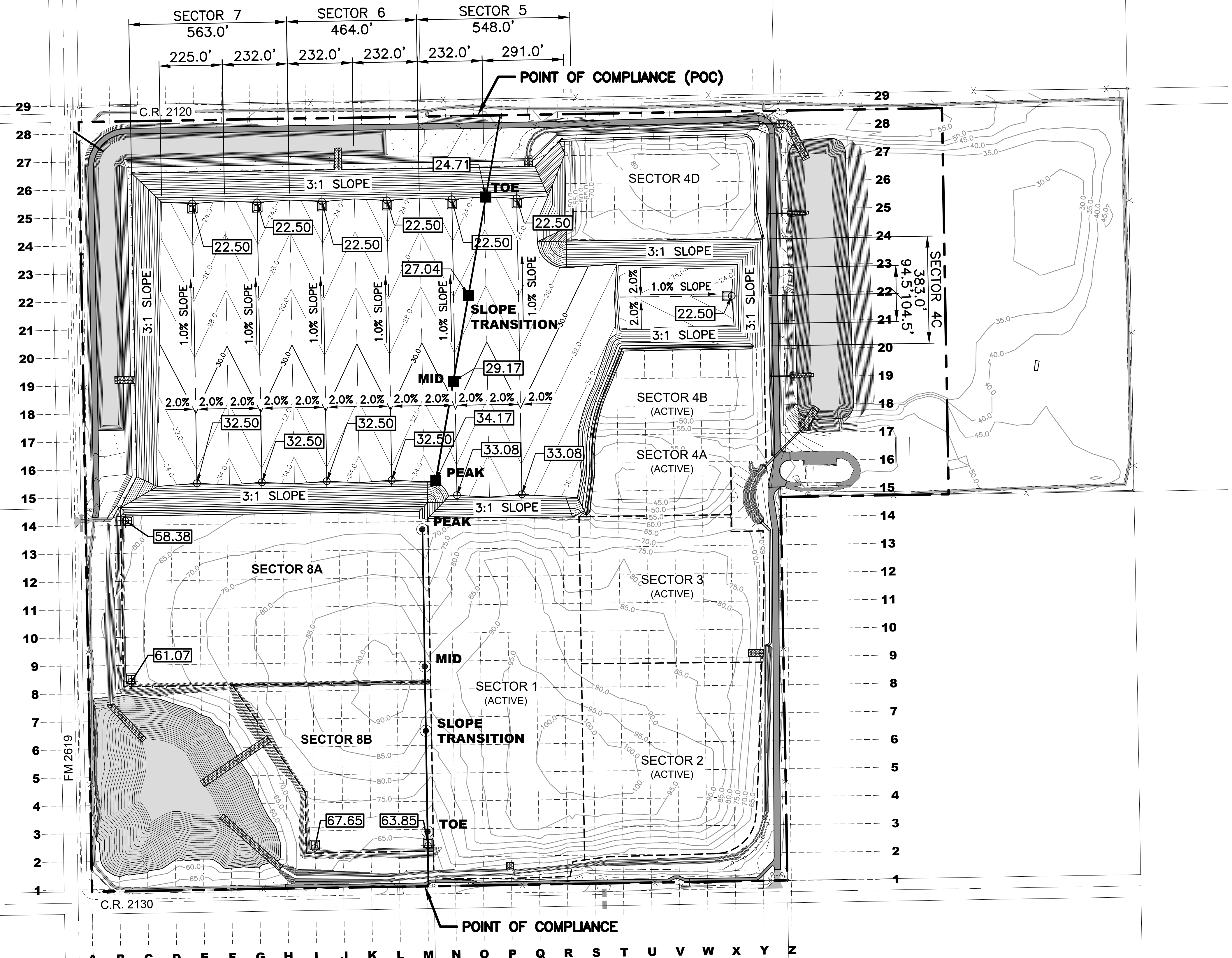
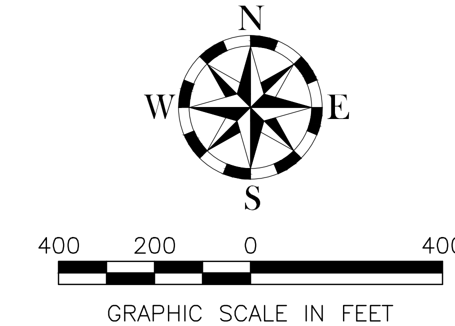
PART III, ATTACHMENT 5, APPENDIX A
LANDFILL COMPLETION SITE PLAN
CITY OF KINGSVILLE LANDFILL
MSW PERMIT No. 235-C
KINGSVILLE, TEXAS
KLEBERG COUNTY, TEXAS

FIGURE:
III.5-A.1




**LEGEND:**

- EXISTING FENCE CORNER
- EXISTING FENCE
- EXISTING CONTOUR
- EXISTING ROAD
- PERMIT BOUNDARY LIMITS
- BASE OF EXCAVATION CONTOURS
- 22.50 BASE OF EXCAVATION ELEVATION
- PROPOSED ROAD
- PROPOSED STORMWATER LETDOWN STRUCTURE
- PROPOSED STORMWATER PONDS
- PROPOSED ALTERNATIVE LINER
- PROPOSED OVERLINER

NOTE:
FUTURE SECTOR 4D (EXISTING TYPE IV SECTOR IS LINED WITH GCL, 60 MIL HDPE GEOMEMBRANE, GEOCOMPOSITE, AND 2 FT. OF PROTECTIVE COVER SOIL)

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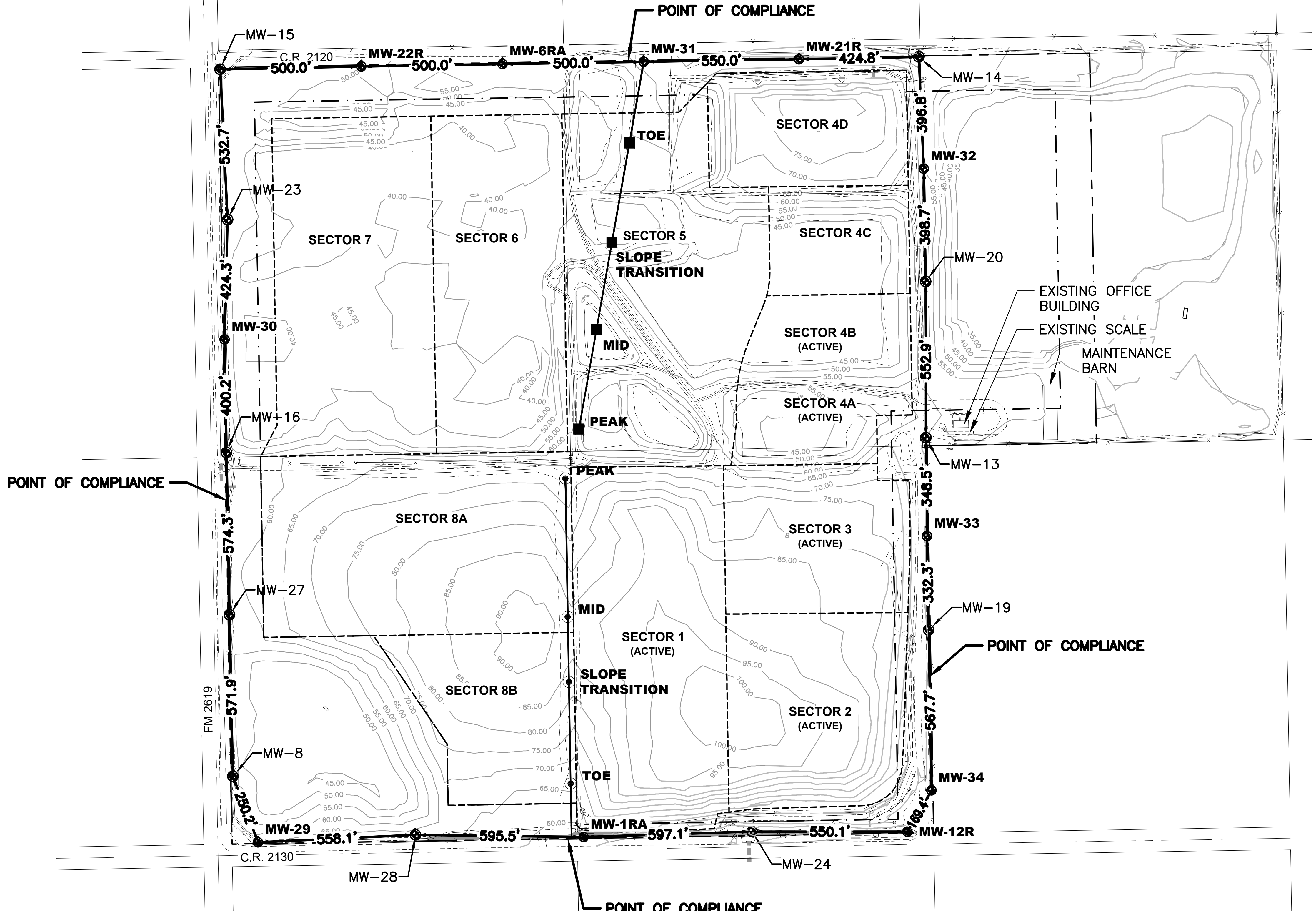
LANDFILL COMPLETION
EXCAVATION PLAN
CITY OF KINGSVILLE LANDFILL
MSW PERMIT No. 235-C
KINGSVILLE, TEXAS
KLEBERG COUNTY, TEXAS

FIGURE:
III.5-A.2

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GRAPHIC SCALE IN FEET

## LEGEND:

| | |
|---|---|
| MW-20 | MONITOR WELL LOCATION |
| | EXISTING FENCE |
| 65.00 | EXISTING SURFACE CONTOUR (2015) |
| | SECTOR OUTLINE |
| | PERMIT BOUNDARY (175.89 ACRES) |
| | BUFFER ZONE |
| 400.2' | POINT OF COMPLIANCE |
| | PROPOSED ALTERNATIVE LINER |
| | PROPOSED OVERLINER |

| SITE COORDINATES | | |
|---|---|---|
| MONITOR WELL LOCATIONS | | |
| MW | Northing | Easting |
| MW-8 | 17051473.78 | 1203673.74 |
| MW-13 | 17052672.16 | 1206127.95 |
| MW-14 | 17054020.04 | 1206103.02 |
| MW-15 | 17053976.10 | 1203628.61 |
| MW-16 | 17052619.76 | 1203651.21 |
| MW-19 | 17051991.35 | 1206137.50 |
| MW-20 | 17053225.01 | 1206127.20 |
| MW-23 | 17053444.05 | 1203654.88 |
| MW-24 | 17051277.99 | 1205512.42 |
| MW-27 | 17052045.52 | 1203661.75 |
| MW-28 | 17051266.46 | 1204320.24 |
| MW-1RA | 17051258.70 | 1204915.66 |
| MW-32 | 17053623.64 | 1206120.29 |
| MW-6RA | 17053994.38 | 1204628.44 |
| MW-12R | 17051277.38 | 1206062.51 |
| MW-21R | 17054011.48 | 1205678.30 |
| MW-22R | 17053986.24 | 1204128.51 |
| MW-29 | 17051239.92 | 1203762.81 |
| MW-30 | 17053019.90 | 1203644.60 |
| MW-31 | 17054002.53 | 1205128.38 |
| MW-33 | 17052323.65 | 1206132.04 |
| MW-34 | 17051423.79 | 1206147.64 |

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LANDFILL POINT OF COMPLIANCE LOCATIONS
CITY OF KINGSVILLE LANDFILL
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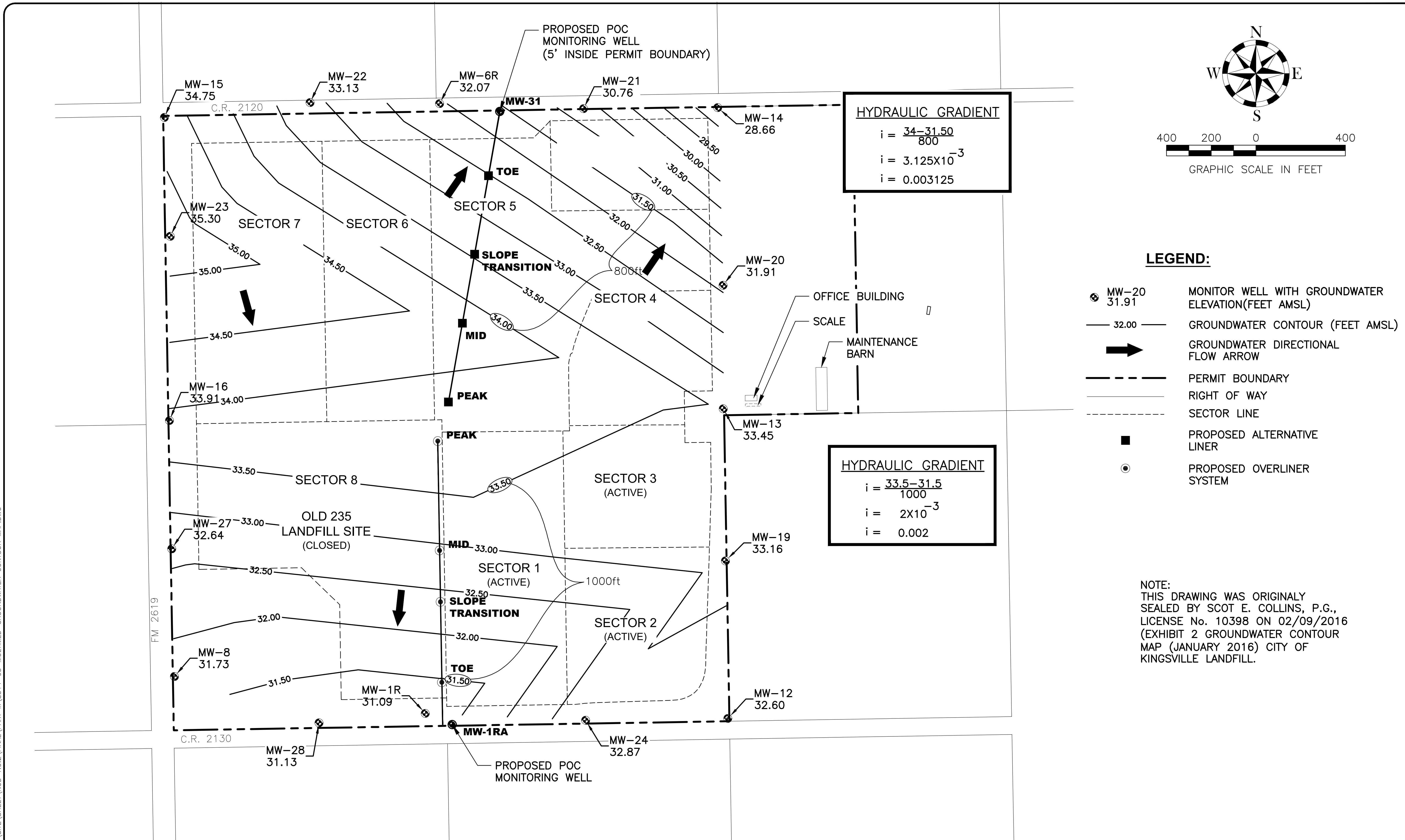
KLEBERG COUNTY, TEXAS

FIGURE:
III.5-A.3

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PART III, ATTACHMENT 5, APPENDIX A
LANDFILL GROUNDWATER CONTOUR MAP/HYDRAULIC GRADIENT
CITY OF KINGSVILLE LANDFILL
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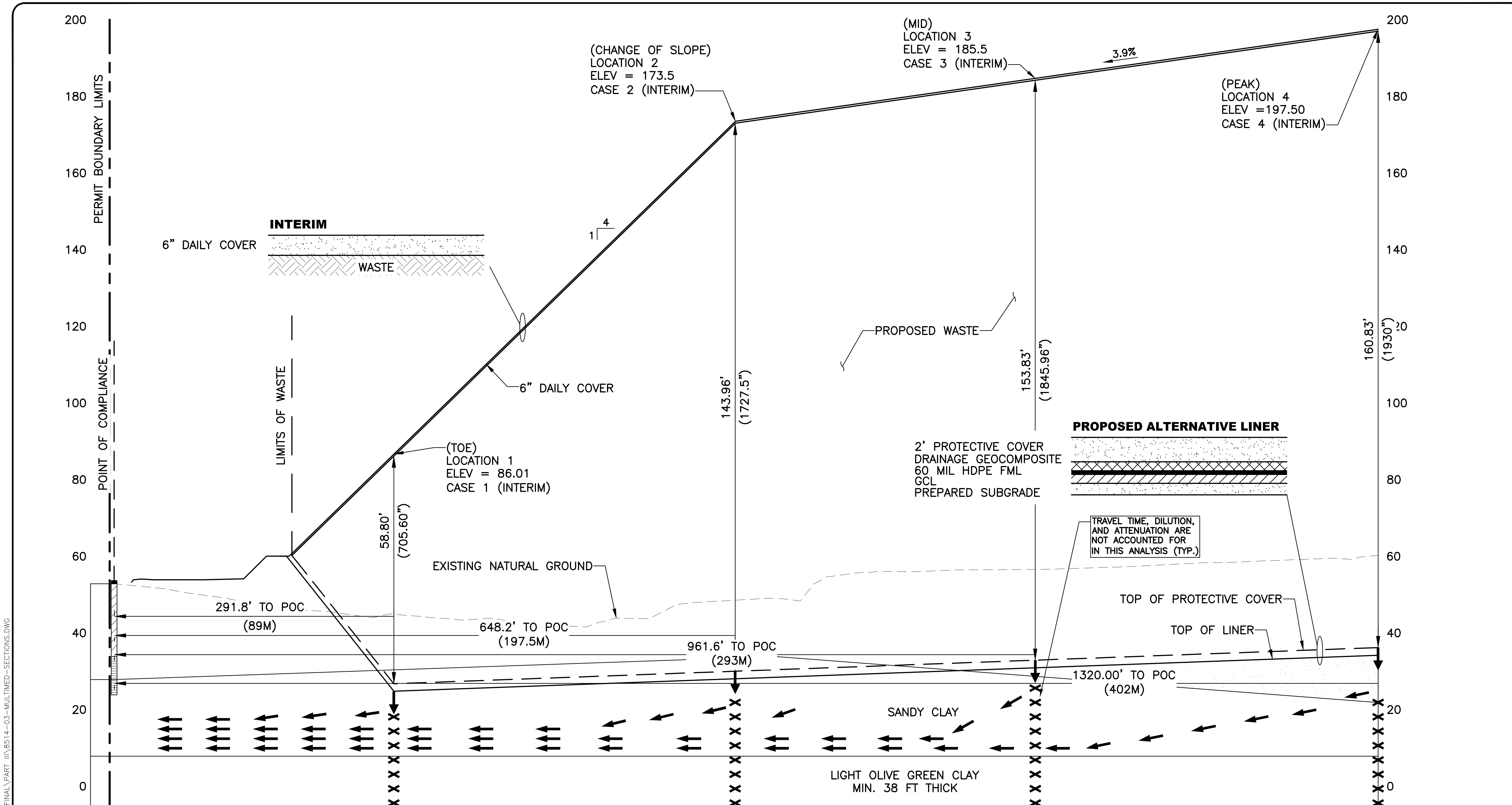
KLEBERG COUNTY, TEXAS

FIGURE:
III.5-A.4




ALTERNATIVE LINER DEMONSTRATION – INTERIM LANDFILL CONDITION

1. USE HELP TO MODEL PERCOLATION THROUGH THE ALTERNATIVE LINER.
2. USE MULTIMED TO CALCULATE THE DILUTION ATTENUATION FACTOR (DAF).

| MULTIMED INFORMATION |
|---|
| AVERAGE AQUIFER THICKNESS = 32.81FT (10M) |
| HYDRAULIC CONDUCTIVITY = $4.12 \times 10^{-4}$ CM/SEC OR 130 M/YR |
| HYDRAULIC GRADIENT = i = 0.003125 |

NOTES:

1. EVANGELINE AQUIFER (500 FT BELOW GROUND SURFACE) (FRESH)
2. CHICOT AQUIFER (220 FT BELOW GROUND SURFACE)

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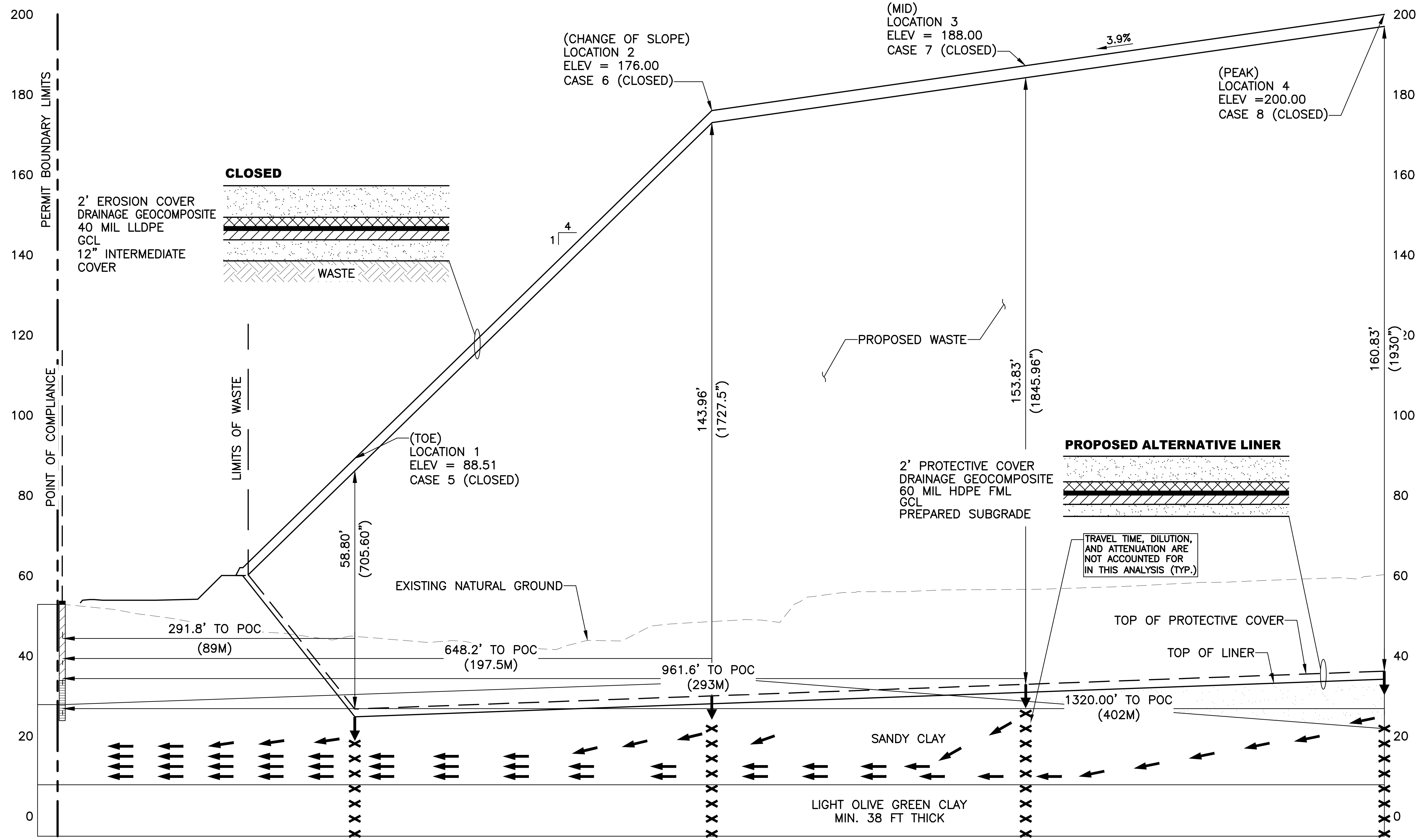
PART III, ATTACHMENT 5, APPENDIX A
LANDFILL TYPICAL PROFILE-INTERIM
LANDFILL WITH ALTERNATIVE LINER
CITY OF KINGSVILLE LANDFILL
MSW PERMIT No. 235-C
KINGSVILLE, TEXAS
KLEBERG COUNTY, TEXAS

FIGURE:
III.5-A.5




ALTERNATIVE LINER DEMONSTRATION – CLOSED LANDFILL CONDITION

1. USE HELP TO MODEL PERCOLATION THROUGH THE ALTERNATIVE LINER.
2. USE MULTIMED TO CALCULATE THE DILUTION ATTENUATION FACTOR (DAF).

MULTIMED INFORMATION

AVERAGE AQUIFER THICKNESS = 32.81FT (10M)
HYDRAULIC CONDUCTIVITY = $4.12 \times 10^{-4}$ CM/SEC OR 130 M/YR
HYDRAULIC GRADIENT = i = 0.003125

NOTES:

1. EVANGELINE AQUIFER (500 FT BELOW GROUND SURFACE) (FRESH)
2. CHICOT AQUIFER (220 FT BELOW GROUND SURFACE)

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PART III, ATTACHMENT 5, APPENDIX A
LANDFILL TYPICAL PROFILE-CLOSED LANDFILL WITH ALTERNATIVE LINER
CITY OF KINGSVILLE LANDFILL
MSW PERMIT No. 235-C
KINGSVILLE, TEXAS
KLEBERG COUNTY, TEXAS

FIGURE:
III.5-A.6

# APPENDIX B

# HELP MODEL ANALYSIS ALTERNATIVE LINER

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# APPENDIX B.1

# HELP MODEL/MULTIMED MODEL-SUMMARY OF CASES 1-8

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04/24/19

Jose C. Garza, P.E.

TBPE Firm No. F-417

Project No. 8514-3 Permit Amendment

Description: HELP Model/MULTIMED Model-Summary of Cases 1-8

Date: 3/01/17

By: JCG

**Case 1-Interim Landfill (Location 1)**- An open landfill with a Geosynthetic Clay Liner (GCL), a 60 mil HDPE Flexible Membrane Liner (FML), a Geocomposite drainage layer (Geonet), a 24 inch protective soil layer (Protective Cover),58.80 feet of waste with 250 foot drain length at 2%, and 6 inches of daily soil cover.

**Case 2-Interim Landfill (Location 2)**- An open landfill with a Geosynthetic Clay Liner (GCL), a 60 mil HDPE Flexible Membrane Liner (FML), a Geocomposite drainage layer (Geonet), a 24 inch protective soil layer (Protective Cover), 143.96 feet of waste with 500 foot drain length at 2%, and 6 inches of daily soil cover.

**Case 3-Interim Landfill (Location 3)**- An open landfill with a Geosynthetic Clay Liner (GCL), a 60 mil HDPE Flexible Membrane Liner (FML), a Geocomposite drainage layer (Geonet), a 24 inch protective soil layer (Protective Cover), 153.83 feet of waste with 500 foot drain length at 2%, and 6 inches of daily soil cover.

**Case 4-Interim Landfill (Location 4)**- An open landfill with a Geosynthetic Clay Liner (GCL), a 60 mil HDPE Flexible Membrane Liner (FML), a Geocomposite drainage layer (Geonet), a 24 inch protective soil layer (Protective Cover), 160.83 feet of waste with 500 foot drain length at 2%, and 6 inches of daily soil cover.

**Case 5-Closed Landfill (Location 1)** - A closed landfill with a Geosynthetic Clay Liner (GCL), a 60 mil HDPE Flexible Membrane Liner (FML), a Geocomposite drainage layer (Geonet), a 24 inch protective soil layer (Protective Cover), 58.80 feet of waste with 250 foot drain length at 2%, and 12 inches of intermediate cover, a GCL, a 40 mil LLDPE membrane, a Geocomposite drainage layer, and 24 inch erosion cover.

**Case 6-Closed Landfill (Location 2)**- A closed landfill with a Geosynthetic Clay Liner (GCL), a 60 mil HDPE Flexible Membrane Liner (FML), a Geocomposite drainage layer (Geonet), a 24 inch protective soil layer (Protective Cover), 143.96 feet of waste with 500 foot drain length at 2%, and 12 inches of intermediate cover, a GCL, a 40 mil LLDPE membrane, a Geocomposite drainage layer, and 24 inch erosion cover.

**Case7-Closed Landfill (Location 3)**- A closed landfill with a Geosynthetic Clay Liner (GCL), a 60 mil HDPE Flexible Membrane Liner (FML), a Geocomposite drainage layer (Geonet), a 12 inch protective soil layer (Protective Cover), 153.83 feet of waste with 500 foot drain length at 2%, and 12 inches of intermediate cover, a GCL, a 40 mil LLDPE membrane, a Geocomposite drainage layer, and 24 inch erosion cover.

**Case 8-Closed Landfill (Location 4)**- A closed landfill with a Geosynthetic Clay Liner (GCL), a 60 mil HDPE Flexible Membrane Liner (FML), a Geocomposite drainage layer (Geonet), a 24 inch protective soil layer (Protective Cover), 160.83 feet of waste with 500 foot drain length at 2%, and 12 inches of intermediate cover, a GCL, a 40 mil LLDPE membrane, a Geocomposite drainage layer, and 24 inch erosion cover.

# APPENDIX B.2

# HELP MODEL CASE SUMMARY

For Permitting Purposes Only


04/24/19

Jose C. Garza, P.E.

TBPE Firm No. F-417

## HELP MODEL CASE SUMMARY

| Case Alternative Liner | Average Precipitation (IN/YR) | Average Runoff (IN/YR) | Average Evapotranspiration (IN/YR) | Average Percolation Through Liner (CF/YR) | Peak Percolation Through Liner (CF/DAY) | *Peak Percolation Through Liner (M/YR) |
|---|---|---|---|---|---|---|
| **Interim Landfill HELP Information** | | | | | | |
| Location 1<br>• 58.80 feet of waste (Case 1) | | | | | | |
| 20 yr | 25.74 | 2.391 | 21.632 | 0.004 | 0.000050 | 1.28E-07 |
| Location 2<br>• 143.96 feet of waste (Case 2) | | | | | | |
| 20 yr | 25.74 | 2.135 | 21.716 | 0.004 | 0.00007 | 1.79E-07 |
| Location 3<br>• 153.83 feet of waste (Case 3) | | | | | | |
| 20 yr | 25.74 | 2.197 | 21.691 | 0.004 | 0.00007 | 1.79E-07 |
| Location 4<br>• 160.83 feet of waste (Case 4) | | | | | | |
| 20 yr | 25.74 | 1.907 | 21.787 | 0.005 | 0.00007 | 1.79E-07 |
| **Closed Landfill HELP Information** | | | | | | |
| Location 1<br>• 58.80 feet of waste (Case 5) | | | | | | |
| 30 yr | 27.20 | 1.880 | 21.749 | 0.001 | 0.00002 | 5.11E-08 |
| Location 2<br>• 143.96 feet of waste (Case 6) | | | | | | |
| 30 yr | 27.20 | 1.680 | 21.481 | 0.004 | 0.00002 | 5.11E-08 |
| Location 3<br>• 153.83 feet of waste (Case 7) | | | | | | |
| 30 yr | 27.20 | 1.711 | 21.470 | 0.004 | 0.00002 | 5.11E-08 |
| Location 4<br>• 160.83 feet of waste (Case 8) | | | | | | |
| 30 yr | 27.20 | 1.533 | 21.495 | 0.004 | 0.00002 | 5.11E-08 |

* Determined Using Peak Daily Percolation/Leakage Rate Through GCL and Converted to (M/YR)
Example: ((.00005 $FT^3$/Day-Acre)x(1 Acre/43,560 $FT^2$)/(1 Meter/3.28 FT)) x (365 Days/1 YR)= 1.28 x $10^{-7}$ M/YR

# APPENDIX B.3

# HELP OUTPUT FOR ALTERNATIVE LINER INTERIM CASE 1-LOCATION 1

For Permitting Purposes Only

STATE OF TEXAS
JOSE C. GARZA
91790
LICENSED
PROFESSIONAL ENGINEER

04/24/19

Jose C. Garza, P.E.

TBPE Firm No. F-417

CASE1R20.OUT

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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:\HELP3\MDATA\KGVPR20Y.D4
TEMPERATURE DATA FILE:      C:\HELP3\MDATA\KGVTE20Y.D7
SOLAR RADIATION DATA FILE:  C:\HELP3\MDATA\KGVSO20Y.D13
EVAPOTRANSPIRATION DATA:    C:\HELP3\MDATA\KGVEV20Y.D11
SOIL AND DESIGN DATA FILE:  C:\HELP3\MDATA\CASE1R.D10
OUTPUT DATA FILE:           C:\HELP3\MDATA\CASE1R20.OUT


TIME:   8:28     DATE:   4/22/2019


******************************************************************************

     TITLE:  CITY OF KINGSVILLE SOLID WASTE LANDFILL-CASE 1 (Location 1)

******************************************************************************


     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
            COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                                  LAYER  1
                                  --------

                     TYPE 1 - VERTICAL PERCOLATION LAYER
                        MATERIAL TEXTURE NUMBER  13
           THICKNESS                 =     6.00   INCHES
           POROSITY                  =     0.4300 VOL/VOL
           FIELD CAPACITY            =     0.3210 VOL/VOL
           WILTING POINT             =     0.2210 VOL/VOL
           INITIAL SOIL WATER CONTENT =    0.2393 VOL/VOL
           EFFECTIVE SAT. HYD. COND.  =  0.330000003000E-04 CM/SEC
         NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  3.00
                FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.


                                  LAYER  2
                                  --------

                     TYPE 1 - VERTICAL PERCOLATION LAYER
                        MATERIAL TEXTURE NUMBER  18
           THICKNESS                 =   705.60   INCHES
```

```
POROSITY                     =    0.6710 VOL/VOL
FIELD CAPACITY               =    0.2920 VOL/VOL
WILTING POINT                =    0.0770 VOL/VOL
INITIAL SOIL WATER CONTENT   =    0.2905 VOL/VOL
EFFECTIVE SAT. HYD. COND.    = 0.100000005000E-02 CM/SEC


                    LAYER  3
                    --------

         TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  13
THICKNESS                    =   24.00    INCHES
POROSITY                     =    0.4300 VOL/VOL
FIELD CAPACITY               =    0.3210 VOL/VOL
WILTING POINT                =    0.2210 VOL/VOL
INITIAL SOIL WATER CONTENT   =    0.3244 VOL/VOL
EFFECTIVE SAT. HYD. COND.    = 0.330000003000E-04 CM/SEC


                    LAYER  4
                    --------

           TYPE 2 - LATERAL DRAINAGE LAYER
             MATERIAL TEXTURE NUMBER  20
THICKNESS                    =    0.20    INCHES
POROSITY                     =    0.8500 VOL/VOL
FIELD CAPACITY               =    0.0100 VOL/VOL
WILTING POINT                =    0.0050 VOL/VOL
INITIAL SOIL WATER CONTENT   =    0.0152 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  10.0000000000     CM/SEC
SLOPE                        =    2.00    PERCENT
DRAINAGE LENGTH              =  250.0     FEET


                    LAYER  5
                    --------

           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     =    2.00    HOLES/ACRE
FML PLACEMENT QUALITY        = 3 - GOOD


                    LAYER  6
                    --------

             TYPE 3 - BARRIER SOIL LINER
             MATERIAL TEXTURE NUMBER  17
THICKNESS                    =    0.24    INCHES
POROSITY                     =    0.7500 VOL/VOL
FIELD CAPACITY               =    0.7470 VOL/VOL
```

CASE1R20.OUT

```
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 #13 WITH A
       FAIR STAND OF GRASS, A SURFACE SLOPE OF 25.%
       AND A SLOPE LENGTH OF  100. FEET.

SCS RUNOFF CURVE NUMBER              =     89.50
FRACTION OF AREA ALLOWING RUNOFF     =     80.0    PERCENT
AREA PROJECTED ON HORIZONTAL PLANE   =      1.000  ACRES
EVAPORATIVE ZONE DEPTH               =     12.0    INCHES
INITIAL WATER IN EVAPORATIVE ZONE    =      2.124  INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE   =      6.606  INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE   =      1.788  INCHES
INITIAL SNOW WATER                   =      0.000  INCHES
INITIAL WATER IN LAYER MATERIALS     =    214.375  INCHES
TOTAL INITIAL WATER                  =    214.375  INCHES
TOTAL SUBSURFACE INFLOW              =      0.00   INCHES/YEAR
```

EVAPOTRANSPIRATION AND WEATHER DATA

```
NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
       CORPUS CHRISTI        TEXAS

     STATION LATITUDE                           =  27.77 DEGREES
     MAXIMUM LEAF AREA INDEX                    =   2.00
     START OF GROWING SEASON (JULIAN DATE)      =      0
     END OF GROWING SEASON (JULIAN DATE)        =    367
     EVAPORATIVE ZONE DEPTH                     =  12.0  INCHES
     AVERAGE ANNUAL WIND SPEED                  =  12.00 MPH
     AVERAGE 1ST QUARTER RELATIVE HUMIDITY      =  76.00 %
     AVERAGE 2ND QUARTER RELATIVE HUMIDITY      =  78.00 %
     AVERAGE 3RD QUARTER RELATIVE HUMIDITY      =  76.00 %
     AVERAGE 4TH QUARTER RELATIVE HUMIDITY      =  76.00 %

NOTE:  PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
       COEFFICIENTS FOR     CORPUS CHRISTI       TEXAS

       NORMAL MEAN MONTHLY PRECIPITATION (INCHES)
```

| JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|
| 1.63 | 1.69 | 1.20 | 1.57 | 3.29 | 3.12 |
| 2.26 | 2.78 | 5.31 | 2.92 | 1.61 | 1.17 |

```
NOTE:  TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
       COEFFICIENTS FOR     CORPUS CHRISTI       TEXAS

     NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)
```

CASE1R20.OUT

| JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|
| 56.30 | 59.30 | 65.90 | 73.00 | 78.10 | 82.70 |
| 84.90 | 85.00 | 81.50 | 74.00 | 65.00 | 59.10 |

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR CORPUS CHRISTI TEXAS
AND STATION LATITUDE = 27.77 DEGREES

*******************************************************************************

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 20

| | JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|---|
| PRECIPITATION | | | | | | |
| TOTALS | 1.15 | 2.02 | 1.05 | 1.42 | 2.41 | 2.71 |
| | 2.43 | 2.37 | 5.38 | 2.30 | 1.33 | 1.18 |
| STD. DEVIATIONS | 0.63 | 1.18 | 0.55 | 1.20 | 1.88 | 2.04 |
| | 2.55 | 1.63 | 3.12 | 1.75 | 1.17 | 0.85 |
| RUNOFF | | | | | | |
| TOTALS | 0.015 | 0.067 | 0.006 | 0.104 | 0.281 | 0.288 |
| | 0.380 | 0.193 | 0.784 | 0.181 | 0.073 | 0.020 |
| STD. DEVIATIONS | 0.043 | 0.081 | 0.009 | 0.237 | 0.504 | 0.348 |
| | 0.817 | 0.198 | 0.914 | 0.274 | 0.212 | 0.070 |
| EVAPOTRANSPIRATION | | | | | | |
| TOTALS | 0.939 | 2.086 | 1.297 | 1.241 | 1.988 | 2.114 |
| | 2.037 | 1.875 | 3.620 | 2.256 | 1.089 | 1.091 |
| STD. DEVIATIONS | 0.543 | 0.911 | 0.701 | 0.915 | 1.322 | 1.388 |
| | 1.606 | 1.312 | 1.225 | 1.220 | 0.757 | 0.583 |
| LATERAL DRAINAGE COLLECTED FROM LAYER 4 | | | | | | |
| TOTALS | 0.0661 | 0.0208 | 0.0717 | 0.0580 | 0.0362 | 0.0534 |
| | 0.1445 | 0.1781 | 0.1018 | 0.4104 | 0.4037 | 0.1921 |
| STD. DEVIATIONS | 0.0861 | 0.0317 | 0.1423 | 0.1051 | 0.0619 | 0.1057 |
| | 0.2592 | 0.3508 | 0.2000 | 0.5929 | 0.7428 | 0.3262 |
| 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)

CASE1R20.OUT

DAILY AVERAGE HEAD ON TOP OF LAYER 5

| | | | | | | |
|---|---|---|---|---|---|---|
| AVERAGES | 0.0005 | 0.0002 | 0.0005 | 0.0004 | 0.0003 | 0.0004 |
| | 0.0010 | 0.0013 | 0.0007 | 0.0029 | 0.0030 | 0.0014 |
| STD. DEVIATIONS | 0.0006 | 0.0002 | 0.0010 | 0.0008 | 0.0004 | 0.0008 |
| | 0.0018 | 0.0025 | 0.0015 | 0.0042 | 0.0055 | 0.0023 |

*****************************************************************************

*****************************************************************************

AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 20

| | INCHES | | CU. FEET | PERCENT |
|---|---|---|---|---|
| PRECIPITATION | 25.74 | ( 5.706) | 93448.9 | 100.00 |
| RUNOFF | 2.391 | ( 1.2854) | 8679.79 | 9.288 |
| EVAPOTRANSPIRATION | 21.632 | ( 3.6809) | 78522.88 | 84.028 |
| LATERAL DRAINAGE COLLECTED FROM LAYER 4 | 1.73689 | ( 1.43661) | 6304.908 | 6.74690 |
| PERCOLATION/LEAKAGE THROUGH LAYER 6 | 0.00000 | ( 0.00000) | 0.004 | 0.00000 |
| AVERAGE HEAD ON TOP OF LAYER 5 | 0.001 | ( 0.001) | | |
| CHANGE IN WATER STORAGE | -0.016 | ( 0.5277) | -58.67 | -0.063 |

*****************************************************************************

*****************************************************************************

PEAK DAILY VALUES FOR YEARS 1 THROUGH 20

| | (INCHES) | (CU. FT.) |
|---|---|---|
| PRECIPITATION | 5.07 | 18404.102 |
| RUNOFF | 2.138 | 7761.3745 |
| DRAINAGE COLLECTED FROM LAYER 4 | 0.16413 | 595.80011 |
| PERCOLATION/LEAKAGE THROUGH LAYER 6 | 0.000000 | 0.00005 |
| AVERAGE HEAD ON TOP OF LAYER 5 | 0.036 | |
| MAXIMUM HEAD ON TOP OF LAYER 5 | 0.072 | |
| LOCATION OF MAXIMUM HEAD IN LAYER 4 (DISTANCE FROM DRAIN) | 2.7 FEET | |
| SNOW WATER | 0.00 | 0.0000 |

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.3879

CASE1R20.OUT

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.1490

*** 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 20

| LAYER | (INCHES) | (VOL/VOL) |
|---|---|---|
| 1 | 1.4211 | 0.2369 |
| 2 | 204.7451 | 0.2902 |
| 3 | 7.7040 | 0.3210 |
| 4 | 0.0020 | 0.0100 |
| 5 | 0.0000 | 0.0000 |
| 6 | 0.1800 | 0.7500 |
| SNOW WATER | 0.000 | |

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# APPENDIX B.4

# HELP OUTPUT FOR ALTERNATIVE LINER INTERIM CASE 2-LOCATION 2

For Permitting Purposes Only

STATE OF TEXAS
JOSE C. GARZA
91790
LICENSED PROFESSIONAL ENGINEER

04/24/19

Jose C. Garza, P.E.

TBPE Firm No. F-417

CASE2R20.OUT

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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:\HELP3\MDATA\KGVPR20Y.D4
TEMPERATURE DATA FILE:      C:\HELP3\MDATA\KGVTE20Y.D7
SOLAR RADIATION DATA FILE:  C:\HELP3\MDATA\KGVSO20Y.D13
EVAPOTRANSPIRATION DATA:    C:\HELP3\MDATA\KGVEV20Y.D11
SOIL AND DESIGN DATA FILE:  C:\HELP3\MDATA\CASE2R.D10
OUTPUT DATA FILE:           C:\HELP3\MDATA\CASE2R20.OUT


TIME: 15:24     DATE:  4/14/2019


****************************************************************************

     TITLE:  CITY OF KINGSVILLE SOLID WASTE LANDFILL-CASE 2 (LOCATION 2)

****************************************************************************


     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
            COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                              LAYER  1
                              --------

                 TYPE 1 - VERTICAL PERCOLATION LAYER
                      MATERIAL TEXTURE NUMBER  13
           THICKNESS                  =      6.00   INCHES
           POROSITY                   =      0.4300 VOL/VOL
           FIELD CAPACITY             =      0.3210 VOL/VOL
           WILTING POINT              =      0.2210 VOL/VOL
           INITIAL SOIL WATER CONTENT =      0.2391 VOL/VOL
           EFFECTIVE SAT. HYD. COND.  =  0.330000003000E-04 CM/SEC
         NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY   3.00
                FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.


                              LAYER  2
                              --------

                 TYPE 1 - VERTICAL PERCOLATION LAYER
                      MATERIAL TEXTURE NUMBER  18
           THICKNESS                  =   1727.50   INCHES
```

CASE2R20.OUT

```
POROSITY                     =     0.6710 VOL/VOL
FIELD CAPACITY               =     0.2920 VOL/VOL
WILTING POINT                =     0.0770 VOL/VOL
INITIAL SOIL WATER CONTENT   =     0.2914 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.100000005000E-02 CM/SEC


                  LAYER  3
                  --------

        TYPE 1 - VERTICAL PERCOLATION LAYER
           MATERIAL TEXTURE NUMBER  13
THICKNESS                    =    24.00   INCHES
POROSITY                     =     0.4300 VOL/VOL
FIELD CAPACITY               =     0.3210 VOL/VOL
WILTING POINT                =     0.2210 VOL/VOL
INITIAL SOIL WATER CONTENT   =     0.3245 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.330000003000E-04 CM/SEC


                  LAYER  4
                  --------

         TYPE 2 - LATERAL DRAINAGE LAYER
           MATERIAL TEXTURE NUMBER  20
THICKNESS                    =     0.20   INCHES
POROSITY                     =     0.8500 VOL/VOL
FIELD CAPACITY               =     0.0100 VOL/VOL
WILTING POINT                =     0.0050 VOL/VOL
INITIAL SOIL WATER CONTENT   =     0.0205 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =   10.0000000000     CM/SEC
SLOPE                        =     2.00   PERCENT
DRAINAGE LENGTH              =   500.0    FEET


                  LAYER  5
                  --------

         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     =     2.00   HOLES/ACRE
FML PLACEMENT QUALITY        =  3 - GOOD


                  LAYER  6
                  --------

          TYPE 3 - BARRIER SOIL LINER
           MATERIAL TEXTURE NUMBER  17
THICKNESS                    =     0.24   INCHES
POROSITY                     =     0.7500 VOL/VOL
FIELD CAPACITY               =     0.7470 VOL/VOL
```

CASE2R20.OUT

```
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 #13 WITH A FAIR STAND OF GRASS, A SURFACE SLOPE OF 25.% AND A SLOPE LENGTH OF 350. FEET.

```
SCS RUNOFF CURVE NUMBER              =     88.80
FRACTION OF AREA ALLOWING RUNOFF     =     80.0    PERCENT
AREA PROJECTED ON HORIZONTAL PLANE   =      1.000  ACRES
EVAPORATIVE ZONE DEPTH               =     12.0    INCHES
INITIAL WATER IN EVAPORATIVE ZONE    =      2.124  INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE   =      6.606  INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE   =      1.788  INCHES
INITIAL SNOW WATER                   =      0.000  INCHES
INITIAL WATER IN LAYER MATERIALS     =    512.775  INCHES
TOTAL INITIAL WATER                  =    512.775  INCHES
TOTAL SUBSURFACE INFLOW              =      0.00   INCHES/YEAR
```

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM CORPUS CHRISTI TEXAS

```
STATION LATITUDE                         =  27.77 DEGREES
MAXIMUM LEAF AREA INDEX                  =   2.00
START OF GROWING SEASON (JULIAN DATE)    =      0
END OF GROWING SEASON (JULIAN DATE)      =    367
EVAPORATIVE ZONE DEPTH                   =  12.0  INCHES
AVERAGE ANNUAL WIND SPEED                =  12.00 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY    =  76.00 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY    =  78.00 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY    =  76.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY    =  76.00 %
```

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR CORPUS CHRISTI TEXAS

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

| JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|
| 1.63 | 1.69 | 1.20 | 1.57 | 3.29 | 3.12 |
| 2.26 | 2.78 | 5.31 | 2.92 | 1.61 | 1.17 |

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR CORPUS CHRISTI TEXAS

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

CASE2R20.OUT

| JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|
| 56.30 | 59.30 | 65.90 | 73.00 | 78.10 | 82.70 |
| 84.90 | 85.00 | 81.50 | 74.00 | 65.00 | 59.10 |

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR CORPUS CHRISTI TEXAS
AND STATION LATITUDE = 27.77 DEGREES

*******************************************************************************

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 20

| | JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|---|
| PRECIPITATION | | | | | | |
| TOTALS | 1.15 | 2.02 | 1.05 | 1.42 | 2.41 | 2.71 |
| | 2.43 | 2.37 | 5.38 | 2.30 | 1.33 | 1.18 |
| STD. DEVIATIONS | 0.63 | 1.18 | 0.55 | 1.20 | 1.88 | 2.04 |
| | 2.55 | 1.63 | 3.12 | 1.75 | 1.17 | 0.85 |
| RUNOFF | | | | | | |
| TOTALS | 0.012 | 0.055 | 0.003 | 0.092 | 0.254 | 0.252 |
| | 0.350 | 0.170 | 0.716 | 0.149 | 0.066 | 0.016 |
| STD. DEVIATIONS | 0.037 | 0.071 | 0.006 | 0.216 | 0.479 | 0.315 |
| | 0.770 | 0.181 | 0.864 | 0.234 | 0.199 | 0.057 |
| EVAPOTRANSPIRATION | | | | | | |
| TOTALS | 0.932 | 2.093 | 1.304 | 1.251 | 1.993 | 2.128 |
| | 2.048 | 1.899 | 3.628 | 2.264 | 1.098 | 1.076 |
| STD. DEVIATIONS | 0.540 | 0.899 | 0.714 | 0.930 | 1.317 | 1.382 |
| | 1.634 | 1.319 | 1.222 | 1.208 | 0.786 | 0.592 |
| LATERAL DRAINAGE COLLECTED FROM LAYER 4 | | | | | | |
| TOTALS | 0.0715 | 0.0326 | 0.0735 | 0.0598 | 0.0433 | 0.0680 |
| | 0.1629 | 0.1994 | 0.1144 | 0.4246 | 0.4282 | 0.2293 |
| STD. DEVIATIONS | 0.0919 | 0.0521 | 0.1373 | 0.1034 | 0.0699 | 0.1461 |
| | 0.3039 | 0.4252 | 0.2386 | 0.5907 | 0.7366 | 0.4181 |
| 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)

CASE2R20.OUT

DAILY AVERAGE HEAD ON TOP OF LAYER 5

| | | | | | | |
|---|---|---|---|---|---|---|
| AVERAGES | 0.0010 | 0.0005 | 0.0010 | 0.0009 | 0.0006 | 0.0010 |
| | 0.0023 | 0.0028 | 0.0017 | 0.0060 | 0.0063 | 0.0033 |
| STD. DEVIATIONS | 0.0013 | 0.0008 | 0.0020 | 0.0015 | 0.0010 | 0.0021 |
| | 0.0043 | 0.0061 | 0.0035 | 0.0084 | 0.0108 | 0.0060 |

*******************************************************************************

*******************************************************************************

AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 20

| | INCHES | CU. FEET | PERCENT |
|---|---|---|---|
| PRECIPITATION | 25.74 ( 5.706) | 93448.9 | 100.00 |
| RUNOFF | 2.135 ( 1.1936) | 7751.57 | 8.295 |
| EVAPOTRANSPIRATION | 21.716 ( 3.6903) | 78829.24 | 84.355 |
| LATERAL DRAINAGE COLLECTED FROM LAYER 4 | 1.90751 ( 1.54779) | 6924.272 | 7.40969 |
| PERCOLATION/LEAKAGE THROUGH LAYER 6 | 0.00000 ( 0.00000) | 0.004 | 0.00000 |
| AVERAGE HEAD ON TOP OF LAYER 5 | 0.002 ( 0.002) | | |
| CHANGE IN WATER STORAGE | -0.015 ( 0.5511) | -56.18 | -0.060 |

*******************************************************************************

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 20

| | (INCHES) | (CU. FT.) |
|---|---|---|
| PRECIPITATION | 5.07 | 18404.102 |
| RUNOFF | 2.088 | 7578.4883 |
| DRAINAGE COLLECTED FROM LAYER 4 | 0.15857 | 575.60864 |
| PERCOLATION/LEAKAGE THROUGH LAYER 6 | 0.000000 | 0.00007 |
| AVERAGE HEAD ON TOP OF LAYER 5 | 0.070 | |
| MAXIMUM HEAD ON TOP OF LAYER 5 | 0.139 | |
| LOCATION OF MAXIMUM HEAD IN LAYER 4 (DISTANCE FROM DRAIN) | 2.3 FEET | |
| SNOW WATER | 0.00 | 0.0000 |
| MAXIMUM VEG. SOIL WATER (VOL/VOL) | 0.3901 | |

CASE2R20.OUT

```
MINIMUM VEG. SOIL WATER (VOL/VOL)                0.1490

 ***  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   20
 ----------------------------------------------------------------------
               LAYER         (INCHES)       (VOL/VOL)
               -----         --------       ---------
                 1             1.4393         0.2399

                 2           503.1399         0.2913

                 3             7.7040         0.3210

                 4             0.0020         0.0100

                 5             0.0000         0.0000

                 6             0.1800         0.7500

             SNOW WATER        0.000

******************************************************************************
******************************************************************************
```

# APPENDIX B.5

# HELP OUTPUT FOR ALTERNATIVE LINER INTERIM CASE 3-LOCATION 3

For Permitting Purposes Only

STATE OF TEXAS
JOSE C. GARZA
91790
LICENSED
PROFESSIONAL ENGINEER

04/24/19

Jose C. Garza, P.E.

TBPE Firm No. F-417

CASE3R20.OUT

```
******************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
**              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:\HELP3\MDATA\KGVPR20Y.D4
TEMPERATURE DATA FILE:       C:\HELP3\MDATA\KGVTE20Y.D7
SOLAR RADIATION DATA FILE:   C:\HELP3\MDATA\KGVSO20Y.D13
EVAPOTRANSPIRATION DATA:     C:\HELP3\MDATA\KGVEV20Y.D11
SOIL AND DESIGN DATA FILE:   C:\HELP3\MDATA\CASE3R.D10
OUTPUT DATA FILE:            C:\HELP3\MDATA\CASE3R20.OUT


TIME:   8:37     DATE:   4/22/2019


******************************************************************************

     TITLE:  CITY OF KINGSVILLE SOLID WASTE LANDFILL-CASE 3 (LOCATION 3)

******************************************************************************


     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
            COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                                 LAYER  1
                                 --------

                       TYPE 1 - VERTICAL PERCOLATION LAYER
                          MATERIAL TEXTURE NUMBER  13
          THICKNESS                  =      6.00   INCHES
          POROSITY                   =      0.4300 VOL/VOL
          FIELD CAPACITY             =      0.3210 VOL/VOL
          WILTING POINT              =      0.2210 VOL/VOL
          INITIAL SOIL WATER CONTENT =      0.2391 VOL/VOL
          EFFECTIVE SAT. HYD. COND.  =  0.330000003000E-04 CM/SEC
        NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  3.00
               FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.


                                 LAYER  2
                                 --------

                       TYPE 1 - VERTICAL PERCOLATION LAYER
                          MATERIAL TEXTURE NUMBER  18
          THICKNESS                  =   1845.90   INCHES
```

CASE3R20.OUT

```
POROSITY                      =      0.6710 VOL/VOL
FIELD CAPACITY                =      0.2920 VOL/VOL
WILTING POINT                 =      0.0770 VOL/VOL
INITIAL SOIL WATER CONTENT    =      0.2914 VOL/VOL
EFFECTIVE SAT. HYD. COND.     =  0.100000005000E-02 CM/SEC


                    LAYER  3
                    --------

        TYPE 1 - VERTICAL PERCOLATION LAYER
            MATERIAL TEXTURE NUMBER  13
THICKNESS                     =     24.00   INCHES
POROSITY                      =      0.4300 VOL/VOL
FIELD CAPACITY                =      0.3210 VOL/VOL
WILTING POINT                 =      0.2210 VOL/VOL
INITIAL SOIL WATER CONTENT    =      0.3245 VOL/VOL
EFFECTIVE SAT. HYD. COND.     =  0.330000003000E-04 CM/SEC


                    LAYER  4
                    --------

          TYPE 2 - LATERAL DRAINAGE LAYER
            MATERIAL TEXTURE NUMBER  20
THICKNESS                     =      0.20   INCHES
POROSITY                      =      0.8500 VOL/VOL
FIELD CAPACITY                =      0.0100 VOL/VOL
WILTING POINT                 =      0.0050 VOL/VOL
INITIAL SOIL WATER CONTENT    =      0.0205 VOL/VOL
EFFECTIVE SAT. HYD. COND.     =   10.0000000000     CM/SEC
SLOPE                         =      2.00   PERCENT
DRAINAGE LENGTH               =    500.0    FEET


                    LAYER  5
                    --------

          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      =      2.00   HOLES/ACRE
FML PLACEMENT QUALITY         =  3 - GOOD


                    LAYER  6
                    --------

            TYPE 3 - BARRIER SOIL LINER
            MATERIAL TEXTURE NUMBER  17
THICKNESS                     =      0.24   INCHES
POROSITY                      =      0.7500 VOL/VOL
FIELD CAPACITY                =      0.7470 VOL/VOL
```

Page 2

CASE3R20.OUT

```
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 #13 WITH A
FAIR STAND OF GRASS, A SURFACE SLOPE OF 12.%
AND A SLOPE LENGTH OF 200. FEET.

```
SCS RUNOFF CURVE NUMBER            =     89.00
FRACTION OF AREA ALLOWING RUNOFF   =     80.0    PERCENT
AREA PROJECTED ON HORIZONTAL PLANE =      1.000  ACRES
EVAPORATIVE ZONE DEPTH             =     12.0    INCHES
INITIAL WATER IN EVAPORATIVE ZONE  =      2.124  INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE =      6.606  INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE =      1.788  INCHES
INITIAL SNOW WATER                 =      0.000  INCHES
INITIAL WATER IN LAYER MATERIALS   =    547.348  INCHES
TOTAL INITIAL WATER                =    547.348  INCHES
TOTAL SUBSURFACE INFLOW            =      0.00   INCHES/YEAR
```

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
CORPUS CHRISTI TEXAS

```
STATION LATITUDE                         =  27.77 DEGREES
MAXIMUM LEAF AREA INDEX                  =   2.00
START OF GROWING SEASON (JULIAN DATE)    =     0
END OF GROWING SEASON (JULIAN DATE)      =   367
EVAPORATIVE ZONE DEPTH                   =  12.0  INCHES
AVERAGE ANNUAL WIND SPEED                =  12.00 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY    =  76.00 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY    =  78.00 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY    =  76.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY    =  76.00 %
```

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR CORPUS CHRISTI TEXAS

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

| JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|
| 1.63 | 1.69 | 1.20 | 1.57 | 3.29 | 3.12 |
| 2.26 | 2.78 | 5.31 | 2.92 | 1.61 | 1.17 |

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR CORPUS CHRISTI TEXAS

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

CASE3R20.OUT

| JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|
| 56.30 | 59.30 | 65.90 | 73.00 | 78.10 | 82.70 |
| 84.90 | 85.00 | 81.50 | 74.00 | 65.00 | 59.10 |

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR CORPUS CHRISTI TEXAS
AND STATION LATITUDE = 27.77 DEGREES

*******************************************************************************

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 20

| | JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|---|
| **PRECIPITATION** | | | | | | |
| TOTALS | 1.15 | 2.02 | 1.05 | 1.42 | 2.41 | 2.71 |
| | 2.43 | 2.37 | 5.38 | 2.30 | 1.33 | 1.18 |
| STD. DEVIATIONS | 0.63 | 1.18 | 0.55 | 1.20 | 1.88 | 2.04 |
| | 2.55 | 1.63 | 3.12 | 1.75 | 1.17 | 0.85 |
| **RUNOFF** | | | | | | |
| TOTALS | 0.013 | 0.058 | 0.004 | 0.095 | 0.261 | 0.260 |
| | 0.358 | 0.176 | 0.733 | 0.155 | 0.067 | 0.017 |
| STD. DEVIATIONS | 0.038 | 0.074 | 0.007 | 0.221 | 0.486 | 0.324 |
| | 0.783 | 0.186 | 0.879 | 0.241 | 0.202 | 0.058 |
| **EVAPOTRANSPIRATION** | | | | | | |
| TOTALS | 0.931 | 2.093 | 1.302 | 1.250 | 1.993 | 2.121 |
| | 2.045 | 1.896 | 3.629 | 2.258 | 1.099 | 1.074 |
| STD. DEVIATIONS | 0.537 | 0.898 | 0.710 | 0.928 | 1.312 | 1.384 |
| | 1.629 | 1.315 | 1.227 | 1.202 | 0.786 | 0.593 |
| **LATERAL DRAINAGE COLLECTED FROM LAYER 4** | | | | | | |
| TOTALS | 0.0691 | 0.0358 | 0.0747 | 0.0581 | 0.0416 | 0.0640 |
| | 0.1587 | 0.1953 | 0.1104 | 0.4155 | 0.4199 | 0.2281 |
| STD. DEVIATIONS | 0.0917 | 0.0545 | 0.1437 | 0.1048 | 0.0686 | 0.1397 |
| | 0.2949 | 0.4190 | 0.2386 | 0.5824 | 0.7312 | 0.4168 |
| **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)

CASE3R20.OUT

DAILY AVERAGE HEAD ON TOP OF LAYER 5

| | | | | | | |
|---|---|---|---|---|---|---|
| AVERAGES | 0.0010 | 0.0006 | 0.0011 | 0.0009 | 0.0006 | 0.0009 |
| | 0.0023 | 0.0028 | 0.0016 | 0.0059 | 0.0062 | 0.0032 |
| STD. DEVIATIONS | 0.0013 | 0.0009 | 0.0020 | 0.0015 | 0.0010 | 0.0021 |
| | 0.0042 | 0.0060 | 0.0035 | 0.0083 | 0.0108 | 0.0059 |

*******************************************************************************

*******************************************************************************

AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 20

| | INCHES | CU. FEET | PERCENT |
|---|---|---|---|
| PRECIPITATION | 25.74 ( 5.706) | 93448.9 | 100.00 |
| RUNOFF | 2.197 ( 1.2161) | 7975.32 | 8.534 |
| EVAPOTRANSPIRATION | 21.691 ( 3.6830) | 78736.87 | 84.257 |
| LATERAL DRAINAGE COLLECTED FROM LAYER 4 | 1.87134 ( 1.53422) | 6792.958 | 7.26917 |
| PERCOLATION/LEAKAGE THROUGH LAYER 6 | 0.00000 ( 0.00000) | 0.004 | 0.00000 |
| AVERAGE HEAD ON TOP OF LAYER 5 | 0.002 ( 0.002) | | |
| CHANGE IN WATER STORAGE | -0.015 ( 0.5521) | -56.24 | -0.060 |

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 20

| | (INCHES) | (CU. FT.) |
|---|---|---|
| PRECIPITATION | 5.07 | 18404.102 |
| RUNOFF | 2.106 | 7646.4312 |
| DRAINAGE COLLECTED FROM LAYER 4 | 0.16188 | 587.61462 |
| PERCOLATION/LEAKAGE THROUGH LAYER 6 | 0.000000 | 0.00007 |
| AVERAGE HEAD ON TOP OF LAYER 5 | 0.071 | |
| MAXIMUM HEAD ON TOP OF LAYER 5 | 0.142 | |
| LOCATION OF MAXIMUM HEAD IN LAYER 4 (DISTANCE FROM DRAIN) | 1.9 FEET | |
| SNOW WATER | 0.00 | 0.0000 |

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.3893

CASE3R20.OUT

```
MINIMUM VEG. SOIL WATER (VOL/VOL)              0.1490

 ***  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 20

| LAYER | (INCHES) | (VOL/VOL) |
|---|---|---|
| 1 | 1.4394 | 0.2399 |
| 2 | 537.7128 | 0.2913 |
| 3 | 7.7040 | 0.3210 |
| 4 | 0.0020 | 0.0100 |
| 5 | 0.0000 | 0.0000 |
| 6 | 0.1800 | 0.7500 |
| SNOW WATER | 0.000 | |

```
*******************************************************************************
*******************************************************************************
```

# APPENDIX B.6

# HELP OUTPUT FOR ALTERNATIVE LINER INTERIM CASE 4-LOCATION 4

For Permitting Purposes Only

STATE OF TEXAS
JOSE C. GARZA
91790
LICENSED
PROFESSIONAL ENGINEER

04/24/19

Jose C. Garza, P.E.

TBPE Firm No. F-417

CASE4R20.OUT

```
******************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
**              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:\HELP3\MDATA\KGVPR20Y.D4
TEMPERATURE DATA FILE:       C:\HELP3\MDATA\KGVTE20Y.D7
SOLAR RADIATION DATA FILE:   C:\HELP3\MDATA\KGVSO20Y.D13
EVAPOTRANSPIRATION DATA:     C:\HELP3\MDATA\KGVEV20Y.D11
SOIL AND DESIGN DATA FILE:   C:\HELP3\MDATA\CASE4R.D10
OUTPUT DATA FILE:            C:\HELP3\MDATA\CASE4R20.OUT


TIME:  15:39     DATE:   4/14/2019


******************************************************************************

     TITLE:  CITY OF KINGSVILLE SOLID WASTE LANDFILL-CASE 4 (LOCATION 4)

******************************************************************************


     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                                 LAYER  1
                                 --------

                    TYPE 1 - VERTICAL PERCOLATION LAYER
                       MATERIAL TEXTURE NUMBER  13
           THICKNESS                  =      6.00   INCHES
           POROSITY                   =      0.4300 VOL/VOL
           FIELD CAPACITY             =      0.3210 VOL/VOL
           WILTING POINT              =      0.2210 VOL/VOL
           INITIAL SOIL WATER CONTENT =      0.2210 VOL/VOL
           EFFECTIVE SAT. HYD. COND.  =  0.330000003000E-04 CM/SEC
         NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  3.00
                FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.


                                 LAYER  2
                                 --------

                    TYPE 1 - VERTICAL PERCOLATION LAYER
                       MATERIAL TEXTURE NUMBER  18
           THICKNESS                  =   1930.00   INCHES
```

```
                                    CASE4R20.OUT
POROSITY                         =       0.6710 VOL/VOL
FIELD CAPACITY                   =       0.2920 VOL/VOL
WILTING POINT                    =       0.0770 VOL/VOL
INITIAL SOIL WATER CONTENT       =       0.2914 VOL/VOL
EFFECTIVE SAT. HYD. COND.        =   0.100000005000E-02 CM/SEC


                       LAYER  3
                       --------

           TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  13
THICKNESS                        =      24.00    INCHES
POROSITY                         =       0.4300 VOL/VOL
FIELD CAPACITY                   =       0.3210 VOL/VOL
WILTING POINT                    =       0.2210 VOL/VOL
INITIAL SOIL WATER CONTENT       =       0.3246 VOL/VOL
EFFECTIVE SAT. HYD. COND.        =   0.330000003000E-04 CM/SEC


                       LAYER  4
                       --------

              TYPE 2 - LATERAL DRAINAGE LAYER
              MATERIAL TEXTURE NUMBER  20
THICKNESS                        =       0.20    INCHES
POROSITY                         =       0.8500 VOL/VOL
FIELD CAPACITY                   =       0.0100 VOL/VOL
WILTING POINT                    =       0.0050 VOL/VOL
INITIAL SOIL WATER CONTENT       =       0.0206 VOL/VOL
EFFECTIVE SAT. HYD. COND.        =    10.0000000000      CM/SEC
SLOPE                            =       2.00    PERCENT
DRAINAGE LENGTH                  =     500.0     FEET


                       LAYER  5
                       --------

              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         =       2.00    HOLES/ACRE
FML PLACEMENT QUALITY            =   3 - GOOD


                       LAYER  6
                       --------

               TYPE 3 - BARRIER SOIL LINER
               MATERIAL TEXTURE NUMBER  17
THICKNESS                        =       0.24    INCHES
POROSITY                         =       0.7500 VOL/VOL
FIELD CAPACITY                   =       0.7470 VOL/VOL
                                                  Page 2
```

CASE4R20.OUT

```
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 #13 WITH A FAIR STAND OF GRASS, A SURFACE SLOPE OF 4.% AND A SLOPE LENGTH OF 600. FEET.

```
SCS RUNOFF CURVE NUMBER            =    88.00
FRACTION OF AREA ALLOWING RUNOFF   =    80.0    PERCENT
AREA PROJECTED ON HORIZONTAL PLANE =     1.000  ACRES
EVAPORATIVE ZONE DEPTH             =    12.0    INCHES
INITIAL WATER IN EVAPORATIVE ZONE  =     1.920  INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE =     6.606  INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE =     1.788  INCHES
INITIAL SNOW WATER                 =     0.000  INCHES
INITIAL WATER IN LAYER MATERIALS   =   571.702  INCHES
TOTAL INITIAL WATER                =   571.702  INCHES
TOTAL SUBSURFACE INFLOW            =     0.00   INCHES/YEAR
```

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM CORPUS CHRISTI TEXAS

```
STATION LATITUDE                          = 27.77 DEGREES
MAXIMUM LEAF AREA INDEX                   =  2.00
START OF GROWING SEASON (JULIAN DATE)     =     0
END OF GROWING SEASON (JULIAN DATE)       =   367
EVAPORATIVE ZONE DEPTH                    = 12.0  INCHES
AVERAGE ANNUAL WIND SPEED                 = 12.00 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY     = 76.00 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY     = 78.00 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY     = 76.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY     = 76.00 %
```

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR CORPUS CHRISTI TEXAS

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

| JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|
| 1.63 | 1.69 | 1.20 | 1.57 | 3.29 | 3.12 |
| 2.26 | 2.78 | 5.31 | 2.92 | 1.61 | 1.17 |

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR CORPUS CHRISTI TEXAS

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

CASE4R20.OUT

| JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|
| 56.30 | 59.30 | 65.90 | 73.00 | 78.10 | 82.70 |
| 84.90 | 85.00 | 81.50 | 74.00 | 65.00 | 59.10 |

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR CORPUS CHRISTI TEXAS
AND STATION LATITUDE = 27.77 DEGREES

*******************************************************************************

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 20

| | JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|---|
| PRECIPITATION | | | | | | |
| TOTALS | 1.15 | 2.02 | 1.05 | 1.42 | 2.41 | 2.71 |
| | 2.43 | 2.37 | 5.38 | 2.30 | 1.33 | 1.18 |
| STD. DEVIATIONS | 0.63 | 1.18 | 0.55 | 1.20 | 1.88 | 2.04 |
| | 2.55 | 1.63 | 3.12 | 1.75 | 1.17 | 0.85 |
| RUNOFF | | | | | | |
| TOTALS | 0.010 | 0.044 | 0.002 | 0.080 | 0.229 | 0.222 |
| | 0.322 | 0.145 | 0.650 | 0.131 | 0.058 | 0.013 |
| STD. DEVIATIONS | 0.032 | 0.059 | 0.004 | 0.198 | 0.452 | 0.284 |
| | 0.721 | 0.160 | 0.809 | 0.208 | 0.182 | 0.047 |
| EVAPOTRANSPIRATION | | | | | | |
| TOTALS | 0.926 | 2.091 | 1.307 | 1.259 | 2.002 | 2.140 |
| | 2.063 | 1.908 | 3.649 | 2.262 | 1.101 | 1.080 |
| STD. DEVIATIONS | 0.553 | 0.908 | 0.722 | 0.938 | 1.315 | 1.392 |
| | 1.651 | 1.324 | 1.215 | 1.209 | 0.795 | 0.582 |
| LATERAL DRAINAGE COLLECTED FROM LAYER 4 | | | | | | |
| TOTALS | 0.0726 | 0.0392 | 0.0796 | 0.0589 | 0.0482 | 0.0756 |
| | 0.1774 | 0.2167 | 0.1255 | 0.4498 | 0.4595 | 0.2523 |
| STD. DEVIATIONS | 0.0955 | 0.0557 | 0.1545 | 0.1063 | 0.0799 | 0.1563 |
| | 0.3182 | 0.4582 | 0.2771 | 0.6084 | 0.7550 | 0.4586 |
| 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)

CASE4R20.OUT

DAILY AVERAGE HEAD ON TOP OF LAYER 5

| | | | | | | |
|---|---|---|---|---|---|---|
| AVERAGES | 0.0010 | 0.0006 | 0.0011 | 0.0009 | 0.0007 | 0.0011 |
| | 0.0025 | 0.0031 | 0.0018 | 0.0064 | 0.0068 | 0.0036 |
| STD. DEVIATIONS | 0.0014 | 0.0009 | 0.0022 | 0.0016 | 0.0011 | 0.0023 |
| | 0.0045 | 0.0065 | 0.0041 | 0.0087 | 0.0111 | 0.0065 |

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 20

| | INCHES | CU. FEET | PERCENT |
|---|---|---|---|
| PRECIPITATION | 25.74 ( 5.706) | 93448.9 | 100.00 |
| RUNOFF | 1.907 ( 1.1083) | 6921.00 | 7.406 |
| EVAPOTRANSPIRATION | 21.787 ( 3.6980) | 79085.98 | 84.630 |
| LATERAL DRAINAGE COLLECTED FROM LAYER 4 | 2.05535 ( 1.61445) | 7460.923 | 7.98396 |
| PERCOLATION/LEAKAGE THROUGH LAYER 6 | 0.00000 ( 0.00000) | 0.005 | 0.00000 |
| AVERAGE HEAD ON TOP OF LAYER 5 | 0.002 ( 0.002) | | |
| CHANGE IN WATER STORAGE | -0.005 ( 0.5759) | -18.99 | -0.020 |

*******************************************************************************

*******************************************************************************

PEAK DAILY VALUES FOR YEARS 1 THROUGH 20

| | (INCHES) | (CU. FT.) |
|---|---|---|
| PRECIPITATION | 5.07 | 18404.102 |
| RUNOFF | 2.016 | 7318.0361 |
| DRAINAGE COLLECTED FROM LAYER 4 | 0.16119 | 585.10394 |
| PERCOLATION/LEAKAGE THROUGH LAYER 6 | 0.000000 | 0.00007 |
| AVERAGE HEAD ON TOP OF LAYER 5 | 0.071 | |
| MAXIMUM HEAD ON TOP OF LAYER 5 | 0.142 | |
| LOCATION OF MAXIMUM HEAD IN LAYER 4 (DISTANCE FROM DRAIN) | 1.6 FEET | |
| SNOW WATER | 0.00 | 0.0000 |

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.3947

CASE4R20.OUT

```
MINIMUM VEG. SOIL WATER (VOL/VOL)                  0.1490

 ***  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   20
   ----------------------------------------------------------------------
               LAYER         (INCHES)        (VOL/VOL)
               -----         --------        ---------
                 1            1.4410           0.2402

                 2          562.2700           0.2913

                 3            7.7040           0.3210

                 4            0.0020           0.0100

                 5            0.0000           0.0000

                 6            0.1800           0.7500

              SNOW WATER      0.000

******************************************************************************
******************************************************************************
```

# APPENDIX B.7

# HELP OUTPUT FOR ALTERNATIVE LINER CLOSED CASE 5-LOCATION 1

For Permitting Purposes Only


04/24/19

Jose C. Garza, P.E.

TBPE Firm No. F-417

CASE5R30.OUT

```
******************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
**              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:\HELP3\MDATA\KGVPR30Y.D4
TEMPERATURE DATA FILE:       C:\HELP3\MDATA\KGVTE30Y.D7
SOLAR RADIATION DATA FILE:   C:\HELP3\MDATA\KGVSO30Y.D13
EVAPOTRANSPIRATION DATA:     C:\HELP3\MDATA\KGVEV30Y.D11
SOIL AND DESIGN DATA FILE:   C:\HELP3\MDATA\CASE5R.D10
OUTPUT DATA FILE:            C:\HELP3\MDATA\CASE5R30.OUT


TIME:   8:47     DATE:   4/22/2019


******************************************************************************

     TITLE:  CITY OF KINGSVILLE SOLID WASTE LANDFILL-CASE 5 (LOCATION 1)

******************************************************************************


     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
            COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                                  LAYER  1
                                  --------

                   TYPE 1 - VERTICAL PERCOLATION LAYER
                        MATERIAL TEXTURE NUMBER  13
          THICKNESS                 =     24.00    INCHES
          POROSITY                  =      0.4300 VOL/VOL
          FIELD CAPACITY            =      0.3210 VOL/VOL
          WILTING POINT             =      0.2210 VOL/VOL
          INITIAL SOIL WATER CONTENT =     0.2719 VOL/VOL
          EFFECTIVE SAT. HYD. COND.  =  0.330000003000E-04 CM/SEC
        NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  4.63
               FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.


                                  LAYER  2
                                  --------

                     TYPE 2 - LATERAL DRAINAGE LAYER
                        MATERIAL TEXTURE NUMBER  20
          THICKNESS                 =      0.20    INCHES
```

Page 1

CASE5R30.OUT

```
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.     =   10.0000000000     CM/SEC
SLOPE                         =      2.00   PERCENT
DRAINAGE LENGTH               =    250.0    FEET


                 LAYER  3
                 --------

          TYPE 4 - FLEXIBLE MEMBRANE LINER
            MATERIAL TEXTURE NUMBER  36
THICKNESS                     =      0.04   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.     =  0.399999993000E-12 CM/SEC
FML PINHOLE DENSITY           =      1.00   HOLES/ACRE
FML INSTALLATION DEFECTS      =      2.00   HOLES/ACRE
FML PLACEMENT QUALITY         =  3 - GOOD


                 LAYER  4
                 --------

            TYPE 3 - BARRIER SOIL LINER
            MATERIAL TEXTURE NUMBER  17
THICKNESS                     =      0.24   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


                 LAYER  5
                 --------

         TYPE 1 - VERTICAL PERCOLATION LAYER
            MATERIAL TEXTURE NUMBER  13
THICKNESS                     =     12.00   INCHES
POROSITY                      =      0.4300 VOL/VOL
FIELD CAPACITY                =      0.3210 VOL/VOL
WILTING POINT                 =      0.2210 VOL/VOL
INITIAL SOIL WATER CONTENT    =      0.3210 VOL/VOL
EFFECTIVE SAT. HYD. COND.     =  0.330000003000E-04 CM/SEC


                 LAYER  6
                 --------

         TYPE 1 - VERTICAL PERCOLATION LAYER
            MATERIAL TEXTURE NUMBER  18
THICKNESS                     =    705.60   INCHES
POROSITY                      =      0.6710 VOL/VOL
FIELD CAPACITY                =      0.2920 VOL/VOL
```

Page 2

CASE5R30.OUT

```
WILTING POINT              =      0.0770 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.2920 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  0.100000005000E-02 CM/SEC


                     LAYER  7
                     --------

         TYPE 1 - VERTICAL PERCOLATION LAYER
            MATERIAL TEXTURE NUMBER  13
THICKNESS                  =     24.00   INCHES
POROSITY                   =      0.4300 VOL/VOL
FIELD CAPACITY             =      0.3210 VOL/VOL
WILTING POINT              =      0.2210 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.3210 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  0.330000003000E-04 CM/SEC


                     LAYER  8
                     --------

          TYPE 2 - LATERAL DRAINAGE LAYER
            MATERIAL TEXTURE NUMBER  20
THICKNESS                  =      0.20   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.  =   10.0000000000     CM/SEC
SLOPE                      =      2.00   PERCENT
DRAINAGE LENGTH            =    250.0    FEET


                     LAYER  9
                     --------

          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   =      2.00   HOLES/ACRE
FML PLACEMENT QUALITY      =  3 - GOOD


                     LAYER 10
                     --------

            TYPE 3 - BARRIER SOIL LINER
            MATERIAL TEXTURE NUMBER  17
THICKNESS                  =      0.24   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
```

CASE5R30.OUT

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 #13 WITH A GOOD STAND OF GRASS, A SURFACE SLOPE OF 25.% AND A SLOPE LENGTH OF 100. FEET.

| | | | |
|---|---|---|---|
| SCS RUNOFF CURVE NUMBER | = | 85.60 | |
| FRACTION OF AREA ALLOWING RUNOFF | = | 100.0 | PERCENT |
| AREA PROJECTED ON HORIZONTAL PLANE | = | 1.000 | ACRES |
| EVAPORATIVE ZONE DEPTH | = | 12.0 | INCHES |
| INITIAL WATER IN EVAPORATIVE ZONE | = | 2.674 | INCHES |
| UPPER LIMIT OF EVAPORATIVE STORAGE | = | 5.160 | INCHES |
| LOWER LIMIT OF EVAPORATIVE STORAGE | = | 2.652 | INCHES |
| INITIAL SNOW WATER | = | 0.000 | INCHES |
| INITIAL WATER IN LAYER MATERIALS | = | 224.481 | INCHES |
| TOTAL INITIAL WATER | = | 224.481 | INCHES |
| TOTAL SUBSURFACE INFLOW | = | 0.00 | INCHES/YEAR |

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM CORPUS CHRISTI TEXAS

| | | | |
|---|---|---|---|
| STATION LATITUDE | = | 27.77 | DEGREES |
| MAXIMUM LEAF AREA INDEX | = | 3.50 | |
| START OF GROWING SEASON (JULIAN DATE) | = | 0 | |
| END OF GROWING SEASON (JULIAN DATE) | = | 367 | |
| EVAPORATIVE ZONE DEPTH | = | 12.0 | INCHES |
| AVERAGE ANNUAL WIND SPEED | = | 12.00 | MPH |
| AVERAGE 1ST QUARTER RELATIVE HUMIDITY | = | 76.00 | % |
| AVERAGE 2ND QUARTER RELATIVE HUMIDITY | = | 78.00 | % |
| AVERAGE 3RD QUARTER RELATIVE HUMIDITY | = | 76.00 | % |
| AVERAGE 4TH QUARTER RELATIVE HUMIDITY | = | 76.00 | % |

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR CORPUS CHRISTI TEXAS

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

| JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|
| 1.63 | 1.69 | 1.20 | 1.57 | 3.29 | 3.12 |
| 2.26 | 2.78 | 5.31 | 2.92 | 1.61 | 1.17 |

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR CORPUS CHRISTI TEXAS

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

| JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|

CASE5R30.OUT

| | | | | | |
|---|---|---|---|---|---|
| 56.30 | 59.30 | 65.90 | 73.00 | 78.10 | 82.70 |
| 84.90 | 85.00 | 81.50 | 74.00 | 65.00 | 59.10 |

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR CORPUS CHRISTI TEXAS
AND STATION LATITUDE = 27.77 DEGREES

*******************************************************************************

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 30

| | JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|---|
| **PRECIPITATION** | | | | | | |
| TOTALS | 1.37 | 1.81 | 1.19 | 1.40 | 2.51 | 2.59 |
| | 2.36 | 2.86 | 5.39 | 2.99 | 1.49 | 1.25 |
| STD. DEVIATIONS | 0.81 | 1.21 | 0.57 | 1.05 | 1.80 | 1.82 |
| | 2.23 | 2.36 | 2.96 | 1.90 | 1.16 | 0.84 |
| **RUNOFF** | | | | | | |
| TOTALS | 0.007 | 0.022 | 0.005 | 0.051 | 0.188 | 0.174 |
| | 0.342 | 0.218 | 0.608 | 0.191 | 0.067 | 0.007 |
| STD. DEVIATIONS | 0.022 | 0.041 | 0.026 | 0.171 | 0.500 | 0.243 |
| | 0.789 | 0.366 | 0.822 | 0.318 | 0.265 | 0.028 |
| **EVAPOTRANSPIRATION** | | | | | | |
| TOTALS | 1.093 | 1.768 | 1.331 | 1.252 | 1.966 | 2.071 |
| | 1.754 | 2.186 | 3.474 | 2.435 | 1.312 | 1.107 |
| STD. DEVIATIONS | 0.665 | 0.864 | 0.621 | 0.803 | 1.191 | 1.228 |
| | 1.256 | 1.504 | 1.237 | 1.136 | 0.899 | 0.681 |
| **LATERAL DRAINAGE COLLECTED FROM LAYER 2** | | | | | | |
| TOTALS | 0.0698 | 0.2237 | 0.1155 | 0.0457 | 0.1805 | 0.3327 |
| | 0.3318 | 0.3490 | 0.8839 | 0.7081 | 0.2403 | 0.0780 |
| STD. DEVIATIONS | 0.1315 | 0.2604 | 0.1270 | 0.1234 | 0.2785 | 0.4691 |
| | 0.5455 | 0.5857 | 0.9977 | 0.7204 | 0.3203 | 0.1153 |
| **PERCOLATION/LEAKAGE THROUGH LAYER 4** | | | | | | |
| 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 |
| **LATERAL DRAINAGE COLLECTED FROM 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 |

CASE5R30.OUT

```
                          0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

 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  3
 -------------------------------------
   AVERAGES               0.0005   0.0017   0.0008   0.0003   0.0013   0.0139
                          0.0206   0.0177   0.1061   0.0240   0.0018   0.0006

   STD. DEVIATIONS        0.0009   0.0020   0.0009   0.0009   0.0020   0.0415
                          0.1028   0.0537   0.2641   0.0529   0.0024   0.0008

 DAILY AVERAGE HEAD ON TOP OF LAYER  9
 -------------------------------------
   AVERAGES               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

*******************************************************************************


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    AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS    1 THROUGH   30
-------------------------------------------------------------------------------
                                      INCHES           CU. FEET     PERCENT
                                -------------------  ------------  ---------
 PRECIPITATION                   27.20   (  5.704)     98722.7     100.00

 RUNOFF                           1.880  ( 1.2157)      6825.49      6.914

 EVAPOTRANSPIRATION              21.749  ( 3.7373)     78947.65     79.969

 LATERAL DRAINAGE COLLECTED       3.55912 ( 1.91851)    12919.604   13.08676
   FROM LAYER  2

 PERCOLATION/LEAKAGE THROUGH      0.00001 ( 0.00001)        0.023    0.00002
   LAYER  4

 AVERAGE HEAD ON TOP              0.016 (   0.026)
   OF LAYER  3

 LATERAL DRAINAGE COLLECTED       0.00001 ( 0.00001)        0.022   0.00002
   FROM LAYER  8

 PERCOLATION/LEAKAGE THROUGH      0.00000 ( 0.00000)        0.001    0.00000
   LAYER 10

 AVERAGE HEAD ON TOP              0.000 (   0.000)
   OF LAYER  9

 CHANGE IN WATER STORAGE          0.008  ( 0.4489)        29.91      0.030
```

CASE5R30.OUT

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 30

| | (INCHES) | (CU. FT.) |
|---|---|---|
| PRECIPITATION | 5.07 | 18404.102 |
| RUNOFF | 2.585 | 9382.1035 |
| DRAINAGE COLLECTED FROM LAYER 2 | 0.91251 | 3312.41650 |
| PERCOLATION/LEAKAGE THROUGH LAYER 4 | 0.000012 | 0.04380 |
| AVERAGE HEAD ON TOP OF LAYER 3 | 14.568 | |
| MAXIMUM HEAD ON TOP OF LAYER 3 | 18.997 | |
| LOCATION OF MAXIMUM HEAD IN LAYER 2 (DISTANCE FROM DRAIN) | 87.9 FEET | |
| DRAINAGE COLLECTED FROM LAYER 8 | 0.00001 | 0.03665 |
| PERCOLATION/LEAKAGE THROUGH LAYER 10 | 0.000000 | 0.00002 |
| AVERAGE HEAD ON TOP OF LAYER 9 | 0.000 | |
| MAXIMUM HEAD ON TOP OF LAYER 9 | 0.000 | |
| LOCATION OF MAXIMUM HEAD IN LAYER 8 (DISTANCE FROM DRAIN) | 0.0 FEET | |
| SNOW WATER | 0.02 | 73.7433 |

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.4285

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.2210

*** 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 30

| LAYER | (INCHES) | (VOL/VOL) |
|---|---|---|
| 1 | 6.7730 | 0.2822 |

Page 7

CASE5R30.OUT

| | | |
|---|---|---|
| 2 | 0.0020 | 0.0100 |
| 3 | 0.0000 | 0.0000 |
| 4 | 0.1800 | 0.7500 |
| 5 | 3.8520 | 0.3210 |
| 6 | 206.0352 | 0.2920 |
| 7 | 7.7040 | 0.3210 |
| 8 | 0.0020 | 0.0100 |
| 9 | 0.0000 | 0.0000 |
| 10 | 0.1800 | 0.7500 |
| SNOW WATER | 0.000 | |

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# APPENDIX B.8

# HELP OUTPUT FOR ALTERNATIVE LINER CLOSED CASE 6-LOCATION 2

For Permitting Purposes Only

STATE OF TEXAS
JOSE C. GARZA
91790
LICENSED
PROFESSIONAL ENGINEER

04/24/19

Jose C. Garza, P.E.

TBPE Firm No. F-417

CASE6R30.OUT

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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:\HELP3\MDATA\KGVPR30Y.D4
TEMPERATURE DATA FILE:        C:\HELP3\MDATA\KGVTE30Y.D7
SOLAR RADIATION DATA FILE:    C:\HELP3\MDATA\KGVSO30Y.D13
EVAPOTRANSPIRATION DATA:      C:\HELP3\MDATA\KGVEV30Y.D11
SOIL AND DESIGN DATA FILE:    C:\HELP3\MDATA\CASE6R.D10
OUTPUT DATA FILE:             C:\HELP3\MDATA\CASE6R30.OUT


TIME:  13:23      DATE:   4/18/2019


******************************************************************************

     TITLE:  CITY OF KINGSVILLE SOLID WASTE LANDFILL-CASE 6 (LOCATION 2)

******************************************************************************


     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                                  LAYER  1
                                  --------

                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER  13
           THICKNESS                    =     24.00   INCHES
           POROSITY                     =      0.4300 VOL/VOL
           FIELD CAPACITY               =      0.3210 VOL/VOL
           WILTING POINT                =      0.2210 VOL/VOL
           INITIAL SOIL WATER CONTENT   =      0.2754 VOL/VOL
           EFFECTIVE SAT. HYD. COND.    =  0.330000003000E-04 CM/SEC
         NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  4.63
                 FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.


                                  LAYER  2
                                  --------

                       TYPE 2 - LATERAL DRAINAGE LAYER
                         MATERIAL TEXTURE NUMBER  20
           THICKNESS                    =      0.20   INCHES
```

CASE6R30.OUT

```
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.   =   10.0000000000     CM/SEC
SLOPE                       =      2.00   PERCENT
DRAINAGE LENGTH             =    500.0    FEET


                  LAYER  3
                  --------

         TYPE 4 - FLEXIBLE MEMBRANE LINER
           MATERIAL TEXTURE NUMBER  36
THICKNESS                   =      0.04   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.   =  0.399999993000E-12 CM/SEC
FML PINHOLE DENSITY         =      1.00   HOLES/ACRE
FML INSTALLATION DEFECTS    =      2.00   HOLES/ACRE
FML PLACEMENT QUALITY       =  3 - GOOD


                  LAYER  4
                  --------

           TYPE 3 - BARRIER SOIL LINER
           MATERIAL TEXTURE NUMBER  17
THICKNESS                   =      0.24   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


                  LAYER  5
                  --------

         TYPE 1 - VERTICAL PERCOLATION LAYER
           MATERIAL TEXTURE NUMBER  13
THICKNESS                   =     12.00   INCHES
POROSITY                    =      0.4300 VOL/VOL
FIELD CAPACITY              =      0.3210 VOL/VOL
WILTING POINT               =      0.2210 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.3210 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.330000003000E-04 CM/SEC


                  LAYER  6
                  --------

         TYPE 1 - VERTICAL PERCOLATION LAYER
           MATERIAL TEXTURE NUMBER  18
THICKNESS                   =   1727.50   INCHES
POROSITY                    =      0.6710 VOL/VOL
FIELD CAPACITY              =      0.2920 VOL/VOL
```

CASE6R30.OUT

```
WILTING POINT              =      0.0770 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.2920 VOL/VOL
EFFECTIVE SAT. HYD. COND.  = 0.100000005000E-02 CM/SEC


                    LAYER  7
                    --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
             MATERIAL TEXTURE NUMBER  13
THICKNESS                  =     24.00   INCHES
POROSITY                   =      0.4300 VOL/VOL
FIELD CAPACITY             =      0.3210 VOL/VOL
WILTING POINT              =      0.2210 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.3210 VOL/VOL
EFFECTIVE SAT. HYD. COND.  = 0.330000003000E-04 CM/SEC


                    LAYER  8
                    --------

            TYPE 2 - LATERAL DRAINAGE LAYER
             MATERIAL TEXTURE NUMBER  20
THICKNESS                  =      0.20   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.  =  10.0000000000     CM/SEC
SLOPE                      =      2.00   PERCENT
DRAINAGE LENGTH            =    500.0    FEET


                    LAYER  9
                    --------

            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   =      2.00   HOLES/ACRE
FML PLACEMENT QUALITY      = 3 - GOOD


                    LAYER 10
                    --------

              TYPE 3 - BARRIER SOIL LINER
             MATERIAL TEXTURE NUMBER  17
THICKNESS                  =      0.24   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
```

CASE6R30.OUT

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 #13 WITH A GOOD STAND OF GRASS, A SURFACE SLOPE OF 25.% AND A SLOPE LENGTH OF 350. FEET.

| | | | |
|---|---|---|---|
| SCS RUNOFF CURVE NUMBER | = | 84.60 | |
| FRACTION OF AREA ALLOWING RUNOFF | = | 100.0 | PERCENT |
| AREA PROJECTED ON HORIZONTAL PLANE | = | 1.000 | ACRES |
| EVAPORATIVE ZONE DEPTH | = | 12.0 | INCHES |
| INITIAL WATER IN EVAPORATIVE ZONE | = | 2.757 | INCHES |
| UPPER LIMIT OF EVAPORATIVE STORAGE | = | 5.160 | INCHES |
| LOWER LIMIT OF EVAPORATIVE STORAGE | = | 2.652 | INCHES |
| INITIAL SNOW WATER | = | 0.000 | INCHES |
| INITIAL WATER IN LAYER MATERIALS | = | 522.959 | INCHES |
| TOTAL INITIAL WATER | = | 522.959 | INCHES |
| TOTAL SUBSURFACE INFLOW | = | 0.00 | INCHES/YEAR |

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM CORPUS CHRISTI TEXAS

| | | | |
|---|---|---|---|
| STATION LATITUDE | = | 27.77 | DEGREES |
| MAXIMUM LEAF AREA INDEX | = | 3.50 | |
| START OF GROWING SEASON (JULIAN DATE) | = | 0 | |
| END OF GROWING SEASON (JULIAN DATE) | = | 367 | |
| EVAPORATIVE ZONE DEPTH | = | 12.0 | INCHES |
| AVERAGE ANNUAL WIND SPEED | = | 12.00 | MPH |
| AVERAGE 1ST QUARTER RELATIVE HUMIDITY | = | 76.00 | % |
| AVERAGE 2ND QUARTER RELATIVE HUMIDITY | = | 78.00 | % |
| AVERAGE 3RD QUARTER RELATIVE HUMIDITY | = | 76.00 | % |
| AVERAGE 4TH QUARTER RELATIVE HUMIDITY | = | 76.00 | % |

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR CORPUS CHRISTI TEXAS

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

| JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|
| 1.63 | 1.69 | 1.20 | 1.57 | 3.29 | 3.12 |
| 2.26 | 2.78 | 5.31 | 2.92 | 1.61 | 1.17 |

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR CORPUS CHRISTI TEXAS

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

| JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|

CASE6R30.OUT

| | | | | | |
|---|---|---|---|---|---|
| 56.30 | 59.30 | 65.90 | 73.00 | 78.10 | 82.70 |
| 84.90 | 85.00 | 81.50 | 74.00 | 65.00 | 59.10 |

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR CORPUS CHRISTI TEXAS
AND STATION LATITUDE = 27.77 DEGREES

*******************************************************************************

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 30

| | JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|---|
| **PRECIPITATION** | | | | | | |
| TOTALS | 1.37 | 1.81 | 1.19 | 1.40 | 2.51 | 2.59 |
| | 2.36 | 2.86 | 5.39 | 2.99 | 1.49 | 1.25 |
| STD. DEVIATIONS | 0.81 | 1.21 | 0.57 | 1.05 | 1.80 | 1.82 |
| | 2.23 | 2.36 | 2.96 | 1.90 | 1.16 | 0.84 |
| **RUNOFF** | | | | | | |
| TOTALS | 0.005 | 0.016 | 0.004 | 0.047 | 0.169 | 0.145 |
| | 0.325 | 0.191 | 0.568 | 0.161 | 0.044 | 0.004 |
| STD. DEVIATIONS | 0.016 | 0.032 | 0.020 | 0.171 | 0.495 | 0.206 |
| | 0.770 | 0.339 | 0.843 | 0.294 | 0.176 | 0.018 |
| **EVAPOTRANSPIRATION** | | | | | | |
| TOTALS | 1.081 | 1.760 | 1.314 | 1.251 | 1.928 | 2.038 |
| | 1.728 | 2.139 | 3.444 | 2.384 | 1.304 | 1.109 |
| STD. DEVIATIONS | 0.675 | 0.902 | 0.615 | 0.801 | 1.168 | 1.210 |
| | 1.204 | 1.461 | 1.229 | 1.106 | 0.896 | 0.689 |
| **LATERAL DRAINAGE COLLECTED FROM LAYER 2** | | | | | | |
| TOTALS | 0.0809 | 0.2406 | 0.1121 | 0.0567 | 0.2251 | 0.3948 |
| | 0.3796 | 0.4275 | 0.9447 | 0.7920 | 0.2900 | 0.0857 |
| STD. DEVIATIONS | 0.1435 | 0.2996 | 0.1230 | 0.1528 | 0.3265 | 0.5469 |
| | 0.6067 | 0.6486 | 0.9618 | 0.8406 | 0.4048 | 0.1200 |
| **PERCOLATION/LEAKAGE THROUGH LAYER 4** | | | | | | |
| 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 |
| **LATERAL DRAINAGE COLLECTED FROM 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 |

CASE6R30.OUT

| | | | | | | |
|---|---|---|---|---|---|---|
| | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

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 3

| | | | | | | |
|---|---|---|---|---|---|---|
| AVERAGES | 0.0012 | 0.0038 | 0.0016 | 0.0008 | 0.0104 | 0.0589 |
| | 0.0681 | 0.0899 | 0.3548 | 0.1774 | 0.0241 | 0.0012 |
| STD. DEVIATIONS | 0.0020 | 0.0047 | 0.0017 | 0.0022 | 0.0324 | 0.1912 |
| | 0.2573 | 0.2432 | 0.7287 | 0.4575 | 0.1013 | 0.0017 |

DAILY AVERAGE HEAD ON TOP OF LAYER 9

| | | | | | | |
|---|---|---|---|---|---|---|
| AVERAGES | 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 |

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 30

| | INCHES | CU. FEET | PERCENT |
|---|---|---|---|
| PRECIPITATION | 27.20 ( 5.704) | 98722.7 | 100.00 |
| RUNOFF | 1.680 ( 1.1902) | 6099.48 | 6.178 |
| EVAPOTRANSPIRATION | 21.481 ( 3.7202) | 77976.52 | 78.985 |
| LATERAL DRAINAGE COLLECTED FROM LAYER 2 | 4.02954 ( 2.05403) | 14627.235 | 14.81649 |
| PERCOLATION/LEAKAGE THROUGH LAYER 4 | 0.00002 ( 0.00003) | 0.077 | 0.00008 |
| AVERAGE HEAD ON TOP OF LAYER 3 | 0.066 ( 0.096) | | |
| LATERAL DRAINAGE COLLECTED FROM LAYER 8 | 0.00002 ( 0.00003) | 0.073 | 0.00007 |
| PERCOLATION/LEAKAGE THROUGH LAYER 10 | 0.00000 ( 0.00000) | 0.004 | 0.00000 |
| AVERAGE HEAD ON TOP OF LAYER 9 | 0.000 ( 0.000) | | |
| CHANGE IN WATER STORAGE | 0.005 ( 0.4311) | 19.37 | 0.020 |

CASE6R30.OUT

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 30

| | (INCHES) | (CU. FT.) |
|---|---|---|
| PRECIPITATION | 5.07 | 18404.102 |
| RUNOFF | 2.585 | 9382.0957 |
| DRAINAGE COLLECTED FROM LAYER 2 | 0.45365 | 1646.75024 |
| PERCOLATION/LEAKAGE THROUGH LAYER 4 | 0.000023 | 0.08305 |
| AVERAGE HEAD ON TOP OF LAYER 3 | 22.812 | |
| MAXIMUM HEAD ON TOP OF LAYER 3 | 31.119 | |
| LOCATION OF MAXIMUM HEAD IN LAYER 2 (DISTANCE FROM DRAIN) | 158.8 FEET | |
| DRAINAGE COLLECTED FROM LAYER 8 | 0.00002 | 0.07910 |
| PERCOLATION/LEAKAGE THROUGH LAYER 10 | 0.000000 | 0.00002 |
| AVERAGE HEAD ON TOP OF LAYER 9 | 0.000 | |
| MAXIMUM HEAD ON TOP OF LAYER 9 | 0.000 | |
| LOCATION OF MAXIMUM HEAD IN LAYER 8 (DISTANCE FROM DRAIN) | 0.0 FEET | |
| SNOW WATER | 0.02 | 73.7433 |

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.4300

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.2210

*** 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 30

| LAYER | (INCHES) | (VOL/VOL) |
|---|---|---|
| 1 | 6.7691 | 0.2820 |

CASE6R30.OUT

| | | |
|---|---|---|
| 2 | 0.0020 | 0.0100 |
| 3 | 0.0000 | 0.0000 |
| 4 | 0.1800 | 0.7500 |
| 5 | 3.8520 | 0.3210 |
| 6 | 504.4300 | 0.2920 |
| 7 | 7.7040 | 0.3210 |
| 8 | 0.0020 | 0.0100 |
| 9 | 0.0000 | 0.0000 |
| 10 | 0.1800 | 0.7500 |
| SNOW WATER | 0.000 | |

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# APPENDIX B.9

# HELP OUTPUT FOR ALTERNATIVE LINER CLOSED CASE 7-LOCATION 3

For Permitting Purposes Only

STATE OF TEXAS
JOSE C. GARZA
91790
LICENSED
PROFESSIONAL ENGINEER

04/24/19

Jose C. Garza, P.E.

TBPE Firm No. F-417

CASE7R30.OUT

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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:\HELP3\MDATA\KGVPR30Y.D4
TEMPERATURE DATA FILE:       C:\HELP3\MDATA\KGVTE30Y.D7
SOLAR RADIATION DATA FILE:   C:\HELP3\MDATA\KGVSO30Y.D13
EVAPOTRANSPIRATION DATA:     C:\HELP3\MDATA\KGVEV30Y.D11
SOIL AND DESIGN DATA FILE:   C:\HELP3\MDATA\CASE7R.D10
OUTPUT DATA FILE:            C:\HELP3\MDATA\CASE7R30.OUT


TIME:   9: 9     DATE:   4/22/2019


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     TITLE:  CITY OF KINGSVILLE SOLID WASTE LANDFILL-CASE 7 (LOCATION 3)

******************************************************************************


     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
            COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                             LAYER  1
                             --------

                  TYPE 1 - VERTICAL PERCOLATION LAYER
                       MATERIAL TEXTURE NUMBER  13
          THICKNESS                  =     24.00    INCHES
          POROSITY                   =      0.4300 VOL/VOL
          FIELD CAPACITY             =      0.3210 VOL/VOL
          WILTING POINT              =      0.2210 VOL/VOL
          INITIAL SOIL WATER CONTENT =      0.2734 VOL/VOL
          EFFECTIVE SAT. HYD. COND.  =  0.330000003000E-04 CM/SEC
        NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  4.63
               FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.


                             LAYER  2
                             --------

                    TYPE 2 - LATERAL DRAINAGE LAYER
                       MATERIAL TEXTURE NUMBER  20
          THICKNESS                  =      0.20    INCHES
                                          Page 1
```

```
                                  CASE7R30.OUT
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.   =   10.0000000000     CM/SEC
SLOPE                       =      2.00    PERCENT
DRAINAGE LENGTH             =    500.0     FEET


                        LAYER  3
                        --------

            TYPE 4 - FLEXIBLE MEMBRANE LINER
              MATERIAL TEXTURE NUMBER  36
THICKNESS                   =      0.04    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.   =  0.399999993000E-12 CM/SEC
FML PINHOLE DENSITY         =      1.00    HOLES/ACRE
FML INSTALLATION DEFECTS    =      2.00    HOLES/ACRE
FML PLACEMENT QUALITY       =  3 - GOOD


                        LAYER  4
                        --------

              TYPE 3 - BARRIER SOIL LINER
              MATERIAL TEXTURE NUMBER  17
THICKNESS                   =      0.24    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


                        LAYER  5
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  13
THICKNESS                   =     12.00    INCHES
POROSITY                    =      0.4300 VOL/VOL
FIELD CAPACITY              =      0.3210 VOL/VOL
WILTING POINT               =      0.2210 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.3210 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.330000003000E-04 CM/SEC


                        LAYER  6
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  18
THICKNESS                   =   1845.90    INCHES
POROSITY                    =      0.6710 VOL/VOL
FIELD CAPACITY              =      0.2920 VOL/VOL
                                  Page 2
```

CASE7R30.OUT

```
WILTING POINT               =       0.0770 VOL/VOL
INITIAL SOIL WATER CONTENT  =       0.2920 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC


                      LAYER  7
                      --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
            MATERIAL TEXTURE NUMBER  13
THICKNESS                   =     24.00    INCHES
POROSITY                    =       0.4300 VOL/VOL
FIELD CAPACITY              =       0.3210 VOL/VOL
WILTING POINT               =       0.2210 VOL/VOL
INITIAL SOIL WATER CONTENT  =       0.3210 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.330000003000E-04 CM/SEC


                      LAYER  8
                      --------

           TYPE 2 - LATERAL DRAINAGE LAYER
            MATERIAL TEXTURE NUMBER  20
THICKNESS                   =      0.20    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.   =   10.0000000000     CM/SEC
SLOPE                       =      2.00    PERCENT
DRAINAGE LENGTH             =    500.0     FEET


                      LAYER  9
                      --------

           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    =      2.00    HOLES/ACRE
FML PLACEMENT QUALITY       =  3 - GOOD


                      LAYER 10
                      --------

            TYPE 3 - BARRIER SOIL LINER
            MATERIAL TEXTURE NUMBER  17
THICKNESS                   =      0.24    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
```

CASE7R30.OUT

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 #13 WITH A GOOD STAND OF GRASS, A SURFACE SLOPE OF 12.% AND A SLOPE LENGTH OF 200. FEET.

| | | | |
|---|---|---|---|
| SCS RUNOFF CURVE NUMBER | = | 84.80 | |
| FRACTION OF AREA ALLOWING RUNOFF | = | 100.0 | PERCENT |
| AREA PROJECTED ON HORIZONTAL PLANE | = | 1.000 | ACRES |
| EVAPORATIVE ZONE DEPTH | = | 12.0 | INCHES |
| INITIAL WATER IN EVAPORATIVE ZONE | = | 2.709 | INCHES |
| UPPER LIMIT OF EVAPORATIVE STORAGE | = | 5.160 | INCHES |
| LOWER LIMIT OF EVAPORATIVE STORAGE | = | 2.652 | INCHES |
| INITIAL SNOW WATER | = | 0.000 | INCHES |
| INITIAL WATER IN LAYER MATERIALS | = | 557.484 | INCHES |
| TOTAL INITIAL WATER | = | 557.484 | INCHES |
| TOTAL SUBSURFACE INFLOW | = | 0.00 | INCHES/YEAR |

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM CORPUS CHRISTI TEXAS

| | | | |
|---|---|---|---|
| STATION LATITUDE | = | 27.77 | DEGREES |
| MAXIMUM LEAF AREA INDEX | = | 3.50 | |
| START OF GROWING SEASON (JULIAN DATE) | = | 0 | |
| END OF GROWING SEASON (JULIAN DATE) | = | 367 | |
| EVAPORATIVE ZONE DEPTH | = | 12.0 | INCHES |
| AVERAGE ANNUAL WIND SPEED | = | 12.00 | MPH |
| AVERAGE 1ST QUARTER RELATIVE HUMIDITY | = | 76.00 | % |
| AVERAGE 2ND QUARTER RELATIVE HUMIDITY | = | 78.00 | % |
| AVERAGE 3RD QUARTER RELATIVE HUMIDITY | = | 76.00 | % |
| AVERAGE 4TH QUARTER RELATIVE HUMIDITY | = | 76.00 | % |

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR CORPUS CHRISTI TEXAS

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

| JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|
| 1.63 | 1.69 | 1.20 | 1.57 | 3.29 | 3.12 |
| 2.26 | 2.78 | 5.31 | 2.92 | 1.61 | 1.17 |

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR CORPUS CHRISTI TEXAS

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

| JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|

CASE7R30.OUT

| | | | | | |
|---|---|---|---|---|---|
| 56.30 | 59.30 | 65.90 | 73.00 | 78.10 | 82.70 |
| 84.90 | 85.00 | 81.50 | 74.00 | 65.00 | 59.10 |

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR CORPUS CHRISTI TEXAS
AND STATION LATITUDE = 27.77 DEGREES

*******************************************************************************

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 30

| | JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|---|
| **PRECIPITATION** | | | | | | |
| TOTALS | 1.37 | 1.81 | 1.19 | 1.40 | 2.51 | 2.59 |
| | 2.36 | 2.86 | 5.39 | 2.99 | 1.49 | 1.25 |
| STD. DEVIATIONS | 0.81 | 1.21 | 0.57 | 1.05 | 1.80 | 1.82 |
| | 2.23 | 2.36 | 2.96 | 1.90 | 1.16 | 0.84 |
| **RUNOFF** | | | | | | |
| TOTALS | 0.005 | 0.017 | 0.004 | 0.048 | 0.172 | 0.150 |
| | 0.327 | 0.197 | 0.576 | 0.165 | 0.045 | 0.004 |
| STD. DEVIATIONS | 0.017 | 0.034 | 0.021 | 0.172 | 0.495 | 0.212 |
| | 0.771 | 0.344 | 0.849 | 0.296 | 0.177 | 0.019 |
| **EVAPOTRANSPIRATION** | | | | | | |
| TOTALS | 1.078 | 1.759 | 1.312 | 1.250 | 1.927 | 2.039 |
| | 1.733 | 2.138 | 3.441 | 2.378 | 1.302 | 1.114 |
| STD. DEVIATIONS | 0.678 | 0.893 | 0.613 | 0.800 | 1.166 | 1.215 |
| | 1.208 | 1.465 | 1.222 | 1.103 | 0.899 | 0.690 |
| **LATERAL DRAINAGE COLLECTED FROM LAYER 2** | | | | | | |
| TOTALS | 0.0770 | 0.2413 | 0.1130 | 0.0569 | 0.2266 | 0.3893 |
| | 0.3734 | 0.4229 | 0.9423 | 0.7940 | 0.2864 | 0.0853 |
| STD. DEVIATIONS | 0.1384 | 0.3007 | 0.1237 | 0.1480 | 0.3277 | 0.5341 |
| | 0.6049 | 0.6418 | 0.9643 | 0.8378 | 0.4003 | 0.1205 |
| **PERCOLATION/LEAKAGE THROUGH LAYER 4** | | | | | | |
| 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 |
| **LATERAL DRAINAGE COLLECTED FROM 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

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  3
-------------------------------------
 AVERAGES           0.0011   0.0038   0.0016   0.0008   0.0105   0.0584
                    0.0675   0.0853   0.3606   0.1844   0.0215   0.0012

 STD. DEVIATIONS    0.0020   0.0047   0.0018   0.0022   0.0325   0.1892
                    0.2555   0.2308   0.7392   0.4599   0.0994   0.0017

DAILY AVERAGE HEAD ON TOP OF LAYER  9
-------------------------------------
 AVERAGES           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

*******************************************************************************


*******************************************************************************

    AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS   1 THROUGH   30
-------------------------------------------------------------------------------
                                INCHES              CU. FEET       PERCENT
                          -------------------    -------------    ---------
PRECIPITATION              27.20    (   5.704)      98722.7      100.00

RUNOFF                      1.711   (  1.1947)       6210.31       6.291

EVAPOTRANSPIRATION         21.470   (  3.7084)      77936.37      78.945

LATERAL DRAINAGE COLLECTED  4.00840 (  2.03256)     14550.508    14.73877
  FROM LAYER  2

PERCOLATION/LEAKAGE THROUGH 0.00002 (  0.00003)         0.078     0.00008
  LAYER  4

AVERAGE HEAD ON TOP         0.066 (    0.097)
  OF LAYER  3

LATERAL DRAINAGE COLLECTED  0.00002 (  0.00003)         0.073    0.00007
  FROM LAYER  8

PERCOLATION/LEAKAGE THROUGH 0.00000 (  0.00000)         0.004     0.00000
  LAYER 10

AVERAGE HEAD ON TOP         0.000 (    0.000)
  OF LAYER  9

CHANGE IN WATER STORAGE     0.007   (  0.4345)         25.43      0.026
```

CASE7R30.OUT

```
*******************************************************************************


*******************************************************************************

            PEAK DAILY VALUES FOR YEARS    1 THROUGH   30
  ------------------------------------------------------------------------
                                              (INCHES)      (CU. FT.)
                                             ----------    -------------
   PRECIPITATION                                5.07        18404.102

   RUNOFF                                       2.585        9382.0957

   DRAINAGE COLLECTED FROM LAYER  2             0.45365      1646.75073

   PERCOLATION/LEAKAGE THROUGH LAYER  4         0.000023        0.08307

   AVERAGE HEAD ON TOP OF LAYER  3             22.816

   MAXIMUM HEAD ON TOP OF LAYER  3             31.124

   LOCATION OF MAXIMUM HEAD IN LAYER  2
         (DISTANCE FROM DRAIN)                158.8 FEET

   DRAINAGE COLLECTED FROM LAYER  8             0.00002         0.07912

   PERCOLATION/LEAKAGE THROUGH LAYER 10         0.000000        0.00002

   AVERAGE HEAD ON TOP OF LAYER  9              0.000

   MAXIMUM HEAD ON TOP OF LAYER  9              0.000

   LOCATION OF MAXIMUM HEAD IN LAYER  8
         (DISTANCE FROM DRAIN)                  0.0 FEET

   SNOW WATER                                   0.02           73.7433


   MAXIMUM VEG. SOIL WATER (VOL/VOL)                    0.4300

   MINIMUM VEG. SOIL WATER (VOL/VOL)                    0.2210

    ***  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   30
    ----------------------------------------------------------------------
               LAYER        (INCHES)       (VOL/VOL)
               -----        --------       ---------
                 1           6.7714         0.2821
```

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| | | |
|---|---|---|
| 2 | 0.0020 | 0.0100 |
| 3 | 0.0000 | 0.0000 |
| 4 | 0.1800 | 0.7500 |
| 5 | 3.8520 | 0.3210 |
| 6 | 539.0029 | 0.2920 |
| 7 | 7.7040 | 0.3210 |
| 8 | 0.0020 | 0.0100 |
| 9 | 0.0000 | 0.0000 |
| 10 | 0.1800 | 0.7500 |
| SNOW WATER | 0.000 | |

******************************************************************************
******************************************************************************

# APPENDIX B.10

# HELP OUTPUT FOR ALTERNATIVE LINER CLOSED CASE 8-LOCATION 4

For Permitting Purposes Only

STATE OF TEXAS
JOSE C. GARZA
91790
LICENSED
PROFESSIONAL ENGINEER

04/24/19

Jose C. Garza, P.E.

TBPE Firm No. F-417

CASE8R30.OUT

```
******************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
**              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:\HELP3\MDATA\KGVPR30Y.D4
TEMPERATURE DATA FILE:        C:\HELP3\MDATA\KGVTE30Y.D7
SOLAR RADIATION DATA FILE:    C:\HELP3\MDATA\KGVSO30Y.D13
EVAPOTRANSPIRATION DATA:      C:\HELP3\MDATA\KGVEV30Y.D11
SOIL AND DESIGN DATA FILE:    C:\HELP3\MDATA\CASE8R.D10
OUTPUT DATA FILE:             C:\HELP3\MDATA\CASE8R30.OUT


TIME:  13:42      DATE:   4/18/2019


******************************************************************************

     TITLE:  CITY OF KINGSVILLE SOLID WASTE LANDFILL-CASE 8 (LOCATION 4)

******************************************************************************


     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
            COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                                 LAYER  1
                                 --------

                     TYPE 1 - VERTICAL PERCOLATION LAYER
                        MATERIAL TEXTURE NUMBER  13
           THICKNESS                  =     24.00    INCHES
           POROSITY                   =      0.4300 VOL/VOL
           FIELD CAPACITY             =      0.3210 VOL/VOL
           WILTING POINT              =      0.2210 VOL/VOL
           INITIAL SOIL WATER CONTENT =      0.2733 VOL/VOL
           EFFECTIVE SAT. HYD. COND.  = 0.330000003000E-04 CM/SEC
         NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  4.63
                FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.


                                 LAYER  2
                                 --------

                      TYPE 2 - LATERAL DRAINAGE LAYER
                        MATERIAL TEXTURE NUMBER  20
           THICKNESS                  =      0.20    INCHES
```

CASE8R30.OUT

```
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.     =   10.0000000000     CM/SEC
SLOPE                         =      2.00   PERCENT
DRAINAGE LENGTH               =    500.0    FEET


                    LAYER  3
                    --------

            TYPE 4 - FLEXIBLE MEMBRANE LINER
              MATERIAL TEXTURE NUMBER  36
THICKNESS                     =      0.04   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.     =  0.399999993000E-12 CM/SEC
FML PINHOLE DENSITY           =      1.00   HOLES/ACRE
FML INSTALLATION DEFECTS      =      2.00   HOLES/ACRE
FML PLACEMENT QUALITY         =  3 - GOOD


                    LAYER  4
                    --------

              TYPE 3 - BARRIER SOIL LINER
              MATERIAL TEXTURE NUMBER  17
THICKNESS                     =      0.24   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


                    LAYER  5
                    --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  13
THICKNESS                     =     12.00   INCHES
POROSITY                      =      0.4300 VOL/VOL
FIELD CAPACITY                =      0.3210 VOL/VOL
WILTING POINT                 =      0.2210 VOL/VOL
INITIAL SOIL WATER CONTENT    =      0.3210 VOL/VOL
EFFECTIVE SAT. HYD. COND.     =  0.330000003000E-04 CM/SEC


                    LAYER  6
                    --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  18
THICKNESS                     =   1930.00   INCHES
POROSITY                      =      0.6710 VOL/VOL
FIELD CAPACITY                =      0.2920 VOL/VOL
```

Page 2

```
                                    CASE8R30.OUT
WILTING POINT                 =       0.0770 VOL/VOL
INITIAL SOIL WATER CONTENT    =       0.2920 VOL/VOL
EFFECTIVE SAT. HYD. COND.     =  0.100000005000E-02 CM/SEC


                    LAYER  7
                    --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
             MATERIAL TEXTURE NUMBER  13
THICKNESS                     =      24.00   INCHES
POROSITY                      =       0.4300 VOL/VOL
FIELD CAPACITY                =       0.3210 VOL/VOL
WILTING POINT                 =       0.2210 VOL/VOL
INITIAL SOIL WATER CONTENT    =       0.3210 VOL/VOL
EFFECTIVE SAT. HYD. COND.     =  0.330000003000E-04 CM/SEC


                    LAYER  8
                    --------

            TYPE 2 - LATERAL DRAINAGE LAYER
             MATERIAL TEXTURE NUMBER  20
THICKNESS                     =       0.20   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.     =   10.0000000000      CM/SEC
SLOPE                         =       2.00   PERCENT
DRAINAGE LENGTH               =     500.0    FEET


                    LAYER  9
                    --------

            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      =       2.00   HOLES/ACRE
FML PLACEMENT QUALITY         =  3 - GOOD


