PERMIT AMENDMENT APPLICATION

MESQUITE CREEK LANDFILL
COMAL AND GUADALUPE COUNTIES, TEXAS

MSW PERMIT NO. 66C

VOLUME III OF IV

Physical Site Address:
1700 Kohlenberg Rd
New Braunfels, TX 78130
(830) 625-7894

Prepared for:
Waste Management of Texas, Inc.

Prepared by:

Geosyntec consultants

8627 N Mopac Expy, Suite 300
Austin, Texas 78759
(512) 451-4003

Submitted October 2023
Revised November 2023; February 2024; April 2024
Compiled Technically Complete Copy

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STATE OF TEXAS
SCOTT M. GRAVES
86557
LICENSED
PROFESSIONAL ENGINEER

10/11/2023

Prepared by:
Geosyntec Consultants, Inc.
Texas Board of Professional Engineers Firm Registration No. F-1182
8217 Shoal Creek Blvd, Suite 200
Austin, TX 78757
(512) 451-4003

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October 2023

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PART I and PART II – SITE AND APPLICANT INFORMATION, EXISTING CONDITIONS SUMMARY, AND CHARACTER OF THE FACILITY AND SURROUNDING LAND

10/11/2023

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ATTACHMENT 3D.2

SLOPE STABILITY ANALYSIS

Written by: **P. Pandey**	Date: **7/3/2023**	Reviewed by & Revised by: **S. Graves**	Date: **7/16/2023; 2/7/2024**
Client: **WMTX**	Project: **Mesquite Creek Landfill**	Project No.: **GW8636**	Phase No.: **05**

SLOPE STABILITY ANALYSIS

2/19/2024

STATE OF TEXAS
SCOTT M. GRAVES
86557
LICENSED
PROFESSIONAL ENGINEER

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CALCULATION PAGES
1 THROUGH 76

GEOSYNTEC CONSULTANTS
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1. INTRODUCTION

1.1 Purpose

The purpose of this calculation package is to present the slope stability analysis of the Mesquite Creek Landfill (site). Analyses were performed along initial, interim, and final landfill slopes, which were developed based on critical combinations of slope geometry and shear strength properties. Slope stability factors of safety (FS) are evaluated herein for a variety of potential sliding failure scenarios.

1.2 Seismic Stability Requirements

Geosyntec performed an evaluation of the seismicity of the site area to assess whether the site is in a seismic impact zone and, accordingly, whether seismic slope stability analyses would be necessary. The Federal Subtitle D Regulation (40 CFR §258.14) and TCEQ MSW Rule 30 TAC §330.557 define a seismic impact zone as an area with a 10% or greater probability that the maximum horizontal acceleration (MHA) in lithified earth material exceeds 0.10g in 250 years. The regulations further require that landfills located in a seismic impact zone should be designed to resist the MHA occurring in bedrock (i.e., lithified material) at the site.

Values of MHA having a certain probability of exceedance (P_e) are generally determined from United States Geologic Survey (USGS) National Seismic Hazard Maps. Note that current National Seismic Hazard Maps present MHA values for a seismic risk level of 2% probability that the MHA will be exceeded in 50 years (i.e., P_e = 2% in 50 years). A seismic risk level of P_e = 2% in 50 years is approximately statistically equivalent to P_e = 10% in 250 years. According to the 2014 and 2018 USGS National Seismic Hazard Maps, the MHA at the site (98.02° W, 29.73° N) corresponding to P_e = 2% in 50 years is approximately 0.0243g (Figure 1A) based on the long-term models. Based on the low seismicity of the area and the MHA of less than 0.10g in 250 years, it is concluded that the site is not located in a seismic impact zone and, therefore, does not require seismic stability analyses.

It is also noted that the USGS has also published hazard maps based on short-term induced seismicity models. These maps convey the probability of minor-damage ground shaking induced by human activities (e.g., deep fluid injection such as for oil/gas fracking wells). While assessing short-term induced seismicity is not required under the above-referenced regulations, Geosyntec checked the latest (2018) USGS short-term induced seismicity model map and confirmed that the site is not located within an area of increased activity (i.e., elevated probability) of short-term human-induced ground shaking (Figure 1B).

Based on the above information, the remainder of this calculation package presents the static slope stability analyses.

1.3 Method

The static limit equilibrium slope stability of the landfill components was analyzed using the computer program Slide2© (Rocscience). A two-dimensional effective stress analysis was performed using the method of slices. The program generates circular and non-circular (block-type) potential failure surfaces and calculates the factor of safety (FS) for each of these surfaces using Spencer's method (Spencer, 1967), as implemented in Slide2©.

Two types of slope stability analyses were performed: (i) "forward-analyses" using the site-specific measured interface testing results provided by the facility, measured shear strengths of the site-specific strata from the geotechnical investigation, and strengths obtained from published literature, and (ii) "back-analyses" to establish the minimum allowable interface strength requirements for shear surfaces that pass through the liner or final cover system that would meet the minimum target factors of safety. The back-calculated minimum strength values for the liner system and final cover system are incorporated in Part III (Site Development Plan (SDP)), Attachments 3C (Liner Quality Control Plan (LQCP)) and 7B (Final Cover Quality Control Plan (FCQCP)).

1.4 Analysis Scenarios

The components of the landfill for which static slope stability analyses were performed are:

- excavation slope of expansion area, next to the existing landfill (Permit No. MSW-66B);
- liner system sideslope prior to waste placement (i.e., short-term liner veneer stability);
- interim landfill slopes during waste placement operations;
- final landfill slopes with liner system, cover system, and foundation soils at the final closure/post-closure (long-term) condition; and

- final cover system slope on its own, to check final cover veneer stability.

Conceptual illustrations of the analysis scenarios described above are provided in Figures 2A through 2H.

1.5 Selection of Minimum Factors of Safety

The slope stability factor of safety (FS) is evaluated for cross-sections that represent critical combinations of geometry and shear strength. Minimum acceptable calculated factors of safety for landfill slope stability depend on project-specific conditions and uncertainties. Consistent with industry standards for waste containment design and related recommendations in technical literature, this includes making a distinction in allowable target factors of safety between short-term interim scenarios vs. long-term (final) slope conditions. The target minimum factors of safety selected for this project are as follows:

- For slopes under interim conditions (i.e., landfill slopes during construction or operation), the minimum FS is 1.25 under peak (P) shear strength conditions. This FS is based on recommendations by Duncan (1992).
- For slopes under final conditions (i.e., slopes in their finished grades, either at the end of operation, or during closure/post-closure), the minimum FS is 1.5 under peak (P) shear strength conditions (EPA, 2004). Note that the factors of safety recommended in the EPA Technical Guidance Document (2004) references Duncan (1992) which recommends considering the uncertainty of strength measurements and the consequences of failure into the factor of safety, and the FS for this project was selected accordingly.
- Also, other minimum FS targets are established for sliding scenarios along liner system interfaces that could have residual (hereafter, "large-displacement") (LD) strengths mobilized [i.e., strains beyond the peak strength condition, resulting in lower mobilized strengths]. This is to provide additional confidence in the reliability of the design and is based on standard industry practices for landfill design [Stark and Choi (2004)]. For cases considered herein with shear surfaces that pass along a liner or final cover system interface, target factors of safety when using LD strengths along appropriate portions of the interface where relatively large strains are possible are also set, as follows:
    - For analyses of interface sliding during interim conditions, the target minimum calculated factor of safety using LD strengths is 1.0; and
    - For analyses of interface sliding at final conditions, the target minimum factor of safety using LD strengths is 1.1.

- Note that this approach of analyzing LD strengths for interim conditions may be overly conservative and could have been justifiably omitted but was included for completeness. This is because large displacements are typically induced by long-term behavior such as creep that would not be expected to occur in the short-term period when interim conditions exist.

2. CRITICAL CROSS-SECTIONS

Slope stability analyses were performed for seven cross-sections carefully chosen from different areas and conditions at the landfill to evaluate the different configurations of the various components of the landfill judged to capture the range of worst-case or potentially worst-case scenarios. These sections are termed "critical cross-sections," because they have the potential to produce the lowest factors of safety because of their combination of geometry and materials present – and are therefore carried forward for analysis. For example, a landfill location having the tallest and steepest waste slope represents a potential critical location because, all things being equal, it would be expected to produce a lower factor of safety than a location having slopes not as steep or tall. By selecting several cross-sections for analysis, this allows for multiple verifications to check several locations, conditions, and sliding modes (i.e., more than just one cross-section) to help provide confidence that the analysis does indeed capture the worst-case. The critical cross-sections selected for analysis are summarized below.

- Section A: critical section for excavation slope geometry and liner system veneer, occurring in Unit 2, Phase VII (i.e., proposed expansion area).
- Section B: critical section for excavation slope geometry occurring in Unit 2, Phase VIII (i.e., proposed expansion area).
- Section C: critical section for landfill geometry at interim conditions (i.e., tall, steepest, and unbuttressed landfill waste slope), occurring across Unit 2, Phase VIII at the development stage portrayed on Drawing I/IIA-23 in Part I/II.
- Section D: critical section for landfill geometry at interim conditions (i.e., tallest, steepest and unbuttressed landfill waste slope), occurring across Unit 2, Phase XII at the development stage portrayed on Drawing I/IIA-25 in Part I/II.
- Section E: critical section for final landfill geometry, and cover system veneer, in expansion area (i.e., maximum landfill elevation).
- Section F: critical section for final landfill geometry in the Unit 1, Phase V landfill area which has already been constructed and final covered, as a check to assess and confirm stability of the existing unit.

- Section G: critical section for final landfill geometry, and cover system veneer, in existing Unit 2 landfill area.

The critical cross-sections are identified on Figures 3A, 3B and 3C of this calculation package and are described in more detail below.

2.1 Initial Landfill Slopes (Excavation)

This case refers to the short-term stability of the initial excavation slopes prior to sideslope liner construction. The critical cross-section for initial landfill slope occurs along Section A which is the longest and steepest excavation slope in the expansion area and is next to the existing Unit 2 landfill area (analyzed for a condition with waste having been placed). Additionally, Section B was also evaluated as an additional check for the initial condition. The interior landfill liner sideslope is inclined at a slope ratio of 3H:1V based on the landfill grading plans presented in Part III (SDP), Attachment 3A. The stability of initial excavation slopes was evaluated using both circular and block-type slip surfaces passing through the adjacent waste and the foundation soil strata.

2.2 Interim Landfill Slopes (Waste Slopes During Operations)

These cases refer to stability of interim landfill conditions (including the liner and the waste mass slopes) as waste placement is progressing. For analysis, the interim waste slopes will be inclined at 3H:1V in interior portions of the landfill. Two interim cases (Cross-Sections C and D) were analyzed, to account for differing conditions as development occurs so as to encompass the critical conditions for slope height, liner configuration, and unbuttressed interim waste slopes. One case (Section C in this analysis) is for the development stage represented on Drawing I/IIA-23 in Part I/II, with waste filling and an interim waste slope occurring at Unit 2, Phase VIII with an interim crest of slope elevation at approximately 786.5 feet above mean sea level (ft MSL) and a liner elevation at the toe-of-slope of approximately 673.3 ft MSL. The other case (Section D in this analysis) is for the development stage represented on Drawing I/IIA-25 in Part I/II, with waste filling and an interim slope occurring at Unit 2, Phase XII with a crest of slope elevation at approximately elevation 786.5 ft MSL and a liner elevation at the toe-of-slope of approximately elevation 657.5 ft MSL. The stability of the interim landfill slopes was evaluated using both circular and block-type slip surfaces passing through the waste and/or the weakest liner material. Undrained soil strengths were considered herein as they would be the appropriate and more critical case for interim (short-term) conditions.

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2.3 Final Landfill Slopes (Final Closure and- Post Closure Conditions)

These cases refer to stability of the overall landfill (including the final cover system, waste mass, liner system, and underlying/adjacent foundation soil strata) when constructed to final closure conditions. The final landfill slopes in the proposed expansion area and existing Unit 2 landfill area were evaluated for both short-term conditions (representing the time of closure when landfilling has just been completed) and long-term (representing long-term/post-closure) final closure conditions. The stability of the landfill at final grades was evaluated for critical Section E, and critical Section G in the proposed expansion area and existing Unit 2 landfill area, respectively. Additionally, the long-term/post-closure conditions were evaluated for Section F from the existing Unit 1 landfill area which has been filled and is final covered. The sections were evaluated using both circular and block-type slip surfaces that pass through the final cover system, waste mass, through the underlying/adjacent foundation soil strata, and/or through the weakest liner material. It is noted that compacted fill will be used to construct perimeter berms and to replace unsuitable subgrade (if any) beneath the liner system. As a simplifying assumption, compacted fill was not modeled in the slope stability analyses. This decision was made based on the geometry of the selected cross-sections that have perimeter berms of minimal size, as well as no known locations of unsuitable subgrade beneath the liner system. To the extent that the cross-section geometry includes the presence of the small perimeter berm, it was not differentiated in the analysis, but instead simply assigned the Stratum I/II material properties because those properties are representative, and because further differentiation would have a negligible effect on long-term global slope stability.

2.4 Liner and Final Cover System Veneer

These cases refer to the veneer stability analysis of the liner system and final cover system along their longest and steepest slopes.

For the liner veneer stability analysis, the critical slope was identified to be along Section A which is the tallest 3H:1V sideslope with a height of 61.8 ft. For the final cover veneer stability analysis, the critical slope was identified to be along Section E with a 3.5H:1V sideslope that reaches a maximum height of approximately 115.8 ft in the proposed expansion area and along Section G with a 3H:1V sideslope that reaches a maximum height of approximately 158.5 ft in the existing Unit 2 landfill area.

3. LINER AND FINAL COVER SYSTEM

Liner System

The liner system for the proposed expansion disposal cells and existing Unit 2 landfill area consists of the following components, from top to bottom:

- 2-ft thick protective cover soil;
- double-sided geocomposite drainage layer;
- 60-mil textured HDPE geomembrane liner; and
- 2-ft thick compacted clay liner.

It is noted that Unit 1, which is filled and final covered, was constructed using a Pre-Subtitle D liner system in Phases I and II, while Phases III and V employed Subtitle D liner system. The Subtitle D liner system in Unit 1, Phase V which has been reevaluated as a confirmatory check, and included in this calculation package, consisted of following components, from top to bottom:

- 2-ft thick protective cover;
- leachate collection system:
  - on side slope of Phase V, double-sided geocomposite (i.e., geonet with geotextile bonded to its top and bottom surfaces); and
  - on the floor of Phase V, nonwoven geotextile filter layer over geonet drainage layer;
- 60-mil HDPE geomembrane liner (smooth on floor and textured on side slopes);
- GCL; and
- 0.5-ft thick prepared subgrade.

Final Cover System

The standard Subtitle D final cover system cross-section, as shown on Drawing 3A-13 in Attachment 3 of the Site Development Plan (SDP), consists of the following components from top to bottom:

- 2-ft thick vegetative soil/cover soil;
- geocomposite layer;
- 40-mil LLDPE geomembrane liner (textured on sideslopes); and
- 1.5-ft thick compacted soil liner.

It is noted that the Pre-subtitle D areas in Unit 1 have already been final capped with a final cover system consisting of a 1.5-ft thick layer of compacted soil, overlain by a 6-in layer of topsoil. The Subtitle D areas in Unit 1 have already been final capped with a final cover system consisting of 1.5-ft thick layer of compacted clay, overlain by a 2.5 ft thick vegetative soil/cover soil. The existing and now installed Pre-Subtitle D and Subtitle D final cover systems in Unit 1 are shown on Drawing 3A-13 in Part III (SDP), Attachment 3A. At Unit 2, a water-balance soil-only final cover is proposed as an allowable alternative final cover system. For all of the soil-only final cover systems (existing as-installed, and proposed), the soil components have higher strengths than the weakest interface in the standard final cover system, which incorporates geosynthetics. Therefore, only the standard Subtitle D final cover system will be considered herein, as it represents the critical case.

4. MATERIAL PARAMETERS

4.1 Foundation Soils

The geotechnical site characterization of the foundation soils beneath the site is presented in Attachment 3D.1 of this permit amendment application. The foundation soils beneath the site were investigated in 2022-2023 as part of this permit design, and by previous site investigations. The subsurface soils are divided into four strata (I through IV) as described in Attachment 3D.1.

Geotechnical laboratory tests conducted during the 2022-2023 site investigation and previous site investigation programs included water content and index property tests, one-dimensional (1-D) consolidation tests, permeability tests, unconsolidated undrained (UU) triaxial compression tests, consolidated undrained (CU) triaxial compression tests, and unconfined compression (UC) tests. The results from these tests were used to establish the unit weight and the shear strength (i.e., the drained cohesion and friction angle, c' and ϕ', and the undrained cohesion and friction angle, c and ϕ) properties of the foundation strata. It is noted that Stratum IV measured considerably high undrained shear strength of 45,835 psf and 61,704 psf during the 2022-2023 investigation and in the range of 37,900 psf to 113,000 psf during the 2004-2005 site investigation - indicating the stratum to be highly competent and more rock-like (i.e., claystone) than soil-like. However, for the purpose of analysis, an undrained shear strength of 6,500 psf was selected as a highly conservative approach, as this assumption is approximately one order of magnitude lower than the average strength value of about 66,690 psf calculated from the actual strength tests on this stratum. Finally, it is noted that for instances where material-specific data were not obtained during the site investigation and testing program, values consistent with previous local experience or published literature for similar soil strata were selected for design.

4.2 Liner and Final Cover System

The liner system and final cover system have soil components and geosynthetic components. A discussion of the selection of the unit weight and shear strength values used for the slope stability analysis is provided below.

4.2.1. Final Cover System Soil

On-site soil (generally classified as CL to CH material) will likely be used as the compacted soil and cover soils in the final cover system. The moist unit weight of these soils was selected to be 120 pcf.

The drained and undrained shear strength properties of these materials was selected using the values recommended by NAVFAC (1986). For the purpose of analysis, the drained parameters were conservatively assumed to be equal to average reported values for CH soils (Table 1), which typically have lower drained strengths than CL soils. Accordingly, the final cover system soils were modeled with an average drained friction angle, φ', of 19° and a cohesion, c', of 230 psf for long-term stability analysis.

For the short-term stability, the final cover system soils were modeled using undrained strength. Typical undrained shear strengths (i.e., cohesion) for CL soils range from 270 psf for saturated conditions to 1,800 psf for as-compacted conditions (Table 1); for CH soils, saturated and as-compacted strengths respectively range from 230 psf to 2,150 psf. Because the upper cover soil layers may be only lightly to moderately compacted, the cover may not achieve the full "as-compacted" strengths indicated in Table 1. Based on the above rationale, an undrained shear strength of 800 psf was selected for the final cover system soils. This value is considered a reasonable yet conservative short-term strength for design because it is substantially lower than the typical strength achieved by "as-compacted" soils indicated in Table 1, and in actuality the compacted soil layer will be well-compacted, and the erosion layer will receive some compaction via its placement (as well as from placement of overlying materials, as applicable).

For the limit equilibrium analyses performed using the Slide2 computer program, the final cover system is conceptualized as a single layer as a simplifying assumption for the global stability analysis, and assigned the conservative strength parameters detailed earlier. The geosynthetic layers, despite their presence in the cover system, are not modeled in the global analysis because they provide negligible contribution to the driving and resisting forces of global movement scenarios. However, it is noted that the analysis does not disregard the influence of geosynthetics in the final cover, and the sliding potential through a weakest interface within the composite final cover system is specifically evaluated through a veneer analysis presented herein.

4.2.2. Liner System Soil

The compacted clay liner and the liner protective cover soil layer will be constructed of on-site soil generally classified as CL to CH material. The moist unit weight of the soil liner system was selected to be 120 pcf.

As with the final cover soils, the drained and undrained parameters for liner system soils were selected using NAVFAC (1986). Given that the same basic material classifications will be used for both final cover system soils and liner system soils, the liner system soils were assigned the same shear strength properties as the final cover system soils (typical average drained friction angle, φ', of 19° and a cohesion, c', of 230 psf and undrained shear strength parameter of 800 psf) With respect to the undrained strength, it is important to note that the actual in-service properties, particularly of the compacted clay liner, would very likely be higher since (similar to the discussion above for the cover soils) the material will undergo a rigorous compaction process as well as subsequent loading that would result in strength gain over time. As such, the parameters used here are conservative short-term strengths assumed for design.

In context of the liner system, which is a composite system including geosynthetic material layers (as detailed in Section 3), the potential for sliding on interfaces between different layers is an important consideration to be analyzed for global stability. In general terms, the overall analysis is governed by the weakest interface within the system, thus producing the lowest calculated factor of safety. Accordingly, for the limit equilibrium analyses performed using the Slide2 computer program, the liner system is modeled in a simplified manner as a single layer for the global stability analysis, and is assigned the strength properties of the weakest interface (discussed in the subsequent section). This simplification imparts conservatism in the analysis because the intrinsic strengths of the liner soil components would be higher than the weakest interface in the liner system. Also note that the strength parameters of liner system soils are specifically used in the evaluation of veneer stability of liner system.

4.2.3 Interface Shear Strength

The liner configuration proposed for the expansion area has the same components as the liner recently constructed at Unit 2, Phase V South. Site-specific liner interface test results from the adjacent cell (as documented in its approved liner evaluation reports) were provided by the facility (see Appendix 2) and used for the slope stability analyses of the expansion area presented herein. The critical liner system interface identified in the test results (which was between the textured geomembrane and clay) was assigned in the model (see Section 4.4).

For existing Unit 1 and Unit 2 landfill areas, the test results and critical interface obtained during the construction phase have been assigned in the model. For the analysis of existing Unit 1, the critical interface of smooth HDPE geomembrane and geonet was identified for the floor liner system of Unit 1, Phase V. For the sideslope liner, the critical interface was identified between GCL and the overlying textured geomembrane at low stresses and between GCL and the underlying soil at higher stresses. Therefore, respective interface properties were assigned in the model to reevaluate the stability of Unit 1 landfill area in a post-closure condition. Likewise, test results and critical interface identified for Unit 2 (which was between textured geomembrane and clay soil) was assigned in the model for post closure evaluation of existing Unit 2 area.

For the final cover system, the interface strength parameters were selected based on published literature for the forward-analysis, in consideration of the low normal stresses of the final cover loads.

The parameters used in the forward-analysis represent the values that were directly measured and/or would reasonably be expected to be met, but they are not necessarily the lowest tolerable strengths that would still produce an acceptable factor of safety. For this reason, back-analyses of the lowest allowable interface shear strengths were also performed, so that these minimum required values may be incorporated into the LQCP and FCQCP.

As additional demonstration that all interfaces have been considered to identify and focus on the critical (weakest) interface, the following table provides a summary of the typical interface strength characteristics between relevant geosynthetics and soil interfaces (i.e., those that are included in or generally consistent with/analogous to the interfaces at the site). This tabulated information is based on a large body of published technical literature and, importantly, also includes site-specific test interface strength data. The relevant soil-geosynthetic and geosynthetic-geosynthetic interfaces are:

- cover soil-geotextile (of the geocomposite drainage layer);
- geotextile (of the geocomposite drainage layer)-textured HDPE geomembrane;
- textured HDPE geomembrane-compacted soil liner (i.e., "clay"); and
- geotextile (of underdrain system geocomposite) and native soil (which is predominantly cohesive materials).

The table indicates that the geomembrane-clay interface is the most critical (weakest), with a peak interface strength envelope having a friction angle typically ranging from 8.2° to 10.9°. This finding aligns with our basis for stating above that the critical interface is identified as the textured geomembrane-compacted soil. Note that the analysis presented subsequently (including selected parameters for interfaces) use the best-fit strength envelope (including friction and adhesion) as measured during site-specific interface testing. The table below is only for general comparison purposes to help confirm the critical interface based on typical strength values/ranges for the various relevant interfaces.

Written by: **P. Pandey** Date: **7/3/2023** Reviewed by & Revised by: **S. Graves** Date: **7/16/2023; 2/7/2024**

Client: **WMTX** Project: **Mesquite Creek Landfill** Project No.: **GW8636** Phase No.: **05**

Interfaces	δ_p	δ_{LD}	References
Textured HDPE Geomembrane-Clay	8.2 -10.9	5-9.4	Site-specific interface strength test data (expressed on a secant friction angle basis); along with publications by Feng and Cheng (2014); Feng and Lu (2015)
Textured HDPE Geomembrane-Clay[1]	9.1-10.9	NR	Marriapan et al (2011)
Textured HDPE Geomembrane-Geotextile	17-32	10-19	Stark et al (1996); Dixon (2006); Feng and Lu (2015); Bacas et al (2015); Cen et al (2018)
Textured HDPE Geomembrane-Geocomposite[2]	19.6	8.6	Site-specific interface strength test data
Geotextile-Silty Clay	30-40	NR	Athanasopoulos (1996)
Geotextile-Clay (Saturated)	NR	>24	Mitchell et al (1990)
Non-woven Geotextile-Coarse soils/sand)	16.4- 38	34.2	Dixon (2006); Choudhary and Krishna (2016); Tuna and Altun (2012); Ferreira et al (2015)
Non-woven Geocomposite-Sand	35.8	30.2	Vieira et al (2013)

NR= Not Reported

Notes:

1. The Mariappan et al (2011) results are shown above as a separate table entry because their tested interfaces included soil mixtures including bentonite additives. While this is not proposed for this facility, the results are informative (and help confirm the typical ranges for analogous interface conditions).
2. The site-specific testing of the geomembrane-geocomposite interface was conducted using a double sided geocomposite (i.e., the textured geomembrane was in contact with the non-woven geotextile component of the geocomposite drainage layer).

4.3 Waste

Municipal solid waste (MSW) will be placed in the landfill. Typically, the unit weight of MSW, as reported in technical literature based on waste composition studies, is about 65-80 pcf. For slope stability analysis, the unit weight of the waste was selected to be 80 pcf.

Shear Strength

The shear strength parameters of the waste material were selected based on published information on the shear strength of MSW waste (Kavazanjian et al., 1995). A bilinear effective-stress shear strength envelope was used to model the waste and is defined as: (i) a cohesion of 501 psf and a friction angle of zero degrees for normal stresses up to 772 psf; and (ii) a cohesion of zero and a friction angle of 33° for normal stresses greater than 772 psf.

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4.4 Summary of Material Parameters Used in Stability Analysis

The following tables presented below summarize the soil, waste and interface parameters used in the stability analysis.

Soil Layer	Total Unit Weight, γ (pcf)	Drained Strength		Undrained Strength	
		c' (psf)	ϕ' (degrees)	c (psf)	ϕ (degrees)
Final Cover System Soils[2]	120	230	19	800	0
Liner System Soils[3]	120	230	19	800	0
Stratum I/II	120	500	19	5000	0
Stratum III	127	900	20	4000	0
Stratum IV[4]	124	900	20	6500	0
Waste Material	80	For σ_v' < 772 psf, c' = 501 psf and ϕ' = 0° For σ_v' > 772 psf, c' = 0 psf and ϕ' = 33°			

NOTE:

1. γ = moist unit weight; c' = effective-stress cohesion; ϕ' = effective-stress friction angle; c = undrained cohesion; and ϕ = undrained friction angle
2. The final cover system is modeled as a single layer for the global stability analysis in Slide2 (Refer Section 4.2.1 for detailed discussion)
3. The liner system soil properties are specifically used for the liner veneer analysis. For the global stability scenarios, the liner system is modeled as a single layer assigned the unit weight indicated above, and assigned the weakest interface strength (Refer Section 4.2.2 for detailed discussion).
4. Stratum IV measured considerably higher undrained shear strength of 45,835 psf and 61,704 psf during the recent lab testing and 37,900 psf to 113,000 psf during the previous site investigation indicating the stratum to be highly competent. However, for the purpose of analysis, an undrained shear strength of 6500 psf was selected, which is approximately one order of magnitude lower than the calculated average strength value of about 66,690 psf, and therefore is a very conservative approach.

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Liner and Final Cover System Forward-Analysis, Envelope at High Normal Stresses					
	Peak Interface Parameters		LD Interface Parameters		Comments
Liner System	Friction Angle (degrees)	Adhesion (psf)	Friction Angle (degrees)	Adhesion (psf)	
UNIT 2 Expansion Area					
Side Slope	Note 2		8.5	361	Site-specific interface strength testing (2021)
Floor	9.4	609	8.5	361	
UNIT 1, Phase V (Constructed and Final Covered Landfill Area)					
Side Slope	Note 3		10	266	Measured during Unit 1, Phase V construction (2005)
Floor			9	204	
UNIT 2, Phase I (Constructed)					
Side Slope	Note 3		6.8	329	Measured during Unit 2, Phase I construction (2009)
Floor			6.8	329	
Forward-Analysis, Envelope at Low Normal Stresses [Veneer Case]					
Liner System	34.8	Zero[(4)]	Note 2		Site-specific interface strength testing (2021)
Final Cover System	26	Zero[(4)]	Note 2		Howell and Kirsten (2016)

Notes:

1. The critical (i.e., lowest) liner system interface shear strength taken from site-specific lab test results was:
   a) For side slope liner of Unit 1 Phase V, GCL and the overlying textured geomembrane at low stresses; and GCL and the underlying soil at higher stresses; For floor liner of Unit 1, smooth HDPE geomembrane and geonet; and
   b) For Unit 2, the clay soil-textured geomembrane interface.
2. Peak strengths are not used for the high normal stress cases for the liner side slopes. Instead, these areas are conservatively assigned LD conditions under high normal stresses because of the potential for detrimental shear displacement that may possibly occur along the weakest interface on sideslopes, resulting in the mobilization of LD strengths on sideslopes as discussed in Stark and Choi (2004). On the other hand, the low normal stress cases for the veneer analyses (where there is minimal load on the interface) are evaluated using the peak secant friction angle rather than LD strengths based on the short-term condition (for the liner veneer), and the absence of large detrimental shear displacement under low normal stresses for final covers (also discussed in Stark and Choi, 2004).
3. The long-term stability pertains to the scenario where the shear resistance may gradually decrease from its peak value during the post closure period, potentially resulting in the mobilization of LD strength.

Therefore, the existing Unit 1 and Unit 2 landfill areas were analyzed only under the LD/LD scenario (see Section 6.3) for the representative post-closure condition.

4. The low normal stress veneer cases were performed using a secant friction angle (assuming zero adhesion).

5. GROUNDWATER ELEVATION

The LQCP (Attachment 3C of Part III (SDP)) presents a conservatively developed seasonal high groundwater table map. Based on this map, portions of the landfill may be constructed below the seasonal high-water table. The LQCP provides further discussion on observed and measured groundwater as it relates to excavation and liner stability, and the Geology Report (Part III, Attachment 4) provides more in-depth discussion on hydrogeology at the site. In summary, the subsurface strata have low permeability and do not appear to have a continuous zone of saturation. That said, the conceptual site model of the site hydrogeology is that there is an unconfined water-bearing zone at the site. Namely, the lower part of Stratum III exhibits a greater occurrence of secondary features (e.g., higher density of fractures, seams, and fissures), which allows it to contain and transmit groundwater. Piezometers and monitoring wells screened at the base of Stratum III generally do contain sufficient quantities of groundwater for gauging and/or sampling and analysis purposes. Groundwater occurs as unconfined conditions at the lower part of Stratum III, where it is perched above the lower confining unit (aquiclude) of Stratum IV.

Based on the foregoing, a piezometric groundwater level using the seasonal high groundwater table was included in our analyses of the final landfill slopes in the post-closure condition. This assumption for analysis of long-term final conditions is considered appropriate, but conservative, given the likelihood that construction of the lined landfill will significantly reduce (or even eliminate) the ability for groundwater to be recharged because the source of recharge, namely infiltration percolating downward from the ground surface, will be blocked by the presence of the landfill and its liner system leading to an expected lowering of groundwater levels over time. By accounting for the seasonal high groundwater table in the stability analyses for long-term conditions, this represents a worst-case assumption as compared to if the stability analysis was performed with a reduced or eliminated groundwater table. Additionally, it is noted that the landfill design and operation as reflected elsewhere in this permit amendment application addresses short-term stability through a pressure relief system (i.e., underdrain) that will be installed in appropriate locations of future cells to collect and control groundwater adjacent to the liner until sufficient ballast is present to resist the theoretical uplift. This information is presented in Attachment 3D.4.

Also, on a related topic of piezometric head potential and its effect on the stability analyses, to account for the potential leachate buildup within the leachate collection system drainage layer within the landfill, a piezometric level was modeled at 0.017 ft (0.2 inches) above the top of the

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liner for applicable analyses. Additionally, the final cover system veneer stability analysis incorporates a piezometric head of about 0.2 inches, which is conservatively more than the peak average head calculated in the final cover drainage layer design calculation package (Part III (SDP), Attachment 3G).

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6. RESULTS AND CONCLUSIONS

6.1 Initial Landfill Slopes (Excavation)

A summary of the evaluated initial excavation slope stability scenarios and calculated factors of safety is presented in the following table. The Slide2© computer output and figures that illustrate each of the shear surface scenarios and show the critical shear surface for each scenario are presented in Appendix 3D.2-1. It is noted that results for critical shear surfaces passing through interim waste slopes are provided in Section 6.2.

Initial Landfill Slopes Shear Surface Scenario	**Calculated FS (✓ if OK)**	**Target FS**
Section A: Stability of Initial Landfill Slope in Phase VII with Adjacent Existing Unit 2 Waste Slope (short-term, undrained strengths) (See Pages 40-41 for Slide2© outputs)		
3H:1V sideslope: Circular shear surfaces through the existing landfill and foundation soils	3.05 ✓	1.25
3H:1V sideslope: Block-type shear surfaces through the existing landfill and foundation soils	3.03 ✓	1.25
Section B: Stability of Initial Landfill Slope in Phase VIII with Adjacent Existing Unit 2 Waste Slope (short-term, undrained strengths) (See Pages 42-43 for Slide2© outputs)		
3H:1V sideslope: Circular shear surfaces through the existing landfill and foundation soils	3.21 ✓	1.25
3H:1V sideslope: Block-type shear surfaces through the existing landfill and foundation soils	3.22 ✓	1.25

As shown above, for each considered shear surface scenario, the calculated factor of safety of the initial landfill configuration exceeds the target minimum calculated factor of safety.

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6.2 Interim Landfill Slopes (Waste Slopes During Operations)

Three scenarios were considered for the interim landfill slopes:

- circular shear surfaces through the interim waste slope;
- circular shear surfaces through interim waste slope and liner system, and;
- block-type shear surfaces through the waste and along liner system.

Consistent with Stark and Poeppel (1994) and Stark and Choi (2004), for the interface sliding scenarios, peak shear strengths were used on the floor liner system, and large-displacement strengths were used on the sideslope liner system. Under this "P/LD" assumption and for an interim case, the minimum calculated factor of safety should meet or exceed 1.25. Also, interface scenarios were included using large-displacement strengths on both the floor and side slopes to represent a conservative worst-case (that is unlikely to manifest under the short-term duration of the interim conditions). Under this "LD/LD" assumption and for an interim case, the minimum calculated factor of safety should meet or exceed 1.0. A summary of the evaluated interim waste slope stability scenarios and calculated factors of safety is presented in the following table. The analyses presented below correspond to shear surfaces through the waste slopes and liner system materials using the site-specific interface data. The Slide2© output and figures that illustrate each of the shear surface scenarios and show the critical shear surface for each scenario are presented in Appendix 3D.2-1.

Interim Landfill Slopes Shear Surface Scenario	**Calculated FS (✓ if OK)**	**Target FS**
Section C: Stability of Interim Landfill Slopes (short-term, undrained strengths) (See Pages 44-46 for Slide2© outputs)		
Circular shear surfaces through interim waste slope	2.11 ✓	1.25
Circular shear surfaces through interim waste slope and liner system using site specific interface testing results (LD/LD scenario)	2.02 ✓	1.0
Block-type shear surfaces through the waste and along liner system using site specific interface testing results (P/LD scenario)	1.37 ✓	1.25
Block-type shear surfaces through waste and along liner system using site specific interface testing results (LD/LD scenario)	1.20 ✓	1.0
Section D: Stability of Interim Landfill Slopes (short-term, undrained strengths) (See Pages 47-49 for Slide2© outputs)		
Circular shear surfaces through interim waste slope	2.09 ✓	1.25

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Interim Landfill Slopes Shear Surface Scenario	Calculated FS (✓ if OK)	Target FS
Circular shear surfaces through interim waste slope and liner system (LD/LD scenario)	2.02 ✓	1.0
Block-type shear surfaces through interim waste slope and along the liner using specific interface testing results (P/LD scenario)	1.65 ✓	1.25
Block-type shear surfaces through interim waste slope and along the liner using specific interface testing results (LD/LD scenario)	1.43 ✓	1.0

Notes:

a) P/LD represents a scenario when peak shear strength is assigned for floor liner system and large displacement shear strength is assigned for sideslope.

b) LD/LD represents a scenario when large displacement shear strength is assigned for floor and sideslope liner system.

As shown above, for each considered shear surface scenario, the calculated factor of safety of the interim landfill configuration exceeds the target minimum calculated factor of safety. Additionally, the minimum interface shear strength of the liner system required to achieve the target calculated factor of safety for critical Section C was back-calculated for block-type shear surfaces passing through the waste and along the liner system and are summarized below. These values were further assigned in the final conditions to verify its adequacy in the overall final slope stability.

Back-Analysis Shear Surface Scenario	Back-Calculated Interface Friction Angle (assuming no adhesion)
Interim Landfill Slopes (See Pages 50-51 for Slide2© outputs)	
Section C: Block-type shear surfaces through the waste and along the liner system (LD/LD Scenario), producing minimum acceptable interim and large displacement FS of 1.0	δ_{LD}= 9.8°
Section C: Block-type shear surfaces through the waste and along the liner system (P/LD Scenario), producing minimum acceptable interim FS of 1.25.	δ_{p}= 15.5°

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6.3 Final Landfill Slopes and Foundation (Final Closure and Post Closure Conditions)

Three scenarios were considered for final landfill slopes and foundation soils at the time of closure (i.e., short-term stability) and for post-closure conditions (i.e., long-term stability):

- circular shear surfaces through the waste;
- circular shear surfaces through the waste and liner system; and
- block-type shear surfaces through the waste and along liner system.

It is noted that the short-term stability of final landfill slopes representing the time immediately after the landfill closure was analyzed only under P/LD scenario as the large displacement strengths typically mobilize in the longer-term and may not exist in the short-term condition right after closure. The long-term stability, on the other hand, was evaluated under LD/LD scenario considering that the shear resistance could reduce from peak value in the longer-term post-closure period, potentially resulting in the mobilization of LD strength. The results of the analysis are summarized below. The Slide2© computer output and figures that illustrate each of the shear surface scenarios and show the critical shear surface for each scenario are presented in Appendix 3D.2-1.

	Final Landfill Slopes Shear Surface Scenario	**Calculated FS (✓ if OK)**	**Targe t FS**
UNIT-2 (Expansion Area)	**Section E: Stability of Final Landfill Slopes in the Proposed Expansion Area (short-term, undrained strengths) (See Pages 52-53 for Slide2© outputs)**		
	3.5H:1V Slope- Circular shear surfaces through the waste	2.44 ✓	1.5
	Circular shear surface through the waste and liner system using site-specific interface testing results (P/LD scenario)	2.62 ✓	1.5
	Block-type shear surfaces through the waste and along the liner system using site specific interface testing results (P/LD scenario)	1.94 ✓	1.5
	Section E: Stability of Final Landfill Slopes in the Proposed Expansion Area (long-term, drained strengths) (See Pages 54-55 for Slide2© outputs)		
	3.5H:1V Slope- Circular shear surfaces through the waste	2.39 ✓	1.1
	Circular shear surface through the waste and liner system using site-specific interface testing results (LD/LD Scenario)	2.53 ✓	1.1

	Final Landfill Slopes Shear Surface Scenario	**Calculated FS (✓ if OK)**	**Target FS**
	Block-type shear surfaces through the waste and along the liner system using site specific interface testing results (LD/LD Scenario)	1.79 ✓	1.1
UNIT-1, Phase V	**Section F: Stability of Final Landfill Slopes in the Existing Unit 1, Phase V area (long-term, drained strengths) (See Pages 56-57 for Slide2© outputs)**		
UNIT-1, Phase V	3H:1V Slope- Circular shear surfaces through the waste and foundation	2.48 ✓	1.1
UNIT-1, Phase V	Block-type shear surfaces through the waste and along the liner system using site specific interface testing results (LD/LD Scenario)	1.58 ✓	1.1
UNIT-2 (Existing Area)	**Section G: Stability of Final Landfill Slopes in the Existing Unit 2, Phase I area (long-term, drained strengths) (See Pages 58-59 for Slide2© outputs)**		
UNIT-2 (Existing Area)	3H:1V Slope- Circular shear surfaces through the waste	2.53 ✓	1.1
UNIT-2 (Existing Area)	Circular shear surface through the waste and liner system using site-specific interface testing results (LD/LD Scenario)	2.48 ✓	1.1
UNIT-2 (Existing Area)	Block-type shear surfaces through the waste and along the liner system using site specific interface testing results (LD/LD Scenario)	1.30 ✓	1.1

As shown above, for each considered shear surface scenario, the calculated factor of safety of the final landfill configuration exceeds the target minimum calculated factor of safety.

The table below presents and compares the calculated factor of safety in the final condition for the proposed expansion area (i.e., Section E) when the back-calculated minimum strength envelopes (expressed as secant friction angles, assuming zero adhesion) from Section 6.2 were used. In all cases, the back-calculated envelopes required as minimums for the previously presented interim case met the minimum requirement for the final slope cases. In other words, the interim case was more critical for the interface sliding scenarios, so those strengths become a project specification (requirement), and using such strengths, the final conditions are less critical, and the factor of safety goes up.

Shear Surface Scenario (See Pages 60-61 for Slide2© outputs)	Minimum Secant Angles (Using Back calculated Values from Interim case)	Calculated FS (✓ if OK)	Target FS
Final Landfill Slopes- Section E Short term			
Block-type shear surfaces through the waste and along the liner (P/LD Scenario)	δ_p= 15.5° δ_{LD}= 9.8°	1.97 ✓	1.5
Final Landfill Slopes- Section E Long term			
Block-type shear surfaces through the waste and along the liner (LD/LD Scenario)	δ_{LD}= 9.8°	1.65 ✓	1.1

6.4 Liner and Final Cover System Veneer Stability

The veneer stability analysis for the proposed expansion area was performed using two different methods. The first method was a forward analysis using the peak strength from tests during the construction of an adjacent cell and from published literature (see Section 4.2 and 4.4). The second method was a back-analysis, targeting the minimum design calculated factors of safety. In addition to the expansion area, a final cover veneer analysis was evaluated for the existing Unit 2 landfill area which has not been final covered yet.

The liner system stability represents an interim condition for the relatively short period between the liner system installation and waste placement against the liner system; therefore, the target minimum calculated factor of safety is 1.25 using peak strengths. The final cover system will be constructed on 3H:1V waste slopes in the existing Unit 2 area and 3.5H:1V waste slopes in the expansion area. Because the final cover system stability represents a long-term condition, the target minimum calculated factor of safety is 1.5 using peak strengths. The results of the analysis are summarized below. The Slide2© computer output and figures that illustrate each of the scenarios and show the critical shear surface for each scenario are presented in Appendix 3D.2-1.

Shear Surface Scenario (See Pages 62-65 for Slide2© outputs)	Calculated FS (✓ if OK)	Target FS
Section A: 3H:1V Liner Veneer Analysis (Undrained cover soil)		
Using site specific measured peak interface value for low normal stresses i.e., δ_p= 34.8°	2.36 ✓	1.25
Section E: 3.5H:1V Final Cover Veneer Analysis (Drained cover soil)[1]		

Using published peak interface value expected for low normal stresses i.e., δ_p= 26°	1.75 ✓	1.5
Section G: 3H:1V Final Cover Veneer Analysis (Drained cover soil)[1]		
Using published peak interface value expected for low normal stresses i.e., δ_p= 26°	1.74 ✓	1.5
Section E: 3.5H:1V Final Cover Veneer Analysis (Undrained cover soil)[1]		
Using published peak interface value expected for low normal stresses i.e., δ_p= 26°	1.91 ✓	1.5

Note:

1. Because the final cover system will have no or limited amount detrimental shear displacement along the weakest interface, the veneer stability was evaluated for peak interface strength only, as recommended by Stark and Choi (2004).

As shown above, for each considered shear surface scenario, the calculated factor of safety for the final landfill configuration is greater than the target minimum calculated factor of safety.

The table below presents the back-calculated interface strength parameters from the veneer analyses.

Shear Surface Scenario (See Pages 66-69 for Slide2© outputs)	Back-calculated Interface Friction Angle
Section A: 3H:1V Liner Veneer Analysis (Undrained cover soil)	
Peak interface value at low normal stresses producing minimum acceptable interim FS of 1.25	δp= 18.3°
Section E: 3.5H:1V Final Cover Veneer Analysis (Drained cover soil)	
Peak interface value at low normal stresses producing minimum acceptable FS of 1.5	δp= 22.3°
Section G: 3H:1V Final Cover Veneer Analysis (Drained cover soil)	
Peak interface value at low normal stresses producing minimum acceptable FS of 1.5	δp= 21.4°
Section E: 3.5H:1V Final Cover Veneer Analysis (Undrained cover soil)	
Peak interface value at low normal stresses producing minimum acceptable FS of 1.5	δp= 20.4°

From the table above, the back-calculated peak friction angles to achieve the target minimum calculated factors of safety is 18.3° (assuming zero adhesion), for the liner system veneer stability. Additionally, for the final cover system veneer stability, the back-calculated peak friction angle to achieve the target minimum calculated factor of safety is 22.3° (assuming zero adhesion). It should be recognized that these strengths correspond to low normal stress conditions, and that other combinations of friction angle and adhesion (i.e., a somewhat lower friction angle combined with adhesion) can produce an acceptable factor of safety.

7. INTERFACE STRENGTH VALUES FOR LQCP AND FCQCP

Based on the results of the stability analyses the following minimum interface strength values are incorporated into the LQCP and FCQCP.

	Normal Stress (psf)	Peak Effective-Stress Interface Strength (1)		Large-Displacement Effective-Stress Interface Strength (1)	
		Shear Strength (psf)	Equivalent Secant Friction Angle (°)	Shear Strength (psf)	Equivalent Secant Friction Angle (°)
Liner System(3)	500	165	18.3	N/A(2)	N/A(2)
	7,500	2,080	15.5	1,295	9.8
	15,000	4,160	15.5	2,591	9.8
Final Cover System(4) (on 3H:1V and 3.5H:1V slopes)	500	205	22.3	N/A(2)	N/A(2)

Notes:

1. The equivalent secant friction angles given above are presented only for convenience. The actual required strength envelope is formed by the listed shear strength values (psf) corresponding to each normal stress increment (psf), which could be achieved by friction or adhesion (or any combination thereof) meeting or exceeding the specified shear strength. It should be recognized that, because the liner system strength envelope has multiple normal stress increments, it is possible that an alternate envelope could be acceptable even if one or two stress increments do not achieve the specified shear strength. If such conditions are measured, a re-analysis of slope stability may be performed by a qualified Texas Professional Engineer as a "forward-analysis" using the actual as-measured interface shear strength envelope and the applicable critical cross-section(s). The results should demonstrate that the calculated factors of safety meet or exceed the minimum criteria specified herein.
2. As explained previously in this calculation package, the large displacement strength at the low normal stress increment is not applicable ("N/A").
3. For the liner system, the geomembrane-clay interface is judged as the most critical (i.e., weakest) interface as explained previously in Section 4.2. It should be recognized that the strengths reported above represent the minimum required envelope for all liner system interfaces, but as further explained in Section 4.2, all the other interfaces typically possess much higher strengths than the geomembrane-clay interface. Therefore, the strengths reported above have been incorporated into the LQCP as part of associated testing specified for the most critical interface (namely, the geomembrane-clay interface) because if it can be verified that this critical interface is sufficient, then one can be confident that all the other stronger liner system interfaces also possess adequate strength.
4. For the final cover system, the geomembrane-compacted soil interface is judged as the most critical (i.e., weakest) interface as explained previously in Section 4.2. It should be recognized that the strengths reported above represent the minimum required envelope for all final cover system interfaces, but as further explained in Section 4.2, all the other interfaces typically possess much higher strengths than the geomembrane-compacted soil interface. Therefore, the strengths reported above have been incorporated into the FCQCP as part of associated testing specified for the most critical interface (namely, the geomembrane-compacted soil interface) because if it can be verified that this critical interface is sufficient, then one can be confident that all the other stronger final cover system interfaces also possess adequate strength.

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Written by: **P. Pandey**	Date: **7/3/2023**	Reviewed by & Revised by: **S. Graves**	Date: **7/16/2023; 2/7/2024**

Client: **WMTX**	Project: **Mesquite Creek Landfill**	Project No.: **GW8636**	Phase No.: **05**

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TABLES

Written by: **P. Pandey** Date: **7/3/2023** Reviewed by & Revised by: **S. Graves** Date: **7/16/2023; 2/7/2024**

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Table 1. Typical Properties of Compacted Soils (after NAVFAC, 1986).

Group Symbol	Soil Type	Range of Maximum Dry Unit Weight (pcf)	Range of Optimum Moisture Content (%)	Typical Strength Characteristics			
				Cohesion, as compacted (psf)	Cohesion, saturated (psf)	ϕ, Effective-Stress Envelope (degrees)	tan(ϕ)
SP	Poorly graded clean sands, sand-gravel mix.	100 - 120	12-21	0	0	37	0.74
SM	Silty sands, poorly graded sand-silt mix.	110 - 125	11 - 16	1,050	420	34	0.67
SM-SC	Sand-silt clay mix with slightly plastic fines	110 - 130	11 - 15	1,050	300	33	0.66
SC	Clayey sands, poorly-graded sand-clay mix.	105 - 125	11 - 19	1,550	230	31	0.60
ML	Inorganic silts and clayey silts	95 - 120	12 - 24	1,400	190	32	0.62
CL	Inorganic clays of low to medium plasticity	95 - 120	12 - 24	1,800	270	28	0.54
CH	Inorganic clays of high plasticity	75 - 105	19 - 36	2,150	230	19	0.35

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FIGURES

Written by: **P. Pandey** Date: **7/3/2023** Reviewed by & Revised by: **S. Graves** Date: **7/16/2023; 2/7/2024**

Client: **WMTX** Project: **Mesquite Creek Landfill** Project No.: **GW8636** Phase No.: **05**

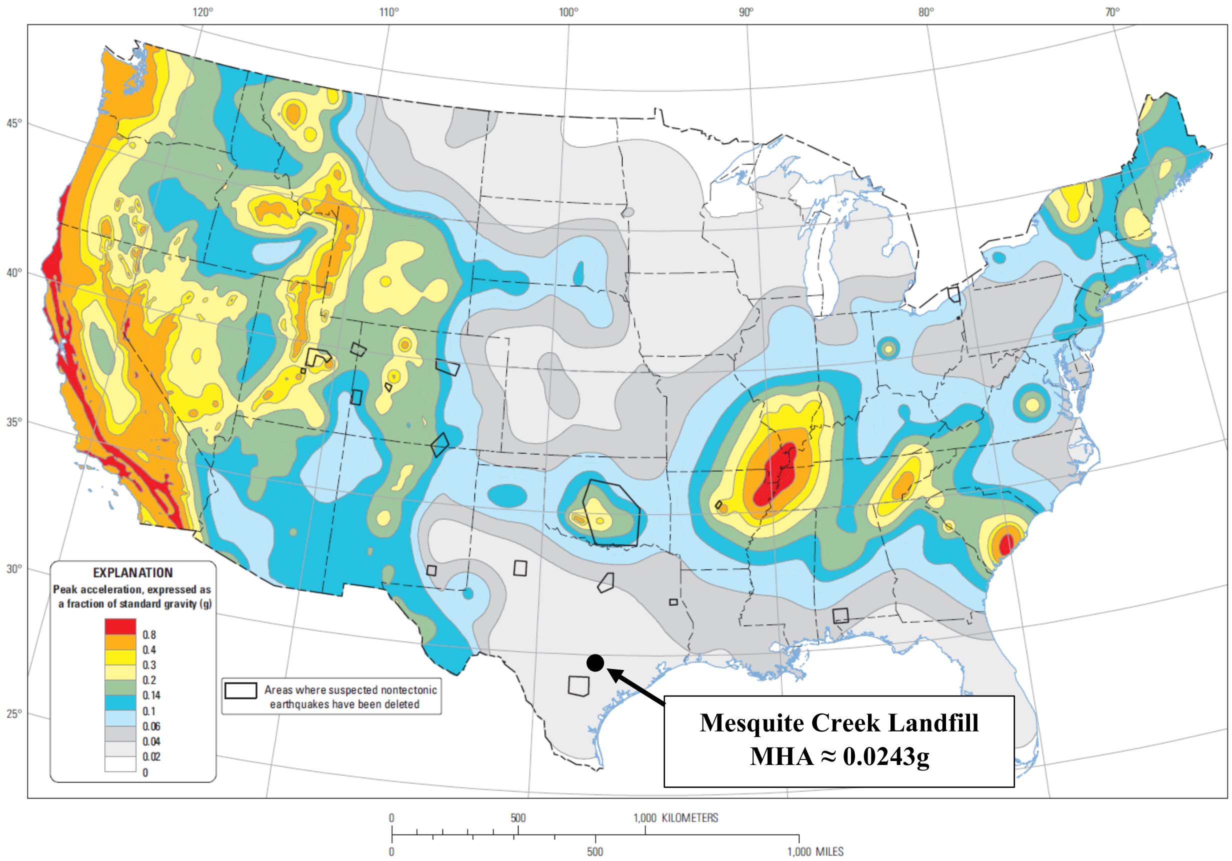

Figure 1A. 2014[1] USGS National Seismic Hazard Map showing maximum horizontal acceleration (as a fraction of standard gravity, g) with 2% probability of exceedance in 50 years.

Note:

1. It is noted that as of August 2023, a more recent seismic hazard map dated 2018 is also available from the USGS website. Based on a comparison of the 2014 and 2018 maps, the peak ground accelerations are consistent for the site vicinity and for Texas in general. The 2014 map also identifies areas where suspected nontectonic earthquakes have been detected, and therefore is used as the base map on this above figure based on the added information included (see also Figure 1B for a more recently published "short-term induced seismicity" map).