                    LAYER 10
                    --------

              TYPE 3 - BARRIER SOIL LINER
             MATERIAL TEXTURE NUMBER  17
THICKNESS                     =       0.24   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
                                    Page 3
```

CASE8R30.OUT

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 #13 WITH A GOOD STAND OF GRASS, A SURFACE SLOPE OF 4.% AND A SLOPE LENGTH OF 600. FEET.

| | | | |
|---|---|---|---|
| SCS RUNOFF CURVE NUMBER | = | 83.40 | |
| FRACTION OF AREA ALLOWING RUNOFF | = | 100.0 | PERCENT |
| AREA PROJECTED ON HORIZONTAL PLANE | = | 1.000 | ACRES |
| EVAPORATIVE ZONE DEPTH | = | 12.0 | INCHES |
| INITIAL WATER IN EVAPORATIVE ZONE | = | 2.708 | INCHES |
| UPPER LIMIT OF EVAPORATIVE STORAGE | = | 5.160 | INCHES |
| LOWER LIMIT OF EVAPORATIVE STORAGE | = | 2.652 | INCHES |
| INITIAL SNOW WATER | = | 0.000 | INCHES |
| INITIAL WATER IN LAYER MATERIALS | = | 582.040 | INCHES |
| TOTAL INITIAL WATER | = | 582.040 | INCHES |
| TOTAL SUBSURFACE INFLOW | = | 0.00 | INCHES/YEAR |

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM CORPUS CHRISTI TEXAS

| | | | |
|---|---|---|---|
| STATION LATITUDE | = | 27.77 | DEGREES |
| MAXIMUM LEAF AREA INDEX | = | 3.50 | |
| START OF GROWING SEASON (JULIAN DATE) | = | 0 | |
| END OF GROWING SEASON (JULIAN DATE) | = | 367 | |
| EVAPORATIVE ZONE DEPTH | = | 12.0 | INCHES |
| AVERAGE ANNUAL WIND SPEED | = | 12.00 | MPH |
| AVERAGE 1ST QUARTER RELATIVE HUMIDITY | = | 76.00 | % |
| AVERAGE 2ND QUARTER RELATIVE HUMIDITY | = | 78.00 | % |
| AVERAGE 3RD QUARTER RELATIVE HUMIDITY | = | 76.00 | % |
| AVERAGE 4TH QUARTER RELATIVE HUMIDITY | = | 76.00 | % |

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR CORPUS CHRISTI TEXAS

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

| JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|
| 1.63 | 1.69 | 1.20 | 1.57 | 3.29 | 3.12 |
| 2.26 | 2.78 | 5.31 | 2.92 | 1.61 | 1.17 |

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR CORPUS CHRISTI TEXAS

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

| JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|

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| | | | | | |
|---|---|---|---|---|---|
| 56.30 | 59.30 | 65.90 | 73.00 | 78.10 | 82.70 |
| 84.90 | 85.00 | 81.50 | 74.00 | 65.00 | 59.10 |

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR CORPUS CHRISTI TEXAS
AND STATION LATITUDE = 27.77 DEGREES

*******************************************************************************

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 30

| | JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|---|
| **PRECIPITATION** | | | | | | |
| TOTALS | 1.37 | 1.81 | 1.19 | 1.40 | 2.51 | 2.59 |
| | 2.36 | 2.86 | 5.39 | 2.99 | 1.49 | 1.25 |
| STD. DEVIATIONS | 0.81 | 1.21 | 0.57 | 1.05 | 1.80 | 1.82 |
| | 2.23 | 2.36 | 2.96 | 1.90 | 1.16 | 0.84 |
| **RUNOFF** | | | | | | |
| TOTALS | 0.003 | 0.011 | 0.003 | 0.043 | 0.154 | 0.117 |
| | 0.320 | 0.167 | 0.536 | 0.138 | 0.039 | 0.002 |
| STD. DEVIATIONS | 0.012 | 0.024 | 0.015 | 0.167 | 0.494 | 0.168 |
| | 0.765 | 0.317 | 0.853 | 0.285 | 0.166 | 0.012 |
| **EVAPOTRANSPIRATION** | | | | | | |
| TOTALS | 1.075 | 1.755 | 1.316 | 1.246 | 1.943 | 2.036 |
| | 1.740 | 2.149 | 3.445 | 2.375 | 1.304 | 1.111 |
| STD. DEVIATIONS | 0.680 | 0.890 | 0.616 | 0.799 | 1.174 | 1.212 |
| | 1.225 | 1.476 | 1.225 | 1.098 | 0.904 | 0.695 |
| **LATERAL DRAINAGE COLLECTED FROM LAYER 2** | | | | | | |
| TOTALS | 0.0871 | 0.2477 | 0.1143 | 0.0601 | 0.2280 | 0.4259 |
| | 0.3740 | 0.4325 | 0.9802 | 0.8286 | 0.2979 | 0.0849 |
| STD. DEVIATIONS | 0.1585 | 0.3090 | 0.1186 | 0.1609 | 0.3250 | 0.5887 |
| | 0.6004 | 0.6575 | 0.9888 | 0.8731 | 0.4168 | 0.1196 |
| **PERCOLATION/LEAKAGE THROUGH LAYER 4** | | | | | | |
| 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 |
| **LATERAL DRAINAGE COLLECTED FROM 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 |

CASE8R30.OUT

| | | | | | | |
|---|---|---|---|---|---|---|
| | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

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 3

| | | | | | | |
|---|---|---|---|---|---|---|
| AVERAGES | 0.0012 | 0.0039 | 0.0016 | 0.0009 | 0.0104 | 0.0748 |
| | 0.0679 | 0.0824 | 0.3707 | 0.2120 | 0.0248 | 0.0012 |
| STD. DEVIATIONS | 0.0023 | 0.0048 | 0.0017 | 0.0024 | 0.0323 | 0.2328 |
| | 0.2719 | 0.2347 | 0.7766 | 0.4906 | 0.1168 | 0.0017 |

DAILY AVERAGE HEAD ON TOP OF LAYER 9

| | | | | | | |
|---|---|---|---|---|---|---|
| AVERAGES | 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 |

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 30

| | INCHES | CU. FEET | PERCENT |
|---|---|---|---|
| PRECIPITATION | 27.20 ( 5.704) | 98722.7 | 100.00 |
| RUNOFF | 1.533 ( 1.1930) | 5565.96 | 5.638 |
| EVAPOTRANSPIRATION | 21.495 ( 3.7381) | 78026.06 | 79.036 |
| LATERAL DRAINAGE COLLECTED FROM LAYER 2 | 4.16123 ( 2.10988) | 15105.281 | 15.30072 |
| PERCOLATION/LEAKAGE THROUGH LAYER 4 | 0.00002 ( 0.00003) | 0.083 | 0.00008 |
| AVERAGE HEAD ON TOP OF LAYER 3 | 0.071 ( 0.104) | | |
| LATERAL DRAINAGE COLLECTED FROM LAYER 8 | 0.00002 ( 0.00003) | 0.079 | 0.00008 |
| PERCOLATION/LEAKAGE THROUGH LAYER 10 | 0.00000 ( 0.00000) | 0.004 | 0.00000 |
| AVERAGE HEAD ON TOP OF LAYER 9 | 0.000 ( 0.000) | | |
| CHANGE IN WATER STORAGE | 0.007 ( 0.4342) | 25.30 | 0.026 |

CASE8R30.OUT

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 30

| | (INCHES) | (CU. FT.) |
|---|---|---|
| PRECIPITATION | 5.07 | 18404.102 |
| RUNOFF | 2.585 | 9382.0947 |
| DRAINAGE COLLECTED FROM LAYER 2 | 0.45365 | 1646.74548 |
| PERCOLATION/LEAKAGE THROUGH LAYER 4 | 0.000023 | 0.08285 |
| AVERAGE HEAD ON TOP OF LAYER 3 | 22.774 | |
| MAXIMUM HEAD ON TOP OF LAYER 3 | 31.078 | |
| LOCATION OF MAXIMUM HEAD IN LAYER 2 (DISTANCE FROM DRAIN) | 158.7 FEET | |
| DRAINAGE COLLECTED FROM LAYER 8 | 0.00002 | 0.07933 |
| PERCOLATION/LEAKAGE THROUGH LAYER 10 | 0.000000 | 0.00002 |
| AVERAGE HEAD ON TOP OF LAYER 9 | 0.000 | |
| MAXIMUM HEAD ON TOP OF LAYER 9 | 0.000 | |
| LOCATION OF MAXIMUM HEAD IN LAYER 8 (DISTANCE FROM DRAIN) | 0.0 FEET | |
| SNOW WATER | 0.02 | 73.7433 |

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.4300

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.2210

*** 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 30

| LAYER | (INCHES) | (VOL/VOL) |
|---|---|---|
| 1 | 6.7694 | 0.2821 |

| | | |
|---|---|---|
| 2 | 0.0020 | 0.0100 |
| 3 | 0.0000 | 0.0000 |
| 4 | 0.1800 | 0.7500 |
| 5 | 3.8520 | 0.3210 |
| 6 | 563.5601 | 0.2920 |
| 7 | 7.7040 | 0.3210 |
| 8 | 0.0020 | 0.0100 |
| 9 | 0.0000 | 0.0000 |
| 10 | 0.1800 | 0.7500 |
| SNOW WATER | 0.000 | |

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# APPENDIX B.21

# TABLE 1 – HELP MODEL ANALYSIS ALTERNATIVE LINER SUMMARY

For Permitting Purposes Only
STATE OF TEXAS
JOSE C. GARZA
91790
LICENSED
PROFESSIONAL ENGINEER
04/24/19
Jose C. Garza, P.E.
TBPE Firm No. F-417

**TABLE 1-HELP MODEL ANALYSIS ALTERNATIVE LINER SUMMARY**

| ***Case No.*** | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 1OL | 2OL | 3OL | 4OL | 5OL | 6OL | 7OL | 8OL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cover | Interim | Interim | Interim | Interim | Closed | Closed | Closed | Closed | Interim | Interim | Interim | Interim | Closed | Closed | Closed | Closed |
| Average Waste Thickness (ft) | 58.80 | 143.96 | 153.83 | 160.83 | 58.80 | 143.96 | 153.82 | 160.83 | | | | | | | | |
| Average Waste Thickness-Above Liner(ft) | | | | | | | | | 12 | 82.5 | 85.5 | 119.5 | 12 | 82.5 | 85.5 | 119.5 |
| Average Waste Thickness-Below Liner(ft) | | | | | | | | | 15.5 | 34 | 37 | 16 | 15.5 | 34 | 37 | 16 |
| Years | 20 | 20 | 20 | 20 | 30 | 30 | 30 | 30 | 20 | 20 | 20 | 20 | 30 | 30 | 30 | 30 |
| Ground Cover | Fair | Fair | Fair | Fair | Good | Good | Good | Good | Fair | Fair | Fair | Fair | Good | Good | Good | Good |
| Runoff Curve No. | 89.5 | 88.8 | 89 | 88 | 85.6 | 84.6 | 84.8 | 83.4 | 89.5 | 88.8 | 88.5 | 88 | 85.6 | 84.6 | 84.1 | 83.4 |
| Model Area (acre) | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Runoff Area (%) | 80 | 80 | 80 | 80 | 100 | 100 | 100 | 100 | 80 | 80 | 80 | 80 | 100 | 100 | 100 | 100 |
| Maximum Leaf Area Index | 2 | 2 | 2 | 2 | 3.5 | 3.5 | 3.5 | 3.5 | 2 | 2 | 2 | 2 | 3.5 | 3.5 | 3.5 | 3.5 |
| Evaporative Zone Depth (in) | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 |
| ***Erosion Layer*** | | | | | | | | | | | | | | | | |
| Layer No. | | | | | 1 | 1 | 1 | 1 | | | | | 1 | 1 | 1 | 1 |
| Type | | | | | Vertical Percolation | Vertical Percolation | Vertical Percolation | Vertical Percolation | | | | | Vertical Percolation | Vertical Percolation | Vertical Percolation | Vertical Percolation |
| Texture No. | | | | | 13 | 13 | 13 | 13 | | | | | 13 | 13 | 13 | 13 |
| Thickness (in) | | | | | 24 | 24 | 24 | 24 | | | | | 24 | 24 | 24 | 24 |
| ***Geocomposite*** | | | | | | | | | | | | | | | | |
| Layer No. | | | | | 2 | 2 | 2 | 2 | | | | | 2 | 2 | 2 | 2 |
| Type | | | | | Lateral Drainage | Lateral Drainage | Lateral Drainage | Lateral Drainage | | | | | Lateral Drainage | Lateral Drainage | Lateral Drainage | Lateral Drainage |
| Texture No. | | | | | 20 | 20 | 20 | 20 | | | | | 20 | 20 | 20 | 20 |
| Thickness (in) | | | | | 0.2 | 0.2 | 0.2 | 0.2 | | | | | 0.2 | 0.2 | 0.2 | 0.2 |
| Slope (%) | | | | | 2 | 2 | 2 | 2 | | | | | 2 | 2 | 2 | 2 |
| Flow Distance (ft) | | | | | 250 | 500 | 500 | 500 | | | | | 250 | 250 | 250 | 250 |
| Hydraulic Conductivity (cm/sec) | | | | | 10 | 10 | 10 | 10 | | | | | 10 | 10 | 10 | 10 |
| ***Geomembrane (40-mil LLDPE)*** | | | | | | | | | | | | | | | | |
| Layer No. | | | | | 3 | 3 | 3 | 3 | | | | | 3 | 3 | 3 | 3 |
| Type | | | | | Geomembrane Liner | Geomembrane Liner | Geomembrane Liner | Geomembrane Liner | | | | | Geomembrane Liner | Geomembrane Liner | Geomembrane Liner | Geomembrane Liner |
| Texture No. | | | | | 36 | 36 | 36 | 36 | | | | | 36 | 36 | 36 | 36 |
| Thickness (in) | | | | | 0.04 | 0.04 | 0.04 | 0.04 | | | | | 0.04 | 0.04 | 0.04 | 0.04 |
| Installation Quality | | | | | 3-Good | 3-Good | 3-Good | 3-Good | | | | | 3-Good | 3-Good | 3-Good | 3-Good |
| Defects per acre | | | | | 2 | 2 | 2 | 2 | | | | | 2 | 2 | 2 | 2 |
| Pinholes per acre | | | | | 1 | 1 | 1 | 1 | | | | | 1 | 1 | 1 | 1 |
| ***Barrier Soil Liner (GCL)*** | | | | | | | | | | | | | | | | |
| Layer No. | | | | | 4 | 4 | 4 | 4 | | | | | 4 | 4 | 4 | 4 |
| Type | | | | | Barrier Soil Liner | Barrier Soil Liner | Barrier Soil Liner | Barrier Soil Liner | | | | | Barrier Soil Liner | Barrier Soil Liner | Barrier Soil Liner | Barrier Soil Liner |
| Texture No. | | | | | 17 | 17 | 17 | 17 | | | | | 17 | 17 | 17 | 17 |
| Thickness (in) | | | | | 0.24 | 0.24 | 0.24 | 0.24 | | | | | 0.24 | 0.24 | 0.24 | 0.24 |
| ***Daily/Intermediate Cover*** | | | | | | | | | | | | | | | | |
| Layer No. | 1 | 1 | 1 | 1 | 5 | 5 | 5 | 5 | 1 | 1 | 1 | 1 | 5 | 5 | 5 | 5 |
| Type | Vertical Percolation | Vertical Percolation | Vertical Percolation | Vertical Percolation | Vertical Percolation | Vertical Percolation | Vertical Percolation | Vertical Percolation | Vertical Percolation | Vertical Percolation | Vertical Percolation | Vertical Percolation | Vertical Percolation | Vertical Percolaton | Vertical Percolation | Vertical Percolation |
| Texture No. | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 |
| Thickness (in) | 6 | 6 | 6 | 6 | 12 | 12 | 12 | 12 | 6 | 6 | 6 | 6 | 12 | 12 | 12 | 12 |
| ***Solid Waste*** | | | | | | | | | | | | | | | | |
| Layer No. | 2 | 2 | 2 | 2 | 6 | 6 | 6 | 6 | 2 | 2 | 2 | 2 | 6 | 6 | 6 | 6 |
| Type | Vertical Percolation | Vertical Percolation | Vertical Percolation | Vertical Percolation | Vertical Percolation | Vertical Percolation | Vertical Percolation | Vertical Percolation | Vertical Percolation | Vertical Percolation | Vertical Percolation | Vertical Percolation | Vertical Percolation | Vertical Percolaton | Vertical Percolation | Vertical Percolation |
| Texture No. | 18 | 18 | 18 | 18 | 18 | 18 | 18 | 18 | 18 | 18 | 18 | 18 | 18 | 18 | 18 | 18 |
| Thickness (in) | 705.60 | 1,727.50 | 1,845.96 | 1,930 | 705.60 | 1,727.50 | 1,845.96 | 1,930 | 144 | 990 | 1,026 | 1,434 | 144 | 990 | 1,026 | 1434 |
| ***Protective Soil Cover*** | | | | | | | | | | | | | | | | |
| Layer No. | 3 | 3 | 3 | 3 | 7 | 7 | 7 | 7 | 3 | 3 | 3 | 3 | 7 | 7 | 7 | 7 |
| Type | Vertical Percolation | Vertical Percolation | Vertical Percolation | Vertical Percolation | Vertical Percolation | Vertical Percolation | Vertical Percolation | Vertical Percolation | Vertical Percolation | Vertical Percolation | Vertical Percolation | Vertical Percolation | Vertical Percolation | Vertical Percolaton | Vertical Percolation | Vertical Percolation |
| Texture No. | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 |
| Thickness (in) | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 |
| ***Geocomposite*** | | | | | | | | | | | | | | | | |
| Layer No. | 4 | 4 | 4 | 4 | 8 | 8 | 8 | 8 | 4 | 4 | 4 | 4 | 8 | 8 | 8 | 8 |
| Type | Lateral Drainage | Lateral Drainage | Lateral Drainage | Lateral Drainage | Lateral Drainage | Lateral Drainage | Lateral Drainage | Lateral Drainage | Lateral Drainage | Lateral Drainage | Lateral Drainage | Lateral Drainage | Lateral Drainage | Lateral Drainage | Lateral Drainage | Lateral Drainage |
| Texture No. | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 |
| Thickness (in) | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 |
| Slope (%) | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| Flow Distance (ft) | 250 | 500 | 500 | 500 | 250 | 500 | 500 | 500 | 400 | 400 | 400 | 400 | 250 | 250 | 250 | 250 |
| Hydraulic Conductivity (cm/sec) | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 |
| ***Geomembrane (60-mil HDPE)*** | | | | | | | | | | | | | | | | |
| Layer No. | 5 | 5 | 5 | 5 | 9 | 9 | 9 | 9 | 5 | 5 | 5 | 5 | 9 | 9 | 9 | 9 |
| Type | Geomembrane Liner | Geomembrane Liner | Geomembrane Liner | Geomembrane Liner | Geomembrane Liner | Geomembrane Liner | Geomembrane Liner | Geomembrane Liner | Geomembrane Liner | Geomembrane Liner | Geomembrane Liner | Geomembrane Liner | Geomembrane Liner | Geomembrane Liner | Geomembrane Liner | Geomembrane Liner |
| Texture No. | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 |
| Thickness (in) | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 |
| Installation Quality | 3-Good | 3-Good | 3-Good | 3-Good | 3-Good | 3-Good | 3-Good | 3-Good | 3-Good | 3-Good | 3-Good | 3-Good | 3-Good | 3-Good | 3-Good | 3-Good |
| Defects per acre | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| Pinholes per acre | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| ***Barrier Soil Liner (GCL)*** | | | | | | | | | | | | | | | | |
| Layer No. | 6 | 6 | 6 | 6 | 10 | 10 | 10 | 10 | 6 | 6 | 6 | 6 | 10 | 10 | 10 | 10 |
| Type | Barrier Soil Liner | Barrier Soil Liner | Barrier Soil Liner | Barrier Soil Liner | Barrier Soil Liner | Barrier Soil Liner | Barrier Soil Liner | Barrier Soil Liner | Barrier Soil Liner | Barrier Soil Liner | Barrier Soil Liner | Barrier Soil Liner | Barrier Soil Liner | Barrier Soil Liner | Barrier Soil Liner | Barrier Soil Liner |
| Texture No. | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 |
| Thickness (in) | 0.24 | 0.24 | 0.24 | 0.24 | 0.24 | 0.24 | 0.24 | 0.24 | 0.24 | 0.24 | 0.24 | 0.24 | 0.24 | 0.24 | 0.24 | 0.24 |
| ***Erosion Layer*** | | | | | | | | | | | | | | | | |
| Layer No. | | | | | | | | | 7 | 7 | 7 | 7 | 11 | 11 | 11 | 11 |
| Type | | | | | | | | | Vertical Percolation | Vertical Percolation | Vertical Percolation | Vertical Percolation | Vertical Percolation | Vertical Percolation | Vertical Percolation | Vertical Percolation |
| Texture No. | | | | | | | | | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 |
| Thickness (in) | | | | | | | | | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 |
| ***Solid Waste*** | | | | | | | | | | | | | | | | |
| Layer No. | | | | | | | | | 8 | 8 | 8 | 8 | 12 | 12 | 12 | 12 |
| Type | | | | | | | | | Vertical Percolation | Vertical Percolation | Vertical Percolation | Vertical Percolation | Vertical Percolation | Vertical Percolation | Vertical Percolation | Vertical Percolation |
| Texture No. | | | | | | | | | 18 | 18 | 18 | 18 | 18 | 18 | 18 | 18 |
| Thickness (in) | | | | | | | | | 186 | 408 | 444 | 192 | 186 | 408 | 444 | 192 |
| Average Percolation Through Liner (cf/yr) | 0.004 | 0.004 | 0.004 | 0.005 | 0.001 | 0.004 | 0.004 | 0.004 | 0.004 | 0.004 | 0.004 | 0.004 | 0.001 | 0.002 | 0.002 | 0.002 |
| Max Head on Liner (in/day) | 0.072 | 0.139 | 0.142 | 0.142 | 0.000 | 0.000 | 0.000 | 0.000 | 0.139 | 0.116 | 0.113 | 0.115 | 0.000 | 0.006 | 0.006 | 0.006 |
| Peak Percolation Through Liner (cf/day) | 0.00005 | 0.00007 | 0.00007 | 0.00007 | 0.00002 | 0.00002 | 0.00002 | 0.00002 | 0.00007 | 0.00006 | 0.00006 | 0.00006 | 0.00002 | 0.00002 | 0.00002 | 0.00002 |
| Peak Percolation Through Liner (m/yr) | 1.28E-07 | 1.79E-07 | 1.79E-07 | 1.79E-07 | 5.11E-08 | 5.11E-08 | 5.11E-08 | 5.11E-08 | 1.79E-07 | 1.53E-07 | 1.53E-07 | 1.53E-07 | 5.11E-08 | 5.11E-08 | 5.11E-08 | 5.11E-08 |

# APPENDIX C

# MULTIMED MODEL ANALYSIS

For Permitting Purposes Only

STATE OF TEXAS
JOSE C. GARZA
91790
LICENSED
PROFESSIONAL ENGINEER

04/24/19

Jose C. Garza, P.E.

TBPE Firm No. F-417

# APPENDIX C.3

# MULTIMED SOURCE-SPECIFIC DATA

For Permitting Purposes Only

STATE OF TEXAS
JOSE C. GARZA
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LICENSED
PROFESSIONAL ENGINEER

04/24/19

Jose C. Garza, P.E.

TBPE Firm No. F-417

## MULTIMED SOURCE - SPECIFIC DATA

| Variable Name | Units | Value | Comments |
|---|---|---|---|
| Infiltration rate | m/yr | varies | See table below. |
| Area of waste disposal unit | $m^2$ | 485,623 | 120 acres |
| Spread of contaminant source | m | 0 | Derived by MULTIMED |
| Recharge rate | m/yr | 0.0368 | Five percent of average annual precipitation (1.45 inches/yr) |
| Initial concentration at landfill ($C_0$) | mg/L | 1.0 | Set at 1.0 to find DAF |
| Length scale of facility | m | | Derived by MULTIMED |
| Width scale of facility | m | | Derived by MULTIMED |

| Case | Infiltration Rate (m/yr) | Comments |
|---|---|---|
| Interim cases with Alternative Liner | | |
| • 58.80 feet of waste (Case 1) 20 yr | *$1.28 \times 10^{-7}$ | Calculated using peak daily percolation/ leakage rate through GCL. See Appx. B.2 |
| • 143.96 feet of waste (Case 2) 20 yr | $1.79 \times 10^{-7}$ | Calculated using peak daily percolation/ leakage rate through GCL. See Appx. B.2 |
| • 153.83 feet of waste (Case 3) 20 yr | $1.79 \times 10^{-7}$ | Calculated using peak daily percolation/ leakage rate through GCL. See Appx. B.2 |
| • 160.83 feet of waste (Case 4) 20 yr | $1.79 \times 10^{-7}$ | Calculated using peak daily percolation/ leakage rate through GCL. See Appx. B.2 |
| Closed cases with Alternative Liner | | |
| • 58.80 feet of waste (Case 5) 30 yr | $5.11 \times 10^{-8}$ | Calculated using peak daily percolation/ leakage rate through GCL. See Appx. B.2 |
| • 143.96 feet of waste (Case 6) 30 yr | $5.11 \times 10^{-8}$ | Calculated using peak daily percolation/ leakage rate through GCL. See Appx. B.2 |
| • 153.83 feet of waste (Case 7) 30 yr | $5.11 \times 10^{-8}$ | Calculated using peak daily percolation/ leakage rate through GCL. See Appx. B.2 |
| • 160.83 feet of waste (Case 8) 30 yr | $5.11 \times 10^{-8}$ | Calculated using peak daily percolation/ leakage rate through GCL. See Appx. B.2 |

* Determined Using Peak Daily Percolation/Leakage Rate Through GCL and Converted to (M/YR)
Example: ((.00005 $FT^3$/Day-Acre)x(1 Acre/43,560 $FT^2$)/(1 Meter/3.28 FT)) x (365 Days/1 YR)= $1.28 \times 10^{-7}$ M/YR

# APPENDIX C.4

# MULTIMED SOURCE-SPECIFIC DATA

For Permitting Purposes Only

STATE OF TEXAS
JOSE C. GARZA
91790
LICENSED
PROFESSIONAL ENGINEER

04/24/19

Jose C. Garza, P.E.

TBPE Firm No. F-417

**MULTIMED SOURCE - SPECIFIC DATA**

**Overliner Demonstration**

| Variable Name | Units | Value | Comments |
|---|---|---|---|
| Infiltration rate | m/yr | varies | See table below. |
| Area of waste disposal unit | $m^2$ | 485,623 | 120 acres |
| Spread of contaminant source | m | 0 | Derived by MULTIMED |
| Recharge rate | m/yr | 0.0368 | Five percent of average annual precipitation (1.45 inches/yr) |
| Initial concentration at landfill ($C_0$) | mg/L | 1.0 | Set at 1.0 to find DAF |
| Length scale of facility | m | | Derived by MULTIMED |
| Width scale of facility | m | | Derived by MULTIMED |

| Case | Infiltration Rate (m/yr) | Comments |
|---|---|---|
| Interim Cases with Overliner | | |
| Location 1 (Case 1OL)<br>• 12 feet of waste above liner<br>• 15.5 feet of waste below liner<br>20 yr | *$1.79 \times 10^{-7}$ | Calculated using peak daily percolation/ leakage rate through GCL. See Appx. B.12 |
| Location 2 (Case 2OL)<br>• 82.5 feet of waste above liner<br>• 34 feet of waste below liner<br>20 yr | $1.53 \times 10^{-7}$ | Calculated using peak daily percolation/ leakage rate through GCL. See Appx. B.12 |
| Location 3 (Case 3OL)<br>• 85.5 feet of waste above liner<br>• 37 feet of waste below liner<br>20 yr | $1.53 \times 10^{-7}$ | Calculated using peak daily percolation/ leakage rate through GCL. See Appx. B.12 |
| Location 4 (Case 4OL)<br>• 119.5 feet of waste above liner<br>• 16 feet of waste below liner<br>20 yr | $1.53 \times 10^{-7}$ | Calculated using peak daily percolation/ leakage rate through GCL. See Appx. B.12 |
| Closed cases with Overliner | | |
| Location 1 (Case 5OL)<br>• 12 feet of waste above liner<br>• 15.5 feet of waste below liner<br>30 yr | $5.11 \times 10^{-8}$ | Calculated using peak daily percolation/ leakage rate through GCL. See Appx. B.12 |
| Location 2 (Case 6OL)<br>• 82.5 feet of waste above liner<br>• 34 feet of waste below liner<br>30 yr | $5.11 \times 10^{-8}$ | Calculated using peak daily percolation/ leakage rate through GCL. See Appx. B.12 |
| Location 3 (Case 7OL)<br>• 85.5 feet of waste above liner<br>• 37 feet of waste below liner<br>30 yr | $5.11 \times 10^{-8}$ | Calculated using peak daily percolation/ leakage rate through GCL. See Appx. B.12 |
| Location 4 (Case 8OL)<br>• 119.5 feet of waste above liner<br>• 16 feet of waste below liner<br>30 yr | $5.11 \times 10^{-8}$ | Calculated using peak daily percolation/ leakage rate through GCL. See Appx. B.12 |

* Determined Using Peak Daily Percolation/Leakage Rate Through GCL and Converted to (M/YR)
Example: ((.00007 $FT^3$/Day-Acre)x(1 Acre/43,560 $FT^2$)/(1 Meter/3.28 FT)) x (365 Days/1 YR)= $1.79 \times 10^{-7}$ M/YR

# APPENDIX C.6

# MULTIMED SOURCE-SPECIFIC DATA

For Permitting Purposes Only

STATE OF TEXAS
JOSE C. GARZA
91790
LICENSED
PROFESSIONAL ENGINEER

04/24/19

Jose C. Garza, P.E.

TBPE Firm No. F-417

## MULTIMED AQUIFER - SPECIFIC DATA

| Variable Name | Units | Value | Comments |
|---|---|---|---|
| Particle Diameter* | cm | 0.0381 | From Permit 235-B Amendment Volume II of V<br>Pages 36-39 (PDF)-1998<br>Reference Appendix C.7.2<br>Material ranges from fine to coarse. Use an average<br>for medium sand (0.010-0.020 in); 0.015 in or 0.0381 cm |
| Aquifer porosity* | unitless | 0.43 | From Permit 235-B Amendment Volume V of V<br>Pages 467-473 (PDF)-1998<br>Reference Appendix C.7.1 |
| Bulk density | g/cc | 1.65 | From Permit 235-B Amendment Volume V of V<br>Pages 467-473 (PDF)-1998<br>Reference Appendix C.7.1 |
| Aquifer thickness | m | 10 | From Permit 235-B Amendment Volume V of V Pgs.<br>467-473 (PDF)-1998 Avg depth of uppermost aquifer<br>Reference Appendix C.7.1 |
| Mixing zone depth | m | | Derived by MULTIMED |
| Hydraulic conductivity | m/yr | 130 | From Permit 235-B Amendment Volume V of V<br>Pages 467-473 (PDF)-1998<br>Reference Appendix C.7.1<br>Average hydraulic conductivity of 4.12 x $10^{-4}$ cm/sec |
| Hydraulic gradient | unitless | 0.0031 | From Groundwater Contour Map (January 2016) |
| Groundwater seepage velocity | m/yr | | Derived by MULTIMED |
| Retardation coefficient | unitless | | Derived by MULTIMED |
| Longitudinal dispersivity | m | | Derived by MULTIMED |
| Transveral dispersivity | m | | Derived by MULTIMED |
| Vertical dispersivity | m | | Derived by MULTIMED |
| Organic carbon content | % | 0.003 | From Permit 235-B Amendment Volume V of V<br>Pages 467-473 (PDF)-1998<br>Reference Appendix C.7.1 |
| Receptor distance from well | m | Varies | Distance from analysis location to point of<br>compliance. |
| Z-distance from water table | m | 0 | Assume water table is at bottom of liner. |

*** If Aquifer porosity is known MULTIMED will not use particle diameter.**

# APPENDIX C.7

# MULTIMED SOURCE-SPECIFIC DATA

For Permitting Purposes Only

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## MULTIMED AQUIFER - SPECIFIC DATA

### Overliner Demonstration

| Variable Name | Units | Value | Comments |
|---|---|---|---|
| Particle Diameter* | cm | 0.0381 | From Permit 235-B Amendment Volume II of V<br>Pages 36-39 (PDF)-1998<br>Reference Appendix C.7.2<br>Material ranges from fine to coarse. Use an average for medium sand (0.010-0.020 in); 0.015 in or 0.0381 cm |
| Aquifer porosity* | unitless | 0.43 | From Permit 235-B Amendment Volume V of V<br>Pages 467-473 (PDF)-1998<br>Reference Appendix C.7.1 |
| Bulk density | g/cc | 1.65 | From Permit 235-B Amendment Volume V of V<br>Pages 467-473 (PDF)-1998<br>Reference Appendix C.7.1 |
| Aquifer thickness | m | 10 | From Permit 235-B Amendment Volume V of V Pgs. 467-473 (PDF)-1998 Avg depth of uppermost aquifer<br>Reference Appendix C.7.1 |
| Mixing zone depth | m | | Derived by MULTIMED |
| Hydraulic conductivity | m/yr | 130 | From Permit 235-B Amendment Volume V of V<br>Pages 467-473 (PDF)-1998<br>Reference Appendix C.7.1<br>Average hydraulic conductivity of $4.12 \times 10^{-4}$ cm/sec |
| Hydraulic gradient | unitless | 0.002 | From Groundwater Contour Map (January 2016) |
| Groundwater seepage velocity | m/yr | | Derived by MULTIMED |
| Retardation coefficient | unitless | | Derived by MULTIMED |
| Longitudinal dispersivity | m | | Derived by MULTIMED |
| Transveral dispersivity | m | | Derived by MULTIMED |
| Vertical dispersivity | m | | Derived by MULTIMED |
| Organic carbon content | % | 0.003 | From Permit 235-B Amendment Volume V of V<br>Pages 467-473 (PDF)-1998<br>Reference Appendix C.7.1 |
| Receptor distance from well | m | Varies | Distance from analysis location to point of compliance. |
| Z-distance from water table | m | 0 | Assume water table is at bottom of liner. |

*** If Aquifer porosity is known MULTIMED will not use particle diameter.**

# APPENDIX D

# CALCULATIONS OF THE DILUTION ATTENUATION FACTOR (DAF)

For Permitting Purposes Only


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# APPENDIX D

# CALCULATIONS OF THE DILUTION ATTENUATION FACTOR (DAF)

For Permitting Purposes Only

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## CALCULATIONS OF THE DILUTION ATTENUATION FACTOR

Example Calculation for the Interim Case with Alternative Liner

Result from MULTIMED model:

Chemical concentration at the point of compliance = $0.2449 \times 10^{-4}$ mg/l
**(see MULTIMED model output)**

To find the resulting DAF, take the recipricol:

DAF= $1/\ 0.2449 \times 10^{-4}$ mg/1
**DAF= 40,833**

**Table 1**

| Location | Interim Case DAF | Closed Case DAF |
|---|---|---|
| Alternative Liner Location 1 | 40,833 | 102,301 |
| Alternative Liner Location 2 | 68,446 | 239,750 |
| Alternative Liner Location 3 | 137,381 | 481,231 |
| Alternative Liner Location 4 | 286,533 | 1,003,814 |

| Location | Interim Case DAF | Closed Case DAF |
|---|---|---|
| Overliner Location 1 | 18,797 | 65,833 |
| Overliner Location 2 | 77,640 | 232,450 |
| Overliner Location 3 | 158,253 | 473,934 |
| Overliner Location 4 | 615,385 | 1,842,639 |

# APPENDIX D.1

# TYPICAL PROFILE-ALTERNATIVE LINER INTERIM LANDFILL DAF

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04/24/19

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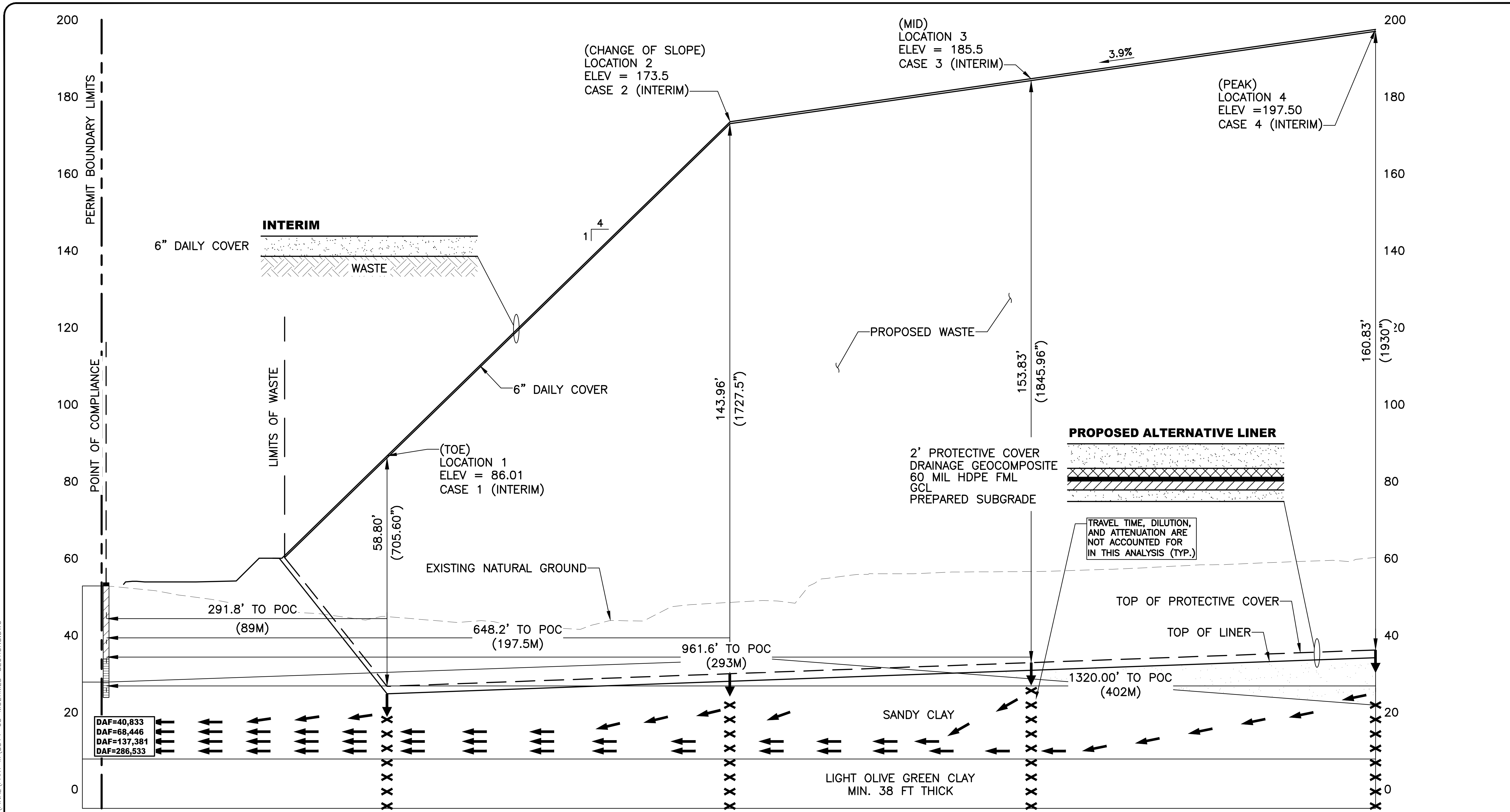


ALTERNATIVE LINER DEMONSTRATION – INTERIM LANDFILL CONDITION

1. USE HELP TO MODEL PERCOLATION THROUGH THE ALTERNATIVE LINER.
2. USE MULTIMED TO CALCULATE THE DILUTION ATTENUATION FACTOR (DAF).

| MULTIMED INFORMATION |
|---|
| AVERAGE AQUIFER THICKNESS = 32.81FT (10M)<br>HYDRAULIC CONDUCTIVITY = $4.12\times10^{-4}$ CM/SEC OR 130 M/YR<br>HYDRAULIC GRADIENT = i = 0.003125 |

NOTES:

1. EVANGELINE AQUIFER (500 FT BELOW GROUND SURFACE) (FRESH)
2. CHICOT AQUIFER (220 FT BELOW GROUND SURFACE)

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| NUMBER | REVISION | DATE | DRAWN | DESIGNED | REVIEWED |
|---|---|---|---|---|---|
| | | | | | |

STATE OF TEXAS
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Jose C. Garza, P.E.

Hanson No. 16L0438
Filename
Scale AS SHOWN
Date 04/23/2019

| LAYOUT | DT | 04/23/2019 |
|---|---|---|
| DRAWN | DT | 04/23/2019 |
| REVIEWED | JCG | 04/23/2019 |

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Hanson Professional Services Inc.
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Corpus Chrisiti, Texas 78411

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PART III, ATTACHMENT 5, APPENDIX D
TYPICAL PROFILE-ALTERNATIVE LINER
INTERIM LANDFILL DAF
CITY OF KINGSVILLE LANDFILL
MSW PERMIT No. 235-C
KINGSVILLE, TEXAS
KLEBERG COUNTY, TEXAS

FIGURE:
III.5-D.1

# APPENDIX D.2

# TYPICAL PROFILE-ALTERNATIVE LINER CLOSED LANDFILL DAF

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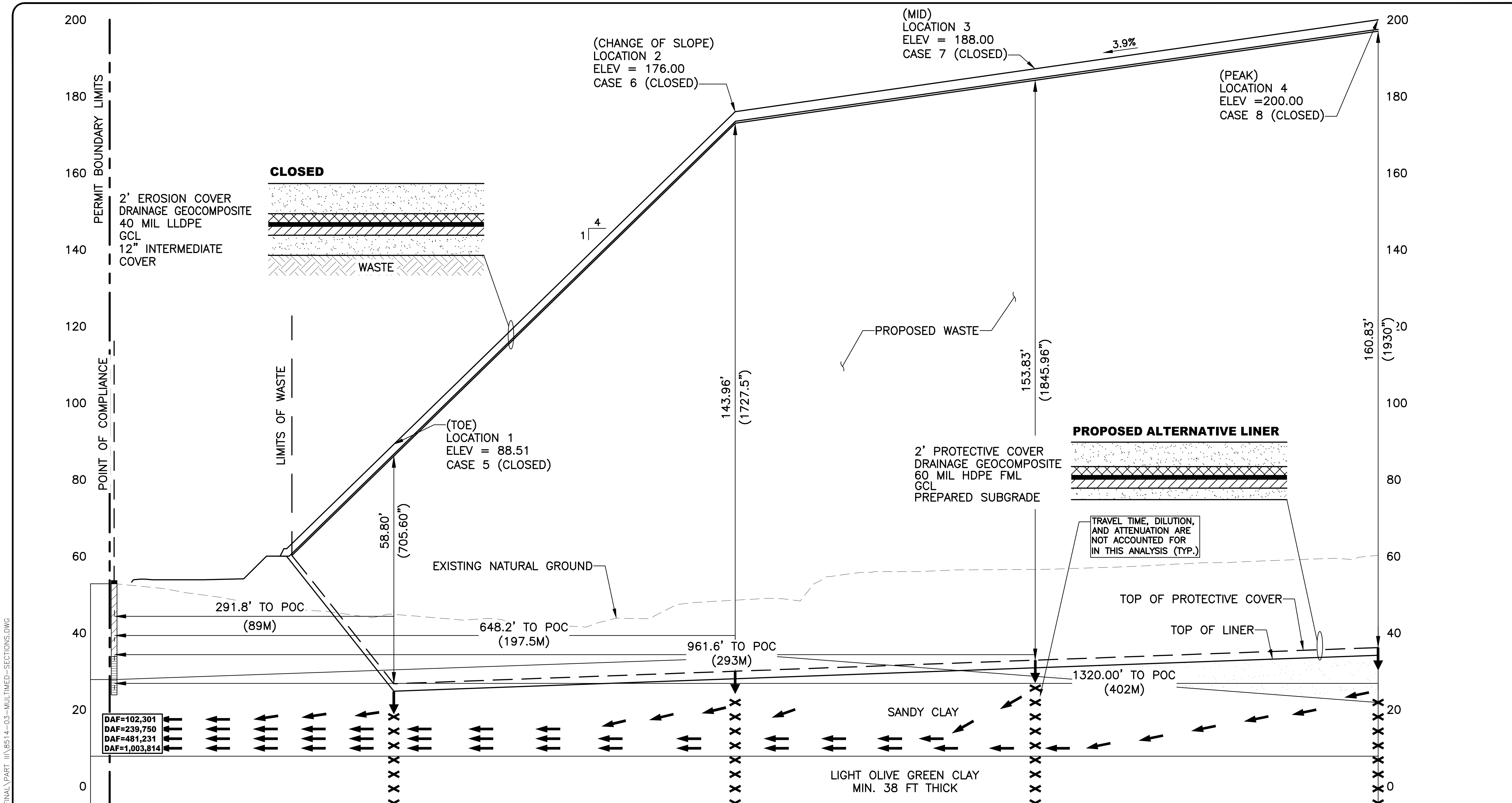


ALTERNATIVE LINER DEMONSTRATION – CLOSED LANDFILL CONDITION

1. USE HELP TO MODEL PERCOLATION THROUGH THE ALTERNATIVE LINER.
2. USE MULTIMED TO CALCULATE THE DILUTION ATTENUATION FACTOR (DAF).

**MULTIMED INFORMATION**

AVERAGE AQUIFER THICKNESS = 32.81FT (10M)
HYDRAULIC CONDUCTIVITY = $4.12 \times 10^{-4}$ CM/SEC OR 130 M/YR
HYDRAULIC GRADIENT = i = 0.003125

NOTES:

1. EVANGELINE AQUIFER (500 FT BELOW GROUND SURFACE) (FRESH)
2. CHICOT AQUIFER (220 FT BELOW GROUND SURFACE)

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| NUMBER | REVISION | DATE | DRAWN | DESIGNED | REVIEWED |
|---|---|---|---|---|---|
| | | | | | |

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Hanson No. 16L0438
Filename
Scale AS SHOWN
Date 04/23/2019

| | | |
|---|---|---|
| LAYOUT | DT | 04/23/2019 |
| DRAWN | DT | 04/23/2019 |
| REVIEWED | JCG | 04/23/2019 |

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PART III, ATTACHMENT 5, APPENDIX D
TYPICAL PROFILE-ALTERNATIVE LINER
CLOSED LANDFILL DAF
CITY OF KINGSVILLE LANDFILL
MSW PERMIT No. 235-C
KINGSVILLE, TEXAS
KLEBERG COUNTY, TEXAS

FIGURE:
III.5-D.2

# APPENDIX F

# MULTIMED MODEL OUTPUT

For Permitting Purposes Only

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# APPENDIX F.1

# MULTIMED OUTPUT FOR ALTERNATIVE LINER INTERIM CASE 1-LOCATION 1

For Permitting Purposes Only

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CASE1R

1

U. S. ENVIRONMENTAL PROTECTION AGENCY

EXPOSURE ASSESSMENT

MULTIMEDIA MODEL

MULTIMED (Version 1.01, June 1991)

1

Run options

--- -------

Case 1

Location 1

Chemical simulated is DEFAULT CHEMICAL

Option Chosen Saturated zone model
Run was DETERMIN
Infiltration input by user
Run was steady-state
Reject runs if Y coordinate outside plume
Reject runs if Z coordinate outside plume
Gaussian source used in saturated zone model

1

1

CHEMICAL SPECIFIC VARIABLES

| VARIABLE NAME | UNITS | DISTRIBUTION | PARAMETERS MEAN | PARAMETERS STD DEV | LIMITS MIN | LIMITS MAX |
|---|---|---|---|---|---|---|
| Solid phase decay coefficient | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 0.100E+11 |
| Dissolved phase decay coefficient | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 0.100E+11 |
| Overall chemical decay coefficient | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 0.100E+11 |
| Acid catalyzed hydrolysis rate | 1/M-yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Neutral hydrolysis rate constant | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Base catalyzed hydrolysis rate | 1/M-yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Reference temperature | C | CONSTANT | 20.0 | -999. | 0.000E+00 | 100. |
| Normalized distribution coefficient | ml/g | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Distribution coefficient | -- | DERIVED | -999. | -999. | 0.000E+00 | 0.100E+11 |
| Biodegradation coefficient (sat. zone) | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Air diffusion coefficient | cm2/s | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 10.0 |
| Reference temperature for air diffusion | C | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 100. |
| Molecular weight | g/M | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Mole fraction of solute | -- | CONSTANT | 0.000E+00 | -999. | 0.100E-08 | 1.00 |
| Vapor pressure of solute | mm Hg | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 100. |
| Henry's law constant | atm-m^3/M | CONSTANT | 0.000E+00 | -999. | 0.100E-09 | 1.00 |

Page 1

CASE1R

| | | | | | | |
|---|---|---|---|---|---|---|
| Overall 1st order decay sat. zone | 1/yr | DERIVED | 0.000E+00 | 0.000E+00 | 0.000E+00 | 1.00 |
| Not currently used | | CONSTANT | -999. | -999. | 0.000E+00 | 1.00 |
| Not currently used | | CONSTANT | -999. | -999. | 0.000E+00 | 1.00 |

1

SOURCE SPECIFIC VARIABLES

| VARIABLE NAME | UNITS | DISTRIBUTION | PARAMETERS MEAN | PARAMETERS STD DEV | LIMITS MIN | LIMITS MAX |
|---|---|---|---|---|---|---|
| Infiltration rate | m/yr | CONSTANT | 0.128E-06 | -999. | 0.100E-09 | 0.100E+11 |
| Area of waste disposal unit | m^2 | CONSTANT | 0.486E+06 | -999. | 0.100E-01 | -999. |
| Duration of pulse | yr | CONSTANT | -999. | -999. | 0.100E-08 | -999. |
| Spread of contaminant source | m | DERIVED | -999. | -999. | 0.100E-08 | 0.100E+11 |
| Recharge rate | m/yr | CONSTANT | 0.368E-01 | -999. | 0.000E+00 | 0.100E+11 |
| Source decay constant | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Initial concentration at landfill | mg/l | CONSTANT | 1.00 | -999. | 0.000E+00 | -999. |
| Length scale of facility | m | DERIVED | -999. | -999. | 0.100E-08 | 0.100E+11 |
| Width scale of facility | m | DERIVED | -999. | -999. | 0.100E-08 | 0.100E+11 |
| Near field dilution | | DERIVED | 1.00 | 0.000E+00 | 0.000E+00 | 1.00 |

1

AQUIFER SPECIFIC VARIABLES

| VARIABLE NAME | UNITS | DISTRIBUTION | PARAMETERS MEAN | PARAMETERS STD DEV | LIMITS MIN | LIMITS MAX |
|---|---|---|---|---|---|---|
| Particle diameter | cm | CONSTANT | 0.381E-01 | -999. | 0.100E-08 | 100. |
| Aquifer porosity | -- | CONSTANT | 0.430 | -999. | 0.100E-08 | 0.990 |
| Bulk density | g/cc | CONSTANT | 1.65 | -999. | 0.100E-01 | 5.00 |
| Aquifer thickness | m | CONSTANT | 10.0 | -999. | 0.100E-08 | 0.100E+06 |
| Source thickness (mixing zone depth) | m | DERIVED | -999. | -999. | 0.100E-08 | 0.100E+06 |
| Conductivity (hydraulic) | m/yr | CONSTANT | 130. | -999. | 0.100E-06 | 0.100E+09 |
| Gradient (hydraulic) | | CONSTANT | 0.310E-02 | -999. | 0.100E-07 | -999. |
| Groundwater seepage velocity | m/yr | DERIVED | -999. | -999. | 0.100E-09 | 0.100E+09 |
| Retardation coefficient | -- | DERIVED | -999. | -999. | 1.00 | 0.100E+09 |
| Longitudinal dispersivity | m | FUNCTION OF X | -999. | -999. | -999. | -999. |
| Transverse dispersivity | m | FUNCTION OF X | -999. | -999. | -999. | -999. |
| Vertical dispersivity | m | FUNCTION OF X | -999. | -999. | -999. | -999. |
| Temperature of aquifer | C | CONSTANT | 21.0 | -999. | 0.000E+00 | 100. |
| pH | -- | CONSTANT | 7.20 | -999. | 0.300 | 14.0 |
| Organic carbon content (fraction) | | CONSTANT | 0.300E-02 | -999. | 0.100E-05 | 1.00 |
| Well distance from site | m | CONSTANT | 89.0 | -999. | 1.00 | -999. |
| Angle off center | degree | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 360. |
| Well vertical distance | m | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 1.00 |

CONCENTRATION AFTER SATURATED ZONE MODEL 0.2449E-04

# APPENDIX F.2

# MULTIMED OUTPUT FOR ALTERNATIVE LINER INTERIM CASE 2-LOCATION 2

For Permitting Purposes Only

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1

U. S. ENVIRONMENTAL PROTECTION AGENCY

EXPOSURE ASSESSMENT

MULTIMEDIA MODEL

MULTIMED (Version 1.01, June 1991)

1

Run options
--- -------

Case 2

Location 2
Chemical simulated is DEFAULT CHEMICAL

| | |
|---|---|
| Option Chosen | Saturated zone model |
| Run was | DETERMIN |

Infiltration input by user
Run was steady-state
Reject runs if Y coordinate outside plume
Reject runs if Z coordinate outside plume
Gaussian source used in saturated zone model

1
1

CHEMICAL SPECIFIC VARIABLES

| VARIABLE NAME | UNITS | DISTRIBUTION | PARAMETERS MEAN | PARAMETERS STD DEV | LIMITS MIN | LIMITS MAX |
|---|---|---|---|---|---|---|
| Solid phase decay coefficient | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 0.100E+11 |
| Dissolved phase decay coefficient | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 0.100E+11 |
| Overall chemical decay coefficient | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 0.100E+11 |
| Acid catalyzed hydrolysis rate | 1/M-yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Neutral hydrolysis rate constant | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Base catalyzed hydrolysis rate | 1/M-yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Reference temperature | C | CONSTANT | 20.0 | -999. | 0.000E+00 | 100. |
| Normalized distribution coefficient | ml/g | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Distribution coefficient | -- | DERIVED | -999. | -999. | 0.000E+00 | 0.100E+11 |
| Biodegradation coefficient (sat. zone) | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Air diffusion coefficient | cm2/s | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 10.0 |
| Reference temperature for air diffusion | C | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 100. |
| Molecular weight | g/M | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Mole fraction of solute | -- | CONSTANT | 0.000E+00 | -999. | 0.100E-08 | 1.00 |
| Vapor pressure of solute | mm Hg | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 100. |
| Henry`s law constant | atm-m^3/M | CONSTANT | 0.000E+00 | -999. | 0.100E-09 | 1.00 |

CASE2R

| | | | | | | |
|---|---|---|---|---|---|---|
| Overall 1st order decay sat. zone | 1/yr | DERIVED | 0.000E+00 | 0.000E+00 | 0.000E+00 | 1.00 |
| Not currently used | | CONSTANT | -999. | -999. | 0.000E+00 | 1.00 |
| Not currently used | | CONSTANT | -999. | -999. | 0.000E+00 | 1.00 |

1

SOURCE SPECIFIC VARIABLES

| VARIABLE NAME | UNITS | DISTRIBUTION | PARAMETERS MEAN | PARAMETERS STD DEV | LIMITS MIN | LIMITS MAX |
|---|---|---|---|---|---|---|
| Infiltration rate | m/yr | CONSTANT | 0.179E-06 | -999. | 0.100E-09 | 0.100E+11 |
| Area of waste disposal unit | m^2 | CONSTANT | 0.486E+06 | -999. | 0.100E-01 | -999. |
| Duration of pulse | yr | CONSTANT | -999. | -999. | 0.100E-08 | -999. |
| Spread of contaminant source | m | DERIVED | -999. | -999. | 0.100E-08 | 0.100E+11 |
| Recharge rate | m/yr | CONSTANT | 0.368E-01 | -999. | 0.000E+00 | 0.100E+11 |
| Source decay constant | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Initial concentration at landfill | mg/l | CONSTANT | 1.00 | -999. | 0.000E+00 | -999. |
| Length scale of facility | m | DERIVED | -999. | -999. | 0.100E-08 | 0.100E+11 |
| Width scale of facility | m | DERIVED | -999. | -999. | 0.100E-08 | 0.100E+11 |
| Near field dilution | | DERIVED | 1.00 | 0.000E+00 | 0.000E+00 | 1.00 |

1

AQUIFER SPECIFIC VARIABLES

| VARIABLE NAME | UNITS | DISTRIBUTION | PARAMETERS MEAN | PARAMETERS STD DEV | LIMITS MIN | LIMITS MAX |
|---|---|---|---|---|---|---|
| Particle diameter | cm | CONSTANT | 0.381E-01 | -999. | 0.100E-08 | 100. |
| Aquifer porosity | -- | CONSTANT | 0.430 | -999. | 0.100E-08 | 0.990 |
| Bulk density | g/cc | CONSTANT | 1.65 | -999. | 0.100E-01 | 5.00 |
| Aquifer thickness | m | CONSTANT | 10.0 | -999. | 0.100E-08 | 0.100E+06 |
| Source thickness (mixing zone depth) | m | DERIVED | -999. | -999. | 0.100E-08 | 0.100E+06 |
| Conductivity (hydraulic) | m/yr | CONSTANT | 130. | -999. | 0.100E-06 | 0.100E+09 |
| Gradient (hydraulic) | | CONSTANT | 0.310E-02 | -999. | 0.100E-07 | -999. |
| Groundwater seepage velocity | m/yr | DERIVED | -999. | -999. | 0.100E-09 | 0.100E+09 |
| Retardation coefficient | -- | DERIVED | -999. | -999. | 1.00 | 0.100E+09 |
| Longitudinal dispersivity | m | FUNCTION OF X | -999. | -999. | -999. | -999. |
| Transverse dispersivity | m | FUNCTION OF X | -999. | -999. | -999. | -999. |
| Vertical dispersivity | m | FUNCTION OF X | -999. | -999. | -999. | -999. |
| Temperature of aquifer | C | CONSTANT | 21.0 | -999. | 0.000E+00 | 100. |
| pH | -- | CONSTANT | 7.20 | -999. | 0.300 | 14.0 |
| Organic carbon content (fraction) | | CONSTANT | 0.300E-02 | -999. | 0.100E-05 | 1.00 |
| Well distance from site | m | CONSTANT | 197. | -999. | 1.00 | -999. |
| Angle off center | degree | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 360. |
| Well vertical distance | m | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 1.00 |

CONCENTRATION AFTER SATURATED ZONE MODEL 0.1461E-04

# APPENDIX F.3

# MULTIMED OUTPUT FOR ALTERNATIVE LINER INTERIM CASE 3-LOCATION 3

For Permitting Purposes Only

STATE OF TEXAS
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04/24/19

Jose C. Garza, P.E.

TBPE Firm No. F-417

CASE3R

1

U. S.   E N V I R O N M E N T A L   P R O T E C T I O N   A G E N C Y

E X P O S U R E   A S S E S S M E N T

M U L T I M E D I A   M O D E L

MULTIMED (Version 1.01, June 1991)

1

Run options
--- -------

Case 3

Location 3
Chemical simulated is DEFAULT CHEMICAL

Option Chosen — Saturated zone model
Run was — DETERMIN
Infiltration input by user
Run was steady-state
Reject runs if Y coordinate outside plume
Reject runs if Z coordinate outside plume
Gaussian source used in saturated zone model

1
1

CHEMICAL SPECIFIC VARIABLES

| VARIABLE NAME | UNITS | DISTRIBUTION | PARAMETERS MEAN | PARAMETERS STD DEV | LIMITS MIN | LIMITS MAX |
|---|---|---|---|---|---|---|
| Solid phase decay coefficient | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 0.100E+11 |
| Dissolved phase decay coefficient | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 0.100E+11 |
| Overall chemical decay coefficient | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 0.100E+11 |
| Acid catalyzed hydrolysis rate | 1/M-yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Neutral hydrolysis rate constant | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Base catalyzed hydrolysis rate | 1/M-yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Reference temperature | C | CONSTANT | 20.0 | -999. | 0.000E+00 | 100. |
| Normalized distribution coefficient | ml/g | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Distribution coefficient | -- | DERIVED | -999. | -999. | 0.000E+00 | 0.100E+11 |
| Biodegradation coefficient (sat. zone) | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Air diffusion coefficient | cm2/s | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 10.0 |
| Reference temperature for air diffusion | C | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 100. |
| Molecular weight | g/M | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Mole fraction of solute | -- | CONSTANT | 0.000E+00 | -999. | 0.100E-08 | 1.00 |
| Vapor pressure of solute | mm Hg | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 100. |
| Henry`s law constant | atm-m^3/M | CONSTANT | 0.000E+00 | -999. | 0.100E-09 | 1.00 |

Page 1

CASE3R

| | | | | | | |
|---|---|---|---|---|---|---|
| Overall 1st order decay sat. zone | 1/yr | DERIVED | 0.000E+00 | 0.000E+00 | 0.000E+00 | 1.00 |
| Not currently used | | CONSTANT | -999. | -999. | 0.000E+00 | 1.00 |
| Not currently used | | CONSTANT | -999. | -999. | 0.000E+00 | 1.00 |

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SOURCE SPECIFIC VARIABLES

| VARIABLE NAME | UNITS | DISTRIBUTION | PARAMETERS MEAN | PARAMETERS STD DEV | LIMITS MIN | LIMITS MAX |
|---|---|---|---|---|---|---|
| Infiltration rate | m/yr | CONSTANT | 0.179E-06 | -999. | 0.100E-09 | 0.100E+11 |
| Area of waste disposal unit | m^2 | CONSTANT | 0.486E+06 | -999. | 0.100E-01 | -999. |
| Duration of pulse | yr | CONSTANT | -999. | -999. | 0.100E-08 | -999. |
| Spread of contaminant source | m | DERIVED | -999. | -999. | 0.100E-08 | 0.100E+11 |
| Recharge rate | m/yr | CONSTANT | 0.368E-01 | -999. | 0.000E+00 | 0.100E+11 |
| Source decay constant | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Initial concentration at landfill | mg/l | CONSTANT | 1.00 | -999. | 0.000E+00 | -999. |
| Length scale of facility | m | DERIVED | -999. | -999. | 0.100E-08 | 0.100E+11 |
| Width scale of facility | m | DERIVED | -999. | -999. | 0.100E-08 | 0.100E+11 |
| Near field dilution | | DERIVED | 1.00 | 0.000E+00 | 0.000E+00 | 1.00 |

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AQUIFER SPECIFIC VARIABLES

| VARIABLE NAME | UNITS | DISTRIBUTION | PARAMETERS MEAN | PARAMETERS STD DEV | LIMITS MIN | LIMITS MAX |
|---|---|---|---|---|---|---|
| Particle diameter | cm | CONSTANT | 0.381E-01 | -999. | 0.100E-08 | 100. |
| Aquifer porosity | -- | CONSTANT | 0.430 | -999. | 0.100E-08 | 0.990 |
| Bulk density | g/cc | CONSTANT | 1.65 | -999. | 0.100E-01 | 5.00 |
| Aquifer thickness | m | CONSTANT | 10.0 | -999. | 0.100E-08 | 0.100E+06 |
| Source thickness (mixing zone depth) | m | DERIVED | -999. | -999. | 0.100E-08 | 0.100E+06 |
| Conductivity (hydraulic) | m/yr | CONSTANT | 130. | -999. | 0.100E-06 | 0.100E+09 |
| Gradient (hydraulic) | | CONSTANT | 0.310E-02 | -999. | 0.100E-07 | -999. |
| Groundwater seepage velocity | m/yr | DERIVED | -999. | -999. | 0.100E-09 | 0.100E+09 |
| Retardation coefficient | -- | DERIVED | -999. | -999. | 1.00 | 0.100E+09 |
| Longitudinal dispersivity | m | FUNCTION OF X | -999. | -999. | -999. | -999. |
| Transverse dispersivity | m | FUNCTION OF X | -999. | -999. | -999. | -999. |
| Vertical dispersivity | m | FUNCTION OF X | -999. | -999. | -999. | -999. |
| Temperature of aquifer | C | CONSTANT | 21.0 | -999. | 0.000E+00 | 100. |
| pH | -- | CONSTANT | 7.20 | -999. | 0.300 | 14.0 |
| Organic carbon content (fraction) | | CONSTANT | 0.300E-02 | -999. | 0.100E-05 | 1.00 |
| Well distance from site | m | CONSTANT | 293. | -999. | 1.00 | -999. |
| Angle off center | degree | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 360. |
| Well vertical distance | m | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 1.00 |

CONCENTRATION AFTER SATURATED ZONE MODEL 0.7279E-05

# APPENDIX F.5

# MULTIMED OUTPUT FOR ALTERNATIVE LINER CLOSED CASE 5-LOCATION 1

For Permitting Purposes Only

STATE OF TEXAS
JOSE C. GARZA
91790
LICENSED
PROFESSIONAL ENGINEER

04/24/19

Jose C. Garza, P.E.

TBPE Firm No. 417

CASE5R

1

U. S. ENVIRONMENTAL PROTECTION AGENCY

EXPOSURE ASSESSMENT

MULTIMEDIA MODEL

MULTIMED (Version 1.01, June 1991)

1

Run options
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Case 5

Location 1
Chemical simulated is DEFAULT CHEMICAL

```
Option Chosen                      Saturated zone model
Run was                            DETERMIN
Infiltration input by user
Run was steady-state
Reject runs if Y coordinate outside plume
Reject runs if Z coordinate outside plume
Gaussian source used in saturated zone model
1
1
```

CHEMICAL SPECIFIC VARIABLES

| VARIABLE NAME | UNITS | DISTRIBUTION | PARAMETERS MEAN | PARAMETERS STD DEV | LIMITS MIN | LIMITS MAX |
|---|---|---|---|---|---|---|
| Solid phase decay coefficient | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 0.100E+11 |
| Dissolved phase decay coefficient | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 0.100E+11 |
| Overall chemical decay coefficient | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 0.100E+11 |
| Acid catalyzed hydrolysis rate | 1/M-yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Neutral hydrolysis rate constant | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Base catalyzed hydrolysis rate | 1/M-yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Reference temperature | C | CONSTANT | 20.0 | -999. | 0.000E+00 | 100. |
| Normalized distribution coefficient | ml/g | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Distribution coefficient | -- | DERIVED | -999. | -999. | 0.000E+00 | 0.100E+11 |
| Biodegradation coefficient (sat. zone) | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Air diffusion coefficient | cm2/s | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 10.0 |
| Reference temperature for air diffusion | C | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 100. |
| Molecular weight | g/M | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Mole fraction of solute | -- | CONSTANT | 0.000E+00 | -999. | 0.100E-08 | 1.00 |
| Vapor pressure of solute | mm Hg | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 100. |
| Henry`s law constant | atm-m^3/M | CONSTANT | 0.000E+00 | -999. | 0.100E-09 | 1.00 |

CASE5R

| | | | | | | |
|---|---|---|---|---|---|---|
| Overall 1st order decay sat. zone | 1/yr | DERIVED | 0.000E+00 | 0.000E+00 | 0.000E+00 | 1.00 |
| Not currently used | | CONSTANT | -999. | -999. | 0.000E+00 | 1.00 |
| Not currently used | | CONSTANT | -999. | -999. | 0.000E+00 | 1.00 |

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SOURCE SPECIFIC VARIABLES

| VARIABLE NAME | UNITS | DISTRIBUTION | PARAMETERS MEAN | PARAMETERS STD DEV | LIMITS MIN | LIMITS MAX |
|---|---|---|---|---|---|---|
| Infiltration rate | m/yr | CONSTANT | 0.511E-07 | -999. | 0.100E-09 | 0.100E+11 |
| Area of waste disposal unit | m^2 | CONSTANT | 0.486E+06 | -999. | 0.100E-01 | -999. |
| Duration of pulse | yr | CONSTANT | -999. | -999. | 0.100E-08 | -999. |
| Spread of contaminant source | m | DERIVED | -999. | -999. | 0.100E-08 | 0.100E+11 |
| Recharge rate | m/yr | CONSTANT | 0.368E-01 | -999. | 0.000E+00 | 0.100E+11 |
| Source decay constant | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Initial concentration at landfill | mg/l | CONSTANT | 1.00 | -999. | 0.000E+00 | -999. |
| Length scale of facility | m | DERIVED | -999. | -999. | 0.100E-08 | 0.100E+11 |
| Width scale of facility | m | DERIVED | -999. | -999. | 0.100E-08 | 0.100E+11 |
| Near field dilution | | DERIVED | 1.00 | 0.000E+00 | 0.000E+00 | 1.00 |

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AQUIFER SPECIFIC VARIABLES

| VARIABLE NAME | UNITS | DISTRIBUTION | PARAMETERS MEAN | PARAMETERS STD DEV | LIMITS MIN | LIMITS MAX |
|---|---|---|---|---|---|---|
| Particle diameter | cm | CONSTANT | 0.381E-01 | -999. | 0.100E-08 | 100. |
| Aquifer porosity | -- | CONSTANT | 0.430 | -999. | 0.100E-08 | 0.990 |
| Bulk density | g/cc | CONSTANT | 1.65 | -999. | 0.100E-01 | 5.00 |
| Aquifer thickness | m | CONSTANT | 10.0 | -999. | 0.100E-08 | 0.100E+06 |
| Source thickness (mixing zone depth) | m | DERIVED | -999. | -999. | 0.100E-08 | 0.100E+06 |
| Conductivity (hydraulic) | m/yr | CONSTANT | 130. | -999. | 0.100E-06 | 0.100E+09 |
| Gradient (hydraulic) | | CONSTANT | 0.310E-02 | -999. | 0.100E-07 | -999. |
| Groundwater seepage velocity | m/yr | DERIVED | -999. | -999. | 0.100E-09 | 0.100E+09 |
| Retardation coefficient | -- | DERIVED | -999. | -999. | 1.00 | 0.100E+09 |
| Longitudinal dispersivity | m | FUNCTION OF X | -999. | -999. | -999. | -999. |
| Transverse dispersivity | m | FUNCTION OF X | -999. | -999. | -999. | -999. |
| Vertical dispersivity | m | FUNCTION OF X | -999. | -999. | -999. | -999. |
| Temperature of aquifer | C | CONSTANT | 21.0 | -999. | 0.000E+00 | 100. |
| pH | -- | CONSTANT | 7.20 | -999. | 0.300 | 14.0 |
| Organic carbon content (fraction) | | CONSTANT | 0.300E-02 | -999. | 0.100E-05 | 1.00 |
| Well distance from site | m | CONSTANT | 89.0 | -999. | 1.00 | -999. |
| Angle off center | degree | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 360. |
| Well vertical distance | m | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 1.00 |

CONCENTRATION AFTER SATURATED ZONE MODEL 0.9775E-05

# APPENDIX F.6

# MULTIMED OUTPUT FOR ALTERNATIVE LINER CLOSED CASE 6-LOCATION 2

For Permitting Purposes Only

STATE OF TEXAS
JOSE C. GARZA
91790
LICENSED
PROFESSIONAL ENGINEER

04/24/19

Jose C. Garza, P.E.

TBPE Firm No. F-417

CASE6R

1

U. S. . E N V I R O N M E N T A L P R O T E C T I O N A G E N C Y

E X P O S U R E A S S E S S M E N T

M U L T I M E D I A M O D E L

MULTIMED (Version 1.01, June 1991)

1

Run options
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Case 6

Location 2
Chemical simulated is DEFAULT CHEMICAL

Option Chosen Saturated zone model
Run was DETERMIN
Infiltration input by user
Run was steady-state
Reject runs if Y coordinate outside plume
Reject runs if Z coordinate outside plume
Gaussian source used in saturated zone model
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CHEMICAL SPECIFIC VARIABLES

| VARIABLE NAME | UNITS | DISTRIBUTION | PARAMETERS MEAN | STD DEV | LIMITS MIN | MAX |
|---|---|---|---|---|---|---|
| Solid phase decay coefficient | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 0.100E+11 |
| Dissolved phase decay coefficient | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 0.100E+11 |
| Overall chemical decay coefficient | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 0.100E+11 |
| Acid catalyzed hydrolysis rate | 1/M-yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Neutral hydrolysis rate constant | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Base catalyzed hydrolysis rate | 1/M-yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Reference temperature | C | CONSTANT | 20.0 | -999. | 0.000E+00 | 100. |
| Normalized distribution coefficient | ml/g | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Distribution coefficient | -- | DERIVED | -999. | -999. | 0.000E+00 | 0.100E+11 |
| Biodegradation coefficient (sat. zone) | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Air diffusion coefficient | cm2/s | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 10.0 |
| Reference temperature for air diffusion | C | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 100. |
| Molecular weight | g/M | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Mole fraction of solute | -- | CONSTANT | 0.000E+00 | -999. | 0.100E-08 | 1.00 |
| Vapor pressure of solute | mm Hg | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 100. |
| Henry`s law constant | atm-m^3/M | CONSTANT | 0.000E+00 | -999. | 0.100E-09 | 1.00 |

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CASE6R

| | | | | | | |
|---|---|---|---|---|---|---|
| Overall 1st order decay sat. zone | 1/yr | DERIVED | 0.000E+00 | 0.000E+00 | 0.000E+00 | 1.00 |
| Not currently used | | CONSTANT | -999. | -999. | 0.000E+00 | 1.00 |
| Not currently used | | CONSTANT | -999. | -999. | 0.000E+00 | 1.00 |

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SOURCE SPECIFIC VARIABLES

| VARIABLE NAME | UNITS | DISTRIBUTION | PARAMETERS | | LIMITS | |
|---|---|---|---|---|---|---|
| | | | MEAN | STD DEV | MIN | MAX |
| Infiltration rate | m/yr | CONSTANT | 0.511E-07 | -999. | 0.100E-09 | 0.100E+11 |
| Area of waste disposal unit | m^2 | CONSTANT | 0.486E+06 | -999. | 0.100E-01 | -999. |
| Duration of pulse | yr | CONSTANT | -999. | -999. | 0.100E-08 | -999. |
| Spread of contaminant source | m | DERIVED | -999. | -999. | 0.100E-08 | 0.100E+11 |
| Recharge rate | m/yr | CONSTANT | 0.368E-01 | -999. | 0.000E+00 | 0.100E+11 |
| Source decay constant | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Initial concentration at landfill | mg/l | CONSTANT | 1.00 | -999. | 0.000E+00 | -999. |
| Length scale of facility | m | DERIVED | -999. | -999. | 0.100E-08 | 0.100E+11 |
| Width scale of facility | m | DERIVED | -999. | -999. | 0.100E-08 | 0.100E+11 |
| Near field dilution | | DERIVED | 1.00 | 0.000E+00 | 0.000E+00 | 1.00 |

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AQUIFER SPECIFIC VARIABLES

| VARIABLE NAME | UNITS | DISTRIBUTION | PARAMETERS | | LIMITS | |
|---|---|---|---|---|---|---|
| | | | MEAN | STD DEV | MIN | MAX |
| Particle diameter | cm | CONSTANT | 0.381E-01 | -999. | 0.100E-08 | 100. |
| Aquifer porosity | -- | CONSTANT | 0.430 | -999. | 0.100E-08 | 0.990 |
| Bulk density | g/cc | CONSTANT | 1.65 | -999. | 0.100E-01 | 5.00 |
| Aquifer thickness | m | CONSTANT | 10.0 | -999. | 0.100E-08 | 0.100E+06 |
| Source thickness (mixing zone depth) | m | DERIVED | -999. | -999. | 0.100E-08 | 0.100E+06 |
| Conductivity (hydraulic) | m/yr | CONSTANT | 130. | -999. | 0.100E-06 | 0.100E+09 |
| Gradient (hydraulic) | | CONSTANT | 0.310E-02 | -999. | 0.100E-07 | -999. |
| Groundwater seepage velocity | m/yr | DERIVED | -999. | -999. | 0.100E-09 | 0.100E+09 |
| Retardation coefficient | -- | DERIVED | -999. | -999. | 1.00 | 0.100E+09 |
| Longitudinal dispersivity | m | FUNCTION OF X | -999. | -999. | -999. | -999. |
| Transverse dispersivity | m | FUNCTION OF X | -999. | -999. | -999. | -999. |
| Vertical dispersivity | m | FUNCTION OF X | -999. | -999. | -999. | -999. |
| Temperature of aquifer | C | CONSTANT | 21.0 | -999. | 0.000E+00 | 100. |
| pH | -- | CONSTANT | 7.20 | -999. | 0.300 | 14.0 |
| Organic carbon content (fraction) | | CONSTANT | 0.300E-02 | -999. | 0.100E-05 | 1.00 |
| Well distance from site | m | CONSTANT | 197. | -999. | 1.00 | -999. |
| Angle off center | degree | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 360. |
| Well vertical distance | m | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 1.00 |

CONCENTRATION AFTER SATURATED ZONE MODEL 0.4171E-05

# APPENDIX F.7

# MULTIMED OUTPUT FOR ALTERNATIVE LINER CLOSED CASE 7-LOCATION 3

For Permitting Purposes Only

STATE OF TEXAS
JOSE C. GARZA
91790
LICENSED
PROFESSIONAL ENGINEER

04/24/19

Jose C. Garza, P.E.

TBPE Firm No. F-417

CASE7R

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          U. S.   E N V I R O N M E N T A L   P R O T E C T I O N   A G E N C Y

                         E X P O S U R E   A S S E S S M E N T

                            M U L T I M E D I A   M O D E L

                           MULTIMED  (Version 1.01, June 1991)
1
 Run options
 --- -------

 Case 7


 Location 3
 Chemical simulated is DEFAULT CHEMICAL


 Option Chosen                        Saturated zone model
 Run was                              DETERMIN
 Infiltration input by user
 Run was steady-state
 Reject runs if Y coordinate outside plume
 Reject runs if Z coordinate outside plume
 Gaussian source used in saturated zone model
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CHEMICAL SPECIFIC VARIABLES

| VARIABLE NAME | UNITS | DISTRIBUTION | PARAMETERS MEAN | PARAMETERS STD DEV | LIMITS MIN | LIMITS MAX |
|---|---|---|---|---|---|---|
| Solid phase decay coefficient | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 0.100E+11 |
| Dissolved phase decay coefficient | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 0.100E+11 |
| Overall chemical decay coefficient | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 0.100E+11 |
| Acid catalyzed hydrolysis rate | 1/M-yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Neutral hydrolysis rate constant | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Base catalyzed hydrolysis rate | 1/M-yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Reference temperature | C | CONSTANT | 20.0 | -999. | 0.000E+00 | 100. |
| Normalized distribution coefficient | ml/g | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Distribution coefficient | -- | DERIVED | -999. | -999. | 0.000E+00 | 0.100E+11 |
| Biodegradation coefficient (sat. zone) | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Air diffusion coefficient | cm2/s | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 10.0 |
| Reference temperature for air diffusion | C | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 100. |
| Molecular weight | g/M | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Mole fraction of solute | -- | CONSTANT | 0.000E+00 | -999. | 0.100E-08 | 1.00 |
| Vapor pressure of solute | mm Hg | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 100. |
| Henry`s law constant | atm-m^3/M | CONSTANT | 0.000E+00 | -999. | 0.100E-09 | 1.00 |

Page 1

CASE7R

| | | | | | | |
|---|---|---|---|---|---|---|
| Overall 1st order decay sat. zone | 1/yr | DERIVED | 0.000E+00 | 0.000E+00 | 0.000E+00 | 1.00 |
| Not currently used | | CONSTANT | -999. | -999. | 0.000E+00 | 1.00 |
| Not currently used | | CONSTANT | -999. | -999. | 0.000E+00 | 1.00 |

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SOURCE SPECIFIC VARIABLES

| VARIABLE NAME | UNITS | DISTRIBUTION | PARAMETERS MEAN | PARAMETERS STD DEV | LIMITS MIN | LIMITS MAX |
|---|---|---|---|---|---|---|
| Infiltration rate | m/yr | CONSTANT | 0.511E-07 | -999. | 0.100E-09 | 0.100E+11 |
| Area of waste disposal unit | m^2 | CONSTANT | 0.486E+06 | -999. | 0.100E-01 | -999. |
| Duration of pulse | yr | CONSTANT | -999. | -999. | 0.100E-08 | -999. |
| Spread of contaminant source | m | DERIVED | -999. | -999. | 0.100E-08 | 0.100E+11 |
| Recharge rate | m/yr | CONSTANT | 0.368E-01 | -999. | 0.000E+00 | 0.100E+11 |
| Source decay constant | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Initial concentration at landfill | mg/l | CONSTANT | 1.00 | -999. | 0.000E+00 | -999. |
| Length scale of facility | m | DERIVED | -999. | -999. | 0.100E-08 | 0.100E+11 |
| Width scale of facility | m | DERIVED | -999. | -999. | 0.100E-08 | 0.100E+11 |
| Near field dilution | | DERIVED | 1.00 | 0.000E+00 | 0.000E+00 | 1.00 |

1

AQUIFER SPECIFIC VARIABLES

| VARIABLE NAME | UNITS | DISTRIBUTION | PARAMETERS MEAN | PARAMETERS STD DEV | LIMITS MIN | LIMITS MAX |
|---|---|---|---|---|---|---|
| Particle diameter | cm | CONSTANT | 0.381E-01 | -999. | 0.100E-08 | 100. |
| Aquifer porosity | -- | CONSTANT | 0.430 | -999. | 0.100E-08 | 0.990 |
| Bulk density | g/cc | CONSTANT | 1.65 | -999. | 0.100E-01 | 5.00 |
| Aquifer thickness | m | CONSTANT | 10.0 | -999. | 0.100E-08 | 0.100E+06 |
| Source thickness (mixing zone depth) | m | DERIVED | -999. | -999. | 0.100E-08 | 0.100E+06 |
| Conductivity (hydraulic) | m/yr | CONSTANT | 130. | -999. | 0.100E-06 | 0.100E+09 |
| Gradient (hydraulic) | | CONSTANT | 0.310E-02 | -999. | 0.100E-07 | -999. |
| Groundwater seepage velocity | m/yr | DERIVED | -999. | -999. | 0.100E-09 | 0.100E+09 |
| Retardation coefficient | -- | DERIVED | -999. | -999. | 1.00 | 0.100E+09 |
| Longitudinal dispersivity | m | FUNCTION OF X | -999. | -999. | -999. | -999. |
| Transverse dispersivity | m | FUNCTION OF X | -999. | -999. | -999. | -999. |
| Vertical dispersivity | m | FUNCTION OF X | -999. | -999. | -999. | -999. |
| Temperature of aquifer | C | CONSTANT | 21.0 | -999. | 0.000E+00 | 100. |
| pH | -- | CONSTANT | 7.20 | -999. | 0.300 | 14.0 |
| Organic carbon content (fraction) | | CONSTANT | 0.300E-02 | -999. | 0.100E-05 | 1.00 |
| Well distance from site | m | CONSTANT | 293. | -999. | 1.00 | -999. |
| Angle off center | degree | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 360. |
| Well vertical distance | m | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 1.00 |

CONCENTRATION AFTER SATURATED ZONE MODEL 0.2078E-05

# APPENDIX G

# ALTERNATE COMPOSITE FINAL COVER DESIGN DEMONSTRATION

For Permitting Purposes Only

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04/24/19

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## 1.0 INTRODUCTION

This alternate composite final cover design demonstration will demonstrate that the use of a geosynthetic clay liner (GCL) will provide equivalent infiltration and protection from wind and water erosion as the conventional composite final cover defined in 30 TAC §330.457 (a).

### 1.1 Alternative Composite Liner System

The GCL Alternative Final Cover System is as follows from top to bottom:

25 - inch thick erosion layer
Double-sided geocomposite drainage layer
40-mil LLDPE textured geomembrane
GCL

GCLs are frequently used in liner systems. GCLs are geocomposite materials of low hydraulic conductivity and are readily available by several manufacturers. The GCLs have varying characteristics. They are generally manufactured by placing powdered or granulated bentonite on a geotextile or geomembrane substrate. The bentonite layer is typically 6 to 10 mm thick (following hydration) and is placed at a unit weight of approximately 0.8 pounds per square feet ($lb/ft^2$). The GCLs with a geotextile substrate also have a covering geotextile, which is often needle-punched, connecting the underlying geotextile to increase the structural integrity. Non-woven and woven geotextiles of various weights are used.

Generally, the permeability of the bentonite component of GCLs ranges from less than $1 \times 10^{-9}$ to $5 \times 10^{-9}$ cm/sec.

## 2.0 EQUIVALENCY

### 2.1 Leakage Rate Estimates

The leakage through composite liners can be estimated using the "Giroud equation", as illustrated in Appendix G.1. The method requires assumptions regarding the characteristics of the composite liner. It is assumed that permeation through the full area of the geomembrane is insignificant in comparison to rapid leakage through isolated defects or holes. Also, assumptions need to be made regarding the extent to which intimate contact has been made. A composite liner that has intimate contact has been constructed such that the geomembrane lies flush with the surface of the underlying clay component, with few or no gaps between two liners. When intimate contact has been achieved, the effective area of leakage is very small, and the total liner system leakage is minimized. This phenomenon is referred to as "composite action."

The equation used in the analysis is derived both from theoretical models of fluid flow and from empirical analyses of actual composite liner systems. Flow through a circular defect in a composite liner is calculated as follows:

$Q = C[1+0.1(h/t_s)^{0.95}]a^{0.1}h^{0.9}k_s^{0.74}$ [Ref 1] in Appendix G.1

Where:

Q = rate of leakage through a defect ($m^3$/sec)

# APPENDIX H

# MULTIMED MODEL SENSITIVITY ANALYSIS

For Permitting Purposes Only

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# MULTIMED MODEL SENSITIVITY ANALYSIS

## RESULTS

### Alternate Liner Demonstration Methods

The alternate liner demonstration methods are described in Section 2. ALTERNATE LINER DEMONSTRATION METHODS of this attachment.

### Model Input Parameters

Model input parameters are described in Section 3. MODEL INPUT PARAMETERS of this attachment.

### Point of Compliance Demonstration Results

Point of compliance Demonstration Results are described in Section 4. POINT OF COMPLIANCE DEMONSTRATION RESULTS of this attachment. Interim cases represent various waste fill heights at various locations (toe of slope, change of slope, midway, and at the peak) with daily cover. Various infiltration rates were determined and analyzed at various waste fill heights at the various locations using MULTIMED. As shown in Section 4, the most conservative case is at Overliner Location 1 with the lowest Interim Case DAF of 18,797. Therefore, Case 1OL (Interim) is selected as the most conservative Base Case for the MULTIMED Model Sensitivity Analysis and 15 variations from the base case are presented in Tables 1 and 2 in Appendix H.1 MULTIMED Model Sensitivity Analysis Tables and discussed below. MULTIMED Model Output Files are in Appendix H.3 .

### Base Case

The DAF for the base case is 18,797.

### Sensitivity to Leakage Rates

As referenced in Appendix H.2 HELP Model Input and Output Files for Case1OL Base Case & Case 1OL Base Case with Liner Defects (4 Defects/Acre); four defects per acre were used in the HELP model (CASE1OL base case with 4 liner defects) to calculate the leakage rate, which is a highly conservative case with a peak daily percolation/leakage rate of (0.00010 $ft^3$/day-ac) or 2.55 x $10^{-7}$ m/yr., the DAF decreases from the base case value to 13,194.

### Sensitivity to Recharge Rate

If the recharge rate is set to zero, the DAF is reduced to 8,780. The DAF will remain high because most of the dilution is occurring underneath the landfill.

**Sensitivity to Aquifer Porosity**

Varying the aquifer porosity from 0.2 to 0.6 yields no apparent change in DAFs from the base case because dilution under the landfill is independent of porosity when contaminant decay is neglected.

**Sensitivity to Bulk Density**

Varying the bulk density from 1.65 g/cc to 1.60 g/cc and 1.70 g/cc yields no apparent change in DAFs from the base case when considering variations of sandy clay and loam and sandy clay loam material.

**Sensitivity to Aquifer Thickness**

When the thickness of the aquifer is reduced to 5 m, the DAF decreases from the base case value to 18,409.The DAF decreases because the volume of uncontaminated groundwater beneath the landfill is reduced and the volumetric discharge from leakage remains the same.

**Sensitivity to Hydraulic Conductivity**

Significantly increasing and decreasing the hydraulic conductivity leads to an increase in the DAFs. DAFs range from 95,238 to 183,790. Under these conditions groundwater is moving either very slowly or very quickly through the media and there is more dilution underneath the landfill. An increase in hydraulic conductivity will increase the Darcy velocity. Under these conditions groundwater is moving faster and there is more dilution underneath the landfill due to mechanical dispersion. A decrease in hydraulic conductivity will decrease the Darcy velocity. Under these conditions groundwater is moving slower and there is more dilution underneath the landfill due to chemical diffusion.

**Sensitivity to Hydraulic Gradient**

Varying the hydraulic gradient from the base case of $2 \times 10^{-3}$ from low ($10^{-3)}$ to high ($10^{-1}$) causes the DAFs to increase considerably from 18,409 to 446,030. When the hydraulic gradient is decreased, the DAF is lower. Under these conditions groundwater is moving very slowly and there is less dilution underneath the landfill. When the hydraulic gradient is increased, the DAF is very high. Under these conditions groundwater is moving faster and there is more dilution underneath the landfill due to mechanical dispersion.

**Sensitivity to Organic Carbon Content**

If the organic carbon content is set to zero, the DAF remains the same at 18,797. The Aquifer Specific Data indicates that the organic carbon content is 0.003 and therefore reducing it to zero does not change the DAF.

### Sensitivity to Point of Compliance (POC)

If the distance to the POC is reduced conservatively to 2 m instead of 57.9 m, the DAF falls to 8,953. If the distance is increased to 150 m, the DAF rises to 54,705. This is likely due to the recharging of the aquifer and dilution of the contaminant plume with the increased distance.

## SUMMARY

1. A composite 60 mil HDPE geomembrane and geosynthetic clay liner (GCL) is proposed for use at the City of Kingsville Landfill as an alternative liner in which the GCL is substituted for the clay liner component of the standard clay/geomembrane composite liner.

2. A series of MULTIMED models were developed using methodology recommended in EPA (1990) and TWC (1993).

3. A conservative base case model was defined and was varied 15 times to evaluate sensitivity to various model parameters, including recharge rate, carbon content, hydraulic gradient, hydraulic conductivity, porosity, number of defects in liner, distance to point of compliance (POC), and aquifer thickness.

4. MULTIMED dilution attenuation factors (DAFs) were used to determine the effectiveness of the alternative liner design.

5. MULTIMED simulations demonstrate that the proposed alternative liner design and overliner design meets or exceeds the requirements of Title 30 TAC §330.331 (a) (1). The DAF's calculated by the use of HELP and MULTIMED are well in excess of the 260 minimum criterion. The actual DAFs are expected to be substantially higher that the DAFs predicted by this modeling demonstration because the model input was conservatively estimated as discussed in previous sections of this report.

## REFERENCES

Sharp-Hanson, S., C. Travers, P. Hummel, and T. Allison, 1990, "A Subtitle D Landfill Application Manual for the Multimedia Exposure Assessment Model (MULTIMED)," Environmental Research Laboratory, Office of Research and Development, U.S. Environmental Protection Agency, Athens, GA.

TWC, 1993, "Alternate Liner Design Handbook, Version 1," August 1993.

# APPENDIX H.1

# MULTIMED MODEL SENSITIVITY ANALYSIS TABLES

For Permitting Purposes Only

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## MULTIMED MODEL SENSITIVITY ANALYSIS TABLES

| Variable Name | Units | Value | Comments |
|---|---|---|---|
| Area of disposal unit | $m^2$ | 0.486 x $10^6$ | 120 acres |
| Leakage rate (Source Infiltration Rate) | m/yr | 0.179 x $10^{-6}$<br>**0.255 X $10^{-6}$* | 2 defects/acre<br>4 defects/acre |
| Recharge rate | m/yr | 0.368 x $10^{-1}$<br>**0* | Reference Appendix C.4<br>Variation |
| Initial concentration at landfill | mg/l | 1 | Set at 1.0 to find DAF |
| Aquifer porosity | Unitless | 0.43<br>**0.20*<br>**0.60* | Reference Appendix C.7.1<br>Variation<br>Variation |
| Bulk density | g/cc | 1.65<br>**1.60*<br>**1.70* | Reference Appendix C.7.1<br>Variation (Sandy Clay)<br>Variation (Loam & Sandy Clay Loam) |
| Aquifer thickness | m | 10<br>**5* | Reference Appendix C.7.1<br>Variation |
| Hydraulic conductivity | m/yr | 130<br>**1,299*<br>**12.99* | Reference Appendix C.7.1<br>(4.12 x $10^{-4}$ cm/sec)<br>(4.12 x $10^{-3}$ cm/sec) Variation<br>(4.12 x $10^{-5}$ cm/sec) Variation |
| Hydraulic gradient | Unitless | 0.200 x $10^{-2}$<br>**$10^{-3}$*<br>**$10^{-2}$*<br>**$10^{-1}$* | From Groundwater Map (January 2016)<br>Variation<br>Variation<br>Variation |
| Organic carbon content | % | 0.003<br>**0* | Reference Appendix C.7.1<br>Conservative Assumption |
| Point of compliance distance | m | 58<br>**2*<br>**150* | 190 ft<br>Variation<br>Variation |
| Z-distance from water table | m | 0 | Assume water table at bottom of liner. |

Table 1. MULTIMED source inputs for the base case values and changes from the base case values used for sensitivity analysis (shown with an asterisk and in italics).

| | Peak Percolation Through Liner (cf/day) | Peak Percolation Through Liner (m/yr) | MULTIMED Chemical Concentration at POC (mg/l) | DAF |
|---|---|---|---|---|
| **Base case** | **0.00007** | **1.79E-07** | **5.32E-05** | **18,797** |
| **Varied inputs** | | | | |
| Base case with four defects in liner | 0.0001 | 2.55E-07 | 7.58E-05 | 13,194 |
| Base case with zero recharge | 0.00007 | 1.79E-07 | 1.14E-04 | 8,780 |
| Base case with porosity = 0.2 | 0.00007 | 1.79E-07 | 5.32E-05 | 18,797 |
| Base case with porosity = 0.6 | 0.00007 | 1.79E-07 | 5.32E-05 | 18,797 |
| Base case with bulk density = 1.60 g/cc | 0.00007 | 1.79E-07 | 5.32E-05 | 18,797 |
| Base case with bulk density = 1.70 g/cc | 0.00007 | 1.79E-07 | 5.32E-05 | 18,797 |
| Base case with aquifer thickness of 5 m | 0.00007 | 1.79E-07 | 5.43E-05 | 18,409 |
| Base case with hydraulic conductivity = 1,299 m/yr | 0.00007 | 1.79E-07 | 1.05E-05 | 95,238 |
| Base case with hydraulic conductivity = 12.99 m/yr | 0.00007 | 1.79E-07 | 5.44E-06 | 183,790 |
| Base case with hydraulic gradient = $10^{-3}$ | 0.00007 | 1.79E-07 | 5.43E-05 | 18,409 |
| Base case with hydraulic gradient = $10^{-2}$ | 0.00007 | 1.79E-07 | 1.94E-05 | 51,573 |
| Base case with hydraulic gradient = $10^{-1}$ | 0.00007 | 1.79E-07 | 2.24E-06 | 446,030 |
| Base case with organic carbon content = 0% | 0.00007 | 1.79E-07 | 5.32E-05 | 18,797 |
| Base case with point of compliance at 2 m | 0.00007 | 1.79E-07 | 1.12E-04 | 8,953 |
| Base case with point of compliance at 150 m | 0.00007 | 1.79E-07 | 1.83E-05 | 54,705 |

Table 2. Dilution factors for each of the simulations of transport.

# APPENDIX H.2

# HELP MODEL INPUT AND OUTPUT FILES FOR CASE1OL BASE CASE & CASE1OL BASE CASE WITH LINER DEFECTS (4 DEFECTS/ACRE)

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04/24/19

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TBPE Firm No. F-417

```
                                 CASE1OLB.OUT

******************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
**              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:\HELP3\MDATA\KGVPR20Y.D4
TEMPERATURE DATA FILE:       C:\HELP3\MDATA\KGVTE20Y.D7
SOLAR RADIATION DATA FILE:   C:\HELP3\MDATA\KGVSO20Y.D13
EVAPOTRANSPIRATION DATA:     C:\HELP3\MDATA\KGVEV20Y.D11
SOIL AND DESIGN DATA FILE:   C:\HELP3\MDATA\CASE1OLB.D10
OUTPUT DATA FILE:            C:\HELP3\MDATA\CASE1OLB.OUT


TIME:  15:40      DATE:   4/11/2019


******************************************************************************

     TITLE:  CITY OF KINGSVILLE SOLID WASTE LANDFILL-CASE1OL BASE CASE

******************************************************************************


     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
            COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                                 LAYER  1
                                 --------

                   TYPE 1 - VERTICAL PERCOLATION LAYER
                      MATERIAL TEXTURE NUMBER  13
        THICKNESS                  =      6.00   INCHES
        POROSITY                   =      0.4300 VOL/VOL
        FIELD CAPACITY             =      0.3210 VOL/VOL
        WILTING POINT              =      0.2210 VOL/VOL
        INITIAL SOIL WATER CONTENT =      0.2210 VOL/VOL
        EFFECTIVE SAT. HYD. COND.  =  0.330000003000E-04 CM/SEC
      NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  3.00
             FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.


                                 LAYER  2
                                 --------

                   TYPE 1 - VERTICAL PERCOLATION LAYER
                      MATERIAL TEXTURE NUMBER  18
        THICKNESS                  =    144.00   INCHES
                                              Page 1
```

```
POROSITY                    =       0.6710 VOL/VOL
FIELD CAPACITY              =       0.2920 VOL/VOL
WILTING POINT               =       0.0770 VOL/VOL
INITIAL SOIL WATER CONTENT  =       0.2837 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC


                    LAYER  3
                    --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  13
THICKNESS                   =     24.00    INCHES
POROSITY                    =       0.4300 VOL/VOL
FIELD CAPACITY              =       0.3210 VOL/VOL
WILTING POINT               =       0.2210 VOL/VOL
INITIAL SOIL WATER CONTENT  =       0.3242 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.330000003000E-04 CM/SEC


                    LAYER  4
                    --------

            TYPE 2 - LATERAL DRAINAGE LAYER
              MATERIAL TEXTURE NUMBER  20
THICKNESS                   =      0.20    INCHES
POROSITY                    =       0.8500 VOL/VOL
FIELD CAPACITY              =       0.0100 VOL/VOL
WILTING POINT               =       0.0050 VOL/VOL
INITIAL SOIL WATER CONTENT  =       0.0181 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =    10.0000000000     CM/SEC
SLOPE                       =      2.00    PERCENT
DRAINAGE LENGTH             =    400.0     FEET


                    LAYER  5
                    --------

            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    =      2.00    HOLES/ACRE
FML PLACEMENT QUALITY       =  3 - GOOD


                    LAYER  6
                    --------

              TYPE 3 - BARRIER SOIL LINER
              MATERIAL TEXTURE NUMBER  17
THICKNESS                   =      0.24    INCHES
POROSITY                    =       0.7500 VOL/VOL
FIELD CAPACITY              =       0.7470 VOL/VOL
```

CASE1OLB.OUT

```
WILTING POINT              =        0.4000 VOL/VOL
INITIAL SOIL WATER CONTENT =        0.7500 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  0.300000003000E-08 CM/SEC
```

```
                    LAYER  7
                    --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
             MATERIAL TEXTURE NUMBER  13
THICKNESS                  =     30.00    INCHES
POROSITY                   =      0.4300 VOL/VOL
FIELD CAPACITY             =      0.3210 VOL/VOL
WILTING POINT              =      0.2210 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.3210 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  0.330000003000E-04 CM/SEC
```

```
                    LAYER  8
                    --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
             MATERIAL TEXTURE NUMBER  18
THICKNESS                  =    186.00    INCHES
POROSITY                   =      0.6710 VOL/VOL
FIELD CAPACITY             =      0.2920 VOL/VOL
WILTING POINT              =      0.0770 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.2919 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 #13 WITH A
          FAIR STAND OF GRASS, A SURFACE SLOPE OF 25.%
          AND A SLOPE LENGTH OF  100. FEET.

SCS RUNOFF CURVE NUMBER            =    89.50
FRACTION OF AREA ALLOWING RUNOFF   =    80.0     PERCENT
AREA PROJECTED ON HORIZONTAL PLANE =     1.000   ACRES
EVAPORATIVE ZONE DEPTH             =    12.0     INCHES
INITIAL WATER IN EVAPORATIVE ZONE  =     1.886   INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE =     6.606   INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE =     1.788   INCHES
INITIAL SNOW WATER                 =     0.000   INCHES
INITIAL WATER IN LAYER MATERIALS   =   114.065   INCHES
TOTAL INITIAL WATER                =   114.065   INCHES
TOTAL SUBSURFACE INFLOW            =     0.00    INCHES/YEAR
```

```
          EVAPOTRANSPIRATION AND WEATHER DATA
          -----------------------------------

NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
          CORPUS CHRISTI         TEXAS
```

CASE10LB.OUT

| | |
|---|---|
| STATION LATITUDE | = 27.77 DEGREES |
| MAXIMUM LEAF AREA INDEX | = 2.00 |
| START OF GROWING SEASON (JULIAN DATE) | = 0 |
| END OF GROWING SEASON (JULIAN DATE) | = 367 |
| EVAPORATIVE ZONE DEPTH | = 12.0 INCHES |
| AVERAGE ANNUAL WIND SPEED | = 12.00 MPH |
| AVERAGE 1ST QUARTER RELATIVE HUMIDITY | = 76.00 % |
| AVERAGE 2ND QUARTER RELATIVE HUMIDITY | = 78.00 % |
| AVERAGE 3RD QUARTER RELATIVE HUMIDITY | = 76.00 % |
| AVERAGE 4TH QUARTER RELATIVE HUMIDITY | = 76.00 % |

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR CORPUS CHRISTI TEXAS

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

| JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|
| 1.63 | 1.69 | 1.20 | 1.57 | 3.29 | 3.12 |
| 2.26 | 2.78 | 5.31 | 2.92 | 1.61 | 1.17 |

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR CORPUS CHRISTI TEXAS

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

| JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|
| 56.30 | 59.30 | 65.90 | 73.00 | 78.10 | 82.70 |
| 84.90 | 85.00 | 81.50 | 74.00 | 65.00 | 59.10 |

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR CORPUS CHRISTI TEXAS AND STATION LATITUDE = 27.77 DEGREES

*******************************************************************************

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 20

| | JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|---|
| PRECIPITATION | | | | | | |
| TOTALS | 1.15 | 2.02 | 1.05 | 1.42 | 2.41 | 2.71 |
| | 2.43 | 2.37 | 5.38 | 2.30 | 1.33 | 1.18 |
| STD. DEVIATIONS | 0.63 | 1.18 | 0.55 | 1.20 | 1.88 | 2.04 |
| | 2.55 | 1.63 | 3.12 | 1.75 | 1.17 | 0.85 |
| RUNOFF | | | | | | |
| TOTALS | 0.015 | 0.067 | 0.006 | 0.103 | 0.278 | 0.282 |
| | 0.377 | 0.192 | 0.779 | 0.173 | 0.073 | 0.019 |
| STD. DEVIATIONS | 0.042 | 0.081 | 0.009 | 0.233 | 0.504 | 0.344 |

CASE1OLB.OUT

```
                        0.815     0.200     0.918     0.257     0.214     0.065

EVAPOTRANSPIRATION
------------------
  TOTALS                0.927     2.081     1.305     1.245     1.981     2.108
                        2.038     1.886     3.610     2.255     1.096     1.069

  STD. DEVIATIONS       0.558     0.899     0.714     0.924     1.308     1.378
                        1.630     1.312     1.219     1.213     0.780     0.585

LATERAL DRAINAGE COLLECTED FROM LAYER  4
----------------------------------------
  TOTALS                0.0557    0.0293    0.0663    0.0567    0.0409    0.0574
                        0.1701    0.1696    0.1118    0.5501    0.3280    0.1472

  STD. DEVIATIONS       0.0736    0.0491    0.1278    0.1001    0.0685    0.1269
                        0.2914    0.3491    0.2088    0.8668    0.5012    0.2297

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  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    0.0004    0.0008    0.0007    0.0005    0.0007
                        0.0019    0.0019    0.0013    0.0063    0.0039    0.0017

  STD. DEVIATIONS       0.0008    0.0006    0.0015    0.0012    0.0008    0.0015
                        0.0033    0.0040    0.0025    0.0099    0.0059    0.0026

*******************************************************************************


*******************************************************************************

     AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS    1 THROUGH   20
-------------------------------------------------------------------------------
                                   INCHES              CU. FEET      PERCENT
                             -------------------    -------------   ---------
PRECIPITATION                 25.74   (   5.706)       93448.9       100.00

RUNOFF                         2.364  (  1.2831)        8580.98        9.183

EVAPOTRANSPIRATION            21.601  (  3.6817)       78409.91       83.907

LATERAL DRAINAGE COLLECTED     1.78305 (  1.49648)      6472.482       6.92623
  FROM LAYER  4
```

| | | | | |
|---|---|---|---|---|
| PERCOLATION/LEAKAGE THROUGH LAYER 6 | 0.00000 ( | 0.00000) | 0.004 | 0.00000 |
| AVERAGE HEAD ON TOP OF LAYER 5 | 0.002 ( | 0.001) | | |
| PERCOLATION/LEAKAGE THROUGH LAYER 8 | 0.00000 ( | 0.00000) | 0.000 | 0.00000 |
| CHANGE IN WATER STORAGE | -0.004 ( | 0.5412) | -14.46 | -0.015 |

*******************************************************************************

*******************************************************************************

PEAK DAILY VALUES FOR YEARS 1 THROUGH 20

| | (INCHES) | (CU. FT.) |
|---|---|---|
| PRECIPITATION | 5.07 | 18404.102 |
| RUNOFF | 2.156 | 7827.0879 |
| DRAINAGE COLLECTED FROM LAYER 4 | 0.19851 | 720.60400 |
| PERCOLATION/LEAKAGE THROUGH LAYER 6 | 0.000000 | 0.00007 |
| AVERAGE HEAD ON TOP OF LAYER 5 | 0.070 | |
| MAXIMUM HEAD ON TOP OF LAYER 5 | 0.139 | |
| LOCATION OF MAXIMUM HEAD IN LAYER 4 (DISTANCE FROM DRAIN) | 4.2 FEET | |
| PERCOLATION/LEAKAGE THROUGH LAYER 8 | 0.000000 | 0.00000 |
| SNOW WATER | 0.00 | 0.0000 |

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.3865

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.1490

*** 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 20

| LAYER | (INCHES) | (VOL/VOL) |
|---|---|---|

CASE1OLB.OUT

| | | |
|---|---|---|
| 1 | 1.4228 | 0.2371 |
| 2 | 40.7579 | 0.2830 |
| 3 | 7.7040 | 0.3210 |
| 4 | 0.0020 | 0.0100 |
| 5 | 0.0000 | 0.0000 |
| 6 | 0.1800 | 0.7500 |
| 7 | 9.6289 | 0.3210 |
| 8 | 54.2892 | 0.2919 |
| SNOW WATER | 0.000 | |

*****************************************************************************
*****************************************************************************

CASE1OLD.OUT

```
******************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
**              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:\HELP3\MDATA\KGVPR20Y.D4
TEMPERATURE DATA FILE:      C:\HELP3\MDATA\KGVTE20Y.D7
SOLAR RADIATION DATA FILE:  C:\HELP3\MDATA\KGVSO20Y.D13
EVAPOTRANSPIRATION DATA:    C:\HELP3\MDATA\KGVEV20Y.D11
SOIL AND DESIGN DATA FILE:  C:\HELP3\MDATA\CASE1OLD.D10
OUTPUT DATA FILE:           C:\HELP3\MDATA\CASE1OLD.OUT


TIME:  15:32     DATE:   4/11/2019


******************************************************************************

     TITLE:  CITY OF KINGSVILLE SOLID WASTE LANDFILL-CASE1OL (4 DEF/AC)

******************************************************************************


     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
            COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                             LAYER  1
                             --------

               TYPE 1 - VERTICAL PERCOLATION LAYER
                   MATERIAL TEXTURE NUMBER  13
        THICKNESS                  =       6.00   INCHES
        POROSITY                   =       0.4300 VOL/VOL
        FIELD CAPACITY             =       0.3210 VOL/VOL
        WILTING POINT              =       0.2210 VOL/VOL
        INITIAL SOIL WATER CONTENT =       0.2210 VOL/VOL
        EFFECTIVE SAT. HYD. COND.  =   0.330000003000E-04 CM/SEC
      NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY   3.00
             FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.


                             LAYER  2
                             --------

               TYPE 1 - VERTICAL PERCOLATION LAYER
                   MATERIAL TEXTURE NUMBER  18
        THICKNESS                  =     144.00   INCHES
```

CASE1OLD.OUT

```
POROSITY                        =        0.6710 VOL/VOL
FIELD CAPACITY                  =        0.2920 VOL/VOL
WILTING POINT                   =        0.0770 VOL/VOL
INITIAL SOIL WATER CONTENT      =        0.2837 VOL/VOL
EFFECTIVE SAT. HYD. COND.       =  0.100000005000E-02 CM/SEC


                     LAYER  3
                     --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
               MATERIAL TEXTURE NUMBER  13
THICKNESS                       =     24.00    INCHES
POROSITY                        =        0.4300 VOL/VOL
FIELD CAPACITY                  =        0.3210 VOL/VOL
WILTING POINT                   =        0.2210 VOL/VOL
INITIAL SOIL WATER CONTENT      =        0.3242 VOL/VOL
EFFECTIVE SAT. HYD. COND.       =  0.330000003000E-04 CM/SEC


                     LAYER  4
                     --------

            TYPE 2 - LATERAL DRAINAGE LAYER
               MATERIAL TEXTURE NUMBER  20
THICKNESS                       =      0.20    INCHES
POROSITY                        =        0.8500 VOL/VOL
FIELD CAPACITY                  =        0.0100 VOL/VOL
WILTING POINT                   =        0.0050 VOL/VOL
INITIAL SOIL WATER CONTENT      =        0.0181 VOL/VOL
EFFECTIVE SAT. HYD. COND.       =   10.0000000000      CM/SEC
SLOPE                           =      2.00    PERCENT
DRAINAGE LENGTH                 =    400.0     FEET


                     LAYER  5
                     --------

            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        =      4.00    HOLES/ACRE
FML PLACEMENT QUALITY           =  3 - GOOD


                     LAYER  6
                     --------

             TYPE 3 - BARRIER SOIL LINER
               MATERIAL TEXTURE NUMBER  17
THICKNESS                       =      0.24    INCHES
POROSITY                        =        0.7500 VOL/VOL
FIELD CAPACITY                  =        0.7470 VOL/VOL
```

CASE1OLD.OUT

```
WILTING POINT              =      0.4000 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.7500 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  0.300000003000E-08 CM/SEC


                    LAYER  7
                    --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  13
THICKNESS                  =     30.00   INCHES
POROSITY                   =      0.4300 VOL/VOL
FIELD CAPACITY             =      0.3210 VOL/VOL
WILTING POINT              =      0.2210 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.3210 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  0.330000003000E-04 CM/SEC


                    LAYER  8
                    --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  18
THICKNESS                  =    186.00   INCHES
POROSITY                   =      0.6710 VOL/VOL
FIELD CAPACITY             =      0.2920 VOL/VOL
WILTING POINT              =      0.0770 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.2919 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 #13 WITH A
         FAIR STAND OF GRASS, A SURFACE SLOPE OF 25.%
         AND A SLOPE LENGTH OF  100. FEET.

SCS RUNOFF CURVE NUMBER              =     89.50
FRACTION OF AREA ALLOWING RUNOFF     =     80.0    PERCENT
AREA PROJECTED ON HORIZONTAL PLANE   =      1.000  ACRES
EVAPORATIVE ZONE DEPTH               =     12.0    INCHES
INITIAL WATER IN EVAPORATIVE ZONE    =      1.886  INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE   =      6.606  INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE   =      1.788  INCHES
INITIAL SNOW WATER                   =      0.000  INCHES
INITIAL WATER IN LAYER MATERIALS     =    114.065  INCHES
TOTAL INITIAL WATER                  =    114.065  INCHES
TOTAL SUBSURFACE INFLOW              =      0.00   INCHES/YEAR


          EVAPOTRANSPIRATION AND WEATHER DATA
          -----------------------------------

NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
         CORPUS CHRISTI        TEXAS
```

CASE1OLD.OUT

```
STATION LATITUDE                              =  27.77 DEGREES
MAXIMUM LEAF AREA INDEX                       =   2.00
START OF GROWING SEASON (JULIAN DATE)         =     0
END OF GROWING SEASON (JULIAN DATE)           =   367
EVAPORATIVE ZONE DEPTH                        =  12.0  INCHES
AVERAGE ANNUAL WIND SPEED                     =  12.00 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY         =  76.00 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY         =  78.00 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY         =  76.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY         =  76.00 %
```

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR CORPUS CHRISTI TEXAS

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

| JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|
| 1.63 | 1.69 | 1.20 | 1.57 | 3.29 | 3.12 |
| 2.26 | 2.78 | 5.31 | 2.92 | 1.61 | 1.17 |

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR CORPUS CHRISTI TEXAS

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

| JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|
| 56.30 | 59.30 | 65.90 | 73.00 | 78.10 | 82.70 |
| 84.90 | 85.00 | 81.50 | 74.00 | 65.00 | 59.10 |

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR CORPUS CHRISTI TEXAS
AND STATION LATITUDE = 27.77 DEGREES

*******************************************************************************

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 20

| | JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|---|
| PRECIPITATION | | | | | | |
| TOTALS | 1.15 | 2.02 | 1.05 | 1.42 | 2.41 | 2.71 |
| | 2.43 | 2.37 | 5.38 | 2.30 | 1.33 | 1.18 |
| STD. DEVIATIONS | 0.63 | 1.18 | 0.55 | 1.20 | 1.88 | 2.04 |
| | 2.55 | 1.63 | 3.12 | 1.75 | 1.17 | 0.85 |
| RUNOFF | | | | | | |
| TOTALS | 0.015 | 0.067 | 0.006 | 0.103 | 0.278 | 0.282 |
| | 0.377 | 0.192 | 0.779 | 0.173 | 0.073 | 0.019 |
| STD. DEVIATIONS | 0.042 | 0.081 | 0.009 | 0.233 | 0.504 | 0.344 |

CASE1OLD.OUT

| | | | | | | |
|---|---|---|---|---|---|---|
| | 0.815 | 0.200 | 0.918 | 0.257 | 0.214 | 0.065 |

EVAPOTRANSPIRATION

| | | | | | | |
|---|---|---|---|---|---|---|
| TOTALS | 0.927 | 2.081 | 1.305 | 1.245 | 1.981 | 2.108 |
| | 2.038 | 1.886 | 3.610 | 2.255 | 1.096 | 1.069 |
| STD. DEVIATIONS | 0.558 | 0.899 | 0.714 | 0.924 | 1.308 | 1.378 |
| | 1.630 | 1.312 | 1.219 | 1.213 | 0.780 | 0.585 |

LATERAL DRAINAGE COLLECTED FROM LAYER 4

| | | | | | | |
|---|---|---|---|---|---|---|
| TOTALS | 0.0557 | 0.0293 | 0.0663 | 0.0567 | 0.0409 | 0.0574 |
| | 0.1701 | 0.1696 | 0.1118 | 0.5501 | 0.3280 | 0.1472 |
| STD. DEVIATIONS | 0.0736 | 0.0491 | 0.1278 | 0.1001 | 0.0685 | 0.1269 |
| | 0.2914 | 0.3491 | 0.2088 | 0.8668 | 0.5012 | 0.2297 |

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 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 | 0.0004 | 0.0008 | 0.0007 | 0.0005 | 0.0007 |
| | 0.0019 | 0.0019 | 0.0013 | 0.0063 | 0.0039 | 0.0017 |
| STD. DEVIATIONS | 0.0008 | 0.0006 | 0.0015 | 0.0012 | 0.0008 | 0.0015 |
| | 0.0033 | 0.0040 | 0.0025 | 0.0099 | 0.0059 | 0.0026 |

*******************************************************************************

*******************************************************************************

AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 20

| | INCHES | | CU. FEET | PERCENT |
|---|---|---|---|---|
| PRECIPITATION | 25.74 | ( 5.706) | 93448.9 | 100.00 |
| RUNOFF | 2.364 | ( 1.2831) | 8580.98 | 9.183 |
| EVAPOTRANSPIRATION | 21.601 | ( 3.6817) | 78409.91 | 83.907 |
| LATERAL DRAINAGE COLLECTED FROM LAYER 4 | 1.78305 | ( 1.49648) | 6472.482 | 6.92623 |

CASE1OLD.OUT

```
PERCOLATION/LEAKAGE THROUGH     0.00000 (  0.00000)        0.004     0.00000
  LAYER  6

AVERAGE HEAD ON TOP             0.002 (    0.001)
  OF LAYER  5

PERCOLATION/LEAKAGE THROUGH     0.00000 (  0.00000)        0.000     0.00000
  LAYER  8

CHANGE IN WATER STORAGE        -0.004   (  0.5412)       -14.46     -0.015

*******************************************************************************


*******************************************************************************

            PEAK DAILY VALUES FOR YEARS    1 THROUGH   20
  ------------------------------------------------------------------------
                                              (INCHES)      (CU. FT.)
                                             ----------   -------------
     PRECIPITATION                              5.07        18404.102

     RUNOFF                                     2.156        7827.0879

     DRAINAGE COLLECTED FROM LAYER  4           0.19851       720.60400

     PERCOLATION/LEAKAGE THROUGH LAYER  6       0.000000        0.00010

     AVERAGE HEAD ON TOP OF LAYER  5            0.070

     MAXIMUM HEAD ON TOP OF LAYER  5            0.139

     LOCATION OF MAXIMUM HEAD IN LAYER  4
           (DISTANCE FROM DRAIN)                4.2 FEET

     PERCOLATION/LEAKAGE THROUGH LAYER  8       0.000000        0.00000

     SNOW WATER                                 0.00            0.0000


     MAXIMUM VEG. SOIL WATER (VOL/VOL)                  0.3865

     MINIMUM VEG. SOIL WATER (VOL/VOL)                  0.1490

      ***  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   20
  ------------------------------------------------------------------------
                 LAYER        (INCHES)       (VOL/VOL)
                 -----        --------       ---------
```

CASE1OLD.OUT

| | | |
|---|---|---|
| 1 | 1.4228 | 0.2371 |
| 2 | 40.7579 | 0.2830 |
| 3 | 7.7040 | 0.3210 |
| 4 | 0.0020 | 0.0100 |
| 5 | 0.0000 | 0.0000 |
| 6 | 0.1800 | 0.7500 |
| 7 | 9.6289 | 0.3210 |
| 8 | 54.2892 | 0.2919 |
| SNOW WATER | 0.000 | |

******************************************************************************
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# APPENDIX H.3

# MULTIMED MODEL OUTPUT FILES

For Permitting Purposes Only

STATE OF TEXAS
JOSE C. GARZA
91790
LICENSED
PROFESSIONAL ENGINEER

04/24/19

Jose C. Garza, P.E.

TBPE Firm No. F-417

CASE10LB

1 U. S. ENVIRONMENTAL PROTECTION AGENCY

EXPOSURE ASSESSMENT

MULTIMEDIA MODEL

MULTIMED (Version 1.01, June 1991)

1

Run options

--- -------

CASE1OL Base Case

Location 1

Chemical simulated is DEFAULT CHEMICAL

| | |
|---|---|
| Option Chosen | Saturated zone model |
| Run was | DETERMIN |

Infiltration input by user

Run was steady-state

Reject runs if Y coordinate outside plume

Reject runs if Z coordinate outside plume

Gaussian source used in saturated zone model

1

1

CHEMICAL SPECIFIC VARIABLES

| VARIABLE NAME | UNITS | DISTRIBUTION | PARAMETERS MEAN | PARAMETERS STD DEV | LIMITS MIN | LIMITS MAX |
|---|---|---|---|---|---|---|
| Solid phase decay coefficient | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 0.100E+11 |
| Dissolved phase decay coefficient | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 0.100E+11 |
| Overall chemical decay coefficient | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 0.100E+11 |
| Acid catalyzed hydrolysis rate | 1/M-yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Neutral hydrolysis rate constant | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Base catalyzed hydrolysis rate | 1/M-yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Reference temperature | C | CONSTANT | 20.0 | -999. | 0.000E+00 | 100. |
| Normalized distribution coefficient | ml/g | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Distribution coefficient | -- | DERIVED | -999. | -999. | 0.000E+00 | 0.100E+11 |
| Biodegradation coefficient (sat. zone) | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Air diffusion coefficient | cm2/s | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 10.0 |
| Reference temperature for air diffusion | C | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 100. |
| Molecular weight | g/M | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Mole fraction of solute | -- | CONSTANT | 0.000E+00 | -999. | 0.100E-08 | 1.00 |
| Vapor pressure of solute | mm Hg | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 100. |
| Henry`s law constant | atm-m^3/M | CONSTANT | 0.000E+00 | -999. | 0.100E-09 | 1.00 |
| Overall 1st order decay sat. zone | 1/yr | DERIVED | 0.000E+00 | 0.000E+00 | 0.000E+00 | 1.00 |

CASE1OLB

| | | | | | |
|---|---|---|---|---|---|
| Not currently used | CONSTANT | -999. | -999. | 0.000E+00 | 1.00 |
| Not currently used | CONSTANT | -999. | -999. | 0.000E+00 | 1.00 |

1

SOURCE SPECIFIC VARIABLES

| VARIABLE NAME | UNITS | DISTRIBUTION | PARAMETERS MEAN | PARAMETERS STD DEV | LIMITS MIN | LIMITS MAX |
|---|---|---|---|---|---|---|
| Infiltration rate | m/yr | CONSTANT | 0.179E-06 | -999. | 0.100E-09 | 0.100E+11 |
| Area of waste disposal unit | m^2 | CONSTANT | 0.486E+06 | -999. | 0.100E-01 | -999. |
| Duration of pulse | yr | CONSTANT | -999. | -999. | 0.100E-08 | -999. |
| Spread of contaminant source | m | DERIVED | -999. | -999. | 0.100E-08 | 0.100E+11 |
| Recharge rate | m/yr | CONSTANT | 0.368E-01 | -999. | 0.000E+00 | 0.100E+11 |
| Source decay constant | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Initial concentration at landfill | mg/l | CONSTANT | 1.00 | -999. | 0.000E+00 | -999. |
| Length scale of facility | m | DERIVED | -999. | -999. | 0.100E-08 | 0.100E+11 |
| Width scale of facility | m | DERIVED | -999. | -999. | 0.100E-08 | 0.100E+11 |
| Near field dilution | | DERIVED | 1.00 | 0.000E+00 | 0.000E+00 | 1.00 |

1

AQUIFER SPECIFIC VARIABLES

| VARIABLE NAME | UNITS | DISTRIBUTION | PARAMETERS MEAN | PARAMETERS STD DEV | LIMITS MIN | LIMITS MAX |
|---|---|---|---|---|---|---|
| Particle diameter | cm | CONSTANT | 0.381E-01 | -999. | 0.100E-08 | 100. |
| Aquifer porosity | -- | CONSTANT | 0.430 | -999. | 0.100E-08 | 0.990 |
| Bulk density | g/cc | CONSTANT | 1.65 | -999. | 0.100E-01 | 5.00 |
| Aquifer thickness | m | CONSTANT | 10.0 | -999. | 0.100E-08 | 0.100E+06 |
| Source thickness (mixing zone depth) | m | DERIVED | -999. | -999. | 0.100E-08 | 0.100E+06 |
| Conductivity (hydraulic) | m/yr | CONSTANT | 130. | -999. | 0.100E-06 | 0.100E+09 |
| Gradient (hydraulic) | | CONSTANT | 0.200E-02 | -999. | 0.100E-07 | -999. |
| Groundwater seepage velocity | m/yr | DERIVED | -999. | -999. | 0.100E-09 | 0.100E+09 |
| Retardation coefficient | -- | DERIVED | -999. | -999. | 1.00 | 0.100E+09 |
| Longitudinal dispersivity | m | FUNCTION OF X | -999. | -999. | -999. | -999. |
| Transverse dispersivity | m | FUNCTION OF X | -999. | -999. | -999. | -999. |
| Vertical dispersivity | m | FUNCTION OF X | -999. | -999. | -999. | -999. |
| Temperature of aquifer | C | CONSTANT | 21.0 | -999. | 0.000E+00 | 100. |
| pH | -- | CONSTANT | 7.20 | -999. | 0.300 | 14.0 |
| Organic carbon content (fraction) | | CONSTANT | 0.300E-02 | -999. | 0.100E-05 | 1.00 |
| Well distance from site | m | CONSTANT | 58.0 | -999. | 1.00 | -999. |
| Angle off center | degree | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 360. |
| Well vertical distance | m | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 1.00 |

CONCENTRATION AFTER SATURATED ZONE MODEL 0.5320E-04

CASE1OLD

1 U. S. ENVIRONMENTAL PROTECTION AGENCY

EXPOSURE ASSESSMENT

MULTIMEDIA MODEL

MULTIMED (Version 1.01, June 1991)

1

Run options
--- -------

CASE1OL Base Case With 4 Defects Per Acre in Liner

Location 1
Chemical simulated is DEFAULT CHEMICAL

Option Chosen Saturated zone model
Run was DETERMIN
Infiltration input by user
Run was steady-state
Reject runs if Y coordinate outside plume
Reject runs if Z coordinate outside plume
Gaussian source used in saturated zone model
1
1

CHEMICAL SPECIFIC VARIABLES

| VARIABLE NAME | UNITS | DISTRIBUTION | PARAMETERS | | LIMITS | |
|---|---|---|---|---|---|---|
| | | | MEAN | STD DEV | MIN | MAX |
| Solid phase decay coefficient | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 0.100E+11 |
| Dissolved phase decay coefficient | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 0.100E+11 |
| Overall chemical decay coefficient | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 0.100E+11 |
| Acid catalyzed hydrolysis rate | 1/M-yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Neutral hydrolysis rate constant | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Base catalyzed hydrolysis rate | 1/M-yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Reference temperature | C | CONSTANT | 20.0 | -999. | 0.000E+00 | 100. |
| Normalized distribution coefficient | ml/g | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Distribution coefficient | -- | DERIVED | -999. | -999. | 0.000E+00 | 0.100E+11 |
| Biodegradation coefficient (sat. zone) | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Air diffusion coefficient | cm2/s | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 10.0 |
| Reference temperature for air diffusion | C | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 100. |
| Molecular weight | g/M | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Mole fraction of solute | -- | CONSTANT | 0.000E+00 | -999. | 0.100E-08 | 1.00 |
| Vapor pressure of solute | mm Hg | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 100. |
| Henry`s law constant | atm-m^3/M | CONSTANT | 0.000E+00 | -999. | 0.100E-09 | 1.00 |
| Overall 1st order decay sat. zone | 1/yr | DERIVED | 0.000E+00 | 0.000E+00 | 0.000E+00 | 1.00 |

CASE1OLD

| | | | | | | |
|---|---|---|---|---|---|---|
| Not currently used | | CONSTANT | -999. | -999. | 0.000E+00 | 1.00 |
| Not currently used | | CONSTANT | -999. | -999. | 0.000E+00 | 1.00 |

1

SOURCE SPECIFIC VARIABLES

| VARIABLE NAME | UNITS | DISTRIBUTION | PARAMETERS MEAN | PARAMETERS STD DEV | LIMITS MIN | LIMITS MAX |
|---|---|---|---|---|---|---|
| Infiltration rate | m/yr | CONSTANT | 0.255E-06 | -999. | 0.100E-09 | 0.100E+11 |
| Area of waste disposal unit | m^2 | CONSTANT | 0.486E+06 | -999. | 0.100E-01 | -999. |
| Duration of pulse | yr | CONSTANT | -999. | -999. | 0.100E-08 | -999. |
| Spread of contaminant source | m | DERIVED | -999. | -999. | 0.100E-08 | 0.100E+11 |
| Recharge rate | m/yr | CONSTANT | 0.368E-01 | -999. | 0.000E+00 | 0.100E+11 |
| Source decay constant | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Initial concentration at landfill | mg/l | CONSTANT | 1.00 | -999. | 0.000E+00 | -999. |
| Length scale of facility | m | DERIVED | -999. | -999. | 0.100E-08 | 0.100E+11 |
| Width scale of facility | m | DERIVED | -999. | -999. | 0.100E-08 | 0.100E+11 |
| Near field dilution | | DERIVED | 1.00 | 0.000E+00 | 0.000E+00 | 1.00 |

1

AQUIFER SPECIFIC VARIABLES

| VARIABLE NAME | UNITS | DISTRIBUTION | PARAMETERS MEAN | PARAMETERS STD DEV | LIMITS MIN | LIMITS MAX |
|---|---|---|---|---|---|---|
| Particle diameter | cm | CONSTANT | 0.381E-01 | -999. | 0.100E-08 | 100. |
| Aquifer porosity | -- | CONSTANT | 0.430 | -999. | 0.100E-08 | 0.990 |
| Bulk density | g/cc | CONSTANT | 1.65 | -999. | 0.100E-01 | 5.00 |
| Aquifer thickness | m | CONSTANT | 10.0 | -999. | 0.100E-08 | 0.100E+06 |
| Source thickness (mixing zone depth) | m | DERIVED | -999. | -999. | 0.100E-08 | 0.100E+06 |
| Conductivity (hydraulic) | m/yr | CONSTANT | 130. | -999. | 0.100E-06 | 0.100E+09 |
| Gradient (hydraulic) | | CONSTANT | 0.200E-02 | -999. | 0.100E-07 | -999. |
| Groundwater seepage velocity | m/yr | DERIVED | -999. | -999. | 0.100E-09 | 0.100E+09 |
| Retardation coefficient | -- | DERIVED | -999. | -999. | 1.00 | 0.100E+09 |
| Longitudinal dispersivity | m | FUNCTION OF X | -999. | -999. | -999. | -999. |
| Transverse dispersivity | m | FUNCTION OF X | -999. | -999. | -999. | -999. |
| Vertical dispersivity | m | FUNCTION OF X | -999. | -999. | -999. | -999. |
| Temperature of aquifer | C | CONSTANT | 21.0 | -999. | 0.000E+00 | 100. |
| pH | -- | CONSTANT | 7.20 | -999. | 0.300 | 14.0 |
| Organic carbon content (fraction) | | CONSTANT | 0.300E-02 | -999. | 0.100E-05 | 1.00 |
| Well distance from site | m | CONSTANT | 58.0 | -999. | 1.00 | -999. |
| Angle off center | degree | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 360. |
| Well vertical distance | m | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 1.00 |

CONCENTRATION AFTER SATURATED ZONE MODEL 0.7579E-04

CASE10LR

1

U. S. ENVIRONMENTAL PROTECTION AGENCY

EXPOSURE ASSESSMENT

MULTIMEDIA MODEL

MULTIMED (Version 1.01, June 1991)

1

Run options
--- -------

CASE10L Base Case With Zero Recharge

Location 1
Chemical simulated is DEFAULT CHEMICAL

```
Option Chosen                    Saturated zone model
Run was                          DETERMIN
Infiltration input by user
Run was steady-state
Reject runs if Y coordinate outside plume
Reject runs if Z coordinate outside plume
Gaussian source used in saturated zone model
```

1
1

CHEMICAL SPECIFIC VARIABLES

| VARIABLE NAME | UNITS | DISTRIBUTION | PARAMETERS | | LIMITS | |
|---|---|---|---|---|---|---|
| | | | MEAN | STD DEV | MIN | MAX |
| Solid phase decay coefficient | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 0.100E+11 |
| Dissolved phase decay coefficient | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 0.100E+11 |
| Overall chemical decay coefficient | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 0.100E+11 |
| Acid catalyzed hydrolysis rate | 1/M-yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Neutral hydrolysis rate constant | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Base catalyzed hydrolysis rate | 1/M-yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Reference temperature | C | CONSTANT | 20.0 | -999. | 0.000E+00 | 100. |
| Normalized distribution coefficient | ml/g | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Distribution coefficient | -- | DERIVED | -999. | -999. | 0.000E+00 | 0.100E+11 |
| Biodegradation coefficient (sat. zone) | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Air diffusion coefficient | cm2/s | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 10.0 |
| Reference temperature for air diffusion | C | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 100. |
| Molecular weight | g/M | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Mole fraction of solute | -- | CONSTANT | 0.000E+00 | -999. | 0.100E-08 | 1.00 |
| Vapor pressure of solute | mm Hg | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 100. |
| Henry`s law constant | atm-m^3/M | CONSTANT | 0.000E+00 | -999. | 0.100E-09 | 1.00 |

Page 1

CASE1OLR

| | | | | | | |
|---|---|---|---|---|---|---|
| Overall 1st order decay sat. zone | 1/yr | DERIVED | 0.000E+00 | 0.000E+00 | 0.000E+00 | 1.00 |
| Not currently used | | CONSTANT | -999. | -999. | 0.000E+00 | 1.00 |
| Not currently used | | CONSTANT | -999. | -999. | 0.000E+00 | 1.00 |

1

SOURCE SPECIFIC VARIABLES

| VARIABLE NAME | UNITS | DISTRIBUTION | PARAMETERS MEAN | PARAMETERS STD DEV | LIMITS MIN | LIMITS MAX |
|---|---|---|---|---|---|---|
| Infiltration rate | m/yr | CONSTANT | 0.179E-06 | -999. | 0.100E-09 | 0.100E+11 |
| Area of waste disposal unit | m^2 | CONSTANT | 0.486E+06 | -999. | 0.100E-01 | -999. |
| Duration of pulse | yr | CONSTANT | -999. | -999. | 0.100E-08 | -999. |
| Spread of contaminant source | m | DERIVED | -999. | -999. | 0.100E-08 | 0.100E+11 |
| Recharge rate | m/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 0.100E+11 |
| Source decay constant | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Initial concentration at landfill | mg/l | CONSTANT | 1.00 | -999. | 0.000E+00 | -999. |
| Length scale of facility | m | DERIVED | -999. | -999. | 0.100E-08 | 0.100E+11 |
| Width scale of facility | m | DERIVED | -999. | -999. | 0.100E-08 | 0.100E+11 |
| Near field dilution | | DERIVED | 1.00 | 0.000E+00 | 0.000E+00 | 1.00 |

1

AQUIFER SPECIFIC VARIABLES

| VARIABLE NAME | UNITS | DISTRIBUTION | PARAMETERS MEAN | PARAMETERS STD DEV | LIMITS MIN | LIMITS MAX |
|---|---|---|---|---|---|---|
| Particle diameter | cm | CONSTANT | 0.381E-01 | -999. | 0.100E-08 | 100. |
| Aquifer porosity | -- | CONSTANT | 0.430 | -999. | 0.100E-08 | 0.990 |
| Bulk density | g/cc | CONSTANT | 1.65 | -999. | 0.100E-01 | 5.00 |
| Aquifer thickness | m | CONSTANT | 10.0 | -999. | 0.100E-08 | 0.100E+06 |
| Source thickness (mixing zone depth) | m | DERIVED | -999. | -999. | 0.100E-08 | 0.100E+06 |
| Conductivity (hydraulic) | m/yr | CONSTANT | 130. | -999. | 0.100E-06 | 0.100E+09 |
| Gradient (hydraulic) | | CONSTANT | 0.200E-02 | -999. | 0.100E-07 | -999. |
| Groundwater seepage velocity | m/yr | DERIVED | -999. | -999. | 0.100E-09 | 0.100E+09 |
| Retardation coefficient | -- | DERIVED | -999. | -999. | 1.00 | 0.100E+09 |
| Longitudinal dispersivity | m | FUNCTION OF X | -999. | -999. | -999. | -999. |
| Transverse dispersivity | m | FUNCTION OF X | -999. | -999. | -999. | -999. |
| Vertical dispersivity | m | FUNCTION OF X | -999. | -999. | -999. | -999. |
| Temperature of aquifer | C | CONSTANT | 21.0 | -999. | 0.000E+00 | 100. |
| pH | -- | CONSTANT | 7.20 | -999. | 0.300 | 14.0 |
| Organic carbon content (fraction) | | CONSTANT | 0.300E-02 | -999. | 0.100E-05 | 1.00 |
| Well distance from site | m | CONSTANT | 58.0 | -999. | 1.00 | -999. |
| Angle off center | degree | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 360. |
| Well vertical distance | m | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 1.00 |

CONCENTRATION AFTER SATURATED ZONE MODEL 0.1139E-03

1

U. S. ENVIRONMENTAL PROTECTION AGENCY

EXPOSURE ASSESSMENT

MULTIMEDIA MODEL

MULTIMED (Version 1.01, June 1991)

1

Run options
--- -------

CASE10L Base Case Aquifer Porosity = 0.2

Location 1
Chemical simulated is DEFAULT CHEMICAL

| | |
|---|---|
| Option Chosen | Saturated zone model |
| Run was | DETERMIN |

Infiltration input by user
Run was steady-state
Reject runs if Y coordinate outside plume
Reject runs if Z coordinate outside plume
Gaussian source used in saturated zone model

1
1

CHEMICAL SPECIFIC VARIABLES

| VARIABLE NAME | UNITS | DISTRIBUTION | PARAMETERS MEAN | PARAMETERS STD DEV | LIMITS MIN | LIMITS MAX |
|---|---|---|---|---|---|---|
| Solid phase decay coefficient | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 0.100E+11 |
| Dissolved phase decay coefficient | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 0.100E+11 |
| Overall chemical decay coefficient | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 0.100E+11 |
| Acid catalyzed hydrolysis rate | 1/M-yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Neutral hydrolysis rate constant | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Base catalyzed hydrolysis rate | 1/M-yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Reference temperature | C | CONSTANT | 20.0 | -999. | 0.000E+00 | 100. |
| Normalized distribution coefficient | ml/g | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Distribution coefficient | -- | DERIVED | -999. | -999. | 0.000E+00 | 0.100E+11 |
| Biodegradation coefficient (sat. zone) | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Air diffusion coefficient | cm2/s | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 10.0 |
| Reference temperature for air diffusion | C | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 100. |
| Molecular weight | g/M | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Mole fraction of solute | -- | CONSTANT | 0.000E+00 | -999. | 0.100E-08 | 1.00 |
| Vapor pressure of solute | mm Hg | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 100. |
| Henry`s law constant | atm-m^3/M | CONSTANT | 0.000E+00 | -999. | 0.100E-09 | 1.00 |

CASE1OLP

| | | | | | | |
|---|---|---|---|---|---|---|
| Overall 1st order decay sat. zone | 1/yr | DERIVED | 0.000E+00 | 0.000E+00 | 0.000E+00 | 1.00 |
| Not currently used | | CONSTANT | -999. | -999. | 0.000E+00 | 1.00 |
| Not currently used | | CONSTANT | -999. | -999. | 0.000E+00 | 1.00 |

1

SOURCE SPECIFIC VARIABLES

| VARIABLE NAME | UNITS | DISTRIBUTION | PARAMETERS MEAN | PARAMETERS STD DEV | LIMITS MIN | LIMITS MAX |
|---|---|---|---|---|---|---|
| Infiltration rate | m/yr | CONSTANT | 0.179E-06 | -999. | 0.100E-09 | 0.100E+11 |
| Area of waste disposal unit | m^2 | CONSTANT | 0.486E+06 | -999. | 0.100E-01 | -999. |
| Duration of pulse | yr | CONSTANT | -999. | -999. | 0.100E-08 | -999. |
| Spread of contaminant source | m | DERIVED | -999. | -999. | 0.100E-08 | 0.100E+11 |
| Recharge rate | m/yr | CONSTANT | 0.368E-01 | -999. | 0.000E+00 | 0.100E+11 |
| Source decay constant | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Initial concentration at landfill | mg/l | CONSTANT | 1.00 | -999. | 0.000E+00 | -999. |
| Length scale of facility | m | DERIVED | -999. | -999. | 0.100E-08 | 0.100E+11 |
| Width scale of facility | m | DERIVED | -999. | -999. | 0.100E-08 | 0.100E+11 |
| Near field dilution | | DERIVED | 1.00 | 0.000E+00 | 0.000E+00 | 1.00 |

1

AQUIFER SPECIFIC VARIABLES

| VARIABLE NAME | UNITS | DISTRIBUTION | PARAMETERS MEAN | PARAMETERS STD DEV | LIMITS MIN | LIMITS MAX |
|---|---|---|---|---|---|---|
| Particle diameter | cm | CONSTANT | 0.381E-01 | -999. | 0.100E-08 | 100. |
| Aquifer porosity | -- | CONSTANT | 0.200 | -999. | 0.100E-08 | 0.990 |
| Bulk density | g/cc | CONSTANT | 1.65 | -999. | 0.100E-01 | 5.00 |
| Aquifer thickness | m | CONSTANT | 10.0 | -999. | 0.100E-08 | 0.100E+06 |
| Source thickness (mixing zone depth) | m | DERIVED | -999. | -999. | 0.100E-08 | 0.100E+06 |
| Conductivity (hydraulic) | m/yr | CONSTANT | 130. | -999. | 0.100E-06 | 0.100E+09 |
| Gradient (hydraulic) | | CONSTANT | 0.200E-02 | -999. | 0.100E-07 | -999. |
| Groundwater seepage velocity | m/yr | DERIVED | -999. | -999. | 0.100E-09 | 0.100E+09 |
| Retardation coefficient | -- | DERIVED | -999. | -999. | 1.00 | 0.100E+09 |
| Longitudinal dispersivity | m | FUNCTION OF X | -999. | -999. | -999. | -999. |
| Transverse dispersivity | m | FUNCTION OF X | -999. | -999. | -999. | -999. |
| Vertical dispersivity | m | FUNCTION OF X | -999. | -999. | -999. | -999. |
| Temperature of aquifer | C | CONSTANT | 21.0 | -999. | 0.000E+00 | 100. |
| pH | -- | CONSTANT | 7.20 | -999. | 0.300 | 14.0 |
| Organic carbon content (fraction) | | CONSTANT | 0.300E-02 | -999. | 0.100E-05 | 1.00 |
| Well distance from site | m | CONSTANT | 58.0 | -999. | 1.00 | -999. |
| Angle off center | degree | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 360. |
| Well vertical distance | m | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 1.00 |

CONCENTRATION AFTER SATURATED ZONE MODEL 0.5320E-04

CASE10LZ

1

U. S. ENVIRONMENTAL PROTECTION AGENCY

EXPOSURE ASSESSMENT

MULTIMEDIA MODEL

MULTIMED (Version 1.01, June 1991)

1

Run options
--- -------

CASE10L Base Case With Aquifer Porosity = 0.6

Location 1
Chemical simulated is DEFAULT CHEMICAL

| | |
|---|---|
| Option Chosen | Saturated zone model |
| Run was | DETERMIN |

Infiltration input by user
Run was steady-state
Reject runs if Y coordinate outside plume
Reject runs if Z coordinate outside plume
Gaussian source used in saturated zone model

1
1

CHEMICAL SPECIFIC VARIABLES

| VARIABLE NAME | UNITS | DISTRIBUTION | PARAMETERS | | LIMITS | |
|---|---|---|---|---|---|---|
| | | | MEAN | STD DEV | MIN | MAX |
| Solid phase decay coefficient | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 0.100E+11 |
| Dissolved phase decay coefficient | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 0.100E+11 |
| Overall chemical decay coefficient | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 0.100E+11 |
| Acid catalyzed hydrolysis rate | 1/M-yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Neutral hydrolysis rate constant | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Base catalyzed hydrolysis rate | 1/M-yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Reference temperature | C | CONSTANT | 20.0 | -999. | 0.000E+00 | 100. |
| Normalized distribution coefficient | ml/g | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Distribution coefficient | -- | DERIVED | -999. | -999. | 0.000E+00 | 0.100E+11 |
| Biodegradation coefficient (sat. zone) | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Air diffusion coefficient | cm2/s | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 10.0 |
| Reference temperature for air diffusion | C | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 100. |
| Molecular weight | g/M | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Mole fraction of solute | -- | CONSTANT | 0.000E+00 | -999. | 0.100E-08 | 1.00 |
| Vapor pressure of solute | mm Hg | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 100. |
| Henry`s law constant | atm-m^3/M | CONSTANT | 0.000E+00 | -999. | 0.100E-09 | 1.00 |

CASE1OLZ

| | | | | | | |
|---|---|---|---|---|---|---|
| Overall 1st order decay sat. zone | 1/yr | DERIVED | 0.000E+00 | 0.000E+00 | 0.000E+00 | 1.00 |
| Not currently used | | CONSTANT | -999. | -999. | 0.000E+00 | 1.00 |
| Not currently used | | CONSTANT | -999. | -999. | 0.000E+00 | 1.00 |

1

SOURCE SPECIFIC VARIABLES

| VARIABLE NAME | UNITS | DISTRIBUTION | PARAMETERS | | LIMITS | |
|---|---|---|---|---|---|---|
| | | | MEAN | STD DEV | MIN | MAX |
| Infiltration rate | m/yr | CONSTANT | 0.179E-06 | -999. | 0.100E-09 | 0.100E+11 |
| Area of waste disposal unit | m^2 | CONSTANT | 0.486E+06 | -999. | 0.100E-01 | -999. |
| Duration of pulse | yr | CONSTANT | -999. | -999. | 0.100E-08 | -999. |
| Spread of contaminant source | m | DERIVED | -999. | -999. | 0.100E-08 | 0.100E+11 |
| Recharge rate | m/yr | CONSTANT | 0.368E-01 | -999. | 0.000E+00 | 0.100E+11 |
| Source decay constant | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Initial concentration at landfill | mg/l | CONSTANT | 1.00 | -999. | 0.000E+00 | -999. |
| Length scale of facility | m | DERIVED | -999. | -999. | 0.100E-08 | 0.100E+11 |
| Width scale of facility | m | DERIVED | -999. | -999. | 0.100E-08 | 0.100E+11 |
| Near field dilution | | DERIVED | 1.00 | 0.000E+00 | 0.000E+00 | 1.00 |

1

AQUIFER SPECIFIC VARIABLES

| VARIABLE NAME | UNITS | DISTRIBUTION | PARAMETERS | | LIMITS | |
|---|---|---|---|---|---|---|
| | | | MEAN | STD DEV | MIN | MAX |
| Particle diameter | cm | CONSTANT | 0.381E-01 | -999. | 0.100E-08 | 100. |
| Aquifer porosity | -- | CONSTANT | 0.600 | -999. | 0.100E-08 | 0.990 |
| Bulk density | g/cc | CONSTANT | 1.65 | -999. | 0.100E-01 | 5.00 |
| Aquifer thickness | m | CONSTANT | 10.0 | -999. | 0.100E-08 | 0.100E+06 |
| Source thickness (mixing zone depth) | m | DERIVED | -999. | -999. | 0.100E-08 | 0.100E+06 |
| Conductivity (hydraulic) | m/yr | CONSTANT | 130. | -999. | 0.100E-06 | 0.100E+09 |
| Gradient (hydraulic) | | CONSTANT | 0.200E-02 | -999. | 0.100E-07 | -999. |
| Groundwater seepage velocity | m/yr | DERIVED | -999. | -999. | 0.100E-09 | 0.100E+09 |
| Retardation coefficient | -- | DERIVED | -999. | -999. | 1.00 | 0.100E+09 |
| Longitudinal dispersivity | m | FUNCTION OF X | -999. | -999. | -999. | -999. |
| Transverse dispersivity | m | FUNCTION OF X | -999. | -999. | -999. | -999. |
| Vertical dispersivity | m | FUNCTION OF X | -999. | -999. | -999. | -999. |
| Temperature of aquifer | C | CONSTANT | 21.0 | -999. | 0.000E+00 | 100. |
| pH | -- | CONSTANT | 7.20 | -999. | 0.300 | 14.0 |
| Organic carbon content (fraction) | | CONSTANT | 0.300E-02 | -999. | 0.100E-05 | 1.00 |
| Well distance from site | m | CONSTANT | 58.0 | -999. | 1.00 | -999. |
| Angle off center | degree | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 360. |
| Well vertical distance | m | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 1.00 |

CONCENTRATION AFTER SATURATED ZONE MODEL 0.5320E-04

CASE1OLT

1

U. S. ENVIRONMENTAL PROTECTION AGENCY

EXPOSURE ASSESSMENT

MULTIMEDIA MODEL

MULTIMED (Version 1.01, June 1991)

1

Run options
--- -------

CASE1OL Base Case Bulk Density = 1.60 (Sandy Clay)

Location 1
Chemical simulated is DEFAULT CHEMICAL

| | |
|---|---|
| Option Chosen | Saturated zone model |
| Run was | DETERMIN |

Infiltration input by user
Run was steady-state
Reject runs if Y coordinate outside plume
Reject runs if Z coordinate outside plume
Gaussian source used in saturated zone model

1
1

CHEMICAL SPECIFIC VARIABLES

| VARIABLE NAME | UNITS | DISTRIBUTION | PARAMETERS MEAN | PARAMETERS STD DEV | LIMITS MIN | LIMITS MAX |
|---|---|---|---|---|---|---|
| Solid phase decay coefficient | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 0.100E+11 |
| Dissolved phase decay coefficient | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 0.100E+11 |
| Overall chemical decay coefficient | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 0.100E+11 |
| Acid catalyzed hydrolysis rate | 1/M-yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Neutral hydrolysis rate constant | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Base catalyzed hydrolysis rate | 1/M-yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Reference temperature | C | CONSTANT | 20.0 | -999. | 0.000E+00 | 100. |
| Normalized distribution coefficient | ml/g | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Distribution coefficient | -- | DERIVED | -999. | -999. | 0.000E+00 | 0.100E+11 |
| Biodegradation coefficient (sat. zone) | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Air diffusion coefficient | cm2/s | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 10.0 |
| Reference temperature for air diffusion | C | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 100. |
| Molecular weight | g/M | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Mole fraction of solute | -- | CONSTANT | 0.000E+00 | -999. | 0.100E-08 | 1.00 |
| Vapor pressure of solute | mm Hg | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 100. |
| Henry`s law constant | atm-m^3/M | CONSTANT | 0.000E+00 | -999. | 0.100E-09 | 1.00 |

Page 1

CASE1OLT

| | | | | | | |
|---|---|---|---|---|---|---|
| Overall 1st order decay sat. zone | 1/yr | DERIVED | 0.000E+00 | 0.000E+00 | 0.000E+00 | 1.00 |
| Not currently used | | CONSTANT | -999. | -999. | 0.000E+00 | 1.00 |
| Not currently used | | CONSTANT | -999. | -999. | 0.000E+00 | 1.00 |

1

SOURCE SPECIFIC VARIABLES

| VARIABLE NAME | UNITS | DISTRIBUTION | PARAMETERS MEAN | PARAMETERS STD DEV | LIMITS MIN | LIMITS MAX |
|---|---|---|---|---|---|---|
| Infiltration rate | m/yr | CONSTANT | 0.179E-06 | -999. | 0.100E-09 | 0.100E+11 |
| Area of waste disposal unit | m^2 | CONSTANT | 0.486E+06 | -999. | 0.100E-01 | -999. |
| Duration of pulse | yr | CONSTANT | -999. | -999. | 0.100E-08 | -999. |
| Spread of contaminant source | m | DERIVED | -999. | -999. | 0.100E-08 | 0.100E+11 |
| Recharge rate | m/yr | CONSTANT | 0.368E-01 | -999. | 0.000E+00 | 0.100E+11 |
| Source decay constant | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Initial concentration at landfill | mg/l | CONSTANT | 1.00 | -999. | 0.000E+00 | -999. |
| Length scale of facility | m | DERIVED | -999. | -999. | 0.100E-08 | 0.100E+11 |
| Width scale of facility | m | DERIVED | -999. | -999. | 0.100E-08 | 0.100E+11 |
| Near field dilution | | DERIVED | 1.00 | 0.000E+00 | 0.000E+00 | 1.00 |

1

AQUIFER SPECIFIC VARIABLES

| VARIABLE NAME | UNITS | DISTRIBUTION | PARAMETERS MEAN | PARAMETERS STD DEV | LIMITS MIN | LIMITS MAX |
|---|---|---|---|---|---|---|
| Particle diameter | cm | CONSTANT | 0.381E-01 | -999. | 0.100E-08 | 100. |
| Aquifer porosity | -- | CONSTANT | 0.430 | -999. | 0.100E-08 | 0.990 |
| Bulk density | g/cc | CONSTANT | 1.60 | -999. | 0.100E-01 | 5.00 |
| Aquifer thickness | m | CONSTANT | 10.0 | -999. | 0.100E-08 | 0.100E+06 |
| Source thickness (mixing zone depth) | m | DERIVED | -999. | -999. | 0.100E-08 | 0.100E+06 |
| Conductivity (hydraulic) | m/yr | CONSTANT | 130. | -999. | 0.100E-06 | 0.100E+09 |
| Gradient (hydraulic) | | CONSTANT | 0.200E-02 | -999. | 0.100E-07 | -999. |
| Groundwater seepage velocity | m/yr | DERIVED | -999. | -999. | 0.100E-09 | 0.100E+09 |
| Retardation coefficient | -- | DERIVED | -999. | -999. | 1.00 | 0.100E+09 |
| Longitudinal dispersivity | m | FUNCTION OF X | -999. | -999. | -999. | -999. |
| Transverse dispersivity | m | FUNCTION OF X | -999. | -999. | -999. | -999. |
| Vertical dispersivity | m | FUNCTION OF X | -999. | -999. | -999. | -999. |
| Temperature of aquifer | C | CONSTANT | 21.0 | -999. | 0.000E+00 | 100. |
| pH | -- | CONSTANT | 7.20 | -999. | 0.300 | 14.0 |
| Organic carbon content (fraction) | | CONSTANT | 0.300E-02 | -999. | 0.100E-05 | 1.00 |
| Well distance from site | m | CONSTANT | 58.0 | -999. | 1.00 | -999. |
| Angle off center | degree | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 360. |
| Well vertical distance | m | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 1.00 |

CONCENTRATION AFTER SATURATED ZONE MODEL 0.5320E-04

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CASE10LU

1

U. S. ENVIRONMENTAL PROTECTION AGENCY

EXPOSURE ASSESSMENT

MULTIMEDIA MODEL

MULTIMED (Version 1.01, June 1991)

1

Run options

CASE10L Base Case Bulk Density = 1.70 (Loam & Sandy Clay Loam)

Location 1
Chemical simulated is DEFAULT CHEMICAL

| | |
|---|---|
| Option Chosen | Saturated zone model |
| Run was | DETERMIN |

Infiltration input by user
Run was steady-state
Reject runs if Y coordinate outside plume
Reject runs if Z coordinate outside plume
Gaussian source used in saturated zone model

1
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CHEMICAL SPECIFIC VARIABLES

| VARIABLE NAME | UNITS | DISTRIBUTION | PARAMETERS MEAN | STD DEV | LIMITS MIN | MAX |
|---|---|---|---|---|---|---|
| Solid phase decay coefficient | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 0.100E+11 |
| Dissolved phase decay coefficient | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 0.100E+11 |
| Overall chemical decay coefficient | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 0.100E+11 |
| Acid catalyzed hydrolysis rate | 1/M-yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Neutral hydrolysis rate constant | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Base catalyzed hydrolysis rate | 1/M-yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Reference temperature | C | CONSTANT | 20.0 | -999. | 0.000E+00 | 100. |
| Normalized distribution coefficient | ml/g | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Distribution coefficient | -- | DERIVED | -999. | -999. | 0.000E+00 | 0.100E+11 |
| Biodegradation coefficient (sat. zone) | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Air diffusion coefficient | cm2/s | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 10.0 |
| Reference temperature for air diffusion | C | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 100. |
| Molecular weight | g/M | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Mole fraction of solute | -- | CONSTANT | 0.000E+00 | -999. | 0.100E-08 | 1.00 |
| Vapor pressure of solute | mm Hg | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 100. |
| Henry`s law constant | atm-m^3/M | CONSTANT | 0.000E+00 | -999. | 0.100E-09 | 1.00 |

Page 1

CASE1OLU

| | | | | | | |
|---|---|---|---|---|---|---|
| Overall 1st order decay sat. zone | 1/yr | DERIVED | 0.000E+00 | 0.000E+00 | 0.000E+00 | 1.00 |
| Not currently used | | CONSTANT | -999. | -999. | 0.000E+00 | 1.00 |
| Not currently used | | CONSTANT | -999. | -999. | 0.000E+00 | 1.00 |

1

SOURCE SPECIFIC VARIABLES

| VARIABLE NAME | UNITS | DISTRIBUTION | PARAMETERS MEAN | PARAMETERS STD DEV | LIMITS MIN | LIMITS MAX |
|---|---|---|---|---|---|---|
| Infiltration rate | m/yr | CONSTANT | 0.179E-06 | -999. | 0.100E-09 | 0.100E+11 |
| Area of waste disposal unit | m^2 | CONSTANT | 0.486E+06 | -999. | 0.100E-01 | -999. |
| Duration of pulse | yr | CONSTANT | -999. | -999. | 0.100E-08 | -999. |
| Spread of contaminant source | m | DERIVED | -999. | -999. | 0.100E-08 | 0.100E+11 |
| Recharge rate | m/yr | CONSTANT | 0.368E-01 | -999. | 0.000E+00 | 0.100E+11 |
| Source decay constant | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Initial concentration at landfill | mg/l | CONSTANT | 1.00 | -999. | 0.000E+00 | -999. |
| Length scale of facility | m | DERIVED | -999. | -999. | 0.100E-08 | 0.100E+11 |
| Width scale of facility | m | DERIVED | -999. | -999. | 0.100E-08 | 0.100E+11 |
| Near field dilution | | DERIVED | 1.00 | 0.000E+00 | 0.000E+00 | 1.00 |

1

AQUIFER SPECIFIC VARIABLES

| VARIABLE NAME | UNITS | DISTRIBUTION | PARAMETERS MEAN | PARAMETERS STD DEV | LIMITS MIN | LIMITS MAX |
|---|---|---|---|---|---|---|
| Particle diameter | cm | CONSTANT | 0.381E-01 | -999. | 0.100E-08 | 100. |
| Aquifer porosity | -- | CONSTANT | 0.430 | -999. | 0.100E-08 | 0.990 |
| Bulk density | g/cc | CONSTANT | 1.70 | -999. | 0.100E-01 | 5.00 |
| Aquifer thickness | m | CONSTANT | 10.0 | -999. | 0.100E-08 | 0.100E+06 |
| Source thickness (mixing zone depth) | m | DERIVED | -999. | -999. | 0.100E-08 | 0.100E+06 |
| Conductivity (hydraulic) | m/yr | CONSTANT | 130. | -999. | 0.100E-06 | 0.100E+09 |
| Gradient (hydraulic) | | CONSTANT | 0.200E-02 | -999. | 0.100E-07 | -999. |
| Groundwater seepage velocity | m/yr | DERIVED | -999. | -999. | 0.100E-09 | 0.100E+09 |
| Retardation coefficient | -- | DERIVED | -999. | -999. | 1.00 | 0.100E+09 |
| Longitudinal dispersivity | m | FUNCTION OF X | -999. | -999. | -999. | -999. |
| Transverse dispersivity | m | FUNCTION OF X | -999. | -999. | -999. | -999. |
| Vertical dispersivity | m | FUNCTION OF X | -999. | -999. | -999. | -999. |
| Temperature of aquifer | C | CONSTANT | 21.0 | -999. | 0.000E+00 | 100. |
| pH | -- | CONSTANT | 7.20 | -999. | 0.300 | 14.0 |
| Organic carbon content (fraction) | | CONSTANT | 0.300E-02 | -999. | 0.100E-05 | 1.00 |
| Well distance from site | m | CONSTANT | 58.0 | -999. | 1.00 | -999. |
| Angle off center | degree | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 360. |
| Well vertical distance | m | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 1.00 |

CONCENTRATION AFTER SATURATED ZONE MODEL 0.5320E-04

CASE10LA

1

U. S. ENVIRONMENTAL PROTECTION AGENCY

EXPOSURE ASSESSMENT

MULTIMEDIA MODEL

MULTIMED (Version 1.01, June 1991)

1

Run options
--- -------

CASE10L Base Case With Aquifer Thickness of 5 m

Location 1
Chemical simulated is DEFAULT CHEMICAL

| | |
|---|---|
| Option Chosen | Saturated zone model |
| Run was | DETERMIN |

Infiltration input by user
Run was steady-state
Reject runs if Y coordinate outside plume
Reject runs if Z coordinate outside plume
Gaussian source used in saturated zone model
1
1

CHEMICAL SPECIFIC VARIABLES

| VARIABLE NAME | UNITS | DISTRIBUTION | PARAMETERS | | LIMITS | |
|---|---|---|---|---|---|---|
| | | | MEAN | STD DEV | MIN | MAX |
| Solid phase decay coefficient | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 0.100E+11 |
| Dissolved phase decay coefficient | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 0.100E+11 |
| Overall chemical decay coefficient | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 0.100E+11 |
| Acid catalyzed hydrolysis rate | 1/M-yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Neutral hydrolysis rate constant | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Base catalyzed hydrolysis rate | 1/M-yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Reference temperature | C | CONSTANT | 20.0 | -999. | 0.000E+00 | 100. |
| Normalized distribution coefficient | ml/g | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Distribution coefficient | -- | DERIVED | -999. | -999. | 0.000E+00 | 0.100E+11 |
| Biodegradation coefficient (sat. zone) | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Air diffusion coefficient | cm2/s | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 10.0 |
| Reference temperature for air diffusion | C | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 100. |
| Molecular weight | g/M | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Mole fraction of solute | -- | CONSTANT | 0.000E+00 | -999. | 0.100E-08 | 1.00 |
| Vapor pressure of solute | mm Hg | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 100. |
| Henry`s law constant | atm-m^3/M | CONSTANT | 0.000E+00 | -999. | 0.100E-09 | 1.00 |

CASE1OLA

| | | | | | | |
|---|---|---|---|---|---|---|
| Overall 1st order decay sat. zone | 1/yr | DERIVED | 0.000E+00 | 0.000E+00 | 0.000E+00 | 1.00 |
| Not currently used | | CONSTANT | -999. | -999. | 0.000E+00 | 1.00 |
| Not currently used | | CONSTANT | -999. | -999. | 0.000E+00 | 1.00 |

1

SOURCE SPECIFIC VARIABLES

| VARIABLE NAME | UNITS | DISTRIBUTION | PARAMETERS MEAN | PARAMETERS STD DEV | LIMITS MIN | LIMITS MAX |
|---|---|---|---|---|---|---|
| Infiltration rate | m/yr | CONSTANT | 0.179E-06 | -999. | 0.100E-09 | 0.100E+11 |
| Area of waste disposal unit | m^2 | CONSTANT | 0.486E+06 | -999. | 0.100E-01 | -999. |
| Duration of pulse | yr | CONSTANT | -999. | -999. | 0.100E-08 | -999. |
| Spread of contaminant source | m | DERIVED | -999. | -999. | 0.100E-08 | 0.100E+11 |
| Recharge rate | m/yr | CONSTANT | 0.368E-01 | -999. | 0.000E+00 | 0.100E+11 |
| Source decay constant | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Initial concentration at landfill | mg/l | CONSTANT | 1.00 | -999. | 0.000E+00 | -999. |
| Length scale of facility | m | DERIVED | -999. | -999. | 0.100E-08 | 0.100E+11 |
| Width scale of facility | m | DERIVED | -999. | -999. | 0.100E-08 | 0.100E+11 |
| Near field dilution | | DERIVED | 1.00 | 0.000E+00 | 0.000E+00 | 1.00 |

1

AQUIFER SPECIFIC VARIABLES

| VARIABLE NAME | UNITS | DISTRIBUTION | PARAMETERS MEAN | PARAMETERS STD DEV | LIMITS MIN | LIMITS MAX |
|---|---|---|---|---|---|---|
| Particle diameter | cm | CONSTANT | 0.381E-01 | -999. | 0.100E-08 | 100. |
| Aquifer porosity | -- | CONSTANT | 0.430 | -999. | 0.100E-08 | 0.990 |
| Bulk density | g/cc | CONSTANT | 1.65 | -999. | 0.100E-01 | 5.00 |
| Aquifer thickness | m | CONSTANT | 5.00 | -999. | 0.100E-08 | 0.100E+06 |
| Source thickness (mixing zone depth) | m | DERIVED | -999. | -999. | 0.100E-08 | 0.100E+06 |
| Conductivity (hydraulic) | m/yr | CONSTANT | 130. | -999. | 0.100E-06 | 0.100E+09 |
| Gradient (hydraulic) | | CONSTANT | 0.200E-02 | -999. | 0.100E-07 | -999. |
| Groundwater seepage velocity | m/yr | DERIVED | -999. | -999. | 0.100E-09 | 0.100E+09 |
| Retardation coefficient | -- | DERIVED | -999. | -999. | 1.00 | 0.100E+09 |
| Longitudinal dispersivity | m | FUNCTION OF X | -999. | -999. | -999. | -999. |
| Transverse dispersivity | m | FUNCTION OF X | -999. | -999. | -999. | -999. |
| Vertical dispersivity | m | FUNCTION OF X | -999. | -999. | -999. | -999. |
| Temperature of aquifer | C | CONSTANT | 21.0 | -999. | 0.000E+00 | 100. |
| pH | -- | CONSTANT | 7.20 | -999. | 0.300 | 14.0 |
| Organic carbon content (fraction) | | CONSTANT | 0.300E-02 | -999. | 0.100E-05 | 1.00 |
| Well distance from site | m | CONSTANT | 58.0 | -999. | 1.00 | -999. |
| Angle off center | degree | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 360. |
| Well vertical distance | m | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 1.00 |

CONCENTRATION AFTER SATURATED ZONE MODEL 0.5432E-04

CASE1OLF

1
U. S. ENVIRONMENTAL PROTECTION AGENCY

EXPOSURE ASSESSMENT

MULTIMEDIA MODEL

MULTIMED (Version 1.01, June 1991)

1
Run options
--- -------

CASE1OL Base Case Hydraulic Conductivity = 1,299 m/yr

Location 1
Chemical simulated is DEFAULT CHEMICAL

| | |
|---|---|
| Option Chosen | Saturated zone model |
| Run was | DETERMIN |

Infiltration input by user
Run was steady-state
Reject runs if Y coordinate outside plume
Reject runs if Z coordinate outside plume
Gaussian source used in saturated zone model
1
1

CHEMICAL SPECIFIC VARIABLES

| VARIABLE NAME | UNITS | DISTRIBUTION | PARAMETERS MEAN | PARAMETERS STD DEV | LIMITS MIN | LIMITS MAX |
|---|---|---|---|---|---|---|
| Solid phase decay coefficient | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 0.100E+11 |
| Dissolved phase decay coefficient | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 0.100E+11 |
| Overall chemical decay coefficient | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 0.100E+11 |
| Acid catalyzed hydrolysis rate | 1/M-yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Neutral hydrolysis rate constant | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Base catalyzed hydrolysis rate | 1/M-yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Reference temperature | C | CONSTANT | 20.0 | -999. | 0.000E+00 | 100. |
| Normalized distribution coefficient | ml/g | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Distribution coefficient | -- | DERIVED | -999. | -999. | 0.000E+00 | 0.100E+11 |
| Biodegradation coefficient (sat. zone) | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Air diffusion coefficient | cm2/s | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 10.0 |
| Reference temperature for air diffusion | C | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 100. |
| Molecular weight | g/M | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Mole fraction of solute | -- | CONSTANT | 0.000E+00 | -999. | 0.100E-08 | 1.00 |
| Vapor pressure of solute | mm Hg | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 100. |
| Henry`s law constant | atm-m^3/M | CONSTANT | 0.000E+00 | -999. | 0.100E-09 | 1.00 |

Page 1

CASE1OLF

| | | | | | | |
|---|---|---|---|---|---|---|
| Overall 1st order decay sat. zone | 1/yr | DERIVED | 0.000E+00 | 0.000E+00 | 0.000E+00 | 1.00 |
| Not currently used | | CONSTANT | -999. | -999. | 0.000E+00 | 1.00 |
| Not currently used | | CONSTANT | -999. | -999. | 0.000E+00 | 1.00 |

1

SOURCE SPECIFIC VARIABLES

| VARIABLE NAME | UNITS | DISTRIBUTION | PARAMETERS MEAN | PARAMETERS STD DEV | LIMITS MIN | LIMITS MAX |
|---|---|---|---|---|---|---|
| Infiltration rate | m/yr | CONSTANT | 0.179E-06 | -999. | 0.100E-09 | 0.100E+11 |
| Area of waste disposal unit | m^2 | CONSTANT | 0.486E+06 | -999. | 0.100E-01 | -999. |
| Duration of pulse | yr | CONSTANT | -999. | -999. | 0.100E-08 | -999. |
| Spread of contaminant source | m | DERIVED | -999. | -999. | 0.100E-08 | 0.100E+11 |
| Recharge rate | m/yr | CONSTANT | 0.368E-01 | -999. | 0.000E+00 | 0.100E+11 |
| Source decay constant | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Initial concentration at landfill | mg/l | CONSTANT | 1.00 | -999. | 0.000E+00 | -999. |
| Length scale of facility | m | DERIVED | -999. | -999. | 0.100E-08 | 0.100E+11 |
| Width scale of facility | m | DERIVED | -999. | -999. | 0.100E-08 | 0.100E+11 |
| Near field dilution | | DERIVED | 1.00 | 0.000E+00 | 0.000E+00 | 1.00 |

1

AQUIFER SPECIFIC VARIABLES

| VARIABLE NAME | UNITS | DISTRIBUTION | PARAMETERS MEAN | PARAMETERS STD DEV | LIMITS MIN | LIMITS MAX |
|---|---|---|---|---|---|---|
| Particle diameter | cm | CONSTANT | 0.381E-01 | -999. | 0.100E-08 | 100. |
| Aquifer porosity | -- | CONSTANT | 0.430 | -999. | 0.100E-08 | 0.990 |
| Bulk density | g/cc | CONSTANT | 1.65 | -999. | 0.100E-01 | 5.00 |
| Aquifer thickness | m | CONSTANT | 10.0 | -999. | 0.100E-08 | 0.100E+06 |
| Source thickness (mixing zone depth) | m | DERIVED | -999. | -999. | 0.100E-08 | 0.100E+06 |
| Conductivity (hydraulic) | m/yr | CONSTANT | 0.130E+04 | -999. | 0.100E-06 | 0.100E+09 |
| Gradient (hydraulic) | | CONSTANT | 0.200E-02 | -999. | 0.100E-07 | -999. |
| Groundwater seepage velocity | m/yr | DERIVED | -999. | -999. | 0.100E-09 | 0.100E+09 |
| Retardation coefficient | -- | DERIVED | -999. | -999. | 1.00 | 0.100E+09 |
| Longitudinal dispersivity | m | FUNCTION OF X | -999. | -999. | -999. | -999. |
| Transverse dispersivity | m | FUNCTION OF X | -999. | -999. | -999. | -999. |
| Vertical dispersivity | m | FUNCTION OF X | -999. | -999. | -999. | -999. |
| Temperature of aquifer | C | CONSTANT | 21.0 | -999. | 0.000E+00 | 100. |
| pH | -- | CONSTANT | 7.20 | -999. | 0.300 | 14.0 |
| Organic carbon content (fraction) | | CONSTANT | 0.300E-02 | -999. | 0.100E-05 | 1.00 |
| Well distance from site | m | CONSTANT | 58.0 | -999. | 1.00 | -999. |
| Angle off center | degree | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 360. |
| Well vertical distance | m | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 1.00 |

CONCENTRATION AFTER SATURATED ZONE MODEL 0.1050E-04

CASE1OLY

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1
                U. S.   E N V I R O N M E N T A L   P R O T E C T I O N   A G E N C Y

                            E X P O S U R E   A S S E S S M E N T

                               M U L T I M E D I A   M O D E L

                             MULTIMED  (Version 1.01, June 1991)
1
 Run options
 --- -------

 CASE1OL Base Case With Hydraulic Conductivity = 12.99 m/yr


 Location 1
 Chemical simulated is DEFAULT CHEMICAL


 Option Chosen                    Saturated zone model
 Run was                          DETERMIN
 Infiltration input by user
 Run was steady-state
 Reject runs if Y coordinate outside plume
 Reject runs if Z coordinate outside plume
 Gaussian source used in saturated zone model
1
1
```

CHEMICAL SPECIFIC VARIABLES

| VARIABLE NAME | UNITS | DISTRIBUTION | PARAMETERS MEAN | PARAMETERS STD DEV | LIMITS MIN | LIMITS MAX |
|---|---|---|---|---|---|---|
| Solid phase decay coefficient | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 0.100E+11 |
| Dissolved phase decay coefficient | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 0.100E+11 |
| Overall chemical decay coefficient | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 0.100E+11 |
| Acid catalyzed hydrolysis rate | 1/M-yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Neutral hydrolysis rate constant | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Base catalyzed hydrolysis rate | 1/M-yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Reference temperature | C | CONSTANT | 20.0 | -999. | 0.000E+00 | 100. |
| Normalized distribution coefficient | ml/g | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Distribution coefficient | -- | DERIVED | -999. | -999. | 0.000E+00 | 0.100E+11 |
| Biodegradation coefficient (sat. zone) | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Air diffusion coefficient | cm2/s | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 10.0 |
| Reference temperature for air diffusion | C | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 100. |
| Molecular weight | g/M | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Mole fraction of solute | -- | CONSTANT | 0.000E+00 | -999. | 0.100E-08 | 1.00 |
| Vapor pressure of solute | mm Hg | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 100. |
| Henry`s law constant | atm-m^3/M | CONSTANT | 0.000E+00 | -999. | 0.100E-09 | 1.00 |

Page 1

CASE1OLY

| | | | | | | |
|---|---|---|---|---|---|---|
| Overall 1st order decay sat. zone | 1/yr | DERIVED | 0.000E+00 | 0.000E+00 | 0.000E+00 | 1.00 |
| Not currently used | | CONSTANT | -999. | -999. | 0.000E+00 | 1.00 |
| Not currently used | | CONSTANT | -999. | -999. | 0.000E+00 | 1.00 |

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SOURCE SPECIFIC VARIABLES

| VARIABLE NAME | UNITS | DISTRIBUTION | PARAMETERS MEAN | PARAMETERS STD DEV | LIMITS MIN | LIMITS MAX |
|---|---|---|---|---|---|---|
| Infiltration rate | m/yr | CONSTANT | 0.179E-06 | -999. | 0.100E-09 | 0.100E+11 |
| Area of waste disposal unit | m^2 | CONSTANT | 0.486E+06 | -999. | 0.100E-01 | -999. |
| Duration of pulse | yr | CONSTANT | -999. | -999. | 0.100E-08 | -999. |
| Spread of contaminant source | m | DERIVED | -999. | -999. | 0.100E-08 | 0.100E+11 |
| Recharge rate | m/yr | CONSTANT | 0.368E-01 | -999. | 0.000E+00 | 0.100E+11 |
| Source decay constant | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Initial concentration at landfill | mg/l | CONSTANT | 1.00 | -999. | 0.000E+00 | -999. |
| Length scale of facility | m | DERIVED | -999. | -999. | 0.100E-08 | 0.100E+11 |
| Width scale of facility | m | DERIVED | -999. | -999. | 0.100E-08 | 0.100E+11 |
| Near field dilution | | DERIVED | 1.00 | 0.000E+00 | 0.000E+00 | 1.00 |

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AQUIFER SPECIFIC VARIABLES

| VARIABLE NAME | UNITS | DISTRIBUTION | PARAMETERS MEAN | PARAMETERS STD DEV | LIMITS MIN | LIMITS MAX |
|---|---|---|---|---|---|---|
| Particle diameter | cm | CONSTANT | 0.381E-01 | -999. | 0.100E-08 | 100. |
| Aquifer porosity | -- | CONSTANT | 0.430 | -999. | 0.100E-08 | 0.990 |
| Bulk density | g/cc | CONSTANT | 1.65 | -999. | 0.100E-01 | 5.00 |
| Aquifer thickness | m | CONSTANT | 10.0 | -999. | 0.100E-08 | 0.100E+06 |
| Source thickness (mixing zone depth) | m | DERIVED | -999. | -999. | 0.100E-08 | 0.100E+06 |
| Conductivity (hydraulic) | m/yr | CONSTANT | 13.0 | -999. | 0.100E-06 | 0.100E+09 |
| Gradient (hydraulic) | | CONSTANT | 0.200E-02 | -999. | 0.100E-07 | -999. |
| Groundwater seepage velocity | m/yr | DERIVED | -999. | -999. | 0.100E-09 | 0.100E+09 |
| Retardation coefficient | -- | DERIVED | -999. | -999. | 1.00 | 0.100E+09 |
| Longitudinal dispersivity | m | FUNCTION OF X | -999. | -999. | -999. | -999. |
| Transverse dispersivity | m | FUNCTION OF X | -999. | -999. | -999. | -999. |
| Vertical dispersivity | m | FUNCTION OF X | -999. | -999. | -999. | -999. |
| Temperature of aquifer | C | CONSTANT | 21.0 | -999. | 0.000E+00 | 100. |
| pH | -- | CONSTANT | 7.20 | -999. | 0.300 | 14.0 |
| Organic carbon content (fraction) | | CONSTANT | 0.300E-02 | -999. | 0.100E-05 | 1.00 |
| Well distance from site | m | CONSTANT | 58.0 | -999. | 1.00 | -999. |
| Angle off center | degree | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 360. |
| Well vertical distance | m | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 1.00 |

CONCENTRATION AFTER SATURATED ZONE MODEL 0.5441E-05

CASE1OLH

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U. S. ENVIRONMENTAL PROTECTION AGENCY

EXPOSURE ASSESSMENT

MULTIMEDIA MODEL

MULTIMED (Version 1.01, June 1991)

1

Run options

--- -------

CASE1OL Base Case Hydraulic Gradient = 10E-3

Location 1

Chemical simulated is DEFAULT CHEMICAL

| | |
|---|---|
| Option Chosen | Saturated zone model |
| Run was | DETERMIN |

Infiltration input by user

Run was steady-state

Reject runs if Y coordinate outside plume

Reject runs if Z coordinate outside plume

Gaussian source used in saturated zone model

1

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CHEMICAL SPECIFIC VARIABLES

| VARIABLE NAME | UNITS | DISTRIBUTION | PARAMETERS | | LIMITS | |
|---|---|---|---|---|---|---|
| | | | MEAN | STD DEV | MIN | MAX |
| Solid phase decay coefficient | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 0.100E+11 |
| Dissolved phase decay coefficient | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 0.100E+11 |
| Overall chemical decay coefficient | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 0.100E+11 |
| Acid catalyzed hydrolysis rate | 1/M-yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Neutral hydrolysis rate constant | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Base catalyzed hydrolysis rate | 1/M-yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Reference temperature | C | CONSTANT | 20.0 | -999. | 0.000E+00 | 100. |
| Normalized distribution coefficient | ml/g | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Distribution coefficient | -- | DERIVED | -999. | -999. | 0.000E+00 | 0.100E+11 |
| Biodegradation coefficient (sat. zone) | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Air diffusion coefficient | cm2/s | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 10.0 |
| Reference temperature for air diffusion | C | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 100. |
| Molecular weight | g/M | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Mole fraction of solute | -- | CONSTANT | 0.000E+00 | -999. | 0.100E-08 | 1.00 |
| Vapor pressure of solute | mm Hg | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 100. |
| Henry`s law constant | atm-m^3/M | CONSTANT | 0.000E+00 | -999. | 0.100E-09 | 1.00 |

Page 1

CASE1OLH

| | | | | | | |
|---|---|---|---|---|---|---|
| Overall 1st order decay sat. zone | 1/yr | DERIVED | 0.000E+00 | 0.000E+00 | 0.000E+00 | 1.00 |
| Not currently used | | CONSTANT | -999. | -999. | 0.000E+00 | 1.00 |
| Not currently used | | CONSTANT | -999. | -999. | 0.000E+00 | 1.00 |

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SOURCE SPECIFIC VARIABLES

| VARIABLE NAME | UNITS | DISTRIBUTION | PARAMETERS MEAN | PARAMETERS STD DEV | LIMITS MIN | LIMITS MAX |
|---|---|---|---|---|---|---|
| Infiltration rate | m/yr | CONSTANT | 0.179E-06 | -999. | 0.100E-09 | 0.100E+11 |
| Area of waste disposal unit | m^2 | CONSTANT | 0.486E+06 | -999. | 0.100E-01 | -999. |
| Duration of pulse | yr | CONSTANT | -999. | -999. | 0.100E-08 | -999. |
| Spread of contaminant source | m | DERIVED | -999. | -999. | 0.100E-08 | 0.100E+11 |
| Recharge rate | m/yr | CONSTANT | 0.368E-01 | -999. | 0.000E+00 | 0.100E+11 |
| Source decay constant | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Initial concentration at landfill | mg/l | CONSTANT | 1.00 | -999. | 0.000E+00 | -999. |
| Length scale of facility | m | DERIVED | -999. | -999. | 0.100E-08 | 0.100E+11 |
| Width scale of facility | m | DERIVED | -999. | -999. | 0.100E-08 | 0.100E+11 |
| Near field dilution | | DERIVED | 1.00 | 0.000E+00 | 0.000E+00 | 1.00 |

1

AQUIFER SPECIFIC VARIABLES

| VARIABLE NAME | UNITS | DISTRIBUTION | PARAMETERS MEAN | PARAMETERS STD DEV | LIMITS MIN | LIMITS MAX |
|---|---|---|---|---|---|---|
| Particle diameter | cm | CONSTANT | 0.381E-01 | -999. | 0.100E-08 | 100. |
| Aquifer porosity | -- | CONSTANT | 0.430 | -999. | 0.100E-08 | 0.990 |
| Bulk density | g/cc | CONSTANT | 1.65 | -999. | 0.100E-01 | 5.00 |
| Aquifer thickness | m | CONSTANT | 10.0 | -999. | 0.100E-08 | 0.100E+06 |
| Source thickness (mixing zone depth) | m | DERIVED | -999. | -999. | 0.100E-08 | 0.100E+06 |
| Conductivity (hydraulic) | m/yr | CONSTANT | 130. | -999. | 0.100E-06 | 0.100E+09 |
| Gradient (hydraulic) | | CONSTANT | 0.100E-02 | -999. | 0.100E-07 | -999. |
| Groundwater seepage velocity | m/yr | DERIVED | -999. | -999. | 0.100E-09 | 0.100E+09 |
| Retardation coefficient | -- | DERIVED | -999. | -999. | 1.00 | 0.100E+09 |
| Longitudinal dispersivity | m | FUNCTION OF X | -999. | -999. | -999. | -999. |
| Transverse dispersivity | m | FUNCTION OF X | -999. | -999. | -999. | -999. |
| Vertical dispersivity | m | FUNCTION OF X | -999. | -999. | -999. | -999. |
| Temperature of aquifer | C | CONSTANT | 21.0 | -999. | 0.000E+00 | 100. |
| pH | -- | CONSTANT | 7.20 | -999. | 0.300 | 14.0 |
| Organic carbon content (fraction) | | CONSTANT | 0.300E-02 | -999. | 0.100E-05 | 1.00 |
| Well distance from site | m | CONSTANT | 58.0 | -999. | 1.00 | -999. |
| Angle off center | degree | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 360. |
| Well vertical distance | m | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 1.00 |

CONCENTRATION AFTER SATURATED ZONE MODEL 0.5432E-04

CASE1OLJ

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1
                  U. S.   E N V I R O N M E N T A L   P R O T E C T I O N   A G E N C Y

                                   E X P O S U R E   A S S E S S M E N T

                                      M U L T I M E D I A   M O D E L

                                      MULTIMED  (Version 1.01, June 1991)
1
 Run options
 --- -------

 CASE1OL Base Case Hydraulic Gradient = 10E-2


 Location 1
 Chemical simulated is DEFAULT CHEMICAL


 Option Chosen                        Saturated zone model
 Run was                              DETERMIN
 Infiltration input by user
 Run was steady-state
 Reject runs if Y coordinate outside plume
 Reject runs if Z coordinate outside plume
 Gaussian source used in saturated zone model
1
1
```

CHEMICAL SPECIFIC VARIABLES

| VARIABLE NAME | UNITS | DISTRIBUTION | PARAMETERS MEAN | PARAMETERS STD DEV | LIMITS MIN | LIMITS MAX |
|---|---|---|---|---|---|---|
| Solid phase decay coefficient | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 0.100E+11 |
| Dissolved phase decay coefficient | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 0.100E+11 |
| Overall chemical decay coefficient | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 0.100E+11 |
| Acid catalyzed hydrolysis rate | 1/M-yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Neutral hydrolysis rate constant | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Base catalyzed hydrolysis rate | 1/M-yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Reference temperature | C | CONSTANT | 20.0 | -999. | 0.000E+00 | 100. |
| Normalized distribution coefficient | ml/g | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Distribution coefficient | -- | DERIVED | -999. | -999. | 0.000E+00 | 0.100E+11 |
| Biodegradation coefficient (sat. zone) | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Air diffusion coefficient | cm2/s | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 10.0 |
| Reference temperature for air diffusion | C | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 100. |
| Molecular weight | g/M | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Mole fraction of solute | -- | CONSTANT | 0.000E+00 | -999. | 0.100E-08 | 1.00 |
| Vapor pressure of solute | mm Hg | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 100. |
| Henry`s law constant | atm-m^3/M | CONSTANT | 0.000E+00 | -999. | 0.100E-09 | 1.00 |

CASE1OLJ

| | | | | | | |
|---|---|---|---|---|---|---|
| Overall 1st order decay sat. zone | 1/yr | DERIVED | 0.000E+00 | 0.000E+00 | 0.000E+00 | 1.00 |
| Not currently used | | CONSTANT | -999. | -999. | 0.000E+00 | 1.00 |
| Not currently used | | CONSTANT | -999. | -999. | 0.000E+00 | 1.00 |

1

SOURCE SPECIFIC VARIABLES

| VARIABLE NAME | UNITS | DISTRIBUTION | PARAMETERS | | LIMITS | |
|---|---|---|---|---|---|---|
| | | | MEAN | STD DEV | MIN | MAX |
| Infiltration rate | m/yr | CONSTANT | 0.179E-06 | -999. | 0.100E-09 | 0.100E+11 |
| Area of waste disposal unit | m^2 | CONSTANT | 0.486E+06 | -999. | 0.100E-01 | -999. |
| Duration of pulse | yr | CONSTANT | -999. | -999. | 0.100E-08 | -999. |
| Spread of contaminant source | m | DERIVED | -999. | -999. | 0.100E-08 | 0.100E+11 |
| Recharge rate | m/yr | CONSTANT | 0.368E-01 | -999. | 0.000E+00 | 0.100E+11 |
| Source decay constant | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Initial concentration at landfill | mg/l | CONSTANT | 1.00 | -999. | 0.000E+00 | -999. |
| Length scale of facility | m | DERIVED | -999. | -999. | 0.100E-08 | 0.100E+11 |
| Width scale of facility | m | DERIVED | -999. | -999. | 0.100E-08 | 0.100E+11 |
| Near field dilution | | DERIVED | 1.00 | 0.000E+00 | 0.000E+00 | 1.00 |

1

AQUIFER SPECIFIC VARIABLES

| VARIABLE NAME | UNITS | DISTRIBUTION | PARAMETERS | | LIMITS | |
|---|---|---|---|---|---|---|
| | | | MEAN | STD DEV | MIN | MAX |
| Particle diameter | cm | CONSTANT | 0.381E-01 | -999. | 0.100E-08 | 100. |
| Aquifer porosity | -- | CONSTANT | 0.430 | -999. | 0.100E-08 | 0.990 |
| Bulk density | g/cc | CONSTANT | 1.65 | -999. | 0.100E-01 | 5.00 |
| Aquifer thickness | m | CONSTANT | 10.0 | -999. | 0.100E-08 | 0.100E+06 |
| Source thickness (mixing zone depth) | m | DERIVED | -999. | -999. | 0.100E-08 | 0.100E+06 |
| Conductivity (hydraulic) | m/yr | CONSTANT | 130. | -999. | 0.100E-06 | 0.100E+09 |
| Gradient (hydraulic) | | CONSTANT | 0.100E-01 | -999. | 0.100E-07 | -999. |
| Groundwater seepage velocity | m/yr | DERIVED | -999. | -999. | 0.100E-09 | 0.100E+09 |
| Retardation coefficient | -- | DERIVED | -999. | -999. | 1.00 | 0.100E+09 |
| Longitudinal dispersivity | m | FUNCTION OF X | -999. | -999. | -999. | -999. |
| Transverse dispersivity | m | FUNCTION OF X | -999. | -999. | -999. | -999. |
| Vertical dispersivity | m | FUNCTION OF X | -999. | -999. | -999. | -999. |
| Temperature of aquifer | C | CONSTANT | 21.0 | -999. | 0.000E+00 | 100. |
| pH | -- | CONSTANT | 7.20 | -999. | 0.300 | 14.0 |
| Organic carbon content (fraction) | | CONSTANT | 0.300E-02 | -999. | 0.100E-05 | 1.00 |
| Well distance from site | m | CONSTANT | 58.0 | -999. | 1.00 | -999. |
| Angle off center | degree | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 360. |
| Well vertical distance | m | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 1.00 |

CONCENTRATION AFTER SATURATED ZONE MODEL 0.1939E-04

CASE1OLG

1

U. S. ENVIRONMENTAL PROTECTION AGENCY

EXPOSURE ASSESSMENT

MULTIMEDIA MODEL

MULTIMED (Version 1.01, June 1991)

1

Run options

--- -------

CASE1OL Base Case Hydraulic Gradient = 10E-1

Location 1

Chemical simulated is DEFAULT CHEMICAL

| | |
|---|---|
| Option Chosen | Saturated zone model |
| Run was | DETERMIN |

Infiltration input by user
Run was steady-state
Reject runs if Y coordinate outside plume
Reject runs if Z coordinate outside plume
Gaussian source used in saturated zone model

1

1

CHEMICAL SPECIFIC VARIABLES

| VARIABLE NAME | UNITS | DISTRIBUTION | PARAMETERS | | LIMITS | |
|---|---|---|---|---|---|---|
| | | | MEAN | STD DEV | MIN | MAX |
| Solid phase decay coefficient | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 0.100E+11 |
| Dissolved phase decay coefficient | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 0.100E+11 |
| Overall chemical decay coefficient | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 0.100E+11 |
| Acid catalyzed hydrolysis rate | 1/M-yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Neutral hydrolysis rate constant | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Base catalyzed hydrolysis rate | 1/M-yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Reference temperature | C | CONSTANT | 20.0 | -999. | 0.000E+00 | 100. |
| Normalized distribution coefficient | ml/g | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Distribution coefficient | -- | DERIVED | -999. | -999. | 0.000E+00 | 0.100E+11 |
| Biodegradation coefficient (sat. zone) | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Air diffusion coefficient | cm2/s | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 10.0 |
| Reference temperature for air diffusion | C | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 100. |
| Molecular weight | g/M | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Mole fraction of solute | -- | CONSTANT | 0.000E+00 | -999. | 0.100E-08 | 1.00 |
| Vapor pressure of solute | mm Hg | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 100. |
| Henry`s law constant | atm-m^3/M | CONSTANT | 0.000E+00 | -999. | 0.100E-09 | 1.00 |

Page 1

CASE1OLG

| | | | | | | |
|---|---|---|---|---|---|---|
| Overall 1st order decay sat. zone | 1/yr | DERIVED | 0.000E+00 | 0.000E+00 | 0.000E+00 | 1.00 |
| Not currently used | | CONSTANT | -999. | -999. | 0.000E+00 | 1.00 |
| Not currently used | | CONSTANT | -999. | -999. | 0.000E+00 | 1.00 |

1

SOURCE SPECIFIC VARIABLES

| VARIABLE NAME | UNITS | DISTRIBUTION | PARAMETERS MEAN | PARAMETERS STD DEV | LIMITS MIN | LIMITS MAX |
|---|---|---|---|---|---|---|
| Infiltration rate | m/yr | CONSTANT | 0.179E-06 | -999. | 0.100E-09 | 0.100E+11 |
| Area of waste disposal unit | m^2 | CONSTANT | 0.486E+06 | -999. | 0.100E-01 | -999. |
| Duration of pulse | yr | CONSTANT | -999. | -999. | 0.100E-08 | -999. |
| Spread of contaminant source | m | DERIVED | -999. | -999. | 0.100E-08 | 0.100E+11 |
| Recharge rate | m/yr | CONSTANT | 0.368E-01 | -999. | 0.000E+00 | 0.100E+11 |
| Source decay constant | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Initial concentration at landfill | mg/l | CONSTANT | 1.00 | -999. | 0.000E+00 | -999. |
| Length scale of facility | m | DERIVED | -999. | -999. | 0.100E-08 | 0.100E+11 |
| Width scale of facility | m | DERIVED | -999. | -999. | 0.100E-08 | 0.100E+11 |
| Near field dilution | | DERIVED | 1.00 | 0.000E+00 | 0.000E+00 | 1.00 |

1

AQUIFER SPECIFIC VARIABLES

| VARIABLE NAME | UNITS | DISTRIBUTION | PARAMETERS MEAN | PARAMETERS STD DEV | LIMITS MIN | LIMITS MAX |
|---|---|---|---|---|---|---|
| Particle diameter | cm | CONSTANT | 0.381E-01 | -999. | 0.100E-08 | 100. |
| Aquifer porosity | -- | CONSTANT | 0.430 | -999. | 0.100E-08 | 0.990 |
| Bulk density | g/cc | CONSTANT | 1.65 | -999. | 0.100E-01 | 5.00 |
| Aquifer thickness | m | CONSTANT | 10.0 | -999. | 0.100E-08 | 0.100E+06 |
| Source thickness (mixing zone depth) | m | DERIVED | -999. | -999. | 0.100E-08 | 0.100E+06 |
| Conductivity (hydraulic) | m/yr | CONSTANT | 130. | -999. | 0.100E-06 | 0.100E+09 |
| Gradient (hydraulic) | | CONSTANT | 0.100 | -999. | 0.100E-07 | -999. |
| Groundwater seepage velocity | m/yr | DERIVED | -999. | -999. | 0.100E-09 | 0.100E+09 |
| Retardation coefficient | -- | DERIVED | -999. | -999. | 1.00 | 0.100E+09 |
| Longitudinal dispersivity | m | FUNCTION OF X | -999. | -999. | -999. | -999. |
| Transverse dispersivity | m | FUNCTION OF X | -999. | -999. | -999. | -999. |
| Vertical dispersivity | m | FUNCTION OF X | -999. | -999. | -999. | -999. |
| Temperature of aquifer | C | CONSTANT | 21.0 | -999. | 0.000E+00 | 100. |
| pH | -- | CONSTANT | 7.20 | -999. | 0.300 | 14.0 |
| Organic carbon content (fraction) | | CONSTANT | 0.300E-02 | -999. | 0.100E-05 | 1.00 |
| Well distance from site | m | CONSTANT | 58.0 | -999. | 1.00 | -999. |
| Angle off center | degree | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 360. |
| Well vertical distance | m | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 1.00 |

CONCENTRATION AFTER SATURATED ZONE MODEL 0.2242E-05

CASE1OLO

1

U. S. ENVIRONMENTAL PROTECTION AGENCY

EXPOSURE ASSESSMENT

MULTIMEDIA MODEL

MULTIMED (Version 1.01, June 1991)

1

Run options
--- -------

CASE1OL Base Case Organic Carbon Content 0%

Location 1
Chemical simulated is DEFAULT CHEMICAL

| | |
|---|---|
| Option Chosen | Saturated zone model |
| Run was | DETERMIN |

Infiltration input by user
Run was steady-state
Reject runs if Y coordinate outside plume
Reject runs if Z coordinate outside plume
Gaussian source used in saturated zone model
1
1

CHEMICAL SPECIFIC VARIABLES

| VARIABLE NAME | UNITS | DISTRIBUTION | PARAMETERS MEAN | PARAMETERS STD DEV | LIMITS MIN | LIMITS MAX |
|---|---|---|---|---|---|---|
| Solid phase decay coefficient | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 0.100E+11 |
| Dissolved phase decay coefficient | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 0.100E+11 |
| Overall chemical decay coefficient | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 0.100E+11 |
| Acid catalyzed hydrolysis rate | 1/M-yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Neutral hydrolysis rate constant | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Base catalyzed hydrolysis rate | 1/M-yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Reference temperature | C | CONSTANT | 20.0 | -999. | 0.000E+00 | 100. |
| Normalized distribution coefficient | ml/g | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Distribution coefficient | -- | DERIVED | -999. | -999. | 0.000E+00 | 0.100E+11 |
| Biodegradation coefficient (sat. zone) | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Air diffusion coefficient | cm2/s | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 10.0 |
| Reference temperature for air diffusion | C | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 100. |
| Molecular weight | g/M | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Mole fraction of solute | -- | CONSTANT | 0.000E+00 | -999. | 0.100E-08 | 1.00 |
| Vapor pressure of solute | mm Hg | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 100. |
| Henry`s law constant | atm-m^3/M | CONSTANT | 0.000E+00 | -999. | 0.100E-09 | 1.00 |

CASE1OLO

| | | | | | | |
|---|---|---|---|---|---|---|
| Overall 1st order decay sat. zone | 1/yr | DERIVED | 0.000E+00 | 0.000E+00 | 0.000E+00 | 1.00 |
| Not currently used | | CONSTANT | -999. | -999. | 0.000E+00 | 1.00 |
| Not currently used | | CONSTANT | -999. | -999. | 0.000E+00 | 1.00 |

1

SOURCE SPECIFIC VARIABLES

| VARIABLE NAME | UNITS | DISTRIBUTION | PARAMETERS | | LIMITS | |
|---|---|---|---|---|---|---|
| | | | MEAN | STD DEV | MIN | MAX |
| Infiltration rate | m/yr | CONSTANT | 0.179E-06 | -999. | 0.100E-09 | 0.100E+11 |
| Area of waste disposal unit | m^2 | CONSTANT | 0.486E+06 | -999. | 0.100E-01 | -999. |
| Duration of pulse | yr | CONSTANT | -999. | -999. | 0.100E-08 | -999. |
| Spread of contaminant source | m | DERIVED | -999. | -999. | 0.100E-08 | 0.100E+11 |
| Recharge rate | m/yr | CONSTANT | 0.368E-01 | -999. | 0.000E+00 | 0.100E+11 |
| Source decay constant | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Initial concentration at landfill | mg/l | CONSTANT | 1.00 | -999. | 0.000E+00 | -999. |
| Length scale of facility | m | DERIVED | -999. | -999. | 0.100E-08 | 0.100E+11 |
| Width scale of facility | m | DERIVED | -999. | -999. | 0.100E-08 | 0.100E+11 |
| Near field dilution | | DERIVED | 1.00 | 0.000E+00 | 0.000E+00 | 1.00 |

1

AQUIFER SPECIFIC VARIABLES

| VARIABLE NAME | UNITS | DISTRIBUTION | PARAMETERS | | LIMITS | |
|---|---|---|---|---|---|---|
| | | | MEAN | STD DEV | MIN | MAX |
| Particle diameter | cm | CONSTANT | 0.381E-01 | -999. | 0.100E-08 | 100. |
| Aquifer porosity | -- | CONSTANT | 0.430 | -999. | 0.100E-08 | 0.990 |
| Bulk density | g/cc | CONSTANT | 1.65 | -999. | 0.100E-01 | 5.00 |
| Aquifer thickness | m | CONSTANT | 10.0 | -999. | 0.100E-08 | 0.100E+06 |
| Source thickness (mixing zone depth) | m | DERIVED | -999. | -999. | 0.100E-08 | 0.100E+06 |
| Conductivity (hydraulic) | m/yr | CONSTANT | 130. | -999. | 0.100E-06 | 0.100E+09 |
| Gradient (hydraulic) | | CONSTANT | 0.200E-02 | -999. | 0.100E-07 | -999. |
| Groundwater seepage velocity | m/yr | DERIVED | -999. | -999. | 0.100E-09 | 0.100E+09 |
| Retardation coefficient | -- | DERIVED | -999. | -999. | 1.00 | 0.100E+09 |
| Longitudinal dispersivity | m | FUNCTION OF X | -999. | -999. | -999. | -999. |
| Transverse dispersivity | m | FUNCTION OF X | -999. | -999. | -999. | -999. |
| Vertical dispersivity | m | FUNCTION OF X | -999. | -999. | -999. | -999. |
| Temperature of aquifer | C | CONSTANT | 21.0 | -999. | 0.000E+00 | 100. |
| pH | -- | CONSTANT | 7.20 | -999. | 0.300 | 14.0 |
| Organic carbon content (fraction) | | CONSTANT | 0.100E-05 | -999. | 0.100E-05 | 1.00 |
| Well distance from site | m | CONSTANT | 58.0 | -999. | 1.00 | -999. |
| Angle off center | degree | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 360. |
| Well vertical distance | m | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 1.00 |

CONCENTRATION AFTER SATURATED ZONE MODEL 0.5320E-04

CASE1OLC

1

U. S. ENVIRONMENTAL PROTECTION AGENCY

EXPOSURE ASSESSMENT

MULTIMEDIA MODEL

MULTIMED (Version 1.01, June 1991)

1

Run options

--- -------

CASE1OL Base Case Point of Compliance 2 m

Location 1
Chemical simulated is DEFAULT CHEMICAL

Option Chosen Saturated zone model
Run was DETERMIN
Infiltration input by user
Run was steady-state
Reject runs if Y coordinate outside plume
Reject runs if Z coordinate outside plume
Gaussian source used in saturated zone model

1
1

CHEMICAL SPECIFIC VARIABLES

| VARIABLE NAME | UNITS | DISTRIBUTION | PARAMETERS MEAN | PARAMETERS STD DEV | LIMITS MIN | LIMITS MAX |
|---|---|---|---|---|---|---|
| Solid phase decay coefficient | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 0.100E+11 |
| Dissolved phase decay coefficient | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 0.100E+11 |
| Overall chemical decay coefficient | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 0.100E+11 |
| Acid catalyzed hydrolysis rate | 1/M-yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Neutral hydrolysis rate constant | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Base catalyzed hydrolysis rate | 1/M-yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Reference temperature | C | CONSTANT | 20.0 | -999. | 0.000E+00 | 100. |
| Normalized distribution coefficient | ml/g | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Distribution coefficient | -- | DERIVED | -999. | -999. | 0.000E+00 | 0.100E+11 |
| Biodegradation coefficient (sat. zone) | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Air diffusion coefficient | cm2/s | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 10.0 |
| Reference temperature for air diffusion | C | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 100. |
| Molecular weight | g/M | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Mole fraction of solute | -- | CONSTANT | 0.000E+00 | -999. | 0.100E-08 | 1.00 |
| Vapor pressure of solute | mm Hg | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 100. |
| Henry`s law constant | atm-m^3/M | CONSTANT | 0.000E+00 | -999. | 0.100E-09 | 1.00 |

Page 1

CASE1OLC

| | | | | | | |
|---|---|---|---|---|---|---|
| Overall 1st order decay sat. zone | 1/yr | DERIVED | 0.000E+00 | 0.000E+00 | 0.000E+00 | 1.00 |
| Not currently used | | CONSTANT | -999. | -999. | 0.000E+00 | 1.00 |
| Not currently used | | CONSTANT | -999. | -999. | 0.000E+00 | 1.00 |

1

SOURCE SPECIFIC VARIABLES

| VARIABLE NAME | UNITS | DISTRIBUTION | PARAMETERS MEAN | PARAMETERS STD DEV | LIMITS MIN | LIMITS MAX |
|---|---|---|---|---|---|---|
| Infiltration rate | m/yr | CONSTANT | 0.179E-06 | -999. | 0.100E-09 | 0.100E+11 |
| Area of waste disposal unit | m^2 | CONSTANT | 0.486E+06 | -999. | 0.100E-01 | -999. |
| Duration of pulse | yr | CONSTANT | -999. | -999. | 0.100E-08 | -999. |
| Spread of contaminant source | m | DERIVED | -999. | -999. | 0.100E-08 | 0.100E+11 |
| Recharge rate | m/yr | CONSTANT | 0.368E-01 | -999. | 0.000E+00 | 0.100E+11 |
| Source decay constant | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Initial concentration at landfill | mg/l | CONSTANT | 1.00 | -999. | 0.000E+00 | -999. |
| Length scale of facility | m | DERIVED | -999. | -999. | 0.100E-08 | 0.100E+11 |
| Width scale of facility | m | DERIVED | -999. | -999. | 0.100E-08 | 0.100E+11 |
| Near field dilution | | DERIVED | 1.00 | 0.000E+00 | 0.000E+00 | 1.00 |

1

AQUIFER SPECIFIC VARIABLES

| VARIABLE NAME | UNITS | DISTRIBUTION | PARAMETERS MEAN | PARAMETERS STD DEV | LIMITS MIN | LIMITS MAX |
|---|---|---|---|---|---|---|
| Particle diameter | cm | CONSTANT | 0.381E-01 | -999. | 0.100E-08 | 100. |
| Aquifer porosity | -- | CONSTANT | 0.430 | -999. | 0.100E-08 | 0.990 |
| Bulk density | g/cc | CONSTANT | 1.65 | -999. | 0.100E-01 | 5.00 |
| Aquifer thickness | m | CONSTANT | 10.0 | -999. | 0.100E-08 | 0.100E+06 |
| Source thickness (mixing zone depth) | m | DERIVED | -999. | -999. | 0.100E-08 | 0.100E+06 |
| Conductivity (hydraulic) | m/yr | CONSTANT | 130. | -999. | 0.100E-06 | 0.100E+09 |
| Gradient (hydraulic) | | CONSTANT | 0.200E-02 | -999. | 0.100E-07 | -999. |
| Groundwater seepage velocity | m/yr | DERIVED | -999. | -999. | 0.100E-09 | 0.100E+09 |
| Retardation coefficient | -- | DERIVED | -999. | -999. | 1.00 | 0.100E+09 |
| Longitudinal dispersivity | m | FUNCTION OF X | -999. | -999. | -999. | -999. |
| Transverse dispersivity | m | FUNCTION OF X | -999. | -999. | -999. | -999. |
| Vertical dispersivity | m | FUNCTION OF X | -999. | -999. | -999. | -999. |
| Temperature of aquifer | C | CONSTANT | 21.0 | -999. | 0.000E+00 | 100. |
| pH | -- | CONSTANT | 7.20 | -999. | 0.300 | 14.0 |
| Organic carbon content (fraction) | | CONSTANT | 0.300E-02 | -999. | 0.100E-05 | 1.00 |
| Well distance from site | m | CONSTANT | 2.00 | -999. | 1.00 | -999. |
| Angle off center | degree | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 360. |
| Well vertical distance | m | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 1.00 |

CONCENTRATION AFTER SATURATED ZONE MODEL 0.1117E-03

CASE10LX

1

U. S.   E N V I R O N M E N T A L   P R O T E C T I O N   A G E N C Y

E X P O S U R E   A S S E S S M E N T

M U L T I M E D I A   M O D E L

MULTIMED (Version 1.01, June 1991)

1

Run options
--- -------

CASE10L Base Case Point of Compliance 150 m

Location 1
Chemical simulated is DEFAULT CHEMICAL

| | |
|---|---|
| Option Chosen | Saturated zone model |
| Run was | DETERMIN |

Infiltration input by user
Run was steady-state
Reject runs if Y coordinate outside plume
Reject runs if Z coordinate outside plume
Gaussian source used in saturated zone model

1
1

CHEMICAL SPECIFIC VARIABLES

| VARIABLE NAME | UNITS | DISTRIBUTION | PARAMETERS MEAN | PARAMETERS STD DEV | LIMITS MIN | LIMITS MAX |
|---|---|---|---|---|---|---|
| Solid phase decay coefficient | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 0.100E+11 |
| Dissolved phase decay coefficient | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 0.100E+11 |
| Overall chemical decay coefficient | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 0.100E+11 |
| Acid catalyzed hydrolysis rate | 1/M-yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Neutral hydrolysis rate constant | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Base catalyzed hydrolysis rate | 1/M-yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Reference temperature | C | CONSTANT | 20.0 | -999. | 0.000E+00 | 100. |
| Normalized distribution coefficient | ml/g | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Distribution coefficient | -- | DERIVED | -999. | -999. | 0.000E+00 | 0.100E+11 |
| Biodegradation coefficient (sat. zone) | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Air diffusion coefficient | cm2/s | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 10.0 |
| Reference temperature for air diffusion | C | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 100. |
| Molecular weight | g/M | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Mole fraction of solute | -- | CONSTANT | 0.000E+00 | -999. | 0.100E-08 | 1.00 |
| Vapor pressure of solute | mm Hg | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 100. |
| Henry`s law constant | atm-m^3/M | CONSTANT | 0.000E+00 | -999. | 0.100E-09 | 1.00 |

CASE1OLX

| | | | | | | |
|---|---|---|---|---|---|---|
| Overall 1st order decay sat. zone | 1/yr | DERIVED | 0.000E+00 | 0.000E+00 | 0.000E+00 | 1.00 |
| Not currently used | | CONSTANT | -999. | -999. | 0.000E+00 | 1.00 |
| Not currently used | | CONSTANT | -999. | -999. | 0.000E+00 | 1.00 |

1

SOURCE SPECIFIC VARIABLES

| VARIABLE NAME | UNITS | DISTRIBUTION | PARAMETERS MEAN | PARAMETERS STD DEV | LIMITS MIN | LIMITS MAX |
|---|---|---|---|---|---|---|
| Infiltration rate | m/yr | CONSTANT | 0.179E-06 | -999. | 0.100E-09 | 0.100E+11 |
| Area of waste disposal unit | m^2 | CONSTANT | 0.486E+06 | -999. | 0.100E-01 | -999. |
| Duration of pulse | yr | CONSTANT | -999. | -999. | 0.100E-08 | -999. |
| Spread of contaminant source | m | DERIVED | -999. | -999. | 0.100E-08 | 0.100E+11 |
| Recharge rate | m/yr | CONSTANT | 0.368E-01 | -999. | 0.000E+00 | 0.100E+11 |
| Source decay constant | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Initial concentration at landfill | mg/l | CONSTANT | 1.00 | -999. | 0.000E+00 | -999. |
| Length scale of facility | m | DERIVED | -999. | -999. | 0.100E-08 | 0.100E+11 |
| Width scale of facility | m | DERIVED | -999. | -999. | 0.100E-08 | 0.100E+11 |
| Near field dilution | | DERIVED | 1.00 | 0.000E+00 | 0.000E+00 | 1.00 |

1

AQUIFER SPECIFIC VARIABLES

| VARIABLE NAME | UNITS | DISTRIBUTION | PARAMETERS MEAN | PARAMETERS STD DEV | LIMITS MIN | LIMITS MAX |
|---|---|---|---|---|---|---|
| Particle diameter | cm | CONSTANT | 0.381E-01 | -999. | 0.100E-08 | 100. |
| Aquifer porosity | -- | CONSTANT | 0.430 | -999. | 0.100E-08 | 0.990 |
| Bulk density | g/cc | CONSTANT | 1.65 | -999. | 0.100E-01 | 5.00 |
| Aquifer thickness | m | CONSTANT | 10.0 | -999. | 0.100E-08 | 0.100E+06 |
| Source thickness (mixing zone depth) | m | DERIVED | -999. | -999. | 0.100E-08 | 0.100E+06 |
| Conductivity (hydraulic) | m/yr | CONSTANT | 130. | -999. | 0.100E-06 | 0.100E+09 |
| Gradient (hydraulic) | | CONSTANT | 0.200E-02 | -999. | 0.100E-07 | -999. |
| Groundwater seepage velocity | m/yr | DERIVED | -999. | -999. | 0.100E-09 | 0.100E+09 |
| Retardation coefficient | -- | DERIVED | -999. | -999. | 1.00 | 0.100E+09 |
| Longitudinal dispersivity | m | FUNCTION OF X | -999. | -999. | -999. | -999. |
| Transverse dispersivity | m | FUNCTION OF X | -999. | -999. | -999. | -999. |
| Vertical dispersivity | m | FUNCTION OF X | -999. | -999. | -999. | -999. |
| Temperature of aquifer | C | CONSTANT | 21.0 | -999. | 0.000E+00 | 100. |
| pH | -- | CONSTANT | 7.20 | -999. | 0.300 | 14.0 |
| Organic carbon content (fraction) | | CONSTANT | 0.300E-02 | -999. | 0.100E-05 | 1.00 |
| Well distance from site | m | CONSTANT | 150. | -999. | 1.00 | -999. |
| Angle off center | degree | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 360. |
| Well vertical distance | m | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 1.00 |

CONCENTRATION AFTER SATURATED ZONE MODEL 0.1828E-04

# APPENDIX I

# PRE-SUBTITLE D AREA (SECTOR 8A AND SECTOR 8B) FINAL COVER TEST DATA & PROPERTIES FIGURE

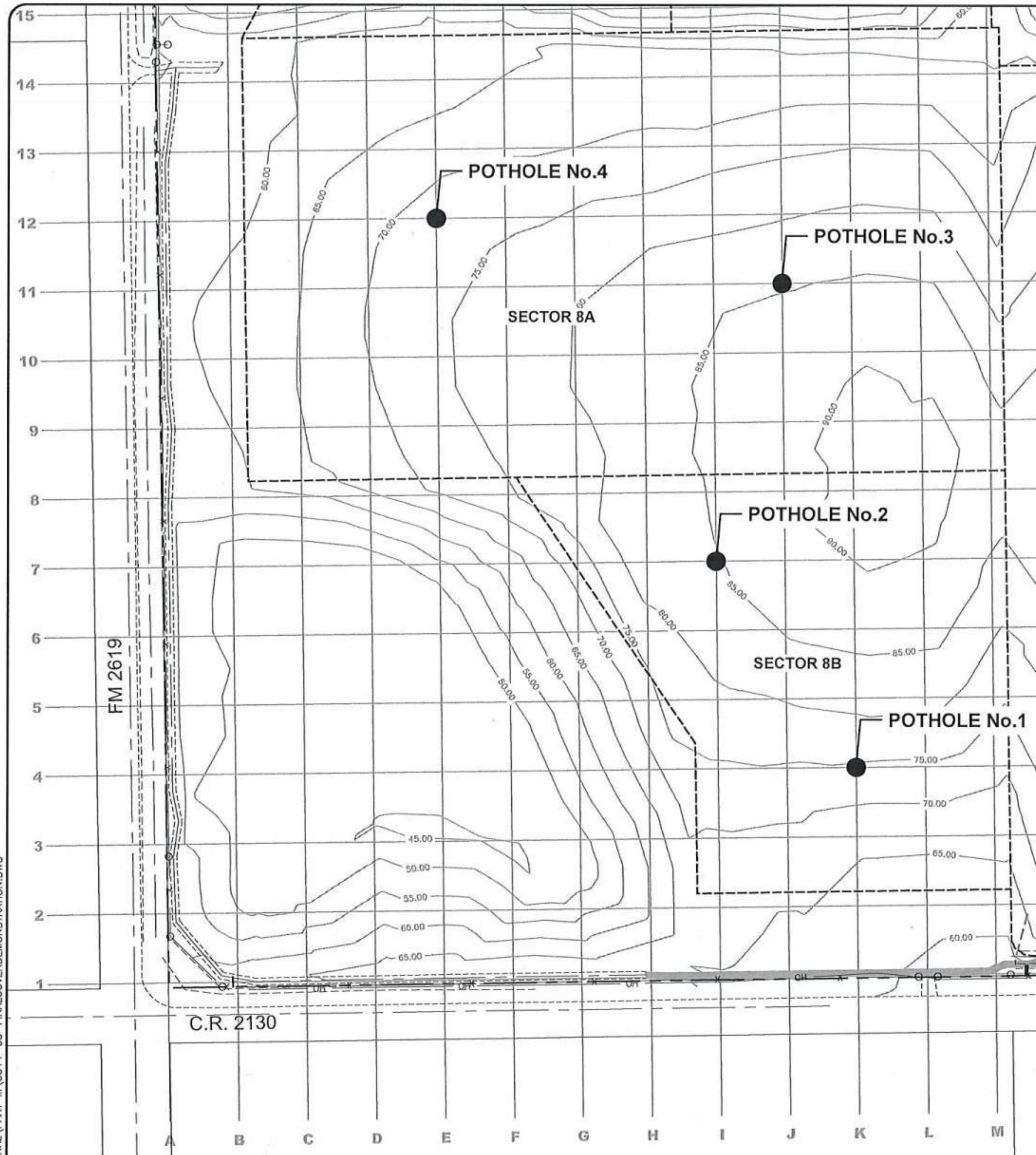
For Permitting Purposes Only

STATE OF TEXAS
JOSE C. GARZA
91790
LICENSED
PROFESSIONAL ENGINEER

04/24/19

Jose C. Garza, P.E.

TBPE Firm No. F-417





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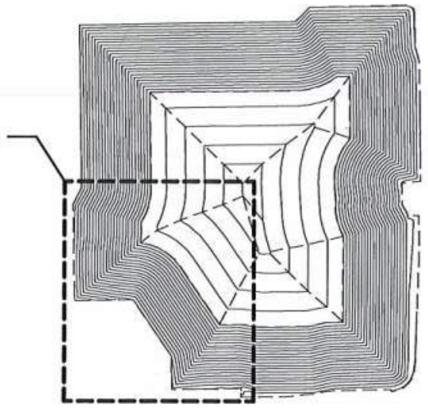


**KEY MAP**

**POTHOLE No.1 - SAMPLE**

**POTHOLE No.3 - SAMPLE**

**POTHOLE No.2 - SAMPLE**

**POTHOLE No.4 - SAMPLE**

STATE OF TEXAS
TAD A. GASS
GEOLOGY
11496
LICENSED
PROFESSIONAL GEOSCIENTIST

Tad A. Gass
4/23/2019

**FINAL COVER DEMONSTRATION - MIN. 2FT THICK**
**SOIL CLASSIFICATION - SC (CLAYEY SAND)**

| NUMBER | REVISION | DATE | DRAWN | DESIGNED | REVIEWED |
|---|---|---|---|---|---|

STATE OF TEXAS
JOSE C. GARZA
91790
LICENSED
PROFESSIONAL ENGINEER
04/23/19
Jose C. Garza, P.E.

Hanson No. 16L0438
Filename 8514-03-FINALCOVERDEMONSTRATION
Scale AS SHOWN
Date 04/23/2019

| | | |
|---|---|---|
| LAYOUT | DT | 04/23/2019 |
| DRAWN | DT | 04/23/2019 |
| REVIEWED | JCG | 04/23/2019 |

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PART III, ATTACHMENT 5
APPENDIX I
FIGURE - I.1
PRE-SUBTITLE D AREA (SECTOR 8A & SECTOR 8B)
FINAL COVER TEST DATA & PROPERTIES
CITY OF KINGSVILLE LANDFILL
PA. MSW 235-C
KINGSVILLE, TEXAS, KLEBERG COUNTY, TEXAS

FIGURE:
III.5-I-I.1

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THE CITY OF KINGSVILLE LANDFILL

TCEQ PERMIT MSW 235C

# PERMIT AMENDMENT APPLICATION

## Volume 5 of 6

CITY OF KINGSVILLE, KLEBERG COUNTY, TEXAS

For Permitting Purposes Only

STATE OF TEXAS
JON M. REINHARD
64541
LICENSED PROFESSIONAL ENGINEER
04/25/19

TBPE Firm No. F-417

September 2018
Revision 1 – November 2018
Revision 2 – February 2019
Revision 3 – April 2019

Prepared by

HANSON
Engineering | Planning | Allied Services

TBPE F-417

HANSON PROJECT NO. 16L0438-0003

# CITY OF KINGSVILLE LANDFILL

# PART III

# ATTACHMENT 7

LANDFILL COMPLETION PLAN

For Permitting Purposes Only

STATE OF TEXAS
JON M. REINHARD
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LICENSED
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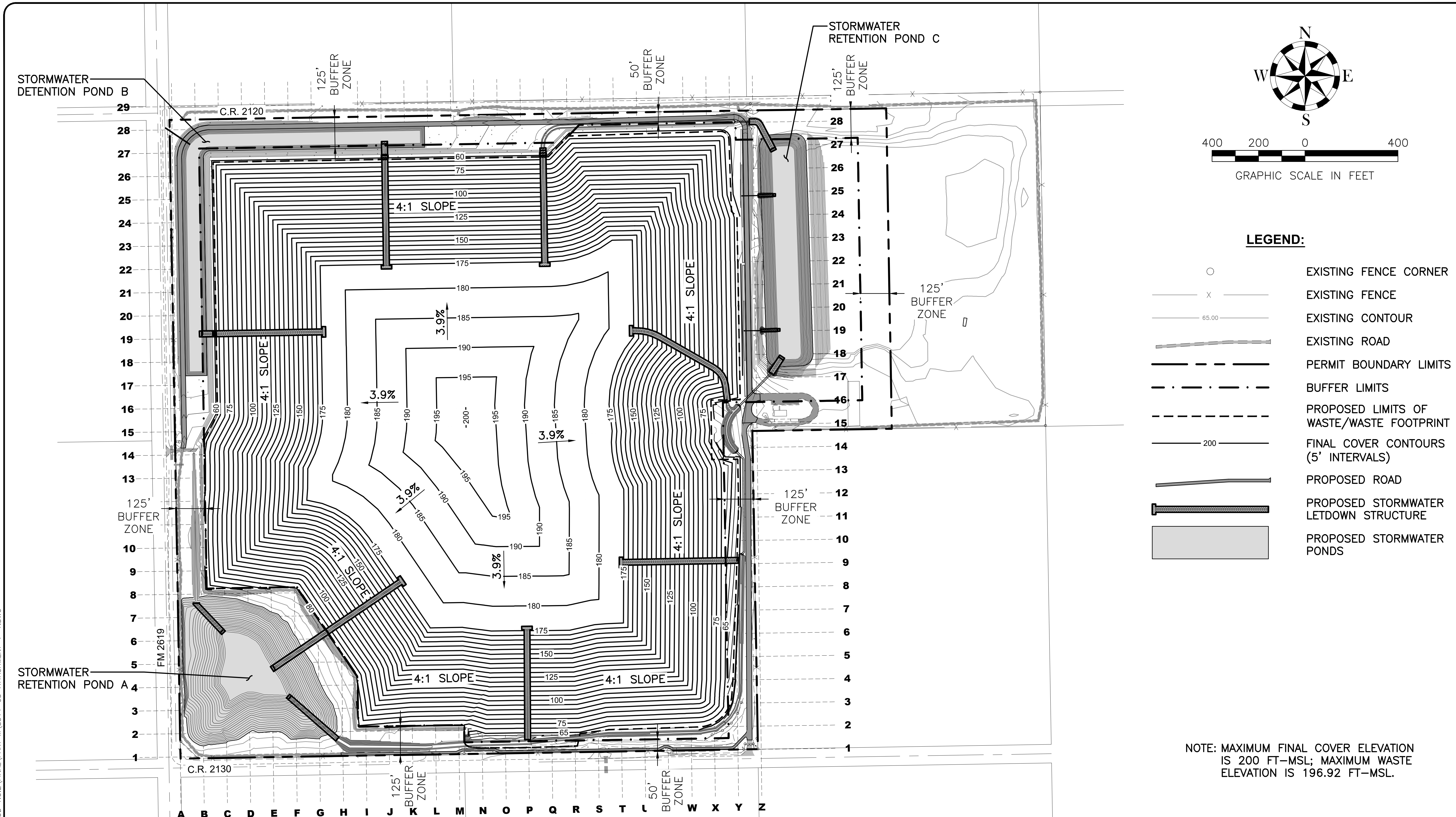
04/25/19

TBPE Firm No. F-417




**LEGEND:**

| | |
|---|---|
| ○ | EXISTING FENCE CORNER |
| x | EXISTING FENCE |
| 65.00 | EXISTING CONTOUR |
| | EXISTING ROAD |
| | PERMIT BOUNDARY LIMITS |
| | BUFFER LIMITS |
| | PROPOSED LIMITS OF WASTE/WASTE FOOTPRINT |
| 200 | FINAL COVER CONTOURS (5' INTERVALS) |
| | PROPOSED ROAD |
| | PROPOSED STORMWATER LETDOWN STRUCTURE |
| | PROPOSED STORMWATER PONDS |

NOTE: MAXIMUM FINAL COVER ELEVATION IS 200 FT–MSL; MAXIMUM WASTE ELEVATION IS 196.92 FT–MSL.

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| NUMBER | REVISION | DATE | DRAWN | DESIGNED | REVIEWED |
|---|---|---|---|---|---|

STATE OF TEXAS
JON M. REINHARD
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LICENSED PROFESSIONAL ENGINEER
04/23/19

Hanson No. 16L0438
Filename 8514–03–ATTACHMENT–7–1
Scale AS SHOWN
Date 04/23/2019

| | | |
|---|---|---|
| LAYOUT | DT | 04/23/2019 |
| DRAWN | DT | 04/23/2019 |
| REVIEWED | JMR | 04/23/2019 |

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PART III, ATTACHMENT 7
LANDFILL COMPLETION PLAN
CITY OF KINGSVILLE LANDFILL
MSW PERMIT No. 235-C
KINGSVILLE, TEXAS
KLEBERG COUNTY, TEXAS

FIGURE: III.7-1

# CITY OF KINGSVILLE LANDFILL

# PART III

# ATTACHMENT 10

LINER QUALITY CONTROL PLAN

For Permitting Purposes Only

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04/25/19

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THE CITY OF KINGSVILLE LANDFILL

TCEQ PERMIT MSW 235C

# PERMIT AMENDMENT APPLICATION

## Part III

## Attachment 10
## Liner Quality Control Plan

City of Kingsville TEXAS

CITY OF KINGSVILLE, KLEBERG COUNTY, TEXAS

For Permitting Purposes Only

September 2018
Revision 1 – November 2018
Revision 2 - February 2019
Revision 3 - April 2019

STATE OF TEXAS
JON M. REINHARD
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LICENSED
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04/25/19

Prepared by

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Engineering | Planning | Allied Services

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HANSON PROJECT NO. 16L0438- 0003

# TABLE OF CONTENTS



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04/25/19
TBPE Firm No. F-417
For Pages i - v

# 1. GENERAL

## 1.1. Scope and Purpose

This Liner Quality Control Plan (LQCP) is applicable to the construction of all landfill liner systems at the City of Kingsville Landfill, a Municipal Solid Waste (MSW) disposal facility in Kleberg County, Texas. This LQCP shall govern the material characteristics, installation and testing for the various construction components for the landfill liners at the facility. Qualifications for quality control personnel are also identified in this LQCP. The provisions of this LCQP were developed based on the latest technical guidelines of the TCEQ, including quality control of construction, testing frequencies and procedures, and quality assurance of sampling and testing procedures.

## 1.2. Lining and Cover Systems Used for the Landfill

The lining and cover systems that will be used at this facility will be alternative liner designs. Alternative liner design demonstrations can be found in Part III, Attachment 5. The following lining and/or cover systems will be used at the facility:

### 1.2.1. Landfill Lining System

The landfill lining system to be used in Sectors 4C, 5, 6 and 7 will consist of (from bottom to top):

- A prepared subgrade;
- A geosynthetic clay liner (GCL);
- A geomembrane liner consisting of sixty mil (0.06 inch) thick HDPE;
- A leachate collection layer consisting of a drainage geocomposite (a synthetic drainage net with geotextile fabric on one or both sides), gravel, collection piping, and geotextile separation fabric;
- A two (2) foot protective cover soil layer.

### 1.2.2. Landfill Cover System

The landfill cover system will consist of (from bottom to top):

- A prepared soil subgrade;
- A geosynthetic clay liner (GCL) layer;
- A forty mil (0.04 inch) thick LLDPE geomembrane layer;
- A geocomposite drainage layer consisting of a synthetic drainage net and geotextile fabric;
- A twenty five (25) inch thick protective cover soil layer, the top seven (7) inches of which must be capable of supporting vegetation.

### 1.2.3. Piggyback Liner System

This liner system will be used in areas of the landfill where disposal development will occur over existing unlined MSW fill locations and will include components that will provide additional geotechnical stability. The piggyback lining system will consist of (from bottom to top):

| | |
|---|---|
| D 5261 | Standard Test Method for Measuring Mass per Unit Area of Geotextiles |
| D 5321 | Standard Test Method for Determining the Shear Strength of Soil-Geosynthetic and Geosynthetic-Geosynthetic Interfaces by Direct Shear |
| D 5596 | Standard Test Method for Microscopic Evaluation of the Dispersion of Carbon Black in Polyolefin Geosynthetics |
| D 5887 | Standard Test Method for Measurement of Index Flux Through Saturated Geosynthetic Clay Liner Specimens Using a Flexible Wall Permeameter |
| D 5890 | Standard Test Method for Swell Index of Clay Mineral Component of Geosynthetic Clay Liners |
| D 5891 | Standard Test Method for Fluid Loss of Clay Component of Geosynthetic Clay Liners |
| D 5993 | Standard Test Method for Measuring Mass Per Unit of Geosynthetic Clay Liners |
| D 5994 | Standard Test Method for Measuring Core Thickness of Textured Geomembranes |
| D 6392 | Standard Test Method for Determining the Integrity of Nonreinforced Geomembrane Seams Produced Using Thermo-Fusion Methods |
| D 6241 | Standard Test Method for Static Puncture Strength of Geotextiles and Geotextile-Related Products Using a 50-mm Probe |
| D 6243 | Standard Test Method for Determining the Internal and Interface Shear Strength of Geosynthetic Clay Liner by the Direct Shear Method |
| D 6496 | Standard Test Method for Determining Average Bonding Peel Strength Between Top and Bottom Layers of Needle-Punched Geosynthetic Clay Liners |
| D 6768 | Standard Test Method for Tensile Strength of Geosynthetic Clay Liners |
| D 7176 | Standard Specification for Non-Reinforced Polyvinyl Chloride (PVC) Geomembranes Used in Buried Applications |
| D 7179 | Standard Test Method for Determining Geonet Breaking Force |
| F 480 | Standard Specification for Thermoplastic Well Casing Pipe and Couplings Made in Standard Dimension Ratios (SDR), SCH 40 and SCH 80 |
| F 714 | Standard Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter |

### 1.7.2. Geosynthetics Research Institute

| | |
|---|---|
| GM13 | Standard Specification for Test Methods, Test Properties and Testing Frequency for High Density Polyethylene (HDPE) Smooth and Textured Geomembranes |
| GM17 | Test Methods, Test Properties and Testing Frequency for Linear Low Density Polyethylene (LLDPE) Smooth and Textured Geomembranes |
| GM19 | Seam Strength and Related Properties of Thermally Bonded Polyolefin Geomembranes |

## 1.8. Material Conformance Tests for Soils and Gravel

Soil materials used for construction at the facility shall be subjected to the following conformance tests to demonstrate compliance with the LQCP. Unless otherwise specified, one set of tests shall be performed for each material type. If there is a visually distinguishable change in the soil characteristics or a change in the soils Liquid Limit (LL) or Plasticity Index (PI) by more than 10 points, the soil shall be considered a separate borrow source and shall require an additional set of tests. In any condition, a minimum of one (1) complete set of tests must be performed for each type of soil material used. Conformance testing will be conducted by the party identified in sections 2.4 . The results of these tests shall be used for field quality control. The Contractor shall ensure that the required samples are collected and tested in a timely manner to be available for field quality control. Not all tests will be required for all soils; only those tests for which the individual components specify a required material property.

#### 1.8.1. Soil Classification

All soil materials used shall be classified in accordance with the Unified Soil Classification System (USCS - ASTM D 2487).

#### 1.8.2. Gradation

All soil materials used shall be tested to determine the particle size gradation, including the percentage passing the #200 sieve. Gradation shall be determined in accordance with ASTM D 1140. Gravel materials used shall be tested to determine the gradation in accordance with ASTM C 136 or ASTM D 422.

#### 1.8.3. Atterberg Limits

All soil materials used shall be tested to determine the Atterberg Limits (Liquid Limit and Plastic Limit) and the Plasticity Index (ASTM D 4318).

#### 1.8.4. Soil Moisture-Density

The soil moisture/density relationship shall be determined using the Standard Proctor method (ASTM D 698).

#### 1.8.5. Coefficient of Permeability/Hydraulic Conductivity

Where the LQCP indicates to determine the coefficient of permeability or the hydraulic conductivity (in centimeters per second [cm/sec]), use one of the following test procedures:

Constant Head Permeability

Permeability of Granular Soils (Constant Head) – ASTM D 2434

Hydraulic Conductivity

Flexible Wall Permeameter (back pressure saturation) ASTM D 5084.

#### 1.8.6. Calcium Carbonate Content

All gravel materials used shall be tested to determine the calcium carbonate content in accordance with ASTM D 3042.

#### 1.9.5. Thickness

Smooth HDPE geomembrane sheet and HDPE drainage net shall be tested for thickness in accordance with ASTM D 5199. Textured HDPE geomembrane sheet shall be tested for thickness in accordance with ASTM D 5994.

#### 1.9.6. Tear Resistance

The geomembrane sheet shall be tested for tear resistance in accordance with ASTM D 1004.

#### 1.9.7. Puncture Resistance

The geomembrane and geotextile materials shall be tested for puncture resistance in accordance with ASTM D 4833 and ASTM D 6241, respectively.

#### 1.9.8. Apparent Opening Size

Geotextile shall be tested for apparent opening size (AOS) in accordance with ASTM D 4751.

## 2. SUBGRADE PREPARATION AND CONTROLLED FILL

The following requirements govern the subgrade preparation for liners and covers used at the facility:

### 2.1. Subgrade Description

Subgrade materials shall not exhibit excessive cohesion and shall be free of large particles, rocks or other foreign material. The finished subgrade should be smooth, with no large or protruding items that may damage liner materials placed on the subgrade. Soil materials used as fill to finish the subgrade shall be obtained either from on-site or off-site sources.

### 2.2. Required Material Properties

Soil materials used for fill to construct subgrade shall be free of sod, trash, roots, and organic matter. The materials shall meet the following minimum requirements which are also summarized in Table 10-1:

#### 2.2.1. Soil Materials

##### 2.2.1.1. Classification

Soil materials shall be classified using the USCS. Acceptable classifications are CH CL, ML, SW, SP, SM, or SC.

#### 2.2.1.2.Gradation:

The soil material shall be composed of particles of which no more than ninety six percent (96%) pass the #200 sieve.

#### 2.2.1.3.Atterberg Limits

The soil material used shall have a Liquid Limit of no greater than seventy five percent (75%) and a Plasticity Index (Liquid Limit minus Plastic Limit) of no greater than forty five percent (45%).

### 2.2.2. Moisture Density for Subgrade Materials Placed as Fill

Subgrade materials placed as fill shall be compacted to at least ninety five percent (95%) of the maximum dry density, Standard Proctor Basis, as per ASTM D698. The moisture content shall range from optimum moisture to five percent (5%) above the optimum moisture content.

**Table 10-1**
**Required Testing for Subgrade Soil Materials Used as Fill**

| Property | Frequency | Test Method | Value |
|---|---|---|---|
| Sieve Analysis | 1 test per each 100,000 s.f. per lift, minimum of 1 test/lift | ASTM D 1140 | 96% maximum |
| Atterberg Limits | 1 test per each 100,000 s.f. per lift, minimum of 1 test/lift | ASTM D 4618 | LL = 75% maximum<br>PI = 45% maximum |
| Field Density and Moisture Content | 1 test per each 10,000 s.f. per lift | ASTM D 698 | 95% maximum dry density; optimum to optimum plus 5% above moisture content |

## 2.3.Installation Procedures

The subgrade installation procedures shall be conducted by the Earthwork Contractor and observed by QAO. The installation procedures shall conform to the following requirements:

### 2.3.1. Excavation

Overlying materials shall be excavated and removed to achieve the required subgrade lines and grades as indicated in the project plans and specifications. The Earthwork Contractor shall exercise care and provide sufficient grade control during the excavation process to minimize or eliminate the placement of fill to meet the required subgrade lines and grades. Soil overburden shall be excavated using standard mobile construction equipment. Where the bedrock is encountered within the planned excavation and cannot be removed using this equipment, it will be removed either through rock saw or blasting. For areas requiring rock removal, the rock will be removed at least 1 foot beyond the lines and grades shown to accommodate the construction of a soil subgrade layer. In the event voids in bedrock are discovered intersecting the limits of the planned excavation, these voids will be hydro or vacuum excavated to remove any loose material and will be filled with cement grout or concrete to align with the limits of the planned excavation. Once allowed to properly cure and set, these filled voids will be covered with subgrade material.

### 2.3.2. Subgrade Preparation

The subgrade shall be excavated and/or graded to the appropriate lines and grades as shown in the project contract documents. Where subgrade materials are placed as fill, the in-situ material shall be properly scarified and prepared to receive the subgrade material. Any soft areas shall be excavated and replaced with compacted materials to provide a solid working base. In areas where bedrock has been removed to accommodate a subgrade layer, the subgrade may be constructed from on-site soils, off-site soils, millings from the rock saw process or a combination of these sources, with the subgrade material meeting the requirements of this section.

### 2.3.3. Placement

The subgrade soil materials shall be broken down such that all material is uniformly hydrated. The finished material shall not contain clods that exceed one (1) inch in diameter or that total more than ten percent (10%) by weight. Any gravel size particles shall not be of sufficient number or size to be a detriment to the integrity of the overlying component. When placed as fill, the subgrade material shall be placed in loose lifts as required to obtain compacted lift thickness of six (6) to eight (8) inches, or the pad or prong length of the compactor feet, whichever is less.

### 2.3.4. Hydration

Prior to compaction, the soil material shall be hydrated so that proper moisture can be maintained during the compaction process. Once water has been added, the soil material shall be worked to provide proper mixing. Soil hydration is allowed either on a stockpile or in-place. The soil material shall be hydrated to a moisture content wet of optimum.

### 2.3.5. Compaction

The soil material shall be compacted using a pad or tamping foot roller or a prong foot ("sheepsfoot") roller. Bulldozers and/or pneumatic tired compactors will not be used. The lift thickness shall be controlled, as outlined above, such that the compactor feet penetrate through the entire lift under compaction into the top of the previously compacted lift. Therefore, the compacted lift thickness must not be greater than the pad or prong length of the compactor feet. Adequate cleaning devices shall be used to prevent clogging of the compactor from excess soil material. Sections of re-compacted subgrade that do not pass both the density and moisture requirements shall be re-worked and re-tested until the section in question does pass, and to the extent that the re-worked area(s) tie-in to an area which passed the testing. The re-worked area shall be re-worked and re-tested until passing tests are achieved.

#### 2.3.6. Finishing

The subgrade shall be prepared and finished in a manner consistent with proper subgrade preparation techniques for the installation of geosynthetics materials and as recommended by the GCL manufacturer. The subgrade shall be properly compacted to a minimum of 95% Standard Proctor Density per ASTM D698, so as not to settle and cause excessive strains in the GCL or other synthetic liner materials. Prior to installation, ensure a surface free of debris, roots, or angular stones larger than 0.5-inch. The subgrade must be rolled with a smooth-wheeled roller. During installation, ensure rutting or raveling is not caused by installation equipment.

#### 2.3.7. Proof rolling

The top surface of the completed subgrade must be proof rolled with a smooth-wheel roller prior to final grade/thickness surveying and placement of overlying layers. Additional proof-rolling may be employed if it is necessary to minimize desiccation and cracking of the subgrade.

#### 2.3.8. Protection of Subgrade Surface

Prior to and during the installation of overlying components, the Earthwork Contractor shall preserve and protect the exposed surface of the subgrade from desiccation and cracking, rutting, erosion, and ponding using regular watering and proof rolling.

### 2.4. Quality Assurance Quality Control Requirements

The Earthwork Contractor shall conduct material conformance tests and the QAO shall monitor the placement and finishing of the subgrade, and coordinate the necessary surveys with the project surveyor. Prior to placement of any overlying layers, the QAO shall coordinate with the GMI to execute a subgrade acceptance form for all areas of completed subgrade. In addition, the Earthwork Contractor shall employ testing personnel to conduct the following QC verification activities:

#### 2.4.1. Field Density

A minimum of one (1) field density test per 10,000 square feet ($ft^2$), or less, for each lift. A minimum of three (3) field density tests are required for each lift.

#### 2.4.2. Sieve Analysis (Percent Passing #200)

A minimum of one (1) test for each 100,000 $ft^2$ or less, for each lift, shall be performed in accordance with ASTM D 1140. A minimum of one (1) test shall be performed for each lift regardless of the area.

#### 2.4.3. Atterberg Limits

A minimum of one (1) test for each 100,000 $ft^2$ per lift shall be performed in accordance with ASTM D 4318. A minimum of one (1) test shall be performed for each lift regardless of the area.

### 2.4.4. Survey Verification

A minimum of one (1) survey verification shall be made per 5,000 $ft^2$ of surface area. Reference locations will be noted on a drawing of the area.

### 2.4.5. Repair of Test Holes

All holes in the subgrade created from tests and test samples shall be completely backfilled with soil and shall be tamped into place.

## 3. GEOGRID

The following requirements govern the geogrid used at the facility:

### 3.1. Geogrid Description

A geogrid is a reinforcing geosynthetic structure formed by a regular network of tensile members with appropriate apertures to allow interlocking with surrounding soil or aggregate. Geogrid materials shall be High Density Polyethylene (HDPE). Geogrid material will be placed on a prepared subgrade and will underlie the GCL layer. The geogrid shall be stored, handled and installed in accordance with the manufacturer's recommendations.

### 3.2. Required Material Properties

The geogrid shall have a minimum tensile strength of 2500 pounds per foot at an allowable stress of 5% or less over 50 years. Properties, test methods and minimum values are listed below and summarized in Table 10-2.

| | |
|---|---|
| Ultimate Tensile Strength (ASTM D6637) | 7810 lb/ft |
| Tensile Strength @ 5% Strain (ASTM D6637) | 3560 lb/ft |
| Junction Strength (ASTM D7737) | 7200 lb/ft |
| Maximum Allowable Strength for 120 yr Design Life (GRI-GG4) | 2860 lb/ft |

**Table 10-2**
**Required Testing for Uniaxial Geogrid**

| Property | Frequency | Test Method | Value |
|---|---|---|---|
| Ultimate Tensile Strength | MARV based on 95% confidence level | ASTM D 6637 | 7810 lb/ft |
| Tensile Strength @ 5% Strain | MARV based on 95% confidence level | ASTM D 6637 | 3560 lb/ft |
| Junction Strength | MARV based on 95% confidence level | ASTM D 7737 | 7200 lb/ft |
| Maximum Allowable Strength for 120-yr Design Life | MARV based on 95% confidence level | GRI – GG4 | 2860 lb/ft |

The manufacturer shall certify that the geogrid has been quality control tested during the manufacturing process and that the liner meets all strength requirements for the intended use.

### 3.3.Installation Procedures

The geogrid installation procedures shall be conducted by the GMI and observed by the QAO. The installation procedures shall conform to the following requirements:

#### 3.3.1. Surface Preparation

The surface to receive the geogrid shall be prepared in accordance with the requirements specified in Section 2, Subgrade Preparation and Controlled Fill. Prior to placing geogrid materials, the GMI shall execute a subgrade acceptance form. This form shall be submitted to the QAO and signed by the QAE and the Owner. A copy of the form is included in Appendix A.

#### 3.3.2. Delivery and Storage

All rolls of geogrid delivered to the site shall be marked with the name of the manufacturer, the product type, the manufacturing batch code, roll number, date of manufacture and roll dimensions. The QAO must inspect the delivered materials for damage and defects. Pushing, sliding, or dragging of rolls or pallets can cause damage and must be avoided. The geogrid rolls shall be dept free of dirt and debris, must be protected from soft or wet ground and rocky or rough ground and must not be stacked more than five (5) rolls high to avoid crushing the cores of the rolls. A sacrificial cover must be used to protect the geogrid if stored on site for more than six (6) months.

#### 3.3.3. Geogrid Anchor Trench

A geosynthetic materials anchor trench shall be completed along the perimeter of the area to be lined where indicated on the project contract documents. The anchor trench may be excavated in sections, as necessary. Loose soil shall be removed from the anchor trench and shall not underlie the geosynthetic materials to be placed in the anchor trench. The excavated anchor trench shall have rounded corners in order to help protect the geosynthetic materials. The anchor trench shall conform to the dimensions and requirements shown on the project contract documents.

#### 3.3.4. Geogrid Deployment

The geogrid shall be deployed in accordance with the procedures recommended by the manufacturer and as outlined below:

- Only those geogrid panels which can be anchored and connected in one (1) day should be deployed.
- Each geogrid panel shall be inspected for damage and manufacturing defects prior to anchoring or connecting to other panels.
- Geogrid panels shall be placed in a controlled manner, such as pulling, hoisting, or rolling and shall be pulled taut to remove slack. Geogrid shall be deployed from a top to bottom direction on slopes.
- Adjacent geomembrane panels shall not be overlapped but shall be deployed side by side. Panel end connections shall be made using a Bodkin connection.
- Geogrid panels shall be anchored in place after placement so as to remain in the deployed alignment. Anchoring can be accomplished using stakes, sandbags, or small quantities of fill soil. Sandbag anchorage must be removed as the

subsequent GCL layer is placed. Stakes must be driven flush with the subgrade as the subsequent GCL layer is placed.

- The geogrid panels shall be placed and aligned such that endroll connections on slopes are minimized. Connections should be located as close to the bottom of the slope as possible.
- No construction equipment traffic shall be allowed on the geogrid.
- Personnel working on the geogrid shall not smoke, wear damaging shoes, throw equipment or engage in other activities which could damage the geogrid.

## 4. GEOSYNTHETIC CLAY LINER (GCL)

### 4.1. General

This section includes the requirements for selection, installation, and protection of GCL.

### 4.2. Submittals

**A. Pre-installation**

Submit the following to the QAO for approval prior to GCL deployment.

1. Supplier of the GCL manufacturer results for standard tests described in Table 10-3.
2. Written certification the GCL meets the properties listed in Table 10-3.
3. Written certification that GCL manufacturer has continuously inspected each roll of GCL for the presence of needles and other defects and found GCL defect-free.
4. Written certification from the GCL manufacturer the bentonite will not shift during transportation or installation thereby causing thin spots in the body of the GCL.
5. QC certificates signed by a responsible party of the GCL manufacturer for each roll delivered to the site. Each certificate shall include roll identification numbers and results of all QC tests. At a minimum, results shall be given for tests corresponding to Table 10-3. The bentonite and textile suppliers shall each certify the respective properties under Manufacturer's Quality Control. The GCL manufacturer shall also perform the bentonite tests described under Manufacturer's Quality Control and third party tests.

**Table 10-3 –STANDARD TESTS ON GEOSYNTHETIC CLAY LINER MATERIAL**

| Test | Item | Type of Test | Standard Test Method | Frequency of Testing |
|---|---|---|---|---|
| Manufacturer's Quality Control | Bentonite(A) | Swell Index(A) | ASTM D5890 | per 100,000-lbs and every truck or railcar |
| | | Moisture Content(A) | ASTM D4643 | per 100,000-lbs and every truck or railcar |
| | | Fluid Loss(A) | ASTM D5891 | per 100,000-lbs and every truck or railcar |
| | Geotextile | Grab Tensile Strength(B) | ASTM D4632 | per 200,000-ft$^2$ |
| | | Mass/Unit Area | ASTM D5261 | per 200,000-ft$^2$ |
| | GCL Product | Grab Tensile Strength(B) | ASTM D6768 ASTM D4632 | per 200,000-ft$^2$ |
| | | Peel Strength(H) | ASTM D 6496 ASTM D 4632 | per 40,000-ft$^2$ |
| | | Clay Mass/Unit Area(C) | ASTM D5993 | per 40,000-ft$^2$ |
| | | Permeability(D) | ASTM D5887 | per week for each production line(E) |
| | | Lap Joint Permeability(D)(F) | ASTM D5887 | per each material and lap type |
| Conformance Testing by 3rd Party Independent Laboratory | GCL Product | Clay Mass/Unit Area(C) | ASTM D5993 | at least one (1) test per 100,000-ft$^2$ and ASTM D4254 procedure A |
| | | Permeability(D)(F) | ASTM D5084 | per 100,000-ft$^2$ |
| | | Direct Shear(F)(G)(I) | ASTM D5321 ASTM D6243 | Per GCL/adjoining material type |

Notes:

A - Tests performed on bentonite before incorporation into GCL. Free swell shall have a minimum test value of 24-ml. Fluid loss shall have a maximum value of 18-mil.

B - Geotextiles shall meet minimum manufacturer criteria.

C - Minimum Test value – 0.75-lb/sq. ft. MARV at 0% moisture content

D - 5 x $10^{-9}$ cm/ sec max or as required by the permit.

E - Report last twenty (20) permeability values, ending on production date of supplied GCL.

F - Test at confining/consolidating pressures simulating field conditions.

G - Not applicable for slopes of 7H:IV or flatter. Testing must be on material in hydrated state unless GCL includes geomembrane on both side of GCL.

H - Peel strength for unreinforced GCL 1 lb/in (1.75 N/cm) min. Peel strength for reinforced GCL 3.5 lbs/in (6.1 N/cm) min.

I - Hydrated internal shear strength for unreinforced GCL 150 psf. Hydrated internal shear strength for reinforced GCL 500 psf.

### 4.3. Installation

The GCL installation Contractor shall submit to the QAI a Subgrade Surface Acceptance Form, signed by the GCL installation Contractor, for each area covered directly by GCL as installation proceeds.

### 4.4. Delivery, Storage, and Handling

#### A. Packing and Shipping

The GCL shall be supplied in rolls wrapped individually in relatively impermeable and opaque protective covers. The GCL rolls shall be marked or tagged with the following information:

1. Manufacturer's name.
2. Product identification.
3. Roll number.
4. Roll dimensions.
5. Roll weight.

**B. Storage and Protection**

An onsite storage area for GCL rolls from the time of delivery until installed as recommended by the GCL Manufacturer shall store and protect GCL from dirt, water, ultraviolet light exposure, and other sources of damage. Contractor shall preserve integrity and readability of GCL roll labels. Rolls must not be stacked higher than recommended by the manufacturer to preclude thinning of bentonite at contact points.

Use wooden pallets for above ground storage of GCL and heavy, waterproof tarpaulin for protecting unused GCL unless otherwise specified by GCL manufacturer.

### 4.5.Materials

The active ingredient of the GCL shall be natural sodium bentonite and encapsulated between two (2) geotextiles. The geotextile-backed GCL shall provide sufficient internal shear strength of the slopes to be lined. The GCL shall have a coefficient of permeability of 5 x $10^{-9}$-centimeters/second (cm/sec) or less and an index flux of 1 x $10^{-8}$- ($m^3/m^2$/sec).

The bentonite shall be continuously adhered to both geotextiles to ensure the bentonite will not be displaced during handling, transportation, storage, and installation, including cutting, patching, and fitting around penetrations. The bentonite sealing compound or bentonite granules used to seal penetrations and make repairs shall be made of the same natural sodium bentonite as the GCL and recommended by the GCL manufacturer. The permeability of the GCL seams shall be equal to or less than the permeability of the body of the GCL sheet.

### 4.6.Manufacturer

**A. Manufacturing Experience**

The GCL manufacturer shall have a minimum of two (2) years of continuous experience in the manufacture of similar CGL products. The Manufacturer must demonstrate, by submitting a list of previous projects, a minimum of 5-million sq.ft. of manufacturing experience of similar GCL products.

### 4.7.Warranty

The Manufacturer shall provide a 5-year warranty to the Owner against manufacturing defects. The warranty shall include the supply of the replacement GCL material and shall not include the cost of re-installation, defects, or failures due to improper installation.

### 4.8. Execution

#### A. Examination

The QAE or his representative will collect samples of material delivered to the site for conformance testing. Alternatively, the QAE may coordinate the collection and shipping of samples collected by the manufacturer and shipped directly to the QAL.

#### B. Installation

##### i. GCL Deployment

Handle GCL in a manner to ensure it is not damaged as recommended by the GCL Manufacturer. At a minimum, comply with the following:

1. On slopes, anchor the GCL securely and deploy it down the slope in controlled manner.
2. Weight the GCL with sandbags or equivalent in the present of wind.
3. Cut GCL with a cutter (hook blade), scissors, or other approved device.
4. Prevent damage to underlying layers during placement of GCL.
5. During GCL deployment, do not entrap in or beneath GCL stones, trash, or moisture that could damage GCL.
6. Visually examine entire GCL surface. Ensure no potentially harmful foreign objects such as needles are present.
7. Do not place GCL in the rain or a times of impending rain.
8. Do not place GCL in areas of ponded water.
9. Replace GCL that is hydrated before placement of overlying geomembrane and cover soil.
10. In general, only deploy GCL that can be covered during the day by geomembrane.
11. Prepare seam overlap areas as specified by the manufacturer.
12. Protective soil cover (including leachate collection media) shall be placed over the liner as soon as practicable.
13. Avoid dragging GCL on the subgrade.
14. Vehicular traffic other than low contact pressure vehicles such as UTV/ATV’s or golf carts are not allowed on deployed GCL.
15. Installation personnel shall not smoke or wear damaging shoes when working on GCL.

##### ii. Overlaps

Overlap GCL to the manufacturer’s recommendations that will vary according to seam location and climatic conditions. Prepare the overlap area as required by the manufacturer. At sumps, overlapped GCL shall be a minimum of 1-foot. At bottom of collection and leak detection sumps, unroll an extra layer of GCL on top of previously installed GCL. Avoid placing seams on top of underlying seams. Horizontal seams and mid-slope anchor trenches are not allowed on side slopes.

**iii Defects and Repairs**

Repair all flaws or damaged areas by placing a patch of the same material extending at least 1-foot beyond the flaw or damaged area. Add granular bentonite to the overlapped edges of the patch at the manufacturer's specified rate.

**iv Interface with Other Products**

Ensure the following when deploying overlying material:

1. GCL and underlying materials are not damaged.
2. Minimal slippage of GCL on underlying layers occurs.
3. No excess tensile stresses occur in GCL.
4. If necessary, bond overlap seams and patches in place prior to placement of overlying materials to prevent dislocating the GCL seam or patch.

### 4.9. Equipment

#### A. Installation

1. Use front-end loader, crane, or similar equipment for GCL deployment with a spreader bar and spindle to prevent slings from damaging edges.
2. Use 3-inch wide grips for moving GCL panels into place for each installation technician.
3. Use sealing and securing materials as required by specifications and drawings at attachment or penetration locations.
4. Use sand bags for securing tarpaulin when being stored and to secure GCL prior to placement of GML.

## 5. GEOMEMBRANE LINERS

The following requirements govern the geomembrane liners used at the facility:

### 5.1. Geomembrane Description

Geomembrane materials shall be High Density Polyethylene (HDPE) or Linear Low Density Polyethylene (LLDPE). The thicknesses of these geomembrane materials will vary based on project documents. Geomembrane sheets will be placed on a prepared subgrade and will be continuously seamed in accordance with the manufacturer's instructions to provide a water-tight seam.

### 5.2. Required Material Properties

The geomembrane shall be made of new, first quality materials with no more that 10% re-grind manufactured specifically for the purpose of liquid containment.

### 5.2.1. All HDPE Geomembrane Materials

Minimum specifications for all HDPE materials, including geomembrane and extrudate (welding rods):

| | |
|---|---|
| Density (ASTM D 1505) | 0.94 gm/cm$^3$ |
| Percent Carbon Black (ASTM D 1603 or ASTM D 4218) | 2.0% to 3.0% |

Minimum specifications for all HDPE geomembrane sheet:

| | |
|---|---|
| Carbon Black Dispersion (ASTM D 5596) | Only near spherical agglomerates, for 10 different view: 9 in Categories 1 or 2 and 1 in Category 3 |

### 5.2.2. Smooth HDPE Geomembrane

| | |
|---|---|
| Thickness (ASTM D 5199) | 60 mils (average of all measurements)<br>54 mils (lowest of any 10 measurements) |
| Tensile strength @ yield (ASTM D 6693) | 126 pounds per inch (ppi) |
| Tensile strength @ break (ASTM D 6693) | 228 ppi |
| Elongation @ yield (ASTM D 6693) | 12% |
| Elongation @ break (ASTM D 6693) | 700% |
| Tear resistance (ASTM D 1004) | 42 pounds |
| Puncture resistance (ASTM D 4833) | 108 pounds |

### 5.2.3. Textured HDPE Geomembrane

| | |
|---|---|
| Thickness (ASTM D 5994) | 60 mils (average of all measurements)<br>54 mils (lowest for 8 out of 10)<br>51 mils (lowest of any 10) |
| Tensile strength @ yield (ASTM D 6693) | 120 ppi |
| Tensile strength @ break (ASTM D 6693) | 90 ppi |
| Elongation @ yield (ASTM D 6693) | 12% |
| Elongation @ break (ASTM D 6693) | 100% |
| Tear resistance (ASTM D 1004) | 42 pounds |
| Puncture resistance (ASTM D 4833) | 90 pounds |

### 5.2.4. All LLDPE Geomembrane Materials

Minimum specifications for all LLDPE materials, including geomembrane and extrudate (welding rods):

| | |
|---|---|
| Density (ASTM D 1505) | 0.939 gm/cm$^3$ |
| Percent Carbon Black (ASTM D 1603 or ASTM D 4218) | 2.0% to 3.0% |

Minimum specifications for all LLDPE geomembrane sheet:

| | |
|---|---|
| Carbon Black Dispersion (ASTM D 5596) | Only near spherical agglomerates, for 10 different view: 9 in Categories 1 or 2 and 1 in Category 3 |

**5.2.5. Smooth LLDPE Geomembrane**

| | |
|---|---|
| Thickness (ASTM D 5199) | 40 mils (average of all measurements)<br>36 mils (lowest of any 10 measurements) |
| Tensile strength @ break (ASTM D 6693) | 152 pounds per inch (ppi) |
| Elongation @ break (ASTM D 6693) | 800% |
| Tear resistance (ASTM D 1004) | 22 pounds |
| Puncture resistance (ASTM D 4833) | 56 pounds |

**5.2.6. Textured LLDPE Geomembrane**

| | |
|---|---|
| Thickness (ASTM D 5994) | 40 mils (average of all measurements)<br>36 mils (lowest for 8 out of 10) |
| Tensile strength @ break (ASTM D 6693) | 60 ppi |
| Elongation @ break (ASTM D 6693) | 250% |
| Tear resistance (ASTM D 1004) | 22 pounds |
| Puncture resistance (ASTM D 4833) | 44 pounds |

The manufacturer shall certify that the geomembrane has been quality control tested during the manufacturing process and that the materials are first quality and free of holes, blisters, undispersed raw materials, and contamination by foreign materials. In addition, the manufacturer shall certify that the liner meets all strength and resistance requirements for the intended use.

Properties, test methods, testing frequencies, and required values are summarized in Tables 10-4 and 10-5 for HDPE geomembranes, and Tables 10-6 and 10-7 for LLDPE geomembranes.

## Table 10-4

## Required Testing for 60-mil HDPE Geomembrane (Smooth and Textured)[1]

| Test | Property | Frequency | Test Method |
|---|---|---|---|
| Resin | Specific Gravity/Density<br>Melt Flow Index | Per 200,000 lbs and every resin lot<br>Per 100,000 $ft^2$ and every resin lot | ASTM D 1505 or ASTM D 792<br>ASTM D 1238 |
| Manufacturer's Quality Control | Thickness | Per roll of geomembrane | ASTM D 5199 (smooth), and ASTM D 5994 (textured) |
| | Specific Gravity/Density | Per 200,000 lbs and every resin lot | ASTM D 1505 or ASTM D 792 |
| | Carbon Black Content | Per 20,000 lbs | ASTM D 4218 or ASTM D 1603 |
| | Carbon Black Dispersion | Per 45,000 lbs | ASTM D 5596 |
| | Tensile Properties | Per 20,000 lbs | ASTM D 6693 |
| | Tear Resistance | Per 45,000 lbs | ASTM D 1004 |
| | Puncture Resistance | Per 45,000 lbs | ASTM D 4833 |
| | Stress Crack Resistance | Per GRI-GM10 | ASTM D 5397 |
| | Oxidative Induction Time | Per 200,000 lbs | ASTM D 3895 or ASTM D 5885 |
| | Oven Aging @ 85°C<br>(a) Standard OIT, or<br>(b) High Pressure OIT | Per each formulation | ASTM D 5721<br>ASTM D 3895<br>ASTM D 5885 |
| | UV Resistance<br>High Pressure OIT | Per each formulation | ASTM D 7238<br>ASTM D 5885 |
| | Asperity Height[2] | Every second roll of geomembrane | ASTM D 7466 |
| Conformance Testing by 3rd Party Independent Laboratory | Thickness<br>Specific Gravity/Density<br>Carbon Black Content<br>Carbon Black Dispersion<br>Tensile Properties | Per 100,000 $ft^2$ and every resin lot | ASTM D ASTM D 5199 (smooth), and ASTM D 5994 (textured)<br>ASTM D 1505 or ASTM D 792<br>ASTM D 4218 or ASTM D 1603<br>ASTM D 5596<br>ASTM D 6693 |
| Destructive Seam Field Testing | Shear & Peel | Various for field, lab & archive | ASTM D 6392 |
| Non-Destructive Seam Field Testing | Air Pressure<br>Vacuum | All dual-track fusion weld seams<br>All non-air pressure tested seams when possible | ASTM D 5820<br>ASTM D 4437 |

[1] All tests will conform to the minimum requirements set forth by GRI testing standard GM13. Required values for the properties are listed in Table 10-5.
[2] This testing is for textured geomembrane only. Measurement side will be alternated for double-sided textured sheet.

## Table 10-5

## Minimum Required Property Values for 60-mil HDPE Geomembrane (Smooth and Textured)[1]

| Property | Test Method | Minimum Required Value | |
|---|---|---|---|
| | | Smooth | Textured |
| Thickness, mils<br>Minimum average<br>Lowest individual reading<br>Lowest individual of 8 of 10 readings | ASTM D 5199<br>ASTM D 5994 (textured) | <br>60<br>54<br>NA | <br>57<br>51<br>54 |
| Density, g/cc | ASTM D 1505/ D 792 | 0.94 | 0.94 |
| Asperity Height, mils | ASTM D 7466 | NA | 10 |
| Tensile Properties[1]<br>1. Yield Strength, lb/in<br>2. Break Strength, lb/in<br>3. Yield Elongation, %<br>4. Break Elongation, % | ASTM D 6693 | <br>126<br>228<br>12<br>700 | <br>126<br>90<br>12<br>100 |
| Tear Resistance, lb | ASTM D 1004 | 42 | 42 |
| Puncture Resistance, lb | ASTM D 4833 | 108 | 90 |
| Stress Crack Resistance[2], hrs | ASTM D 5397 | 300 | 300 |
| Carbon Black Content, % | ASTM D 4218 or ASTM D 1603 | 2.0 – 3.0 | 2.0 – 3.0 |
| Carbon Black Dispersion[3], Category | ASTM D 5596 | 1 or 2 and 3 | 1 or 2 and 3 |
| Oxidative Induction Time (OIT)[4] (min. avg)<br>Standard OIT, minutes<br>High Pressure OIT, minutes | <br>ASTM D 3895<br>ASTM D 5885 | <br>100<br>400 | <br>100<br>400 |
| Oven Aging @ 85°C<br>Standard OIT, % retained after 90 days<br>High Pressure OIT, % retained after 90 days | ASTM D 5721<br>ASTM D 3895<br>ASTM D 5885 | <br>55<br>80 | <br>55<br>80 |
| UV Resistance[5]<br>High Pressure OIT[6], % retained after 1600 hrs | ASTM D 7238<br>ASTM D 5885 | <br>50 | <br>50 |
| Seam Properties (4 out of 5 specimens, 5th specimen can be as low as 80%)<br>1. Shear Strength, lb/in<br>2. Peel Strength, lb/in | ASTM D 6392 | <br>120<br>91 & FTB<br>(78, ext. weld) | <br>120<br>91 & FTB<br>(78, ext. weld) |

[1] Machine direction (MD) and cross machine direction (XMD) average values will be on the basis of 5 test specimens each direction. Yield elongation is calculated using a gauge length of 1.3 inches; break elongation is calculated using a gauge length of 2.0 inches.
[2] The yield stress used to calculate the applied load for the Single Point Notched Constant Tensile Load (SP-NCTL) test will be the mean value via MQC testing
[3] Carbon Black Dispersion for 10 different views; 9 in Categories 1 and 2 and 1 in Category 3.
[4] The manufacturer has the option to select either one of the OIT methods listed to evaluate the antioxidant content in the geomembrane.
[5] The condition of the test will be 20 hr UV cycle at 75°C followed by 4 hr condensation at 60°C.
[6] UV resistance is based on percent retained value regardless of the original HP-OIT value.
[7] Required values are based on GRI GM13, except for the seam properties which are based on GRI GM19.

**Table 10-6**

**Required Testing for 40-mil LLDPE Geomembrane (Textured)[1]**

| Test | Property | Frequency | Test Method |
|---|---|---|---|
| Resin | Specific Gravity/Density<br>Melt Flow Index | Per 200,000 lbs and every resin lot<br>Per 100,000 ft$^2$ and every resin lot | ASTM D 1505 or ASTM D 792<br>ASTM D 1238 |
| Manufacturer's Quality Control | Thickness<br>Specific Gravity/Density<br>Carbon Black Content<br>Carbon Black Dispersion<br>Tensile Properties<br>Tear Resistance<br>Puncture Resistance<br>Axi-Symmetric Break Resistance Strain<br>Oxidative Induction Time<br>Oven Aging @ 85°C<br>(a) Standard OIT, or<br>(b) High Pressure OIT<br>UV Resistance<br>High Pressure OIT<br>Asperity Height[2] | Per roll of geomembrane<br>Per 200,000 lbs and every resin lot<br>Per 20,000 lbs<br>Per 45,000 lbs<br>Per 20,000 lbs<br>Per 45,000 lbs<br>Per 45,000 lbs<br>Per each formulation<br>Per 200,000 lbs<br>Per each formulation<br><br><br>Per each formulation<br><br>Every second roll of geomembrane | ASTM D 5994<br>ASTM D 1505 or ASTM D 792<br>ASTM D 4218 or ASTM D 1603<br>ASTM D 5596<br>ASTM D 6693 Type IV<br>ASTM D 1004<br>ASTM D 4833<br>ASTM D 5617<br>ASTM D 3895 or ASTM D 5885<br>ASTM D 5721<br>ASTM D 3895<br>ASTM D 5885<br>ASTM D 7238<br>ASTM D 5885<br>ASTM D 7466 |
| Conformance Testing by 3rd Party Independent Laboratory | Thickness[2]<br>Specific Gravity/Density<br>Carbon Black Content<br>Carbon Black Dispersion<br>Tensile Properties | Per 100,000 ft$^2$ and every resin lot | ASTM D 5994<br>ASTM D 1505 or ASTM D 792<br>ASTM D 4218 or ASTM D 1603<br>ASTM D 5596<br>ASTM D 6693 Type IV |
| Destructive Seam Field Testing[3] | Shear & Peel | Various for field, lab & archive | ASTM D 6392 |
| Non-Destructive Seam Field Testing | Air Pressure<br>Vacuum | All dual-track fusion weld seams<br>All non-air pressure tested seams when possible | ASTM D 5820<br>ASTM D 4437 |

[1] All tests will conform to the minimum requirements set forth by GRI testing standard GM17. Required values for the properties are listed in Table 10-7.
[2] Field thickness measurements for each roll must be conducted. The lowest 8 out of 10 values will not be less than 10% below the nominal thickness and no single measurement will be less than 15% below the nominal thickness for the roll to be acceptable.
[3] Passing criteria for the geomembrane materials are listed in Table 10-7. Passing criteria for seams are listed in Section 5.4.8.3.3

**Table 10-7**

**Minimum Required Property Values for 40-mil LLDPE Geomembrane (Textured)[1]**

| Property | Test Method | Minimum Required Value |
|---|---|---|
| Thickness, mils<br>Minimum average<br>Lowest individual reading<br>Lowest individual of 8 of 10 readings | ASTM D 5994 | <br>38<br>34<br>36 |
| Density, g/cc (max.) | ASTM D 1505/ D 792 | 0.939 |
| Asperity Height, mils[1] | ASTM D 7466 | 10 |
| Tensile Properties[2]<br>1. Break Strength, lb/in<br>2. Break Elongation, % | ASTM D 6693 Type IV | <br>60<br>250 |
| Tear Resistance, lb | ASTM D 1004 | 22 |
| Puncture Resistance, lb | ASTM D 4833 | 44 |
| Break Resistance Strain, % (min.) | ASTM D 5617 | 30 |
| Carbon Black Content, % | ASTM D 4218 or ASTM D 1603 | 2.0 – 3.0 |
| Carbon Black Dispersion[3], Category | ASTM D 5596 | 1 or 2 and 3 |
| Oxidative Induction Time (OIT)[4] (min. avg)<br>Standard OIT, minutes<br>High Pressure OIT, minutes | <br>ASTM D 3895<br>ASTM D 5885 | <br>100<br>400 |
| Oven Aging @ 85°C<br>Standard OIT, % retained after 90 days<br>High Pressure OIT, % retained after 90 days | ASTM D 5721<br>ASTM D 3895<br>ASTM D 5885 | <br>35<br>60 |
| UV Resistance[5]<br>High Pressure OIT[6], % retained after 1600 hrs | ASTM D 7238<br>ASTM D 5885 | <br>35 |
| Seam Properties (4 out of 5 specimens, 5th specimen can be as low as 80%)<br>Shear Strength, lb/in<br>Peel Strength, lb/in | ASTM D 6392 | 60<br>50 & FTB<br>(44, ext. weld) |

[1] Measurement side will be alternated for double-sided textured sheet.
[2] Machine direction (MD) and cross machine direction (XMD) average values will be on the basis of 5 test specimens each direction. Break elongation is calculated using a gauge length of 2.0 inches.
[3] Carbon Black Dispersion for 10 different views; 9 in Categories 1 and 2 and 1 in Category 3.
[4] The manufacturer has the option to select either one of the OIT methods listed to evaluate the antioxidant content in the geomembrane.
[5] The condition of the test will be 20 hr UV cycle at 75°C followed by 4 hr condensation at 60°C.
[6] UV resistance is based on percent retained value regardless of the original HP-OIT value.
[7] Required values are based on GRI GM17, except for the seam properties which are based on GRI GM19.

## 5.3. Installation Procedures

The geomembrane liner installation procedures shall be conducted by the GMI and observed by QAO. The installation procedures shall conform to the following requirements:

### 5.3.1. Surface Preparation

The surface to be lined shall be prepared so as to provide a surface which is relatively free of irregularities, loose earth, desiccation cracks, and abrupt changes in grade. This preparation shall consist of the removal of loose scale materials which might damage the geomembrane. Prior to placing geomembrane materials, the GMI shall execute a subgrade acceptance form unless installed over a GCL. This form shall be submitted to the QAO and signed by the QAE and the Owner. A copy of this form has been included in Appendix A.

### 5.3.2. Delivery and Storage

All rolls of geomembrane delivered to the site shall be marked with the name of the manufacturer, the product type, the nominal thickness, the manufacturing batch code, roll number, date of manufacture, and roll dimensions. The QAO must inspect the delivered materials for damage and defects. Pushing, sliding or dragging or rolls or pallets can cause damage and must be avoided. The geomembrane rolls shall be kept free of dirt and debris, must be protected from soft or wet ground and rocky or rough ground, and must not be stacked more than five (5) rolls high to avoid crushing the cores of the rolls. A sacrificial cover must be used to protect the geomembrane if stored on site for more than six (6) months. The rolls shall be stored on level ground in such a manner as to avoid shifting, abrasion, or other adverse movements that can damage the geomembrane materials.

### 5.3.3. Geosynthetic Materials Anchor Trench

A geosynthetic materials anchor trench shall be completed along the perimeter of the area to be lined where indicated on the project contract documents. The anchor trench may be excavated in sections, as necessary. Loose soil shall be removed from the anchor trench and shall not underlie the geosynthetic materials to be placed in the anchor trench. The excavated anchor trench shall have rounded corners in order to help protect the geosynthetic materials. The anchor trench shall conform to the dimensions and requirements shown on the project contract documents.

### 5.3.4. Geomembrane Deployment

#### 5.3.4.1. Weather Conditions

Geomembrane deployment shall not proceed:

- During precipitation events;
- In the presence of excessive moisture (humidity);
- In areas of ponded water; or,
- In the presence of excessive wind.

#### 5.3.4.2. Temporary Geomembrane Anchoring

All unseamed edges of geomembrane panels shall be temporarily anchored each day using sand bags, rubber tires or a comparable means that does not damage the material, and does not degrade during the time it is in use. Similar procedures may be used to temporarily anchor the geomembrane in the anchor trench. Penetrating anchors shall not be used for temporary anchorage unless the penetrations will be beyond the inside wall of the anchor trench and will not require repair. Anchorage shall be sufficient to prevent loss or damage.

### 5.3.4.3.Panel Placement and Alignment

The geomembrane shall be deployed in accordance with the procedures outlined below:

- Only those geomembrane panels which can be seamed in one (1) day should be deployed.
- Each geomembrane panel shall be inspected for damage and manufacturing defects prior to seaming.
- Geomembrane panels shall be placed in a controlled manner, such as pulling, hoisting, or rolling. The geomembrane panels shall be installed such that there will be neither excessive tension nor wrinkles that could cause creasing in the final use condition. Wrinkles shall be walked out or removed as much as possible prior to field seaming.
- Panels shall be placed in such a manner that the geomembrane is not scratched or crimped. Any such damage shall be repaired or removed and replaced in accordance with the procedures described in Section 5.3.7.
- Adjacent geomembrane panels shall be overlapped a minimum of three (3) inches (HDPE) after seaming is completed. The QAI shall visually inspect the placement and overlap of the geomembrane to verify that the material is placed with sufficient overlap. Geomembrane seams with insufficient overlap shall be repaired or replaced.
- Geomembrane panels shall be placed such that there are no horizontal or cross-panel seams on the side slopes unless approved by the QAE and the owner. In addition, geomembrane panels placed on the bottom shall be overlapped from top to bottom in the downslope direction. In this configuration the upslope geomembrane panel will overlie the immediately adjacent downslope panel. This overlap shall be a minimum of three (3) inches.
- The geomembrane panels shall be placed and aligned such that seam joining of the sidewalls and bottom sections must be located in the bottom and at least five (5) feet from the sidewall. In corners and odd-shaped geometric locations, the number of field seams should be minimized.
- No vehicular traffic shall be allowed on the geomembrane. Only low-ground pressure supporting equipment may be allowed to traverse the geomembrane. The equipment used for placement and seaming shall not damage the geomembrane by leaking fluids or other means. Areas which are damaged in this manner shall be removed or repaired.
- Personnel working on the geomembrane shall not smoke, wear damaging shoes, throw equipment or engage in other activities which could damage the geomembrane.

#### 5.3.4.4. Panel Identification

As each geomembrane panel is placed, it shall be labeled in bold print visible from a distance of approximately thirty (30) feet. In general, these markings shall be placed in an area which will remain un-obscured until subsequent layers are placed. Panel numbers shall be sequential based on the placement order. The roll number from which the panel is from shall be included with the panel number.

### 5.3.5. Field Seaming

All field seaming shall be performed using method(s) approved by the manufacturer of the geomembrane sheet. For HDPE geomembrane, this will include fusion and extrusion welding.

#### 5.3.5.1. Weather Conditions

Field seaming of the geomembrane shall not be performed at ambient temperatures below 40° Fahrenheit (F) [5° Celsius (C)] unless the geomembrane seam area is preheated, by sun or hot air device, to a temperature in excess of 50°F (5°C). However, in any case, field seaming of the geomembrane shall not be performed at ambient temperatures below 34°F (1°C). The GMI shall consult with the QAE if it is anticipated that seaming will be attempted or performed above 113°F (45°C) ambient air temperature. The QAE shall establish and the GMI shall implement agreed-upon measures to prevent liner stretching and thickness reduction or no seaming shall be performed above 113°F (45°C) ambient air temperature. The temperature shall be recorded at regular, periodic intervals by the GMI.

#### 5.3.5.2. Trial Seams

All personnel responsible for seaming shall perform a trial seam prior to the start of seaming with each apparatus used that day. The beginning of each seaming period is considered to be the morning, and immediately after a break. Whenever seaming with a particular apparatus is discontinued for more than one hour or turned off more than ten (10) minutes, a new trial seam shall be performed. An additional trial seam shall be performed for each seaming period for each apparatus used that day, and for each six (6) hours if a break is not taken. In any instance, a minimum of one (1) trial seam shall be performed for each six (6) hours of operation for each seaming apparatus used.

An additional trial seam shall also be performed for each occurrence of significantly different environmental conditions (i.e., temperature, humidity, dust, etc.), and when fusion seaming different geomembranes (tie-ins and smooth to textured). Both the welder and the machine must be tested for each trial seam when extrusion welding. Only the machine needs to be tested for each new trial seam when fusion welding, since the machine is not as operator dependent. Each individual seaming shall make at least one (1) trial seam each day they actually perform seaming.

Trial seams shall be performed on "fragment" pieces of geomembrane and shall be a minimum of twelve (12) inches in width by three (3) feet in length. A minimum three (3) inch overlap shall be provided and the seam shall be approximately centered throughout the length of the geomembrane fragment used. All trial seams shall be performed under the same conditions as production seaming. Trial seams shall be tested in the field by the GMI for peel and shear performance, as outlined in Sections 5.4.6 and 4.4.7.

#### 5.3.5.3. General Seaming Requirements

All geomembrane seams shall extend to the end of each panel to be anchored. All geomembrane seams shall be clean and free of moisture, oil, dust, dirt, debris of any kind, and foreign matter at the time of welding. No folds, large wrinkles, or fish mouths shall be allowed in the seam. Only normal factory-induced creasing from the blown film process may be acceptable. Where wrinkles or folds occur, the material shall be cut and overlapped, and an extrusion weld applied, in accordance with the procedures outlined in this LQCP. Areas of insufficient overlap shall be repaired in accordance with the procedures detailed in Section 5.3.7. All complete seams shall be tightly bonded and sealed.

If geomembrane seaming operations are performed at night, adequate lighting shall be provided for seaming as well as for inspection of the seaming conditions and the seams.

#### 5.3.5.4. Extrusion Seaming Requirements

The extrusion welding apparatus shall have a temperature gauge which indicates the temperature of the extrudate. Additionally, the temperature of the extrudate at the nozzle will be monitored at the time of trial seaming using a probe (pyrometer). A significant difference (greater than 15°C) in the indicated vs. monitored temperature shall result in investigation and repair of the seaming apparatus. The QAI may request that the GMI check extrudate temperatures at other times as well.

The extruder shall be purged to remove heat-degraded material prior to the beginning of seaming and whenever the extruder is stopped for an appreciable length of time.

Grinding in preparation for extrusion welding should be done carefully. Grinding beyond the area to be covered with extrudate is unnecessary, and will be minimized. Grinding shall not extend more than one-eighth (1/8) inch beyond the edge of the seam.

#### 5.3.5.5. Fusion Seaming Requirements

The fusion welding apparatus shall be a vehicular mounted, automated device. The temperature, pressure and welding speed shall be independently adjustable and the apparatus shall be equipped with a gauge which displays the actual internal temperature.

### 5.3.6. Nondestructive Seam Continuity Testing

The GMI shall conduct the following nondestructive seam continuity testing:

#### 5.3.6.1.General

Continuous non-destructive testing shall be performed on all seams by the GMI. Air pressure testing shall be performed on all dual track fusion welds and vacuum-box testing for extrusion welds are the only acceptable methods for geomembrane seams. All leaks identified during testing must be isolated and repaired by the following procedures described in this LQCP.

Areas thought to be potentially inaccessible to nondestructive continuity testing equipment shall be brought to the QAE's attention prior to the start of work.

Nondestructive continuity testing of field seams, including repairs, shall be performed by the GMI as the work progresses to provide the opportunity for immediate rewelding and retesting as necessary. All defects discovered shall be marked, repaired and retested.

#### 5.3.6.2.Testing Procedures

The GMI shall submit the proposed specific nondestructive testing procedures to be employed on this project to the QAE. The testing procedures shall be consistent with the requirements of this specification. The testing procedures must be approved by the QAE.

For vacuum box testing, a suction value of approximately three (3) to five (5) inches of gauge vacuum shall be applied to all extrusion seams that can be tested in this manner. The seam that has been wetted with soapy water must be observed for leaks a minimum of five (5) seconds while subjected to this vacuum. Areas where soap bubbles appear shall be marked, repaired and re-tested. The GMI shall record the test results, including technician ID, date, time and pass/fail condition on the geomembrane near the test location.

For air pressure testing, the air space created by the fusion weld shall be tested for continuity. The ends of the air channel of the dual track fusion weld must be sealed and pressured to a minimum of 30 psi. The air pump must then be shut off and the air pressure observed after five minutes. A loss of less than four (4) psi is acceptable, if it is determined that the air channel is not blocked between the sealed ends. A loss of more than four (4) psi indicates the presence of a seam leak which must then be marked, isolated, repaired and re-tested. The GMI shall record the test results, including technician ID, date, the before and after times and pressures and pass/fail condition at a minimum on the geomembrane near the test location. All openings in air channels must be sealed subsequent to testing.

### 5.3.7. Defects and Repairs

#### 5.3.7.1.General

All seam and non-seam areas of the geomembrane shall be visually inspected for signs of defective seams, blisters, punctures, undispersed raw materials, and any sign of contamination by foreign matter. Any problems discovered shall be marked, repaired and retested or reevaluated in accordance with this document. The geomembrane surface shall be clean at the time of these inspections.

Any sheets which become seriously damaged (torn or twisted permanently) shall be replaced. Less serious damage (inadvertent punctures during installation) shall be repaired by welding a piece of geomembrane over the damaged area. The repairs must comply with the LQCP to be considered adequate.

#### 5.3.7.2. Evaluation

Each suspect location in both seam and non-seam areas shall be inspected and, where appropriate, tested using the methods described in this document. Work shall not proceed with any materials which will cover the locations which require repair or which have been repaired but require testing with passing results.

#### 5.3.7.3. Procedures for Repair

Grinding and welding procedures may be used to repair small sections of deficient extrusion seams and small surface blemishes which do not penetrate the entire thickness of the geomembrane. The geomembrane surfaces requiring repair shall be abraded no more than one hour prior to the repair being made. The allowable time between abrading the surface and making the repair may be reduced if determined necessary by the QAI. Grinding shall be performed only within the area requiring repair and shall not significantly damage the liner.

Defects which do not require replacement of the sheet shall be repaired and covered with a patch or a cap (a patch with an extended length). Patches and caps shall extend a minimum of six (6) inches beyond the limits of the defect and all corners of patches and caps shall be rounded with a radius of approximately two inches. All seaming for patches and caps shall be accomplished by extrusion welding.

The GMI shall record repair information, including technician and seaming apparatus ID, date, and time on the repair or on the geomembrane near the repair.

### 5.3.8. Permanent Anchorage in Anchor Trench

Following completion of the seaming activities as determined by the GMI, the geomembrane (and any other geosynthetic materials) shall be permanently anchored in the anchor trench. A detail indicating proper anchoring procedures is included in the project contract documents. The anchor trench shall be backfilled and compacted using hand-operated or rubber-tired equipment. Care should be used when backfilling and compacting the anchor trench to prevent damage to the geosynthetic materials. The final configuration of the anchor trench shall conform to the dimensions and requirements shown on the project contract documents.

### 5.4. Quality Assurance Requirements

The QAO shall review quality control documents, conduct material conformance tests and inspect the placement and installation of the geomembrane, and coordinate necessary surveys. In addition, the QAI shall ensure the following QA verification activities are performed:

#### 5.4.1. Inspection Upon Delivery

The QAI shall inspect the geomembrane material delivered to the site. All rolls of geomembrane shall be marked with the name of the manufacturer, the product type, the nominal thickness, the manufacturing batch code and/or roll number, date of manufacture, and roll dimensions. The QAI shall document that the quality control and conformance data has been received and is acceptable for each roll. The QAI shall also verify that the geomembrane rolls are being stored in a manner to protect them from the elements.

#### 5.4.2. Thickness Determination

The QAI shall check the thickness of each roll of geomembrane delivered to the site. Thickness shall be checked with a micrometer on the leading edge at five (5) locations. The geomembrane shall meet the required material properties. See Section 5.2, except that thickness criteria are for five (5) measurements or four of five as appropriate. Geomembrane rolls which fail this thickness determination shall be removed from the site. The QAI shall document the thickness determinations taken for each roll.

#### 5.4.3. Inspection During Deployment

The QAI shall visually inspect the deployment of the geomembrane to ensure that the panels are properly placed and that each seam will have sufficient overlap.

#### 5.4.4. Observation of Non-Destructive Testing

The GMI shall coordinate the non-destructive testing with the QAE to ensure that a QAI is present for non-destructive testing. The QAE or QAI will verify that all non-destructive testing is successfully completed and will document the testing on data forms.

#### 5.4.5. Survey Documentation

The QAE shall locate all seams, destructive test locations and patches for the geomembrane and may coordinate a survey for such purposes if appropriate. Reference locations will be noted on a drawing of the area.

#### 5.4.6. Trial Seam Testing

Each trial test seam shall be at least three (3) feet long by one (1) foot wide. Four (six when possible if using dual track fusion welding) adjoining one (1) inch wide specimens shall be cut in a controlled manner, by die or template from the test seam sample. Two (2) specimens shall be tested in the field for shear, and two (2) for peel (four [4] when possible if testing both inner and outer welds for dual track fusion welding) using testing procedures outlined in the following paragraph. Specimens cut in an uncontrolled fashion to a random width shall not be used.

All trial seam specimens shall be tested by the GMI and observed by a QAI in the field for shear and peel using an electrically operated tensiometer, with the capability of registering the force imparted on a geomembrane test specimen. Hand operated tensiometers shall not be used. The trial seam specimens shall be tested at a cross-head rate of two (2) inches per minute. The GMI shall provide a calibration certificate for each load cell within the tensiometer. Calibration shall have been conducted within 90 days of the start of installation.

The GMI's seaming and testing technician(s) shall record the following information on a remnant portion of the trial seam sample. The remnant portion will be retained until project completion and may then be stored by the Owner. The QAI will log the information on a data form and assign each sample a number.

- Date and time of test;
- The name of the welder and identification of the apparatus used in performing the test;
- The failure mode: either "Pass" indicating a film-tear bond not in the weld or "Fail" for each specimen; and,
- The peak yield load in pounds per inch for each specimen.

### 5.4.7. Trial Seam Evaluation Criteria

The criteria for evaluating trial seams is as follows:

#### 5.4.7.1.Shear

Two (2) trial seam specimens shall be tested in shear. Each must fail at a strength equal to or greater than ninety five percent (95%) of the rated yield strength of the parent sheet material as indicated on the manufacturer's quality control certifications, but in no instance at less than the specified yield strength for sheet material. Neither trial seam test shall fail in the weld. If both of these criteria are not met, the entire trial seam shall be considered failing.

#### 5.4.7.2.Peel

Two (2) trial seam specimens (four if necessary to test both inner and outer welds) shall be tested in peel and neither shall fail in the weld area. If this criteria is not met, the entire trial seam shall be considered failing. The peel strength of the geomembrane outside of the weld shall be equal to or greater than sixty two percent (62%) of the rated yield strength of the parent sheet material as indicated on the manufacturer's quality control certifications, but in no instance less than 90 ppi for fusion seams and 78 ppi for extrusion seams. Peel seams must exhibit a Film Tear Bond (FTB) failure.

If a trial seam fails, the entire procedure shall be repeated after the appropriate adjustments to the welding apparatus or procedures have been made. This process shall be repeated until two (2) consecutive successful trial seam tests have been achieved. Alternatively, if a successful trial seam is not achieved, the welding apparatus and/or the operator shall not be used for seaming until such time as the deficiencies are resolved.

### 5.4.8. Destructive Seam Testing

#### 5.4.8.1. Testing Location and Frequency

Destructive seam samples will be obtained at an average minimum frequency of one (1) per five hundred (500) lineal feet of weld. Destructive seam-testing locations shall be cap-stripped and the cap completely seamed by extrusion welding to the geomembrane. Capped sections shall be non-destructively tested. The seam destructive test sampling frequency may be increased by the QAE beyond the specified minimum based upon actual welding conditions and the results of other samples obtained.

The sample locations will be selected by the QAI as welding progresses. Additional sample locations may be prompted by suspicion of a poor quality weld.

The GMI will not be informed in advance of seam destructive test locations but will be required to physically obtain the samples from the geomembrane no later than twenty four (24) hours after the location has been selected.

The total footage of individual repairs of leaks of more than ten (10) feet and individual repairs of more than ten (10) feet for failed seams must also be counted and destructively tested using the same frequency of testing described above.

#### 5.4.8.2. Sample Size

The location for the destructive samples shall be marked by the QAI. The dimensions for the destructive samples shall, as a minimum, be twelve (12) inches wide by thirty six (36) inches long with the seam centered widthwise. Sample lengths may be increased at the request of the QAL. The GMI shall obtain two specimens from each end of the marked seam destructive sample, each a minimum of one inch in width for preliminary field testing as described in Section 5.4.8.3.1. If the preliminary field testing exceeds the pass/fail criteria, the sample shall be cut and divided into two parts as described below:

- One portion of the sample, measuring twelve (12) inches by fifteen (15) inches, to be sent by the QAO to the QAL for testing.
- One portion of the sample, measuring twelve (12) inches by twelve (12) inches to be retained by the owner for archiving.
- The sample length shall be increased to accommodate the additional length required by the GMI for laboratory testing or archiving.

### 5.4.8.3. Testing Procedure

#### 5.4.8.3.1. Preliminary Field Testing

Four (4) specimens, two (2) from each end of the destructive sample seam, are to be removed and tested by the GMI while in the field. One (1) specimen from each end of the original sample is to be tested in shear and the other in peel. Specimen and test procedures shall be the same as described for trial seams in Section 5.4.6. Field testing shall include testing on both tracks on dual track fusion welded seams for each specimen tested for peel.

#### 5.4.8.3.2. Laboratory Seam Destructive Testing

The destructive seam testing will be performed by QAO in an off-site laboratory. This testing is to be completed within seventy two (72) hours of the time the samples are removed from the geomembrane installation. The Contractor may test samples in the field with observation by the QAI.

The testing shall be performed on a total of ten (10) specimens obtained from the field sample described in Section 5.4.8.2. Five (5) specimens shall be tested in each of the shear and peel modes. For the dual-tracked fusion welds, five (5) peel tests shall be performed for each track of weld. These shear and peel specimens shall be selected from the sample alternately so that no two (2) immediately adjacent specimens are tested in the same mode.

The specimens shall be tested in accordance with ASTM D 6392.

#### 5.4.8.3.3. Seam Evaluation Criteria

Each seam sample must meet both the shear and peel criteria before being considered passing. Field tested specimens are determined as passing if the specimen tested in peel fails in FTB and all test specimens meet the criteria listed in this LQCP. The QAL testing must confirm these field results.

##### 5.4.8.3.3.1. Shear

The shear strength must be at least 120 lb/in for HDPE geomembrane and 60 lb/in for LLDPE geomembrane. The minimum passing criteria for independent laboratory testing are all of the following: (1) at least four of the five specimens shall not fail in the weld, (2) at least four of the five specimens must meet the minimum specified value, and (3) the average value from all the specimens must meet the minimum specified value. The above criteria apply to both tracks from each dual track fusion welded seam before it is considered passing. If these criteria are not met then the entire seam destructive sample is considered failing.

##### 5.4.8.3.3.2. Peel

The peel strength must be at least 91 lb/in for HDPE geomembrane (78 lb/in for extrusion welds) and 50 lb/in for LLDPE geomembrane (44 lb/in for extrusion welds). The minimum passing criteria for laboratory testing are all of the following: (1) at least four of the five specimens shall not fail in the weld, (2) at least four of the five specimens must meet the minimum specified value, and (3) the average value from all five specimens must meet the minimum specified value. The above criteria apply to both tracks from each dual track fusion welded seam before it is considered as passing. If these criteria are not met, then the entire seam destructive sample is considered failing.

#### 5.4.8.3.4. Seam Destructive Test Failure Procedures

In the instance of the dual-tracked fusion weld, both tracks of the weld will be tested in peel. If either peel test performed on specimens of this weld type fails, the entire specimen is considered failing.

The GMI shall reconstruct the failing seam bound by two passing seam destructive tests. The GMI shall have the option of obtaining additional destructive test samples at a minimum of ten (10) foot intervals in both directions along the failing seam from the failure location. The minimum interval may be increased by the QAE if test failures become excessive.

If both of these samples pass the laboratory seam destructive test then the seam can be reconstructed between them. If one (1) or both of these samples fail the laboratory seam destructive test, then the procedure is repeated until passing laboratory results are obtained. (Note: The tracking procedure described may be extended beyond the limits of an individual seam.)

If a seam is reconstructed to a length in excess of fifty (50) feet, a seam destructive sample may be obtained from the reconstruction zone which must meet the requirements described above.

# 6. LEACHATE COLLECTION SYSTEM

The following requirements govern the leachate collection system used in the landfill units:

## 6.1. Leachate Collection System Description

The leachate collection system (LCS) used consists of layers of geotextile fabric, HDPE drainage net, gravel and piping, as described in conjunction with the lining systems in Section 1.2. In general, the LCSs will be sloped to drain to one or more collector pipes running through each landfill unit. The underlying lining system will be sloped to the collector pipe, and along the line of the collector pipe toward the sump. The sump will have a riser pipe for the removal of collected liquids. Detailed design descriptions and drawings of the leachate collection system and geocomposite drainage layer are provided in the project construction documents.

## 6.2. Required Material Properties

The LCS and geocomposite drainage layer materials shall be new, first quality materials manufactured specifically for the purpose of liquid conveyance and collection. All LCS and geocomposite drainage layer materials shall have sufficient strength and resistance to chemical or ultraviolet radiation attack for the intended use. Properties, test methods, testing frequencies, and required values are summarized in Table 10-8 below for geotextiles, drainage nets and drainage geocomposites.

**Table 10-8**
**Required Testing for Geotextile and Drainage Geocomposite[1]**

| Responsible Party | Material | Property | Test Method | Value |
|---|---|---|---|---|
| Manufacturer | Geotextile for Drainage Geocomposite | Unit Weight<br>Apparent Opening Size<br>Grab Strength<br>Grab Elongation<br>CBR Puncture Strength<br>Permittivity | ASTM D 5261<br>ASTM D 4751<br>ASTM D 4632<br>ASTM D 4632<br>ASTM D 6241<br>ASTM D 4491 | 8 oz/sy<br>0.15 mm<br>220 lb<br>50%<br>575 lb<br>1.3 $sec^{-1}$ |
| Manufacturer | Geotextile for leak detection trench wrap | Unit Weight<br>Apparent Opening Size<br>Grab Strength<br>Grab Elongation<br>CBR Puncture Strength<br>Permittivity | ASTM D 5261<br>ASTM D 4751<br>ASTM D 4632<br>ASTM D 4632<br>ASTM D 6241<br>ASTM D 4491 | 12 oz/sy<br>0.15 mm<br>320 lb<br>50%<br>925 lb<br>0.8 $sec^{-1}$ |
| Manufacturer | HDPE Geonet | Specific Gravity/Density<br>Thickness<br>Peak Tensile Strength<br>Percent Carbon Black<br>Transmissivity[2] | ASTM D 1505<br>ASTM D 5199<br>ASTM D 5035 or ASTM D 7179<br>ASTM D 1603 or ASTM D 4218<br>ASTM D 4716 | 0.94 $gm/cm^3$<br>250 mils<br>45 lb/in<br>2.0 %<br>2 x $10^{-3}$ $m^2/sec$ |
| Manufacturer | Drainage Geocomposite | Ply Adhesion | ASTM D 7005 | 1.0 lb/in |
| Manufacturer/ Third Party Lab | | Transmissivity[2] | ASTM D 4716 | 5 x $10^{-4}$ $m^2/sec$ (double sided)<br>1.5 x $10^{-3}$ $m^2/sec$ (single sided) |

[1] The minimum testing frequency for materials in this table will be one test sample per 100,000 square feet.
[2] Gradient of O.1, normal load of 10,000 psf, between steel plates for 15 minutes.

### 6.2.1. Geotextile

All geotextile fabric shall be non-woven polypropylene, meeting the following minimum specifications:

Geotextile fabric for use in drainage geocomposite:

| | |
|---|---|
| Mass per Unit Areas (ASTM D 5261) | 8 ounces per square yard |
| CBR Puncture Strength (ASTM D 6241) | 575 pounds |
| Grab Tensile Strength/Elongation (ASTM D 4632) | 220 pounds/50% |
| Apparent Opening Size (ASTM D 4751) | 0.15 mm |
| Permittivity (ASTM D4491) | 1.3 per second ($sec^{-1}$) |

Geotextile fabric for use in leachate collection/leak detection trench:

| | |
|---|---|
| Mass per Unit Areas (ASTM D 5261) | 12 ounces per square yard |
| CBR Puncture Strength (ASTM D 6241) | 925 pounds |
| Grab Tensile Strength/Elongation (ASTM D 4632) | 320 pounds/50% |
| Apparent Opening Size (ASTM D 4751) | 0.15 mm |
| Permittivity (ASTM D4491) | 0.8 per second ($sec^{-1}$) |

### 6.2.2. HDPE Drainage Net

Minimum specifications for HDPE Drainage Net:

| | |
|---|---|
| Thickness (ASTM D 5199) | 250 mils (average of all measurements) |
| Density (ASTM D 1505) | 0.94 $gm/cm^3$ |
| Peak Tensile strength (ASTM D 5035 or ASTM D 7179) | 45 ppi |
| Percent Carbon Black (ASTM D 1603 or ASTM D 4218) | 2.0% to 3.0% |
| Transmissivity (ASTM D4716) | 2 x $10^{-3}$ square meters per second ($m^2/sec$) at a gradient of 0.1 and a loading of 478.8 kilo-newtons per square meter ($kN/m^2$) [10,000 pounds per square foot] |

### 6.2.3. Piping

Minimum specifications for Liquids Collection Piping:

| | |
|---|---|
| Material | HDPE or PVC, single wall |
| Specifications | HDPE – ASTM F714<br>PVC – ASTM D1785, D2241 or D3034 |
| Standard Dimension Ratio (SDR) [Outside Diameter to Wall Thickness] | 21 Maximum |
| Joint Type | HDPE - Fusion Welded<br>PVC – Fusion or Solvent-Cement Welded |
| Perforation Type (Where required) | Round |
| Perforation Size (Where required) | ½” Max. |
| Perforation Area (Where required) | 1-1/2 square inches ($in^2$) per foot |

#### 6.2.4. Gravel

Minimum specifications for LCS gravel:

| | |
|---|---|
| Material Source | Washed, rounded river gravel |
| Maximum particle size (100% Passing – ASTM C136 or D422) | 2” |
| At least 90% of Material Smaller Than (ASTM C136 or D422) | 1-1/2” |
| No more than 10% of Material Smaller Than (ASTM C136 or D422) | ½” |
| Calcium Carbonate Content (ASTM D3042) | Less than 15% |
| Coefficient of Permeability (ASTM D2434) | Greater than 0.2 cm/sec |

### 6.3. Installation Procedures

The LCS and GDL material installation procedures shall be conducted by the GMI and observed by QAO. The installation procedures shall conform to the following requirements:

#### 6.3.1. Geotextile

##### 6.3.1.1. Delivery and Storage

All rolls of geotextile delivered to the site shall be marked with the name of the manufacturer, the product type, the manufacturing batch code, roll number, date of manufacture, and roll dimensions. The QAE or QAI must inspect the delivered materials for damage and defects. Damage during unloading must be avoided. The rolls shall be kept free of dirt and debris, must be protected from soft or wet ground and rocky or rough ground, and must not be stacked more than five (5) rolls high to avoid crushing the cores of the rolls. A sacrificial cover must be used to protect the rolls if stored on site for more than six (6) months. The rolls shall be stored in such a manner as to avoid shifting, abrasion, or other adverse movements that can damage the materials.

##### 6.3.1.2. Deployment

Geotextile shall not be deployed in the presence of excessive wind. On slopes, the geotextile shall be secured and rolled down the slope so that it is kept continuously in tension. Geotextile shall be placed parallel to sideslopes, except in special locations approved by the QAI. It shall be anchored in the synthetic materials anchor trench. All unseamed edges shall be temporarily anchored each day using sand bags, rubber tires or a comparable means that does not damage the material, and does not degrade during the time it is in use. During placement of the geotextile, the GMI shall ensure that it is not clogged with dirt or foreign materials. Geotextile shall be cut only with devices that are recommended by the manufacturer.

#### 6.3.1.3. Panel Placement and Alignment

Geotextile panels shall be deployed in accordance with procedures approved by the QAE. As a minimum, the procedures outlined below shall be followed.

- Only those panels which can be seamed in one (1) day should be deployed.
- Each panel shall be inspected for damage prior to seaming.
- Panels shall be placed in a controlled manner, such as pulling, hoisting, or rolling. The panels shall be installed such that there will be neither excessive tension nor wrinkles that could cause creasing in the final use condition. Wrinkles shall be walked out or removed as much as possible prior to field seaming.
- Adjacent panels shall be overlapped a minimum of three (3) inches (or as sufficient for seaming.) The QAE or QAI shall visually inspect the placement and overlap of the panels to verify that the material is placed with sufficient overlap.
- No vehicular traffic shall be allowed on the geotextile.

#### 6.3.1.4. Field Seaming

All field seaming shall be performed by sewing using polymeric thread having chemical and ultraviolet light resistance properties equal to or exceeding those of the geotextile. Thread shall be supplied by the geotextile manufacturer or shall be as recommended by the manufacturer. Provide documentation of the source or recommendation by the manufacturer. Glues and heat bonding are strictly prohibited. In general, horizontal seams or splices should be avoided on side slopes. No two adjacent slope pulls may have a horizontal seam.

#### 6.3.1.5. Procedures for Repair

Holes or tears in the geotextile shall be repaired by placing a patch extending at least six (6) inches beyond the edges of the hole or tear. The patch shall be seamed to the panel. Care shall be taken to remove any soil or other material which may have penetrated the damaged geotextile.

### 6.3.2. HDPE Drainage Net

#### 6.3.2.1. Delivery and Storage

All rolls of HDPE drainage net delivered to the site shall be marked with the name of the manufacturer, the product type, the manufacturing batch code, roll number, date of manufacture, and roll dimensions. The QAE or QAI must inspect the delivered materials for damage and defects. Pushing, sliding or dragging of rolls or pallets can cause damage and must be avoided. The rolls shall be kept free of dirt and debris, must be protected from soft or wet ground and rocky or rough ground, and must not be stacked more than five (5) rolls high to avoid crushing the cores of the rolls. A sacrificial cover must be used to protect the rolls if stored on site for more than six (6) months. The rolls shall be stored in such a manner as to avoid shifting, abrasion, or other adverse movements that can damage the materials.

#### 6.3.2.2. Deployment

HDPE Drainage net shall not be deployed in the presence of excessive wind. On slopes, the net shall be secured and rolled down the slope so that it is kept continuously in tension. Drainage net shall be placed parallel to sideslopes, except in special locations approved by the QAI. The drainage net shall be anchored in the synthetic materials anchor trench. All unseamed edges shall be temporarily anchored each day using sand bags, rubber tires or a comparable means that does not damage the material, and does not degrade during the time it is in use. During placement of the net, the GMI shall ensure that the net is not clogged with dirt or foreign materials.

#### 6.3.2.3. Panel Placement and Alignment

Drainage net panels shall be deployed in accordance with procedures approved by the QAE. As a minimum, the procedures outlined below shall be followed.

- Only those panels which can be seamed in one (1) day should be deployed.
- Each panel shall be inspected for damage prior to seaming.
- Panels shall be placed in a controlled manner, such as pulling, hoisting, or rolling. The panels shall be installed such that there will be neither excessive tension nor wrinkles that could cause creasing in the final use condition. Wrinkles shall be walked out or removed as much as possible prior to field seaming.
- Adjacent panels shall be overlapped a minimum of three (3) inches. The QAE or QAI shall visually inspect the placement and overlap of the panels to verify that the material is placed with sufficient overlap.
- No vehicular traffic shall be allowed on the drainage net.

#### 6.3.2.4. Field Seaming

All field seaming shall be performed using method(s) approved by the manufacturer of the HDPE drainage net. Seaming can be achieved using string, plastic fasteners or ties, or polymer braid. Metallic devices are strictly prohibited. Submit the proposed seam (tie-pattern) with the quality control documents. In general, no horizontal seams are allowed on side slopes.

#### 6.3.2.5. Procedures for Repair

Holes or tears in the drainage net shall be repaired by placing a patch extending at least six (6) inches beyond the edges of the hole or tear. The patch shall be seamed to the panel.

### 6.3.3. Piping

#### 6.3.3.1. Delivery and Storage

All piping delivered to the site shall be marked with the name of the manufacturer, the product type, and applicable specifications under which the material was manufactured. The QAE or QAI must inspect the delivered materials for damage and defects. Piping shall be kept free of dirt and debris, must be protected from soft or wet ground and rocky or rough ground, and must not be stacked more than ten (10) sections high. The piping shall be stored in such a manner as to avoid shifting, abrasion, or other adverse movements that can damage the materials.

#### 6.3.3.2.Deployment

Piping shall be placed to the lines and grades shown on the project construction documents. Piping shall be temporarily anchored using sand bags, rubber tires or a comparable means that does not damage the piping and ensures proper alignment until covered. During placement of the piping, the GMI shall ensure that dirt or foreign materials do not enter the piping.

#### 6.3.3.3.Field Joints/Seaming

All field joints or seaming shall be performed using fittings and method(s) approved by the manufacturer of the piping. Field joints shall be butt-fusion welded. For PVC piping, joints may be solvent-cement welded with prior written approval by the QAE. If solvent cement joints are to be completed over underlying geosynthetic materials, the GMI shall ensure that a sacrificial impermeable barrier is placed underneath each joint to prevent solvent material from coming in contact with the underlying material. Gasketed joints shall not be used.

#### 6.3.3.4.Procedures for Repair

Damaged piping shall be removed and replaced using procedures consistent with those for installing new piping.

### 6.3.4. Gravel

#### 6.3.4.1.Delivery and Storage

Gravel to be used for LCS construction shall be stockpiled as near as possible to the construction area. Signage near the stockpile shall identify the source, intended use, and gradation specifications (size). Gravel shall not be placed on wet ground.

#### 6.3.4.2.Deployment

Gravel may be placed using mobile equipment or hand tools (e.g. wheel barrows, etc.). Where gravel placement must traverse underlying geosynthetic materials, the GMI shall use only low-ground pressure supporting equipment. If such equipment is operating over the geosynthetic materials, it must be placed on a sacrificial surface or rub sheet. Areas of underlying geosynthetic materials that are damaged in this manner shall be repaired as required by this LQCP. Gravel shall be placed to the lines and grades shown on the project construction documents. Gravel materials shall not be placed in direct contact with geomembrance materials. Where this is possible to occur, the GMI shall place a layer of geotextile fabric between the gravel and the geomembrane. During placement of the gravel, the GMI shall ensure that it is not obstructed by dirt or foreign materials.

### 6.4. Quality Assurance Requirements

The GMS or the QAO shall conduct material conformance tests, as outlined in Section 1.9 and the QAO shall review quality control documents, inspect the placement and finishing of the LCS, and coordinate necessary surveys. In addition, the QAI shall ensure the following QA verification activities are performed:

#### 6.4.1. Inspection Upon Delivery

The QAI shall inspect the geosynthetic, piping and gravel materials delivered to the site, and shall document that the quality control and conformance data has been received and is acceptable for each material lot. The QAI shall also verify that the materials are being stored in a manner to protect them from the elements.

#### 6.4.2. Inspection During Deployment

The QAI shall visually inspect the deployment of the drainage net, geotextile, piping and gravel to ensure proper placement as outlined in the LQCP and in the project construction documents.

#### 6.4.3. Sieve Analysis (Gradation) for Gravel

A minimum of one (1) test for each 5,000 cubic yards ($cy^3$) or less of gravel shall be performed in accordance with ASTM C136 or ASTM D422. A minimum of one (1) test shall be performed regardless of the quantity.

#### 6.4.4. Survey Verification

The QAE shall coordinate a survey to locate the piping and verify that proper grades are achieved. Where required to document grades, a minimum of one (1) survey verification shall be made per 5,000 $ft^2$ of surface area. Reference locations will be noted on a drawing of the area.

## 7. PROTECTIVE COVER

The following requirements govern the protective cover that will be installed on top of constructed liner materials and leachate collection systems:

### 7.1. Protective Cover Description

Protective cover soil material will be placed with a minimum thickness of 2 feet over the drainage layer component of the leachate collection system, including drainage aggregate where applicable.

### 7.2. Required Material Properties

The protective cover will consist of soils that do not contain any materials detrimental to the underlying geosynthetics. The protective cover shall be free of organics, angular rocks, foreign objects, or other deleterious materials.

### 7.3. Installation Procedures

The protective cover soils shall be placed using low ground pressure equipment. The protective cover shall be placed by spreading in front of the spreading equipment with a minimum of 12 inches of soil between the spreading equipment and the underlying installed geosynthetics. Under no circumstances shall the construction equipment come into direct contact with the installed geosynthetics. Unless otherwise specified by the QAE, all lifts of protective cover soil placed over geosynthetics will conform with the following equipment and lift thickness guidelines.

| Equipment Ground Pressure (psi) | Minimum Lift Thickness (in) |
|---|---|
| < 5.0 | 12 |
| 5.1 – 8.0 | 18 |
| 8.1 – 16.0 | 24 |
| > 16.0 | 36 |

Protective cover placed on sideslopes shall be placed from the bottom and pushed up the slope.

### 7.4. Quality Assurance Requirements

The protective cover soil thickness shall be verified by field surveys using a minimum of one survey point per 5,000 square feet of constructed area. Surveys shall be performed by a licensed Texas land surveyor and the survey results shall be included in the GLER submittal.

During construction the QAE shall:

- Verify that grade control is performed prior to work.
- Verify that underlying geosynthetic installations are not damaged during placement operations or by survey grade controls. Mark damaged geosynthetics and verify and document damage repairs.
- Verify that cover soil for sideslopes is pushed from the toe up the slope.
- Monitor haul road thickness over geosynthetic installations and verify that equipment hauling and materials placement meet equipment specifications.

## 8. FINAL COVER CONSTRUCTION

The following requirements govern the final cover system used at the facility:

### 8.1. Final Cover Description

The final cover system will consist of a six (6) inch thick (minimum) prepared subgrade layer, a geosynthetic clay liner (GCL) layer, a forty mil (0.04 inch) thick LLDPE geomembrane liner, a geocomposite drainage layer, and a twenty five (25) inch thick protective cover soil layer. Soil materials used for the final cover system shall be obtained either from on-site or off-site sources.

## 8.2.Required Material Properties

Soil materials and geosynthetic materials used for final cover construction comply with the following required material properties.

### 8.2.1. Soil Materials

#### 8.2.1.1.Subgrade Soils

Soil materials shall meet the requirements of Section 2.2.

#### 8.2.1.2.Protective Cover Vegetative Soil Layer:

The soil material for the protective cover vegetative soil layer shall consist of earthen material capable of sustaining native plant gowth and be composed of particles of which at least thirty percent (30%) but no more than ninety six percent (96%) pass the #200 sieve.

### 8.2.2. Geosynthetic Materials

#### 8.2.2.1.Geosynthetic Clay Liner (GCL)

The GCL material shall meet the requirements of Section 4.2.

#### 8.2.2.2.Geomembrane Liner

The forty mil (0.04 inch) thick LLDPE geomembrane liner shall meet the requirements of Section 5.2.

#### 8.2.2.3.Geocomposite Drainage Layer

The HDPE drainage net and geotextile fabric used in the geocomposite drainage layer shall meet the requirements of Section 6.2.

## 8.3.Installation Procedures

The final cover installation procedures shall be conducted by the Earthwork Contractor and observed by QAO. The installation procedures shall conform to the following requirements:

### 8.3.1. Subgrade Preparation

The existing intermediate cover material shall be shaped to the appropriate lines and grades as shown in the project contract documents and should coincide with the bottom of the final cover system. Subgrade soil materials shall be installed in accordance with the procedures specified in Section 2.3.

#### 8.3.2. GCL Installation

The GCL shall be installed in accordance with the procedures specified in Section 4.8.

#### 8.3.3. Geomembrane Liner Installation

The forty mil (0.04 inch) thick LLDPE geomembrane liner shall be installed in accordance with the procedures specified in Section 5.3.

#### 8.3.4. Geocomposite Drainage Layer

The geocomposite drainage layer shall be installed in accordance with the procedures specified in Section 6.3.

#### 8.3.5. Protective Cover Vegetative Soil Layer

A minimum twenty five (25) inch thick layer of protective cover soil shall be placed above the geocomposite drainage layer on the top and side walls of the area to receive cover. Protective cover does not require compaction control; however it should be stable for construction, operations and maintenance traffic. Care shall be exercised in placement so as not to shift or wrinkle or damage the underlying geosynthetics layers. Protective cover shall be placed using low ground pressure dozers (i.e. track pressure less than 5 psi). A 12-inch thickness of protective cover shall be maintained at all times. A greater thickness will be required to support loaded hauling trucks and trailers and for turning areas. Drivers shall proceed with caution when on the overlying soil and prevent spinning of tires and sharp turns. Protective cover shall be placed in an upslope direction on sidewalls.

The required thickness of the protective cover layer will be verified by survey methods on an established grid system with not less than one verification point per 10,000 square feet of surface area.

## 9. GENERAL DOCUMENTATION REQUIREMENTS

The QAE shall be responsible for ensuring that adequate documentation is prepared to comply with the LQCP. Documentation may consist of daily recordkeeping, manufacturer's test reports, conformance testing and installation reports, nonconformance reports (if necessary), progress reports, and design and specification revisions (if necessary). The appropriate documentation shall be used by the QAE to develop the GCLER, GLER and BER (if required) as well as other reports that may be required by the owner.

### 9.1. Daily Field Reports

The QAI shall prepare a daily field report. This report shall be prepared on the form included in Appendix C or a form containing similar information and shall be submitted to the owner and the QAE. The QAE shall review and sign all daily field reports. These daily field reports shall describe the work performed during the day.

**9.2.Test Results**

All tests shall be documented. The QAE shall develop and implement a tracking process to discretely identify each test result, including failures and subsequent re-tests. All laboratory tests shall have a written report prepared to indicate the results. The QAE or QAI shall review all test results and determine whether the test results meet project requirements. The QAE shall track each failing test result and shall require re-work or re-testing of the failed component to ensure that the completed component meets project requirements. Written and/or tabular summaries of field test results shall be prepared for inclusion in the GCLER/GLER. Copies of laboratory test results shall also be included in the GCLER/GLER.

**9.3.Surveying Results**

The QAE shall ensure that the surveying results are presented on a project drawing prepared to indicate the as-built condition of the constructed components. The QAE shall work with the surveyor to develop and implement a tracking process to discretely identify each surveyed location and the date on which the survey was conducted, including failures and subsequent re-surveys. The QAE shall track each failing survey result and shall require re-work or re-testing of the failed component to ensure that the completed component meets project requirements. Calculations supporting the thickness verifications shall be submitted by the surveyor to the QAE for inclusion in the GLER.

**9.4.Sample Location Plan**

The QAE shall be responsible for preparing and maintaining a site map which depicts the components being constructed on which can be documented the progress of the work, including inspections, sampling, testing and surveying. This map may be supplemented with additional maps and drawings sufficient to maintain proper records.

**9.5.Final Reporting Requirements**

The QAE shall be responsible for preparing, signing, and sealing the final GCLER/GLER document. The GCLER/GLER shall also be signed by the site operator and will be submitted to the TCEQ by the QAE. Submittal shall be to the MSW Permits Section of the Waste Permits Division for review and acceptance. If no response is received, either oral or written, within 14 days of receipt at the Waste Permits Division of the TCEQ, the report will be considered accepted. Any notice of deficiency received from the TCEQ will be promptly addressed and incorporated into the GCLER/GLER document. No solid waste will be placed over the constructed liner areas until final acceptance is obtained from the TCEQ.

If a layer of waste has not been placed over the top of protective cover within six months, then the QAE or the design engineer will visually observe that the protective cover has not undergone significant erosion that could compromise the protection of the underlying geosynthetics. A letter report documenting the observation of the cover and the repair measures undertaken to correct any cover damage will be submitted to the TCEQ for review and acceptance. This procedure shall be repeated at six month intervals until all protective cover has been covered with a layer of waste.

The QAE shall be responsible for preparing, signing and sealing the final BER that will document that enough ballast has been placed in a lined area to offset the potential hydrostatic uplift forces which may exist below the liner. The BER shall also be signed by the site operator and will be submitted to the TCEQ by the QAE. The BER shall also verify that the liner did not undergo uplift during construction. Additional documentation to accompany the BER includes a waste as ballast placement record completed and signed by the site operator, a survey of the top of waste elevations to document that the required waste thickness has been placed, and ballast thickness calculations. Submittal of the BER shall be to the MSW Permits Section of the Waste Permits Division for review and acceptance. The ballast placement and BER will not be considered accepted, and the temporary dewatering system must remain operational, until the TCEQ has given confirmation of its acceptance, or 14 days from the date of arrival of the BER at the Waste Permits Division, TCEQ have lapsed.

## 10. CONSTRUCTION BELOW THE HIGHEST GROUNDWATER LEVEL

### 10.1. Applicability

Future landfill sectors may be constructed below groundwater levels and could potentially experience uplift due to hydrostatic pressure acting on the liner system. Measures for both short term and long term protection of the liner system against uplift forces are described in this section of the LQCP.

A temporary dewatering system consisting of a dewatering drainage geocomposite and dewatering piping installed in gravel filled collection trenches will be installed below the footprint of future sectors prior to construction of the new liner. The geocomposite will also extend up the sidewalls of each newly developed sector to prevent the buildup of hydrostatic forces on the liner system. The sidewall geocomposite will drain to a toe trench and dewatering pipe collection system that will flow to a dewatering sump at the low point of the sector.

Long term protection of the liner system will be accomplished with the placement of sufficient ballast consisting of a combination of drainage gravel, protective cover soils, waste and final cover as applicable. Sample ballast calculations are provided in Appendix E – Example Ballast Calculations.

The highest groundwater elevation contours are shown on Figure III.10D-1of Appendix D. The contours on this drawing are based upon the highest individual reading in each of the monitor wells shown and do not represent a single event, existing conditions or groundwater flow. This contour map will be updated with the design of each new sector or partial sector to incorporate any higher well level data that has been recorded since the previous sector was constructed.

## 10.2. Dewatering System

To prevent the buildup of hydrostatic forces on the liner system, each new sector will have a temporary dewatering system installed prior to liner construction. The temporary dewatering system design is presented in Appendix D and consists of a drainage geocomposite extending across the floor of the sector that will transmit captured groundwater to a gravel filled collection trench that drains to a groundwater collection sump. The drainage geocomposite will also extend up the sidewalls and will drain to a gravel filled toe trench that coveys collected water to the groundwater collection sump. Water collected in the sump will be pumped to the facility perimeter stormwater drainage system. The drainage geocomposite will be covered with a 1-foot thick foundation soil layer that will serve as a subgrade for the GCL component of the liner system. The foundation soil layer will consist of on-site or off-site soil material that is free of organics, angular rocks, foreign objects or other deleterious materials.

Operation of the temporary dewatering system will continue until sufficient ballast is placed to offset the potential hydrostatic uplift forces acting on the liner. The liner can only be taken out of service upon the written approval of TCEQ once sufficient documentation of ballast placement has been submitted.

Alternate temporary dewatering systems may be submitted to TCEQ for consideration and approval if circumstances warrant the development of such alternate systems. A permit modification application must be submitted detailing the purpose and details of any such changes to this LCQP.

## 10.3. Dewatering System Materials

### 10.3.1. Piping

The dewatering collection trench piping shall meet the requirements of Section 6.2.3. Collection pipes will be 6-inch diameter HDPE SDR 17 or an approved equal. Installation procedures shall be in accordance with Section 6.3.3.

### 10.3.2. Drainage Gravel

Aggregate for the dewatering system collection trenches shall meet the minimum specifications listed in Section 6.2.4. Calcium carbonate content requirements for the dewatering system drainage gravel will be waived as the groundwater pH is expected to be neutral. Installation of the drainage gravel shall be in accordance with Section 6.3.4.

### 10.3.3. Drainage Geocomposite

The drainage geocomposite shall meet the requirements specified in Appendix D as well the construction documents for the specific sector development project. Installation of the drainage geocomposite shall be in accordance with Section 6.3.

### 10.4. Operation of the Dewatering System

The dewatering system shall be kept in operation until the ballast evaluation report is submitted to and approved in writing by TCEQ. Pumps used for pumping out water that collects in the dewatering sumps shall be inspected on a weekly basis to ensure proper operation. The pumps will be controlled with pressure transducers to ensure that the groundwater is below the liner elevations. Alternatives to pressure transducers for measuring groundwater levels in the sump include bubbler levels or graduated measuring rods. The QAE will identify the allowable groundwater level in the dewatering sump for each sector. Water levels in the sump shall be recorded weekly and the volume of water pumped shall be recorded on a monthly basis.

### 10.5. Liner System Ballast

Liner protection against long-term hydrostatic uplift pressures will be provided by the counteracting weight of the materials placed above the geomembrane liner, referred to as ballast. The ballast includes the weight of the leachate collection system, protective cover soil materials, and compacted waste. Additional soil in excess of the minimum protective thickness may also be used as ballast. Example calculations for determining the height of compacted waste or additional protective cover soils above the liner system are provided in Appendix E. Once ballast has been placed to the calculated height above the liner in a newly constructed sector, the temporary dewatering system below the liner no longer needs to remain operational and the groundwater can be allowed to rebound against the bottom of the liner system. A ballast evaluation report (BER) must be prepared and submitted to TCEQ to document that the adequate height of ballast has been achieved in the sector to offset potential hydrostatic uplift forces, and to request that the temporary dewatering system operations be discontinued. Once the BER is accepted by the TCEQ in writing, operation of the temporary dewatering system may be discontinued.

Ballast calculations will be performed to provide an adequate thickness of soil and/or waste to offset the potential hydrostatic uplift forces for each sector constructed below the groundwater table. A calculated factor of safety against uplift of 1.5 will be required for ballasting with waste and a factor of safety of 1.2 will be used for soil ballast. The unit weight for waste used as ballast will be 1200 pounds per cubic yard. The unit weight for soil used as ballast will be determined by laboratory testing for each specific sector construction project.

Landfill personnel working under the supervision of the landfill superintendent will be on site full time during placement of the first 5 feet of waste over the liner system. The site operator will verify and document on a daily basis that this lower 5 feet of waste does not contain brush or large bulky items that could damage the liner system or that cannot be compacted to the required density. Documentation will also be provided on a daily basis that the waste for ballast has been compacted with compaction equipment which weighs in excess of 40,000 pounds. The site operator will complete and sign a waste-as-ballast placement record that will be attached to the BER. A copy of the form, TCEQ-10073, is included in Appendix F. The latest revision of TCEQ-10073 or an equivalent form will be submitted for each sector associated with the BER.

### 10.6. Verification of Liner Performance

The QAE will verify that the ballast placed is consistent with the established criteria and that uplift of the liner system did not occur during construction. The QAE shall observe the liner subgrade for evidence of seepage during construction. Any areas of seepage will be documented by the QAE as to seepage location, methods and procedures used to control the seepage, and continued monitoring of the seepage area after control.

To document that short-term uplift has not occurred during construction of the liner, the QAE shall verify that the elevations of the GCL are consistent with the design subgrade elevations on shown on the construction drawings. The QAE shall also verify that the protective cover elevations have not increased from those submitted with the GLER. Survey measurements to check against uplift will be taken at a minimum frequency of 1 point per 10,000 square feet. The protective cover uplift survey will be performed once between submittal of the GLER and the beginning of waste placement.

### 10.7. Documentation

The GCLER, GLER, and BER will include information relevant to construction of the liner below the groundwater table. The calculations for the constructed liner ballast installed over the liner system will be submitted with the BER. The GCLER and GLER shall include a discussion identifying areas constructed below the highest measured groundwater elevations and a discussion of current groundwater conditions. The GCLER and GLER shall also include a discussion addressing any seepage that may have been encountered during construction. The BER will contain survey information verifying that the appropriate depth of ballast has been installed and that the liner did not experience hydrostatic uplift.

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# APPENDIX D

Temporary Dewatering System Design

For Permitting Purposes Only

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04/25/19

TBPE Firm No. F-417

**CITY OF KINGSVILLE MUNICIPAL SOLID WASTE LANDFILL**
**GROUNDWATER GEOCOMPOSITE**

**B DEWATERING DRAINAGE GEOCOMPOSITE FLOW CAPACITY**

**I. Objective:** Verify that the dewatering drainage geocomposite has the flow capacity for the estimated groundwater flows and results in a reduction of hydrostatic forces by a factor of 1.2.

**II. Approach:** Compute the maximum depth of groundwater in the geocomposite for the estimated design flow.

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TBPE Firm No. F-417