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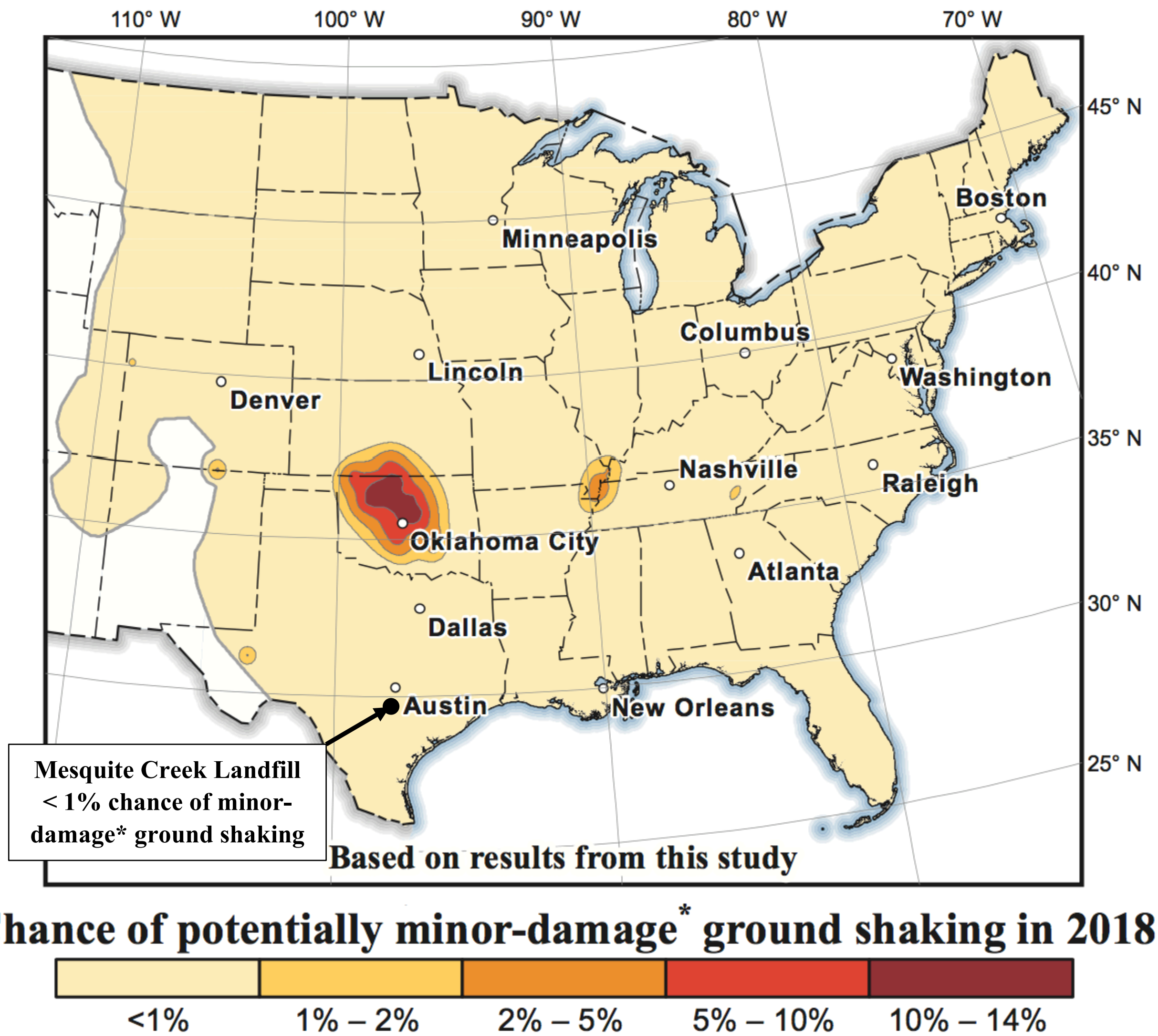

Figure 1B. 2018 USGS Short-term Induced Seismicity Models showing chance of potentially minor damage* ground shaking in 2018.

***Note: USGS refers to minor-damage ground shaking as equivalent to Modified Mercalli Intensity VI, which is defined as: "Felt by all, many frightened. Some heavy furniture moved; a few instances of fallen plaster. Damage slight."**

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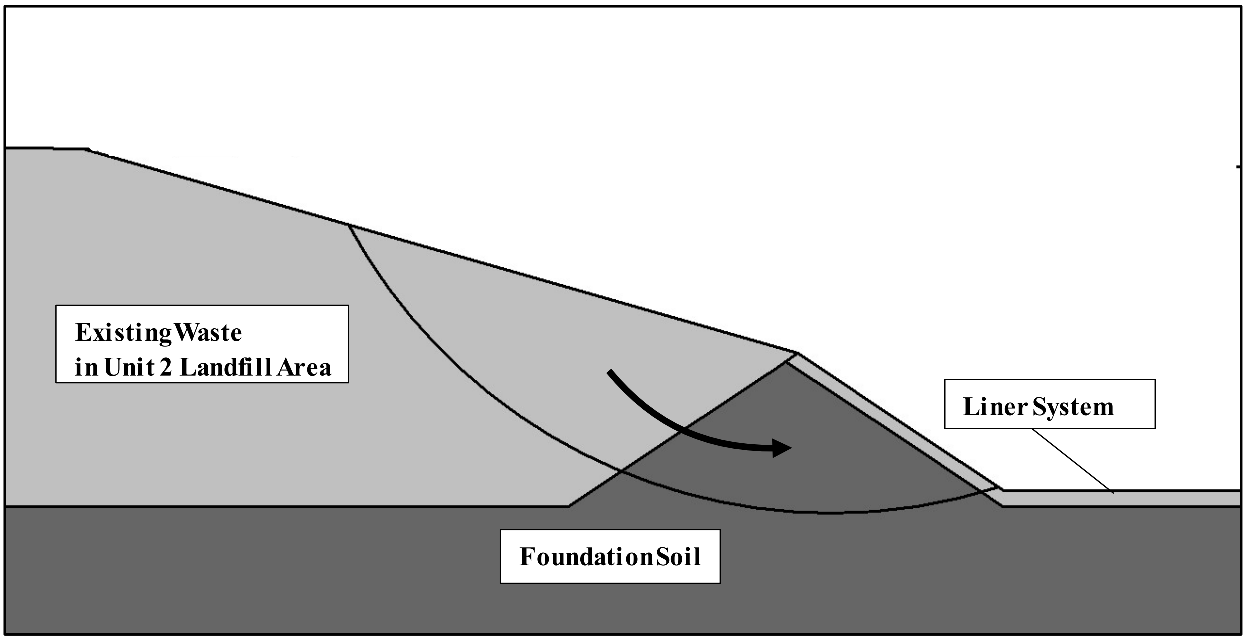

Figure 2A. Illustration of circular shear surface through existing landfill and initial excavation slope in proposed expansion area.

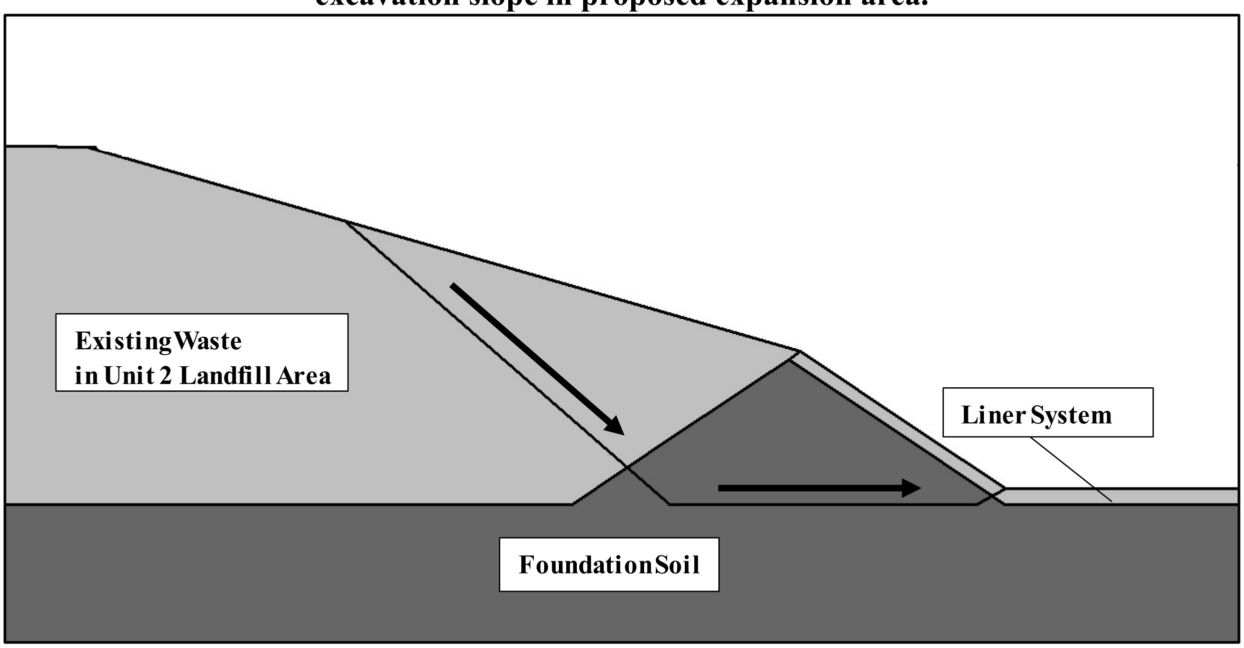

Figure 2B. Illustration of block-type shear surface through existing landfill and initial excavation slope in proposed expansion area.

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Client: **WMTX** Project: **Mesquite Creek Landfill** Project No.: **GW8636** Phase No.: **05**

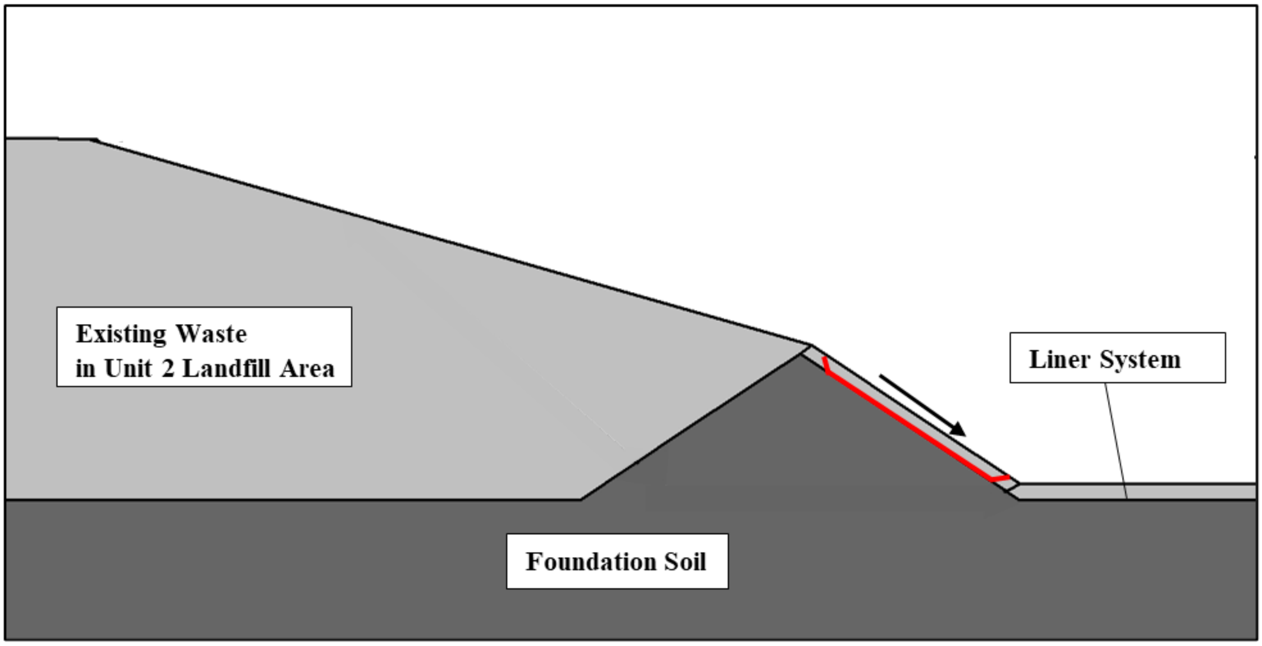

Figure 2C. Illustration of shallow, block-type shear surface through sideslope liner (i.e., liner veneer).

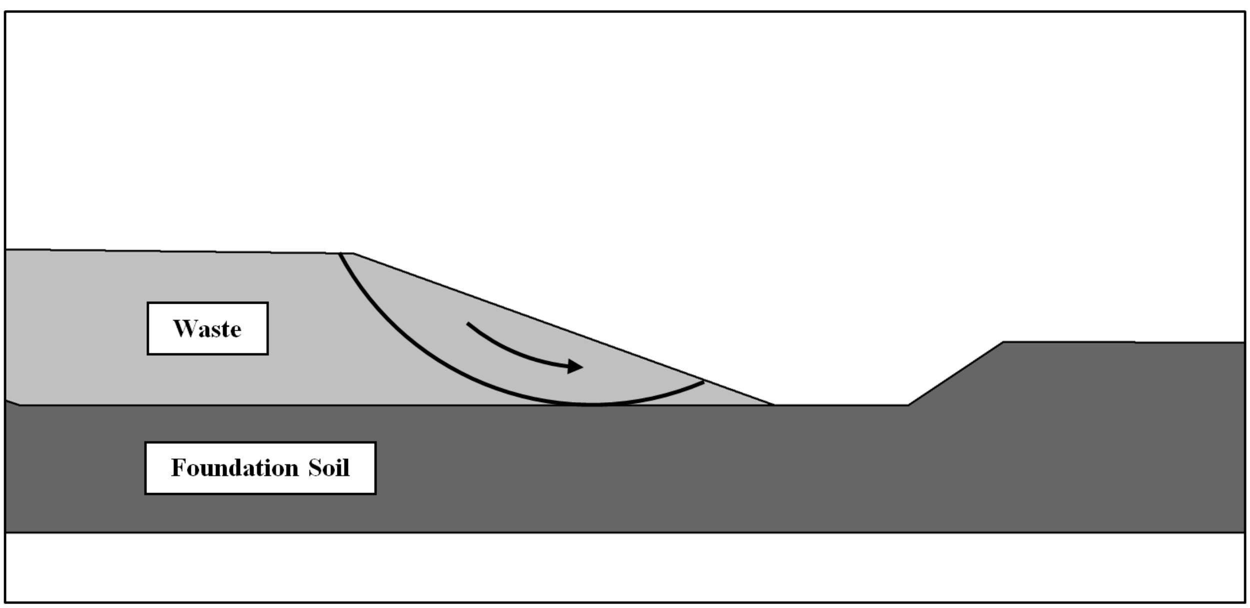

Figure 2D. Illustration of circular shear surface through interim waste slopes.

Written by: **P. Pandey** Date: **7/3/2023** Reviewed by & Revised by: **S. Graves** Date: **7/16/2023; 2/7/2024**

Client: **WMTX** Project: **Mesquite Creek Landfill** Project No.: **GW8636** Phase No.: **05**

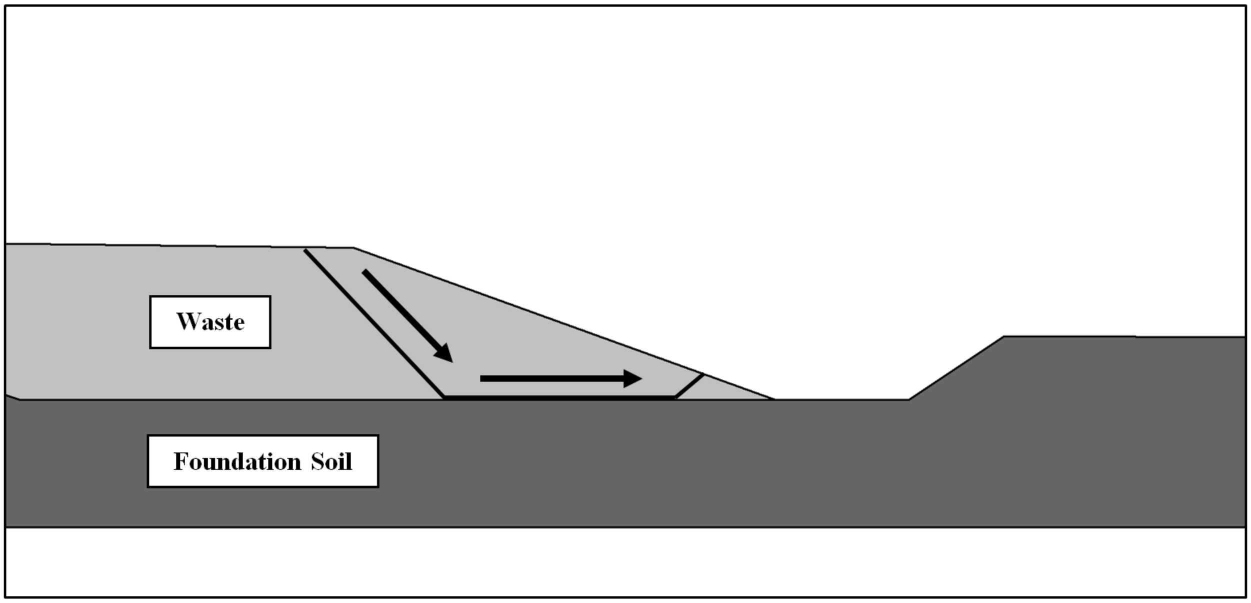

Figure 2E. Illustration of block-type shear surface through interim waste slopes.

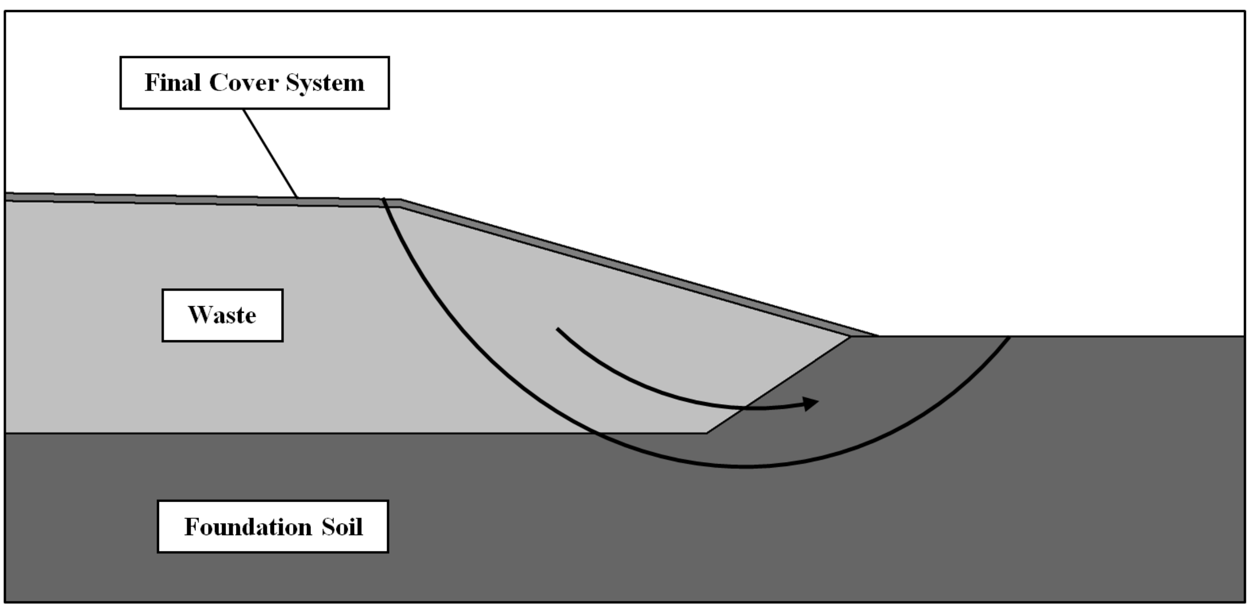

Figure 2F. Illustration of circular shear surface through final waste slopes and foundation.

Written by: **P. Pandey** Date: **7/3/2023** Reviewed by & Revised by: **S. Graves** Date: **7/16/2023; 2/7/2024**

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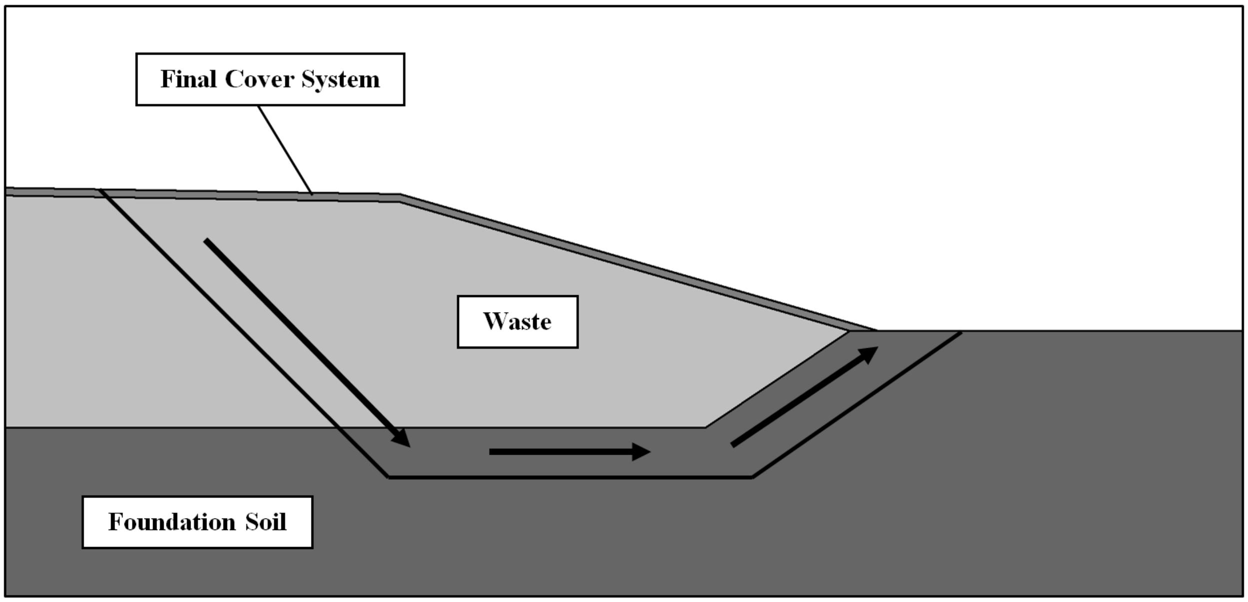

Figure 2G. Illustration of block-type shear surface through final waste slopes and foundation.

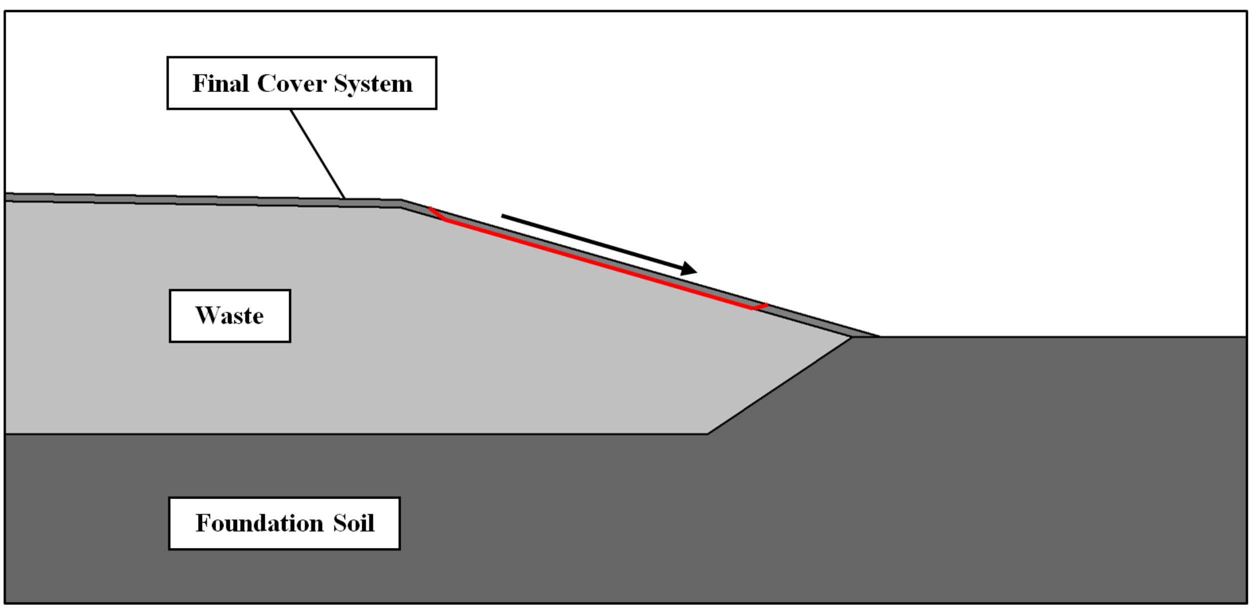

Figure 2H. Illustration of shallow, block-type shear surface through final cover system.

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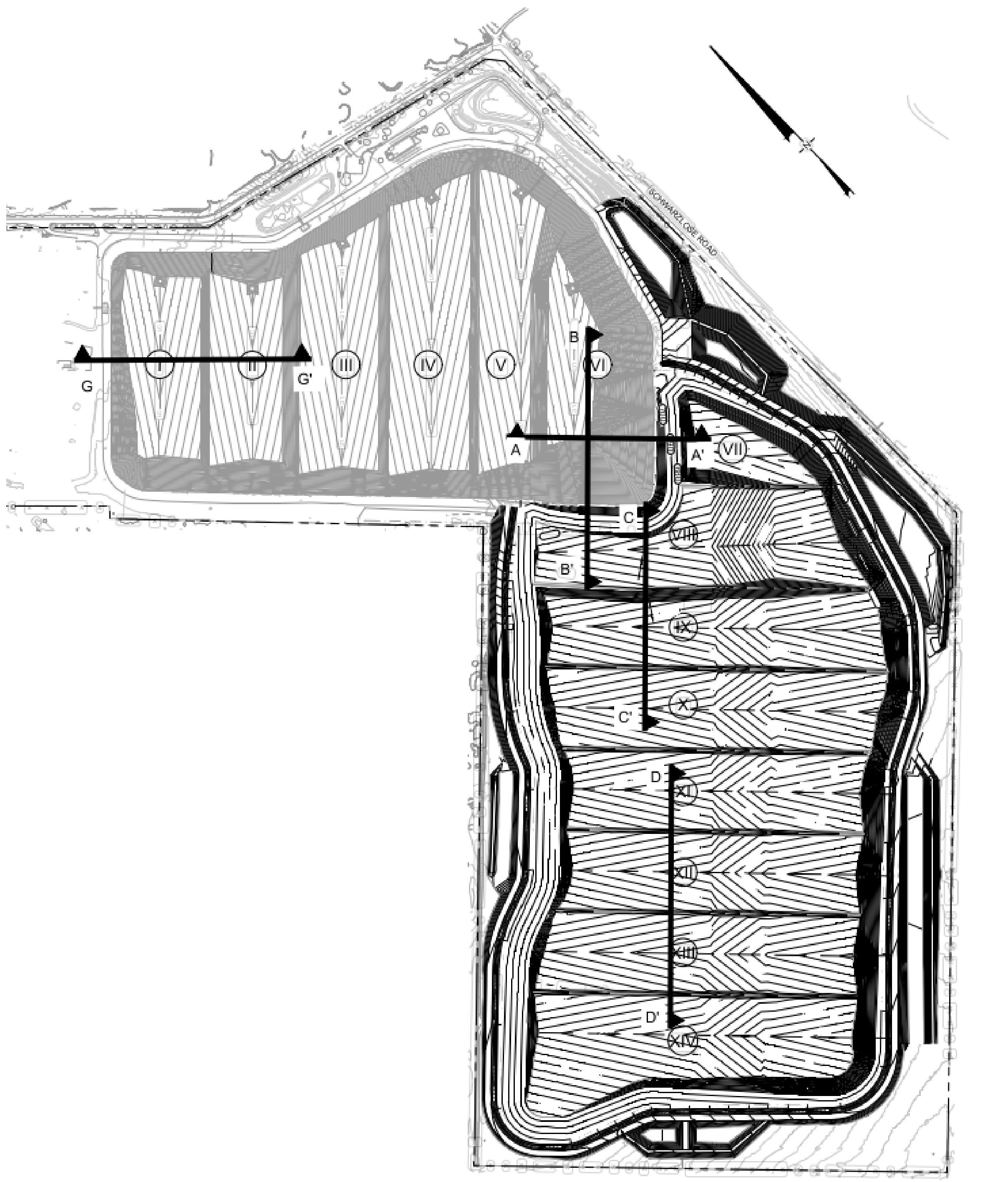

Figure 3A. Locations of the stability cross-sections in relation to overall base liner grading plan.

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Client: **WMTX**	Project: **Mesquite Creek Landfill**	Project No.: **GW8636**	Phase No.: **05**

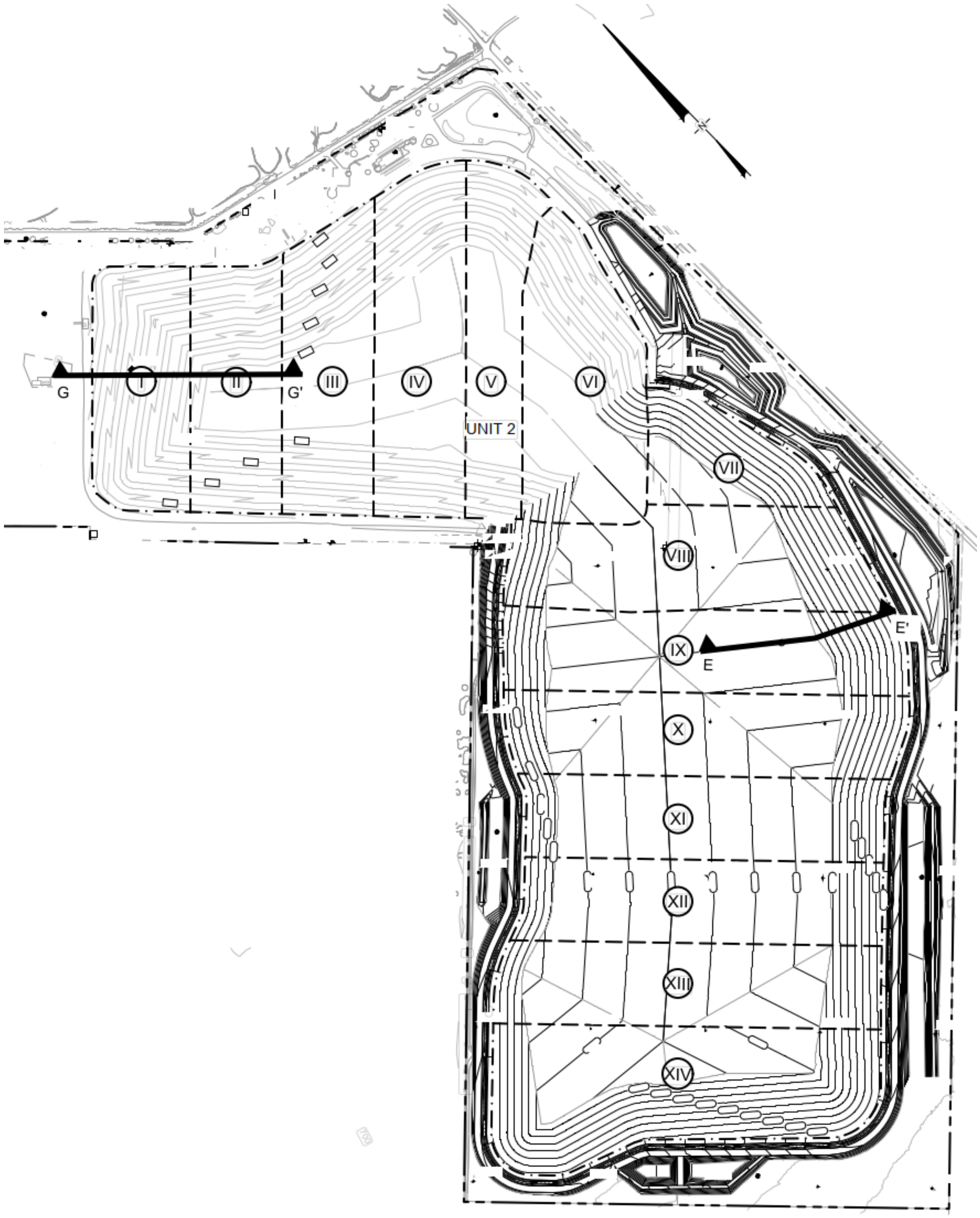

Figure 3B. Locations of the stability cross-sections in relation to final cover grading plan in Unit 2

Written by: **P. Pandey**	Date: **7/3/2023**	Reviewed by & Revised by: **S. Graves**	Date: **7/16/2023; 2/7/2024**

Client: **WMTX** Project: **Mesquite Creek Landfill** Project No.: **GW8636** Phase No.: **05**

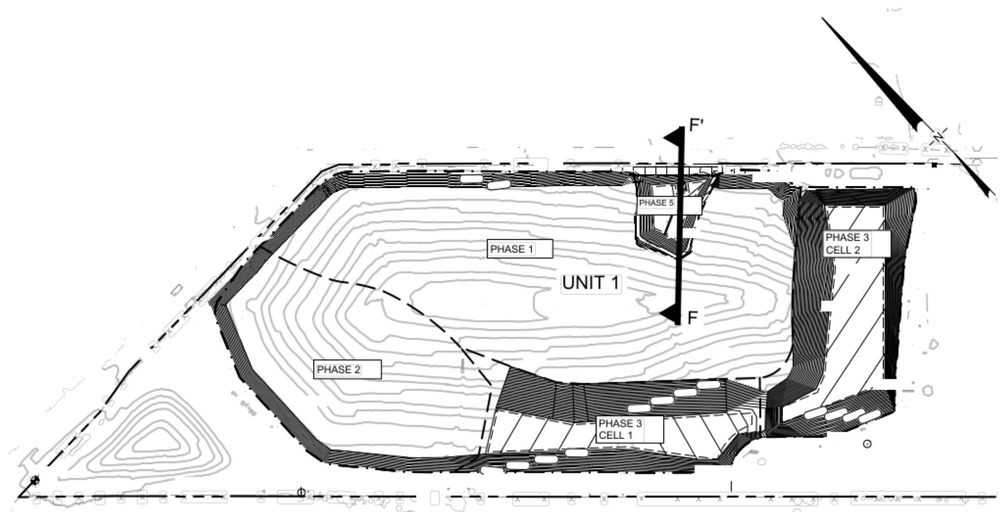

Figure 3C. Locations of the stability cross-section in relation to final cover grading plan in Unit 1

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Client:	WMTX	Project:	Mesquite Creek Landfill	Project No.:	GW8636	Phase No.:	05

APPENDIX 1 OF ATTACHMENT 3D.2

SLIDE OUTPUT
Initial Excavation Landfill Slopes
Interim Landfill Slopes
Final Landfill Slopes
Liner and Final Cover Veneer Analyses

Written by:	P. Pandey	Date:	7/3/2023	Reviewed by & Revised by:	S. Graves	Date:	7/16/2023; 2/7/2024
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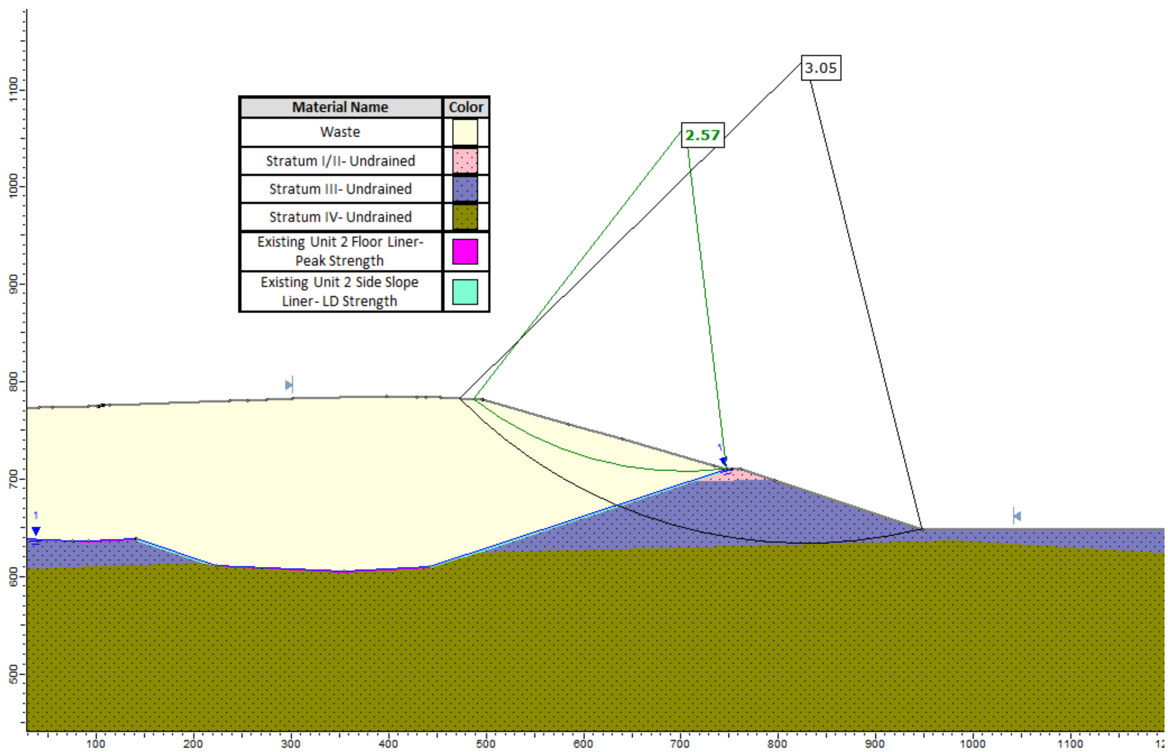
INITIAL EXCAVATION LANDFILL SLOPES

Section A, Circular Shear Surfaces through Existing Landfill and Foundation Soils



Written by: **P. Pandey** Date: **7/3/2023** Reviewed by & Revised by: **S. Graves** Date: **7/16/2023; 2/7/2024**

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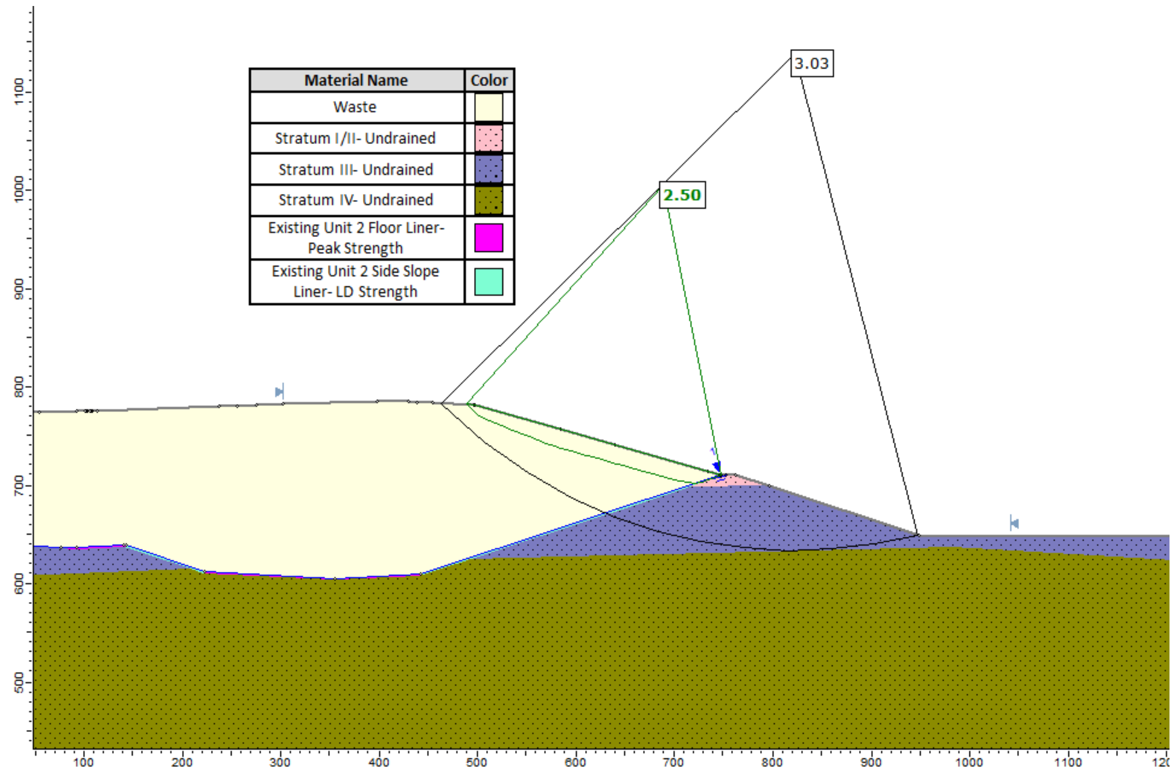
Section A, Block-type Shear Surfaces through Existing Landfill and Foundation Soils



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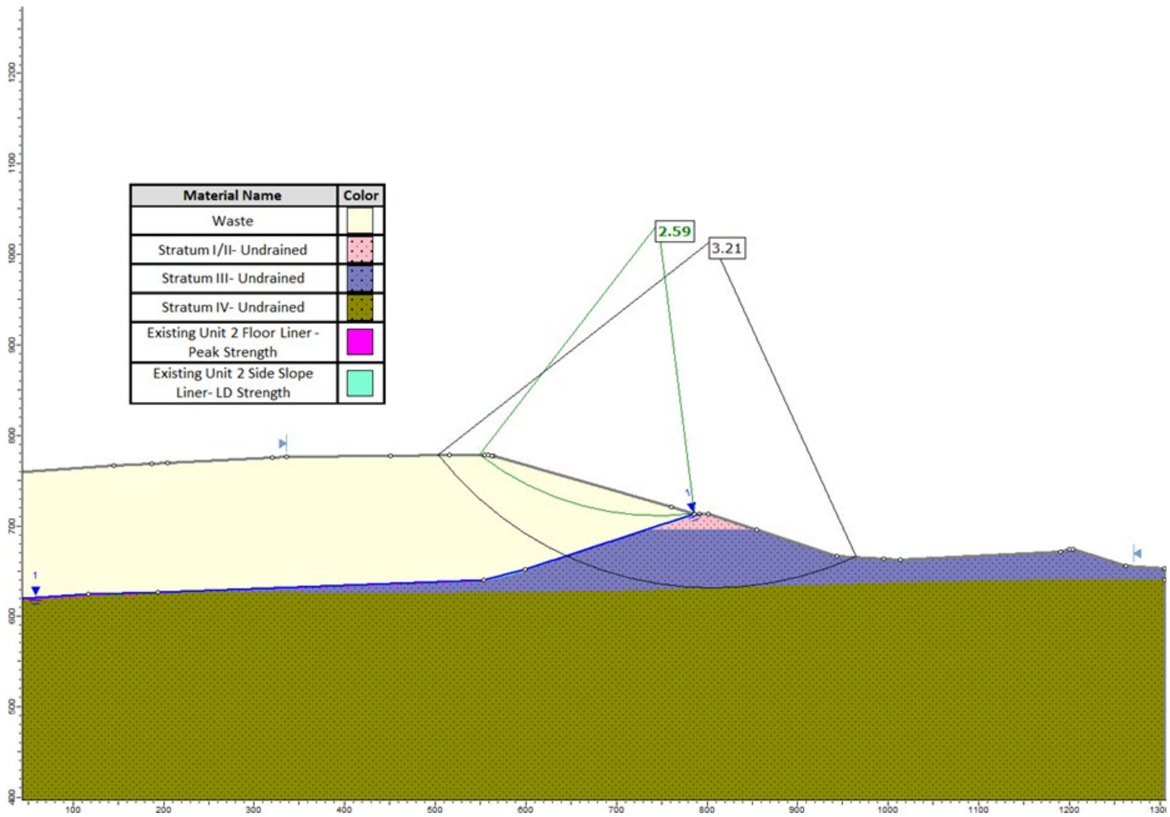
Client: **WMTX**	Project: **Mesquite Creek Landfill**	Project No.: **GW8636**	Phase No.: **05**

Section B, Circular Shear Surfaces through Existing Landfill and Foundation Soils



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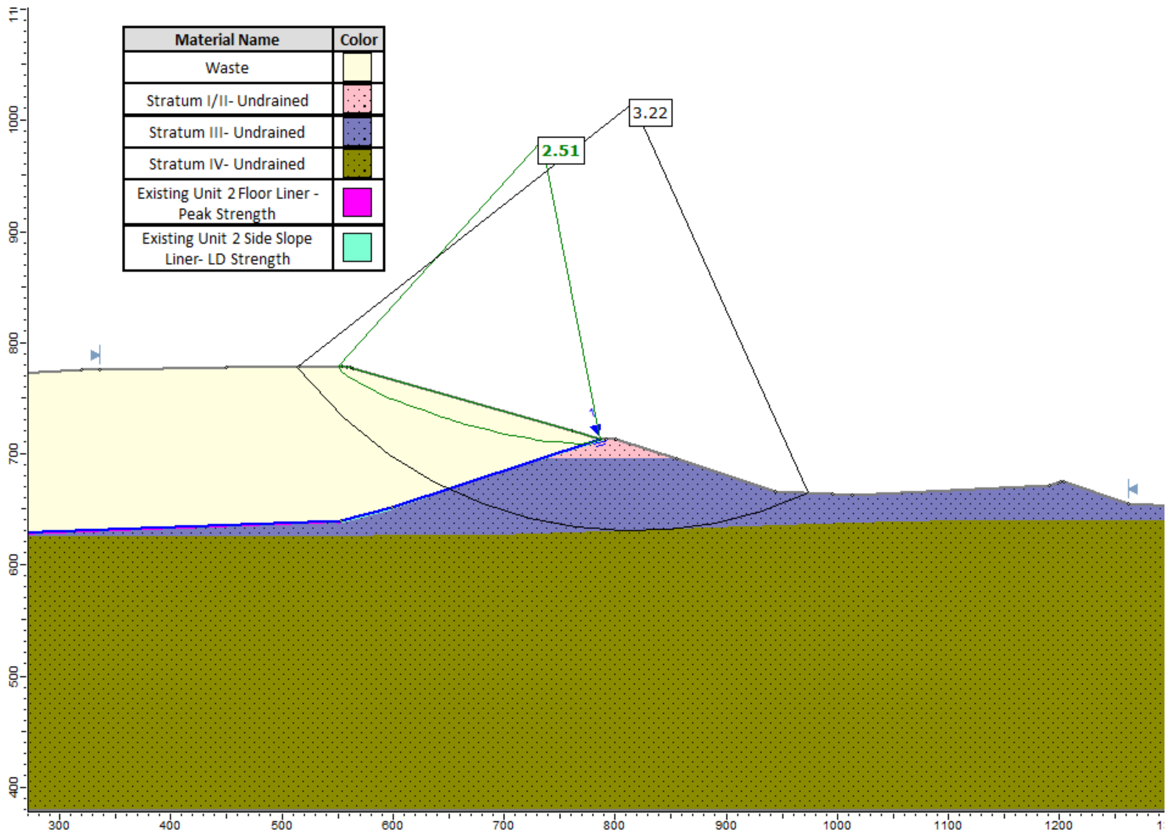
Client:	**WMTX**	Project:	**Mesquite Creek Landfill**	Project No.:	**GW8636**	Phase No.:	**05**

Section B, Block-type Shear Surfaces through Existing Landfill and Foundation Soils



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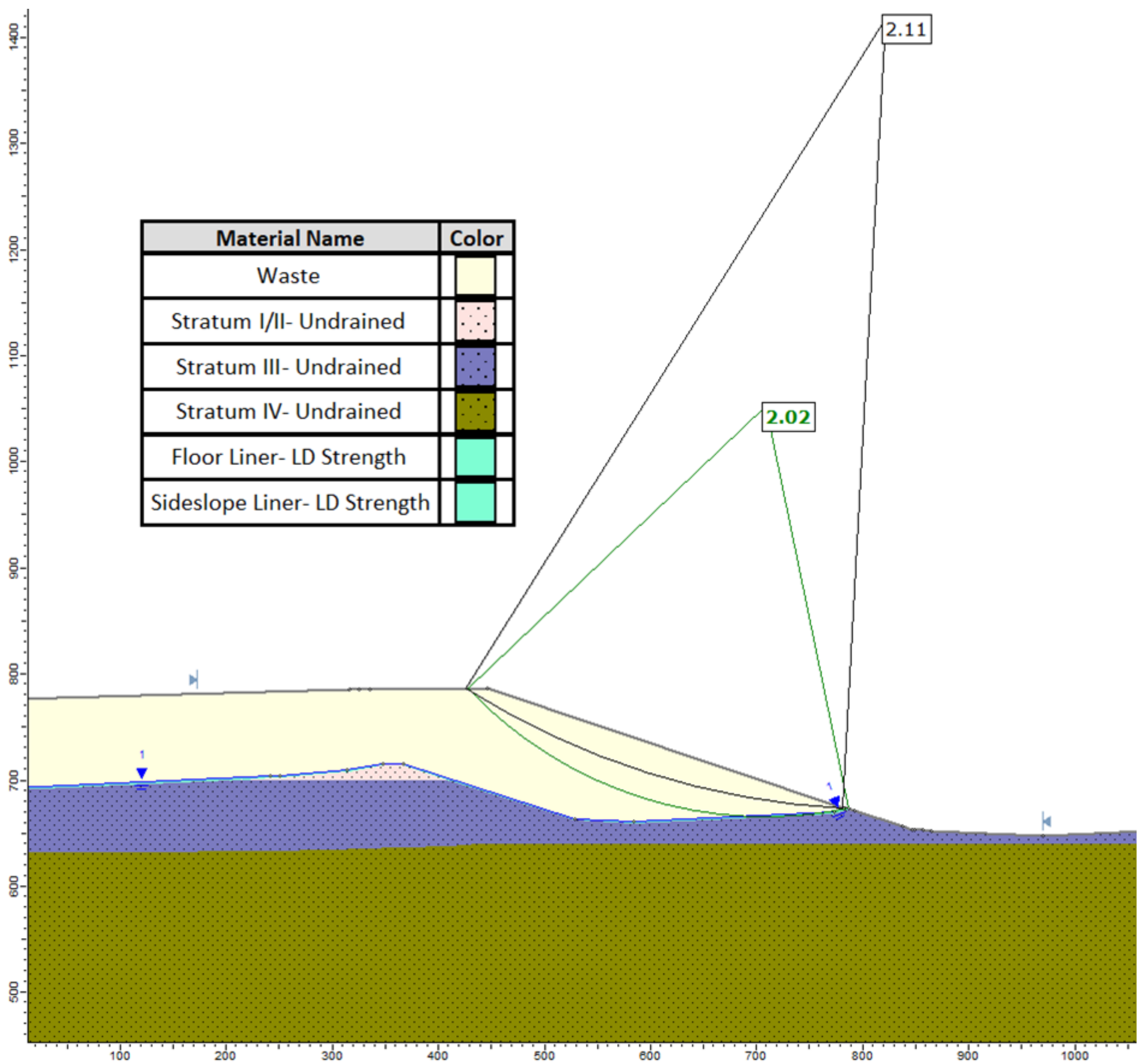
INTERIM LANDFILL SLOPES

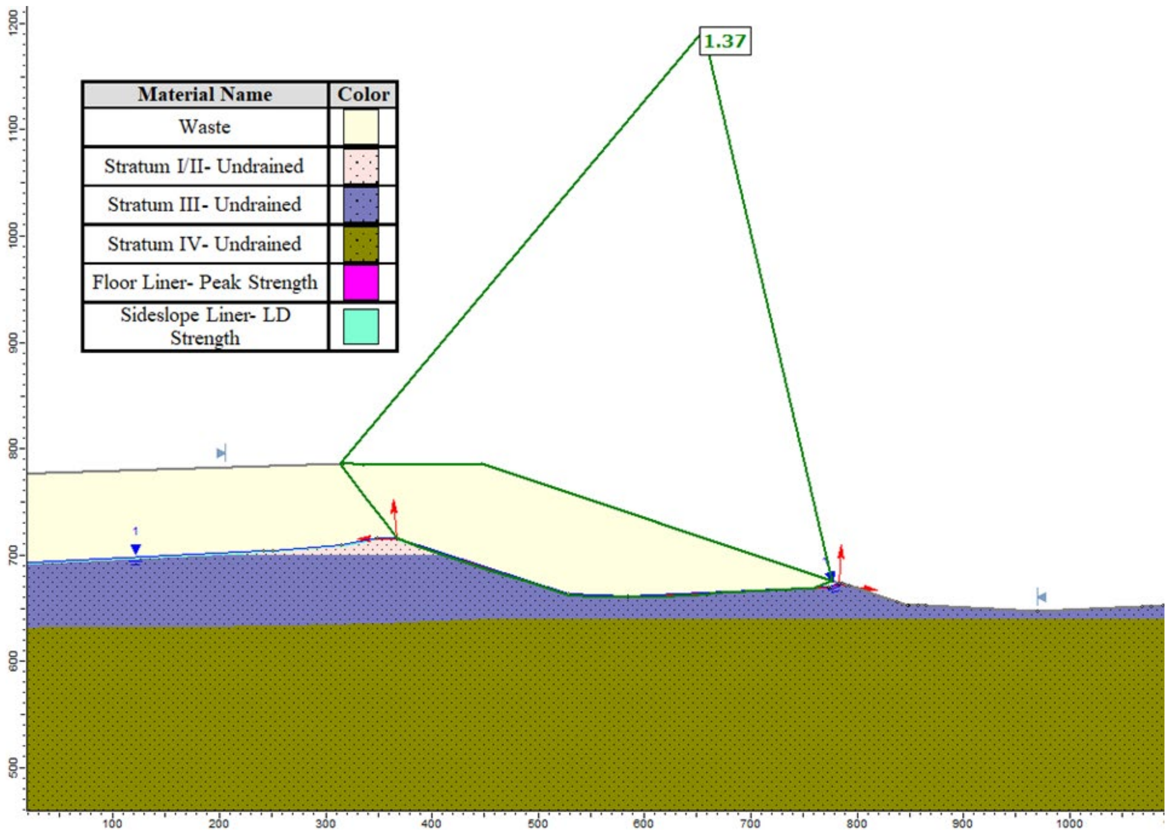
Section C, Short-Term Stability, Circular Shear Surfaces through Interim Waste Slope and Liner System using Site Specific Interface Results (LD/LD Scenario)



Written by: **P. Pandey** Date: **7/3/2023** Reviewed by & Revised by: **S. Graves** Date: **7/16/2023; 2/7/2024**

Client: **WMTX** Project: **Mesquite Creek Landfill** Project No.: **GW8636** Phase No.: **05**

Section C, Short-Term Stability, Block-type Shear Surfaces through the Waste and along Liner System using Site Specific Interface Results (P/LD scenario)