For calculations on
Pages 3.1 and 3.2

**III. Assumptions:**

**A:** Design groundwater flow rate is $2.42 \times 10^{-5}$ cfs/ft which equates to 11.5 gpm for the flow area of 8.47 ac.
**B:** Assume 200 mil geocomposite calculations.

**IV. Calculations:**

for surface area 8.47 ac Q= 11.5 gpm
Q= 0.02562 $ft^3/sec$

$$T_{max} = L\,\frac{[4(e/k) + \tan^2 B]^{1/2} - \tan B}{2\cos B}$$

where,

$T_{max}$= Thickness of groundwater in the collection layer (meters (m))
L= Length of horizontal projection of groundwater layer (m)
e= impingement rate (m/sec)
k= hydraulic conductivity of drainage layer (m/sec)
B= Slope angle of the base of groundwater collection layer (degrees)

| | | | | |
|---|---|---|---|---|
| L=350 ft | L= | 106.715 | m | |
| use surface area | (1 ac.) e= | 2.12E-08 | m/sec | |
| compressed thickness of 187 mils | T= | 0.00475 | m | Use GSE HyperNet Geonet (200 mil) |
| $2.0 \times 10^{-3}$ $m^2/sec$ transmissivity | t= | 0.000185 | $m^2/sec$ | Use t = t allow = 0.002 x [(1/1.5*1*1.2*1.5*4)] |
| k=t/T | k= | 0.039 | m/sec | t allow = t ult [(1/RFcr x Rfin x RFcc x RFbc*RFcb)] |
| | | | | RFcr=Creep Reduction Factor=1.5 |
| | tan B= | 0.020003 | | RFin= Intrusion Reduction Factor=1 |
| | B=arctan(0.02) | 1.146 | deg | RFcc=Chemical Clogging Reduction Factor=1.2 |
| | $T_{max}$= | 0.002894 | m | RFbc=Biological Clogging Reduction Factor=1.5 |
| | | 0.00949 | ft | RFcb=Soil Clogging Reduction Factor=4 |
| | | 0.1139 | in | |
| | | **113.9** | mils | |

Therefore, the selected 200 mil thick drainage geocomposite is adequate.

The GSE Drainage Design Manual, *Second Edition* Chapter 2 – Fundamentals Of Geonets And Geocomposites

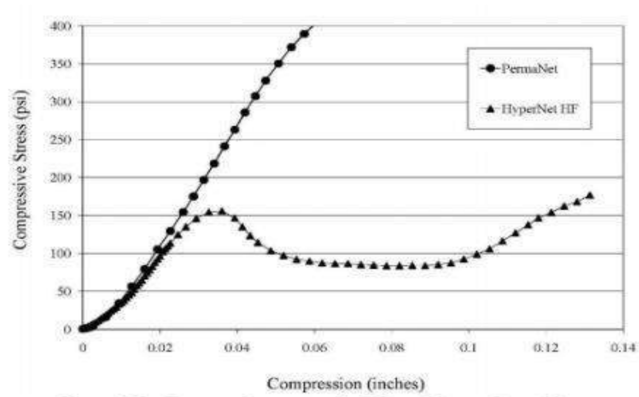


Figure 2.5. Compression strength of HyperNet vs. PermaNet.

**CITY OF KINGSVILLE MUNICIPAL SOLID WASTE LANDFILL**
**GROUNDWATER GEOCOMPOSITE**

**B DEWATERING DRAINAGE GEOCOMPOSITE FLOW CAPACITY (cont.)**

The drainage geocomposite of the underdrain has been designed to remove groundwater inflows, so the uplift pressure in the geocomposite will be that resulting from the depth of liquid contained therein.
The resulting upward hydrostatic pressure head acting on the liner (GCL, geomembrane and 2 feet of protective cover soil) is 0.1139 inches or 0.00949 feet. The factor of safety against hydrostatic uplift is calculated as follows:

| | |
|---|---|
| Hydrostatic Uplift Pressure = | 0.59 psf (.00949 feet of water head at 62.4 pcf) |
| Ballast Pressure = | 240 psf (2 feet of protective cover at 120 pcf) |
| Factor of Safety = | 407 > 1.2 OKAY |

Since the factor of safey is well above 1.2, the temporary dewatering system will provide adequate protection from uplift during its operation.

# APPENDIX E

Ballast Thickness Calculations

For Permitting Purposes Only

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04/25/19

TBPE Firm No. F-417

## EXAMPLE BALLAST THICKNESS CALCULATIONS

Material Unit Weights:

| | |
|---|---|
| Water = | 62.4 pcf |
| Protective Cover = | 120 pcf |
| Waste = | 44.4 pcf |

| Location of Ballast Evaluation | Top of Liner Elevation (ft-msl) | Historic High Groundwater Elevation (ft-msl) | Uplift Force due to Groundwater Head (psf) | Top of Protective Cover Elevation (ft-msl) | Protective Cover Resisting Force (psf) | Uplift FS from Protective Cover Only | Waste as Ballast Req'd? | Depth of Waste Ballast Required (feet) | Top of Waste as Ballast Elevation (ft-msl) |
|---|---|---|---|---|---|---|---|---|---|
| Sump 7B | 22.5 | 40.55 | 1126.3 | 24.5 | 240.0 | 0.2 | Y | 32.6 | 57.1 |
| Sump 7A | 22.5 | 40 | 1092.0 | 24.5 | 240.0 | 0.2 | Y | 31.5 | 56.0 |
| Sump 6B | 22.5 | 39.35 | 1051.4 | 24.5 | 240.0 | 0.2 | Y | 30.1 | 54.6 |
| Sump 6A | 22.5 | 38.9 | 1023.4 | 24.5 | 240.0 | 0.2 | Y | 29.2 | 53.7 |
| Sump 5B | 22.5 | 38.7 | 1010.9 | 24.5 | 240.0 | 0.2 | Y | 28.7 | 53.2 |
| Sump 5A | 22.5 | 38.5 | 998.4 | 24.5 | 240.0 | 0.2 | Y | 28.3 | 52.8 |
| Sump 4C | 22.5 | 37.4 | 929.8 | 24.5 | 240.0 | 0.3 | Y | 26.0 | 50.5 |

See Figure III.10D-2 in Part III, Attachment 10, Appendix D for elevations of liner and historic high groundwater contours.

The last two columns above show the minimum depth of waste as ballast and minimum elevation of the top of waste placed as ballast that is required to provide sufficient resisting force to offset the uplift force due to groundwater with a Factor of Safety of 1.5 at each location selected. The evaluation point selected in each of the sectors is the worst case in each sector with the greatest groundwater head above liner.

# FINAL FILLED CONDITION SUFFICIENT BALLAST CALCULATIONS

For Permitting Purposes Only
STATE OF TEXAS
JON M. REINHARD
64541
LICENSED
PROFESSIONAL ENGINEER
04/25/19
TBPE Firm No. F-417
For calculations on Pages 6 and 7

Material Unit Weights:
Water = 62.4 pcf
Protective Cover = 120 pcf
Waste = 44.4 pcf
Final Cover = 120 pcf

| Location of Ballast Evaluation | Top of Liner Elevation (ft-msl) | Historic High Groundwater Elevation (ft-msl) | Uplift Force due to Groundwater Head (psf) | Top of Protective Cover Elevation (ft-msl) | Protective Cover Resisting Force (psf) | Top of Waste Elevation (feet) | Waste Resisting Force (psf) | Top of Final Cover Elevation (feet) | Final Cover Resisting Force (ft-msl) | Factor Of Safety |
|---|---|---|---|---|---|---|---|---|---|---|
| Sump 7B | 22.5 | 40.55 | 1126.3 | 24.5 | 240.0 | 87.01 | 2775.4 | 90.09 | 369.6 | 3.0 |
| Sump 7A | 22.5 | 40 | 1092.0 | 24.5 | 240.0 | 87.01 | 2775.4 | 90.09 | 369.6 | 3.1 |
| Sump 6B | 22.5 | 39.35 | 1051.4 | 24.5 | 240.0 | 87.01 | 2775.4 | 90.09 | 369.6 | 3.2 |
| Sump 6A | 22.5 | 38.9 | 1023.4 | 24.5 | 240.0 | 87.01 | 2775.4 | 90.09 | 369.6 | 3.3 |
| Sump 5B | 22.5 | 38.7 | 1010.9 | 24.5 | 240.0 | 87.01 | 2775.4 | 90.09 | 369.6 | 3.4 |
| Sump 5A | 22.5 | 38.5 | 998.4 | 24.5 | 240.0 | 87.01 | 2775.4 | 90.09 | 369.6 | 3.4 |
| Sump 4C | 22.5 | 37.4 | 929.8 | 24.5 | 240.0 | 86.91 | 2771.0 | 89.99 | 369.6 | 3.6 |

The calculations above demonstrate that there is sufficient waste and cover material at each of the evaluated locations to offset groundwater uplift forces by greater than a factor of safety of 1.5. Each of the locations evaluated represent the worst case scenario within the future sectors to be constructed below the groundwater table.

# CITY OF KINGSVILLE LANDFILL

# PART III

# ATTACHMENT 11

GROUNDWATER SAMPLING AND ANALYSIS PLAN

THE CITY OF KINGSVILLE LANDFILL

TCEQ PERMIT MSW 235-C

# PERMIT AMENDMENT APPLICATION
# PART III, ATTACHMENT 11
# GROUNDWATER SAMPLING AND ANALYSIS PLAN

City of Kingsville TEXAS

CITY OF KINGSVILLE, TEXAS

STATE OF TEXAS
TAD A. GASS
GEOLOGY
11496
LICENSED
PROFESSIONAL GEOSCIENTIST

Tad A. Gass
4/24/2019

September 2018
Revision 1 – November 2018
Revision 2 – February 2019
Revision 3 – April 2019

Prepared by

HANSON
Engineering | Planning | Allied Services
TBPE F-417

HANSON PROJECT NO. 16L0438-0003

# Contents

# APPENDICES



*I:\16jobs\16L0438\8514-City of Kingsville\8514-03\Permit Amendment\NODs\Technical NOD #1\Part III\Part III, Attachment 11\Part III_att11 - GWSAP Cln.docx*

# 1.0 INTRODUCTION

The State of Texas promulgated regulations governing all aspects of municipal solid waste (MSW) management in Title 30 of the Texas Administrative Code (TAC), Chapter 330. Subchapter J, Section 330.405 (b) requires that the owners or operators of Municipal Solid Waste Landfills (MSWLFs) prepare and submit a Groundwater Sampling and Analysis Plan (GWSAP) to the Texas Commission on Environmental Quality (TCEQ). The purpose of this document is to satisfy the requirements of the above-referenced regulations as they pertain to the City of Kingsville Landfill (hereafter referred to as the Kingsville Landfill) and provide groundwater sampling procedures, frequencies, analytical parameters, monitoring data evaluation, and reporting requirements.

In accordance with TCEQ regulations, this GWSAP contains the procedures and techniques to be used to conduct Background Monitoring Statistical Evaluations, Detection Monitoring, Assessment Monitoring, and Corrective Action implementation should a significant groundwater impact be determined.

## 1.1 Facility Description

The Kingsville Landfill is located 1.7 miles southeast of the City of Kingsville at the intersection of County Road (CR) 2130 and Farm to Market (FM) 2619 in Kleberg County, Texas. The primary land use within a one-mile radius of the site is agricultural consisting of cropland and pasture co-existing with some oil and gas production. Adjacent to the landfill on the east of the property are a series of borrow pits that have been used for the purpose of daily cover and other site soil needs. Low-density residential development is scattered throughout the one-mile radius area of the facility, with most development located to the southeast and northeast. Immediately to the east and west of the permitted facility boundary, the land use is agricultural with some oil and gas production. To the north, south, and southeast, residences are widely scattered throughout brush and agricultural areas.

## 1.2 Groundwater Monitoring System

Based upon an understanding of the local ground water flow regime and site stratigraphy, the groundwater monitoring system will monitor the uppermost aquifer identified in the site Geology and Groundwater Characterization Reports. Analysis of the ground water level data over the life of the facility indicate that the ground water flow tends to leave the site in all directions except the northwest. Construction at the landfill should have minimal impact on ground water flow. The most likely pollutant pathway for pollutant migration in the event that the primary barrier liner system is penetrated would follow the groundwater flow away from the site. Further discussion and detail can be seen in the provided Groundwater Characterization Report (Part III, Attachment 4, Appendix 1, Section 2.0 beginning on page 762).

The completed groundwater monitoring system will be comprised of a total of twenty-two (22) monitoring wells. Monitor Wells 6RA, 15, 22R, 23, and 30 shall be considered upgradient wells until further development of waste sectors occur. The remaining 17 monitor wells shall be considered downgradient wells. All monitoring wells will be installed and monitored throughout the active life and post-closure care period of this site. The design will provide for monitoring well spacing of not more than 600 feet at the closest practicable distance to the point of compliance (when physical obstacles preclude installation of the groundwater monitoring wells at the point of compliance), as defined in 30 TAC §330.3, that will ensure detection of groundwater contamination of the uppermost aquifer. All parts of the groundwater monitoring system shall be operated and maintained so that they perform at least to design specifications. The design of the monitoring system is based on site specific technical information gathered during multiple site investigations and further discussed in the site Geology Report included as Part III Attachment 4 of this permit, Part III Attachment 4 Appendix 1, and the Groundwater Characterization Report included as Part III Attachment 4, Appendix 1 beginning on page 752. The City of Kingsville Landfill will promptly notify the executive director, and any local pollution agency with jurisdiction that has requested to be notified, in writing of changes in facility construction or operation or changes in adjacent property that affect or are likely to affect the direction and rate of groundwater flow and the potential for detecting groundwater contamination from a solid waste management unit and that may require the installation of additional monitoring wells or sampling points and that such additional wells or sampling points require a modification of the site development plan.

A topographic and Groundwater Contour map identifying the existing and proposed monitor well locations, installed depths, property boundary, a delineation of the waste management area, and the point of compliance line has been included in Appendix A-Item 1A and B Site Layout Maps. All monitoring wells will be constructed in accordance with 30 TAC §330.421. Monitor well installation and construction details will be provided on form TCEQ-10308, or current appropriate TCEQ reporting form, upon completion. The Groundwater Monitoring System Design Certification has been included as Appendix A-Item 2.

## 2.0 HEALTH AND SAFETY

Personnel performing water level measurements, well purging, or sampling will, at a minimum, wear latex or other equivalent non-powdered gloves. The gloves will be changed when they become damaged and when activities begin at a different well location. All personnel that are associated with the purging and sample collections from monitor wells will wear other appropriate Personal Protective Equipment (PPE) such as eye protection, safety vests, chemical resistant clothing and/or aprons, and air purifying respirators, as necessary.

## 3.0 GROUNDWATER SAMPLING FREQUENCY

### 3.1 Background Monitoring

At least eight (8) statistically independent background groundwater samples will be obtained on a quarterly basis prior to commencing with Detection Monitoring for each groundwater monitor well at the facility (see Appendix A, Table 1, for parameters). Background monitoring events should allow approximately 90 days between each monitoring event to allow the collection of groundwater data over the different seasons of the year.

### 3.2 Detection Monitoring

After establishment of background groundwater quality, detection monitoring will be performed on a semi-annual basis at approximately 6-month intervals during the remaining operational life and post-closure care period for this facility. Detection monitoring will begin on the first semi-annual monitoring event following the completion of the background monitoring establishment period.

## 4.0 GROUNDWATER ANALYTICAL PARAMETERS

The constituents to be analyzed for both background monitoring and detection monitoring are listed in Appendix A-Table 1. The respective Practical Quantitation Limits (PQLs), analytical methods, and Chemical Abstracts Service number (CAS) are also located in Appendix A-Table1 and Table-2.

At the conclusion of the background monitoring period, all the detection monitoring constituents will be thoroughly reviewed. As a result of this review, the City may request that the Executive Director eliminate subsequent monitoring for those constituents that were consistently below the method detection limits (MDL) throughout this period and are not expected to originate from the MSWLF unit.

## 5.0 GROUNDWATER PURGING AND SAMPLING

The following subsections will summarize tasks involved in the purging and sampling of the groundwater monitoring wells at the facility.

### 5.1 Well Inspection

Prior to performing any purging or sampling, each monitoring well will be inspected to assess its integrity. The visual inspection will include the lock, protective casing or collar, concrete pad, and casing for signs of damage by vandalism, animals, heavy equipment, or other causes. All necessary repairs or maintenance needed will be documented on the Monitor Well Field Data Sheet for each respective well. If it is determined that the integrity of the well has been compromised, the necessary information will be documented and the TCEQ will be notified. No additional actions will be taken without prior approval of the TCEQ.

### 5.2 Well Headspace Screening

Upon the opening of each monitoring well, an appropriately calibrated gas meter capable of measuring methane concentrations in percent volume and combustible gases in a percentage of the Lower Explosive Limit (LEL) will be utilized to screen the well headspace for hazardous concentrations of gasses that the sampling personnel could be exposed to during the well gauging and sampling procedures. The gas meter will contain a methane specific sensor and be able to measure the percent volume of methane in air. The concentration of methane, or percentage of the LEL, will dictate what precautions will be necessary during sampling activities. If methane is detected in excess of 5.0% by volume (100% LEL), the well will be left open and allowed to vent. No work will be performed at the well until methane concentrations fall below 5.0% by volume. Results of the well headspace screening for methane will be recorded and retained in the facility operating record.

### 5.3 Equipment Decontamination

All non-dedicated equipment used for water level measurement, purging, and/or the collection of groundwater samples will be decontaminated prior to use at each well location. An appropriate decontamination procedure consists of washing the non-dedicated equipment in a solution of Alconox, or equivalent laboratory-grade detergent, and distilled water followed by a distilled or deionized water rinse. Containers for the collection of rinsates will be utilized, as appropriate,

# CITY OF KINGSVILLE LANDFILL

# PART III, ATTACHMENT 11

# APPENDIX A

# TABLE 3
MONITOR WELL DESIGNATIONS

| Monitor Well Designation | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Monitor Well | Sector 1 | Sector 2 | Sector 3 | Sector 4 | Sector 5 | Sector 6 | Sector 7 | Sector 8 |
| MW-1RA | C | C | C | C | C | C | C | C |
| MW-6RA | U | U | U | U | U | C | C | C |
| MW-8 | C | C | C | C | C | C | C | C |
| MW-12RA | C | C | C | C | C | C | C | C |
| MW-13 | C | C | C | C | C | C | C | C |
| MW-14 | C | C | C | C | C | C | C | C |
| MW-15 | U | U | U | U | U | U | U | U |
| MW-16 | C | C | C | C | C | C | C | C |
| MW-19 | C | C | C | C | C | C | C | C |
| MW-20 | C | C | C | C | C | C | C | C |
| MW-21R | C | C | C | C | C | C | C | C |
| MW-22R | U | U | U | U | U | U | C | C |
| MW-23 | U | U | U | U | U | U | U | U |
| MW-24 | C | C | C | C | C | C | C | C |
| MW-27 | C | C | C | C | C | C | C | C |
| MW-28 | C | C | C | C | C | C | C | C |
| MW-29 | C | C | C | C | C | C | C | C |
| MW-30 | U | U | U | U | U | U | U | U |
| MW-31 | C | C | C | C | C | C | C | C |
| MW-32 | C | C | C | C | C | C | C | C |
| MW-33 | C | C | C | C | C | C | C | C |
| MW-34 | C | C | C | C | C | C | C | C |

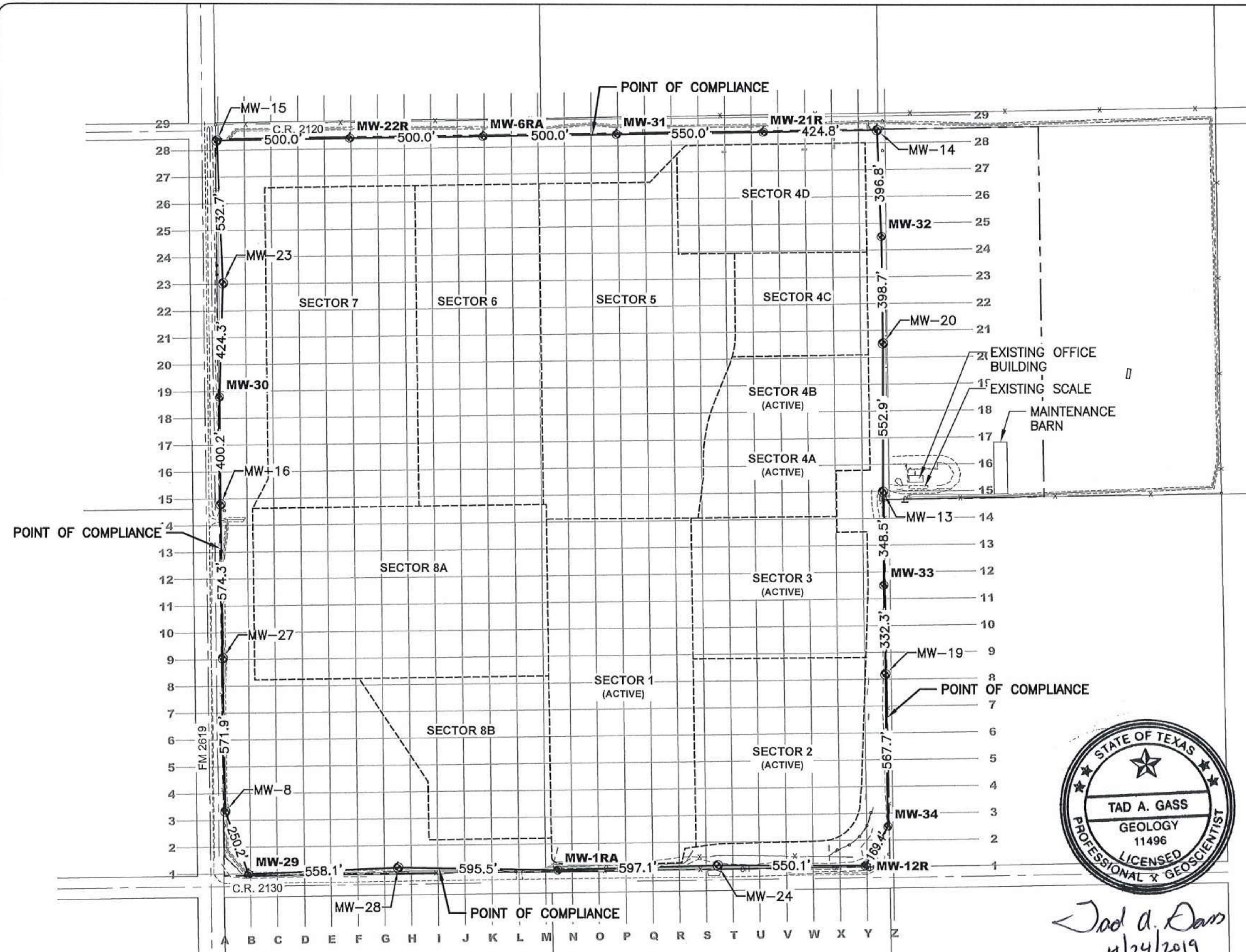
U = Upgradient Well
C = Compliance Well

# CITY OF KINGSVILLE LANDFILL

## PART III, ATTACHMENT 11

## APPENDIX A

ITEM 1A-SITE LAYOUT MAP (TOPO)
ITEM 1B-SITE LAYOUT MAP (GW CONTOUR)




| SITE COORDINATES | | | | |
|---|---|---|---|---|
| MONITOR WELL LOCATIONS | | | | |
| MW | Northing | Easting | DEPTH (FT BGS) | STATUS |
| MW-8 | 17051473.78 | 1203673.74 | 43 | EXISTING |
| MW-13 | 17052672.16 | 1206127.95 | 40 | EXISTING |
| MW-14 | 17054020.04 | 1206103.02 | 35 | EXISTING |
| MW-15 | 17053976.10 | 1203628.61 | 33 | EXISTING |
| MW-16 | 17052619.76 | 1203651.21 | 40 | EXISTING |
| MW-19 | 17051991.35 | 1206137.50 | 43 | EXISTING |
| MW-20 | 17053225.01 | 1206127.20 | 39 | EXISTING |
| MW-23 | 17053444.05 | 1203654.88 | 35 | EXISTING |
| MW-24 | 17051277.99 | 1205512.42 | 33 | EXISTING |
| MW-27 | 17052045.52 | 1203661.75 | 40 | EXISTING |
| MW-28 | 17051266.46 | 1204320.24 | 43 | EXISTING |
| MW-1RA | 17051258.70 | 1204915.66 | 35 | PROPOSED |
| MW-32 | 17053623.64 | 1206120.29 | 31 | PROPOSED |
| MW-6RA | 17053994.38 | 1204628.44 | 30 | PROPOSED |
| MW-12RA | 17051277.38 | 1206062.51 | 35 | PROPOSED |
| MW-21R | 17054011.48 | 1205678.30 | 32 | PROPOSED |
| MW-22R | 17053986.24 | 1204128.51 | 30 | PROPOSED |
| MW-29 | 17051239.92 | 1203762.81 | 40 | PROPOSED |
| MW-30 | 17053019.90 | 1203644.60 | 30 | PROPOSED |
| MW-31 | 17054002.53 | 1205128.38 | 31 | PROPOSED |
| MW-33 | 17052323.65 | 1206132.04 | 35 | PROPOSED |
| MW-34 | 17051423.79 | 1206147.64 | 35 | PROPOSED |

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| NUMBER | REVISION | DATE | DRAWN | DESIGNED | REVIEWED |
|---|---|---|---|---|---|

Hanson No. 16L0438
Filename 8514-03-APPENDIX-SITE-LAYOUT
Scale AS SHOWN
Date 04/23/2019

| | | |
|---|---|---|
| LAYOUT | DT | 04/23/2019 |
| DRAWN | DT | 04/23/2019 |
| REVIEWED | TAC | 04/23/2019 |

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Hanson Professional Services Inc.
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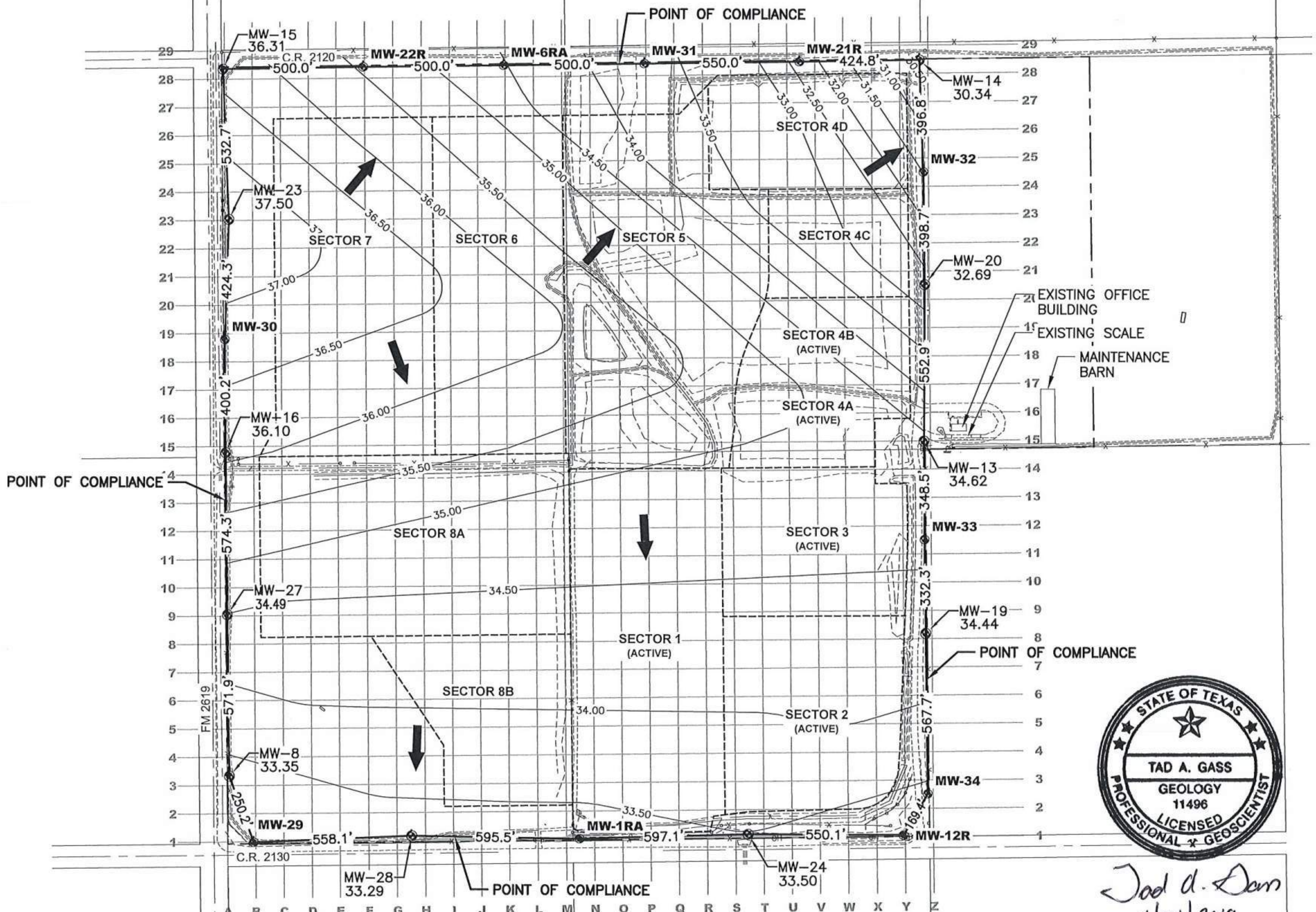
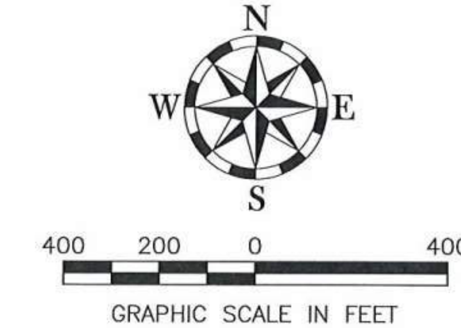
Offices Nationwide

PART III, ATTACHMENT 11
APPENDIX A
ITEM - 1A
SITE LAYOUT MAP
GROUNDWATER SAMPLING AND ANALYSIS PLAN
CITY OF KINGSVILLE LANDFILL
PA. MSW 235-C
KINGSVILLE, TEXAS, KLEBERG COUNTY, TEXAS

FIGURE:
III.11-A-1A




## LEGEND:

- MW-20 — MONITOR WELL LOCATION
- x — EXISTING FENCE
- 35.00 — GROUNDWATER CONTOURS (FEET AMSL)
- SECTOR OUTLINE
- PERMIT BOUNDARY (175.89 ACRES)
- 400.2' — POINT OF COMPLIANCE
- GROUNDWATER DIRECTIONAL FLOW ARROW

| SITE COORDINATES | | | | |
|---|---|---|---|---|
| MONITOR WELL LOCATIONS | | | | |
| MW | Northing | Easting | DEPTH (FT BGS) | STATUS |
| MW-8 | 17051473.78 | 1203673.74 | 43 | EXISTING |
| MW-13 | 17052672.16 | 1206127.95 | 40 | EXISTING |
| MW-14 | 17054020.04 | 1206103.02 | 35 | EXISTING |
| MW-15 | 17053976.10 | 1203628.61 | 33 | EXISTING |
| MW-16 | 17052619.76 | 1203651.21 | 40 | EXISTING |
| MW-19 | 17051991.35 | 1206137.50 | 43 | EXISTING |
| MW-20 | 17053225.01 | 1206127.20 | 39 | EXISTING |
| MW-23 | 17053444.05 | 1203654.88 | 35 | EXISTING |
| MW-24 | 17051277.99 | 1205512.42 | 33 | EXISTING |
| MW-27 | 17052045.52 | 1203661.75 | 40 | EXISTING |
| MW-28 | 17051266.46 | 1204320.24 | 43 | EXISTING |
| MW-1RA | 17051258.70 | 1204915.66 | 35 | PROPOSED |
| MW-32 | 17053623.64 | 1206120.29 | 31 | PROPOSED |
| MW-6RA | 17053994.38 | 1204628.44 | 30 | PROPOSED |
| MW-12RA | 17051277.38 | 1206062.51 | 35 | PROPOSED |
| MW-21R | 17054011.48 | 1205678.30 | 32 | PROPOSED |
| MW-22R | 17053986.24 | 1204128.51 | 30 | PROPOSED |
| MW-29 | 17051239.92 | 1203762.81 | 40 | PROPOSED |
| MW-30 | 17053019.90 | 1203644.60 | 30 | PROPOSED |
| MW-31 | 17054002.53 | 1205128.38 | 31 | PROPOSED |
| MW-33 | 17052323.65 | 1206132.04 | 35 | PROPOSED |
| MW-34 | 17051423.79 | 1206147.64 | 35 | PROPOSED |

NOTE: GROUNDWATER ELEVATIONS FROM JANUARY 2017

STATE OF TEXAS
TAD A. GASS
GEOLOGY
11496
LICENSED
PROFESSIONAL GEOSCIENTIST

Tad A. Gass
4/24/2019

| NUMBER | REVISION | DATE | DRAWN | DESIGNED | REVIEWED |
|---|---|---|---|---|---|

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Scale AS SHOWN
Date 04/23/2019

| | | |
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| LAYOUT | DT | 04/23/2019 |
| DRAWN | DT | 04/23/2019 |
| REVIEWED | TAG | 04/23/2019 |

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PART III, ATTACHMENT 11
APPENDIX A
ITEM - 1B
SITE LAYOUT MAP
GROUNDWATER SAMPLING AND ANALYSIS PLAN
CITY OF KINGSVILLE LANDFILL
PA. MSW 235-C
KINGSVILLE, TEXAS, KLEBERG COUNTY, TEXAS

FIGURE:
III.11-A-1B

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# CITY OF KINGSVILLE LANDFILL

# PART III

# ATTACHMENT 12

## FINAL CLOSURE PLAN

For Permitting Purposes Only

STATE OF TEXAS
JON M. REINHARD
64541
LICENSED
PROFESSIONAL ENGINEER
04/25/19

TBPE Firm No. F-417

# Texas Commission on Environmental Quality

## Closure Plan for Municipal Solid Waste Type I Landfill Units and Final Facility Closure

This form is for use by applicants or site operators of Municipal Solid Waste (MSW) Type I landfills to detail the plan for closure of a landfill unit, closure of associated storage or processing units, and final closure of the facility to meet the requirements in 30 TAC Chapter 330, §330.63(h) and 30 TAC Chapter 330 Subchapter K for a MSW Type I facility.

If you need assistance in completing this form, please contact the MSW Permits Section in the Waste Permits Division at (512) 239-2335.

## I. General Information

Facility Name: The City Of Kingsville Landfill

MSW Permit No.: 235C

Site Operator/Permittee Name: City of Kingsville

## II. Landfill and Other Waste Management Units and Operations Requiring Closure at the Facility

### A. Facility Units

*Table 1. Description of Landfill Units.*

| Name or Descriptor of Unit | Operating Status of Unit | Type of Liner System Under Unit | Above Grade Class 1 Disposal Cells in this Unit | Below Grade Class 1 Disposal Cells in this Unit | Other Class 1 Disposal Cells in this Unit (describe) | Size of Unit's Waste Footprint (acres) | Maximum Inventory of Waste Ever in Unit (cubic yards) | Other Necessary Information that Pertains to the Unit |
|---|---|---|---|---|---|---|---|---|
| Type I | Active | Alternate Liner | ☐ | ☐ | ☐ | 121.3 | 17,994,286 | |
| Totals | | | | | | 121.3 | 17,994,286 | |

## C. Drawings Showing Details of the Waste Management Units at Closure

*Table 4. Location of the Drawings showing Details of the Waste Management Units at Closure (outlines, dimensions, maximum elevations of waste and final cover of landfill units, and waste storage or processing units or operations at closure of the facility).*

| Drawing Location in the SDP | Drawing Figure Number | Drawing Title | Waste Management Units Details Shown |
|---|---|---|---|
| Part III, Attachment 1 | III.1-3 | Landfill Excavation Plan | Outlines, waste footprints, and dimensions of the landfill units |
| Part III, Attachment 1 | III.1-4 | Landfill Completion Plan | Maximum elevations of waste and final cover of the landfill units |
| Part III, Attachment 1 | III.1-14 | Support Area Layout | Locations and limits of storage and processing units in the support area |

## III. Description of the Final Cover System Design

## A. Types and Descriptions of the Final Cover Systems

*Table 5. Types and Descriptions of the Final Cover Systems Permitted or Proposed for Closure of the Landfill Units.*

| Landfill Unit Name or Descriptor | Type of Final Cover System | Final Cover System Components Description | Other Information (Enter other information as applicable) |
|---|---|---|---|
| Type I Landfill | Alternative Composite Final Cover | A prepared soil subgrade;<br>A geosynthetic clay liner (GCL) layer;<br>A forty mil (0.04 inch) thick LLDPE geomembrane layer;<br>A geocomposite drainage layer consisting of a synthetic drainage net and geotextile fabric;<br>A twenty five (25) inch thick protective cover soil layer, the top seven (7) inches of which must be capable of supporting vegetation. | |

## VII. Professional Engineer's Statement, Seal, and Signature

Name: Jon M. Reinhard, P.E. Title: Project Engineer

Date: April 25, 2019

Company Name: Hanson Professional Services Inc. Firm Registration Number: F-417

Professional Engineer's Seal

For Permitting Purposes Only


04/25/19

TBPE Firm No. F-417

Signature

# THE CITY OF KINGSVILLE LANDFILL

# TCEQ PERMIT MSW 235C

## PERMIT AMENDMENT APPLICATION

## Volume 6 of 6

CITY OF KINGSVILLE, KLEBERG COUNTY, TEXAS

For Permitting Purposes Only

STATE OF TEXAS
JON M. REINHARD
64541
LICENSED
PROFESSIONAL ENGINEER
04/25/19

TBPE Firm No. F-417

September 2018
Revision 1 – November 2018
Revision 2 – February 2019
Revision 3 – April 2019

Prepared by

HANSON
Engineering | Planning | Allied Services

TBPE F-417

HANSON PROJECT NO. 16L0438-0003

THE CITY OF KINGSVILLE LANDFILL

TCEQ PERMIT MSW 235C

# PERMIT AMENDMENT APPLICATION
# PART IV

CITY OF KINGSVILLE, KLEBERG COUNTY, TEXAS

For Permitting Purposes Only

STATE OF TEXAS
JON M. REINHARD
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04/25/19

TBPE Firm No. F-417

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TBPE F-417

HANSON PROJECT NO. 16L0438-0003

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STATE OF TEXAS
JON M. REINHARD
64541
LICENSED PROFESSIONAL ENGINEER
04/25/19
TBPE Firm No. F-417
For Pages i - v

## LIST OF TABLES



## LIST OF FIGURES



## LIST OF ATTACHMENTS

## LIST OF ACRONYMS

ADC – Alternate Daily Cover
CESQG – Conditionally Exempt Small Quantity Generator
CFC – Chlorinated Fluorocarbon
CFR – Code of Federal Regulations
DIY – Do It Yourself
EPA – Environmental Protection Agency
GLER – Geosynthetics Liner Evaluation Report
GWSAP – Groundwater Sampling and Analysis Plan
LCS – Leachate Collection System
LCWMP – Leachate and Contaminated Water Management Plan
LFG – Landfill Gas
LGMP – Landfill Gas Management Plan
LQCP – Liner Quality Control Plan
M/S – Landfill Manager/Supervisor
MSW – Municipal Solid Waste
MSWLF – Municipal Solid Waste Landfill
MSWMR – Municipal Solid Waste Management Regulations
PCB – Polychlorinated Biphenyl
RRC – Railroad Commission of Texas
SDP – Site Development Plan
SLER – Soil Liner Evaluation Report
SOP – Site Operating Plan
SOR – Site Operating Record
SPCC – Spill Prevention, Control, and Countermeasures Plan
SWAP – Special Waste Acceptance Plan
SWPPP – Stormwater Pollution Prevention Plan
TAC – Texas Administrative Code
TCEQ – Texas Commission on Environmental Quality
TPDES – Texas Pollutant Discharge Elimination System
TXDOT – Texas Department of Transportation

should be maintained in the site operating records and should include evidence of successful completion of the training, type of training received, and the name of the instructor. The minimum level of training for the facility manager should be a Class A license as defined in §30.213. In addition, key on-site personnel should attend a course for screening for unauthorized waste.

### 4.2.2 Wastes Prohibited From Disposal

The City of Kingsville Landfill will not accept the following types of waste for disposal:

- Municipal Hazardous Waste other than from a Conditionally Exempt Small Quantity Generator (CESQG) as defined in 30 TAC §330.171(c)(6);
- Polychlorinated Biphenyls (PCBs) as discussed in section 4.2.1;
- Class 1industrial waste;
- Do-it-yourself (DIY) used motor vehicle oil will not be intentionally or knowingly accepted for disposal per §330.15(e)(2);
- Whole used or scrap tires shall not be accepted for disposal or disposed of in any MSW landfill, unless processed prior to disposal in a manner acceptable to the executive director per §330.15(e)(4);
- Lead acid storage batteries will not be intentionally or knowingly accepted for disposal per §330.15(e)(1);
- Used oil filters from internal combustion engines will not be intentionally or knowingly accepted for disposal per §330.171(d);
- Items containing chlorinated fluorocarbon (CFC) unless all the CFC contained within them is properly managed as defined in §330.15(e)(5);
- The following special wastes without prior approval from TCEQ and accompanied with the relevant analytical test results, MSDS documents, or process knowledge documents:
  - Septic tank pumpings which have been stabilized and have passed the paint filter test;
  - Wastes from commercial or industrial wastewater treatment plants; air pollution control facilities; and tanks, drums, or containers used for shipping or storing any material that has been listed as a hazardous constituent in 40 CFR, Part 261, Appendix VIII but has not been listed as a commercial chemical product in 40 CFR Part 261.33(e) or (f);
  - Drugs, contaminated foods, or contaminated beverages, other than those contained in normal household waste;
  - Incinerator ash;
  - Light ballasts and/or small capacitors containing PCB compounds with a PCB content less than 50 parts per million;
  - And waste generated outside the boundaries of Texas that contains:
  - Any industrial waste,

1. **<u>The active working face(s):</u>** Municipal solid waste will be unloaded at the active working face(s). Unloading of municipal solid waste at the active working face will be confined to as small an area as practical and will not exceed 30,000 square feet, or about 300 feet by 100 feet. The size of the working face will be directly impacted by the amount of waste being received and may vary accordingly. There may be one, two or three working faces open at any given time. Typically, there will be one general purpose waste unloading area. The M/S may designate up to three waste unloading areas; one for commercial customers, one for light commercial/residential customers, and one for other wastes requiring special attention or while moving a working face (i.e., establishing a working face in a new location, while covering, or during periods of emergency clean up operations (i.e., hurricane, hailstorm, flood, etc.).
2. **<u>White Goods and Metal Recyclable Storage Area:</u>** The white goods and metal recyclable unloading and storage area will not be larger than 20,000 square feet (100 feet by 200 feet). Large items/white goods may include ovens, dishwashers, freezers, air conditioners, and other items. These items will not be stored in excess of 180 days.
3. **<u>Tire storage and processing area:</u>** Tires will be managed in a manner that minimizes possible ponding of water in order to eliminate potential conditions that would promote disease vectors. The quantity of tires stored on-site will not exceed 500 tires on the ground (maximum storage area of 25 feet by 25 feet), or 2,000 tires in enclosed containers (maximum storage area of one standard 40 to 52 foot trailer). The tires will be processed/reduced in size to the extent practical for disposal in the landfill or sent to an authorized tire recycler. Whole used or scrap tires will not be disposed of in the landfill. Tires will not be stored in excess of 180 days.
4. **<u>Liquid waste solidification area:</u>** Liquid waste will be unloaded into one (1) of four (4) approximately eight (8) feet by 20 feet liquid tight mixing containers and will be located within a lined landfill sector. The maximum size of the liquid waste solidification area will be 75 feet by 115 feet. Bulking agents such as on-site soil, sawdust, kiln dust, coal combustion residuals, auto-fluff or other inert material with absorptive capacity will be mixed with the liquids until the resulting mixture passes the paint filter test and any other requirements outlined for the specific material. Once the liquids have been solidified, the solidified waste material will be transported and disposed of in the working face. Liquid waste will be unloaded directly into the mixing containers and solidification will begin upon receipt. See Part IV, Attachment 5 for the Liquid Waste Solidification Operating Plan.
5. **<u>Brush storage and processing area:</u>** Vegetative material not mixed with other wastes will be diverted to a location outside of the active disposal area and drainage ways so that they do not interfere with on-site drainage or wash off-site. The maximum size of the unloading area for brush and yard waste is 200 feet by 400 feet. Brush will be processed for mulch. Brush will not be stored in excess of 180 days.

**4.11.2 Site Grid System Markers §330.143(b)(5)**

Site grid system markers (White) will be installed at the facility. The grid system will encompass at least the area expected to be filled within the next 3 year period. Grid markers will be maintained during the active life of the site: post-closure maintenance of the grid system is recommended but not required. The grid system will consist of lettered markers along one (1) side and numbered markers along the other perpendicular side. Markers will be spaced no greater than 100 feet apart measured along perpendicular lines. Where markers cannot be seen from opposite boundaries, intermediate markers will be installed, where feasible.

**4.11.3 SLER or GLER Area Markers §330.143(b)(6)**

SLER or GLER area markers (Red) will be placed so that all areas for which a SLER or GLER has been submitted and approved by TCEQ are readily determinable. Such markers are to provide site workers immediate knowledge of the extent of approved disposal areas. These markers will be located so that they are not destroyed during operations until operations extend into the next SLER or GLER. The location of these markers will be tied into the site grid system and will be reported on each SLER/GLER submitted. SLER and GLER markers will not be placed inside the constructed/evaluated areas.

**4.11.4 100 Year Flood Limit Protection Markers §330.143(b)(7)**

Flood protection markers (Blue) must be installed in any area within a solid waste disposal facility that is subject to flooding prior to the construction of flood protection levee. The area subject to flooding will be clearly marked by means of permanent posts spaced not more than 300 feet apart or closer if necessary to retain visual continuity. City of Kingsville Landfill is NOT located within a 100 year floodplain.

**4.11.5 Site Boundary Markers §330.143(b )(2)**

Site boundary markers (Black) will be placed at each corner of the site and along each boundary line at intervals no greater than 300 feet. Fencing may be placed within these markers as required.

**4.11.6 Buffer Zone Markers §330.143(b)(3)**

Markers (Yellow) identifying the buffer zone will be placed along each buffer zone boundary at all corners and between corners at intervals no greater than 300 feet. Placement of the landfill grid markers may be made along a buffer zone boundary.

**4.11.7 Permanent Benchmark §330.143(b)(8)**

A permanent monument has been established at the site. The monument is established at the site in an area that is readily accessible and will not be used for disposal. The monument elevation was surveyed from a known United States Coast and Geodetic Survey benchmark. The location (NAD 27: N 27° 26' 41.95", W 97° 48' 55.89"/NAD 83: N 27; 26'; 43.08", W 97; 48'; 56.88") and elevation (52.61 ft above mean sea level) of the reference benchmark monument are provided in Part II, Attachment 1, Figure II.1-2,

# CITY OF KINGSVILLE LANDFILL

# ATTACHMENT 5

# LIQUID WASTE SOLIDIFICATION OPERATING PLAN

For Permitting Purposes Only

STATE OF TEXAS
JON M. REINHARD
64541
LICENSED
PROFESSIONAL ENGINEER

04/25/19

TBPE Firm No. F-417

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# FIGURES



For Permitting Purposes Only

STATE OF TEXAS
JON M. REINHARD
64541
LICENSED
PROFESSIONAL ENGINEER

04/25/19

TBPE Firm No. F-417

I:\16jobs\16L0438\8514-City of Kingsville\8514-03\Permit Amendment\NODs\Technical NOD #2\Part IV\Part IV_Att 5 LWSAOP Rdln.docx

## 1.0 Background and Purpose

For those wastes sent to the Liquid Waste Solidification Area (LWSA), the LWSA site operating plan (SOP) is as follows. The LWSA SOP is to document the design and operation procedures of a liquid waste solidification/bulking operation, which will consist of four (4) approximately eight (8) feet by 20 feet liquid tight mixing containers/basins located within a lined landfill sector, constructed in accordance with 30 TAC §330.331(b), of the City of Kingsville Landfill permit boundary. The LWSA will be installed within an area that is operationally feasible where final cover has not been constructed; and will periodically be relocated because of general sequence of filling operations. The LWSA will include basins that may vary in size with a maximum number of four liquid tight mixing containers/basins – only one LWSA may be operational at one time. Processing or bulking of liquid material is typically needed to allow direct disposal to the landfill (i.e., liquid waste material requires bulking to pass the paint filter test). The liquid material collected at the facility will be bulked and disposed of in the landfill

## 2.0 Design

The facility will utilize a liquid tight mixing containers/basin(s), placed and secured in landfill material and soil. Wastes excavated during liquid tight mixing container/basin installation will be properly disposed at the active working face. The liquid tight mixing container/basin will be installed so that a minimum of 1 foot of the liquid tight mixing container/basin extends above the surrounding soil where the surrounding soils are graded away from the liquid tight mixing container/basin to prevent stormwater run-on into the liquid tight mixing container(s)/basin(s). A runoff/run-on control berm will be installed around perimeter of the liquid tight mixing container(s)/basin(s) and solidifying/stabilizing material storage area. This berm constructed of compacted earthen material will be a minimum of 2 foot in height unless the location of the LWSA is adjacent to a waste slope with potential for storm water run-on. In addition, the bottom of the liquid tight mixing container(s)/basin(s) will be at least 10 ft above the top of protective cover soil of the underlying constructed lining system. Figure IV.5-1, Liquid Waste Solidification Area Layout Plan shows typical layout and liquid tight mixing containers/basins and runoff/run-on control berm details.

## 3.0 Liquid Waste Processing Operations

The liquids collected at the facility will be bulked (i.e., solidified) and disposed of in the landfill. The installation of a liquid processing operation at the Facility will provide an essential service for food, beverage, and other commercial and industrial facilities in the surrounding region.

Liquid waste will be unloaded into one (1) of four (4) approximately eight (8) feet by 20 feet liquid tight mixing containers/basins and will be located within a lined landfill sector. The maximum size of the liquid waste solidification area will be 75 feet by 115 feet. Bulking agents such as on-site soil, sawdust, kiln dust, coal combustion residuals, auto-fluff or other inert material with absorptive capacity will be mixed with the liquids until the resulting mixture passes the paint filter test and any other requirements outlined for the specific material. Once the liquids have been solidified, the solidified waste material will be transported and disposed of in the working face. Liquid waste will be unloaded directly into the mixing containers/basins and solidification will begin upon receipt

Dust and odors will be controlled by covering the containers/basins or by adding sawdust or wood chips to the waste.

Any rainfall or water entering the LWSA will be managed as contaminated water and will be solidified before disposal in the landfill.

Control of liquids processed at the operation will be controlled by the procedures in Part IV – Attachment 3– Special Waste Acceptance Plan. A more complete discussion of the quality control process is presented in the following sections.

## 4.0 Description of Waste

Untreated liquid wastes which typically cannot pass the paint filter test include nonhazardous industrial wastes and sludges, food and beverage byproducts and other nonhazardous liquids. These liquids will generally be transported to the facility by private haulers in vacuum trucks, tank trucks, and sealed containers in accordance with §330.171(b)(3). The facility is approved to accept liquid waste by approval of this permit for processing in the LWSA. The liquids will originate from food and beverage processing plants, and other commercial and industrial facilities.

## 5.0 Processing Method

The bulking/solidification process involves the addition of a solid material that will absorb the liquid and form a sludge that can pass the paint filter test to be disposed of in the landfill.
Liquid waste will be unloaded directly into the mixing containers/basins and solidification will begin upon receipt. Liquid waste will be unloaded into one (1) of four (4) approximately eight (8) feet by 20 feet liquid tight mixing containers/basins located within a lined landfill sector.

Bulking agents will be mixed with the liquids until the resulting mixture passes the paint filter test and any other requirements outlined for the specific material. The bulking agent used in the liquid waste solidification process will be soil, sawdust, kiln dust, coal combustion residuals, auto-fluff or other inert material with absorptive capacity as approved by the Texas Commission on Environmental Quality (TCEQ).

Once the liquids have been solidified, the solidified waste material will be transported and disposed of in the working face.

The bulking process has the advantages of being a simple process that does not require discharge to a wastewater treatment plant.

## 6.0 Monitoring

Incoming liquid waste will be documented on a Part IV, Attachment 1, Form 3 – Special Waste Inspection Form, or other required manifest. Incoming waste will also be pre-characterized by the generator in accordance with the facility's approved waste acceptance procedures listed in the Part IV – Attachment 3. The pre-characterization will include analytical analysis and/or process information as necessary to make the determination that the waste is nonhazardous. No waste material will be accepted at the site that is not precharacterized or does not have the proper manifest(s).

The landfill may request and use additional information to assist in evaluating an industrial or non-industrial liquid waste for management at the Facility. Such information includes, but is not limited to, analytical data, product and/or raw component Material Safety Data Sheets (MSDS), additional waste composition data, and pertinent letters or memoranda

Upon arrival, each load shall be verified and the shipment compared to the waste approval records for conformity. Any discrepancy which cannot be rectified will result in the rejection of the load.

## 7.0 Storage and Processing

Accepted loads of liquids will be directed to the LWSA for discharge into the mixing containers/ basins and solidification will begin upon receipt. Bulked wastes will pass a paint filter test (EPA SW-846/9095) before disposal at the landfill working face.

Operation of the facility will include the following:

- Control of dust by wetting the roads and facility area and covering the bulking agents when not in use.
- Control of odors by covering the containers/basins, or using sawdust or wood chips for temporary odor masking.
- Protect the health and environment of employees, citizens, and surrounding communities by operating the facility in accordance with TCEQ, EPA, OSHA, and other applicable regulations.

Facility personnel will be trained in the bulking/solidification procedure, acceptable testing method, recognition of waste streams and their compatibility, daily operations, recordkeeping and reporting, implementation of emergency procedures, fire protection, and regulations pertaining to liquid waste disposal as set forth by the TCEQ.

## 8.0 Testing and Recordkeeping

The testing and recordkeeping requirements are listed below.

- The Paint Filter Liquid Test (EPA Method SW-846/9095) is required immediately prior to disposal of the waste in the landfill. Representative grab samples shall be obtained at a rate of one per batch of treated material.
- Records concerning the type, quantity, source, and test results of liquid wastes processed shall be maintained on a daily basis, and become part of the site operating record.

## 9.0 Training of Operational Personnel

Personnel involved in the bulking/ shall receive adequate training in the bulking procedure, acceptable testing method, recognition of waste streams and their compatibility, daily operations, recordkeeping and reporting, implementation of emergency procedures, and regulations pertaining to liquid waste disposal.

## 10.0 Closure

All liquid wastes will be treated and disposed of in the landfill or an off-site permitted disposal facility. A notice will be sent to the TCEQ and placed in the Site Operating Record noting the specific steps taken to decommission the facility.

## 11.0 Fire Protection

Landfill personnel, including equipment operators, will watch for signs of fire at the liquid waste solidification area. Landfill personnel will watch for fire, smoke, steam, or signs of heat. If signs of fire are detected at the liquid waste solidification area, all vehicles and equipment will be immediately moved away from the fire. The unloading of materials will either be relocated to a safe location away from the fire and a collection area established there or halted all together until the fire is extinguished.

If detected soon enough, a small fire may be fought with a hand-held fire extinguisher. The fire area may be watered down or smothered with 6 inches of soil, as appropriate, to ensure that the fire is out.

If the fire cannot be quickly extinguished with the fire extinguisher, the bulldozer, earth moving equipment, and water truck will immediately mobilize to the site of the fire. All available landfill personnel will assist with fire protection measures unless otherwise directed by the M/S.

Fire fighting methods for processed liquid wastes or bulking agents include smothering with soil, separating burning material from other waste, spraying with water from an on-site water truck, or pumping with water from an on-site pond. The burning material should be isolated or pushed away immediately before the fire can spread, or fire breaks should be cut around the fire before it can spread. If moving the material is not possible, or if it is unsafe, efforts should be made to cover the burning area with earth immediately to smother the fire.

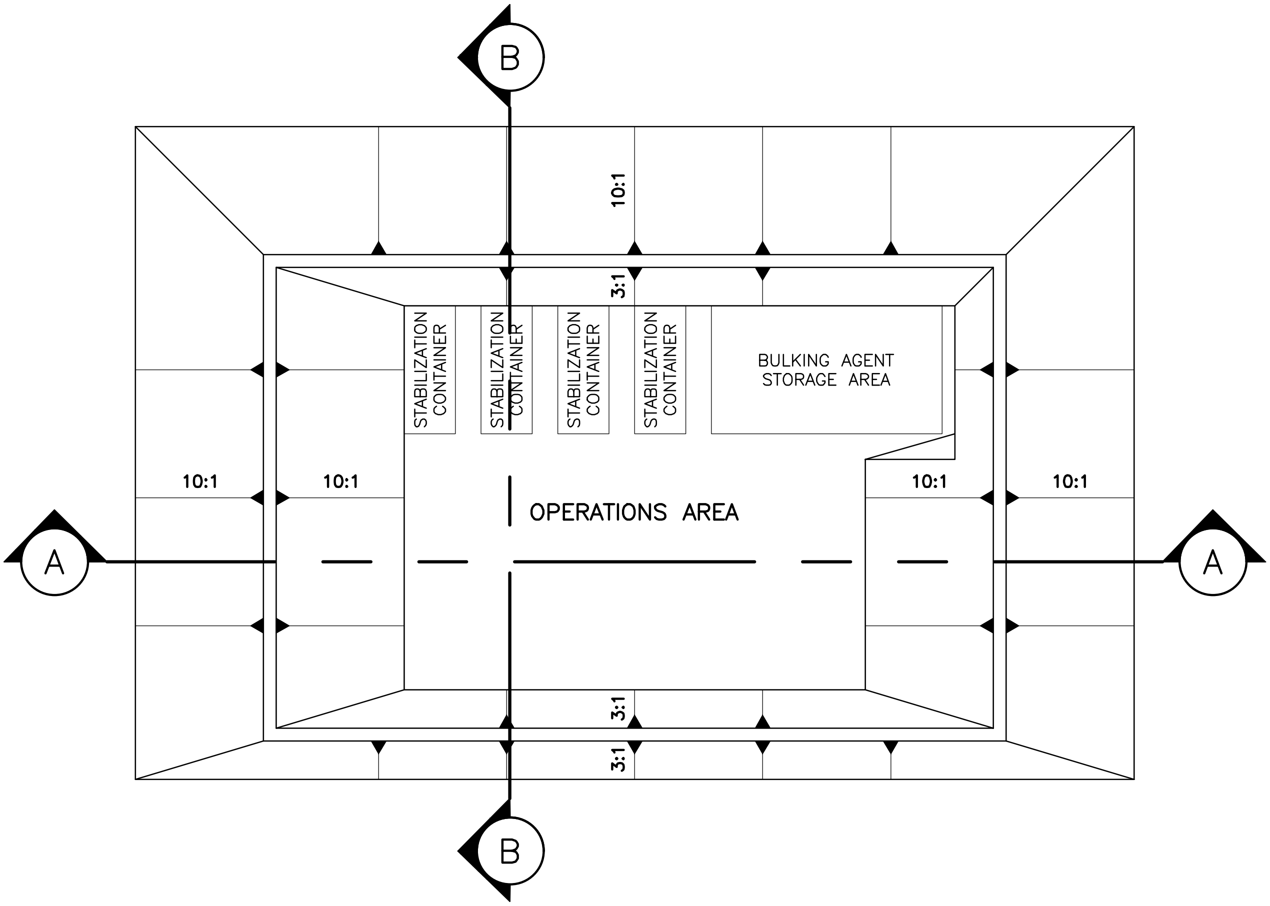
# CITY OF KINGSVILLE LANDFILL

# ATTACHMENT 5

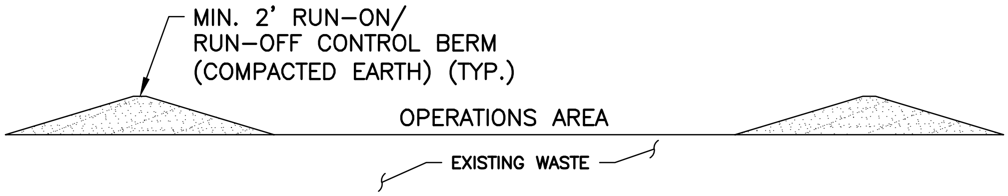
# FIGURE IV.5-1

# LIQUID WASTE SOLIDIFICATION AREA

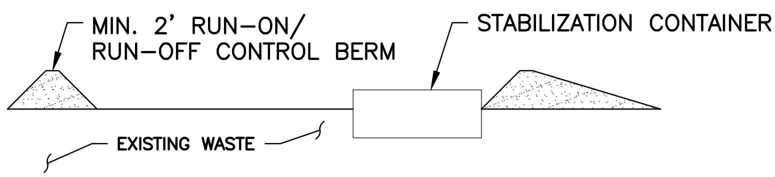
# LAYOUT PLAN




1 PLAN – LIQUID SOLIDIFICATION AREA LAYOUT
SCALE: 1"=30'




A SECTION – A–A
SCALE: H:1"=30'; V:1"=10'




B SECTION – B–B
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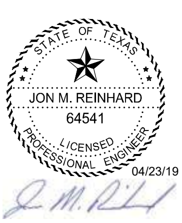


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TBPLS F-10038500
TBPG F-50556
TBAE F-BR 2458

PART IV, ATTACHMENT 5
LIQUID WASTE SOLIDIFICATION AREA LAYOUT PLAN
CITY OF KINGSVILLE LANDFILL
MSW PERMIT No.235-C
KINGSVILLE, TEXAS
KLEBERG COUNTY, TEXAS

| Drawn By: DT | Appr. By: JMR | Scale: AS SHOWN | Dwg. File: 8514-03-SolidificationLayoutPlan | FIGURE: |
|---|---|---|---|---|
| Checked By: JMR | Project No.: 16L0438 | Date: 04/23/2019 | Rev.: | IV.5-1 |

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THE CITY OF KINGSVILLE LANDFILL

TCEQ PERMIT MSW 235C

# PERMIT AMENDMENT APPLICATION

# TECH NOD #2 RESPONSE - APRIL 2019

## Volume 2 of 2

## REDLINE STRIKEOUT

CITY OF KINGSVILLE, KLEBERG COUNTY, TEXAS

For Permitting Purposes Only

STATE OF TEXAS
JON M. REINHARD
64541
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PROFESSIONAL ENGINEER
04/25/19

TBPE Firm No. F-417

Prepared by

TBPE F-417

HANSON PROJECT NO. 16L0438-0003

# THE CITY OF KINGSVILLE LANDFILL

# TCEQ PERMIT MSW 235C

## PERMIT AMENDMENT APPLICATION

## Volume 1 of 6

CITY OF KINGSVILLE, KLEBERG COUNTY, TEXAS

September 2018
Revision 1 – November 2018
Revision 2 – February 2019
Revision 3 – April 2019

Prepared by

HANSON
Engineering | Planning | Allied Services
TBPE F-417

HANSON PROJECT NO. 16L0438-0003

THE CITY OF KINGSVILLE LANDFILL

TCEQ PERMIT MSW 235C

# PERMIT AMENDMENT APPLICATION

CITY OF KINGSVILLE, KLEBERG COUNTY, TEXAS

September 2018

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Revision 3 - April 2019

Prepared by

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Engineering | Planning | Allied Services

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HANSON PROJECT NO. 16L0438- 0003

# VOLUME 1 of 6

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# Part II

## Part II Attachments



# Part III

## Part III Attachments



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## Part IV Attachments

# THE CITY OF KINGSVILLE LANDFILL

# TCEQ PERMIT MSW 235C

## PERMIT AMENDMENT APPLICATION

## Part I

CITY OF KINGSVILLE, KLEBERG COUNTY, TEXAS

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# ATTACHMENTS

**Facility Name: City of Kingsville Landfill**
**Permittee/Registrant Name: City of Kingsville**
**MSW Authorization #:235C**
**Initial Submittal Date: September/2018**
**Revision Date:** April/2019

## Texas Commission on Environmental Quality

# Part I Form for New Permit/Registration and Amendment Applications for an MSW Facility

### 1. Reason for Submittal

☐ Initial Submittal ☒ Notice of Deficiency (NOD) Response

### 2. Authorization Type

☒ Permit ☐ Registration

### 3. Application Type

☐ New ☒ Major Amendment ☐ Major Amendment (Limited Scope)

### 4. Application Fees

☐ Pay by Check ☒ Online Payment

If paid online, e-Pay Confirmation Number: **Trace Number: 582EA000315158, Voucher Number: 385823, Voucher Number: 385824**

### 5. Application URL

Is the application submitted for Type I Arid Exempt (AE) and/or Type IV AE facility?

☐ Yes ☒ No

If the answer is "No", provide the URL address of a publicly accessible internet web site where the application and all revisions to that application will be posted.
http://**www.cityofkingsville.com/departments/public-works/landfill/landfill-amendment-application/**

### 6. Application Publishing

Party Responsible for Publishing Notice:

☐ Applicant ☐ Agent in Service ☒ Consultant

Contact Name: **Scot Collins, P.G.** Title: **Project Manager**

## Signature Page

I, ________________________________, ________________________________,
(Site Operator (Permittee/Registrant)'s Authorized Signatory) (Title)

certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Signature: ________________________________ Date: __________

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TO BE COMPLETED BY THE OPERATOR IF THE APPLICATION IS SIGNED BY AN AUTHORIZED REPRESENTATIVE FOR THE OPERATOR

I, ____________________, hereby designate ________________________
(Print or Type Operator Name) (Print or Type Representative Name)

as my representative and hereby authorize said representative to sign any application, submit additional information as may be requested by the Commission; and/or appear for me at any hearing or before the Texas Commission on Environmental Quality in conjunction with this request for a Texas Water Code or Texas Solid Waste Disposal Act permit. I further understand that I am responsible for the contents of this application, for oral statements given by my authorized representative in support of the application, and for compliance with the terms and conditions of any permit which might be issued based upon this application.

___________________
Printed or Typed Name of Operator or Principal Executive Officer

___________________
Signature

- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

SUBSCRIBED AND SWORN to before me by the said_____________________

On this ______ day of ______, ______

My commission expires on the ______ day of ______, ______

____________________
Notary Public in and for

____________________ County, Texas
(Note: Application Must Bear Signature & Seal of Notary Public)

# CITY OF KINGSVILLE LANDFILL

# PART I

# ATTACHMENT 1

# SUPPLEMENTARY TECHNICAL REPORT

THE CITY OF KINGSVILLE LANDFILL

TCEQ PERMIT MSW 235C

# PERMIT AMENDMENT APPLICATION

## Part I

## Attachment 1
## Supplementary Technical Report

CITY OF KINGSVILLE, KLEBERG COUNTY, TEXAS

September 2018

Revision 1 – November 2018

Revision 2 - February 2019

Revision 3 - April 2019

Prepared by

HANSON

Engineering | Planning | Allied Services

TBPE F-417

HANSON PROJECT NO. 16L0438-0003

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## 1.4 Nature of Business and Solid Waste Data

The existing City of Kingsville Landfill serves residences and businesses in Kleberg County and portions of several surrounding counties, including Nueces, Jim Wells, Brooks and Kenedy. This service area is based on current economic conditions. As economic and available landfill disposal capacity change, the landfill may accept waste from areas other than those noted above.

Kingsville Landfill (current MSW Permit No. 235-B) receives approximately 100.46 tons of waste per day for disposal, six days a week (313 days), or 31,444 tons of waste per year for disposal. Types of waste accepted (currently~~ and under the new permit amendment~~) for disposal include residential and commercial municipal solid waste, including household wastes, brush, construction/demolition waste and special wastes as authorized by the TCEQ. Wastes currently not accepted at the landfill include hazardous wastes, prohibited wastes, radioactive wastes, industrial wastes, some special wastes including batteries and friable asbestos.

Kingsville Landfill (under the new permit amendment) will accept wastes from residential, municipal, commercial and industrial sources. Kingsville Landfill will accept the following types of waste for processing and/or disposal at the landfill:

- **Residential and commercial wastes typical of waste generated by residential and commercial businesses in the area (Municipal Solid Waste):**

  Municipal Solid Waste (MSW) is defined as: Any solid waste resulting from or incidental to municipal, community, commercial, institutional, and recreational activities, including garbage, rubbish, ashes, street cleanings, dead animals, abandoned automobiles, and all other solid waste other than industrial solid waste;

- **Construction and demolition waste:**

  The waste resulting from construction or demolition projects; includes all materials that are directly or indirectly the by-products of construction work or that result from demolition of buildings and other structures, including, but not limited to, paper, cartons, gypsum board, wood, excelsior, rubber, and plastics;

- **Whole and scrap tires for processing:**

  Whole and scrap tires are defined as any tire that can no longer be used for its original intended purpose;

- **Commercial grease and grit trap waste:**

  Grease and grit trap waste is defined as: material collected from a grease interceptor in the sanitary sewer service line of a commercial, institutional, or industrial food service or processing establishment, including the solids resulting from dewatering processes; and grit trap wastes from interceptors placed in the drains prior to entering the sewer system at maintenance and repair shops, automobile service stations, and washes, laundries, and other similar establishments;

- **Liquid wastes for solidification:**

  The liquid wastes accepted for solidification are characterized as/by untreated liquid wastes which typically do not pass the paint filter test including nonhazardous industrial waste and sludges, food and beverage byproducts and other nonhazardous liquids originated from food and beverage processing plants, and other commercial and industrial facilities;

- **Industrial non-hazardous waste:**

  Solid waste resulting from or incidental to any process of industry or manufacturing, mining or agricultural operations, classified as follows:

  - Class 2 Industrial Solid Waste - any individual solid waste or combination of industrial solid wastes that cannot be described as Class 1 or Class 3, as defined in 30 TAC §335.506 (relating to Class 2 waste determination);
  - Class 3 Industrial Solid Waste – any inert and essentially insoluble industrial solid waste, including materials such as rock, brick, glass, dirt, and certain plastics and rubber, etc., that are not readily decomposable as defined in 30 TAC §335.507 (relating to Class 3 waste determination);

- **and;**

- **Other special wastes:**

  Special waste is any solid waste or combination of solid wastes that because of its quantity, concentration, physical or chemical characteristics, or biological properties requires special handling and disposal to protect human health or the environment. Special wastes as defined in 30 TAC §330.3, 30 TAC §330.171, and 30 TAC §330.173 include the following:

  - Municipal hazardous waste from conditionally exempt small-quantity generators that may be exempt from full controls under Chapter 335, Subchapter N (relating to Household Materials Which Could Be Classified as Hazardous Wastes);
  - Class 1 industrial nonhazardous waste;
  - Untreated medical waste;
  - Municipal wastewater treatment plant sludges, other types of domestic sewage treatment plant sludges, and water-supply treatment plant sludges;
  - Septic tank pumpings;
  - Grease and grit trap wastes;
  - Wastes from commercial or industrial wastewater treatment plants; air pollution control facilities; and tanks, drums, or containers used for shipping or storing any material that has been listed as a hazardous constituent in 40 Code of Federal Regulations (CFR) Part 261, Appendix VIII but has not been listed as a commercial chemical product in 40 CFR §261.33(e) or (f);
  - Slaughterhouse wastes;

- Dead animals;
- Drugs, contaminated foods, or contaminated beverages, other than those contained in normal household waste;
- Pesticide (insecticide, herbicide, fungicide, or rodenticide) containers;
- Discarded materials containing asbestos;
- Incinerator ash;
- Soil contaminated by petroleum products, crude oils, or chemicals in concentrations of greater than 1,500 milligrams per kilogram total petroleum hydrocarbons; or contaminated by constituents of concern that exceed the concentrations listed in Table 1 of §335.521(a)(1);
- Used oil;
- Waste from oil, gas, and geothermal activities subject to regulation by the Railroad Commission of Texas when those wastes are to be processed, treated, or disposed of at a solid waste management facility;
- Waste generated outside the boundaries of Texas that contains:
  - any industrial waste;
  - any waste associated with oil, gas, and geothermal exploration, production, or development activities; or
  - any item listed as a special waste in this paragraph;
- Lead acid storage batteries;
- Used-oil filters from internal combustion engines;
- Regulated asbestos-containing material (RACM) as defined in 40 CFR Part 61;
- Nonregulated asbestos-containing material (non-RACM).

Industrial (non-hazardous) and special wastes are accepted and handled in accordance with Part IV – Site Operating Plan.

See Part II, Section 2 for a more detailed breakdown of the quantities, types and characteristics of wastes accepted at the facility.

The life expectancy of the existing permitted sectors is approximately 43 years. The expected rate of solid waste deposition is anticipated to increase at approximately one (1) percent per year (corresponding to the anticipated growth in population) according to information provided by the Texas State Data Center. Based on the anticipated annual growth rate, the expanded facility will last approximately 98 years. See Part II, Section 2.2 and Part III, Section 5.3 for a detailed analysis of the projected life of the expanded site.

The following table provides a summary of the current permitted conditions and proposed permit conditions.

***TABLE 2: PERMIT CONDITION SUMMARY***

| | **CURRENT CONDITIONS** | **PROPOSED CONDITIONS** |
|---|---|---|
| Permitted Area | 120 acres | 176.33 acres |
| Total Permitted Capacity | Type I - 4,993,000 cy<br>Type IV - 820,000 cy<br>5,813,000 cy | 17,994,286 cy |
| Total Remaining Capacity | 1,258,576 tons<br>3,043,714 cy | 6,295,538 tons<br>15,225,000 cy |
| Remaining Projected Site Life | 43 | 98 |
| Maximum Elevation of Final Cover (msl) | 125 | 200 |
| Elevation of Deepest Excavation (msl) | 42.5 | 22.5 |

# 2 FACILITY LOCATION §330.59(b)

## 2.1 Location Description

The City of Kingsville Landfill is located southeast of the City of Kingsville at the northeast corner of the intersection of Farm to Market Road 2619 and East County Road 2130. Kingsville Landfill is outside the City of Kingsville city limits which are approximately 1.45 miles from the northeast corner of the landfill boundary. It however falls within the City of Kingsville's extraterritorial jurisdiction.

## 2.1 Facility Name, Address and Telephone

| | |
|---|---|
| Name: | City of Kingsville Municipal Solid Waste Landfill |
| MSW Permit No: | 235-C |
| Physical Address: | 348 East C.R. 2130 |
| | Kingsville, TX 78363 |
| Mailing Address: | P.O Box 1458 |
| | Kingsville, TX 78364 |
| Telephone: | (361) 595-0092 |

## 2.2 Access Routes

The main local public roadways providing access to the facility are East County Road 2130 (E CR 2130), Farm to Market Road 2619 (FM 2619) and Farm to Market Road 1717 (FM 1717). The entrance to the City of Kingsville Landfill is via an existing 24-foot-wide roadway. Refer to Part II, Section 9 - Transportation for more detailed transportation information. Refer to Part I, Attachment 2, Figure I.2-2 - General Highway Map - Kleberg County for the location of the facility in relation to the surrounding roads.

## 2.3 Geographic Coordinates

The latitudinal and longitudinal geographic coordinates of the permanent site benchmark are:
Latitude: N 27° 26' 41.95"
Longitude: W 97° 48’ 55.89"
Elevation (above msl): 52.60 feet

# 3 MAPS §330.59(c)

## 3.1 General Location Map §330.59(c)(1)-(2)

The following maps collectively as a group, comply with the rule requirements of §330.59(c)(1)-(2) and §305.45. These general location maps are included in Part I, Attachment 2 - General Location Maps.

Figure I.2-1 – General Location Map
Figure I.2-2 – General Highway Map - Kleberg County (Texas Department of Transportation, General Highway Map for Kleberg County, Texas)
Figure I.2-4 – Aerial Photograph
Figure I.2-5 – Facility Layout

## 3.2 Topographic Map

Figure I.2-3 – General Topographic Map (USGS General Topographic Map for the Ricardo, Texas Quadrant)

## 3.3 Land ownership and Mineral Interests Map

A Land Ownership Map and Land Owners List are included in Part I, Attachment 3. The map and list reflect current property ownership within one-quarter (1/4) mile of the permit boundary and all mineral interest ownership under the facility, as derived from the real property appraisal records as listed on the date that this application was filed. Refer to Figure I.3-1 for location of the properties and Figure I.3-2 for property ownership list. The map and list meet the requirements of 30 TAC §330.59(c)(3), and §281.5. The property ownership list in electronic form is provided in Part I, Attachment 3, Appendix 1, per the requirements of 30 TAC §330.59(c)(3)(B).

Figure I.3-1 – Adjacent Land Ownership Map
Figure I.3-2 – Land Owners List

# 4 CHARACTER OF THE ADJACENT LAND §305.45(a)(6)

The following sections provide an overview of the various land use conditions of the surrounding area.

1) Wind Direction. The nearest reporting station is Corpus Christi, located to the northeast of the landfill site. A wind rose is included as part of Part I, Attachment 2, Figure I.2-1. The wind is predominantly from the southeast.

2) Water Wells. A well search was performed using the Texas Department of Licensing and Regulation's (TDLR) State of Texas Well Report Submission and Retrieval System, developed by the Texas Water Development Board in cooperation with the TDLR and the Texas Water Information Network. Based on this search, one well (Tracking Number 178262) is identified within 500 feet of the City of Kingsville Landfill site. During a site reconnaissance visit, this well was not confirmed to be located at the identified location (near the intersection of CR 2130 and CR 2619) and is believed to be plotted incorrectly based on available data, shown on Part II, Attachment 1, Figure II.1-4.

3) Existing Structures. The number of structures located within 500 feet of the landfill were determined through a visual reconnaissance and review of aerial photography. Approximately four (4) non-habitable structures are located within the 500-foot boundary of the City of Kingsville Landfill. These structures are associated with agricultural activities within the surrounding areas. Within the permitted boundary of the site, there is a scale house, an office building, and a maintenance shop, (see Part I, Attachment 2, Figure I.2-5and Part III, Attachment 1, Figures III.1-2and III.1-14).

4) Special Use areas. A visual reconnaissance and available records search revealed that other than the City of Kingsville Landfill, there are no active disposal facilities located within one mile of the landfill. Surrounding land uses include agriculture (crop land and pasture) with a few remote residences interspaced within the agricultural areas. There are no known licensed day care facilities, hospitals, cemeteries, ponds, or lakes within one mile of the permitted boundary of the landfill.

5) Area Streams. The nearest stream to the City of Kingsville Landfill is the Santa Gertrudis Creek. Santa Gertrudis Creek is located about 3,000 feet to the northeast of the northeast corner of the current site and about 2,000 feet to the northeast of the northeast corner of the proposed easterly expansion. No perennial or intermittent streams are located within 500 feet of the location of the proposed expansion.

6) Airports. The nearest airfield is the non-public-use Kingsville Naval Air Station (NAS-Kingsville) located northeast of the landfill. The north landfill boundary line is approximately 2.73 miles to the end of the nearest runway and falls within the 6 miles jurisdictional limit of the regulatory airport restrictions. NAS-Kingsville personnel have been notified of the proposed development and how it may impact their activities. The Kingsville Naval Air Station has provided notice that the airfield operations will not be adversely affected by the development. A detailed discussion on airports within the proximity of the landfill site can be found in Part II, Section 9.5. as well as correspondence with NAS-Kingsville and the FAA can be found in Part II, Section 9.5.

7) Easements. There is one (1) known aerial electrical line easement within the permitted boundary of the City of Kingsville Landfill.

8) Historic Sites. A review of the Texas Historical Commission's database for a one-mile radius and visual observations indicated that no historic sites are present. A detailed discussion on historic sites within one-mile of the landfill site can be found in Part II, Section 15 as well as applicable correspondence with the Texas Historical Commission can be found in See Part II, Attachment 7.

# 5 PROPERTY OWNER INFORMATION §330.59(d)

## 5.1 Legal Description

The legal description for the City of Kingsville Landfill property boundary and the Kleberg County Clerk's file number are included in Part I, Attachment 4, Appendix 1. The drawing of the property boundary metes and bounds is included in Part I, Attachment 4, Appendix 1.

The legal description for the City of Kingsville Landfill permit boundary and the Kleberg County Clerk's file number are included in Part I, Attachment 4, Appendix 2. The drawing of the permit boundary metes and bounds is included in Part I, Attachment 4, Appendix 2.

## 5.2 Ownership

Kingsville Landfill is owned and operated by the City of Kingsville (City). The facility services residences and businesses within Kleberg County and portions of several surrounding counties, including Nueces, Jim Wells, Brooks and Kenedy.

## 5.3 Property Owner Affidavit

The property owner affidavit for this permit amendment application found in Part I, Attachment 6 meets the requirements of §330.59(d)(2).

# 6 LEGAL AUTHORITY §330.59(e)

The legal authority and status of the applicant has been verified as required by §330.59(e) and §281.5 and is included in Part I, Attachment 5 – Verification of Legal Status. The City of Kingsville owns and operates the City of Kingsville Landfill. No other person or entity owns more than 20 percent of the facility.

# 7 EVIDENCE OF COMPETENCY §330.59(f)

Kingsville Landfill is owned and operated by the City of Kingsville (City). The landfill serves residences and businesses within Kleberg County and portions of surrounding Texas counties. The City has been providing waste disposal since the 1970's and has successfully operated the municipal landfill operation. The City owns and operates the City of Kingsville Citizens Collection Station MSW Registration # 120081, since June 2012. The City does not own and has not operated any other solid waste sites in the last 10 years, in Texas or any other state. It has, to this date, complied with all regulations and requirements set forth by the regulatory agency and most currently, Texas Commission on Environmental Quality (TCEQ). Evidence of Competency for the City of Kingsville Landfill is provided in Part I, Attachment 7.

# 8 APPOINTMENTS §330.59(g)

Part I, Attachment 9 provides documentation that the person signing the application meets the requirements of §305.44 of this title (relating to Signatories to Applications). Article V, Section 31 of the City of Kingsville Charter, establishes that the City Manager is the chief administrative and executive officer of the City. As the City's executive officer, the City Manager has the authority to sign this application and to delegate signatory responsibility related to the permit amendment application.

# 9 OTHER PERMITS AND AUTHORIZATIONS §305.45(a)(7)

Section 11 of the TCEQ Part I Form for New Permit/Registration and Amendment Applications for an MSW Facility (TCEQ-0650) contains the required information relating to additional permits or approvals. The City of Kingsville currently has Standard Air Operating Permit (#3337), Air New Source Registration (#91376), Air New Source Registration (#54070L001) and General Permit to Discharge Under The Texas Pollutant Discharge Elimination System (TPDES) under provisions of Section 402 of the Clean Water Act and Chapter 26 of the Texas Water Code (#TXR05L074).

# 10 APPLICATION FEES §330.59(h)

In accordance with §330.59(h), The City of Kingsville has made payment of $150.00. This fee was paid to TCEQ online via the TCEQ ePay online payment system, the receipt is provided in Part I, Attachment 10.

THE CITY OF KINGSVILLE LANDFILL

TCEQ PERMIT MSW 235C

# PERMIT AMENDMENT APPLICATION

# PART II

CITY OF KINGSVILLE, KLEBERG COUNTY, TEXAS

September 2018

Revision 1 – November 2018

Revision 2 - February 2019

Revision 3 - April 2019

Prepared by

TBPE F-417

HANSON PROJECT NO. 16L0438-0003

# CONTENTS

# LIST OF TABLES

# ATTACHMENTS



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# 1 EXISTING CONDITIONS SUMMARY §330.61(a)

The City of Kingsville currently operates the City of Kingsville Landfill, which is a Type I and Type IV municipal solid waste facility operating under TCEQ Permit No. 235-B. The landfill is scheduled to cease operation in 2061. The City intends to increase the site life and better utilize the available space at the landfill through the proposed expansion and design modifications.

## 1.1 General Facility Description

The City of Kingsville Landfill (Kingsville Landfill) is located in Kleberg County, Texas, at the northeast corner of the intersection of Farm to Market Road 2619 and County Road 2130. The northern boundary of the property is approximately 2,811 feet from FM 1717, while the eastern boundary is approximately 1,300 feet from N. County Road 1070 (See Part I, Attachment 2, Figure I.2-1 – General Location Map).

The Kingsville Landfill has been in existence since February 1977 and is intended to provide waste disposal for residences and businesses in Kleberg County and surrounding Texas counties. The nearest community is the City of Kingsville, whose city limits are approximately 1.45 miles from the northeast corner of the landfill boundary. The facility has undergone two permit amendments to date allowing it to extend its initial permit boundaries, and increase the permitted maximum elevation (Refer to Part I, Attachment 1, Section 1.2 – Permit History).

The existing Kingsville Landfill includes a scale house, an office building, and a maintenance shop, all enclosed within a perimeter fence. These facilities will continue to be operational for the life of the landfill. No new building or infrastructure improvements will be constructed as part of the proposed permit amendment.

The overall property consists of gently undulating grasslands with limited forest cover. The property generally slopes to the northeast with no major topographic features. The nearest 100-year floodplain is located to the northeast of the site along Santa Gertrudis Creek. There is one (1) known aerial electrical line easement within the permitted facility boundary. Surrounding land use is predominantly agricultural.

## 1.2 Purpose of the Permit Amendment Application

The City of Kingsville proposes to redesign the current City of Kingsville Landfill Permit 235-B, a Type I and Type IV Municipal Solid Waste Facility, in accordance with the Texas Administrative Code Chapter 330: Municipal Solid Waste Regulations. The redesign includes both a vertical and lateral expansion to increase the currently permitted disposal facility from 120-acres to 176.33-acres (121.3 acre waste disposal footprint), and the permitted maximum (final cover) elevation for the facility from 125-feet to 200-feet above MSL (the maximum waste elevation for the facility will be 196.92 feet-msl) as indicated in Part III, Attachment 1, Figure~~s III.1-4 and~~ III.7-1. The elevation of the deepest excavation will also be increased 20-feet to an elevation of 22.5 feet-msl

# 2 WASTE ACCEPTANCE PLAN §330.61(b)

## 2.1 Sources and Characteristics of Waste

The operational procedures and redesign described in the Permit Amendment Application, once approved, will allow the facility to accept, store, process and/or dispose of municipal solid waste, construction and/or demolition waste, whole and scrap tires, grease and grit trap waste, liquid waste, industrial waste non-hazardous Class 2 and Class 3 and some special wastes as defined by 30 TAC §330.3, 30 TAC §330.171, and 30 TAC §330.173.

The facility will accept for disposal the following special waste allowable under 30 TAC §330.171: special wastes from health care related facilities, dead animals and/or slaughterhouse waste, non-regulated asbestos-containing materials (non-RACM), empty containers which have been used for pesticides, herbicides, fungicides, or rodenticides, Municipal hazardous waste from a conditionally exempt small quantity generator (CESQG), sludge, grease trap waste, grit trap waste, soil contaminated by petroleum products, crude oils, or chemicals and liquid waste from oilfield activities. Procedures for accepting and processing all special waste are detailed in the Site Operating Plan (Part IV). In the event that the City of Kingsville Landfill elects to accept other special wastes in the future, TCEQ authorization will be sought and procedures for acceptance and processing will be provided. Other materials that will be received for processing and potentially beneficial reuse include scrap tires and unsorted mixed recyclables.

Consistent with 30 TAC §330.15, the City of Kingsville Landfill will not accept for disposal lead acid storage batteries, used motor vehicle oil, used oil filters, refrigerators, freezers, air conditioners or other items containing chlorinated fluorocarbons (CFC), regulated hazardous waste, polychlorinated biphenyls (PCB) waste, radioactive materials, or other wastes prohibited by TCEQ. Friable asbestos-containing materials, and empty containers, as well as industrial hazardous waste, and Non-hazardous Class 1~~, Class 2, and Class 3~~ industrial waste will not be accepted for disposal.

The Site Operating Plan in Part IV of the application contains a detailed description of the restrictions pertaining to waste acceptance procedures. The Applicant (City of Kingsville) reserves the right to reject any waste material, including those mentioned above, that contributes a constituent or characteristic that may impact or influence the design or operation of the facility.

## 2.2 Volume and Rate of Disposal

Kingsville Landfill received approximately 31,444 tons of incoming solid waste in 2017. The maximum annual waste acceptance rate is anticipated to increase at approximately one (1) percent per year which corresponds to the anticipated yearly population growth rate for Kleberg County (based on population projections from the Texas State Data Center).

# 9 TRANSPORTATION §330.61(i)

## 9.1 Selected Routes

Vehicles entering the City of Kingsville Landfill include semi-trailers, dump trucks and trailers, and light duty trucks. E County Road 2130 (CR E 2130), Farm to Market Road 1717 (FM 1717), and Farm to Market Road 2169 (FM 2169) will provide access to the site. These routes are asphalt paved and are the same routes currently in use for the City of Kingsville Landfill. The transportation network used to access the landfill is presented as Part II, Attachment 1. Figure II.1-1.

## 9.2 Adequacy of Roads

The privately owned site entrance road is currently a two-lane, 24-foot wide road maintained by the City of Kingsville to ensure access to the facility. The Texas Department of Transportation is responsible for maintaining FM 2169 and FM 1717 while E CR 2130 is maintained by Kleberg County. All roads are adequate for use by vehicles up to the legal maximum of 58,420 pounds, including solid waste collection vehicles entering and exiting the facility. Periodic maintenance of the roads is routinely undertaken by the City and TXDOT as necessary to maintain availability of these routes to the landfill and to ensure that residents and businesses along the routes have continued access. Correspondence with TXDOT regarding the adequacy of roads used to access the facility is included in Part II, Attachment 3. TXDOT responded to the NORI with a memo, dated April 16, 2019, stating that the facility is subject to the Highway Beautification Act requirements (43 TAC Chapter 21, Subchapter H). The April 16, 2019 memo is included with Part II, Attachment 3–B. Further communication with TXDOT is required to determine if the facility is subject to the Highway Beautification Act requirements or not. If it is determined that the facility is subject to the Highway Beautification Act requirements (43 TAC Chapter 21, Subchapter H), the facility will provide screening in accordance with those requirements and as approved by the TXDOT District Engineer for Kleberg County.

## 9.3 Existing Traffic Volumes

All landfill traffic access the facility via the single site entrance road from E County Road 2130 (E CR 2130) and Farm to Market Road 2619 (FM 2619) which is in-turn accessed via Farm to Market Road 1717 (FM 1717). TXDOT records show the Annual Average Daily Traffic (2016 AADT) is approximately 731 on FM 2619 at the nearest traffic count northwest of the landfill and 1,218 on FM 1717 at the traffic count northwest of the landfill (Refer to Part II, Attachment 1. Figure II.1-1. There are no available traffic counts for E CR 2130. Approximately 46 City, commercial, and citizen waste hauling vehicles per day use the City of Kingsville Landfill.

## 9.4 Projected Volume of Vehicular Traffic

The proposed vertical and lateral expansion will not have an impact on vehicular traffic in the area as the rate at which municipal solid waste is received by the facility will not be affected. The traffic volume projection is calculated at the expected annual population growth rate of approximately one (1) percent. Traffic volumes and calculations are presented in the Table 3.

# CITY OF KINGSVILLE LANDFILL

# PART II

# ATTACHMENT 3-B

RESPONSES FROM

TEXAS DEPARTMENT OF TRANSPORTATION (TxDOT)

# CITY OF KINGSVILLE LANDFILL

# PART II

# ATTACHMENT 3-C

# SUBMITTAL TO

# KLEBERG COUNTY (COUNTY)

THE CITY OF KINGSVILLE LANDFILL

TCEQ PERMIT MSW 235C

# PERMIT AMENDMENT APPLICATION

# PART III

# SITE DEVELOPMENT PLAN

CITY OF KINGSVILLE, KLEBERG COUNTY, TEXAS

September 2018

Revision 1 – November 2018

Revision 2 - February 2019

Revision 3 - April 2019

Prepared by

HANSON
Engineering | Planning | Allied Services
TBPE F-417

HANSON PROJECT NO. 16L0438-000

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### 3.2.2 Ventilation and Odor Control Measures

Potential odor sources associated with a landfill can vary considerably and may include the wastes being delivered to the landfill, waste in the open working face, landfill gas, the leachate collection system, or ponded water. Some wastes such as sludge and dead animals are a source of odor upon receipt, while other wastes have the potential for becoming a source of odor by their biodegradable nature. Leachate, liquid that has passed through or emerged from solid waste, may also be a source of odor if not properly handled in a timely manner.

Landfill operation at the site will occur in open areas within the permitted waste disposal footprint, therefore adequate ventilation will be provided. Landfill operators will ensure that odors are kept to a minimum by keeping the size of the working face area to a minimum, identifying any waste streams that require special attention to control odor, proper handling and disposal of leachate in a timely manner, and preventing ponded water. These and other odor control measures are discussed in detail in Part IV – Site Operating Plan.

The site will comply with all the applicable air quality rules and regulations. Accidental fires will be controlled, and open burning of waste will not be permitted.

### 3.2.3 Generalized Construction

Generalized construction details for the landfill are included in Part III, Attachments 1 through 3. Storage and Processing Area Plans, Figure III.1-16 in Part III, Attachment 1, provides details for the White Goods and Metal Recyclables Storage Area and the Tire Storage and Processing Area. Design and operation requirements for the Liquid Waste Solidification ~~Facility~~ Area are included in Part IV- SOP, Attachment 5. Construction details for the liquid waste solidification area are shown on Figure IV.5-1. Details of the leachate management system are included in Part III, Attachment 15. Construction details for the leachate storage tanks are shown on Part III, Attachment 15, Appendix G, Figure III.15-G-3.

## 3.3 Sanitation and Water Pollution Control §330.63(b)(3) – (4)

The white goods and metal recyclables storage area and the tire storage and processing area contains waste handling and storage operations but there is no process wastewater produced at these areas or other operations of the landfill. The areas will be built up with an all-weather surface that is graded and bermed to prevent surface water from running into the storage area. In addition to preventing surface water runon into the areas, the berms enclosing the areas will also serve to contain runoff. The areas will be graded to a stormwater collection sump that wil collect and hold runoff from within the area. If runoff is determined to be contaminated it will be collected and transported to the contaminated water evaporation pond or the contaminated water management area.

## 3.4 Endangered Species Protection §330.63(b)(5)

A literature review of threatened or endangered species in Kleberg County was conducted as discussed in Part II, Section 14. The review included both US Fish and Wildlife (USFWS) and Texas Parks and Wildlife Department documentation and their requirements for endangered species assessment and compliance. No potential habitat for federally listed threatened or endangered species or designated critical habitat occurs within the permit area, or the property. And no federally listed threatened or endangered species have been observed on the property. Neither the facility nor its operations will result in the destruction or adverse modification of the critical habitat of threatened or endangered species. If endangered species are encountered during site operations, USFWS and TPWD will be notified.

# 9 CLOSURE PLAN §330.63(h)

Part III, Attachment 12 - Final Closure Plan contains the details of the final cover design, which has been developed to comply with Subchapter K, §330.501 through 330.505 of the TCEQ regulations. A composite cover will be constructed over the entire landfill. The composite cover will overlay a 12-inch thick intermediate cover layer immediately above the top of waste. The composite cover will consist of, from bottom to top, a prepared soil subgrade, a geosynthetic clay liner (GCL), a 40-mil flexible membrane cover, a drainage geocomposite, and a 25-inch thick protective soil erosion layer. The Alternative Liner and Overliner Point of Compliance Demonstrations found in Part III, Attachment 5 includes a demonstration that the GCL material proposed in the final cover design is acceptable.

The initial and primary vegetative cover for the site will include appropriate native grasses. Typical types of grasses include Coastal Bermuda, Buffalo Grass, Texas Grama, Bluestem and Johnson Grass. Winter Rye and Fescue may be used in the cool seasons. The Kleberg County Extension Agent may also be consulted on the use of appropriate grasses and the appropriate planting seasons as cover projects are initiated. The maintenance of grass cover over completed areas is an essential component of erosion control in post closure care.

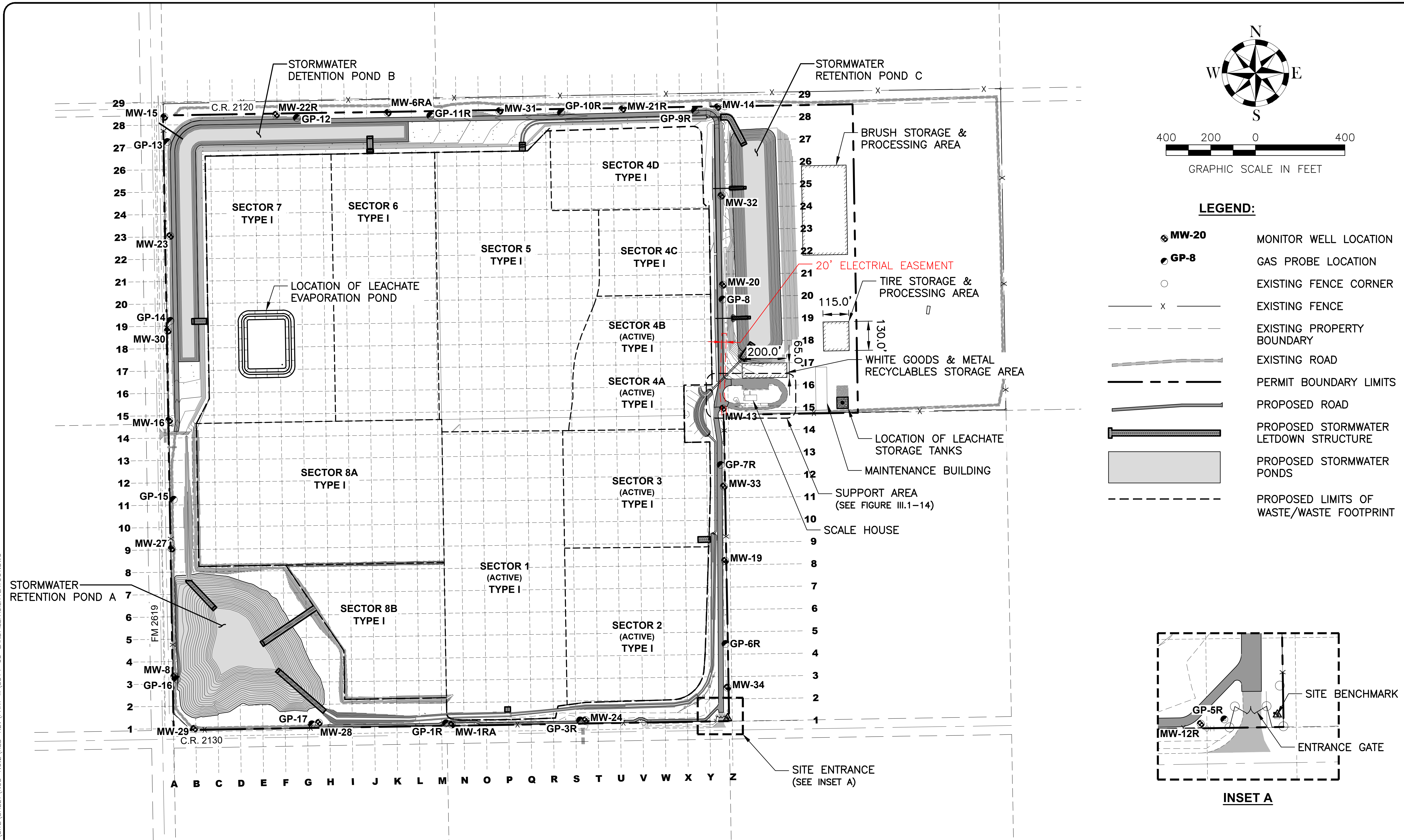
A demonstration that this specified final cover design will provide effective long term erosional stability is included in Part III, Attachment 6 - FSWDR.

# CITY OF KINGSVILLE LANDFILL

# PART III

# ATTACHMENT 1

SITE LAYOUT PLANS

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| NUMBER | REVISION | DATE | DRAWN | DESIGNED | REVIEWED |
|---|---|---|---|---|---|

STATE OF TEXAS
JON M. REINHARD
64541
LICENSED PROFESSIONAL ENGINEER
04/23/19

Hanson No. 16L0438
Filename
Scale AS SHOWN
Date 04/23/2019

| | | |
|---|---|---|
| LAYOUT | DT | 04/23/2019 |
| DRAWN | DT | 04/23/2019 |
| REVIEWED | JMR | 04/23/2019 |

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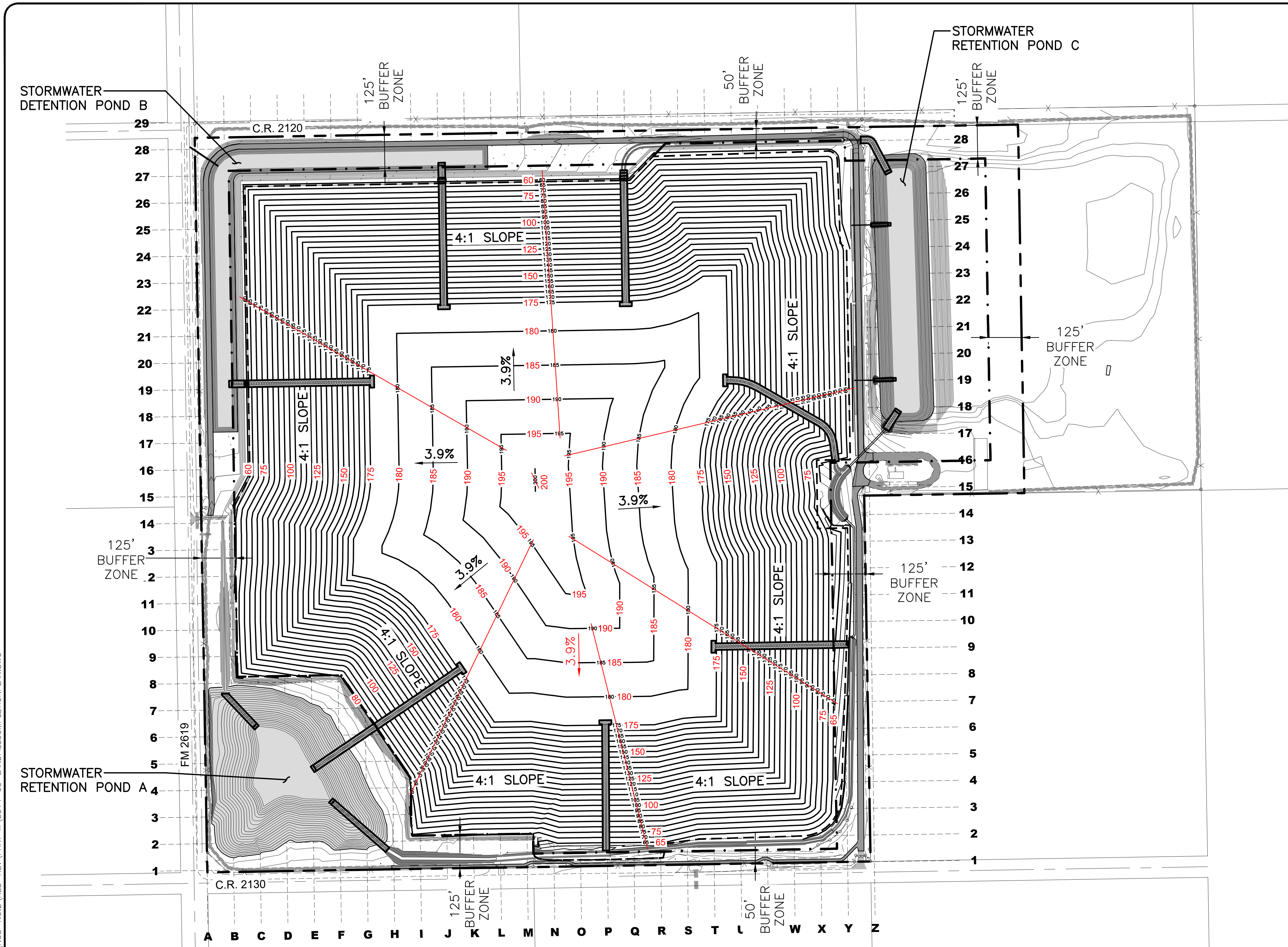
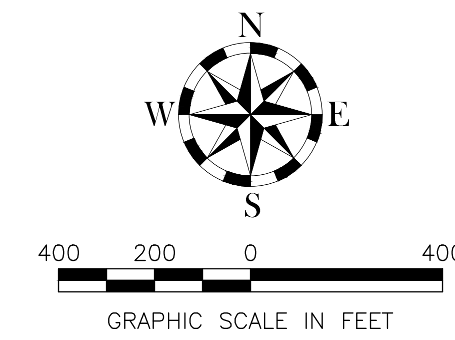
PART III, ATTACHMENT 1
FACILITY LAYOUT
CITY OF KINGSVILLE LANDFILL
MSW PERMIT No. 235-C
KINGSVILLE, TEXAS
KLEBERG COUNTY, TEXAS

FIGURE:
III.1-2




**LEGEND:**

| | |
|---|---|
| | EXISTING FENCE CORNER |
| | EXISTING FENCE |
| 65.00 | EXISTING CONTOUR |
| | EXISTING ROAD |
| | PERMIT BOUNDARY LIMITS |
| | BUFFER LIMITS |
| | PROPOSED LIMITS OF WASTE/WASTE FOOTPRINT |
| 200 | FINAL COVER CONTOURS (5' INTERVALS) |
| | PROPOSED ROAD |
| | PROPOSED STORMWATER LETDOWN STRUCTURE |
| | PROPOSED STORMWATER PONDS |

NOTE: MAXIMUM FINAL COVER ELEVATION IS 200 FT–MSL; MAXIMUM WASTE ELEVATION IS 196.92 FT–MSL.

| NUMBER | REVISION | DATE | DRAWN | DESIGNED | REVIEWED |
|---|---|---|---|---|---|
| | | | | | |

STATE OF TEXAS
JON M. REINHARD
64541
LICENSED PROFESSIONAL ENGINEER
04/23/19

Hanson No. 16L0438
Filename 8514-03-LANDFILLCOMPLETIONPLAN
Scale AS SHOWN
Date 04/23/2019

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| LAYOUT | DT | 04/23/2019 |
| DRAWN | DT | 04/23/2019 |
| REVIEWED | JMR | 04/23/2019 |

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PART III, ATTACHMENT 1
LANDFILL COMPLETION PLAN
CITY OF KINGSVILLE LANDFILL
MSW PERMIT No. 235-C
KINGSVILLE, TEXAS
KLEBERG COUNTY, TEXAS

FIGURE:
III.1-4

APR 22, 2019 3:27 PM TORRE01809
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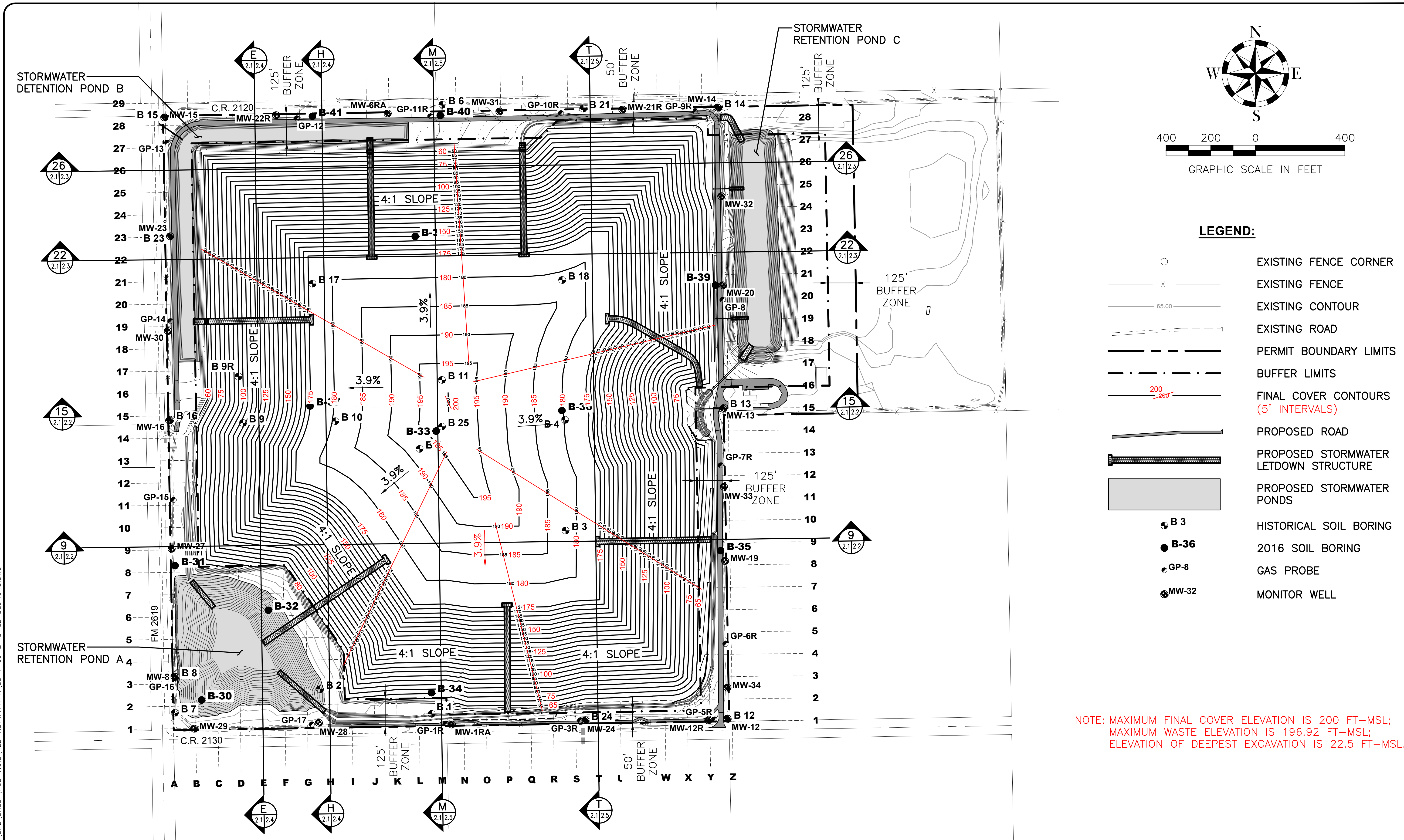
# CITY OF KINGSVILLE LANDFILL

# PART III

# ATTACHMENT 2

CROSS-SECTIONS




LEGEND:

| | |
|---|---|
| ○ | EXISTING FENCE CORNER |
| x | EXISTING FENCE |
| 65.00 | EXISTING CONTOUR |
| | EXISTING ROAD |
| | PERMIT BOUNDARY LIMITS |
| | BUFFER LIMITS |
| 200 | FINAL COVER CONTOURS (5' INTERVALS) |
| | PROPOSED ROAD |
| | PROPOSED STORMWATER LETDOWN STRUCTURE |
| | PROPOSED STORMWATER PONDS |
| B 3 | HISTORICAL SOIL BORING |
| B-36 | 2016 SOIL BORING |
| GP-8 | GAS PROBE |
| MW-32 | MONITOR WELL |

NOTE: MAXIMUM FINAL COVER ELEVATION IS 200 FT-MSL; MAXIMUM WASTE ELEVATION IS 196.92 FT-MSL; ELEVATION OF DEEPEST EXCAVATION IS 22.5 FT-MSL.

| NUMBER | REVISION | DATE | DRAWN | DESIGNED | REVIEWED |
|---|---|---|---|---|---|

STATE OF TEXAS
JON M. REINHARD
64541
LICENSED PROFESSIONAL ENGINEER
04/23/19

Hanson No. 16L0438
Filename
Scale AS SHOWN
Date 04/23/2019

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| REVIEWED | JMR | 04/23/2019 |

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PART III, ATTACHMENT 2
LANDFILL CROSS - SECTION LOCATION PLAN
CITY OF KINGSVILLE LANDFILL
PA. MSW 235-C
KINGSVILLE, TEXAS, KLEBERG COUNTY, TEXAS

FIGURE: III.2-1

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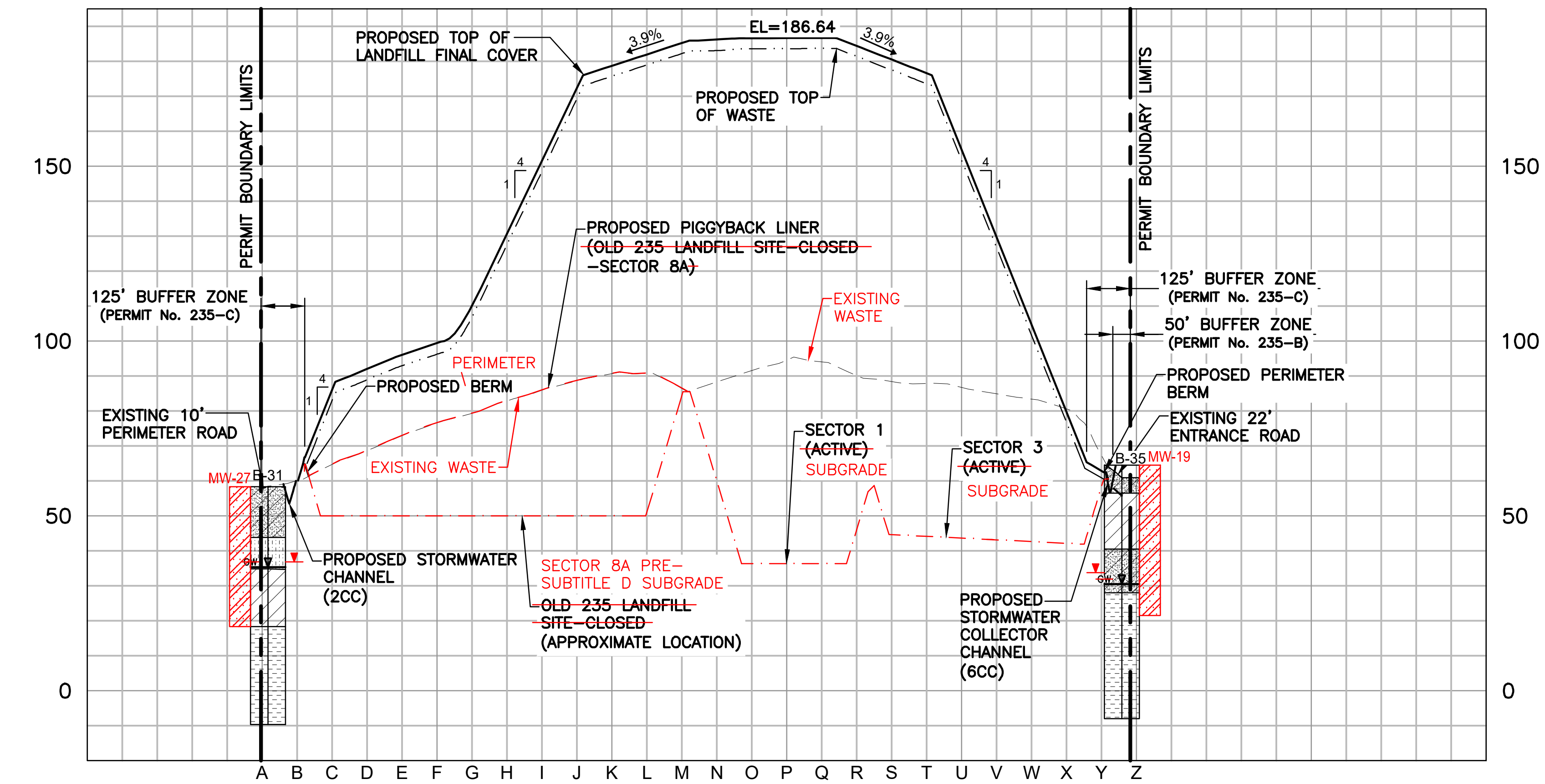


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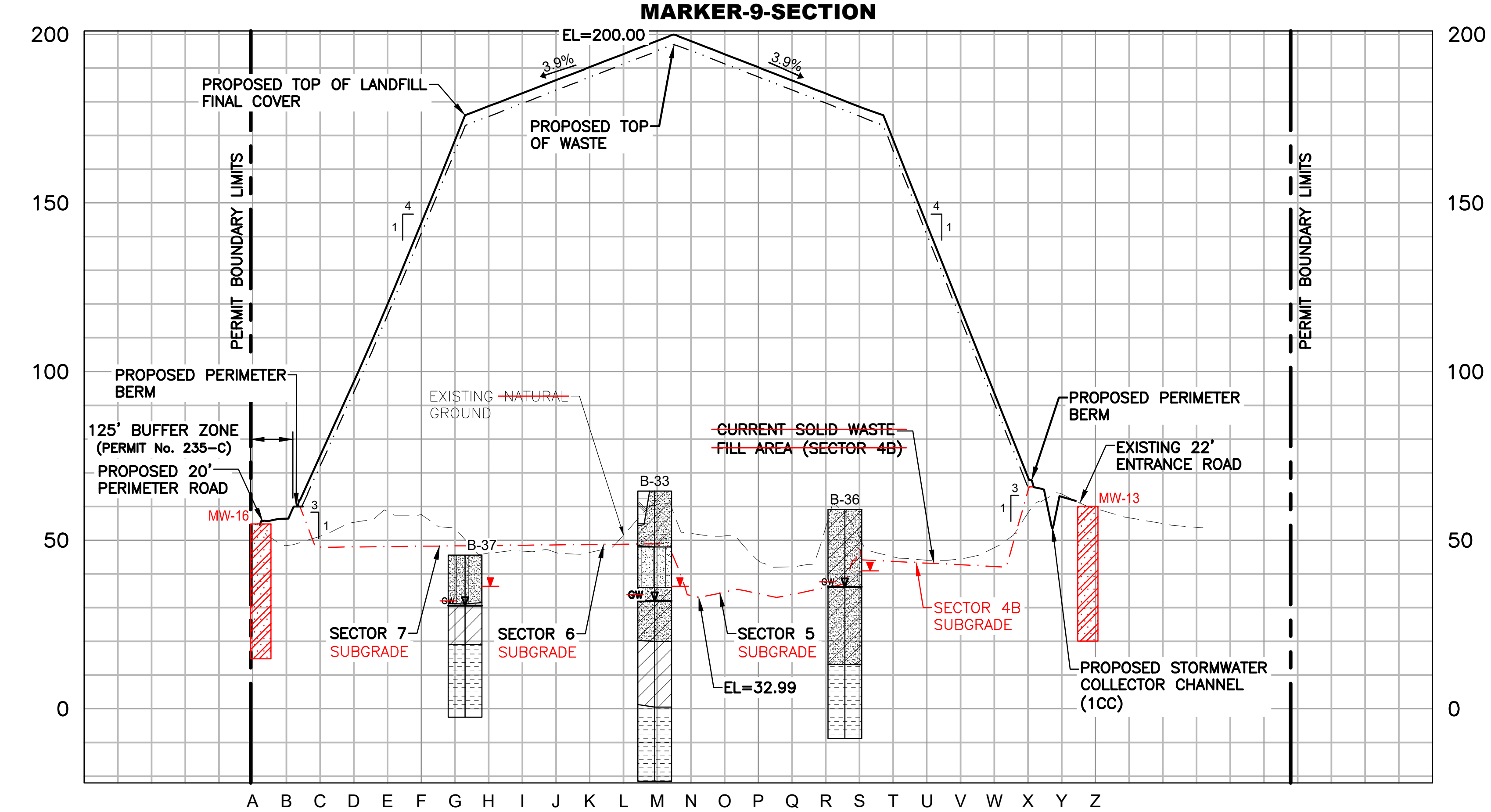


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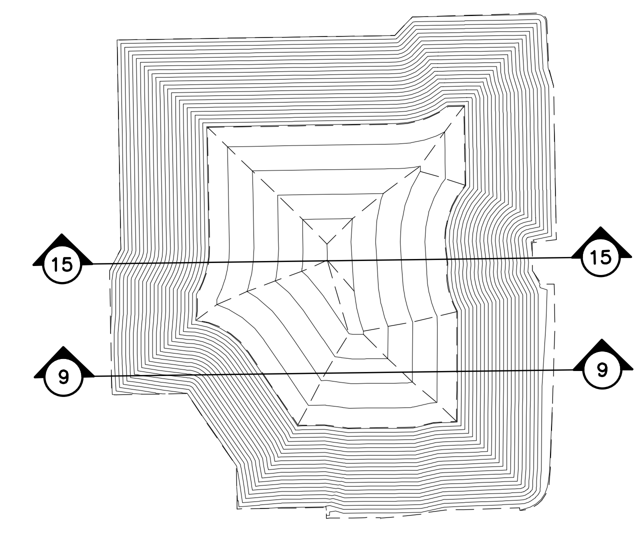



**KEY MAP**

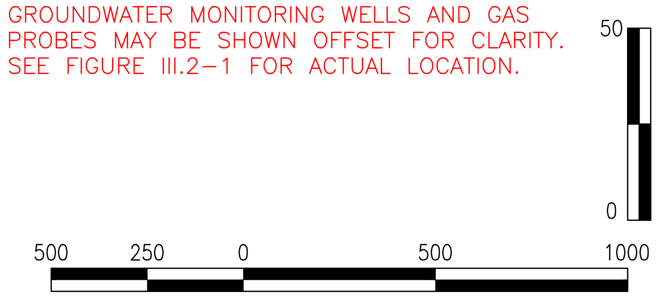
**LEGEND**

- LEAN CLAY, LEAN CLAY WITH SAND, SANDY LEAN SILTY CLAY (CL, CL–ML)
- CLAYEY SAND (SC)
- SILTY SAND, POORLY GRADED SAND WITH SILT (SM, SP–SM)
- FAT CLAY, SANDY FAT CLAY FAT CLAY WITH SAND (CH)
- POORLY GRADED SAND WITH CLAY (SP–SC)
- INITIAL ~~GROUND~~ WATER LEVEL ~~(GW)~~
- STATIC WATER LEVEL

- FINAL GRADE
- TOP OF WASTE
- EXISTING GRADE
- SUBGRADE
- PIGGYBACK LINER

NOTES:

1. THE ELEVATION OF THE DEEPEST EXCAVATION WITHIN THE FACILITY IS 22.5 FT–MSL LOCATED AT THE SUMPS IN SECTORS 4C, 5, 6, AND 7.
2. GROUNDWATER MONITORING WELLS AND GAS PROBES MAY BE SHOWN OFFSET FOR CLARITY. SEE FIGURE III.2–1 FOR ACTUAL LOCATION.




GRAPHIC SCALE IN FEET

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04/23/19

Hanson No. 16L0438
Filename
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Date 04/23/2019

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PART III, ATTACHMENT 2
LANDFILL CROSS - SECTIONS 9 & 15
CITY OF KINGSVILLE LANDFILL
MSW PERMIT No. 235-C
KINGSVILLE, TEXAS
KLEBERG COUNTY, TEXAS

FIGURE:
III.2-2

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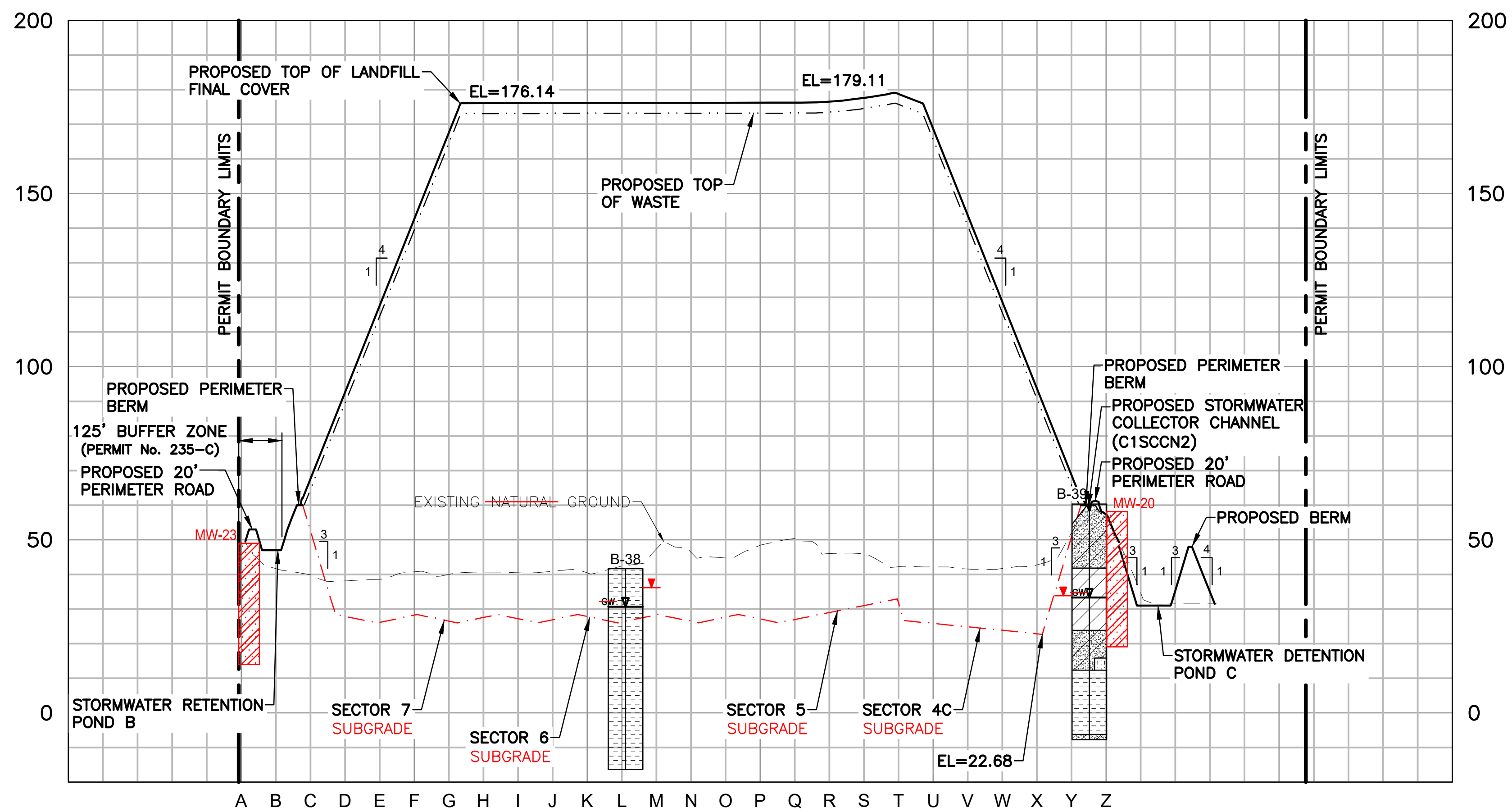


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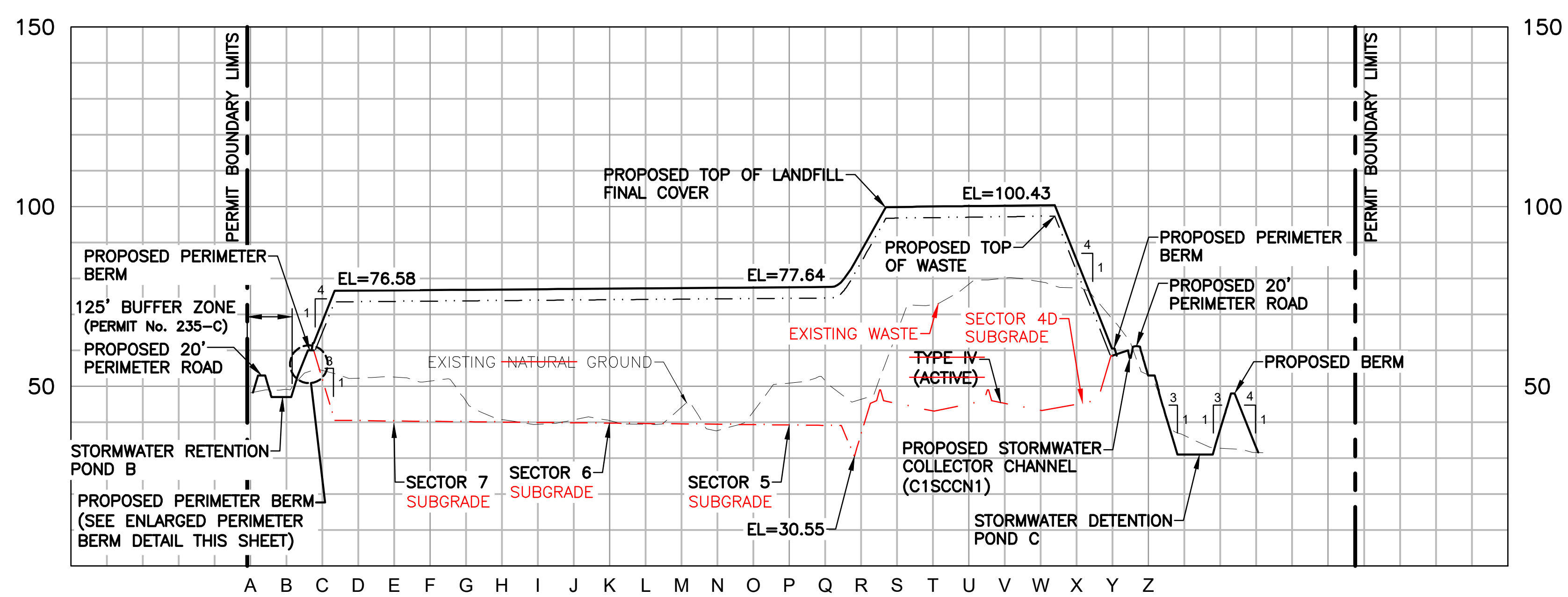
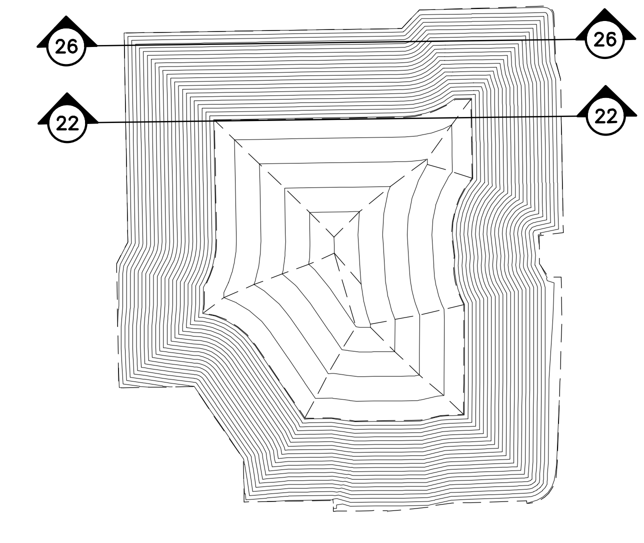



**MARKER-26-SECTION**




**KEY MAP**

## LEGEND

- LEAN CLAY, LEAN CLAY WITH SAND, SANDY LEAN SILTY CLAY (CL, CL–ML)
- CLAYEY SAND (SC)
- SILTY SAND, POORLY GRADED SAND WITH SILT (SM, SP–SM)
- FAT CLAY, SANDY FAT CLAY FAT CLAY WITH SAND (CH)
- POORLY GRADED SAND WITH CLAY (SP–SC)
- INITIAL ~~GROUND~~ WATER LEVEL ~~(GW)~~
- STATIC WATER LEVEL
- FINAL GRADE
- TOP OF WASTE
- EXISTING GRADE
- SUBGRADE
- PIGGYBACK LINER

NOTES:

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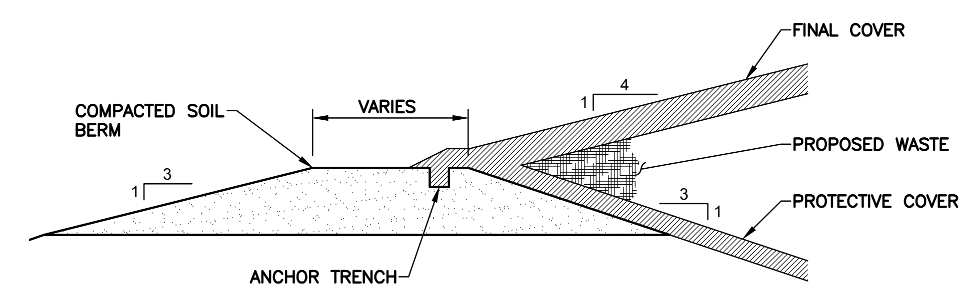
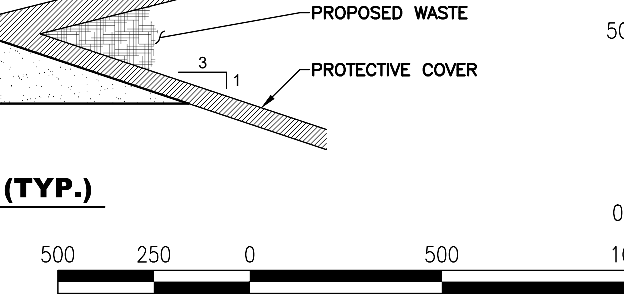
2. GROUNDWATER MONITORING WELLS AND GAS PROBES MAY BE SHOWN OFFSET FOR CLARITY. SEE FIGURE III.2–1 FOR ACTUAL LOCATION.




**PERIMETER BERM - DETAIL (TYP.)**

SCALE: 1" = 20'

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STATE OF TEXAS
JON M. REINHARD
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04/23/19

Hanson No. 16L0438
Filename
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Date 04/23/2019

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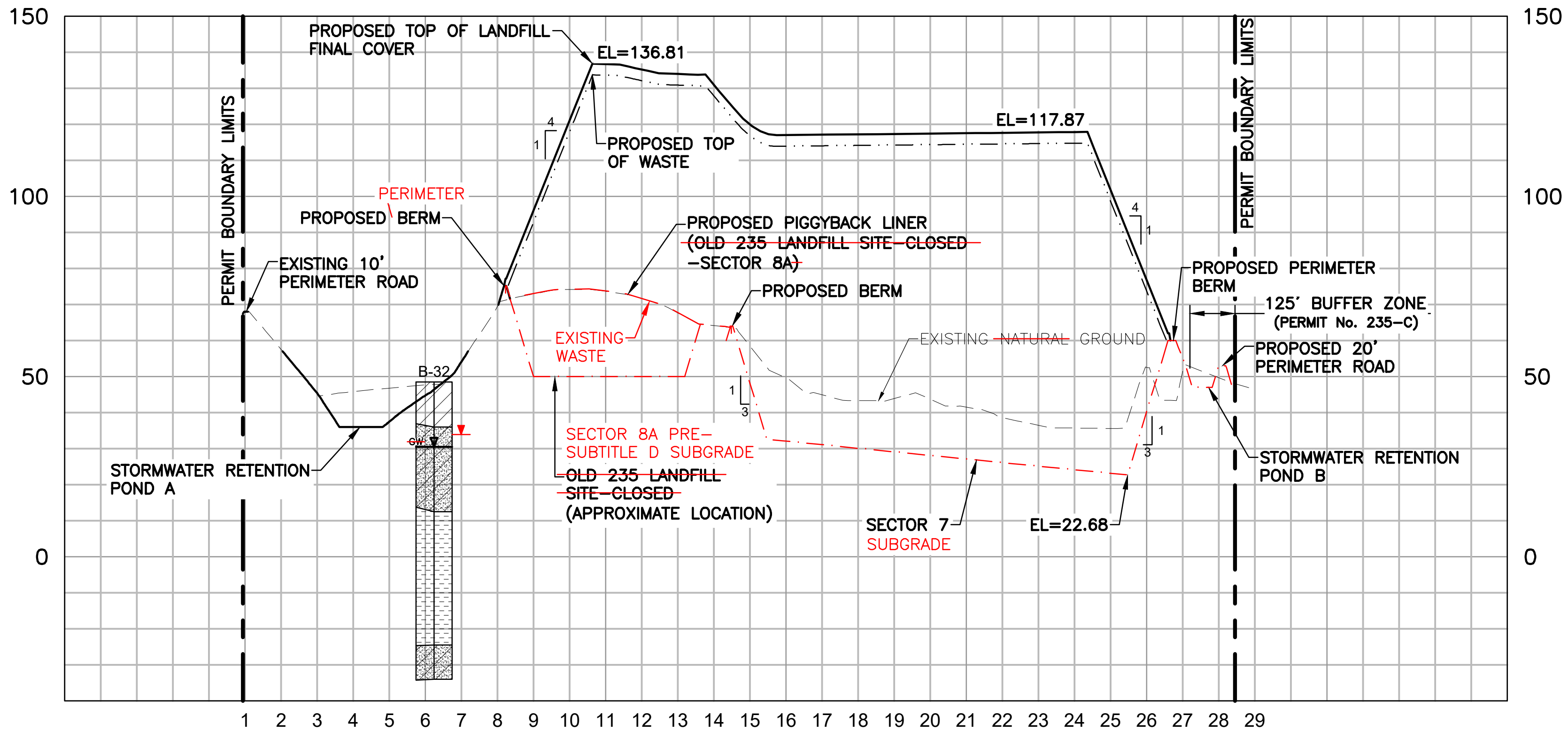
PART III, ATTACHMENT 2
LANDFILL CROSS - SECTIONS 22 & 26
CITY OF KINGSVILLE LANDFILL
MSW PERMIT No. 235-C
KINGSVILLE, TEXAS
KLEBERG COUNTY, TEXAS

FIGURE:
III.2-3

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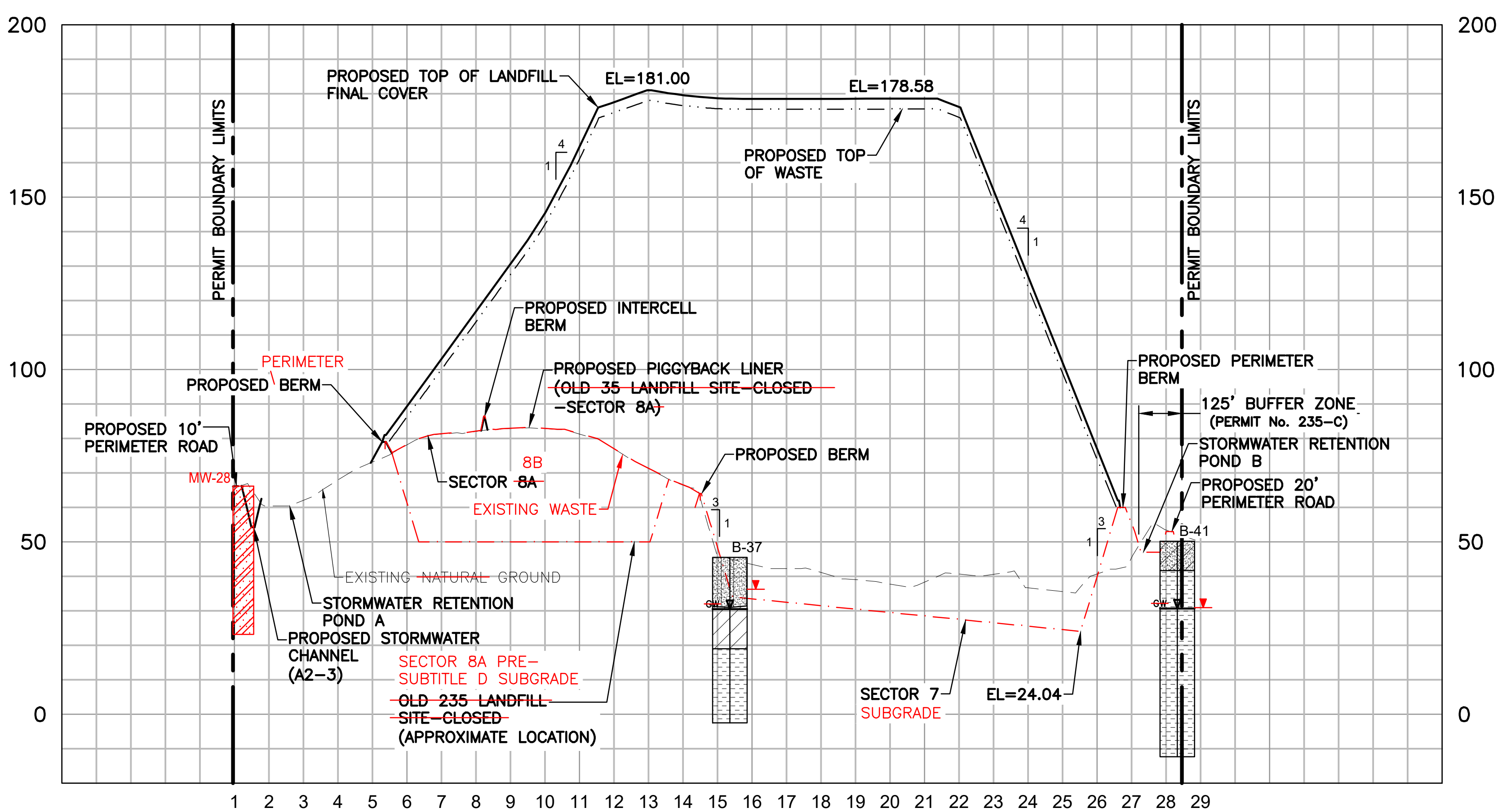


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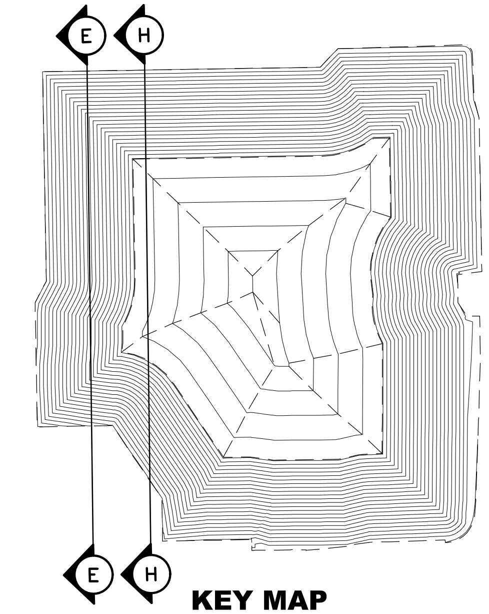


**KEY MAP**

**LEGEND**

LEAN CLAY, LEAN CLAY WITH SAND, SANDY LEAN SILTY CLAY (CL, CL-ML)

CLAYEY SAND (SC)

SILTY SAND, POORLY GRADED SAND WITH SILT (SM, SP-SM)

FAT CLAY, SANDY FAT CLAY FAT CLAY WITH SAND (CH)

POORLY GRADED SAND WITH CLAY (SP-SC)

INITIAL ~~GROUND~~ WATER LEVEL ~~(GW)~~

STATIC WATER LEVEL

FINAL GRADE

TOP OF WASTE

EXISTING GRADE

SUBGRADE

PIGGYBACK LINER

NOTES:

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2. GROUNDWATER MONITORING WELLS AND GAS PROBES MAY BE SHOWN OFFSET FOR CLARITY. SEE FIGURE III.2-1 FOR ACTUAL LOCATION.

50 0

500 250 0 500 1000

GRAPHIC SCALE IN FEET

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LICENSED PROFESSIONAL ENGINEER
04/23/19

Hanson No. 16L0438
Filename
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Date 04/23/2019

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PART III, ATTACHMENT 2
LANDFILL CROSS - SECTIONS E & H
CITY OF KINGSVILLE LANDFILL
MSW PERMIT No. 235-C
KINGSVILLE, TEXAS
KLEBERG COUNTY, TEXAS

FIGURE:
III.2-4

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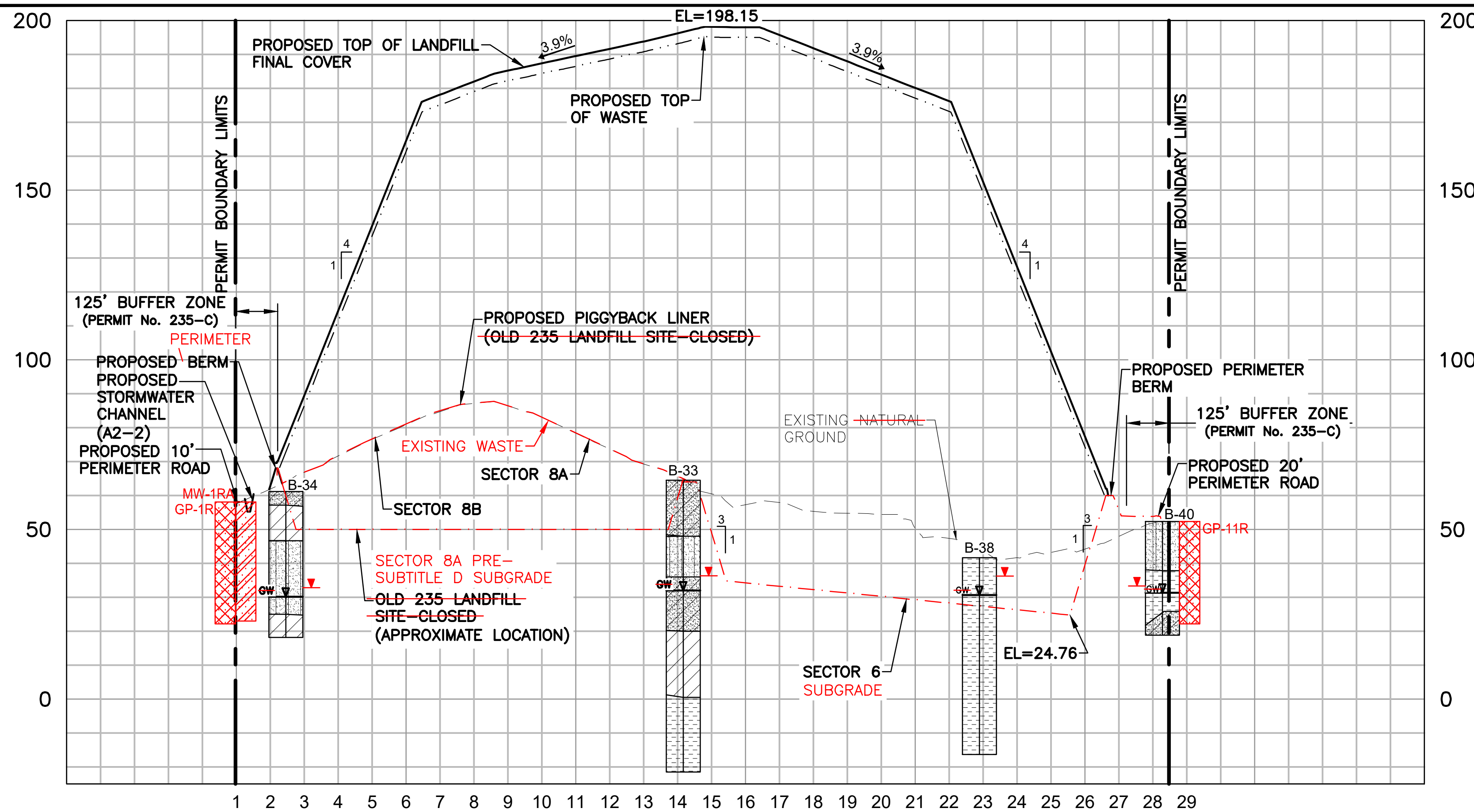


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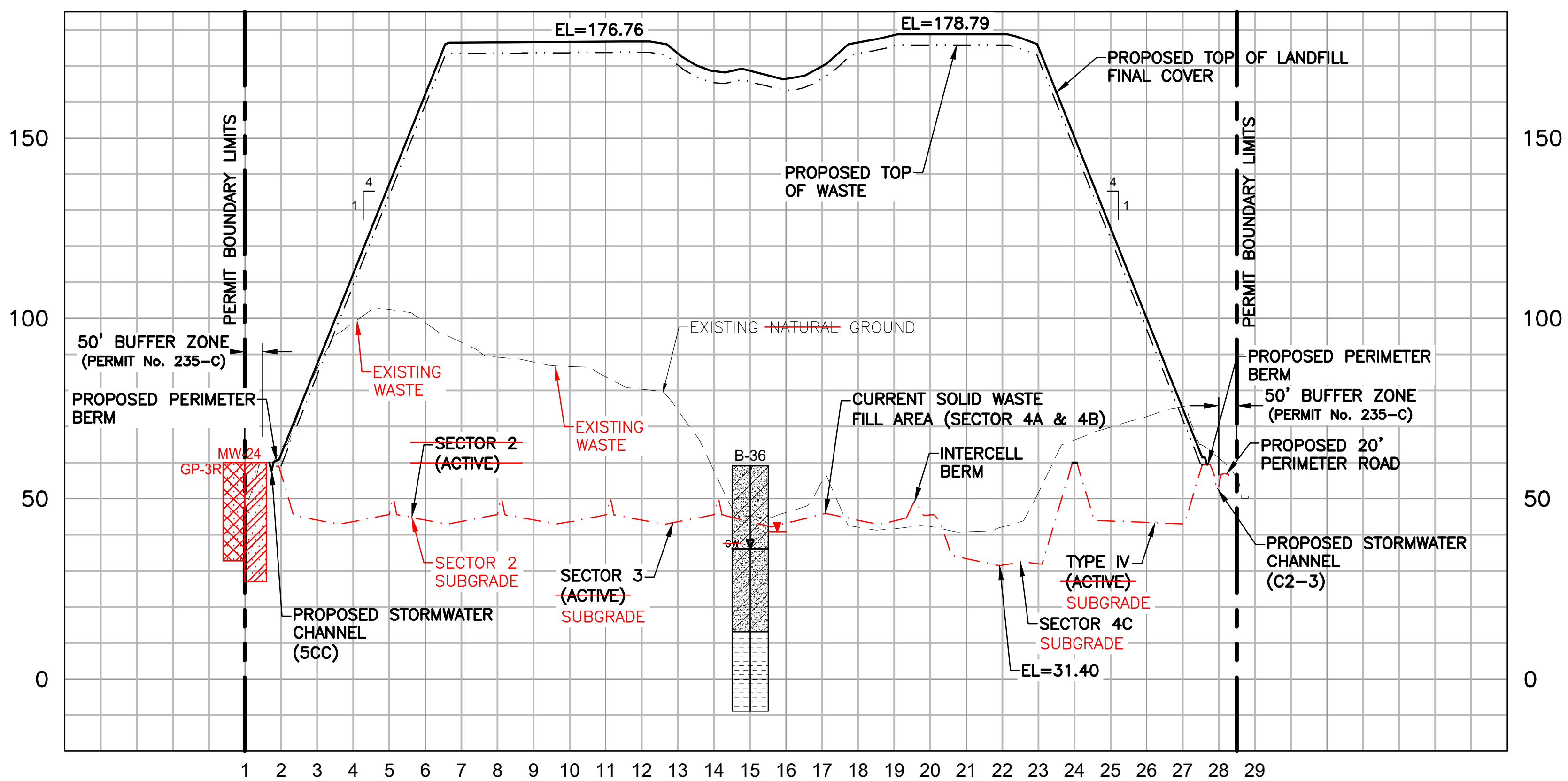


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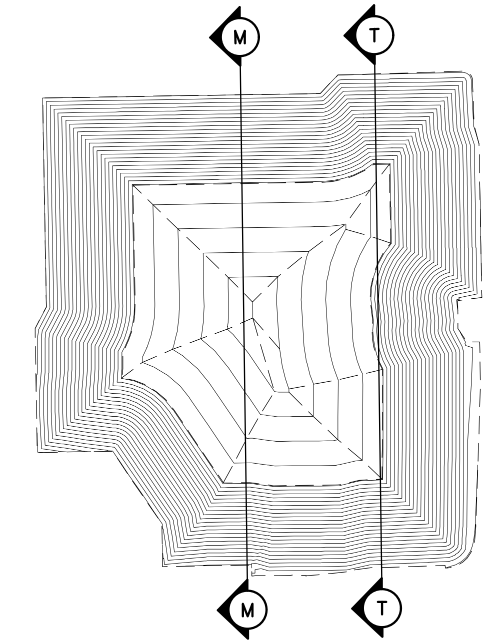



**KEY MAP**

**LEGEND**

LEAN CLAY, LEAN CLAY WITH SAND, SANDY LEAN SILTY CLAY (CL, CL-ML)

CLAYEY SAND (SC)

SILTY SAND, POORLY GRADED SAND WITH SILT (SM, SP-SM)

FAT CLAY, SANDY FAT CLAY FAT CLAY WITH SAND (CH)

POORLY GRADED SAND WITH CLAY (SP-SC)

INITIAL ~~GROUND~~ WATER LEVEL ~~(GW)~~

STATIC WATER LEVEL

FINAL GRADE

TOP OF WASTE

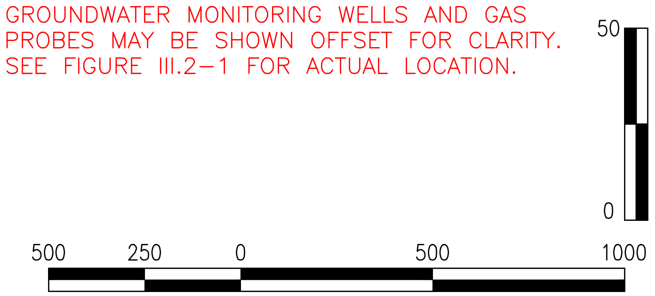
EXISTING GRADE

SUBGRADE

PIGGYBACK LINER

NOTES:

1. THE ELEVATION OF THE DEEPEST EXCAVATION WITHIN THE FACILITY IS 22.5 FT-MSL LOCATED AT THE SUMPS IN SECTORS 4C, 5, 6, AND 7.
2. GROUNDWATER MONITORING WELLS AND GAS PROBES MAY BE SHOWN OFFSET FOR CLARITY. SEE FIGURE III.2-1 FOR ACTUAL LOCATION.




GRAPHIC SCALE IN FEET

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LICENSED PROFESSIONAL ENGINEER
04/23/19

Hanson No. 16L0438
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PART III, ATTACHMENT 2
LANDFILL CROSS - SECTIONS M & T
CITY OF KINGSVILLE LANDFILL
MSW PERMIT No. 235-C
KINGSVILLE, TEXAS
KLEBERG COUNTY, TEXAS

FIGURE:
III.2-5

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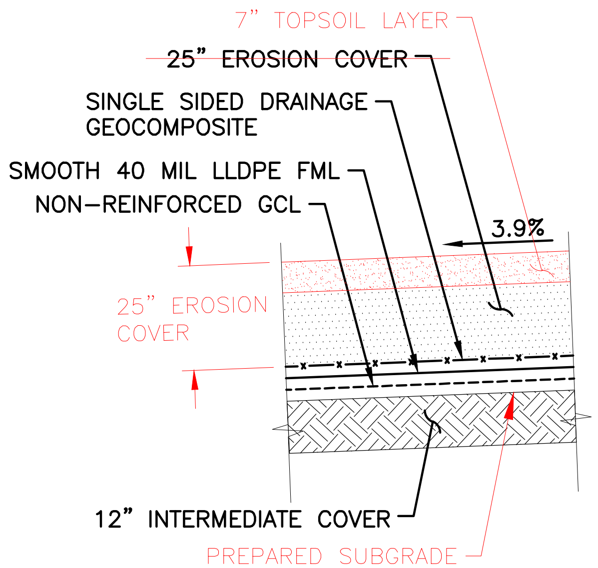
# CITY OF KINGSVILLE LANDFILL

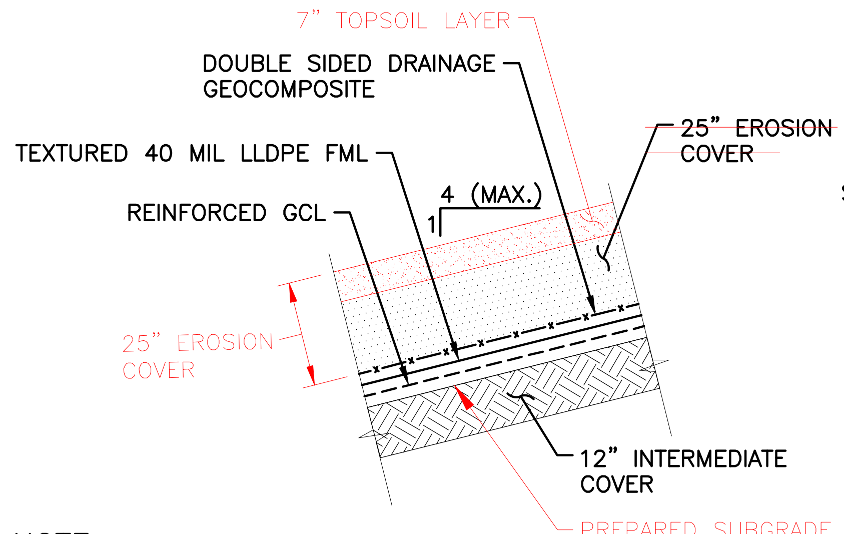
## PART III

## ATTACHMENT 3

WASTE MANAGEMENT UNIT DESIGN DRAWINGS




TOP SLOPE FINAL COVER



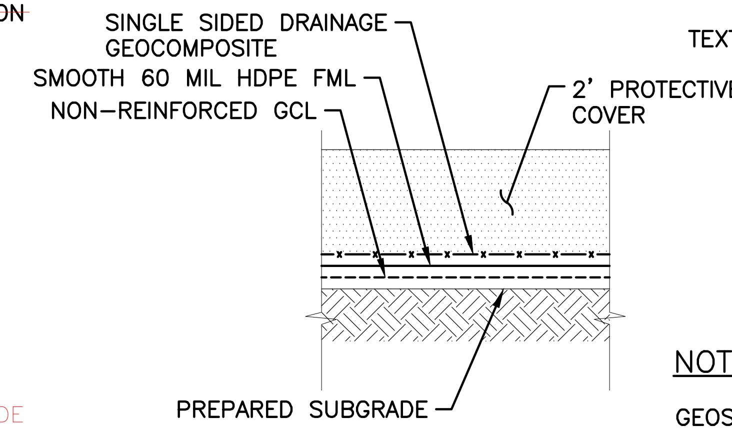

NOTE:

GEOSYNTHETIC COMPONENT THICKNESSES HAVE BEEN ENLARGED FOR CLARITY

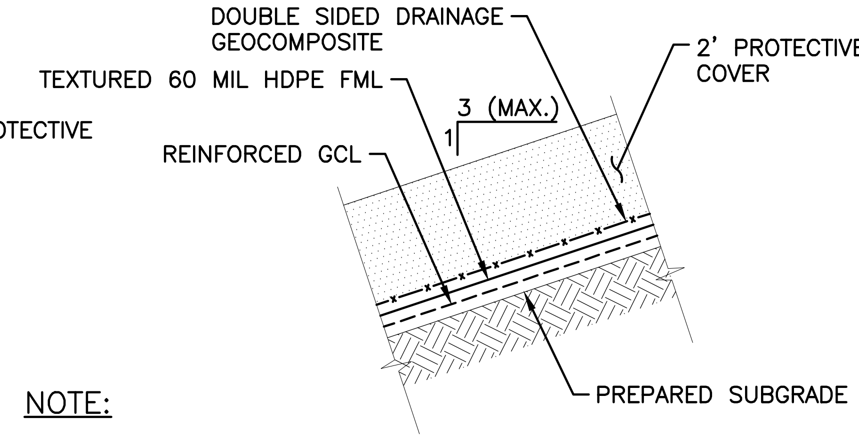
SIDE SLOPE FINAL COVER

8 | 1 | 1 FINAL COVER LINING DETAIL

SCALE: N.T.S.




LANDFILL BOTTOM LINING



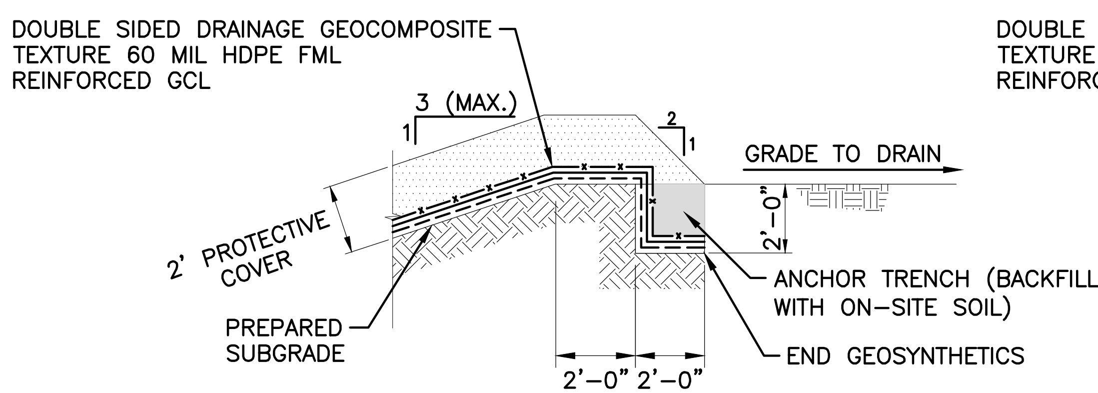

NOTE:

GEOSYNTHETIC COMPONENT THICKNESSES HAVE BEEN ENLARGED FOR CLARITY

LANDFILL SIDE SLOPE LINING

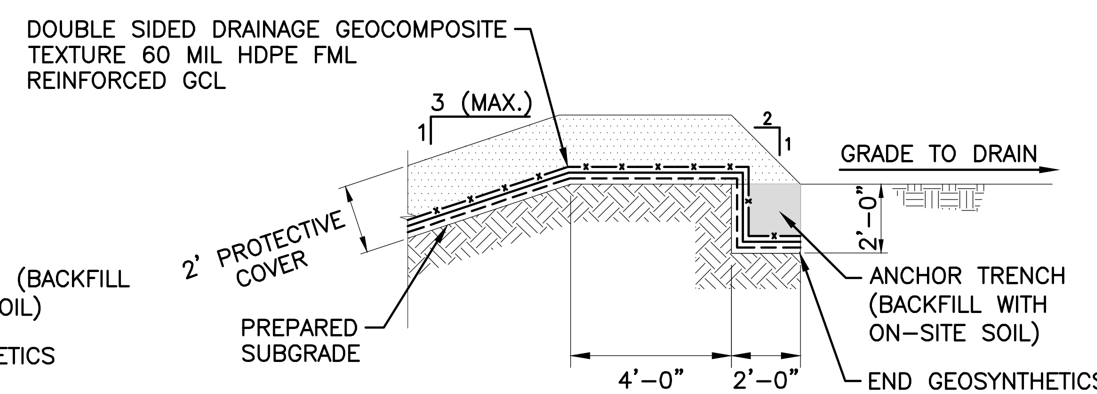
9 | 1 | 1 LANDFILL LINING DETAILS

SCALE: N.T.S.



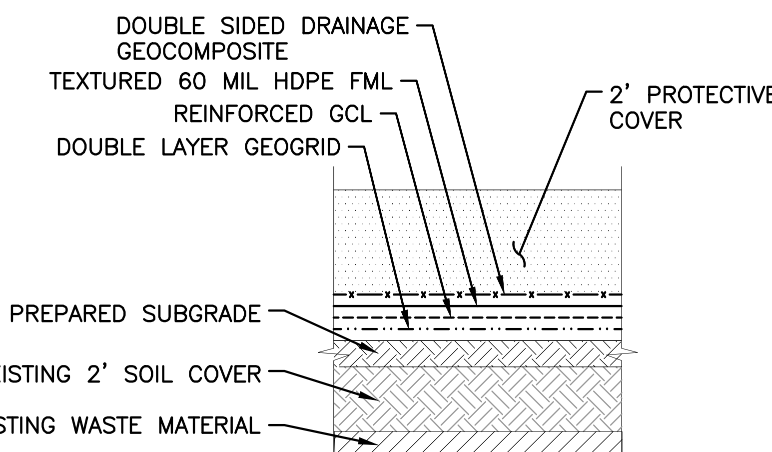

10 | 1 | 1 ANCHOR TRENCH

SCALE: N.T.S.




11 | 1 | 1 ANCHOR TRENCH

SCALE: N.T.S.




NOTE:

GEOSYNTHETIC COMPONENT THICKNESSES HAVE BEEN ENLARGED FOR CLARITY

12 | 1 | 1 PIGGY BACK LINER DETAIL

SCALE: N.T.S.

NOTE:

1. ALL LINER SYSTEMS DEPICTED ARE ALTERNATIVE LINER SYSTEMS. ALTERNATIVE LINER DEMONSTRATIONS CAN BE FOUND IN PART III, ATTACHMENT 5.

| NUMBER | REVISION | DATE | DRAWN | DESIGNED | REVIEWED |
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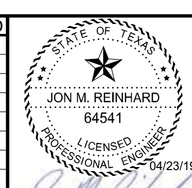


Hanson No. 16L0438
Filename 8514-03-FLOODPLAIN-MAP
Scale AS SHOWN
Date 04/23/2019

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| REVIEWED | JMR | 04/23/2019 |

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PART III, ATTACHMENT 3
LINER DETAILS
CITY OF KINGSVILLE LANDFILL
MSW PERMIT No. 235-C
KINGSVILLE, TEXAS
KLEBERG COUNTY, TEXAS

FIGURE:
III.3-1

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# THE CITY OF KINGSVILLE LANDFILL
# TCEQ PERMIT MSW 235C

## PERMIT AMENDMENT APPLICATION
## Volume 2 of 6

CITY OF KINGSVILLE, KLEBERG COUNTY, TEXAS

September 2018
Revision 1 – November 2018
Revision 2 – February 2019
Revision 3 – April 2019

Prepared by

HANSON
Engineering | Planning | Allied Services
TBPE F-417

HANSON PROJECT NO. 16L0438-0003

# CITY OF KINGSVILLE LANDFILL

## PART III

## ATTACHMENT 4

GEOLOGY REPORT

THE CITY OF KINGSVILLE LANDFILL
TCEQ PERMIT MSW 235C

# PERMIT AMENDMENT APPLICATION
# PART III, ATTACHMENT 4
# GEOLOGY REPORT

CITY OF KINGSVILLE, KLEBERG COUNTY, TEXAS

September 2018
Revision 1 – November 2018
Revision 2 – –February 2019
Revision 3 – April 2019

Prepared by

HANSON
Engineering | Planning | Allied Services
TBPE F-417

HANSON PROJECT NO. 16L0438-0003

# Contents

# APPENDICES

**APPENDIX 1** – FEE GEOLOGY REPORT DATED MAY 29, 1998 AND JUNE 29, 1998, AND REVISED SEPTEMBER 30, 1998, WITH APPENDICES FEE GROUNDWATER CHARACTERIZATION REPORT DATED NOVEMBER 1997, REVISED JUNE 1998 AND SEPTEMBER 1998, WITH APPENDICES

**Appendix 1 Contents**

**Finch Energy and Environmental Services, Inc.**
**Geology Report**

**Appendices**

**Finch Energy and Environmental Services, Inc.**

**Groundwater Characterization Report**



**TABLES**



**FIGURES**

**APPENDICES**



**APPENDIX 2** – TOLUNAY-WONG ENGINEERS, INC. GEOTECHNICAL ENGINEERING STUDY

**Appendix 2 Contents**

**TABLES**



**APPENDICES**



**APPENDIX 3** – HANSON PROFESSIONAL SERVICES, INC. SOIL BORING REPORT

**Appendix 3 Contents**



**EXHIBITS**

# ATTACHMENTS



# LIST OF TABLES



*I:\16jobs\16L0438\8514-City of Kingsville\8514-03\Permit Amendment\NODs\Technical NOD #1\Part III\Part III, Attachment 4\Part III_att4 - Geology Report - R2 Cln.docx*

# 1.0 INTRODUCTION

## 1.1 Project Information

The City of Kingsville Landfill is located approximately 1.45 miles southeast of the City of Kingsville city limits, at the northeast corner of the intersection of Farm to Market Road 2619 and East County Road 2130 as shown on Attachment 1- Location Map (Figure III.4-1-1). The initial facility was permitted by the State of Texas in 1977 (Permit No. 235), and initial filling operations began in February 1977. The original 40 acre landfill is currently closed and is not Subtitle D compliant. The City of Kingsville was authorized a permit amendment for a 40-acre lateral landfill expansion of the site in 1986 (Permit No. 235-A). The approved Permit No. 235-A was developed and Sector 1 received its first load of waste material in March 1992. The City of Kingsville was again authorized a permit amendment in 1999 (Permit No. 235-B). This amendment increased the permitted acreage from 80 acres to approximately 120 acres and a maximum height of final cover of 125 feet-msl. The Kingsville Landfill is currently operating under Permit No. 235-B and subsequent permit modifications and/or authorizations.

The City of Kingsville Landfill is currently comprised of 120 acres. The City of Kingsville wishes to increase the capacity of the landfill site via a vertical and horizontal expansion through a permit amendment. The proposed permit amendment will increase the total permitted area to 176.33 acres. This will be accomplished by incorporating additional acreage to the northeast and southwest of the current permitted boundary. The existing active 108-acre waste disposal area will be expanded to a total of 121.3-acres. Other parts of this permit amendment are to; convert the current Type IV waste sector to accept Type I waste, request approval to process and dispose of liquid wastes and used tires, and to revise the floor contour and final contour plans to incorporate the vertical and horizontal expansion previously discussed.

## 1.2 Scope of ~~Investiagation~~Investigation

The purpose of this study is to provide geological and geotechnical data for the design of the city of Kingsville Landfill. The scope of services included reviewing previous subsurface studies, summarizing the engineering properties of the subsurface materials and determining certain geotechnical design criteria such as estimated settlement and future slope stability.

## 1.3 Previous Subsurface Investigations

Previous subsurface investigations were conducted for the City of Kingsville Landfill to characterize subsurface conditions and assist with the development of landfill disposal cell designs. The previous testing and soils exploration work was performed by:

- Finch Energy and Environmental Services, Inc. (FEE)
- and Professional Service Industries, Inc. (PSI).

These reports are included in Appendix 1. A total of 23 soil borings were installed at this site at varying depths and testing intervals during these previous investigations. Finch Energy and Environmental Services, Inc. conducted an investigation of subsurface materials at the Landfill location. Twelve (12) soil borings were installed and sampled. Laboratory tests were performed to determine the engineering properties of the subsurface materials. The report discussed the soils, sediments, and geologic and groundwater conditions encountered by FEE, Inc. during the hydrogeological/geotechnical investigations at the City of Kingsville Landfill. The report also discussed the characteristics of the soil samples collected and tested during the investigation.

As requested by the Texas Natural Resource Conservation Commission (TNRCC) in an NOD letter, Professional Service Industries, Inc. also conducted a subsurface investigation for FEE, Inc. and the City of Kingsville to evaluate the soil and groundwater conditions present at the site and to better define the aquiclude below the landfill site. A total of eleven (11) soil test borings were drilled and laboratory tests were performed to determine the engineering properties of the subsurface materials. This additional study discussed the types of subsurface materials encountered in the test borings and the results of the field and other laboratory tests performed for this site.

## 1.4 Current Subsurface Investigation

As previously identified, the proposed permit boundary for this facility will incorporate 176 acres of land with 128 acres being utilized for waste disposal. In accordance with 30 TAC 330.63 (e)(4)(B), a facility of this size requires 23-26 borings with 13-15 of these borings being installed at least 30 feet below the elevation of deepest excavation (EDE) and the remainder of the borings being installed at least 5 feet below the EDE. Before this subsurface investigation, there were fifteen (15) borings that were installed at least 5 feet below the EDE and four (4) of those borings were installed at least 30 feet below the EDE.

For this investigation, nine (9) soil borings were advanced to a minimum depth of 30 feet below the elevation of the deepest excavation of 22.5 ft and one (1) additional soil boring was advanced to 5 feet below the elevation of the deepest excavation to supplement the existing facility data. The borings were drilled in the locations identified on Attachment 2- Soil Boring Location Map (Figure III.4-2-1). Attachment 2 also identifies the locations of the previously installed soil borings. Attachment 3- Groundwater Contour Map (Figure III.4-3-1) identifies groundwater elevations in addition to the current groundwater monitoring system.

The soil borings for the current subsurface investigation were installed by Tolunay-Wong Engineers, Inc. Representative samples were collected with split-barrel sampling procedures in general accordance with the procedures for “Penetration Test and Split-Barrel Sampling of Soils” (ASTM Designation D-1586) and Standard Practice for Thin-Walled Tube Sampling of Soils for Geotechnical Purposes (ASTM Designation D-1587). Borings were dry-augered using hollow stem augers to advance the boreholes until groundwater was encountered or until the boreholes became unstable and/or collapsed. Wash rotary drilling techniques were used as necessary in order to continue advancing the borings to their required completion depths. No borings collapsed during this investigation. Samples were identified according to boring number and depth, protected against moisture loss, and transported to the laboratory for analysis. After obtaining all required soil samples and groundwater level readings, the soil borings were properly plugged and abandoned in accordance with 16 TAC Chapter 76, Texas Department of Licensing and Regulation (TDLR)-Water Well Drillers and Pump Installers rules. Table 1-1 below identifies specific details for both existing and newly installed soil borings. For this investigation, borings B30 through B41 were installed. These borings were advanced to depths ranging from 33.5 to 86 feet beneath the existing ground surface. Tolunay-Wong Engineers, Inc. prepared a Geotechnical Engineering Study Report that is provided in Appendix 2. Hanson Professional Services also prepared a soil boring report that has been included as Appendix 3.

**Table 1-1**
**Soil Borings**

| Boring Identification | Surface Elevation (ft. AMSL) | Boring Depth (ft. bgs) | Bottom Elevation (ft. AMSL) | ≥5 Feet Below E.D.E? | ≥30 Feet Below E.D.E? |
|---|---|---|---|---|---|
| Finch Energy and Environmental Services, Inc. Borings | | | | | |
| B-1 | 59.25 | 42 | 17.25 | YES | NO |
| B-2 | 52.64 | 27 | 25.64 | NO | NO |
| B-3 | 56.1 | 37 | 19.1 | NO | NO |
| B-4 | 58.01 | 39 | 19.01 | NO | NO |
| B-5 | 60.54 | 48 | 12.54 | YES | NO |
| B-6 | 55.46 | 38 | 17.46 | YES | NO |
| B-7 | 61.05 | 36 | 25.05 | NO | NO |
| B-8 | 59.79 | 43 | 16.79 | YES | NO |
| B-9 | 62.51 | 44 | 18.51 | NO | NO |
| B-9R | 41.41 | 17 | 24.41 | NO | NO |
| B-10 | 49.78 | 29 | 20.78 | NO | NO |
| B-11 | 60.2 | 33 | 27.2 | NO | NO |
| Professional Service Industries, Inc. Borings | | | | | |
| B-12 | 52.38 | 48 | 4.38 | YES | NO |
| B-13 | 59.13 | 50 | 9.13 | YES | NO |
| B-14 | 49.94 | 42 | 7.94 | YES | NO |
| B-15 | 48.39 | 37 | 11.39 | YES | NO |
| B-16 | 55.96 | 47 | 8.96 | YES | NO |
| B-17 | 41.35 | 33 | 8.35 | YES | NO |
| B-18 | 50.04 | 42 | 8.04 | YES | NO |
| B-21 | 52.41 | 84 | -31.59 | YES | YES |
| B-23 | 49.5 | 86 | -36.5 | YES | YES |
| B-24 | 47.38 | 72 | -24.62 | YES | YES |
| B-25 | 61.12 | 88 | -26.88 | YES | YES |
| Tolunay-Wong Engineers, Inc. Borings | | | | | |
| B-30 | 45.99 | 82.5 | -36.51 | YES | YES |
| B-31 | 58.37 | 68 | -9.63 | YES | YES |
| B-32 | 48.46 | 82.5 | -34.04 | YES | YES |
| B-33 | 64.51 | 86 | -21.49 | YES | YES |
| B-34 | 61.14 | 43 | 18.14 | NO | NO |
| B-35 | 64.5 | 72.5 | -8 | YES | YES |
| B-36 | 59.13 | 68 | -8.87 | YES | YES |
| B-37 | 45.52 | 48 | -2.48 | YES | NO |

| Boring Identification | Surface Elevation (ft. AMSL) | Boring Depth (ft. bgs) | Bottom Elevation (ft. AMSL) | ≥5 Feet Below E.D.E? | ≥30 Feet Below E.D.E? |
|---|---|---|---|---|---|
| B-38 | 41.64 | 58 | -16.36 | YES | YES |
| B-39 | 60.26 | 68 | -7.74 | YES | YES |
| B-40 | 52.31 | 33.5 | 18.81 | NO | NO |
| B-41 | 50.2 | 62.5 | -12.3 | YES | YES |

E.D.E.-Elevation of Deepest Excavation (22.5' Above Mean Sea Level (AMSL))

Locations of borings B-32, B-33, B-34, B-35, B-38 and B-40 deviated from locations specified in the soil boring plan due to boring locations being unknowingly moved from original locations during installation. These deviations were identified when the boring locations were surveyed. The distance of boring location deviation varied from approximately 90 feet in B-35 to approximately 440 feet in B-33. With the information obtained during previous subsurface investigations, these discrepancies did not affect the ability to obtain the needed information identified in 30 TAC §330.63(e)(4)(A).

Borings B-34 and B-40 were not drilled to 5 foot below EDE due to the boring locations being unknowingly moved from the original locations during installation. Boring B-34 was 0.64 feet short of 5 foot below EDE and B-40 was 1.31 feet short of 5 foot below EDE. Although these borings were not drilled to the target depth, the information obtained from these borings is useful in characterizing the subsurface conditions at the facility and was used for that purpose. Other borings installed at the site in conjunction with the current subsurface investigation are adequate in meeting the requirements identified in 30 TAC §330.63(e)(4)(B).

# 2.0 REGIONAL INFORMATION

## 2.1 Regional Physiography

As discussed in Finch Energy and Environmental Services' Report (Appendix 1, Section 2.0, Page 11-12), the site of the landfill is located in the part of the Gulf Coastal Plain that has been defined as the Coastal Bend of Texas. The coastal plain is gently, but irregularly, inclined gulfward at about 5 feet or less per mile. In many areas, coastal plain slopes range from 1 to 3 feet per mile, and on the lagoonal wind-tidal flats, slopes are usually less than 1 foot per mile. Elevations within the county range from 0 feet (Gulf of Mexico) to 125 feet above Mean Seal Level (MSL) in the extreme northwestern part. It is characterized as an arid, desert like region where wind (Eolian) erosion and wind transported sediment have determined much of the area's character and distinctiveness. The surface features of the county are broad, dune covered mainland prairies and extensive coastal wind-tidal flats.

Eolian transport of silts and sands has produced the South Texas Eolian System (Sand Sheet). Extensive, hummocky prairies within the South Texas sand sheet are underlain by relic sand dunes and wind-deflated depressions which extend inland from broad wind-tidal flats along the landward margin of Laguna Madre and parts of Baffin Bay.

## 2.2 Regional Stratigraphy

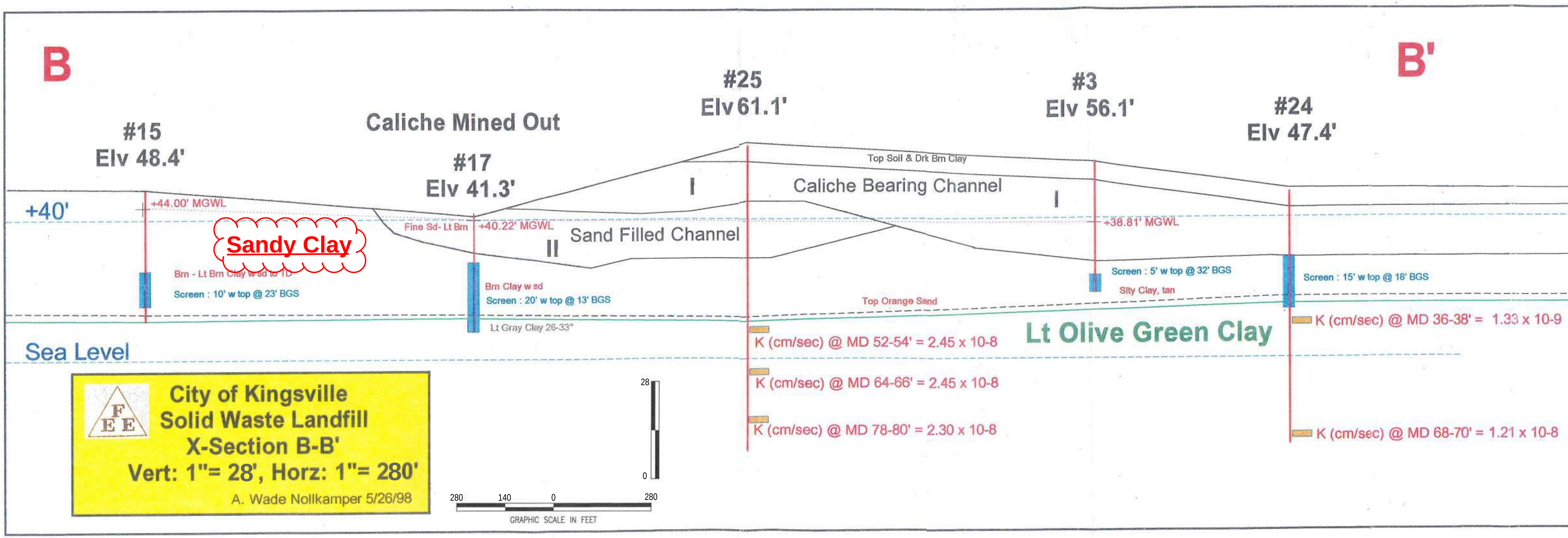
Table 2-1 presents the geologic formations that characterize the regional stratigraphy of Kleberg County.

# ATTACHMENT 4

## Geology Report

For Permitting Purposes Only. Applies to pages of Attachment 4 – Finch Energy & Environmental Services, Inc. Geology Report, sealed by Ray N. Finch, P.E. on 6-26-98 and 9-30-98 altered to provide a clean and legible copy and includes pages: 3, 3.0 Cover Page, 8, 9, 15 - 17,22 - 25, 29 – 30, 33 - 35, 39 - 46, 48 – 60, 60a, 62 - 98, 100 - 101, 104, 108 – 109, ~~and~~ D-32 - D-46 and K-1 – K-12. No information or data was altered or changed from the original 6-26-98 and 9-30-98 Geology Report other than text scale corrections on pages 48-60. Bar scales were also added to pages 48-60.

Finch Energy & Environmental Services, Inc.
P.O. Box 73/1204 W. King, Kingsville, TX 78364
Phone: (512) 592-9810 Fax: (512) 592-5552


B
B'
#15
Elv 48.4'
Caliche Mined Out
#17
Elv 41.3'
#25
Elv 61.1'
#3
Elv 56.1'
#24
Elv 47.4'
+40'
+44.00' MGWL
Sandy Clay
Fine Sd- Lt Brn
+40.22' MGWL
Sand Filled Channel
Top Soil & Drk Brn Clay
Caliche Bearing Channel
I
II
+38.81' MGWL
Screen : 10' w top @ 23' BGS
Brn Clay w sd
Screen : 20' w top @ 13' BGS
Lt Gray Clay 26-33"
Screen : 5' w top @ 32' BGS
Slty Clay, tan
Screen : 15' w top @ 18' BGS
Top Orange Sand
Lt Olive Green Clay
K (cm/sec) @ MD 36-38' = 1.33 x 10-9
K (cm/sec) @ MD 52-54' = 2.45 x 10-8
K (cm/sec) @ MD 64-66' = 2.45 x 10-8
K (cm/sec) @ MD 78-80' = 2.30 x 10-8
K (cm/sec) @ MD 68-70' = 1.21 x 10-8
Sea Level
City of Kingsville
Solid Waste Landfill
X-Section B-B'
Vert: 1"= 28', Horz: 1"= 280'
A. Wade Nollkamper 5/26/98
28
0
280 140 0 280
GRAPHIC SCALE IN FEET

# THE CITY OF KINGSVILLE LANDFILL

# TCEQ PERMIT MSW 235C

## PERMIT AMENDMENT APPLICATION

## Volume 3 of 6

CITY OF KINGSVILLE, KLEBERG COUNTY, TEXAS

September 2018
Revision 1 – November 2018
Revision 2 – February 2019
Revision 3 – April 2019

Prepared by

HANSON
Engineering | Planning | Allied Services

TBPE F-417

HANSON PROJECT NO. 16L0438-0003

K-1
MW-12

Send original copy by certified return receipt requested m[illegible] TNRCC, MC 177, P.O. Box 13087, Austin, TX 787[illegible]

**ATTENTION OWNER:** *Confidentiality Privilege Notice on on reverse side of Well Owner's copy (pink)*

# State of Texas WELL REPORT

Texas Water Well Drillers Advisory Council
MC 177
P.O. Box 13087
Austin, TX 78711-3087
512-239-0530

1) OWNER City of Kingsville (Name) ADDRESS P.O Box 1458 Kingsville (Street or RFD) TX (City) (State) 78363 (Zip)

2) ADDRESS OF WELL: County Kleberg Kingsville Landfill (Street, RFD or other) Kingsville (City) TX (State) (Zip) GRID # 83-34-4

3) TYPE OF WORK (Check):
- ☑ New Well ☐ Deepening
- ☐ Reconditioning ☐ Plugging

4) PROPOSED USE (Check): ☑ Monitor ☐ Environmental Soil Boring ☐ Domestic ☐ Industrial ☐ Irrigation ☐ Injection ☐ Public Supply ☐ De-watering ☐ Testwell
If Public Supply well, were plans submitted to the TNRCC? ☐ Yes ☐ No

5) MW-12 (SB-12)

6) WELL LOG:
Date Drilling:
Started 7-7 19 97
Completed 7-7 19 97

| DIAMETER OF HOLE | | |
|---|---|---|
| Dia. (in.) | From (ft.) | To (ft.) |
| 12.0 | Surface | 45.0 |

7) DRILLING METHOD (Check): ☐ Driven ☐ Air Rotary ☐ Mud Rotary ☑ Bored ☐ Air Hammer ☐ Cable Tool ☐ Jetted ☐ Other

| From (ft.) | To (ft.) | Description and color of formation material |
|---|---|---|
| See attached logs | | |

*(Use reverse side of Well Owner's copy, if necessary)*

8) Borehole Completion (Check): ☐ Open Hole ☐ Straight Wall ☐ Underreamed ☐ Gravel Packed ☑ Other 16/30 Silica
If Gravel Packed give interval ... from 35.0 ft. to 25.0 ft.

CASING, BLANK PIPE, AND WELL SCREEN DATA:

| Dia. (in.) | New or Used | Steel, Plastic, etc. Perf., Slotted, etc. Screen Mfg., if commercial | Setting (ft.) From | To | Gage Casting Screen |
|---|---|---|---|---|---|
| 4 | N | PVC Screen Tri-Loc | 35.0 | 25.0 | .010 |
| 4 | N | PVC Riser | 25.0 | +2.5 | |

9) CEMENTING DATA [Rule 338.44(1)]
Cemented from 21.0 ft. to 0.0 ft. No. of sacks used 5.0
___ ft. to ___ ft. No. of sacks used ___
Method used
Cemented by PSI Inc.
Distance to septic system field lines or other concentrated contamination ___ ft.
Method of verification of above distance

13) TYPE PUMP: N/A
☐ Turbine ☐ Jet ☐ Submersible ☐ Cylinder ☐ Other
Depth to pump bowls, cylinder, jet, etc., ___ ft.

10) SURFACE COMPLETION
- ☑ Specified Surface Slab Installed [Rule 338.44(2)(A)]
- ☐ Specified Steel Sleeve Installed [Rule 338.44(3)(A)]
- ☐ Pitless Adapter Used [Rule 338.44(3)(b)]
- ☐ Approved Alternative Procedure Used [Rule 338.71]

14) WELL TESTS: N/A
Type test: ☐ Pump ☐ Bailer ☐ Jetted ☐ Estimated
Yield: ___ gpm with ___ ft. drawdown after ___ hrs.

11) WATER LEVEL: N/A
Static level ___ ft. below land surface Date ___
Artesian flow ___ gpm. Date ___

15) WATER QUALITY:
Did you knowingly penetrate any strata which contained undesirable constituents?
☐ Yes ☑ No If yes, submit "REPORT OF UNDESIRABLE WATER"
Type of water? ___ Depth of strata ___
Was a chemical analysis made? ☐ Yes ☐ No

12) PACKERS:

| Type | | Depth |
|---|---|---|
| Bentonite Pellets | 1/4" | [illegible] |

I hereby certify that this well was drilled by me (or under my supervision) and that each and all of the statements herein are true to the best of my knowledge and belief. I understand that failure to complete items 1 thru 15 will result in the log(s) being returned for completion and resubmittal.

COMPANY NAME PSI Inc. (Type or print) WELL DRILLER'S LICENSE NO. 4694-M

ADDRESS [illegible] (Street or RFD) Corpus Christi (City) TX (State) 78416 (Zip)

(Signed) [signature] (Licensed Well Driller) (Signed) ___ (Registered Driller Trainee)

Please attach electric log, chemical analysis, and other pertinent information, if available.

K-2
MW-13

Send original copy by certified return receipt requested to TNRCC, MC 177, P.O. Box 13087, Austin, TX 787

ATTENTION OWNER: *Confidentiality Privilege Notice on on reverse side of Well Owner's copy (pink)*

# State of Texas WELL REPORT

Texas Water Well Drillers Advisory Council
MC 177
P.O. Box 13087
Austin, TX 78711-3087
512-239-0530

1) OWNER City of Kingsville (Name) ADDRESS P.O. Box 1458 (Street or RFD) Kingsville (City) TX (State) 78363 (Zip)

2) ADDRESS OF WELL: County Kleberg Kingsville Landfill (Street, RFD or other) Kingsville (City) TX (State) (Zip) GRID # 83-34-4

3) TYPE OF WORK (Check): ☑ New Well ☐ Deepening ☐ Reconditioning ☐ Plugging

4) PROPOSED USE (Check): ☑ Monitor ☐ Environmental Soil Boring ☐ Domestic ☐ Industrial ☐ Irrigation ☐ Injection ☐ Public Supply ☐ De-watering ☐ Testwell
If Public Supply well, were plans submitted to the TNRCC? ☐ Yes ☐ No

5) MW-13 (SB-13)

6) WELL LOG:
Date Drilling:
Started 7-25 19 97
Completed 7-25 19 97

DIAMETER OF HOLE

| Dia. (in.) | From (ft.) | To (ft.) |
|---|---|---|
| 8.0 | Surface | 50.0 |

7) DRILLING METHOD (Check): ☐ Driven ☐ Air Rotary ☐ Mud Rotary ☑ Bored ☐ Air Hammer ☐ Cable Tool ☐ Jetted ☐ Other

| From (ft.) | To (ft.) | Description and color of formation material |
|---|---|---|
| | | See attached log |

(Use reverse side of Well Owner's copy, if necessary)

8) Borehole Completion (Check): ☐ Open Hole ☐ Straight Wall ☐ Underreamed ☐ Gravel Packed ☑ Other 16/30 Silica
If Gravel Packed give interval ... from 40.0 ft. to 28.0 ft.

CASING, BLANK PIPE, AND WELL SCREEN DATA:

| Dia. (in.) | New or Used | Steel, Plastic, etc. Perf., Slotted, etc. Screen Mfg., if commercial | Setting (ft.) From | Setting (ft.) To | Gage Casting Screen |
|---|---|---|---|---|---|
| 4 | N | PVC Screen Mfg. TRI-LOC | 40.0 | 50.0 | .010 |
| 4 | N | PVC Riser | 30.0 | +2.5 | |

9) CEMENTING DATA [Rule 338.44(1)]
Cemented from 26.0 ft. to 0.0 ft. No. of sacks used 50
ft. to ft. No. of sacks used
Method used
Cemented by PSI Inc.
Distance to septic system field lines or other concentrated contamination ft.
Method of verification of above distance

13) TYPE PUMP: N/A
☐ Turbine ☐ Jet ☐ Submersible ☐ Cylinder
☐ Other
Depth to pump bowls, cylinder, jet, etc., ft.

10) SURFACE COMPLETION
☑ Specified Surface Slab Installed [Rule 338.44(2)(A)]
☐ Specified Steel Sleeve Installed [Rule 338.44(3)(A)]
☐ Pitless Adapter Used [Rule 338.44(3)(b)]
☐ Approved Alternative Procedure Used [Rule 338.71]

14) WELL TESTS: N/A
Type test: ☐ Pump ☐ Bailer ☐ Jetted ☐ Estimated
Yield: gpm with ft. drawdown after hrs.

11) WATER LEVEL: N/A
Static level ft. below land surface Date
Artesian flow gpm. Date

15) WATER QUALITY:
Did you knowingly penetrate any strata which contained undesirable constituents?
☐ Yes ☑ No If yes, submit "REPORT OF UNDESIRABLE WATER"
Type of water? Depth of strata
Was a chemical analysis made? ☐ Yes ☐ No

12) PACKERS:

| | Type | Depth |
|---|---|---|
| Bentonite Pellets | 1/4" | 28.0-26.0 |

I hereby certify that this well was drilled by me (or under my supervision) and that each and all of the statements herein are true to the best of my knowledge and belief. I understand that failure to complete items 1 thru 15 will result in the log(s) being returned for completion and resubmittal.

COMPANY NAME PSI Inc. (Type or print) WELL DRILLER'S LICENSE NO. 4674-M

ADDRESS 5520 (Street or RFD) Corpus Christi (City) TX (State) 78416 (Zip)

(Signed) [signature] (Licensed Well Driller) (Signed) (Registered Driller Trainee)

Please attach electric log, chemical analysis, and other pertinent information, if available.

K-2
MW-13

*Please use black ink.*
File WHITE COPY with:
TNRCC
P.O. Box 13087, MC 177
Austin, TX 78711-3087
512-239-0530

## State of Texas
## PLUGGING REPORT

(This form must be completed and filed with the TNRCC within 30 days following the date the well is plugged as required by current statutory law.)

Texas Water Well Drillers Advisory Council
P.O. Box 13087
Austin, TX 78711-3087
512-239-0530

### A. WELL IDENTIFICATION AND LOCATION DATA

1) OWNER City of Kingsville (Name) ADDRESS P.O. Box 1458 (Street or RFD) Kingsville (City) TX (State) 78363 (Zip)

2) ADDRESS OF WELL: County Kleberg Kingsville Landfill (Street, RFD or other) Kingsville (City) TX (State) (Zip) GRID # 83-30-4

3) OWNER'S WELL NO: MW-13 4) WELL TYPE (Check): ☐ Water ☑ Monitor ☐ Injection ☐ De-watering 5)

Driller, Pump Installer, or Landowner performing the plugging operations **must** locate and identify the location of the well within a specific grid on a full scale-gridded County map available from the TNRCC/Installers Certification Program. The location of the well should be denoted within the grid by placing a corresponding dot in the grid to the right. The legal description section below is optional.

☐ LEGAL DESCRIPTION: n/a

Section No. ______ Block No. ______ Township ______

Abstract No. ______ Survey Name ______

Distance and direction from two intersecting section lines or survey lines: ______

N

### B. HISTORICAL DATA ON WELL TO BE PLUGGED (if available)

6) Driller Craig Scherer License No. 4694-M City Corpus Christi

7) Drilled 7-8 19 97; 8) Diameter of hole 10.0 inches; 9) Total depth of well 40.0 feet.

### C. CURRENT PLUGGING DATA

10) Date well plugged 7-28 ,19 97

11) Sketch of well: Using space at right, show method of plugging the well including all casing and cemented intervals.

12) Name of Driller/Pump Installer actually performing the plugging operations Craig Scherer

License number 4694-M

13) Casing and cementing data relative to the plugging operations:

Monitor well was filled and well pressure grouted from bottom to surface.

| DIAMETER (inches) | CASING LEFT IN WELL FROM (feet) | TO (feet) |
|---|---|---|
| | 0.0 | 0.0 |
| | | |
| | | |

| CEMENT PLUG(S) PLACED IN WELL FROM (feet) | TO (feet) | SACK(S) OF CEMENT USED |
|---|---|---|
| 40.0 | 0.0 | 10.0 |
| | | |
| | | |
| | | |
| | | |

### D. VALIDATION OF INFORMATION INCLUDED IN FORM

I hereby certify that this well was plugged by me (or under my supervision) and that each and all of the statements herein are true to the best of my knowledge and belief. I understand that failure to complete items 1 thru 13 will result in the report(s) being returned for completion and resubmittal.

Company or Individual's Name (*type or print*) PSI Inc

Address: Street or RFD 610 S.T.D City Corpus Christi State TX Zip 78416

Signatures: Craig Scherer 8-13-97

Licensed Driller/Pump Installer Date Owner of Well Date

Trainee/Apprentice Date

*White - TNRCC* *Yellow - Well Owner* *Pink - Licensed Well Driller/Pump Installer*

K-4
MW-14

Send original copy by certified return receipt requested m[illegible] TNRCC, MC 177, P.O. Box 13087, Austin, TX 78[illegible]7

ATTENTION OWNER: *Confidentiality Privilege Notice on on reverse side of Well Owner's copy (pink)*

# State of Texas WELL REPORT

Texas Water Well Drillers Advisory Council
MC 177
P.O. Box 13087
Austin, TX 78711-3087
512-239-0530

1) OWNER City of Kingsville (Name) ADDRESS P.O. Box 1458 (Street or RFD) Kingsville (City) TX (State) 78363 (Zip)

2) ADDRESS OF WELL: County Kleberg — Kingsville Landfill (Street, RFD or other) Kingsville (City) TX (State) (Zip) GRID # 83-34-4

3) TYPE OF WORK (Check): ☑ New Well ☐ Deepening ☐ Reconditioning ☐ Plugging

4) PROPOSED USE (Check): ☑ Monitor ☐ Environmental Soil Boring ☐ Domestic ☐ Industrial ☐ Irrigation ☐ Injection ☐ Public Supply ☐ De-watering ☐ Testwell
If Public Supply well, were plans submitted to the TNRCC? ☐ Yes ☐ No

5) MW-14 (53-14)

6) WELL LOG:
Date Drilling:
Started 7-8 19 97
Completed 7-8 19 97

| DIAMETER OF HOLE | | |
|---|---|---|
| Dia. (in.) | From (ft.) | To (ft.) |
| 10 | Surface | 42.0 |

7) DRILLING METHOD (Check): ☐ Driven ☐ Air Rotary ☐ Mud Rotary ☑ Bored ☐ Air Hammer ☐ Cable Tool ☐ Jetted ☐ Other

| From (ft.) | To (ft.) | Description and color of formation material |
|---|---|---|
| | | See attached logs |

(Use reverse side of Well Owner's copy, if necessary)

8) Borehole Completion (Check): ☐ Open Hole ☐ Straight Wall ☐ Underreamed ☐ Gravel Packed ☑ Other 16/30 Silica
If Gravel Packed give interval ... from 35.0 ft. to 23.0 ft.

CASING, BLANK PIPE, AND WELL SCREEN DATA:

| Dia (in.) | New or Used | Steel, Plastic, etc. Perf., Slotted, etc. Screen Mfg., if commercial | Setting (ft.) From | Setting (ft.) To | Gage Casting Screen |
|---|---|---|---|---|---|
| 4 | N | PVC Screen Mfg. TRI-LOC | 35.0 | 25.0 | .010 |
| 4 | N | PVC Riser | 25.0 | +2.5 | |

9) CEMENTING DATA [Rule 338.44(1)]
Cemented from 21.0 ft. to 0.0 ft. No. of sacks used 5
ft. to ft. No. of sacks used
Method used
Cemented by PSI Inc.
Distance to septic system field lines or other concentrated contamination ____ ft.
Method of verification of above distance

13) TYPE PUMP: N/A
☐ Turbine ☐ Jet ☐ Submersible ☐ Cylinder ☐ Other
Depth to pump bowls, cylinder, jet, etc., ____ ft.

10) SURFACE COMPLETION
☑ Specified Surface Slab Installed [Rule 338.44(2)(A)]
☐ Specified Steel Sleeve Installed [Rule 338.44(3)(A)]
☐ Pitless Adapter Used [Rule 338.44(3)(b)]
☐ Approved Alternative Procedure Used [Rule 338.71]

14) WELL TESTS: N/A
Type test: ☐ Pump ☐ Bailer ☐ Jetted ☐ Estimated
Yield: ____ gpm with ____ ft. drawdown after ____ hrs.

11) WATER LEVEL: N/A
Static level ____ ft. below land surface Date ____
Artesian flow ____ gpm. Date ____

15) WATER QUALITY:
Did you knowingly penetrate any strata which contained undesirable constituents?
☐ Yes ☑ No If yes, submit "REPORT OF UNDESIRABLE WATER"
Type of water? ____ Depth of strata ____
Was a chemical analysis made? ☐ Yes ☐ No

12) PACKERS:

| | Type | Depth |
|---|---|---|
| Bentonite Pellets | 10 | 23.0 - 21.0 |

I hereby certify that this well was drilled by me (or under my supervision) and that each and all of the statements herein are true to the best of my knowledge and belief. I understand that failure to complete items 1 thru 15 will result in the log(s) being returned for completion and resubmittal.

COMPANY NAME PSI Inc. (Type or print) WELL DRILLER'S LICENSE NO. 4694-M

ADDRESS 810 [illegible] (Street or RFD) Corpus Christi (City) TX (State) 78416 (Zip)

(Signed) [signature] (Licensed Well Driller) (Signed) ____ (Registered Driller Trainee)

Please attach electric log, chemical analysis, and other pertinent information, if available.

K-5
MW-15

Send original copy by certified return receipt requested to TNRCC, MC 177, P.O. Box 13087, Austin, TX 78711-3087

ATTENTION OWNER: *Confidentiality Privilege Notice on on reverse side of Well Owner's copy (pink)*

# State of Texas WELL REPORT

Texas Water Well Drillers Advisory Council
MC 177
P.O. Box 13087
Austin, TX 78711-3087
512-239-0530

1) OWNER City of Kingsville (Name) ADDRESS PO Box 1458 (Street or RFD) Kingsville (City) TX (State) 78363 (Zip)

2) ADDRESS OF WELL: County Kleberg — Kingsville Landfill (Street, RFD or other) Kingsville (City) TX (State) (Zip) GRID # 83-34-4

3) TYPE OF WORK (Check): ☑ New Well ☐ Deepening ☐ Reconditioning ☐ Plugging

4) PROPOSED USE (Check): ☑ Monitor ☐ Environmental Soil Boring ☐ Domestic ☐ Industrial ☐ Irrigation ☐ Injection ☐ Public Supply ☐ De-watering ☐ Testwell
If Public Supply well, were plans submitted to the TNRCC? ☐ Yes ☐ No

5) MW-15 (53-15)

6) WELL LOG:
Date Drilling:
Started 7-8 19 97
Completed 7-8 19 97

DIAMETER OF HOLE

| Dia (in.) | From (ft.) | To (ft.) |
|---|---|---|
| 7.0 | Surface | 37.0 |
| | | |

7) DRILLING METHOD (Check): ☐ Driven ☐ Air Rotary ☐ Mud Rotary ☑ Bored ☐ Air Hammer ☐ Cable Tool ☐ Jetted ☐ Other

| From (ft.) | To (ft.) | Description and color of formation material |
|---|---|---|
| | | Attached Logs |

*(Use reverse side of Well Owner's copy, if necessary)*

8) Borehole Completion (Check): ☐ Open Hole ☐ Straight Wall ☐ Underreamed ☐ Gravel Packed ☑ Other 16/30 SILICA
If Gravel Packed give interval ... from 33.0 ft. to 21.0 ft.

CASING, BLANK PIPE, AND WELL SCREEN DATA:

| Dia (in.) | New or Used | Steel, Plastic, etc. Perf., Slotted, etc. Screen Mfg., if commercial | Setting (ft.) From | To | Gage Casting Screen |
|---|---|---|---|---|---|
| 4 | N | PVC SCREEN, MFG. TRI-LOC | 33.0 | 23.0 | .010 |
| 4 | N | PVC RISER | 23.0 | +2.5 | |

9) CEMENTING DATA [Rule 338.44(1)]
Cemented from 19.0 ft. to 0.0 ft. No. of sacks used 5.0
___ ft. to ___ ft. No. of sacks used ___
Method used
Cemented by PSI, INC
Distance to septic system field lines or other concentrated contamination ___ ft.
Method of verification of above distance

10) SURFACE COMPLETION
☑ Specified Surface Slab Installed [Rule 338.44(2)(A)]
☐ Specified Steel Sleeve Installed [Rule 338.44(3)(A)]
☐ Pitless Adapter Used [Rule 338.44(3)(b)]
☐ Approved Alternative Procedure Used [Rule 338.71]

11) WATER LEVEL: N/A
Static level ___ ft. below land surface Date ___
Artesian flow ___ gpm. Date ___

12) PACKERS: Type Depth
Bentonite Pellets 3/8" 21.0-19.0

13) TYPE PUMP: N/A
☐ Turbine ☐ Jet ☐ Submersible ☐ Cylinder
☐ Other
Depth to pump bowls, cylinder, jet, etc. ___ ft.

14) WELL TESTS: N/A
Type test: ☐ Pump ☐ Bailer ☐ Jetted ☐ Estimated
Yield ___ gpm with ___ ft. drawdown after ___ hrs.

15) WATER QUALITY:
Did you knowingly penetrate any strata which contained undesirable constituents?
☐ Yes ☑ No If yes, submit "REPORT OF UNDESIRABLE WATER"
Type of water? ___ Depth of strata ___
Was a chemical analysis made? ☐ Yes ☐ No

I hereby certify that this well was drilled by me (or under my supervision) and that each and all of the statements herein are true to the best of my knowledge and belief. I understand that failure to complete items 1 thru 15 will result in the log(s) being returned for completion and resubmittal.

COMPANY NAME PSI, INC (Type or print) WELL DRILLER'S LICENSE NO. 4290-M

ADDRESS P.T. (Street or RFD) Corpus Christi (City) TX (State) 784[illegible] (Zip)

(Signed) [signature] (Licensed Well Driller) (Signed) ___ (Registered Driller Trainee)

Please attach electric log, chemical analysis, and other pertinent information, if available.

TNRCC-0199 Rev. [illegible]

K-6
MW-16

Send original copy by certified return receipt requested m[illegible] TNRCC, MC 177, P.O. Box 13087, Austin, TX 787[illegible]

**ATTENTION OWNER:** *Confidentiality Privilege Notice on on reverse side of Well Owner's copy (pink)*

# State of Texas WELL REPORT

Texas Water Well Drillers Advisory Council
MC 177
P.O. Box 13087
Austin, TX 78711-3087
512-239-0530

1) OWNER City of Kingsville (Name) ADDRESS P.O. Box 1458 Kingsville TX 78363 (Street or RFD) (City) (State) (Zip)

2) ADDRESS OF WELL: County Kleberg Kingsville Landfill Kingsville TX (Street, RFD or other) (City) (State) (Zip) GRID # 83-34-4

3) TYPE OF WORK (Check): ☑ New Well ☐ Deepening ☐ Reconditioning ☐ Plugging

4) PROPOSED USE (Check): ☑ Monitor ☐ Environmental Soil Boring ☐ Domestic ☐ Industrial ☐ Irrigation ☐ Injection ☐ Public Supply ☐ De-watering ☐ Testwell
If Public Supply well, were plans submitted to the TNRCC? ☐ Yes ☐ No

5) MW-16 (SB-16)

6) WELL LOG:
Date Drilling:
Started 7-10 19 97
Completed 7-10 19 97

DIAMETER OF HOLE

| Dia. (in.) | From (ft.) | To (ft.) |
|---|---|---|
| 10.0 | Surface | 47.0 |

7) DRILLING METHOD (Check): ☐ Driven ☐ Air Rotary ☐ Mud Rotary ☑ Bored ☐ Air Hammer ☐ Cable Tool ☐ Jetted ☐ Other ____

N

| From (ft.) | To (ft.) | Description and color of formation material |
|---|---|---|
| | | See attached logs |

*(Use reverse side of Well Owner's copy, if necessary)*

8) Borehole Completion (Check): ☐ Open Hole ☐ Straight Wall ☐ Underreamed ☐ Gravel Packed ☑ Other 16/30 silica
If Gravel Packed give interval ... from 40.0 ft. to 28.0 ft.

CASING, BLANK PIPE, AND WELL SCREEN DATA:

| Dia. (in.) | New or Used | Steel, Plastic, etc. Perf., Slotted, etc. Screen Mfg., if commercial | Setting (ft.) From | Setting (ft.) To | Gage Casting Screen |
|---|---|---|---|---|---|
| 4 | N | PVC Screen mfl. Tri-Loc | 40.0 | 30.0 | .010 |
| 4 | N | PVC Riser | 0.0 | +2.5 | |

9) CEMENTING DATA [Rule 338.44(1)]
Cemented from 26.0 ft. to 0.0 ft. No. of sacks used 7.0
____ ft. to ____ ft. No. of sacks used ____
Method used ____
Cemented by FSI Inc.
Distance to septic system field lines or other concentrated contamination ____ ft.
Method of verification of above distance ____

10) SURFACE COMPLETION
☑ Specified Surface Slab Installed [Rule 338.44(2)(A)]
☐ Specified Steel Sleeve Installed [Rule 338.44(3)(A)]
☐ Pitless Adapter Used [Rule 338.44(3)(b)]
☐ Approved Alternative Procedure Used [Rule 338.71]

11) WATER LEVEL: N/A
Static level ____ ft. below land surface Date ____
Artesian flow ____ gpm. Date ____

12) PACKERS:

| | Type | Depth |
|---|---|---|
| Bentonite pellets | 1/2 | 28.0 - 26.0 |

13) TYPE PUMP: N/A
☐ Turbine ☐ Jet ☐ Submersible ☐ Cylinder
☐ Other ____
Depth to pump bowls, cylinder, jet, etc., ____ ft.

14) WELL TESTS: N/A
Type test: ☐ Pump ☐ Bailer ☐ Jetted ☐ Estimated
Yield: ____ gpm with ____ ft. drawdown after ____ hrs.

15) WATER QUALITY:
Did you knowingly penetrate any strata which contained undesirable constituents?
☐ Yes ☑ No If yes, submit "REPORT OF UNDESIRABLE WATER"
Type of water? ____ Depth of strata ____
Was a chemical analysis made? ☐ Yes ☐ No

I hereby certify that this well was drilled by me (or under my supervision) and that each and all of the statements herein are true to the best of my knowledge and belief. I understand that failure to complete items 1 thru 15 will result in the log(s) being returned for completion and resubmittal.

COMPANY NAME FSI Inc (Type or print) WELL DRILLER'S LICENSE NO. 4694-M

ADDRESS 910 S-ID Corpus Christi TX 78416 (Street or RFD) (City) (State) (Zip)

(Signed) Craig [illegible] (Licensed Well Driller) (Signed) ____ (Registered Driller Trainee)

**Please attach electric log, chemical analysis, and other pertinent information, if available.**

K-7
MW-17

Send original copy by certified return receipt requested TNRCC, MC 177, P.O. Box 13087, Austin, TX 78[redacted]87

**ATTENTION OWNER:** *Confidentiality Privilege Notice on on reverse side of Well Owner's copy (pink)*

# State of Texas
# WELL REPORT

Texas Water Well Drillers Advisory Council
MC 177
P.O. Box 13087
Austin, TX 78711-3087
512-239-0530

1) OWNER City of Kingsville (Name) ADDRESS P.O. Box 1458 (Street or RFD) Kingsville (City) TX (State) 78363 (Zip)

2) ADDRESS OF WELL: County Kleberg Kingsville Landfill (Street, RFD or other) Kingsville (City) TX (State) (Zip) GRID # 83-54-4

3) TYPE OF WORK (Check): ☑ New Well ☐ Deepening ☐ Reconditioning ☐ Plugging

4) PROPOSED USE (Check): ☑ Monitor ☐ Environmental Soil Boring ☐ Domestic ☐ Industrial ☐ Irrigation ☐ Injection ☐ Public Supply ☐ De-watering ☐ Testwell
If Public Supply well, were plans submitted to the TNRCC? ☐ Yes ☐ No

5) MW-17 (S3-17)

6) WELL LOG:
Date Drilling:
Started 7-9 19 97
Completed 7-9 19 97

DIAMETER OF HOLE

| Dia. (in.) | From (ft.) | To (ft.) |
|---|---|---|
| 8.0 | Surface | 33.0 |
| | | |

7) DRILLING METHOD (Check): ☐ Driven ☐ Air Rotary ☐ Mud Rotary ☑ Bored ☐ Air Hammer ☐ Cable Tool ☐ Jetted ☐ Other

| From (ft.) | To (ft.) | Description and color of formation material |
|---|---|---|
| See attached logs | | |

*(Use reverse side of Well Owner's copy, if necessary)*

8) Borehole Completion (Check): ☐ Open Hole ☐ Straight Wall ☐ Underreamed ☐ Gravel Packed ☑ Other 16/30 Silica
If Gravel Packed give interval ... from 33.0 ft. to 10.0 ft.

CASING, BLANK PIPE, AND WELL SCREEN DATA:

| Dia. (in.) | New or Used | Steel, Plastic, etc. Perf., Slotted, etc. Screen Mfg., if commercial | Setting (ft.) From | Setting (ft.) To | Gage Casting Screen |
|---|---|---|---|---|---|
| 2 | N | PVC Screen | 33.0 | 13.0 | .010 |
| | | MFG. TRI-LOC | | | |
| 2 | N | PVC Riser | 13.0 | +2.0 | |

9) CEMENTING DATA [Rule 338.44(1)]
Cemented from 8.0 ft. to 0.0 ft. No. of sacks used 1.0
____ ft. to ____ ft. No. of sacks used ____
Method used ____
Cemented by PSI Inc
Distance to septic system field lines or other concentrated contamination ____ ft.
Method of verification of above distance ____

13) TYPE PUMP: N/A
☐ Turbine ☐ Jet ☐ Submersible ☐ Cylinder
☐ Other ____
Depth to pump bowls, cylinder, jet, etc., ____ ft.

10) SURFACE COMPLETION
☑ Specified Surface Slab Installed [Rule 338.44(2)(A)]
☐ Specified Steel Sleeve Installed [Rule 338.44(3)(A)]
☐ Pitless Adapter Used [Rule 338.44(3)(b)]
☐ Approved Alternative Procedure Used [Rule 338.71]

14) WELL TESTS: N/A
Type test: ☐ Pump ☐ Bailer ☐ Jetted ☐ Estimated
Yield: ____ gpm with ____ ft. drawdown after ____ hrs.

11) WATER LEVEL: N/A
Static level ____ ft. below land surface Date ____
Artesian flow ____ gpm. Date ____

15) WATER QUALITY:
Did you knowingly penetrate any strata which contained undesirable constituents?
☐ Yes ☑ No If yes, submit "REPORT OF UNDESIRABLE WATER"
Type of water? ____ Depth of strata ____
Was a chemical analysis made? ☐ Yes ☐ No

12) PACKERS:

| Packers | Type | Depth |
|---|---|---|
| Bentonite pellets | 1/4 | 10.0-8.0 |

I hereby certify that this well was drilled by me (or under my supervision) and that each and all of the statements herein are true to the best of my knowledge and belief. I understand that failure to complete items 1 thru 15 will result in the log(s) being returned for completion and resubmittal.

COMPANY NAME PSI Inc (Type or print) WELL DRILLER'S LICENSE NO. 4694-M

ADDRESS Rio Road (Street or RFD) Corpus Christi (City) TX (State) 78416 (Zip)

(Signed) [signature] (Licensed Well Driller) (Signed) ____ (Registered Driller Trainee)

Please attach electric log, chemical analysis, and other pertinent information, if available.

TNRCC-0199 (Rev. 05-21-96) White DRILLER Pink WELL OWNER

K-8
MW-18

Send original copy by certified return receipt requested TNRCC, MC 177, P.O. Box 13087, Austin, TX 78711-3087

ATTENTION OWNER: Confidentiality Privilege Notice on reverse side of Well Owner's copy (pink)

# State of Texas WELL REPORT

Texas Water Well Drillers Advisory Council
MC 177
P.O. Box 13087
Austin, TX 78711-3087
512-239-0530

1) OWNER: City of Kingsville (Name) ADDRESS: P.O. Box 1458 (Street or RFD) Kingsville (City) TX (State) 78363 (Zip)

2) ADDRESS OF WELL: County: Kleberg — Kingsville Landfill (Street, RFD or other) Kingsville (City) TX (State) (Zip) GRID # 83-34-4

3) TYPE OF WORK (Check): ☑ New Well ☐ Deepening ☐ Reconditioning ☐ Plugging

4) PROPOSED USE (Check): ☑ Monitor ☐ Environmental Soil Boring ☐ Domestic ☐ Industrial ☐ Irrigation ☐ Injection ☐ Public Supply ☐ De-watering ☐ Testwell
If Public Supply well, were plans submitted to the TNRCC? ☐ Yes ☐ No

5) MW-18 (SB-18)

6) WELL LOG:
Date Drilling:
Started 7-9 19 97
Completed 7-9 19 97

DIAMETER OF HOLE

| Dia. (in.) | From (ft.) | To (ft.) |
|---|---|---|
| 8.0 | Surface | 42.0 |
| | | |

7) DRILLING METHOD (Check): ☐ Driven ☐ Air Rotary ☐ Mud Rotary ☑ Bored ☐ Air Hammer ☐ Cable Tool ☐ Jetted ☐ Other ______

| From (ft.) | To (ft.) | Description and color of formation material |
|---|---|---|
| | | See attached logs |

(Use reverse side of Well Owner's copy, if necessary)

8) Borehole Completion (Check): ☐ Open Hole ☐ Straight Wall ☐ Underreamed ☐ Gravel Packed ☑ Other 16/30 Silica
If Gravel Packed give interval ... from 42.0 ft. to 19.0 ft.

CASING, BLANK PIPE, AND WELL SCREEN DATA:

| Dia. (in.) | New or Used | Steel, Plastic, etc. Perf., Slotted, etc. Screen Mfg., if commercial | Setting (ft.) From | Setting (ft.) To | Gage Casting Screen |
|---|---|---|---|---|---|
| 2 | N | PVC Screen | 42.0 | 22.0 | .010 |
| | | MFG. Tri-Loc | | | |
| 2 | N | PVC Riser | | | |

9) CEMENTING DATA [Rule 338.44(1)]
Cemented from 17.0 ft. to 3.0 ft. No. of sacks used 3.0
______ ft. to ______ ft. No. of sacks used ______
Method used ______
Cemented by PSI Inc
Distance to septic system field lines or other concentrated contamination ______ ft.
Method of verification of above distance ______

10) SURFACE COMPLETION
☑ Specified Surface Slab Installed [Rule 338.44(2)(A)]
☐ Specified Steel Sleeve Installed [Rule 338.44(3)(A)]
☐ Pitless Adapter Used [Rule 338.44(3)(b)]
☐ Approved Alternative Procedure Used [Rule 338.71]

11) WATER LEVEL: N/A
Static level ______ ft. below land surface Date ______
Artesian flow ______ gpm. Date ______

12) PACKERS: Type Depth
Bentonite pellets 1/2" 19.0-17.0

13) TYPE PUMP: N/A
☐ Turbine ☐ Jet ☐ Submersible ☐ Cylinder
☐ Other ______
Depth to pump bowls, cylinder, jet, etc., ______ ft.

14) WELL TESTS: N/A
Type test: ☐ Pump ☐ Bailer ☐ Jetted ☐ Estimated
Yield: ______ gpm with ______ ft. drawdown after ______ hrs.

15) WATER QUALITY:
Did you knowingly penetrate any strata which contained undesirable constituents?
☐ Yes ☑ No If yes, submit "REPORT OF UNDESIRABLE WATER"
Type of water? ______ Depth of strata ______
Was a chemical analysis made? ☐ Yes ☐ No

I hereby certify that this well was drilled by me (or under my supervision) and that each and all of the statements herein are true to the best of my knowledge and belief. I understand that failure to complete items 1 thru 15 will result in the log(s) being returned for completion and resubmittal.

COMPANY NAME PSI Inc (Type or print) WELL DRILLER'S LICENSE NO. 4694-M

ADDRESS 810 (PTO) (Street or RFD) Corpus Christi (City) TX (State) 78416 (Zip)

(Signed) Craig [signature] (Licensed Well Driller) (Signed) ______ (Registered Driller Trainee)

Please attach electric log, chemical analysis, and other pertinent information, if available.

K-9
MW-21

Send original copy by certified return receipt requested mail to: TNRCC, MC 177, P.O. Box 13087, Austin, TX 78711-3087

ATTENTION OWNER: *Confidentiality Privilege Notice on on reverse side of Well Owner's copy (pink)*

# State of Texas
# WELL REPORT

Texas Water Well Drillers Advisory Council
MC 177
P.O. Box 13087
Austin, TX 78711-3087
512-239-0530

1) OWNER City of Kingsville (Name) ADDRESS P.O. Box 1458 (Street or RFD) Kingsville (City) Texas (State) 78363 (Zip)

2) ADDRESS OF WELL: County Kleberg Kingsville Landfill (Street, RFD or other) Kingsville (City) Texas (State) (Zip) GRID # 83-34-4

3) TYPE OF WORK (Check): [x] New Well ☐ Deepening ☐ Reconditioning [x] Plugging

4) PROPOSED USE (Check): ☐ Monitor [x] Environmental Soil Boring ☐ Domestic ☐ Industrial ☐ Irrigation ☐ Injection ☐ Public Supply ☐ De-watering ☐ Testwell
If Public Supply well, were plans submitted to the TNRCC? ☐ Yes ☐ No

5)

6) WELL LOG:
Date Drilling:
Started 4-27 19 98
Completed 4-27 19 98

| DIAMETER OF HOLE | | |
|---|---|---|
| Dia. (in.) | From (ft.) | To (ft.) |
| 6.0 | Surface | 84.0 |

7) DRILLING METHOD (Check): ☐ Driven ☐ Air Rotary ☐ Mud Rotary [x] Bored ☐ Air Hammer ☐ Cable Tool ☐ Jetted ☐ Other

N

| From (ft.) | To (ft.) | Description and color of formation material |
|---|---|---|
| see attached log | | MW-21 |

*(Use reverse side of Well Owner's copy, if necessary)*

8) Borehole Completion (Check): ☐ Open Hole ☐ Straight Wall ☐ Underreamed ☐ Gravel Packed [x] Other grout
If Gravel Packed give interval ... from ____ ft. to ____ ft.

CASING, BLANK PIPE, AND WELL SCREEN DATA: N/A

| Dia. (in.) | New or Used | Steel, Plastic, etc. Perf., Slotted, etc. Screen Mfg., if commercial | Setting (ft.) From | To | Gage Casting Screen |
|---|---|---|---|---|---|
| | | | | | |

9) CEMENTING DATA [Rule 338.44(1)]
Cemented from 84.0 ft. to 0.0 ft. No. of sacks used 12.5
____ ft. to ____ ft. No. of sacks used ____
Method used mixed with 5% bentonite
Cemented by PSI Inc.
Distance to septic system field lines or other concentrated contamination ____ ft.
Method of verification of above distance ____

10) SURFACE COMPLETION N/A
☐ Specified Surface Slab Installed [Rule 338.44(2)(A)]
☐ Specified Steel Sleeve Installed [Rule 338.44(3)(A)]
☐ Pitless Adapter Used [Rule 338.44(3)(b)]
☐ Approved Alternative Procedure Used [Rule 338.71]

11) WATER LEVEL: N/AS
Static level ____ ft. below land surface Date ____
Artesian flow ____ gpm. Date ____

12) PACKERS: N/A Type Depth

13) TYPE PUMP: N/A
☐ Turbine ☐ Jet ☐ Submersible ☐ Cylinder
☐ Other ____
Depth to pump bowls, cylinder, jet, etc., ____ ft.

14) WELL TESTS: N/A
Type test: ☐ Pump ☐ Bailer ☐ Jetted ☐ Estimated
Yield: ____ gpm with ____ ft. drawdown after ____ hrs.

15) WATER QUALITY:
Did you knowingly penetrate any strata which contained undesirable constituents?
☐ Yes [x] No If yes, submit "REPORT OF UNDESIRABLE WATER"
Type of water? ____ Depth of strata ____
Was a chemical analysis made? ☐ Yes ☐ No

I hereby certify that this well was drilled by me (or under my supervision) and that each and all of the statements herein are true to the best of my knowledge and belief. I understand that failure to complete items 1 thru 15 will result in the log(s) being returned for completion and resubmittal.

COMPANY NAME PSI Inc. (Type or print) WELL DRILLER'S LICENSE NO. 4694-M

ADDRESS 810 SPID (Street or RFD) Corpus Christi (City) Texas (State) 78416 (Zip)

(Signed) Craig Sikema (Licensed Well Driller) (Signed) ____ (Registered Driller Trainee)

**Please attach electric log, chemical analysis, and other pertinent information, if available.**

TNRCC-0199 (Rev. 05-21-96)

K-10
MW-23

Send original copy by certified return receipt requested mail to: TNRCC, MC 177, P.O. Box 13087, Austin, TX 78711-3087

ATTENTION OWNER: *Confidentiality Privilege Notice on on reverse side of Well Owner's copy (pink)*

# State of Texas WELL REPORT

Texas Water Well Drillers Advisory Council
MC 177
P.O. Box 13087
Austin, TX 78711-3087
512-239-0530

1) OWNER Kingsville City of (Name) ADDRESS P.O. Box 1456 Kingsville Texas 78363 (Street or RFD) (City) (State) (Zip)

2) ADDRESS OF WELL: County Kleberg Kingsville Landfill Kingsville Texas (Street, RFD or other) (City) (State) (Zip) GRID # 83-34-4

3) TYPE OF WORK (Check): ☒ New Well ☐ Deepening ☐ Reconditioning ☒ Plugging

4) PROPOSED USE (Check): ☐ Monitor ☒ Environmental Soil Boring ☐ Domestic ☐ Industrial ☐ Irrigation ☐ Injection ☐ Public Supply ☐ De-watering ☐ Testwell
If Public Supply well, were plans submitted to the TNRCC? ☐ Yes ☐ No

5)

N

6) WELL LOG:
Date Drilling:
Started 4-24 19 98
Completed 4-24 19 95

DIAMETER OF HOLE

| Dia. (in.) | From (ft.) | To (ft.) |
|---|---|---|
| 6.0 | Surface | 86.0 |
| | | |

7) DRILLING METHOD (Check): ☐ Driven ☐ Air Rotary ☐ Mud Rotary ☒ Bored ☐ Air Hammer ☐ Cable Tool ☐ Jetted ☐ Other

| From (ft.) | To (ft.) | Description and color of formation material |
|---|---|---|
| see attached log | | MW-23 |

*(Use reverse side of Well Owner's copy, if necessary)*

8) Borehole Completion (Check): ☐ Open Hole ☐ Straight Wall ☐ Underreamed ☐ Gravel Packed ☒ Other grout
If Gravel Packed give interval ... from ____ ft. to ____ ft.

CASING, BLANK PIPE, AND WELL SCREEN DATA: N/A

| Dia. (in.) | New or Used | Steel, Plastic, etc. Perf., Slotted, etc. Screen Mfg., if commercial | Setting (ft.) From | Setting (ft.) To | Gage Casting Screen |
|---|---|---|---|---|---|
| | | | | | |

9) CEMENTING DATA [Rule 338.44(1)]
Cemented from 86.0 ft. to 0.0 ft. No. of sacks used 12.5
____ ft. to ____ ft. No. of sacks used ____
Method used -mixed with 5% bentonite
Cemented by PSI Inc.
Distance to septic system field lines or other concentrated contamination ____ ft.
Method of verification of above distance ____

13) TYPE PUMP: N/A
☐ Turbine ☐ Jet ☐ Submersible ☐ Cylinder
☐ Other ____
Depth to pump bowls, cylinder, jet, etc., ____ ft.

10) SURFACE COMPLETION N/A
☐ Specified Surface Slab Installed [Rule 338.44(2)(A)]
☐ Specified Steel Sleeve Installed [Rule 338.44(3)(A)]
☐ Pitless Adapter Used [Rule 338.44(3)(b)]
☐ Approved Alternative Procedure Used [Rule 338.71]

14) WELL TESTS: N/A
Type test: ☐ Pump ☐ Bailer ☐ Jetted ☐ Estimated
Yield: ____ gpm with ____ ft. drawdown after ____ hrs.

11) WATER LEVEL: N/A
Static level ____ ft. below land surface Date ____
Artesian flow ____ gpm. Date ____

15) WATER QUALITY:
Did you knowingly penetrate any strata which contained undesirable constituents?
☐ Yes ☒ No If yes, submit "REPORT OF UNDESIRABLE WATER"
Type of water? ____ Depth of strata ____
Was a chemical analysis made? ☐ Yes ☐ No

12) PACKERS: N/A Type Depth

I hereby certify that this well was drilled by me (or under my supervision) and that each and all of the statements herein are true to the best of my knowledge and belief. I understand that failure to complete items 1 thru 15 will result in the log(s) being returned for completion and resubmittal.

COMPANY NAME PSI INc. (Type or print) WELL DRILLER'S LICENSE NO. 4694-M

ADDRESS 810 SPID (Street or RFD) Corpus Christi (City) Texas (State) 78416 (Zip)

(Signed) [signature] (Licensed Well Driller) (Signed) ____ (Registered Driller Trainee)

**Please attach electric log, chemical analysis, and other pertinent information, if available.**

TNRCC 0199 (Rev. 05-21-96)

K-11
MW-24

Send original copy by certified return receipt requested mail to: TNRCC, MC 177, P.O. Box 13087, Austin, TX 78711-3087

ATTENTION OWNER: *Confidentiality Privilege Notice on on reverse side of Well Owner's copy (pink)*

# State of Texas
# WELL REPORT

Texas Water Well Drillers Advisory Council
MC 177
P.O. Box 13087
Austin, TX 78711-3087
512-239-0530

1) OWNER City of Kingsville (Name) ADDRESS P.O. Box 1458 (Street or RFD) Kingsville (City) Texas (State) 78363 (Zip)

2) ADDRESS OF WELL: County Kleberg Kingsville Landfill (Street, RFD or other) Kingsville (City) Texas (State) (Zip) GRID # 83-34-4

3) TYPE OF WORK (Check): ☒ New Well ☐ Deepening ☐ Reconditioning ☐ Plugging

4) PROPOSED USE (Check): ☒ Monitor ☐ Environmental Soil Boring ☐ Domestic ☐ Industrial ☐ Irrigation ☐ Injection ☐ Public Supply ☐ De-watering ☐ Testwell
If Public Supply well, were plans submitted to the TNRCC? ☐ Yes ☐ No

5)

6) WELL LOG:
Date Drilling:
Started 4-28 19 98
Completed 4-29 19 98

DIAMETER OF HOLE

| Dia. (in.) | From (ft.) | To (ft.) |
|---|---|---|
| 6.0 | Surface | 72.0 |
| 11.0 | | 33.0 |

7) DRILLING METHOD (Check): ☐ Driven ☐ Air Rotary ☐ Mud Rotary ☒ Bored ☐ Air Hammer ☐ Cable Tool ☐ Jetted ☐ Other

| From (ft.) | To (ft.) | Description and color of formation material |
|---|---|---|
| see attached log | | MW-24 |

*(Use reverse side of Well Owner's copy, if necessary)*

8) Borehole Completion (Check): ☐ Open Hole ☐ Straight Wall ☐ Underreamed ☐ Gravel Packed ☒ Other 16/30 silica sand
If Gravel Packed give interval ... from 33.0 ft. to 16.0 ft.

CASING, BLANK PIPE, AND WELL SCREEN DATA:

| Dia. (in.) | New or Used | Steel, Plastic, etc. Perf., Slotted, etc. Screen Mfg., if commercial | Setting (ft.) From | To | Gage Casting Screen |
|---|---|---|---|---|---|
| 4 | N | Pvc screen Mfg. National Wells&Supply | 33.0 | 16.0 | .010 |
| 4 | N | Pvc risear | 16.0, | +2.5 | |

9) CEMENTING DATA [Rule 338.44(1)]
Cemented from 72.0 ft. to 33.0 ft. No. of sacks used 6.0
14.0 ft. to 0.0 ft. No. of sacks used 1.5
Method used mixed with 5% bentonite
Cemented by PSI INc.
Distance to septic system field lines or other concentrated contamination ____ ft.
Method of verification of above distance

10) SURFACE COMPLETION
☒ Specified Surface Slab Installed [Rule 338.44(2)(A)]
☐ Specified Steel Sleeve Installed [Rule 338.44(3)(A)]
☐ Pitless Adapter Used [Rule 338.44(3)(b)]
☐ Approved Alternative Procedure Used [Rule 338.71]

11) WATER LEVEL: N/A
Static level ____ ft. below land surface Date ____
Artesian flow ____ gpm. Date ____

12) PACKERS:

| | Type | Depth |
|---|---|---|
| bentonite pellets | 4' | 16'-14' |

13) TYPE PUMP: N/A
☐ Turbine ☐ Jet ☐ Submersible ☐ Cylinder
☐ Other
Depth to pump bowls, cylinder, jet, etc., ____ ft.

14) WELL TESTS: N/A
Type test: ☐ Pump ☐ Bailer ☐ Jetted ☐ Estimated
Yield: ____ gpm with ____ ft. drawdown after ____ hrs.

15) WATER QUALITY:
Did you knowingly penetrate any strata which contained undesirable constituents?
☐ Yes ☒ No If yes, submit "REPORT OF UNDESIRABLE WATER"
Type of water? ____ Depth of strata ____
Was a chemical analysis made? ☐ Yes ☐ No

I hereby certify that this well was drilled by me (or under my supervision) and that each and all of the statements herein are true to the best of my knowledge and belief. I understand that failure to complete items 1 thru 15 will result in the log(s) being returned for completion and resubmittal.

COMPANY NAME PSI Inc. (Type or print) WELL DRILLER'S LICENSE NO. 4694-M

ADDRESS 810 SPID (Street or RFD) Corpus Christi (City) Texas (State) 78416 (Zip)

(Signed) Craig Schen (Licensed Well Driller) (Signed) ____ (Registered Driller Trainee)

Please attach electric log, chemical analysis, and other pertinent information, if available.

K-12
MW-25

Send original copy by certified return receipt requested mail to: TNRCC, MC 177, P.O. Box 13087, Austin, TX 78711-3087

ATTENTION OWNER: *Confidentiality Privilege Notice on on reverse side of Well Owner's copy (pink)*

# State of Texas WELL REPORT

Texas Water Well Drillers Advisory Council
MC 177
P.O. Box 13087
Austin, TX 78711-3087
512-239-0530

1) OWNER City of Kingsville (Name) ADDRESS P.O. Box 1458 (Street or RFD) Kingsville (City) Texas (State) 78363 (Zip)

2) ADDRESS OF WELL: County Kleberg — Kingsville Landfill (Street, RFD or other) Kingsville (City) Texas (State) (Zip) GRID # 83-34-4

3) TYPE OF WORK (Check): ☒ New Well ☐ Deepening ☐ Reconditioning ☒ Plugging

4) PROPOSED USE (Check): ☐ Monitor ☒ Environmental Soil Boring ☐ Domestic ☐ Industrial ☐ Irrigation ☐ Injection ☐ Public Supply ☐ De-watering ☐ Testwell
If Public Supply well, were plans submitted to the TNRCC? ☐ Yes ☐ No

5)

N

6) WELL LOG:
Date Drilling:
Started 4-29 19 98
Completed 4629 1998

DIAMETER OF HOLE

| Dia. (in.) | From (ft.) | To (ft.) |
|---|---|---|
| 6.0 | Surface | 86.0 |
| | | |
| | | |

7) DRILLING METHOD (Check): ☐ Driven ☐ Air Rotary ☐ Mud Rotary ☒ Bored ☐ Air Hammer ☐ Cable Tool ☐ Jetted ☐ Other

| From (ft.) | To (ft.) | Description and color of formation material |
|---|---|---|
| see attached log | | MW-25 |

*(Use reverse side of Well Owner's copy, if necessary)*

8) Borehole Completion (Check): ☐ Open Hole ☐ Straight Wall ☐ Underreamed ☐ Gravel Packed ☒ Other grout
If Gravel Packed give interval ... from ____ ft. to ____ ft.

CASING, BLANK PIPE, AND WELL SCREEN DATA: N/A

| Dia. (in.) | New or Used | Steel, Plastic, etc. Perf., Slotted, etc. Screen Mfg., if commercial | Setting (ft.) From | Setting (ft.) To | Gage Casting Screen |
|---|---|---|---|---|---|
| | | | | | |
| | | | | | |
| | | | | | |

9) CEMENTING DATA [Rule 338.44(1)]
Cemented from 86.0 ft. to 0.0 ft. No. of sacks used 13.0
____ ft. to ____ ft. No. of sacks used ____
Method used mixedwwith 5% bentonite
Cemented by PSI Inc.
Distance to septic system field lines or other concentrated contamination ____ ft.
Method of verification of above distance ____

13) TYPE PUMP: N/A
☐ Turbine ☐ Jet ☐ Submersible ☐ Cylinder
☐ Other ____
Depth to pump bowls, cylinder, jet, etc., ____ ft.

10) SURFACE COMPLETION N/A
☐ Specified Surface Slab Installed [Rule 338.44(2)(A)]
☐ Specified Steel Sleeve Installed [Rule 338.44(3)(A)]
☐ Pitless Adapter Used [Rule 338.44(3)(b)]
☐ Approved Alternative Procedure Used [Rule 338.71]

14) WELL TESTS: N/A
Type test: ☐ Pump ☐ Bailer ☐ Jetted ☐ Estimated
Yield: ____ gpm with ____ ft. drawdown after ____ hrs.

11) WATER LEVEL: N/A
Static level ____ ft. below land surface Date ____
Artesian flow ____ gpm. Date ____

15) WATER QUALITY:
Did you knowingly penetrate any strata which contained undesirable constituents?
☐ Yes ☒ No If yes, submit "REPORT OF UNDESIRABLE WATER"
Type of water? ____ Depth of strata ____
Was a chemical analysis made? ☐ Yes ☐ No

12) PACKERS: N/A Type Depth

I hereby certify that this well was drilled by me (or under my supervision) and that each and all of the statements herein are true to the best of my knowledge and belief. I understand that failure to complete items 1 thru 15 will result in the log(s) being returned for completion and resubmittal.

COMPANY NAME PSI Inc. (Type or print) WELL DRILLER'S LICENSE NO. 4694-M

ADDRESS 810 SPID (Street or RFD) Corpus Christit (City) Texas (State) 78416 (Zip)

(Signed) Craig Shaw (Licensed Well Driller) (Signed) ____ (Registered Driller Trainee)

**Please attach electric log, chemical analysis, and other pertinent information, if available.**

**Tolunay-Wong Engineers, Inc.**

**GEOTECHNICAL ENGINEERING STUDY**
**CITY OF KINGSVILLE MUNICIPAL SOLID**
**WASTE LANDFILL EXPANSION**
**KINGSVILLE, TEXAS**

For Permitting Purposes Only. Applies to boring logs in Appendix B of Tolunay-Wong Engineers, Inc. Geotechnical Engineering Study, City of Kingsville Municipal Solid Waste Landfill Expansion, Kingsville, Texas – Report No. 12788R1, sealed by Don R. Rokohl, P.E. on 8-30-18 altered to provide text showing surface elevations, ~~and~~ the elevations of all contacts between soil and rock layers, and unit identifiers in the soil boring logs. No information or data was altered or changed from the original report other than the addition of text showing these elevations and unit identifiers in Appendix B.

*Prepared for:*

**Naismith/Hanson**
**Corpus Christi, Texas**

*Prepared by:*

**Tolunay-Wong Engineers, Inc.**
**826 South Padre Island Drive**
**Corpus Christi, Texas 78416**

**August 30, 2018**

**Project No. 16.53.042 / Report No. 12788R1**

GEOTECHNICAL ENGINEERING, DEEP FOUNDATIONS TESTING, ENVIRONMENTAL SERVICES, CONSTRUCTION MATERIALS TESTING

1-888-887-9932
WWW.TWEINC.COM

# LOG OF BORING B-30

PROJECT: City of Kingsville
Municipal Solid Waste Landfill
Aerial Expansion

CLIENT: Naismith Engineering, Inc.

COORDINATES: N 27° 26' 44.0"
W 97° 49' 23.1"
SURFACE ELEVATION: 45.99' AMSL
DRILLING METHOD:
Dry Augered: 0-ft. to 82.5-ft.
Wash Bored: -- to --

| DEPTH (ft) | MATERIAL DESCRIPTION | (P) POCKET PEN (tsf) (T) TORVANE (psf) | STD. PENETRATION TEST (blows/ft) | MOISTURE CONTENT (%) | DRY UNIT WEIGHT (pcf) | LIQUID LIMIT (%) | PLASTICITY INDEX (%) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi) | PASSING #200 SIEVE (%) | OTHER TESTS PERFORMED |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | Dense to very dense tan and gray CLAYEY SAND (SC) with gypsum crystals | | 11/6" 23/6" 50/5" | 16 | | 42 | 17 | | | | 37 | |
| 5 | -color changes to tan with ferrous staining | | 34/6" 50/3" | | | | | | | | | |
| | -with sand partings | | 13/6" 50/3" | | | | | | | | | |
| 10 | | | | | | | | | | | | |
| | | | 7/6" 12/6" 20/6" | 35 | | | | | | | 33 | |
| 15 | | | | | | | | | | | | |
| | -color changes to reddish tan and light gray | | 6/6" 15/6" 20/6" | | | | | | | | | |
| 20 | 25.49' AMSL | | | | | | | | | | | |
| | Very stiff to hard reddish tan and light gray FAT CLAY (CH) with gypsum crystals<br>LIGHT OLIVE GREEN TO GRAY CLAY | | 10/6" 17/6" 26/6" | | | | | | | | | |
| 25 | -color changes to reddish tan and tan | | 10/6" 18/6" 30/6" | 25 | | 50 | 28 | | | | 92 | |
| | -color changes to tan and reddish brown | | 8/6" 11/6" 16/6" | | | | | | | | | |
| 30 | | | | | | | | | | | | |
| | -color changes to tan and gray | | 8/6" 12/6" 18/6" | | | | | | | | | |
| 35 | | | | | | | | | | | | |

COMPLETION DEPTH: 82.5 ft
DATE BORING STARTED: 07/22/2016
DATE BORING COMPLETED: 07/23/2016
LOGGER: J. Gonzalez
PROJECT NO.: 16.53.042

REMARKS: Free water was encounterd at an approximate depth of 21' below existing grade during drilling operations. After a 10 to 15-minute waiting period, water was at a depth of 10'-6". At the completion of the boring, the open bore-hole was backfilled with cement-bentonite grout.

Page 1 of 3

TOLUNAY-WONG ENGINEERS, INC.

# LOG OF BORING B-30

PROJECT: City of Kingsville
Municipal Solid Waste Landfill
Aerial Expansion

CLIENT: Naismith Engineering, Inc.

COORDINATES: N 27° 26' 44.0"
W 97° 49' 23.1"
SURFACE ELEVATION: 45.99' AMSL
DRILLING METHOD:
Dry Augered: 0-ft. to 82.5-ft.
Wash Bored: -- to --

| DEPTH (ft) | MATERIAL DESCRIPTION | (P) POCKET PEN (tsf) (T) TORVANE (psf) | STD. PENETRATION TEST (blows/ft) | MOISTURE CONTENT (%) | DRY UNIT WEIGHT (pcf) | LIQUID LIMIT (%) | PLASTICITY INDEX (%) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi) | PASSING #200 SIEVE (%) | OTHER TESTS PERFORMED |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 35 | Very stiff to hard reddish tan and tan FAT CLAY (CH) with gypsum crystals and ferrous stains<br>LIGHT OLIVE GREEN TO GRAY CLAY | | 10/6" 17/6" 21/6" | 30 | | | | | | | 90 | |
| 40 | -color changes to tan and reddish brown | | 9/6" 14/6" 21/6" | | | | | | | | | |
| 45 | | | 13/6" 19/6" 29/6" | | | | | | | | | |
| | -becomes sandy 48' to 52' | | 8/6" 11/6" 13/6" | 30 | | | | | | | 70 | |
| 50 | -color changes to tan and becomes slickensided | (P) 4.50+ | | 23 | 100 | 71 | 51 | | | | 87 | |
| 55 | | (P) 4.50+ | | | | | | | | | | |
| 60 | | (P) 4.50+ | | | | | | | | | | |
| 65 | -becomes sandy and color changes to tan and gray | (P) 4.50+ | | 26 | 97 | 54 | 30 | 1.75 | 3 | | 69 | |
| 70 | -color changes to tan and reddish brown with trace calcareous nodules | (P) 3.00 | | | | | | | | | | |

COMPLETION DEPTH: 82.5 ft
DATE BORING STARTED: 07/22/2016
DATE BORING COMPLETED: 07/23/2016
LOGGER: J. Gonzalez
PROJECT NO.: 16.53.042

REMARKS: Free water was encounterd at an approximate depth of 21' below existing grade during drilling operations. After a 10 to 15-minute waiting period, water was at a depth of 10'-6". At the completion of the boring, the open bore-hole was backfilled with cement-bentonite grout.

Page 2 of 3

TOLUNAY-WONG ENGINEERS, INC.

# LOG OF BORING B-31

PROJECT: City of Kingsville
Municipal Solid Waste Landfill
Aerial Expansion

CLIENT: Naismith Engineering, Inc.

COORDINATES: N 27° 26' 50.1"
W 97° 49' 24.3"
SURFACE ELEVATION: 58.37' AMSL
DRILLING METHOD:
Dry Augered: 0-ft. to 68-ft.
Wash Bored: -- to --

**MATERIAL DESCRIPTION**

| DEPTH (ft) | MATERIAL DESCRIPTION | (P) POCKET PEN (tsf) (T) TORVANE (psf) | STD. PENETRATION TEST (blows/ft) | MOISTURE CONTENT (%) | DRY UNIT WEIGHT (pcf) | LIQUID LIMIT (%) | PLASTICITY INDEX (%) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi) | PASSING #200 SIEVE (%) | OTHER TESTS PERFORMED |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | Medium dense to very dense gray CLAYEY SAND (SC) BODY I | | 4/6" 5/6" 7/6" | | | | | | | | | |
| | -with calcareous nodules and sand pockets | | 10/6" 22/6" 18/6" | | | | | | | | | |
| 5 | | | 4/6" 5/6" 6/6" | 11 | | | | | | | 46 | |
| | | | 5/6" 6/6" 8/6" | | | | | | | | | |
| | | | 6/6" 8/6" 12/6" | | | | | | | | | |
| 10 | -with cemented sand layers | | 8/6" 27/6" 29/6" | 27 | | | | | | | 22 | |
| | -color changes to tan<br>43.87' AMSL | | 18/6" 32/6" 39/6" | | | | | | | | | |
| 15 | Very dense tan POORLY GRADED SAND with CLAY (SP-SC) and sand partings BODY IV | | 36/6" 50/5" | | | | | | | | | |
| | | | 12/6" 50/5" | 15 | | | | | | | 9 | |
| | | | 45/6" 50/5" | | | | | | | | | |
| 20 | | | 35/6" 50/4" | | | | | | | | | |
| | | | 17/6" 26/6" 50/5" | | | | | | | | | |
| | 34.87' AMSL | | 17/6" 38/6" 38/6" | | | | | | | | | |
| 25 | Hard reddish tan and light gray SANDY LEAN SILTY CLAY (CL-ML) with sand partings | | 13/6" 20/6" 31/6" | 26 | | 29 | 7 | | | | 66 | |
| | | | 23/6" 34/6" 50/4" | | | | | | | | | |
| | | | 12/6" 17/6" 50/5" | | | | | | | | | |
| 30 | -color changes to reddish tan and tan with ferrous stains | | 13/6" 32/6" 50/5" | | | | | | | | | |
| | | | 7/6" 36/6" 39/6" | | | | | | | | | |
| | | | 10/6" 21/6" 36/6" | | | | | | | | | |
| 35 | | | 10/6" 18/6" 35/6" | 25 | | | | | | | 62 | |

COMPLETION DEPTH: 68 ft
DATE BORING STARTED: 07/20/2016
DATE BORING COMPLETED: 07/21/2016
LOGGER: J. Gonzalez
PROJECT NO.: 16.53.042

REMARKS: Free water was encounterd at an approximate depth of 23' below existing grade during drilling operations. After a 10 to 15-minute waiting period, water was at a depth of 21'-6". At the completion of the boring, the open bore-hole was backfilled with cement-bentonite grout.

Page 1 of 2

TOLUNAY-WONG ENGINEERS, INC.

# LOG OF BORING B-31

PROJECT: City of Kingsville
Municipal Solid Waste Landfill
Aerial Expansion

CLIENT: Naismith Engineering, Inc.

COORDINATES: N 27° 26' 50.1"
W 97° 49' 24.3"
SURFACE ELEVATION: 58.37' AMSL
DRILLING METHOD:
Dry Augered: 0-ft. to 68-ft.
Wash Bored: -- to --

| DEPTH (ft) | MATERIAL DESCRIPTION | (P) POCKET PEN (tsf) (T) TORVANE (psf) | STD. PENETRATION TEST (blows/ft) | MOISTURE CONTENT (%) | DRY UNIT WEIGHT (pcf) | LIQUID LIMIT (%) | PLASTICITY INDEX (%) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi) | PASSING #200 SIEVE (%) | OTHER TESTS PERFORMED |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 35 | Hard reddish tan and tan SANDY LEAN CLAY (CL) with ferrous stains and laminated sands | | 17/6"<br>25/6"<br>35/6"<br>17/6"<br>13/6"<br>19/6"<br>7/6"<br>16/6"<br>17/6" | | | | | | | | | |
| | 18.87' AMSL | | | | | | | | | | | |
| 40 | Very stiff to hard reddish tan and tan FAT CLAY with SAND (CH) and ferrous stains<br>LIGHT OLIVE GREEN TO GRAY CLAY | | 3/6"<br>7/6"<br>10/6"<br>9/6"<br>20/6"<br>27/6" | 37 | | 59 | 36 | | | | 76 | |
| 45 | -with trace gypsum crystals and ferrous stains | | 5/6"<br>14/6"<br>17/6"<br>10/6"<br>18/6"<br>21/6"<br>18/6"<br>23/6"<br>30/6"<br>6/6"<br>20/6"<br>21/6" | 30 | | | | | | | 83 | |
| 50 | | | 9/6"<br>17/6"<br>19/6"<br>9/6"<br>18/6"<br>23/6"<br>11/6"<br>23/6"<br>26/6" | | | | | | | | | |
| | -with calcareous nodules and ferrous stains | (P) 4.50+ | | 32 | 91 | 83 | 50 | 4.14 | 2 | | 87 | |
| 55 | | (P) 4.50+ | | | | | | | | | | |
| | | (P) 4.50+ | | | | | | | | | | |
| | | (P) 4.50+ | | 34 | 87 | | | 2.88 | 2 | | 83 | |
| 60 | -with trace gypsum crystals and ferrous stains | (P) 4.50+ | | | | | | | | | | |
| | | (P) 4.50+ | | | | | | | | | | |
| 65 | | (P) 4.50+ | | | | | | | | | | |
| | -9.63' AMSL | (P) 4.50+ | | | | | | | | | | |
| | Bottom @ 68' | | | | | | | | | | | |
| 70 | | | | | | | | | | | | |

COMPLETION DEPTH: 68 ft
DATE BORING STARTED: 07/20/2016
DATE BORING COMPLETED: 07/21/2016
LOGGER: J. Gonzalez
PROJECT NO.: 16.53.042

REMARKS: Free water was encounterd at an approximate depth of 23' below existing grade during drilling operations. After a 10 to 15-minute waiting period, water was at a depth of 21'-6". At the completion of the boring, the open bore-hole was backfilled with cement-bentonite grout.

Page 2 of 2

TOLUNAY-WONG ENGINEERS, INC.

# LOG OF BORING B-32

PROJECT: City of Kingsville
Municipal Solid Waste Landfill
Aerial Expansion

CLIENT: Naismith Engineering, Inc.

COORDINATES: N 27° 26' 49.7"
W 97° 49' 17.0"
SURFACE ELEVATION: 48.46' AMSL
DRILLING METHOD:
Dry Augered: 0-ft. to 82.5-ft.
Wash Bored: -- to --

| DEPTH (ft) | MATERIAL DESCRIPTION | (P) POCKET PEN (tsf) (T) TORVANE (psf) | STD. PENETRATION TEST (blows/ft) | MOISTURE CONTENT (%) | DRY UNIT WEIGHT (pcf) | LIQUID LIMIT (%) | PLASTICITY INDEX (%) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi) | PASSING #200 SIEVE (%) | OTHER TESTS PERFORMED |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 35 | Medium dense to dense reddish tan and gray CLAYEY SAND (SC) with gypsum crystals 12.46' AMSL | | | | | | | | | | | |
| | Very stiff to hard tan FAT CLAY with SAND (CH), slickensided, with calcareous nodules | (P) 4.50+ | | 29 | 89 | | | | | | 79 | |
| | LIGHT OLIVE GREEN TO GRAY CLAY | | | | | | | | | | | |
| 40 | | | | | | | | | | | | |
| | -color changes to tan and reddish brown with gypsum crystals and ferrous stains | | 8/6" 12/6" 15/6" | | | | | | | | | |
| 45 | -color changes to tan, gray, and reddish brown | (P) 4.50+ | | | | | | | | | | |
| 50 | -color changes to tan and reddish brown | | 4/6" 9/6" 10/6" | 30 | | 73 | 51 | | | | 82 | |
| | | (P) 4.50+ | | | | | | | | | | |
| 55 | | | | | | | | | | | | |
| | -color changes to tan and gray | (P) 4.50+ | | | | | | | | | | |
| 60 | | | | | | | | | | | | |
| | | (P) 4.50+ | | 26 | 94 | | | 0.61 | 2 | | 81 | |
| 65 | -color changes to tan, red, and brown | (P) 4.00 | | | | | | | | | | |
| | -color changes to tan and gray | (P) 4.50+ | | | | | | | | | | |
| 70 | | | | | | | | | | | | |

COMPLETION DEPTH: 82.5 ft
DATE BORING STARTED: 07/27/2016
DATE BORING COMPLETED: 07/28/2016
LOGGER: J. Gonzalez
PROJECT NO.: 16.53.042

REMARKS: Free water was encounterd at an approximate depth of 18' below existing grade during drilling operations. After a 10 to 15-minute waiting period, water was at a depth of 14'-7". At the completion of the boring, the open bore-hole was backfilled with cement-bentonite grout.

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TOLUNAY-WONG ENGINEERS, INC.

# LOG OF BORING B-32

PROJECT: City of Kingsville Municipal Solid Waste Landfill Aerial Expansion

CLIENT: Naismith Engineering, Inc.

COORDINATES: N 27° 26' 49.7" W 97° 49' 17.0"
SURFACE ELEVATION: 48.46' AMSL
DRILLING METHOD:
Dry Augered: 0-ft. to 82.5-ft.
Wash Bored: -- to --

| DEPTH (ft) | MATERIAL DESCRIPTION | (P) POCKET PEN (tsf) (T) TORVANE (psf) | STD. PENETRATION TEST (blows/ft) | MOISTURE CONTENT (%) | DRY UNIT WEIGHT (pcf) | LIQUID LIMIT (%) | PLASTICITY INDEX (%) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi) | PASSING #200 SIEVE (%) | OTHER TESTS PERFORMED |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 70 | Very stiff to hard tan and gray FAT CLAY with SAND (CH), slickensided with gypsum crystals and calcareous nodules LIGHT OLIVE GREEN TO GRAY CLAY<br>-24.54' AMSL | | | | | | | | | | | |
| | Medium dense to dense tan CLAYEY SAND (SC) with calcareous nodules | (P) 0.75 | | 21 | | 24 | 8 | | | | 24 | |
| 75 | | | | | | | | | | | | |
| | -with gypsum crystals and ferrous stains | | 5/6"<br>10/6"<br>13/6" | | | | | | | | | |
| 80 | | | 13/6"<br>20/6"<br>20/6" | | | | | | | | | |
| | -34.04' AMSL | | | | | | | | | | | |
| | Bottom @ 82.5' | | | | | | | | | | | |
| 85 | | | | | | | | | | | | |
| 90 | | | | | | | | | | | | |
| 95 | | | | | | | | | | | | |
| 100 | | | | | | | | | | | | |
| 105 | | | | | | | | | | | | |

COMPLETION DEPTH: 82.5 ft
DATE BORING STARTED: 07/27/2016
DATE BORING COMPLETED: 07/28/2016
LOGGER: J. Gonzalez
PROJECT NO.: 16.53.042

REMARKS: Free water was encounterd at an approximate depth of 18' below existing grade during drilling operations. After a 10 to 15-minute waiting period, water was at a depth of 14'-7". At the completion of the boring, the open bore-hole was backfilled with cement-bentonite grout.

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TOLUNAY-WONG ENGINEERS, INC.

# LOG OF BORING B-33

PROJECT: City of Kingsville
Municipal Solid Waste Landfill
Aerial Expansion

CLIENT: Naismith Engineering, Inc.

COORDINATES: N 27° 26' 55.9"
W 97° 49' 11.3"
SURFACE ELEVATION: 64.51' AMSL
DRILLING METHOD:
Dry Augered: 0-ft. to 86-ft.
Wash Bored: -- to --

| DEPTH (ft) | MATERIAL DESCRIPTION | (P) POCKET PEN (tsf) (T) TORVANE (psf) | STD. PENETRATION TEST (blows/ft) | MOISTURE CONTENT (%) | DRY UNIT WEIGHT (pcf) | LIQUID LIMIT (%) | PLASTICITY INDEX (%) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi) | PASSING #200 SIEVE (%) | OTHER TESTS PERFORMED |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | Medium dense to very dense tan CLAYEY SAND (SC) with gypsum crystals BODY I | | 2/6" 7/6" 9/6" | | | | | | | | | |
| 5 | -color changes to dark gray and gray with trace gravel | | 7/6" 11/6" 9/6" | 16 | | | | | | | 47 | |
| 10 | -color changes to tan and light gray sand partings | | 27/6" 50/6" | | | | | | | | | |
| | -color changes to tan and white with trace caliche | | 50/5" | | | | | | | | | |
| 15 | 48.01' AMSL | | | | | | | | | | | |
| | Dense to very dense tan and white POORLY GRADED SAND with SILT (SP-SM), and trace caliche BODY II | | 17/6" 48/6" 50/3" | 11 | | 35 | 8 | | | | 12 | |
| 20 | | | 17/6" 21/6" 27/6" | | | | | | | | | |
| 25 | -color changes to light gray and tan with gypsum crystals and ferrous stains | | 15/6" 17/6" 32/6" | | | | | | | | | |
| | 36.01' AMSL | | | | | | | | | | | |
| 30 | Medium dense to dense gray and white CLAYEY SAND (SC) with gypsum crystals | | 14/6" 22/6" 26/6" | 42 | | | | | | | 20 | |
| | -color changes to tan | | 13/6" 21/6" 22/6" | | | | | | | | | |
| 35 | | | | | | | | | | | | |

COMPLETION DEPTH: 86 ft
DATE BORING STARTED: 08/05/2016
DATE BORING COMPLETED: 08/05/2016
LOGGER: J. Gonzalez
PROJECT NO.: 16.53.042

REMARKS: Free water was encounterd at an approximate depth of 32'-6" below existing grade during drilling operations. After a 10 to 15-minute waiting period, water was at a depth of 28'-2". At the completion of the boring, the open bore-hole was backfilled with cement-bentonite grout.

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TOLUNAY-WONG ENGINEERS, INC.

# LOG OF BORING B-33

PROJECT: City of Kingsville Municipal Solid Waste Landfill Aerial Expansion

CLIENT: Naismith Engineering, Inc.

COORDINATES: N 27° 26' 55.9" W 97° 49' 11.3"
SURFACE ELEVATION: 64.51' AMSL
DRILLING METHOD:
Dry Augered: 0-ft. to 86-ft.
Wash Bored: -- to --

| DEPTH (ft) | MATERIAL DESCRIPTION | (P) POCKET PEN (tsf) (T) TORVANE (psf) | STD. PENETRATION TEST (blows/ft) | MOISTURE CONTENT (%) | DRY UNIT WEIGHT (pcf) | LIQUID LIMIT (%) | PLASTICITY INDEX (%) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi) | PASSING #200 SIEVE (%) | OTHER TESTS PERFORMED |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 35 | Medium dense to dense reddish tan CLAYEY SAND (SC) with gypsum crystals and ferrous stains | | 6/6" 9/6" 12/6" | | | | | | | | | |
| 40 | -color changes to tan and reddish tan | | 8/6" 16/6" 18/6" | | | | | | | | | |
| | 20.01' AMSL | | | | | | | | | | | |
| 45 | Stiff to very stiff reddish tan LEAN CLAY with SAND (CL), slickensided, with ferrous stains<br>SANDY SILTY CLAY BED | | 9/6" 12/6" 18/6" | 29 | | 43 | 24 | | | | 79 | |
| 50 | -color changes to reddish tan and tan with gypsum crystals | | 5/6" 6/6" 9/6" | | | | | | | | | |
| | 12.51' AMSL | | | | | | | | | | | |
| | Stiff to very stiff LEAN CLAY (CL), slickensided, with ferrous stains<br>SANDY SILTY CLAY BED | (P) 2.00 | | 40 | 79 | | | 1.06 | 3 | | 96 | |
| 55 | -color changes to reddish brown and tan with gypsum crystals | (P) 3.50 | | | | | | | | | | |
| 60 | | (P) 4.00 | | 34 | 87 | | | | | | | |
| | -0.51' AMSL | | | | | | | | | | | |
| 65 | Very stiff to hard tan FAT CLAY (CH), slickensided, with gypsum crystals and ferrous stains<br>LIGHT OLIVE GREEN TO GRAY CLAY | (P) 4.50+ | | 32 | 42 | 64 | 33 | 2.57 | 2 | | 95 | |
| 70 | -color changes to tan and reddish brown | | 7/6" 12/6" 14/6" | | | | | | | | | |

COMPLETION DEPTH: 86 ft
DATE BORING STARTED: 08/05/2016
DATE BORING COMPLETED: 08/05/2016
LOGGER: J. Gonzalez
PROJECT NO.: 16.53.042

REMARKS: Free water was encounterd at an approximate depth of 32'-6" below existing grade during drilling operations. After a 10 to 15-minute waiting period, water was at a depth of 28'-2". At the completion of the boring, the open bore-hole was backfilled with cement-bentonite grout.

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TOLUNAY-WONG ENGINEERS, INC.

# LOG OF BORING B-33

PROJECT: City of Kingsville
Municipal Solid Waste Landfill
Aerial Expansion

CLIENT: Naismith Engineering, Inc.

COORDINATES: N 27° 26' 55.9"
W 97° 49' 11.3"
SURFACE ELEVATION: 64.51' AMSL
DRILLING METHOD:
Dry Augered: 0-ft. to 86-ft.
Wash Bored: -- to --

| DEPTH (ft) | MATERIAL DESCRIPTION | (P) POCKET PEN (tsf) (T) TORVANE (psf) | STD. PENETRATION TEST (blows/ft) | MOISTURE CONTENT (%) | DRY UNIT WEIGHT (pcf) | LIQUID LIMIT (%) | PLASTICITY INDEX (%) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi) | PASSING #200 SIEVE (%) | OTHER TESTS PERFORMED |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 70 | Very stiff to hard tan and reddish brown FAT CLAY (CH), slickensided, with gypsum crystals and ferrous stains LIGHT OLIVE GREEN TO GRAY CLAY | (P) 4.50+ | | | | | | | | | | |
| | -color changes to tan and light gray | | | | | | | | | | | |
| 75 | -with layers of calcareous nodules | | 9/6" 10/6" 21/6" | | | | | | | | | |
| | -15.49' AMSL | | | | | | | | | | | |
| 80 | Very stiff to hard tan FAT CLAY with SAND (CH) with gypsum crystals and ferrous stains LIGHT OLIVE GREEN TO GRAY CLAY | (P) 4.50+ | | 18 | 106 | | | 3.57 | 3 | | 77 | |
| | -color changes to tan and white | (P) 4.50+ | | | | | | | | | | |
| 85 | -21.49' AMSL | | | | | | | | | | | |
| | Bottom @ 86' | | | | | | | | | | | |
| 90 | | | | | | | | | | | | |
| 95 | | | | | | | | | | | | |
| 100 | | | | | | | | | | | | |
| 105 | | | | | | | | | | | | |

COMPLETION DEPTH: 86 ft
DATE BORING STARTED: 08/05/2016
DATE BORING COMPLETED: 08/05/2016
LOGGER: J. Gonzalez
PROJECT NO.: 16.53.042

REMARKS: Free water was encounterd at an approximate depth of 32'-6" below existing grade during drilling operations. After a 10 to 15-minute waiting period, water was at a depth of 28'-2". At the completion of the boring, the open bore-hole was backfilled with cement-bentonite grout.

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TOLUNAY-WONG ENGINEERS, INC.

# LOG OF BORING B-34

PROJECT: City of Kingsville
Municipal Solid Waste Landfill
Aerial Expansion

CLIENT: Naismith Engineering, Inc.

COORDINATES: N 27° 26' 43.4"
W 97° 49' 11.4"
SURFACE ELEVATION: 61.14' AMSL
DRILLING METHOD:
Dry Augered: 0 ft. to 30 ft.
Wash Bored: 30 ft. to 43 ft.

| DEPTH (ft) | SAMPLE TYPE | SYMBOL/USCS | MATERIAL DESCRIPTION | (P) POCKET PEN (tsf) (T) TORVANE (psf) | STD. PENETRATION TEST (blows/ft) | MOISTURE CONTENT (%) | DRY UNIT WEIGHT (pcf) | LIQUID LIMIT (%) | PLASTICITY INDEX (%) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi) | PASSING #200 SIEVE (%) | OTHER TESTS PERFORMED |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | | Medium dense dark gray, gray, and light gray CLAYEY SAND (SC) with trace of organics | | 2/6" 5/6" 6/6" | | | | | | | | | |
| | | | | (P) 4.50+ | | 15 | 112 | | | 2.53 | 6 | | 42 | |
| | | | 57.14' AMSL | | | | | | | | | | | |
| 5 | | | Very stiff to hard gray and light gray SANDY LEAN SILTY CLAY (CL-ML) with calcareous nodules | (P) 4.50+ | | 15 | 115 | 21 | 7 | | | | 59 | |
| | | | | (P) 4.50+ | | 14 | 114 | | | 6.13 | 4 | | 62 | |
| | | | -color changes to light gray | | | | | | | | | | | |
| | | | -color changes to light gray and tan | | 4/6" 12/6" 16/6" | | | | | | | | | |
| 10 | | | -color changes to white and light gray | | 11/6" 18/6" 16/6" | | | | | | | | | |
| | | | -becomes stiff | | 5/6" 6/6" 8/6" | | | | | | | | | |
| | | | 46.64' AMSL | | | | | | | | | | | |
| 15 | | | Medium dense to dense white and light gray SILTY SAND (SM) with calcareous nodules BODY II | | 4/6" 6/6" 8/6" | 17 | | 38 | 7 | | | | 31 | |
| | | | | | 4/6" 10/6" 19/6" | | | | | | | | | |
| | | | -color changes to light gray and tan with ferrous stains | | 23/6" 50/5" | | | | | | | | | |
| 20 | | | | | 23/6" 50/4" | | | | | | | | | |
| | | | -color changes to light gray | | 27/6" 35/6" 50/4" | 22 | | | | | | | 25 | |
| 25 | | | | | 5/6" 37/6" 45/6" | | | | | | | | | |
| | | | | | 20/6" 39/6" 37/6" | | | | | | | | | |
| | | | -becomes medium dense | | 8/6" 12/6" 9/6" | 26 | | 39 | 2 | | | | 28 | |
| 30 | | | | | 4/6" 12/6" 10/6" | 33 | | | | | | | 39 | |
| | | | | | 5/6" 6/6" 10/6" | | | | | | | | | |
| 35 | | | -color changes to tan and marine green | | 3/6" | | | | | | | | | |

COMPLETION DEPTH: 43 ft
DATE BORING STARTED: 06/22/2016
DATE BORING COMPLETED: 06/22/2016
LOGGER: J. Garcia
PROJECT NO.: 16.53.042

REMARKS: Free water was encounterd at an approximate depth of 31' below existing grade during drilling operations. After a 10 to 15-minute waiting period, water was at a depth of 28'-4". At the completion of the boring, the open bore-hole was backfilled with cement-bentonite grout.

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TOLUNAY-WONG ENGINEERS, INC.

# LOG OF BORING B-34

PROJECT: City of Kingsville
Municipal Solid Waste Landfill
Aerial Expansion

CLIENT: Naismith Engineering, Inc.

COORDINATES: N 27° 26' 43.4"
W 97° 49' 11.4"
SURFACE ELEVATION: 61.14' AMSL
DRILLING METHOD:
Dry Augered: 0 ft. to 30 ft.
Wash Bored: 30 ft. to 43 ft.

| DEPTH (ft) | SAMPLE TYPE | SYMBOL/USCS | MATERIAL DESCRIPTION | (P) POCKET PEN (tsf) (T) TORVANE (psf) | STD. PENETRATION TEST (blows/ft) | MOISTURE CONTENT (%) | DRY UNIT WEIGHT (pcf) | LIQUID LIMIT (%) | PLASTICITY INDEX (%) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi) | PASSING #200 SIEVE (%) | OTHER TESTS PERFORMED |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 35 | | | Medium dense tan and marine green SILTY SAND (SM) with sand lenses and trace organics 25.14' AMSL | | 8/6" 13/6" | | | | | | | | | |
| | | | Hard tan and light gray LEAN CLAY (CL) | (P) 4.50+ | | | | | | | | | | |
| | | | SANDY SILTY CLAY BED | (P) 4.50+ | | 30 | 91 | 40 | 17 | 0.93 | 1 | | 91 | |
| 40 | | | | (P) 4.50+ | | | | | | | | | | |
| | | | 18.14' AMSL | (P) 4.50+ | | | | | | | | | | |
| | | | Bottom @ 43' | | | | | | | | | | | |
| 45 | | | | | | | | | | | | | | |
| 50 | | | | | | | | | | | | | | |
| 55 | | | | | | | | | | | | | | |
| 60 | | | | | | | | | | | | | | |
| 65 | | | | | | | | | | | | | | |
| 70 | | | | | | | | | | | | | | |

COMPLETION DEPTH: 43 ft
DATE BORING STARTED: 06/22/2016
DATE BORING COMPLETED: 06/22/2016
LOGGER: J. Garcia
PROJECT NO.: 16.53.042

REMARKS: Free water was encounterd at an approximate depth of 31' below existing grade during drilling operations. After a 10 to 15-minute waiting period, water was at a depth of 28'-4". At the completion of the boring, the open bore-hole was backfilled with cement-bentonite grout.

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TOLUNAY-WONG ENGINEERS, INC.

# LOG OF BORING B-35

PROJECT: City of Kingsville
Municipal Solid Waste Landfill
Aerial Expansion

CLIENT: Naismith Engineering, Inc.

COORDINATES: N 27° 26' 50.5"
W 97° 48' 57.2"
SURFACE ELEVATION: 64.50' AMSL
DRILLING METHOD:
Dry Augered: 0-ft. to 72.5-ft.
Wash Bored: -- to --

| DEPTH (ft) | MATERIAL DESCRIPTION | (P) POCKET PEN (tsf) (T) TORVANE (psf) | STD. PENETRATION TEST (blows/ft) | MOISTURE CONTENT (%) | DRY UNIT WEIGHT (pcf) | LIQUID LIMIT (%) | PLASTICITY INDEX (%) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi) | PASSING #200 SIEVE (%) | OTHER TESTS PERFORMED |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | Medium dense tan and brown CLAYEY SAND (SC) with trace caliche | | 5/6" 8/6" 7/6" | | | | | | | | | |
| 5 | -color changes to reddish brown with ferrous stains | | 5/6" 8/6" 5/6" | 12 | | 31 | 17 | | | | 38 | |
| | 56.50' AMSL | | | | | | | | | | | |
| | Very stiff to hard reddish tan SANDY LEAN CLAY (CL) with gypsum crystals | (P) 4.50+ | | 14 | 117 | | | 2.22 | 3 | | 52 | |
| 10 | | | | | | | | | | | | |
| | -color changes to reddish tan and tan with ferrous stains | | 5/6" 10/6" 12/6" | | | | | | | | | |
| 15 | -color changes to reddish tan | (P) 4.50+ | | 17 | 109 | 42 | 25 | | | | | |
| 20 | -color changes to reddish tan and tan | (P) 4.50+ | | | | | | | | | | |
| | 40.50' AMSL | | | | | | | | | | | |
| 25 | Medium dense to dense reddish tan and tan CLAYEY SAND (SC) with gypsum crystals and ferrous stains BODY III | (P) 4.50+ | | 17 | 104 | | | 1.29 | 3 | | 40 | |
| 30 | -color changes to reddish tan | | 4/6" 7/6" 9/6" | | | | | | | | | |
| 35 | | | 8/6" 13/6" 20/6" | | | | | | | | | |

COMPLETION DEPTH: 72.5 ft
DATE BORING STARTED: 07/29/2016
DATE BORING COMPLETED: 07/29/2016
LOGGER: J. Gonzalez
PROJECT NO.: 16.53.042

REMARKS: Free water was encounterd at an approximate depth of 34' below existing grade during drilling operations. After a 10 to 15-minute waiting period, water was at a depth of 30'-9". At the completion of the boring, the open bore-hole was backfilled with cement-bentonite grout.

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TOLUNAY-WONG ENGINEERS, INC.

# LOG OF BORING B-35

PROJECT: City of Kingsville Municipal Solid Waste Landfill Aerial Expansion

CLIENT: Naismith Engineering, Inc.

COORDINATES: N 27° 26' 50.5" W 97° 48' 57.2"
SURFACE ELEVATION: 64.50' AMSL
DRILLING METHOD:
Dry Augered: 0-ft. to 72.5-ft.
Wash Bored: -- to --

| DEPTH (ft) | MATERIAL DESCRIPTION | (P) POCKET PEN (tsf) (T) TORVANE (psf) | STD. PENETRATION TEST (blows/ft) | MOISTURE CONTENT (%) | DRY UNIT WEIGHT (pcf) | LIQUID LIMIT (%) | PLASTICITY INDEX (%) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi) | PASSING #200 SIEVE (%) | OTHER TESTS PERFORMED |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 35 | 28.00' AMSL<br>Medium dense to dense reddish tan and tan CLAYEY SAND (SC) with gypsum crystals and ferrous stains | | | | | | | | | | | |
| | Hard tan and light gray FAT CLAY with SAND (CH), gypsum crystals, and ferrous stains<br>LIGHT OLIVE GREEN TO GRAY CLAY | | 17/6"<br>26/6"<br>30/6" | 25 | | 109 | 72 | | | | 77 | |
| 40 | -color changes to tan and reddish brown | | 8/6"<br>15/6"<br>24/6" | | | | | | | | | |
| 45 | -with sand partings | | 10/6"<br>16/6"<br>16/6" | | | | | | | | | |
| | 16.00' AMSL<br>Stiff to hard reddish brown and tan FAT CLAY (CH) with gypsum crystals and ferrous stains<br>LIGHT OLIVE GREEN TO GRAY CLAY | | 4/6"<br>7/6"<br>10/6" | 34 | | | | | | | 96 | |
| 50 | -becomes slickensided with sand layers | (P) 2.00 | | | | | | | | | | |
| 55 | -color changes to tan | | 4/6"<br>7/6"<br>10/6" | | | | | | | | | |
| 60 | | (P) 3.75 | | 33 | 89 | 90 | 67 | 3.88 | 4 | | 89 | |
| 65 | | (P) 4.25 | | | | | | | | | | |
| | -color changes to tan and reddish brown | (P) 4.50+ | | | | | | | | | | |
| 70 | | | | | | | | | | | | |

COMPLETION DEPTH: 72.5 ft
DATE BORING STARTED: 07/29/2016
DATE BORING COMPLETED: 07/29/2016
LOGGER: J. Gonzalez
PROJECT NO.: 16.53.042

REMARKS: Free water was encounterd at an approximate depth of 34' below existing grade during drilling operations. After a 10 to 15-minute waiting period, water was at a depth of 30'-9". At the completion of the boring, the open bore-hole was backfilled with cement-bentonite grout.

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TOLUNAY-WONG ENGINEERS, INC.

# LOG OF BORING B-36

PROJECT: City of Kingsville Municipal Solid Waste Landfill Aerial Expansion

CLIENT: Naismith Engineering, Inc.

COORDINATES: N 27° 26' 56.8" W 97° 49' 04.9"
SURFACE ELEVATION: 59.13' AMSL
DRILLING METHOD:
Dry Augered: 0-ft. to 22-ft.
Wash Bored: 22-ft. to 68-ft.

| DEPTH (ft) | MATERIAL DESCRIPTION | (P) POCKET PEN (tsf) (T) TORVANE (psf) | STD. PENETRATION TEST (blows/ft) | MOISTURE CONTENT (%) | DRY UNIT WEIGHT (pcf) | LIQUID LIMIT (%) | PLASTICITY INDEX (%) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi) | PASSING #200 SIEVE (%) | OTHER TESTS PERFORMED |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | Loose to medium dense dark gray and gray CLAYEY SAND (SC) BODY I | | | | | | | | | | | |
| | -with calcareous nodules | | 18/6" 20/6" 21/6" | 10 | | | | | | | 36 | |
| 5 | -color changes to light gray and tan | | 4/6" 5/6" 5/6" | | | | | | | | | |
| 10 | -color changes to tan | | 4/6" 5/6" 6/6" | 12 | | 47 | 28 | | | | 44 | |
| 15 | | | 2/6" 4/6" 6/6" | | | | | | | | | |
| | -color changes to light gray with ferrous stains | | 4/6" 10/6" 14/6" | | | | | | | | | |
| 20 | -becomes very dense and color changes to light gray and tan | | 15/6" 24/6" 50/6" | 25 | | | | | | | 32 | |
| 25 | | | 12/6" 14/6" 15/6" | | | | | | | | | |
| 30 | -becomes dense | | 5/6" 17/6" 27/6" | | | | | | | | | |
| 35 | | | 4/6" | | | | | | | | | |

COMPLETION DEPTH: 68 ft
DATE BORING STARTED: 06/24/2016
DATE BORING COMPLETED: 06/24/2016
LOGGER: J. Garcia
PROJECT NO.: 16.53.042

REMARKS: Free water was encounterd at an approximate depth of 23' below existing grade during drilling operations. After a 10 to 15-minute waiting period, water was at a depth of 18'-3". At the completion of the boring, the open bore-hole was backfilled with cement-bentonite grout.

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TOLUNAY-WONG ENGINEERS, INC.

# LOG OF BORING B-36

PROJECT: City of Kingsville
Municipal Solid Waste Landfill
Aerial Expansion

CLIENT: Naismith Engineering, Inc.

COORDINATES: N 27° 26' 56.8"
W 97° 49' 04.9"
SURFACE ELEVATION: 59.13' AMSL
DRILLING METHOD:
Dry Augered: 0-ft. to 22-ft.
Wash Bored: 22-ft. to 68-ft.

| DEPTH (ft) | MATERIAL DESCRIPTION | (P) POCKET PEN (tsf) (T) TORVANE (psf) | STD. PENETRATION TEST (blows/ft) | MOISTURE CONTENT (%) | DRY UNIT WEIGHT (pcf) | LIQUID LIMIT (%) | PLASTICITY INDEX (%) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi) | PASSING #200 SIEVE (%) | OTHER TESTS PERFORMED |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 35 | Medium dense light gray and tan CLAYEY SAND (SC) BODY I | | 7/6" 8/6" | | | | | | | | | |
| | -with sand seams, calcareous nodules, and ferrous staining | | 6/6" 10/6" 13/6" | 21 | | 47 | 30 | | | | 35 | |
| 40 | | | | | | | | | | | | |
| | -color changes to reddish brown and light gray | | 4/6" 8/6" 10/6" | | | | | | | | | |
| 45 | 13.13' AMSL | | | | | | | | | | | |
| | Stiff to very stiff reddish brown and light gray FAT CLAY (CH), slickensided, with ferrous staining LIGHT OLIVE GREEN TO GRAY CLAY | (P) 4.50+ | | | | | | | | | | |
| 50 | | | | | | | | | | | | |
| | -with sand seams and calcareous nodules | | 4/6" 6/6" 8/6" | 42 | | | | | | | 96 | |
| 55 | -color changes to light gray with sand layers | | 11/6" 12/6" 14/6" | | | | | | | | | |
| | -becomes hard | | 11/6" 21/6" 26/6" | 37 | | 70 | 44 | | | | 94 | |
| 60 | | | | | | | | | | | | |
| | | | 7/6" 8/6" 9/6" | | | | | | | | | |
| 65 | | | | | | | | | | | | |
| | -color changes to brown yellow, reddish brown, and light gray -8.87' AMSL | | 7/6" 10/6" 10/6" | | | | | | | | | |
| | Bottom @ 68' | | | | | | | | | | | |
| 70 | | | | | | | | | | | | |

COMPLETION DEPTH: 68 ft
DATE BORING STARTED: 06/24/2016
DATE BORING COMPLETED: 06/24/2016
LOGGER: J. Garcia
PROJECT NO.: 16.53.042

REMARKS: Free water was encounterd at an approximate depth of 23' below existing grade during drilling operations. After a 10 to 15-minute waiting period, water was at a depth of 18'-3". At the completion of the boring, the open bore-hole was backfilled with cement-bentonite grout.

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TOLUNAY-WONG ENGINEERS, INC.

# LOG OF BORING B-37

PROJECT: City of Kingsville
Municipal Solid Waste Landfill
Aerial Expansion

CLIENT: Naismith Engineering, Inc.

COORDINATES: N 27° 26' 57.1"
W 97° 49' 17.6"
SURFACE ELEVATION: 45.52' AMSL
DRILLING METHOD:
Dry Augered: 0-ft. to 12-ft.
Wash Bored: 12-ft. to 48-ft.

| DEPTH (ft) | MATERIAL DESCRIPTION | (P) POCKET PEN (tsf) (T) TORVANE (psf) | STD. PENETRATION TEST (blows/ft) | MOISTURE CONTENT (%) | DRY UNIT WEIGHT (pcf) | LIQUID LIMIT (%) | PLASTICITY INDEX (%) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi) | PASSING #200 SIEVE (%) | OTHER TESTS PERFORMED |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | Very dense light gray and tan SILTY SAND (SM)<br>BODY II | | | | | | | | | | | |
| | -with ferrous staining | | 6/6" 16/6" 50/5" | | | | | | | | | |
| 5 | | | | | | | | | | | | |
| | | | 11/6" 50/5" | 20 | | 33 | 9 | | | | 20 | |
| 10 | -with calcareous nodules | | 23/6" 37/6" 50/6" | | | | | | | | | |
| | 31.02' AMSL | | | | | | | | | | | |
| 15 | Very stiff to hard tan and light tan SANDY LEAN SILTY CLAY (CL-ML)<br>SANDY SILTY CLAY BED | | 6/6" 7/6" 10/6" | 31 | | | | | | | 52 | |
| | -color changes to tan and light gray with ferrous staining | | 9/6" 17/6" 27/6" | | | | | | | | | |
| 20 | | | | | | | | | | | | |
| | | | 7/6" 12/6" 13/6" | | | | | | | | | |
| 25 | 19.02' AMSL | | | | | | | | | | | |
| | Stiff to very stiff reddish brown and light gray FAT CLAY (CH) with calcareous nodules and ferrous staining<br>LIGHT OLIVE GREEN TO GRAY CLAY | | 4/6" 5/6" 9/6" | 33 | | 56 | 39 | | | | 99 | |
| 30 | -color changes to light gray with sand layers | | 5/6" 7/6" 12/6" | | | | | | | | | |
| 35 | | | 5/6" | 34 | | | | | | | 86 | |

COMPLETION DEPTH: 48 ft
DATE BORING STARTED: 06/24/2016
DATE BORING COMPLETED: 06/25/2016
LOGGER: J. Garcia
PROJECT NO.: 16.53.042

REMARKS: Free water was encounterd at an approximate depth of 15' below existing grade during drilling operations. After a 10 to 15-minute waiting period, water was at a depth of 9'-3". At the completion of the boring, the open bore-hole was backfilled with cement-bentonite grout.

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TOLUNAY-WONG ENGINEERS, INC.

# LOG OF BORING B-37

PROJECT: City of Kingsville Municipal Solid Waste Landfill Aerial Expansion

CLIENT: Naismith Engineering, Inc.

COORDINATES: N 27° 26' 57.1" W 97° 49' 17.6"
SURFACE ELEVATION: 45.52' AMSL
DRILLING METHOD:
Dry Augered: 0-ft. to 12-ft.
Wash Bored: 12-ft. to 48-ft.

| DEPTH (ft) | MATERIAL DESCRIPTION | (P) POCKET PEN (tsf) (T) TORVANE (psf) | STD. PENETRATION TEST (blows/ft) | MOISTURE CONTENT (%) | DRY UNIT WEIGHT (pcf) | LIQUID LIMIT (%) | PLASTICITY INDEX (%) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi) | PASSING #200 SIEVE (%) | OTHER TESTS PERFORMED |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 35 | Stiff to very stiff light gray and brownish tan FAT CLAY (CH) with sand seams, calcareous nodules, and ferrous staining<br>LIGHT OLIVE GREEN TO GRAY CLAY | | 7/6" 12/6" | | | | | | | | | |
| 40 | | | 4/6" 5/6" 7/6" | | | | | | | | | |
| | -color changes to light gray and reddish brown | | 6/6" 6/6" 9/6" | | | | | | | | | |
| 45 | -color changes to light gray<br>-2.48' AMSL | | 4/6" 5/6" 9/6" | 35 | | 80 | 51 | | | | 86 | |
| 48 | Bottom @ 48' | | | | | | | | | | | |

COMPLETION DEPTH: 48 ft
DATE BORING STARTED: 06/24/2016
DATE BORING COMPLETED: 06/25/2016
LOGGER: J. Garcia
PROJECT NO.: 16.53.042

REMARKS: Free water was encounterd at an approximate depth of 15' below existing grade during drilling operations. After a 10 to 15-minute waiting period, water was at a depth of 9'-3". At the completion of the boring, the open bore-hole was backfilled with cement-bentonite grout.

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TOLUNAY-WONG ENGINEERS, INC.

# LOG OF BORING B-38

PROJECT: City of Kingsville Municipal Solid Waste Landfill Aerial Expansion
CLIENT: Naismith Engineering, Inc.

COORDINATES: N 27° 27' 03.76" W 97° 49' 12.19"
SURFACE ELEVATION: 41.64' AMSL
DRILLING METHOD:
Dry Augered: 0 ft. to 10 ft.
Wash Bored: 10 ft. to 58 ft.

| DEPTH (ft) | MATERIAL DESCRIPTION | (P) POCKET PEN (tsf) (T) TORVANE (psf) | STD. PENETRATION TEST (blows/ft) | MOISTURE CONTENT (%) | DRY UNIT WEIGHT (pcf) | LIQUID LIMIT (%) | PLASTICITY INDEX (%) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi) | PASSING #200 SIEVE (%) | OTHER TESTS PERFORMED |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 35 | Very stiff to hard reddish brown and light gray SANDY FAT CLAY (CH) with sand seams and layers | (P) 4.50+ | 8/6" 10/6" | | | | | | | | | |
| | 3.64' AMSL | | | | | | | | | | | |
| | Stiff to hard light gray FAT CLAY (CH), slickensided, with calcareous nodules and ferrous stains | (P) 4.50+ | | 42 | 78 | 100 | 72 | 2.95 | 2 | | 93 | |
| 40 | -color changes to reddish brown and light gray | (P) 4.50+ | | | | | | | | | | |
| | LIGHT OLIVE GREEN TO GRAY CLAY | | | | | | | | | | | |
| | | (P) 4.50+ | | | | | | | | | | |
| | -color changes to tannish brown and light gray with trace organics | (P) 4.50+ | | | | | | | | | | |
| 45 | -color changes to light gray | | 5/6" 6/6" 8/6" | | | | | | | | | |
| | | (P) 4.50+ | | 30 | 91 | | | 2.14 | 3 | | 87 | |
| 50 | | | 6/6" 7/6" 7/6" | | | | | | | | | |
| | | | 4/6" 5/6" 8/6" | | | | | | | | | |
| 55 | -color changes to tannish brown and light gray | | 5/6" 7/6" 9/6" | | | | | | | | | |
| | -color changes to light gray | | 6/6" 7/6" 9/6" | | | | | | | | | |
| | -16.36' AMSL | | | | | | | | | | | |
| | Bottom @ 58' | | | | | | | | | | | |
| 60 | | | | | | | | | | | | |
| 65 | | | | | | | | | | | | |
| 70 | | | | | | | | | | | | |

COMPLETION DEPTH: 58 ft
DATE BORING STARTED: 06/23/2016
DATE BORING COMPLETED: 06/23/2016
LOGGER: J. Garcia
PROJECT NO.: 16.53.042

REMARKS: Free water was encounterd at an approximate depth of 11' below existing grade during drilling operations. After a 10 to 15-minute waiting period, water was at a depth of 5'-5". At the completion of the boring, the open bore-hole was backfilled with cement-bentonite grout.

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TOLUNAY-WONG ENGINEERS, INC.

# LOG OF BORING B-39

PROJECT: City of Kingsville
Municipal Solid Waste Landfill
Aerial Expansion

CLIENT: Naismith Engineering, Inc.

COORDINATES: N 27° 27' 01.3"
W 97° 48' 57.3"
SURFACE ELEVATION: 60.26' AMSL
DRILLING METHOD:
Dry Augered: 0 ft. to 26 ft.
Wash Bored: 26 ft. to 68 ft.

| DEPTH (ft) | MATERIAL DESCRIPTION | (P) POCKET PEN (tsf) (T) TORVANE (psf) | STD. PENETRATION TEST (blows/ft) | MOISTURE CONTENT (%) | DRY UNIT WEIGHT (pcf) | LIQUID LIMIT (%) | PLASTICITY INDEX (%) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi) | PASSING #200 SIEVE (%) | OTHER TESTS PERFORMED |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | Medium dense to dense tan and light gray CLAYEY SAND FILL with trace gravel BODY I | | 8/6" 9/6" 6/6" | 18 | | | | | | | 33 | |
| | -color changes to brown | | 40/6" 27/6" 19/6" | | | | | | | | | |
| | 55.76' AMSL | | | | | | | | | | | |
| 5 | Medium dense to dense brown and reddish brown CLAYEY SAND (SC) BODY I | | 6/6" 7/6" 8/6" | | | | | | | | | |
| | -color changes to tan and gray with calcareous nodules | | 4/6" 5/6" 6/6" | | | | | | | | | |
| | | | 5/6" 6/6" 8/6" | 11 | | 36 | 20 | | | | 49 | |
| 10 | -color changes to tan and light gray | | 4/6" 6/6" 7/6" | | | | | | | | | |
| | -color changes to light gray | | 7/6" 8/6" 11/6" | | | | | | | | | |
| 15 | -color changes to light gray and tan with ferrous stains | | 6/6" 12/6" 19/6" | | | | | | | | | |
| | -color changes to light gray | | 11/6" 19/6" 22/6" | | | | | | | | | |
| | 41.76' AMSL | | | | | | | | | | | |
| | Stiff to hard light gray SANDY LEAN CLAY (CL) with calcareous nodules and ferrous stains | | 3/6" 4/6" 5/6" | 19 | | | | | | | 65 | |
| 20 | | | 6/6" 9/6" 13/6" | | | | | | | | | |
| | | | 8/6" 11/6" 20/6" | | | | | | | | | |
| | -color changes to light tan and light gray | (P) 4.50+ | | | | | | | | | | |
| 25 | -color changes to light gray | (P) 4.00 | | | | | | | | | | |
| | | | 7/6" 11/6" 13/6" | | | | | | | | | |
| 30 | -color changes to light gray and tan | (P) 4.50+ | | 19 | 102 | | | 1.14 | 7 | | 50 | |
| | | | 12/6" 16/6" 20/6" | | | | | | | | | |
| 35 | | | 8/6" | | | | | | | | | |

COMPLETION DEPTH: 68 ft
DATE BORING STARTED: 06/20/2016
DATE BORING COMPLETED: 06/24/2016
LOGGER: J. Garcia
PROJECT NO.: 16.53.042

REMARKS: Free water was encounterd at an approximate depth of 27' below existing grade during drilling operations. After a 10 to 15-minute waiting period, water was at a depth of 26'-6". At the completion of the boring, the open bore-hole was backfilled with cement-bentonite grout.

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TOLUNAY-WONG ENGINEERS, INC.

# LOG OF BORING B-39

PROJECT: City of Kingsville
Municipal Solid Waste Landfill
Aerial Expansion

CLIENT: Naismith Engineering, Inc.

COORDINATES: N 27° 27' 01.3"
W 97° 48' 57.3"
SURFACE ELEVATION: 60.26' AMSL
DRILLING METHOD:
Dry Augered: 0 ft. to 26 ft.
Wash Bored: 26 ft. to 68 ft.

| DEPTH (ft) | MATERIAL DESCRIPTION | (P) POCKET PEN (tsf) (T) TORVANE (psf) | STD. PENETRATION TEST (blows/ft) | MOISTURE CONTENT (%) | DRY UNIT WEIGHT (pcf) | LIQUID LIMIT (%) | PLASTICITY INDEX (%) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi) | PASSING #200 SIEVE (%) | OTHER TESTS PERFORMED |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 35 | Stiff to hard light gray and tan SANDY LEAN CLAY (CL) with ferrous stains 23.76' AMSL | | 12/6" 16/6" | | | | | | | | | |
| | Medium dense to dense light gray CLAYEY SAND (SC) with ferrous stains BODY III | | 7/6" 8/6" 11/6" | | | | | | | | | |
| | | | 6/6" 11/6" 12/6" | | | | | | | | | |
| 40 | | | 7/6" 10/6" 13/6" | 25 | | 69 | 51 | | | | 45 | |
| | 15.76' AMSL | | 13/6" 19/6" 21/6" | | | | | | | | | |
| 45 | Dense light gray POORLY GRADED SAND with CLAY (SP- SC) | | 12/6" 21/6" 20/6" | | | | | | | | | |
| | 12.26' AMSL | | 11/6" 16/6" 16/6" | | | | | | | | | |
| | Hard reddish brown and light gray FAT CLAY with SAND (CH) LIGHT OLIVE GREEN TO GRAY CLAY | (P) 4.50+ | | | | | | | | | | |
| 50 | | (P) 4.50+ | | 28 | 93 | | | 0.85 | 1 | | 72 | |
| | -becomes slickensided with calcareous nodules | (P) 4.50+ | | | | | | | | | | |
| 55 | -with ferrous stains | (P) 4.50+ | | | | | | | | | | |
| | | (P) 4.50+ | | | | | | | | | | |
| | | (P) 4.50+ | | | | | | | | | | |
| 60 | | (P) 4.50+ | | | | | | | | | | |
| | -becomes stiff | | 7/6" 7/6" 7/6" | | | | | | | | | |
| 65 | -6.24' AMSL | | | | | | | | | | | |
| | Medium dense light gray CLAYEY SAND (SC) with calcareous nodules and ferrous stains -7.74' AMSL | | 6/6" 10/6" 13/6" | 20 | 102 | 61 | 45 | 1.91 | 5 | | 46 | |
| 70 | Bottom @ 68' | | | | | | | | | | | |

COMPLETION DEPTH: 68 ft
DATE BORING STARTED: 06/20/2016
DATE BORING COMPLETED: 06/24/2016
LOGGER: J. Garcia
PROJECT NO.: 16.53.042

REMARKS: Free water was encounterd at an approximate depth of 27' below existing grade during drilling operations. After a 10 to 15-minute waiting period, water was at a depth of 26'-6". At the completion of the boring, the open bore-hole was backfilled with cement-bentonite grout.

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TOLUNAY-WONG ENGINEERS, INC.

# LOG OF BORING B-40

PROJECT: City of Kingsville
Municipal Solid Waste Landfill
Aerial Expansion

CLIENT: Naismith Engineering, Inc.

COORDINATES: N 27° 27' 09.97" W 97° 49' 11.18"
SURFACE ELEVATION: 52.31' AMSL
DRILLING METHOD:
Dry Augered: 0 ft. to 22 ft.
Wash Bored: 22 ft. to 33.75 ft.

| DEPTH (ft) | MATERIAL DESCRIPTION | (P) POCKET PEN (tsf) (T) TORVANE (psf) | STD. PENETRATION TEST (blows/ft) | MOISTURE CONTENT (%) | DRY UNIT WEIGHT (pcf) | LIQUID LIMIT (%) | PLASTICITY INDEX (%) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi) | PASSING #200 SIEVE (%) | OTHER TESTS PERFORMED |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | Loose to very dense light gray and gray SILTY SAND (SM) with trace caliche BODY II | | 4/6" 4/6" 6/6" | | | | | | | | | |
| | -color changes to light gray and tan with ferrous stains | | 5/6" 7/6" 11/6" | 16 | | 35 | 10 | | | | 31 | |
| 5 | | | 7/6" 17/6" 17/6" | | | | | | | | | |
| | -color changes to light gray with calcareous nodules | | 12/6" 21/6" 34/6" | | | | | | | | | |
| | -color changes to light gray and white | | 12/6" 27/6" 50/3" | 18 | | | | | | | 34 | |
| 10 | -color changes to white | | 15/6" 50/3" | | | | | | | | | |
| | -color changes to light gray and white | | 25/6" 50/4" | | | | | | | | | |
| | 37.81' AMSL | | | | | | | | | | | |
| 15 | Hard light gray FAT CLAY with SAND (CH), calcareous nodules, and ferrous stains | | 7/6" 26/6" 50/5" | 22 | | 70 | 41 | | | | 80 | |
| | | | 5/6" 17/6" 28/6" | | | | | | | | | |
| | | | 10/6" 30/6" 35/6" | | | | | | | | | |
| 20 | 31.81' AMSL | | | | | | | | | | | |
| | Hard light gray SANDY FAT CLAY (CH) with calcareous nodules and ferrous stains | | 9/6" 25/6" 35/6" | 31 | | | | | | | 59 | |
| | | | 16/6" 32/6" 50/5" | | | | | | | | | |
| 25 | | | 16/6" 31/6" 50/5" | | | | | | | | | |
| | 25.81' AMSL | | | | | | | | | | | |
| | Dense to very dense light gray CLAYEY SAND (SC) with calcareous nodules | | 8/6" 18/6" 27/6" | 30 | | 53 | 32 | | | | 49 | |
| 30 | | | 6/6" 18/6" 50/6" | | | | | | | | | |
| | | | 6/6" 20/6" 50/5" | | | | | | | | | |
| | 18.81' AMSL | | 3/6" 40/6" 50/3" | 16 | | | | | | | 30 | |
| | Bottom @ 33.5' | | | | | | | | | | | |
| 35 | | | | | | | | | | | | |

COMPLETION DEPTH: 33.5 ft
DATE BORING STARTED: 06/21/2016
DATE BORING COMPLETED: 06/22/2016
LOGGER: J. Garcia
PROJECT NO.: 16.53.042

REMARKS: Free water was encounterd at an approximate depth of 21' below existing grade during drilling operations. After a 10 to 15-minute waiting period, water was at a depth of 19'. At the completion of the boring, the open bore-hole was backfilled with cement-bentonite grout.

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TOLUNAY-WONG ENGINEERS, INC.

# LOG OF BORING B-41

PROJECT: City of Kingsville
Municipal Solid Waste Landfill
Aerial Expansion

CLIENT: Naismith Engineering, Inc.

COORDINATES: N 27° 27' 09.8"
W 97° 49' 17.4"
SURFACE ELEVATION: 50.20' AMSL
DRILLING METHOD:
Dry Augered: 0-ft. to 62.5-ft.
Wash Bored: -- to --

| DEPTH (ft) | MATERIAL DESCRIPTION | (P) POCKET PEN (tsf) (T) TORVANE (psf) | STD. PENETRATION TEST (blows/ft) | MOISTURE CONTENT (%) | DRY UNIT WEIGHT (pcf) | LIQUID LIMIT (%) | PLASTICITY INDEX (%) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi) | PASSING #200 SIEVE (%) | OTHER TESTS PERFORMED |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | Loose to medium dense gray CLAYEY SAND (SC) with calcareous nodules BODY I | | 4/6" 5/6" 5/6" | 8 | | | | | | | 35 | |
| 5 | -color changes to light gray | | 4/6" 5/6" 6/6" | | | | | | | | | |
| | 41.70' AMSL | | | | | | | | | | | |
| | Stiff to very stiff gray SANDY FAT CLAY (CH) LIGHT OLIVE GREEN TO GRAY CLAY | | 5/6" 8/6" 11/6" | 20 | | 78 | 52 | | | | 64 | |
| 10 | | | | | | | | | | | | |
| | -becomes hard and color changes to brown with interbedded sand seams | | 9/6" 17/6" 25/6" | | | | | | | | | |
| 15 | | | | | | | | | | | | |
| | -color changes to brown and tan | | 7/6" 12/6" 14/6" | | | | | | | | | |
| 20 | -color changes to tan with sand layers | | 3/6" 4/6" 6/6" | 36 | | | | | | | 64 | |
| 25 | -color changes to brown with sand partings | | 5/6" 4/6" 6/6" | | | | | | | | | |
| | -color changes to brown and tan | | 6/6" 7/6" 8/6" | 31 | | 52 | 30 | | | | 51 | |
| 30 | | | | | | | | | | | | |
| | | | 4/6" 6/6" 6/6" | | | | | | | | | |
| 35 | | | | | | | | | | | | |

COMPLETION DEPTH: 62.5 ft
DATE BORING STARTED: 07/20/2016
DATE BORING COMPLETED: 07/20/2016
LOGGER: M. Anderson
PROJECT NO.: 16.53.042

REMARKS: Free water was encounterd at an approximate depth of 19'-6" below existing grade during drilling operations. After a 10 to 15-minute waiting period, water was at a depth of 19'-3". At the completion of the boring, the open bore-hole was backfilled with cement-bentonite grout.

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TOLUNAY-WONG ENGINEERS, INC.

# LOG OF BORING B-41

PROJECT: City of Kingsville Municipal Solid Waste Landfill Aerial Expansion

CLIENT: Naismith Engineering, Inc.

COORDINATES: N 27° 27' 09.8" W 97° 49' 17.4"
SURFACE ELEVATION: 50.20' AMSL
DRILLING METHOD:
Dry Augered: 0-ft. to 62.5-ft.
Wash Bored: -- to --

| DEPTH (ft) | MATERIAL DESCRIPTION | (P) POCKET PEN (tsf) (T) TORVANE (psf) | STD. PENETRATION TEST (blows/ft) | MOISTURE CONTENT (%) | DRY UNIT WEIGHT (pcf) | LIQUID LIMIT (%) | PLASTICITY INDEX (%) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi) | PASSING #200 SIEVE (%) | OTHER TESTS PERFORMED |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 35 | 14.20' AMSL<br>Stiff to very stiff gray SANDY FAT CLAY (CH) | | | | | | | | | | | |
| | Very stiff brown FAT CLAY with SAND (CH)<br>LIGHT OLIVE GREEN TO GRAY CLAY | (P) 3.25 | | 27 | 92 | | | | | | 77 | |
| 40 | -color changes to brown and tan | | 6/6"<br>13/6"<br>11/6" | | | | | | | | | |
| 45 | | | 4/6"<br>9/6"<br>14/6" | | | | | | | | | |
| | | | 6/6"<br>8/6"<br>9/6" | 35 | | 97 | 75 | | | | 84 | |
| 50 | -color changes to brown and gray | | 7/6"<br>9/6"<br>12/6" | | | | | | | | | |
| 55 | -color changes to gray | (P) 4.50+ | | | | | | | | | | |
| 60 | | (P) 3.50 | | | | | | | | | | |
| | -12.30' AMSL<br>Bottom @ 62.5' | | | | | | | | | | | |
| 65 | | | | | | | | | | | | |
| 70 | | | | | | | | | | | | |

COMPLETION DEPTH: 62.5 ft
DATE BORING STARTED: 07/20/2016
DATE BORING COMPLETED: 07/20/2016
LOGGER: M. Anderson
PROJECT NO.: 16.53.042

REMARKS: Free water was encounterd at an approximate depth of 19'-6" below existing grade during drilling operations. After a 10 to 15-minute waiting period, water was at a depth of 19'-3". At the completion of the boring, the open bore-hole was backfilled with cement-bentonite grout.

Page 2 of 2

TOLUNAY-WONG ENGINEERS, INC.

**Tolunay-Wong Engineers, Inc.**

**GEOTECHNICAL ENGINEERING STUDY
CITY OF KINGSVILLE MUNICIPAL SOLID
WASTE LANDFILL EXPANSION
KINGSVILLE, TEXAS**

For Permitting Purposes Only. Applies to boring logs in Appendix B of Tolunay-Wong Engineers, Inc. Geotechnical Engineering Study, City of Kingsville Municipal Solid Waste Landfill Expansion, Kingsville, Texas – Report No. 12788R1, sealed by Don R. Rokohl, P.E. on 8-30-18 altered to provide text showing surface elevations, ~~and~~ the elevations of all contacts between soil and rock layers, and unit identifiers in the soil boring logs. No information or data was altered or changed from the original report other than the addition of text showing these elevations and unit identifiers in Appendix B.

*Prepared for:*

**Naismith/Hanson
Corpus Christi, Texas**

*Prepared by:*

**Tolunay-Wong Engineers, Inc.
826 South Padre Island Drive
Corpus Christi, Texas 78416**

**August 30, 2018**

**Project No. 16.53.042 / Report No. 12788R1**

GEOTECHNICAL ENGINEERING, DEEP FOUNDATIONS TESTING,
ENVIRONMENTAL SERVICES, CONSTRUCTION MATERIALS TESTING

1-888-887-9932
WWW.TWEINC.COM

# LOG OF BORING B-30

PROJECT: City of Kingsville
Municipal Solid Waste Landfill
Aerial Expansion

CLIENT: Naismith Engineering, Inc.

COORDINATES: N 27° 26' 44.0"
W 97° 49' 23.1"
SURFACE ELEVATION: 45.99' AMSL
DRILLING METHOD:
Dry Augered: 0-ft. to 82.5-ft.
Wash Bored: -- to --

| DEPTH (ft) | MATERIAL DESCRIPTION | (P) POCKET PEN (tsf) (T) TORVANE (psf) | STD. PENETRATION TEST (blows/ft) | MOISTURE CONTENT (%) | DRY UNIT WEIGHT (pcf) | LIQUID LIMIT (%) | PLASTICITY INDEX (%) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi) | PASSING #200 SIEVE (%) | OTHER TESTS PERFORMED |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | Dense to very dense tan and gray CLAYEY SAND (SC) with gypsum crystals | | 11/6" 23/6" 50/5" | 16 | | 42 | 17 | | | | 37 | |
| 5 | -color changes to tan with ferrous staining | | 34/6" 50/3" | | | | | | | | | |
| | -with sand partings | | 13/6" 50/3" | | | | | | | | | |
| 10 | | | | | | | | | | | | |
| | | | 7/6" 12/6" 20/6" | 35 | | | | | | | 33 | |
| 15 | -color changes to reddish tan and light gray | | 6/6" 15/6" 20/6" | | | | | | | | | |
| 20 | 25.49' AMSL | | | | | | | | | | | |
| | Very stiff to hard reddish tan and light gray FAT CLAY (CH) with gypsum crystals<br>LIGHT OLIVE GREEN TO GRAY CLAY | | 10/6" 17/6" 26/6" | | | | | | | | | |
| 25 | -color changes to reddish tan and tan | | 10/6" 18/6" 30/6" | 25 | | 50 | 28 | | | | 92 | |
| | -color changes to tan and reddish brown | | 8/6" 11/6" 16/6" | | | | | | | | | |
| 30 | | | | | | | | | | | | |
| | -color changes to tan and gray | | 8/6" 12/6" 18/6" | | | | | | | | | |
| 35 | | | | | | | | | | | | |

COMPLETION DEPTH: 82.5 ft
DATE BORING STARTED: 07/22/2016
DATE BORING COMPLETED: 07/23/2016
LOGGER: J. Gonzalez
PROJECT NO.: 16.53.042

REMARKS: Free water was encounterd at an approximate depth of 21' below existing grade during drilling operations. After a 10 to 15-minute waiting period, water was at a depth of 10'-6". At the completion of the boring, the open bore-hole was backfilled with cement-bentonite grout.

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TOLUNAY-WONG ENGINEERS, INC.

# LOG OF BORING B-30

PROJECT: City of Kingsville Municipal Solid Waste Landfill Aerial Expansion

CLIENT: Naismith Engineering, Inc.

COORDINATES: N 27° 26' 44.0" W 97° 49' 23.1"
SURFACE ELEVATION: 45.99' AMSL
DRILLING METHOD:
Dry Augered: 0-ft. to 82.5-ft.
Wash Bored: -- to --

| DEPTH (ft) | MATERIAL DESCRIPTION | (P) POCKET PEN (tsf) (T) TORVANE (psf) | STD. PENETRATION TEST (blows/ft) | MOISTURE CONTENT (%) | DRY UNIT WEIGHT (pcf) | LIQUID LIMIT (%) | PLASTICITY INDEX (%) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi) | PASSING #200 SIEVE (%) | OTHER TESTS PERFORMED |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 35 | Very stiff to hard reddish tan and tan FAT CLAY (CH) with gypsum crystals and ferrous stains LIGHT OLIVE GREEN TO GRAY CLAY | | 10/6" 17/6" 21/6" | 30 | | | | | | | 90 | |
| 40 | -color changes to tan and reddish brown | | 9/6" 14/6" 21/6" | | | | | | | | | |
| 45 | | | 13/6" 19/6" 29/6" | | | | | | | | | |
| | -becomes sandy 48' to 52' | | 8/6" 11/6" 13/6" | 30 | | | | | | | 70 | |
| 50 | -color changes to tan and becomes slickensided | (P) 4.50+ | | 23 | 100 | 71 | 51 | | | | 87 | |
| 55 | | (P) 4.50+ | | | | | | | | | | |
| 60 | | (P) 4.50+ | | | | | | | | | | |
| | -becomes sandy and color changes to tan and gray | (P) 4.50+ | | 26 | 97 | 54 | 30 | 1.75 | 3 | | 69 | |
| 65 | -color changes to tan and reddish brown with trace calcareous nodules | (P) 3.00 | | | | | | | | | | |
| 70 | | | | | | | | | | | | |

COMPLETION DEPTH: 82.5 ft
DATE BORING STARTED: 07/22/2016
DATE BORING COMPLETED: 07/23/2016
LOGGER: J. Gonzalez
PROJECT NO.: 16.53.042

REMARKS: Free water was encounterd at an approximate depth of 21' below existing grade during drilling operations. After a 10 to 15-minute waiting period, water was at a depth of 10'-6". At the completion of the boring, the open bore-hole was backfilled with cement-bentonite grout.

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TOLUNAY-WONG ENGINEERS, INC.

# LOG OF BORING B-31

PROJECT: City of Kingsville Municipal Solid Waste Landfill Aerial Expansion

CLIENT: Naismith Engineering, Inc.

COORDINATES: N 27° 26' 50.1" W 97° 49' 24.3"
SURFACE ELEVATION: 58.37' AMSL
DRILLING METHOD:
Dry Augered: 0-ft. to 68-ft.
Wash Bored: -- to --

| DEPTH (ft) | MATERIAL DESCRIPTION | STD. PENETRATION TEST (blows/ft) | MOISTURE CONTENT (%) | LIQUID LIMIT (%) | PLASTICITY INDEX (%) | PASSING #200 SIEVE (%) |
|---|---|---|---|---|---|---|
| 0 | Medium dense to very dense gray CLAYEY SAND (SC) BODY I | 4/6" 5/6" 7/6" | | | | |
| | -with calcareous nodules and sand pockets | 10/6" 22/6" 18/6" | | | | |
| 5 | | 4/6" 5/6" 6/6" | 11 | | | 46 |
| | | 5/6" 6/6" 8/6" | | | | |
| | | 6/6" 8/6" 12/6" | | | | |
| 10 | -with cemented sand layers | 8/6" 27/6" 29/6" | 27 | | | 22 |
| | -color changes to tan | 18/6" 32/6" 39/6" | | | | |
| | 43.87' AMSL | | | | | |
| 15 | Very dense tan POORLY GRADED SAND with CLAY (SP-SC) and sand partings BODY IV | 36/6" 50/5" | | | | |
| | | 12/6" 50/5" | 15 | | | 9 |
| | | 45/6" 50/5" | | | | |
| 20 | | 35/6" 50/4" | | | | |
| | | 17/6" 26/6" 50/5" | | | | |
| | 34.87' AMSL | 17/6" 38/6" 38/6" | | | | |
| | Hard reddish tan and light gray SANDY LEAN SILTY CLAY (CL-ML) with sand partings | 13/6" 20/6" 31/6" | | | | |
| 25 | | 23/6" 34/6" 50/4" | 26 | 29 | 7 | 66 |
| | | 12/6" 17/6" 50/5" | | | | |
| | -color changes to reddish tan and tan with ferrous stains | 13/6" 32/6" 50/5" | | | | |
| 30 | | 7/6" 36/6" 39/6" | | | | |
| | | 10/6" 21/6" 36/6" | | | | |
| | | 10/6" 18/6" 35/6" | 25 | | | 62 |
| 35 | | | | | | |

Other columns (SAMPLE TYPE, SYMBOL/USCS, (P) POCKET PEN (tsf) (T) TORVANE (psf), DRY UNIT WEIGHT (pcf), COMPRESSIVE STRENGTH (tsf), FAILURE STRAIN (%), CONFINING PRESSURE (psi), OTHER TESTS PERFORMED) contain no values.

COMPLETION DEPTH: 68 ft
DATE BORING STARTED: 07/20/2016
DATE BORING COMPLETED: 07/21/2016
LOGGER: J. Gonzalez
PROJECT NO.: 16.53.042

REMARKS: Free water was encounterd at an approximate depth of 23' below existing grade during drilling operations. After a 10 to 15-minute waiting period, water was at a depth of 21'-6". At the completion of the boring, the open bore-hole was backfilled with cement-bentonite grout.

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TOLUNAY-WONG ENGINEERS, INC.

# LOG OF BORING B-31

PROJECT: City of Kingsville
Municipal Solid Waste Landfill
Aerial Expansion

CLIENT: Naismith Engineering, Inc.

COORDINATES: N 27° 26' 50.1"
W 97° 49' 24.3"
SURFACE ELEVATION: 58.37' AMSL
DRILLING METHOD:
Dry Augered: 0-ft. to 68-ft.
Wash Bored: -- to --

| DEPTH (ft) | MATERIAL DESCRIPTION | (P) POCKET PEN (tsf) (T) TORVANE (psf) | STD. PENETRATION TEST (blows/ft) | MOISTURE CONTENT (%) | DRY UNIT WEIGHT (pcf) | LIQUID LIMIT (%) | PLASTICITY INDEX (%) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi) | PASSING #200 SIEVE (%) | OTHER TESTS PERFORMED |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 35 | Hard reddish tan and tan SANDY LEAN CLAY (CL) with ferrous stains and laminated sands | | 17/6" 25/6" 35/6" 17/6" 13/6" 19/6" 7/6" 16/6" 17/6" | | | | | | | | | |
| | 18.87' AMSL | | | | | | | | | | | |
| 40 | Very stiff to hard reddish tan and tan FAT CLAY with SAND (CH) and ferrous stains<br>LIGHT OLIVE GREEN TO GRAY CLAY | | 3/6" 7/6" 10/6" | 37 | | 59 | 36 | | | | 76 | |
| | | | 9/6" 20/6" 27/6" 5/6" 14/6" 17/6" 10/6" 18/6" 21/6" | | | | | | | | | |
| 45 | -with trace gypsum crystals and ferrous stains | | 18/6" 23/6" 30/6" 6/6" 20/6" 21/6" | 30 | | | | | | | 83 | |
| 50 | | | 9/6" 17/6" 19/6" 9/6" 18/6" 23/6" 11/6" 23/6" 26/6" | | | | | | | | | |
| | -with calcareous nodules and ferrous stains | (P) 4.50+ | | 32 | 91 | 83 | 50 | 4.14 | 2 | | 87 | |
| 55 | | (P) 4.50+ | | | | | | | | | | |
| | | (P) 4.50+ | | | | | | | | | | |
| | | (P) 4.50+ | | 34 | 87 | | | 2.88 | 2 | | 83 | |
| 60 | -with trace gypsum crystals and ferrous stains | (P) 4.50+ | | | | | | | | | | |
| | | (P) 4.50+ | | | | | | | | | | |
| 65 | | (P) 4.50+ | | | | | | | | | | |
| | -9.63' AMSL | (P) 4.50+ | | | | | | | | | | |
| | Bottom @ 68' | | | | | | | | | | | |
| 70 | | | | | | | | | | | | |

COMPLETION DEPTH: 68 ft
DATE BORING STARTED: 07/20/2016
DATE BORING COMPLETED: 07/21/2016
LOGGER: J. Gonzalez
PROJECT NO.: 16.53.042

REMARKS: Free water was encounterd at an approximate depth of 23' below existing grade during drilling operations. After a 10 to 15-minute waiting period, water was at a depth of 21'-6". At the completion of the boring, the open bore-hole was backfilled with cement-bentonite grout.

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TOLUNAY-WONG ENGINEERS, INC.

# LOG OF BORING B-32

PROJECT: City of Kingsville
Municipal Solid Waste Landfill
Aerial Expansion

CLIENT: Naismith Engineering, Inc.

COORDINATES: N 27° 26' 49.7"
W 97° 49' 17.0"
SURFACE ELEVATION: 48.46' AMSL
DRILLING METHOD:
Dry Augered: 0-ft. to 82.5-ft.
Wash Bored: -- to --

| DEPTH (ft) | MATERIAL DESCRIPTION | (P) POCKET PEN (tsf) (T) TORVANE (psf) | STD. PENETRATION TEST (blows/ft) | MOISTURE CONTENT (%) | DRY UNIT WEIGHT (pcf) | LIQUID LIMIT (%) | PLASTICITY INDEX (%) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi) | PASSING #200 SIEVE (%) | OTHER TESTS PERFORMED |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 35 | Medium dense to dense reddish tan and gray CLAYEY SAND (SC) with gypsum crystals 12.46' AMSL | | | | | | | | | | | |
| | Very stiff to hard tan FAT CLAY with SAND (CH), slickensided, with calcareous nodules LIGHT OLIVE GREEN TO GRAY CLAY | (P) 4.50+ | | 29 | 89 | | | | | | 79 | |
| 40 | -color changes to tan and reddish brown with gypsum crystals and ferrous stains | | 8/6" 12/6" 15/6" | | | | | | | | | |
| 45 | -color changes to tan, gray, and reddish brown | (P) 4.50+ | | | | | | | | | | |
| 50 | -color changes to tan and reddish brown | | 4/6" 9/6" 10/6" | 30 | | 73 | 51 | | | | 82 | |
| | | (P) 4.50+ | | | | | | | | | | |
| 55 | -color changes to tan and gray | (P) 4.50+ | | | | | | | | | | |
| 60 | | (P) 4.50+ | | 26 | 94 | | | 0.61 | 2 | | 81 | |
| 65 | -color changes to tan, red, and brown | (P) 4.00 | | | | | | | | | | |
| | -color changes to tan and gray | (P) 4.50+ | | | | | | | | | | |
| 70 | | | | | | | | | | | | |

COMPLETION DEPTH: 82.5 ft
DATE BORING STARTED: 07/27/2016
DATE BORING COMPLETED: 07/28/2016
LOGGER: J. Gonzalez
PROJECT NO.: 16.53.042

REMARKS: Free water was encounterd at an approximate depth of 18' below existing grade during drilling operations. After a 10 to 15-minute waiting period, water was at a depth of 14'-7". At the completion of the boring, the open bore-hole was backfilled with cement-bentonite grout.

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TOLUNAY-WONG ENGINEERS, INC.

# LOG OF BORING B-32

PROJECT: City of Kingsville Municipal Solid Waste Landfill Aerial Expansion

CLIENT: Naismith Engineering, Inc.

COORDINATES: N 27° 26' 49.7" W 97° 49' 17.0"
SURFACE ELEVATION: 48.46' AMSL
DRILLING METHOD:
Dry Augered: 0-ft. to 82.5-ft.
Wash Bored: -- to --

| DEPTH (ft) | MATERIAL DESCRIPTION | (P) POCKET PEN (tsf) (T) TORVANE (psf) | STD. PENETRATION TEST (blows/ft) | MOISTURE CONTENT (%) | DRY UNIT WEIGHT (pcf) | LIQUID LIMIT (%) | PLASTICITY INDEX (%) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi) | PASSING #200 SIEVE (%) | OTHER TESTS PERFORMED |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 70 | Very stiff to hard tan and gray FAT CLAY with SAND (CH), slickensided with gypsum crystals and calcareous nodules LIGHT OLIVE GREEN TO GRAY CLAY<br>-24.54' AMSL | | | | | | | | | | | |
| | Medium dense to dense tan CLAYEY SAND (SC) with calcareous nodules | (P) 0.75 | | 21 | | 24 | 8 | | | | 24 | |
| 75 | | | | | | | | | | | | |
| | -with gypsum crystals and ferrous stains | | 5/6"<br>10/6"<br>13/6" | | | | | | | | | |
| 80 | | | 13/6"<br>20/6"<br>20/6" | | | | | | | | | |
| | -34.04' AMSL | | | | | | | | | | | |
| | Bottom @ 82.5' | | | | | | | | | | | |
| 85 | | | | | | | | | | | | |
| 90 | | | | | | | | | | | | |
| 95 | | | | | | | | | | | | |
| 100 | | | | | | | | | | | | |
| 105 | | | | | | | | | | | | |

COMPLETION DEPTH: 82.5 ft
DATE BORING STARTED: 07/27/2016
DATE BORING COMPLETED: 07/28/2016
LOGGER: J. Gonzalez
PROJECT NO.: 16.53.042

REMARKS: Free water was encounterd at an approximate depth of 18' below existing grade during drilling operations. After a 10 to 15-minute waiting period, water was at a depth of 14'-7". At the completion of the boring, the open bore-hole was backfilled with cement-bentonite grout.

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TOLUNAY-WONG ENGINEERS, INC.

# LOG OF BORING B-33

PROJECT: City of Kingsville Municipal Solid Waste Landfill Aerial Expansion
CLIENT: Naismith Engineering, Inc.

COORDINATES: N 27° 26' 55.9" W 97° 49' 11.3"
SURFACE ELEVATION: 64.51' AMSL
DRILLING METHOD:
Dry Augered: 0-ft. to 86-ft.
Wash Bored: -- to --

| DEPTH (ft) | MATERIAL DESCRIPTION | (P) POCKET PEN (tsf) (T) TORVANE (psf) | STD. PENETRATION TEST (blows/ft) | MOISTURE CONTENT (%) | DRY UNIT WEIGHT (pcf) | LIQUID LIMIT (%) | PLASTICITY INDEX (%) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi) | PASSING #200 SIEVE (%) | OTHER TESTS PERFORMED |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | Medium dense to very dense tan CLAYEY SAND (SC) with gypsum crystals BODY I | | 2/6" 7/6" 9/6" | | | | | | | | | |
| 5 | -color changes to dark gray and gray with trace gravel | | 7/6" 11/6" 9/6" | 16 | | | | | | | 47 | |
| | -color changes to tan and light gray sand partings | | 27/6" 50/6" | | | | | | | | | |
| 10 | | | | | | | | | | | | |
| | -color changes to tan and white with trace caliche | | 50/5" | | | | | | | | | |
| 15 | 48.01' AMSL | | | | | | | | | | | |
| | Dense to very dense tan and white POORLY GRADED SAND with SILT (SP-SM), and trace caliche BODY II | | 17/6" 48/6" 50/3" | 11 | | 35 | 8 | | | | 12 | |
| 20 | | | 17/6" 21/6" 27/6" | | | | | | | | | |
| 25 | -color changes to light gray and tan with gypsum crystals and ferrous stains | | 15/6" 17/6" 32/6" | | | | | | | | | |
| | 36.01' AMSL | | | | | | | | | | | |
| 30 | Medium dense to dense gray and white CLAYEY SAND (SC) with gypsum crystals | | 14/6" 22/6" 26/6" | 42 | | | | | | | 20 | |
| | -color changes to tan | | 13/6" 21/6" 22/6" | | | | | | | | | |
| 35 | | | | | | | | | | | | |

COMPLETION DEPTH: 86 ft
DATE BORING STARTED: 08/05/2016
DATE BORING COMPLETED: 08/05/2016
LOGGER: J. Gonzalez
PROJECT NO.: 16.53.042

REMARKS: Free water was encounterd at an approximate depth of 32'-6" below existing grade during drilling operations. After a 10 to 15-minute waiting period, water was at a depth of 28'-2". At the completion of the boring, the open bore-hole was backfilled with cement-bentonite grout.

Page 1 of 3

TOLUNAY-WONG ENGINEERS, INC.

# LOG OF BORING B-33

PROJECT: City of Kingsville
Municipal Solid Waste Landfill
Aerial Expansion

CLIENT: Naismith Engineering, Inc.

COORDINATES: N 27° 26' 55.9"
W 97° 49' 11.3"
SURFACE ELEVATION: 64.51' AMSL
DRILLING METHOD:
Dry Augered: 0-ft. to 86-ft.
Wash Bored: -- to --

| DEPTH (ft) | MATERIAL DESCRIPTION | (P) POCKET PEN (tsf) (T) TORVANE (psf) | STD. PENETRATION TEST (blows/ft) | MOISTURE CONTENT (%) | DRY UNIT WEIGHT (pcf) | LIQUID LIMIT (%) | PLASTICITY INDEX (%) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi) | PASSING #200 SIEVE (%) | OTHER TESTS PERFORMED |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 35 | Medium dense to dense reddish tan CLAYEY SAND (SC) with gypsum crystals and ferrous stains | | 6/6" 9/6" 12/6" | | | | | | | | | |
| 40 | -color changes to tan and reddish tan | | 8/6" 16/6" 18/6" | | | | | | | | | |
| | 20.01' AMSL | | | | | | | | | | | |
| 45 | Stiff to very stiff reddish tan LEAN CLAY with SAND (CL), slickensided, with ferrous stains<br>SANDY SILTY CLAY BED | | 9/6" 12/6" 18/6" | 29 | | 43 | 24 | | | | 79 | |
| 50 | -color changes to reddish tan and tan with gypsum crystals | | 5/6" 6/6" 9/6" | | | | | | | | | |
| | 12.51' AMSL | | | | | | | | | | | |
| | Stiff to very stiff LEAN CLAY (CL), slickensided, with ferrous stains<br>SANDY SILTY CLAY BED | (P) 2.00 | | 40 | 79 | | | 1.06 | 3 | | 96 | |
| 55 | -color changes to reddish brown and tan with gypsum crystals | (P) 3.50 | | | | | | | | | | |
| 60 | | (P) 4.00 | | 34 | 87 | | | | | | | |
| | -0.51' AMSL | | | | | | | | | | | |
| 65 | Very stiff to hard tan FAT CLAY (CH), slickensided, with gypsum crystals and ferrous stains<br>LIGHT OLIVE GREEN TO GRAY CLAY | (P) 4.50+ | | 32 | 42 | 64 | 33 | 2.57 | 2 | | 95 | |
| 70 | -color changes to tan and reddish brown | | 7/6" 12/6" 14/6" | | | | | | | | | |

COMPLETION DEPTH: 86 ft
DATE BORING STARTED: 08/05/2016
DATE BORING COMPLETED: 08/05/2016
LOGGER: J. Gonzalez
PROJECT NO.: 16.53.042

REMARKS: Free water was encounterd at an approximate depth of 32'-6" below existing grade during drilling operations. After a 10 to 15-minute waiting period, water was at a depth of 28'-2". At the completion of the boring, the open bore-hole was backfilled with cement-bentonite grout.

Page 2 of 3

TOLUNAY-WONG ENGINEERS, INC.

# LOG OF BORING B-33

PROJECT: City of Kingsville Municipal Solid Waste Landfill Aerial Expansion

CLIENT: Naismith Engineering, Inc.

COORDINATES: N 27° 26' 55.9" W 97° 49' 11.3"
SURFACE ELEVATION: 64.51' AMSL
DRILLING METHOD:
Dry Augered: 0-ft. to 86-ft.
Wash Bored: -- to --

| DEPTH (ft) | MATERIAL DESCRIPTION | (P) POCKET PEN (tsf) (T) TORVANE (psf) | STD. PENETRATION TEST (blows/ft) | MOISTURE CONTENT (%) | DRY UNIT WEIGHT (pcf) | LIQUID LIMIT (%) | PLASTICITY INDEX (%) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi) | PASSING #200 SIEVE (%) | OTHER TESTS PERFORMED |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 70 | Very stiff to hard tan and reddish brown FAT CLAY (CH), slickensided, with gypsum crystals and ferrous stains LIGHT OLIVE GREEN TO GRAY CLAY | (P) 4.50+ | | | | | | | | | | |
| | -color changes to tan and light gray | | | | | | | | | | | |
| 75 | -with layers of calcareous nodules | | 9/6" 10/6" 21/6" | | | | | | | | | |
| | -15.49' AMSL | | | | | | | | | | | |
| 80 | Very stiff to hard tan FAT CLAY with SAND (CH) with gypsum crystals and ferrous stains LIGHT OLIVE GREEN TO GRAY CLAY | (P) 4.50+ | | 18 | 106 | | | 3.57 | 3 | | 77 | |
| | -color changes to tan and white | (P) 4.50+ | | | | | | | | | | |
| 85 | -21.49' AMSL | | | | | | | | | | | |
| | Bottom @ 86' | | | | | | | | | | | |
| 90 | | | | | | | | | | | | |
| 95 | | | | | | | | | | | | |
| 100 | | | | | | | | | | | | |
| 105 | | | | | | | | | | | | |

COMPLETION DEPTH: 86 ft
DATE BORING STARTED: 08/05/2016
DATE BORING COMPLETED: 08/05/2016
LOGGER: J. Gonzalez
PROJECT NO.: 16.53.042

REMARKS: Free water was encounterd at an approximate depth of 32'-6" below existing grade during drilling operations. After a 10 to 15-minute waiting period, water was at a depth of 28'-2". At the completion of the boring, the open bore-hole was backfilled with cement-bentonite grout.

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TOLUNAY-WONG ENGINEERS, INC.

# LOG OF BORING B-34

PROJECT: City of Kingsville
Municipal Solid Waste Landfill
Aerial Expansion

CLIENT: Naismith Engineering, Inc.

COORDINATES: N 27° 26' 43.4"
W 97° 49' 11.4"
SURFACE ELEVATION: 61.14' AMSL
DRILLING METHOD:
Dry Augered: 0 ft. to 30 ft.
Wash Bored: 30 ft. to 43 ft.

| DEPTH (ft) | MATERIAL DESCRIPTION | (P) POCKET PEN (tsf) (T) TORVANE (psf) | STD. PENETRATION TEST (blows/ft) | MOISTURE CONTENT (%) | DRY UNIT WEIGHT (pcf) | LIQUID LIMIT (%) | PLASTICITY INDEX (%) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi) | PASSING #200 SIEVE (%) | OTHER TESTS PERFORMED |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | Medium dense dark gray, gray, and light gray CLAYEY SAND (SC) with trace of organics | | 2/6" 5/6" 6/6" | | | | | | | | | |
| | | (P) 4.50+ | | 15 | 112 | | | 2.53 | 6 | | 42 | |
| | 57.14' AMSL | | | | | | | | | | | |
| 5 | Very stiff to hard gray and light gray SANDY LEAN SILTY CLAY (CL-ML) with calcareous nodules | (P) 4.50+ | | 15 | 115 | 21 | 7 | | | | 59 | |
| | | (P) 4.50+ | | 14 | 114 | | | 6.13 | 4 | | 62 | |
| | -color changes to light gray | | | | | | | | | | | |
| 10 | -color changes to light gray and tan | | 4/6" 12/6" 16/6" | | | | | | | | | |
| | -color changes to white and light gray | | 11/6" 18/6" 16/6" | | | | | | | | | |
| | -becomes stiff | | 5/6" 6/6" 8/6" | | | | | | | | | |
| | 46.64' AMSL | | | | | | | | | | | |
| 15 | Medium dense to dense white and light gray SILTY SAND (SM) with calcareous nodules BODY II | | 4/6" 6/6" 8/6" | 17 | | 38 | 7 | | | | 31 | |
| | | | 4/6" 10/6" 19/6" | | | | | | | | | |
| | -color changes to light gray and tan with ferrous stains | | | | | | | | | | | |
| | | | 23/6" 50/5" | | | | | | | | | |
| 20 | | | 23/6" 50/4" | | | | | | | | | |
| | -color changes to light gray | | 27/6" 35/6" 50/4" | 22 | | | | | | | 25 | |
| 25 | | | 5/6" 37/6" 45/6" | | | | | | | | | |
| | | | 20/6" 39/6" 37/6" | | | | | | | | | |
| | -becomes medium dense | | 8/6" 12/6" 9/6" | 26 | | 39 | 2 | | | | 28 | |
| 30 | | | 4/6" 12/6" 10/6" | 33 | | | | | | | 39 | |
| | | | 5/6" 6/6" 10/6" | | | | | | | | | |
| 35 | -color changes to tan and marine green | | 3/6" | | | | | | | | | |

COMPLETION DEPTH: 43 ft
DATE BORING STARTED: 06/22/2016
DATE BORING COMPLETED: 06/22/2016
LOGGER: J. Garcia
PROJECT NO.: 16.53.042

REMARKS: Free water was encounterd at an approximate depth of 31' below existing grade during drilling operations. After a 10 to 15-minute waiting period, water was at a depth of 28'-4". At the completion of the boring, the open bore-hole was backfilled with cement-bentonite grout.

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TOLUNAY-WONG ENGINEERS, INC.

# LOG OF BORING B-34

PROJECT: City of Kingsville Municipal Solid Waste Landfill Aerial Expansion

CLIENT: Naismith Engineering, Inc.

COORDINATES: N 27° 26' 43.4" W 97° 49' 11.4"
SURFACE ELEVATION: 61.14' AMSL
DRILLING METHOD:
Dry Augered: 0 ft. to 30 ft.
Wash Bored: 30 ft. to 43 ft.

| DEPTH (ft) | MATERIAL DESCRIPTION | (P) POCKET PEN (tsf) (T) TORVANE (psf) | STD. PENETRATION TEST (blows/ft) | MOISTURE CONTENT (%) | DRY UNIT WEIGHT (pcf) | LIQUID LIMIT (%) | PLASTICITY INDEX (%) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi) | PASSING #200 SIEVE (%) | OTHER TESTS PERFORMED |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 35 | Medium dense tan and marine green SILTY SAND (SM) with sand lenses and trace organics 25.14' AMSL | | 8/6" 13/6" | | | | | | | | | |
| | Hard tan and light gray LEAN CLAY (CL) | (P) 4.50+ | | | | | | | | | | |
| | SANDY SILTY CLAY BED | (P) 4.50+ | | 30 | 91 | 40 | 17 | 0.93 | 1 | | 91 | |
| 40 | | (P) 4.50+ | | | | | | | | | | |
| | 18.14' AMSL | (P) 4.50+ | | | | | | | | | | |
| | Bottom @ 43' | | | | | | | | | | | |
| 45 | | | | | | | | | | | | |
| 50 | | | | | | | | | | | | |
| 55 | | | | | | | | | | | | |
| 60 | | | | | | | | | | | | |
| 65 | | | | | | | | | | | | |
| 70 | | | | | | | | | | | | |

COMPLETION DEPTH: 43 ft
DATE BORING STARTED: 06/22/2016
DATE BORING COMPLETED: 06/22/2016
LOGGER: J. Garcia
PROJECT NO.: 16.53.042

REMARKS: Free water was encounterd at an approximate depth of 31' below existing grade during drilling operations. After a 10 to 15-minute waiting period, water was at a depth of 28'-4". At the completion of the boring, the open bore-hole was backfilled with cement-bentonite grout.

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TOLUNAY-WONG ENGINEERS, INC.

# LOG OF BORING B-35

PROJECT: City of Kingsville
Municipal Solid Waste Landfill
Aerial Expansion

CLIENT: Naismith Engineering, Inc.

COORDINATES: N 27° 26' 50.5"
W 97° 48' 57.2"
SURFACE ELEVATION: 64.50' AMSL
DRILLING METHOD:
Dry Augered: 0-ft. to 72.5-ft.
Wash Bored: -- to --

| DEPTH (ft) | MATERIAL DESCRIPTION | (P) POCKET PEN (tsf) (T) TORVANE (psf) | STD. PENETRATION TEST (blows/ft) | MOISTURE CONTENT (%) | DRY UNIT WEIGHT (pcf) | LIQUID LIMIT (%) | PLASTICITY INDEX (%) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi) | PASSING #200 SIEVE (%) | OTHER TESTS PERFORMED |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | Medium dense tan and brown CLAYEY SAND (SC) with trace caliche | | 5/6" 8/6" 7/6" | | | | | | | | | |
| 5 | -color changes to reddish brown with ferrous stains | | 5/6" 8/6" 5/6" | 12 | | 31 | 17 | | | | 38 | |
| | 56.50' AMSL | | | | | | | | | | | |
| | Very stiff to hard reddish tan SANDY LEAN CLAY (CL) with gypsum crystals | (P) 4.50+ | | 14 | 117 | | | 2.22 | 3 | | 52 | |
| 10 | | | | | | | | | | | | |
| | -color changes to reddish tan and tan with ferrous stains | | 5/6" 10/6" 12/6" | | | | | | | | | |
| 15 | -color changes to reddish tan | (P) 4.50+ | | 17 | 109 | 42 | 25 | | | | | |
| 20 | -color changes to reddish tan and tan | (P) 4.50+ | | | | | | | | | | |
| | 40.50' AMSL | | | | | | | | | | | |
| 25 | Medium dense to dense reddish tan and tan CLAYEY SAND (SC) with gypsum crystals and ferrous stains | (P) 4.50+ | | 17 | 104 | | | 1.29 | 3 | | 40 | |
| | BODY III | | | | | | | | | | | |
| 30 | -color changes to reddish tan | | 4/6" 7/6" 9/6" | | | | | | | | | |
| | | | 8/6" 13/6" 20/6" | | | | | | | | | |
| 35 | | | | | | | | | | | | |

COMPLETION DEPTH: 72.5 ft
DATE BORING STARTED: 07/29/2016
DATE BORING COMPLETED: 07/29/2016
LOGGER: J. Gonzalez
PROJECT NO.: 16.53.042

REMARKS: Free water was encounterd at an approximate depth of 34' below existing grade during drilling operations. After a 10 to 15-minute waiting period, water was at a depth of 30'-9". At the completion of the boring, the open bore-hole was backfilled with cement-bentonite grout.

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TOLUNAY-WONG ENGINEERS, INC.

# LOG OF BORING B-35

PROJECT: City of Kingsville
Municipal Solid Waste Landfill
Aerial Expansion

CLIENT: Naismith Engineering, Inc.

COORDINATES: N 27° 26' 50.5"
W 97° 48' 57.2"
SURFACE ELEVATION: 64.50' AMSL
DRILLING METHOD:
Dry Augered: 0-ft. to 72.5-ft.
Wash Bored: -- to --

| DEPTH (ft) | MATERIAL DESCRIPTION | (P) POCKET PEN (tsf) (T) TORVANE (psf) | STD. PENETRATION TEST (blows/ft) | MOISTURE CONTENT (%) | DRY UNIT WEIGHT (pcf) | LIQUID LIMIT (%) | PLASTICITY INDEX (%) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi) | PASSING #200 SIEVE (%) | OTHER TESTS PERFORMED |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 35 | 28.00' AMSL<br>Medium dense to dense reddish tan and tan CLAYEY SAND (SC) with gypsum crystals and ferrous stains | | | | | | | | | | | |
| | Hard tan and light gray FAT CLAY with SAND (CH), gypsum crystals, and ferrous stains<br>LIGHT OLIVE GREEN TO GRAY CLAY | | 17/6"<br>26/6"<br>30/6" | 25 | | 109 | 72 | | | | 77 | |
| 40 | -color changes to tan and reddish brown | | 8/6"<br>15/6"<br>24/6" | | | | | | | | | |
| 45 | -with sand partings | | 10/6"<br>16/6"<br>16/6" | | | | | | | | | |
| | 16.00' AMSL | | | | | | | | | | | |
| | Stiff to hard reddish brown and tan FAT CLAY (CH) with gypsum crystals and ferrous stains<br>LIGHT OLIVE GREEN TO GRAY CLAY | | 4/6"<br>7/6"<br>10/6" | 34 | | | | | | | 96 | |
| 50 | -becomes slickensided with sand layers | (P) 2.00 | | | | | | | | | | |
| 55 | -color changes to tan | | 4/6"<br>7/6"<br>10/6" | | | | | | | | | |
| 60 | | (P) 3.75 | | 33 | 89 | 90 | 67 | 3.88 | 4 | | 89 | |
| 65 | | (P) 4.25 | | | | | | | | | | |
| | -color changes to tan and reddish brown | (P) 4.50+ | | | | | | | | | | |
| 70 | | | | | | | | | | | | |

COMPLETION DEPTH: 72.5 ft
DATE BORING STARTED: 07/29/2016
DATE BORING COMPLETED: 07/29/2016
LOGGER: J. Gonzalez
PROJECT NO.: 16.53.042

REMARKS: Free water was encounterd at an approximate depth of 34' below existing grade during drilling operations. After a 10 to 15-minute waiting period, water was at a depth of 30'-9". At the completion of the boring, the open bore-hole was backfilled with cement-bentonite grout.

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TOLUNAY-WONG ENGINEERS, INC.

# LOG OF BORING B-36

PROJECT: City of Kingsville
Municipal Solid Waste Landfill
Aerial Expansion

CLIENT: Naismith Engineering, Inc.

COORDINATES: N 27° 26' 56.8"
W 97° 49' 04.9"
SURFACE ELEVATION: 59.13' AMSL
DRILLING METHOD:
Dry Augered: 0-ft. to 22-ft.
Wash Bored: 22-ft. to 68-ft.

| DEPTH (ft) | MATERIAL DESCRIPTION | (P) POCKET PEN (tsf) (T) TORVANE (psf) | STD. PENETRATION TEST (blows/ft) | MOISTURE CONTENT (%) | DRY UNIT WEIGHT (pcf) | LIQUID LIMIT (%) | PLASTICITY INDEX (%) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi) | PASSING #200 SIEVE (%) | OTHER TESTS PERFORMED |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | Loose to medium dense dark gray and gray CLAYEY SAND (SC) BODY I | | | | | | | | | | | |
| | -with calcareous nodules | | 18/6" 20/6" 21/6" | 10 | | | | | | | 36 | |
| 5 | -color changes to light gray and tan | | 4/6" 5/6" 5/6" | | | | | | | | | |
| 10 | -color changes to tan | | 4/6" 5/6" 6/6" | 12 | | 47 | 28 | | | | 44 | |
| 15 | | | 2/6" 4/6" 6/6" | | | | | | | | | |
| | -color changes to light gray with ferrous stains | | 4/6" 10/6" 14/6" | | | | | | | | | |
| 20 | -becomes very dense and color changes to light gray and tan | | 15/6" 24/6" 50/6" | 25 | | | | | | | 32 | |
| 25 | | | 12/6" 14/6" 15/6" | | | | | | | | | |
| 30 | -becomes dense | | 5/6" 17/6" 27/6" | | | | | | | | | |
| 35 | | | 4/6" | | | | | | | | | |

COMPLETION DEPTH: 68 ft
DATE BORING STARTED: 06/24/2016
DATE BORING COMPLETED: 06/24/2016
LOGGER: J. Garcia
PROJECT NO.: 16.53.042

REMARKS: Free water was encounterd at an approximate depth of 23' below existing grade during drilling operations. After a 10 to 15-minute waiting period, water was at a depth of 18'-3". At the completion of the boring, the open bore-hole was backfilled with cement-bentonite grout.

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TOLUNAY-WONG ENGINEERS, INC.

# LOG OF BORING B-36

PROJECT: City of Kingsville
Municipal Solid Waste Landfill
Aerial Expansion

CLIENT: Naismith Engineering, Inc.

COORDINATES: N 27° 26' 56.8"
W 97° 49' 04.9"
SURFACE ELEVATION: 59.13' AMSL
DRILLING METHOD:
Dry Augered: 0-ft. to 22-ft.
Wash Bored: 22-ft. to 68-ft.

| DEPTH (ft) | MATERIAL DESCRIPTION | (P) POCKET PEN (tsf) (T) TORVANE (psf) | STD. PENETRATION TEST (blows/ft) | MOISTURE CONTENT (%) | DRY UNIT WEIGHT (pcf) | LIQUID LIMIT (%) | PLASTICITY INDEX (%) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi) | PASSING #200 SIEVE (%) | OTHER TESTS PERFORMED |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 35 | Medium dense light gray and tan CLAYEY SAND (SC)<br>BODY I | | 7/6" 8/6" | | | | | | | | | |
| | -with sand seams, calcareous nodules, and ferrous staining | | 6/6" 10/6" 13/6" | 21 | | 47 | 30 | | | | 35 | |
| 40 | | | | | | | | | | | | |
| | -color changes to reddish brown and light gray | | 4/6" 8/6" 10/6" | | | | | | | | | |
| 45 | 13.13' AMSL | | | | | | | | | | | |
| | Stiff to very stiff reddish brown and light gray FAT CLAY (CH), slickensided, with ferrous staining<br>LIGHT OLIVE GREEN TO GRAY CLAY | (P) 4.50+ | | | | | | | | | | |
| 50 | -with sand seams and calcareous nodules | | 4/6" 6/6" 8/6" | 42 | | | | | | | 96 | |
| 55 | -color changes to light gray with sand layers | | 11/6" 12/6" 14/6" | | | | | | | | | |
| | -becomes hard | | 11/6" 21/6" 26/6" | 37 | | 70 | 44 | | | | 94 | |
| 60 | | | | | | | | | | | | |
| | | | 7/6" 8/6" 9/6" | | | | | | | | | |
| 65 | -color changes to brown yellow, reddish brown, and light gray<br>-8.87' AMSL | | 7/6" 10/6" 10/6" | | | | | | | | | |
| | Bottom @ 68' | | | | | | | | | | | |
| 70 | | | | | | | | | | | | |

COMPLETION DEPTH: 68 ft
DATE BORING STARTED: 06/24/2016
DATE BORING COMPLETED: 06/24/2016
LOGGER: J. Garcia
PROJECT NO.: 16.53.042

REMARKS: Free water was encounterd at an approximate depth of 23' below existing grade during drilling operations. After a 10 to 15-minute waiting period, water was at a depth of 18'-3". At the completion of the boring, the open bore-hole was backfilled with cement-bentonite grout.

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TOLUNAY-WONG ENGINEERS, INC.

# LOG OF BORING B-37

PROJECT: City of Kingsville
Municipal Solid Waste Landfill
Aerial Expansion

CLIENT: Naismith Engineering, Inc.

COORDINATES: N 27° 26' 57.1"
W 97° 49' 17.6"
SURFACE ELEVATION: 45.52' AMSL
DRILLING METHOD:
Dry Augered: 0-ft. to 12-ft.
Wash Bored: 12-ft. to 48-ft.

| DEPTH (ft) | MATERIAL DESCRIPTION | (P) POCKET PEN (tsf) (T) TORVANE (psf) | STD. PENETRATION TEST (blows/ft) | MOISTURE CONTENT (%) | DRY UNIT WEIGHT (pcf) | LIQUID LIMIT (%) | PLASTICITY INDEX (%) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi) | PASSING #200 SIEVE (%) | OTHER TESTS PERFORMED |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | Very dense light gray and tan SILTY SAND (SM) BODY II | | | | | | | | | | | |
| | -with ferrous staining | | 6/6" 16/6" 50/5" | | | | | | | | | |
| 5 | | | | | | | | | | | | |
| | | | 11/6" 50/5" | 20 | | 33 | 9 | | | | 20 | |
| 10 | -with calcareous nodules | | 23/6" 37/6" 50/6" | | | | | | | | | |
| | 31.02' AMSL | | | | | | | | | | | |
| 15 | Very stiff to hard tan and light tan SANDY LEAN SILTY CLAY (CL-ML) SANDY SILTY CLAY BED | | 6/6" 7/6" 10/6" | 31 | | | | | | | 52 | |
| | -color changes to tan and light gray with ferrous staining | | 9/6" 17/6" 27/6" | | | | | | | | | |
| 20 | | | | | | | | | | | | |
| | | | 7/6" 12/6" 13/6" | | | | | | | | | |
| 25 | 19.02' AMSL | | | | | | | | | | | |
| | Stiff to very stiff reddish brown and light gray FAT CLAY (CH) with calcareous nodules and ferrous staining LIGHT OLIVE GREEN TO GRAY CLAY | | 4/6" 5/6" 9/6" | 33 | | 56 | 39 | | | | 99 | |
| 30 | -color changes to light gray with sand layers | | 5/6" 7/6" 12/6" | | | | | | | | | |
| 35 | | | 5/6" | 34 | | | | | | | 86 | |

COMPLETION DEPTH: 48 ft
DATE BORING STARTED: 06/24/2016
DATE BORING COMPLETED: 06/25/2016
LOGGER: J. Garcia
PROJECT NO.: 16.53.042

REMARKS: Free water was encounterd at an approximate depth of 15' below existing grade during drilling operations. After a 10 to 15-minute waiting period, water was at a depth of 9'-3". At the completion of the boring, the open bore-hole was backfilled with cement-bentonite grout.

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TOLUNAY-WONG ENGINEERS, INC.

# LOG OF BORING B-37

PROJECT: City of Kingsville
Municipal Solid Waste Landfill
Aerial Expansion

CLIENT: Naismith Engineering, Inc.

COORDINATES: N 27° 26' 57.1"
W 97° 49' 17.6"
SURFACE ELEVATION: 45.52' AMSL
DRILLING METHOD:
Dry Augered: 0-ft. to 12-ft.
Wash Bored: 12-ft. to 48-ft.

| DEPTH (ft) | MATERIAL DESCRIPTION | (P) POCKET PEN (tsf) (T) TORVANE (psf) | STD. PENETRATION TEST (blows/ft) | MOISTURE CONTENT (%) | DRY UNIT WEIGHT (pcf) | LIQUID LIMIT (%) | PLASTICITY INDEX (%) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi) | PASSING #200 SIEVE (%) | OTHER TESTS PERFORMED |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 35 | Stiff to very stiff light gray and brownish tan FAT CLAY (CH) with sand seams, calcareous nodules, and ferrous staining LIGHT OLIVE GREEN TO GRAY CLAY | | 7/6" 12/6" | | | | | | | | | |
| 40 | | | 4/6" 5/6" 7/6" | | | | | | | | | |
| | -color changes to light gray and reddish brown | | 6/6" 6/6" 9/6" | | | | | | | | | |
| 45 | -color changes to light gray | | 4/6" 5/6" 9/6" | 35 | | 80 | 51 | | | | 86 | |
| 48 | -2.48' AMSL | | | | | | | | | | | |

Bottom @ 48'

50
55
60
65
70

COMPLETION DEPTH: 48 ft
DATE BORING STARTED: 06/24/2016
DATE BORING COMPLETED: 06/25/2016
LOGGER: J. Garcia
PROJECT NO.: 16.53.042

REMARKS: Free water was encounterd at an approximate depth of 15' below existing grade during drilling operations. After a 10 to 15-minute waiting period, water was at a depth of 9'-3". At the completion of the boring, the open bore-hole was backfilled with cement-bentonite grout.

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TOLUNAY-WONG ENGINEERS, INC.

# LOG OF BORING B-38

PROJECT: City of Kingsville
Municipal Solid Waste Landfill
Aerial Expansion

CLIENT: Naismith Engineering, Inc.

COORDINATES: N 27° 27' 03.76"
W 97° 49' 12.19"
SURFACE ELEVATION: 41.64' AMSL
DRILLING METHOD:
Dry Augered: 0 ft. to 10 ft.
Wash Bored: 10 ft. to 58 ft.

| DEPTH (ft) | MATERIAL DESCRIPTION | (P) POCKET PEN (tsf) (T) TORVANE (psf) | STD. PENETRATION TEST (blows/ft) | MOISTURE CONTENT (%) | DRY UNIT WEIGHT (pcf) | LIQUID LIMIT (%) | PLASTICITY INDEX (%) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi) | PASSING #200 SIEVE (%) | OTHER TESTS PERFORMED |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 35 | Very stiff to hard reddish brown and light gray SANDY FAT CLAY (CH) with sand seams and layers | (P) 4.50+ | 8/6" 10/6" | | | | | | | | | |
| | 3.64' AMSL | | | | | | | | | | | |
| | Stiff to hard light gray FAT CLAY (CH), slickensided, with calcareous nodules and ferrous stains | (P) 4.50+ | | 42 | 78 | 100 | 72 | 2.95 | 2 | | 93 | |
| 40 | -color changes to reddish brown and light gray | (P) 4.50+ | | | | | | | | | | |
| | LIGHT OLIVE GREEN TO GRAY CLAY | | | | | | | | | | | |
| | | (P) 4.50+ | | | | | | | | | | |
| 45 | -color changes to tannish brown and light gray with trace organics | (P) 4.50+ | | | | | | | | | | |
| | -color changes to light gray | | 5/6" 6/6" 8/6" | | | | | | | | | |
| | | (P) 4.50+ | | 30 | 91 | | | 2.14 | 3 | | 87 | |
| 50 | | | 6/6" 7/6" 7/6" | | | | | | | | | |
| | | | 4/6" 5/6" 8/6" | | | | | | | | | |
| 55 | -color changes to tannish brown and light gray | | 5/6" 7/6" 9/6" | | | | | | | | | |
| | -color changes to light gray | | 6/6" 7/6" 9/6" | | | | | | | | | |
| | -16.36' AMSL | | | | | | | | | | | |
| | Bottom @ 58' | | | | | | | | | | | |
| 60 | | | | | | | | | | | | |
| 65 | | | | | | | | | | | | |
| 70 | | | | | | | | | | | | |

COMPLETION DEPTH: 58 ft
DATE BORING STARTED: 06/23/2016
DATE BORING COMPLETED: 06/23/2016
LOGGER: J. Garcia
PROJECT NO.: 16.53.042

REMARKS: Free water was encounterd at an approximate depth of 11' below existing grade during drilling operations. After a 10 to 15-minute waiting period, water was at a depth of 5'-5". At the completion of the boring, the open bore-hole was backfilled with cement-bentonite grout.

Page 2 of 2

TOLUNAY-WONG ENGINEERS, INC.

# LOG OF BORING B-39

PROJECT: City of Kingsville
Municipal Solid Waste Landfill
Aerial Expansion

CLIENT: Naismith Engineering, Inc.

COORDINATES: N 27° 27' 01.3"
W 97° 48' 57.3"
SURFACE ELEVATION: 60.26' AMSL
DRILLING METHOD:
Dry Augered: 0 ft. to 26 ft.
Wash Bored: 26 ft. to 68 ft.

| DEPTH (ft) | MATERIAL DESCRIPTION | (P) POCKET PEN (tsf) (T) TORVANE (psf) | STD. PENETRATION TEST (blows/ft) | MOISTURE CONTENT (%) | DRY UNIT WEIGHT (pcf) | LIQUID LIMIT (%) | PLASTICITY INDEX (%) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi) | PASSING #200 SIEVE (%) | OTHER TESTS PERFORMED |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | Medium dense to dense tan and light gray CLAYEY SAND FILL with trace gravel BODY I | | 8/6" 9/6" 6/6" | 18 | | | | | | | 33 | |
| | -color changes to brown | | 40/6" 27/6" 19/6" | | | | | | | | | |
| | 55.76' AMSL | | | | | | | | | | | |
| 5 | Medium dense to dense brown and reddish brown CLAYEY SAND (SC) BODY I | | 6/6" 7/6" 8/6" | | | | | | | | | |
| | -color changes to tan and gray with calcareous nodules | | 4/6" 5/6" 6/6" | | | | | | | | | |
| | | | 5/6" 6/6" 8/6" | 11 | | 36 | 20 | | | | 49 | |
| 10 | -color changes to tan and light gray | | 4/6" 6/6" 7/6" | | | | | | | | | |
| | -color changes to light gray | | 7/6" 8/6" 11/6" | | | | | | | | | |
| 15 | -color changes to light gray and tan with ferrous stains | | 6/6" 12/6" 19/6" | | | | | | | | | |
| | -color changes to light gray | | 11/6" 19/6" 22/6" | | | | | | | | | |
| | 41.76' AMSL | | | | | | | | | | | |
| 20 | Stiff to hard light gray SANDY LEAN CLAY (CL) with calcareous nodules and ferrous stains | | 3/6" 4/6" 5/6" | 19 | | | | | | | 65 | |
| | | | 6/6" 9/6" 13/6" | | | | | | | | | |
| | | | 8/6" 11/6" 20/6" | | | | | | | | | |
| 25 | -color changes to light tan and light gray | (P) 4.50+ | | | | | | | | | | |
| | -color changes to light gray | (P) 4.00 | | | | | | | | | | |
| | | | 7/6" 11/6" 13/6" | | | | | | | | | |
| 30 | -color changes to light gray and tan | (P) 4.50+ | | 19 | 102 | | | 1.14 | 7 | | 50 | |
| | | | 12/6" 16/6" 20/6" | | | | | | | | | |
| 35 | | | 8/6" | | | | | | | | | |

COMPLETION DEPTH: 68 ft
DATE BORING STARTED: 06/20/2016
DATE BORING COMPLETED: 06/24/2016
LOGGER: J. Garcia
PROJECT NO.: 16.53.042

REMARKS: Free water was encounterd at an approximate depth of 27' below existing grade during drilling operations. After a 10 to 15-minute waiting period, water was at a depth of 26'-6". At the completion of the boring, the open bore-hole was backfilled with cement-bentonite grout.

Page 1 of 2

TOLUNAY-WONG ENGINEERS, INC.

# LOG OF BORING B-39

PROJECT: City of Kingsville
Municipal Solid Waste Landfill
Aerial Expansion

CLIENT: Naismith Engineering, Inc.

COORDINATES: N 27° 27' 01.3"
W 97° 48' 57.3"
SURFACE ELEVATION: 60.26' AMSL
DRILLING METHOD:
Dry Augered: 0 ft. to 26 ft.
Wash Bored: 26 ft. to 68 ft.

| DEPTH (ft) | MATERIAL DESCRIPTION | (P) POCKET PEN (tsf) (T) TORVANE (psf) | STD. PENETRATION TEST (blows/ft) | MOISTURE CONTENT (%) | DRY UNIT WEIGHT (pcf) | LIQUID LIMIT (%) | PLASTICITY INDEX (%) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi) | PASSING #200 SIEVE (%) | OTHER TESTS PERFORMED |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 35 | Stiff to hard light gray and tan SANDY LEAN CLAY (CL) with ferrous stains 23.76' AMSL | | 12/6" 16/6" | | | | | | | | | |
| | Medium dense to dense light gray CLAYEY SAND (SC) with ferrous stains BODY III | | 7/6" 8/6" 11/6" | | | | | | | | | |
| | | | 6/6" 11/6" 12/6" | | | | | | | | | |
| 40 | | | 7/6" 10/6" 13/6" | 25 | | 69 | 51 | | | | 45 | |
| | 15.76' AMSL | | 13/6" 19/6" 21/6" | | | | | | | | | |
| 45 | Dense light gray POORLY GRADED SAND with CLAY (SP- SC) | | 12/6" 21/6" 20/6" | | | | | | | | | |
| | 12.26' AMSL | | 11/6" 16/6" 16/6" | | | | | | | | | |
| | Hard reddish brown and light gray FAT CLAY with SAND (CH) LIGHT OLIVE GREEN TO GRAY CLAY | (P) 4.50+ | | | | | | | | | | |
| 50 | | (P) 4.50+ | | 28 | 93 | | | 0.85 | 1 | | 72 | |
| | -becomes slickensided with calcareous nodules | (P) 4.50+ | | | | | | | | | | |
| | -with ferrous stains | (P) 4.50+ | | | | | | | | | | |
| 55 | | (P) 4.50+ | | | | | | | | | | |
| | | (P) 4.50+ | | | | | | | | | | |
| 60 | | (P) 4.50+ | | | | | | | | | | |
| | -becomes stiff | | 7/6" 7/6" 7/6" | | | | | | | | | |
| 65 | -6.24' AMSL | | | | | | | | | | | |
| | Medium dense light gray CLAYEY SAND (SC) with calcareous nodules and ferrous stains -7.74' AMSL | | 6/6" 10/6" 13/6" | 20 | 102 | 61 | 45 | 1.91 | 5 | | 46 | |
| | Bottom @ 68' | | | | | | | | | | | |
| 70 | | | | | | | | | | | | |

COMPLETION DEPTH: 68 ft
DATE BORING STARTED: 06/20/2016
DATE BORING COMPLETED: 06/24/2016
LOGGER: J. Garcia
PROJECT NO.: 16.53.042

REMARKS: Free water was encounterd at an approximate depth of 27' below existing grade during drilling operations. After a 10 to 15-minute waiting period, water was at a depth of 26'-6". At the completion of the boring, the open bore-hole was backfilled with cement-bentonite grout.

Page 2 of 2

TOLUNAY-WONG ENGINEERS, INC.

# LOG OF BORING B-40

PROJECT: City of Kingsville
Municipal Solid Waste Landfill
Aerial Expansion

CLIENT: Naismith Engineering, Inc.

COORDINATES: N 27° 27' 09.97"
W 97° 49' 11.18"
SURFACE ELEVATION: 52.31' AMSL
DRILLING METHOD:
Dry Augered: 0 ft. to 22 ft.
Wash Bored: 22 ft. to 33.75 ft.

| DEPTH (ft) | MATERIAL DESCRIPTION | (P) POCKET PEN (tsf) (T) TORVANE (psf) | STD. PENETRATION TEST (blows/ft) | MOISTURE CONTENT (%) | DRY UNIT WEIGHT (pcf) | LIQUID LIMIT (%) | PLASTICITY INDEX (%) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi) | PASSING #200 SIEVE (%) | OTHER TESTS PERFORMED |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | Loose to very dense light gray and gray SILTY SAND (SM) with trace caliche BODY II | | 4/6" 4/6" 6/6" | | | | | | | | | |
| | -color changes to light gray and tan with ferrous stains | | 5/6" 7/6" 11/6" | 16 | | 35 | 10 | | | | 31 | |
| 5 | | | 7/6" 17/6" 17/6" | | | | | | | | | |
| | -color changes to light gray with calcareous nodules | | 12/6" 21/6" 34/6" | | | | | | | | | |
| | -color changes to light gray and white | | 12/6" 27/6" 50/3" | 18 | | | | | | | 34 | |
| 10 | -color changes to white | | 15/6" 50/3" | | | | | | | | | |
| | -color changes to light gray and white 37.81' AMSL | | 25/6" 50/4" | | | | | | | | | |
| 15 | Hard light gray FAT CLAY with SAND (CH), calcareous nodules, and ferrous stains | | 7/6" 26/6" 50/5" | 22 | | 70 | 41 | | | | 80 | |
| | | | 5/6" 17/6" 28/6" | | | | | | | | | |
| 20 | 31.81' AMSL | | 10/6" 30/6" 35/6" | | | | | | | | | |
| | Hard light gray SANDY FAT CLAY (CH) with calcareous nodules and ferrous stains | | 9/6" 25/6" 35/6" | 31 | | | | | | | 59 | |
| | | | 16/6" 32/6" 50/5" | | | | | | | | | |
| 25 | 25.81' AMSL | | 16/6" 31/6" 50/5" | | | | | | | | | |
| | Dense to very dense light gray CLAYEY SAND (SC) with calcareous nodules | | 8/6" 18/6" 27/6" | 30 | | 53 | 32 | | | | 49 | |
| 30 | | | 6/6" 18/6" 50/6" | | | | | | | | | |
| | | | 6/6" 20/6" 50/5" | | | | | | | | | |
| | 18.81' AMSL | | 3/6" 40/6" 50/3" | 16 | | | | | | | 30 | |
| 35 | Bottom @ 33.5' | | | | | | | | | | | |

COMPLETION DEPTH: 33.5 ft
DATE BORING STARTED: 06/21/2016
DATE BORING COMPLETED: 06/22/2016
LOGGER: J. Garcia
PROJECT NO.: 16.53.042

REMARKS: Free water was encounterd at an approximate depth of 21' below existing grade during drilling operations. After a 10 to 15-minute waiting period, water was at a depth of 19'. At the completion of the boring, the open bore-hole was backfilled with cement-bentonite grout.

Page 1 of 1

TOLUNAY-WONG ENGINEERS, INC.

# LOG OF BORING B-41

PROJECT: City of Kingsville Municipal Solid Waste Landfill Aerial Expansion
CLIENT: Naismith Engineering, Inc.

COORDINATES: N 27° 27' 09.8" W 97° 49' 17.4"
SURFACE ELEVATION: 50.20' AMSL
DRILLING METHOD:
Dry Augered: 0-ft. to 62.5-ft.
Wash Bored: -- to --

| DEPTH (ft) | MATERIAL DESCRIPTION | (P) POCKET PEN (tsf) (T) TORVANE (psf) | STD. PENETRATION TEST (blows/ft) | MOISTURE CONTENT (%) | DRY UNIT WEIGHT (pcf) | LIQUID LIMIT (%) | PLASTICITY INDEX (%) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi) | PASSING #200 SIEVE (%) | OTHER TESTS PERFORMED |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | Loose to medium dense gray CLAYEY SAND (SC) with calcareous nodules BODY I | | 4/6" 5/6" 5/6" | 8 | | | | | | | 35 | |
| 5 | -color changes to light gray | | 4/6" 5/6" 6/6" | | | | | | | | | |
| | 41.70' AMSL | | | | | | | | | | | |
| | Stiff to very stiff gray SANDY FAT CLAY (CH) LIGHT OLIVE GREEN TO GRAY CLAY | | 5/6" 8/6" 11/6" | 20 | | 78 | 52 | | | | 64 | |
| 10 | | | | | | | | | | | | |
| | -becomes hard and color changes to brown with interbedded sand seams | | 9/6" 17/6" 25/6" | | | | | | | | | |
| 15 | -color changes to brown and tan | | 7/6" 12/6" 14/6" | | | | | | | | | |
| 20 | -color changes to tan with sand layers | | 3/6" 4/6" 6/6" | 36 | | | | | | | 64 | |
| 25 | -color changes to brown with sand partings | | 5/6" 4/6" 6/6" | | | | | | | | | |
| | -color changes to brown and tan | | 6/6" 7/6" 8/6" | 31 | | 52 | 30 | | | | 51 | |
| 30 | | | | | | | | | | | | |
| | | | 4/6" 6/6" 6/6" | | | | | | | | | |
| 35 | | | | | | | | | | | | |

COMPLETION DEPTH: 62.5 ft
DATE BORING STARTED: 07/20/2016
DATE BORING COMPLETED: 07/20/2016
LOGGER: M. Anderson
PROJECT NO.: 16.53.042

REMARKS: Free water was encounterd at an approximate depth of 19'-6" below existing grade during drilling operations. After a 10 to 15-minute waiting period, water was at a depth of 19'-3". At the completion of the boring, the open bore-hole was backfilled with cement-bentonite grout.

Page 1 of 2

TOLUNAY-WONG ENGINEERS, INC.

# LOG OF BORING B-41

PROJECT: City of Kingsville
Municipal Solid Waste Landfill
Aerial Expansion

CLIENT: Naismith Engineering, Inc.

COORDINATES: N 27° 27' 09.8"
W 97° 49' 17.4"
SURFACE ELEVATION: 50.20' AMSL
DRILLING METHOD:
Dry Augered: 0-ft. to 62.5-ft.
Wash Bored: -- to --

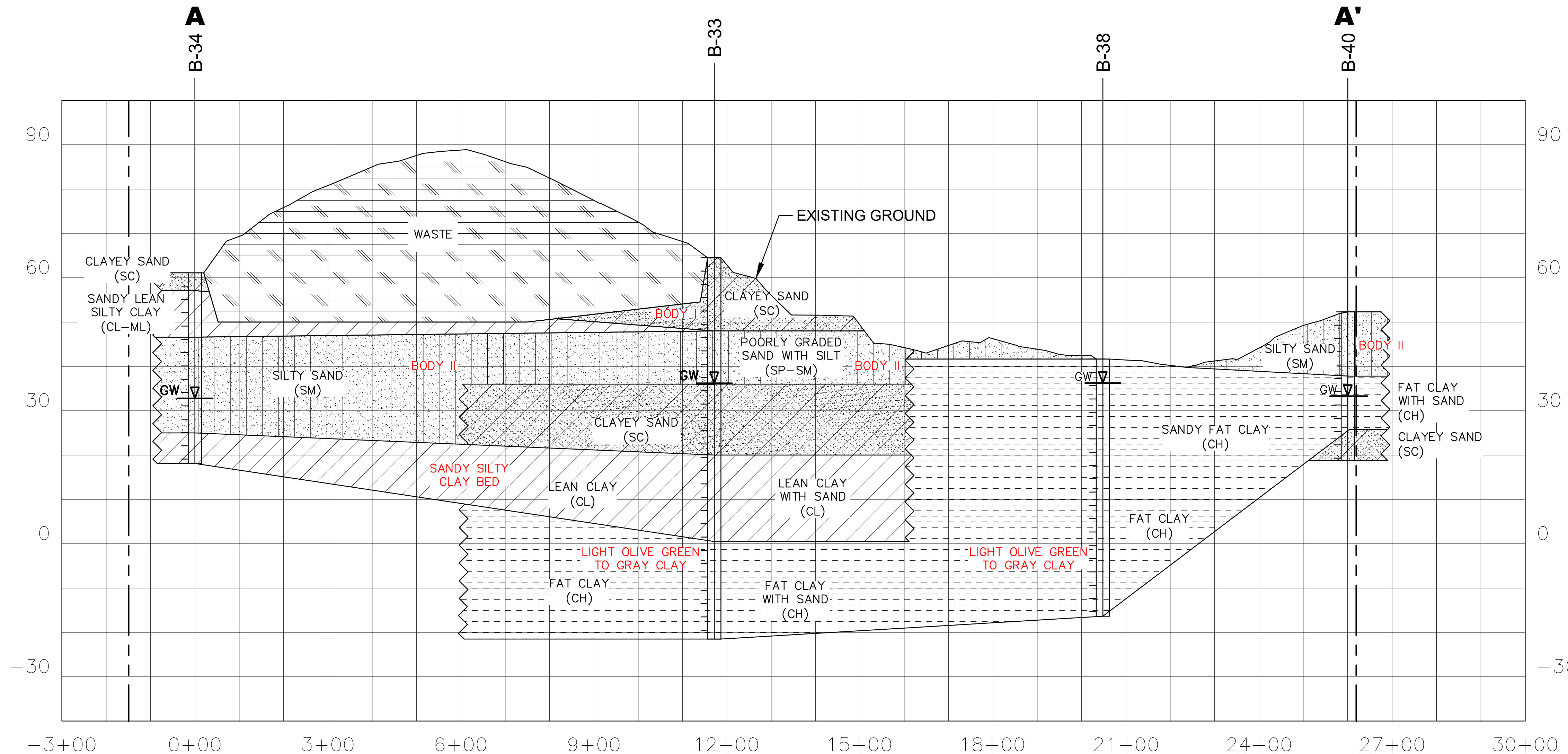
| DEPTH (ft) | MATERIAL DESCRIPTION | (P) POCKET PEN (tsf) (T) TORVANE (psf) | STD. PENETRATION TEST (blows/ft) | MOISTURE CONTENT (%) | DRY UNIT WEIGHT (pcf) | LIQUID LIMIT (%) | PLASTICITY INDEX (%) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi) | PASSING #200 SIEVE (%) | OTHER TESTS PERFORMED |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 35 | 14.20' AMSL<br>Stiff to very stiff gray SANDY FAT CLAY (CH) | | | | | | | | | | | |
| | Very stiff brown FAT CLAY with SAND (CH)<br>LIGHT OLIVE GREEN TO GRAY CLAY | (P) 3.25 | | 27 | 92 | | | | | | 77 | |
| 40 | -color changes to brown and tan | | 6/6"<br>13/6"<br>11/6" | | | | | | | | | |
| 45 | | | 4/6"<br>9/6"<br>14/6" | | | | | | | | | |
| | | | 6/6"<br>8/6"<br>9/6" | 35 | | 97 | 75 | | | | 84 | |
| 50 | -color changes to brown and gray | | 7/6"<br>9/6"<br>12/6" | | | | | | | | | |
| 55 | -color changes to gray | (P) 4.50+ | | | | | | | | | | |
| 60 | | (P) 3.50 | | | | | | | | | | |
| | -12.30' AMSL<br>Bottom @ 62.5' | | | | | | | | | | | |
| 65 | | | | | | | | | | | | |
| 70 | | | | | | | | | | | | |

COMPLETION DEPTH: 62.5 ft
DATE BORING STARTED: 07/20/2016
DATE BORING COMPLETED: 07/20/2016
LOGGER: M. Anderson
PROJECT NO.: 16.53.042

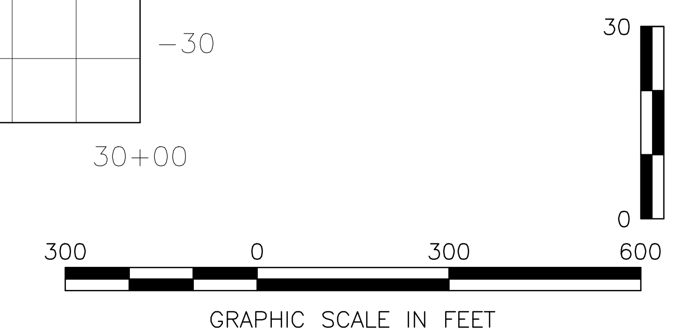
REMARKS: Free water was encounterd at an approximate depth of 19'-6" below existing grade during drilling operations. After a 10 to 15-minute waiting period, water was at a depth of 19'-3". At the completion of the boring, the open bore-hole was backfilled with cement-bentonite grout.

Page 2 of 2

TOLUNAY-WONG ENGINEERS, INC.




## CROSS SECTION A-A'




### LEGEND

- WASTE
- LEAN CLAY, LEAN CLAY WITH SAND, SANDY LEAN SILTY CLAY (CL, CL-ML)
- CLAYEY SAND (SC)
- SILTY SAND, POORLY GRADED SAND WITH SILT (SM, SP-SM)
- FAT CLAY, SANDY FAT CLAY FAT CLAY WITH SAND (CH)
- ▽ GROUND WATER AFTER EQUILIBRIUM (GW)
- — — — PERMIT BOUNDARY



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CITY OF KINGSVILLE LANDFILL

SOIL BORING REPORT
CROSS SECTION A-A'
KLEBERG COUNTY, TEXAS

16L0438 EXHIBIT IV

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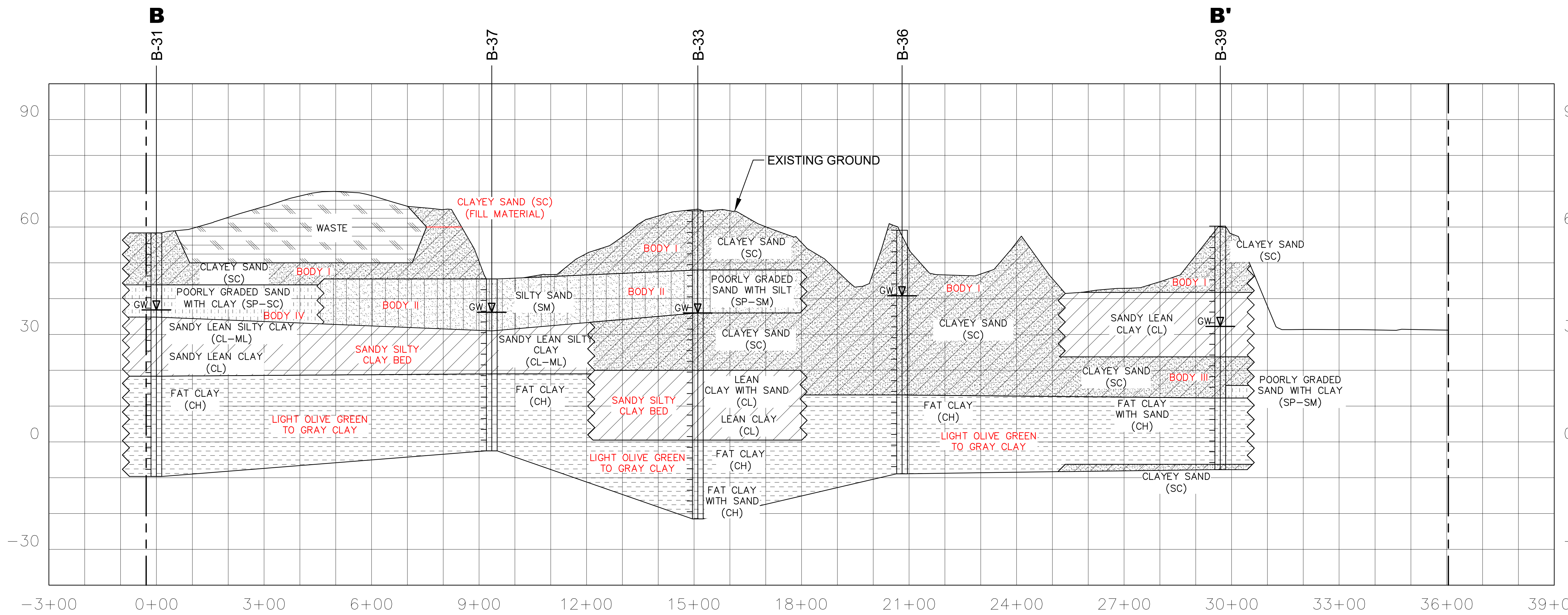


# CROSS SECTION B-B'



## LEGEND

| | |
|---|---|
| | WASTE |
| | LEAN CLAY, LEAN CLAY WITH SAND, SANDY LEAN SILTY CLAY (CL, CL–ML) |
| | CLAYEY SAND (SC) |
| | SILTY SAND, POORLY GRADED SAND WITH SILT (SM, SP–SM) |
| | FAT CLAY, SANDY FAT CLAY FAT CLAY WITH SAND (CH) |
| | POORLY GRADED SAND WITH CLAY (SP–SC) |
| ▽ | GROUND WATER AFTER EQUILIBRIUM (GW) |
| — — — | PERMIT BOUNDARY |



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CITY OF KINGSVILLE LANDFILL

SOIL BORING REPORT
CROSS SECTION B-B'
KLEBERG COUNTY, TEXAS

16L0438 EXHIBIT IV

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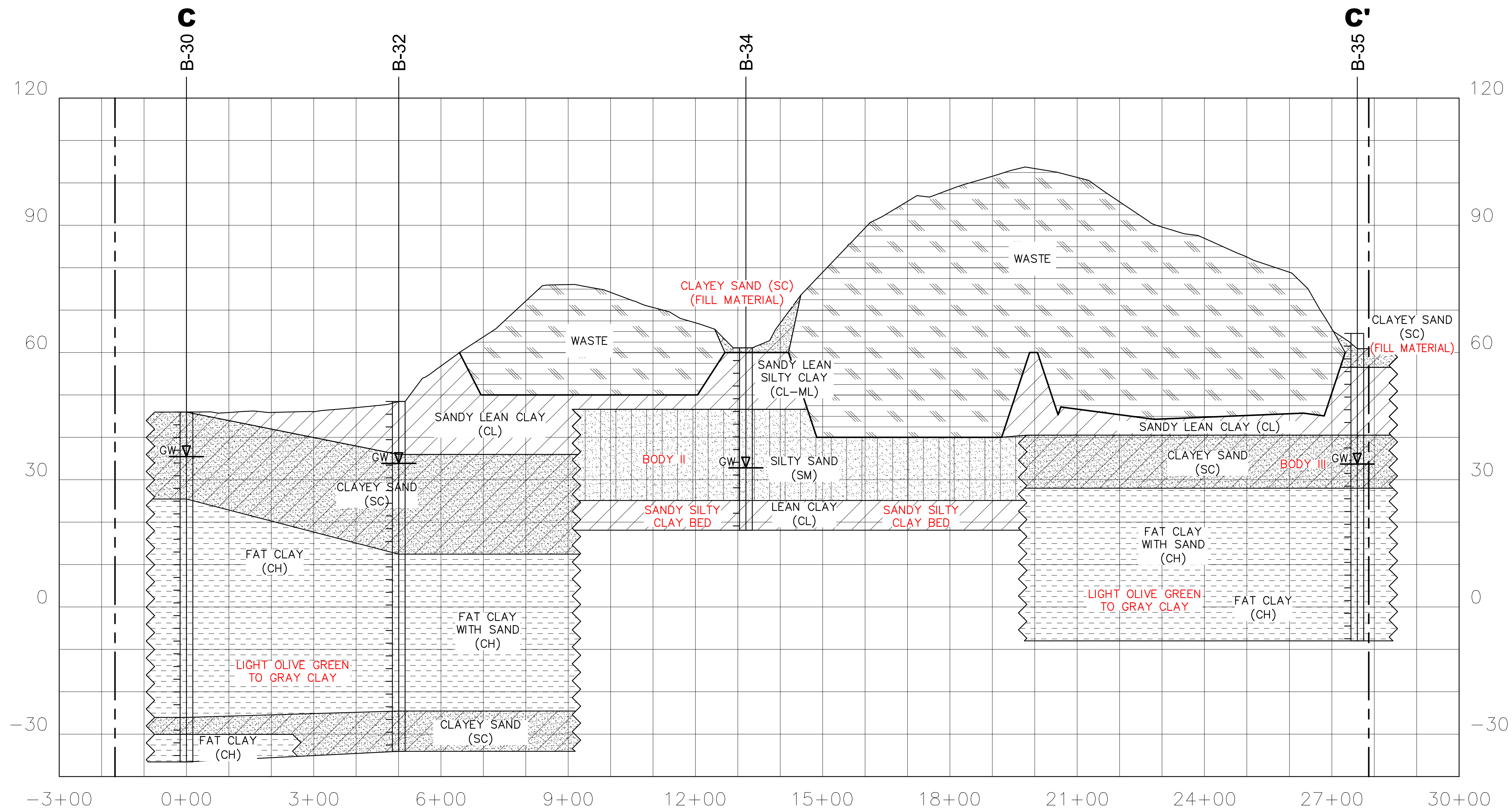
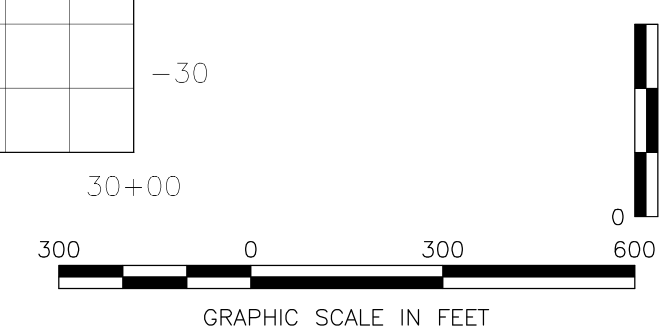



## CROSS SECTION C-C'




| LEGEND | |
|---|---|
| (waste pattern) | WASTE |
| (diagonal hatch) | LEAN CLAY, LEAN CLAY WITH SAND, SANDY LEAN SILTY CLAY (CL, CL−ML) |
| (stippled hatch) | CLAYEY SAND (SC) |
| (stippled vertical) | SILTY SAND, POORLY GRADED SAND WITH SILT (SM, SP−SM) |
| (dashed) | FAT CLAY, SANDY FAT CLAY (CH) |
| ▽ | GROUND WATER AFTER EQUILIBRIUM (GW) |
| — — — | PERMIT BOUNDARY |



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# CITY OF KINGSVILLE LANDFILL

SOIL BORING REPORT
CROSS SECTION C-C'
KLEBERG COUNTY, TEXAS

16L0438 EXHIBIT IV

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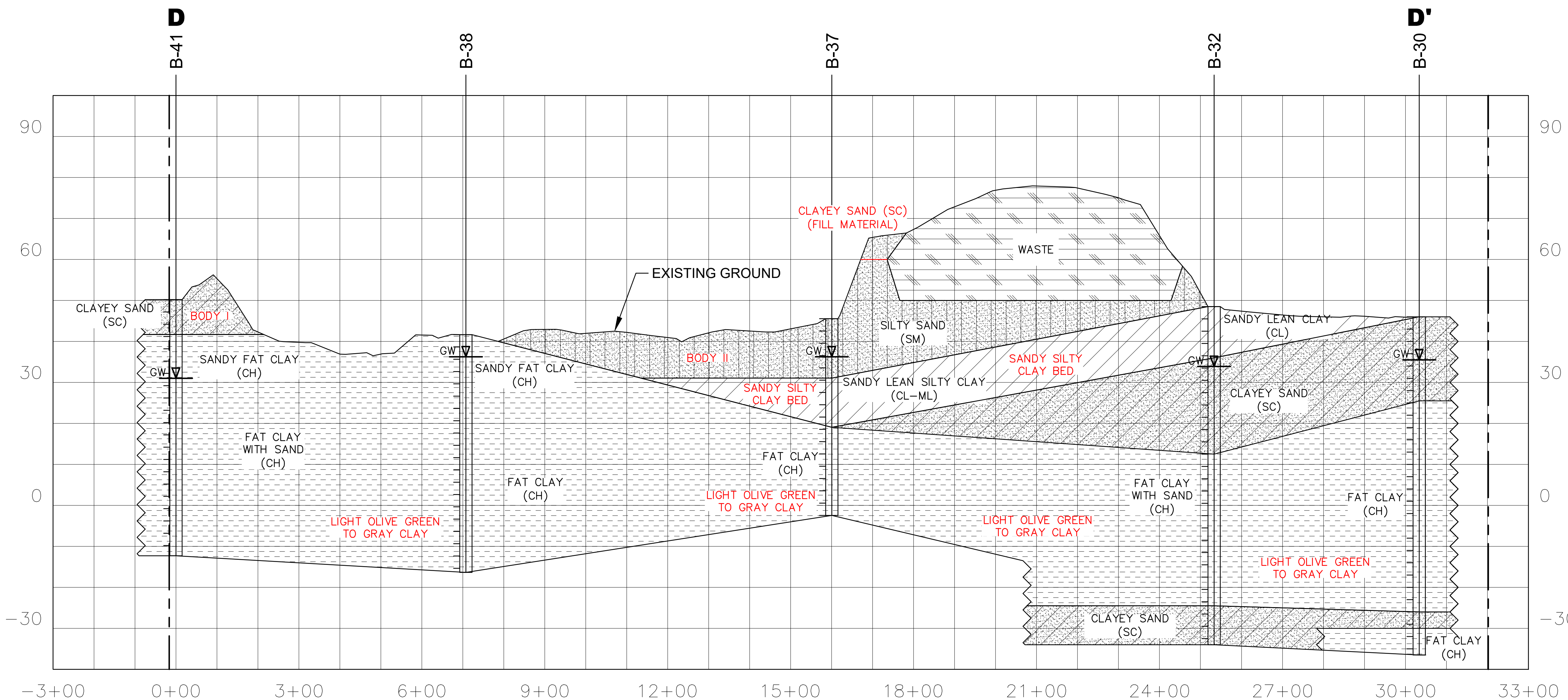


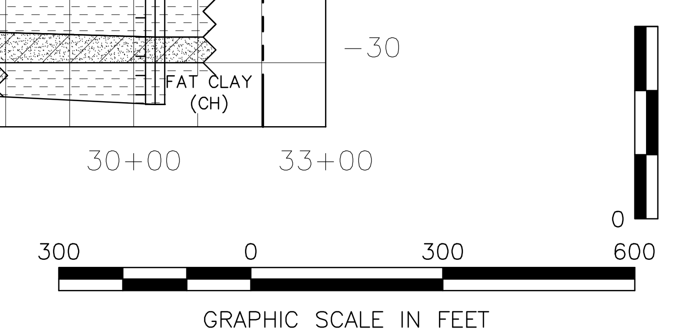


## CROSS SECTION D-D'

### LEGEND

- WASTE
- LEAN CLAY, LEAN CLAY WITH SAND, SANDY LEAN SILTY CLAY (CL, CL−ML)
- CLAYEY SAND (SC)
- SILTY SAND, POORLY GRADED SAND WITH SILT (SM, SP−SM)
- FAT CLAY, SANDY FAT CLAY (CH)
- ∇ GROUND WATER AFTER EQUILIBRIUM (GW)
- — — — PERMIT BOUNDARY



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CITY OF KINGSVILLE LANDFILL

SOIL BORING REPORT
CROSS SECTION D-D'
KLEBERG COUNTY, TEXAS

16L0438 EXHIBIT IV

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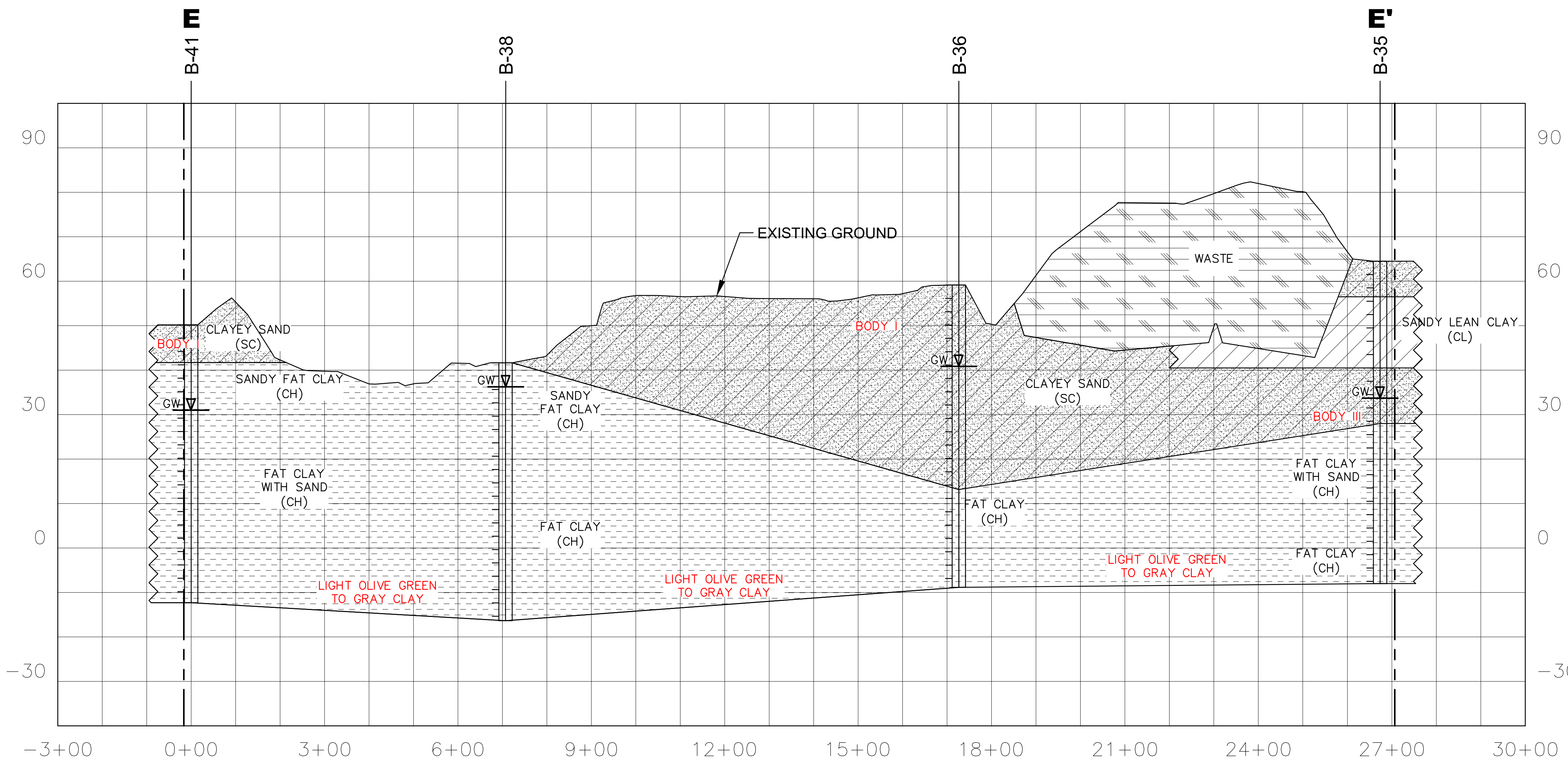


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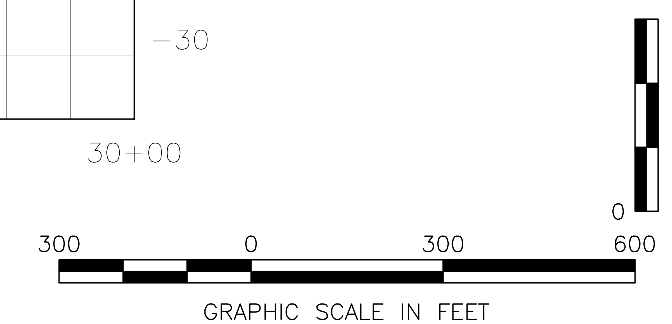


## LEGEND

| | |
|---|---|
| | WASTE |
| | LEAN CLAY, LEAN CLAY WITH SAND, SANDY LEAN SILTY CLAY (CL, CL–ML) |
| | CLAYEY SAND (SC) |
| | FAT CLAY, SANDY FAT CLAY (CH) |
| | GROUND WATER AFTER EQUILIBRIUM (GW) |
| | PERMIT BOUNDARY |



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CITY OF KINGSVILLE LANDFILL

SOIL BORING REPORT
CROSS SECTION E-E'
KLEBERG COUNTY, TEXAS

16L0438 EXHIBIT IV

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# CITY OF KINGSVILLE LANDFILL

# PART III, ATTACHMENT 4

# ATTACHMENT 6

WATER WELL SURVEY DATA ~~TABLE~~

# Water Well Survey Data Table

| Well ID | Figure 4.15 ID | Well Use | Aquifer | Well Depth (Ft.) | Approximate Distance from Site |
|---|---|---|---|---|---|
| **Wells Identified by FEE** | | | | | |
| 83-34-501 | 501 | Domestic | Evangeline Aquifer (Goliad Sand) | 631 | ~0.6 Miles South |
| ~~83-34-502~~ | ~~N/A~~ | ~~Domestic~~ | ~~Evangeline Aquifer (Goliad Sand)~~ | ~~656~~ | ~~~1.8 Miles South~~ |
| 83-34-503 | 503 | N/A | Aquifer Code Is Not Applicable to this Well | 6131 | ~ 0.8 Miles Northeast |
| 83-34-2C | 2C | Domestic | *Evangeline Aquifer (Goliad Sand) | 618 | ~0.9 Miles Northeast |
| 83-34-2D | 2D | Other | *Evangeline Aquifer (Goliad Sand) | 556 | ~0.9 Miles Northeast |
| 83-34-2H | 2H | Domestic | *Evangeline Aquifer (Goliad Sand) | 618 | ~0.9 Mile Northwest |
| 83-34-2K | 2K | Domestic | *Evangeline Aquifer (Goliad Sand) | 591 | ~0.9 Miles Northwest |
| 83-34-2K | 2K | Domestic | *Evangeline Aquifer (Goliad Sand) | 668 | ~0.9 Miles Northwest |
| 83-34-4K | 4K | Domestic | *Evangeline Aquifer (Goliad Sand) | 692 | ~0.9 Miles Southwest |
| 83-34-4S | 4S | Domestic | *Evangeline Aquifer (Goliad Sand) | 640 | ~0.8 Miles Southwest |
| 83-34-5B | 5B | Domestic | *Evangeline Aquifer (Goliad Sand) | 631 | ~0.4 Miles Southeast |
| 83-34-5D | 5D | Domestic | *Evangeline Aquifer (Goliad Sand) | 642 | ~0.7 Miles Northeast |
| 83-34-5E | 5E | Domestic | *Evangeline Aquifer (Goliad Sand) | 612 | ~0.5 Miles Northwest |
| 83-34-5F | 5F | Domestic | *Evangeline Aquifer (Goliad Sand) | 727 | ~0.5 Miles North |
| 83-34-5G | 5G | Domestic | *Evangeline Aquifer (Goliad Sand) | 763 | ~0.9 Miles Southwest |
| 83-34-5H | 5H | Domestic | *Evangeline Aquifer (Goliad Sand) | 687 | ~0.5 Miles South |
| 83-34-5U | 5J | Domestic | *Evangeline Aquifer (Goliad Sand) | 640 | ~ 0.7 Miles Northeast |
| 83-34-1 | 1(1) | Irrigation | *Evangeline Aquifer (Goliad Sand) | 642 | ~0.5 Miles Northwest |
| 83-34-2 | 2(1) | Domestic | *Evangeline Aquifer (Goliad Sand) | 540 | ~1.0 Miles Northeast |
| 83-34-4 | 4(1) | Domestic | *Evangeline Aquifer (Goliad Sand) | 630 | ~0.7 Miles Northwest |
| 83-34-5 | 5(1) | Domestic | *Evangeline Aquifer (Goliad Sand) | 573 | ~0.3 Miles Southwest |
| 83-34-5 | 5(2) | Domestic | *Evangeline Aquifer (Goliad Sand) | 630 | ~0.4 Miles Northwest |
| 83-34-5 | 5(3) | Domestic | *Evangeline Aquifer (Goliad Sand) | 662 | ~0.3 Miles Southeast |
| 83-34-5 | 5(4) | Domestic | *Evangeline Aquifer (Goliad Sand) | 652 | ~0.5 Miles Southeast |
| 83-34-5 | 5(5) | Domestic | *Evangeline Aquifer (Goliad Sand) | 661 | ~0.7 Miles Southwest |
| 83-34-5 | 5(6) | Domestic | *Evangeline Aquifer (Goliad Sand) | 729 | ~0.3 Miles East |
| 83-34-5 | 5(7) | Supply | *Evangeline Aquifer (Goliad Sand) | 720 | ~0.9 Miles Southeast |
| 83-34-5 | 5(8) | Industrial | *Evangeline Aquifer (Goliad Sand) | 801 | ~0.5 Miles West |
| 83-34-5 | 5(9) | Domestic | *Evangeline Aquifer (Goliad Sand) | 645 | ~0.8 Miles Southwest |
| 83-34-5 | 5(10) | Domestic | *Evangeline Aquifer (Goliad Sand) | 656 | ~0.5 Miles Southeast |
| 83-34-5 | 5(11) | Domestic | *Evangeline Aquifer (Goliad Sand) | 663 | ~0.7 Miles Southwest |
| 83-34-5 | 5(12) | Domestic | *Evangeline Aquifer (Goliad Sand) | 612 | ~0.3 Miles Southeast |
| **Additional Wells Identified by Hanson Professional Services** | | | | | |
| **Tracking #** | **Owner Well #** | **Well Use** | **Aquifer** | **Well Depth (Ft.)** | **Approximate Distance from Site** |
| 155775 | No Data | Domestic | *Evangeline Aquifer (Goliad Sand) | 600 | ~0.7 Miles Northeast |
| 100867 | NOLLKINPER #2 | Rig Supply | *Evangeline Aquifer (Goliad Sand) | 640 | ~0.6 Miles Northeast |
| 425307 | 2 | Stock | *Evangeline Aquifer (Goliad Sand) | 650 | ~0.9 Miles Northeast |
| 425295 | 1 | Domestic | *Evangeline Aquifer (Goliad Sand) | 650 | ~0.9 Miles Northeast |
| 494827 | FLAMINGO #1 | Rig Supply | *Evangeline Aquifer (Goliad Sand) | 600 | ~1.0 Miles Southeast |
| 372796 | 1 | Domestic | *Evangeline Aquifer (Goliad Sand) | 660 | ~1.0 Miles Southwest |
| 155888 | No Data | Industrial | *Evangeline Aquifer (Goliad Sand) | 580 | ~0.5 Miles Southwest |
| 305970 | No Data | Industrial | *Evangeline Aquifer (Goliad Sand) | 608 | ~0.8 Miles Southwest |
| 342528 | No Data | Domestic | *Evangeline Aquifer (Goliad Sand) | 645 | ~0.5 Miles Southwest |
| 178262 | No Data | Domestic | *Evangeline Aquifer (Goliad Sand) | 595 | ~0.2 Miles Southwest |
| 208460 | No Data | Domestic | *Evangeline Aquifer (Goliad Sand) | 596 | ~0.8 Milles Northwest |
| 246291 | No Data | Domestic | *Evangeline Aquifer (Goliad Sand) | 560 | ~0.8 Milles Northwest |
| 413217 | No Data | Domestic | *Evangeline Aquifer (Goliad Sand) | 622 | ~0.8 Milles Northwest |
| 295148 | No Data | Domestic | *Evangeline Aquifer (Goliad Sand) | 600 | ~0.5 Milles Northeast |
| 8334503 | No Data | Oil or Gas | Aquifer Code Is Not Applicable to this Well | 6131 | ~0.3 Milles East |
| 166733 | No Data | Industrial | *Evangeline Aquifer (Goliad Sand) | 612 | ~1.0 Miles Southeast |
| 494833 | No Data | Stock | *Evangeline Aquifer (Goliad Sand) | 560 | ~0.9 Miles Northwest |
| 8334501 | No Data | Domestic | Evangeline Aquifer (Goliad Sand) | 631 | ~0.4 Milles South |
| 190906 | No Data | Domestic | *Evangeline Aquifer (Goliad Sand) | 648 | ~1.0 Miles Southwest |

***Aquifer Based on Total Depth of Well and Screening Interval**

THE CITY OF KINGSVILLE LANDFILL

TCEQ PERMIT MSW 235C

# PERMIT AMENDMENT APPLICATION

## Volume 4 of 6

CITY OF KINGSVILLE, KLEBERG COUNTY, TEXAS

September 2018

Revision 1 – November 2018

Revision 2 – February 2019

Revision 3 – April 2019

Prepared by

HANSON

Engineering | Planning | Allied Services

TBPE F-417

HANSON PROJECT NO. 16L0438-0003

# CITY OF KINGSVILLE LANDFILL

# PART III

# ATTACHMENT 5

ALTERNATIVE LINER AND OVERLINER

POINT OF COMPLIANCE DEMONSTRATIONS

# ATTACHMENT 5

# ALTERNATIVE LINER AND OVERLINER DESIGN AND POINT OF COMPLIANCE DEMONSTRATIONS

# CONTENTS

Appendices C.7.1 through C.7.11. The upper clay (light olive green clay) is ubiquitous under the site with a minimum proven thickness of 38 feet thick, the Chicot Aquifer is approximately 220 feet below ground surface, and the Evangeline Aquifer is approximately 500 feet below ground surface. The light olive green clay layer serves as aquiclude between the uppermost acquifer below the landfill site and the Chicot acquifer. To provide a conservative assumption given the bottom of the landfill and the groundwater, the percolation through the alternate liner and overliner system was assumed to be conveyed directly to the upper strata and therefore travel time, dilution, and attenuation are not accounted for in this analysis for upper soils.

## 2.4 SLOPE STABILITY ANALYSIS

The alternative liner and overliner system were analyzed for slope stability by performing two dimensional, effective stress slope stability analyses for the final, closed geometry, using the computer program SLIDE. The slope stability calculations are presented in Part III Attachment 4, Appendix 2-Section 7 WASTE MASS STABILITY and Appendix F: Graphical Representation of Mass Stability Analyses Results.

## 2.5 ALTERNATE COMPOSITE FINAL COVER DESIGN DEMONSTRATION

The alternate composite final cover design demonstration will demonstrate that the use of a geosynthetic clay liner (GCL) will provide equivalent infiltration and protection from wind and water erosion as the conventional composite final cover defined in 30 TAC §330.457 (d)(1) & (d)(2). The design demonstration is shown in Appendix G.

# 4 POINT OF COMPLIANCE DEMONSTRATION RESULTS

The HELP and MULTIMED models were used to evaluate the proposed design of the alternative liner and overliner system by estimating constituent concentrations at the POC for the landfill cases discussed in Section 2.3. The percolation rates obtained from the HELP Model cases included in Appendix C.3 and Appendix C.4 were used as input for the MULTIMED model to determine the DAF. Conservatively, the constituent concentrations at the base of the landfill liner and at the POC were used to calculate the DAF.

A summary of the calculated DAF is presented below and in Appendix D.

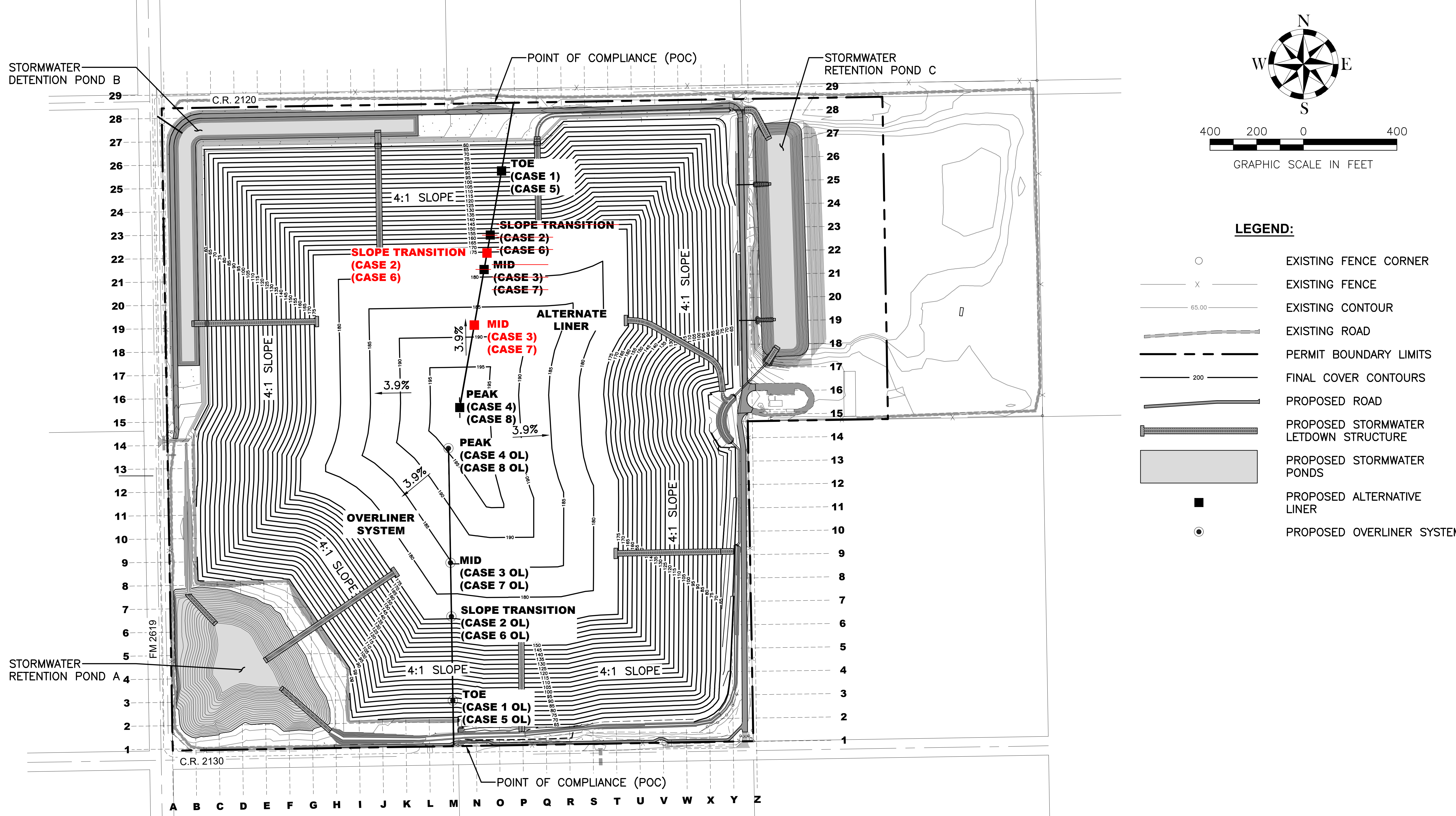
| Location | Interim Case DAF | Closed Case DAF |
|---|---|---|
| Alternative Liner Location 1 | ~~33,979~~40,833 | ~~85,106~~102,301 |
| Alternative Liner Location 2 | ~~57,471~~68,446 | ~~201,288~~239,750 |
| Alternative Liner Location 3 | ~~80,645~~137,381 | ~~282,566~~481,231 |
| Alternative Liner Location 4 | 286,533 | 1,003,814 |

| Location | Interim Case DAF | Closed Case DAF |
|---|---|---|
| Overliner Location 1 | 18,797 | 65,833 |
| Overliner Location 2 | 77,640 | 232,450 |
| Overliner Location 3 | 158,253 | 473,934 |
| Overliner Location 4 | 615,385 | 1,842,639 |

The results demonstrate that the proposed alternative liner design and overliner design meets or exceeds the requirements of Title 30 TAC §330.331(a)(1). The DAF calculated by the use of HELP and MULTIMED are well in excess of the 260 minimum criterion. The actual DAFs are expected to be substantially higher than the DAFs predicted by this modeling demonstration because the model input was conservatively estimated as discussed in previous sections of this report.

# APPENDIX A

# POINT OF COMPLIANCE FIGURES




## LEGEND:

- EXISTING FENCE CORNER
- EXISTING FENCE
- EXISTING CONTOUR (65.00)
- EXISTING ROAD
- PERMIT BOUNDARY LIMITS
- FINAL COVER CONTOURS (200)
- PROPOSED ROAD
- PROPOSED STORMWATER LETDOWN STRUCTURE
- PROPOSED STORMWATER PONDS
- PROPOSED ALTERNATIVE LINER
- PROPOSED OVERLINER SYSTEM

| NUMBER | REVISION | DATE | DRAWN | DESIGNED | REVIEWED |
|---|---|---|---|---|---|

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PART III, ATTACHMENT 5, APPENDIX A
LANDFILL COMPLETION SITE PLAN
CITY OF KINGSVILLE LANDFILL
MSW PERMIT No. 235-C
KINGSVILLE, TEXAS
KLEBERG COUNTY, TEXAS

FIGURE: III.5-A.1

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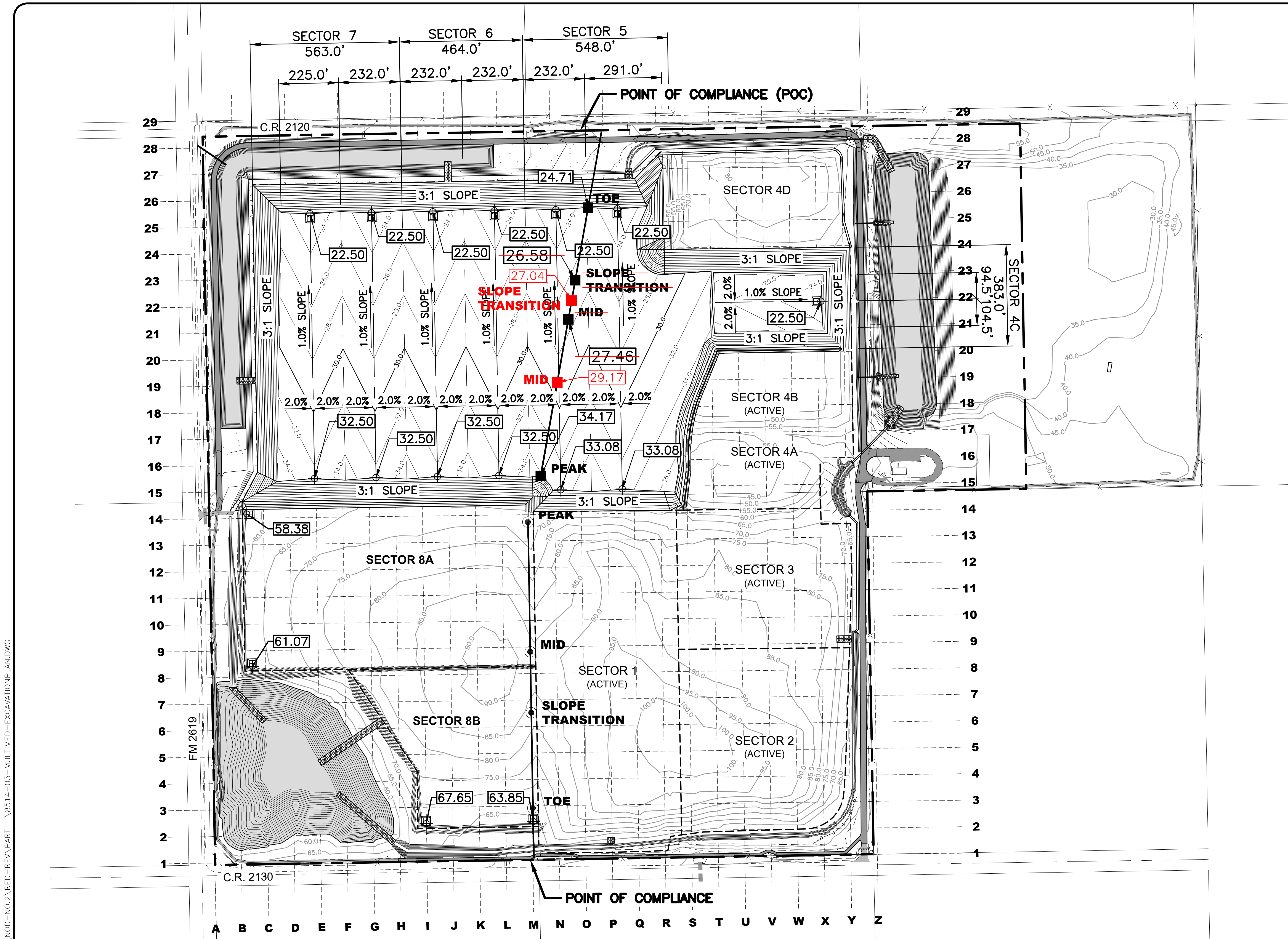


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GRAPHIC SCALE IN FEET

## LEGEND:

- EXISTING FENCE CORNER
- EXISTING FENCE
- EXISTING CONTOUR
- EXISTING ROAD
- PERMIT BOUNDARY LIMITS
- BASE OF EXCAVATION CONTOURS
- 22.50 BASE OF EXCAVATION ELEVATION
- PROPOSED ROAD
- PROPOSED STORMWATER LETDOWN STRUCTURE
- PROPOSED STORMWATER PONDS
- PROPOSED ALTERNATIVE LINER
- PROPOSED OVERLINER

NOTE:
FUTURE SECTOR 4D (EXISTING TYPE IV SECTOR IS LINED WITH GCL, 60 MIL HDPE GEOMEMBRANE, GEOCOMPOSITE, AND 2 FT. OF PROTECTIVE COVER SOIL)

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PART III, ATTACHMENT 5, APPENDIX A
LANDFILL COMPLETION
EXCAVATION PLAN
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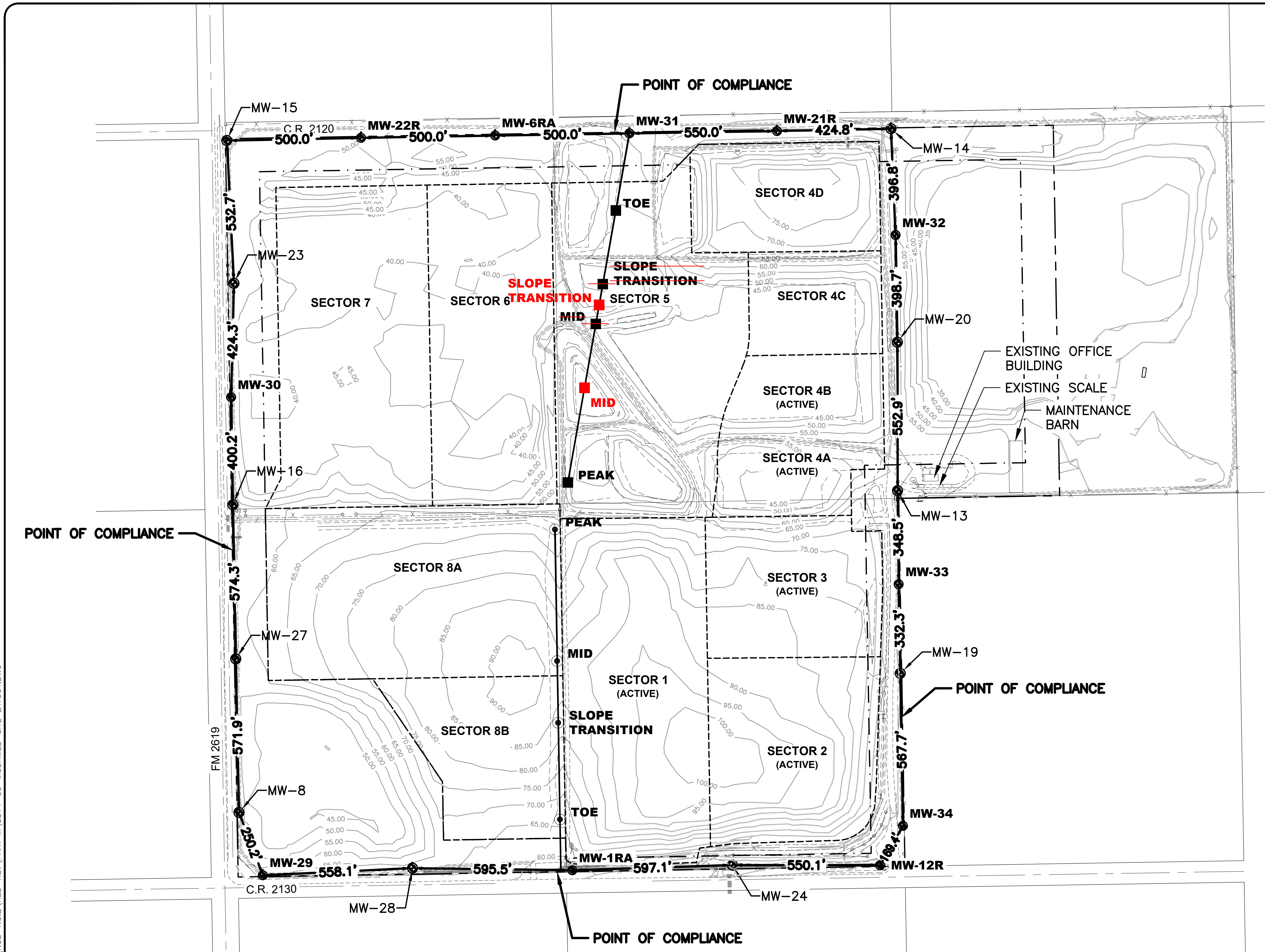
KINGSVILLE, TEXAS
KLEBERG COUNTY, TEXAS

FIGURE:
III.5-A.2




## LEGEND:

- MW-20 MONITOR WELL LOCATION
- EXISTING FENCE
- 65.00 EXISTING SURFACE CONTOUR (2015)
- SECTOR OUTLINE
- PERMIT BOUNDARY (175.89 ACRES)
- BUFFER ZONE
- 400.2' POINT OF COMPLIANCE
- PROPOSED ALTERNATIVE LINER
- PROPOSED OVERLINER

| SITE COORDINATES | | |
|---|---|---|
| MONITOR WELL LOCATIONS | | |
| MW | Northing | Easting |
| MW-8 | 17051473.78 | 1203673.74 |
| MW-13 | 17052672.16 | 1206127.95 |
| MW-14 | 17054020.04 | 1206103.02 |
| MW-15 | 17053976.10 | 1203628.61 |
| MW-16 | 17052619.76 | 1203651.21 |
| MW-19 | 17051991.35 | 1206137.50 |
| MW-20 | 17053225.01 | 1206127.20 |
| MW-23 | 17053444.05 | 1203654.88 |
| MW-24 | 17051277.99 | 1205512.42 |
| MW-27 | 17052045.52 | 1203661.75 |
| MW-28 | 17051266.46 | 1204320.24 |
| MW-1RA | 17051258.70 | 1204915.66 |
| MW-32 | 17053623.64 | 1206120.29 |
| MW-6RA | 17053994.38 | 1204628.44 |
| MW-12R | 17051277.38 | 1206062.51 |
| MW-21R | 17054011.48 | 1205678.30 |
| MW-22R | 17053986.24 | 1204128.51 |
| MW-29 | 17051239.92 | 1203762.81 |
| MW-30 | 17053019.90 | 1203644.60 |
| MW-31 | 17054002.53 | 1205128.38 |
| MW-33 | 17052323.65 | 1206132.04 |
| MW-34 | 17051423.79 | 1206147.64 |

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PART III, ATTACHMENT 5, APPENDIX A
LANDFILL POINT OF COMPLIANCE LOCATIONS
CITY OF KINGSVILLE LANDFILL
MSW PERMIT No. 235-C
KINGSVILLE, TEXAS
KLEBERG COUNTY, TEXAS

FIGURE:
III.5-A.3

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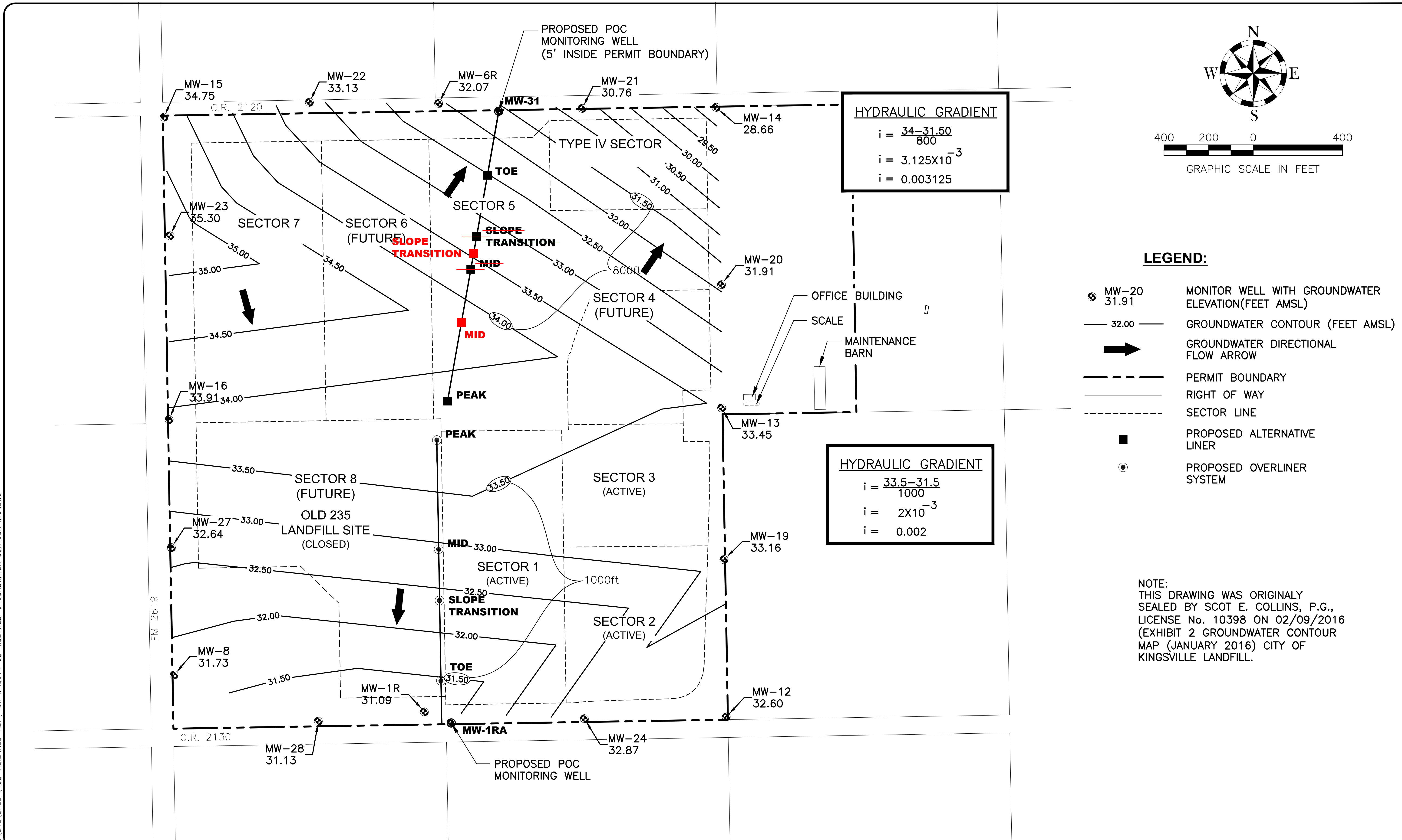


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PART III, ATTACHMENT 5, APPENDIX A
LANDFILL GROUNDWATER CONTOUR MAP/HYDRAULIC GRADIENT
CITY OF KINGSVILLE LANDFILL
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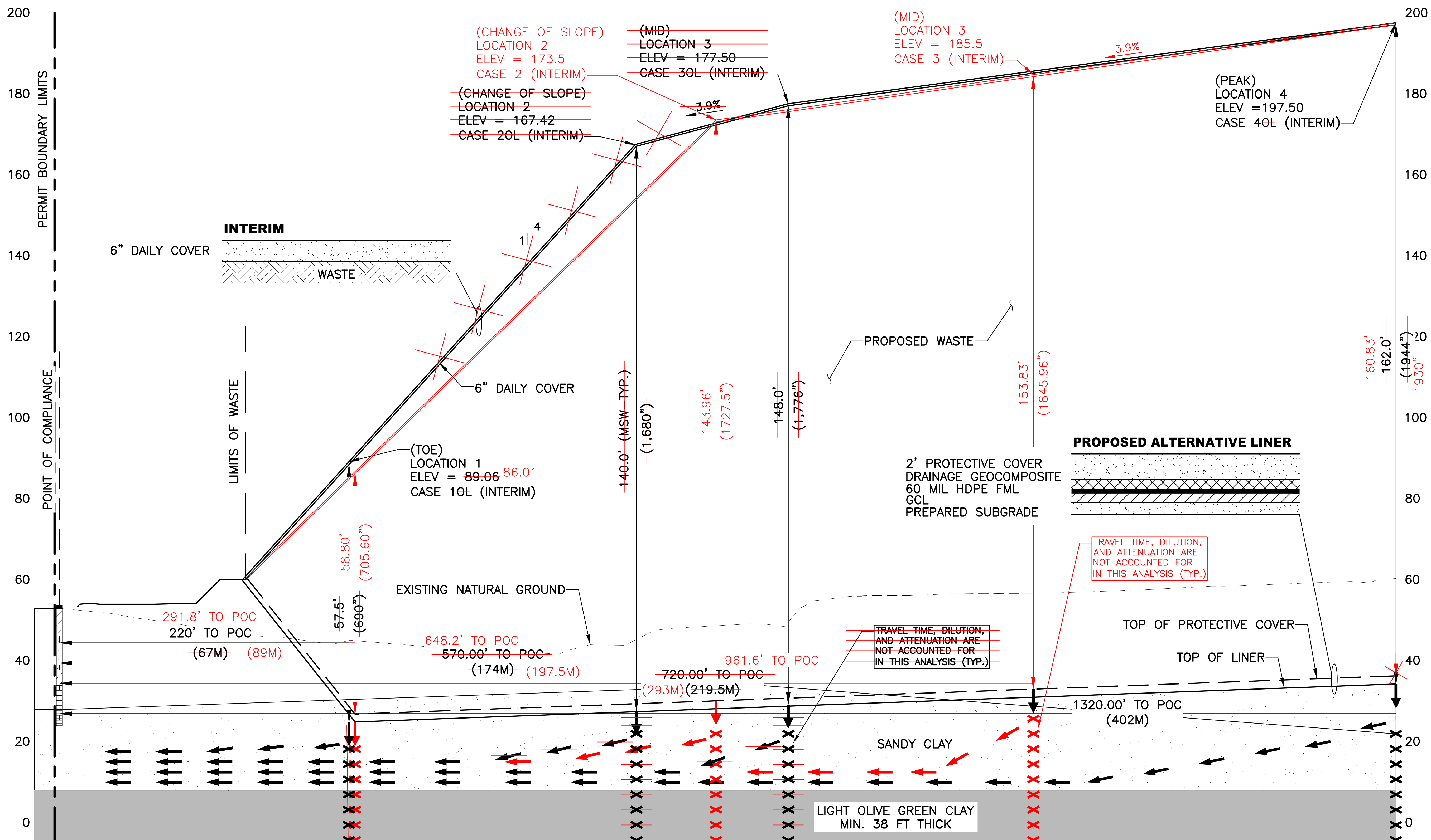
KINGSVILLE, TEXAS
KLEBERG COUNTY, TEXAS

FIGURE:
III.5-A.4




ALTERNATIVE LINER DEMONSTRATION – INTERIM LANDFILL CONDITION

1. USE HELP TO MODEL PERCOLATION THROUGH THE ALTERNATIVE LINER.
2. USE MULTIMED TO CALCULATE THE DILUTION ATTENUATION FACTOR (DAF).

**MULTIMED INFORMATION**

AVERAGE AQUIFER THICKNESS = 32.81FT (10M)
HYDRAULIC CONDUCTIVITY = $4.12 \times 10^{-4}$ CM/SEC OR 130 M/YR
HYDRAULIC GRADIENT = i = 0.003125

NOTES:

1. EVANGELINE AQUIFER (500 FT BELOW GROUND SURFACE) (FRESH)
2. CHICOT AQUIFER (220 FT BELOW GROUND SURFACE)

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|---|---|---|---|---|---|
| | | | | | |

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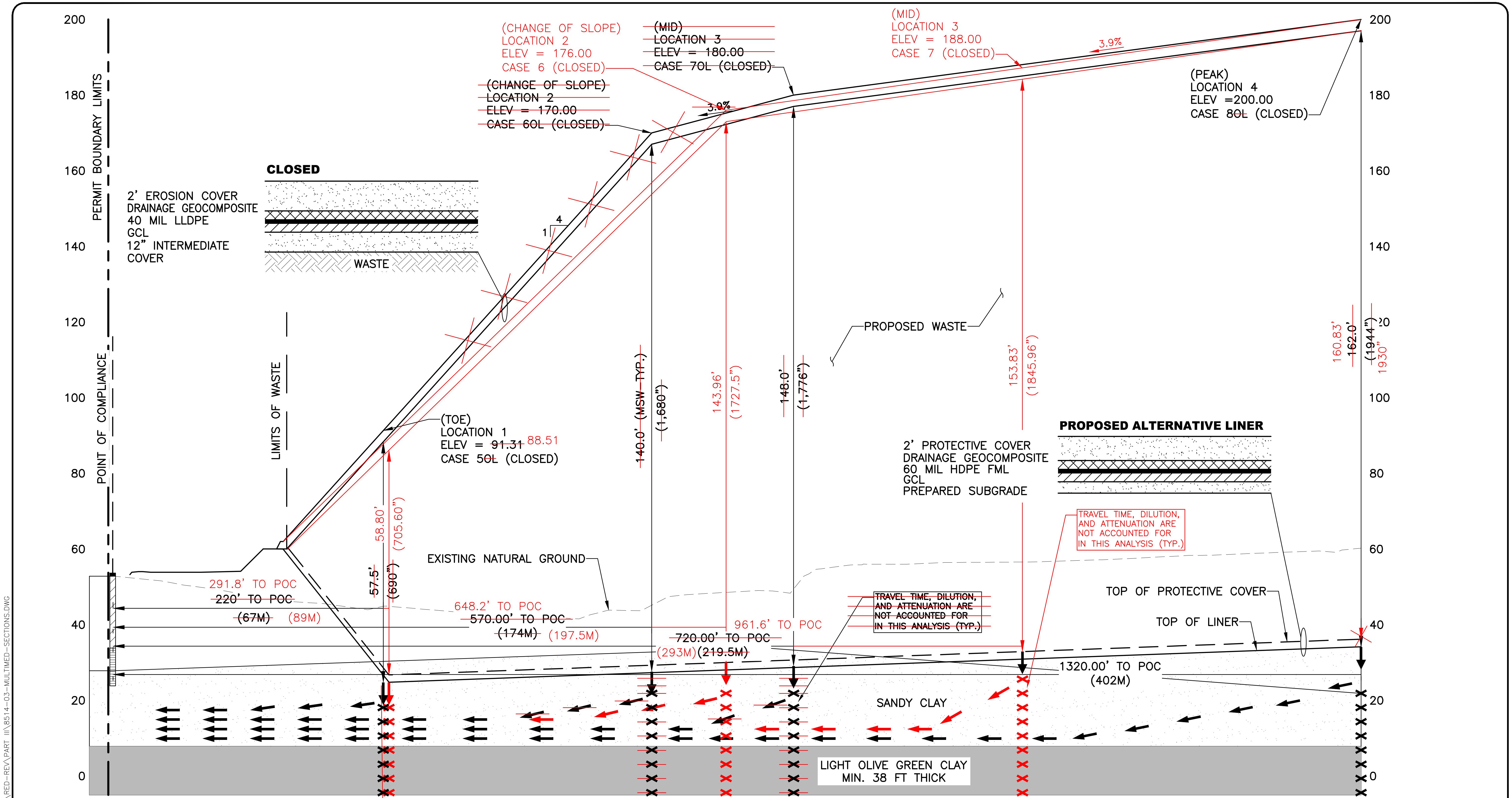
PART III, ATTACHMENT 5, APPENDIX A
LANDFILL TYPICAL PROFILE-INTERIM
LANDFILL WITH ALTERNATIVE LINER
CITY OF KINGSVILLE LANDFILL
MSW PERMIT No. 235-C
KINGSVILLE, TEXAS
KLEBERG COUNTY, TEXAS

FIGURE:
III.5-A.5




## ALTERNATIVE LINER DEMONSTRATION – CLOSED LANDFILL CONDITION

1. USE HELP TO MODEL PERCOLATION THROUGH THE ALTERNATIVE LINER.
2. USE MULTIMED TO CALCULATE THE DILUTION ATTENUATION FACTOR (DAF).

| MULTIMED INFORMATION |
|---|
| AVERAGE AQUIFER THICKNESS = 32.81FT (10M) |
| HYDRAULIC CONDUCTIVITY = $4.12 \times 10^{-4}$ CM/SEC OR 130 M/YR |
| HYDRAULIC GRADIENT = i = 0.003125 |

NOTES:

1. EVANGELINE AQUIFER (500 FT BELOW GROUND SURFACE) (FRESH)
2. CHICOT AQUIFER (220 FT BELOW GROUND SURFACE)

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|---|---|---|---|---|---|
| | | | | | |

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PART III, ATTACHMENT 5, APPENDIX A
LANDFILL TYPICAL PROFILE-CLOSED
LANDFILL WITH ALTERNATIVE LINER
CITY OF KINGSVILLE LANDFILL
MSW PERMIT No. 235-C
KINGSVILLE, TEXAS
KLEBERG COUNTY, TEXAS

FIGURE:
III.5-A.6

APR 24, 2019 1:36 PM TORRE01809
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# APPENDIX B

# HELP MODEL ANALYSIS ALTERNATIVE LINER

# APPENDIX B.1

# HELP MODEL/MULTIMED MODEL-SUMMARY OF CASES 1-8

Project No. 8514-3 Permit Amendment

Description: HELP Model/MULTIMED Model-Summary of Cases 1-8

Date: 3/01/17

By: JCG

**Case 1-Interim Landfill (Location 1)**- An open landfill with a Geosynthetic Clay Liner (GCL), a 60 mil HDPE Flexible Membrane Liner (FML), a Geocomposite drainage layer (Geonet), a 24 inch protective soil layer (Protective Cover),~~57.5~~58.80 feet of waste with 250 foot drain length at 2%, and 6 inches of daily soil cover.

**Case 2-Interim Landfill (Location 2)**- An open landfill with a Geosynthetic Clay Liner (GCL), a 60 mil HDPE Flexible Membrane Liner (FML), a Geocomposite drainage layer (Geonet), a 24 inch protective soil layer (Protective Cover), ~~140~~ 143.96 feet of waste with 500 foot drain length at 2%, and 6 inches of daily soil cover.

**Case 3-Interim Landfill (Location 3)**- An open landfill with a Geosynthetic Clay Liner (GCL), a 60 mil HDPE Flexible Membrane Liner (FML), a Geocomposite drainage layer (Geonet), a 24 inch protective soil layer (Protective Cover), ~~148~~ 153.83 feet of waste with 500 foot drain length at 2%, and 6 inches of daily soil cover.

**Case 4-Interim Landfill (Location 4)**- An open landfill with a Geosynthetic Clay Liner (GCL), a 60 mil HDPE Flexible Membrane Liner (FML), a Geocomposite drainage layer (Geonet), a 24 inch protective soil layer (Protective Cover), ~~162~~ 160.83 feet of waste with 500 foot drain length at 2%, and 6 inches of daily soil cover.

**Case 5-Closed Landfill (Location 1)** - A closed landfill with a Geosynthetic Clay Liner (GCL), a 60 mil HDPE Flexible Membrane Liner (FML), a Geocomposite drainage layer (Geonet), a 24 inch protective soil layer (Protective Cover), ~~57.5~~58.80 feet of waste with 250 foot drain length at 2%, and 12 inches of intermediate cover, a GCL, a 40 mil LLDPE membrane, a Geocomposite drainage layer, and 24 inch erosion cover.

**Case 6-Closed Landfill (Location 2)**- A closed landfill with a Geosynthetic Clay Liner (GCL), a 60 mil HDPE Flexible Membrane Liner (FML), a Geocomposite drainage layer (Geonet), a 24 inch protective soil layer (Protective Cover), ~~140~~ 143.96 feet of waste with 500 foot drain length at 2%, and 12 inches of intermediate cover, a GCL, a 40 mil LLDPE membrane, a Geocomposite drainage layer, and 24 inch erosion cover.

**Case7-Closed Landfill (Location 3)**- A closed landfill with a Geosynthetic Clay Liner (GCL), a 60 mil HDPE Flexible Membrane Liner (FML), a Geocomposite drainage layer (Geonet), a 12 inch protective soil layer (Protective Cover), ~~148~~ 153.83 feet of waste with 500 foot drain length at 2%, and 12 inches of intermediate cover, a GCL, a 40 mil LLDPE membrane, a Geocomposite drainage layer, and 24 inch erosion cover.

**Case 8-Closed Landfill (Location 4)**- A closed landfill with a Geosynthetic Clay Liner (GCL), a 60 mil HDPE Flexible Membrane Liner (FML), a Geocomposite drainage layer (Geonet), a 24 inch protective soil layer (Protective Cover), ~~162~~ 160.83 feet of waste with 500 foot drain length at 2%, and 12 inches of intermediate cover, a GCL, a 40 mil LLDPE membrane, a Geocomposite drainage layer, and 24 inch erosion cover.

# APPENDIX B.2

# HELP MODEL CASE SUMMARY

## HELP MODEL CASE SUMMARY

| Case Alternative Liner | Average Precipitation (IN/YR) | Average Runoff (IN/YR) | Average Evapotranspiration (IN/YR) | Average Percolation Through Liner (CF/YR) | Peak Percolation Through Liner (CF/DAY) | *Peak Percolation Through Liner (M/YR) |
|---|---|---|---|---|---|---|
| **Interim Landfill HELP Information** | | | | | | |
| Location 1<br>• 58.80 ~~57.5~~ feet of waste (Case 1) | | | | | | |
| 20 yr | 25.74 | 2.391 | 21.632 | 0.004 | 0.000050 | 1.28E-07 |
| Location 2<br>• 143.96~~140~~ feet of waste (Case 2) | | | | | | |
| 20 yr | 25.74 | 2.135 | 21.716 | 0.004 | 0.00007 | 1.79E-07 |
| Location 3<br>• 153.83~~148~~ feet of waste (Case 3) | | | | | | |
| 20 yr | 25.74 | 2.197 | 21.691 | 0.004 | 0.00007 | 1.79E-07 |
| Location 4<br>• 160.83~~162~~ feet of waste (Case 4) | | | | | | |
| 20 yr | 25.74 | 1.907 | 21.787 | 0.005 | 0.00007 | 1.79E-07 |
| **Closed Landfill HELP Information** | | | | | | |
| Location 1<br>• 58.80~~57.5~~ feet of waste (Case 5) | | | | | | |
| 30 yr | 27.20 | 1.880 | 21.749 | 0.001 | 0.00002 | 5.11E-08 |
| Location 2<br>• 143.96~~140~~ feet of waste (Case 6) | | | | | | |
| 30 yr | 27.20 | 1.680 | 21.481 | 0.004 | 0.00002 | 5.11E-08 |
| Location 3<br>• 153.83~~148~~ feet of waste (Case 7) | | | | | | |
| 30 yr | 27.20 | 1.711 | 21.470 | 0.004 | 0.00002 | 5.11E-08 |
| Location 4<br>• 160.83~~162~~ feet of waste (Case 8) | | | | | | |
| 30 yr | 27.20 | 1.533 | 21.495 | 0.004 | 0.00002 | 5.11E-08 |

* Determined Using Peak Daily Percolation/Leakage Rate Through GCL and Converted to (M/YR)

Example: ((.00005 $FT^3$/Day-Acre)x(1 Acre/43,560 $FT^2$)/(1 Meter/3.28 FT)) x (365 Days/1 YR)= 1.28 x $10^{-7}$ M/YR

# APPENDIX B.3

# HELP OUTPUT FOR ALTERNATIVE LINER INTERIM CASE 1-LOCATION 1

CASE1R20.OUT