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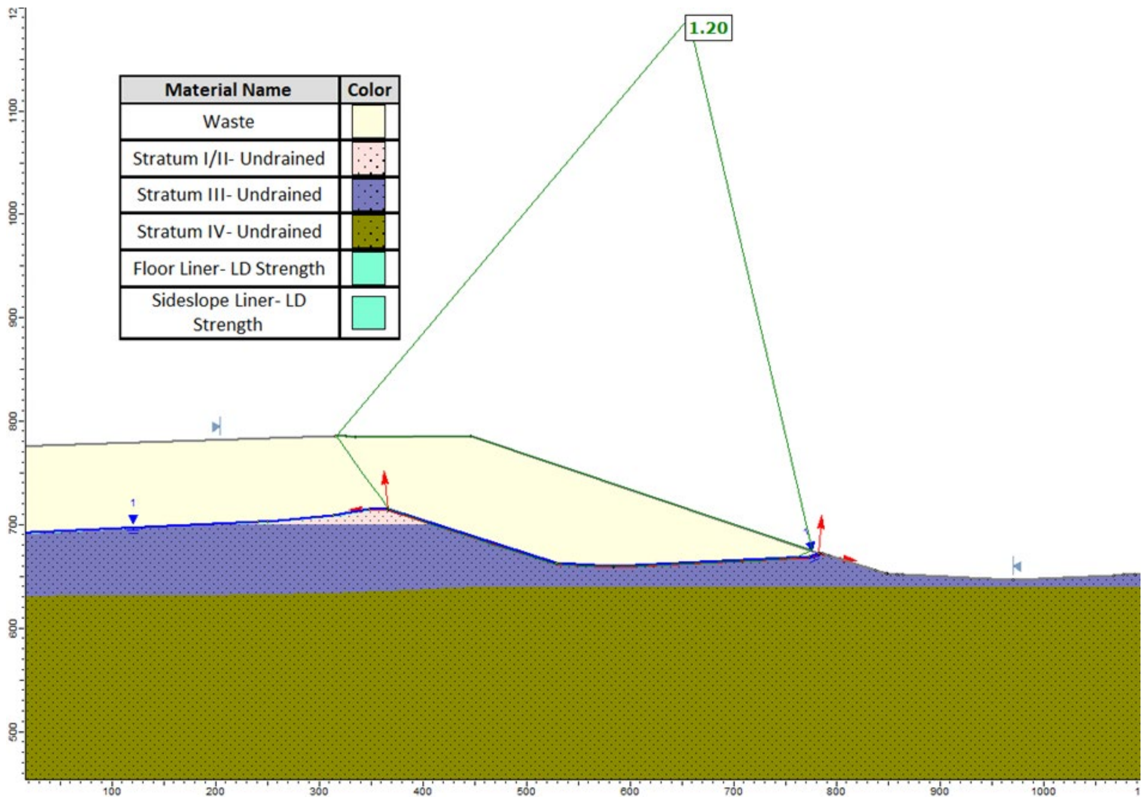
Section C, Short-Term Stability, Block-type Shear Surfaces through the Waste and along Liner System using Site Specific Interface Results (LD/LD scenario)



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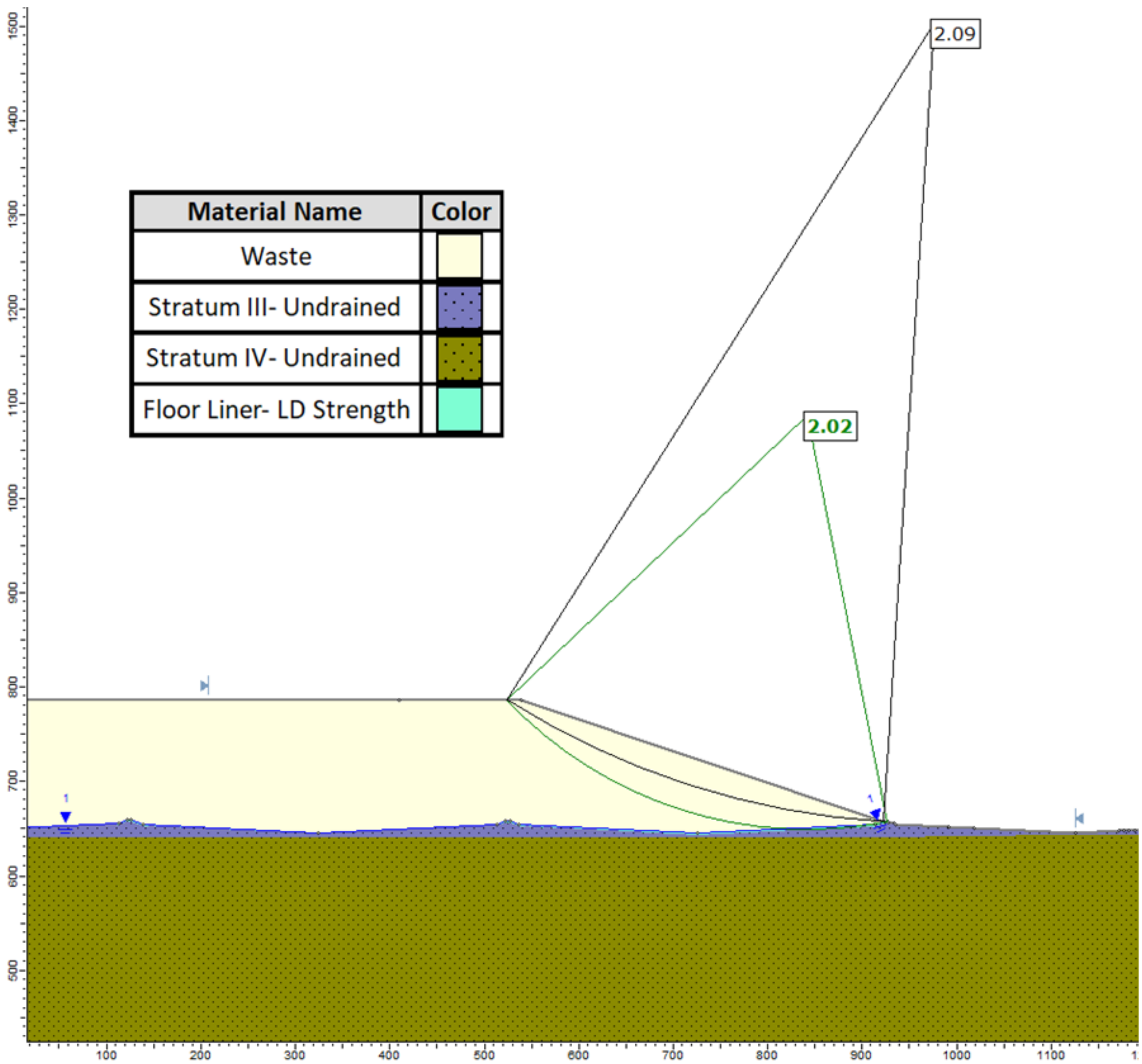
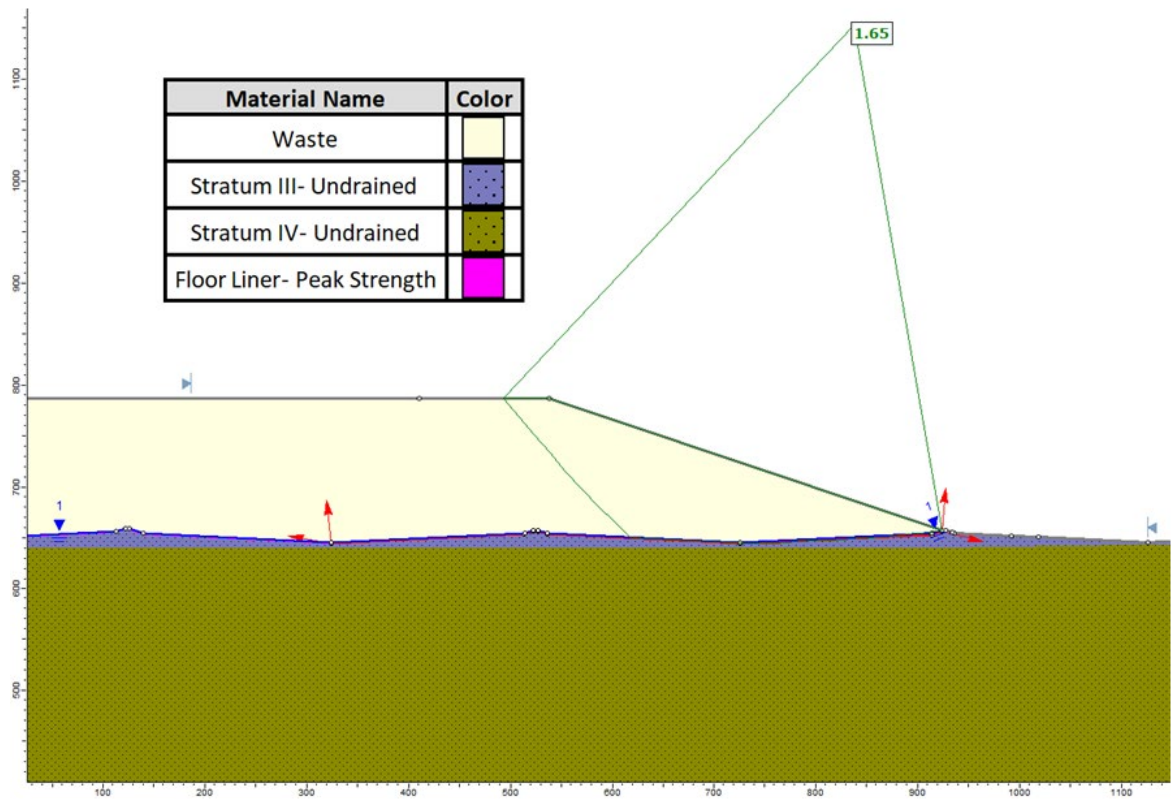
Section D, Short-Term Stability, Circular Shear Surfaces through Interim Waste Slope and Liner System using Site Specific Interface Results (LD Strength for Floor Liner System)



Written by: P. Pandey | Date: 7/3/2023 | Reviewed by & Revised by: S. Graves | Date: 7/16/2023; 2/7/2024

Client: WMTX | Project: Mesquite Creek Landfill | Project No.: GW8636 | Phase No.: 05

Section D, Short-Term Stability, Block- type Shear Surface through the Waste and along Liner System using Site Specific Interface Results (Peak Strength for Floor Liner System)



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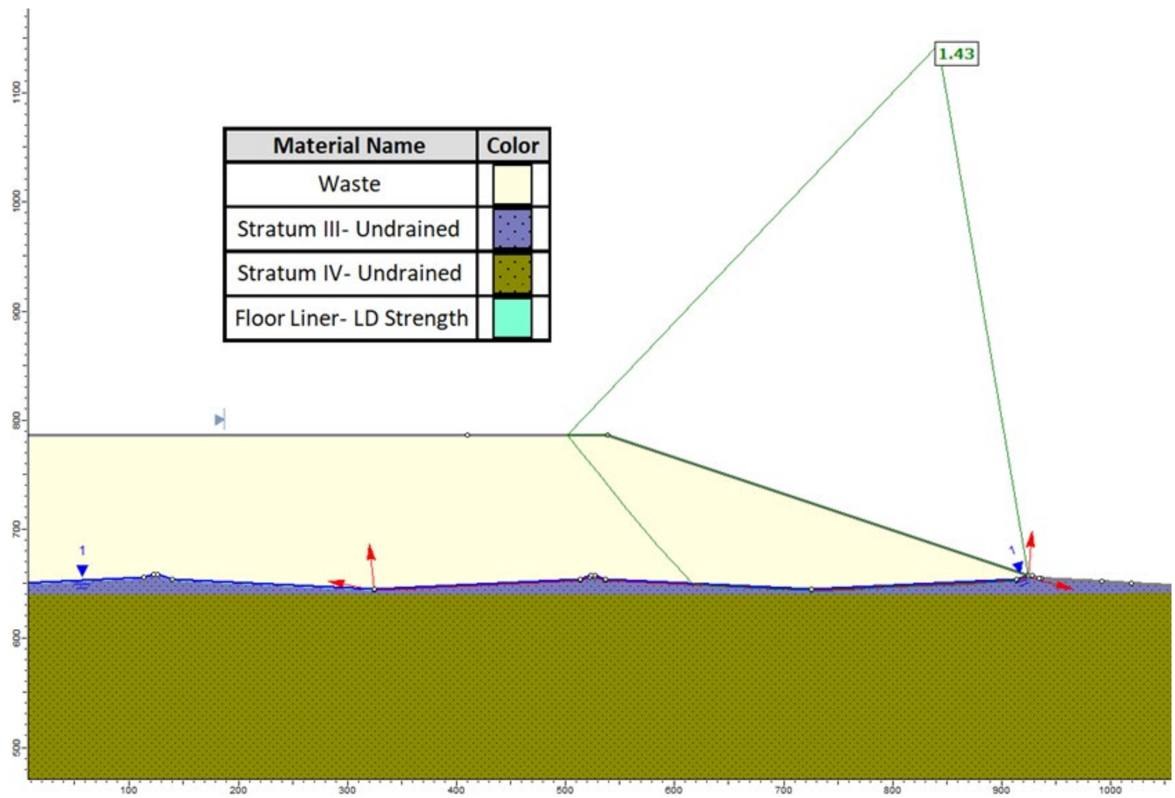
Client:	WMTX	Project:	Mesquite Creek Landfill	Project No.:	GW8636	Phase No.:	05

Section D, Short-Term Stability, Block-type Shear Surfaces through the Waste and along Liner System using Site Specific Interface Results (LD Strength for Floor Liner System)



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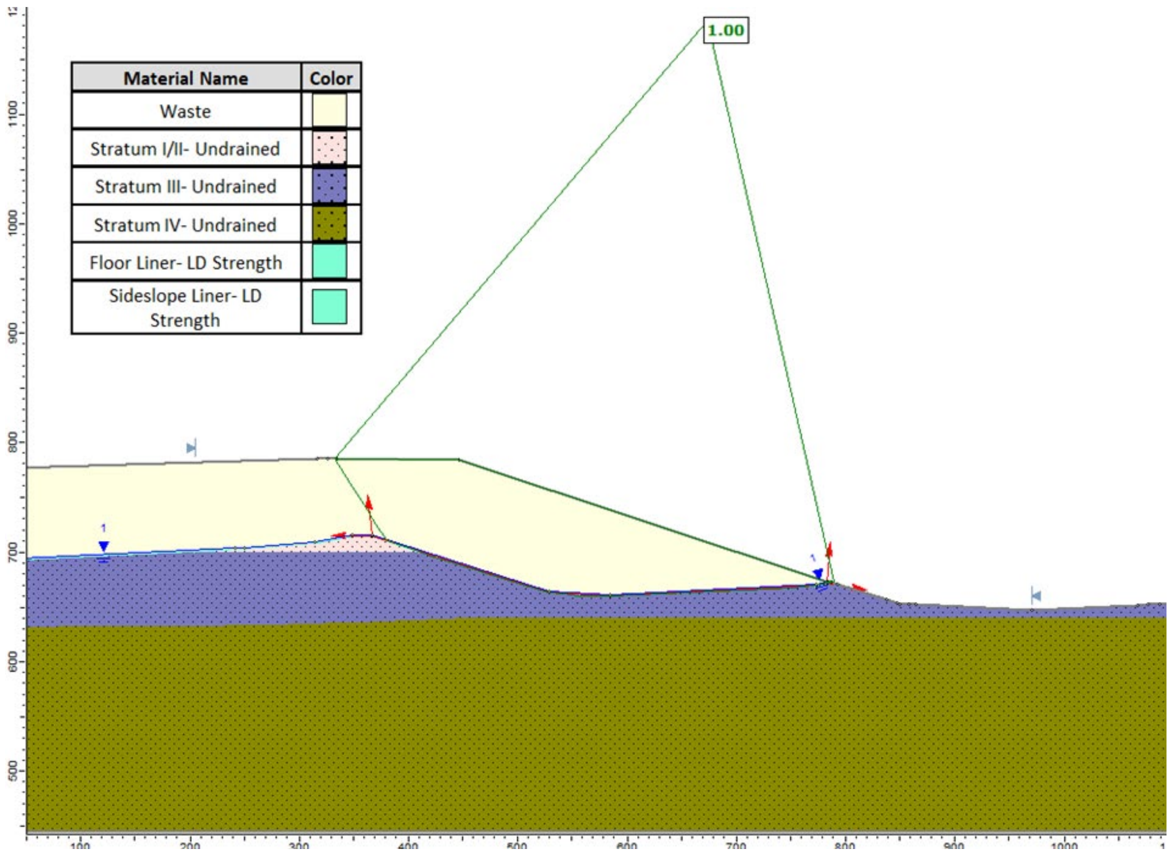
BACK ANALYSES OF MINIMUM REQUIRED INTERFACE STRENGTHS

Section C, Block Type Shear Surface through the Waste and along the Liner System (Minimum LD Strength δ_{LD}= 9.8° under LD/LD scenario)



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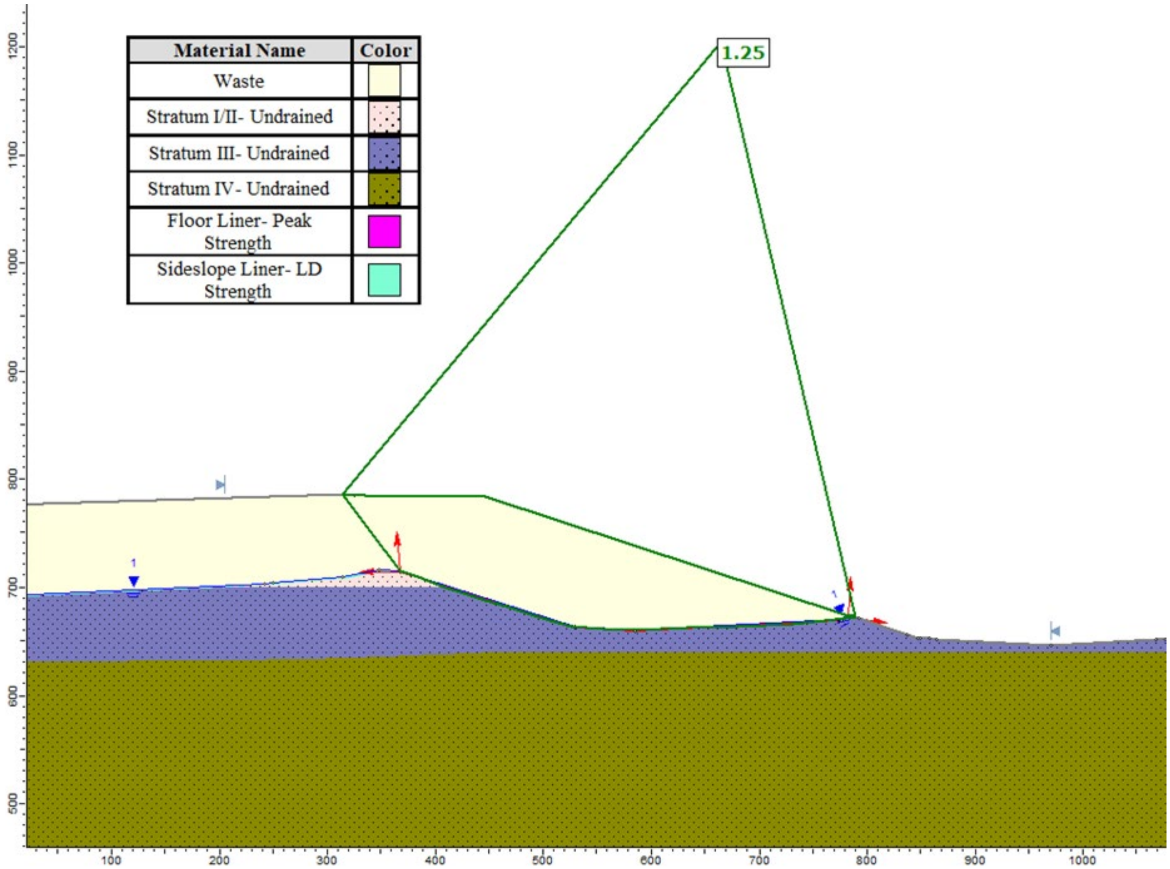
Section C, Block Type Shear Surface through Waste and along the Liner System (Minimum Peak Strength δ_p= 15.5° under P/LD scenario)



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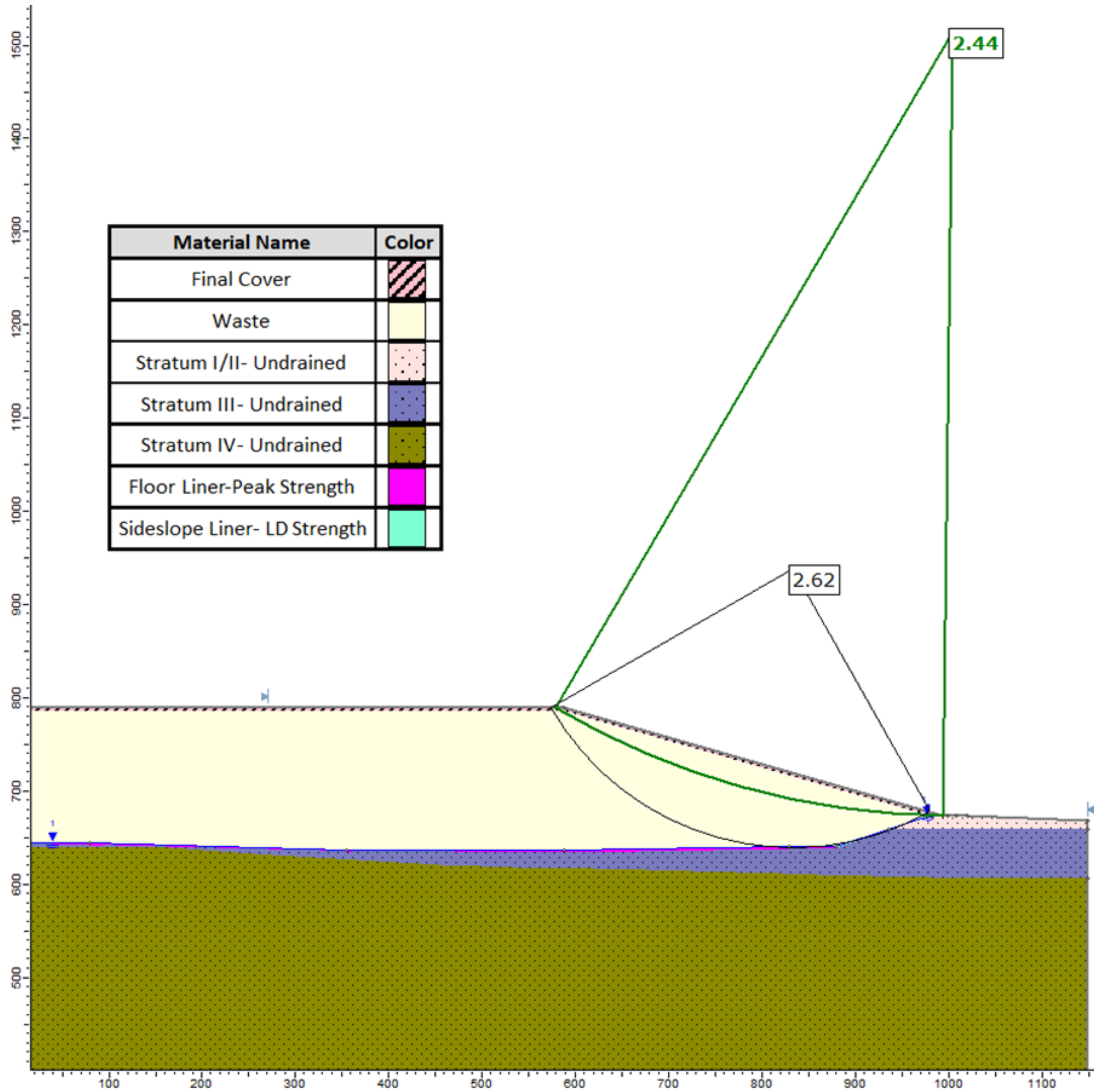
Client: **WMTX**	Project: **Mesquite Creek Landfill**	Project No.: **GW8636**	Phase No.: **05**

FINAL LANDFILL SLOPES- PROPOSED EXPANSION AREA

Section E, Short-Term Stability, Circular Shear Surface through the Waste and Liner System using Site Specific Interface Results (P/LD Scenario)



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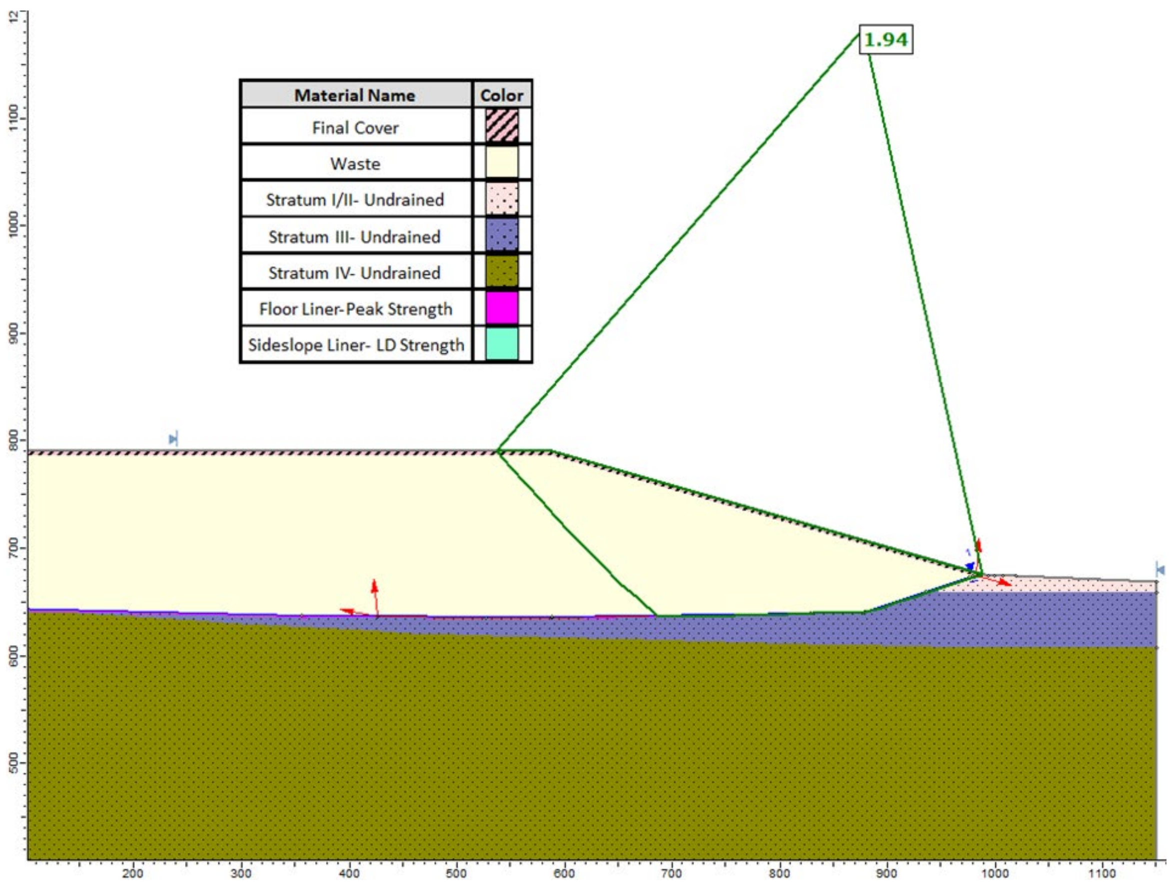
Client: **WMTX** Project: **Mesquite Creek Landfill** Project No.: **GW8636** Phase No.: **05**

Section E, Short-Term Stability, Block- type Shear Surface through the Waste and along the Liner using Site Specific Interface Results (P/LD Scenario)



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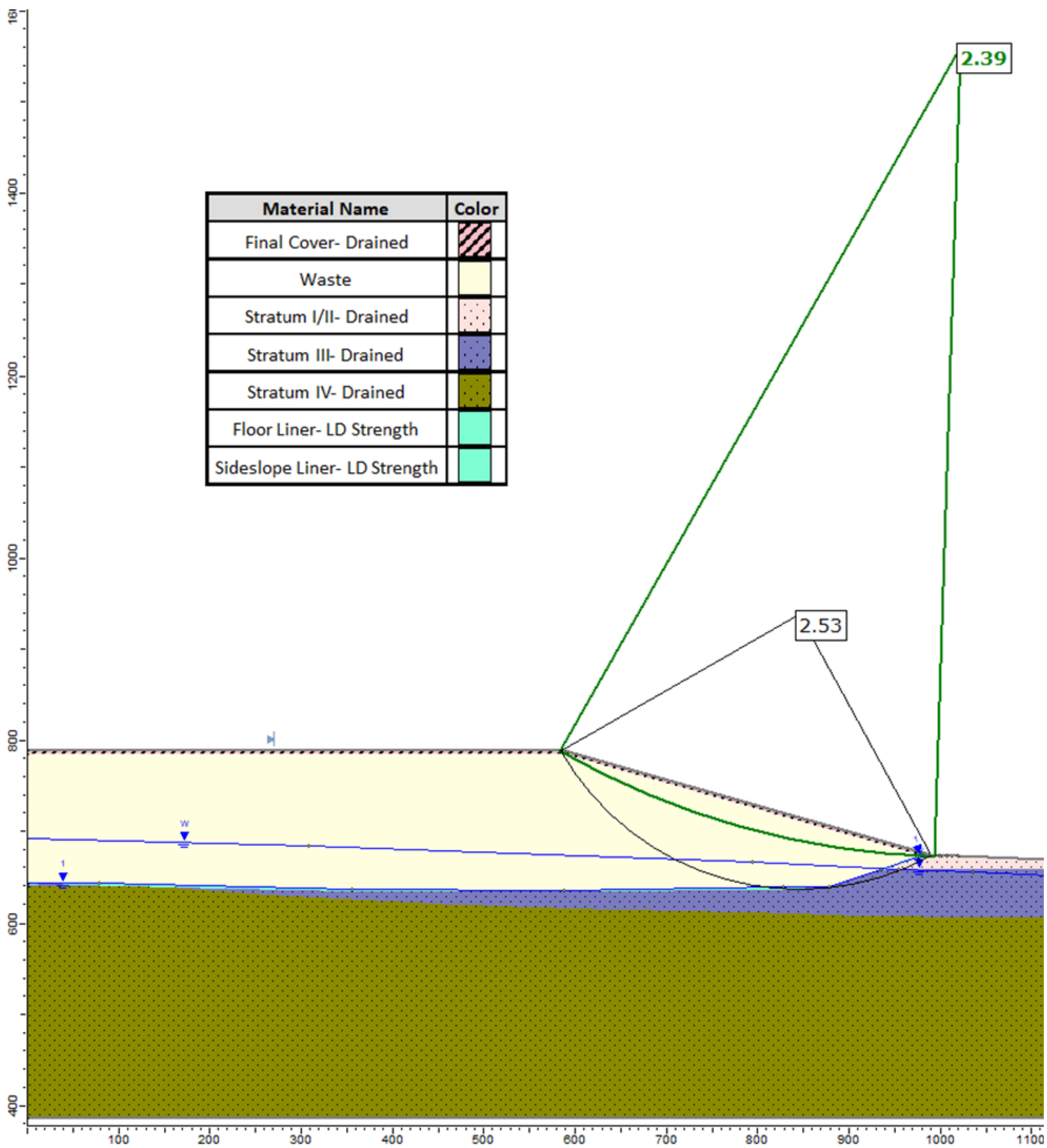
Client: **WMTX** Project: **Mesquite Creek Landfill** Project No.: **GW8636** Phase No.: **05**

Section E, Long-Term Stability, Circular Shear Surface through the Waste and Liner System using Site Specific Interface Results (LD/LD Scenario)



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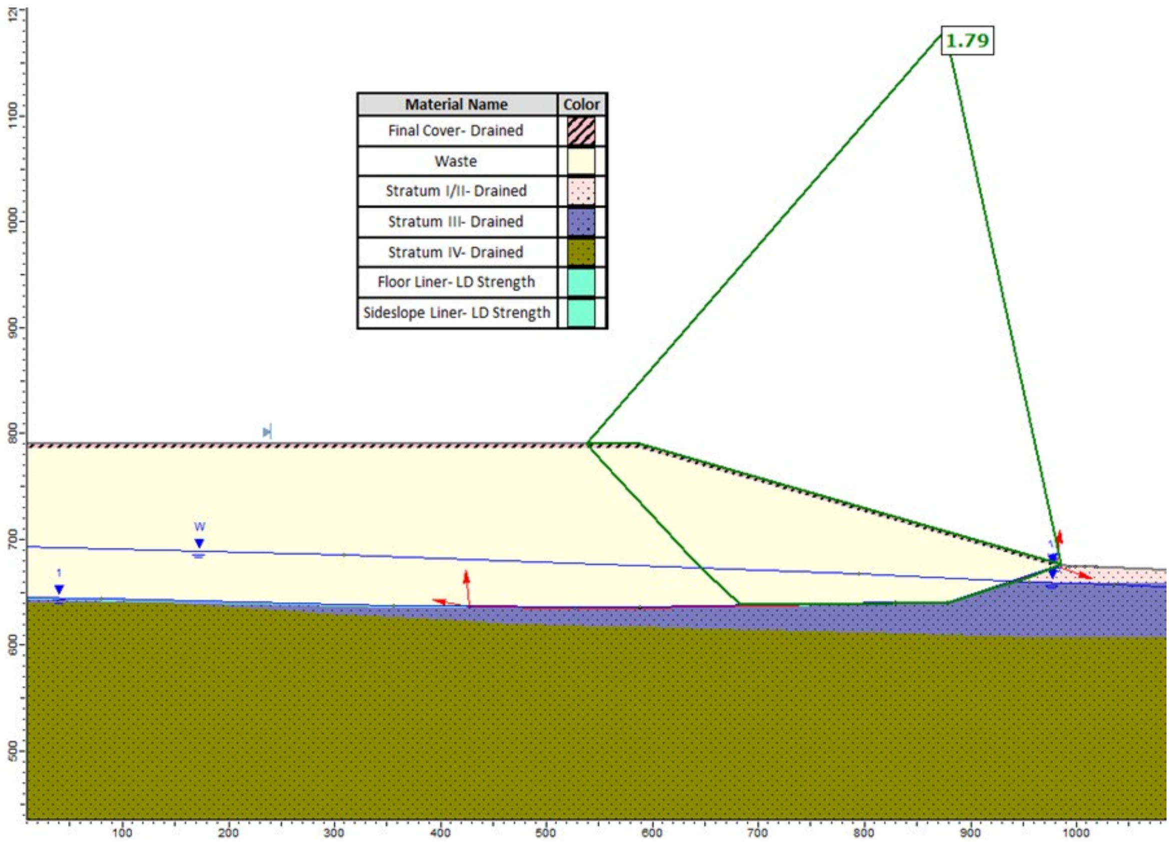
Client: **WMTX**	Project: **Mesquite Creek Landfill**	Project No.: **GW8636**	Phase No.: **05**

Section E, Long-Term Stability, Block- type Shear Surface through the Waste and along the Liner using Site Specific Interface Results (LD/LD Scenario)



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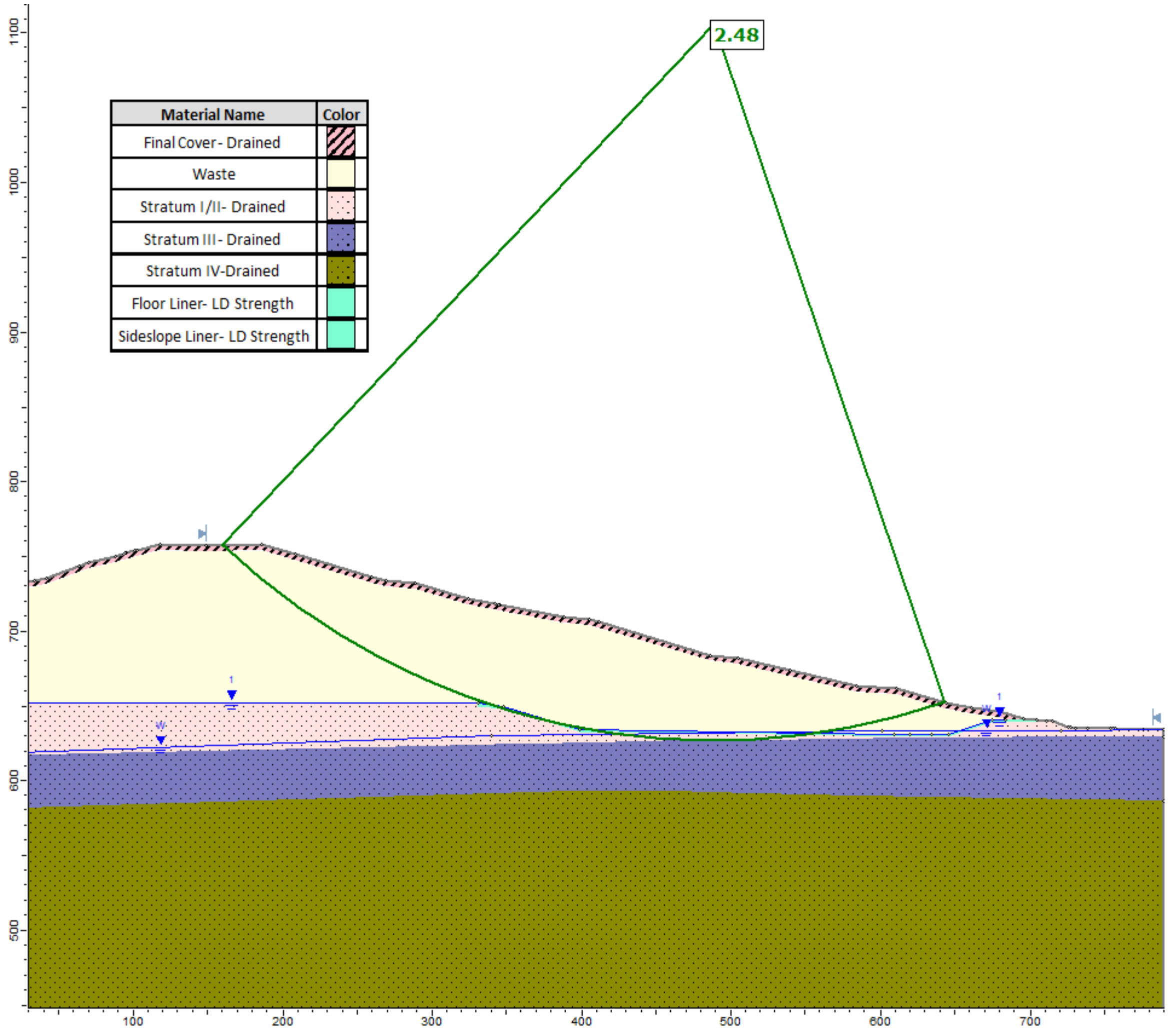
FINAL LANDFILL SLOPE- EXISTING UNIT 1 AREA

Section F, Long-Term Stability, Circular Shear Surface through the Waste and Foundation



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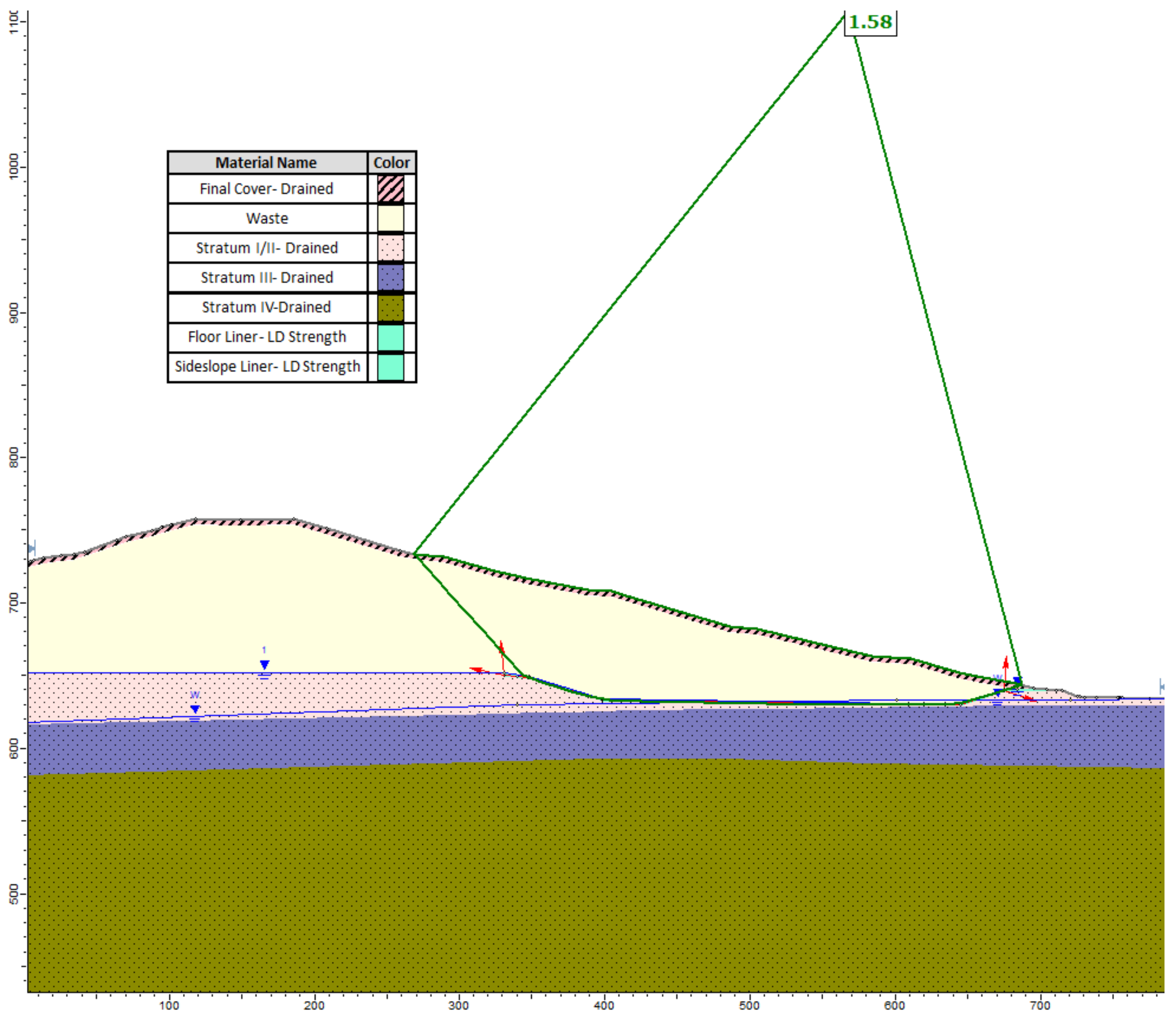
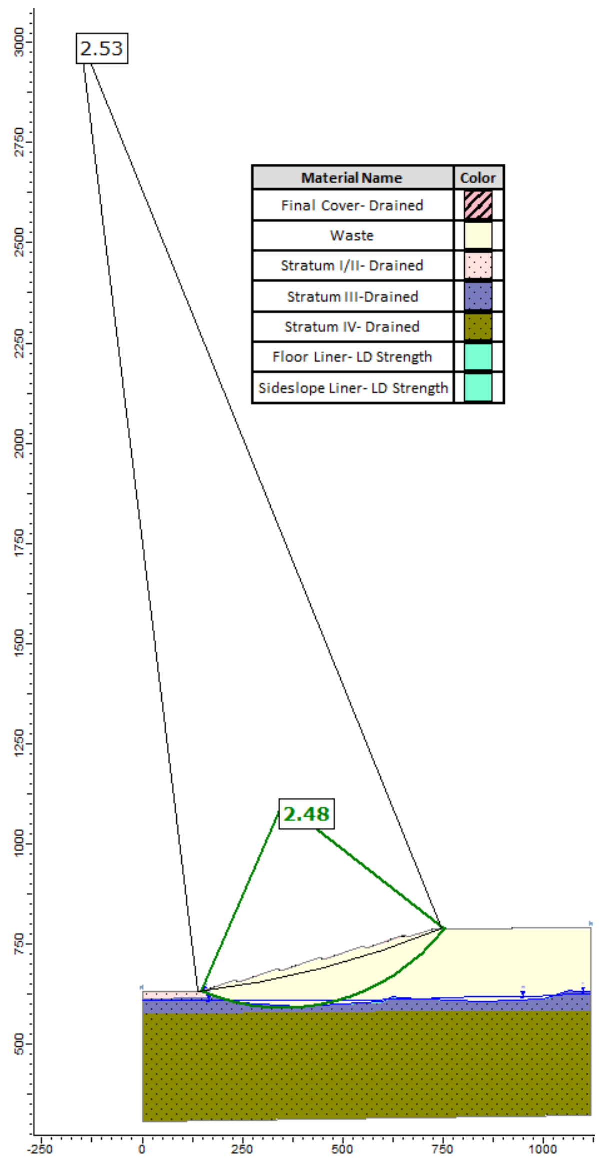
Section F, Long-Term Stability, Block- type Shear Surface through the Waste and along the Liner using Site Specific Interface Results (LD/LD Scenario)



Written by: **P. Pandey**	Date: **7/3/2023**	Reviewed by & Revised by: **S. Graves**	Date: **7/16/2023; 2/7/2024**
Client: **WMTX**	Project: **Mesquite Creek Landfill**	Project No.: **GW8636**	Phase No.: **05**

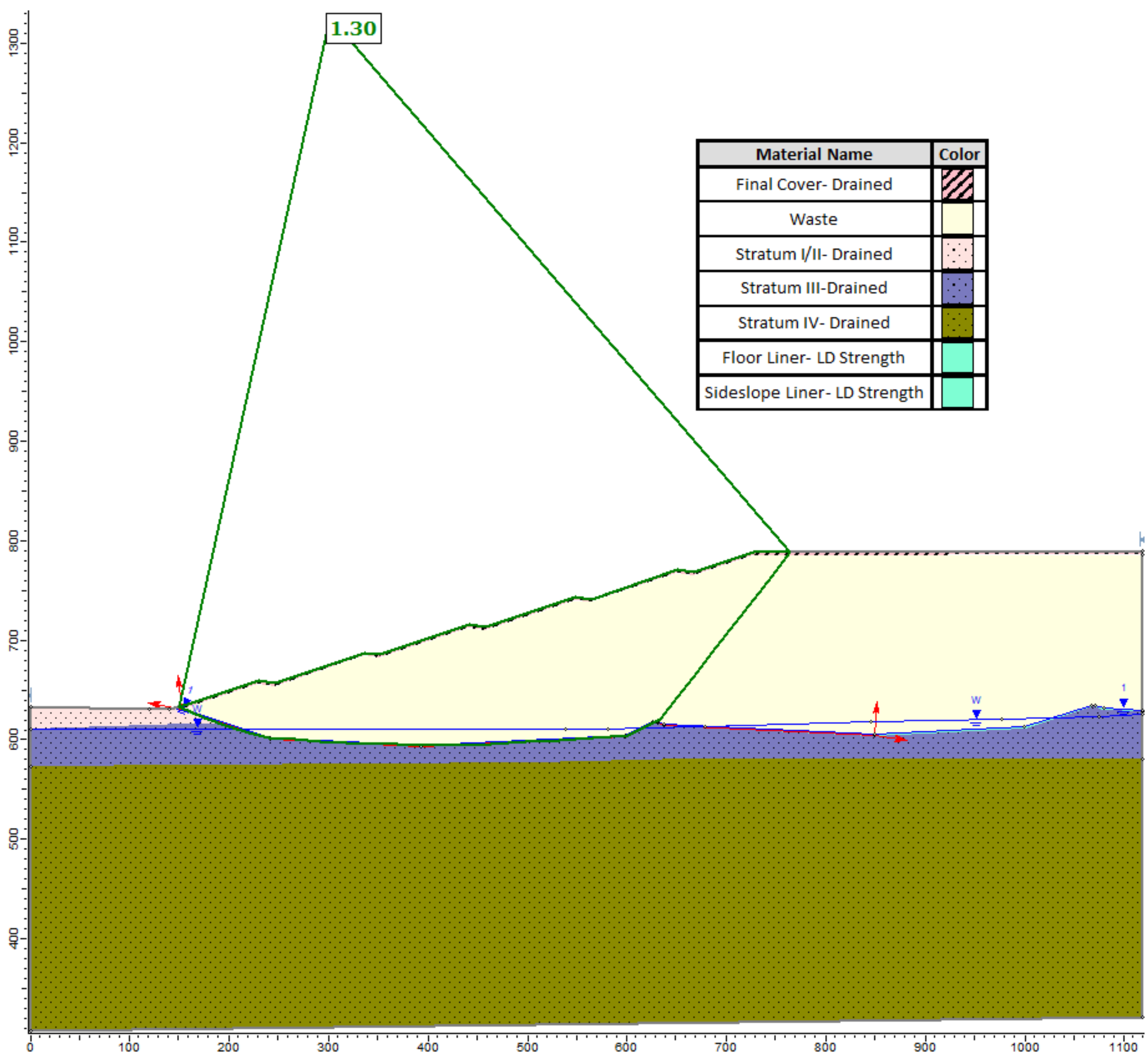
FINAL LANDFILL SLOPE- EXISTING UNIT 2 AREA

Section G, Long-Term Stability, Circular Shear Surface through the Waste and Liner System using Site Specific Interface Results (LD/LD Scenario)



Written by: **P. Pandey**	Date: **7/3/2023**	Reviewed by & Revised by: **S. Graves**	Date: **7/16/2023; 2/7/2024**
Client: **WMTX**	Project: **Mesquite Creek Landfill**	Project No.: **GW8636**	Phase No.: **05**

Section F, Long-Term Stability, Block- type Shear Surface through the Waste and along the Liner using Site Specific Interface Results (LD/LD Scenario)

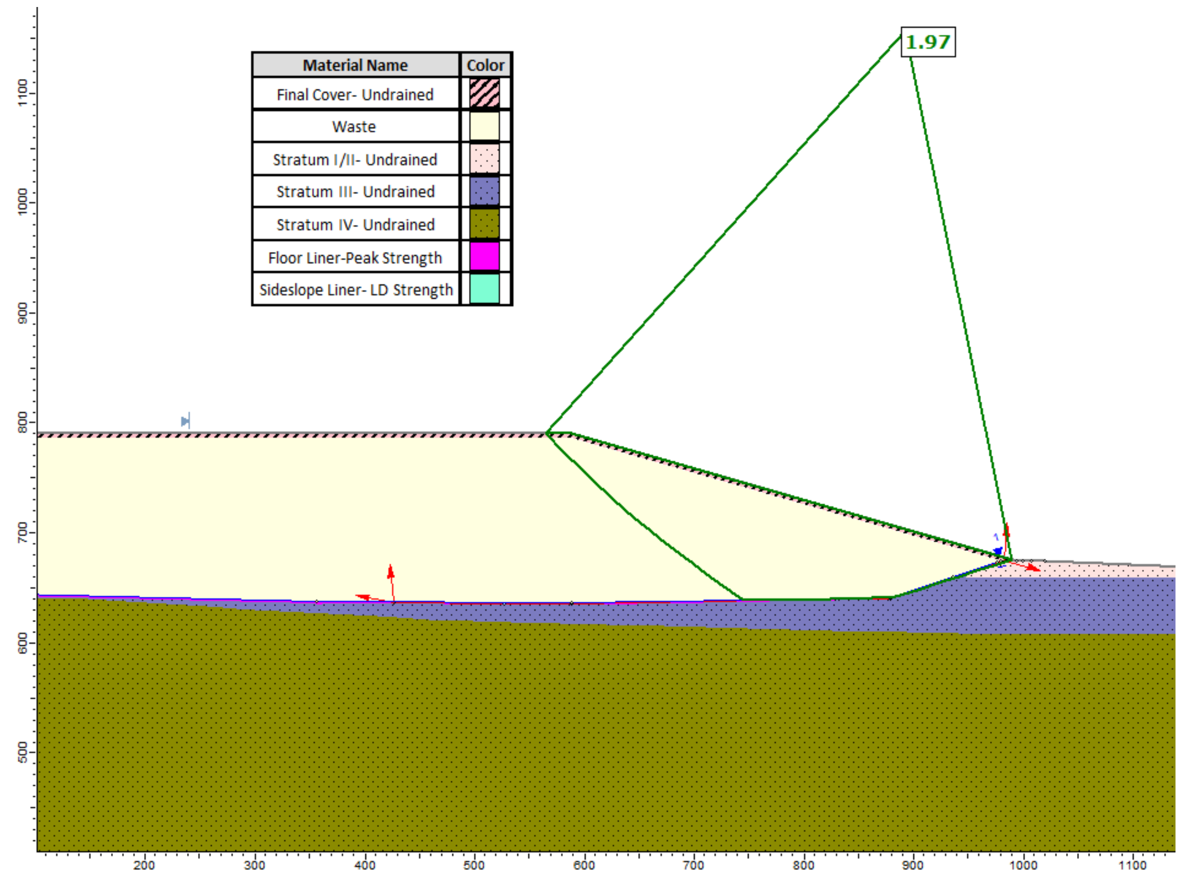


Written by: **P. Pandey** Date: **7/3/2023** Reviewed by & Revised by: **S. Graves** Date: **7/16/2023; 2/7/2024**

Client: **WMTX** Project: **Mesquite Creek Landfill** Project No.: **GW8636** Phase No.: **05**

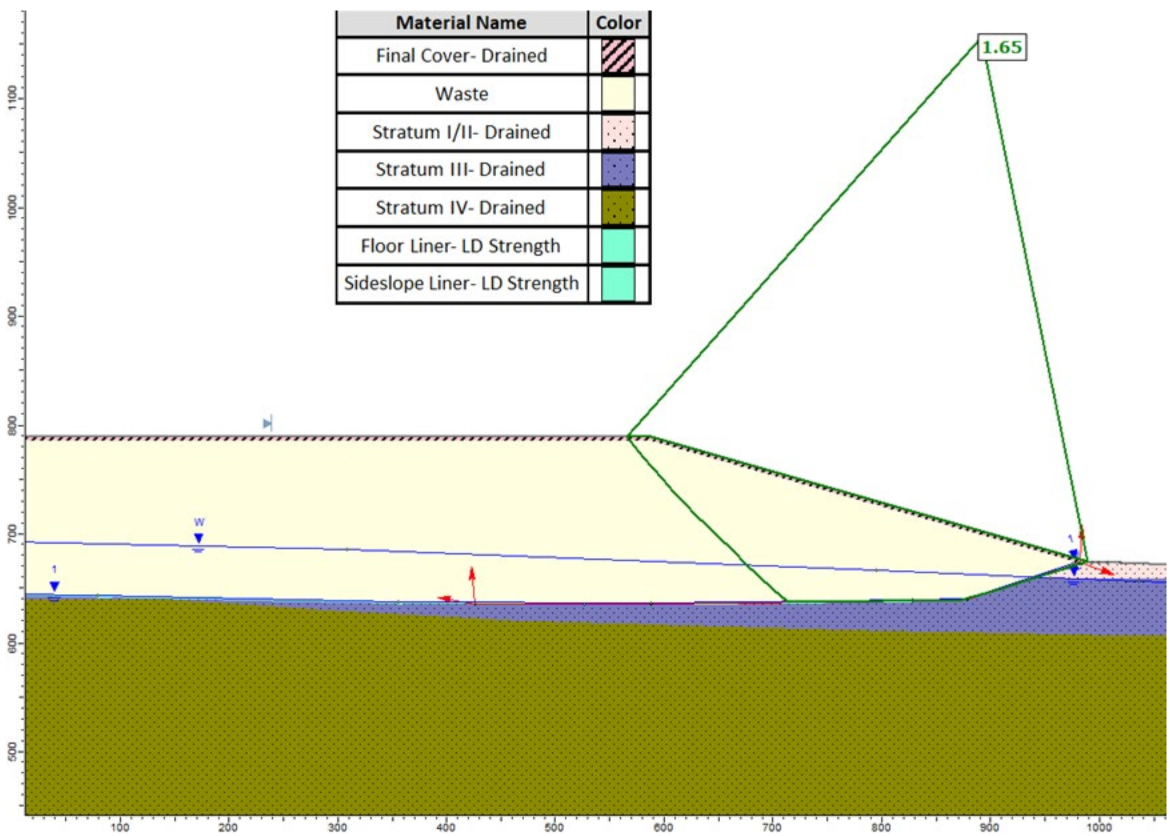
USING BACK CALCULATED INTERFACE STRENGTHS IN FINAL SLOPES

Section E, Short-Term Stability, Block-type Shear Surfaces through the Waste and along the Liner (P/LD Scenario Using Back calculated δ_p= 15.5°; δ_{LD}= 9.8° under P/LD Scenario)



Written by: **P. Pandey**	Date: **7/3/2023**	Reviewed by & Revised by: **S. Graves**	Date: **7/16/2023; 2/7/2024**
Client: **WMTX**	Project: **Mesquite Creek Landfill**	Project No.: **GW8636**	Phase No.: **05**

Section E, Long-Term Stability, Block-type Shear surfaces through the Waste and along the Liner (Using Back calculated δ_{LD}= 9.8° under LD/LD Scenario)

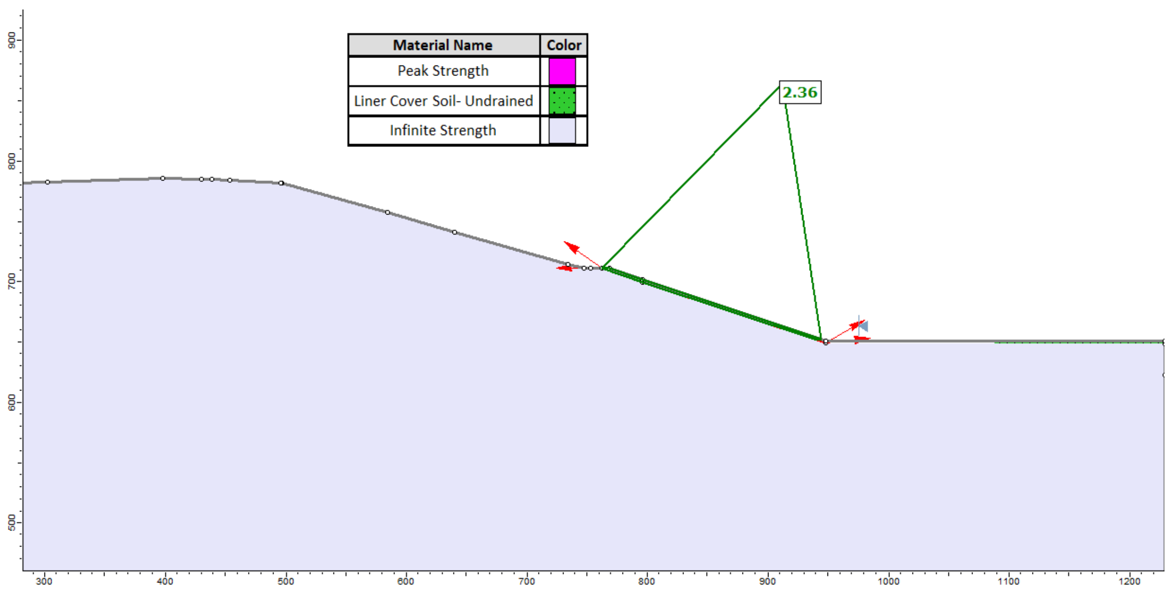


Written by: **P. Pandey** Date: **7/3/2023** Reviewed by & Revised by: **S. Graves** Date: **7/16/2023; 2/7/2024**

Client: **WMTX** Project: **Mesquite Creek Landfill** Project No.: **GW8636** Phase No.: **05**

LINER AND FINAL COVER SYSTEM VENEER ANALYSIS

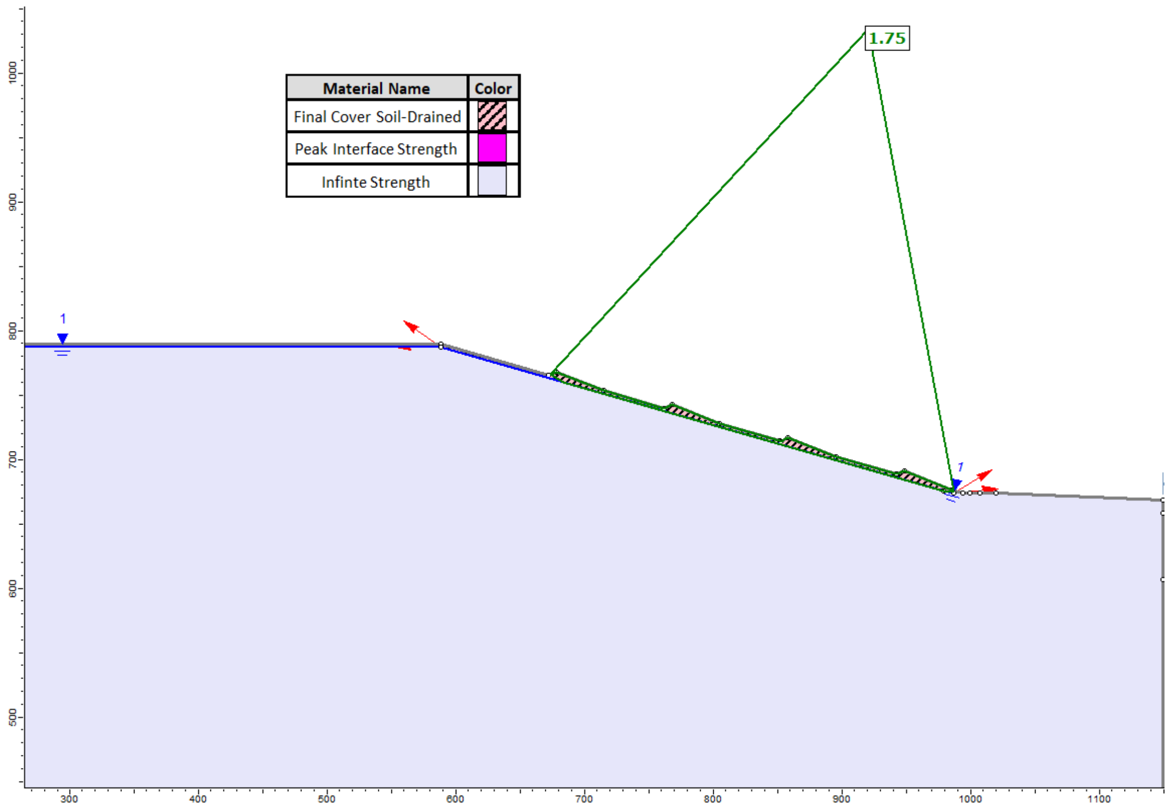
Section A: Liner Veneer Analysis (Undrained cover soil and Peak Interface Strength i.e., δ_p= 34.8°)



Written by: **P. Pandey** Date: **7/3/2023** Reviewed by & Revised by: **S. Graves** Date: **7/16/2023; 2/7/2024**

Client: **WMTX** Project: **Mesquite Creek Landfill** Project No.: **GW8636** Phase No.: **05**

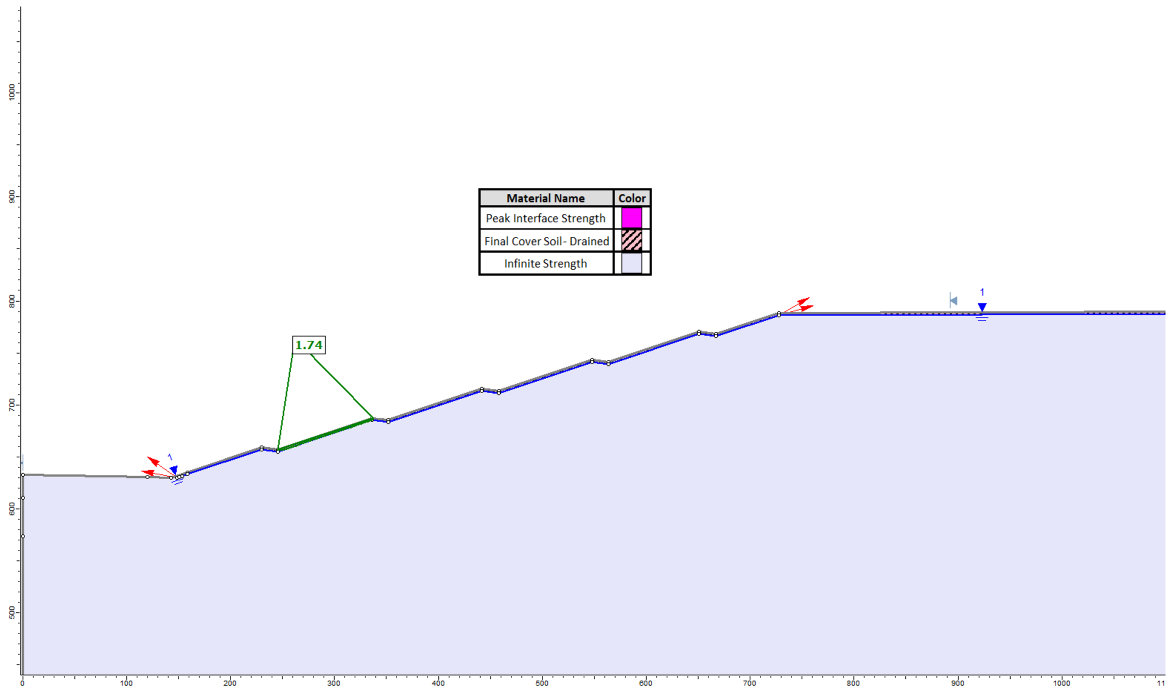
Section E: Final Cover Veneer Analysis (Drained cover soil and Peak Interface Strength)



Written by: **P. Pandey** Date: **7/3/2023** Reviewed by & Revised by: **S. Graves** Date: **7/16/2023; 2/7/2024**

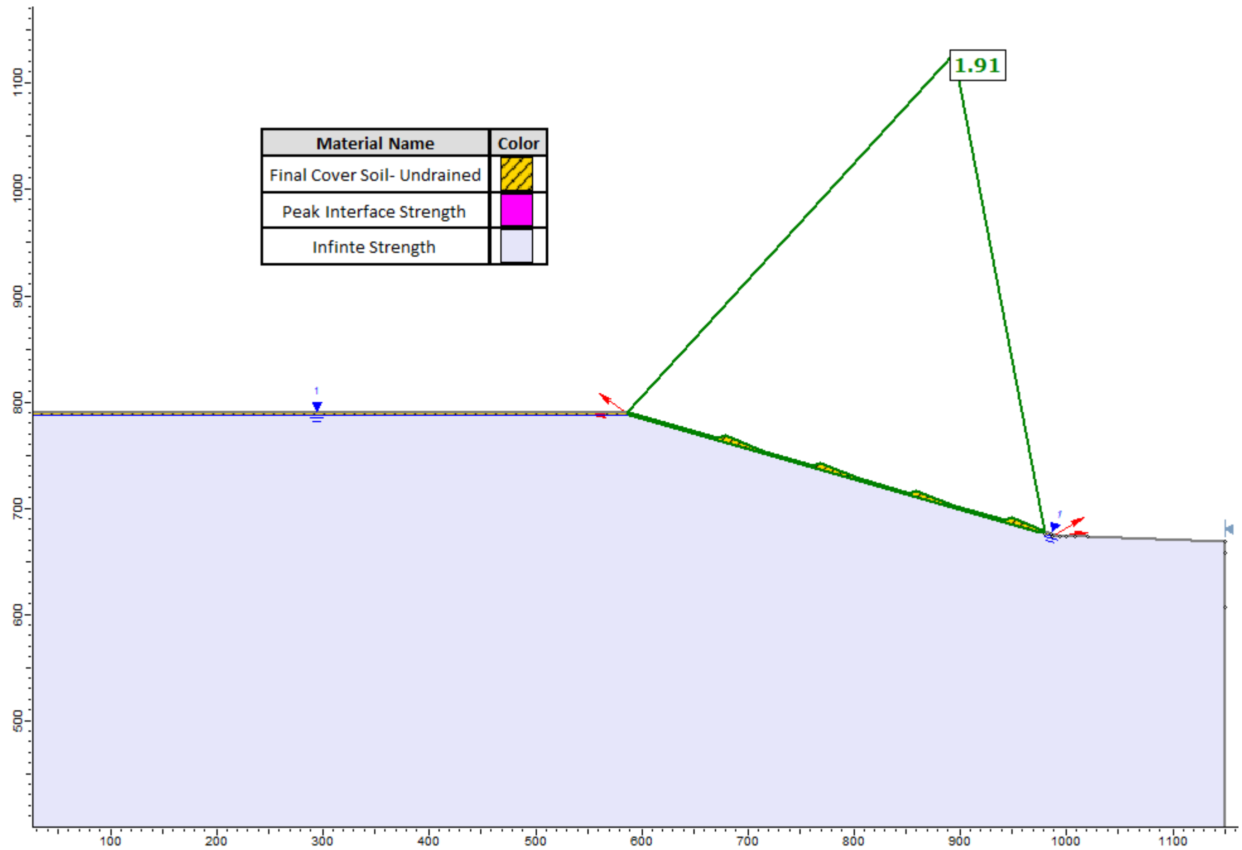
Client: **WMTX** Project: **Mesquite Creek Landfill** Project No.: **GW8636** Phase No.: **05**

Section G: Final Cover Veneer Analysis (Drained cover soil and Peak Interface Strength)



Written by:	P. Pandey	Date:	7/3/2023	Reviewed by & Revised by:	S. Graves	Date:	7/16/2023; 2/7/2024
Client:	WMTX	Project:	Mesquite Creek Landfill	Project No.:	GW8636	Phase No.:	05

Section E: Final Cover Veneer Analysis (Undrained cover soil and Peak Interface Strength)

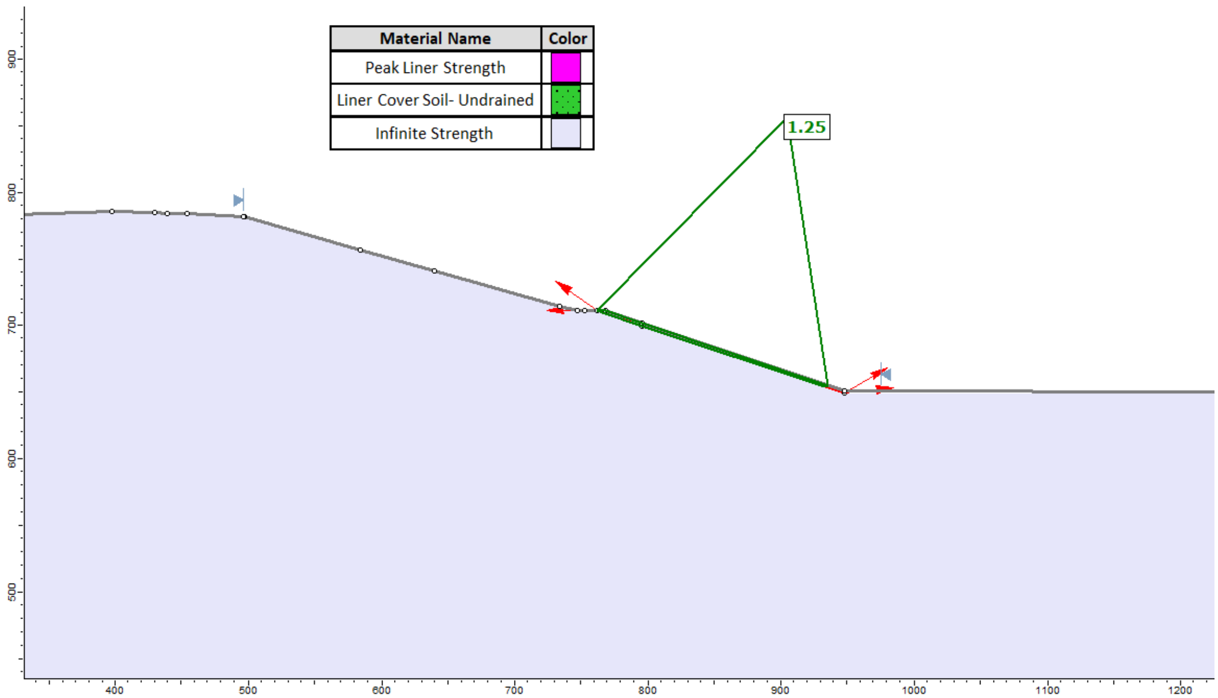


Written by: **P. Pandey** Date: **7/3/2023** Reviewed by & Revised by: **S. Graves** Date: **7/16/2023; 2/7/2024**

Client: **WMTX** Project: **Mesquite Creek Landfill** Project No.: **GW8636** Phase No.: **05**

BACK ANALYSES OF MINIMUM REQUIRED INTERFACE STRENGTHS FROM VENEER STABILITY

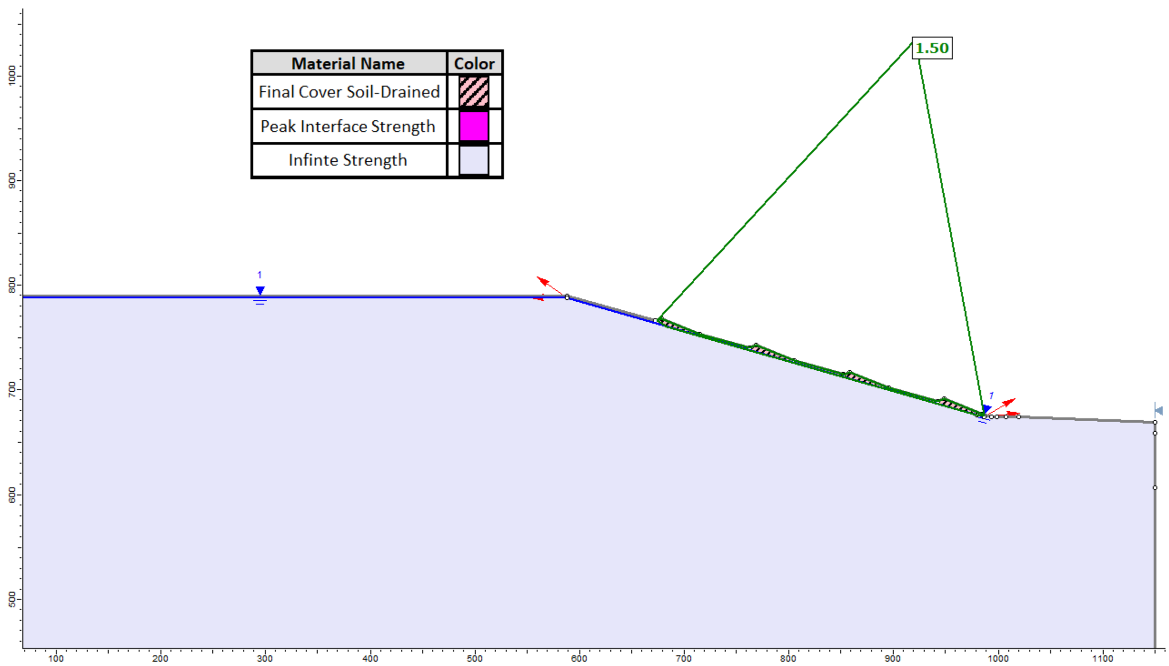
Section A: Liner Veneer Analysis (Undrained cover soil and Peak Interface Strength) Minimum Calculated Peak Strength δ_p= 18.3°



Written by:	**P. Pandey**	Date:	**7/3/2023**	Reviewed by & Revised by:	**S. Graves**	Date:	**7/16/2023; 2/7/2024**
Client:	**WMTX**	Project:	**Mesquite Creek Landfill**	Project No.:	**GW8636**	Phase No.:	**05**

Section E: Final Cover Veneer Analysis (Drained cover soil and Peak Interface Strength)

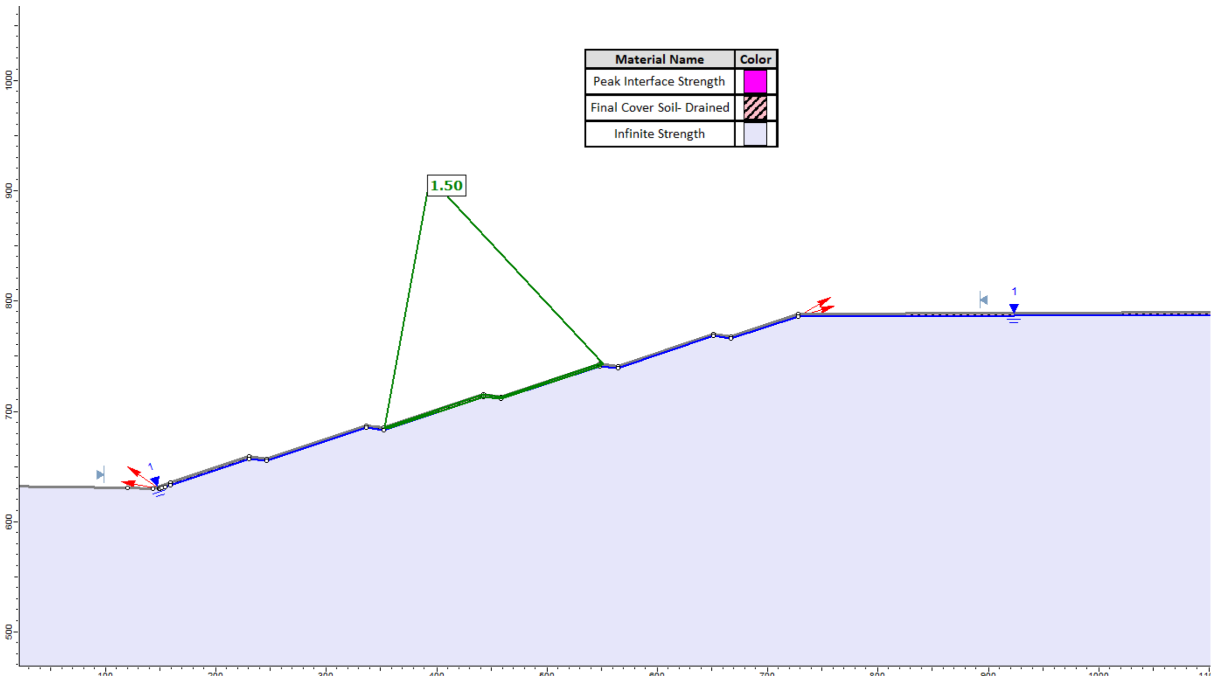
Minimum Calculated Peak Strength δ_p= 22.3°



Written by: **P. Pandey** Date: **7/3/2023** Reviewed by & Revised by: **S. Graves** Date: **7/16/2023; 2/7/2024**

Client: **WMTX** Project: **Mesquite Creek Landfill** Project No.: **GW8636** Phase No.: **05**

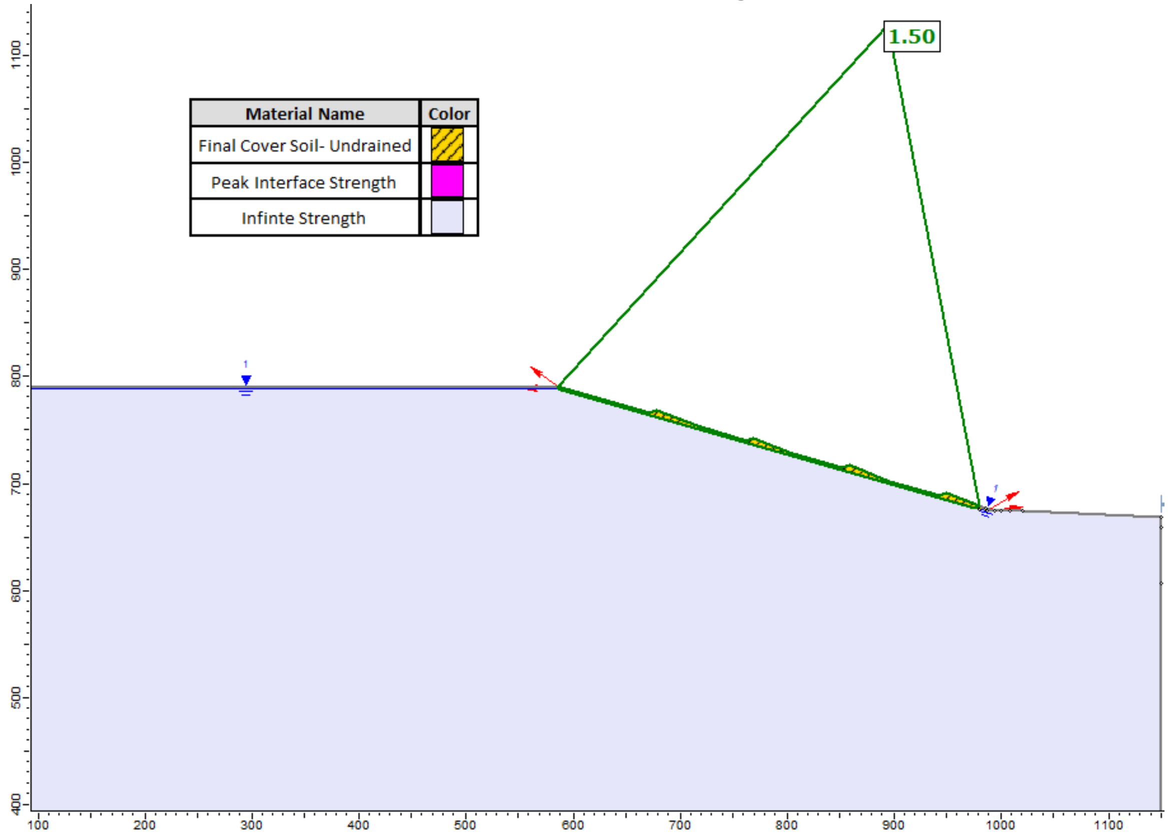
Section G: Final Cover Veneer Analysis (Drained cover soil and Peak Interface Strength)
Minimum Calculated Peak Strength δ_p= 21.4°



Written by: **P. Pandey** Date: **7/3/2023** Reviewed by & Revised by: **S. Graves** Date: **7/16/2023; 2/7/2024**

Client: **WMTX** Project: **Mesquite Creek Landfill** Project No.: **GW8636** Phase No.: **05**

Section E: Final Cover Veneer Analysis (Undrained cover soil and Peak Interface Strength)
Minimum Calculated Peak Strength δ_p= 20.4°



APPENDIX 2 OF ATTACHMENT 3D.2

Site-Specific Critical Interface Strengths (provided by facility)

Critical Interface for Proposed Expansion Area (Based on site specific test results of adjacent cell)

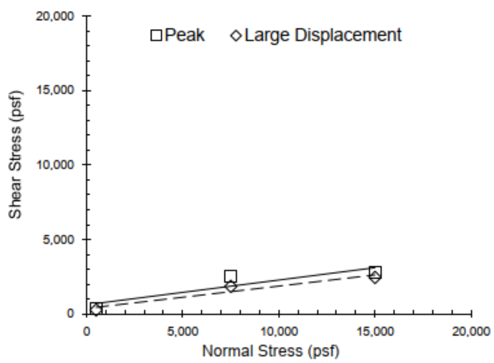
TESTING, RESEARCH, CONSULTING AND FIELD SERVICES
AUSTIN, TX - USA | ANAHEIM, CA - USA | ANDERSON, SC - USA | GOLD COAST - AUSTRALIA | SUZHOU - CHINA

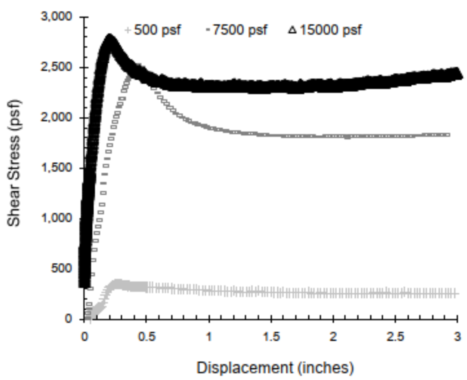
Shear Strength of Soil-Geosynthetic Interface by Direct Shear (ASTM D5321)

Client: Waste Management Inc
Project: Mesquite Creek Landfill - Phase V South

TRI Log #: 60333-6
Richard S. Lacey, P.E. 1/15/2021
Analysis & Quality Review/Date

Stratum I Clay (E-31) vs. Skaps 60mil HDPE TXGM (NL) Representative





Test Results, Linear Regression			
Mohr-Coulomb Parameters		Peak	Large Displacement
Friction Angle	Degrees	9.4	8.5
Y-intercept or Adhesion	psf	609	361
Minimum Secant Angle	Degrees	10.5	9.2

Note - Large Displacement Values Reported for 3.0 inches of Displacement

Test Conditions		
Upper Box	Stratum I Clay (E-31) ω = 33.5 % γ_d = 83.0 pcf	
Lower Box	Skaps 60mil HDPE TXGM (NL) Representative	
Conditioning	Wet/Sprayed - TXGM surface sprayed with water, soil placed, loading applied for a minimum of 24 hours prior to shear.	
Shearing Rate	inches/minute	0.001

Test Notes

Shearing occurred at the interface at all stresses.

Specimen No.		-	1	2	3
Normal Stress		psf	500	7,500	15,000
Box Edge Dimension		in	12	12	12
Bearing Slide Resistance		lbs	13	79	151
Peak	Shear Stress	psf	348	2,518	2,775
	Secant Angle	deg.	34.8	18.6	10.5
Large Displacement	Shear Stress	psf	258	1,831	2,442
	Secant Angle	deg.	27.3	13.7	9.2
Asperity Height, Avg. of 5 Meas.		mils	25	27	28

Page 1 of 1

TRI ENVIRONMENTAL, INC.
9063 BEE CAVES RD. – AUSTIN, TX 78733 – USA | PH: 800.880.TEST OR 512.263.2101

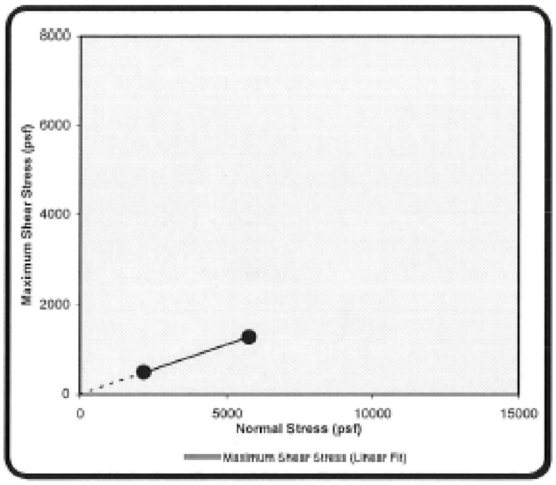
Critical Interface for floor liner of Unit 1, Phase V (Based on site specific test results obtained during the construction)

TRI/ENVIRONMENTAL, INC.
A Texas Research International Company

INTERFACE FRICTION TEST REPORT

Client:	Geosyntec Consultants	TRI Log#:	E2201-76-04
Project:	Comal County	Test Method:	ASTM D 5321
Test Date:	10/17-10/18/05		

Tested Interface: Single-sided Geocomposite net side vs. 60 mil smooth HDPE Geomembrane



Upper Box:	Single-sided geocompostie (net side)
Lower Box:	60 mil smooth HDPE Geomembrane
Interface Conditioning:	Interface soaked and loading applied for a minimum of 15 minutes prior to shear
Box Dimension:	12"x12"x4"
Test Condition:	Wet
Shearing Rate:	0.2 inches/minute

Trial Number	1	2
Bearing Slide Resistance (lbs)	29	63
Normal Stress (psf)	2160	5760
Maximum Shear Stress (psf)	524	1344
Corrected Shear Stress (psf)	495	1281
Secant Angle (degrees)	12.9	12.5

RESULTS: Maximum Friction Angle and Y-intercept

Regression Friction Angle (degrees):		**12.3**		
Y-intercept or Regression Adhesion (psf):		**24**		
Regression Line:	Y=	0.218	* X +	24
Regression Coefficient (r squared):		1.000		

John M. Allen, E.I.T., 10/18/2005
Quality Review/Date

Slipped between smooth geomembrane and single-sided geocomposite.

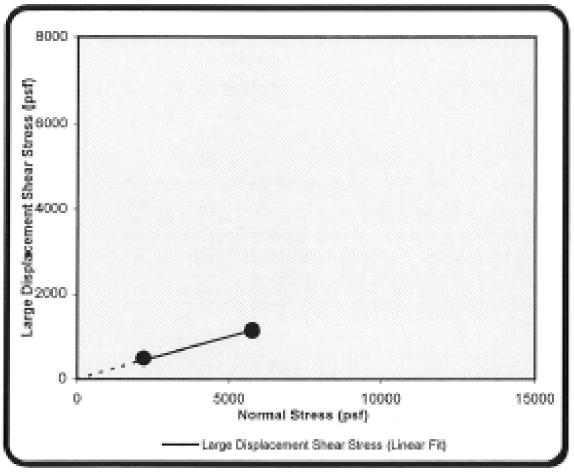
9063 Bee Caves Road □ Austin, TX 78733-6201 □ (512) 263-2101 □ (512) 263-2558 □ 1-800-880-TEST

TRI/ENVIRONMENTAL, INC.
A Texas Research International Company

INTERFACE FRICTION TEST REPORT

Client:	**Geosyntec Consultants**	TRI Log#:	E2201-76-04
Project:	**Comal County**	Test Method:	ASTM D 5321
Test Date:	10/17-10/18/05		

Tested Interface: Single-sided Geocomposite net side vs. 60 mil smooth HDPE Geomembrane



Upper Box:	Single-sided geocompostie (net side)
Lower Box:	60 mil smooth HDPE Geomembrane
Interface Conditioning:	Interface soaked and loading applied for a minimum of 15 minutes prior to shear
Box Dimension:	12"x12"x4"
Test Condition:	Wet
Shearing Rate:	0.2 inches/minute

Trial Number	1	2
Bearing Slide Resistance (lbs)	29	63
Normal Stress (psf)	2160	5760
Large Displacment Shear Stress (psf)	510	1202
Corrected Shear Stress (psf)	481	1139
Secant Angle (degrees)	12.6	11.2

RESULTS: Large Displacement Friction Angle and Y-intercept at 3.3-in. of Displacement

Regression Friction Angle (degrees):		**9.0**		
Y-intercept or Regression Adhesion (psf):		**204**		
Regression Line:	Y=	0.158	* X +	204
Regression Coefficient (r squared):		0.985		

John M. Allen, E.I.T., 10/18/2005
Quality Review/Date

Slipped between smooth geomembrane and single-sided geocomposite.

9063 Bee Caves Road □ Austin, TX 78733-6201 □ (512) 263-2101 □ (512) 263-2558 □ 1-800-880-TEST

Critical Interface for sideslope liner of Unit 1, Phase V (Based on site specific test results obtained during the construction)

TRI/ENVIRONMENTAL, INC.
A Texas Research International Company

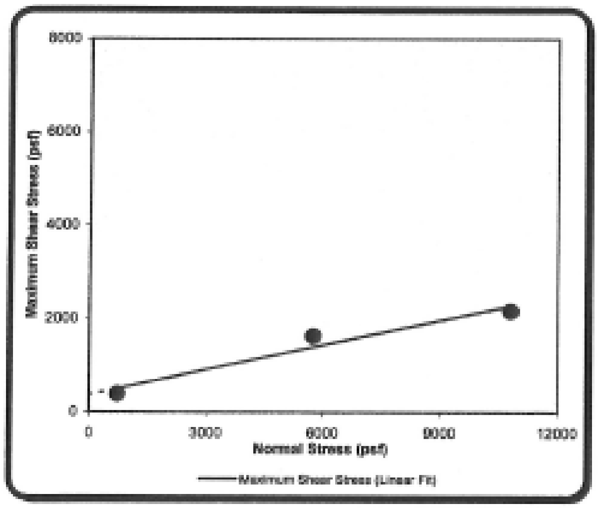
INTERFACE FRICTION TEST REPORT

SIDESLOPE

Client: **Geosyntec Consultants**
Project: **Comal County**
Test Date: 7/19-7/20/05

TRI Log#: E2201-76-04
Test Method: ASTM D 6243

Tested Interface: GSE Textured 60 mil HDPE Geomembrane 102118727 vs. Bentofix NSE GCL 31733 - Woven down (Floating) vs. Soil



Upper Box: Soil compacted to 78.0 pcf at 35.9 % moisture content.

Floating: Bentofix NSE GCL woven side to geomembran

Lower Box: GSE 60 mil textured HDPE geomembrane

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

Box Dimension: 12"x12"x4"

Test Condition: Wet

Shearing Rate: 0.02 inches/minute

Trial Number	1	2	3
Bearing Slide Resistance (lbs)	15	63	111
Normal Stress (psf)	720	5760	10800
Maximum Shear Stress (psf)	397	1684	2271
Corrected Shear Stress (psf)	382	1621	2160
Secant Angle (degrees)	28.0	15.7	11.3

RESULTS: Maximum Friction Angle and Y-intercept				
Regression Friction Angle (degrees):		**10.0**		
Y-intercept or Regression Adhesion (psf):		**372**		
Regression Line:	Y=	0.176	* X +	372
Regression Coefficient (r squared):		0.951		

SRA 07/20/05
Quality Review/Date

Slipped between GCL & GM for low point. Mid & high sheared soil

The testing herein is based upon accepted industry practice as well as the test method listed. Test results reported herein do not apply to samples other than those tested. TRI neither accepts responsibility for nor makes claim as to the final use and purpose of the material. TRI observes and maintains client confidentiality. TRI limits reproduction of this report, except in full, without prior approval of TRI.

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TRI/ENVIRONMENTAL, INC.
A Texas Research International Company

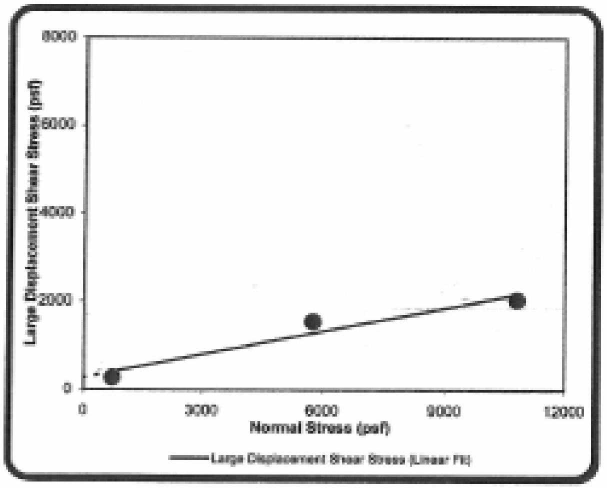
INTERFACE FRICTION TEST REPORT

SIDESLOPE – USE DISPLACEMENT VAL

Client: **Geosyntec Consultants**
Project: **Comal County**
Test Date: 7/19-7/20/05

TRI Log#: E2201-76-04
Test Method: ASTM D 6243

Tested Interface: GSE Textured 60 mil HDPE Geomembrane 102118727 vs. Bentofix NSE GCL 31733 - Woven down (Floating) vs. Soil



Upper Box: Soil compacted to 78.0 pcf at 35.9 % moisture content.

Floating: Bentofix NSE GCL woven side to geomembran

Lower Box: GSE 60 mil textured HDPE geomembrane

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

Box Dimension: 12"x12"x4"

Test Condition: Wet

Shearing Rate: 0.02 inches/minute

Trial Number	1	2	3
Bearing Slide Resistance (lbs)	15	63	111
Normal Stress (psf)	720	5760	10800
Large Displacment Shear Stress (psf)	276	1610	2150
Corrected Shear Stress (psf)	261	1547	2039
Secant Angle (degrees)	19.9	15.0	10.7

RESULTS: Large Displacement Friction Angle and Y-intercept at 3.3-in. of Displacement

Regression Friction Angle (degrees):		**10.0**		
Y-intercept or Regression Adhesion (psf):		**266**		
Regression Line:	Y=	0.176	* X +	266
Regression Coefficient (r squared):		0.938		

SRA 07/20/05
Quality Review/Date

Slipped between GCL & GM for low point. Mid & high sheared soil

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Critical Interface for Unit 2, Phase I (Based on site specific test results obtained during the construction)

TRI/ENVIRONMENTAL, INC.
A Texas Research International Company

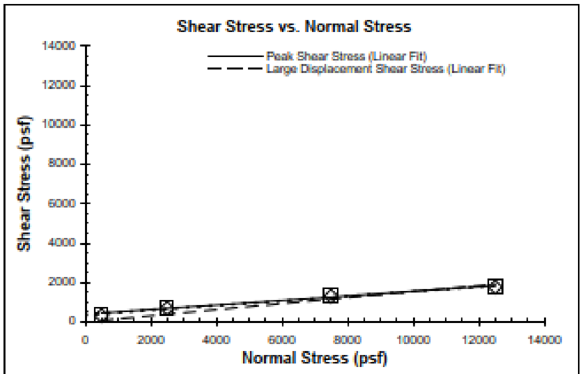
Interface Friction Test Report

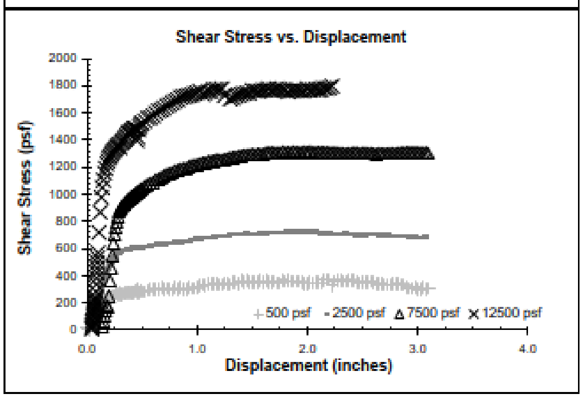
Client: **Waste Management Inc.**
Project: **Mesquite Creek**
Test Date: 01/23/09-1/29/09

TRI Log#: E2308-93-07
Test Method: ASTM D 5321

John M. Allen, P.E., 01/27/2009
Quality Review/Date

Tested Interface: Clay Soil v GSE 60-mil Textured HDPE Geomembrane (105140653)





Test Results	Peak	Large Displacement (@ 3.0 in.)
Friction Angle (degrees):	6.6	6.8
Y-intercept or Adhesion (psf):	386	329

Shearing occurred in the soil. Plowing was noted.

Test Conditions

Upper Box & Clay soil remolded to 96.4 pcf at 24.9% moisture content

Lower Box GSE 60 mil HDPE textured geomembrane.

Box Dimensions: 12"x12"x4"

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

Test Condition: Wet

Shearing Rate: 0.0008 inches/minute

Test Data

Specimen No.	1	2	3	4
Bearing Slide Resistance (lbs)	13	32	79	127
Normal Stress (psf)	500	2500	7500	12500
Corrected Peak Shear Stress (psf)	373	733	1314	1796
Corrected Large Displacement Shear Stress (psf)	308	686	1301	1767
Peak Secant Angle (degrees)	36.7	16.3	9.9	8.2
Large Displacement Secant Angle (degrees)	31.6	15.3	9.8	8.0
Asperity (mils)	19.8	20.6	20.4	20.4

Soil Characterization perfromed by TRI, E2308-82-10

USCS:		Proctor Type:	standard
LL:		Max. Dry Density (pcf):	101.5
PL:		Optimum Moisture Content:	20.9

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ATTACHMENT 3D.3

SETTLEMENT ANALYSIS

Written by: **P. Pandey** Date: **06/28/2023** Reviewed by: **S. Graves** Date: **7/23/2023**

Client: **WMTX** Project: **Mesquite Creek Landfill** Project No.: **GW8636** Phase No.: **05**

SETTLEMENT ANALYSIS
MESQUITE CREEK LANDFILL

STATE OF TEXAS
SCOTT M. GRAVES
86557
LICENSED PROFESSIONAL ENGINEER
10/11/2023

FOR PERMIT PURPOSES ONLY;
CALCULATION PAGES
1 THROUGH 26

GEOSYNTEC CONSULTANTS, INC.
TX ENG FIRM REGISTRATION NO. 1182

1 INTRODUCTION

The purpose of this calculation package is to evaluate the effect of estimated settlements on the grades and strains in the liner system at the Mesquite Creek Landfill (site). Analyses were performed at sections along the leachate collection corridor at the base of the proposed expansion area as well as along a section in the existing Unit 2 landfill area.

The design criteria are that the liner system, and its associated leachate collection system drainage layer should maintain positive drainage towards the leachate collection sumps under post-settlement conditions. Also, calculated tensile strains due to differential settlement should not exceed tolerable strains for the liner system components.

2. METHOD OF ANALYSIS

2.1 Primary and Secondary Settlement

As the site subsurface soil conditions above claystone are primarily clay materials, the settlement analysis is based on one-dimensional (1-D) consolidation theory. According to this mechanism, primary consolidation of a given soil layer (and its associated settlement) is caused by an increase in effective vertical stress resulting from loading on the layer, resulting in the expulsion (drainage) of pore water from the soil matrix. Secondary settlement is a mechanism of ongoing (time-dependent) settlement from compression of the soil matrix, independent of load.

Written by: **P. Pandey** Date: **06/28/2023** Reviewed by: **S. Graves** Date: **7/23/2023**

Client: **WMTX** Project: **Mesquite Creek Landfill** Project No.: **GW8636** Phase No.: **05**

Settlements resulting from primary consolidation were calculated using the general form of the settlement equation as given below [Holtz and Kovacs, 1981]:

$$S_p = \frac{C_r}{1+e_o} H \log\left(\frac{\sigma'_{vo} + \Delta\sigma}{\sigma'_{vo}}\right) \quad \text{for } \sigma'_{vo} + \Delta\sigma < p_c' \qquad (1)$$

$$S_p = \frac{C_c}{1+e_o} H \log\left(\frac{\sigma'_{vo} + \Delta\sigma}{p_c'}\right) + \frac{C_r}{1+e_o} H \log\left(\frac{p_c'}{\sigma'_{vo}}\right) \quad \text{for } \sigma'_{vo} + \Delta\sigma > p_c' \qquad (2)$$

where: S_p = primary settlement;
C_c = compression index;
C_r = recompression index;
e_o = initial void ratio;
H = initial thickness of compressible layer;
σ'_{vo} = initial vertical effective stress;
p_c' = preconsolidation pressure; and
$\Delta\sigma$ = increment of vertical effective stress.

In Equations 1 and 2, the modified compression index, $C_{c\varepsilon}$, and the modified recompression index, $C_{r\varepsilon}$, can be used. These parameters are defined below [Holtz and Kovacs, 1981]:

$$C_{c\varepsilon} = \frac{C_c}{1+e_o} \qquad (3)$$

$$C_{r\varepsilon} = \frac{C_r}{1+e_o} \qquad (4)$$

Settlements resulting from secondary compression were calculated according to the following equation [Holtz and Kovacs, 1981]:

$$S_t = C_{\alpha\varepsilon} H \log\left(\frac{t_2}{t_1}\right) \qquad (5)$$

where: $$C_{\alpha\varepsilon} = \frac{C_\alpha}{1+e_o} \qquad (6)$$

and S_t = time-dependent secondary settlement;
$C_{\alpha\varepsilon}$ = modified secondary compression index;
H = initial thickness of compressible layer;
t_1 = time when secondary compression is assumed to begin; and
t_2 = time of interest for which secondary settlements are calculated.

2.2 Total Settlement

Total settlement is the sum of the primary consolidation settlement and secondary compression, calculated as shown in Equation (7) below:

$$S_t = S_p + S_S \tag{7}$$

Where:
S_t = total long-term settlement,
S_p = primary consolidation settlement, and
S_S = secondary compression.

2.3 Differential Settlement and Strain in the Liner

Differential settlement is defined as the difference in calculated settlement between two adjacent points. Where there are differentials, this can cause strain in the liner due to the uneven settlement causing elongation of the liner between settlement points. The tensile strains are calculated using Equation (8) below:

$$\varepsilon = \frac{L_1 - L_2}{L_1} \tag{8}$$

where:
ε= Tensile strain in liner system between two adjacent points;
L_1 = Distance between two points in their pre-settlement positions; and
L_2= Distance between two points in their post-settlement positions.

For calculations performed according to the above equation for strain, negative values would be indicative of a lengthening of the liner between points (i.e., if $L_2 > L_1$), producing tensile strains. Positive values would indicate compressive strains (shortening of the liner between points).

3. DEVELOPMENT OF CROSS-SECTIONS FOR ANALYSIS

Settlement analyses were considered along cross-sectional profiles or "lines" in the existing Unit 2 area and the expansion area, incorporating critical combinations of landfill slopes/geometry, the representative underlying layers beneath the liner, groundwater conditions, and a broad variation of differential loads caused by the variation of waste thickness across each cross-section. To generate these cross-sections, the following landfill design features were used: (i) overall base liner grading plan (Drawing 3A-4B in Part III, Attachment 3A); and (ii) overall final cover grading plan (Drawing 3A-5B in Part III, Attachment 3A).

Also, the subsurface layering derived from the geologic characterization of the site (e.g., geologic cross-sections in Part III, Attachment 4) was used to add the layer(s) of materials beneath the cross-sections, to the extent they will be present after construction (e.g., some of the subsurface layers will be excavated as part of liner construction, and therefore will not be present beneath the liner). The groundwater conditions, to the extent they may be present, were set based on the seasonal high groundwater table map presented in Part III, Attachment 3C.

Figures 1 and 2 included with this calculation package present the locations of the three cross-sections that were considered, referred to as Line A, Line B, and Line C. Additionally, Figure 3 illustrates the depth of Stratum III (which is a potentially compressible strata) below the liner system of the proposed expansion area. The cross-sections are described in more detail below, to explain the rationale for their selection as potentially critical cross-sections for the settlement analysis.

3.1 Line A

Line A is a cross-section oriented in a northwest-southeast direction, located along the leachate collection corridor in Unit 2, Phase XI (see Figures 1 and 2). Line A was selected for consideration because it is along the minimum slope of the leachate collection system (i.e., the 1% slope of the leachate collection corridor (with a portion in the middle that transitions to 3%)). Additionally, Line A is at a location where the final cover system will be at its peak (highest) elevation; here, waste will be at its thickest, so the corridor will be subjected to the landfill's highest load. At Line A, Stratum I and II will have been completely removed below the base of the landfill. Additionally, the base of the landfill at Line A (and for all new floor areas of Phase VII through Phase XIV) will be founded over a partially excavated Stratum III that is over consolidated and potentially compressible (see Figure 3).

3.2 Line B

Line B is a cross-section oriented in a northwest-southeast direction, located along the leachate corridor in Unit 2, Phase VIII (see Figures 1 and 2). Line B was selected because it is along another location where the leachate collection system is at its minimum slope of 1% (with a portion in the middle that transitions to 8%), and also to assess a case with the thickest potentially compressible Stratum III beneath the base of landfill (see Figure 3), and where loads due to overlying waste thickness will be relatively high.

3.3 Line C

Line C is a cross-section oriented in a northeast-southwest direction, located along the leachate corridor in the existing Unit 2 landfill area, Phase III (see Figures 1 and 2). Line C was selected because it is representative critical section for existing Unit 2 landfill area with the thicker Stratum III soil underneath the floor liner and relatively high loads due to overlying waste thickness. Line C is in a portion of the landfill that has already been constructed under previous MSW Permit No. 66B, and that included a settlement analysis as part of the previously-approved permit design. No changes to the existing area Unit 2 base grades or final cover grades are proposed by the lateral expansion permit amendment application. Nevertheless, a re-analysis of this cross-section location was included herein for completeness.

3 MATERIAL PROPERTIES

3.1 Overview of the Layer Materials

The natural subsurface strata at the site can be summarized as follows:

- Stratum I: Surficial fine-grained Quaternary weathered soil deposits, generally dry, brown to dark gray medium to high-plasticity clay, stiff to hard in consistency (with occasional thin gravelly clay zones).

- Stratum II: Quaternary-Tertiary alluvium (possibly equivalent to Uvalde Gravel), generally clayey gravel to gravelly clay, dry, white or gray limestone gravel and/or chert gravel within a dark brown clay matrix, commonly cemented by caliche and firm in consistency.

- Stratum III: Weathered Lower Taylor Group, brownish yellow/yellow to light gray weathered and oxidized calcareous clay/claystone with thin bedding planes, very stiff to hard in consistency.

- Stratum IV: Unweathered Lower Taylor Group, dry, calcareous green-gray to dark gray unweathered/unoxidized claystone, very hard in consistency.

Strata I, II and III are the potentially compressible materials beneath the liner that could experience settlement if there is an increase in effective stress due to landfill loading.

As mentioned, Stratum I and Stratum II have been (or will be) largely excavated (removed) to obtain the liner floor elevations, and therefore most of the landfill will be founded on the potentially compressible Stratum III (with a few areas founded on competent and incompressible Stratum IV claystone (see Figure 3)).

The landfill -related materials that will provide load on the underlying strata are:
- liner system soils;
- waste (and the daily/intermediate cover soils included in the waste mass); and
- final cover system soils.

The material properties selected for the analyses were primarily derived from the results of the laboratory tests performed on site-specific soil samples, as presented in Part III, Attachment 3D.1 (Geotechnical Report). Some of the material properties were assigned using information presented in published technical literature. The properties that were selected and used in the settlement analysis are presented in Table 1 of this calculation package, with citations provided when obtained from technical literature.

3.2 Unit Weights

Soils

Based on the geotechnical laboratory tests conducted on the undisturbed soil samples from Stratum I, II and Stratum III (Part III, Attachment 3D.1), the average bulk unit weights were calculated and used for the respective subsurface layers. For liner system and final cover system materials, a unit weight of 120 pounds per cubic feet (pcf) was selected based on typical (but probably somewhat conservative/high) compacted properties for such materials.

Waste

A unit weight of 80 pcf was used for the waste. This is consistent with the unit weight used in the slope stability analysis (Part III, Attachment 3D.2), and is a typical long-term unit weight for municipal solid waste reported in technical literature accounting for observations where waste tends to densify over time as additional load is placed above it and as it degrades.

3.3 Consolidation Properties

Stratum III. As noted previously, Strata I and II have been, or will be, essentially or entirely removed from beneath the liner in the existing Unit 2 landfill areas and new floor cells. As such, the focus is loading of and potential consolidation/settlement of Stratum III. The compressibility properties for Stratum III (preconsolidation pressure, primary compression and recompression indices) were derived from the 1-D consolidation test results performed on samples collected from Stratum III during the subsurface investigation (results presented in the Geotechnical Report, Part III, Attachment 3D.1). Based on the measured consolidation properties, the compressibility of the layers is defined as "very slightly compressible" according to Coduto et al. (2011).

It is noted that Stratum IV, which lies underneath Stratum III, is a competent unweathered claystone (based on field assessment during site investigation and as summarized in boring logs) and was therefore considered incompressible bedrock for the settlement evaluation.

4. CALCULATIONS AND RESULTS OF ANALYSIS

The settlement and strain calculations were performed by spreadsheet-based computations using the methods, equations, layers, and material properties described herein. These calculations are presented in Appendix 1 of this package. As shown, the total thickness of waste was subdivided into several sub-layers and settlement of each sub-layer was calculated at its mid-height. Also, it should be recognized that the calculations were performed with a built-in assumption that the entire new load (i.e., new waste and final cover) is instantaneously applied. This is a conservative assumption used to simplify the analysis.