```
******************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
**              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:\HELP3\MDATA\KGVPR20Y.D4
TEMPERATURE DATA FILE:      C:\HELP3\MDATA\KGVTE20Y.D7
SOLAR RADIATION DATA FILE:  C:\HELP3\MDATA\KGVSO20Y.D13
EVAPOTRANSPIRATION DATA:    C:\HELP3\MDATA\KGVEV20Y.D11
SOIL AND DESIGN DATA FILE:  C:\HELP3\MDATA\CASE1R.D10
OUTPUT DATA FILE:           C:\HELP3\MDATA\CASE1R20.OUT


TIME:   8:28     DATE:   4/22/2019


******************************************************************************

     TITLE:  CITY OF KINGSVILLE SOLID WASTE LANDFILL-CASE 1 (Location 1)

******************************************************************************


     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
            COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                                  LAYER  1
                                  --------

                       TYPE 1 - VERTICAL PERCOLATION
                      LAYER MATERIAL TEXTURE NUMBER  13
          THICKNESS                    =      6.00    INCHES
          POROSITY                     =      0.4300 VOL/VOL
          FIELD CAPACITY               =      0.3210 VOL/VOL
          WILTING POINT                =      0.2210 VOL/VOL
          INITIAL SOIL WATER CONTENT   =      0.2393 VOL/VOL
          EFFECTIVE SAT. HYD. COND.    =  0.330000003000E-04 CM/SEC
        NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  3.00
               FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.


                                  LAYER  2
                                  --------

                     TYPE 1 - VERTICAL PERCOLATION LAYER
                        MATERIAL TEXTURE NUMBER  18
          THICKNESS                    =    705.60    INCHES
```

CASE1R20.OUT

```
POROSITY                      =     0.6710  VOL/VOL
FIELD CAPACITY                =     0.2920  VOL/VOL
WILTING POINT                 =     0.0770  VOL/VOL
INITIAL SOIL WATER CONTENT    =     0.2905  VOL/VOL
EFFECTIVE SAT. HYD. COND.     = 0.100000005000E-02 CM/SEC


                      LAYER  3
                      --------

            TYPE 1 - VERTICAL PERCOLATION
           LAYER MATERIAL TEXTURE NUMBER  13
THICKNESS                     =    24.00    INCHES
POROSITY                      =     0.4300  VOL/VOL
FIELD CAPACITY                =     0.3210  VOL/VOL
WILTING POINT                 =     0.2210  VOL/VOL
INITIAL SOIL WATER            =      0.3244 VOL/VOL
CONTENT EFFECTIVE SAT.        = 0.330000003000E-04 CM/SEC
HYD. COND.


                      LAYER  4
                      --------

            TYPE 2 - LATERAL DRAINAGE LAYER
              MATERIAL TEXTURE NUMBER  20
THICKNESS                     =     0.20    INCHES
POROSITY                      =     0.8500  VOL/VOL
FIELD CAPACITY                =     0.0100  VOL/VOL
WILTING POINT                 =     0.0050  VOL/VOL
INITIAL SOIL WATER CONTENT    =     0.0152  VOL/VOL
EFFECTIVE SAT. HYD. COND.     =   10.0000000000     CM/SEC
SLOPE                         =     2.00    PERCENT
DRAINAGE LENGTH               =   250.0     FEET


                      LAYER  5
                      --------

            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      =     2.00    HOLES/ACRE
FML PLACEMENT QUALITY         = 3 - GOOD


                      LAYER  6
                      --------

              TYPE 3 - BARRIER SOIL LINER
              MATERIAL TEXTURE NUMBER  17
THICKNESS                     =     0.24    INCHES
POROSITY FIELD                =     0.7500  VOL/VOL
CAPACITY                      =     0.7470  VOL/VOL
```

CASE1R20.OUT

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 #13 WITH A FAIR STAND OF GRASS, A SURFACE SLOPE OF 25.% AND A SLOPE LENGTH OF 100. FEET.

| | | | |
|---|---|---|---|
| SCS RUNOFF CURVE NUMBER | = | 89.50 | |
| FRACTION OF AREA ALLOWING RUNOFF | = | 80.0 | PERCENT |
| AREA PROJECTED ON HORIZONTAL PLANE | = | 1.000 | ACRES |
| EVAPORATIVE ZONE DEPTH | = | 12.0 | INCHES |
| INITIAL WATER IN EVAPORATIVE ZONE | = | 2.124 | INCHES |
| UPPER LIMIT OF EVAPORATIVE STORAGE | = | 6.606 | INCHES |
| LOWER LIMIT OF EVAPORATIVE STORAGE | = | 1.788 | INCHES |
| INITIAL SNOW WATER | = | 0.000 | INCHES |
| INITIAL WATER IN LAYER MATERIALS | = | 214.375 | INCHES |
| TOTAL INITIAL WATER | = | 214.375 | INCHES |
| TOTAL SUBSURFACE INFLOW | = | 0.00 | INCHES/YEAR |

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM CORPUS CHRISTI TEXAS

| | | | |
|---|---|---|---|
| STATION LATITUDE | = | 27.77 | DEGREES |
| MAXIMUM LEAF AREA INDEX | = | 2.00 | |
| START OF GROWING SEASON (JULIAN DATE) | = | 0 | |
| END OF GROWING SEASON (JULIAN DATE) | = | 367 | |
| EVAPORATIVE ZONE DEPTH | = | 12.0 | INCHES |
| AVERAGE ANNUAL WIND SPEED | = | 12.00 | MPH |
| AVERAGE 1ST QUARTER RELATIVE HUMIDITY | = | 76.00 | % |
| AVERAGE 2ND QUARTER RELATIVE HUMIDITY | = | 78.00 | % |
| AVERAGE 3RD QUARTER RELATIVE HUMIDITY | = | 76.00 | % |
| AVERAGE 4TH QUARTER RELATIVE HUMIDITY | = | 76.00 | % |

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR CORPUS CHRISTI TEXAS

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

| JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|
| 1.63 | 1.69 | 1.20 | 1.57 | 3.29 | 3.12 |
| 2.26 | 2.78 | 5.31 | 2.92 | 1.61 | 1.17 |

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR CORPUS CHRISTI TEXAS

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

CASE1R20.OUT

| JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|
| 56.30 | 59.30 | 65.90 | 73.00 | 78.10 | 82.70 |
| 84.90 | 85.00 | 81.50 | 74.00 | 65.00 | 59.10 |

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR CORPUS CHRISTI TEXAS
AND STATION LATITUDE = 27.77 DEGREES

*******************************************************************************

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 20

| | JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|---|
| **PRECIPITATION** | | | | | | |
| TOTALS | 1.15 | 2.02 | 1.05 | 1.42 | 2.41 | 2.71 |
| | 2.43 | 2.37 | 5.38 | 2.30 | 1.33 | 1.18 |
| STD. DEVIATIONS | 0.63 | 1.18 | 0.55 | 1.20 | 1.88 | 2.04 |
| | 2.55 | 1.63 | 3.12 | 1.75 | 1.17 | 0.85 |
| **RUNOFF** | | | | | | |
| TOTALS | 0.015 | 0.067 | 0.006 | 0.104 | 0.281 | 0.288 |
| | 0.380 | 0.193 | 0.784 | 0.181 | 0.073 | 0.020 |
| STD. DEVIATIONS | 0.043 | 0.081 | 0.009 | 0.237 | 0.504 | 0.348 |
| | 0.817 | 0.198 | 0.914 | 0.274 | 0.212 | 0.070 |
| **EVAPOTRANSPIRATION** | | | | | | |
| TOTALS | 0.939 | 2.086 | 1.297 | 1.241 | 1.988 | 2.114 |
| | 2.037 | 1.875 | 3.620 | 2.256 | 1.089 | 1.091 |
| STD. DEVIATIONS | 0.543 | 0.911 | 0.701 | 0.915 | 1.322 | 1.388 |
| | 1.606 | 1.312 | 1.225 | 1.220 | 0.757 | 0.583 |
| **LATERAL DRAINAGE COLLECTED FROM LAYER 4** | | | | | | |
| TOTALS | 0.0661 | 0.0208 | 0.0717 | 0.0580 | 0.0362 | 0.0534 |
| | 0.1445 | 0.1781 | 0.1018 | 0.4104 | 0.4037 | 0.1921 |
| STD. DEVIATIONS | 0.0861 | 0.0317 | 0.1423 | 0.1051 | 0.0619 | 0.1057 |
| | 0.2592 | 0.3508 | 0.2000 | 0.5929 | 0.7428 | 0.3262 |
| **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)

CASE1R20.OUT

```
 DAILY AVERAGE HEAD ON TOP OF LAYER  5

   AVERAGES                 0.0005  0.0002  0.0005  0.0004  0.0003  0.0004
                            0.0010  0.0013  0.0007  0.0029  0.0030  0.0014

   STD. DEVIATIONS          0.0006  0.0002  0.0010  0.0008  0.0004  0.0008
                            0.0018  0.0025  0.0015  0.0042  0.0055  0.0023

*******************************************************************************


*******************************************************************************

    AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS   1 THROUGH   20
-------------------------------------------------------------------------------
                                 INCHES          CU. FEET       PERCENT
                           -------------------  -------------  ---------
 PRECIPITATION              25.74   (  5.706)     93448.9      100.00

 RUNOFF                      2.391  (  1.2854)     8679.79       9.288

 EVAPOTRANSPIRATION LATERAL 21.632  (  3.6809)    78522.88      84.028

 DRAINAGE COLLECTED          1.73689 (  1.43661)    6304.908      6.74690
   FROM LAYER  4

 PERCOLATION/LEAKAGE THROUGH 0.00000 (  0.00000)       0.004      0.00000
   LAYER  6

 AVERAGE HEAD ON TOP         0.001 (    0.001)
   OF LAYER  5

 CHANGE IN WATER STORAGE    -0.016  (  0.5277)      -58.67      -0.063

*******************************************************************************


*******************************************************************************
            PEAK DAILY VALUES FOR YEARS    1 THROUGH   20
   ------------------------------------------------------------------------
                                                  (INCHES)     (CU. FT.)
                                                 ----------   -------------
     PRECIPITATION                                  5.07        18404.102

     RUNOFF                                         2.138        7761.3745

     DRAINAGE COLLECTED FROM LAYER  4               0.16413       595.80011

     PERCOLATION/LEAKAGE THROUGH LAYER  6           0.000000        0.00005

     AVERAGE HEAD ON TOP OF LAYER  5                0.036

     MAXIMUM HEAD ON TOP OF LAYER  5                0.072

     LOCATION OF MAXIMUM HEAD IN LAYER  4
           (DISTANCE FROM DRAIN)                    2.7 FEET

     SNOW WATER                                     0.00            0.0000


     MAXIMUM VEG. SOIL WATER (VOL/VOL)                    0.3879
```

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.1490

*** 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 20

| LAYER | (INCHES) | (VOL/VOL) |
|---|---|---|
| 1 | 1.4211 | 0.2369 |
| 2 | 204.7451 | 0.2902 |
| 3 | 7.7040 | 0.3210 |
| 4 | 0.0020 | 0.0100 |
| 5 | 0.0000 | 0.0000 |
| 6 | 0.1800 | 0.7500 |
| SNOW WATER | 0.000 | |

*******************************************************************************
*
*******************************************************************************

# APPENDIX B.4

# HELP OUTPUT FOR ALTERNATIVE LINER INTERIM CASE 2-LOCATION 2

CASE2R20.OUT

```
******************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
**              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:\HELP3\MDATA\KGVPR20Y.D4
TEMPERATURE DATA FILE:        C:\HELP3\MDATA\KGVTE20Y.D7
SOLAR RADIATION DATA FILE:    C:\HELP3\MDATA\KGVSO20Y.D13
EVAPOTRANSPIRATION DATA:      C:\HELP3\MDATA\KGVEV20Y.D11
SOIL AND DESIGN DATA FILE:    C:\HELP3\MDATA\CASE2R.D10
OUTPUT DATA FILE:             C:\HELP3\MDATA\CASE2R20.OUT


TIME: 15:24       DATE:   4/14/2019


******************************************************************************

     TITLE: CITY OF KINGSVILLE SOLID WASTE LANDFILL-CASE 2 (LOCATION 2)

******************************************************************************


     NOTE: INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                                  LAYER 1
                                  --------

                      TYPE 1 -VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER 13
          THICKNESS                    =        6.00 INCHES
          POROSITY                     =      0.4300 VOL/VOL
          FIELD CAPACITY               =      0.3210 VOL/VOL
          WILTING POINT                =      0.2210 VOL/VOL
          INITIAL SOIL WATER CONTENT   =      0.2391 VOL/VOL
          EFFECTIVE SAT. HYD. COND.    =  0.330000003000E-04 CM/SEC
        NOTE: SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY 3.00
              FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.


                                  LAYER 2
                                  --------

                      TYPE 1 -VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER 18
          THICKNESS                    =     1727.50    INCHES
```

CASE2R20.OUT

POROSITY = 0.6710 VOL/VOL
FIELD CAPACITY = 0.2920 VOL/VOL
WILTING POINT = 0.0770 VOL/VOL
INITIAL SOIL WATER = 0.2914 VOL/VOL
CONTENT EFFECTIVE SAT. = 0.100000005000E-02 CM/SEC
HYD. COND.

LAYER 3
--------

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 13
THICKNESS = 24.00 INCHES
POROSITY = 0.4300 VOL/VOL
FIELD CAPACITY = 0.3210 VOL/VOL
WILTING POINT = 0.2210 VOL/VOL
INITIAL SOIL WATER = 0.3245 VOL/VOL
CONTENT EFFECTIVE SAT. = 0.330000003000E-04 CM/SEC
HYD. COND.

LAYER 4
--------

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 20
THICKNESS = 0.20 INCHES
POROSITY = 0.8500 VOL/VOL
FIELD CAPACITY = 0.0100 VOL/VOL
WILTING POINT = 0.0050 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.0205 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 10.0000000000 CM/SEC
SLOPE = 2.00 PERCENT
DRAINAGE LENGTH = 500.0 FEET

LAYER 5
--------

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURENUMBER 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 = 2.00 HOLES/ACRE
FML PLACEMENT QUALITY = 3 - GOOD

LAYER 6
--------

TYPE 3 - BARRIER SOIL
LINER MATERIAL TEXTURE
THICKNESS NUMBER 17 = 0.24 INCHES
POROSITY FIELD = 0.7500 VOL/VOL
CAPACITY = 0.7470 VOL/VOL

CASE2R20.OUT

```
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 #13 WITH A
         FAIR STAND OF GRASS, A SURFACE SLOPE OF 25.%
         AND A SLOPE LENGTH OF  350. FEET.

SCS RUNOFF CURVE NUMBER            =     88.80
FRACTION OF AREA ALLOWING RUNOFF   =     80.0    PERCENT
AREA PROJECTED ON HORIZONTAL PLANE =      1.000  ACRES
EVAPORATIVE ZONE DEPTH             =     12.0    INCHES
INITIAL WATER IN EVAPORATIVE ZONE  =      2.124  INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE =      6.606  INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE =      1.788  INCHES
INITIAL SNOW WATER                 =      0.000  INCHES
INITIAL WATER IN LAYER MATERIALS   =    512.775  INCHES
TOTAL INITIAL WATER                =    512.775  INCHES
TOTAL SUBSURFACE INFLOW            =      0.00   INCHES/YEAR
```

EVAPOTRANSPIRATION AND WEATHER DATA

```
NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
         CORPUS CHRISTI        TEXAS

    STATION LATITUDE                            =  27.77 DEGREES
    MAXIMUM LEAF AREA INDEX                     =   2.00
    START OF GROWING SEASON (JULIAN DATE)       =      0
    END OF GROWING SEASON (JULIAN DATE)         =    367
    EVAPORATIVE ZONE DEPTH                      =  12.0  INCHES
    AVERAGE ANNUAL WIND SPEED                   =  12.00 MPH
    AVERAGE 1ST QUARTER RELATIVE HUMIDITY       =  76.00 %
    AVERAGE 2ND QUARTER RELATIVE HUMIDITY       =  78.00 %
    AVERAGE 3RD QUARTER RELATIVE HUMIDITY       =  76.00 %
    AVERAGE 4TH QUARTER RELATIVE HUMIDITY       =  76.00 %

NOTE:  PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
         COEFFICIENTS FOR    CORPUS CHRISTI      TEXAS

         NORMAL MEAN MONTHLY PRECIPITATION (INCHES)
```

| JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|
| 1.63 | 1.69 | 1.20 | 1.57 | 3.29 | 3.12 |
| 2.26 | 2.78 | 5.31 | 2.92 | 1.61 | 1.17 |

```
NOTE:  TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
         COEFFICIENTS FOR    CORPUS CHRISTI      TEXAS

    NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)
```

CASE2R20.OUT

| JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|
| 56.30 | 59.30 | 65.90 | 73.00 | 78.10 | 82.70 |
| 84.90 | 85.00 | 81.50 | 74.00 | 65.00 | 59.10 |

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR CORPUS CHRISTI TEXAS
AND STATION LATITUDE = 27.77 DEGREES

*******************************************************************************

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 20

| | JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|---|
| **PRECIPITATION** | | | | | | |
| TOTALS | 1.15 | 2.02 | 1.05 | 1.42 | 2.41 | 2.71 |
| | 2.43 | 2.37 | 5.38 | 2.30 | 1.33 | 1.18 |
| STD. DEVIATIONS | 0.63 | 1.18 | 0.55 | 1.20 | 1.88 | 2.04 |
| | 2.55 | 1.63 | 3.12 | 1.75 | 1.17 | 0.85 |
| **RUNOFF** | | | | | | |
| TOTALS | 0.012 | 0.055 | 0.003 | 0.092 | 0.254 | 0.252 |
| | 0.350 | 0.170 | 0.716 | 0.149 | 0.066 | 0.016 |
| STD. DEVIATIONS | 0.037 | 0.071 | 0.006 | 0.216 | 0.479 | 0.315 |
| | 0.770 | 0.181 | 0.864 | 0.234 | 0.199 | 0.057 |
| **EVAPOTRANSPIRATION** | | | | | | |
| TOTALS | 0.932 | 2.093 | 1.304 | 1.251 | 1.993 | 2.128 |
| | 2.048 | 1.899 | 3.628 | 2.264 | 1.098 | 1.076 |
| STD. DEVIATIONS | 0.540 | 0.899 | 0.714 | 0.930 | 1.317 | 1.382 |
| | 1.634 | 1.319 | 1.222 | 1.208 | 0.786 | 0.592 |
| **LATERAL DRAINAGE COLLECTED FROM LAYER 4** | | | | | | |
| TOTALS | 0.0715 | 0.0326 | 0.0735 | 0.0598 | 0.0433 | 0.0680 |
| | 0.1629 | 0.1994 | 0.1144 | 0.4246 | 0.4282 | 0.2293 |
| STD. DEVIATIONS | 0.0919 | 0.0521 | 0.1373 | 0.1034 | 0.0699 | 0.1461 |
| | 0.3039 | 0.4252 | 0.2386 | 0.5907 | 0.7366 | 0.4181 |
| **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)

CASE2R20.OUT

DAILY AVERAGE HEAD ON TOP OF LAYER 5

| | | | | | | |
|---|---|---|---|---|---|---|
| AVERAGES | 0.0010 | 0.0005 | 0.0010 | 0.0009 | 0.0006 | 0.0010 |
| | 0.0023 | 0.0028 | 0.0017 | 0.0060 | 0.0063 | 0.0033 |
| STD. DEVIATIONS | 0.0013 | 0.0008 | 0.0020 | 0.0015 | 0.0010 | 0.0021 |
| | 0.0043 | 0.0061 | 0.0035 | 0.0084 | 0.0108 | 0.0060 |

AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 20

| | INCHES | | CU. FEET | PERCENT |
|---|---|---|---|---|
| PRECIPITATION | 25.74 | ( 5.706) | 93448.9 | 100.00 |
| RUNOFF | 2.135 | ( 1.1936) | 7751.57 | 8.295 |
| EVAPOTRANSPIRATION LATERAL | 21.716 | ( 3.6903) | 78829.24 | 84.355 |
| DRAINAGE COLLECTED FROM LAYER 4 | 1.90751 | ( 1.54779) | 6924.272 | 7.40969 |
| PERCOLATION/LEAKAGE THROUGH LAYER 6 | 0.00000 | ( 0.00000) | 0.004 | 0.00000 |
| AVERAGE HEAD ON TOP OF LAYER 5 | 0.002 | ( 0.002) | | |
| CHANGE IN WATER STORAGE | -0.015 | ( 0.5511) | -56.18 | -0.060 |

PEAK DAILY VALUES FOR YEARS 1 THROUGH 20

| | (INCHES) | (CU. FT.) |
|---|---|---|
| PRECIPITATION | 5.07 | 18404.102 |
| RUNOFF | 2.088 | 7578.4883 |
| DRAINAGE COLLECTED FROM LAYER 4 | 0.15857 | 575.60864 |
| PERCOLATION/LEAKAGE THROUGH LAYER 6 | 0.000000 | 0.00007 |
| AVERAGE HEAD ON TOP OF LAYER 5 | 0.070 | |
| MAXIMUM HEAD ON TOP OF LAYER 5 | 0.139 | |
| LOCATION OF MAXIMUM HEAD IN LAYER 4 (DISTANCE FROM DRAIN) | 2.3 FEET | |
| SNOW WATER | 0.00 | 0.0000 |

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.3901

CASE2R20.OUT

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.1490

*** 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 20

| LAYER | (INCHES) | (VOL/VOL) |
|---|---|---|
| 1 | 1.4393 | 0.2399 |
| 2 | 503.1399 | 0.2913 |
| 3 | 7.7040 | 0.3210 |
| 4 | 0.0020 | 0.0100 |
| 5 | 0.0000 | 0.0000 |
| 6 | 0.1800 | 0.7500 |
| SNOW WATER | 0.000 | |

******************************************************************************
******************************************************************************

# APPENDIX B.5

# HELP OUTPUT FOR ALTERNATIVE LINER INTERIM CASE 3-LOCATION 3

CASE3R20.OUT

```
******************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
**              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:\HELP3\MDATA\KGVPR20Y.D4
TEMPERATURE DATA FILE:       C:\HELP3\MDATA\KGVTE20Y.D7
SOLAR RADIATION DATA FILE:   C:\HELP3\MDATA\KGVSO20Y.D13
EVAPOTRANSPIRATION DATA:     C:\HELP3\MDATA\KGVEV20Y.D11
SOIL AND DESIGN DATA FILE:   C:\HELP3\MDATA\CASE3R.D10
OUTPUT DATA FILE:            C:\HELP3\MDATA\CASE3R20.OUT


TIME:   8:37     DATE:   4/22/2019


******************************************************************************

     TITLE:  CITY OF KINGSVILLE SOLID WASTE LANDFILL-CASE 3 (LOCATION 3)

******************************************************************************


     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
            COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                              LAYER  1
                              --------

                    TYPE 1 - VERTICAL PERCOLATION LAYER
                        MATERIAL TEXTURE NUMBER  13
          THICKNESS                   =      6.00    INCHES
          POROSITY                    =      0.4300 VOL/VOL
          FIELD CAPACITY              =      0.3210 VOL/VOL
          WILTING POINT               =      0.2210 VOL/VOL
          INITIAL SOIL WATER CONTENT  =      0.2391 VOL/VOL
          EFFECTIVE SAT. HYD. COND.   =  0.330000003000E-04 CM/SEC
        NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY   3.00
                FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.