For the secondary compression component in the settlement analyses, t_1 was set such that it represents the time based on the starting time/year when the liner was installed, and new load is applied that would result in the settlement of underlying subsurface materials. Time t_2, on the other hand represents an estimate of the duration of site life plus a 30-year post closure period. With this rationale, for "Line A and B" which is located in Phase VIII and Phase XI of proposed new cells, t_1 was set at year 1 and t_2 was set at 54 years [assuming the liner will be placed in 2024, plus the projected remaining site life and post-closure period]. As for the existing Unit 2 landfill area where the liner system already exists with the documented installation year of 2015 for Phase III, t_1 was set at 1 year and t_2 was set at 57 years [approximate age of landfill, plus projected remaining site life and post-closure period]. This considered timeframe, t_2 will take into account the secondary compression that has/ or will be occurred after the liner construction in Phase III, Unit 2 area.

The results of the analysis presented in Appendix 1 reveal the following:

- The calculated total settlement along the leachate corridor at Line A range from 0.00 (where it cuts into and rests on the incompressible Stratum IV) to 0.21 feet. Tensile strains are negligible, and the area with 1% slope changed to 0.98% and 3% slope changed to 2.97% slope under post-settlement conditions (i.e., minimal change, and no grade reversals).
- The calculated total settlement along the leachate corridor at Line B range from 0.03 to 0.35 feet. These results are similar in magnitude to the settlements along Line A, but slightly higher due to the presence of the relatively thicker Stratum III underneath the liner. Tensile strains are negligible; the area with 1% slope changed to 0.93% and the area with 8% slope changed to 7.97% slope under post-settlement conditions (i.e., minimal change, and no grade reversals).
- At the existing Unit 2 landfill area (represented by Line C), the calculated total settlement along the leachate corridor range from 0.06 to 1.0 feet. Tensile strains are negligible, and the slope changes from 1% under pre-settlement conditions to 0.77% under post-settlement conditions (i.e., minimal change, and no grade reversals).

To assess the adequacy of the calculated strains, typical allowable tensile strains in compacted clay liners are up to about 1.0% (Koerner and Daniel, 1993). Allowable strains in geosynthetics materials are even higher (e.g., the yield strain of HDPE geomembranes is about 12%). The computed tensile strains are less than allowable tensile strains of the liner materials.

5. CONCLUSIONS

The results of the analyses presented herein reveal the following:

- The expansion area (Unit 2, Phase VII through XIV) is designed to be founded well into Stratum III, (potentially compressible stratum); however, the calculations presented herein reveal that the liners are not expected to undergo settlement to any significant degree (i.e., the settlements are relatively small, and are tolerable).

- The calculated post-settlement slopes along critical points of the leachate collection corridors will provide positive drainage to the leachate collection sumps. There are no predicted grade reversals (minimum calculated post-settlement slope is 0.77% in the existing Unit 2 area and 0.93% in the expansion area where the pre settlement slope is 1%, which is acceptable)
- The stretch of leachate corridor in the expansion area of Unit 2 Phase XI and Phase VIII was transitioned to 3% and 8% slopes, respectively, in the middle portions of these and adjacent cells to minimize excavating into the harder Stratum IV claystone for constructability purposes. The calculations reveal that this situation will not cause excessive differential settlements between adjacent areas founded on more compressible Stratum III. There are no predicted grade reversals (minimum calculated post-settlement slope is 2.97% and 7.97% respectively, which is acceptable).

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Koerner, R. M., & Daniel, D. E. (1993). Technical equivalency assessment of GCLs to CCLs. *Geosynthetic Liner Systems: innovations, concerns and designs*, 265-285.

Qian, X., Koerner, R.M., and Gray, D.H., *Geotechnical Aspects of Landfill Design and Construction*. Prentice Hall, New Jersey.2002.

TABLES

Table 1. Material Properties Used in Settlement Analysis

Material and Parameter	Parameter Value	Basis
Liner System Soil Layers; Final Cover System Soil Layers		
• Unit Weight (γ_{cover}, γ_{pc} and γ_{liner})	120 pcf	• Assumed typical values for onsite soils.
Waste		
• Unit Weight (γ_{waste})	80 pcf	• Typical value reported in literature for municipal solid waste (and consistent with the slope stability analyses)
Stratum I/II		
• Unit Weight (γ_{waste})	120 pcf	• Typical values for onsite soils; also consistent to laboratory measurements Stratum I/II soils.
Stratum III		
• Dry Unit Weight (γ_d) • Void Ratio (e) • Moisture Content (w) • Unit Weight (γ) • Preconsolidation Pressure (σ'_p) • Compression Index (C_c) • Recompression Index (C_r)	104.6 0.64 21.3% 126.9 10,000 0.094 0.034	• Based on laboratory measurements for one-dimensional consolidation (see Part III, Attachment 3D.1, Geotechnical Report)
• Modified Compression Index ($C_{c\varepsilon}$)	0.057	• Calculated using Equation 6
• Modified Recompression Index ($C_{r\varepsilon}$)	0.021	• Calculated using Equation 7
• Secondary Compression Index (C_α)	0.005	• Assumed to be 5% of C_c from Holtz and Kovacs, 1981.
• Modified Secondary Compression Index ($C_{\alpha\varepsilon}$)	0.0029	• Calculated using C_α with e = 0.64

FIGURES

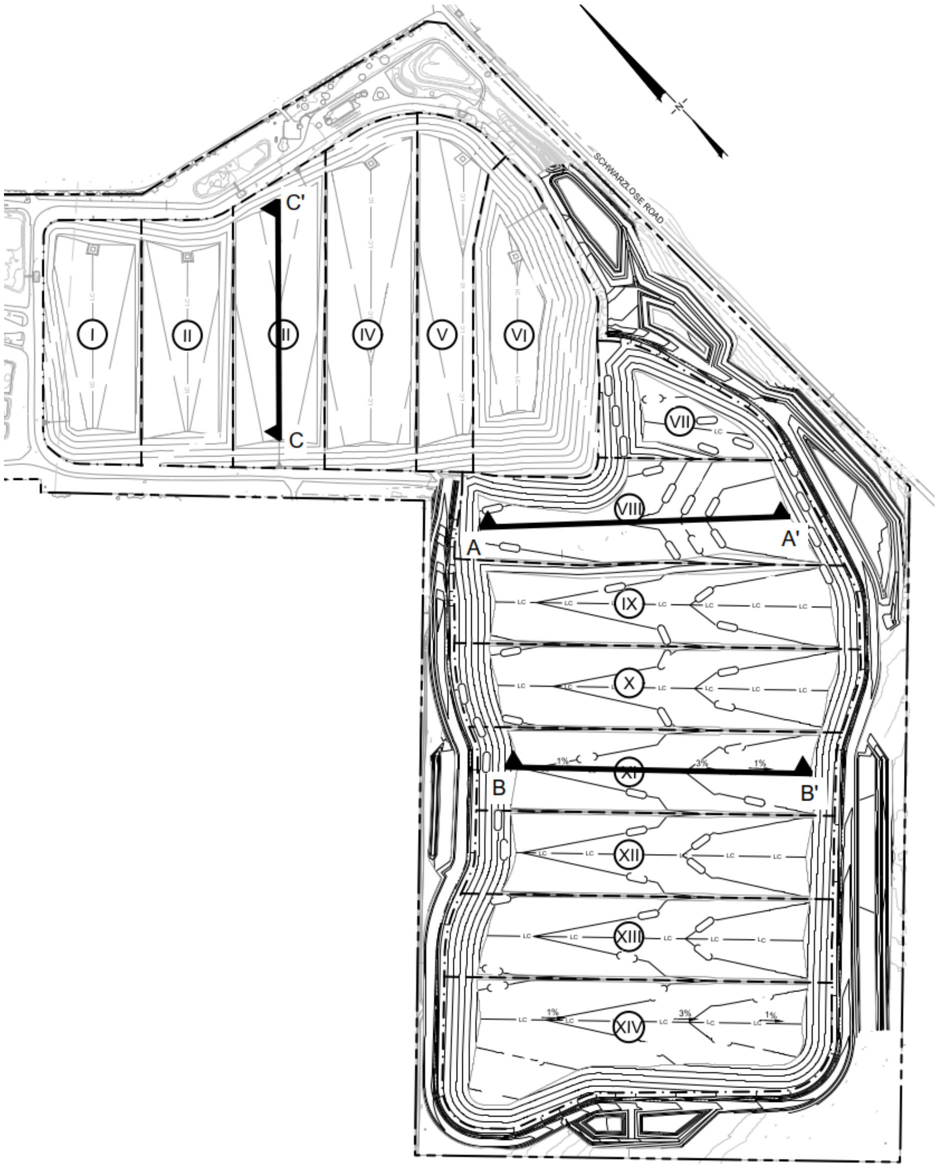


Figure 1. Location of the cross-sections in relation to overall base grading plan in the existing Unit 2 landfill area and proposed expansion area

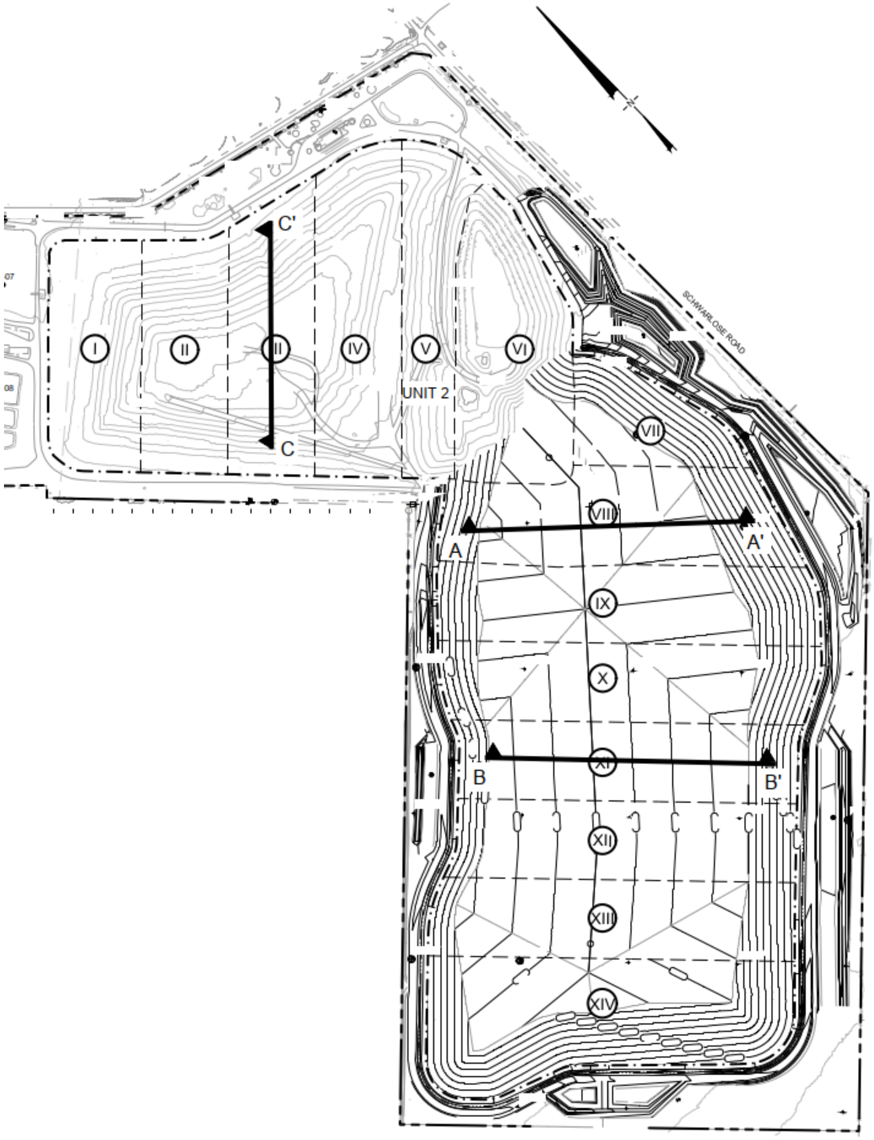


Figure 2. Location of the cross-sections in relation to final cover grading plan in the existing Unit 2 landfill area and proposed expansion area

Color	Stratum	Min. Thickness (ft)	Max Thickness (ft)
	IV	0	3.8
	III	0	5
	III	5	10
	III	10	15
	III	15	20
	III	20	25
	III	25	40
	III	40	88

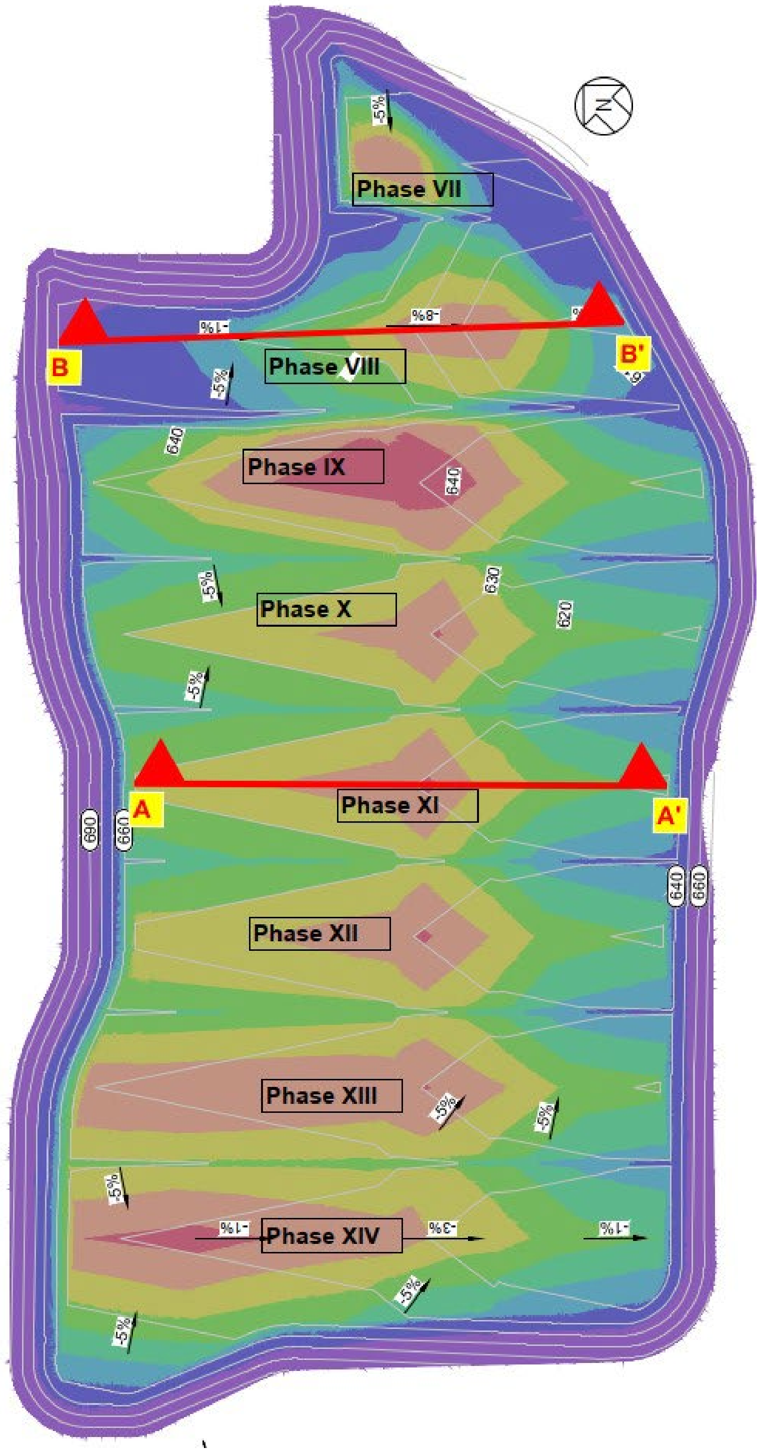


Figure 3. Location of the cross-sections in relation to underlying Strata III and IV beneath bottom of liner system in the proposed expansion area

APPENDIX 1 OF ATTACHMENT 3D.3

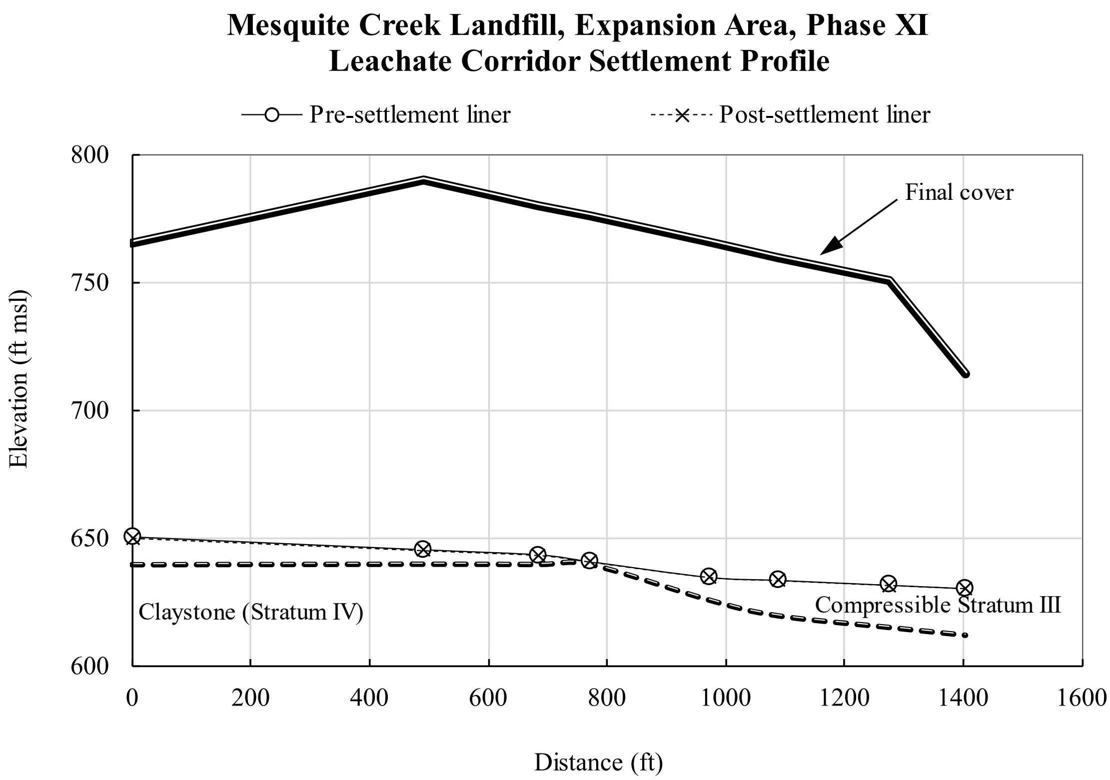
Result of Settlement Analysis

SPREADSHEET 1: EXPANSION AREA, PHASE XI **LINE A: MESQUITE CREEK LANDFILL, Settlement Calculation**									
	Point #	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
	Distance (ft)	0.0	490.1	683.9	771.6	970.5	1087.5	1275.0	1402.8
Unit weights	Final Cover Soil, γ_{cover} (pcf)	120	120	120	120	120	120	120	120
	Liner System Soils, γ_{liner} (pcf)	120	120	120	120	120	120	120	120
	Protective Cover Soil, γ_{pc} (pcf)	120	120	120	120	120	120	120	120
	Waste, γ_{waste} (pcf)	80	80	80	80	80	80	80	80
	Stratum I/II Soil (pcf)	120.0	120.0	120.0	120.0	120.0	120.0	120.0	120.0
	Stratum III Soil (pcf)	127.0	127.0	127.0	127.0	127.0	127.0	127.0	127.0
Initial Conditions Prior to Cell Construction	Water table Elevation (ft msl)	691.1	697.5	692.9	690.2	683.3	678.9	671.9	667.8
	Pre- construction Natural G.S Elevation (ft msl)	711.5	698.4	695.6	693.0	687.4	683.9	677.6	674.3
	Stratum II- III Interface (ft msl)	700.0	694.9	688.7	686.0	679.2	675.4	669.5	665.9
	Stratum III- IV Interface (ft msl)	639.93	640.1	640.0	640.0	626.2	620.0	615.5	612.4
Final Conditions at the end of Construction	Water table Elevation (ft msl)	648.44	643.5	641.6	639.0	683.3	631.8	630.0	628.7
	Top of final cover (ft msl)	765.6	789.9	780.2	775.9	765.9	760.1	750.7	714.2
	Top of waste (ft msl)	762.1	786.4	776.7	772.4	762.4	756.6	747.2	710.7
	Top of bottom liner (ft msl)	650.4	645.5	643.6	641.0	635.0	633.8	632.0	630.7
	Top of Subgrade (ft msl)	648.4	643.5	641.6	639.0	633.0	631.8	630.0	628.7
Thicknesses	Total Waste (ft)	109.7	138.9	131.1	129.4	125.4	120.8	113.3	78.1
	Final Cover Soil (ft)	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
	Bottom Liner Soil (ft)	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
	Protective Cover Soil (ft)	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
	Excavated Stratum I/II	11.5	3.5	6.9	7.0	8.3	8.5	8.1	8.4
	Excavated Stratum III	51.6	51.4	47.1	47.0	46.2	43.6	39.5	37.2
SUBGRADE RESTS ON		*Stratum III*	*Stratum III*	*Stratum III*	*Stratum IV*	*Stratum III*	*Stratum III*	*Stratum III*	*Stratum III*
Sublayer	Compressible Stratum III Soil (ft)	8.5	3.4	1.6	0.0	6.8	11.8	14.5	16.3

1-D Consolidation Theory (Plastic Method)								
Consolidation Properties- Compressible Stratum III Soil								
Modified Primary Compression Index, $C_{c\varepsilon}$	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057
Modified Recompression Index, $C_{r\varepsilon}$	0.021	0.021	0.021	0.021	0.021	0.021	0.021	0.021

Preconsolidation Pressure, p_c' (psf)		10000	10000	10000	10000	10000	10000	10000	10000
Modified Secondary Compression Index, $C_{\alpha\varepsilon}$		0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003
Compressible Stratum III Soil									
Stresses	Sub Layer	***1***							
	Final Midpoint Elevation, yres-mf (ft)	644.19	641.83	640.82	638.96	629.61	625.92	622.71	620.53
	Initial Total Stress, σ_i (psf)	8466.1	7155.0	6903.8	6811.5	7282.2	7305.7	6915.9	6764.9
	Final Total Stress, σ_f (psf)	10216.4	12226.0	11489.5	11251.2	11365.6	11312.0	10883.3	8179.9
	Initial Effective Stress, σ'_i (psf)	5540.5	3681.8	3657.1	3612.3	3934.8	4002.0	3846.1	3816.5
	Final Effective Stress, σ'_f (psf)	9950.9	12119.3	11440.8	11251.2	8018.1	10942.9	10431.2	7671.3
Settlements-Compressible Stratum III Sublayer									
OCR		1.80	2.72	2.73	2.77	2.54	2.50	2.60	2.62
Primary Settlement, (ft)		0.05	0.05	0.02	0.00	0.04	0.13	0.14	0.10
Secondary Settlement (t_1= 1 year, t_2= 54 years) (ft)		0.04	0.02	0.01	0.00	0.03	0.06	0.07	0.08
Total Settlement (ft)		0.09	0.06	0.03	0.00	0.08	0.18	0.21	0.19
TOTAL SETTLEMENT		0.09	0.06	0.03	0.00	0.08	0.18	0.21	0.19
Post settlement liner elev. (ft msl)		650.35	645.48	643.57	640.96	634.92	633.65	631.74	630.49

GRADES AND STRAINS BASED ON CALCULATED SETTLEMENT							
Initial Liner Segment Length, L_1 (ft)	490.0855	193.8167	87.8127	198.8983	117.1018	187.4874	127.7393
Post Settle. Liner Segment Length, L_2 (ft)	490.0852	193.8164	87.8118	198.9007	117.1029	187.4877	127.7391
Post Settlement Liner Strain (+ comp, - tension)	-0.0001%	-0.0002%	-0.001%	0.0012%	0.0009%	0.0002%	-0.0002%
Pre-Settlement Slope (+ up, - down)	-1.00%	-1.00%	-3.01%	-3.00%	-1.00%	-1.00%	-0.99%
Post Settlement Slope	-0.99%	-0.99%	-2.97%	-3.04%	-1.08%	-1.02%	-0.98%
Grade Difference (+ steeper, - milder)	0.006%	0.015%	0.034%	0.040%	0.085%	0.016%	0.016%


Mesquite Creek Landfill, Expansion Area, Phase XI
Leachate Corridor Settlement Profile
Pre-settlement liner
Post-settlement liner
Final cover
Claystone (Stratum IV)
Compressible Stratum III
Elevation (ft msl)
Distance (ft)
800
750
700
650
600
0
200
400
600
800
1000
1200
1400
1600

SPREADSHEET 2: EXPANSION AREA, PHASE VIII
LINE B: MESQUITE CREEK LANDFILL, Settlement Calculation

			1	2	3	4	5	6	7	8
	Point #		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
	Distance (ft)		0.0	87.3	599.3	851.3	1162.9	1249.1	1373.9	1478.2
Unit weights	Final Cover Soil, γ_{cover} (pcf)		120	120	120	120	120	120	120	120
Unit weights	Liner System Soils, γ_{liner} (pcf)		120	120	120	120	120	120	120	120
Unit weights	Protective Cover Soil, γ_{pc} (pcf)		120	120	120	120	120	120	120	120
Unit weights	Waste, γ_{waste} (pcf)		80	80	80	80	80	80	80	80
Unit weights	Stratum I/II Soil (pcf)		120.0	120.0	120.0	120.0	120.0	120.0	120.0	120.0
Unit weights	Stratum III Soil (pcf)		127.0	127.0	127.0	127.0	127.0	127.0	127.0	127.0
Initial Conditions Prior to Cell Construction	Water table Elevation (ft msl)		680.7	681.6	684.3	683.2	674.5	672.9	668.4	664.2
Initial Conditions Prior to Cell Construction	Pre- construction Natural G.S Elevation (ft msl)		699.9	705.7	709.5	698.0	676.0	673.3	665.7	664.8
Initial Conditions Prior to Cell Construction	Stratum II- III Interface (ft msl)		685.5	689.9	700.0	694.8	676.0	673.3	668.6	664.2
Initial Conditions Prior to Cell Construction	Stratum III- IV Interface (ft msl)		628.6	631.2	643.7	650.0	629.8	623.1	610.0	607.7
Final Conditions at the end of Construction	Water table Elevation (ft msl)		664.3	663.5	658.5	656.0	631.1	630.3	629.0	628.0
Final Conditions at the end of Construction	Top of final cover (ft msl)		743.1	767.1	790.0	777.4	771.4	771.7	740.1	713.7
Final Conditions at the end of Construction	Top of waste (ft msl)		739.6	763.6	786.5	773.9	767.9	768.2	736.6	710.2
Final Conditions at the end of Construction	Top of bottom liner (ft msl)		666.3	665.5	660.5	658.0	633.1	632.3	631.0	630.0
Final Conditions at the end of Construction	Top of Subgrade (ft msl)		664.3	663.5	658.5	656.0	631.1	630.3	629.0	628.0
Thicknesses	Total Waste (ft)		71.3	96.2	124.0	113.9	132.8	134.0	103.6	78.2
Thicknesses	Final Cover Soil (ft)		3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
Thicknesses	Bottom Liner Soil (ft)		2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Thicknesses	Protective Cover Soil (ft)		2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Thicknesses	Excavated Stratum I/II		14.5	15.9	9.5	3.3	0.0	0.0	-3.0	0.7
Thicknesses	Excavated Stratum III		21.2	26.4	41.5	38.8	44.9	43.1	39.6	36.2
SUBGRADE RESTS ON			*Stratum III*	*Stratum III*	*Stratum III*	*Stratum III*	*Stratum III*	*Stratum III*	*Stratum III*	*Stratum III*
Sublayer	Compressible Stratum III Soil (ft)	1	35.7	32.3	14.8	6.0	1.3	7.2	19.0	20.3

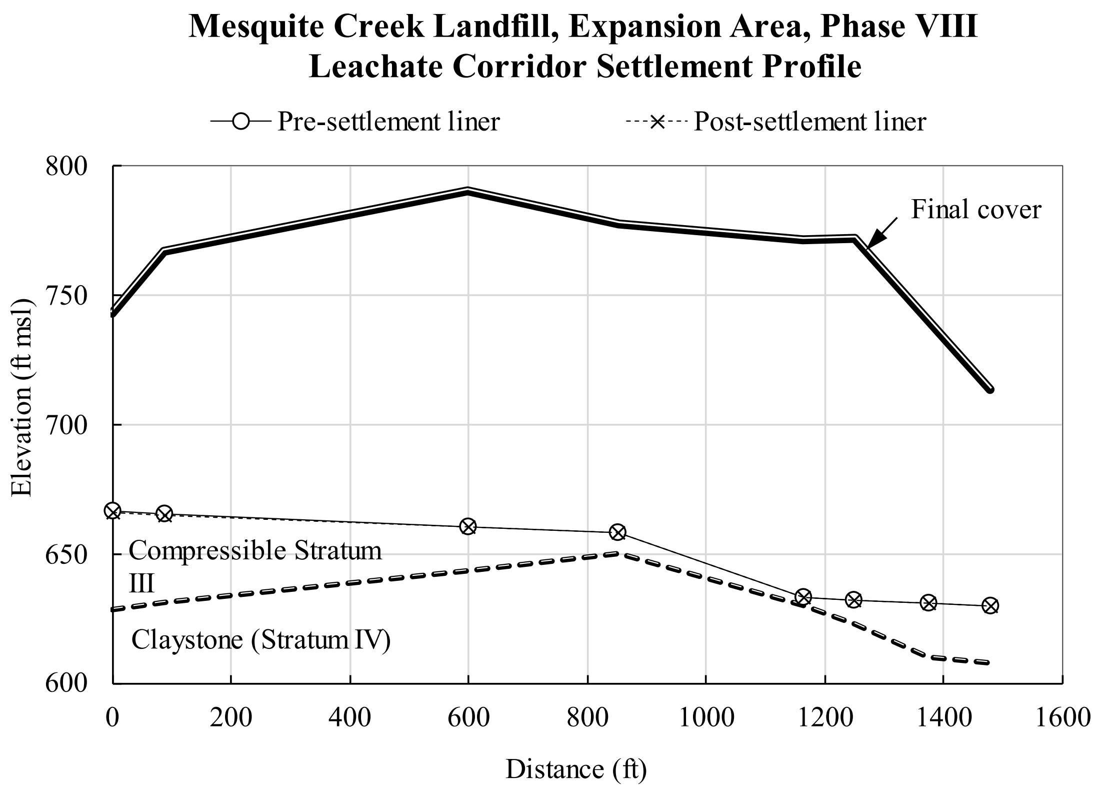
1-D Consolidation Theory (Plastic Method)

Consolidation Properties- Compressible Stratum III Soil

Modified Primary Compression Index, $C_{c\varepsilon}$	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057

Modified Recompression Index, $C_{r\varepsilon}$	0.021	0.021	0.021	0.021	0.021	0.021	0.021	0.021
Preconsolidation Pressure, p_c' (psf)	10000	10000	10000	10000	10000	10000	10000	10000
Modified Secondary Compression Index, $C_{\alpha\varepsilon}$	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003
Compressible Stratum III Soil								
Sub Layer	*1*							
Stresses: Final Midpoint Elevation, yres-mf (ft)	646.43	647.33	651.07	653.00	630.46	626.65	619.50	617.82
Initial Total Stress, σ_i (psf)	6694.6	7305.1	7350.2	5696.1	5787.2	5924.6	5883.2	5963.1
Final Total Stress, σ_f (psf)	8875.9	10642.3	11761.7	10393.0	11603.4	12074.0	10395.3	8444.6
Initial Effective Stress, σ'_i (psf)	4557.4	5168.9	5277.9	3813.5	3040.3	3036.7	2831.8	3071.5
Final Effective Stress, σ'_f (psf)	7760.8	9636.1	11300.6	10205.8	11562.8	11849.4	9802.5	7811.8
Settlements-Compressible Stratum III Sublayer								
OCR	2.19	1.93	1.89	2.62	3.29	3.29	3.53	3.26
Primary Settlement, (ft)	0.17	0.18	0.13	0.06	0.02	0.11	0.22	0.17
Secondary Settlement (t_1= 1 year, t_2= 54 years) (ft)	0.18	0.16	0.07	0.03	0.01	0.04	0.10	0.10
Total Settlement (ft)	0.35	0.35	0.21	0.09	0.03	0.14	0.31	0.27
TOTAL SETTLEMENT	0.35	0.35	0.21	0.09	0.03	0.14	0.31	0.27
Post settlement liner elev. (ft msl)	665.95	665.10	660.25	657.91	633.08	632.11	630.69	629.69

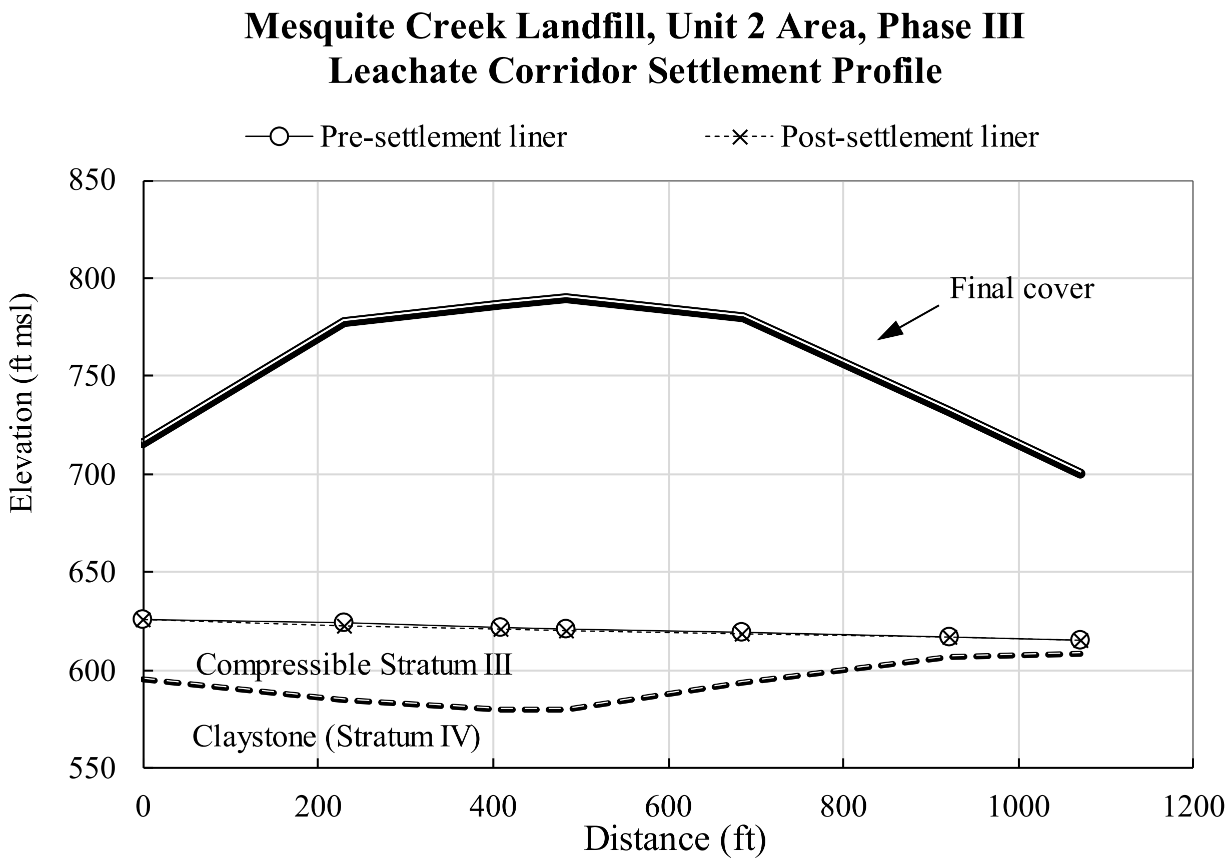
GRADES AND STRAINS BASED ON CALCULATED SETTLEMENT							
Initial Liner Segment Length, L_1 (ft)	87.3061	511.9803	252.0870	312.5646	86.2393	124.7263	104.3652
Post Settle. Liner Segment Length, L_2 (ft)	87.3061	511.9790	252.0859	312.5598	86.2405	124.7281	104.3648
Post Settlement Liner Strain (+ comp, - tension)	0.0000%	-0.0003%	-0.0005%	-0.0015%	0.0014%	0.0015%	-0.0004%
Pre-Settlement Slope (+ up, - down)	-1.0%	-1.0%	-1.0%	-8.0%	-1.0%	-1.0%	-1.0%
Post Settlement Slope	-0.97%	-0.95%	-0.93%	-7.97%	-1.12%	-1.14%	-0.96%
Grade Difference (+ steeper, - milder)	0.00%	0.03%	0.05%	0.02%	0.13%	0.14%	0.04%


Mesquite Creek Landfill, Expansion Area, Phase VIII
Leachate Corridor Settlement Profile
Pre-settlement liner
Post-settlement liner
Final cover
Compressible Stratum III
Claystone (Stratum IV)
Elevation (ft msl)
Distance (ft)
800
750
700
650
600
0
200
400
600
800
1000
1200
1400
1600

SPREADSHEET 3: EXISTING UNIT 2 AREA, PHASE III **LINE C: MESQUITE CREEK LANDFILL, Settlement Calculation**									
	Point #		**1**	**2**	**3**	**4**	**5**	**6**	**7**
	Distance (ft)		0.0	229.9	408.8	483.2	685.2	921.4	1071.0
Unit weights	Final Cover Soil, γ_{cover} (pcf)		120	120	120	120	120	120	120
Unit weights	Liner System Soils, γ_{liner} (pcf)		120	120	120	120	120	120	120
Unit weights	Protective Cover Soil, γ_{pc} (pcf)		120	120	120	120	120	120	120
Unit weights	Waste, γ_{waste} (pcf)		80	80	80	80	80	80	80
Unit weights	Stratum I/II Soil (pcf)		120.0	120.0	120.0	120.0	120.0	120.0	120.0
Unit weights	Stratum III Soil (pcf)		127.0	127.0	127.0	127.0	127.0	127.0	127.0
Initial Conditions Prior to Cell Construction	Water table Elevation (ft msl)		644.4	632.8	629.9	630.4	637.3	647.5	646.4
Initial Conditions Prior to Cell Construction	Pre- construction Natural G.S Elevation (ft msl)		649.9	636.0	643.3	647.4	662.3	661.3	655.9
Initial Conditions Prior to Cell Construction	Stratum II- III Interface (ft msl)		649.9	636.0	643.1	643.3	651.3	658.0	655.9
Initial Conditions Prior to Cell Construction	Stratum III- IV Interface (ft msl)		595.8	584.5	580.0	580.0	594.1	606.9	608.2
Final Conditions at the end of Construction	Water table Elevation (ft msl)		624.2	621.9	620.1	619.4	617.3	615.0	613.5
Final Conditions at the end of Construction	Top of final cover (ft msl)		715.4	777.4	786.3	790.0	779.8	732.1	700.3
Final Conditions at the end of Construction	Top of waste (ft msl)		711.9	773.9	782.8	786.5	776.3	728.6	696.8
Final Conditions at the end of Construction	Top of bottom liner (ft msl)		626.2	623.9	622.1	621.4	619.3	617.0	615.5
Final Conditions at the end of Construction	Top of Subgrade (ft msl)		624.2	621.9	620.1	619.4	617.3	615.0	613.5
Thicknesses	Total Waste (ft)		83.7	148.0	158.7	163.1	155.0	109.6	79.3
Thicknesses	Final Cover Soil (ft)		3.5	3.5	3.5	3.5	3.5	3.5	3.5
Thicknesses	Bottom Liner Soil (ft)		2.0	2.0	2.0	2.0	2.0	2.0	2.0
Thicknesses	Protective Cover Soil (ft)		2.0	2.0	2.0	2.0	2.0	2.0	2.0
Thicknesses	Excavated Stratum I/II		0.0	0.0	0.2	4.0	11.0	3.4	0.0
Thicknesses	Excavated Stratum III		25.7	14.1	23.0	23.9	33.9	43.0	42.4
SUBGRADE RESTS ON			*Stratum III*	*Stratum III*	*Stratum III*	*Stratum III*	*Stratum III*	*Stratum III*	*Stratum III*
Sublayer	Compressible Stratum III Soil (ft)	1	28.4	37.4	40.1	39.4	23.3	8.0	5.3

1-D Consolidation Theory (Plastic Method) Consolidation Properties- Compressible Stratum III Soil							
Modified Primary Compression Index, $C_{c\varepsilon}$	0.057	0.057	0.057	0.057	0.057	0.057	0.057

Modified Recompression Index, $C_{r\varepsilon}$	0.021	0.021	0.021	0.021	0.021	0.021	0.021
Preconsolidation Pressure, p_c' (psf)	10000	10000	10000	10000	10000	10000	10000
Modified Secondary Compression Index, $C_{\alpha\varepsilon}$	0.003	0.003	0.003	0.003	0.003	0.003	0.003
Compressible Stratum III Soil							
Stresses: Sub Layer			1				
Stresses: Final Midpoint Elevation, yres-mf (ft)	609.98	603.17	600.05	599.68	605.71	610.96	610.86
Stresses: Initial Total Stress, σ_i (psf)	5074.6	4170.6	5491.9	6026.4	7104.8	6375.2	5723.1
Stresses: Final Total Stress, σ_f (psf)	9401.5	15114.2	16141.4	16451.2	14775.4	10176.3	7579.0
Stresses: Initial Effective Stress, σ'_i (psf)	2929.3	2322.3	3627.7	4108.0	5136.1	4095.4	3503.2
Stresses: Final Effective Stress, σ'_f (psf)	8514.8	13946.1	14890.0	15222.9	14049.7	9925.8	7415.2
Settlements-Compressible Stratum III Sublayer							
OCR	3.41	4.31	2.76	2.43	1.95	2.44	2.85
Primary Settlement, (ft)	0.28	0.81	0.77	0.73	0.34	0.06	0.04
Secondary Settlement (t_1= 1 year, t_2= 57 years) (ft)	0.14	0.19	0.20	0.20	0.12	0.04	0.03
Total Settlement (ft)	0.42	1.00	0.97	0.93	0.46	0.11	0.06
TOTAL SETTLEMENT	0.42	1.00	0.97	0.93	0.46	0.11	0.06
Post settlement liner elev. (ft msl)	625.77	622.89	621.13	620.43	618.88	616.86	615.42
GRADES AND STRAINS BASED ON CALCULATED SETTLEMENT							
Initial Liner Segment Length, L_1 (ft)		229.8665	178.9590	74.4397	201.9611	236.2299	149.6344
Post Settle. Liner Segment Length, L_2 (ft)		229.8730	178.9587	74.4393	201.9569	236.2266	149.6339
Post Settlement Liner Strain (+ comp, - tension)		0.003%	0.000%	-0.001%	-0.002%	-0.001%	0.000%
Pre-Settlement Slope (+ up, - down)		-1.00%	-1.00%	-0.99%	-1.00%	-1.00%	-1.00%
Post Settlement Slope		-1.25%	-0.98%	-0.94%	-0.77%	-0.86%	-0.96%
Grade Difference (+ steeper, - milder)		0.252%	0.017%	0.054%	0.233%	0.148%	0.033%


Mesquite Creek Landfill, Unit 2 Area, Phase III
Leachate Corridor Settlement Profile
Pre-settlement liner
Post-settlement liner
850
800
750
700
650
600
550
Elevation (ft msl)
Final cover
Compressible Stratum III
Claystone (Stratum IV)
0
200
400
600
800
1000
1200
Distance (ft)

ATTACHMENT 3D.4

LINER UPLIFT AND BALLAST CALCULATIONS

AND

PRESSURE RELIEF/DEWATERING SYSTEM DESIGN

TABLE OF CONTENTS

REFER TO EACH SUB-ATTACHMENT (REPORT OR CALCULATION) WITHIN ATTACHMENT 3D.4 FOR THE RESPONSIBLE PROFESSIONAL ENGINEER'S (P.E.'S) SEAL AND SIGNATURE.

ATTACHMENT 3D.4

LINER UPLIFT AND BALLAST CALCULATIONS

AND

PRESSURE RELIEF/DEWATERING SYSTEM DESIGN

TABLE OF CONTENTS

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ATTACHMENT 3D.4.1

LINER UPLIFT AND BALLAST CALCULATIONS

Written by: **P. Pandey** Date: **7/1/2023** Reviewed by: **S. Graves** Date: **8/3/2023**

Client: **WMTX** Project: **Mesquite Creek Landfill Expansion** Project No.: **GW8636** Phase No.: **05**

LINER UPLIFT AND BALLAST CALCULATIONS

GEOSYNTEC CONSULTANTS, INC.
TX ENG FIRM REGISTRATION NO. 1182

FOR PERMIT PURPOSES ONLY.
CALCULATION PAGES
1 THROUGH 15

1. INTRODUCTION

The purpose of this calculation package is to evaluate the potential for liner uplift based on the highest groundwater conditions at the proposed Unit 2 lateral expansion area at the Mesquite Creek Landfill ("Site"), and to calculate the thickness of ballast required to resist the worst-case uplift pressures that may act on the liner system (i.e., based on the historical fluctuations of groundwater and the resulting seasonal high groundwater table levels at the Site). This includes calculating the waste thickness, if any, required for ballast in the proposed expansion cells (Unit 2 Phase VII through Phase XIV).

2. METHODOLOGY

The Texas Commission on Environmental Quality (TCEQ) recommends a minimum factor of safety (FS_{min}) against liner system uplift of 1.2 if no ballast is required or if soils are used as ballast. Alternatively, if waste is selected as ballast, the required FS_{min} is 1.5. Based on the calculations presented herein computed at several critical (worst-case) locations, ballast is required in Unit 2 Phases VII through XIV. For the purpose of these calculations, it is assumed that if ballast is calculated to be required and it will be accomplished using waste (and if necessary, also final cover soils), the required FS_{min} is 1.5. However, if only soil is used as ballast, the required FS_{min} is 1.2.

The required thickness of ballast on the liner system to achieve a selected FS_{min} value can be calculated using the following steps:

- Select critical point(s) for evaluation of a cell based on local groundwater conditions with respect to landfill base and/or sidewall (i.e., sideslope) elevations, top of liner, and critical subsurface strata. Evaluate the elevations of the seasonal high groundwater table (SHGT) (synonymous with the term "historical high" groundwater levels used herein). Or, use observed groundwater levels if conditions are intermittent and not represented by a continuous water table.

- Select the required long-term factor of safety against uplift (1.2 or 1.5) depending on the ballast material.

- Calculate the maximum hydrostatic uplift force, U_N, acting normal to the bottom of the liner at each point:

  $$U_N = \gamma_w \times H_{wt}$$

  where: γ_w = unit weight of water; and H_{wt} = vertical distance from the bottom of the liner to the seasonal high groundwater table at that point.

- Evaluate the unit weight of the liner system and ballast materials (soil, waste, and/or final cover soils).
  - Waste - For municipal solid waste, TCEQ requires in 30 TAC §330.337(h)(2) that the unit weight of waste used as ballast material be selected as 1,200 pounds per cubic yard, or 44 pounds per cubic foot (pcf). Hence, 44 pcf will be used as the unit weight of waste in these calculations, although the unit weight of the typical municipal solid waste as placed and compacted at the Mesquite Creek Landfill is likely higher than 44 pcf.
  - Protective Cover and Topsoil – Assume loose dumped unit weight of protective cover soil as 70% of the typical in-situ unit weight. If material is lightly compacted during placement, 80% of the typical in-situ or standard Proctor maximum unit weight may be used. From these guidelines and the anticipated light compaction during placement (e.g., dozer), a value of 96 pcf was selected for the unit weight of the protective cover and/or topsoil materials in both the liner and final cover systems (as applicable).
  - Compacted Clay Liner – The compacted clay liner material will be compacted to at least 95% of its standard Proctor maximum dry density. A value of 120 pcf was selected for computing the resistance to uplift by the compacted clay liner.
  - Compacted Soil Final Cover – The compacted soil final cover material will be compacted to at least 95% of its standard Proctor maximum dry density. A value of 120 pcf was selected for computing the resistance to uplift by the compacted soil final cover.

- Leachate Sump Gravel – A value of 100 pcf was selected for computing the resistance to uplift by the 4-ft thick coarse aggregate (gravel) layer in a leachate collection sump (for points evaluated at the sumps).

For the calculations presented subsequently, waste and final cover soils will be considered as ballast for Unit 2 Phase VII through Phase XIV. When possible, the total unit weight of soil layers used for ballast should be verified by laboratory or field data. It should be noted that Mesquite Creek Landfill is a Type I municipal solid waste landfill with a composite liner system at all of Unit 2. The geomembrane liner and the geocomposite drainage layer, which are a part of the liner system, do not contribute significant resistance to the uplift force from the hydrostatic pressure and were therefore not included in the analysis (i.e., they have negligible weight).

- Calculate the resisting force, R_N, provided by the liner system, acting normal to the liner system at each point:

$$R_{N\,(liner)} = \Sigma\,(\gamma_{il} \times T_{il}) \times \cos\beta$$

where: R_N = normal resisting force; γ_{il} = total unit weight of the i^{th} liner system component; and T_{il} = vertical thickness of the i^{th} liner system component. It is noted that the slope of the liner system (i.e., β) is taken as zero for the calculation since the evaluation points (with the maximum head) are all either in the cell floor or toe of the sideslope. Additionally, $R_{N\,(liner)}$ *includes* the resistance due to 4' gravel for the sump locations.

- Calculate the provided FS without ballast at each point:

$$FS = R_{N\,(liner)} / U_N = \Sigma(\gamma_{il} \times T_{il}) \times \cos\beta / (\gamma_w \times H_{wt})$$

If the provided FS is greater than or equal to FS_{min}, then no ballast is required. If FS is less than the FS_{min}, then ballast is required.

- If ballast is required, calculate the required vertical thickness, T_{ib}, of the soil or waste ballast materials required to achieve the target factor of safety:

$$\Sigma(\gamma_{ib} \times T_{ib}) \times \cos\beta = ((FS_{min} \times U_N) - R_{N\,(liner)})$$

where: γ_{ib} = total unit weight of the i^{th} ballast component (soil or waste); and T_{ib} = vertical thickness of the i^{th} ballast component.

- If the proposed soil or waste ballast does not provide the resisting force needed, calculate the additional R_N, provided by the final cover system soils, acting normal to the final cover system at each point:

  $$R_{N\,(cover)} = \Sigma\,(\gamma_{ic} \times T_{ic}) \times \cos\beta$$

  where: γ_{ic} = total unit weight of the i^{th} final cover system component; T_{ic} = vertical thickness of the i^{th} final cover system component; and β = the slope of the liner system.

- Calculate the R_N of the soil or waste ballast:

  $$R_{N(b)} = (\gamma_{ib} \times T_{ib}) \times \cos\beta$$

  where: γ_{ib} = total unit weight of the i^{th} ballast component; T_{ib} = vertical thickness of the i^{th} ballast component; and β = the slope of the liner system.

- Calculate the combined R_N:

  $$R_{N\,(total)} = R_{N\,(liner)} + R_{N\,(cover)} + R_{N(b)}$$

- Re-calculate the FS considering the total ballast (liner soils, soil or waste ballast, and final cover soils):

  $$FS = R_{N\,(total)} / U_N$$

3. SELECTION OF ANALYSIS CASES

The approach for this calculation package is to select critical locations for analysis along the bottom of the liner system of the yet-to-be-constructed cells (i.e., Unit 2 Phase VII through Phase XIV), and calculate the uplift forces and resulting ballast thickness requirements (if any) given the selected input parameters. Specific conditions that exist at particular points of interest are evaluated individually to calculate the required ballast at each point, using the methodology described previously.

Section 10.2 of the Liner Quality Control Plan (LQCP) presents a discussion on the Site subsurface stratigraphy and hydrogeology, and an evaluation of the possible areas where groundwater may be present that could be sufficient to exert a hydrostatic uplift force on the liner. In summary, majority of the landfill base (as well as sideslopes) in new cells (Phase VII through XIV) are located in Stratum III (potential water-bearing zone, where groundwater is perched above the confining and unsaturated claystone of Stratum IV). As such, portions of the sideslopes and base of landfill liner will encounter zones with the potential for groundwater to be present. Additional discussion on groundwater conditions and observations during site investigations and historical construction excavations are provided in the LQCP and are not repeated here. Ultimately, based on the available information the development of uplift pressures on the liner system may not occur, but nevertheless has been conservatively assumed to exist as a possibility. The Unit 2 lateral expansion area has been evaluated accordingly to calculate the thickness of ballast required to resist the worst-case uplift pressures that may act on the liner system. The design of pressure relief system that will be installed in future cells and will be operated until sufficient ballast is present to resist the theoretical uplift is part of a companion calculation package to this (Attachment 3D.4.2).

The base liner system grading plan and final cover grading plan at Unit 2 are presented in Part III, Attachment 3A, Drawings 3A-4B and 3A-5B, respectively. The SHGT map is presented in Drawing 3C-1 of the LQCP. Additionally, geologic cross-sections and a contour map of the top of Stratum III and Stratum IV (i.e., unweathered claystone) were developed for the Site using the boring logs in Part III, Attachment 4C and are provided in the Geology Report (Part III, Attachment 4A). Landfill cross-sections are provided in the Waste Management Unit Design (Part III, Attachment 3A). A general concept-level illustration of the typical liner conditions for Unit 2 Phase VII through Phase XIV are presented on Figure 1 below.

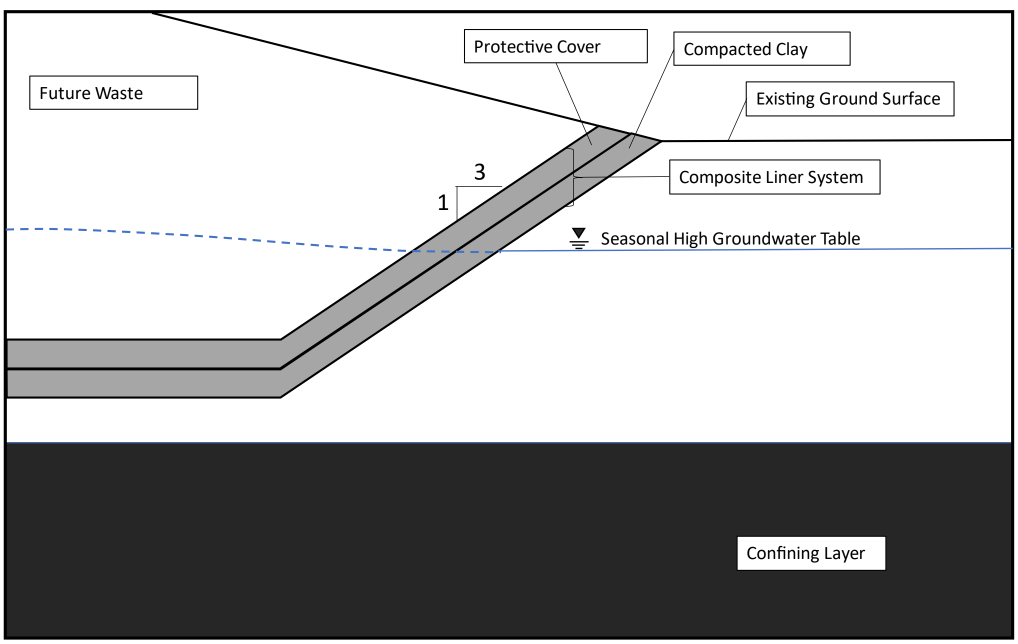

Figure 1: Typical Layout at Liner Conditions for New Cells in Phase VII through Phase XIV

From the above illustration, it is evident that the critical condition would be where the groundwater head (H_{wt}) is the greatest (thereby requiring the greatest amount of ballast). The bottom of the base liner system and SHGT map were used to identify these critical points with the greatest height of the groundwater table at different locations in the expansion area. In total, 22 evaluation points (five at the interior cell floor; eight at the sump location and nine on the opposite end of the cell) were selected for analysis (see Figure 2 below). Further, the elevations of the various surfaces (i.e., bottom of clay liner, top of waste, top of final cover, SHGT elevation, top of confining Stratum IV) at the critical locations required for the analysis were determined using the available liner system and final cover grading plans, SHGT map, Stratum IV structure map and geologic and landfill cross-sections.

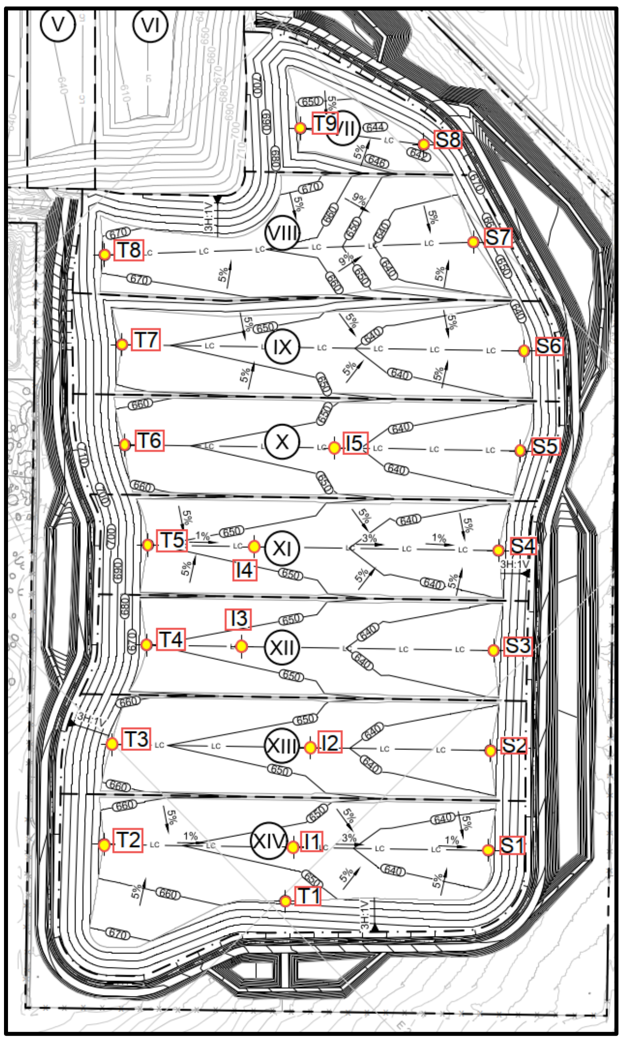

Figure 2: Approximate Location of Critical Cases Selected for Analysis in Phase VII through XIV

The SHGT and bottom of liner system elevations used to evaluate the need for ballast at the 22 evaluation points at the slope toe and interior cell floor locations shown in Figure 2 are as follows:

Locations	SHGT Elevation (ft, MSL)	Bottom of Clay Liner Elevation (ft, MSL)	Maximum Potential Groundwater Head H_{wt}, (ft)
At the sump locations			
S1 (Phase XIV)	669.9	626.0	43.8
S2 (Phase XIII)	668.5	625.4	43.1
S3 (Phase XII)	665.5	624.7	40.8
S4 (Phase XI)	667.8	624.7	43.1
S5 (Phase X)	668.2	625.1	43.1
S6 (Phase IX)	665.2	624.1	41.1
S7 (Phase VIII)	664.2	624.0	40.3
S8 (Phase VII)	659.5	633.8	25.7
At the slope toe (In western side of expansion area)			
T1 (Phase XIV)	692.5	654.4	38.1
T2 (Phase XIV)	700.0	651.1	48.9
T3 (Phase XIII)	699.3	650.2	49.1
T4 (Phase XII)	698.4	648.3	50.2
T5 (Phase XI)	696.6	648.4	48.2
T6 (Phase X)	691.6	650.7	40.9
T7 (Phase IX)	690.1	649.9	40.1
T8 (Phase VIII)	680.9	664.3	16.6
T9 (Phase VII)	660.0	642.8	17.2
At the interior cell floor			
I1 (Phase XIV)	698.6	643.6	55.0
I2 (Phase XIII)	699.3	642.3	57.0
I3 (Phase XII)	699.5	644.5	55.0
I4 (Phase XI)	699.3	644.2	55.1
I5 (Phase X)	698.1	641.1	57.0

As noted earlier, the majority of the landfill base will rest within Stratum III where there is potential groundwater presence (and above the unweathered claystone layer (Stratum IV) beneath the Site). Normally, the critical point of any given cell for uplift and ballast purposes is the low point at the sumps. However, this may not always be the case, depending on how the groundwater levels vary across a cell relative to the landfill base grades. A review of the bottom of liner system and SHGT map indicates that the sump locations may not necessarily be the most critical points for ballast since the theoretical seasonal high-water level rises towards the center of the landfill area. Therefore, to be thorough, the analysis herein evaluates sump locations, plus interior floor areas and at toe of the cell sideslope on the other end of the cells (e.g., the high end, opposite from the sumps).

4. CALCULATIONS

The following section presents the calculations of the required thickness of ballast to resist uplift at the critical locations along the liner system. Using the methodology described previously, the equations were coded into a spreadsheet solution to perform these calculations and evaluate whether the design thickness (i.e., minimum thickness) of the liner system is sufficient to resist uplift, or whether additional ballast (i.e., soil or waste) is needed. In the next subsections that follow, several sample calculations for a few point locations are provided, showing the numbers plugged-in to the equations, to check and help validate the spreadsheet solution. The tabulated results for all analysis cases are also presented in Table 1.

At the sump locations

Phase	XIV	XIII	XII	XI	X	IX	VIII	VII	
Location Point	S1	S2	S3	S4	S5	S6	S7	S8	
SHGT Elevation (ft, MSL)	669.9	668.5	665.5	667.8	668.2	665.2	664.2	659.5	
Bottom of Clay Liner Elev (ft, MSL)	626.0	625.4	624.7	624.7	625.1	624.1	624.0	633.8	
Top of Final Cover Elev (ft, MSL)	729.6	724.5	719.7	714.2	715.8	718.5	714.2	709.1	
Height of water (ft)	43.8	43.1	40.8	43.1	43.1	41.1	40.3	25.7	
U_N (Uplift Pressure, psf)	2733.1	2689.4	2545.9	2689.4	2689.4	2564.6	2514.7	1603.7	
R_N_Liner Only									
R_N Liner Compacted Clay	240.0	240.0	240.0	240.0	240.0	240.0	240.0	240.0	
R_N Liner Protective Cover	192.0	192.0	192.0	192.0	192.0	192.0	192.0	192.0	
R_N Sump Gravel	400	400	400	400	400	400	400	400	
Total $R_{N\ (liner+gravel)}$, (psf)	832.0	832.0	832.0	832.0	832.0	832.0	832.0	832.0	
F.S_Liner Only (i.e., No Ballast)	0.30	0.31	0.33	0.31	0.31	0.32	0.33	0.52	*(< 1.2)*
Need Ballast (?)	YES	YES	YES	YES	YES	YES	YES	YES	
Required WASTE ballast thickness									
Tb_{min} (ft)	74.3	72.8	67.9	72.8	72.8	68.5	66.8	35.8	
Corresponding waste elevation (ft, MSL) for target F.S 1.5	708.3	706.1	700.5	705.5	705.9	700.7	698.8	677.6	

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At the opposing cell ends toe-of-slope

Phase	XIV		XIII	XII	XI	X	IX	VIII	VII	
Location Point	T1	T2	T3	T4	T5	T6	T7	T8	T9	
SHGT Elevation (ft, MSL)	692.5	700.0	699.3	698.4	696.6	691.6	690.1	680.9	660.0	
Bottom of Clay Liner Elev (ft, MSL)	654.4	651.1	650.2	648.3	648.4	650.7	649.9	664.3	642.8	
Top of Final Cover Elev (ft, MSL)	740.7	770.9	759.9	764.4	765.7	775.0	781.1	743.1	772.2	
Height of water (ft)	38.1	48.9	49.1	50.2	48.2	40.9	40.1	16.6	17.2	
U_N (Uplift Pressure, psf)	2377.4	3051.4	3063.8	3132.5	3007.7	2552.2	2502.2	1035.8	1073.3	
R_N_Liner Only										
R_N Liner Compacted Clay	240.0	240.0	240.0	240.0	240.0	240.0	240.0	240.0	240.0	
R_N Liner Protective Cover	192.0	192.0	192.0	192.0	192.0	192.0	192.0	192.0	192.0	
Total $R_{N\ (liner)}$, (psf)	432.0	432.0	432.0	432.0	432.0	432.0	432.0	432.0	432.0	
F.S_Liner Only (i.e., No Ballast)	0.18	0.14	0.14	0.14	0.14	0.17	0.17	0.42	0.40	*(< 1.2)*
Need Ballast (?)	YES	YES	YES	YES	YES	YES	YES	YES	YES	
Required WASTE ballast thickness										
Tb_{min} (ft)	71.2	94.2	94.6	97.0	92.7	77.2	75.5	25.5	26.8	
Corresponding waste elevation (ft, MSL) for target F.S 1.5	729.6	749.3	748.8	749.2	745.2	731.9	729.4	693.8	673.6	

Interior cell floor locations

Phase	XIV	XIII	XII	XI	X	
Location Point	I1	I2	I3	I4	I5	
SHGT Elevation (ft, MSL)	698.6	699.3	699.5	699.3	698.1	
Bottom of Clay Liner Elev (ft, MSL)	643.6	642.3	644.5	644.2	641.1	
Top of Final Cover Elev (ft, MSL)	786.9	781.7	783.4	786.9	776.0	
Height of water (ft)	55.0	57.0	55.0	55.1	57.0	
UN (Uplift Pressure, psf)	3432.0	3556.8	3432.0	3438.2	3556.8	
R_N_Liner Only						
R_N Liner Compacted Clay	240.0	240.0	240.0	240.0	240.0	
R_N Liner Protective Cover	192.0	192.0	192.0	192.0	192.0	
Total $R_{N\ (liner)}$, (psf)	432.0	432.0	432.0	432.0	432.0	
F.S_Liner Only (i.e., No Ballast)	0.13	0.12	0.13	0.13	0.12	*(< 1.2)*
Need Ballast (?)	YES	YES	YES	YES	YES	
Required WASTE ballast thickness						
Tb_{min} (ft)	107.2	111.4	107.2	107.4	111.4	
Corresponding waste elevation (ft, MSL) for target F.S 1.5	754.8	757.7	755.6	755.6	756.5	

4.1 Uplift Calculations at the sump location of Phase XIV (Point S1)

The height of the water table above the analysis location is calculated as follows:

$$H_{wt} = 669.9\ ft\ MSL - 626.0\ ft\ MSL = 43.8\ ft$$

The uplift force acting normal to the liner system at the sump location ($\beta = 0.0°$) is computed as:

$$U_N = (H_{wt} \times \gamma_w) = (43.8\ ft \times 62.4\ pcf) = 2733.1\ psf$$

It is noted that the initial uplift resistance at the sump location will be provided by the compacted clay liner with a vertical thickness of 2.0 feet, protective cover with a vertical thickness of 2.0 feet, and the leachate collection sump gravel with a vertical thickness of 4.0 feet; and is computed as follows:

$$R_{N\ (liner)} = (\ \gamma_{il} \times T_{il}) \times \cos\beta$$
$$R_{N\ (liner)} = (120\ pcf \times 2.0\ ft + 96\ pcf \times 2.0\ ft + 100\ pcf \times 4\ ft\ ) \times \cos(0.0°) = 832\ psf$$

The calculated factor of safety is:

$$FS = R_{N\ (liner)} / U_N = 832\ psf / 2733.1\ psf = 0.30 < 1.2\ (Waste\ ballast\ required)$$

The total vertical thickness of waste ballast required to meet $FS_{min} = 1.5$ is:

$$T_{b,\ min} = (FS_{min} \times U_N) / (\gamma_{wb} \times \cos\ \beta\ )$$
$$T_{b,\ min} = (1.5\ \times 2733.1\ psf - 832\ psf) / (44\ pcf \times \cos\ 0.0°\ ) = 74.3\ ft$$

Therefore, at the sump location of Phase XIV, approximately 74.3 feet of waste ballast is required over the uplift evaluation point to achieve a calculated FS of 1.5. The corresponding waste elevation for this FS value is approximately 708.3 ft MSL [626.0 MSL + liner system vertical thickness (4.0 feet) + leachate collection sump gravel thickness (4.0 feet) +waste ballast thickness (74.3 feet)].

4.2 Uplift Calculations at the toe of the slope on the other end of cell (western side) of Phase XIV (Point T2)

The height of the water table above the analysis location is calculated as follows:

$$H_{wt} = 700.0\ ft\ MSL - 651.1\ ft\ MSL = 48.9\ ft$$

The uplift force acting normal to the liner system ($\beta = 0.0°$) is computed as:

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$$U_N = (H_{wt} \times \gamma_w) = (48.9\,ft \times 62.4\,pcf) = 3051.4\,psf$$

The uplift resistance available from the compacted clay sideslope liner with a vertical thickness of 2.0 feet and protective cover with a vertical thickness of 2.0 feet acting normal to the liner system, is computed as follows:

$$R_{N\,(liner)} = (\,\gamma_{il} \times T_{il}) \times \cos\beta$$
$$R_{N\,(liner)} = (120\,pcf \times 2.0\,ft + 96\,pcf \times 2.0\,ft) \times \cos(0.0°) = 432\,psf$$

The calculated factor of safety is:

$$FS = R_{N\,(liner)} / U_N = 432\,psf / 3051.4\,psf = 0.14 < 1.2\ (Waste\ ballast\ required)$$

The total vertical thickness of waste ballast required to meet FS_{min} = 1.5 is:

$$T_{b,\,min} = (FS_{min} \times U_N) / (\gamma_{wb} \times \cos\beta)$$
$$T_{b,\,min} = (1.5 \times 3051.4\,psf - 432\,psf) / (44\,pcf \times \cos 0.0°) = 94.2\,ft$$

Therefore, at the other end cell in Phase XIV, approximately 94.2 feet of waste ballast is required over the uplift evaluation point to achieve a calculated FS of 1.5. The corresponding waste elevation for this FS value is approximately 749.3 ft MSL [651.1 ft MSL + liner system vertical thickness (4.0 feet) + waste ballast thickness (94.2 feet)].

4.3 Uplift Calculations at the interior cell floor of Phase XIV (Point I1)

The height of the water table above the analysis location is calculated as follows:

$$H_{wt} = 698.6\,ft\,MSL - 643.6\,ft\,MSL = 55.0\,ft$$

The uplift force acting normal to the liner system (β = 0.0°) is computed as:

$$U_N = (H_{wt} \times \gamma_w) = (55\,ft \times 62.4\,pcf) = 3432.0\,psf$$

The uplift resistance available from the compacted clay sideslope liner with a vertical thickness of 2.0 feet and protective cover with a vertical thickness of 2.0 feet acting normal to the liner system, is computed as follows:

$$R_{N\,(liner)} = (\gamma_{il} \times T_{il}) \times \cos\beta$$
$$R_{N\,(liner)} = (120\ pcf \times 2.0\ ft + 96\ pcf \times 2.0\ ft) \times \cos(0.0°) = 432\ psf$$

The calculated factor of safety is:

$$FS = R_{N\,(liner)} / U_N = 432\ psf / 3432.0\ psf = 0.13 < 1.2\ (Waste\ ballast\ required)$$

The total vertical thickness of waste ballast required to meet FS_{min} = 1.5 is:

$$T_{b,\,min} = (FS_{min} \times U_N) / (\gamma_{wb} \times \cos\beta)$$
$$T_{b,\,min} = (1.5 \times 3432.0\ psf - 432\ psf) / (44\ pcf \times \cos 0.0°) = 107.2\ ft$$

Therefore, at the interior cell floor of Phase XIV, approximately 107.2 feet of waste ballast is required over the uplift evaluation point to achieve a calculated FS of 1.5. The corresponding waste elevation for this FS value is approximately 754.8 ft MSL [643.6 ft MSL + liner system vertical thickness (4.0 feet) + waste ballast thickness (107.2 feet)].

5. CONCLUSIONS AND RECOMMENDATIONS

Results and conclusions of the analysis presented herein are summarized below and in Table 1:

- Based on the SHGT elevations and soil properties assumed herein and as shown in Table 1, ballast is required. Further, the use of waste ballast is found to be sufficient to meet the factor of safety requirements.
- Table 1 provides the eventual (as-permitted) final thickness of waste at each point, and from comparison to the required waste-as-ballast thickness, shows that the waste ballast requirements are feasible (and that the final-condition factor of safety against uplift exceeds the minimum required value).
- An underdrain system will be installed beneath the liner system (floor and sideslopes) in Unit 2 Phase VII through XIV. The underdrain will be operated until sufficient ballast has been placed to resist uplift forces on the liner system, at which point its operation will be discontinued. The underdrain system design is presented in Part III, Attachment 3D.4.2. Engineering drawings of the underdrain system are provided in Part III, Attachment 3A. The material properties and installation requirements of the underdrain components are provided in the LQCP (Part III, Attachment 3C).

Written by: **P. Pandey** Date: **7/1/2023** Reviewed by: **S. Graves** Date: **8/3/2023**

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Table 1. Summary of Ballast Calculations with Calculated Ballast Thicknesses

	At the sump location							
	Point S1 Phase XIV	Point S2 Phase XIII	Point S3 Phase XII	Point S4 Phase XI	Point S5 Phase X	Point S6 Phase IX	Point S7 Phase VIII	Point S8 Phase VII
Seasonal High Groundwater Table (ft MSL)	669.9	668.5	665.5	667.8	668.2	665.2	664.2	659.5
Bottom of Clay Liner (ft MSL)	626.0	625.4	624.7	624.7	625.1	624.1	624.0	633.8
Height of Groundwater at Critical Location (ft)	43.8	43.1	40.8	43.1	43.1	41.1	40.3	25.7
Unit Weight of Compacted Clay Liner (pcf)	120	120	120	120	120	120	120	120
Unit Weight of Protective Cover/Topsoil (pcf)	96	96	96	96	96	96	96	96
Unit Weight of Water (pcf)	62.4	62.4	62.4	62.4	62.4	62.4	62.4	62.4
Unit Weight of Compacted Soil Final Cover (pcf)	120	120	120	120	120	120	120	120
H: V of Sideslope Liner	3:1	3:1	3:1	3:1	3:1	3:1	3:1	3:1
Vertical Thickness of Compacted Clay Liner (ft)	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Vertical Thickness of Protective Cover (ft)	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Sump Gravel Thickness	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Vertical Thickness of Waste Ballast (ft)	74.3	72.8	67.9	72.8	72.8	68.5	66.8	35.8
Vertical Thickness of Final Cover Compacted Soil (ft)	1.56	1.56	1.56	1.56	1.56	1.56	1.56	1.56
Vertical Thickness of Final Cover Protective Cover and Topsoil (ft)	2.08	2.08	2.08	2.08	2.08	2.08	2.08	2.08
Uplift Force Acting Normal to Liner, U_N (psf)	2733.1	2689.4	2545.9	2689.4	2689.4	2564.6	2514.7	1603.7
Resisting Force Acting Normal to Liner, R_N (psf)	4099.7	4034.2	3818.9	4034.2	4034.2	3847.0	3772.1	2405.5
Factor of Safety Against Uplift, FS	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Final Resisting Force Against Uplift, R_N (psf)*	5262.9	5068.4	4886.7	4647.4	4700.2	4858.6	4675.1	4019.5
Target Factor of Safety	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Permitted waste thickness	91.91	87.49	83.36	77.92	79.12	82.72	78.55	63.65
Factor of Safety Against Uplift Under Final Conditions, FS*	1.93	1.88	1.92	1.73	1.75	1.89	1.86	2.51
OK?	OK	OK	OK	OK	OK	OK	OK	OK

Notes:

1. * Indicates this value was calculated considering liner soil materials, permitted waste thickness, and final cover soil materials as ballast under final built conditions

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	At the slope toe (In Western side of the cell)								
	Point T1 Phase XIV	Point T2 Phase XIV	Point T3 Phase XIII	Point T4 Phase XII	Point T5 Phase XI	Point T6 Phase X	Point T7 Phase IX	Point T8 Phase VIII	Point T9 Phase VII
Seasonal High Groundwater Table (ft MSL)	692.5	700.0	699.3	698.4	696.6	691.6	690.1	680.9	660.0
Bottom of Clay Liner (ft MSL)	654.4	651.1	650.2	648.3	648.4	650.7	649.9	664.3	642.8
Height of Groundwater at Critical Location (ft)	38.1	48.9	49.1	50.2	48.2	40.9	40.1	16.6	17.2
Unit Weight of Compacted Clay Liner (pcf)	120	120	120	120	120	120	120	120	120
Unit Weight of Protective Cover/Topsoil (pcf)	96	96	96	96	96	96	96	96	96
Unit Weight of Water (pcf)	62.4	62.4	62.4	62.4	62.4	62.4	62.4	62.4	62.4
Unit Weight of Compacted Soil Final Cover (pcf)	120	120	120	120	120	120	120	120	120
H: V of Sideslope Liner	3:1	3:1	3:1	3:1	3:1	3:1	3:1	3:1	3:1
Vertical Thickness of Compacted Clay Liner (ft)	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Vertical Thickness of Protective Cover (ft)	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Vertical Thickness of Waste Ballast (ft)	71.2	94.2	94.6	97.0	92.7	77.2	75.5	25.5	26.8
Vertical Thickness of Final Cover Compacted Soil (ft)	1.56	1.56	1.56	1.56	1.56	1.56	1.56	1.56	1.56
Vertical Thickness of Final Cover Protective Cover and Topsoil (ft)	2.08	2.08	2.08	2.08	2.08	2.08	2.08	2.08	2.08
Uplift Force Acting Normal to Liner, U_N (psf)	2377.4	3051.4	3063.8	3132.5	3007.7	2552.2	2502.2	1035.8	1073.3
Resisting Force Acting Normal to Liner, R_N (psf)	3566.2	4577.0	4595.8	4698.7	4511.5	3828.2	3753.4	1553.8	1609.9
Factor of Safety Against Uplift, FS	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50
Final Resisting Force Against Uplift, R_N (psf)*	4280.4	5753.0	5307.3	5591.6	5640.4	5948.8	6254.6	3951.2	6176.3
Target Factor of Safety	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Permitted waste thickness	78.67	112.14	102.1	108.47	109.58	116.59	123.54	71.19	121.76
Factor of Safety Against Uplift Under Final Conditions, FS*	1.80	1.89	1.73	1.79	1.88	2.33	2.50	3.81	5.75
OK?	OK	OK	OK	OK	OK	OK	OK	OK	OK

Notes:

1. * Indicates this value was calculated considering liner soil materials, permitted waste thickness, and final cover soil materials as ballast under final built conditions

Written by: **P. Pandey** Date: **7/1/2023** Reviewed by: **S. Graves** Date: **8/3/2023**

Client: **WMTX** Project: **Mesquite Creek Landfill Expansion** Project No.: **GW8636** Phase No.: **05**

	Interior cell floor				
	Point I1 Phase XIV	Point I2 Phase XIII	Point I3 Phase XII	Point I4 Phase XI	Point I5 Phase X
Seasonal High Groundwater Table (ft MSL)	698.6	699.3	699.5	699.3	698.1
Bottom of Clay Liner (ft MSL)	643.6	642.3	644.5	644.2	641.1
Height of Groundwater at Critical Location (ft)	55.0	57.0	55.0	55.1	57.0
Unit Weight of Compacted Clay Liner (pcf)	120	120	120	120	120
Unit Weight of Protective Cover/Topsoil (pcf)	96	96	96	96	96
Unit Weight of Water (pcf)	62.4	62.4	62.4	62.4	62.4
Unit Weight of Compacted Soil Final Cover (pcf)	120	120	120	120	120
H: V of Sideslope Liner	3:1	3:1	3:1	3:1	3:1
Vertical Thickness of Compacted Clay Liner (ft)	2.0	2.0	2.0	2.0	2.0
Vertical Thickness of Protective Cover (ft)	2.0	2.0	2.0	2.0	2.0
Vertical Thickness of Waste Ballast (ft)	107.2	111.4	107.2	107.4	111.4
Vertical Thickness of Final Cover Compacted Soil (ft)	1.5	1.5	1.5	1.5	1.5
Vertical Thickness of Final Cover Protective Cover and Topsoil (ft)	2.0	2.0	2.0	2.0	2.0
Uplift Force Acting Normal to Liner, U_N (psf)	3432.0	3556.8	3432.0	3438.2	3556.8
Resisting Force Acting Normal to Liner, R_N (psf)	5148.0	5335.2	5148.0	5157.4	5335.2
Factor of Safety Against Uplift, FS	1.50	1.50	1.50	1.50	1.50
Final Resisting Force Against Uplift, R_N (psf)*	6778.3	6606.7	6586.9	6751.9	6410.9
Target Factor of Safety	1.5	1.5	1.5	1.5	1.5
Permitted waste thickness	135.78	131.88	131.43	135.18	127.43
Factor of Safety Against Uplift Under Final Conditions, FS*	1.98	1..86	1.92	1.96	1.80
OK?	OK	OK	OK	OK	OK

Notes:

1. * Indicates this value was calculated considering liner soil materials, permitted waste thickness, and final cover soil materials as ballast under final built conditions

ATTACHMENT 3D.4.2

PRESSURE RELIEF / DEWATERING SYSTEM DESIGN

Written by: **P. Pandey** Date: **7/19/2023** Reviewed & Revised by: **S. Graves** Date: **8/3/2023; 2/7/2024**

Client: **WMTX** Project: **Mesquite Creek Landfill Expansion** Project No.: **GW8636** Phase No.: **05**

HYDRAULIC CAPACITY OF PRESSURE RELIEF / DEWATERING SYSTEM FOR PHASE VII THROUGH XIV

2/19/2024

STATE OF TEXAS
SCOTT M. GRAVES
86557
LICENSED
PROFESSIONAL ENGINEER

FOR PERMIT PURPOSES ONLY;
CALCULATION PAGES
1 THROUGH 20

GEOSYNTEC CONSULTANTS, INC.
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1. INTRODUCTION

From the results presented in Attachment 3D.4.1 (Liner Uplift and Ballast Calculations), waste ballast is required in Unit 2 Phase VII through XIV to resist the calculated potential uplift pressures that may act on the liner system constructed below the seasonal high-water table. At these locations, a pressure relief/dewatering system (hereafter referred to as an underdrain system) will be installed underneath the liner system and operated until sufficient ballast has been placed, at which point its operation may be discontinued. The purpose of this calculation package is to estimate the unit rate of groundwater inflow from the water bearing zone to the bottom of the liner system (both in the cell floor and on the side slope) at locations in Phase VII through XIV requiring waste ballast, and to size the underdrain components (i.e., calculate the hydraulic capacity of the underdrain required to intercept and collect this groundwater seepage without the buildup of excess head on the liner system).

2. METHODOLOGY

The methodology used to design the dewatering system for each area involved following steps:

1. Estimation of representative flow depth and hydraulic conductivity of the water bearing zone and generation of a flow net diagram.

2. Calculation of inflow into the side slope and cell floor liner system due to groundwater in the water bearing zone.
3. Estimation of underdrain strips spacing in the side slope and cell floor.
4. Sizing of appropriate geocomposite to handle inflow with appropriate factor of safety (FS) taking into account partial reduction factors due to creep, chemical clogging and/or precipitation of chemicals, and biological clogging.
5. Estimation of maximum flow rate in centerline and sideslope toe drains leading to sump for water collection.
6. Recommendation for temporary dewatering pump sizing and operation to remove the water collected in the sump.

3. CALCULATIONS

The critical location for the underdrain system design basis occurs where the required hydraulic capacity of the underdrain needs to be the highest, corresponding to where seasonal-high groundwater table elevations are the highest. In the assessment of various points in the ballast calculations (Attachment 3D.1), two locations in the interior cell floor were identified to be potentially critical with highest seasonal high groundwater head of 57 feet. However, it is noted that the water bearing stratum beneath these locations is relatively thin (i.e., on the order of about one foot). Since the majority of interior cell floor will undergo excavation to reach depths nearing the upper boundary of the “rock-like” and very low permeability (not water-bearing) claystone, which essentially confines the groundwater and acts as an aquiclude, and because recharge from above will be eliminated via the liner, the predominant flow is expected to occur via groundwater flowing in a lateral direction. Accordingly, a cross-sectional flow net was employed to model the groundwater condition and prepare the underdrain system design.

The flow rate of groundwater into the liner system can be calculated using a cross-sectional flow net and the following equation (Harr 1962):

$$Q = k\Delta h \frac{N_F}{N_D}$$

Where, Q = Flow rate
k = Hydraulic conductivity
Δh = Change in head

N_F= Number of flow lines
N_D= Number of equipotential head drops

An underdrain system will be installed around all perimeter sideslopes and the cell floor of Unit 2 Phase VII through XIV based on the documented presence of groundwater in the water-bearing zone (Stratum III) above the confining layer of unweathered claystone (Stratum IV). Note that the critical hydraulic capacity of the sideslope underdrain occurs in Phase XII where the difference between the seasonal high groundwater table (SHGT) elevation (approximately 698.4 feet mean sea level (ft msl)) and the elevation of the bottom of the clay liner (approximately 648.3 ft msl) in the northwestern slope is the highest (i.e., water head = 50.2 ft). The elevation of top of Stratum IV (i.e., confining layer) at this location is 642.1 ft msl. For the cell floor, the critical hydraulic capacity occurs in Phase XIV where the lateral flow could potentially be encountered along three exterior perimeter sideslopes of that cell, and with a maximum water head of 48.9 ft, 38.1 ft, and 43.8 ft. Although the hydraulic capacity required at other points along the sideslope and the cell floor liner of Phase VII through XIV varies and would be less than this critical case, an underdrain system design based on the critical case is presented herein, to be used throughout the sideslope and cell floor locations of Unit 2 Phase VII through XIV. This calculation is performed under the assumption that a continuous column of groundwater is present above the top of the confining layer all the way up to the SHGT. This is believed to be conservative because the SHGT in the Unit 2 expansion area for which these calculations pertain is a calculated surface that is substantially higher than observed groundwater levels to-date; and also, because site investigation observations during drilling and construction activities over time have revealed that there does not appear to be a continuous saturated zone across the site throughout the materials above the confining layer.

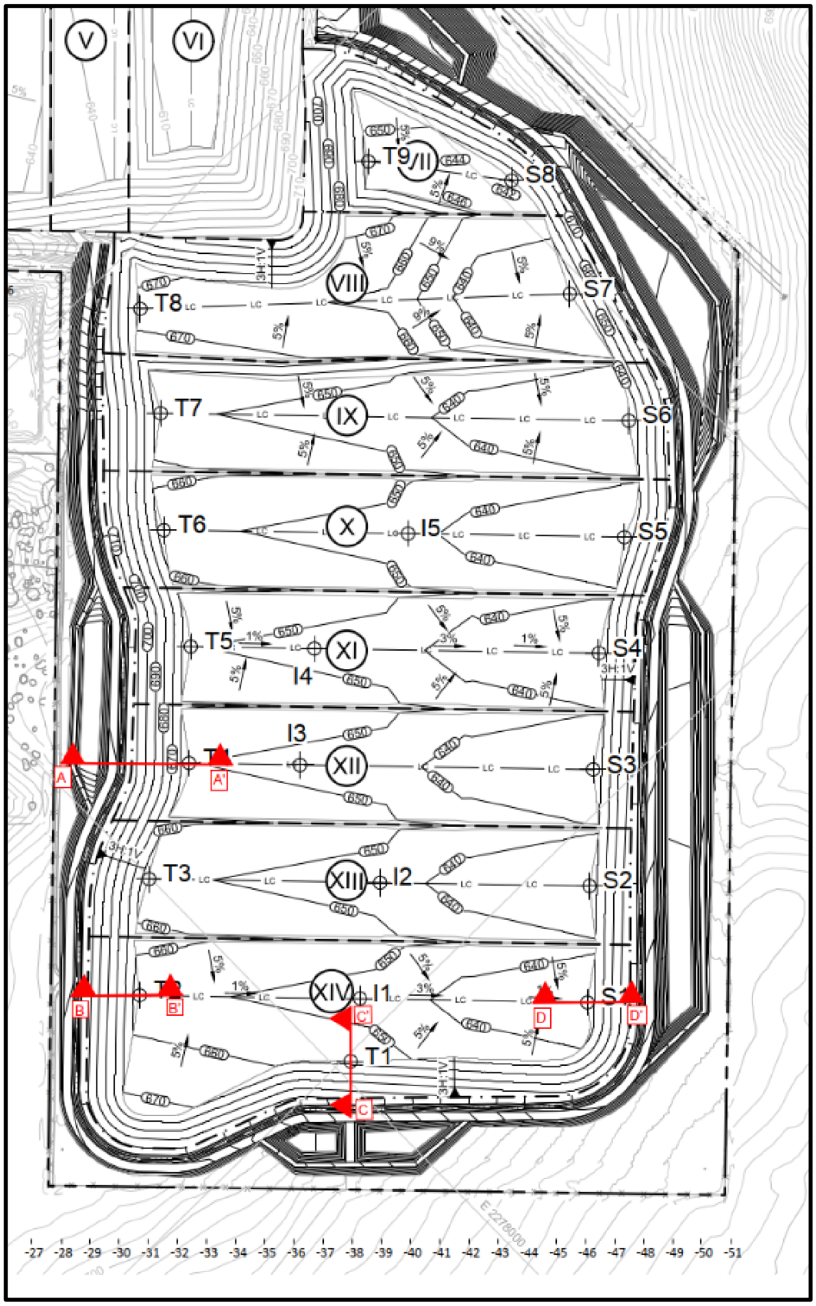

Figure 1: Critical Sections for Underdrain System Design in Phase VII through Phase XIV

Step 1: Hydraulic Conductivity Estimation and Flow Net Construction

For the cases where horizontal permeability is not equal to vertical permeability (i.e., anisotropic condition), the equivalent cross-sectional hydraulic conductivity, $k_{equivalent}$ given by the following equation is used:

$$k_{equivalent} = \sqrt{k_{horizontal} k_{vertical}}$$
$$= \sqrt{(2.5 \times 10^{-6})(4.2 \times 10^{-9})}$$
$$= 1 \times 10^{-7} \text{ cm/s} = 1 \times 10^{-9} \text{ m/s}$$

where $k_{horizontal} = 2.5 \times 10^{-6}$ cm/s from slug test results and $k_{vertical} = 4.2 \times 10^{-9}$ cm/s from laboratory tests.

Because the results obtained from slug tests offer an estimation of the hydraulic conductivity in the horizontal direction and representative of the in-situ permeability at the field-scale, they were utilized in the calculations presented herein.

Additionally, the coordinate system in the horizontal or x direction was transformed to a coordinate system equivalent to the vertical coordinates to develop a flow net for anisotropic conditions. The relationship between the actual x coordinates and the transformed x or x' coordinates is (Harr 1962):

$$x' = x\sqrt{\frac{k_{vertical}}{k_{horizontal}}} = x\sqrt{\frac{4.2 \times 10^{-9}}{2.5 \times 10^{-6}}} = 0.04\,x = \frac{1}{25}\,x$$

Based on the calculation above, coordinates in the x direction will be reduced by 1/25 of their actual value when drawn on a flow net. For example, if one inch is equal to 10 feet in the vertical (z) direction, then one inch is equal to 250 feet in the x direction. Figure 2a through 2d presents the flow nets for the analyzed sections, with this exaggeration reflected (which distorts the vertical direction and exaggerates the appearance of the liner sideslope angle).

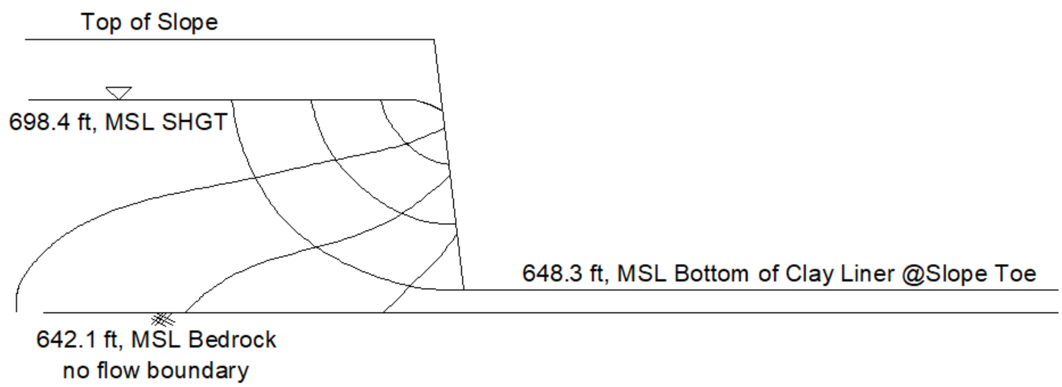

Figure 2a: Flow Net for Section A-A' (at evaluation point T4)

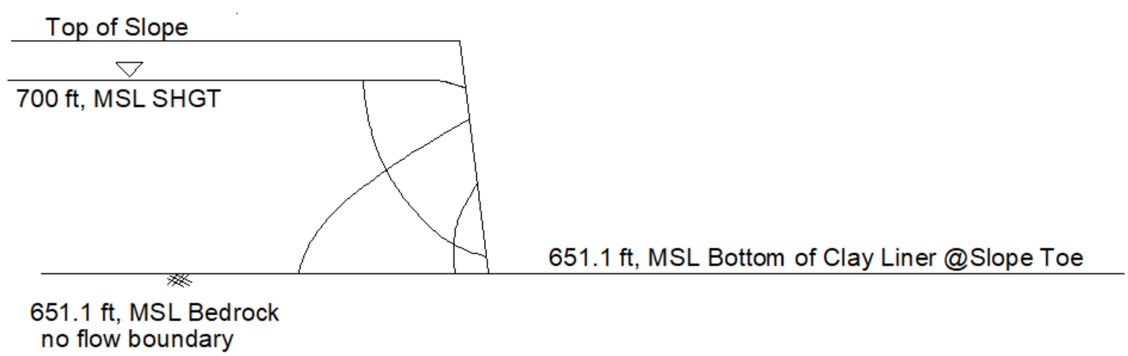

Figure 2b: Flow Net for Section B-B' (at evaluation point T2)

Written by: **P. Pandey** Date: **7/19/2023** Reviewed & Revised by: **S. Graves** Date: **8/3/2023; 2/7/2024**

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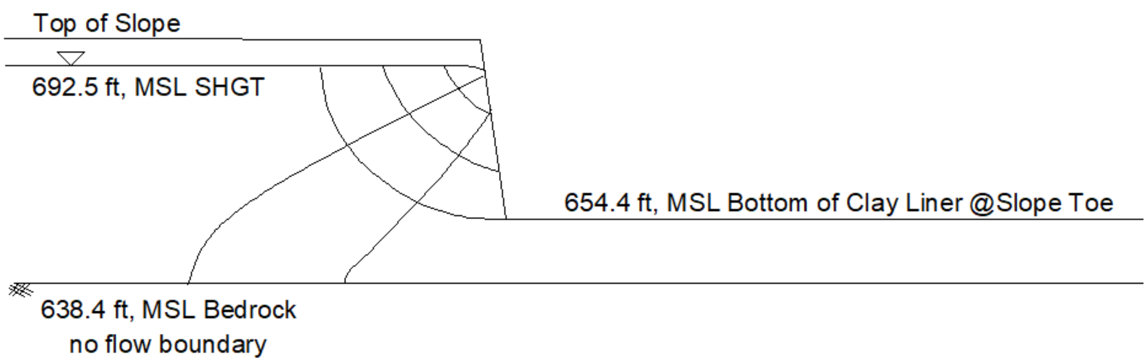


Figure 2c: Flow Net for Section C-C (at evaluation point T1)

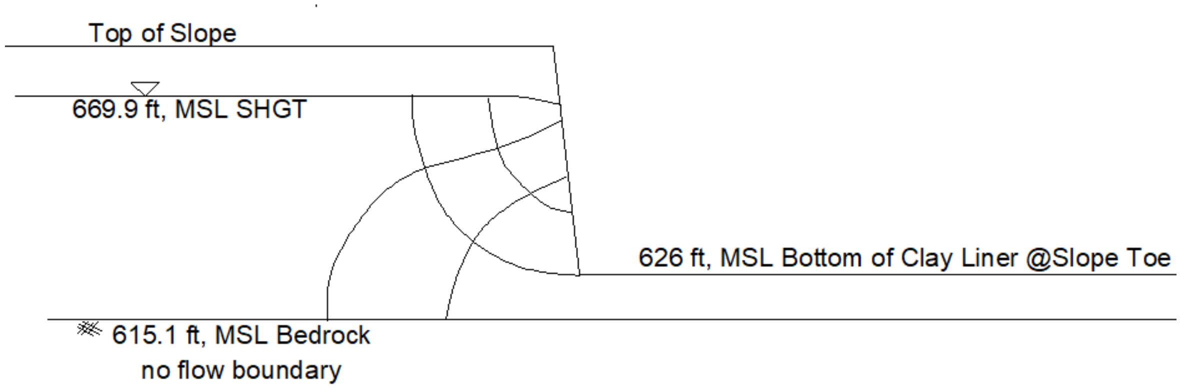


Figure 2d: Flow Net for Section D-D' (at evaluation point S1)

Step 2: Estimation of Sideslope and Cell Floor Flow Rate

a. Critical Sideslope Inflow Rate (From Section A-A' – Figure 2a)

Flow depth (Δh) = 698.4 ft – 648.3 ft = 50.1 ft = 15.28 m

No. of flow channels allowing seepage to the side slope, $N_{F,\ side\ slope} = 3$

No. of equipotential head drops, $N_D = 4$

$$Q_{IN,sideslope} = k\Delta h \frac{N_F}{N_D}$$

$$Q_{IN,sideslope} = 1 \times 10^{-9} \frac{m}{s} \times 15.28 \times \frac{3}{4}$$

$$Q_{IN,sideslope} = 1.15 \times 10^{-8}\ m^3/s \text{ per meter of slope}$$

b. <u>Critical Cell floor Inflow Rate (From Section B-B', C-C' and D-D'- Figure 2b through 2d)</u>

I. Inflow from Northwestern Slope (Section B-B')

Flow depth (Δh) = 700 ft – 651.1 ft = 48.9 ft = 14.91 m

No. of flow channels allowing seepage to the cell floor, $N_{F,\ cell\ floor} = 0$

$$Q_{IN,I,cell\ floor} = 0$$

II. Inflow from Western Slope (Section C-C')

Flow depth (Δh) = 692.5 ft – 654.4 ft = 38.1 ft = 11.62 m

No. of flow channels allowing seepage to the cell floor, $N_{F,\ cell\ floor} = 1$

No. of equipotential head drops, $N_D = 3$

$$Q_{IN,sideslope} = k\Delta h \frac{N_F}{N_D}$$

$$Q_{IN,sideslope} = 1 \times 10^{-9} \frac{m}{s} \times 11.62 \times \frac{1}{3}$$

$$Q_{IN,II,cell\ floor} = 3.87 \times 10^{-9}\ m^3/s \text{ per meter of slope}$$

III. Inflow from Southeastern Slope (Section D-D')

Flow depth (Δh) = 669.8 ft – 626 ft = 43.8 ft = 13.3 m

No. of flow channels allowing seepage to the cell floor, $N_{F,\ cell\ floor} = 1$

No. of equipotential head drops, $N_D = 3$

$$Q_{IN,sideslope} = k\Delta h \frac{N_F}{N_D}$$

$$Q_{IN,sideslope} = 1 \times 10^{-9} \frac{m}{s} \times 13.3 \times \frac{1}{3}$$

$$Q_{IN,III,sideslope} = 4.43 \times 10^{-9}\ m^3/s \text{ per meter of slope}$$

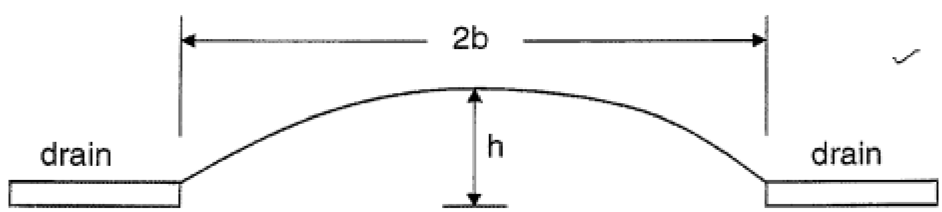
Total cell inflow rate $Q_{IN,cell\ floor} = (3.87 \times 10^{-9}\ m^3/s) + (4.43 \times 10^{-9}\ m^3/s) = 8.3 \times 10^{-9}\ m^3/s$ per meter of slope.

<u>Step 3</u>: Underdrain Spacing and Required Flow Rate Estimation

The spacing of the underdrain geocomposite strips is determined using the following equation (Cedergren, 1967):

$$Q = k\,\frac{h^2}{b}$$

Where Q =volumetric flow rate per unit width; k = hydraulic conductivity; h = driving head; and b = maximum length of drainage path as shown in the sketch below:



a. <u>Sideslope Underdrain Design</u>

Based on the cross-sectional flow nets, the maximum flow to the side slope is $1.15 \times 10^{-8}\ m^3/s$ per meter of slope. The spacing of the underdrain strips is designed in such a way that the allowable excess head (or the uplift head) is adequately resisted by the weight of the liner system (compacted clay and protective cover) (i.e., with a F.S of 1.2). It is noted that the protective cover will be 2.1 ft thick in the vertical direction on the sideslope, with a selected unit weight of approximately 96 pcf. Likewise, compacted clay will be 2.1 ft thick in the vertical direction on the sideslope, with the selected unit weight of approximately 120 pcf. Therefore, the allowable uplift head is given by:

$$h = \frac{2.1 \times 96 + 2.1 \times 120}{1.2 \times 62.4} = 6.05 \text{ ft} = 1.84 \text{ m}$$

Therefore, maximum drainage path:

$$b = k\,\frac{h^2}{Q} = 2.5 \times 10^{-8}\, m/s \times \frac{1.84^2}{1.15 \times 10^{-8}\, m^3/s} = 7.36 \text{ m}$$

Because the flow path of the groundwater from the subsurface to the underdrain strips will primarily be in the horizontal plane, the horizontal hydraulic conductivity of Stratum III was used for the calculation of spacing.

The maximum spacing (edge-edge) of the geocomposite strips on the sideslope is twice the maximum drainage path length, therefore:

Maximum spacing of geocomposite Strips = 2 × 7.36 m = 14.7 m ≈ 14.5 m (i.e., 47.6 ft maximum edge-to-edge spacing). Note that the engineering drawings in Part III, Attachment 3A and Figure 4 at the end of this package show a 45 ft (i.e., 13.7 m) maximum edge-to-edge spacing (the spacing was rounded down slightly for convenience/practicality).

Each geocomposite drainage strip will accept a fraction of the total flow to the sideslope. Assuming the flow to the sideslope is uniformly distributed, each drainage strip will drain a sideslope area with a length equal to the length of the sideslope (assumed for conservatism although the entire slope may not have water in its perimeter sideslope) in Phase XII and a width equal to the width of the strip plus the distance to the adjacent drainage strip. Assuming the width of the underdrain strip as 7 ft (i.e., 2.1 m), the required flow capacity of the geocomposite drainage strip is:

$Q_{IN,\ sideslope\ strip} = Q_{IN,\ sideslope} \times (2b + w) = 1.15 \times 10^{-8}\, m^3/s \times (13.7 + 2.1)$

$Q_{IN,\ sideslope\ strip} = 1.82 \times 10^{-7}\, m^3/s$

b. Cell Floor Underdrain Design

Based on the cross-sectional flow nets, the maximum flow to the cell floor of Phase XIV is $8.35 \times 10^{-9}\, m^3/s$ per meter of side slope. Because the cell floor will be graded at 5% and sloped towards the centerline, the underdrain strips are recommended to be placed accordingly (i.e., sloped at 5% allowing the incoming water to be drained to the centerline drain which will be installed beneath the liner system, aligned under the leachate corridor). The flow into the centerline drain will ultimately be directed to the underdrain sump constructed at the lowest point of the cell (see Figures 3 and 4). The required hydraulic capacity calculated for the floor geocomposite strips is presented below:

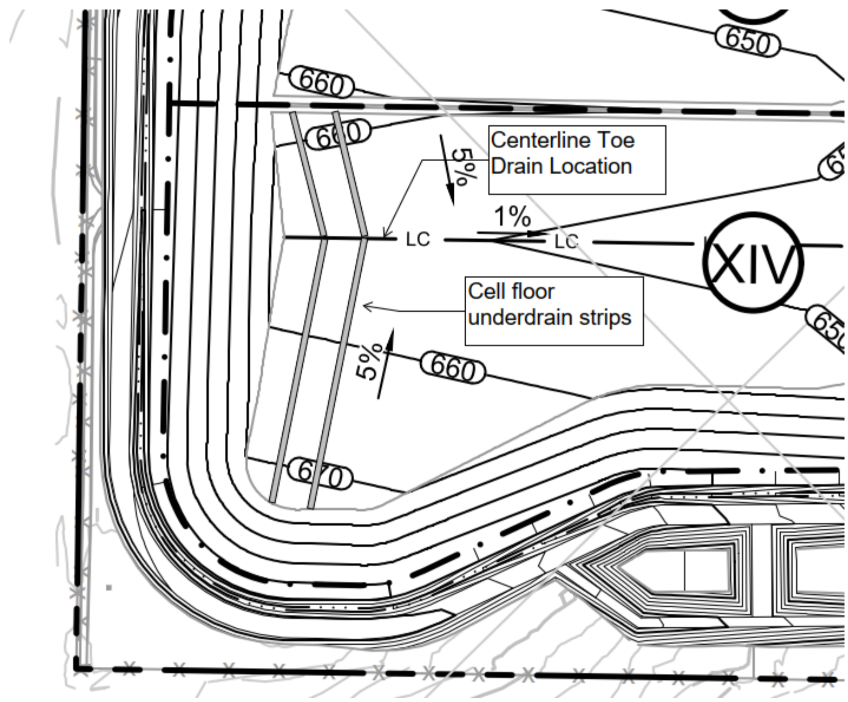


Figure 3. Cell floor – example of underdrain strips layout

[Note – in Figure 3, the underdrain strip locations are examples of a couple of adjacent strips to portray the concept. The strips would then repeat in this manner throughout the rest of the cell floors (to provide complete cell floor coverage in evenly spaced strips), according to the required spacing calculated herein. Please see attached Figure 4 at the end of this calculation package for an example underdrain system layout for a full cell.]

$Q_{\text{total, cell floor}} = 8.3 \times 10^{-9}\ m^3/s \times 781.5$ m (exterior toe perimeter= 2562.3 ft)

Written by: **P. Pandey** Date: **7/19/2023** Reviewed Revised by: **& S. Graves** Date: **8/3/2023; 2/7/2024**

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$Q_{\text{total, cell floor}} = 6.48 \times 10^{-6}\ m^3/s$

Assuming the flow is distributed uniformly throughout the cell floor, inflow into the bottom of liner system on either side of the centerline gravel drain is equivalent to the half of the total inflow:

$$Q_{\text{half, cell floor}} = \frac{6.48\times 10^{-6}\ m^3/s}{2}\frac{m^3}{s} = 3.24 \times 10^{-6}\ m^3/s$$

Therefore, volumetric flow per unit width of centerline from each side of the cell is given by:

$$Q_{\text{IN, centerline}} = \frac{3.24\times10^{-6}\ m^3/s}{length\ of\ centerline\ toe\ drain\ (468.6\ m)}$$

$Q_{\text{IN, centerline}} = 6.91 \times 10^{-9}\ m^3/s$ per m of centerline drain

where, length of centerline drain= 1536.5 ft ≈ 468.6 m

As stated earlier, the spacing of the underdrain strips is designed in such a way that the allowable excess head (or the uplift head) is well resisted by the weight of the liner system (compacted clay and protective cover) with a F.S of 1.2. Therefore, the allowable uplift head from 2 ft thick protective cover and 2 ft compacted clay in the cell floor with the corresponding unit weight of 96 pcf and 120 pcf, respectively is given by:

$$h = \frac{2\times96+2\times120}{1.2\times62.4} = 5.77\text{ ft} = 1.76\text{ m}$$

Therefore, maximum drainage path:

$$b = k\ \frac{h^2}{Q} = 2.5\ \times 10^{-8}\ m/s\ \times \frac{1.76^2}{6.91\times10^{-9}\ m^3/s} = 11.2\text{ m}$$

Because the flow path of the groundwater from the subsurface to the underdrain strips will primarily be in the horizontal plane, the horizontal hydraulic conductivity of Stratum III was used for the calculation of spacing.

The maximum spacing (edge-edge) of the geocomposite strips on the floor is twice the maximum drainage path length, therefore:

Maximum spacing of geocomposite strips = 2 × 11.2 m = 22. 4 m ≈ 22 m on each side of the centerline (i.e., 72.2-ft maximum edge-to-edge spacing). Note that the engineering drawings in Part III, Attachment 3A and Figure 4 at the end of this package show a 72 ft (i.e., 21.9 m) maximum edge-to-edge spacing (the spacing was rounded down slightly for convenience/practicality).