                              LAYER  2
                              --------

                    TYPE 1 - VERTICAL PERCOLATION LAYER
                        MATERIAL TEXTURE NUMBER  18
          THICKNESS                   =   1845.90    INCHES
```

```
                                        CASE3R20.OUT
POROSITY                        =       0.6710 VOL/VOL
FIELD CAPACITY                  =       0.2920 VOL/VOL
WILTING POINT                   =       0.0770 VOL/VOL
INITIAL SOIL WATER CONTENT      =       0.2914 VOL/VOL
EFFECTIVE SAT. HYD. COND.       =  0.100000005000E-02 CM/SEC


                    LAYER  3
                    --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
             MATERIAL TEXTURE NUMBER  13
THICKNESS                       =      24.00    INCHES
POROSITY                        =       0.4300 VOL/VOL
FIELD CAPACITY                  =       0.3210 VOL/VOL
WILTING POINT                   =       0.2210 VOL/VOL
INITIAL SOIL WATER CONTENT      =       0.3245 VOL/VOL
EFFECTIVE SAT. HYD. COND.       =  0.330000003000E-04 CM/SEC


                    LAYER  4
                    --------

          TYPE 2 - LATERAL DRAINAGE LAYER
             MATERIAL TEXTURE NUMBER  20
THICKNESS                       =       0.20    INCHES
POROSITY                        =       0.8500
FIELD CAPACITY                  =       VOL/VOL 0.0100
WILTING POINT                   =       0.0050 VOL/VOL
INITIAL SOIL WATER CONTENT      =       0.0205 VOL/VOL
EFFECTIVE SAT. HYD. COND.       =   10.0000000000       CM/SEC
SLOPE                           =       2.00    PERCENT
DRAINAGE LENGTH                 =     500.0     FEET


                    LAYER  5
                    --------

          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        =       2.00    HOLES/ACRE
FML PLACEMENT QUALITY           =    3 - GOOD


                    LAYER  6
                    --------

             TYPE 3 - BARRIER SOIL LINER
             MATERIAL TEXTURE NUMBER  17
THICKNESS                       =       0.24    INCHES
POROSITY FIELD                  =       0.7500 VOL/VOL
CAPACITY                        =       0.7470 VOL/VOL
                                            Page 2
```

CASE3R20.OUT

```
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 #13 WITH A
         FAIR STAND OF GRASS, A SURFACE SLOPE OF 12.%
         AND A SLOPE LENGTH OF  200. FEET.

SCS RUNOFF CURVE NUMBER            =    89.00
FRACTION OF AREA ALLOWING RUNOFF   =    80.0    PERCENT
AREA PROJECTED ON HORIZONTAL PLANE =     1.000  ACRES
EVAPORATIVE ZONE DEPTH             =    12.0    INCHES
INITIAL WATER IN EVAPORATIVE ZONE  =     2.124  INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE =     6.606  INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE =     1.788  INCHES
INITIAL SNOW WATER                 =     0.000  INCHES
INITIAL WATER IN LAYER MATERIALS   =   547.348  INCHES
TOTAL INITIAL WATER                =   547.348  INCHES
TOTAL SUBSURFACE INFLOW            =     0.00   INCHES/YEAR
```

EVAPOTRANSPIRATION AND WEATHER DATA

```
NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
         CORPUS CHRISTI        TEXAS

     STATION LATITUDE                         = 27.77 DEGREES
     MAXIMUM LEAF AREA INDEX                  =  2.00
     START OF GROWING SEASON (JULIAN DATE)    =     0
     END OF GROWING SEASON (JULIAN DATE)      =   367
     EVAPORATIVE ZONE DEPTH                   = 12.0  INCHES
     AVERAGE ANNUAL WIND SPEED                = 12.00 MPH
     AVERAGE 1ST QUARTER RELATIVE HUMIDITY    = 76.00 %
     AVERAGE 2ND QUARTER RELATIVE HUMIDITY    = 78.00 %
     AVERAGE 3RD QUARTER RELATIVE HUMIDITY    = 76.00 %
     AVERAGE 4TH QUARTER RELATIVE HUMIDITY    = 76.00 %

NOTE:  PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
         COEFFICIENTS FOR    CORPUS CHRISTI       TEXAS
```

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

| JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|
| 1.63 | 1.69 | 1.20 | 1.57 | 3.29 | 3.12 |
| 2.26 | 2.78 | 5.31 | 2.92 | 1.61 | 1.17 |

```
NOTE:  TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
         COEFFICIENTS FOR    CORPUS CHRISTI       TEXAS
```

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

CASE3R20.OUT

| JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|
| 56.30 | 59.30 | 65.90 | 73.00 | 78.10 | 82.70 |
| 84.90 | 85.00 | 81.50 | 74.00 | 65.00 | 59.10 |

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR CORPUS CHRISTI TEXAS
AND STATION LATITUDE = 27.77 DEGREES

***************************************************************************

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 20

| | JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|---|
| PRECIPITATION | | | | | | |
| TOTALS | 1.15 | 2.02 | 1.05 | 1.42 | 2.41 | 2.71 |
| | 2.43 | 2.37 | 5.38 | 2.30 | 1.33 | 1.18 |
| STD. DEVIATIONS | 0.63 | 1.18 | 0.55 | 1.20 | 1.88 | 2.04 |
| | 2.55 | 1.63 | 3.12 | 1.75 | 1.17 | 0.85 |
| RUNOFF | | | | | | |
| TOTALS | 0.013 | 0.058 | 0.004 | 0.095 | 0.261 | 0.260 |
| | 0.358 | 0.176 | 0.733 | 0.155 | 0.067 | 0.017 |
| STD. DEVIATIONS | 0.038 | 0.074 | 0.007 | 0.221 | 0.486 | 0.324 |
| | 0.783 | 0.186 | 0.879 | 0.241 | 0.202 | 0.058 |
| EVAPOTRANSPIRATION | | | | | | |
| TOTALS | 0.931 | 2.093 | 1.302 | 1.250 | 1.993 | 2.121 |
| | 2.045 | 1.896 | 3.629 | 2.258 | 1.099 | 1.074 |
| STD. DEVIATIONS | 0.537 | 0.898 | 0.710 | 0.928 | 1.312 | 1.384 |
| | 1.629 | 1.315 | 1.227 | 1.202 | 0.786 | 0.593 |
| LATERAL DRAINAGE COLLECTED FROM LAYER 4 | | | | | | |
| TOTALS | 0.0691 | 0.0358 | 0.0747 | 0.0581 | 0.0416 | 0.0640 |
| | 0.1587 | 0.1953 | 0.1104 | 0.4155 | 0.4199 | 0.2281 |
| STD. DEVIATIONS | 0.0917 | 0.0545 | 0.1437 | 0.1048 | 0.0686 | 0.1397 |
| | 0.2949 | 0.4190 | 0.2386 | 0.5824 | 0.7312 | 0.4168 |
| 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)

CASE3R20.OUT

DAILY AVERAGE HEAD ON TOP OF LAYER 5

| | | | | | | |
|---|---|---|---|---|---|---|
| AVERAGES | 0.0010 | 0.0006 | 0.0011 | 0.0009 | 0.0006 | 0.0009 |
| | 0.0023 | 0.0028 | 0.0016 | 0.0059 | 0.0062 | 0.0032 |
| STD. DEVIATIONS | 0.0013 | 0.0009 | 0.0020 | 0.0015 | 0.0010 | 0.0021 |
| | 0.0042 | 0.0060 | 0.0035 | 0.0083 | 0.0108 | 0.0059 |

*******************************************************************************

*******************************************************************************

AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 20

| | INCHES | | CU. FEET | PERCENT |
|---|---|---|---|---|
| PRECIPITATION | 25.74 | ( 5.706) | 93448.9 | 100.00 |
| RUNOFF | 2.197 | ( 1.2161) | 7975.32 | 8.534 |
| EVAPOTRANSPIRATION LATERAL | 21.691 | ( 3.6830) | 78736.87 | 84.257 |
| DRAINAGE COLLECTED FROM LAYER 4 | 1.87134 | ( 1.53422) | 6792.958 | 7.26917 |
| PERCOLATION/LEAKAGE THROUGH LAYER 6 | 0.00000 | ( 0.00000) | 0.004 | 0.00000 |
| AVERAGE HEAD ON TOP OF LAYER 5 | 0.002 | 0.002) | | |
| CHANGE IN WATER STORAGE | ( | ( 0.5521) | -56.24 | -0.060 |

*******************************************************************************
-0.01

5

*******************************************************************************

PEAK DAILY VALUES FOR YEARS 1 THROUGH 20

| | (INCHES) | (CU. FT.) |
|---|---|---|
| PRECIPITATION | 5.07 | 18404.102 |
| RUNOFF | 2.106 | 7646.4312 |
| DRAINAGE COLLECTED FROM LAYER 4 | 0.16188 | 587.61462 |
| PERCOLATION/LEAKAGE THROUGH LAYER 6 | 0.000000 | 0.00007 |
| AVERAGE HEAD ON TOP OF LAYER 5 | 0.071 | |
| MAXIMUM HEAD ON TOP OF LAYER 5 | 0.142 | |
| LOCATION OF MAXIMUM HEAD IN LAYER 4 (DISTANCE FROM DRAIN) | 1.9 FEET | |
| SNOW WATER | 0.00 | 0.0000 |

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.3893

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.1490

*** 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 20

| LAYER | (INCHES) | (VOL/VOL) |
|---|---|---|
| 1 | 1.4394 | 0.2399 |
| 2 | 537.7128 | 0.2913 |
| 3 | 7.7040 | 0.3210 |
| 4 | 0.0020 | 0.0100 |
| 5 | 0.0000 | 0.0000 |
| 6 | 0.1800 | 0.7500 |
| SNOW WATER | 0.000 | |

*******************************************************************************
*******************************************************************************

# APPENDIX B.6

# HELP OUTPUT FOR ALTERNATIVE LINER INTERIM CASE 4-LOCATION 4

CASE4R20.OUT

```
******************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
**              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:\HELP3\MDATA\KGVPR20Y.D4
TEMPERATURE DATA FILE:        C:\HELP3\MDATA\KGVTE20Y.D7
SOLAR RADIATION DATA FILE:    C:\HELP3\MDATA\KGVSO20Y.D13
EVAPOTRANSPIRATION DATA:      C:\HELP3\MDATA\KGVEV20Y.D11
SOIL AND DESIGN DATA FILE: C:\HELP3\MDATA\CASE4R.D10
OUTPUT DATA FILE:             C:\HELP3\MDATA\CASE4R20.OUT


TIME: 15:39       DATE:   4/14/2019


******************************************************************************

     TITLE: CITY OF KINGSVILLE SOLID WASTE LANDFILL-CASE 4 (LOCATION 4)

******************************************************************************


     NOTE: INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
           COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                              LAYER 1
                              --------

                    TYPE 1 -VERTICAL PERCOLATION LAYER
                      MATERIAL TEXTURE NUMBER 13
          THICKNESS                  =       6.00 INCHES
          POROSITY                   =     0.4300 VOL/VOL
          FIELD CAPACITY             =     0.3210 VOL/VOL
          WILTING POINT              =     0.2210 VOL/VOL
          INITIAL SOIL WATER CONTENT =     0.2210 VOL/VOL
          EFFECTIVE SAT. HYD. COND.  =  0.330000003000E-04 CM/SEC
      NOTE: SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY 3.00
            FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.


                              LAYER 2
                              --------

                    TYPE 1 -VERTICAL PERCOLATION LAYER
                      MATERIAL TEXTURE NUMBER 18
          THICKNESS                  =    1930.00    INCHES
```

CASE4R20.OU

```
POROSITY                       =     T 0.6710 VOL/VOL
FIELD CAPACITY                 =      0.2920 VOL/VOL
WILTING POINT                  =      0.0770 VOL/VOL
INITIAL SOIL WATER CONTENT     =      0.2914 VOL/VOL
EFFECTIVE SAT. HYD. COND.      =  0.100000005000E-02 CM/SEC
```

```
                          LAYER  3
                          --------

             TYPE 1 - VERTICAL PERCOLATION
           LAYER MATERIAL TEXTURE NUMBER  13
THICKNESS                      =     24.00   INCHES
POROSITY                       =      0.4300 VOL/VOL
FIELD CAPACITY                 =      0.3210    VOL/
WILTING POINT                  =      VOL      0.2210
INITIAL SOIL WATER CONTENT     =      VOL/VOL 0.3246
EFFECTIVE SAT. HYD. COND.      =  0.33000VOL/VOL1000E-04 CM/SEC
```

```
                          LAYER  4
                          --------

               TYPE 2 - LATERAL DRAINAGE
             LAYER MATERIAL TEXTURE NUMBER
THICKNESS                    20=       0.20   INCHES
POROSITY                       =      0.8500 VOL/VOL
FIELD CAPACITY                 =      0.0100 VOL/VOL
WILTING POINT                  =      0.0050 VOL/VOL
INITIAL SOIL WATER CONTENT     =      0.0206 VOL/VOL
EFFECTIVE SAT. HYD. COND.      =   10.0000000000     CM/SEC
SLOPE                          =      2.00   PERCENT
DRAINAGE LENGTH                =    500.0    FEET
```

```
                          LAYER  5
                          --------

             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       =      2.00   HOLES/ACRE
FML PLACEMENT QUALITY          =  3 - GOOD
```

```
                          LAYER  6
                          --------

               TYPE 3 - BARRIER SOIL LINER
               MATERIAL TEXTURE NUMBER  17
THICKNESS                      =      0.24   INCHES
POROSITY FIELD                 =      0.7500 VOL/
CAPACITY                       =      VOL 0.7470
                                      VOL/VOL
```

CASE4R20.OUT

| | | |
|---|---|---|
| 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 #13 WITH A FAIR STAND OF GRASS, A SURFACE SLOPE OF 4.% AND A SLOPE LENGTH OF 600. FEET.

| | | |
|---|---|---|
| SCS RUNOFF CURVE NUMBER | = | 88.00 |
| FRACTION OF AREA ALLOWING RUNOFF | = | 80.0 PERCENT |
| AREA PROJECTED ON HORIZONTAL PLANE | = | 1.000 ACRES |
| EVAPORATIVE ZONE DEPTH | = | 12.0 INCHES |
| INITIAL WATER IN EVAPORATIVE ZONE | = | 1.920 INCHES |
| UPPER LIMIT OF EVAPORATIVE STORAGE | = | 6.606 INCHES |
| LOWER LIMIT OF EVAPORATIVE STORAGE | = | 1.788 INCHES |
| INITIAL SNOW WATER | = | 0.000 INCHES |
| INITIAL WATER IN LAYER MATERIALS | = | 571. 702 INCHES |
| TOTAL INITIAL WATER | = | 571.702 INCHES |
| TOTAL SUBSURFACE INFLOW | = | 0.00 INCHES/YEAR |

EVAPOTRANSPIRATION AND WEATHER DATA
-----------------------------------

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM CORPUS CHRISTI TEXAS

| | | |
|---|---|---|
| STATION LATITUDE | = | 27.77 DEGREES |
| MAXIMUM LEAF AREA INDEX | = | 2.00 |
| START OF GROWING SEASON (JULIAN DATE) | = | 0 |
| END OF GROWING SEASON (JULIAN DATE) | = | 367 |
| EVAPORATIVE ZONE DEPTH | = | 12.0 INCHES |
| AVERAGE ANNUAL WIND SPEED | = | 12.00 MPH |
| AVERAGE 1ST QUARTER RELATIVE HUMIDITY | = | 76.00 % |
| AVERAGE 2ND QUARTER RELATIVE HUMIDITY | = | 78.00 % |
| AVERAGE 3RD QUARTER RELATIVE HUMIDITY | = | 76.00 % |
| AVERAGE 4TH QUARTER RELATIVE HUMIDITY | = | 76.00 % |

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR CORPUS CHRISTI TEXAS

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

| JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|
| 1.63 | 1.69 | 1.20 | 1.57 | 3.29 | 3.12 |
| 2.26 | 2.78 | 5.31 | 2.92 | 1.61 | 1.17 |

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR CORPUS CHRISTI TEXAS

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

CASE4R20.OUT

| JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|
| 56.30 | 59 .30 | 65.90 | 73.00 | 78.10 | 82.70 |
| 84.90 | 85.00 | 81.50 | 74.00 | 65.00 | 59.10 |

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR CORPUS CHRISTI TEXAS
AND STATION LATITUDE = 27.77 DEGREES

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 20

| | JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|---|
| **PRECIPITATION** | | | | | | |
| TOTALS | 1.15 | 2.02 | 1.05 | 1.42 | 2.41 | 2.71 |
| | 2.43 | 2.37 | 5.38 | 2.30 | 1. 33 | 1.18 |
| STD. DEVIATIONS | 0.63 | 1.18 | 0.55 | 1.20 | 1.88 | 2.04 |
| | 2.55 | 1.63 | 3.12 | 1. 75 | 1.17 | 0.85 |
| **RUNOFF** | | | | | | |
| TOTALS | 0.010 | 0.044 | 0.002 | 0.080 | 0.229 | 0.222 |
| | 0.322 | 0.145 | 0.650 | 0.131 | 0.058 | 0.013 |
| STD. DEVIATIONS | 0.032 | 0.059 | 0.004 | 0.198 | 0.452 | 0.284 |
| | 0.721 | 0.160 | 0.809 | 0.208 | 0.182 | 0.047 |
| **EVAPOTRANSPIRATION** | | | | | | |
| TOTALS | 0.926 | 2.091 | 1.307 | 1.259 | 2.002 | 2.140 |
| | 2.063 | 1.908 | 3.649 | 2.262 | 1.101 | 1.080 |
| STD. DEVIATIONS | 0.553 | 0.908 | 0.722 | 0.938 | 1.315 | 1.392 |
| | 1.651 | 1.324 | 1.215 | 1.209 | 0.795 | 0.582 |
| **LATERAL DRAINAGE COLLECTED FROM LAYER 4** | | | | | | |
| TOTALS | 0.0726 | 0.0392 | 0.0796 | 0.0589 | 0.0482 | 0.0756 |
| | 0.1774 | 0.2167 | 0.1255 | 0.4498 | 0.4595 | 0.2523 |
| STD. DEVIATIONS | 0.0955 | 0.0557 | 0.1545 | 0.1063 | 0.0799 | 0.1563 |
| | 0.3182 | 0.4582 | 0.2771 | 0.6084 | 0.7550 | 0.4586 |
| **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)

CASE4R20.OUT

```
 DAILY  AVERAGE  HEAD  ON  TOP  OF  LAYER
 5
   AVERAGES               0.0010   0.0006   0.0011   0.0009   0.0007   0.0011
 -------------------------0.0025---0.0031   0.0018   0.0064   0.0068   0.0036

   STD. DEVIATIONS        0.0014   0.0009   0.0022   0.0016   0.0011   0.0023
                          0.0045   0.0065   0.0041   0.0087   0.0111   0.0065

*******************************************************************************


*******************************************************************************

     AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS    1 THROUGH   20
-------------------------------------------------------------------------------
                                     INCHES              CU. FEET       PERCENT
                               -------------------   -------------   ---------
 PRECIPITATION                  25.74     (   5.706)     93448.9     100.00

 RUNOFF                          1.907    (  1.1083)      6921.00      7.406

 EVAPOTRANSPIRATION LATERAL     21.787    (  3.6980)     79085.98     84.630

 DRAINAGE COLLECTED              2.05535 (  1.61445)      7460.923     7.98396
   FROM LAYER   4

 PERCOLATION/LEAKAGE  THROUGH    0.00000 (  0.00000)         0.005     0.00000
   LAYER   6

 AVERAGE HEAD ON TOP             0.002 (     0.002)
   OF LAYER   5

 CHANGE  IN WATER STORAGE       -0.005    (  0.5759)       -18.99     -0.020

*******************************************************************************


*******************************************************************************
            PEAK DAILY VALUES FOR YEARS     1 THROUGH    20
   ------------------------------------------------------------------------
                                                 (INCHES)       (CU. FT.)
                                                ----------    -------------
      PRECIPITATION                                5.07         18404.102

      RUNOFF                                       2.016          7318.0361

      DRAINAGE  COLLECTED  FROM  LAYER   4         0.16119         585.10394

      PERCOLATION/LEAKAGE  THROUGH  LAYER   6      0.000000          0.00007

      AVERAGE  HEAD  ON  TOP  OF  LAYER   5        0.071

      MAXIMUM  HEAD  ON  TOP  OF  LAYER   5        0.142

      LOCATION  OF  MAXIMUM  HEAD  IN  LAYER   4
            (DISTANCE  FROM  DRAIN)                1.6 FEET

      SNOW  WATER                                  0.00            0.0000


      MAXIMUM  VEG.  SOIL  WATER  (VOL/VOL)                 0.3947
```

CASE4R20.OUT

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.1490

*** 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 20

| LAYER | (INCHES) | (VOL/VOL) |
|---|---|---|
| 1 | 1.4410 | 0.2402 |
| 2 | 562.2700 | 0.2913 |
| 3 | 7.7040 | 0.3210 |
| 4 | 0.0020 | 0.0100 |
| 5 | 0.0000 | 0.0000 |
| 6 | 0.1800 | 0.7500 |
| SNOW WATER | 0.000 | |

******************************************************************************
*
******************************************************************************

# APPENDIX B.7

# HELP OUTPUT FOR ALTERNATIVE LINER CLOSED CASE 5-LOCATION 1

CASE5R30.OUT

```
*
******************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
**              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:\HELP3\MDATA\KGVPR30Y.D4
TEMPERATURE DATA FILE:       C:\HELP3\MDATA\KGVTE30Y.D7
SOLAR RADIATION DATA FILE:   C:\HELP3\MDATA\KGVSO30Y.D13
EVAPOTRANSPIRATION DATA:     C:\HELP3\MDATA\KGVEV30Y.D11
SOIL AND DESIGN DATA         C:\HELP3\MDATA\CASE5R.D10
FILE:OUTPUT DATA FILE:       C:\HELP3\MDATA\CASE5R30.OUT


TIME:   8:47     DATE:   4/22/2019


******************************************************************************

     TITLE:  CITY OF KINGSVILLE SOLID WASTE LANDFILL-CASE 5 (LOCATION 1)

******************************************************************************


     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
            COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                                  LAYER  1
                                  --------

                   TYPE 1 - VERTICAL PERCOLATION LAYER
                       MATERIAL TEXTURE NUMBER  13
          THICKNESS                   =     24.00   INCHES
          POROSITY                    =      0.4300 VOL/VOL
          FIELD CAPACITY              =      0.3210
          WILTING POINT               =      VOL/VOL 0.2210
          INITIAL SOIL WATER CONTENT  =      VOL/VOL 0.2719
          EFFECTIVE SAT. HYD. COND.   =  0.330000000000E-04 CM/SEC
        NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  4.63
                 FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.


                                  LAYER  2
                                  --------

                     TYPE 2 - LATERAL DRAINAGE LAYER
                       MATERIAL TEXTURE NUMBER  20
          THICKNESS                   =      0.20   INCHES
```

```
                                           CASE5R30.OU
POROSITY                        =      T 0.8500 VOL/VOL
FIELD CAPACITY                  =      0.0100 VOL/VOL
WILTING POINT                   =      0.0050 VOL/VOL 0.
INITIAL SOIL WATER CONTENT      =      0100 VOL/VOL
EFFECTIVE SAT. HYD. COND.       =   10.0000000000      CM/SEC
SLOPE                           =      2.00    PERCEN
DRAINAGE LENGTH                 =    250.0     T FEET


                         LAYER  3
                         --------

              TYPE 4 - FLEXIBLE MEMBRANE LINER
                MATERIAL TEXTURE NUMBER  36
THICKNESS                       =       0.04    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.       =  0.399999993000E-12 CM/SEC
FML PINHOLE DENSITY             =      1.00    HOLES/ACRE
FML INSTALLATION DEFECTS        =      2.00    HOLES/ACRE
FML PLACEMENT QUALITY           =  3 - GOOD


                         LAYER  4
                         --------

              TYPE  3  -  BARRIER  SOIL
              LINER  MATERIAL  TEXTURE
THICKNESS     NUMBER  17        =       0.24    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


                         LAYER  5
                         --------

              TYPE 1 - VERTICAL PERCOLATION
             LAYER MATERIAL TEXTURE NUMBER  13
THICKNESS                       =     12.00    INCHES
POROSITY                        =      0.4300  VOL/VOL
FIELD CAPACITY                  =      0.3210 VOL/VOL
WILTING POINT                   =        0.2210 VOL/VOL
INITIAL SOIL WATER CONTENT      =        0.3210 VOL/VOL
EFFECTIVE SAT. HYD. COND.       =  0.330000003000E-04 CM/SEC


                         LAYER  6
                         --------

              TYPE 1 - VERTICAL PERCOLATION
             LAYER MATERIAL TEXTURE NUMBER  18
THICKNESS                       =    705.60    INCHES
POROSITY FIELD                  =      0.6710 VOL/VOL
CAPACITY                        =      0.2920 VOL/VOL
                                           Page 2
```

CASE5R30.OUT

WILTING POINT = 0.0770 VOL/VOL
INITIAL SOIL WATER = 0.2920 VOL/VOL
CONTENT EFFECTIVE SAT. = 0.100000005000E-02 CM/SEC
HYD. COND.

LAYER 7
--------

TYPE 1 - VERTICAL PERCOLATION
LAYER MATERIAL TEXTURE NUMBER 13

THICKNES = 24.00 INCHES
S = 0.4300 VOL/VOL
POROSITY CAPACITY = 0.3210 VOL/VOL
WILTING POINT = 0.2210 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.3210 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.330000003000E-04 CM/SEC

LAYER 8
--------

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 20

THICKNESS = 0.20 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. = 10.0000000000 CM/SEC
SLOPE = 2.00 PERCENT
DRAINAGE LENGTH = 250.0 FEET

LAYER 9
--------

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 = 2.00 HOLES/ACRE
FML PLACEMENT QUALITY = 3 - GOOD

LAYER 10
--------

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 17

THICKNESS = 0.24 INCHES
POROSITY = 0.7500 VOL/VOL
FIELD CAPACITY = 0.7470 VOL/VOL
WILTING POINT = 0.4000 VOL/
INITIAL SOIL WATER CONTENT = VOL 0.7500
VOL/VOL

CASE5R30.OUT

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 #13 WITH A GOOD STAND OF GRASS, A SURFACE SLOPE OF 25.% AND A SLOPE LENGTH OF 100. FEET.

| | | | |
|---|---|---|---|
| SCS RUNOFF CURVE NUMBER | = | 85.60 | |
| FRACTION OF AREA ALLOWING RUNOFF | = | 100.0 | PERCENT |
| AREA PROJECTED ON HORIZONTAL PLANE | = | 1.000 | ACRES |
| EVAPORATIVE ZONE DEPTH | = | 12.0 | INCHES |
| INITIAL WATER IN EVAPORATIVE ZONE | = | 2.674 | INCHES |
| UPPER LIMIT OF EVAPORATIVE STORAGE | = | 5.160 | INCHES |
| LOWER LIMIT OF EVAPORATIVE STORAGE | = | 2.652 | INCHES |
| INITIAL SNOW WATER | = | 0.000 | INCHES |
| INITIAL WATER IN LAYER MATERIALS | = | 224.481 | INCHES |
| TOTAL INITIAL WATER | = | 224.481 | INCHES |
| TOTAL SUBSURFACE INFLOW | = | 0.00 | INCHES/YEAR |

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM CORPUS CHRISTI TEXAS

| | | |
|---|---|---|
| STATION LATITUDE | = | 27.77 DEGREES |
| MAXIMUM LEAF AREA INDEX | = | 3.50 |
| START OF GROWING SEASON (JULIAN DATE) | = | 0 |
| END OF GROWING SEASON (JULIAN DATE) | = | 367 |
| EVAPORATIVE ZONE DEPTH | = | 12.0 INCHES |
| AVERAGE ANNUAL WIND SPEED | = | 12.00 MPH |
| AVERAGE 1ST QUARTER RELATIVE HUMIDITY | = | 76.00 % |
| AVERAGE 2ND QUARTER RELATIVE HUMIDITY | = | 78.00 % |
| AVERAGE 3RD QUARTER RELATIVE HUMIDITY | = | 76.00 % |
| AVERAGE 4TH QUARTER RELATIVE HUMIDITY | = | 76.00 % |

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR CORPUS CHRISTI TEXAS

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

| JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|
| 1.63 | 1.69 | 1.20 | 1.57 | 3.29 | 3.12 |
| 2.26 | 2.78 | 5.31 | 2.92 | 1.61 | 1.17 |

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR CORPUS CHRISTI TEXAS

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

| JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|

| | | | | | |
|---|---|---|---|---|---|
| 56.30 | 59.30 | 65.90 | 73.00 | 78.10 | 82.70 |
| 84.90 | 85.00 | 81.50 | 74.00 | 65.00 | 59.10 |

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR CORPUS CHRISTI TEXAS
AND STATION LATITUDE = 27.77 DEGREES

*******************************************************************************

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 30

| | JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|---|
| **PRECIPITATION** | | | | | | |
| TOTALS | 1.37 | 1.81 | 1.19 | 1.40 | 2.51 | 2.59 |
| | 2.36 | 2.86 | 5.39 | 2.99 | 1.49 | 1.25 |
| STD. DEVIATIONS | 0.81 | 1.21 | 0.57 | 1.05 | 1.80 | 1.82 |
| | 2.23 | 2.36 | 2.96 | 1.90 | 1.16 | 0.84 |
| **RUNOFF** | | | | | | |
| TOTALS | 0.007 | 0.022 | 0.005 | 0.051 | 0.188 | 0.174 |
| | 0.342 | 0.218 | 0.608 | 0.191 | 0.067 | 0.007 |
| STD. DEVIATIONS | 0.022 | 0.041 | 0.026 | 0.171 | 0.500 | 0.243 |
| | 0.789 | 0.366 | 0.822 | 0.318 | 0.265 | 0.028 |
| **EVAPOTRANSPIRATION** | | | | | | |
| TOTALS | 1.093 | 1.768 | 1.331 | 1.252 | 1.966 | 2.071 |
| | 1.754 | 2.186 | 3.474 | 2.435 | 1.312 | 1.107 |
| STD. DEVIATIONS | 0.665 | 0.864 | 0.621 | 0.803 | 1.191 | 1.228 |
| | 1.256 | 1.504 | 1.237 | 1.136 | 0.899 | 0.681 |
| **LATERAL DRAINAGE COLLECTED FROM LAYER 2** | | | | | | |
| TOTALS | 0.0698 | 0.2237 | 0.1155 | 0.0457 | 0.1805 | 0.3327 |
| | 0.3318 | 0.3490 | 0.8839 | 0.7081 | 0.2403 | 0.0780 |
| STD. DEVIATIONS | 0.1315 | 0.2604 | 0.1270 | 0.1234 | 0.2785 | 0.4691 |
| | 0.5455 | 0.5857 | 0.9977 | 0.7204 | 0.3203 | 0.1153 |
| **PERCOLATION/LEAKAGE THROUGH LAYER 4** | | | | | | |
| 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 |
| **LATERAL DRAINAGE COLLECTED FROM 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 |

CASE5R30.OUT

| | | | | | | |
|---|---|---|---|---|---|---|
| | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

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 3

| | | | | | | |
|---|---|---|---|---|---|---|
| AVERAGES | 0.0005 | 0.0017 | 0.0008 | 0.0003 | 0.0013 | 0.0139 |
| | 0.0206 | 0.0177 | 0.1061 | 0.0240 | 0.0018 | 0.0006 |
| STD. DEVIATIONS | 0.0009 | 0.0020 | 0.0009 | 0.0009 | 0.0020 | 0.0415 |
| | 0.1028 | 0.0537 | 0.2641 | 0.0529 | 0.0024 | 0.0008 |

DAILY AVERAGE HEAD ON TOP OF LAYER 9

| | | | | | | |
|---|---|---|---|---|---|---|
| AVERAGES | 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 |

*******************************************************************************

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 30

| | INCHES | | CU. FEET | PERCENT |
|---|---|---|---|---|
| PRECIPITATION | 27.20 | ( 5.704) | 98722.7 | 100.00 |
| RUNOFF | 1.880 | ( 1.2157) | 6825.49 | 6.914 |
| EVAPOTRANSPIRATION | 21.749 | ( 3.7373) | 78947.65 | 79.969 |
| LATERAL DRAINAGE COLLECTED FROM LAYER 2 | 3.55912 | ( 1.91851) | 12919.604 | 13.08676 |
| PERCOLATION/LEAKAGE THROUGH LAYER 4 | 0.00001 | ( 0.00001) | 0.023 | 0.00002 |
| AVERAGE HEAD ON TOP OF LAYER 3 | 0.016 | ( 0.026) | | |
| LATERAL DRAINAGE COLLECTED FROM LAYER 8 | 0.00001 | ( 0.00001) | 0.022 | 0.00002 |
| PERCOLATION/LEAKAGE THROUGH LAYER 10 | 0.00000 | ( 0.00000) | 0.001 | 0.00000 |
| AVERAGE HEAD ON TOP OF LAYER 9 | 0.000 | ( 0.000) | | |
| CHANGE IN WATER STORAGE | 0.008 | ( 0.4489) | 29.91 | 0.030 |

CASE5R30.OUT

```
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******************************************************************************
              PEAK DAILY VALUES FOR YEARS    1 THROUGH   30
   ------------------------------------------------------------------------
                                              (INCHES)       (CU. FT.)
                                             ----------    -------------
      PRECIPITATION                             5.07         18404.102

      RUNOFF                                    2.585         9382.1035

      DRAINAGE COLLECTED FROM LAYER  2          0.91251       3312.41650

      PERCOLATION/LEAKAGE THROUGH LAYER  4      0.000012         0.04380

      AVERAGE HEAD ON TOP OF LAYER  3          14.568

      MAXIMUM HEAD ON TOP OF LAYER  3          18.997

      LOCATION OF MAXIMUM HEAD IN LAYER  2
            (DISTANCE FROM DRAIN)              87.9 FEET

      DRAINAGE COLLECTED FROM LAYER  8          0.00001          0.03665

      PERCOLATION/LEAKAGE THROUGH LAYER 10      0.000000         0.00002

      AVERAGE HEAD ON TOP OF LAYER  9           0.000

      MAXIMUM HEAD ON TOP OF LAYER  9           0.000

      LOCATION OF MAXIMUM HEAD IN LAYER  8
            (DISTANCE FROM DRAIN)               0.0 FEET

      SNOW WATER                                0.02            73.7433


      MAXIMUM VEG. SOIL WATER (VOL/VOL)                 0.4285

      MINIMUM VEG. SOIL WATER (VOL/VOL)                 0.2210

       ***  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   30
   ------------------------------------------------------------------------
                    LAYER        (INCHES)       (VOL/VOL)
                    -----        --------       ---------
                      1           6.7730         0.2822
```

| | | |
|---|---|---|
| 2 | 0.0020 | 0.0100 |
| 3 | 0.0000 | 0.0000 |
| 4 | 0.1800 | 0.7500 |
| 5 | 3.8520 | 0.3210 |
| 6 | 206.0352 | 0.2920 |
| 7 | 7.7040 | 0.3210 |
| 8 | 0.0020 | 0.0100 |
| 9 | 0.0000 | 0.0000 |
| 10 | 0.1800 | 0.7500 |
| SNOW WATER | 0.000 | |

*****************************************************************************
****************************************************************************
*

# APPENDIX B.8

# HELP OUTPUT FOR ALTERNATIVE LINER CLOSED CASE 6-LOCATION 2

CASE6R30.OUT

```
******************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
**              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:\HELP3\MDATA\KGVPR30Y.D4
TEMPERATURE DATA FILE:       C:\HELP3\MDATA\KGVTE30Y.D7
SOLAR RADIATION DATA FILE:   C:\HELP3\MDATA\KGVSO30Y.D13
EVAPOTRANSPIRATION DATA:     C:\HELP3\MDATA\KGVEV30Y.D11
SOIL AND DESIGN DATA FILE:   C:\HELP3\MDATA\CASE6R.D10
OUTPUT DATA FILE:            C:\HELP3\MDATA\CASE6R30.OUT


TIME:  13:23      DATE:   4/18/2019


******************************************************************************

     TITLE:  CITY OF KINGSVILLE SOLID WASTE LANDFILL-CASE 6 (LOCATION 2)

******************************************************************************


     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
            COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                                    LAYER  1
                                    --------

                          TYPE 1 - VERTICAL PERCOLATION
                         LAYER MATERIAL TEXTURE NUMBER  13
           THICKNESS                   =     24.00    INCHES
           POROSITY                    =      0.4300 VOL/VOL
           FIELD CAPACITY              =      0.3210 VOL/VOL
           WILTING POINT               =      0.2210 VOL/VOL
           INITIAL SOIL WATER CONTENT  =      0.2754 VOL/VOL
           EFFECTIVE SAT. HYD. COND.   =  0.330000003000E-04 CM/SEC
         NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  4.63
                FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.


                                    LAYER  2
                                    --------

                          TYPE 2 - LATERAL DRAINAGE LAYER
                            MATERIAL TEXTURE NUMBER  20
           THICKNESS                   =      0.20    INCHES
```

CASE6R30.OUT

```
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.     =   10.0000000000     CM/SEC
SLOPE                         =      2.00
DRAINAGE LENGTH               =    PERCENT 500.0
                                   FEET


                        LAYER  3
                        --------

             TYPE 4 - FLEXIBLE MEMBRANE LINER
               MATERIAL TEXTURE NUMBER  36
THICKNESS                     =      0.04   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.     =  0.399999993000E-12 CM/SEC
FML PINHOLE DENSITY           =      1.00   HOLES/ACRE
FML INSTALLATION DEFECTS      =      2.00   HOLES/ACRE
FML PLACEMENT QUALITY         =  3 - GOOD


                        LAYER  4
                        --------

               TYPE  3  -  BARRIER  SOIL
               LINER   MATERIAL   TEXTURE
THICKNESS      NUMBER  17     =      0.24   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


                        LAYER  5
                        --------

              TYPE 1 - VERTICAL PERCOLATION
             LAYER MATERIAL TEXTURE NUMBER  13
THICKNESS                     =     12.00   INCHES
POROSITY                      =      0.4300 VOL/VOL
FIELD CAPACITY                =      0.  3210   VOL/
WILTING POINT                 =      VOL      0.2210
INITIAL SOIL WATER CONTENT    =      VOL/VOL  0.3210
EFFECTIVE SAT. HYD. COND.     =  0.330000001000E-04 CM/SEC


                        LAYER  6
                        --------

            TYPE 1 - VERTICAL PERCOLATION LAYER
               MATERIAL TEXTURE NUMBER  18
THICKNESS                     =   1727.50   INCHES
POROSITY FIELD                =      0.6710 VOL/VOL
CAPACITY                      =      0.2920 VOL/VOL
```

CASE6R30.OUT

```
WILTING POINT                =      0.0770 VOL/VOL
INITIAL SOIL WATER CONTENT   =      0.2920 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.100000005000E-02 CM/SEC


                  LAYER  7
                  --------

        TYPE 1 - VERTICAL PERCOLATION LAYER
           MATERIAL TEXTURE NUMBER  13
THICKNESS                    =     24.00   INCHES
POROSITY                     =      0.4300 VOL/VOL
FIELD CAPACITY               =      0.3210 VOL/VOL
WILTING POINT                =      0.2210 VOL/VOL
INITIAL SOIL WATER CONTENT   =      0.3210 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.330000003000E-04 CM/SEC


                  LAYER  8
                  --------

            TYPE 2 - LATERAL DRAINAGE
          LAYER MATERIAL TEXTURE NUMBER
THICKNESS                  20=      0.20   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.    =   10.0000000000     CM/SEC
SLOPE                        =      2.00   PERCENT
DRAINAGE LENGTH              =    500.0    FEET


                  LAYER  9
                  --------

         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     =      2.00   HOLES/ACRE
FML PLACEMENT QUALITY        =  3 - GOOD


                  LAYER 10
                  --------

            TYPE 3 - BARRIER SOIL LINER
           MATERIAL TEXTURE NUMBER  17
THICKNESS                    =      0.24   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
```

CASE6R30.OUT

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 #13 WITH A GOOD STAND OF GRASS, A SURFACE SLOPE OF 25. % AND A SLOPE LENGTH OF 350. FEET.

| | | | |
|---|---|---|---|
| SCS RUNOFF CURVE NUMBER | = | 84.60 | |
| FRACTION OF AREA ALLOWING RUNOFF | = | 100.0 | PERCENT |
| AREA PROJECTED ON HORIZONTAL PLANE | = | 1.000 | ACRES |
| EVAPORATIVE ZONE DEPTH | = | 12.0 | INCHES |
| INITIAL WATER IN EVAPORATIVE ZONE | = | 2.757 | INCHES |
| UPPER LIMIT OF EVAPORATIVE STORAGE | = | 5.160 | INCHES |
| LOWER LIMIT OF EVAPORATIVE STORAGE | = | 2.652 | INCHES |
| INITIAL SNOW WATER | = | 0.000 | INCHES |
| INITIAL WATER IN LAYER MATERIALS | = | 522.959 | INCHES |
| TOTAL INITIAL WATER | = | 522.959 | INCHES |
| TOTAL SUBSURFACE INFLOW | = | 0.00 | INCHES/YEAR |

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM CORPUS CHRISTI TEXAS

| | | |
|---|---|---|
| STATION LATITUDE | = | 27.77 DEGREES |
| MAXIMUM LEAF AREA INDEX | = | 3.50 |
| START OF GROWING SEASON (JULIAN DATE) | = | 0 |
| END OF GROWING SEASON (JULIAN DATE) | = | 367 |
| EVAPORATIVE ZONE DEPTH | = | 12.0 INCHES |
| AVERAGE ANNUAL WIND SPEED | = | 12.00 MPH |
| AVERAGE 1ST QUARTER RELATIVE | = | 76.00 % |
| HUMIDITY AVERAGE 2ND QUARTER RELATIVE | = | 78.00 % |
| HUMIDITY AVERAGE 3RD QUARTER RELATIVE | = | 76.00 % |
| HUMIDITY AVERAGE 4TH QUARTER RELATIVE | = | 76.00 % |
| HUMIDITY | | |

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR CORPUS CHRISTI TEXAS

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

| JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|
| 1.63 | 1.69 | 1.20 | 1.57 | 3.29 | 3.12 |
| 2.26 | 2.78 | 5.31 | 2.92 | 1.61 | 1.17 |

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR CORPUS CHRISTI TEXAS

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

| JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|

CASE6R30.OUT

| | | | | | |
|---|---|---|---|---|---|
| 56.30 | 59.30 | 65.90 | 73.00 | 78.10 | 82.70 |
| 84.90 | 85.00 | 81.50 | 74.00 | 65.00 | 59.10 |

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR CORPUS CHRISTI TEXAS
AND STATION LATITUDE = 27.77 DEGREES

*******************************************************************************

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 30

| | JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|---|
| **PRECIPITATION** | | | | | | |
| TOTALS | 1.37 | 1.81 | 1.19 | 1.40 | 2.51 | 2.59 |
| | 2.36 | 2.86 | 5.39 | 2.99 | 1.49 | 1.25 |
| STD. DEVIATIONS | 0.81 | 1.21 | 0.57 | 1.05 | 1.80 | 1.82 |
| | 2.23 | 2.36 | 2.96 | 1.90 | 1.16 | 0.84 |
| **RUNOFF** | | | | | | |
| TOTALS | 0.005 | 0.016 | 0.004 | 0.047 | 0.169 | 0.145 |
| | 0.325 | 0.191 | 0.568 | 0.161 | 0.044 | 0.004 |
| STD. DEVIATIONS | 0.016 | 0.032 | 0.020 | 0.171 | 0.495 | 0.206 |
| | 0.770 | 0.339 | 0.843 | 0.294 | 0.176 | 0.018 |
| **EVAPOTRANSPIRATION** | | | | | | |
| TOTALS | 1.081 | 1.760 | 1.314 | 1.251 | 1.928 | 2.038 |
| | 1.728 | 2.139 | 3.444 | 2.384 | 1.304 | 1.109 |
| STD. DEVIATIONS | 0.675 | 0.902 | 0.615 | 0.801 | 1.168 | 1.210 |
| | 1.204 | 1.461 | 1.229 | 1.106 | 0.896 | 0.689 |
| **LATERAL DRAINAGE COLLECTED FROM LAYER 2** | | | | | | |
| TOTALS | 0.0809 | 0.2406 | 0.1121 | 0.0567 | 0.2251 | 0.3948 |
| | 0.3796 | 0.4275 | 0.9447 | 0.7920 | 0.2900 | 0.0857 |
| STD. DEVIATIONS | 0.1435 | 0.2996 | 0.1230 | 0.1528 | 0.3265 | 0.5469 |
| | 0.6067 | 0.6486 | 0.9618 | 0.8406 | 0.4048 | 0.1200 |
| **PERCOLATION/LEAKAGE THROUGH LAYER 4** | | | | | | |
| 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 |
| **LATERAL DRAINAGE COLLECTED FROM 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 |

CASE6R30.OUT

```
                       0.00000000  0.0000  0.0000  0.0000  0.0000

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
3
  AVERAGES              0.0012  0.0038  0.0016  0.0008  0.0104  0.0589
------------------------0.0681--0.0899  0.3548  0.1774  0.0241  0.0012

  STD. DEVIATIONS       0.0020  0.0047  0.0017  0.0022  0.0324  0.1912
                        0.2573  0.2432  0.7287  0.4575  0.1013  0.0017

DAILY  AVERAGE  HEAD  ON  TOP  OF  LAYER
9
  AVERAGES              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

*****************************************************************************


*****************************************************************************

    AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS   1 THROUGH   30
-----------------------------------------------------------------------------
                                 INCHES            CU. FEET      PERCENT
                           -------------------   ------------   ---------
PRECIPITATION               27.20    (   5.704)     98722.7      100.00

RUNOFF                       1.680   (  1.1902)      6099.48       6.178

EVAPOTRANSPIRATION          21.481   (  3.7202)     77976.52      78.985

LATERAL DRAINAGE COLLECTED   4.02954 (  2.05403)    14627.235     14.81649
  FROM LAYER  2

PERCOLATION/LEAKAGE THROUGH  0.00002 (  0.00003)        0.077      0.00008
  LAYER  4

AVERAGE HEAD ON TOP          0.066 (     0.096)
  OF LAYER  3

LATERAL DRAINAGE COLLECTED   0.00002 (  0.00003)        0.073     0.00007
  FROM LAYER  8

PERCOLATION/LEAKAGE THROUGH  0.00000 (  0.00000)        0.004      0.00000
  LAYER 10

AVERAGE HEAD ON TOP          0.000 (     0.000)
  OF LAYER  9

CHANGE IN WATER STORAGE      0.005   (  0.4311)        19.37       0.020
```

CASE6R30.OUT

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******************************************************************************

PEAK DAILY VALUES FOR YEARS 1 THROUGH 30

| | (INCHES) | (CU. FT.) |
|---|---|---|
| PRECIPITATION | 5.07 | 18404.102 |
| RUNOFF | 2.585 | 9382.0957 |
| DRAINAGE COLLECTED FROM LAYER 2 | 0.45365 | 1646.75024 |
| PERCOLATION/LEAKAGE THROUGH LAYER 4 | 0.000023 | 0.08305 |
| AVERAGE HEAD ON TOP OF LAYER 3 | 22.812 | |
| MAXIMUM HEAD ON TOP OF LAYER 3 | 31.119 | |
| LOCATION OF MAXIMUM HEAD IN LAYER 2 (DISTANCE FROM DRAIN) | 158.8 FEET | |
| DRAINAGE COLLECTED FROM LAYER 8 | 0.00002 | 0.07910 |
| PERCOLATION/LEAKAGE THROUGH LAYER 10 | 0.000000 | 0.00002 |
| AVERAGE HEAD ON TOP OF LAYER 9 | 0.000 | |
| MAXIMUM HEAD ON TOP OF LAYER 9 | 0.000 | |
| LOCATION OF MAXIMUM HEAD IN LAYER 8 (DISTANCE FROM DRAIN) | 0.0 FEET | |
| SNOW WATER | 0.02 | 73.7433 |

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.4300

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.2210

*** 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 30

| LAYER | (INCHES) | (VOL/VOL) |
|---|---|---|
| 1 | 6.7691 | 0.2820 |

CASE6R30.OUT

| | | |
|---|---|---|
| 2 | 0.0020 | 0.0100 |
| 3 | 0.0000 | 0.0000 |
| 4 | 0.1800 | 0.7500 |
| 5 | 3.8520 | 0.3210 |
| 6 | 504.4300 | 0.2920 |
| 7 | 7.7040 | 0.3210 |
| 8 | 0.0020 | 0.0100 |
| 9 | 0.0000 | 0.0000 |
| 10 | 0.1800 | 0.7500 |
| SNOW WATER | 0.000 | |

***************************************************************************
***************************************************************************

# APPENDIX B.9

# HELP OUTPUT FOR ALTERNATIVE LINER CLOSED CASE 7-LOCATION 3

```
****************************************************************************
****************************************************************************
**                                                                        **
**                                                                        **
**              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:\HELP3\MDATA\KGVPR30Y.D4
TEMPERATURE DATA FILE:       C:\HELP3\MDATA\KGVTE30Y.D7
SOLAR RADIATION DATA         C:\HELP3\MDATA\KGVSO30Y.D13
FILE:EVAPOTRANSPIRATION      C:\HELP3\MDATA\KGVEV30Y.D11
DATA:SOIL AND DESIGN DATA    C:\HELP3\MDATA\CASE7R.D10
FILE:                        C:\HELP3\MDATA\CASE7R30.OUT
OUTPUT DATA FILE:


TIME:    9: 9      DATE:    4/22/2019


****************************************************************************

     TITLE:  CITY OF KINGSVILLE SOLID WASTE LANDFILL-CASE 7 (LOCATION 3)

****************************************************************************


     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
            COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                                   LAYER  1
                                   --------

                      TYPE 1 - VERTICAL PERCOLATION LAYER
                          MATERIAL TEXTURE NUMBER  13
           THICKNESS                  =      24.00    INCHES
           POROSITY                   =       0.4300 VOL/VOL
           FIELD CAPACITY             =       0.3210 VOL/VOL
           WILTING POINT              =       0.2210 VOL/VOL
           INITIAL SOIL WATER CONTENT =       0.2734 VOL/VOL
           EFFECTIVE SAT. HYD. COND.  =   0.330000003000E-04 CM/SEC
         NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  4.63
                FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.



                                   LAYER  2
                                   --------

                        TYPE 2 - LATERAL DRAINAGE LAYER
                          MATERIAL TEXTURE NUMBER  20
           THICKNESS                  =       0.20    INCHES
```

CASE7R30.OU

```
POROSITY                     =     T 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.    =   10.0000000000      CM/SEC
SLOPE                        =       2.00    PERCENT
DRAINAGE LENGTH              =     500.0     FEET


                        LAYER  3
                        --------

            TYPE 4 - FLEXIBLE MEMBRANE LINER
              MATERIAL TEXTURE NUMBER  36
THICKNESS                    =       0.04    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.    =   0.399999993000E-12 CM/SEC
FML PINHOLE DENSITY          =       1.00    HOLES/ACRE
FML INSTALLATION DEFECTS     =       2.00    HOLES/ACRE
FML PLACEMENT QUALITY        =   3 - GOOD


                        LAYER  4
                        --------

              TYPE  3  -  BARRIER  SOIL
              LINER  MATERIAL  TEXTURE
THICKNESS     NUMBER  17     =       0.24    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


                        LAYER  5
                        --------

             TYPE 1 - VERTICAL PERCOLATION
            LAYER MATERIAL TEXTURE NUMBER  13
THICKNESS                    =      12.00    INCHES
POROSITY                     =       0.4300 VOL/VOL
FIELD CAPACITY               =       0.3210 VOL/VOL
WILTING POINT                =       0.2210 VOL/VOL
INITIAL SOIL WATER CONTENT   =       0.3210 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =   0.330000003000E-04 CM/SEC


                        LAYER  6
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  18
THICKNESS                    =    1845.90    INCHES
POROSITY FIELD               =       0.6710 VOL/VOL
CAPACITY                     =       0.2920 VOL/VOL
```

```
                                CASE7R30.OUT
WILTING POINT                =          0.0770 VOL/VOL
INITIAL SOIL WATER CONTENT   =          0.2920 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.100000005000E-02 CM/SEC


                     LAYER  7
                     --------

           TYPE 1 - VERTICAL PERCOLATION LAYER
             MATERIAL TEXTURE NUMBER  13
THICKNESS                    =      24.00    INCHES
POROSITY                     =       0.4300 VOL/VOL
FIELD CAPACITY               =       0.3210 VOL/VOL
WILTING POINT                =       0.2210 VOL/VOL
INITIAL SOIL WATER CONTENT   =       0.3210 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.330000003000E-04 CM/SEC


                     LAYER  8
                     --------

            TYPE 2 - LATERAL DRAINAGE LAYER
             MATERIAL TEXTURE NUMBER  20
THICKNESS                    =       0.20    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.    =   10.0000000000     CM/SEC
SLOPE                        =       2.00    PERCENT
DRAINAGE LENGTH              =     500.0     FEET


                     LAYER  9
                     --------

            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     =       2.00    HOLES/ACRE
FML PLACEMENT QUALITY        =  3 - GOOD


                     LAYER 10
                     --------

             TYPE 3 - BARRIER SOIL LINER
             MATERIAL TEXTURE NUMBER  17
THICKNESS                    =       0.24    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
                                        Page 3
```

CASE7R30.OUT

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 #13 WITH A GOOD STAND OF GRASS, A SURFACE SLOPE OF 12.% AND A SLOPE LENGTH OF 200. FEET.

| | | | |
|---|---|---|---|
| SCS RUNOFF CURVE NUMBER | = | 84.80 | |
| FRACTION OF AREA ALLOWING RUNOFF | = | 100.0 | PERCENT |
| AREA PROJECTED ON HORIZONTAL PLANE | = | 1.000 | ACRES |
| EVAPORATIVE ZONE DEPTH | = | 12.0 | INCHES |
| INITIAL WATER IN EVAPORATIVE ZONE | = | 2.709 | INCHES |
| UPPER LIMIT OF EVAPORATIVE STORAGE | = | 5.160 | INCHES |
| LOWER LIMIT OF EVAPORATIVE STORAGE | = | 2.652 | INCHES |
| INITIAL SNOW WATER | = | 0.000 | INCHES |
| INITIAL WATER IN LAYER MATERIALS | = | 557.484 | INCHES |
| TOTAL INITIAL WATER | = | 557.484 | INCHES |
| TOTAL SUBSURFACE INFLOW | = | 0.00 | INCHES/YEAR |

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM CORPUS CHRISTI TEXAS

| | | |
|---|---|---|
| STATION LATITUDE | = | 27.77 DEGREES |
| MAXIMUM LEAF AREA INDEX | = | 3.50 |
| START OF GROWING SEASON (JULIAN DATE) | = | 0 |
| END OF GROWING SEASON (JULIAN DATE) | = | 367 |
| EVAPORATIVE ZONE DEPTH | = | 12.0 INCHES |
| AVERAGE ANNUAL WIND SPEED | = | 12.00 MPH |
| AVERAGE 1ST QUARTER RELATIVE HUMIDITY | = | 76.00 % |
| AVERAGE 2ND QUARTER RELATIVE HUMIDITY | = | 78.00 % |
| AVERAGE 3RD QUARTER RELATIVE HUMIDITY | = | 76.00 % |
| AVERAGE 4TH QUARTER RELATIVE HUMIDITY | = | 76.00 % |

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR CORPUS CHRISTI TEXAS

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

| JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|
| 1.63 | 1.69 | 1.20 | 1.57 | 3.29 | 3.12 |
| 2.26 | 2.78 | 5.31 | 2.92 | 1.61 | 1.17 |

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR CORPUS CHRISTI TEXAS

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

| JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|

CASE7R30.OUT

| | | | | | |
|---|---|---|---|---|---|
| 56.30 | 59.30 | 65.90 | 73.00 | 78.10 | 82.70 |
| 84.90 | 85.00 | 81.50 | 74.00 | 65.00 | 59.10 |

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR CORPUS CHRISTI TEXAS
AND STATION LATITUDE = 27.77 DEGREES

*****************************************************************************

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 30

| | JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|---|
| **PRECIPITATION** | | | | | | |
| TOTALS | 1.37 | 1.81 | 1.19 | 1.40 | 2.51 | 2.59 |
| | 2.36 | 2.86 | 5.39 | 2.99 | 1.49 | 1.25 |
| STD. DEVIATIONS | 0.81 | 1.21 | 0.57 | 1.05 | 1.80 | 1.82 |
| | 2.23 | 2.36 | 2.96 | 1.90 | 1.16 | 0.84 |
| **RUNOFF** | | | | | | |
| TOTALS | 0.005 | 0.017 | 0.004 | 0.048 | 0.172 | 0.150 |
| | 0.327 | 0.197 | 0.576 | 0.165 | 0.045 | 0.004 |
| STD. DEVIATIONS | 0.017 | 0.034 | 0.021 | 0.172 | 0.495 | 0.212 |
| | 0.771 | 0.344 | 0.849 | 0.296 | 0.177 | 0.019 |
| **EVAPOTRANSPIRATIO N** | | | | | | |
| TOTALS | 1.078 | 1.759 | 1.312 | 1.250 | 1.927 | 2.039 |
| | 1.733 | 2.138 | 3.441 | 2.378 | 1.302 | 1.114 |
| STD. DEVIATIONS | 0.678 | 0.893 | 0.613 | 0.800 | 1.166 | 1.215 |
| | 1.208 | 1.465 | 1.222 | 1.103 | 0.899 | 0.690 |
| **LATERAL DRAINAGE COLLECTED FROM LAYER 2** | | | | | | |
| TOTALS | 0.0770 | 0.2413 | 0.1130 | 0.0569 | 0.2266 | 0.3893 |
| | 0.3734 | 0.4229 | 0.9423 | 0.7940 | 0.2864 | 0.0853 |
| STD. DEVIATIONS | 0.1384 | 0.3007 | 0.1237 | 0.1480 | 0.3277 | 0.5341 |
| | 0.6049 | 0.6418 | 0.9643 | 0.8378 | 0.4003 | 0.1205 |
| **PERCOLATION/LEAKAGE THROUGH LAYER 4** | | | | | | |
| 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 |
| **LATERAL DRAINAGE COLLECTED FROM 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 |

CASE7R30.OUT

```
                          0.00000000   0.0000   0.0000   0.0000   0.0000

 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
 3
  AVERAGES              0.0011   0.0038   0.0016   0.0008   0.0105   0.0584
                        0.0675   0.0853   0.3606   0.1844   0.0215   0.0012

  STD. DEVIATIONS       0.0020   0.0047   0.0018   0.0022   0.0325   0.1892
                        0.2555   0.2308   0.7392   0.4599   0.0994   0.0017

 DAILY AVERAGE HEAD ON TOP OF LAYER  9

  AVERAGES              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

*******************************************************************************


*******************************************************************************

    AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS   1 THROUGH   30
-------------------------------------------------------------------------------
                                 INCHES           CU. FEET      PERCENT
                                                 -----------   ---------
 PRECIPITATION               27.20    (   5.704)    98722.7     100.00

 RUNOFF                       1.711   (  1.1947)    6210.31      6.291

 EVAPOTRANSPIRATION LATERAL  21.470   (  3.7084)    77936.37    78.945

 DRAINAGE COLLECTED           4.00840 ( 2.03256)    14550.508   14.73877
   FROM LAYER  2

 PERCOLATION/LEAKAGE THROUGH  0.00002 ( 0.00003)        0.078    0.00008
   LAYER  4

 AVERAGE HEAD ON TOP          0.066 (    0.097)
   OF LAYER  3

 LATERAL DRAINAGE COLLECTED   0.00002 ( 0.00003)        0.073    0.00007
   FROM LAYER  8

 PERCOLATION/LEAKAGE THROUGH  0.00000 ( 0.00000)        0.004    0.00000
   LAYER 10

 AVERAGE HEAD ON TOP          0.000 (    0.000)
   OF LAYER  9

 CHANGE IN WATER STORAGE      0.007   (  0.4345)       25.43     0.026
```

CASE7R30.OUT

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 30

| | (INCHES) | (CU. FT.) |
|---|---|---|
| PRECIPITATION | 5.07 | 18404.102 |
| RUNOFF | 2.585 | 9382.0957 |
| DRAINAGE COLLECTED FROM LAYER 2 | 0.45365 | 1646.75073 |
| PERCOLATION/LEAKAGE THROUGH LAYER 4 | 0.000023 | 0.08307 |
| AVERAGE HEAD ON TOP OF LAYER 3 | 22.816 | |
| MAXIMUM HEAD ON TOP OF LAYER 3 | 31.124 | |
| LOCATION OF MAXIMUM HEAD IN LAYER 2 (DISTANCE FROM DRAIN) | 158.8 FEET | |
| DRAINAGE COLLECTED FROM LAYER 8 | 0.00002 | 0.07912 |
| PERCOLATION/LEAKAGE THROUGH LAYER 10 | 0.000000 | 0.00002 |
| AVERAGE HEAD ON TOP OF LAYER 9 | 0.000 | |
| MAXIMUM HEAD ON TOP OF LAYER 9 | 0.000 | |
| LOCATION OF MAXIMUM HEAD IN LAYER 8 (DISTANCE FROM DRAIN) | 0.0 FEET | |
| SNOW WATER | 0.02 | 73.7433 |

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.4300

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.2210

*** 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 30

| LAYER | (INCHES) | (VOL/VOL) |
|---|---|---|
| 1 | 6.7714 | 0.2821 |

| | | |
|---|---|---|
| 2 | 0.0020 | 0.0100 |
| 3 | 0.0000 | 0.0000 |
| 4 | 0.1800 | 0.7500 |
| 5 | 3.8520 | 0.3210 |
| 6 | 539.0029 | 0.2920 |
| 7 | 7.7040 | 0.3210 |
| 8 | 0.0020 | 0.0100 |
| 9 | 0.0000 | 0.0000 |
| 10 | 0.1800 | 0.7500 |
| SNOW WATER | 0.000 | |

****************************************************************************
*
******************************************************************************

# APPENDIX B.10

# HELP OUTPUT FOR ALTERNATIVE LINER CLOSED CASE 8-LOCATION 4

CASE8R30.OUT

```
******************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
**              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:\HELP3\MDATA\KGVPR30Y.D4
TEMPERATURE DATA FILE:      C:\HELP3\MDATA\KGVTE30Y.D7
SOLAR RADIATION DATA        C:\HELP3\MDATA\KGVSO30Y.D13
FILE: EVAPOTRANSPIRATION    C:\HELP3\MDATA\KGVEV30Y.D11
DATA: SOIL AND DESIGN DATA  C:\HELP3\MDATA\CASE8R.D10
FILE: OUTPUT DATA FILE:     C:\HELP3\MDATA\CASE8R30.OUT


TIME:  13:42     DATE:   4/18/2019


******************************************************************************

     TITLE:  CITY OF KINGSVILLE SOLID WASTE LANDFILL-CASE 8 (LOCATION 4)

******************************************************************************


     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
            COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                              LAYER  1
                              --------

                   TYPE 1 - VERTICAL PERCOLATION LAYER
                       MATERIAL TEXTURE NUMBER  13
         THICKNESS                  =     24.00   INCHES
         POROSITY                   =      0.4300 VOL/VOL
         FIELD CAPACITY             =      0.3210 VOL/VOL
         WILTING POINT              =      0.2210
         INITIAL SOIL WATER         =      VOL/VOL 0.2733
         CONTENT EFFECTIVE SAT.     =  0.33000000000E-04 CM/SEC
      NOTED. CONDURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  4.63
                FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.


                              LAYER  2
                              --------

                     TYPE 2 - LATERAL DRAINAGE LAYER
                       MATERIAL TEXTURE NUMBER  20
         THICKNESS                  =      0.20   INCHES
```

CASE8R30.OU

```
POROSITY                      =      T 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.     =    10.0000000000      CM/SEC
SLOPE                         =        2.00    PERCENT
DRAINAGE LENGTH               =      500.0     FEET


                        LAYER  3
                        --------

               TYPE 4 - FLEXIBLE MEMBRANE
              LINER MATERIAL TEXTURE NUMBER
THICKNESS                    36         0.04    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.     =  0.399999993000E-12 CM/SEC
FML PINHOLE DENSITY           =        1.00    HOLES/ACRE
FML INSTALLATION DEFECTS      =        2.00    HOLES/ACRE
FML PLACEMENT QUALITY         =  3 - GOOD


                        LAYER  4
                        --------

              TYPE  3  -  BARRIER  SOIL
              LINER  MATERIAL  TEXTURE
THICKNESS     NUMBER  17      =        0.24    INCHES
POROSITY                      =        0.7500 VOL/VOL
FIELD CAPACITY                =        0.7470 VOL/VOL
WILTING POINT                 =        0.4000 VOL/VOL
INITIAL SOIL WATER            =        0.7500 VOL/VOL
CONTENT EFFECTIVE SAT.        =  0.300000003000E-08 CM/SEC
HYD. COND.


                        LAYER  5
                        --------

             TYPE 1 - VERTICAL PERCOLATION
            LAYER MATERIAL TEXTURE NUMBER  13
THICKNESS                     =       12.00    INCHES
POROSITY                      =        0.4300 VOL/VOL
FIELD CAPACITY                =        0.3210 VOL/VOL
WILTING POINT                 =        0.2210 VOL/VOL
INITIAL SOIL WATER            =        0.3210 VOL/VOL
CONTENT EFFECTIVE SAT.        =  0.330000003000E-04 CM/SEC
HYD. COND.


                        LAYER  6
                        --------

             TYPE 1 - VERTICAL PERCOLATION
            LAYER MATERIAL TEXTURE NUMBER  18
THICKNESS                     =     1930.00    INCHES
POROSITY FIELD                =        0.6710 VOL/VOL
CAPACITY                      =        0.2920 VOL/VOL
```

```
WILTING POINT                =      0.0770 VOL/VOL
INITIAL SOIL WATER           =      0.2920 VOL/VOL
CONTENT EFFECTIVE SAT.       =  0.100000005000E-02 CM/SEC
HYD. COND.


                    LAYER  7
                    --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
             MATERIAL TEXTURE NUMBER  13
THICKNESS                    =     24.00    INCHES
POROSITY                     =      0.4300 VOL/VOL
FIELD CAPACITY               =      0.3210 VOL/VOL
WILTING POINT                =        0.2210 VOL/VOL
INITIAL SOIL WATER CONTENT   =        0.3210 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.330000003000E-04 CM/SEC


                    LAYER  8
                    --------

              TYPE 2 - LATERAL DRAINAGE
             LAYER MATERIAL TEXTURE NUMBER
THICKNESS                  20=      0.20    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.    =   10.0000000000     CM/SEC
SLOPE                        =      2.00    PERCENT
DRAINAGE LENGTH              =    500.0     FEET


                    LAYER  9
                    --------

            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           =        0.0000 VOL/VOL
CONTENT EFFECTIVE SAT.       =  0.199999996000E-12 CM/SEC
HYD. COND. FML PINHOLE       =      1.00    HOLES/ACRE
DENSITY                      =      2.00    HOLES/ACRE
FML INSTALLATION DEFECTS     =  3 - GOOD
FML PLACEMENT QUALITY


                    LAYER 10
                    --------

              TYPE 3 - BARRIER SOIL LINER
             MATERIAL TEXTURE NUMBER  17
THICKNESS                    =      0.24    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
```

CASE8R30.OUT

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 #13 WITH A GOOD STAND OF GRASS, A SURFACE SLOPE OF 4.% AND A SLOPE LENGTH OF 600. FEET.

| | | | |
|---|---|---|---|
| SCS RUNOFF CURVE NUMBER | = | 83.40 | |
| FRACTION OF AREA ALLOWING RUNOFF | = | 100.0 | PERCENT |
| AREA PROJECTED ON HORIZONTAL PLANE | = | 1.000 | ACRES |
| EVAPORATIVE ZONE DEPTH | = | 12.0 | INCHES |
| INITIAL WATER IN EVAPORATIVE ZONE | = | 2.708 | INCHES |
| UPPER LIMIT OF EVAPORATIVE STORAGE | = | 5.160 | INCHES |
| LOWER LIMIT OF EVAPORATIVE STORAGE | = | 2.652 | INCHES |
| INITIAL SNOW WATER | = | 0.000 | INCHES |
| INITIAL WATER IN LAYER MATERIALS | = | 582.040 | INCHES |
| TOTAL INITIAL WATER | = | 582.040 | INCHES |
| TOTAL SUBSURFACE INFLOW | = | 0.00 | INCHES/YEAR |

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM CORPUS CHRISTI TEXAS

| | | |
|---|---|---|
| STATION LATITUDE | = | 27.77 DEGREES |
| MAXIMUM LEAF AREA INDEX | = | 3.50 |
| START OF GROWING SEASON (JULIAN DATE) | = | 0 |
| END OF GROWING SEASON (JULIAN DATE) | = | 367 |
| EVAPORATIVE ZONE DEPTH | = | 12.0 INCHES |
| AVERAGE ANNUAL WIND SPEED | = | 12.00 MPH |
| AVERAGE 1ST QUARTER RELATIVE HUMIDITY | = | 76.00 % |
| AVERAGE 2ND QUARTER RELATIVE HUMIDITY | = | 78.00 % |
| AVERAGE 3RD QUARTER RELATIVE HUMIDITY | = | 76.00 % |
| AVERAGE 4TH QUARTER RELATIVE HUMIDITY | = | 76.00 % |

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR CORPUS CHRISTI TEXAS

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

| JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|
| 1.63 | 1.69 | 1.20 | 1.57 | 3.29 | 3.12 |
| 2.26 | 2.78 | 5.31 | 2.92 | 1.61 | 1.17 |

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR CORPUS CHRISTI TEXAS

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

| JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|

CASE8R30.OUT

| | | | | | |
|---|---|---|---|---|---|
| 56.30 | 59.30 | 65.90 | 73.00 | 78.10 | 82.70 |
| 84.90 | 85.00 | 81.50 | 74.00 | 65.00 | 59.10 |

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR CORPUS CHRISTI TEXAS
AND STATION LATITUDE = 27.77 DEGREES

*******************************************************************************

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 30

| | JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|---|
| **PRECIPITATION** | | | | | | |
| TOTALS | 1.37 | 1.81 | 1.19 | 1.40 | 2.51 | 2.59 |
| | 2.36 | 2.86 | 5.39 | 2.99 | 1.49 | 1.25 |
| STD. DEVIATIONS | 0.81 | 1.21 | 0.57 | 1.05 | 1.80 | 1.82 |
| | 2.23 | 2.36 | 2.96 | 1.90 | 1.16 | 0.84 |
| **RUNOFF** | | | | | | |
| TOTALS | 0.003 | 0.011 | 0.003 | 0.043 | 0.154 | 0.117 |
| | 0.320 | 0.167 | 0.536 | 0.138 | 0.039 | 0.002 |
| STD. DEVIATIONS | 0.012 | 0.024 | 0.015 | 0.167 | 0.494 | 0.168 |
| | 0.765 | 0.317 | 0.853 | 0.285 | 0.166 | 0.012 |
| **EVAPOTRANSPIRATION** | | | | | | |
| TOTALS | 1.075 | 1.755 | 1.316 | 1.246 | 1.943 | 2.036 |
| | 1.740 | 2.149 | 3.445 | 2.375 | 1.304 | 1.111 |
| STD. DEVIATIONS | 0.680 | 0.890 | 0.616 | 0. 799 | 1.174 | 1.212 |
| | 1.225 | 1.476 | 1.225 | 1.098 | 0.904 | 0.695 |
| **LATERAL DRAINAGE COLLECTED FROM LAYER 2** | | | | | | |
| TOTALS | 0.0871 | 0.2477 | 0.1143 | 0.0601 | 0.2280 | 0.4259 |
| | 0.3740 | 0.4325 | 0.9802 | 0.8286 | 0.2979 | 0.0849 |
| STD. DEVIATIONS | 0.1585 | 0.3090 | 0.1186 | 0.1609 | 0.3250 | 0.5887 |
| | 0.6004 | 0.6575 | 0.9888 | 0.8731 | 0.4168 | 0.1196 |
| **PERCOLATION/LEAKAGE THROUGH LAYER 4** | | | | | | |
| 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 |
| **LATERAL DRAINAGE COLLECTED FROM 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 |

CASE8R30.OUT

```
                              0.00000000   0.0000   0.0000   0.0000   0.0000

 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
 3
   AVERAGES                 0.0012   0.0039   0.0016   0.0009   0.0104   0.0748
                            0.0679   0.0824   0.3707   0.2120   0.0248   0.0012

   STD. DEVIATIONS          0.0023   0.0048   0.0017   0.0024   0.0323   0. 2328
                            0.2719   0.2347   0.7766   0.4906   0.1168   0.0017

 DAILY AVERAGE HEAD ON TOP OF LAYER  9

   AVERAGES                 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

*******************************************************************************


*******************************************************************************

    AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS   1 THROUGH   30
-------------------------------------------------------------------------------
                                 INCHES           CU. FEET     PERCENT
                            ----------------   ------------   ---------
 PRECIPITATION               27.20    (  5.704)    98722.7     100.00