Each geocomposite drainage strip will drain a fraction of total flow from each half of the cell into the centerline drain. Assuming the flow is uniformly distributed, each drainage strip will drain a floor area with a length equal to average length of the strip and width equal to width of the strip plus the distance to the adjacent drainage strip. Assuming the width of the underdrain strip as 7 ft (i.e., 2.1 m), the required flow capacity of the floor geocomposite drainage strip is:

$$Q_{IN,\ cell\ floor\ strip} = Q_{IN,\ centerline} \times (2b + w) = 6.91 \times 10^{-9}\ m^3/s \times (21.9 + 2.1)$$

$$Q_{IN,\ cell\ floor\ strip} = 1.66 \times 10^{-7}\ m^3/s$$

Step 4: The minimum baseline product transmissivity of geocomposite (θ_{GC}) required to convey the maximum flow calculated in Step 3 is computed based on the required flow rate (Q_{GC}) and thickness (t) of the geocomposite (Koerner, 2005). The overall FS for the design is defined as the ratio of the allowable flow rate (Q_{allow}) to the required flow rate obtained from design of the actual system ($Q_{required}$):

$$FS = \frac{Q_{allow}}{Q_{required}}$$

$$Q_{allow} = Q_{GC} \frac{1}{(RF_{CR} \times RF_{CC} \times RF_{BC})}$$

Thus,

$$Q_{GC} = (Q_{required} \times FS) \times (RF_{CR} \times RF_{CC} \times RF_{BC})$$

where:

FS = 2.0 (overall factor of safety for design)

$Q_{required}$ = 9.89×10^{-8} (Maximum inflow rate calculated in Step 3)

RF_{CR} = 1.5 (reduction factor for creep deformation)

RF_{CC} = 1.2 (reduction factor for chemical clogging)

RF_{BC} = 1.2 (reduction factor for biological clogging)

$$Q_{GC} = (\ 1.82 \times 10^{-7}\ m^3/s \times 2) \times (1.5 \times 1.2 \times 1.2)$$

$$Q_{GC} = \quad 7.86 \times 10^{-7} m^3/s$$

Assuming thickness of typical geocomposite as 0.2 inches (0.005 m), the transmissivity is given as:

$$\theta_{GC} = \frac{Q_{GC}}{t} = \frac{7.86\times10^{-7} m^3/s}{0.005\ m} = \quad 1.6 \times 10^{-4}\ m^2/s$$

Therefore, the geocomposite (including geotextiles bonded to the geonet core) to be used for design should have a minimum θ_{GC} (transmissivity at 100-hours when placed between two steel plates and subjected to the expected normal stress and gradient) greater than 1.6×10^{-4} m^2/s. Further, the geocomposite should be able to provide this transmissivity at a minimum stress of 8,912 psf (based on the maximum case with about 111.4 ft of waste required to provide the necessary ballast, and a waste unit weight (γ_{waste}) of 80 pcf) [conservatively using same γ_{waste} as is used for settlement analysis rather than the 44 pcf used in the liner uplift calculations solely for computation of stress purposes for establishing the transmissivity condition]. Geocomposite products can readily achieve this minimum θ_{GC} value.

Manufacturers of geocomposite drainage materials often present the hydraulic capacities of their product by reporting the transmissivity between two steel plates for a short duration (i.e., 15-minute) test. These index transmissivities (θ_{INDEX}) are usually higher than those obtained using the site-specific boundary condition of soil on both sides of the geocomposite because the steel plates provide minimal amounts of intrusion into the drainage layer. To compare the specified θ_{GC} of the underdrain drainage layer with θ_{INDEX} reported by the manufacturer, a reduction factor can be applied to θ_{GC} to account for geotextile intrusion into the geonet core of the geocomposite. The index transmissivity, θ_{INDEX}, which accounts for intrusion can be estimated as:

$$\theta_{INDEX} = \theta_{GC} \times RF_{INT}$$

where:
RF_{INT} = 1.5 (reduction factor for geotextile intrusion).

$$\theta_{INDEX} = 1.6 \times 10^{-4} \frac{m^2}{s} \times 1.5 = 2.4 \times 10^{-4}\ m^2/s$$

[Note: nothing in this calculation precludes installation of a geocomposite drainage layer having greater transmissivity than the minimum value computed herein (for example, it may be practical to use the same geocomposite drainage layer product and material specifications (per the LQCP) as will be used for the leachate collection drainage layer, provided that it meets or exceeds the minimum transmissivity for the underdrain, as indicated herein).]

Step 5: Gravel Toe Drain and Centerline Drain Inflow Rates

The underdrain system will include a 2 ft x 1 ft gravel drain installed along the interior toe of the perimeter sideslopes (referred to as sideslope toe drain) and along the centerline of cell floor (referred to as centerline drain) [illustrated on the landfill design drawing details in Part III, Attachment 3A]. These drains are designed to collect and convey the incoming water from the geocomposite strips installed at the side slopes and cell floor to a designated low point (underdrain sump) of the respective cell.

The peak flow rate through the gravel drains occurs in Phase XIV, where the maximum number of underdrain strips are placed to facilitate inflow from the water bearing zone and are contributing to the flow through the gravel drains. Consequently, the calculation of the maximum flow through the centerline drain is based on the estimated flow through 15 underdrain strips spaced at 45 ft max edge-edge spacing in the sideslope and 42 underdrain strips spaced at 72 ft max edge-edge spacing in the cell floor. Likewise, the maximum flow for the sideslope toe drain occurs along the longest flow path on the southwest perimeter slope through 40 underdrain strips positioned with a maximum edge-edge spacing of 45 ft. The maximum flow is estimated as below:

$$Q_{,max} = \left(N_{sideslope}\ X\ Q_{IN,sideslope\ \ strip}\right) + \left(N_{cell\ floor}\ X\ Q_{IN,cell\ floor\ \ strip}\right)$$

where $Q_{,max}$ = Maximum flow through gravel toe drain

$N_{sideslope}$= Number of contributing sideslope strips

$N_{cell\ floor}$= Number of contributing cell floor strips

$Q_{IN,sideslope\ \ strip}$ = Flow through sideslope underdrain strip

$Q_{IN,cell\ floor\ \ strip}$ = Flow through cell floor underdrain strip

Therefore

$$Q_{Sideslope\ toe\ drain,\ \ max} = 40\ X\ (1.82 \times 10^{-7}\frac{m^3}{s})$$

$$= 7.28 \times 10^{-6}\ m^3/s\ (0.115\ gpm)$$

$$Q_{Centerline\ \ drain,\ \ max} = 15\ X\ (1.82 \times 10^{-7}\frac{m^3}{s}) + 42\ X\ (1.66 \times 10^{-7}\frac{m^3}{s})$$

$$= 9.71 \times 10^{-6}\ m^3/s\ (0.154\ gpm)$$

The underdrain system layout for Unit 2, Phase XIV is presented in Figure 4 of this calculation package. This is the largest cell and thus was used as the basis for design. The layout shown on Figure 4 is given as an example, and these features, spacing, and layout approach will similarly apply to all cells in the Unit 2 expansion area (Phases VII through XIV).

Step 6: Centerline and Sideslope Toe Drain Flow Capacity Analysis

These drains are designed to have 1% (min) slope towards the low points and will consists of a clean coarse gravel as a drainage media (same aggregate as will be used for the leachate collection corridors and sumps, as specified in the Liner Quality Control Plan), encased within a geotextile filter. The hydraulic conductivity of clean coarse gravel is ranges from about 1 to 100 cm/s, with a logarithmic average of 10 cm/s (Das, 2011; Holtz and Kovacs, 1981). For the analysis presented herein, the average value of 10 cm/s was reduced by a factor of 10, to use the lower-bound value of 1 cm/s. This assumption is considered reasonable as it not only provides substantial safety margin from the typically observed permeability of clean gravel but also reflects the lower end of the permeability range.

The flow capacity of the gravel drain is determined as

$$Q = k\,I\,A$$
$$Q = \left(1\,\frac{cm}{s} \times \frac{1\,m}{100\,cm}\right) \times (0.01) \times \left(2\,ft\,X\,\frac{0.3048\,m}{1\,ft}\right) X \left(1\,ft\,X\,\frac{0.3048\,m}{1\,ft}\right)$$
$$Q = 1.85 \times 10^{-5}\,m^3/s\ (0.29\,gpm)$$

Where Q = Flow through gravel drainage media
k = Hydraulic conductivity of drainage media = 1 cm/s
I = Hydraulic gradient (equivalent to the minimum slope) = 0.01
A = Cross sectional area of gravel drain

Comparison between the estimated maximum total flow through the sideslope toe drain (0.115 gpm) vs. the gravel drain capacity at 1% slope (0.29 gpm) reveals that the gravel toe drain has adequate hydraulic capacity to convey the maximum estimated maximum toe drain flow.

Similarly comparison between the estimated maximum total flow through the centerline drain (0.154 gpm) vs. the gravel drain capacity at its minimum 1% slope (0.29 gpm) reveals that the gravel centerline drain has adequate hydraulic capacity to convey the maximum estimated maximum centerline drain flow.

Step 7: The underdrain sump at the site will have dimensions of 3 ft depth, 10 ft width, and 10 ft length. Then:

$$Volume\ of\ sump\ (V) = 3 \times 10 \times 10 = 300\ ft^3$$

Assuming porosity of soil as 0.3, the flow is expected as:

$$Sump\ capacity = 300\ ft^3 \times 0.3 = 90\ ft^3\ (670\ gallons)$$

Time to fill sump, $t = \frac{670\ gallons}{(0.115+0.154)\ gpm} = 2481.5\ minutes$ ($\approx$ 41 hours)

As an example, for pump sizing, using a pump with pumping rate of 20 gpm, the time to empty the sump is 33.5 minutes. So, for this example, approximately one pump cycle in a 20 hours interval would be required to empty the temporary dewatering sump at the facility.

4. CONCLUSION

To collect seepage from the water bearing zones control buildup of hydraulic heads beneath the liner system, temporary underdrain systems as presented above will be used in Phase VII through XIV until sufficient ballast has been placed.

Engineering details presenting the underdrain system design, consistent with the spacing/layout presented herein, are provided in Part III, Attachment 3A (Landfill Design Drawings). Also, the underdrain components (geocomposite, drainage aggregate, etc.) should meet the material properties (and be installed) as set forth in the Liner Quality Control Plan (Part III, Attachment 3C).

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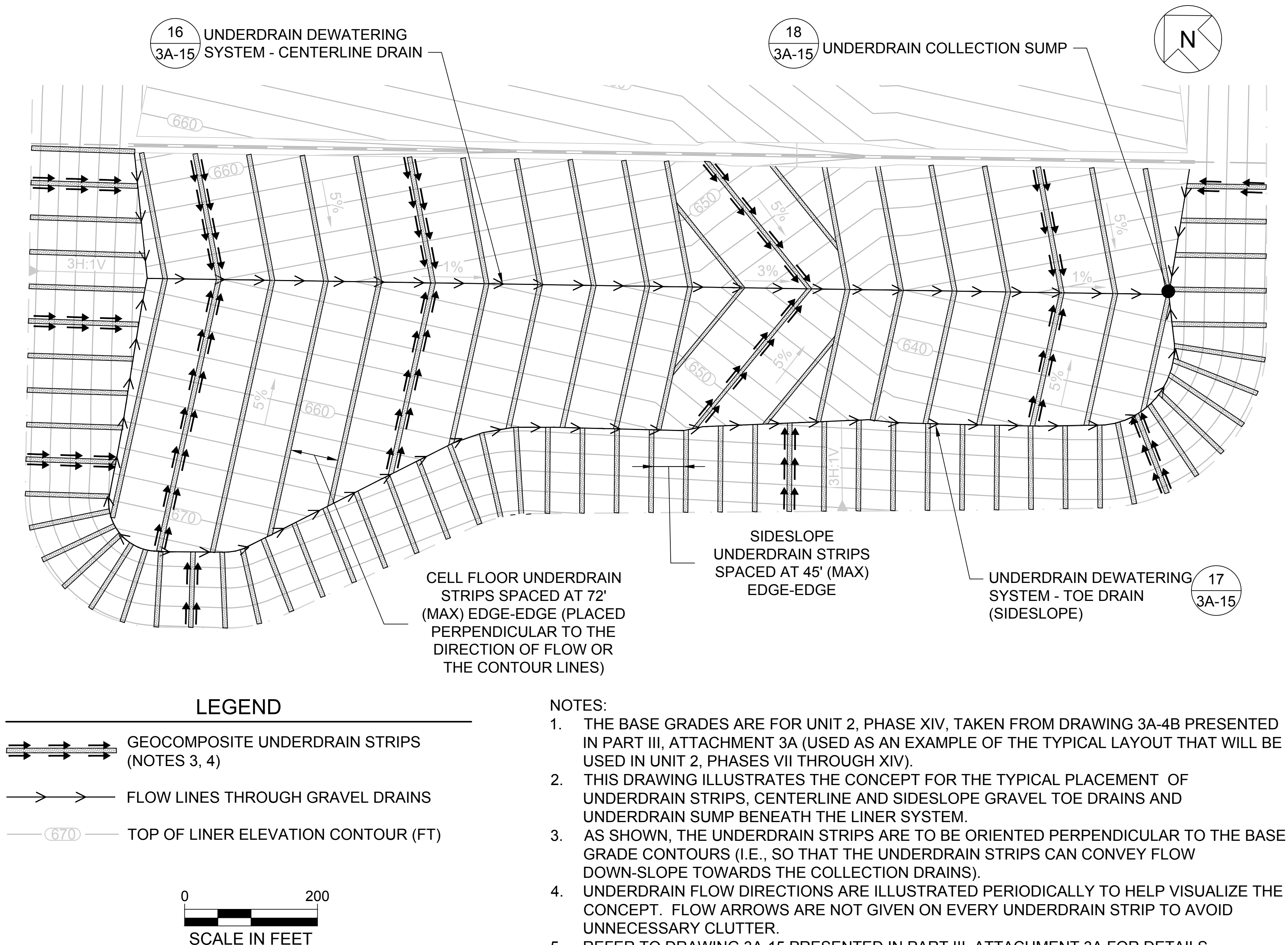

NOTES:

1. THE BASE GRADES ARE FOR UNIT 2, PHASE XIV, TAKEN FROM DRAWING 3A-4B PRESENTED IN PART III, ATTACHMENT 3A (USED AS AN EXAMPLE OF THE TYPICAL LAYOUT THAT WILL BE USED IN UNIT 2, PHASES VII THROUGH XIV).
2. THIS DRAWING ILLUSTRATES THE CONCEPT FOR THE TYPICAL PLACEMENT OF UNDERDRAIN STRIPS, CENTERLINE AND SIDESLOPE GRAVEL TOE DRAINS AND UNDERDRAIN SUMP BENEATH THE LINER SYSTEM.
3. AS SHOWN, THE UNDERDRAIN STRIPS ARE TO BE ORIENTED PERPENDICULAR TO THE BASE GRADE CONTOURS (I.E., SO THAT THE UNDERDRAIN STRIPS CAN CONVEY FLOW DOWN-SLOPE TOWARDS THE COLLECTION DRAINS).
4. UNDERDRAIN FLOW DIRECTIONS ARE ILLUSTRATED PERIODICALLY TO HELP VISUALIZE THE CONCEPT. FLOW ARROWS ARE NOT GIVEN ON EVERY UNDERDRAIN STRIP TO AVOID UNNECESSARY CLUTTER.
5. REFER TO DRAWING 3A-15 PRESENTED IN PART III, ATTACHMENT 3A FOR DETAILS PERTAINING TO THE UNDERDRAIN SYSTEM.

Figure 4. Typical Underdrain Layout

ATTACHMENT 3E

LEACHATE AND CONTAMINATED WATER MANAGEMENT PLAN

PART III – ATTACHMENT 3E
LEACHATE AND CONTAMINATED WATER MANAGEMENT PLAN

MESQUITE CREEK LANDFILL
COMAL AND GUADALUPE COUNTIES, TEXAS
PERMIT AMENDMENT APPLICATION
MSW PERMIT NO. 66C

Prepared for:
Waste Management of Texas, Inc.

Prepared by:

Geosyntec consultants

Texas Board of Professional Engineers Firm Registration No. F-1182
8627 N Mopac Expy, Suite 300
Austin, Texas 78759
(512) 451-4003

STATE OF TEXAS
SCOTT M. GRAVES
86557
LICENSED
PROFESSIONAL ENGINEER

4/15/2024

FOR PERMIT PURPOSES ONLY

Submitted October 2023
Revised February 2024; April 2024

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GEOSYNTEC CONSULTANTS, INC.
TEXAS ENG. FIRM
REGISTRATION NO. F-1182

TABLES

ATTACHMENTS

STATE OF TEXAS
SCOTT M. GRAVES
86557
LICENSED PROFESSIONAL ENGINEER

4/15/2024

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1. INTRODUCTION

1.1 Purpose and Scope

The purpose of this Leachate and Contaminated Water Management Plan is to describe how leachate and contaminated water (as well as gas condensate) generated at the Mesquite Creek Landfill (the facility) will be managed. The plan provides information on the collection, removal, transmission, storage, and disposal of these wastewaters generated during the active (including final closure) and post-closure periods of the landfill. Specifically, this plan addresses the following:

- leachate, gas condensate, and contaminated water generation and management;
- leachate collection system design and operation, including:
  - components and layout;
  - drainage media design and performance (including depth of leachate over the liner);
  - collection pipe design (hydraulic capacity, resistance to clogging, strength);
  - sump design;
  - chemical resistance and long-term durability;
- leachate removal system design and operation;
- leachate, gas condensate, and contaminated water storage;
- leachate and gas condensate recirculation;
- leachate, gas condensate, and contaminated water disposal; and
- long-term performance (including design and operating provisions).

1.2 Leachate Management System Drawings

A series of drawings presenting the layout of the leachate management system and details on its design features and components are provided on Drawings 3E-1A through 3E-9 included in Attachment 3E.1 of this plan.

2. LEACHATE, GAS CONDENSATE, AND CONTAMINATED WATER GENERATION

2.1 Definitions and Overview of Generation Process

Leachate is a liquid that has passed through or emerged from solid waste and contains soluble, suspended, or miscible materials removed from such waste. The general process for leachate generation is water from precipitation infiltrating into the landfill and percolating through the waste. As such, leachate is generated in the normal course of operations of a municipal solid waste landfill; and the quantity of leachate produced depends on the climate, type of cover and associated management practices, grading/layout/topography of the landfill, construction and landfilling sequence and procedures, cover material characteristics, and waste characteristics.

Gas condensate is the liquid generated as a result of any gas recovery process at a municipal solid waste facility. In general, gas condensate liquid is generated as water vapor contained within the landfill gas condenses within a landfill gas collection system.

Contaminated water is leachate, gas condensate, or water that has come into contact with waste. For example, contaminated water is generated when stormwater runoff comes into contact with solid waste at the active working face of the landfill. As stated by 30 TAC §330.165(a) and (c), stormwater runoff from areas that have intact daily cover or intact intermediate cover is not considered as having come into contact with the working face or leachate (i.e., is not contaminated water).

2.2 Leachate Generation

Modeling of leachate generation rates was performed using the Hydrologic Evaluation of Landfill Performance (HELP) computer model (Version 3.95 D) developed by Dr. Klaus Berger of the University of Hamburg, Institute of Soil Science and the U.S. Army Corps of Engineers, Waterways Experiment Station (Berger and Schroeder, 2013) as a windows-based program that maintains consistency with the methodology of U.S. Environmental Protection Agency (USEPA) HELP model version 3.07 (Schroeder et al., 1994a, 1994b).

The HELP program is a quasi two-dimensional hydrologic model of water movement across, into, through, and out of landfills. The program accepts climatologic, soil, and design data, and uses a solution technique that accounts for the effects of surface storage, runoff, infiltration, evapotranspiration, soil moisture storage, and vertical and lateral drainage.

Leachate generation was evaluated using HELP for active (initial and intermediate) and closed/post-closure landfill conditions. Operating conditions with and without leachate recirculation were considered. An explanation of the landfill scenarios that were analyzed, a description of the input parameters that were used, and printouts of HELP model output are included in Attachment 3E.2 (Leachate Generation Rates and Head on Liner (HELP Model

Calculations)). The analyses demonstrate that the leachate collection system is designed to maintain less than a 30-centimeter depth of leachate over the liner, and the results are used to design and develop specifications for the geocomposite drainage layer (discussed subsequently).

2.3 Surface Water Generation and Management (Including Contaminated Water)

Throughout the life of the facility, best management practices will be used to manage surface water, minimize its potential to come into contact with waste, and minimize contaminated water generation at the facility. Also, leachate and gas condensate will be collected and segregated from surface water to minimize contaminated water generation at the facility, using the techniques and measures for leachate and gas condensate management discussed throughout this plan.

2.3.1 Uncontaminated Surface Water Management

The landfill and adjacent areas will be graded with temporary and permanent drainage features to provided run-on/off controls for stormwater. Daily cover, intermediate cover, and final cover will be graded and maintained to promote runoff, minimize the area of exposed waste, and prevent ponding of surface water. Runoff from disturbed areas outside the limits of waste disposal and from landfill areas having intact daily cover, intermediate cover, or final cover is "clean" (not contaminated) and will be managed via facility's surface water management system and discharged in accordance with the facility's Texas Pollutant Discharge Elimination System (TPDES) Multi-Sector General Permit.

At the active working face, a system of temporary diversion berms will be constructed as needed to minimize the possibility of clean stormwater run-on becoming contaminated water. These temporary diversion berms will be constructed up-gradient from and adjacent to the working face with earthen material, and will route (divert) clean stormwater runoff into the surface water management system and away from the active working face. This configuration is illustrated on Drawing 3E-9, which provides requirements for sizing of the berms (which varies depending on their slope configuration and the contributing up-gradient drainage area). The design calculations for sizing of the diversion berms are provided in the On-Site Design – Active Face Surface Water Controls calculation package (Attachment 2E of the Facility Surface Water Drainage Report in Part III, Attachment 2).

2.3.2 Contaminated Water

A system of temporary containment berms will be constructed around the down-gradient portions of the active face (and situated over lined areas) to collect and contain surface water that has come into contact with waste (i.e., contaminated water). Also, similar containment berms will be constructed elsewhere at the facility wherever they are needed to collect and contain contaminated water. Drawing 3E-9 illustrates the containment berms and provides the required size of the berms (which varies depending on the size of the working face and the containment area). As mentioned, the design calculations for sizing of the diversion berms are provided in the On-Site Design –

Active Face Surface Water Controls calculation package (Attachment 2E of the Facility Surface Water Drainage Report in Part III, Attachment 2).

Contaminated water that collects at the active working face may evaporate or be absorbed into the waste and become leachate; however, contaminated water is not allowed to remain ponded, nor is it allowed to cause nuisance conditions (e.g., odors) or the attraction of vectors. The provisions of Sections 16 and 17 of the Site Operating Plan (SOP) will be followed with respect to the control of odors and vectors as it relates to increased potential caused by contaminated water. At on-site haul roads over waste, and only on such roads located over Unit 2 (which is a Subtitle D-lined landfill) areas and within interior landfill areas (not on exterior facing slopes), contaminated water is also allowed to be applied to the roads for surficial dust control (but only if the quantity is minimized to the extent that it does not recirculate into the landfill, runoff, or pond when applied). If contaminated water generation occurs in areas adjacent to the active working face or in other facility operations areas, contaminated water management measures will be implemented in a similar manner as those for the active working face.

Contaminated water at the working face and any other areas of the facility where it is generated will be removed by pumps or tanker/vacuum trucks and will be stored and disposed of as set forth in this plan. Note that recirculation of contaminated water into the waste mass is not allowed. Contaminated water (generally when in small quantities for practicality purposes) may also be taken to the on-site solidification area for solidification followed by on-site disposal of solidified material (having no free liquids) in the landfill. Storage of contaminated water is addressed in Section 5 of this plan. Off-site disposal, including prohibitions on off-site discharge, is addressed in Section 7 of this plan.

2.4 Gas Condensate Management

The facility operates a landfill gas collection and control system (GCCS), as described in Part III, Attachment 6 (Landfill Gas Management Plan). Gas condensate generated at the facility will be collected at low points in the GCCS and will be periodically removed and transferred into the leachate management system, where it will be handled in the same manner as leachate, as described subsequently in this document.

3. LEACHATE COLLECTION SYSTEM

3.1 Description of Existing Leachate Collection System

The existing landfill includes a "pre-Subtitle D" area: Unit 1, Phases I and II. Construction of the pre-Subtitle D area pre-dated the RCRA Subtitle D regulations promulgated in the early 1990s, and as such, they are built with a liner system that has a clay liner without an overlying geomembrane. Unit 1, Phase II has a leachate collection system whereby the clay liner was graded to drain towards a leachate collection pipe located on the west perimeter of the phase. Leachate can also be removed from this phase via two leachate manholes located along the pipe. A leachate pipe was also installed on the east perimeter of Unit 1, Phase II, between Phases I and II.

The remainder of the landfill (i.e., Unit 1, Phases III and V, and all of Unit 2) is designed and has been or is being constructed with a Subtitle D-compliant liner system (with composite liner and leachate collection and removal system). Unit 1 is final covered, and as such, the liner and leachate collection system for Unit 1, Phases III and V has been constructed and waste placement is complete in these phases (as well as for all of Unit 1). Note that there is no Unit 1, Phase IV. The leachate management system plan for the Subtitle D areas of Unit 1 area is shown on Drawing 3E-1A.

Additionally, the liner and leachate collection system for Unit 2, Phases I through VI-North has been constructed, and waste is currently being placed in Unit 2, Phase VI. The leachate management system plan for the Unit 2 area is shown on Drawing 3E-1B.

Each phase is equipped with a sump at the low point of the phase, where leachate removal is performed using a submersible pump that withdraws leachate and transfers it to the existing on-site leachate evaporation ponds. The remainder of this section describes the proposed leachate collection system of the proposed and to-be-constructed Unit 2, Phases VII through XIV.

3.2 Proposed System Layout and Design Details

Primarily, leachate collection at the landfill will be accomplished via the leachate collection system of drainage layers and piping that are sloped and graded to flow by gravity to low points in each phase (i.e., sumps). At the sumps, leachate will be removed and managed via storage (e.g., on-site leachate evaporation ponds or leachate storage tanks) and disposal as described subsequently in this plan.

The leachate management system plan for the Unit 2 area is shown on Drawing 3E-1B. Unit 2, Phases I through VI, will continue to operate as previously designed and constructed, collecting and draining leachate to a sump in each of these phases, where it will be pumped out consistent with current practices and as described herein. Finally, proposed Unit 2, Phases VII through XIV, will also drain leachate to a sump in each of these phases before being pumped out for management as described herein.

Engineering drawings showing the design features and details of the leachate management system are presented in Drawings 3E-2 through 3E-9. Design calculations for the leachate collection system are provided in Attachments 3E.2 through 3E.7 of this plan. Consistent with 30 TAC §330.331(a)(2) and §330.333, the layout and materials of the leachate collection system were designed (as demonstrated in Attachment 3E.2) and will be constructed to maintain less than a 30 cm (12 in.) depth of leachate over the liner.

3.3 Leachate Drainage Layer

The proposed liner system for Unit 2, Phases VII through XIV, includes a drainage layer for leachate collection, composed of a double-sided geocomposite. Liner system details are presented as part of the Landfill Design Drawings in Part III, Attachment 3A. Details specific to leachate collection on the liner are presented on the drawings in Attachment 3E.1 (e.g., Drawing 3E-3).

Leachate percolating through the waste will be collected in the drainage layer above the liner and will flow by gravity to a leachate collection corridor, sideslope chimney drain, or directly into a sump, based on the geometry and grades of each given phase. As shown on Drawing 3E-1B, the leachate collection system on the landfill floor of the proposed expansion area (Unit 2, Phases VII through XIV) slopes at 5% (minimum) towards a leachate collection corridor. The maximum drainage length along the floor is approximately 425 ft, which occurs in Phase XIV. The Unit 2, Phases VII through XIV, sideslopes are configured at 33% (3H:1V) maximum, with a maximum drainage length of approximately 210 ft along the 3H:1V sideslopes.

The HELP model was used to calculate the minimum allowable design transmissivity of the geosynthetic drainage layer based on meeting the regulatory required criterion of maintaining less than 30 cm (12 in.) of head on the liner, as described and demonstrated in Attachment 3E.2 (Leachate Generation Rates and Head on Liner (HELP Model Calculations)). No additional inflow was calculated for a hypothetical case of groundwater potentially flowing into the landfill. This was judged appropriate for this design because the landfill floor (critical location for leachate collection where it will congregate and could build up the largest head on the liner) and sideslopes will have an underdrain system installed and operating to prevent buildup of hydrostatic pressures beneath the liner during the active period of landfill operation when leachate generation rates are the highest. Furthermore, by the presence of the Subtitle D compacted clay liner and geomembrane, there would be an inability for groundwater to migrate readily into the leachate collection system to any significant degree (negligible for the purposes of the design presented herein).

A factor of safety and additional reduction factors accounting for creep, clogging, and intrusion were applied to the design transmissivity to obtain the minimum specified index transmissivity, as described in Attachment 3E.3 (Leachate Collection Geosynthetic Drainage Layer Design). By inspection of Figure 1 in Attachment 3E.3, the most critical operation condition for the geocomposite drainage layer is the intermediate condition in the new fill area, NF3; due to the change in geocomposite transmissivity as a function of stress, the critical condition occurs where the difference between required θ_{100} and measured θ_{100} is the least, not necessarily at the largest calculated transmissivity (e.g., NF1). Based on the foregoing, the resulting minimum specified transmissivity of the geosynthetic drainage layer is 6.2 x 10^{-4} m^2/s at an applied stress of at least 15,200 psf at a gradient of 0.05.

This value is used as a construction specification (incorporated into the Liner Quality Control Plan (LQCP) in Part III, Attachment 3C) for the liner system geocomposite drainage layer.

3.4 Leachate Collection Corridor and Sideslope Chimney Drain

The leachate collection corridors will receive collected leachate from the floor drainage layer and will convey it to the leachate collection sumps. As shown on Drawing 3E-1B, a leachate collection corridor is centrally located within Unit 2, Phases VII through XIV, and slopes at 1% towards a sump.

The proposed leachate collection corridor consists of a perforated 6-in. diameter high-density polyethylene (HDPE) standard dimension ratio (SDR)-11 pipe embedded within a granular drainage media encased within a geotextile filter (Drawing 3E-2). Attachment 3E.3 (Leachate Collection Geosynthetic Drainage Layer Design) presents calculations supporting the specified geotextile filter. Additionally, the structural stability (i.e., strength) of the proposed leachate collection pipe is evaluated in Attachment 3E.6 (Leachate Collection and Riser Pipe Strength Design).

The granular drainage media (i.e., coarse aggregate) of the leachate collection system must (i) have a maximum particle size less than or equal to 2 in., (ii) have a maximum percent passing #4 sieve of 10%, (iii) have a maximum percent passing #200 sieve (i.e., percent fines) of 3%, and (iv) contain less than 15% calcium carbonate. The pipe perforations have been sized to be resistant to clogging based on their diameter compared to the surrounding granular material gradation. As an additional measure to prevent clogging, the perforated pipes are surrounded by granular drainage material wrapped by a geotextile filter. The granular material will extend vertically through the protective cover layer to create a drainage pathway to allow leachate to more easily flow into the corridor. The leachate collection pipes will include cleanout access points. As shown on Drawing 3E-3, Detail 5, the sideslope riser area and riser pad will include a leachate collection system cleanout pipe that connects to and allows access to the leachate collection corridor piping.

At the toe-of-slope of the liner sideslopes, leachate chimney drains will receive and collect leachate from the sideslope drainage layer and convey it to the leachate collection corridors or the leachate collection sumps. As shown on Drawing 3E-1B, the sideslope chimney drains will be located along the toe-of-slope of sideslopes around the perimeter of the waste footprint in Unit 2, Phases VII through XIV.

Like the leachate collection corridors, the sideslope chimney drains have a minimum slope of 1%, consist of the same type of perforated 6-in. diameter HDPE SDR-11 pipe embedded within a granular drainage media wrapped by a geotextile filter, and extend vertically through the protective cover layer to create a drainage pathway (Drawing 3E-2).

The leachate collection corridors and sideslope chimney drains are designed to convey the peak daily volumetric flow rates of leachate they are expected to collect. Attachment 3E.4 (Leachate Collection Corridor and Sideslope Chimney Drain Pipe Design) presents the peak daily leachate collection rates for the leachate collection corridor and the sideslope chimney drain.

3.5 Leachate Collection Sumps

Leachate generated within each phase ultimately drains to the leachate collection sump located at the low point of the phase. The sumps are backfilled with the same granular drainage material as the leachate collection corridors. Each sump has the shape of an inverted truncated pyramid with a square base. The base dimensions are 20 ft by 20 ft, and the sump is 4 ft deep. The base of the sump slopes up to meet the floor of each phase at an angle of 3H:1V. Assuming a granular drainage material porosity of 0.3, the effective volume of the sump is 7,580 gallons. The Leachate Collection Sump Design calculations are provided in Attachment 3E.5. Design details illustrating the proposed leachate collection sumps are provided in Drawing 3E-3.

4. LEACHATE REMOVAL AND TRANSMISSION SYSTEM

4.1 Leachate Pumps and Riser Pipes

Leachate will be removed from each phase by a submersible pump lowered into a sump through an HDPE riser pipe (Drawing 3E-4). Leachate riser pipes will be located on liner sideslopes and extend up from the sumps to the landfill perimeter (Drawing 3E-1B). Riser pipe structural stability (i.e., strength) calculations are included in Attachment 3E.6. The lower portion of the riser within the sump is perforated with holes, allowing the leachate to flow to the pump in the riser. Consistent with the leachate collection corridor pipes and chimney drain pipes, the riser pipe perforations have been sized to be resistant to clogging based on their diameter compared to the surrounding granular material gradation. As an additional measure to prevent clogging, the perforated pipes are surrounded by granular drainage material wrapped by a geotextile filter. The sump riser pipes are of a large enough diameter that they can be accessed from the landfill perimeter at the riser pad and cleaned as needed.

As described previously in this plan, the leachate collection and removal system is designed and will be constructed to maintain less than a 30 cm (12 in., i.e., one foot) depth of leachate over the liner. The submersible pumps will be operated manually or automatically (e.g., through a level switch and controller system) to withdraw accumulated leachate from each sump. If automated systems are used, pressure transducers are typically used on the pumps or as an independent sensor to measure the depth of the leachate in the sump, and can be integrated with a control system to automatically trigger the level switch to maintain acceptably low leachate levels. Under this method, the pumps are set to switch on and off at desired depths to provide for a pump operating range, while maintaining acceptably low leachate levels. The maximum (highest) pump-on level should be set at the elevation of the lip (i.e., top) of the sump so as to maintain free drainage conditions of the leachate collection system drainage layer beyond the sump, and consistent with the basis of design to maintain a maximum head buildup outside of the sump of less than one foot. Based on the sump design (e.g., see Drawing 3E.3), the lip of the sump is 4-ft above the base of the sump, using the top of geomembrane liner around the top edge of the sump as the basis for this measurement. The pump-off level should be set at a desired low depth at an elevation somewhat higher than the base of the sump (e.g., typically set at an elevation just above the intake of the pump based on pump manufacturer's recommendations).

Inspections of the leachate pump control systems (to verify the pumps are operable and to check head levels (i.e., leachate depths) will be conducted at the frequency indicated in Section 8.2.

Note that the sump capacity and pumping scenario presented in Attachment 3E.5 were performed using an assumed operating range consistent with this description (which is intended to demonstrate functionality of the design under a hypothetical but reasonable representation of a typical operating range consistent with the foregoing). Under manual operation mode, pumps are kept in the off position and then are monitored regularly (See Section 8.2 for inspection frequency applicable when the system is operating in manual mode) to manually check leachate levels using the same pump-on criteria as described above for automated operations; then pumps are turned on manually as needed based on the observed leachate levels to maintain acceptably low heads. Leachate pumped out of the sump will be transferred to the storage system features as described in Section 5.

The pumping rate will vary depending on the capacity of the installed pumps and the leachate generation quantities (inflow rate into the sumps). The design calculations (e.g., see sump design in Attachment 3E.5) indicate, for the phase receiving the largest estimated flow, the predicted flowrates may vary from about 7 gallons per minute (gpm) on an average day to about 73 gpm on a peak day. Calculations are presented for an example case using an 80-gpm pump, not presented as a required size, but instead provided as a reasonableness check and as guidance to the operator to confirm that the sump capacity and pump cycle times would keep up with peak flows, and operate acceptably, under such scenario.

4.2 Leachate Transmission

Leachate withdrawn from each sump will be conveyed into a transmission system (forcemain piping), or may be directly transferred (pumped) into tanker trucks. The purpose of a transmission system is to provide for leachate withdrawal into an integrated system of connected piping that conveys all such leachate flows to the storage system features described in Section 5, or into recirculation system features described in Section 6. The forcemain layout is shown on the leachate management system plans (Drawings 3E-1A and 3E-1B). These drawings show the alignment route of forcemain piping in existing landfill areas and the proposed (i.e., Unit 2, Phases VII through XIV) expansion area. As shown, the general approach is to use a leachate forcemain pipeline aligned along the landfill perimeter, into which piping is connected at the riser pad area of each Subtitle D phase to tie-in withdrawal piping from the sumps to the forcemain. The forcemain pipe is routed either to Leachate Evaporation Ponds A, B, and C or Leachate Evaporation Pond D or E (or may be tied-together to route to all ponds). The forcemain may also be extended from the landfill area to future leachate storage tanks to provide flexibility of storage capacity and management locations. Details of the leachate transmission system are shown on Drawings 3E-4 and 3E-8. As shown, the forcemain pipe will be dual-contained, and will consist of a 4-in. (nominal) diameter HDPE carrier pipe and an 8-in. (nominal) diameter HDPE secondary containment pipe (Drawing 3E-4). The forcemain pipe will be made from HDPE, which is chemically resistant to MSW leachate.

If the system head of the leachate transmission system (forcemain) increases in the future to levels that cause excess flow resistance, additional flow capacity may be added to the existing forcemain system by increasing the carrier pipe diameter, by installing one or more pump stations along the forcemain system, by installing a parallel forcemain system, or by using larger pumps (higher-head/flowrate) in one or more sumps. Manholes may be installed to provide adequate maintenance access for the system.

5. LEACHATE AND CONTAMINATED WATER STORAGE

5.1 Leachate Sumps

As previously discussed, leachate generated within each phase ultimately drains to the leachate collection sump located at the low point of the phase. As such, the leachate sumps represent interim storage locations for leachate, at the points where accumulated leachate will be withdrawn and transferred into the transmission system (or directly into tanker trucks). The sumps are sized to provide adequate storage capacity, in conjunction with the pump withdrawal rates and cycle times, as demonstrated in the calculations provided in Attachment 3E.5.

5.2 Storage Tanks

There are no existing leachate storage tanks at the facility. Leachate and contaminated water storage tanks may be added in the future as part of site operations for additional flexibility (e.g., added capacity, availability for on-site storage of contaminated water, etc.). Refer to Section 7 for leachate and contaminated water disposal requirements. If storage tanks are to be added, a permit modification requesting authorization to install and operate such tanks will be submitted to TCEQ, and once approved, they will be installed and managed in accordance with the following minimum criteria:

- The tanks will be equipped with a liquid-level indicator; and when the tanks are almost full, pumping into the tanks will be ceased until the tank(s) are emptied (either by transferring liquid to the leachate evaporation pond(s) or via off-site disposal per Section 7 of this plan).
- The storage tanks will be surrounded by 2-ft (min) tall earthen berms for secondary containment. If a spill occurs from a storage tank, the remaining liquid in the storage tank will be emptied by pumping it to an appropriate leachate evaporation pond, into an intact tank, or directly into tanker trucks.
- For small spills, the liquid within the secondary containment will be treated as contaminated water and will be cleaned using sorbent materials. For larger spills, the liquid will be pumped to an appropriate leachate evaporation pond, into an intact tank, or directly into tanker trucks. Any soil with visible signs of contamination will be removed and disposed of at the working face of the landfill.

5.3 Leachate Evaporation Ponds

Leachate Evaporation Ponds A, B, and C, located northwest of Unit 2, Phase I (see Drawing 3E-1A), are existing double-lined ponds and will remain in-service. The layout of the ponds is shown on Drawing 3E-5; the liner system is summarized below, and design details are shown on the drawings in Attachment 3E.1.

Leachate Evaporation Ponds D and E are proposed double-lined ponds; Leachate Evaporation Pond D would be located adjacent to and east of Unit 2, Phases VI and VII, and Leachate

Evaporation Pond E would be located adjacent to and south of Unit 2, Phase XIV. These ponds are being presented as possible future ponds to provide additional leachate storage and evaporation capacity as part of the Unit 2, Phases VII through XIV, expansion. The decision on if/when to install these ponds will depend on leachate generation rates vs. the capacity of existing on-site storage areas. The proposed layout of Leachate Evaporation Ponds D and E are shown on Drawings 3E-6 and 3E-7, respectively. The liner system is summarized below, and design details are shown on the drawings in Attachment 3E.1 (e.g., Drawing 3E-8).

Leachate will be transported from the leachate sumps into the leachate evaporation ponds via the methods described in Section 4.2 (i.e., via forcemain piping; or by tanker truck into which the leachate is pumped and then transported to the evaporation ponds). The leachate evaporation ponds may receive and store only leachate and/or gas condensate, where such waters will evaporate naturally; mechanical aerators may also be used. The operating level in the ponds shall be such that a minimum of two (2) feet (ft) of freeboard is maintained under normal operating conditions, as described further below.

The existing and proposed pond liners consists of, from top to bottom:

- 60-mil textured HDPE geomembrane;
- GCL; and
- 60-mil textured HDPE geomembrane.

The pond liner will be constructed and documented in accordance with the Liner Quality Control Plan (Part III, Attachment 3C). Weathering and exposure to ultraviolet (UV) light is not expected to degrade the exposed portions of the upper HDPE geomembrane during the lifetime of the landfill or post-closure period. Based on information in the technical literature, HDPE geomembranes with the carbon black content and dispersion, UV resistance, and sheet density specified for this project have an estimated projected life in excess of 100 years for resistance to weathering (GSE Lining Technology, 2002).

The design of the ponds and their 2-ft (min) freeboard requirement for normal operating conditions of the ponds has been established to provide a margin of safety (vertical buffer) to safeguard against "abnormal" operations should they arise (wind and wave action, rainfall, equipment malfunctions, human error). The ponds are designed with elevated berms above surrounding grades (thus, the ponds will not receive stormwater run-on). The 25-year, 24-hour design storm depth is 8.9 inches, and therefore by operating the ponds with at least the specified minimum freeboard, ample freeboard will be available that is more than adequate to receive and accommodate the 25-year, 24-hour rainfall while preventing overtopping from this rainfall event. The evaporation pond liquid levels (adequacy of freeboard) and liner integrity will be checked at the frequency indicated in Section 8.2. Following an event that causes an abnormal condition that temporarily raises the pond level above the normal operating level, the 2 feet of freeboard will be restored by either: (i) removing liquid from the pond via tanker trucks; or (ii) temporarily ceasing inflows into the pond and instead using another pond or on-site storage tanks as appropriate, thereby allowing evaporation to lower the water level down to normal operations with 2 feet (min) of freeboard prior to resuming inflows to that pond.

6. LEACHATE AND GAS CONDENSATE RECIRCULATION

6.1 General Recirculation Requirements

Leachate and gas condensate can be managed through recirculation at the facility. However, there are certain constraints on how and where the recirculation can occur and the quantities which can be recirculated. The general requirements are outlined below, and additional details and operational procedures for recirculation are presented in the remainder of this section.

- Landfill Unit 1 is complete and final-covered. Leachate recirculation will not be performed into Unit 1.

- At Landfill Unit 2, recirculation will be accomplished by reintroducing the collected leachate and/or gas condensate derived from a landfill unit at the facility back into a landfill unit at the facility that is designed and constructed with a leachate collection system and a composite liner. As such, and pursuant to 30 TAC §330.177, recirculation may occur into waste at Unit 2 since it is designed and has or will be constructed to "Subtitle D" standards [per 30 TAC §330.331(a)(2) and (b); and 30 TAC §330.333].

- Typical recirculation methods include, but are not limited to, spray application on the active working face, vertical recharge wells into the waste, horizontal infiltration trenches into the waste, or drip irrigation into the waste. Recirculation must not exceed the moisture holding capacity of the landfill, and must not cause seeps or ponding, or nuisance conditions, or interfere with facility operations, as further elaborated on subsequently in this section.

- Contaminated water cannot be recirculated.

- Locations where recirculation takes place via infiltration trenches or vertical recharge wells will be located at least 100 feet away from sideslopes, as a general preventative measure to provide a buffer/set-back from the landfill edges/limits of waste, and also specifically to minimize the potential for formation of leachate/gas condensate seeps on landfill sideslopes. It will also be limited to areas where waste depths exceed 50 feet.

- Recirculation quantities will not exceed the peak and average daily limits discussed in the following subsection.

6.2 Recirculation Rates

Daily limits for recirculation, on a per acre basis, were developed using the HELP model (Attachment 3E.2). The limits coincide with recirculation quantities that resulted in acceptably-low calculated heads of leachate on the liner. The allowable recirculation limits are shown in Table 3E-1. The allowable average rate is the amount of leachate that can be recirculated in a given area on a consecutive day basis. The allowable peak recirculation rate is the maximum amount of combined quantity of leachate and/or gas condensate that can be recirculated in a given area in one day on an intermittent basis and in the absence of any recent or forecasted rain event. The peak recirculation rate cannot be conducted in a given area on a consecutive-day basis.

TABLE 3E-1. ALLOWABLE RECIRCULATION RATES

Allowable Average Recirculation Rate (gal/acre/day)	Allowable Peak Recirculation Rate (gal/acre/day)
300	2,000

Note: The total volume of leachate and/or gas condensate recirculation on-site at this landfill shall not exceed 100,000 gallons per day (gpd).

6.3 Operational Procedures for Recirculation

Leachate to be recirculated will be obtained from various points along the leachate management system, such as from sumps, the forcemain, or from on-site leachate storage areas (tanks or leachate evaporation ponds). For example, a recirculation pipeline and valves may be connected to the leachate forcemain at a convenient tie-in point such as a riser area and/or at a valve manhole, thereby allowing the leachate/gas condensate to be diverted into the recirculation pipeline that extends to the planned recirculation area of the landfill. As another example, leachate may be pumped from an on-site leachate storage tank or evaporation pond into a recirculation pipeline that extends to the planned recirculation area of the landfill. As an additional example, leachate may be loaded into tanker trucks and transported to the planned recirculation area. Similarly, gas condensate to be recirculated will be obtained from various points along the gas collection system such as at one or more gas condensate sumps, or from gas condensate that has been conveyed to the on-site storage tanks, or from gas condensate contained in an on-site leachate evaporation pond.

The following procedures will be used during recirculation:

- Contaminated water shall not be recirculated. Therefore, any storage area holding contaminated water (or comingled waters including contaminated water) must not be used for recirculation.

- Containment and diversion berms should be in-place (per Section 2.3 and Drawing 3E-9 of this plan) around the recirculation receiving area when surface-application methods will be used (e.g., spray application or drip irrigation).

- Recirculation will be conducted in a manner that does not result in ponding or seeps. If ponding or seeps occur, recirculation in that area will be discontinued until the condition subsides and is remedied.

- Recirculation must be managed in a way that minimizes odors and vectors. The provisions of the SOP on odor management and vector control are applicable to recirculation operations. In addition, the following procedures will be implemented:
    - Spray application will only be performed in areas set-back a minimum of 100 feet from the perimeter limit of waste, and only on days and times when the wind speed is less than or equal to 15 miles per hour.
    - The sprayers will be oriented downwards towards the waste (not projected upward).
- Surface-application methods (spray or drip irrigation) will not be performed when standing water exists or during rain events.

Recirculation volumes will be monitored at the facility and will not exceed the rates specified above. The facility will maintain records of the volumes recirculated into the landfill, using either flowmeters connected to recirculation pipes, or by manual methods based on the capacity and number of tanker truck loads used.

Consistent with the 30 TAC §330.177 operational standards for recirculation, the owner or operator is not required to characterize leachate and/or gas condensate that is being recirculated into an approved Type I landfill unit at this facility (i.e., the on-site Subtitle D-lined landfill phases described herein). Off-site disposal, and any associated characterization requirements pertaining to leachate and/or gas condensate, is discussed in Section 7 of this plan.

7. LEACHATE AND CONTAMINATED WATER DISPOSAL

As already discussed, leachate and gas condensate will be managed by storing it in the appropriate on-site lined pond(s) where it can evaporate, transferring it into on-site storage tanks, or it may be recirculated. Contaminated water will be transferred to on-site storage tanks or directly removed from the site via tanker trucks.

Ultimately, excess amounts leachate and gas condensate beyond the on-site capacity at the facility to store and evaporate will be disposed of off-site at a duly-authorized publicly owned treatment works (POTW), or other similar and duly-authorized wastewater treatment/disposal facility. Contaminated water will be disposed of off-site at a duly-authorized POTW, or similar and duly-authorized wastewater treatment/disposal facility. Transportation for off-site disposal will be by tanker truck. Sampling and analysis to characterize such liquids will be performed as required by the receiving facility. The results of any characterization/monitoring required by the receiving facility, a copy of the disposal agreement, and documentation of disposal will be placed in the Site Operating Record.

NOTE: The MSW facility must be operated in accordance with 30 TAC §330.207 (Contaminated Water Management) including provisions for proper management of liquids resulting from operation of the facility (including contaminated water, leachate, and gas condensate), obtaining specific written authorization from the TCEQ under TPDES authority prior to off-site discharge, and disposal at a treatment facility. The MSW facility must also be operated in accordance with 30 TAC §330.15(h) regarding prohibitions on discharge of solid wastes or pollutants into waters of the state or the United States. As such, the following general prohibitions shall apply regarding management for prevention of discharge of pollutants including but not limited to leachate, gas condensate, and contaminated water:

The MSW facility shall not cause:

1. a discharge of solid wastes or pollutants adjacent to or into waters of the state, including wetlands, that is in violation of the requirements of Texas Water Code, §26.121;
2. a discharge of pollutants into waters of the United States, including wetlands, that violates any requirements of the Federal Clean Water Act, including, but not limited to, the National Pollutant Discharge Elimination System requirements, under §402, as amended, or Texas Pollutant Discharge Elimination System requirements;
3. a discharge of dredged or fill material to waters of the United States, including wetlands, that is in violation of the requirements under Federal Clean Water Act, §404, as amended; and
4. a discharge of a nonpoint source pollution into waters of the United States, including wetlands, that violates any requirement of an area-wide or state-wide water quality management plan that has been approved under Federal Clean Water Act, §208 or §319, as amended.

8. LONG-TERM PERFORMANCE AND OPERATIONS

8.1 Design Provisions for Compatibility and Long-Term Performance

As explained herein and demonstrated in the calculation packages provided in Attachments 3E.2 through 3E.7, the leachate management system has been designed to function through the active life, scheduled closure, and post-closure care period of the landfill, considering the factors listed below.

- The leachate collection and removal systems are designed and will be constructed of materials that are chemically resistant to the leachate expected to be generated.
- The leachate collection and removal systems are of sufficient strength and thickness to withstand the maximum expected loads (pressures exerted by overlying wastes, waste cover materials, and any equipment used at the landfill).
- The leachate collection and removal systems are designed and will be operated in consideration of the estimated rates of leachate generation and removal, capacity of sumps, pipe layout/grading, pipe material and strength, sump materials and strength, drainage media specifications and performance to resist clogging, with collection pipes having perforation size and surrounding gravel and filters to resist clogging and that are able to be cleaned out, while maintaining sufficient flow capacity under the expected loads.

In addition to the leachate management system being designed to exceed anticipated chemical and physical demands, operational procedures will be implemented to ensure these systems remain functional through the life of the landfill and post-closure period as outlined below.

8.2 Operation and Maintenance (Including Performance Monitoring and Inspections)

Operation and maintenance of the leachate management system will be performed during the active life, scheduled closure, and post-closure care period of the landfill. Operational procedures will be as described previously throughout this document for the various system components (e.g., see Section 4.1 for leachate sump operations, Section 5.3 for leachate evaporation ponds). During the active life, routine inspection will be made on at least a monthly basis, regardless of whether the system is operating in automatic or manual mode, to assess the operation and performance of the leachate management system. This will include monthly at minimum (or when in manual pump system operation mode, more frequently if warranted[1]) inspection checks of the leachate pump control systems (to verify the pumps are operable and to check head levels (i.e., leachate depths) in the sumps), any exposed piping and forcemain manholes, liquid levels/freeboard in the evaporation ponds, integrity of exposed portions of the evaporation pond liner, and associated appurtenances. Abnormal flow rates, damaged components, excessive leachate depths in sumps, evaporation pond freeboard less than the specified minimum, or other anomalies will be noted and addressed. Damaged or inoperable features will be repaired as necessary to restore function.

During the post-closure period, performance monitoring and inspections of the leachate management system will be performed as described in Part III, Attachment 8, (Post-Closure Care Plan).

Results of the monitoring and inspection activities will be documented in the facility's Site Operating Record.

9. REFERENCES

Berger, K. and Schroeder, P.R. "*The Hydrologic Evaluation of Landfill Performance (HELP) Model, User's Guide for HELP-D (Version 3.95 D)*," Institute of Soil Science, University of Hamburg & Environmental Laboratory, U.S. Army Corps of Engineers, Waterways Experiment Station, 2013.

GSE Lining Technology, "*UV Resistance for GSE Geomembranes*," GSE Technical Note TN003, 2002.

Schroeder, P.R., Lloyd, C.M., and Zappi, P.A., "*The Hydrologic Evaluation of Landfill Performance (HELP) Model, User's Guide for Version 3*," U.S. Environmental Protection Agency, Office of Research and Development, Washington, D.C., Report No. EPA/600/R094/168a, 1994a.

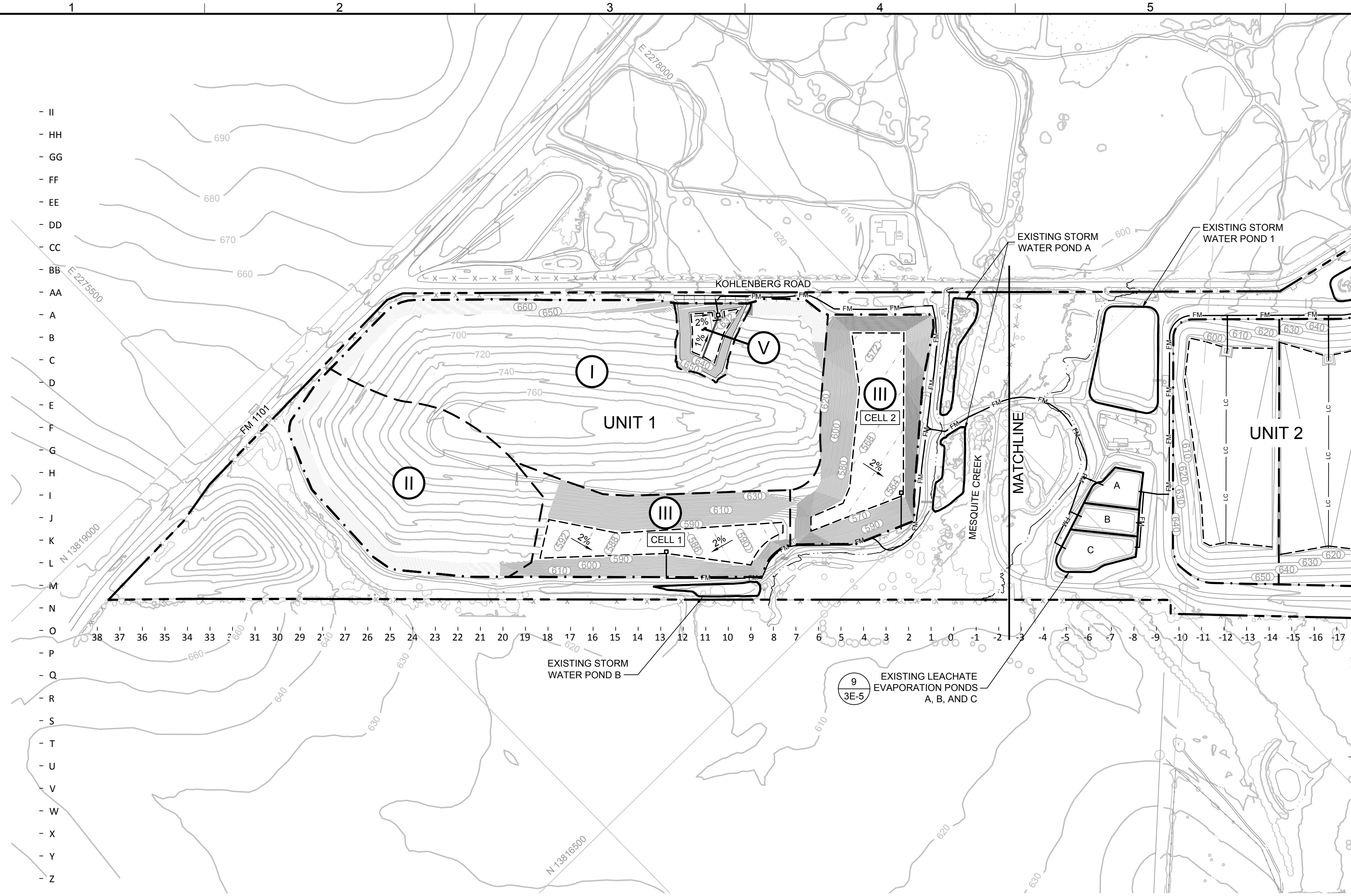
Schroeder, P.R., Dozier, T.S., Zappi, P.A., McEnroe, B.M., Sjostrom, J.W., and Peyton, R.L., "*The Hydrologic Evaluation of Landfill Performance (HELP) Model Engineering Documentation for Version 3*," U.S. Environmental Protection Agency, Office of Research and Development, Washington, D.C., Report No. EPA/600/R-94/168b, 1994b, 116 p.