 RUNOFF                       1.533   ( 1.1930)     5565.96      5.638

 EVAPOTRANSPIRATION LATERAL  21.495   ( 3.7381)    78026.06     79.036

 DRAINAGE COLLECTED           4.16123 ( 2.10988)   15105.281    15.30072
   FROM LAYER  2

 PERCOLATION/LEAKAGE THROUGH  0.00002 ( 0.00003)       0.083     0.00008
   LAYER  4

 AVERAGE HEAD ON TOP          0.071 (   0.104)
   OF LAYER  3

 LATERAL DRAINAGE COLLECTED   0.00002 ( 0.00003)       0.079    0.00008
   FROM LAYER  8

 PERCOLATION/LEAKAGE THROUGH  0.00000 ( 0.00000)       0.004     0.00000
   LAYER 10

 AVERAGE HEAD ON TOP          0.000 (   0.000)
   OF LAYER  9

 CHANGE IN WATER STORAGE      0.007   ( 0.4342)       25.30      0.026
```

CASE8R30.OUT

*******************************************************************************

*******************************************************************************

PEAK DAILY VALUES FOR YEARS 1 THROUGH 30

| | (INCHES) | (CU. FT.) |
|---|---|---|
| PRECIPITATION | 5.07 | 18404.102 |
| RUNOFF | 2.585 | 9382.0947 |
| DRAINAGE COLLECTED FROM LAYER 2 | 0.45365 | 1646.74548 |
| PERCOLATION/LEAKAGE THROUGH LAYER 4 | 0.000023 | 0.08285 |
| AVERAGE HEAD ON TOP OF LAYER 3 | 22.774 | |
| MAXIMUM HEAD ON TOP OF LAYER 3 | 31.078 | |
| LOCATION OF MAXIMUM HEAD IN LAYER 2 (DISTANCE FROM DRAIN) | 158.7 FEET | |
| DRAINAGE COLLECTED FROM LAYER 8 | 0.00002 | 0.07933 |
| PERCOLATION/LEAKAGE THROUGH LAYER 10 | 0.000000 | 0.00002 |
| AVERAGE HEAD ON TOP OF LAYER 9 | 0.000 | |
| MAXIMUM HEAD ON TOP OF LAYER 9 | 0.000 | |
| LOCATION OF MAXIMUM HEAD IN LAYER 8 (DISTANCE FROM DRAIN) | 0.0 FEET | |
| SNOW WATER | 0.02 | 73.7433 |

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.4300

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.2210

*** 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 30

| LAYER | (INCHES) | (VOL/VOL) |
|---|---|---|
| 1 | 6.7694 | 0.2821 |

| | | |
|---|---|---|
| 2 | 0.0020 | 0.0100 |
| 3 | 0.0000 | 0.0000 |
| 4 | 0.1800 | 0.7500 |
| 5 | 3.8520 | 0.3210 |
| 6 | 563.5601 | 0.2920 |
| 7 | 7.7040 | 0.3210 |
| 8 | 0.0020 | 0.0100 |
| 9 | 0.0000 | 0.0000 |
| 10 | 0.1800 | 0.7500 |
| SNOW WATER | 0.000 | |

******************************************************************************
*
******************************************************************************

# APPENDIX C

# MULTIMED MODEL ANALYSIS

# APPENDIX C.3

# MULTIMED SOURCE-SPECIFIC DATA

**MULTIMED SOURCE - SPECIFIC DATA**

| Variable Name | Units | Value | Comments |
|---|---|---|---|
| Infiltration rate | m/yr | varies | See table below. |
| Area of waste disposal unit | $m^2$ | 485,623 | 120 acres |
| Spread of contaminant source | m | 0 | Derived by MULTIMED |
| Recharge rate | m/yr | 0.0368 | Five percent of average annual precipitation (1.45 inches/yr) |
| Initial concentration at landfill ($C_0$) | mg/L | 1.0 | Set at 1.0 to find DAF |
| Length scale of facility | m | | Derived by MULTIMED |
| Width scale of facility | m | | Derived by MULTIMED |

| Case | Infiltration Rate (m/yr) | Comments |
|---|---|---|
| Interim cases with Alternative Liner | | |
| • 58.80~~57.5~~ feet of waste (Case 1) 20 yr | *$1.28 \times 10^{-7}$ | Calculated using peak daily percolation/ leakage rate through GCL. See Appx. B.2 |
| • 143.96~~140~~ feet of waste (Case 2) 20 yr | $1.79 \times 10^{-7}$ | Calculated using peak daily percolation/ leakage rate through GCL. See Appx. B.2 |
| • 153.83~~148~~ feet of waste (Case 3) 20 yr | $1.79 \times 10^{-7}$ | Calculated using peak daily percolation/ leakage rate through GCL. See Appx. B.2 |
| • 160.83~~162~~ feet of waste (Case 4) 20 yr | $1.79 \times 10^{-7}$ | Calculated using peak daily percolation/ leakage rate through GCL. See Appx. B.2 |
| Closed cases with Alternative Liner | | |
| • 58.80~~57.5~~ feet of waste (Case 5) 30 yr | $5.11 \times 10^{-8}$ | Calculated using peak daily percolation/ leakage rate through GCL. See Appx. B.2 |
| • 143.96~~140~~ feet of waste (Case 6) 30 yr | $5.11 \times 10^{-8}$ | Calculated using peak daily percolation/ leakage rate through GCL. See Appx. B.2 |
| • 153.83~~148~~ feet of waste (Case 7) 30 yr | $5.11 \times 10^{-8}$ | Calculated using peak daily percolation/ leakage rate through GCL. See Appx. B.2 |
| • 160.83~~162~~ feet of waste (Case 8) 30 yr | $5.11 \times 10^{-8}$ | Calculated using peak daily percolation/ leakage rate through GCL. See Appx. B.2 |

* Determined Using Peak Daily Percolation/Leakage Rate Through GCL and Converted to (M/YR)
Example: ((.00005 $FT^3$/Day-Acre)x(1 Acre/43,560 $FT^2$)/(1 Meter/3.28 FT)) x (365 Days/1 YR)= $1.28 \times 10^{-7}$ M/YR

# APPENDIX C.4

# MULTIMED SOURCE-SPECIFIC DATA

**MULTIMED SOURCE - SPECIFIC DATA**

**Overliner Demonstration**

| Variable Name | Units | Value | Comments |
|---|---|---|---|
| Infiltration rate | m/yr | varies | See table below. |
| Area of waste disposal unit | $m^2$ | 485,623 | 120 acres |
| Spread of contaminant source | m | 0 | Derived by MULTIMED |
| Recharge rate | m/yr | 0.0368 | Five percent of average annual precipitation (1.45 inches/yr) |
| Initial concentration at landfill ($C_0$) | mg/L | 1.0 | Set at 1.0 to find DAF |
| Length scale of facility | m | | Derived by MULTIMED |
| Width scale of facility | m | | Derived by MULTIMED |

| Case | Infiltration Rate (m/yr) | Comments |
|---|---|---|
| Interim Cases with Overliner | | |
| Location 1 (Case 1OL)<br>• 12 feet of waste above liner<br>• 15.5 feet of waste below liner<br>20 yr | *$1.79 \times 10^{-7}$ | Calculated using peak daily percolation/ leakage rate through GCL. See Appx. B.12 |
| Location 2 (Case 2OL)<br>• 82.5 feet of waste above liner<br>• 34 feet of waste below liner<br>20 yr | $1.53 \times 10^{-7}$ | Calculated using peak daily percolation/ leakage rate through GCL. See Appx. B.12 |
| Location 3 (Case 3OL)<br>• 85.5 feet of waste above liner<br>• 37 feet of waste ~~above~~ below liner<br>20 yr | $1.53 \times 10^{-7}$ | Calculated using peak daily percolation/ leakage rate through GCL. See Appx. B.12 |
| Location 4 (Case 4OL)<br>• 119.5 feet of waste above liner<br>• 16 feet of waste ~~above~~ below liner<br>20 yr | $1.53 \times 10^{-7}$ | Calculated using peak daily percolation/ leakage rate through GCL. See Appx. B.12 |
| Closed cases with Overliner | | |
| Location 1 (Case 5OL)<br>• 12 feet of waste above liner<br>• 15.5 feet of waste below liner<br>30 yr | $5.11 \times 10^{-8}$ | Calculated using peak daily percolation/ leakage rate through GCL. See Appx. B.12 |
| Location 2 (Case 6OL)<br>• 82.5 feet of waste above liner<br>• 34 feet of waste below liner<br>30 yr | $5.11 \times 10^{-8}$ | Calculated using peak daily percolation/ leakage rate through GCL. See Appx. B.12 |
| Location 3 (Case 7OL)<br>• 85.5 feet of waste above liner<br>• 37 feet of waste below liner<br>30 yr | $5.11 \times 10^{-8}$ | Calculated using peak daily percolation/ leakage rate through GCL. See Appx. B.12 |
| Location 4 (Case 8OL)<br>• 119.5 feet of waste above liner<br>• 16 feet of waste below liner<br>30 yr | $5.11 \times 10^{-8}$ | Calculated using peak daily percolation/ leakage rate through GCL. See Appx. B.12 |

* Determined Using Peak Daily Percolation/Leakage Rate Through GCL and Converted to (M/YR)
Example: ((.00007 $FT^3$/Day-Acre)x(1 Acre/43,560 $FT^2$)/(1 Meter/3.28 FT)) x (365 Days/1 YR)= $1.79 \times 10^{-7}$ M/YR

# APPENDIX C.6

# MULTIMED SOURCE-SPECIFIC DATA

## MULTIMED AQUIFER - SPECIFIC DATA

| Variable Name | Units | Value | Comments |
|---|---|---|---|
| Particle Diameter* | cm | 0.0381 | From Permit 235-B Amendment Volume II of V Pages 36-39 (PDF)-1998 Reference Appendix C.7.2 Material ranges from fine to coarse. Use an average for medium sand (0.010-0.020 in); 0.015 in or 0.0381 cm |
| Aquifer porosity* | unitless | 0.43 | From Permit 235-B Amendment Volume V of V Pages 467-473 (PDF)-1998 Reference Appendix C.7.1 |
| Bulk density | g/cc | 1.65 | From Permit 235-B Amendment Volume V of V Pages 467-473 (PDF)-1998 Reference Appendix C.7.1 |
| Aquifer thickness | m | 10 | From Permit 235-B Amendment Volume V of V Pgs. 467-473 (PDF)-1998 Avg depth of uppermost aquifer Reference Appendix C.7.1 |
| Mixing zone depth | m | | Derived by MULTIMED |
| Hydraulic conductivity | m/yr | 130 | From Permit 235-B Amendment Volume V of V Pages 467-473 (PDF)-1998 Reference Appendix C.7.1 Average hydraulic conductivity of $4.12 \times 10^{-4}$ cm/sec |
| Hydraulic gradient | unitless | 0.0031 | From Groundwater Contour Map (January 2016) |
| Groundwater seepage velocity | m/yr | | Derived by MULTIMED |
| Retardation coefficient | unitless | | Derived by MULTIMED |
| Longitudinal dispersivity | m | | Derived by MULTIMED |
| Transveral dispersivity | m | | Derived by MULTIMED |
| Vertical dispersivity | m | | Derived by MULTIMED |
| Organic carbon content | % | 0.003 | From Permit 235-B Amendment Volume V of V Pages 467-473 (PDF)-1998 Reference Appendix C.7.1 |
| Receptor distance from well | m | Varies | Distance from analysis location to point of compliance. |
| Z-distance from water table | m | 0 | Assume water table is at bottom of liner. |

~~Note: According to Amendment Application (1998) the Evangeline Aquifer is the principal aquifer in the region and is considered one of the most prolific aquifers in the Texas Coastal Plain. The aquifer is composed of at least the Goliad Sand and includes sections of sand in the Fleming Formation. The Goliad consists of fine to coarse, mostly gray calcareous sand interbedded with sandstone and varicolored clay.~~
~~(assume medium sand (0.015 in) particle diamter or (0.0381 cm)~~

*** If Aquifer porosity is known MULTIMED will not use particle diameter.**

# APPENDIX C.7

# MULTIMED SOURCE-SPECIFIC DATA

## MULTIMED AQUIFER - SPECIFIC DATA

### Overliner Demonstration

| Variable Name | Units | Value | Comments |
|---|---|---|---|
| Particle Diameter* | cm | 0.0381 | From Permit 235-B Amendment Volume II of V Pages 36-39 (PDF)-1998 Reference Appendix C.7.2 Material ranges from fine to coarse. Use an average for medium sand (0.010-0.020 in); 0.015 in or 0.0381 cm |
| Aquifer porosity* | unitless | 0.43 | From Permit 235-B Amendment Volume V of V Pages 467-473 (PDF)-1998 Reference Appendix C.7.1 |
| Bulk density | g/cc | 1.65 | From Permit 235-B Amendment Volume V of V Pages 467-473 (PDF)-1998 Reference Appendix C.7.1 |
| Aquifer thickness | m | 10 | From Permit 235-B Amendment Volume V of V Pgs. 467-473 (PDF)-1998 Avg depth of uppermost aquifer Reference Appendix C.7.1 |
| Mixing zone depth | m | | Derived by MULTIMED |
| Hydraulic conductivity | m/yr | 130 | From Permit 235-B Amendment Volume V of V Pages 467-473 (PDF)-1998 Reference Appendix C.7.1 Average hydraulic conductivity of 4.12 x $10^{-4}$ cm/sec |
| Hydraulic gradient | unitless | 0.002 | From Groundwater Contour Map (January 2016) |
| Groundwater seepage velocity | m/yr | | Derived by MULTIMED |
| Retardation coefficient | unitless | | Derived by MULTIMED |
| Longitudinal dispersivity | m | | Derived by MULTIMED |
| Transveral dispersivity | m | | Derived by MULTIMED |
| Vertical dispersivity | m | | Derived by MULTIMED |
| Organic carbon content | % | 0.003 | From Permit 235-B Amendment Volume V of V Pages 467-473 (PDF)-1998 Reference Appendix C.7.1 |
| Receptor distance from well | m | Varies | Distance from analysis location to point of compliance. |
| Z-distance from water table | m | 0 | Assume water table is at bottom of liner. |

~~Note: According to Amendment Application (1998) the Evangeline Aquifer is the principal aquifer in the region and is considered one of the most prolific aquifers in the Texas Coastal Plain. The aquifer is composed of at least the Goliad Sand and includes sections of sand in the Fleming Formation. The Goliad consists of fine to coarse, mostly gray calcareous sand interbedded with sandstone and varicolored clay. (assume medium sand (0.015 in) particle diamter or (0.0381 cm)~~

*** If Aquifer porosity is known MULTIMED will not use particle diameter.**

# APPENDIX D

# CALCULATIONS OF THE DILUTION ATTENUATION FACTOR (DAF)

## CALCULATIONS OF THE DILUTION ATTENUATION FACTOR

### Example Calculation for the Interim Case with Alternative Liner

Result from MULTIMED model:

Chemical concentration at the point of compliance = 0.2449 X $10^{-4}$ ~~0.2943 X $10^{-4}$~~ mg/l
**(see MULTIMED model output)**

To find the resulting DAF, take the recipricol:

DAF= 1/ 0.2449 X $10^{-4}$ ~~0.2943 x $10^{-4}$~~ mg/1
**DAF= 40,833 ~~33,979~~**

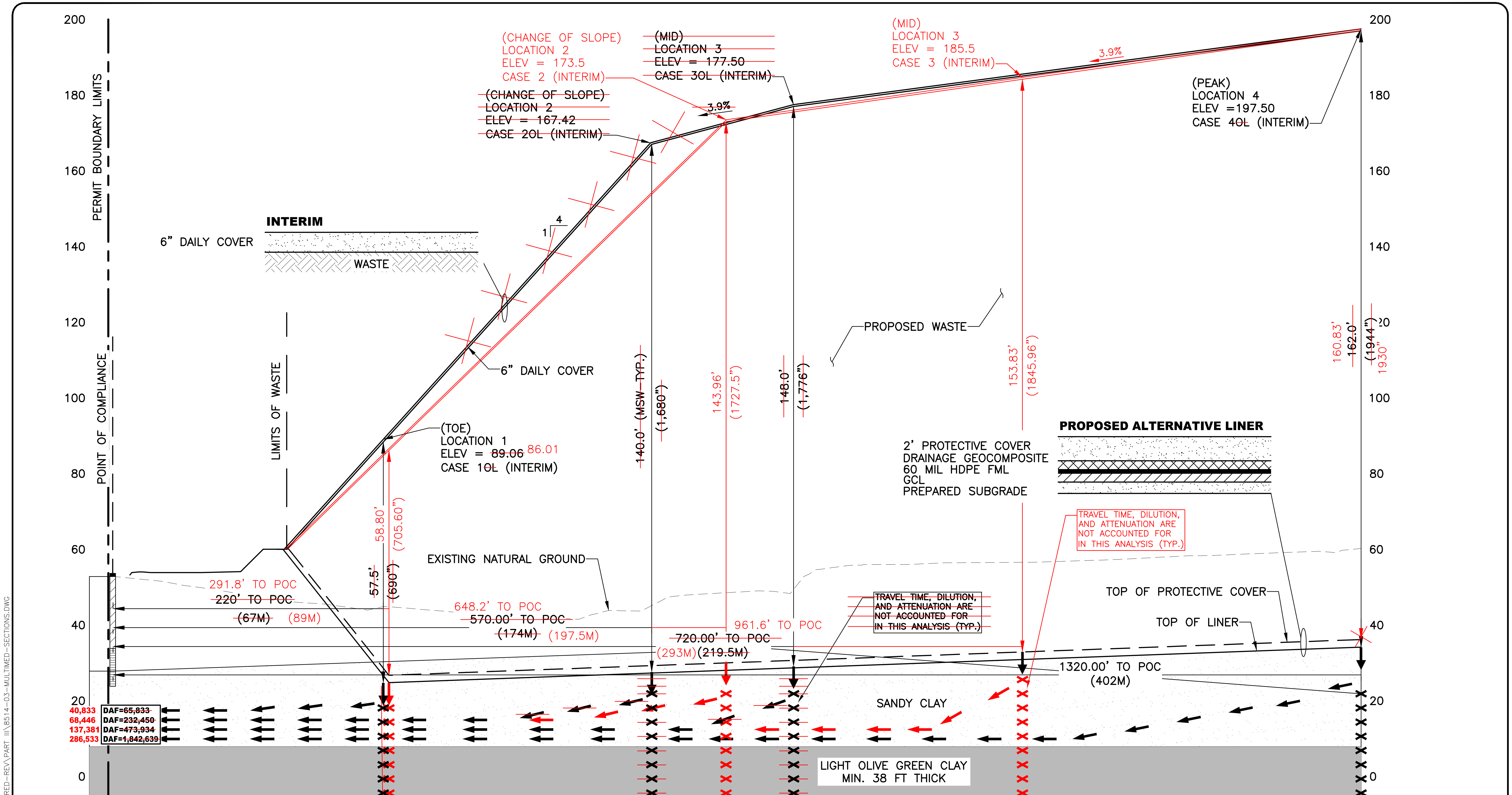
**Table 1**

| Location | Interim Case DAF | Closed Case DAF |
|---|---|---|
| Alternative Liner Location 1 | 40,833 ~~33,979~~ | 102,301 ~~85,106~~ |
| Alternative Liner Location 2 | 68,446 ~~57,471~~ | 239,750 ~~201,288~~ |
| Alternative Liner Location 3 | 137,381 ~~80,645~~ | 481,231 ~~282,566~~ |
| Alternative Liner Location 4 | 286,533 | 1,003,814 |

| Location | Interim Case DAF | Closed Case DAF |
|---|---|---|
| Overliner Location 1 | 18,797 | 65,833 |
| Overliner Location 2 | 77,640 | 232,450 |
| Overliner Location 3 | 158,253 | 473,934 |
| Overliner Location 4 | 615,385 | 1,842,639 |

# APPENDIX D.1

# TYPICAL PROFILE-ALTERNATIVE LINER INTERIM LANDFILL DAF




ALTERNATIVE LINER DEMONSTRATION – INTERIM LANDFILL CONDITION

1. USE HELP TO MODEL PERCOLATION THROUGH THE ALTERNATIVE LINER.
2. USE MULTIMED TO CALCULATE THE DILUTION ATTENUATION FACTOR (DAF).

**MULTIMED INFORMATION**

AVERAGE AQUIFER THICKNESS = 32.81FT (10M)
HYDRAULIC CONDUCTIVITY = $4.12 \times 10^{-4}$ CM/SEC OR 130 M/YR
HYDRAULIC GRADIENT = i = 0.003125

NOTES:

1. EVANGELINE AQUIFER (500 FT BELOW GROUND SURFACE) (FRESH)
2. CHICOT AQUIFER (220 FT BELOW GROUND SURFACE)

| NUMBER | REVISION | DATE | DRAWN | DESIGNED | REVIEWED |
|---|---|---|---|---|---|

STATE OF TEXAS
JOSE C. GARZA
91790
LICENSED PROFESSIONAL ENGINEER
04/23/19
Jose C. Garza, P.E.

| | |
|---|---|
| Hanson No. | 16L0438 |
| Filename | |
| Scale | AS SHOWN |
| Date | 04/23/2019 |

| | | |
|---|---|---|
| LAYOUT | DT | 04/23/2019 |
| DRAWN | DT | 04/23/2019 |
| REVIEWED | JCG | 04/23/2019 |

HANSON


Hanson Professional Services Inc.
4501 Gollihar Rd.
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TBAE F-BR 2458

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(800) 677-2831
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Offices Nationwide

PART III, ATTACHMENT 5, APPENDIX D
TYPICAL PROFILE-ALTERNATIVE LINER
INTERIM LANDFILL DAF
CITY OF KINGSVILLE LANDFILL
MSW PERMIT No. 235-C
KINGSVILLE, TEXAS
KLEBERG COUNTY, TEXAS

FIGURE:
III.5-D.1

APR 24, 2019 1:35 PM TORRE01809
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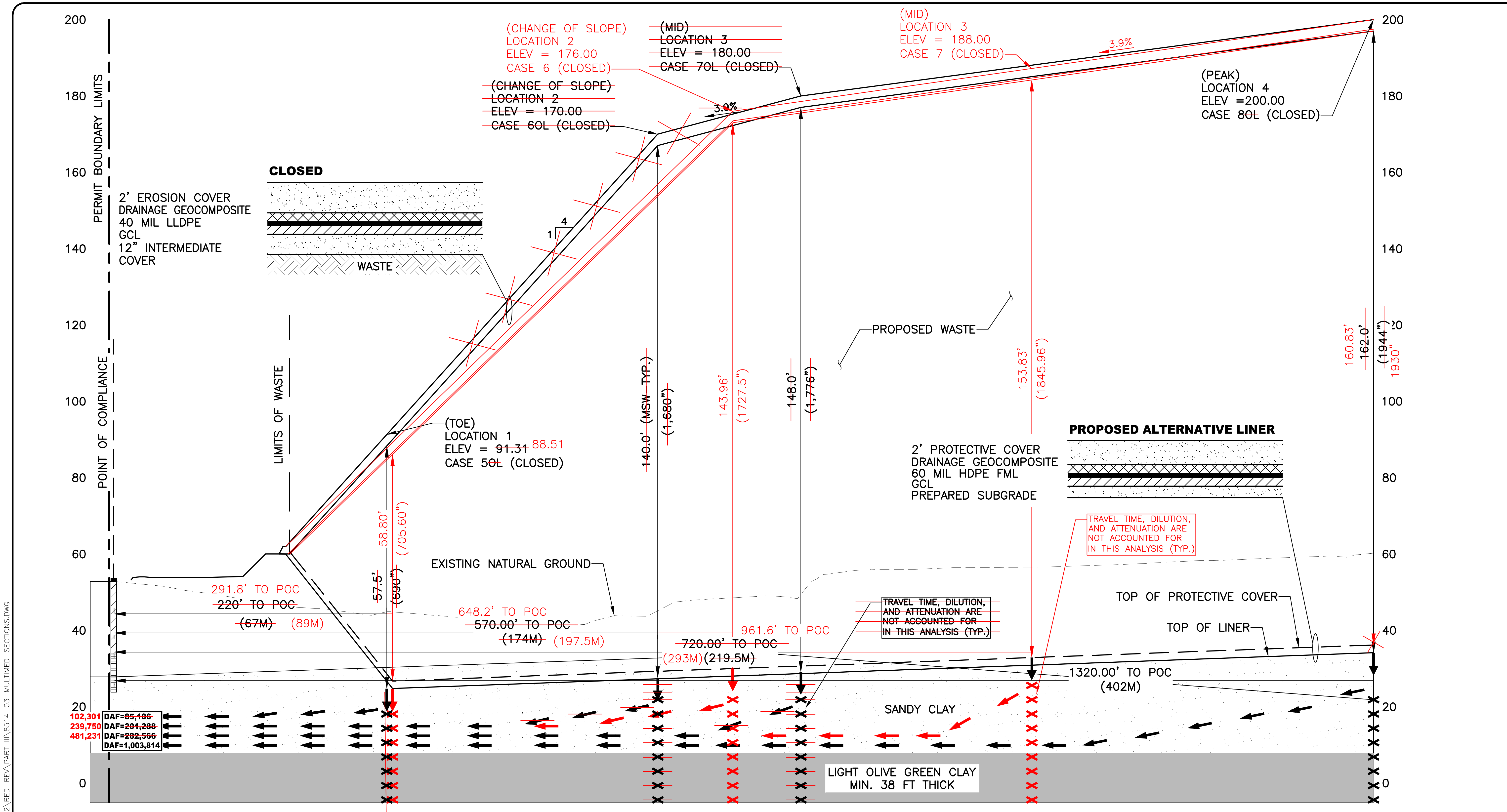
# APPENDIX D.2

# TYPICAL PROFILE-ALTERNATIVE LINER CLOSED LANDFILL DAF




ALTERNATIVE LINER DEMONSTRATION – CLOSED LANDFILL CONDITION

1. USE HELP TO MODEL PERCOLATION THROUGH THE ALTERNATIVE LINER.
2. USE MULTIMED TO CALCULATE THE DILUTION ATTENUATION FACTOR (DAF).

| MULTIMED INFORMATION |
|---|
| AVERAGE AQUIFER THICKNESS = 32.81FT (10M) |
| HYDRAULIC CONDUCTIVITY = $4.12 \times 10^{-4}$ CM/SEC OR 130 M/YR |
| HYDRAULIC GRADIENT = i = 0.003125 |

NOTES:

1. EVANGELINE AQUIFER (500 FT BELOW GROUND SURFACE) (FRESH)
2. CHICOT AQUIFER (220 FT BELOW GROUND SURFACE)

| NUMBER | REVISION | DATE | DRAWN | DESIGNED | REVIEWED |
|---|---|---|---|---|---|
| | | | | | |

STATE OF TEXAS
JOSE C. GARZA
91790
LICENSED PROFESSIONAL ENGINEER
04/23/19
Jose C. Garza, P.E.

Hanson No. 16L0438
Filename
Scale AS SHOWN
Date 04/23/2019

| LAYOUT | DT | 04/23/2019 |
|---|---|---|
| DRAWN | DT | 04/23/2019 |
| REVIEWED | JCG | 04/23/2019 |

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PART III, ATTACHMENT 5, APPENDIX D
TYPICAL PROFILE-ALTERNATIVE LINER
CLOSED LANDFILL DAF
CITY OF KINGSVILLE LANDFILL
MSW PERMIT No. 235-C
KINGSVILLE, TEXAS
KLEBERG COUNTY, TEXAS

FIGURE:
III.5-D.2

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# APPENDIX F

# MULTIMED MODEL OUTPUT

# APPENDIX F.1

# MULTIMED OUTPUT FOR ALTERNATIVE LINER INTERIM CASE 1-LOCATION 1

CASE1R

1

U. S. ENVIRONMENTAL PROTECTION AGENCY

EXPOSURE ASSESSMENT

MULTIMEDIA MODEL

MULTIMED (Version 1.01, June 1991)

1

Run options

--- -------

Case 1

Location 1

Chemical simulated is DEFAULT CHEMICAL

| | |
|---|---|
| Option | Saturated zone |
| Chosen Run | model DETERMIN |

Infiltration input by user

Run was steady-state

Reject runs if Y coordinate outside plume

Reject runs if Z coordinate outside plume

Gaussian source used in saturated zone model

1

1

CHEMICAL SPECIFIC VARIABLES

| VARIABLE NAME | UNITS | DISTRIBUTION | PARAMETERS MEAN | STD DEV | LIMITS MIN | MAX |
|---|---|---|---|---|---|---|
| Solid phase decay coefficient Dissolved | 1/yr | CONSTANT | 0.000E+00 | | 0.000E+00 | 0.100E+11 |
| phase decay coefficient Overall | 1/yr | CONSTANT | -999. | 0.000E+00 | 0.000E+00 | 0.100E+11 |
| chemical decay coefficient Acid | 1/yr | CONSTANT | -999.0.000E+00 | -999. | 0.000E+00 | 0.100E+11 |
| catalyzed hydrolysis rate | 1/M-yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Neutral hydrolysis rate constant | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Base catalyzed hydrolysis rate | 1/M-yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Reference temperature | C | CONSTANT | 20.0 | -999. | 0.000E+00 | 100. |
| Normalized distribution coefficient | ml/g | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Distribution coefficient Biodegradation | -- | DERIVED | -999. | -999. | 0.000E+00 | 0.100E+11 |
| coefficient (sat. zone) Air diffusion | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| coefficient | cm2/s | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 10.0 |
| Reference temperature for air diffusion | C | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 100. |
| Molecular weight | g/M | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Mole fraction of solute | -- | CONSTANT | 0.000E+00 | -999. | 0.100E-08 | 1.00 |
| Vapor pressure of solute | mm Hg | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 100. |
| Henry`s law constant | atm-m^3/M | CONSTANT | 0.000E+00 | -999. | 0.100E-09 | 1.00 |

Page 1

CASE1R

| | | | | | | |
|---|---|---|---|---|---|---|
| Overall 1st order decay sat. zone | 1/yr | DERIVED | 0.000E+00 | 0.000E+00 | 0.000E+00 | 1.00 |
| Not currently used | | CONSTANT | -999. | -999. | 0.000E+00 | 1.00 |
| Not currently used | | CONSTANT | -999. | -999. | 0.000E+00 | 1.00 |

1

SOURCE SPECIFIC VARIABLES

| VARIABLE NAME | UNITS | DISTRIBUTION | PARAMETERS MEAN | STD DEV | LIMITS MIN | MAX |
|---|---|---|---|---|---|---|
| Infiltration rate | m/yr | CONSTANT | 0.128E-06 | -999. | 0.100E-09 | 0.100E+11 |
| Area of waste disposal unit | m^2 | CONSTANT | 0.486E+06 | -999. | 0.100E-01 | -999. |
| Duration of pulse | yr | CONSTANT | -999. | -999. | 0.100E-08 | -999. |
| Spread of contaminant source | m | DERIVED | -999. | -999. | 0.100E-08 | 0.100E+11 |
| Recharge rate | m/yr | CONSTANT | 0.368E-01 | -999. | 0.000E+00 | 0.100E+11 |
| Source decay constant | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Initial concentration at landfill | mg/l | CONSTANT | 1.00 | -999. | 0.000E+00 | -999. |
| Length scale of facility | m | DERIVED | -999. | -999. | 0.100E-08 | 0.100E+11 |
| Width scale of facility | m | DERIVED | -999. | -999. | 0.100E-08 | 0.100E+11 |
| Near field dilution | | DERIVED | 1.00 | 0.000E+00 | 0.000E+00 | 1.00 |

1

AQUIFER SPECIFIC VARIABLES

| VARIABLE NAME | UNITS | DISTRIBUTION | PARAMETERS MEAN | STD DEV | LIMITS MIN | MAX |
|---|---|---|---|---|---|---|
| Particle diameter | cm | CONSTANT | 0.381E-01 | -999. | 0.100E-08 | 100. |
| Aquifer porosity | -- | CONSTANT | 0.430 -999. | 1.65 | 0.100E-08 | 0.990 |
| Bulk density | g/cc | CONSTANT | -999. 10.0 | -999. | 0.100E-01 | 5.00 |
| Aquifer thickness | m | CONSTANT | | | 0.100E-08 | 0.100E+06 |
| Source thickness (mixing zone depth) | m | DERIVED | -999. | -999. | 0.100E-08 | 0.100E+06 |
| Conductivity (hydraulic) | m/yr | CONSTANT | 130. | -999. | 0.100E-06 | 0.100E+09 |
| Gradient (hydraulic) | | CONSTANT | 0.310E-02 | -999. | 0.100E-07 | -999. |
| Groundwater seepage velocity | m/yr | DERIVED | -999. | -999. | 0.100E-09 | 0.100E+09 |
| Retardation coefficient | -- | DERIVED | -999. | -999. | 1.00 | 0.100E+09 |
| Longitudinal dispersivity | m | FUNCTION OF X | -999. | -999. | -999. | -999. |
| Transverse dispersivity | m | FUNCTION OF X | -999. | -999. | -999. | -999. |
| Vertical dispersivity | m | FUNCTION OF X | -999. -999. | 21.0 | -999. | -999. |
| Temperature of aquifer | C | CONSTANT | -999. 7.20 | | 0.000E+00 0 | 100. |
| pH | -- | CONSTANT | -999. | 0.300E-02 | .300 | 14.0 |
| Organic carbon content (fraction) | | CONSTANT | -999. 89.0 | | 0.100E-05 1 | 1.00 |
| Well distance from site | m | CONSTANT | -999. | 0.000E+00 | .00 | -999. |
| Angle off center | degree | CONSTANT | -999. | | 0.000E+00 0 | 360. |
| Well vertical distance | m | CONSTANT | 0.000E+00 | -999. | .000E+00 | 1.00 |

CONCENTRATION AFTER SATURATED ZONE MODEL 0.2449E-04

# APPENDIX F.2

# MULTIMED OUTPUT FOR ALTERNATIVE LINER INTERIM CASE 2-LOCATION 2

FOR PERMIT PURPOSES ONLY

CASE2R

1

U.S. ENVIRONMENTAL PROTECTION AGENCY

EXPOSURE ASSESSMENT

MULTIMEDIA MODEL

MULTIMED (Version 1.01, June 1991)

1

Run options

--- -------

Case 2

Location 2
Chemical simulated is DEFAULT
CHEMICAL

Option Chosen Saturated zone model
Run was DETERMIN
Infiltration input by user
Run was steady-state
Reject runs if Y coordinate outside plume
Reject runs if Z coordinate outside plume
Gaussian source used in saturated zone model
1
1

CHEMICAL SPECIFIC VARIABLES

| VARIABLE NAME | UNITS | DISTRIBUTION | PARAMETERS MEAN | PARAMETERS STD DEV | LIMITS MIN | LIMITS MAX |
|---|---|---|---|---|---|---|
| Solid phase decay coefficient | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 0.100E+11 |
| Dissolved phase decay coefficient | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 0.100E+11 |
| Overall chemical decay coefficient | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 0.100E+11 |
| Acid catalyzed hydrolysis rate | 1/M-yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Neutral hydrolysis rate constant | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Base catalyzed hydrolysis rate | 1/Myr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Reference temperature | C | CONSTANT | 20.0 | -999. | 0.000E+00 | 100. |
| Normalized distribution coefficient | ml/g | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Distribution coefficient | -- | DERIVED | -999. | -999. | 0.000E+00 | 0.100E+11 |
| Biodegradation coefficient (sat. zone) | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Air diffusion coefficient | cm2/s | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 10.0 |
| Reference temperature for air diffusion | C | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 100. |
| Molecular weight | g/M | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Mole fraction of solute | -- | CONSTANT | 0.000E+00 | -999. | 0.100E-08 | 1.00 |
| Vapor pressure of solute | mm Hg | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 100. |
| Henry`s law constant | atm-m^3/M | CONSTANT | 0.000E+00 | -999. | 0.100E-09 | 1.00 |

CASE2R

| | | | | | | |
|---|---|---|---|---|---|---|
| Overall 1st order decay sat. zone | 1/yr | DERIVED | 0.000E+00 | 0.000E+00 | 0.000E+00 | 1.00 |
| Not currently used | | CONSTANT | -999. | -999. | 0.000E+00 | 1.00 |
| Not currently used | | CONSTANT | -999. | -999. | 0.000E+00 | 1.00 |

1

SOURCE SPECIFIC VARIABLES

| VARIABLE NAME | UNITS | DISTRIBUTION | PARAMETERS MEAN | STD DEV | LIMITS MIN | MAX |
|---|---|---|---|---|---|---|
| Infiltration rate | m/yr | CONSTANT | 0.179E-06 | -999. | 0.100E-09 | 0.100E+11 |
| Area of waste disposal unit | m^2 | CONSTANT | 0.486E+06 | -999. | 0.100E-01 | -999. |
| Duration of pulse | yr | CONSTANT | -999. | -999. | 0.100E-08 | -999. |
| Spread of contaminant source | m | DERIVED | -999. | -999. | 0.100E-08 | 0.100E+11 |
| Recharge rate | m/yr | CONSTANT | 0.368E-01 | -999. | 0.000E+00 | 0.100E+11 |
| Source decay constant | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Initial concentration at landfill | mg/l | CONSTANT | 1.00 | -999. | 0.000E+00 | -999. |
| Length scale of facility | m | DERIVED | -999. | -999. | 0.100E-08 | 0.100E+11 |
| Width scale of facility | m | DERIVED | -999. | -999. | 0.100E-08 | 0.100E+11 |
| Near field dilution | | DERIVED | 1.00 | 0.000E+00 | 0.000E+00 | 1.00 |

1

AQUIFER SPECIFIC VARIABLES

| VARIABLE NAME | UNITS | DISTRIBUTION | PARAMETERS MEAN | STD DEV | LIMITS MIN | MAX |
|---|---|---|---|---|---|---|
| Particle diameter | cm | CONSTANT | 0.381E-01 | -999. | 0.100E-08 | 100. |
| Aquifer porosity | -- | CONSTANT | 0.430 | -999. 1.65 | 0.100E-08 | 0.990 |
| Bulk density | g/cc | CONSTANT | -999. 10.0 | -999. | 0.100E-01 | 5.00 |
| Aquifer thickness | m | CONSTANT | | | 0.100E-08 | 0.100E+06 |
| Source thickness (mixing zone depth) | m | DERIVED | -999. | -999. | 0.100E-08 | 0.100E+06 |
| Conductivity (hydraulic) | m/yr | CONSTANT | 130. | -999. | 0.100E-06 | 0.100E+09 |
| Gradient (hydraulic) | | CONSTANT | 0.310E-02 | -999. | 0.100E-07 | -999. |
| Groundwater seepage velocity | m/yr | DERIVED | -999. | -999. | 0.100E-09 | 0.100E+09 |
| Retardation coefficient | -- | DERIVED | | -999. | 1.00 | 0.100E+09 |
| Longitudinal dispersivity | m | FUNCTION OF X | | -999. | -999. | -999. |
| Transverse dispersivity | m | FUNCTION OF X | | -999. | -999. | -999. |
| Vertical dispersivity | m | FUNCTION OF X | 131. | 999. | -999. | -999. |
| Temperature of aquifer | C | CONSTANT | -999. 21.0 | -999. | 0.000E+00 0 | 100. |
| pH | -- | CONSTANT | 7.20 | -999. | .300 | 14.0 |
| Organic carbon content (fraction) | | CONSTANT | 0.300E-02 | -999. | 0.100E-05 1 | 1.00 |
| Well distance from site | m | CONSTANT | 197. | -999. | .00 | -999. |
| Angle off center | degree | CONSTANT | 0.000E+00 | -999. | 0.000E+00 0 | 360. |
| Well vertical distance | m | CONSTANT | 0.000E+00 | -999. | .000E+00 | 1.00 |

CONCENTRATION AFTER SATURATED ZONE MODEL 0.1461E-04

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-999.
-999.

# APPENDIX F.3

# MULTIMED OUTPUT FOR ALTERNATIVE LINER INTERIM CASE 3-LOCATION 3

CASE3 R

1

US. ENVIRONMENTAL PROTECTION AGENCY

EXPOSURE ASSESSMENT

MULTIMEDIA MODEL

MULTIMED (Version 1.01, June 1991)

1

Run options

--- -------

Case 3

Location 3
Chemical simulated is DEFAULT
CHEMICAL

| | |
|---|---|
| Option Chosen | Saturated zone model |
| Run was | DETERMIN |
| Infiltration input by user | |
| Run was steady-state | |
| Reject runs if Y coordinate outside plume | |
| Reject runs if Z coordinate outside plume | |
| Gaussian source used in saturated zone model | |

1
1

CHEMICAL SPECIFIC VARIABLES

| VARIABLE NAME | UNITS | DISTRIBUTION | PARAMETERS MEAN | PARAMETERS STD DEV | LIMITS MIN | LIMITS MAX |
|---|---|---|---|---|---|---|
| Solid phase decay coefficient | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 0.100E+11 |
| Dissolved phase decay coefficient | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 0.100E+11 |
| Overall chemical decay coefficient | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 0.100E+11 |
| Acid catalyzed hydrolysis rate | 1/M-yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Neutral hydrolysis rate constant | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Base catalyzed hydrolysis rate | 1/M-yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Reference temperature | C | CONSTANT | 20.0 | -999. | 0.000E+00 | 100. |
| Normalized distribution coefficient | ml/g | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Distribution coefficient | -- | DERIVED | -999. | -999. | 0.000E+00 | 0.100E+11 |
| Biodegradation coefficient (sat. zone) | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Air diffusion coefficient | cm2/s | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 10.0 |
| Reference temperature for air diffusion | C | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 100. |
| Molecular weight | g/M | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Mole fraction of solute | -- | CONSTANT | 0.000E+00 | -999. | 0.100E-08 | 1.00 |
| Vapor pressure of solute | mm Hg | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 100. |
| Henry`s law constant | atm-m^3/M | CONSTANT | 0.000E+00 | -999. | 0.100E-09 | 1.00 |

Page 1

CASE3R

| | | | | | | |
|---|---|---|---|---|---|---|
| Overall 1st order decay sat. zone | 1/yr | DERIVED | 0.000E+00 | 0.000E+00 | 0.000E+00 | 1.00 |
| Not currently used | | CONSTANT | -999. | -999. | 0.000E+00 | 1.00 |
| Not currently used | | CONSTANT | -999. | -999. | 0.000E+00 | 1.00 |

1

SOURCE SPECIFIC VARIABLES

| VARIABLE NAME | UNITS | DISTRIBUTION | PARAMETERS MEAN | PARAMETERS STD DEV | LIMITS MIN | LIMITS MAX |
|---|---|---|---|---|---|---|
| Infiltration rate | m/yr | CONSTANT | 0.179E-06 | -999. | 0.100E-09 | 0.100E+11 |
| Area of waste disposal unit | m^2 | CONSTANT | 0.486E+06 | -999. | 0.100E-01 | -999. |
| Duration of pulse | yr | CONSTANT | -999. | -999. | 0.100E-08 | -999. |
| Spread of contaminant source | m | DERIVED | -999. | -999. | 0.100E-08 | 0.100E+11 |
| Recharge rate | m/yr | CONSTANT | 0.368E-01 | -999. | 0.000E+00 | 0.100E+11 |
| Source decay constant | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Initial concentration at landfill | mg/l | CONSTANT | 1.00 | -999. | 0.000E+00 | -999. |
| Length scale of facility | m | DERIVED | -999. | -999. | 0.100E-08 | 0.100E+11 |
| Width scale of facility | m | DERIVED | -999. | -999. | 0.100E-08 | 0.100E+11 |
| Near field dilution | | DERIVED | 1.00 | 0.000E+00 | 0.000E+00 | 1.00 |

1

AQUIFER SPECIFIC VARIABLES

| VARIABLE NAME | UNITS | DISTRIBUTION | PARAMETERS MEAN | PARAMETERS STD DEV | LIMITS MIN | LIMITS MAX |
|---|---|---|---|---|---|---|
| Particle diameter | cm | CONSTANT | 0.381E-01 | -999. | 0.100E-08 | 100. |
| Aquifer porosity | -- | CONSTANT | 0.430 | -999. 1.65 | 0.100E-08 | 0.990 |
| Bulk density | g/cc | CONSTANT | -999. | 10.0 -999. | 0.100E-01 | 5.00 |
| Aquifer thickness | m | CONSTANT | | | 0.100E-08 | 0.100E+06 |
| Source thickness (mixing zone depth) | m | DERIVED | -999. | -999. | 0.100E-08 | 0.100E+06 |
| Conductivity (hydraulic) | m/yr | CONSTANT | 130. | -999. | 0.100E-06 | 0.100E+09 |
| Gradient (hydraulic) | | CONSTANT | 0.310E-02 | -999. | 0.100E-07 | -999. |
| Groundwater seepage velocity | m/yr | DERIVED | -999. | -999. | 0.100E-09 | 0.100E+09 |
| Retardation coefficient | -- | DERIVED | -999. | -999. | 1.00 | 0.100E+09 |
| Longitudinal dispersivity | m | FUNCTION OF X | -999. | -999. | -999. | -999. |
| Transverse dispersivity | m | FUNCTION OF X | -999. | -999. | -999. | -999. |
| Vertical dispersivity | m | FUNCTION OF X | -999. | -999. | -999. | -999. |
| Temperature of aquifer | C | CONSTANT | 21.0 | -999. | 0.000E+00 0 | 100. |
| pH | -- | CONSTANT | 7.20 | -999. | .300 | 14.0 |
| Organic carbon content (fraction) | | CONSTANT | 0.300E-02 | | 0.100E-05 1 | 1.00 |
| Well distance from site | m | CONSTANT | -999. | | .00 | -999. |
| Angle off center | degree | CONSTANT | 293. | -999. | 0.000E+00 0 | 360. |
| Well vertical distance | m | CONSTANT | 0.000E+00 | -999. | .000E+00 | 1.00 |
| | | | 0.000E+00 | -999. | | |

CONCENTRATION AFTER SATURATED ZONE MODEL 0.7279E-05

Page 2

# APPENDIX F.5

# MULTIMED OUTPUT FOR ALTERNATIVE LINER CLOSED CASE 5-LOCATION 1

FOR PERMIT PURPOSES ONLY

CASE5R

1

U.S. ENVIRONMENTAL PROTECTION AGENCY

EXPOSURE ASSESSMENT

MULTIMEDIA MODEL

MULTIMED (Version 1.01, June 1991)

1

Run options

--- -------

Case 5

Location 1

Chemical simulated is DEFAULT CHEMICAL

| | |
|---|---|
| Option Chosen | Saturated zone model |
| Run was | DETERMIN |

Infiltration input by user

Run was steady-state

Reject runs if Y coordinate outside plume

Reject runs if Z coordinate outside plume

Gaussian source used in saturated zone model

1

1

CHEMICAL SPECIFIC VARIABLES

| VARIABLE NAME | UNITS | DISTRIBUTION | PARAMETERS MEAN | PARAMETERS STD DEV | LIMITS MIN | LIMITS MAX |
|---|---|---|---|---|---|---|
| Solid phase decay coefficient | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 0.100E+11 |
| Dissolved phase decay coefficient | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 0.100E+11 |
| Overall chemical decay coefficient | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 0.100E+11 |
| Acid catalyzed hydrolysis rate | 1/M-yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Neutral hydrolysis rate constant | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Base catalyzed hydrolysis rate | 1/M-yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Reference temperature | C | CONSTANT | 20.0 | -999. | 0.000E+00 | 100. |
| Normalized distribution coefficient | ml/g | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Distribution coefficient | -- | DERIVED | -999. | -999. | 0.000E+00 | 0.100E+11 |
| Biodegradation coefficient (sat. zone) | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Air diffusion coefficient | cm2/s | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 10.0 |
| Reference temperature for air diffusion | C | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 100. |
| Molecular weight | g/M | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Mole fraction of solute | -- | CONSTANT | 0.000E+00 | -999. | 0.100E-08 | 1.00 |
| Vapor pressure of solute | mm Hg | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 100. |
| Henry`s law constant | atm-m^3/M | CONSTANT | 0.000E+00 | -999. | 0.100E-09 | 1.00 |

CASE5R

| | | | | | | |
|---|---|---|---|---|---|---|
| Overall 1st order decay sat. zone | 1/yr | DERIVED | 0.000E+00 | 0.000E+00 | 0.000E+00 | 1.00 |
| Not currently used | | CONSTANT | -999. | -999. | 0.000E+00 | 1.00 |
| Not currently used | | CONSTANT | -999. | -999. | 0.000E+00 | 1.00 |

1

SOURCE SPECIFIC VARIABLES

| VARIABLE NAME | UNITS | DISTRIBUTION | PARAMETERS MEAN | PARAMETERS STD DEV | LIMITS MIN | LIMITS MAX |
|---|---|---|---|---|---|---|
| Infiltration rate | m/yr | CONSTANT | 1. 511E | -999. | 0.100E-09 | 0.100E+11 |
| Area of waste disposal unit | m^2 | CONSTANT | -07 | -999. | 0.100E-01 | -999. |
| Duration of pulse | yr | CONSTANT | 0.486E+06 | -999. | 0.100E-08 | -999. |
| Spread of contaminant source | m | DERIVED | 2. 999. | -999. | 0.100E-08 | 0.100E+11 0 |
| Recharge rate | m/yr | CONSTANT | 3. 999. | -999. | 0.000E+00 | .100E+11 |
| Source decay constant | 1/yr | CONSTANT | 0.368E-01 | 0-999. | 0.000E+00 | -999. |
| Initial concentration at landfill | mg/l | CONSTANT | .000E+00 | -999. | 0.000E+00 | -999. |
| Length scale of facility | m | DERIVED | 1.00 | -999. | 0.100E-08 | 0.100E+11 0 |
| Width scale of facility | m | DERIVED | 4. 999. | -999. | 0.100E-08 | .100E+11 |
| Near field dilution | | DERIVED | 5. 999. | 0.000E+00 | 0.000E+00 | 1.00 |
| | | | 1.00 | | | |

1

AQUIFER SPECIFIC VARIABLES

| VARIABLE NAME | UNITS | DISTRIBUTION | PARAMETERS MEAN | PARAMETERS STD DEV | LIMITS MIN | LIMITS MAX |
|---|---|---|---|---|---|---|
| Particle diameter | cm | CONSTANT | 0.381E-01 | -999. | 0.100E-08 | 100. |
| Aquifer porosity | -- | CONSTANT | 0.430 | -999. | 0.100E-08 | 0.990 |
| Bulk density | g/cc | CONSTANT | 1.65 | -999. | 0.100E-01 | 5.00 |
| Aquifer thickness | m | CONSTANT | 10.0 | -999. | 0.100E-08 | 0.100E+06 |
| Source thickness (mixing zone depth) | m | DERIVED | -999. | -999. | 0.100E-08 | 0.100E+06 |
| Conductivity (hydraulic) | m/yr | CONSTANT | 130. | -999. | 0.100E-06 | 0.100E+09 |
| Gradient (hydraulic) | | CONSTANT | 0.310E-02 | -999. | 0.100E-07 | -999. |
| Groundwater seepage velocity | m/yr | DERIVED | -999. | -999. | 0.100E-09 | 0.100E+09 |
| Retardation coefficient | -- | DERIVED | -999. | -999. | 1.00 | 0.100E+09 |
| Longitudinal dispersivity | m | FUNCTION OF X | -999. | -999. | -999. | -999. |
| Transverse dispersivity | m | FUNCTION OF X | -999. | -999. | -999. | -999. |
| Vertical dispersivity | m | FUNCTION OF X | -999. -999. | 21.0 | -999. | -999. |
| Temperature of aquifer | C | CONSTANT | -999. 7.20 | | 0.000E+00 0 | 100. |
| pH | -- | CONSTANT | -999. | 0.300E-02 | .300 | 14.0 |
| Organic carbon content (fraction) | | CONSTANT | -999. 89.0 | | 0.100E-05 1 | 1.00 |
| Well distance from site | m | CONSTANT | -999. | 0.000E+00 | .00 | -999. |
| Angle off center | degree | CONSTANT | -999. | 0.000E+00 | 0.000E+00 0 | 360. |
| Well vertical distance | m | CONSTANT | -999. | | .000E+00 | 1.00 |

CONCENTRATION AFTER SATURATED ZONE MODEL 0.9775E-05

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# APPENDIX F.6

# MULTIMED OUTPUT FOR ALTERNATIVE LINER CLOSED CASE 6-LOCATION 2

CASE6R

1

U.S. ENVIRONMENTAL PROTECTION AGENCY

EXPOSURE ASSESSMENT

MULTIMEDIA MODEL

MULTIMED (Version 1.01, June 1991)

1

Run options

--- -------

Case 6

Location 2

Chemical simulated is DEFAULT CHEMICAL

Option Chosen Saturated zone model

Run was DETERMIN

Infiltration input by user

Run was steady-state

Reject runs if Y coordinate outside plume

Reject runs if Z coordinate outside plume

Gaussian source used in saturated zone model

1

1

CHEMICAL SPECIFIC VARIABLES

| VARIABLE NAME | UNITS | DISTRIBUTION | PARAMETERS MEAN | PARAMETERS STD DEV | LIMITS MIN | LIMITS MAX |
|---|---|---|---|---|---|---|
| Solid phase decay coefficient | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 0.100E+11 |
| Dissolved phase decay coefficient | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 0.100E+11 |
| Overall chemical decay coefficient | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 0.100E+11 |
| Acid catalyzed hydrolysis rate | 1/M-yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Neutral hydrolysis rate constant | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Base catalyzed hydrolysis rate | 1/M-yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Reference temperature | C | CONSTANT | 20.0 | -999. | 0.000E+00 | 100. |
| Normalized distribution coefficient | ml/g | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Distribution coefficient | -- | DERIVED | -999. | -999. | 0.000E+00 | 0.100E+11 |
| Biodegradation coefficient (sat. zone) | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Air diffusion coefficient | cm2/s | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 10.0 |
| Reference temperature for air diffusion | C | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 100. |
| Molecular weight | g/M | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Mole fraction of solute | -- | CONSTANT | 0.000E+00 | -999. | 0.100E-08 | 1.00 |
| Vapor pressure of solute | mm Hg | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 100. |
| Henry`s law constant | atm-m^3/M | CONSTANT | 0.000E+00 | -999. | 0.100E-09 | 1.00 |

CASE6R

| | | | | | | |
|---|---|---|---|---|---|---|
| Overall 1st order decay sat. zone | 1/yr | DERIVED | 0.000E+00 | 0.000E+00 | 0.000E+00 | 1.00 |
| Not currently used | | CONSTANT | -999. | -999. | 0.000E+00 | 1.00 |
| Not currently used | | CONSTANT | -999. | -999. | 0.000E+00 | 1.00 |

1

SOURCE SPECIFIC VARIABLES

| VARIABLE NAME | UNITS | DISTRIBUTION | PARAMETERS MEAN | STD DEV | LIMITS MIN | MAX |
|---|---|---|---|---|---|---|
| Infiltration rate | m/yr | CONSTANT | 0.511E-07 | -999. | 0.100E-09 | 0.100E+11 |
| Area of waste disposal unit | m^2 | CONSTANT | 0.486E+06 | -999. | 0.100E-01 | -999. |
| Duration of pulse | yr | CONSTANT | -999. | -999. | 0.100E-08 | -999. |
| Spread of contaminant source | m | DERIVED | -999. | -999. | 0.100E-08 | 0.100E+11 |
| Recharge rate | m/yr | CONSTANT | 0.368E-01 | -999. | 0.000E+00 | 0.100E+11 |
| Source decay constant | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Initial concentration at landfill | mg/l | CONSTANT | 1.00 | -999. | 0.000E+00 | -999. |
| Length scale of facility | m | DERIVED | -999. | -999. | 0.100E-08 | 0.100E+11 |
| Width scale of facility | m | DERIVED | -999. | -999. | 0.100E-08 | 0.100E+11 |
| Near field dilution | | DERIVED | 1.00 | 0.000E+00 | 0.000E+00 | 1.00 |

1

AQUIFER SPECIFIC VARIABLES

| VARIABLE NAME | UNITS | DISTRIBUTION | PARAMETERS MEAN | STD DEV | LIMITS MIN | MAX |
|---|---|---|---|---|---|---|
| Particle diameter | cm | CONSTANT | 1. 381E-01 | -999. | 0.100E-08 | 100. |
| Aquifer porosity | -- | CONSTANT | 0.430 -999. | 1.65 | 0.100E-08 | 0.990 |
| Bulk density | g/cc | CONSTANT | -999. 10.0 | -999. | 0.100E-01 | 5.00 |
| Aquifer thickness | m | CONSTANT | | -999. | 0.100E-08 | 0.100E+06 |
| Source thickness (mixing zone depth) | m | DERIVED | 299999. | | 0.100E-08 | 0.100E+06 |
| Conductivity (hydraulic) | m/yr | CONSTANT | 0.310E-02 | -999. | 0.100E-06 | 0.100E+09 |
| Gradient (hydraulic) | | CONSTANT | | -999. | 0.100E-07 | -999. |
| Groundwater seepage velocity | m/yr | DERIVED | -999. | -999. | 0.100E-09 | 0.100E+09 |
| Retardation coefficient | -- | DERIVED | -999. | -999. | 1.00 | 0.100E+09 |
| Longitudinal dispersivity | m | FUNCTION OF X | -999. | -999. | -999. | -999. |
| Transverse dispersivity | m | FUNCTION OF X | 39999. | -999. | -999. | -999. |
| Vertical dispersivity | m | FUNCTION OF X | 21.0 -999. | 7.20 | -999. | -999. |
| Temperature of aquifer | C | CONSTANT | -999. | 0.300E-02 | 0.000E+00 0 | 100. |
| pH | -- | CONSTANT | -999. | | .300 | 14.0 |
| Organic carbon content (fraction) | | CONSTANT | 197. | -999. | 0.100E-05 1 | 1.00 |
| Well distance from site | m | CONSTANT | 0.000E+00 | -999. | .00 | -999. |
| Angle off center | degree | CONSTANT | 0.000E+00 | -999. | 0.000E+00 0 | 360. |
| Well vertical distance | m | CONSTANT | | | .000E+00 | 1.00 |

CONCENTRATION AFTER SATURATED ZONE MODEL 0.4171E-05

# APPENDIX F.7

# MULTIMED OUTPUT FOR ALTERNATIVE LINER CLOSED CASE 7-LOCATION 3

CASE7R

1

U. S. ENVIRONMENTAL PROTECTION AGENCY

EXPOSURE ASSESSMENT

MULTIMEDIA MODEL

MULTIMED (Version 1.01, June 1991)

1
Run options
--- -------

Case 7

Location 3
Chemical simulated is DEFAULT CHEMICAL

| Option | |
|---|---|
| Chosen Run was | Saturated zone model DETERMIN |

Infiltration input by user
Run was steady-state
Reject runs if Y coordinate outside plume
Reject runs if Z coordinate outside plume
Gaussian source used in saturated zone model
1
1

CHEMICAL SPECIFIC VARIABLES

| VARIABLE NAME | UNITS | DISTRIBUTION | PARAMETERS MEAN | PARAMETERS STD DEV | LIMITS MIN | LIMITS MAX |
|---|---|---|---|---|---|---|
| Solid phase decay coefficient | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 0.100E+11 |
| Dissolved phase decay coefficient | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 0.100E+11 |
| Overall chemical decay coefficient | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | |
| Acid catalyzed hydrolysis rate | 1/M-yr | CONSTANT | 0.000E+00 | -999. | 0.100E+11 | 0.000E+00 |
| Neutral hydrolysis rate constant | 1/yr | CONSTANT | 0.000E+00 | -999. | -999. | |
| Base catalyzed hydrolysis rate | 1/M-yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Reference temperature | C | CONSTANT | 20.0 | -999. | 0.000E+00 | -999. |
| Normalized distribution coefficient | ml/g | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 100. |
| Distribution coefficient | -- | DERIVED | -999. | -999. | 0.000E+00 | -999. |
| Biodegradation coefficient (sat. zone) | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 0.100E+11 |
| Air diffusion coefficient | cm2/s | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Reference temperature for air diffusion | C | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 100. |
| Molecular weight | g/M | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Mole fraction of solute | -- | CONSTANT | 0.000E+00 | -999. | 0.100E-08 | 1.00 |
| Vapor pressure of solute | mm Hg | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | 100. |
| Henry`s law constant | atm-m^3/M | CONSTANT | 0.000E+00 | -999. | 0.100E-09 | 1.00 |

Page 1

CASE7R

| | | | | | | |
|---|---|---|---|---|---|---|
| Overall 1st order decay sat. zone | 1/yr | DERIVED | 0.000E+00 | 0.000E+00 | 0.000E+00 | 1.00 |
| Not currently used | | CONSTANT | -999. | -999. | 0.000E+00 | 1.00 |
| Not currently used | | CONSTANT | -999. | -999. | 0.000E+00 | 1.00 |

1

SOURCE SPECIFIC VARIABLES

| VARIABLE NAME | UNITS | DISTRIBUTION | PARAMETERS MEAN | PARAMETERS STD DEV | LIMITS MIN | LIMITS MAX |
|---|---|---|---|---|---|---|
| Infiltration rate | m/yr | CONSTANT | 0.511E-07 | -999. | 0.100E-09 | 0.100E+11 |
| Area of waste disposal unit | m^2 | CONSTANT | 0.486E+06 | -999. | 0.100E-01 | -999. |
| Duration of pulse | yr | CONSTANT | -999. | -999. | 0.100E-08 | -999. |
| Spread of contaminant source | m | DERIVED | -999. | -999. | 0.100E-08 | 0.100E+11 |
| Recharge rate | m/yr | CONSTANT | 0.368E-01 | -999. | 0.000E+00 | 0.100E+11 |
| Source decay constant | 1/yr | CONSTANT | 0.000E+00 | -999. | 0.000E+00 | -999. |
| Initial concentration at landfill | mg/l | CONSTANT | 1.00 | -999. | 0.000E+00 | -999. |
| Length scale of facility | m | DERIVED | -999. | -999. | 0.100E-08 | 0.100E+11 |
| Width scale of facility | m | DERIVED | -999. | -999. | 0.100E-08 | 0.100E+11 |
| Near field dilution | | DERIVED | 1.00 | 0.000E+00 | 0.000E+00 | 1.00 |

1

AQUIFER SPECIFIC VARIABLES

| VARIABLE NAME | UNITS | DISTRIBUTION | PARAMETERS MEAN | PARAMETERS STD DEV | LIMITS MIN | LIMITS MAX |
|---|---|---|---|---|---|---|
| Particle diameter | cm | CONSTANT | 0.381E-01 | -999. | 0.100E-08 | 100. |
| Aquifer porosity | -- | CONSTANT | 0.430 | -999. | 0.100E-08 | 0.990 |
| Bulk density | g/cc | CONSTANT | 1.65 | -999. | 0.100E-01 | 5.00 |
| Aquifer thickness | m | CONSTANT | 10.0 | -999. | 0.100E-08 | 0.100E+06 |
| Source thickness (mixing zone depth) | m | DERIVED | -999. | -999. | 0.100E-08 | 0.100E+06 |
| Conductivity (hydraulic) | m/yr | CONSTANT | 130. | -999. | 0.100E-06 | 0.100E+09 |
| Gradient (hydraulic) | | CONSTANT | 0.310E-02 | -999. | 0.100E-07 | -999. |
| Groundwater seepage velocity | m/yr | DERIVED | .999. | -999. | 0.100E-09 | 0.100E+09 |
| Retardation coefficient | -- | DERIVED | .999. | -999. | 1.00 | 0.100E+09 |
| Longitudinal dispersivity | m | FUNCTION OF X | .999. | -999. | -999. | -999. |
| Transverse dispersivity | m | FUNCTION OF X | .999. | -999. | -999. | -999. |
| Vertical dispersivity | m | FUNCTION OF X | -999. | -999. | -999. | -999. |
| Temperature of aquifer | C | CONSTANT | 21.0 | -999. | 0.000E+00 0 | 100. |
| pH | -- | CONSTANT | 7.20 | -999. | .300 | 14.0 |
| Organic carbon content (fraction) | | CONSTANT | 0.300E-02 | -999. | 0.100E-05 1 | 1.00 |
| Well distance from site | m | CONSTANT | 293. | -999. | .00 | -999. |
| Angle off center | degree | CONSTANT | 0.000E+00 | -999. | 0.000E+00 0 | 360. |
| Well vertical distance | m | CONSTANT | 0.000E+00 | -999. | .000E+00 | 1.00 |

CONCENTRATION AFTER SATURATED ZONE MODEL 0.2078E-05

# THE CITY OF KINGSVILLE LANDFILL
# TCEQ PERMIT MSW 235C

## PERMIT AMENDMENT APPLICATION
## Volume 5 of 6

CITY OF KINGSVILLE, KLEBERG COUNTY, TEXAS

September 2018
Revision 1 – November 2018
Revision 2 – February 2019
Revision 3 – April 2019

Prepared by

HANSON
Engineering | Planning | Allied Services
TBPE F-417

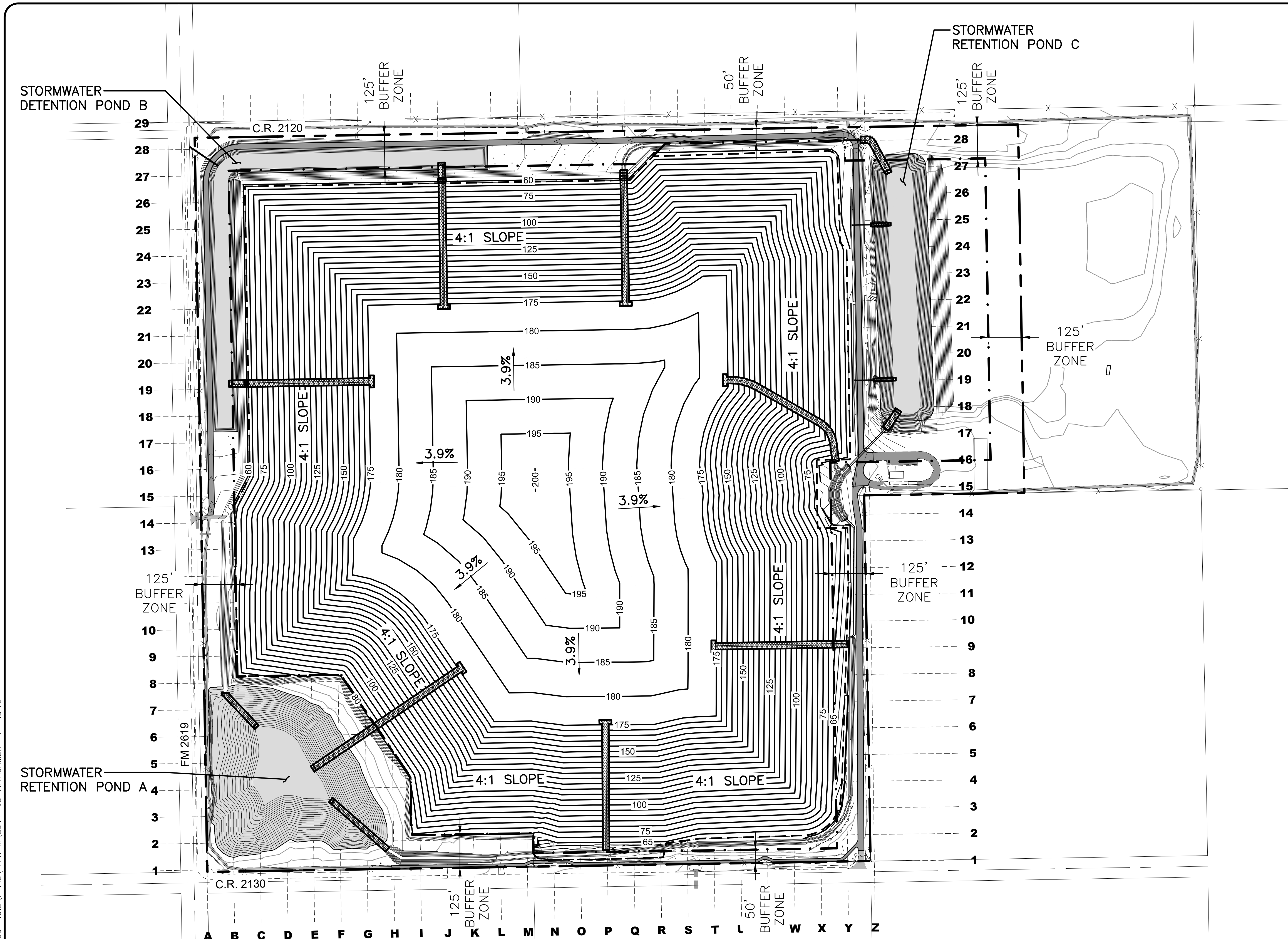
HANSON PROJECT NO. 16L0438-0003

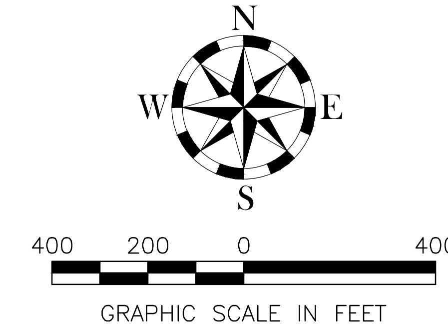
# CITY OF KINGSVILLE LANDFILL

# PART III

# ATTACHMENT 7

LANDFILL COMPLETION PLAN




**LEGEND:**

| | |
|---|---|
| ○ | EXISTING FENCE CORNER |
| x | EXISTING FENCE |
| 65.00 | EXISTING CONTOUR |
| | EXISTING ROAD |
| | PERMIT BOUNDARY LIMITS |
| | BUFFER LIMITS |
| | PROPOSED LIMITS OF WASTE/WASTE FOOTPRINT |
| 200 | FINAL COVER CONTOURS (5' INTERVALS) |
| | PROPOSED ROAD |
| | PROPOSED STORMWATER LETDOWN STRUCTURE |
| | PROPOSED STORMWATER PONDS |

NOTE: MAXIMUM FINAL COVER ELEVATION IS 200 FT–MSL; MAXIMUM WASTE ELEVATION IS 196.92 FT–MSL.

| NUMBER | REVISION | DATE | DRAWN | DESIGNED | REVIEWED |
|---|---|---|---|---|---|

STATE OF TEXAS
JON M. REINHARD
64541
LICENSED
PROFESSIONAL ENGINEER
04/23/19

Hanson No. 16L0438
Filename 8514-03-ATTACHMENT-7-1
Scale AS SHOWN
Date 04/23/2019

| | | |
|---|---|---|
| LAYOUT | DT | 04/23/2019 |
| DRAWN | DT | 04/23/2019 |
| REVIEWED | JMR | 04/23/2019 |

HANSON


Hanson Professional Services Inc.
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PART III, ATTACHMENT 7
LANDFILL COMPLETION PLAN
CITY OF KINGSVILLE LANDFILL
MSW PERMIT No. 235-C
KINGSVILLE, TEXAS
KLEBERG COUNTY, TEXAS

FIGURE:
III.7-1

APR 22, 2019 4:10 PM TORRE01809
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# CITY OF KINGSVILLE LANDFILL

# PART III

# ATTACHMENT 10

LINER QUALITY CONTROL PLAN

THE CITY OF KINGSVILLE LANDFILL

TCEQ PERMIT MSW 235C

# PERMIT AMENDMENT APPLICATION

## Part III

## Attachment 10
## Liner Quality Control Plan

CITY OF KINGSVILLE, KLEBERG COUNTY, TEXAS

September 2018

Revision 1 – November 2018

Revision 2 - February 2019

Revision 3 - April 2019

Prepared by

HANSON

Engineering | Planning | Allied Services

TBPE F-417

HANSON PROJECT NO. 16L0438- 0003

# TABLE OF CONTENTS

# 1. GENERAL

## 1.1. Scope and Purpose

This Liner Quality Control Plan (LQCP) is applicable to the construction of all landfill liner systems at the City of Kingsville Landfill, a Municipal Solid Waste (MSW) disposal facility in Kleberg County, Texas. This LQCP shall govern the material characteristics, installation and testing for the various construction components for the landfill liners at the facility. Qualifications for quality control personnel are also identified in this LQCP. The provisions of this LCQP were developed based on the latest technical guidelines of the TCEQ, including quality control of construction, testing frequencies and procedures, and quality assurance of sampling and testing procedures.

## 1.2. Lining and Cover Systems Used for the Landfill

The lining and cover systems that will be used at this facility will be alternative liner designs. Alternative liner design demonstrations can be found in Part III, Attachment 5. The following lining and/or cover systems will be used at the facility:

### 1.2.1. Landfill Lining System

The landfill lining system to be used in Sectors 4C, 5, 6 and 7 will consist of (from bottom to top):

- A prepared subgrade;
- A geosynthetic clay liner (GCL);
- A geomembrane liner consisting of sixty mil (0.06 inch) thick HDPE;
- A leachate collection layer consisting of a drainage geocomposite (a synthetic drainage net with geotextile fabric on one or both sides), gravel, collection piping, and geotextile separation fabric;
- A two (2) foot protective cover soil layer.

### 1.2.2. Landfill Cover System

The landfill cover system will consist of (from bottom to top):

- A ~~six (6) inch thick (minimum)~~ prepared soil subgrade ~~layer~~;
- A geosynthetic clay liner (GCL) layer;
- A forty mil (0.04 inch) thick LLDPE geomembrane layer;
- A geocomposite drainage layer consisting of a synthetic drainage net and geotextile fabric;
- A twenty five (25) inch thick protective cover soil layer, the top seven (7) inches of which must be capable of supporting vegetation.

### 1.2.3. Piggyback Liner System

This liner system will be used in areas of the landfill where disposal development will occur over existing unlined MSW fill locations and will include components that will provide additional geotechnical stability. The piggyback lining system will consist of (from bottom to top):

| | |
|---|---|
| D 5261 | Standard Test Method for Measuring Mass per Unit Area of Geotextiles |
| D 5321 | Standard Test Method for Determining the Shear Strength of Soil-Geosynthetic and Geosynthetic-Geosynthetic Interfaces by Direct Shear |
| D 5596 | Standard Test Method for Microscopic Evaluation of the Dispersion of Carbon Black in Polyolefin Geosynthetics |
| D 5887 | Standard Test Method for Measurement of Index Flux Through Saturated Geosynthetic Clay Liner Specimens Using a Flexible Wall Permeameter |
| D 5890 | Standard Test Method for Swell Index of Clay Mineral Component of Geosynthetic Clay Liners |
| D 5891 | Standard Test Method for Fluid Loss of Clay Component of Geosynthetic Clay Liners |
| D 5993 | Standard Test Method for Measuring Mass Per Unit of Geosynthetic Clay Liners |
| D 5994 | Standard Test Method for Measuring Core Thickness of Textured Geomembranes |
| D 6392 | Standard Test Method for Determining the Integrity of Nonreinforced Geomembrane Seams Produced Using Thermo-Fusion Methods |
| D 6241 | Standard Test Method for Static Puncture Strength of Geotextiles and Geotextile-Related Products Using a 50-mm Probe |
| D 6243 | Standard Test Method for Determining the Internal and Interface Shear Strength of Geosynthetic Clay Liner by the Direct Shear Method |
| D 6496 | Standard Test Method for Determining Average Bonding Peel Strength Between Top and Bottom Layers of Needle-Punched Geosynthetic Clay Liners |
| D 6768 | Standard Test Method for Tensile Strength of Geosynthetic Clay Liners |
| D 7176 | Standard Specification for Non-Reinforced Polyvinyl Chloride (PVC) Geomembranes Used in Buried Applications |
| D 7179 | Standard Test Method for Determining Geonet Breaking Force |
| F 480 | Standard Specification for Thermoplastic Well Casing Pipe and Couplings Made in Standard Dimension Ratios (SDR), SCH 40 and SCH 80 |
| F 714 | Standard Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter |

### 1.7.2. Geosynthetics Research Institute

| | |
|---|---|
| GM13 | Standard Specification for Test Methods, Test Properties and Testing Frequency for High Density Polyethylene (HDPE) Smooth and Textured Geomembranes |
| GM17 | Test Methods, Test Properties and Testing Frequency for Linear Low Density Polyethylene (LLDPE) Smooth and Textured Geomembranes |
| GM19 | Seam Strength and Related Properties of Thermally Bonded Polyolefin Geomembranes |

## 1.8. Material Conformance Tests for Soils and Gravel

Soil materials used for construction at the facility shall be subjected to the following conformance tests to demonstrate compliance with the LQCP. Unless otherwise specified, one set of tests shall be performed for each material type. If there is a visually distinguishable change in the soil characteristics or a change in the soils Liquid Limit (LL) or Plasticity Index (PI) by more than 10 points, the soil shall be considered a separate borrow source and shall require an additional set of tests. In any condition, a minimum of one (1) complete set of tests must be performed for each type of soil material used. Conformance testing will be conducted by the party identified in sections 2.4 . The results of these tests shall be used for field quality control. The Contractor shall ensure that the required samples are collected and tested in a timely manner to be available for field quality control. Not all tests will be required for all soils; only those tests for which the individual components specify a required material property.

### 1.8.1. Soil Classification

All soil materials used shall be classified in accordance with the Unified Soil Classification System (USCS - ASTM D 2487).

### 1.8.2. Gradation

All soil materials used shall be tested to determine the particle size gradation, including the percentage passing the #200 sieve. Gradation shall be determined in accordance with ASTM D 1140. Gravel materials used shall be tested to determine the gradation in accordance with ASTM C 136 or ASTM D 422.

### 1.8.3. Atterberg Limits

All soil materials used shall be tested to determine the Atterberg Limits (Liquid Limit and Plastic Limit) and the Plasticity Index (ASTM D 4318).

### 1.8.4. Soil Moisture-Density

The soil moisture/density relationship shall be determined using the Standard Proctor method (ASTM D 698).

### 1.8.5. Coefficient of Permeability/Hydraulic Conductivity

Where the LQCP indicates to determine the coefficient of permeability or the hydraulic conductivity (in centimeters per second [cm/sec]), use one of the following test procedures:

Constant Head Permeability

Permeability of Granular Soils (Constant Head) – ASTM D 2434

Hydraulic Conductivity

Flexible Wall Permeameter (back pressure saturation) ASTM D 5084.

### 1.8.6. Calcium Carbonate Content

All gravel materials used shall be tested to determine the calcium carbonate content in accordance with ASTM D 3042.

#### 1.9.5. Thickness

Smooth HDPE geomembrane sheet and HDPE drainage net shall be tested for thickness in accordance with ASTM D 5199. Textured HDPE geomembrane sheet shall be tested for thickness in accordance with ASTM D 5994.

#### 1.9.6. Tear Resistance

The geomembrane sheet shall be tested for tear resistance in accordance with ASTM D 1004.

#### 1.9.7. Puncture Resistance

The geomembrane and geotextile materials shall be tested for puncture resistance in accordance with ASTM D 4833 and ASTM D 6241, respectively.

#### 1.9.8. Apparent Opening Size

Geotextile shall be tested for apparent opening size (AOS) in accordance with ASTM D 4751.

## 2. SUBGRADE PREPARATION AND CONTROLLED FILL

The following requirements govern the subgrade preparation for liners and covers used at the facility:

### 2.1. Subgrade Description

Subgrade materials shall not exhibit excessive cohesion and shall be free of large particles, rocks or other foreign material. The finished subgrade should be smooth, with no large or protruding items that may damage liner materials placed on the subgrade. Soil materials used as fill to finish the subgrade shall be obtained either from on-site or off-site sources.

### 2.2. Required Material Properties

Soil materials used for fill to construct subgrade shall be free of sod, trash, roots, and organic matter. The materials shall meet the following minimum requirements which are also summarized in Table 10-1:

#### 2.2.1. Soil Materials

##### 2.2.1.1. Classification

Soil materials shall be classified using the USCS. Acceptable classifications are CH CL, ML, SW, SP, SM, or SC.

#### 2.2.1.2.Gradation:

The soil material shall be composed of particles of which no more than ninety six percent (96%) pass the #200 sieve.

#### 2.2.1.3.Atterberg Limits

The soil material used shall have a Liquid Limit of no greater than seventy five percent (75%) and a Plasticity Index (Liquid Limit minus Plastic Limit) of no greater than forty five percent (45%).

### 2.2.2. Moisture Density for Subgrade Materials Placed as Fill

Subgrade materials placed as fill shall be compacted to at least ninety five percent (95%) of the maximum dry density, Standard Proctor Basis, as per ASTM D698. The moisture content shall range from optimum moisture to five percent (5%) above the optimum moisture content.

**Table 10-1**
**Required Testing for Subgrade Soil Materials Used as Fill**

| Property | Frequency | Test Method | Value |
|---|---|---|---|
| Sieve Analysis | 1 test per each 100,000 s.f. per lift, minimum of 1 test/lift | ASTM D 1140 | 96% maximum |
| Atterberg Limits | 1 test per each 100,000 s.f. per lift, minimum of 1 test/lift | ASTM D 4618 | LL = 75% maximum<br>PI = 45% maximum |
| Field Density and Moisture Content | 1 test per each 10,000 s.f. per lift | ASTM D 698 | 95% maximum dry density; optimum to optimum plus 5% above moisture content |

## 2.3.Installation Procedures

The subgrade installation procedures shall be conducted by the Earthwork Contractor and observed by QAO. The installation procedures shall conform to the following requirements:

### 2.3.1. Excavation

Overlying materials shall be excavated and removed to achieve the required subgrade lines and grades as indicated in the project plans and specifications. The Earthwork Contractor shall exercise care and provide sufficient grade control during the excavation process to minimize or eliminate the placement of fill to meet the required subgrade lines and grades. Soil overburden shall be excavated using standard mobile construction equipment. Where the bedrock is encountered within the planned excavation and cannot be removed using this equipment, it will be removed either through rock saw or blasting. For areas requiring rock removal, the rock will be removed at least 1 foot beyond the lines and grades shown to accommodate the construction of a soil subgrade layer. In the event voids in bedrock are discovered intersecting the limits of the planned excavation, these voids will be hydro or vacuum excavated to remove any loose material and will be filled with cement grout or concrete to align with the limits of the planned excavation. Once allowed to properly cure and set, these filled voids will be covered with subgrade material.

### 2.3.2. Subgrade Preparation

The subgrade shall be excavated and/or graded to the appropriate lines and grades as shown in the project contract documents. Where subgrade materials are placed as fill, the in-situ material shall be properly scarified and prepared to receive the subgrade material. Any soft areas shall be excavated and replaced with compacted materials to provide a solid working base. In areas where bedrock has been removed to accommodate a subgrade layer, the subgrade may be constructed from on-site soils, off-site soils, millings from the rock saw process or a combination of these sources, with the subgrade material meeting the requirements of this section.

### 2.3.3. Placement

The subgrade soil materials shall be broken down such that all material is uniformly hydrated. The finished material shall not contain clods that exceed one (1) inch in diameter or that total more than ten percent (10%) by weight. Any gravel size particles shall not be of sufficient number or size to be a detriment to the integrity of the overlying component. When placed as fill, the subgrade material shall be placed in loose lifts as required to obtain compacted lift thickness of six (6) to eight (8) inches, or the pad or prong length of the compactor feet, whichever is less.

### 2.3.4. Hydration

Prior to compaction, the soil material shall be hydrated so that proper moisture can be maintained during the compaction process. Once water has been added, the soil material shall be worked to provide proper mixing. Soil hydration is allowed either on a stockpile or in-place. The soil material shall be hydrated to a moisture content wet of optimum.

### 2.3.5. Compaction

The soil material shall be compacted using a pad or tamping foot roller or a prong foot ("sheepsfoot") roller. Bulldozers and/or pneumatic tired compactors will not be used. The lift thickness shall be controlled, as outlined above, such that the compactor feet penetrate through the entire lift under compaction into the top of the previously compacted lift. Therefore, the compacted lift thickness must not be greater than the pad or prong length of the compactor feet. Adequate cleaning devices shall be used to prevent clogging of the compactor from excess soil material. Sections of re-compacted subgrade that do not pass both the density and moisture requirements shall be re-worked and re-tested until the section in question does pass, and to the extent that the re-worked area(s) tie-in to an area which passed the testing. The re-worked area shall be re-worked and re-tested until passing tests are achieved.

### 2.3.6. Finishing

The subgrade shall be prepared and finished in a manner consistent with proper subgrade preparation techniques for the installation of geosynthetics materials and as recommended by the GCL manufacturer. The subgrade shall be properly compacted to a minimum of 95% Standard Proctor Density per ASTM D698, so as not to settle and cause excessive strains in the GCL or other synthetic liner materials. Prior to installation, ensure a surface free of debris, roots, or angular stones larger than 0.5-inch. The subgrade must be rolled with a smooth-wheeled roller. During installation, ensure rutting or raveling is not caused by installation equipment.

### 2.3.7. Proof rolling

The top surface of the completed subgrade must be proof rolled with a smooth-wheel roller prior to final grade/thickness surveying and placement of overlying layers. Additional proof-rolling may be employed if it is necessary to minimize desiccation and cracking of the subgrade.

### 2.3.8. Protection of Subgrade Surface

Prior to and during the installation of overlying components, the Earthwork Contractor shall preserve and protect the exposed surface of the subgrade from desiccation and cracking, rutting, erosion, and ponding using regular watering and proof rolling.

## 2.4. Quality Assurance Quality Control Requirements

The Earthwork Contractor shall conduct material conformance tests and the QAO shall monitor the placement and finishing of the subgrade, and coordinate the necessary surveys with the project surveyor. Prior to placement of any overlying layers, the QAO shall coordinate with the GMI to execute a subgrade acceptance form for all areas of completed subgrade. In addition, the Earthwork Contractor shall employ testing personnel to conduct the following QC verification activities:

### 2.4.1. Field Density

A minimum of one (1) field density test per 10,000 square feet ($ft^2$), or less, for each lift. A minimum of three (3) field density tests are required for each lift.

### 2.4.2. Sieve Analysis (Percent Passing #200)

A minimum of one (1) test for each 100,000 $ft^2$ or less, for each lift, shall be performed in accordance with ASTM D 1140. A minimum of one (1) test shall be performed for each lift regardless of the area.

### 2.4.3. Atterberg Limits

A minimum of one (1) test for each 100,000 $ft^2$ per lift shall be performed in accordance with ASTM D 4318. A minimum of one (1) test shall be performed for each lift regardless of the area.

#### 2.4.4. Survey Verification

A minimum of one (1) survey verification shall be made per 5,000 $ft^2$ of surface area. Reference locations will be noted on a drawing of the area.

#### 2.4.5. Repair of Test Holes

All holes in the subgrade created from tests and test samples shall be completely backfilled with soil and shall be tamped into place.

## 3. GEOGRID

The following requirements govern the geogrid used at the facility:

### 3.1. Geogrid Description

A geogrid is a reinforcing geosynthetic structure formed by a regular network of tensile members with appropriate apertures to allow interlocking with surrounding soil or aggregate. Geogrid materials shall be High Density Polyethylene (HDPE). Geogrid material will be placed on a prepared subgrade and will underlie the GCL layer. The geogrid shall be stored, handled and installed in accordance with the manufacturer's recommendations.

### 3.2. Required Material Properties

The geogrid shall have a minimum tensile strength of 2500 pounds per foot at an allowable stress of 5% or less over 50 years. Properties, test methods and minimum values are listed below and summarized in Table 10-2.

| | |
|---|---|
| Ultimate Tensile Strength (ASTM D6637) | 7810 lb/ft |
| Tensile Strength @ 5% Strain (ASTM D6637) | 3560 lb/ft |
| Junction Strength (ASTM D7737) | 7200 lb/ft |
| Maximum Allowable Strength for 120 yr Design Life (GRI-GG4) | 2860 lb/ft |

**Table 10-2**
**Required Testing for Uniaxial Geogrid**

| Property | Frequency | Test Method | Value |
|---|---|---|---|
| Ultimate Tensile Strength | MARV based on 95% confidence level | ASTM D 6637 | 7810 lb/ft |
| Tensile Strength @ 5% Strain | MARV based on 95% confidence level | ASTM D 6637 | 3560 lb/ft |
| Junction Strength | MARV based on 95% confidence level | ASTM D 7737 | 7200 lb/ft |
| Maximum Allowable Strength for 120-yr Design Life | MARV based on 95% confidence level | GRI – GG4 | 2860 lb/ft |

The manufacturer shall certify that the geogrid has been quality control tested during the manufacturing process and that the liner meets all strength requirements for the intended use.

### 3.3.Installation Procedures

The geogrid installation procedures shall be conducted by the GMI and observed by the QAO. The installation procedures shall conform to the following requirements:

#### 3.3.1. Surface Preparation

The surface to receive the geogrid shall be prepared in accordance with the requirements specified in Section 2, Subgrade Preparation and Controlled Fill. Prior to placing geogrid materials, the GMI shall execute a subgrade acceptance form. This form shall be submitted to the QAO and signed by the QAE and the Owner. A copy of the form is included in Appendix A.

#### 3.3.2. Delivery and Storage

All rolls of geogrid delivered to the site shall be marked with the name of the manufacturer, the product type, the manufacturing batch code, roll number, date of manufacture and roll dimensions. The QAO must inspect the delivered materials for damage and defects. Pushing, sliding, or dragging of rolls or pallets can cause damage and must be avoided. The geogrid rolls shall be dept free of dirt and debris, must be protected from soft or wet ground and rocky or rough ground and must not be stacked more than five (5) rolls high to avoid crushing the cores of the rolls. A sacrificial cover must be used to protect the geogrid if stored on site for more than six (6) months.

#### 3.3.3. Geogrid Anchor Trench

A geosynthetic materials anchor trench shall be completed along the perimeter of the area to be lined where indicated on the project contract documents. The anchor trench may be excavated in sections, as necessary. Loose soil shall be removed from the anchor trench and shall not underlie the geosynthetic materials to be placed in the anchor trench. The excavated anchor trench shall have rounded corners in order to help protect the geosynthetic materials. The anchor trench shall conform to the dimensions and requirements shown on the project contract documents.

#### 3.3.4. Geogrid Deployment

The geogrid shall be deployed in accordance with the procedures recommended by the manufacturer and as outlined below:

- Only those geogrid panels which can be anchored and connected in one (1) day should be deployed.
- Each geogrid panel shall be inspected for damage and manufacturing defects prior to anchoring or connecting to other panels.
- Geogrid panels shall be placed in a controlled manner, such as pulling, hoisting, or rolling and shall be pulled taut to remove slack. Geogrid shall be deployed from a top to bottom direction on slopes.
- Adjacent geomembrane panels shall not be overlapped but shall be deployed side by side. Panel end connections shall be made using a Bodkin connection.
- Geogrid panels shall be anchored in place after placement so as to remain in the deployed alignment. Anchoring can be accomplished using stakes, sandbags, or small quantities of fill soil. Sandbag anchorage must be removed as the

subsequent GCL layer is placed. Stakes must be driven flush with the subgrade as the subsequent GCL layer is placed.

- The geogrid panels shall be placed and aligned such that endroll connections on slopes are minimized. Connections should be located as close to the bottom of the slope as possible.
- No construction equipment traffic shall be allowed on the geogrid.
- Personnel working on the geogrid shall not smoke, wear damaging shoes, throw equipment or engage in other activities which could damage the geogrid.

## 4. GEOSYNTHETIC CLAY LINER (GCL)

### 4.1.General

This section includes the requirements for selection, installation, and protection of GCL.

### 4.2.Submittals

**~~1.~~A. Pre-installation**

Submit the following to the QAO for approval prior to GCL deployment.

1. Supplier of the GCL manufacturer results for standard tests described in Table ~~C.1~~10-3.
2. Written certification the GCL meets the properties listed in Table ~~C.1~~10-3.
3. Written certification that GCL manufacturer has continuously inspected each roll of GCL for the presence of needles and other defects and found GCL defect-free.
4. Written certification from the GCL manufacturer the bentonite will not shift during transportation or installation thereby causing thin spots in the body of the GCL.
5. QC certificates signed by a responsible party of the GCL manufacturer for each roll delivered to the site. Each certificate shall include roll identification numbers and results of all QC tests. At a minimum, results shall be given for tests corresponding to Table ~~C.1~~10-3. The bentonite and textile suppliers shall each certify the respective properties under Manufacturer's Quality Control. The GCL manufacturer shall also perform the bentonite tests described under Manufacturer's Quality Control and third party tests.

**Table ~~C.1~~10-3 –STANDARD TESTS ON GEOSYNTHETIC CLAY LINER MATERIAL**

| Test | Item | Type of Test | Standard Test Method | Frequency of Testing |
|---|---|---|---|---|
| Manufacturer's Quality Control | Bentonite[A] | Swell Index[A] | ASTM D5890 | per 100,000-lbs and every truck or railcar |
| | | Moisture Content[A] | ASTM D4643 | per 100,000-lbs and every truck or railcar |
| | | Fluid Loss[A] | ASTM D5891 | per 100,000-lbs and every truck or railcar |
| | Geotextile | Grab Tensile Strength[B] | ASTM D4632 | per 200,000-$ft^2$ |
| | | Mass/Unit Area | ASTM D5261 | per 200,000-$ft^2$ |
| | GCL Product | Grab Tensile Strength[B] | ASTM D6768<br>ASTM D4632 | per 200,000-$ft^2$ |
| | | Peel Strength[H] | ASTM D 6496<br>ASTM D 4632 | per 40,000-$ft^2$ |
| | | Clay Mass/Unit Area[C] | ASTM D5993 | per 40,000-$ft^2$ |
| | | Permeability[D] | ASTM D5887 | per week for each production line[E] |
| | | Lap Joint Permeability[D][F] | ASTM D5887 | per each material and lap type |
| Conformance Testing by 3rd Party Independent Laboratory | GCL Product | Clay Mass/Unit Area[C] | ASTM D5993 | at least one (1) test per 100,000-$ft^2$ and ASTM D4254 procedure A |
| | | Permeability[D][F] | ASTM D5084 | per 100,000-$ft^2$ |
| | | Direct Shear[F][G][I] | ASTM D5321<br>ASTM D6243 | Per GCL/adjoining material type |

Notes:

A - Tests performed on bentonite before incorporation into GCL. Free swell shall have a minimum test value of 24-ml. Fluid loss shall have a maximum value of 18-mil.

B - Geotextiles shall meet minimum manufacturer criteria.

C - Minimum Test value – 0.75-lb/sq. ft. MARV at 0% moisture content

D - 5 x $10^{-9}$ cm/ sec max or as required by the permit.

E - Report last twenty (20) permeability values, ending on production date of supplied GCL.

F - Test at confining/consolidating pressures simulating field conditions.

G - Not applicable for slopes of 7H:IV or flatter. Testing must be on material in hydrated state unless GCL includes geomembrane on both side of GCL.

H - Peel strength for unreinforced GCL 1 lb/in (1.75 N/cm) min. Peel strength for reinforced GCL 3.5 lbs/in (6.1 N/cm) min.

I - Hydrated internal shear strength for unreinforced GCL 150 psf. Hydrated internal shear strength for reinforced GCL 500 psf.

## 4.3. Installation

The GCL installation Contractor shall submit to the QAI a Subgrade Surface Acceptance Form, signed by the GCL installation Contractor, for each area covered directly by GCL as installation proceeds.

## 4.4. Delivery, Storage, and Handling

### ~~1.~~A. Packing and Shipping

The GCL shall be supplied in rolls wrapped individually in relatively impermeable and opaque protective covers. The GCL rolls shall be marked or tagged with the following information:

1. Manufacturer's name.
2. Product identification.
3. Roll number.
4. Roll dimensions.
5. ~~1.~~5.Roll weight.

### ~~5.~~B. Storage and Protection

An onsite storage area for GCL rolls from the time of delivery until installed as recommended by the GCL Manufacturer shall store and protect GCL from dirt, water, ultraviolet light exposure, and other sources of damage. Contractor shall preserve integrity and readability of GCL roll labels. Rolls must not be stacked higher than recommended by the manufacturer to preclude thinning of bentonite at contact points.

Use wooden pallets for above ground storage of GCL and heavy, waterproof tarpaulin for protecting unused GCL unless otherwise specified by GCL manufacturer.

## 4.5.Materials

The active ingredient of the GCL shall be natural sodium bentonite and encapsulated between two (2) geotextiles. The geotextile-backed GCL shall provide sufficient internal shear strength of the slopes to be lined. The GCL shall have a coefficient of permeability of 5 x $10^{-9}$-centimeters/second (cm/sec) or less and an index flux of 1 x $10^{-8}$- ($m^3/m^2$/sec).

The bentonite shall be continuously adhered to both geotextiles to ensure the bentonite will not be displaced during handling, transportation, storage, and installation, including cutting, patching, and fitting around penetrations. The bentonite sealing compound or bentonite granules used to seal penetrations and make repairs shall be made of the same natural sodium bentonite as the GCL and recommended by the GCL manufacturer. The permeability of the GCL seams shall be equal to or less than the permeability of the body of the GCL sheet.

## 4.6.Manufacturer

### A. Manufacturing Experience

The GCL manufacturer shall have a minimum of two (2) years of continuous experience in the manufacture of similar CGL products. The Manufacturer must demonstrate, by submitting a list of previous projects, a minimum of 5-million sq.ft. of manufacturing experience of similar GCL products.

## 4.7.Warranty

The Manufacturer shall provide a 5-year warranty to the Owner against manufacturing defects. The warranty shall include the supply of the replacement GCL material and shall not include the cost of re-installation, defects, or failures due to improper installation.

## 4.8. Execution

### A. Examination

The QAE or his representative will collect samples of material delivered to the site for conformance testing. Alternatively, the QAE may coordinate the collection and shipping of samples collected by the manufacturer and shipped directly to the QAL.

### B. Installation

#### i. GCL Deployment

Handle GCL in a manner to ensure it is not damaged as recommended by the GCL Manufacturer. At a minimum, comply with the following:

1. On slopes, anchor the GCL securely and deploy it down the slope in controlled manner.
2. Weight the GCL with sandbags or equivalent in the present of wind.
3. Cut GCL with a cutter (hook blade), scissors, or other approved device.
4. Prevent damage to underlying layers during placement of GCL.
5. During GCL deployment, do not entrap in or beneath GCL stones, trash, or moisture that could damage GCL.
6. Visually examine entire GCL surface. Ensure no potentially harmful foreign objects such as needles are present.
7. Do not place GCL in the rain or a times of impending rain.
8. Do not place GCL in areas of ponded water.
9. Replace GCL that is hydrated before placement of overlying geomembrane and cover soil.
10. In general, only deploy GCL that can be covered during the day by geomembrane.
11. Prepare seam overlap areas as specified by the manufacturer.
12. Protective soil cover (including leachate collection media) shall be placed over the liner as soon as practicable.
13. Avoid dragging GCL on the subgrade.
14. Vehicular traffic other than low contact pressure vehicles such as UTV/ATV's or golf carts are not allowed on deployed GCL.
15. Installation personnel shall not smoke or wear damaging shoes when working on GCL.

#### ii. Overlaps

Overlap GCL to the manufacturer's recommendations that will vary according to seam location and climatic conditions. Prepare the overlap area as required by the manufacturer. At sumps, overlapped GCL shall be a minimum of 1-foot. At bottom of collection and leak detection sumps, unroll an extra layer of GCL on top of previously installed GCL. Avoid placing seams on top of underlying seams. Horizontal seams and mid-slope anchor trenches are not allowed on side slopes.

**iii Defects and Repairs**

Repair all flaws or damaged areas by placing a patch of the same material extending at least 1-foot beyond the flaw or damaged area. Add granular bentonite to the overlapped edges of the patch at the manufacturer's specified rate.

**iv Interface with Other Products**

Ensure the following when deploying overlying material:

1. GCL and underlying materials are not damaged.
2. Minimal slippage of GCL on underlying layers occurs.
3. No excess tensile stresses occur in GCL.
4. If necessary, bond overlap seams and patches in place prior to placement of overlying materials to prevent dislocating the GCL seam or patch.

### 4.9. Equipment

**A. Installation**

1. Use front-end loader, crane, or similar equipment for GCL deployment with a spreader bar and spindle to prevent slings from damaging edges.
2. Use 3-inch wide grips for moving GCL panels into place for each installation technician.
3. Use sealing and securing materials as required by specifications and drawings at attachment or penetration locations.
4. Use sand bags for securing tarpaulin when being stored and to secure GCL prior to placement of GML.

## 5. GEOMEMBRANE LINERS

The following requirements govern the geomembrane liners used at the facility:

### 5.1. Geomembrane Description

Geomembrane materials shall be High Density Polyethylene (HDPE) or Linear Low Density Polyethylene (LLDPE). The thicknesses of these geomembrane materials will vary based on project documents. Geomembrane sheets will be placed on a prepared subgrade and will be continuously seamed in accordance with the manufacturer's instructions to provide a water-tight seam.

### 5.2. Required Material Properties

The geomembrane shall be made of new, first quality materials with no more that 10% re-grind manufactured specifically for the purpose of liquid containment.

### 5.2.1. All HDPE Geomembrane Materials

Minimum specifications for all HDPE materials, including geomembrane and extrudate (welding rods):

| | |
|---|---|
| Density (ASTM D 1505) | 0.94 gm/cm$^3$ |
| Percent Carbon Black (ASTM D 1603 or ASTM D 4218) | 2.0% to 3.0% |

Minimum specifications for all HDPE geomembrane sheet:

| | |
|---|---|
| Carbon Black Dispersion (ASTM D 5596) | Only near spherical agglomerates, for 10 different view: 9 in Categories 1 or 2 and 1 in Category 3 |

### 5.2.2. Smooth HDPE Geomembrane

| | |
|---|---|
| Thickness (ASTM D 5199) | 60 mils (average of all measurements)<br>54 mils (lowest of any 10 measurements) |
| Tensile strength @ yield (ASTM D 6693) | 126 pounds per inch (ppi) |
| Tensile strength @ break (ASTM D 6693) | 228 ppi |
| Elongation @ yield (ASTM D 6693) | 12% |
| Elongation @ break (ASTM D 6693) | 700% |
| Tear resistance (ASTM D 1004) | 42 pounds |
| Puncture resistance (ASTM D 4833) | 108 pounds |

### 5.2.3. Textured HDPE Geomembrane

| | |
|---|---|
| Thickness (ASTM D 5994) | 60 mils (average of all measurements)<br>54 mils (lowest for 8 out of 10)<br>51 mils (lowest of any 10) |
| Tensile strength @ yield (ASTM D 6693) | 120 ppi |
| Tensile strength @ break (ASTM D 6693) | 90 ppi |
| Elongation @ yield (ASTM D 6693) | 12% |
| Elongation @ break (ASTM D 6693) | 100% |
| Tear resistance (ASTM D 1004) | 42 pounds |
| Puncture resistance (ASTM D 4833) | 90 pounds |

### 5.2.4. All LLDPE Geomembrane Materials

Minimum specifications for all LLDPE materials, including geomembrane and extrudate (welding rods):

| | |
|---|---|
| Density (ASTM D 1505) | 0.939 gm/cm$^3$ |
| Percent Carbon Black (ASTM D 1603 or ASTM D 4218) | 2.0% to 3.0% |

Minimum specifications for all LLDPE geomembrane sheet:

| | |
|---|---|
| Carbon Black Dispersion (ASTM D 5596) | Only near spherical agglomerates, for 10 different view: 9 in Categories 1 or 2 and 1 in Category 3 |

### 5.2.5. Smooth LLDPE Geomembrane

| | |
|---|---|
| Thickness (ASTM D 5199) | 40 mils (average of all measurements)<br>36 mils (lowest of any 10 measurements) |
| Tensile strength @ break (ASTM D 6693) | 152 pounds per inch (ppi) |
| Elongation @ break (ASTM D 6693) | 800% |
| Tear resistance (ASTM D 1004) | 22 pounds |
| Puncture resistance (ASTM D 4833) | 56 pounds |

### 5.2.6. Textured LLDPE Geomembrane

| | |
|---|---|
| Thickness (ASTM D 5994) | 40 mils (average of all measurements)<br>36 mils (lowest for 8 out of 10) |
| Tensile strength @ break (ASTM D 6693) | 60 ppi |
| Elongation @ break (ASTM D 6693) | 250% |
| Tear resistance (ASTM D 1004) | 22 pounds |
| Puncture resistance (ASTM D 4833) | 44 pounds |

The manufacturer shall certify that the geomembrane has been quality control tested during the manufacturing process and that the materials are first quality and free of holes, blisters, undispersed raw materials, and contamination by foreign materials. In addition, the manufacturer shall certify that the liner meets all strength and resistance requirements for the intended use.

Properties, test methods, testing frequencies, and required values are summarized in Tables 10-4 and 10-5 for HDPE geomembranes, and Tables 10-6 and 10-7 for LLDPE geomembranes.

## Table 10-4

## Required Testing for 60-mil HDPE Geomembrane (Smooth and Textured)[1]

| Test | Property | Frequency | Test Method |
|---|---|---|---|
| Resin | Specific Gravity/Density<br><br>Melt Flow Index | Per 200,000 lbs and every resin lot<br>Per 100,000 ft² and every resin lot | ASTM D 1505 or ASTM D 792<br><br>ASTM D 1238 |
| Manufacturer's<br><br>Quality Control | Thickness<br><br>Specific Gravity/Density<br><br>Carbon Black Content<br>Carbon Black Dispersion<br>Tensile Properties<br>Tear Resistance<br>Puncture Resistance<br>Stress Crack Resistance<br>Oxidative Induction Time<br>Oven Aging @ 85°C<br>(a) Standard OIT, or<br>(b) High Pressure OIT<br>UV Resistance<br>High Pressure OIT<br>Asperity Height[2] | Per roll of geomembrane<br><br>Per 200,000 lbs and every resin lot<br>Per 20,000 lbs<br>Per 45,000 lbs<br>Per 20,000 lbs<br>Per 45,000 lbs<br>Per 45,000 lbs<br>Per GRI-GM10<br>Per 200,000 lbs<br>Per each formulation<br><br><br>Per each formulation<br><br>Every second roll of geomembrane | ASTM D 5199 (smooth), and ASTM D 5994 (textured)<br>ASTM D 1505 or ASTM D 792<br><br>ASTM D 4218 or ASTM D 1603<br>ASTM D 5596<br>ASTM D 6693<br>ASTM D 1004<br>ASTM D 4833<br>ASTM D 5397<br>ASTM D 3895 or ASTM D 5885<br>ASTM D 5721<br>ASTM D 3895<br>ASTM D 5885<br>ASTM D 7238<br>ASTM D 5885<br>ASTM D 7466 |
| Conformance Testing by 3rd Party Independent Laboratory | Thickness<br><br>Specific Gravity/Density<br>Carbon Black Content<br>Carbon Black Dispersion<br>Tensile Properties | Per 100,000 ft² and every resin lot | ASTM D ASTM D 5199 (smooth), and ASTM D 5994 (textured)<br>ASTM D 1505 or ASTM D 792<br>ASTM D 4218 or ASTM D 1603<br>ASTM D 5596<br>ASTM D 6693 |
| Destructive Seam Field Testing | Shear & Peel | Various for field, lab & archive | ASTM D 6392 |
| Non-Destructive Seam Field Testing | Air Pressure<br><br>Vacuum | All dual-track fusion weld seams<br>All non-air pressure tested seams when possible | ASTM D 5820<br><br>ASTM D 4437 |

[1] All tests will conform to the minimum requirements set forth by GRI testing standard GM13. Required values for the properties are listed in Table 10-5.

[2] This testing is for textured geomembrane only. Measurement side will be alternated for double-sided textured sheet.

## Table 10-5

## Minimum Required Property Values for 60-mil HDPE Geomembrane (Smooth and Textured)[1]

| Property | Test Method | Minimum Required Value | |
|---|---|---|---|
| | | Smooth | Textured |
| Thickness, mils<br>Minimum average<br>Lowest individual reading<br>Lowest individual of 8 of 10 readings | ASTM D 5199<br>ASTM D 5994 (textured) | <br>60<br>54<br>NA | <br>57<br>51<br>54 |
| Density, g/cc | ASTM D 1505/ D 792 | 0.94 | 0.94 |
| Asperity Height, mils | ASTM D 7466 | NA | 10 |
| Tensile Properties[1]<br>1. Yield Strength, lb/in<br>2. Break Strength, lb/in<br>3. Yield Elongation, %<br>4. Break Elongation, % | ASTM D 6693 | <br>126<br>228<br>12<br>700 | <br>126<br>90<br>12<br>100 |
| Tear Resistance, lb | ASTM D 1004 | 42 | 42 |
| Puncture Resistance, lb | ASTM D 4833 | 108 | 90 |
| Stress Crack Resistance[2], hrs | ASTM D 5397 | 300 | 300 |
| Carbon Black Content, % | ASTM D 4218 or ASTM D 1603 | 2.0 – 3.0 | 2.0 – 3.0 |
| Carbon Black Dispersion[3], Category | ASTM D 5596 | 1 or 2 and 3 | 1 or 2 and 3 |
| Oxidative Induction Time (OIT)[4] (min. avg)<br>Standard OIT, minutes<br>High Pressure OIT, minutes | <br>ASTM D 3895<br>ASTM D 5885 | <br>100<br>400 | <br>100<br>400 |
| Oven Aging @ 85°C<br>Standard OIT, % retained after 90 days<br>High Pressure OIT, % retained after 90 days | ASTM D 5721<br>ASTM D 3895<br>ASTM D 5885 | <br>55<br>80 | <br>55<br>80 |
| UV Resistance[5]<br>High Pressure OIT[6], % retained after 1600 hrs | ASTM D 7238<br>ASTM D 5885 | <br>50 | <br>50 |
| Seam Properties (4 out of 5 specimens, 5th specimen can be as low as 80%)<br>1. Shear Strength, lb/in<br>2. Peel Strength, lb/in | ASTM D 6392 | <br>120<br>91 & FTB (78, ext. weld) | <br>120<br>91 & FTB (78, ext. weld) |

[1] Machine direction (MD) and cross machine direction (XMD) average values will be on the basis of 5 test specimens each direction. Yield elongation is calculated using a gauge length of 1.3 inches; break elongation is calculated using a gauge length of 2.0 inches.
[2] The yield stress used to calculate the applied load for the Single Point Notched Constant Tensile Load (SP-NCTL) test will be the mean value via MQC testing
[3] Carbon Black Dispersion for 10 different views; 9 in Categories 1 and 2 and 1 in Category 3.
[4] The manufacturer has the option to select either one of the OIT methods listed to evaluate the antioxidant content in the geomembrane.
[5] The condition of the test will be 20 hr UV cycle at 75°C followed by 4 hr condensation at 60°C.
[6] UV resistance is based on percent retained value regardless of the original HP-OIT value.
[7] Required values are based on GRI GM13, except for the seam properties which are based on GRI GM19.

## Table 10-6

## Required Testing for 40-mil LLDPE Geomembrane (Textured)[1]

| Test | Property | Frequency | Test Method |
|---|---|---|---|
| Resin | Specific Gravity/Density<br>Melt Flow Index | Per 200,000 lbs and every resin lot<br>Per 100,000 $ft^2$ and every resin lot | ASTM D 1505 or ASTM D 792<br>ASTM D 1238 |
| Manufacturer's Quality Control | Thickness<br>Specific Gravity/Density<br>Carbon Black Content<br>Carbon Black Dispersion<br>Tensile Properties<br>Tear Resistance<br>Puncture Resistance<br>Axi-Symmetric Break Resistance Strain<br>Oxidative Induction Time<br>Oven Aging @ 85°C<br>(a) Standard OIT, or<br>(b) High Pressure OIT<br>UV Resistance<br>High Pressure OIT<br>Asperity Height[2] | Per roll of geomembrane<br>Per 200,000 lbs and every resin lot<br>Per 20,000 lbs<br>Per 45,000 lbs<br>Per 20,000 lbs<br>Per 45,000 lbs<br>Per 45,000 lbs<br>Per each formulation<br>Per 200,000 lbs<br>Per each formulation<br>Per each formulation<br>Every second roll of geomembrane | ASTM D 5994<br>ASTM D 1505 or ASTM D 792<br>ASTM D 4218 or ASTM D 1603<br>ASTM D 5596<br>ASTM D 6693 Type IV<br>ASTM D 1004<br>ASTM D 4833<br>ASTM D 5617<br>ASTM D 3895 or ASTM D 5885<br>ASTM D 5721<br>ASTM D 3895<br>ASTM D 5885<br>ASTM D 7238<br>ASTM D 5885<br>ASTM D 7466 |
| Conformance Testing by 3rd Party Independent Laboratory | Thickness[2]<br>Specific Gravity/Density<br>Carbon Black Content<br>Carbon Black Dispersion<br>Tensile Properties | Per 100,000 $ft^2$ and every resin lot | ASTM D 5994<br>ASTM D 1505 or ASTM D 792<br>ASTM D 4218 or ASTM D 1603<br>ASTM D 5596<br>ASTM D 6693 Type IV |
| Destructive Seam Field Testing[3] | Shear & Peel | Various for field, lab & archive | ASTM D 6392 |
| Non-Destructive Seam Field Testing | Air Pressure<br>Vacuum | All dual-track fusion weld seams<br>All non-air pressure tested seams when possible | ASTM D 5820<br>ASTM D 4437 |

[1] All tests will conform to the minimum requirements set forth by GRI testing standard GM17. Required values for the properties are listed in Table 10-7.
[2] Field thickness measurements for each roll must be conducted. The lowest 8 out of 10 values will not be less than 10% below the nominal thickness and no single measurement will be less than 15% below the nominal thickness for the roll to be acceptable.
[3] Passing criteria for the geomembrane materials are listed in Table 10-7. Passing criteria for seams are listed in Section 5.4.8.3.3

**Table 10-7**

**Minimum Required Property Values for 40-mil LLDPE Geomembrane (Textured)[1]**

| Property | Test Method | Minimum Required Value |
|---|---|---|
| Thickness, mils<br>Minimum average<br>Lowest individual reading<br>Lowest individual of 8 of 10 readings | ASTM D 5994 | <br>38<br>34<br>36 |
| Density, g/cc (max.) | ASTM D 1505/ D 792 | 0.939 |
| Asperity Height, mils[1] | ASTM D 7466 | 10 |
| Tensile Properties[2]<br>1. Break Strength, lb/in<br>2. Break Elongation, % | ASTM D 6693 Type IV | <br>60<br>250 |
| Tear Resistance, lb | ASTM D 1004 | 22 |
| Puncture Resistance, lb | ASTM D 4833 | 44 |
| Break Resistance Strain, % (min.) | ASTM D 5617 | 30 |
| Carbon Black Content, % | ASTM D 4218 or ASTM D 1603 | 2.0 – 3.0 |
| Carbon Black Dispersion[3], Category | ASTM D 5596 | 1 or 2 and 3 |
| Oxidative Induction Time (OIT)[4] (min. avg)<br>Standard OIT, minutes<br>High Pressure OIT, minutes | <br>ASTM D 3895<br>ASTM D 5885 | <br>100<br>400 |
| Oven Aging @ 85°C<br>Standard OIT, % retained after 90 days<br>High Pressure OIT, % retained after 90 days | ASTM D 5721<br>ASTM D 3895<br>ASTM D 5885 | <br>35<br>60 |
| UV Resistance[5]<br>High Pressure OIT[6], % retained after 1600 hrs | ASTM D 7238<br>ASTM D 5885 | <br>35 |
| Seam Properties (4 out of 5 specimens, 5th specimen can be as low as 80%)<br>Shear Strength, lb/in<br>Peel Strength, lb/in | ASTM D 6392 | 60<br>50 & FTB<br>(44, ext. weld) |

[1] Measurement side will be alternated for double-sided textured sheet.
[2] Machine direction (MD) and cross machine direction (XMD) average values will be on the basis of 5 test specimens each direction. Break elongation is calculated using a gauge length of 2.0 inches.
[3] Carbon Black Dispersion for 10 different views; 9 in Categories 1 and 2 and 1 in Category 3.
[4] The manufacturer has the option to select either one of the OIT methods listed to evaluate the antioxidant content in the geomembrane.
[5] The condition of the test will be 20 hr UV cycle at 75°C followed by 4 hr condensation at 60°C.
[6] UV resistance is based on percent retained value regardless of the original HP-OIT value.
[7] Required values are based on GRI GM17, except for the seam properties which are based on GRI GM19.

## 5.3. Installation Procedures

The geomembrane liner installation procedures shall be conducted by the GMI and observed by QAO. The installation procedures shall conform to the following requirements:

### 5.3.1. Surface Preparation

The surface to be lined shall be prepared so as to provide a surface which is relatively free of irregularities, loose earth, desiccation cracks, and abrupt changes in grade. This preparation shall consist of the removal of loose scale materials which might damage the geomembrane. Prior to placing geomembrane materials, the GMI shall execute a subgrade acceptance form unless installed over a GCL. This form shall be submitted to the QAO and signed by the QAE and the Owner. A copy of this form has been included in Appendix A.

### 5.3.2. Delivery and Storage

All rolls of geomembrane delivered to the site shall be marked with the name of the manufacturer, the product type, the nominal thickness, the manufacturing batch code, roll number, date of manufacture, and roll dimensions. The QAO must inspect the delivered materials for damage and defects. Pushing, sliding or dragging or rolls or pallets can cause damage and must be avoided. The geomembrane rolls shall be kept free of dirt and debris, must be protected from soft or wet ground and rocky or rough ground, and must not be stacked more than five (5) rolls high to avoid crushing the cores of the rolls. A sacrificial cover must be used to protect the geomembrane if stored on site for more than six (6) months. The rolls shall be stored on level ground in such a manner as to avoid shifting, abrasion, or other adverse movements that can damage the geomembrane materials.

### 5.3.3. Geosynthetic Materials Anchor Trench

A geosynthetic materials anchor trench shall be completed along the perimeter of the area to be lined where indicated on the project contract documents. The anchor trench may be excavated in sections, as necessary. Loose soil shall be removed from the anchor trench and shall not underlie the geosynthetic materials to be placed in the anchor trench. The excavated anchor trench shall have rounded corners in order to help protect the geosynthetic materials. The anchor trench shall conform to the dimensions and requirements shown on the project contract documents.

### 5.3.4. Geomembrane Deployment

#### 5.3.4.1. Weather Conditions

Geomembrane deployment shall not proceed:

- During precipitation events;
- In the presence of excessive moisture (humidity);
- In areas of ponded water; or,
- In the presence of excessive wind.

#### 5.3.4.2. Temporary Geomembrane Anchoring

All unseamed edges of geomembrane panels shall be temporarily anchored each day using sand bags, rubber tires or a comparable means that does not damage the material, and does not degrade during the time it is in use. Similar procedures may be used to temporarily anchor the geomembrane in the anchor trench. Penetrating anchors shall not be used for temporary anchorage unless the penetrations will be beyond the inside wall of the anchor trench and will not require repair. Anchorage shall be sufficient to prevent loss or damage.

### 5.3.4.3.Panel Placement and Alignment

The geomembrane shall be deployed in accordance with the procedures outlined below:

- Only those geomembrane panels which can be seamed in one (1) day should be deployed.
- Each geomembrane panel shall be inspected for damage and manufacturing defects prior to seaming.
- Geomembrane panels shall be placed in a controlled manner, such as pulling, hoisting, or rolling. The geomembrane panels shall be installed such that there will be neither excessive tension nor wrinkles that could cause creasing in the final use condition. Wrinkles shall be walked out or removed as much as possible prior to field seaming.
- Panels shall be placed in such a manner that the geomembrane is not scratched or crimped. Any such damage shall be repaired or removed and replaced in accordance with the procedures described in Section 5.3.7.
- Adjacent geomembrane panels shall be overlapped a minimum of three (3) inches (HDPE) after seaming is completed. The QAI shall visually inspect the placement and overlap of the geomembrane to verify that the material is placed with sufficient overlap. Geomembrane seams with insufficient overlap shall be repaired or replaced.
- Geomembrane panels shall be placed such that there are no horizontal or cross-panel seams on the side slopes unless approved by the QAE and the owner. In addition, geomembrane panels placed on the bottom shall be overlapped from top to bottom in the downslope direction. In this configuration the upslope geomembrane panel will overlie the immediately adjacent downslope panel. This overlap shall be a minimum of three (3) inches.
- The geomembrane panels shall be placed and aligned such that seam joining of the sidewalls and bottom sections must be located in the bottom and at least five (5) feet from the sidewall. In corners and odd-shaped geometric locations, the number of field seams should be minimized.
- No vehicular traffic shall be allowed on the geomembrane. Only low-ground pressure supporting equipment may be allowed to traverse the geomembrane. The equipment used for placement and seaming shall not damage the geomembrane by leaking fluids or other means. Areas which are damaged in this manner shall be removed or repaired.
- Personnel working on the geomembrane shall not smoke, wear damaging shoes, throw equipment or engage in other activities which could damage the geomembrane.

#### 5.3.4.4. Panel Identification

As each geomembrane panel is placed, it shall be labeled in bold print visible from a distance of approximately thirty (30) feet. In general, these markings shall be placed in an area which will remain un-obscured until subsequent layers are placed. Panel numbers shall be sequential based on the placement order. The roll number from which the panel is from shall be included with the panel number.

### 5.3.5. Field Seaming

All field seaming shall be performed using method(s) approved by the manufacturer of the geomembrane sheet. For HDPE geomembrane, this will include fusion and extrusion welding.

#### 5.3.5.1. Weather Conditions

Field seaming of the geomembrane shall not be performed at ambient temperatures below 40° Fahrenheit (F) [5° Celsius (C)] unless the geomembrane seam area is preheated, by sun or hot air device, to a temperature in excess of 50°F (5°C). However, in any case, field seaming of the geomembrane shall not be performed at ambient temperatures below 34°F (1°C). The GMI shall consult with the QAE if it is anticipated that seaming will be attempted or performed above 113°F (45°C) ambient air temperature. The QAE shall establish and the GMI shall implement agreed-upon measures to prevent liner stretching and thickness reduction or no seaming shall be performed above 113°F (45°C) ambient air temperature. The temperature shall be recorded at regular, periodic intervals by the GMI.

#### 5.3.5.2. Trial Seams

All personnel responsible for seaming shall perform a trial seam prior to the start of seaming with each apparatus used that day. The beginning of each seaming period is considered to be the morning, and immediately after a break. Whenever seaming with a particular apparatus is discontinued for more than one hour or turned off more than ten (10) minutes, a new trial seam shall be performed. An additional trial seam shall be performed for each seaming period for each apparatus used that day, and for each six (6) hours if a break is not taken. In any instance, a minimum of one (1) trial seam shall be performed for each six (6) hours of operation for each seaming apparatus used.

An additional trial seam shall also be performed for each occurrence of significantly different environmental conditions (i.e., temperature, humidity, dust, etc.), and when fusion seaming different geomembranes (tie-ins and smooth to textured). Both the welder and the machine must be tested for each trial seam when extrusion welding. Only the machine needs to be tested for each new trial seam when fusion welding, since the machine is not as operator dependent. Each individual seaming shall make at least one (1) trial seam each day they actually perform seaming.

Trial seams shall be performed on "fragment" pieces of geomembrane and shall be a minimum of twelve (12) inches in width by three (3) feet in length. A minimum three (3) inch overlap shall be provided and the seam shall be approximately centered throughout the length of the geomembrane fragment used. All trial seams shall be performed under the same conditions as production seaming. Trial seams shall be tested in the field by the GMI for peel and shear performance, as outlined in Sections 5.4.6 and 4.4.7.

#### 5.3.5.3. General Seaming Requirements

All geomembrane seams shall extend to the end of each panel to be anchored. All geomembrane seams shall be clean and free of moisture, oil, dust, dirt, debris of any kind, and foreign matter at the time of welding. No folds, large wrinkles, or fish mouths shall be allowed in the seam. Only normal factory-induced creasing from the blown film process may be acceptable. Where wrinkles or folds occur, the material shall be cut and overlapped, and an extrusion weld applied, in accordance with the procedures outlined in this LQCP. Areas of insufficient overlap shall be repaired in accordance with the procedures detailed in Section 5.3.7. All complete seams shall be tightly bonded and sealed.

If geomembrane seaming operations are performed at night, adequate lighting shall be provided for seaming as well as for inspection of the seaming conditions and the seams.

#### 5.3.5.4. Extrusion Seaming Requirements

The extrusion welding apparatus shall have a temperature gauge which indicates the temperature of the extrudate. Additionally, the temperature of the extrudate at the nozzle will be monitored at the time of trial seaming using a probe (pyrometer). A significant difference (greater than 15°C) in the indicated vs. monitored temperature shall result in investigation and repair of the seaming apparatus. The QAI may request that the GMI check extrudate temperatures at other times as well.

The extruder shall be purged to remove heat-degraded material prior to the beginning of seaming and whenever the extruder is stopped for an appreciable length of time.

Grinding in preparation for extrusion welding should be done carefully. Grinding beyond the area to be covered with extrudate is unnecessary, and will be minimized. Grinding shall not extend more than one-eighth (1/8) inch beyond the edge of the seam.

#### 5.3.5.5. Fusion Seaming Requirements

The fusion welding apparatus shall be a vehicular mounted, automated device. The temperature, pressure and welding speed shall be independently adjustable and the apparatus shall be equipped with a gauge which displays the actual internal temperature.

### 5.3.6. Nondestructive Seam Continuity Testing

The GMI shall conduct the following nondestructive seam continuity testing:

#### 5.3.6.1. General

Continuous non-destructive testing shall be performed on all seams by the GMI. Air pressure testing shall be performed on all dual track fusion welds and vacuum-box testing for extrusion welds are the only acceptable methods for geomembrane seams. All leaks identified during testing must be isolated and repaired by the following procedures described in this LQCP.

Areas thought to be potentially inaccessible to nondestructive continuity testing equipment shall be brought to the QAE's attention prior to the start of work.

Nondestructive continuity testing of field seams, including repairs, shall be performed by the GMI as the work progresses to provide the opportunity for immediate rewelding and retesting as necessary. All defects discovered shall be marked, repaired and retested.

#### 5.3.6.2. Testing Procedures

The GMI shall submit the proposed specific nondestructive testing procedures to be employed on this project to the QAE. The testing procedures shall be consistent with the requirements of this specification. The testing procedures must be approved by the QAE.

For vacuum box testing, a suction value of approximately three (3) to five (5) inches of gauge vacuum shall be applied to all extrusion seams that can be tested in this manner. The seam that has been wetted with soapy water must be observed for leaks a minimum of five (5) seconds while subjected to this vacuum. Areas where soap bubbles appear shall be marked, repaired and re-tested. The GMI shall record the test results, including technician ID, date, time and pass/fail condition on the geomembrane near the test location.

For air pressure testing, the air space created by the fusion weld shall be tested for continuity. The ends of the air channel of the dual track fusion weld must be sealed and pressured to a minimum of 30 psi. The air pump must then be shut off and the air pressure observed after five minutes. A loss of less than four (4) psi is acceptable, if it is determined that the air channel is not blocked between the sealed ends. A loss of more than four (4) psi indicates the presence of a seam leak which must then be marked, isolated, repaired and re-tested. The GMI shall record the test results, including technician ID, date, the before and after times and pressures and pass/fail condition at a minimum on the geomembrane near the test location. All openings in air channels must be sealed subsequent to testing.

### 5.3.7. Defects and Repairs

#### 5.3.7.1. General

All seam and non-seam areas of the geomembrane shall be visually inspected for signs of defective seams, blisters, punctures, undispersed raw materials, and any sign of contamination by foreign matter. Any problems discovered shall be marked, repaired and retested or reevaluated in accordance with this document. The geomembrane surface shall be clean at the time of these inspections.

Any sheets which become seriously damaged (torn or twisted permanently) shall be replaced. Less serious damage (inadvertent punctures during installation) shall be repaired by welding a piece of geomembrane over the damaged area. The repairs must comply with the LQCP to be considered adequate.

#### 5.3.7.2.Evaluation

Each suspect location in both seam and non-seam areas shall be inspected and, where appropriate, tested using the methods described in this document. Work shall not proceed with any materials which will cover the locations which require repair or which have been repaired but require testing with passing results.

#### 5.3.7.3.Procedures for Repair

Grinding and welding procedures may be used to repair small sections of deficient extrusion seams and small surface blemishes which do not penetrate the entire thickness of the geomembrane. The geomembrane surfaces requiring repair shall be abraded no more than one hour prior to the repair being made. The allowable time between abrading the surface and making the repair may be reduced if determined necessary by the QAI. Grinding shall be performed only within the area requiring repair and shall not significantly damage the liner.

Defects which do not require replacement of the sheet shall be repaired and covered with a patch or a cap (a patch with an extended length). Patches and caps shall extend a minimum of six (6) inches beyond the limits of the defect and all corners of patches and caps shall be rounded with a radius of approximately two inches. All seaming for patches and caps shall be accomplished by extrusion welding.

The GMI shall record repair information, including technician and seaming apparatus ID, date, and time on the repair or on the geomembrane near the repair.

### 5.3.8. Permanent Anchorage in Anchor Trench

Following completion of the seaming activities as determined by the GMI, the geomembrane (and any other geosynthetic materials) shall be permanently anchored in the anchor trench. A detail indicating proper anchoring procedures is included in the project contract documents. The anchor trench shall be backfilled and compacted using hand-operated or rubber-tired equipment. Care should be used when backfilling and compacting the anchor trench to prevent damage to the geosynthetic materials. The final configuration of the anchor trench shall conform to the dimensions and requirements shown on the project contract documents.

### 5.4.Quality Assurance Requirements

The QAO shall review quality control documents, conduct material conformance tests and inspect the placement and installation of the geomembrane, and coordinate necessary surveys. In addition, the QAI shall ensure the following QA verification activities are performed:

#### 5.4.1. Inspection Upon Delivery

The QAI shall inspect the geomembrane material delivered to the site. All rolls of geomembrane shall be marked with the name of the manufacturer, the product type, the nominal thickness, the manufacturing batch code and/or roll number, date of manufacture, and roll dimensions. The QAI shall document that the quality control and conformance data has been received and is acceptable for each roll. The QAI shall also verify that the geomembrane rolls are being stored in a manner to protect them from the elements.

#### 5.4.2. Thickness Determination

The QAI shall check the thickness of each roll of geomembrane delivered to the site. Thickness shall be checked with a micrometer on the leading edge at five (5) locations. The geomembrane shall meet the required material properties. See Section 5.2, except that thickness criteria are for five (5) measurements or four of five as appropriate. Geomembrane rolls which fail this thickness determination shall be removed from the site. The QAI shall document the thickness determinations taken for each roll.

#### 5.4.3. Inspection During Deployment

The QAI shall visually inspect the deployment of the geomembrane to ensure that the panels are properly placed and that each seam will have sufficient overlap.

#### 5.4.4. Observation of Non-Destructive Testing

The GMI shall coordinate the non-destructive testing with the QAE to ensure that a QAI is present for non-destructive testing. The QAE or QAI will verify that all non-destructive testing is successfully completed and will document the testing on data forms.

#### 5.4.5. Survey Documentation

The QAE shall locate all seams, destructive test locations and patches for the geomembrane and may coordinate a survey for such purposes if appropriate. Reference locations will be noted on a drawing of the area.

#### 5.4.6. Trial Seam Testing

Each trial test seam shall be at least three (3) feet long by one (1) foot wide. Four (six when possible if using dual track fusion welding) adjoining one (1) inch wide specimens shall be cut in a controlled manner, by die or template from the test seam sample. Two (2) specimens shall be tested in the field for shear, and two (2) for peel (four [4] when possible if testing both inner and outer welds for dual track fusion welding) using testing procedures outlined in the following paragraph. Specimens cut in an uncontrolled fashion to a random width shall not be used.

All trial seam specimens shall be tested by the GMI and observed by a QAI in the field for shear and peel using an electrically operated tensiometer, with the capability of registering the force imparted on a geomembrane test specimen. Hand operated tensiometers shall not be used. The trial seam specimens shall be tested at a cross-head rate of two (2) inches per minute. The GMI shall provide a calibration certificate for each load cell within the tensiometer. Calibration shall have been conducted within 90 days of the start of installation.

The GMI's seaming and testing technician(s) shall record the following information on a remnant portion of the trial seam sample. The remnant portion will be retained until project completion and may then be stored by the Owner. The QAI will log the information on a data form and assign each sample a number.

- Date and time of test;
- The name of the welder and identification of the apparatus used in performing the test;
- The failure mode: either "Pass" indicating a film-tear bond not in the weld or "Fail" for each specimen; and,
- The peak yield load in pounds per inch for each specimen.

### 5.4.7. Trial Seam Evaluation Criteria

The criteria for evaluating trial seams is as follows:

#### 5.4.7.1.Shear

Two (2) trial seam specimens shall be tested in shear. Each must fail at a strength equal to or greater than ninety five percent (95%) of the rated yield strength of the parent sheet material as indicated on the manufacturer's quality control certifications, but in no instance at less than the specified yield strength for sheet material. Neither trial seam test shall fail in the weld. If both of these criteria are not met, the entire trial seam shall be considered failing.

#### 5.4.7.2.Peel

Two (2) trial seam specimens (four if necessary to test both inner and outer welds) shall be tested in peel and neither shall fail in the weld area. If this criteria is not met, the entire trial seam shall be considered failing. The peel strength of the geomembrane outside of the weld shall be equal to or greater than sixty two percent (62%) of the rated yield strength of the parent sheet material as indicated on the manufacturer's quality control certifications, but in no instance less than 90 ppi for fusion seams and 78 ppi for extrusion seams. Peel seams must exhibit a Film Tear Bond (FTB) failure.

If a trial seam fails, the entire procedure shall be repeated after the appropriate adjustments to the welding apparatus or procedures have been made. This process shall be repeated until two (2) consecutive successful trial seam tests have been achieved. Alternatively, if a successful trial seam is not achieved, the welding apparatus and/or the operator shall not be used for seaming until such time as the deficiencies are resolved.

### 5.4.8. Destructive Seam Testing

#### 5.4.8.1. Testing Location and Frequency

Destructive seam samples will be obtained at an average minimum frequency of one (1) per five hundred (500) lineal feet of weld. Destructive seam-testing locations shall be cap-stripped and the cap completely seamed by extrusion welding to the geomembrane. Capped sections shall be non-destructively tested. The seam destructive test sampling frequency may be increased by the QAE beyond the specified minimum based upon actual welding conditions and the results of other samples obtained.

The sample locations will be selected by the QAI as welding progresses. Additional sample locations may be prompted by suspicion of a poor quality weld.

The GMI will not be informed in advance of seam destructive test locations but will be required to physically obtain the samples from the geomembrane no later than twenty four (24) hours after the location has been selected.

The total footage of individual repairs of leaks of more than ten (10) feet and individual repairs of more than ten (10) feet for failed seams must also be counted and destructively tested using the same frequency of testing described above.

#### 5.4.8.2. Sample Size

The location for the destructive samples shall be marked by the QAI. The dimensions for the destructive samples shall, as a minimum, be twelve (12) inches wide by thirty six (36) inches long with the seam centered widthwise. Sample lengths may be increased at the request of the QAL. The GMI shall obtain two specimens from each end of the marked seam destructive sample, each a minimum of one inch in width for preliminary field testing as described in Section 5.4.8.3.1. If the preliminary field testing exceeds the pass/fail criteria, the sample shall be cut and divided into two parts as described below:

- One portion of the sample, measuring twelve (12) inches by fifteen (15) inches, to be sent by the QAO to the QAL for testing.
- One portion of the sample, measuring twelve (12) inches by twelve (12) inches to be retained by the owner for archiving.
- The sample length shall be increased to accommodate the additional length required by the GMI for laboratory testing or archiving.

### 5.4.8.3.Testing Procedure

#### 5.4.8.3.1.Preliminary Field Testing

Four (4) specimens, two (2) from each end of the destructive sample seam, are to be removed and tested by the GMI while in the field. One (1) specimen from each end of the original sample is to be tested in shear and the other in peel. Specimen and test procedures shall be the same as described for trial seams in Section 5.4.6. Field testing shall include testing on both tracks on dual track fusion welded seams for each specimen tested for peel.

#### 5.4.8.3.2.Laboratory Seam Destructive Testing

The destructive seam testing will be performed by QAO in an off-site laboratory. This testing is to be completed within seventy two (72) hours of the time the samples are removed from the geomembrane installation. The Contractor may test samples in the field with observation by the QAI.

The testing shall be performed on a total of ten (10) specimens obtained from the field sample described in Section 5.4.8.2. Five (5) specimens shall be tested in each of the shear and peel modes. For the dual-tracked fusion welds, five (5) peel tests shall be performed for each track of weld. These shear and peel specimens shall be selected from the sample alternately so that no two (2) immediately adjacent specimens are tested in the same mode.

The specimens shall be tested in accordance with ASTM D 6392.

#### 5.4.8.3.3.Seam Evaluation Criteria

Each seam sample must meet both the shear and peel criteria before being considered passing. Field tested specimens are determined as passing if the specimen tested in peel fails in FTB and all test specimens meet the criteria listed in this LQCP. The QAL testing must confirm these field results.

##### 5.4.8.3.3.1.Shear

The shear strength must be at least ~~ninety-five percent (95%) of the manufacturer's parent sheet yield strength, but no less than required material properties~~120 lb/in for HDPE geomembrane and 60 lb/in for LLDPE geomembrane. The minimum passing criteria for independent laboratory testing are all of the following: (1) at least four of the five specimens shall not fail in the weld, (2) at least four of the five specimens must meet the minimum specified value, and (3) the average value from all the specimens must meet the minimum specified value. The above criteria apply to both tracks from each dual track fusion welded seam before it is considered passing. If these criteria are not met then the entire seam destructive sample is considered failing.

##### 5.4.8.3.3.2. Peel

The peel strength must be at least ~~62% of manufacturer's parent sheet yield strength, but no less than the required material properties~~91 lb/in for HDPE geomembrane (78 lb/in for extrusion welds) and 50 lb/in for LLDPE geomembrane (44 lb/in for extrusion welds). The minimum passing criteria for laboratory testing are all of the following: (1) at least four of the five specimens shall not fail in the weld, (2) at least four of the five specimens must meet the minimum specified value, and (3) the average value from all five specimens must meet the minimum specified value. The above criteria apply to both tracks from each dual track fusion welded seam before it is considered as passing. If these criteria are not met, then the entire seam destructive sample is considered failing.

#### 5.4.8.3.4. Seam Destructive Test Failure Procedures

In the instance of the dual-tracked fusion weld, both tracks of the weld will be tested in peel. If either peel test performed on specimens of this weld type fails, the entire specimen is considered failing.

The GMI shall reconstruct the failing seam bound by two passing seam destructive tests. The GMI shall have the option of obtaining additional destructive test samples at a minimum of ten (10) foot intervals in both directions along the failing seam from the failure location. The minimum interval may be increased by the QAE if test failures become excessive.

If both of these samples pass the laboratory seam destructive test then the seam can be reconstructed between them. If one (1) or both of these samples fail the laboratory seam destructive test, then the procedure is repeated until passing laboratory results are obtained. (Note: The tracking procedure described may be extended beyond the limits of an individual seam.)

If a seam is reconstructed to a length in excess of fifty (50) feet, a seam destructive sample may be obtained from the reconstruction zone which must meet the requirements described above.

# 6. LEACHATE COLLECTION SYSTEM

The following requirements govern the leachate collection system used in the landfill units:

## 6.1. Leachate Collection System Description

The leachate collection system (LCS) used consists of layers of geotextile fabric, HDPE drainage net, gravel and piping, as described in conjunction with the lining systems in Section 1.2. In general, the LCSs will be sloped to drain to one or more collector pipes running through each landfill unit. The underlying lining system will be sloped to the collector pipe, and along the line of the collector pipe toward the sump. The sump will have a riser pipe for the removal of collected liquids. Detailed design descriptions and drawings of the leachate collection system and geocomposite drainage layer are provided in the project construction documents.

### 6.2.Required Material Properties

The LCS and geocomposite drainage layer materials shall be new, first quality materials manufactured specifically for the purpose of liquid conveyance and collection. All LCS and geocomposite drainage layer materials shall have sufficient strength and resistance to chemical or ultraviolet radiation attack for the intended use. Properties, test methods, testing frequencies, and required values are summarized in Table 10-8 below for geotextiles, drainage nets and drainage geocomposites.

**Table 10-8**

**Required Testing for Geotextile and Drainage Geocomposite[1]**

| Responsible Party | Material | Property | Test Method | Value |
|---|---|---|---|---|
| Manufacturer | Geotextile for Drainage Geocomposite | Unit Weight<br>Apparent Opening Size<br>Grab Strength<br>Grab Elongation<br>CBR Puncture Strength<br>Permittivity | ASTM D 5261<br>ASTM D 4751<br>ASTM D 4632<br>ASTM D 4632<br>ASTM D 6241<br>ASTM D 4491 | 8 oz/sy<br>0.15 mm<br>220 lb<br>50%<br>575 lb<br>1.3 $sec^{-1}$ |
| Manufacturer | Geotextile for leak detection trench wrap | Unit Weight<br>Apparent Opening Size<br>Grab Strength<br>Grab Elongation<br>CBR Puncture Strength<br>Permittivity | ASTM D 5261<br>ASTM D 4751<br>ASTM D 4632<br>ASTM D 4632<br>ASTM D 6241<br>ASTM D 4491 | 12 oz/sy<br>0.15 mm<br>320 lb<br>50%<br>925 lb<br>0.8 $sec^{-1}$ |
| Manufacturer | HDPE Geonet | Specific Gravity/Density<br>Thickness<br>Peak Tensile Strength<br>Percent Carbon Black<br>Transmissivity[2] | ASTM D 1505<br>ASTM D 5199<br>ASTM D 5035 or ASTM D 7179<br>ASTM D 1603 or ASTM D 4218<br>ASTM D 4716 | 0.94 $gm/cm^3$<br>250 mils<br>45 lb/in<br>2.0 %<br>$2 \times 10^{-3}$ $m^2/sec$ |
| Manufacturer | Drainage Geocomposite | Ply Adhesion | ASTM D 7005 | 1.0 lb/in |
| Manufacturer/ Third Party Lab | | Transmissivity[2] | ASTM D 4716 | $5 \times 10^{-4}$ $m^2/sec$ (double sided)<br>$1.5 \times 10^{-3}$ $m^2/sec$ (single sided) |

[1] The minimum testing frequency for materials in this table will be one test sample per 100,000 square feet.
[2] Gradient of 0.1, normal load of 10,000 psf, between steel plates for 15 minutes.

### 6.2.1. Geotextile

All geotextile fabric shall be non-woven polypropylene, meeting the following minimum specifications:

Geotextile fabric for use in drainage geocomposite:

| | |
|---|---|
| Mass per Unit Areas (ASTM D 5261) | 8 ounces per square yard |
| CBR Puncture Strength (ASTM D 6241) | 575 pounds |
| Grab Tensile Strength/Elongation (ASTM D 4632) | 220 pounds/50% |
| Apparent Opening Size (ASTM D 4751) | 0.15 mm |
| Permittivity (ASTM D4491) | 1.3 per second ($sec^{-1}$) |

Geotextile fabric for use in leachate collection/leak detection trench:

| | |
|---|---|
| Mass per Unit Areas (ASTM D 5261) | 12 ounces per square yard |
| CBR Puncture Strength (ASTM D 6241) | 925 pounds |
| Grab Tensile Strength/Elongation (ASTM D 4632) | 320 pounds/50% |
| Apparent Opening Size (ASTM D 4751) | 0.15 mm |
| Permittivity (ASTM D4491) | 0.8 per second ($sec^{-1}$) |

### 6.2.2. HDPE Drainage Net

Minimum specifications for HDPE Drainage Net:

| | |
|---|---|
| Thickness (ASTM D 5199) | 250 mils (average of all measurements) |
| Density (ASTM D 1505) | 0.94 $gm/cm^3$ |
| Peak Tensile strength (ASTM D 5035 or ASTM D 7179) | 45 ppi |
| Percent Carbon Black (ASTM D 1603 or ASTM D 4218) | 2.0% to 3.0% |
| Transmissivity (ASTM D4716) | 2 x $10^{-3}$ square meters per second ($m^2/sec$) at a gradient of 0.1 and a loading of 478.8 kilo-newtons per square meter ($kN/m^2$) [10,000 pounds per square foot] |

### 6.2.3. Piping

Minimum specifications for Liquids Collection Piping:

| | |
|---|---|
| Material | HDPE or PVC, single wall |
| Specifications | HDPE – ASTM F714<br>PVC – ASTM D1785, D2241 or D3034 |
| Standard Dimension Ratio (SDR) [Outside Diameter to Wall Thickness] | 21 Maximum |
| Joint Type | HDPE - Fusion Welded<br>PVC – Fusion or Solvent-Cement Welded |

| | |
|---|---|
| Perforation Type (Where required) | Round |
| Perforation Size (Where required) | ½" Max. |
| Perforation Area (Where required) | 1-1/2 square inches ($in^2$) per foot |

#### 6.2.4. Gravel

Minimum specifications for LCS gravel:

| | |
|---|---|
| Material Source | Washed, rounded river gravel |
| Maximum particle size (100% Passing – ASTM C136 or D422) | 2" |
| At least 90% of Material Smaller Than (ASTM C136 or D422) | 1-1/2" |
| No more than 10% of Material Smaller Than (ASTM C136 or D422) | ½" |
| Calcium Carbonate Content (ASTM D3042) | Less than 15% |
| Coefficient of Permeability (ASTM D2434) | Greater than 0.2 cm/sec |

### 6.3. Installation Procedures

The LCS and GDL material installation procedures shall be conducted by the GMI and observed by QAO. The installation procedures shall conform to the following requirements:

#### 6.3.1. Geotextile

##### 6.3.1.1. Delivery and Storage

All rolls of geotextile delivered to the site shall be marked with the name of the manufacturer, the product type, the manufacturing batch code, roll number, date of manufacture, and roll dimensions. The QAE or QAI must inspect the delivered materials for damage and defects. Damage during unloading must be avoided. The rolls shall be kept free of dirt and debris, must be protected from soft or wet ground and rocky or rough ground, and must not be stacked more than five (5) rolls high to avoid crushing the cores of the rolls. A sacrificial cover must be used to protect the rolls if stored on site for more than six (6) months. The rolls shall be stored in such a manner as to avoid shifting, abrasion, or other adverse movements that can damage the materials.

##### 6.3.1.2. Deployment

Geotextile shall not be deployed in the presence of excessive wind. On slopes, the geotextile shall be secured and rolled down the slope so that it is kept continuously in tension. Geotextile shall be placed parallel to sideslopes, except in special locations approved by the QAI. It shall be anchored in the synthetic materials anchor trench. All unseamed edges shall be temporarily anchored each day using sand bags, rubber tires or a comparable means that does not damage the material, and does not degrade during the time it is in use. During placement of the geotextile, the GMI shall ensure that it is not clogged with dirt or foreign materials. Geotextile shall be cut only with devices that are recommended by the manufacturer.

#### 6.3.1.3.Panel Placement and Alignment

Geotextile panels shall be deployed in accordance with procedures approved by the QAE. As a minimum, the procedures outlined below shall be followed.

- Only those panels which can be seamed in one (1) day should be deployed.
- Each panel shall be inspected for damage prior to seaming.
- Panels shall be placed in a controlled manner, such as pulling, hoisting, or rolling. The panels shall be installed such that there will be neither excessive tension nor wrinkles that could cause creasing in the final use condition. Wrinkles shall be walked out or removed as much as possible prior to field seaming.
- Adjacent panels shall be overlapped a minimum of three (3) inches (or as sufficient for seaming.) The QAE or QAI shall visually inspect the placement and overlap of the panels to verify that the material is placed with sufficient overlap.
- No vehicular traffic shall be allowed on the geotextile.

#### 6.3.1.4.Field Seaming

All field seaming shall be performed by sewing using polymeric thread having chemical and ultraviolet light resistance properties equal to or exceeding those of the geotextile. Thread shall be supplied by the geotextile manufacturer or shall be as recommended by the manufacturer. Provide documentation of the source or recommendation by the manufacturer. Glues and heat bonding are strictly prohibited. In general, horizontal seams or splices should be avoided on side slopes. No two adjacent slope pulls may have a horizontal seam.

#### 6.3.1.5.Procedures for Repair

Holes or tears in the geotextile shall be repaired by placing a patch extending at least six (6) inches beyond the edges of the hole or tear. The patch shall be seamed to the panel. Care shall be taken to remove any soil or other material which may have penetrated the damaged geotextile.

### 6.3.2. HDPE Drainage Net

#### 6.3.2.1.Delivery and Storage

All rolls of HDPE drainage net delivered to the site shall be marked with the name of the manufacturer, the product type, the manufacturing batch code, roll number, date of manufacture, and roll dimensions. The QAE or QAI must inspect the delivered materials for damage and defects. Pushing, sliding or dragging of rolls or pallets can cause damage and must be avoided. The rolls shall be kept free of dirt and debris, must be protected from soft or wet ground and rocky or rough ground, and must not be stacked more than five (5) rolls high to avoid crushing the cores of the rolls. A sacrificial cover must be used to protect the rolls if stored on site for more than six (6) months. The rolls shall be stored in such a manner as to avoid shifting, abrasion, or other adverse movements that can damage the materials.

#### 6.3.2.2.Deployment

HDPE Drainage net shall not be deployed in the presence of excessive wind. On slopes, the net shall be secured and rolled down the slope so that it is kept continuously in tension. Drainage net shall be placed parallel to sideslopes, except in special locations approved by the QAI. The drainage net shall be anchored in the synthetic materials anchor trench. All unseamed edges shall be temporarily anchored each day using sand bags, rubber tires or a comparable means that does not damage the material, and does not degrade during the time it is in use. During placement of the net, the GMI shall ensure that the net is not clogged with dirt or foreign materials.

#### 6.3.2.3.Panel Placement and Alignment

Drainage net panels shall be deployed in accordance with procedures approved by the QAE. As a minimum, the procedures outlined below shall be followed.

- Only those panels which can be seamed in one (1) day should be deployed.
- Each panel shall be inspected for damage prior to seaming.
- Panels shall be placed in a controlled manner, such as pulling, hoisting, or rolling. The panels shall be installed such that there will be neither excessive tension nor wrinkles that could cause creasing in the final use condition. Wrinkles shall be walked out or removed as much as possible prior to field seaming.
- Adjacent panels shall be overlapped a minimum of three (3) inches. The QAE or QAI shall visually inspect the placement and overlap of the panels to verify that the material is placed with sufficient overlap.
- No vehicular traffic shall be allowed on the drainage net.

#### 6.3.2.4.Field Seaming

All field seaming shall be performed using method(s) approved by the manufacturer of the HDPE drainage net. Seaming can be achieved using string, plastic fasteners or ties, or polymer braid. Metallic devices are strictly prohibited. Submit the proposed seam (tie-pattern) with the quality control documents. In general, no horizontal seams are allowed on side slopes.

#### 6.3.2.5.Procedures for Repair

Holes or tears in the drainage net shall be repaired by placing a patch extending at least six (6) inches beyond the edges of the hole or tear. The patch shall be seamed to the panel.

### 6.3.3. Piping

#### 6.3.3.1.Delivery and Storage

All piping delivered to the site shall be marked with the name of the manufacturer, the product type, and applicable specifications under which the material was manufactured. The QAE or QAI must inspect the delivered materials for damage and defects. Piping shall be kept free of dirt and debris, must be protected from soft or wet ground and rocky or rough ground, and must not be stacked more than ten (10) sections high. The piping shall be stored in such a manner as to avoid shifting, abrasion, or other adverse movements that can damage the materials.

#### 6.3.3.2. Deployment

Piping shall be placed to the lines and grades shown on the project construction documents. Piping shall be temporarily anchored using sand bags, rubber tires or a comparable means that does not damage the piping and ensures proper alignment until covered. During placement of the piping, the GMI shall ensure that dirt or foreign materials do not enter the piping.

#### 6.3.3.3. Field Joints/Seaming

All field joints or seaming shall be performed using fittings and method(s) approved by the manufacturer of the piping. Field joints shall be butt-fusion welded. For PVC piping, joints may be solvent-cement welded with prior written approval by the QAE. If solvent cement joints are to be completed over underlying geosynthetic materials, the GMI shall ensure that a sacrificial impermeable barrier is placed underneath each joint to prevent solvent material from coming in contact with the underlying material. Gasketed joints shall not be used.

#### 6.3.3.4. Procedures for Repair

Damaged piping shall be removed and replaced using procedures consistent with those for installing new piping.

### 6.3.4. Gravel

#### 6.3.4.1. Delivery and Storage

Gravel to be used for LCS construction shall be stockpiled as near as possible to the construction area. Signage near the stockpile shall identify the source, intended use, and gradation specifications (size). Gravel shall not be placed on wet ground.

#### 6.3.4.2. Deployment

Gravel may be placed using mobile equipment or hand tools (e.g. wheel barrows, etc.). Where gravel placement must traverse underlying geosynthetic materials, the GMI shall use only low-ground pressure supporting equipment. If such equipment is operating over the geosynthetic materials, it must be placed on a sacrificial surface or rub sheet. Areas of underlying geosynthetic materials that are damaged in this manner shall be repaired as required by this LQCP. Gravel shall be placed to the lines and grades shown on the project construction documents. Gravel materials shall not be placed in direct contact with geomembrance materials. Where this is possible to occur, the GMI shall place a layer of geotextile fabric between the gravel and the geomembrane. During placement of the gravel, the GMI shall ensure that it is not obstructed by dirt or foreign materials.

### 6.4. Quality Assurance Requirements

The GMS or the QAO shall conduct material conformance tests, as outlined in Section 1.9 and the QAO shall review quality control documents, inspect the placement and finishing of the LCS, and coordinate necessary surveys. In addition, the QAI shall ensure the following QA verification activities are performed:

#### 6.4.1. Inspection Upon Delivery

The QAI shall inspect the geosynthetic, piping and gravel materials delivered to the site, and shall document that the quality control and conformance data has been received and is acceptable for each material lot. The QAI shall also verify that the materials are being stored in a manner to protect them from the elements.

#### 6.4.2. Inspection During Deployment

The QAI shall visually inspect the deployment of the drainage net, geotextile, piping and gravel to ensure proper placement as outlined in the LQCP and in the project construction documents.

#### 6.4.3. Sieve Analysis (Gradation) for Gravel

A minimum of one (1) test for each 5,000 cubic yards ($cy^3$) or less of gravel shall be performed in accordance with ASTM C136 or ASTM D422. A minimum of one (1) test shall be performed regardless of the quantity.

#### 6.4.4. Survey Verification

The QAE shall coordinate a survey to locate the piping and verify that proper grades are achieved. Where required to document grades, a minimum of one (1) survey verification shall be made per 5,000 $ft^2$ of surface area. Reference locations will be noted on a drawing of the area.

## 7. PROTECTIVE COVER

The following requirements govern the protective cover that will be installed on top of constructed liner materials and leachate collection systems:

### 7.1. Protective Cover Description

Protective cover soil material will be placed with a minimum thickness of 2 feet over the drainage layer component of the leachate collection system, including drainage aggregate where applicable.

### 7.2. Required Material Properties

The protective cover will consist of soils that do not contain any materials detrimental to the underlying geosynthetics. The protective cover shall be free of organics, angular rocks, foreign objects, or other deleterious materials.

### 7.3. Installation Procedures

The protective cover soils shall be placed using low ground pressure equipment. The protective cover shall be placed by spreading in front of the spreading equipment with a minimum of 12 inches of soil between the spreading equipment and the underlying installed geosynthetics. Under no circumstances shall the construction equipment come into direct contact with the installed geosynthetics. Unless otherwise specified by the QAE, all lifts of protective cover soil placed over geosynthetics will conform with the following equipment and lift thickness guidelines.

| Equipment Ground Pressure (psi) | Minimum Lift Thickness (in) |
|---|---|
| < 5.0 | 12 |
| 5.1 – 8.0 | 18 |
| 8.1 – 16.0 | 24 |
| > 16.0 | 36 |

Protective cover placed on sideslopes shall be placed from the bottom and pushed up the slope.

### 7.4. Quality Assurance Requirements

The protective cover soil thickness shall be verified by field surveys using a minimum of one survey point per 5,000 square feet of constructed area. Surveys shall be performed by a licensed Texas land surveyor and the survey results shall be included in the GLER submittal.

During construction the QAE shall:

- ~~1.~~ Verify that grade control is performed prior to work.
- ~~1.~~ Verify that underlying geosynthetic installations are not damaged during placement operations or by survey grade controls. Mark damaged geosynthetics and verify and document damage repairs.
- ~~2.~~ Verify that cover soil for sideslopes is pushed from the toe up the slope.
- ~~3.~~ Monitor haul road thickness over geosynthetic installations and verify that equipment hauling and materials placement meet equipment specifications.

## 8. FINAL COVER CONSTRUCTION

The following requirements govern the final cover system used at the facility:

### 8.1. Final Cover Description

The final cover system will consist of a six (6) inch thick (minimum) prepared subgrade layer, a geosynthetic clay liner (GCL) layer, a forty mil (0.04 inch) thick LLDPE geomembrane liner, a geocomposite drainage layer, and a twenty five (25) inch thick protective cover soil layer. Soil materials used for the final cover system shall be obtained either from on-site or off-site sources.

## 8.2.Required Material Properties

Soil materials and geosynthetic materials used for final cover construction comply with the following required material properties.

### 8.2.1. Soil Materials

#### 8.2.1.1.Subgrade Soils

Soil materials shall meet the requirements of Section 2.2.

#### 8.2.1.2.Protective Cover Vegetative Soil Layer:

The soil material for the protective cover vegetative soil layer shall consist of earthen material capable of sustaining native plant gowth and be composed of particles of which at least thirty percent (30%) but no more than ninety six percent (96%) pass the #200 sieve.

### 8.2.2. Geosynthetic Materials

#### 8.2.2.1.Geosynthetic Clay Liner (GCL)

The GCL material shall meet the requirements of Section 4.2.

#### 8.2.2.2.Geomembrane Liner

The forty mil (0.04 inch) thick LLDPE geomembrane liner shall meet the requirements of Section 5.2.

#### 8.2.2.3.Geocomposite Drainage Layer

The HDPE drainage net and geotextile fabric used in the geocomposite drainage layer shall meet the requirements of Section 6.2.

## 8.3.Installation Procedures

The final cover installation procedures shall be conducted by the Earthwork Contractor and observed by QAO. The installation procedures shall conform to the following requirements:

### 8.3.1. Subgrade Preparation

The existing intermediate cover material shall be shaped to the appropriate lines and grades as shown in the project contract documents and should coincide with the bottom of the final cover system. Subgrade soil materials shall be installed in accordance with the procedures specified in Section 2.3.

#### 8.3.2. GCL Installation

The GCL shall be installed in accordance with the procedures specified in Section 4.8.

#### 8.3.3. Geomembrane Liner Installation

The forty mil (0.04 inch) thick LLDPE geomembrane liner shall be installed in accordance with the procedures specified in Section 5.3.

#### 8.3.4. Geocomposite Drainage Layer

The geocomposite drainage layer shall be installed in accordance with the procedures specified in Section 6.3.

#### 8.3.5. Protective Cover Vegetative Soil Layer

A minimum twenty five (25) inch thick layer of protective cover soil shall be placed above the geocomposite drainage layer on the top and side walls of the area to receive cover. Protective cover does not require compaction control; however it should be stable for construction, operations and maintenance traffic. Care shall be exercised in placement so as not to shift or wrinkle or damage the underlying geosynthetics layers. Protective cover shall be placed using low ground pressure dozers (i.e. track pressure less than 5 psi). A 12-inch thickness of protective cover shall be maintained at all times. A greater thickness will be required to support loaded hauling trucks and trailers and for turning areas. Drivers shall proceed with caution when on the overlying soil and prevent spinning of tires and sharp turns. Protective cover shall be placed in an upslope direction on sidewalls.

The required thickness of the protective cover layer will be verified by survey methods on an established grid system with not less than one verification point per 10,000 square feet of surface area.

## 9. GENERAL DOCUMENTATION REQUIREMENTS

The QAE shall be responsible for ensuring that adequate documentation is prepared to comply with the LQCP. Documentation may consist of daily recordkeeping, manufacturer’s test reports, conformance testing and installation reports, nonconformance reports (if necessary), progress reports, and design and specification revisions (if necessary). The appropriate documentation shall be used by the QAE to develop the GCLER, GLER and BER (if required) as well as other reports that may be required by the owner.

### 9.1. Daily Field Reports

The QAI shall prepare a daily field report. This report shall be prepared on the form included in Appendix C or a form containing similar information and shall be submitted to the owner and the QAE. The QAE shall review and sign all daily field reports. These daily field reports shall describe the work performed during the day.

### 9.2. Test Results

All tests shall be documented. The QAE shall develop and implement a tracking process to discretely identify each test result, including failures and subsequent re-tests. All laboratory tests shall have a written report prepared to indicate the results. The QAE or QAI shall review all test results and determine whether the test results meet project requirements. The QAE shall track each failing test result and shall require re-work or re-testing of the failed component to ensure that the completed component meets project requirements. Written and/or tabular summaries of field test results shall be prepared for inclusion in the GCLER/GLER. Copies of laboratory test results shall also be included in the GCLER/GLER.

### 9.3. Surveying Results

The QAE shall ensure that the surveying results are presented on a project drawing prepared to indicate the as-built condition of the constructed components. The QAE shall work with the surveyor to develop and implement a tracking process to discretely identify each surveyed location and the date on which the survey was conducted, including failures and subsequent re-surveys. The QAE shall track each failing survey result and shall require re-work or re-testing of the failed component to ensure that the completed component meets project requirements. Calculations supporting the thickness verifications shall be submitted by the surveyor to the QAE for inclusion in the GLER.

### 9.4. Sample Location Plan

The QAE shall be responsible for preparing and maintaining a site map which depicts the components being constructed on which can be documented the progress of the work, including inspections, sampling, testing and surveying. This map may be supplemented with additional maps and drawings sufficient to maintain proper records.

### 9.5. Final Reporting Requirements

The QAE shall be responsible for preparing, signing, and sealing the final GCLER/GLER document. The GCLER/GLER shall also be signed by the site operator and will be submitted to the TCEQ by the QAE. Submittal shall be to the MSW Permits Section of the Waste Permits Division for review and acceptance. If no response is received, either oral or written, within 14 days of receipt at the Waste Permits Division of the TCEQ, the report will be considered accepted. Any notice of deficiency received from the TCEQ will be promptly addressed and incorporated into the GCLER/GLER document. No solid waste will be placed over the constructed liner areas until final acceptance is obtained from the TCEQ.

If a layer of waste has not been placed over the top of protective cover within six months, then the QAE or the design engineer will visually observe that the protective cover has not undergone significant erosion that could compromise the protection of the underlying geosynthetics. A letter report documenting the observation of the cover and the repair measures undertaken to correct any cover damage will be submitted to the TCEQ for review and acceptance. This procedure shall be repeated at six month intervals until all protective cover has been covered with a layer of waste.

The QAE shall be responsible for preparing, signing and sealing the final BER that will document that enough ballast has been placed in a lined area to offset the potential hydrostatic uplift forces which may exist below the liner. The BER shall also be signed by the site operator and will be submitted to the TCEQ by the QAE. The BER shall also verify that the liner did not undergo uplift during construction. Additional documentation to accompany the BER includes a waste as ballast placement record completed and signed by the site operator, a survey of the top of waste elevations to document that the required waste thickness has been placed, and ballast thickness calculations. Submittal of the BER shall be to the MSW Permits Section of the Waste Permits Division for review and acceptance. The ballast placement and BER will not be considered accepted, and the temporary dewatering system must remain operational, until the TCEQ has given confirmation of its acceptance, or 14 days from the date of arrival of the BER at the Waste Permits Division, TCEQ have lapsed.

## 10. CONSTRUCTION BELOW THE HIGHEST GROUNDWATER LEVEL

### 10.1. Applicability

Future landfill sectors may be constructed below groundwater levels and could potentially experience uplift due to hydrostatic pressure acting on the liner system. Measures for both short term and long term protection of the liner system against uplift forces are described in this section of the LQCP.

A temporary dewatering system consisting of a dewatering drainage geocomposite and dewatering piping installed in gravel filled collection trenches will be installed below the footprint of future sectors prior to construction of the new liner. The geocomposite will also extend up the sidewalls of each newly developed sector to prevent the buildup of hydrostatic forces on the liner system. The sidewall geocomposite will drain to a toe trench and dewatering pipe collection system that will flow to a dewatering sump at the low point of the sector.

Long term protection of the liner system will be accomplished with the placement of sufficient ballast consisting of a combination of drainage gravel, protective cover soils, waste and final cover as applicable. Sample ballast calculations are provided in Appendix E – Example Ballast Calculations.

The highest groundwater elevation contours are shown on Figure III.10D-1of Appendix D. The contours on this drawing are based upon the highest individual reading in each of the monitor wells shown and do not represent a single event, existing conditions or groundwater flow. This contour map will be updated with the design of each new sector or partial sector to incorporate any higher well level data that has been recorded since the previous sector was constructed.

### 10.2. Dewatering System

To prevent the buildup of hydrostatic forces on the liner system, each new sector will have a temporary dewatering system installed prior to liner construction. The temporary dewatering system design is presented in Appendix D and consists of a drainage geocomposite extending across the floor of the sector that will transmit captured groundwater to a gravel filled collection trench that drains to a groundwater collection sump. The drainage geocomposite will also extend up the sidewalls and will drain to a gravel filled toe trench that coveys collected water to the groundwater collection sump. Water collected in the sump will be pumped to the facility perimeter stormwater drainage system. The drainage geocomposite will be covered with a 1-foot thick foundation soil layer that will serve as a subgrade for the GCL component of the liner system. The foundation soil layer will consist of on-site or off-site soil material that is free of organics, angular rocks, foreign objects or other deleterious materials.

Operation of the temporary dewatering system will continue until sufficient ballast is placed to offset the potential hydrostatic uplift forces acting on the liner. The liner can only be taken out of service upon the written approval of TCEQ once sufficient documentation of ballast placement has been submitted.

Alternate temporary dewatering systems may be submitted to TCEQ for consideration and approval if circumstances warrant the development of such alternate systems. A permit modification application must be submitted detailing the purpose and details of any such changes to this LCQP.

### 10.3. Dewatering System Materials

#### 10.3.1. Piping

The dewatering collection trench piping shall meet the requirements of Section 6.2.3. Collection pipes will be 6-inch diameter HDPE SDR 17 or an approved equal. Installation procedures shall be in accordance with Section 6.3.3.

#### 10.3.2. Drainage Gravel

Aggregate for the dewatering system collection trenches shall meet the minimum specifications listed in Section 6.2.4. Calcium carbonate content requirements for the dewatering system drainage gravel will be waived as the groundwater pH is expected to be neutral. Installation of the drainage gravel shall be in accordance with Section 6.3.4.

#### 10.3.3. Drainage Geocomposite

The drainage geocomposite shall meet the requirements specified in Appendix D as well the construction documents for the specific sector development project. Installation of the drainage geocomposite shall be in accordance with Section 6.3.

### 10.4. Operation of the Dewatering System

The dewatering system shall be kept in operation until the ballast evaluation report is submitted to and approved in writing by TCEQ. Pumps used for pumping out water that collects in the dewatering sumps shall be inspected on a weekly basis to ensure proper operation. The pumps will be controlled with pressure transducers to ensure that the groundwater is below the liner elevations. Alternatives to pressure transducers for measuring groundwater levels in the sump include bubbler levels or graduated measuring rods. The QAE will identify the allowable groundwater level in the dewatering sump for each sector. Water levels in the sump shall be recorded weekly and the volume of water pumped shall be recorded on a monthly basis.

### 10.5. Liner System Ballast

Liner protection against long-term hydrostatic uplift pressures will be provided by the counteracting weight of the materials placed above the geomembrane liner, referred to as ballast. The ballast includes the weight of the leachate collection system, protective cover soil materials, and compacted waste. Additional soil in excess of the minimum protective thickness may also be used as ballast. Example calculations for determining the height of compacted waste or additional protective cover soils above the liner system are provided in Appendix E. Once ballast has been placed to the calculated height above the liner in a newly constructed sector, the temporary dewatering system below the liner no longer needs to remain operational and the groundwater can be allowed to rebound against the bottom of the liner system. A ballast evaluation report (BER) must be prepared and submitted to TCEQ to document that the adequate height of ballast has been achieved in the sector to offset potential hydrostatic uplift forces, and to request that the temporary dewatering system operations be discontinued. Once the BER is accepted by the TCEQ in writing, operation of the temporary dewatering system may be discontinued.

Ballast calculations will be performed to provide an adequate thickness of soil and/or waste to offset the potential hydrostatic uplift forces for each sector constructed below the groundwater table. A calculated factor of safety against uplift of 1.5 will be required for ballasting with waste and a factor of safety of 1.2 will be used for soil ballast. The unit weight for waste used as ballast will be 1200 pounds per cubic yard. The unit weight for soil used as ballast will be determined by laboratory testing for each specific sector construction project.

Landfill personnel working under the supervision of the landfill superintendent will be on site full time during placement of the first 5 feet of waste over the liner system. The site operator will verify and document on a daily basis that this lower 5 feet of waste does not contain brush or large bulky items that could damage the liner system or that cannot be compacted to the required density. Documentation will also be provided on a daily basis that the waste for ballast has been compacted with compaction equipment which weighs in excess of 40,000 pounds. The site operator will complete and sign a waste-as-ballast placement record that will be attached to the BER. A copy of the form, TCEQ-10073, is included in Appendix F. The latest revision of TCEQ-10073 or an equivalent form will be submitted for each sector associated with the BER.

### 10.6. Verification of Liner Performance

The QAE will verify that the ballast placed is consistent with the established criteria and that uplift of the liner system did not occur during construction. The QAE shall observe the liner subgrade for evidence of seepage during construction. Any areas of seepage will be documented by the QAE as to seepage location, methods and procedures used to control the seepage, and continued monitoring of the seepage area after control.

To document that short-term uplift has not occurred during construction of the liner, the QAE shall verify that the elevations of the GCL are consistent with the design subgrade elevations on shown on the construction drawings. The QAE shall also verify that the protective cover elevations have not increased from those submitted with the GLER. Survey measurements to check against uplift will be taken at a minimum frequency of 1 point per 10,000 square feet. The protective cover uplift survey will be performed once between submittal of the GLER and the beginning of waste placement.

### 10.7. Documentation

The GCLER, GLER, and BER will include information relevant to construction of the liner below the groundwater table. The calculations for the constructed liner ballast installed over the liner system will be submitted with the BER. The GCLER and GLER shall include a discussion identifying areas constructed below the highest measured groundwater elevations and a discussion of current groundwater conditions. The GCLER and GLER shall also include a discussion addressing any seepage that may have been encountered during construction. The BER will contain survey information verifying that the appropriate depth of ballast has been installed and that the liner did not experience hydrostatic uplift.

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# APPENDIX D

Temporary Dewatering System Design

**CITY OF KINGSVILLE MUNICIPAL SOLID WASTE LANDFILL**
**GROUNDWATER GEOCOMPOSITE**

**~~Appendix~~ B DEWATERING DRAINAGE GEOCOMPOSITE FLOW CAPACITY**

**I. Objective:** Verify that the dewatering drainage geocomposite has the flow capacity for the estimated groundwater flows **and results in a reduction of hydrostatic forces by a factor of 1.2.**

**II. Approach:** Compute the maximum depth of groundwater in the geocomposite for the estimated design flow.

**III. Assumptions:**

- **A:** Design groundwater flow rate is 2.42 x $10^{-5}$ cfs/ft which equates to 11.5 gpm for the flow area of 8.47 ac.
- **B:** Assume 200 mil geocomposite calculations.

**IV. Calculations:**

for surface area 8.47 ac  Q= 11.5 gpm
Q= 0.02562 $ft^3$/sec

$$T_{max} = L \frac{[4(e/k) + \tan^2 B]^{1/2} - \tan B}{2 \cos B}$$

where,

$T_{max}$= Thickness of groundwater in the collection layer (meters (m))
L= Length of horizontal projection of groundwater layer (m)
e= impingement rate (m/sec)
k= hydraulic conductivity of drainage layer (m/sec)
B= Slope angle of the base of groundwater collection layer (degrees)

| | | | | |
|---|---|---|---|---|
| L=350 ft | L= | 106.715 | m | |
| use surface area (1 ac.) | e= | 2.12E-08 | m/sec | |
| compressed thickness of 187 mils | T= | 0.00475 | m | Use GSE HyperNet Geonet (200 mil) |
| 2.0 x $10^{-3}$ $m^2$/sec transmissivity | t= | 0.000185 | $m^2$/sec | Use t = t allow = 0.002 x [(1/1.5*1*1.2*1.5*4)] |
| k=t/T | k= | 0.039 | m/sec | t allow = t ult [(1/RFcr x Rfin x RFcc x RFbc*RFcb)] |
| | | | | RFcr=Creep Reduction Factor=1.5 |
| | tan B= | 0.020003 | | RFin= Intrusion Reduction Factor=1 |
| | B=arctan(0.02) | 1.146 | deg | RFcc=Chemical Clogging Reduction Factor=1.2 |
| | $T_{max}$= | 0.002894 | m | RFbc=Biological Clogging Reduction Factor=1.5 |
| | | 0.00949 | ft | RFcb=Soil Clogging Reduction Factor=4 |
| | | 0.1139 | in | |
| | | **113.9** | mils | |

Therefore, the selected 200 mil thick drainage geocomposite is adequate.

The GSE Drainage Design Manual, *Second Edition*  Chapter 2 – Fundamentals Of Geonets And Geocomposites

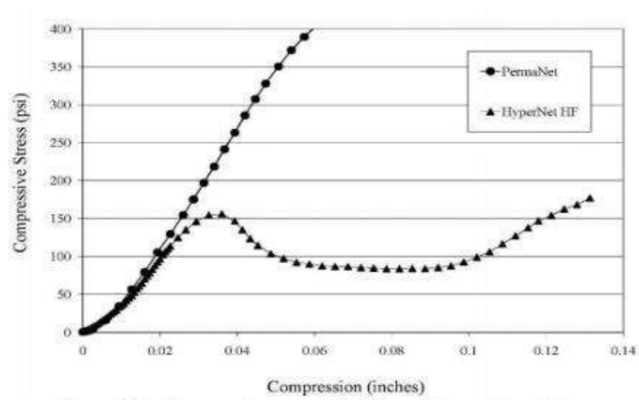



Figure 2.5. Compression strength of HyperNet vs. PermaNet.

## CITY OF KINGSVILLE MUNICIPAL SOLID WASTE LANDFILL
## GROUNDWATER GEOCOMPOSITE

### B DEWATERING DRAINAGE GEOCOMPOSITE FLOW CAPACITY (cont.)

The drainage geocomposite of the underdrain has been designed to remove groundwater inflows, so the uplift pressure in the geocomposite will be that resulting from the depth of liquid contained therein. The resulting upward hydrostatic pressure head acting on the liner (GCL, geomembrane and 2 feet of protective cover soil) is 0.1139 inches or 0.00949 feet. The factor of safety against hydrostatic uplift is calculated as follows:

| | |
|---|---|
| Hydrostatic Uplift Pressure = | 0.59 psf (.00949 feet of water head at 62.4 pcf) |
| Ballast Pressure = | 240 psf (2 feet of protective cover at 120 pcf) |
| Factor of Safety = | 407 > 1.2 OKAY |

Since the factor of safey is well above 1.2, the temporary dewatering system will provide adequate protection from uplift during its operation.

# APPENDIX E

Ballast Thickness Calculations

**EXAMPLE BALLAST THICKNESS CALCULATIONS**

Material Unit Weights:
Water = 62.4 pcf
Protective Cover = 120 pcf
Waste = 44.4 pcf

| Location of Ballast Evaluation | Top of Liner Elevation (ft-msl) | Historic High Groundwater Elevation (ft-msl) | Uplift Force due to Groundwater Head (psf) | Top of Protective Cover Elevation (ft-msl) | Protective Cover Resisting Force (psf) | Uplift FS from Protective Cover Only | Waste as Ballast Req'd? | Depth of Waste Ballast Required (feet) | Top of Waste as Ballast Elevation (ft-msl) |
|---|---|---|---|---|---|---|---|---|---|
| Sump 7B | 22.5 | 40.55 | 1126.3 | 24.5 | 240.0 | 0.2 | Y | 32.6 | 57.1 |
| Sump 7A | 22.5 | 40 | 1092.0 | 24.5 | 240.0 | 0.2 | Y | 31.5 | 56.0 |
| Sump 6B | 22.5 | 39.35 | 1051.4 | 24.5 | 240.0 | 0.2 | Y | 30.1 | 54.6 |
| Sump 6A | 22.5 | 38.9 | 1023.4 | 24.5 | 240.0 | 0.2 | Y | 29.2 | 53.7 |
| Sump 5B | 22.5 | 38.7 | 1010.9 | 24.5 | 240.0 | 0.2 | Y | 28.7 | 53.2 |
| Sump 5A | 22.5 | 38.5 | 998.4 | 24.5 | 240.0 | 0.2 | Y | 28.3 | 52.8 |
| Sump 4C | 22.5 | 37.4 | 929.8 | 24.5 | 240.0 | 0.3 | Y | 26.0 | 50.5 |

See Figure III.10D-2 in Part III, Attachment 10, Appendix D for elevations of liner and historic high groundwater contours.

The last two columns above show the minimum depth of waste as ballast and minimum elevation of the top of waste placed as ballast that is required to provide sufficient resisting force to offset the uplift force due to groundwater with a Factor of Safety of 1.5 at each location selected. The evaluation point selected in each of the sectors is the worst case in each sector with the greatest groundwater head above liner.

# FINAL FILLED CONDITION SUFFICIENT BALLAST CALCULATIONS

Material Unit Weights:
Water = 62.4 pcf
Protective Cover = 120 pcf
Waste = 44.4 pcf
Final Cover = 120 pcf

| Location of Ballast Evaluation | Top of Liner Elevation (ft-msl) | Historic High Groundwater Elevation (ft-msl) | Uplift Force due to Groundwater Head (psf) | Top of Protective Cover Elevation (ft-msl) | Protective Cover Resisting Force (psf) | Top of Waste Elevation (feet) | Waste Resisting Force (psf) | Top of Final Cover Elevation (feet) | Final Cover Resisting Force (ft-msl) | Factor Of Safety |
|---|---|---|---|---|---|---|---|---|---|---|
| Sump 7B | 22.5 | 40.55 | 1126.3 | 24.5 | 240.0 | 87.01 | 2775.4 | 90.09 | 369.6 | 3.0 |
| Sump 7A | 22.5 | 40 | 1092.0 | 24.5 | 240.0 | 87.01 | 2775.4 | 90.09 | 369.6 | 3.1 |
| Sump 6B | 22.5 | 39.35 | 1051.4 | 24.5 | 240.0 | 87.01 | 2775.4 | 90.09 | 369.6 | 3.2 |
| Sump 6A | 22.5 | 38.9 | 1023.4 | 24.5 | 240.0 | 87.01 | 2775.4 | 90.09 | 369.6 | 3.3 |
| Sump 5B | 22.5 | 38.7 | 1010.9 | 24.5 | 240.0 | 87.01 | 2775.4 | 90.09 | 369.6 | 3.4 |
| Sump 5A | 22.5 | 38.5 | 998.4 | 24.5 | 240.0 | 87.01 | 2775.4 | 90.09 | 369.6 | 3.4 |
| Sump 4C | 22.5 | 37.4 | 929.8 | 24.5 | 240.0 | 86.91 | 2771.0 | 89.99 | 369.6 | 3.6 |

The calculations above demonstrate that there is sufficient waste and cover material at each of the evaluated locations to offset groundwater uplift forces by greater than a factor of safety of 1.5. Each of the locations evaluated represent the worst case scenario within the future sectors to be constructed below the groundwater table.

# CITY OF KINGSVILLE LANDFILL

## PART III

## ATTACHMENT 11

GROUNDWATER SAMPLING AND ANALYSIS PLAN

THE CITY OF KINGSVILLE LANDFILL

TCEQ PERMIT MSW 235-C

# PERMIT AMENDMENT APPLICATION
# PART III, ATTACHMENT 11
# GROUNDWATER SAMPLING AND ANALYSIS PLAN

CITY OF KINGSVILLE, TEXAS

September 2018
Revision 1 – November 2018
Revision 2 – February 2019
Revision 3 – April 2019

Prepared by


HANSON
Engineering | Planning | Allied Services
TBPE F-417


HANSON PROJECT NO. 16L0438-0003

# Contents

# APPENDICES



*I:\16jobs\16L0438\8514-City of Kingsville\8514-03\Permit Amendment\NODs\Technical NOD #1\Part III\Part III, Attachment 11\Part III_att11 - GWSAP Cln.docx*

# 1.0 INTRODUCTION

The State of Texas promulgated regulations governing all aspects of municipal solid waste (MSW) management in Title 30 of the Texas Administrative Code (TAC), Chapter 330. Subchapter J, Section 330.405 (b) requires that the owners or operators of Municipal Solid Waste Landfills (MSWLFs) prepare and submit a Groundwater Sampling and Analysis Plan (GWSAP) to the Texas Commission on Environmental Quality (TCEQ). The purpose of this document is to satisfy the requirements of the above-referenced regulations as they pertain to the City of Kingsville Landfill (hereafter referred to as the Kingsville Landfill) and provide groundwater sampling procedures, frequencies, analytical parameters, monitoring data evaluation, and reporting requirements.

In accordance with TCEQ regulations, this GWSAP contains the procedures and techniques to be used to conduct Background Monitoring Statistical Evaluations, Detection Monitoring, Assessment Monitoring, and Corrective Action implementation should a significant groundwater impact be determined.

## 1.1 Facility Description

The Kingsville Landfill is located 1.7 miles southeast of the City of Kingsville at the intersection of County Road (CR) 2130 and Farm to Market (FM) 2619 in Kleberg County, Texas. The primary land use within a one-mile radius of the site is agricultural consisting of cropland and pasture co-existing with some oil and gas production. Adjacent to the landfill on the east of the property are a series of borrow pits that have been used for the purpose of daily cover and other site soil needs. Low-density residential development is scattered throughout the one-mile radius area of the facility, with most development located to the southeast and northeast. Immediately to the east and west of the permitted facility boundary, the land use is agricultural with some oil and gas production. To the north, south, and southeast, residences are widely scattered throughout brush and agricultural areas.

## 1.2 Groundwater Monitoring System

Based upon an understanding of the local ground water flow regime and site stratigraphy, the groundwater monitoring system will monitor the uppermost aquifer identified in the site Geology and Groundwater Characterization Reports. Analysis of the ground water level data over the life of the facility indicate that the ground water flow tends to leave the site in all directions except the northwest. Construction at the landfill should have minimal impact on ground water flow. The most likely pollutant pathway for pollutant migration in the event that the primary barrier liner system is penetrated would follow the groundwater flow away from the site. Further discussion and detail can be seen in the provided Groundwater Characterization Report (Part III, Attachment 4, Appendix 1, Section 2.0 beginning on page 762).

The completed groundwater monitoring system will be comprised of a total of twenty-two (22) monitoring wells. Monitor Wells 6RA, 15, 22R, 23, and 30 shall be considered upgradient wells until further development of waste sectors occur. The remaining 17 monitor wells shall be considered downgradient wells. All monitoring wells will be installed and monitored throughout the active life and post-closure care period of this site. The design will provide for monitoring well spacing of not more than 600 feet at the closest practicable distance to the point of compliance (when physical obstacles preclude installation of the groundwater monitoring wells at the point of compliance), as defined in 30 TAC §330.3, that will ensure detection of groundwater contamination of the uppermost aquifer. All parts of the groundwater monitoring system shall be operated and maintained so that they perform at least to design specifications. The design of the monitoring system is based on site specific technical information gathered during multiple site investigations and further discussed in the site Geology Report included as Part III Attachment 4 of this permit, Part III Attachment 4 Appendix 1, and the Groundwater Characterization Report included as Part III Attachment 4, Appendix 1 beginning on page 752. The City of Kingsville Landfill will promptly notify the executive director, and any local pollution agency with jurisdiction that has requested to be notified, in writing of changes in facility construction or operation or changes in adjacent property that affect or are likely to affect the direction and rate of groundwater flow and the potential for detecting groundwater contamination from a solid waste management unit and that may require the installation of additional monitoring wells or sampling points and that such additional wells or sampling points require a modification of the site development plan.

A topographic and Groundwater Contour map identifying the existing and proposed monitor well locations, installed depths, property boundary, a delineation of the waste management area, and the point of compliance line has been included in Appendix A-Item 1A and B Site Layout Maps. All monitoring wells will be constructed in accordance with 30 TAC §330.421. Monitor well installation and construction details will be provided on form TCEQ-10308, or current appropriate TCEQ reporting form, upon completion. The Groundwater Monitoring System Design Certification has been included as Appendix A-Item 2.

## 2.0 HEALTH AND SAFETY

Personnel performing water level measurements, well purging, or sampling will, at a minimum, wear latex or other equivalent non-powdered gloves. The gloves will be changed when they become damaged and when activities begin at a different well location. All personnel that are associated with the purging and sample collections from monitor wells will wear other appropriate Personal Protective Equipment (PPE) such as eye protection, safety vests, chemical resistant clothing and/or aprons, and air purifying respirators, as necessary.

## 3.0 GROUNDWATER SAMPLING FREQUENCY

### 3.1 Background Monitoring

At least eight (8) statistically independent background groundwater samples will be obtained on a quarterly basis prior to commencing with Detection Monitoring for each groundwater monitor well at the facility (see Appendix A, Table 1, for parameters). Background monitoring events should allow approximately 90 days between each monitoring event to allow the collection of groundwater data over the different seasons of the year.

### 3.2 Detection Monitoring

After establishment of background groundwater quality, detection monitoring will be performed on a semi-annual basis at approximately 6-month intervals during the remaining operational life and post-closure care period for this facility. Detection monitoring will begin on the first semi-annual monitoring event following the completion of the background monitoring establishment period.

## 4.0 GROUNDWATER ANALYTICAL PARAMETERS

The constituents to be analyzed for both background monitoring and detection monitoring are listed in Appendix A-Table 1. The respective Practical Quantitation Limits (PQLs), analytical methods, and Chemical Abstracts Service number (CAS) are also located in Appendix A-Table1 and Table-2.

At the conclusion of the background monitoring period, all the detection monitoring constituents will be thoroughly reviewed. As a result of this review, the City may request that the Executive Director eliminate subsequent monitoring for those constituents that were consistently below the method detection limits (MDL) throughout this period and are not expected to originate from the MSWLF unit.

## 5.0 GROUNDWATER PURGING AND SAMPLING

The following subsections will summarize tasks involved in the purging and sampling of the groundwater monitoring wells at the facility.

### 5.1 Well Inspection

Prior to performing any purging or sampling, each monitoring well will be inspected to assess its integrity. The visual inspection will include the lock, protective casing or collar, concrete pad, and casing for signs of damage by vandalism, animals, heavy equipment, or other causes. All necessary repairs or maintenance needed will be documented on the Monitor Well Field Data Sheet for each respective well. If it is determined that the integrity of the well has been compromised, the necessary information will be documented and the TCEQ will be notified. No additional actions will be taken without prior approval of the TCEQ.

### 5.2 Well Headspace Screening

Upon the opening of each monitoring well, an appropriately calibrated gas meter capable of measuring methane concentrations in percent volume and combustible gases in a percentage of the Lower Explosive Limit (LEL) will be utilized to screen the well headspace for hazardous concentrations of gasses that the sampling personnel could be exposed to during the well gauging and sampling procedures. The gas meter will contain a methane specific sensor and be able to measure the percent volume of methane in air. The concentration of methane, or percentage of the LEL, will dictate what precautions will be necessary during sampling activities. If methane is detected in excess of 5.0% by volume (100% LEL), the well will be left open and allowed to vent. No work will be performed at the well until methane concentrations fall below 5.0% by volume. Results of the well headspace screening for methane will be recorded and retained in the facility operating record.

### 5.3 Equipment Decontamination

All non-dedicated equipment used for water level measurement, purging, and/or the collection of groundwater samples will be decontaminated prior to use at each well location. An appropriate decontamination procedure consists of washing the non-dedicated equipment in a solution of Alconox, or equivalent laboratory-grade detergent, and distilled water followed by a distilled or deionized water rinse. Containers for the collection of rinsates will be utilized, as appropriate,

# CITY OF KINGSVILLE LANDFILL

# PART III, ATTACHMENT 11

# APPENDIX A

# TABLE 3

MONITOR WELL DESIGNATIONS

| Monitor Well Designation | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Monitor Well | Sector 1 | Sector 2 | Sector 3 | Sector 4 | Sector 5 | Sector 6 | Sector 7 | Sector 8 |
| MW-1RA | C | C | C | C | C | C | C | C |
| MW-6RA | U | U | U | U | U | C | C | C |
| MW-8 | C | C | C | C | C | C | C | C |
| MW-12RA | C | C | C | C | C | C | C | C |
| MW-13 | C | C | C | C | C | C | C | C |
| MW-14 | C | C | C | C | C | C | C | C |
| MW-15 | U | U | U | U | U | U | U | U |
| MW-16 | C | C | C | C | C | C | C | C |
| MW-19 | C | C | C | C | C | C | C | C |
| MW-20 | C | C | C | C | C | C | C | C |
| MW-21R | C | C | C | C | C | C | C | C |
| MW-22R | U | U | U | U | U | U | C | C |
| MW-23 | U | U | U | U | U | U | U | U |
| MW-24 | C | C | C | C | C | C | C | C |
| MW-27 | C | C | C | C | C | C | C | C |
| MW-28 | C | C | C | C | C | C | C | C |
| MW-29 | C | C | C | C | C | C | C | C |
| MW-30 | U | U | U | U | U | U | U | U |
| MW-31 | C | C | C | C | C | C | C | C |
| MW-32 | C | C | C | C | C | C | C | C |
| MW-33 | C | C | C | C | C | C | C | C |
| MW-34 | C | C | C | C | C | C | C | C |

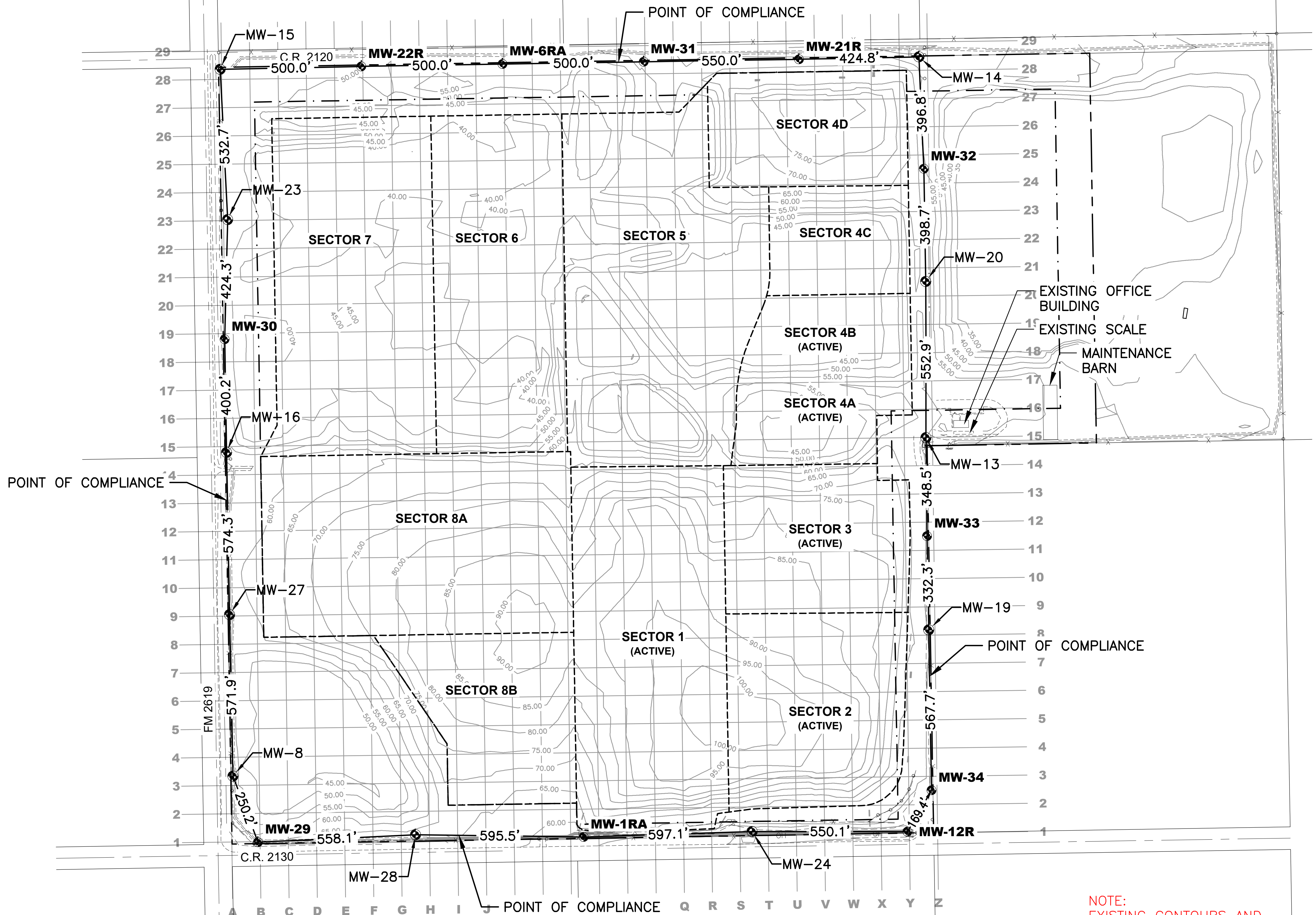
U = Upgradient Well
C = Compliance Well

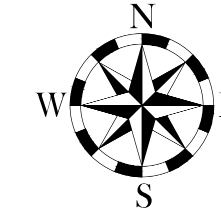
# CITY OF KINGSVILLE LANDFILL

## PART III, ATTACHMENT 11

## APPENDIX A

ITEM 1A-SITE LAYOUT MAP (TOPO)
ITEM 1B-SITE LAYOUT MAP (GW CONTOUR)




400 200 0 400

GRAPHIC SCALE IN FEET

## LEGEND:

| | |
|---|---|
| MW-20 | MONITOR WELL LOCATION |
| | EXISTING FENCE |
| 65.00 | ~~EXISTING SURFACE CONTOUR (2015)~~ |
| | SECTOR OUTLINE |
| | PERMIT BOUNDARY (175.89 ACRES) |
| | ~~BUFFER ZONE~~ |
| 400.2' | POINT OF COMPLIANCE |

| SITE COORDINATES | | | | |
|---|---|---|---|---|
| MONITOR WELL LOCATIONS | | | | |
| MW | Northing | Easting | DEPTH (FT BGS) | STATUS |
| MW-8 | 17051473.78 | 1203673.74 | 43 | EXISTING |
| MW-13 | 17052672.16 | 1206127.95 | 40 | EXISTING |
| MW-14 | 17054020.04 | 1206103.02 | 35 | EXISTING |
| MW-15 | 17053976.10 | 1203628.61 | 33 | EXISTING |
| MW-16 | 17052619.76 | 1203651.21 | 40 | EXISTING |
| MW-19 | 17051991.35 | 1206137.50 | 43 | EXISTING |
| MW-20 | 17053225.01 | 1206127.20 | 39 | EXISTING |
| MW-23 | 17053444.05 | 1203654.88 | 35 | EXISTING |
| MW-24 | 17051277.99 | 1205512.42 | 33 | EXISTING |
| MW-27 | 17052045.52 | 1203661.75 | 40 | EXISTING |
| MW-28 | 17051266.46 | 1204320.24 | 43 | EXISTING |
| MW-1RA | 17051258.70 | 1204915.66 | 35 | PROPOSED |
| MW-32 | 17053623.64 | 1206120.29 | 31 | PROPOSED |
| MW-6RA | 17053994.38 | 1204628.44 | 30 | PROPOSED |
| MW-12RA | 17051277.38 | 1206062.51 | 35 | PROPOSED |
| MW-21R | 17054011.48 | 1205678.30 | 32 | PROPOSED |
| MW-22R | 17053986.24 | 1204128.51 | 30 | PROPOSED |
| MW-29 | 17051239.92 | 1203762.81 | 40 | PROPOSED |
| MW-30 | 17053019.90 | 1203644.60 | 30 | PROPOSED |
| MW-31 | 17054002.53 | 1205128.38 | 31 | PROPOSED |
| MW-33 | 17052323.65 | 1206132.04 | 35 | PROPOSED |
| MW-34 | 17051423.79 | 1206147.64 | 35 | PROPOSED |

NOTE:
EXISTING CONTOURS AND BUFFER ZONE LINE HAVE BEEN TURNED OFF FOR CLARITY.

| NUMBER | REVISION | DATE | DRAWN | DESIGNED | REVIEWED |
|---|---|---|---|---|---|
| | | | | | |

Hanson No. 16L0438
Filename 8514-03-APPENDIX-SITE-LAYOUT
Scale AS SHOWN
Date 04/23/2019

| | | |
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| LAYOUT | DT | 04/23/2019 |
| DRAWN | DT | 04/23/2019 |
| REVIEWED | TAG | 04/23/2019 |

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TBPG F-50556
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PART III, ATTACHMENT 11
APPENDIX A
ITEM - 1A
SITE LAYOUT MAP
GROUNDWATER SAMPLING AND ANALYSIS PLAN
CITY OF KINGSVILLE LANDFILL
PA. MSW 235-C
KINGSVILLE, TEXAS, KLEBERG COUNTY, TEXAS

FIGURE:
III.11-A-1A

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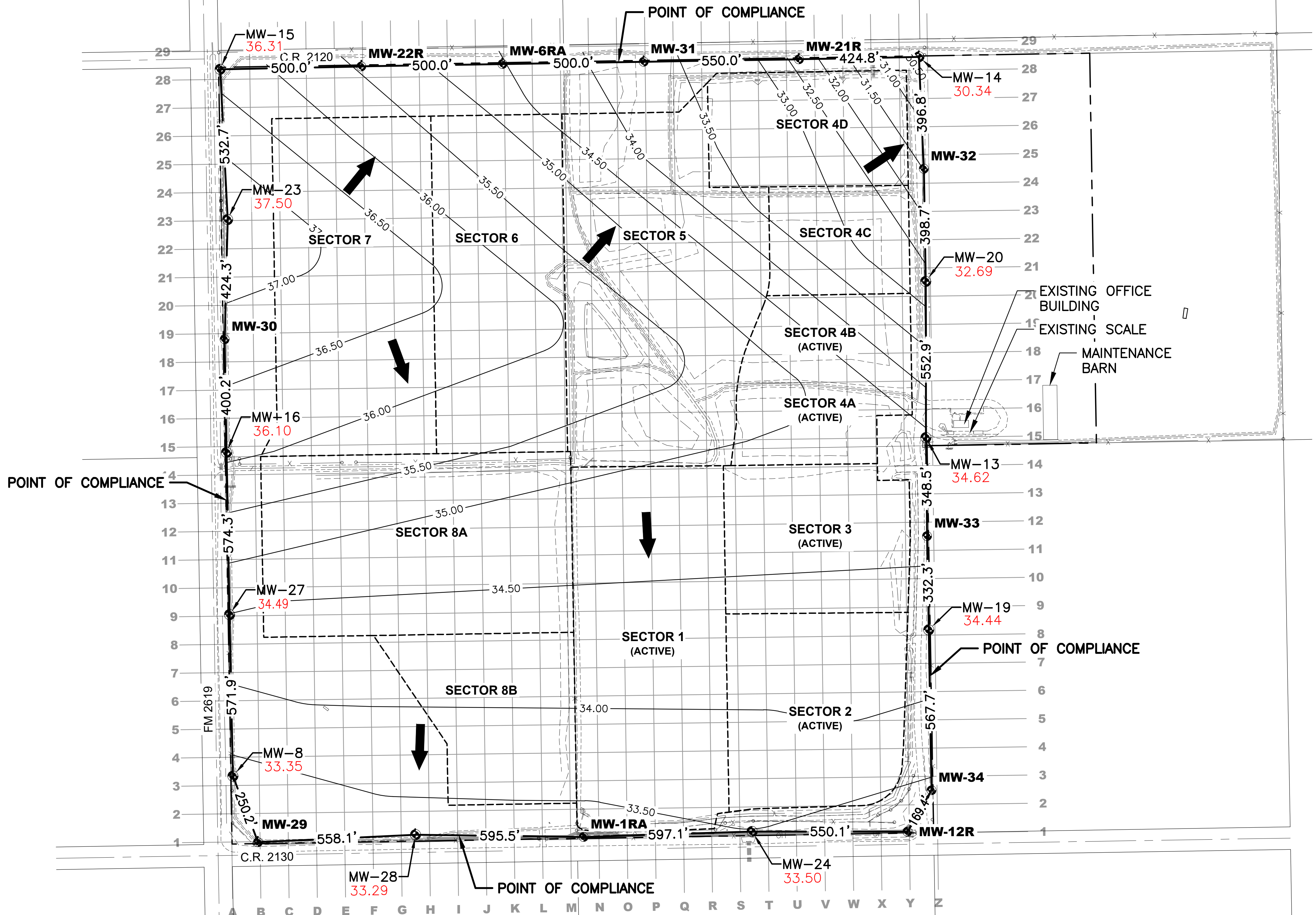


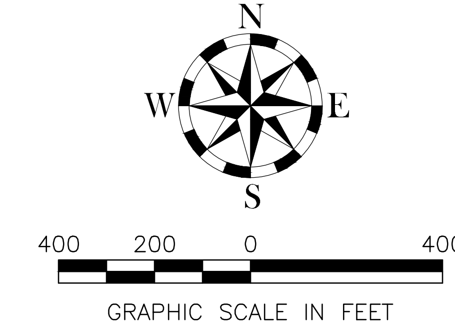


## LEGEND:

| | |
|---|---|
| MW-20 | MONITOR WELL LOCATION |
| | EXISTING FENCE |
| 35.00 | GROUNDWATER CONTOURS (FEET AMSL) |
| | SECTOR OUTLINE |
| | PERMIT BOUNDARY (175.89 ACRES) |
| | ~~BUFFER ZONE~~ |
| 400.2' | POINT OF COMPLIANCE |
| | GROUNDWATER DIRECTIONAL FLOW ARROW |

SITE COORDINATES

MONITOR WELL LOCATIONS

| MW | Northing | Easting | DEPTH (FT BGS) | STATUS |
|---|---|---|---|---|
| MW-8 | 17051473.78 | 1203673.74 | 43 | EXISTING |
| MW-13 | 17052672.16 | 1206127.95 | 40 | EXISTING |
| MW-14 | 17054020.04 | 1206103.02 | 35 | EXISTING |
| MW-15 | 17053976.10 | 1203628.61 | 33 | EXISTING |
| MW-16 | 17052619.76 | 1203651.21 | 40 | EXISTING |
| MW-19 | 17051991.35 | 1206137.50 | 43 | EXISTING |
| MW-20 | 17053225.01 | 1206127.20 | 39 | EXISTING |
| MW-23 | 17053444.05 | 1203654.88 | 35 | EXISTING |
| MW-24 | 17051277.99 | 1205512.42 | 33 | EXISTING |
| MW-27 | 17052045.52 | 1203661.75 | 40 | EXISTING |
| MW-28 | 17051266.46 | 1204320.24 | 43 | EXISTING |
| MW-1RA | 17051258.70 | 1204915.66 | 35 | PROPOSED |
| MW-32 | 17053623.64 | 1206120.29 | 31 | PROPOSED |
| MW-6RA | 17053994.38 | 1204628.44 | 30 | PROPOSED |
| MW-12RA | 17051277.38 | 1206062.51 | 35 | PROPOSED |
| MW-21R | 17054011.48 | 1205678.30 | 32 | PROPOSED |
| MW-22R | 17053986.24 | 1204128.51 | 30 | PROPOSED |
| MW-29 | 17051239.92 | 1203762.81 | 40 | PROPOSED |
| MW-30 | 17053019.90 | 1203644.60 | 30 | PROPOSED |
| MW-31 | 17054002.53 | 1205128.38 | 31 | PROPOSED |
| MW-33 | 17052323.65 | 1206132.04 | 35 | PROPOSED |
| MW-34 | 17051423.79 | 1206147.64 | 35 | PROPOSED |

NOTE: GROUNDWATER ELEVATIONS FROM JANUARY 2017

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APR 22, 2019 1:41 PM TORRE01809

| NUMBER | REVISION | DATE | DRAWN | DESIGNED | REVIEWED |
|---|---|---|---|---|---|

| | |
|---|---|
| Hanson No. | 16L0438 |
| Filename | 8514-03-APPENDIX-SITE-LAYOUT-2 |
| Scale | AS SHOWN |
| Date | 04/23/2019 |

| | | |
|---|---|---|
| LAYOUT | DT | 04/23/2019 |
| DRAWN | DT | 04/23/2019 |
| REVIEWED | TAG | 04/23/2019 |

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PART III, ATTACHMENT 11
APPENDIX A
ITEM - 1B
SITE LAYOUT MAP
GROUNDWATER SAMPLING AND ANALYSIS PLAN
CITY OF KINGSVILLE LANDFILL
PA. MSW 235-C
KINGSVILLE, TEXAS, KLEBERG COUNTY, TEXAS

FIGURE:
III.11-A-1B

# CITY OF KINGSVILLE LANDFILL

# PART III

# ATTACHMENT 12

FINAL CLOSURE PLAN

# Texas Commission on Environmental Quality

## Closure Plan for Municipal Solid Waste Type I Landfill Units and Final Facility Closure

This form is for use by applicants or site operators of Municipal Solid Waste (MSW) Type I landfills to detail the plan for closure of a landfill unit, closure of associated storage or processing units, and final closure of the facility to meet the requirements in 30 TAC Chapter 330, §330.63(h) and 30 TAC Chapter 330 Subchapter K for a MSW Type I facility.

If you need assistance in completing this form, please contact the MSW Permits Section in the Waste Permits Division at (512) 239-2335.

## I. General Information

Facility Name: The City Of Kingsville Landfill

MSW Permit No.: 235C

Site Operator/Permittee Name: City of Kingsville

## II. Landfill and Other Waste Management Units and Operations Requiring Closure at the Facility

### A. Facility Units

*Table 1. Description of Landfill Units.*

| Name or Descriptor of Unit | Operating Status of Unit | Type of Liner System Under Unit | Above Grade Class 1 Disposal Cells in this Unit | Below Grade Class 1 Disposal Cells in this Unit | Other Class 1 Disposal Cells in this Unit (describe) | Size of Unit's Waste Footprint (acres) | Maximum Inventory of Waste Ever in Unit (cubic yards) | Other Necessary Information that Pertains to the Unit |
|---|---|---|---|---|---|---|---|---|
| Type I | Active | Alternate Liner | ☐ | ☐ | ☐ | 121.3 | 17,994,286 | |
| Totals | | | | | | 121.3 | 17,994,286 | |

## C. Drawings Showing Details of the Waste Management Units at Closure

*Table 4. Location of the Drawings showing Details of the Waste Management Units at Closure (outlines, dimensions, maximum elevations of waste and final cover of landfill units, and waste storage or processing units or operations at closure of the facility).*

| Drawing Location in the SDP | Drawing Figure Number | Drawing Title | Waste Management Units Details Shown |
|---|---|---|---|
| Part III, Attachment 1 | III.1-3 | Landfill Excavation Plan | Outlines, waste footprints, and dimensions of the landfill units |
| Part III, Attachment 1 | III.1-4 | Landfill Completion Plan | Maximum elevations of waste and final cover of the landfill units |
| Part III, Attachment 1 | III.1-14 | Support Area Layout | Locations and limits of storage and processing units in the support area |

# III. Description of the Final Cover System Design

## A. Types and Descriptions of the Final Cover Systems

*Table 5. Types and Descriptions of the Final Cover Systems Permitted or Proposed for Closure of the Landfill Units.*

| Landfill Unit Name or Descriptor | Type of Final Cover System | Final Cover System Components Description | Other Information (Enter other information as applicable) |
|---|---|---|---|
| Type I Landfill | Alternative Composite Final Cover | A ~~six (6) inch thick (minimum)~~ prepared soil subgrade ~~layer~~;<br>A geosynthetic clay liner (GCL) layer;<br>A forty mil (0.04 inch) thick LLDPE geomembrane layer;<br>A geocomposite drainage layer consisting of a synthetic drainage net and geotextile fabric;<br>A twenty five (25) inch thick protective cover soil layer, the top seven (7) inches of which must be capable of supporting vegetation. | |

## VII. Professional Engineer's Statement, Seal, and Signature

Name: Jon M. Reinhard, P.E. Title: Project Engineer

Date: ~~September 12, 2018~~ April 25, 2019

Company Name: Hanson Professional Services Inc. Firm Registration Number: F-417

Professional Engineer's Seal

Signature

THE CITY OF KINGSVILLE LANDFILL

TCEQ PERMIT MSW 235C

# PERMIT AMENDMENT APPLICATION

## Volume 6 of 6

CITY OF KINGSVILLE, KLEBERG COUNTY, TEXAS

September 2018

Revision 1 – November 2018

Revision 2 – February 2019

Revision 3 – April 2019

Prepared by

HANSON

Engineering | Planning | Allied Services

TBPE F-417

HANSON PROJECT NO. 16L0438-0003

THE CITY OF KINGSVILLE LANDFILL

TCEQ PERMIT MSW 235C

# PERMIT AMENDMENT APPLICATION
# PART IV

CITY OF KINGSVILLE, KLEBERG COUNTY, TEXAS

September 2018

Revision 1 – November 2018

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## LIST OF FIGURES



## LIST OF ATTACHMENTS

## LIST OF ACRONYMS

ADC – Alternate Daily Cover
CESQG – Conditionally Exempt Small Quantity Generator
CFC – Chlorinated Fluorocarbon
CFR – Code of Federal Regulations
DIY – Do It Yourself
EPA – Environmental Protection Agency
GLER – Geosynthetics Liner Evaluation Report
GWSAP – Groundwater Sampling and Analysis Plan
LCS – Leachate Collection System
LCWMP – Leachate and Contaminated Water Management Plan
LFG – Landfill Gas
LGMP – Landfill Gas Management Plan
LQCP – Liner Quality Control Plan
M/S – Landfill Manager/Supervisor
MSW – Municipal Solid Waste
MSWLF – Municipal Solid Waste Landfill
MSWMR – Municipal Solid Waste Management Regulations
PCB – Polychlorinated Biphenyl
RRC – Railroad Commission of Texas
SDP – Site Development Plan
SLER – Soil Liner Evaluation Report
SOP – Site Operating Plan
SOR – Site Operating Record
SPCC – Spill Prevention, Control, and Countermeasures Plan
SWAP – Special Waste Acceptance Plan
SWPPP – Stormwater Pollution Prevention Plan
TAC – Texas Administrative Code
TCEQ – Texas Commission on Environmental Quality
TPDES – Texas Pollutant Discharge Elimination System
TXDOT – Texas Department of Transportation

should be maintained in the site operating records and should include evidence of successful completion of the training, type of training received, and the name of the instructor. The minimum level of training for the facility manager should be a Class A license as defined in §30.213. In addition, key on-site personnel should attend a course for screening for unauthorized waste.

### 4.2.2 Wastes Prohibited From Disposal

The City of Kingsville Landfill will not accept the following types of waste for disposal:

- Municipal Hazardous Waste other than from a Conditionally Exempt Small Quantity Generator (CESQG) as defined in 30 TAC §330.171(c)(6);
- Polychlorinated Biphenyls (PCBs) as discussed in section 4.2.1;
- Class 1~~, Class 2, and Class 3~~ industrial waste;
- Do-it-yourself (DIY) used motor vehicle oil will not be intentionally or knowingly accepted for disposal per §330.15(e)(2);
- Whole used or scrap tires shall not be accepted for disposal or disposed of in any MSW landfill, unless processed prior to disposal in a manner acceptable to the executive director per §330.15(e)(4);
- Lead acid storage batteries will not be intentionally or knowingly accepted for disposal per §330.15(e)(1);
- Used oil filters from internal combustion engines will not be intentionally or knowingly accepted for disposal per §330.171(d);
- Items containing chlorinated fluorocarbon (CFC) unless all the CFC contained within them is properly managed as defined in §330.15(e)(5);
- The following special wastes without prior approval from TCEQ and accompanied with the relevant analytical test results, MSDS documents, or process knowledge documents:
    - Septic tank pumpings which have been stabilized and have passed the paint filter test;
    - Wastes from commercial or industrial wastewater treatment plants; air pollution control facilities; and tanks, drums, or containers used for shipping or storing any material that has been listed as a hazardous constituent in 40 CFR, Part 261, Appendix VIII but has not been listed as a commercial chemical product in 40 CFR Part 261.33(e) or (f);
    - Drugs, contaminated foods, or contaminated beverages, other than those contained in normal household waste;
    - Incinerator ash;
    - Light ballasts and/or small capacitors containing PCB compounds with a PCB content less than 50 parts per million;
    - And waste generated outside the boundaries of Texas that contains:
    - Any industrial waste,

1. **The active working face(s):** Municipal solid waste will be unloaded at the active working face(s). Unloading of municipal solid waste at the active working face will be confined to as small an area as practical and will not exceed 30,000 square feet, or about 300 feet by 100 feet. The size of the working face will be directly impacted by the amount of waste being received and may vary accordingly. There may be one, two or three working faces open at any given time. Typically, there will be one general purpose waste unloading area. The M/S may designate up to three waste unloading areas; one for commercial customers, one for light commercial/residential customers, and one for other wastes requiring special attention or while moving a working face (i.e., establishing a working face in a new location, while covering, or during periods of emergency clean up operations (i.e., hurricane, hailstorm, flood, etc.).
2. **White Goods and Metal Recyclable Storage Area:** The white goods and metal recyclable unloading and storage area will not be larger than 20,000 square feet (100 feet by 200 feet). Large items/white goods may include ovens, dishwashers, freezers, air conditioners, and other items. These items will not be stored in excess of 180 days.
3. **Tire storage and processing area:** Tires will be managed in a manner that minimizes possible ponding of water in order to eliminate potential conditions that would promote disease vectors. The quantity of tires stored on-site will not exceed 500 tires on the ground (maximum storage area of 25 feet by 25 feet), or 2,000 tires in enclosed containers (maximum storage area of one standard 40 to 52 foot trailer). The tires will be processed/reduced in size to the extent practical for disposal in the landfill or sent to an authorized tire recycler. Whole used or scrap tires will not be disposed of in the landfill. Tires will not be stored in excess of 180 days.
4. **Liquid waste solidification area:** Liquid waste will be unloaded into one (1) of four (4) approximately eight (8) feet by 20 feet liquid tight mixing containers and will be located within a lined landfill sector. The maximum size of the liquid waste solidification area will be ~~30~~ 75 feet by ~~50~~ 115 feet. Bulking agents such as on-site soil, sawdust, kiln dust, coal combustion residuals, auto-fluff or other inert material with absorptive capacity will be mixed with the liquids until the resulting mixture passes the paint filter test and any other requirements outlined for the specific material. Once the liquids have been solidified, the solidified waste material will be transported and disposed of in the working face. Liquid waste will be unloaded directly into the mixing containers and solidification will begin upon receipt. See Part IV, Attachment 5 for the Liquid Waste Solidification Operating Plan.
5. **Brush storage and processing area:** Vegetative material not mixed with other wastes will be diverted to a location outside of the active disposal area and drainage ways so that they do not interfere with on-site drainage or wash off-site. The maximum size of the unloading area for brush and yard waste is 200 feet by 400 feet. Brush will be processed for mulch. Brush will not be stored in excess of 180 days.

### 4.11.2 Site Grid System Markers §330.143(b)(5)

Site grid system markers (White) will be installed at the facility. The grid system will encompass at least the area expected to be filled within the next 3 year period. Grid markers will be maintained during the active life of the site: post-closure maintenance of the grid system is recommended but not required. The grid system will consist of lettered markers along one (1) side and numbered markers along the other perpendicular side. Markers will be spaced no greater than 100 feet apart measured along perpendicular lines. Where markers cannot be seen from opposite boundaries, intermediate markers will be installed, where feasible.

### 4.11.3 SLER or GLER Area Markers §330.143(b)(6)

SLER or GLER area markers (Red) will be placed so that all areas for which a SLER or GLER has been submitted and approved by TCEQ are readily determinable. Such markers are to provide site workers immediate knowledge of the extent of approved disposal areas. These markers will be located so that they are not destroyed during operations until operations extend into the next SLER or GLER. The location of these markers will be tied into the site grid system and will be reported on each SLER/GLER submitted. SLER and GLER markers will not be placed inside the constructed/evaluated areas.

### 4.11.4 100 Year Flood Limit Protection Markers §330.143(b)(7)

Flood protection markers (Blue) must be installed in any area within a solid waste disposal facility that is subject to flooding prior to the construction of flood protection levee. The area subject to flooding will be clearly marked by means of permanent posts spaced not more than 300 feet apart or closer if necessary to retain visual continuity. City of Kingsville Landfill is NOT located within a 100 year floodplain.

### 4.11.5 Site Boundary Markers §330.143(b )(2)

Site boundary markers (Black) will be placed at each corner of the site and along each boundary line at intervals no greater than 300 feet. Fencing may be placed within these markers as required.

### 4.11.6 Buffer Zone Markers §330.143(b)(3)

Markers (Yellow) identifying the buffer zone will be placed along each buffer zone boundary at all corners and between corners at intervals no greater than 300 feet. Placement of the landfill grid markers may be made along a buffer zone boundary.

### 4.11.7 Permanent Benchmark §330.143(b)(8)

A permanent monument has been established at the site. The monument is established at the site in an area that is readily accessible and will not be used for disposal. The monument elevation was surveyed from a known United States Coast and Geodetic Survey benchmark. The location (NAD 27: N 27° 26' 41.95", W 97° 48' 55.89"/NAD 83: N 27; 26'; 43.08", W 97; 48'; 56.88”) and elevation (52.61 ft above mean sea level) of the reference benchmark monument are provided in Part II, Attachment 1, Figure II.1-2,

# CITY OF KINGSVILLE LANDFILL

# PART IV

# ATTACHMENT 5

LIQUID WASTE SOLIDIFICATION OPERATING PLAN

# CONTENTS



# FIGURES



I:\16jobs\16L0438\8514-City of Kingsville\8514-03\Permit Amendment\NODs\Technical NOD #2\Part IV\Part IV_Att 5 LWSAOP Rdln.docx

## 1.0 Background and Purpose

For those wastes sent to the Liquid Waste Solidification Area (LWSA), the LWSA site operating plan (SOP) is as follows. The LWSA SOP is to document the design and operation procedures of a liquid waste solidification/bulking operation, which will consist of four (4) approximately eight (8) feet by 20 feet liquid tight mixing containers/basins located within a lined landfill sector, constructed in accordance with 30 TAC §330.331(b), of the City of Kingsville Landfill permit boundary. The LWSA will be installed within an area that is operationally feasible where final cover has not been constructed; and will periodically be relocated because of general sequence of filling operations. The LWSA will include basins that may vary in size with a maximum number of four liquid tight mixing containers/basins – only one LWSA may be operational at one time. Processing or bulking of liquid material is typically needed to allow direct disposal to the landfill (i.e., liquid waste material requires bulking to pass the paint filter test). The liquid material collected at the facility will be bulked and disposed of in the landfill~~.~~

## 2.0 Design

The facility will utilize a liquid tight mixing containers/basin(s), placed and secured in landfill material and soil. Wastes excavated during liquid tight mixing container/basin installation will be properly disposed at the active working face. The liquid tight mixing container/basin will be installed so that a minimum of 1 foot of the liquid tight mixing container/basin extends above the surrounding soil where the surrounding soils are graded away from the liquid tight mixing container/basin to prevent stormwater run-on into the liquid tight mixing container(s)/basin(s). A runoff/run-on control berm will be installed around perimeter of the liquid tight mixing container(s)/basin(s) and solidifying/stabilizing material storage area. This berm constructed of compacted earthen material will be a minimum of 2 foot in height unless the location of the LWSA is adjacent to a waste slope with potential for storm water run-on. In addition, the bottom of the liquid tight mixing container(s)/basin(s) will be at least 10 ft above the top of protective cover soil of the underlying constructed lining system. Figure IV.5-1, Liquid Waste Solidification Area Layout Plan shows typical layout and liquid tight mixing containers/basins and runoff/run-on control berm details.

## ~~2.0~~3.0 Liquid Waste Processing Operations

The liquids collected at the facility will be bulked (i.e., solidified) and disposed of in the landfill. The installation of a liquid processing operation at the Facility will provide an essential service for food, beverage, and other commercial and industrial facilities in the surrounding region.

Liquid waste will be unloaded into one (1) of four (4) approximately eight (8) feet by 20 feet liquid tight mixing containers/basins and will be located within a lined landfill sector. The maximum size of the liquid waste solidification area will be ~~30~~ 75 feet by ~~50~~ 115 feet. Bulking agents such as on-site soil, sawdust, kiln dust, coal combustion residuals, auto-fluff or other inert material with absorptive capacity will be mixed with the liquids until the resulting mixture passes the paint filter test and any other requirements outlined for the specific material. Once the liquids have been solidified, the solidified waste material will be transported and disposed of in the working face. Liquid waste will be unloaded directly into the mixing containers/basins and solidification will begin upon receipt

Dust and odors will be controlled by covering the containers/basins or by adding sawdust or wood chips to the waste.

Any rainfall or water entering the LWSA will be managed as contaminated water and will be solidified before disposal in the landfill.

Control of liquids processed at the operation will be controlled by the procedures in Part IV – Attachment 3– Special Waste Acceptance Plan. A more complete discussion of the quality control process is presented in the following sections.

## ~~3.0~~4.0 Description of Waste

Untreated liquid wastes which typically cannot pass the paint filter test include nonhazardous industrial wastes and sludges, food and beverage byproducts and other nonhazardous liquids. These liquids will generally be transported to the facility by private haulers in vacuum trucks, tank trucks, and sealed containers in accordance with §330.171(b)(3). The facility is approved to accept liquid waste by approval of this permit for processing in the LWSA. The liquids will originate from food and beverage processing plants, and other commercial and industrial facilities.

## ~~4.0~~5.0 Processing Method

The bulking/solidification process involves the addition of a solid material that will absorb the liquid and form a sludge that can pass the paint filter test to be disposed of in the landfill.
Liquid waste will be unloaded directly into the mixing containers/basins and solidification will begin upon receipt. Liquid waste will be unloaded into one (1) of four (4) approximately eight (8) feet by 20 feet liquid tight mixing containers/basins located within a lined landfill sector.

Bulking agents will be mixed with the liquids until the resulting mixture passes the paint filter test and any other requirements outlined for the specific material. The bulking agent used in the liquid waste solidification process will be soil, sawdust, kiln dust, coal combustion residuals, auto-fluff or other inert material with absorptive capacity as approved by the Texas Commission on Environmental Quality (TCEQ).

Once the liquids have been solidified, the solidified waste material will be transported and disposed of in the working face.

The bulking process has the advantages of being a simple process that does not require discharge to a wastewater treatment plant.

# ~~5.0~~6.0 Monitoring

Incoming liquid waste will be documented on a Part IV, Attachment 1, Form 3 – Special Waste Inspection Form, or other required manifest. Incoming waste will also be pre-characterized by the generator in accordance with the facility's approved waste acceptance procedures listed in the Part IV – Attachment 3. The pre-characterization will include analytical analysis and/or process information as necessary to make the determination that the waste is nonhazardous. No waste material will be accepted at the site that is not precharacterized or does not have the proper manifest(s).

The landfill may request and use additional information to assist in evaluating an industrial or non-industrial liquid waste for management at the Facility. Such information includes, but is not limited to, analytical data, product and/or raw component Material Safety Data Sheets (MSDS), additional waste composition data, and pertinent letters or memoranda

Upon arrival, each load shall be verified and the shipment compared to the waste approval records for conformity. Any discrepancy which cannot be rectified will result in the rejection of the load.

## ~~6.0~~7.0 Storage and Processing

Accepted loads of liquids will be directed to the LWSA for discharge into the mixing containers/ basins and solidification will begin upon receipt. Bulked wastes will pass a paint filter test (EPA SW-846/9095) before disposal at the landfill working face.

Operation of the facility will include the following:

- Control of dust by wetting the roads and facility area and covering the bulking agents when not in use.
- Control of odors by covering the containers/basins, or using sawdust or wood chips for temporary odor masking.
- Protect the health and environment of employees, citizens, and surrounding communities by operating the facility in accordance with TCEQ, EPA, OSHA, and other applicable regulations.

Facility personnel will be trained in the bulking/solidification procedure, acceptable testing method, recognition of waste streams and their compatibility, daily operations, recordkeeping and reporting, implementation of emergency procedures, fire protection, and regulations pertaining to liquid waste disposal as set forth by the TCEQ.

## ~~7.0~~8.0 Testing and Recordkeeping

The testing and recordkeeping requirements are listed below.

- The Paint Filter Liquid Test (EPA Method SW-846/9095) is required immediately prior to disposal of the waste in the landfill. Representative grab samples shall be obtained at a rate of one per batch of treated material.
- Records concerning the type, quantity, source, and test results of liquid wastes processed shall be maintained on a daily basis, and become part of the site operating record.

## ~~8.0~~9.0 Training of Operational Personnel

Personnel involved in the bulking/ shall receive adequate training in the bulking procedure, acceptable testing method, recognition of waste streams and their compatibility, daily operations, recordkeeping and reporting, implementation of emergency procedures, and regulations pertaining to liquid waste disposal.

## ~~9.0~~10.0 Closure

All liquid wastes will be treated and disposed of in the landfill or an off-site permitted disposal facility. A notice will be sent to the TCEQ and placed in the Site Operating Record noting the specific steps taken to decommission the facility.

## ~~10.0~~11.0 Fire Protection

Landfill personnel, including equipment operators, will watch for signs of fire at the liquid waste solidification area. Landfill personnel will watch for fire, smoke, steam, or signs of heat. If signs of fire are detected at the liquid waste solidification area, all vehicles and equipment will be immediately moved away from the fire. The unloading of materials will either be relocated to a safe location away from the fire and a collection area established there or halted all together until the fire is extinguished.

If detected soon enough, a small fire may be fought with a hand-held fire extinguisher. The fire area may be watered down or smothered with 6 inches of soil, as appropriate, to ensure that the fire is out.

If the fire cannot be quickly extinguished with the fire extinguisher, the bulldozer, earth moving equipment, and water truck will immediately mobilize to the site of the fire. All available landfill personnel will assist with fire protection measures unless otherwise directed by the M/S.

Fire fighting methods for processed liquid wastes or bulking agents include smothering with soil, separating burning material from other waste, spraying with water from an on-site water truck, or pumping with water from an on-site pond. The burning material should be isolated or pushed away immediately before the fire can spread, or fire breaks should be cut around the fire before it can spread. If moving the material is not possible, or if it is unsafe, efforts should be made to cover the burning area with earth immediately to smother the fire.