[1] When in manual pumping mode: The frequency of manual pumping and leachate depth checks is dependent on the observed leachate generation rates, which will vary over time based on many factors including but not limited to climate, depth and moisture characteristics of waste, cover, and operational cell configuration. Leachate generation rates are typically highest when a cell is placed into initial operation, and decrease over time to eventually become negligible during the post-closure care period. As such, the operator should use an observational approach to establish the appropriate frequency of depth checks and pumping when operating the system in manual mode, with the objective of achieving equivalent effectiveness (and depth criteria) as when operating the system in automated mode. During the active life of the landfill, the minimum frequency of depth checks is on a monthly basis in both automatic and manual mode; but, when in manual mode the depth checks and associated manual pumping should be conducted more frequently (e.g., biweekly or weekly, as appropriate) if observations reveal a faster rate of sump filling that would fill up the sump more often than monthly.

ATTACHMENT 3E.1

LEACHATE AND CONTAMINATED WATER MANAGEMENT DRAWINGS

LIST OF DRAWINGS		
Drawing No.	**Title**	**Drawing Date (latest revision)**
3E-1A	Leachate Management System Plan – Unit 1	October 2023
3E-1B	Leachate Management System Plan – Unit 2	October 2023
3E-2	Leachate Management System Details I	February 2024
3E-3	Leachate Management System Details II	February 2024
3E-4	Leachate Management System Details III	October 2023
3E-5	Leachate Evaporation Pond A, B, and C	October 2023
3E-6	Leachate Evaporation Pond D	October 2023
3E-7	Leachate Evaporation Pond E	October 2023
3E-8	Leachate Evaporation Pond Details	February 2024
3E-9	Contaminated Run-On and Runoff Details	February 2024



LEGEND

580	EXISTING GROUND ELEVATION CONTOUR (FT, MSL) (NOTES 1, 2)
	EXISTING ROAD
	EXISTING VEGETATION / TREE
x x	EXISTING FENCE
	EXISTING BUILDING
	EXISTING WATER LINE
13 A	SITE GRID
	PERMIT BOUNDARY
	LIMIT OF WASTE
	PHASE/CELL BOUNDARY
390	EXISTING BASE GRADES
LC LC	LEACHATE COLLECTION SYSTEM CORRIDOR
	LEACHATE COLLECTION SUMP AND RISER PIPE
FM	LEACHATE FORCEMAIN
	LEACHATE COLLECTION CHIMNEY DRAIN
	100-YEAR FLOOD LIMITS (NOTE 9)

NOTES:

1. THIS DRAWING PRESENTS THE LAYOUT OF THE LEACHATE MANAGEMENT FEATURES FOR COLLECTION, CONVEYANCE, AND STORAGE. REFER TO THE LEACHATE AND CONTAMINATED WATER MANAGEMENT PLAN (PART III, ATTACHMENT 3E) FOR A DESCRIPTION OF THESE SYSTEM COMPONENTS AND THEIR FUNCTION.
2. EXISTING BASE GRADES SHOWN ON THIS DRAWING REPRESENT TOP OF CLAY LINER.
3. UNIT 1 OF THE EXISTING LANDFILL HAS BEEN CONSTRUCTED AND FINAL COVERED. UNIT 1, PHASES I AND II HAVE PRE-SUBTITLE D CLAY LINERS WITHOUT LEACHATE COLLECTION SYSTEMS EXCEPT FOR THE PIPING AND MANHOLES SHOWN. THERE IS NO UNIT 1, PHASE IV. ALL OTHER PHASES OF UNITS 1 AND 2 HAVE SUBTITLE D LINER SYSTEMS.
4. UNIT 2, PHASES VII THROUGH XIV ARE THE PROPOSED EXPANSION AREA, EACH OF WHICH WILL BE LINED WITH A SUBTITLE D LINER SYSTEM HAVING A COMPOSITE LINER AND LEACHATE COLLECTION SYSTEM.
5. SEE DRAWING I/IIA-22 FOR TABULATED INFORMATION OF THE LANDFILL EXPANSION DEVELOPMENT STAGES. REFER TO DRAWINGS I/IIA-23 THROUGH I/IIA-25 FOR EXAMPLE PHASE DEVELOPMENT LAYOUT PLANS SHOWING REPRESENTATIVE FILLING SEQUENCES AND THEIR LAYOUT CONFIGURATION.
6. DUAL CONTAINMENT PIPING TO BE USED FOR ALL LEACHATE FORCEMAIN PIPELINES, UNLESS CARRIER PIPE IS PLACED WITHIN LINED FOOTPRINT.
7. LEACHATE IS ROUTED INTO EXISTING LEACHATE EVAPORATION PONDS VIA FORCEMAIN PIPING OR DISPOSED OF AT AN AUTHORIZED FACILITY.
8. AIR RELEASE MANHOLES MAY BE PLACED PERIODICALLY AT HIGH POINTS ALONG THE FORCEMAIN ALIGNMENT. LEAK DETECTION SUMPS AND CLEANOUTS MAY BE PLACED PERIODICALLY ALONG THE FORCEMAIN ALIGNMENT.
9. THERE ARE NO FEMA-DESIGNATED 100-YEAR FLOODPLAIN AREAS OR FLOODWAYS AT THE SITE, AS DOCUMENTED IN PARTS I/II, APPENDIX I/IIA, DRAWING I/IIA-16. SITE-SPECIFIC 100-YEAR FLOOD LEVEL AT MESQUITE CREEK AND ITS CORRESPONDING LIMITS, AS SHOWN HEREON, WERE COMPUTED FOR THE 100-YEAR, 24-HOUR STORM EVENT USING THE LATEST AVAILABLE NOAA ATLAS 14 PRECIPITATION DATA. THE CALCULATED FLOOD LEVEL IS ELEVATION 606.0 FT, MSL. NOTE THAT THIS IS SLIGHTLY HIGHER THAN THE FREEDOM LAKE FLOOD POOL THAT EXTENDS ONTO THE SITE (ELEVATION 605.1 FT, MSL ACCORDING TO THE YORK CREEK WATERSHED CONSERVATION DISTRICT). AS SHOWN, NO WASTE DISPOSAL LIMITS ENCROACH ON THE SITE-SPECIFIC CALCULATED 100-YEAR FLOOD LIMITS. FURTHERMORE, THESE ADJACENT LANDFILL AREAS ARE PROTECTED BY PERIMETER BERMS WITH ELEVATIONS HIGHER THAN THE FLOOD LEVEL, THESE PARTS OF THE FACILITY ARE EXISTING (CONSTRUCTED AS AUTHORIZED BY PREVIOUS TCEQ PERMITS), AND NO CHANGES ARE PROPOSED.

STATE OF TEXAS
SCOTT M. GRAVES
86557
LICENSED
PROFESSIONAL ENGINEER

10/11/2023

0 300' 600'
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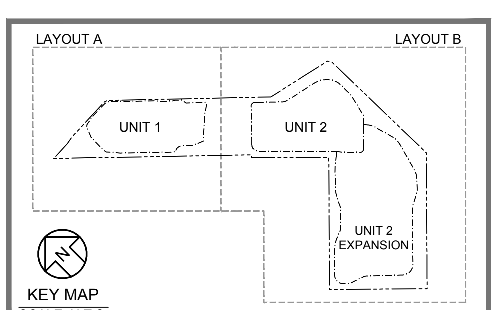


PERMIT DRAWING

REV	DATE	DESCRIPTION	DRN	APP

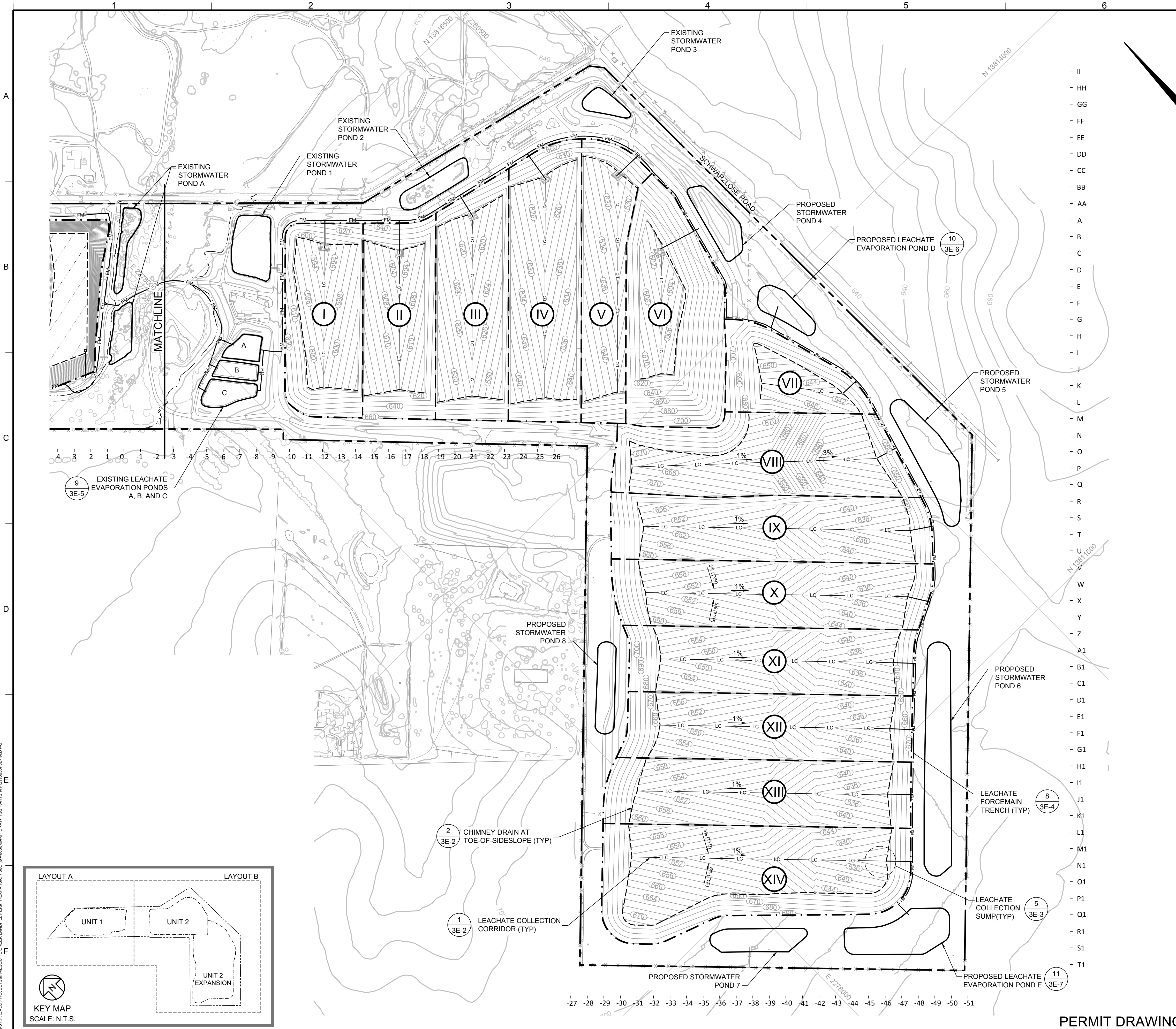
WASTE MANAGEMENT
WASTE MANAGEMENT OF TEXAS, INC.
1700 KOHLENBERG ROAD
NEW BRAUNFELS, TEXAS 78130
PHONE: 830.625.7894

Geosyntec consultants
GEOSYNTEC CONSULTANTS, INC.
TEXAS ENG. FIRM REGISTRATION NUMBER 1182
8217 SHOAL CREEK BLVD, SUITE 200
AUSTIN, TEXAS 78757
PHONE: 512.451.4003

TITLE:
LEACHATE MANAGEMENT SYSTEM PLAN UNIT 1

PROJECT:
MESQUITE CREEK LANDFILL EXPANSION
PERMIT AMENDMENT APPLICATION - MSW PERMIT NO. 66C

PROJECT NO.: GW8636	DESIGN BY: SMG	REVIEWED BY: YB	PART NO.: III	DRAWING: 3E-1A
FILE: GW8636P3E-1B	DRAWN BY: JJV / KH	APPROVED BY: SMG		



LEGEND

580	EXISTING GROUND ELEVATION CONTOUR (FT, MSL) (NOTES 1, 2)
	EXISTING ROAD
	EXISTING VEGETATION / TREE
x x	EXISTING FENCE
	EXISTING BUILDING
	EXISTING WATER LINE
13 A	SITE GRID
	PERMIT BOUNDARY
	LIMIT OF WASTE
	PHASE BOUNDARY
VI	PHASE DESIGNATION
390	BASE GRADES
LC LC	LEACHATE COLLECTION SYSTEM CORRIDOR
	LEACHATE COLLECTION SUMP AND RISER PIPE
FM	LEACHATE FORCEMAIN
	LEACHATE COLLECTION CHIMNEY DRAIN
	100-YEAR FLOOD LIMITS (NOTE 9)

NOTES:

1. THIS DRAWING PRESENTS THE LAYOUT OF THE LEACHATE MANAGEMENT FEATURES FOR COLLECTION, CONVEYANCE, AND STORAGE. REFER TO THE LEACHATE AND CONTAMINATED WATER MANAGEMENT PLAN (PART III, ATTACHMENT 3E) FOR A DESCRIPTION OF THESE SYSTEM COMPONENTS AND THEIR FUNCTION.
2. WITHIN THE LIMITS OF WASTE, THE LANDFILL CONTOURS SHOWN ON THIS DRAWING ARE BASE GRADES REPRESENTING THE TOP OF THE CLAY LINER.
3. UNIT 2, PHASES I THROUGH VI-NORTH OF THE EXISTING LANDFILL HAVE BEEN CONSTRUCTED.
4. UNIT 2, PHASES VII THROUGH XIV ARE THE PROPOSED EXPANSION AREA, EACH OF WHICH WILL BE LINED WITH A SUBTITLE D LINER SYSTEM HAVING A COMPOSITE LINER AND LEACHATE COLLECTION SYSTEM.
5. SEE DRAWING I/IIA-22 FOR TABULATED INFORMATION OF THE LANDFILL EXPANSION DEVELOPMENT STAGES. REFER TO DRAWINGS I/IIA-23 THROUGH I/IIA-25 FOR EXAMPLE PHASE DEVELOPMENT LAYOUT PLANS SHOWING REPRESENTATIVE FILLING SEQUENCES AND THEIR LAYOUT CONFIGURATION.
6. DUAL CONTAINMENT PIPING TO BE USED FOR ALL LEACHATE FORCEMAIN PIPELINES, UNLESS CARRIER PIPE IS PLACED WITHIN LINED FOOTPRINT.
7. LEACHATE IS ROUTED INTO EXISTING LEACHATE EVAPORATION PONDS VIA FORCEMAIN PIPING OR DISPOSED OF AT AN AUTHORIZED FACILITY.
8. AIR RELEASE MANHOLES MAY BE PLACED PERIODICALLY AT HIGH POINTS ALONG THE FORCEMAIN ALIGNMENT. LEAK DETECTION SUMPS AND CLEANOUTS MAY BE PLACED PERIODICALLY ALONG THE FORCEMAIN ALIGNMENT.
9. THERE ARE NO FEMA-DESIGNATED 100-YEAR FLOODPLAIN AREAS OR FLOODWAYS AT THE SITE, AS DOCUMENTED IN PARTS I/II, APPENDIX I/IIA, DRAWING I/IIA-16. SITE-SPECIFIC 100-YEAR FLOOD LEVEL AT MESQUITE CREEK AND ITS CORRESPONDING LIMITS, AS SHOWN HEREON, WERE COMPUTED FOR THE 100-YEAR, 24-HOUR STORM EVENT USING THE LATEST AVAILABLE NOAA ATLAS 14 PRECIPITATION DATA. THE CALCULATED FLOOD LEVEL IS ELEVATION 606.0 FT, MSL. NOTE THAT THIS IS SLIGHTLY HIGHER THAN THE FREEDOM LAKE FLOOD POOL THAT EXTENDS ONTO THE SITE (ELEVATION 605.1 FT, MSL ACCORDING TO THE YORK CREEK WATERSHED CONSERVATION DISTRICT). AS SHOWN, NO WASTE DISPOSAL LIMITS ENCROACH ON THE SITE-SPECIFIC CALCULATED 100-YEAR FLOOD LIMITS. FURTHERMORE, THESE ADJACENT LANDFILL AREAS ARE PROTECTED BY PERIMETER BERMS WITH ELEVATIONS HIGHER THAN THE FLOOD LEVEL. THESE PARTS OF THE FACILITY ARE EXISTING (CONSTRUCTED AS AUTHORIZED BY PREVIOUS TCEQ PERMITS), AND NO CHANGES ARE PROPOSED.

0 300' 600'
SCALE IN FEET

STATE OF TEXAS
SCOTT M. GRAVES
86557
LICENSED PROFESSIONAL ENGINEER

10/11/2023

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REV	DATE	DESCRIPTION	DRN	APP

WASTE MANAGEMENT
WASTE MANAGEMENT OF TEXAS, INC.
1700 KOHLENBERG ROAD
NEW BRAUNFELS, TEXAS 78130
PHONE: 830.625.7894

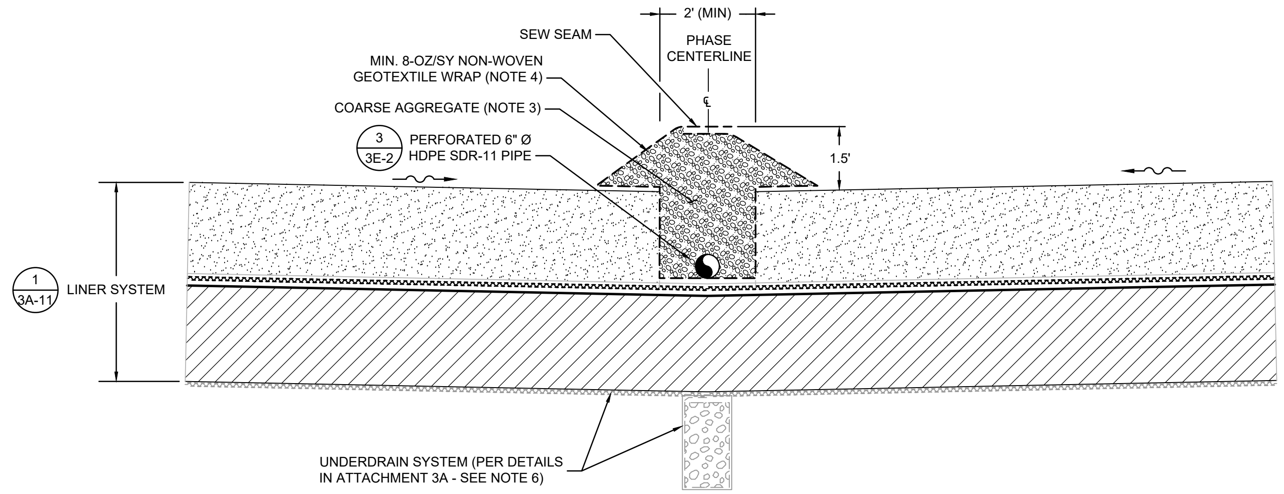
Geosyntec consultants
GEOSYNTEC CONSULTANTS, INC.
TEXAS ENG. FIRM REGISTRATION NUMBER 1182
8217 SHOAL CREEK BLVD, SUITE 200
AUSTIN, TEXAS 78757
PHONE: 512.451.4003

TITLE:
LEACHATE MANAGEMENT SYSTEM PLAN UNIT 2

PROJECT:
MESQUITE CREEK LANDFILL EXPANSION
PERMIT AMENDMENT APPLICATION - MSW PERMIT NO. 66C

PERMIT DRAWING

PROJECT NO.:	GW8636	DESIGN BY:	SMG	REVIEWED BY:	YB	PART NO.:	III	DRAWING: 3E-1B
FILE:	GW8636P3E-1A	DRAWN BY:	JJV / KH	APPROVED BY:	SMG			



1 / 3E-1B DETAIL
LEACHATE COLLECTION CORRIDOR
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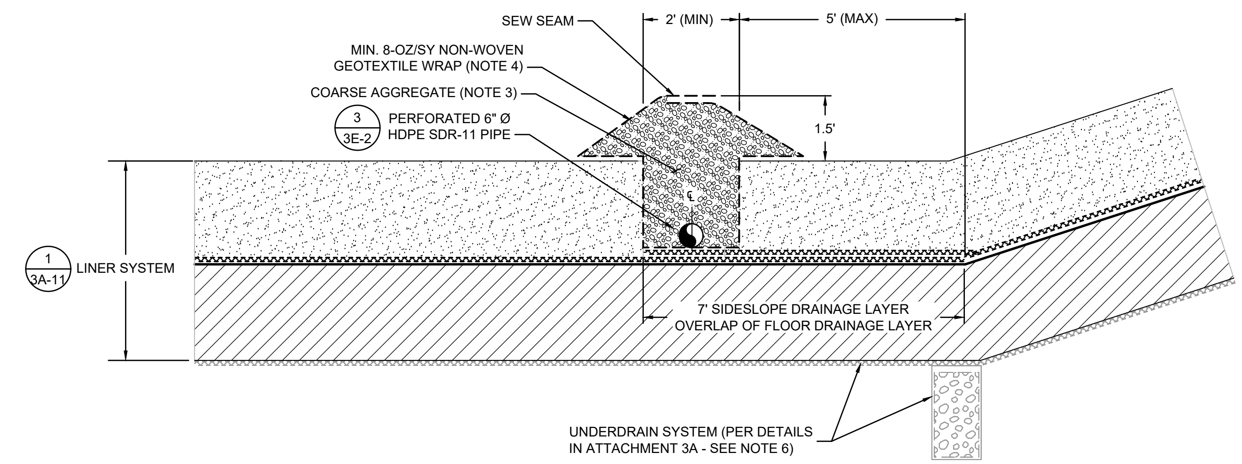
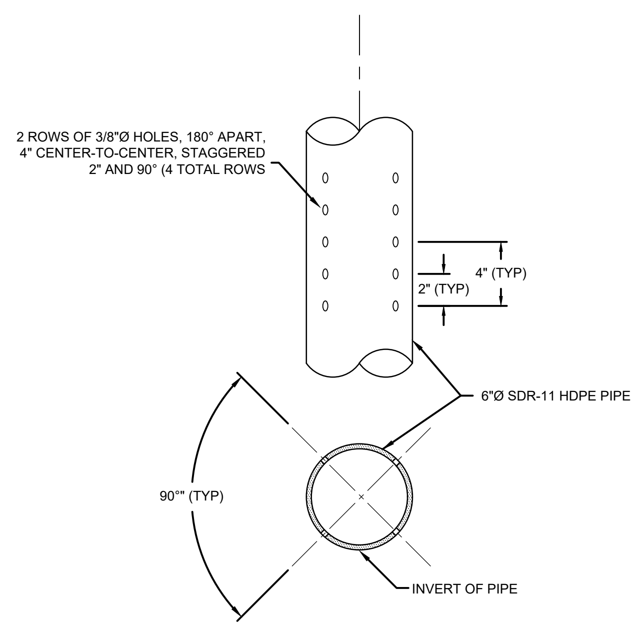


2 / 3E-1B DETAIL
CHIMNEY DRAIN AT TOE-OF-SIDESLOPE
SCALE: N.T.S.



3 / 3E-2 DETAIL
LEACHATE COLLECTION PIPE PERFORATIONS
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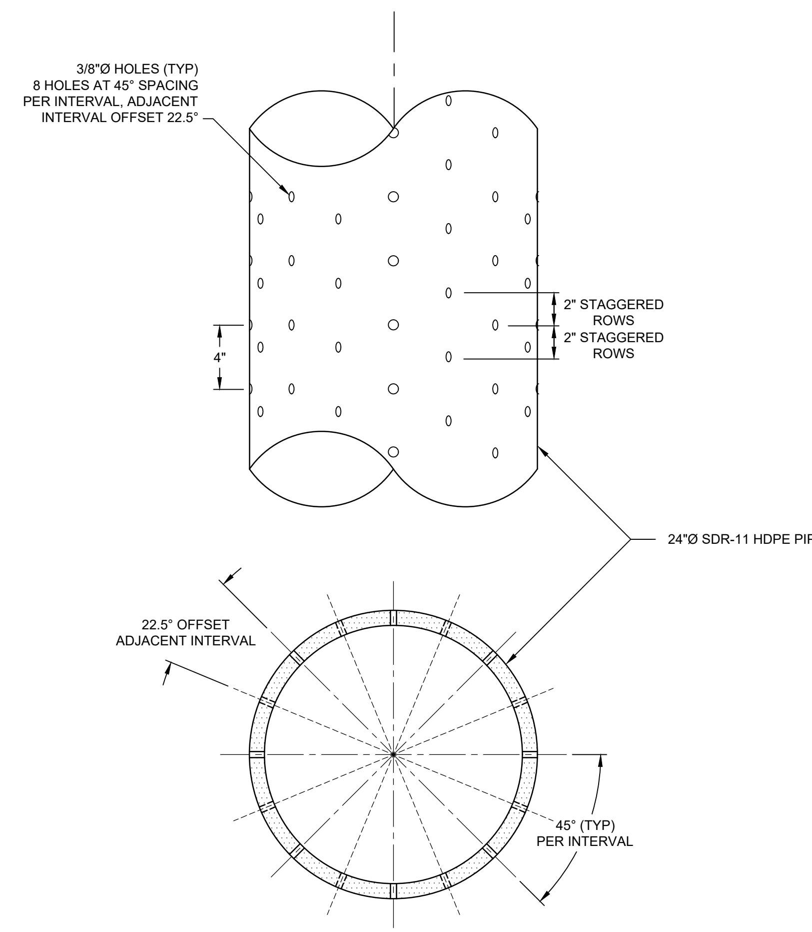

4 / 3E-3 DETAIL
RISER PIPE PERFORATIONS
SCALE: N.T.S.

NOTES:

1. MATERIAL THICKNESSES ARE MINIMUMS.
2. REQUIRED MATERIAL PROPERTIES AND QUALITY ASSURANCE / QUALITY CONTROL (QA / QC) PROCEDURES ARE GIVEN IN THE LINER QUALITY CONTROL PLAN (LQCP) IN PART III, ATTACHMENT 3C OF THE SITE DEVELOPMENT PLAN.
3. DRAINAGE AGGREGATE SHALL CONSIST OF WASHED NATURAL STONE OR GRAVEL, ROUNDED TO SUBROUNDED, FREE OF SHALE, CLAY, ORGANICS, FOREIGN OBJECTS, FRIABLE MATERIALS AND DEBRIS, AND NOT DERIVED FROM LIMESTONE OR DOLOMITE ORIGIN. THE DRAINAGE AGGREGATE SHALL HAVE A CALCIUM CARBONATE CONTENT OF LESS THAN 15 PERCENT AND SHALL MEET THE PARTICLE SIZE REQUIREMENTS SPECIFIED IN THE LQCP.
4. GEOTEXTILE WRAP SHALL BE PLACED IN DIRECT CONTACT WITH UNDERLYING GEOCOMPOSITE DRAINAGE LAYER.
5. PERFORATION HOLES SHOULD BE ORIENTED AS SHOWN IN RELATION TO PIPE INVERT.
6. THE DETAILS ON THIS DRAWING ARE FOCUSED ON SHOWING THE INFORMATION PERTAINING TO THE LEACHATE MANAGEMENT SYSTEM. THE COMPONENTS OF THE UNDERDRAIN SYSTEM HAVE BEEN DE-EMPHASIZED HERE TO HELP DRAW ATTENTION TO THE LEACHATE COLLECTION FEATURES. REFER TO PART III, ATTACHMENT 3A, DRAWING 3A-15 FOR ENGINEERING DETAILS PRESENTING DESIGN INFORMATION (MATERIALS, DIMENSIONS, LAYOUT/SPACING, ETC.) ON THE UNDERDRAIN SYSTEM.

STATE OF TEXAS
SCOTT M. GRAVES
86557
LICENSED
PROFESSIONAL ENGINEER
2/19/2024

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REV	DATE	DESCRIPTION	DRN	APP
1	FEB. 2024	RESPONSE TO TECHNICAL NOD 1	JJV/KH	SMG
-	OCT. 2023	INITIAL SUBMITTAL TO TCEQ	JJV/KH	SMG

WASTE MANAGEMENT
WASTE MANAGEMENT OF TEXAS, INC.
1700 KOHLENBERG ROAD
NEW BRAUNFELS, TEXAS 78130
PHONE: 830.625.7894

Geosyntec consultants
GEOSYNTEC CONSULTANTS, INC.
TEXAS ENG. FIRM REGISTRATION NUMBER 1182
8217 SHOAL CREEK BLVD, SUITE 200
AUSTIN, TEXAS 78757
PHONE: 512.451.4003

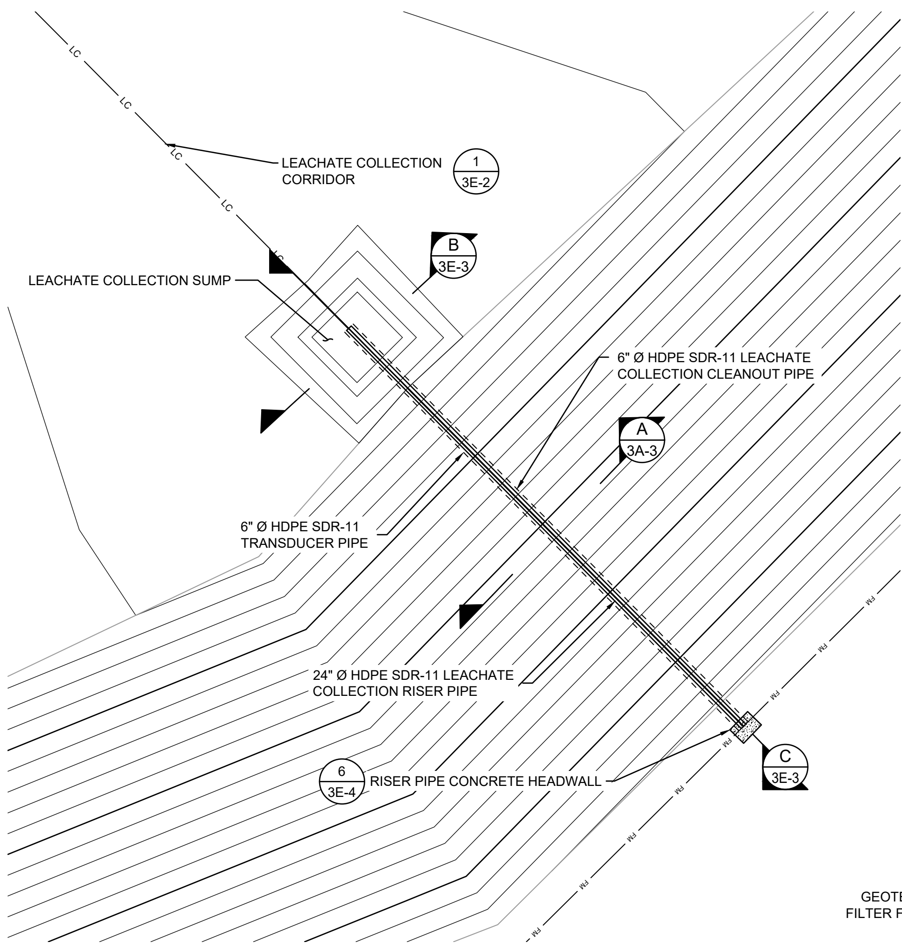
TITLE: LEACHATE MANAGEMENT SYSTEM DETAILS I

PROJECT: MESQUITE CREEK LANDFILL EXPANSION
PERMIT AMENDMENT APPLICATION - MSW PERMIT NO. 66C

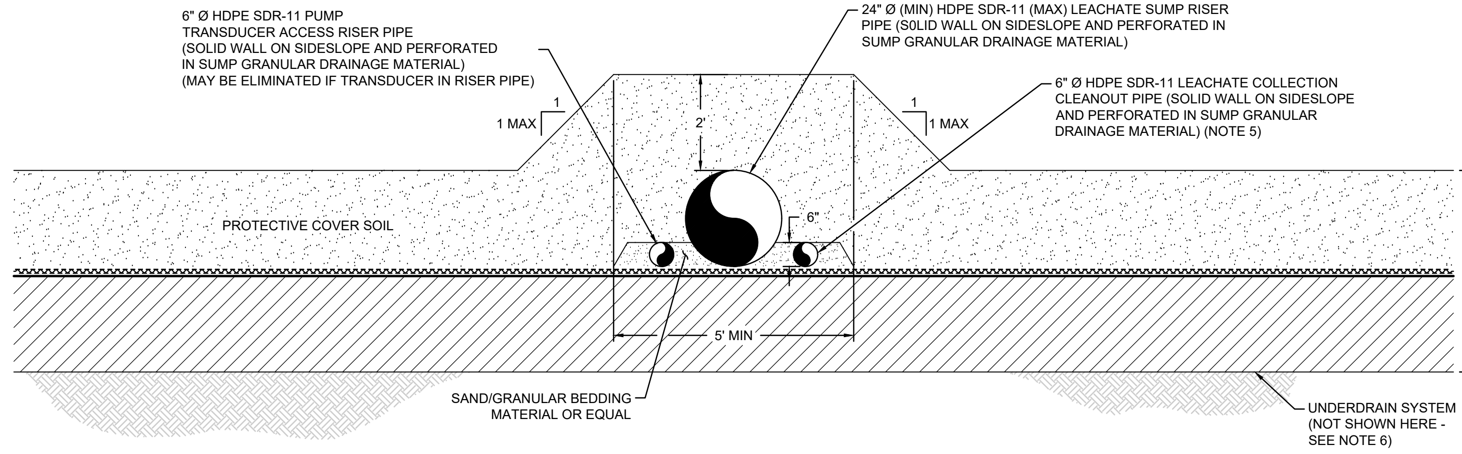
PERMIT DRAWING

PROJECT NO.: GW8636	DESIGN BY: SMG	REVIEWED BY: YB	PART NO.: III	DRAWING: 3E-2
FILE: GW8636P3E-2	DRAWN BY: JJV / KH	APPROVED BY: SMG		

AUS-01\P:\CADD\PROJECTS\MESQUITE CREEK LANDFILL\PERMIT EXPANSION 66C (GW8636)\04-07 DRAWINGS PARTS I-IV\GW8636P3E-2.DWG



5 3E-1B DETAIL
TYPICAL LEACHATE COLLECTION SUMP
SCALE: NOT TO SCALE (N.T.S.)



A 3E-3 SECTION
SIDESLOPE LEACHATE RISER SYSTEM
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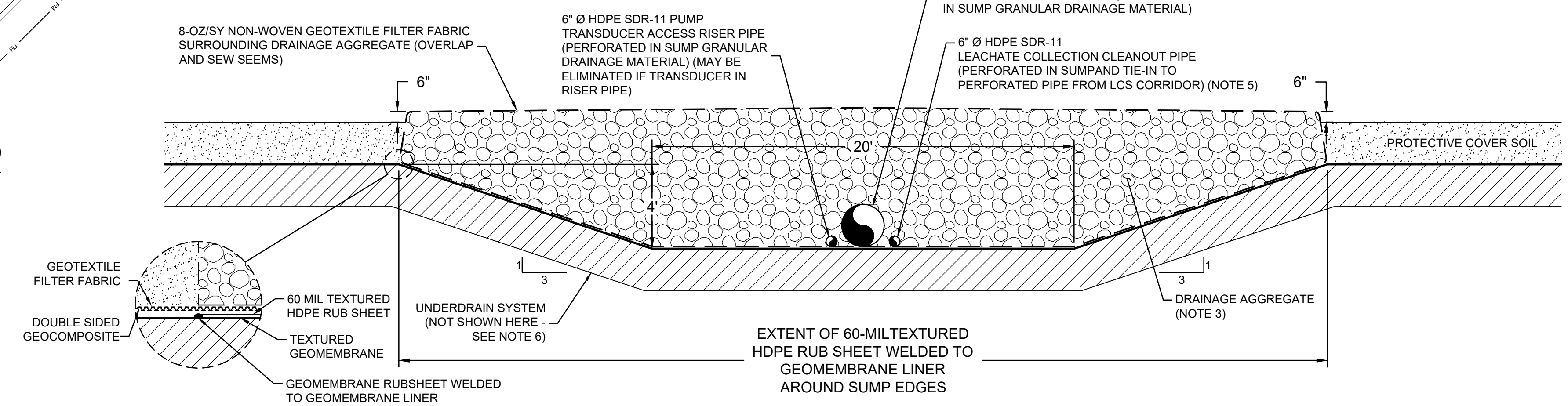
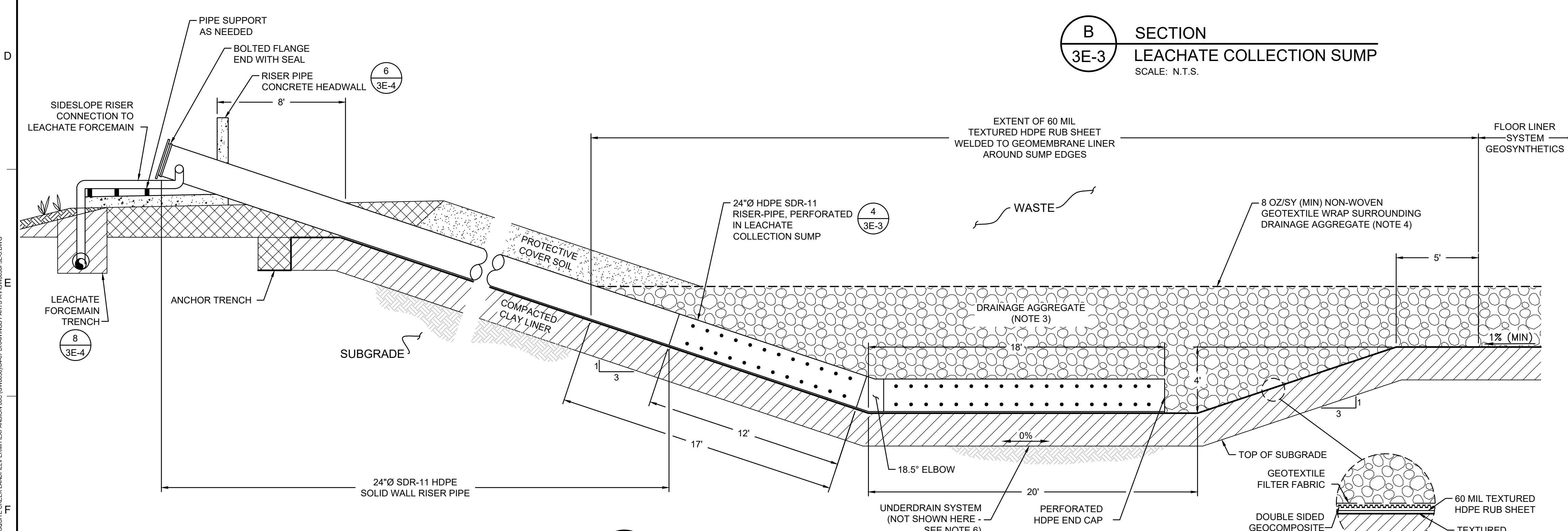


B 3E-3 SECTION
LEACHATE COLLECTION SUMP
SCALE: N.T.S.



C 3E-3 SECTION
LEACHATE RISER PIPE AT LANDFILL PERIMETER
SCALE: N.T.S.

NOTES:

1. MATERIAL THICKNESSES ARE MINIMUMS.
2. REQUIRED MATERIAL PROPERTIES AND QUALITY ASSURANCE / QUALITY CONTROL (QA / QC) PROCEDURES ARE GIVEN IN THE LINER QUALITY CONTROL PLAN (LQCP) IN PART III, ATTACHMENT 3C OF THE SITE DEVELOPMENT PLAN.
3. DRAINAGE AGGREGATE SHALL CONSIST OF WASHED NATURAL STONE OR GRAVEL, ROUNDED TO SUBROUNDED, FREE OF SHALE, CLAY, ORGANICS, FOREIGN OBJECTS, FRIABLE MATERIALS AND DEBRIS, AND NOT DERIVED FROM LIMESTONE OR DOLOMITE ORIGIN. THE DRAINAGE AGGREGATE SHALL HAVE A CALCIUM CARBONATE CONTENT OF LESS THAN 15 PERCENT AND SHALL MEET THE PARTICLE SIZE REQUIREMENTS SPECIFIED IN THE SOIL AND LINER QUALITY CONTROL PLAN (LQCP).
4. GEOTEXTILE WRAP SHALL BE PLACED IN DIRECT CONTACT WITH UNDERLYING GEOCOMPOSITE DRAINAGE LAYER.
5. AT THE FACILITY'S DISCRETION, THE LEACHATE CLEANOUT PIPE MAY BE PERFORATED ALONG THE LOWEST 1/3 OF THE SIDESLOPE.
6. REFER TO PART III, ATTACHMENT 3A, DRAWING 3A-15 FOR ENGINEERING DETAILS PRESENTING DESIGN INFORMATION (MATERIALS, DIMENSIONS, LAYOUT/SPACING, ETC.) ON THE UNDERDRAIN SYSTEM. THE DETAILS ON THIS DRAWING ARE FOCUSED ON SHOWING THE INFORMATION PERTAINING TO THE LEACHATE MANAGEMENT SYSTEM, AND ACCORDINGLY, THE UNDERDRAIN FEATURES ARE NOT PRESENTED ON THIS DRAWING TO EMPHASIZE THE LEACHATE MANAGEMENT SYSTEM INFORMATION PRESENTED HEREON.

STATE OF TEXAS
SCOTT M. GRAVES
86557
LICENSED PROFESSIONAL ENGINEER
2/19/2024

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REV	DATE	DESCRIPTION	DRN	APP
1	FEB. 2024	RESPONSE TO TECHNICAL NOD 1	JJV/KH	SMG
-	OCT. 2023	INITIAL SUBMITTAL TO TCEQ	JJV/KH	SMG

WASTE MANAGEMENT
WASTE MANAGEMENT OF TEXAS, INC.
1700 KOHLENBERG ROAD
NEW BRAUNFELS, TEXAS 78130
PHONE: 830.625.7894

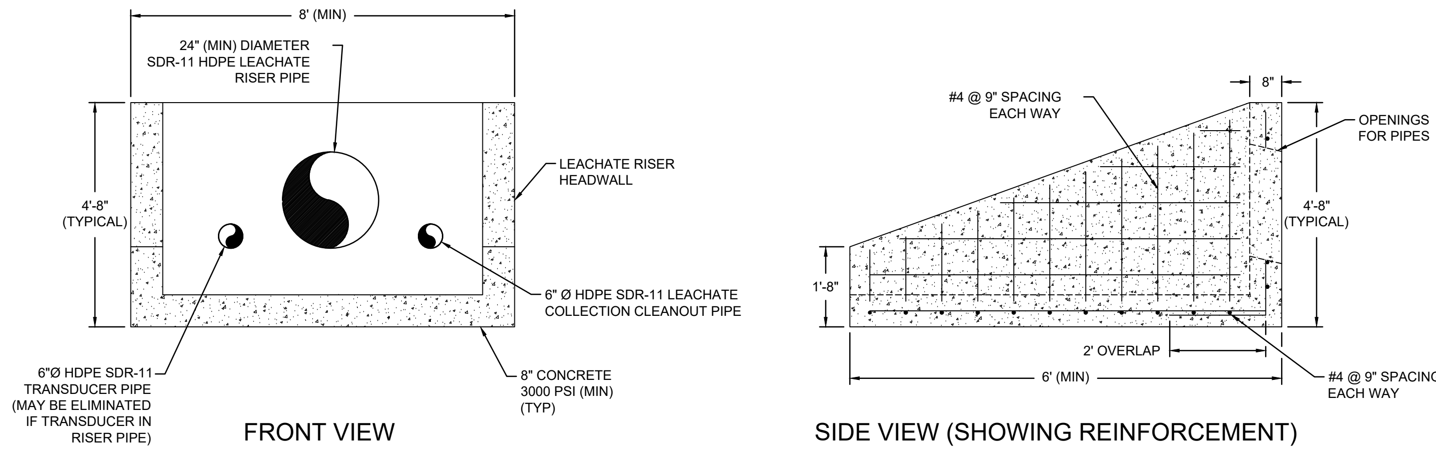
Geosyntec consultants
GEOSYNTEC CONSULTANTS, INC.
TEXAS ENG. FIRM REGISTRATION NUMBER 1182
8217 SHOAL CREEK BLVD, SUITE 200
AUSTIN, TEXAS 78757
PHONE: 512.451.4003

TITLE: LEACHATE MANAGEMENT SYSTEM DETAILS II

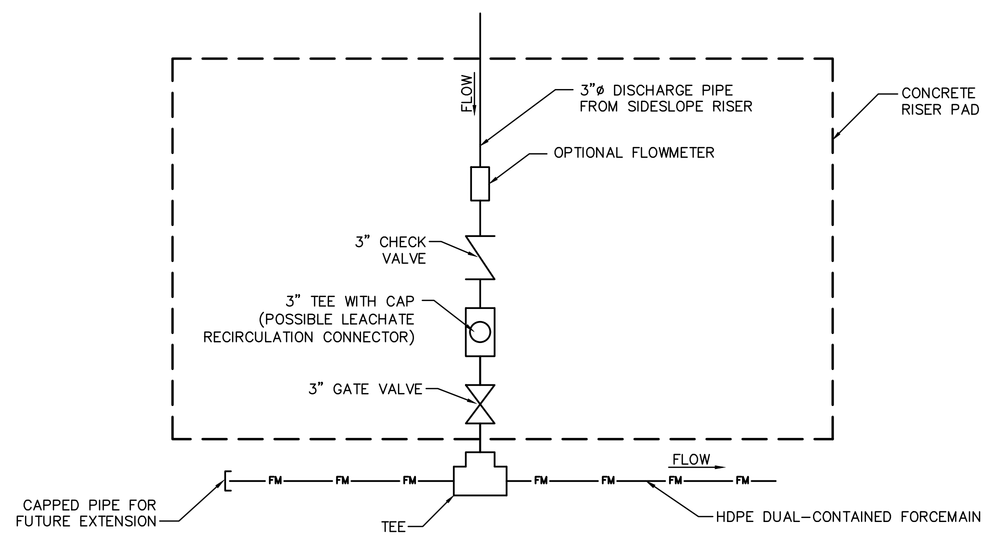
PROJECT: MESQUITE CREEK LANDFILL EXPANSION
PERMIT AMENDMENT APPLICATION - MSW PERMIT NO. 66C

PERMIT DRAWING

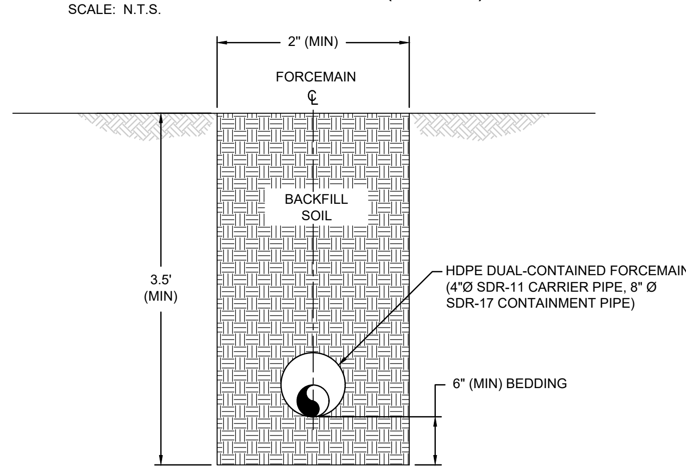
PROJECT NO.: GW8636	DESIGN BY: SMG	REVIEWED BY: YB	PART NO.: III	DRAWING: 3E-3
FILE: GW8636P3E-3	DRAWN BY: JJV / KH	APPROVED BY: SMG		



6 / 3E-3 DETAIL
RISER PIPE CONCRETE HEADWALL
SCALE: NOT TO SCALE (N.T.S.)



7 / - DETAIL
TYPICAL LEACHATE RISER CONNECTION
TO LEACHATE FORCEMAIN (NOTE 1)
SCALE: N.T.S.



8 / 3E-1B DETAIL
LEACHATE FORCEMAIN TRENCH
SCALE: N.T.S.

NOTE:

1. VALVES AND COMPONENTS OF RISER CONNECTION TO LEACHATE FORCEMAIN ARE A CONCEPTUAL SCHEMATIC AND MAY BE ADJUSTED TO PROVIDE NECESSARY FUNCTIONALITY.

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SCOTT M. GRAVES
86557
LICENSED
PROFESSIONAL ENGINEER
10/11/2023

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PERMIT DRAWING

REV	DATE	DESCRIPTION	DRN	APP

WASTE MANAGEMENT
WASTE MANAGEMENT OF TEXAS, INC.
1700 KOHLENBERG ROAD
NEW BRAUNFELS, TEXAS 78130
PHONE: 830.625.7894

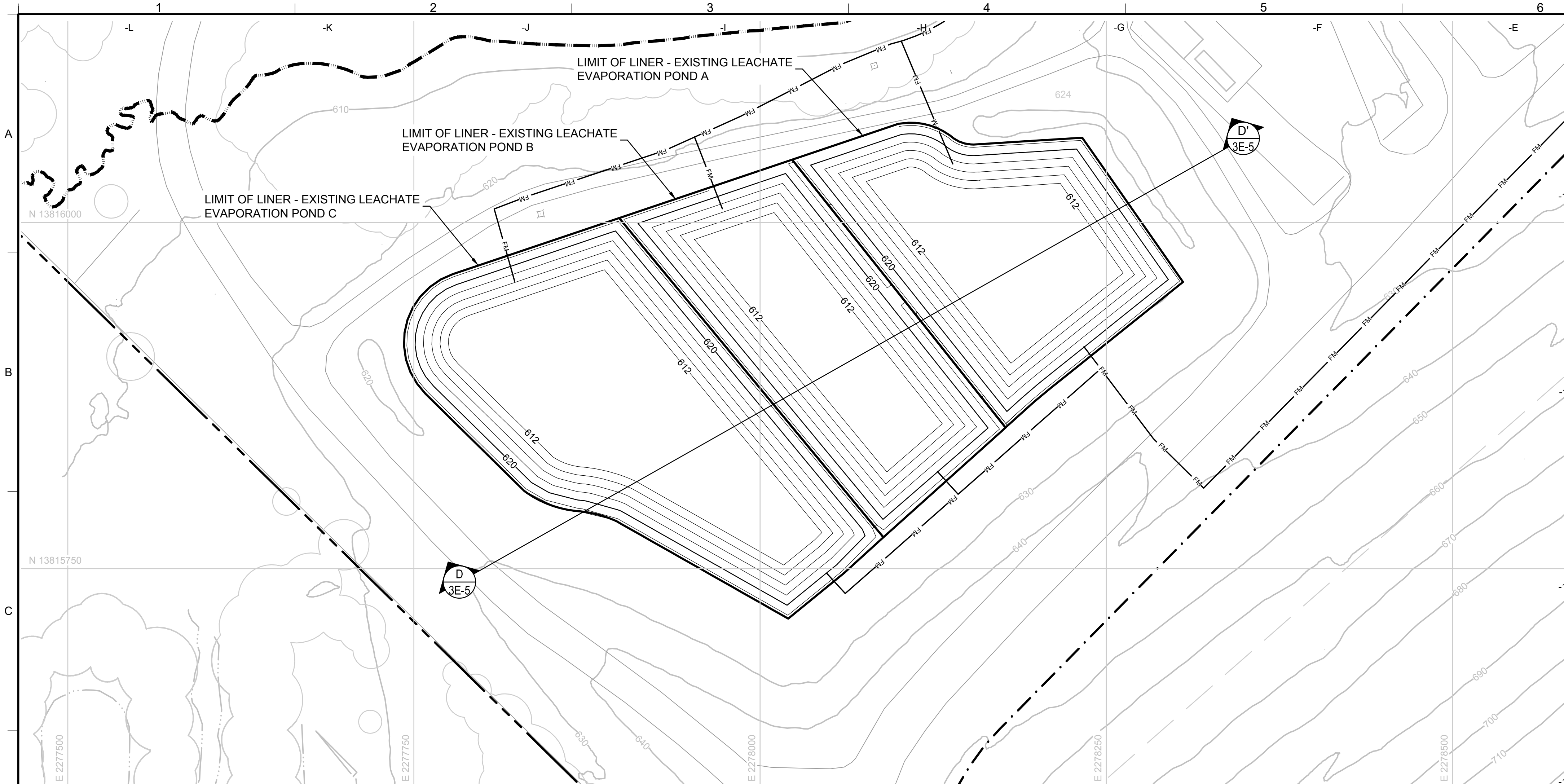
Geosyntec consultants
GEOSYNTEC CONSULTANTS, INC.
TEXAS ENG. FIRM REGISTRATION NUMBER 1182
8217 SHOAL CREEK BLVD, SUITE 200
AUSTIN, TEXAS 78757
PHONE: 512.451.4003

TITLE: LEACHATE MANAGEMENT SYSTEM DETAILS III

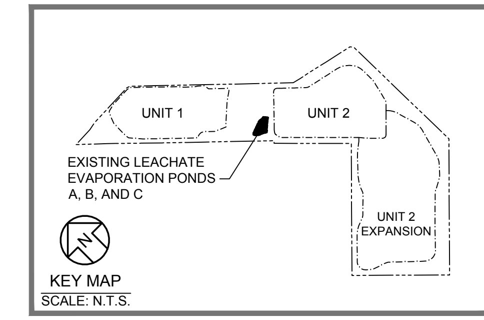
PROJECT: MESQUITE CREEK LANDFILL EXPANSION
PERMIT AMENDMENT APPLICATION - MSW PERMIT NO. 66C

PROJECT NO.: GW8636	DESIGN BY: SMG	REVIEWED BY: YB	PART NO.:	DRAWING:
FILE: GW8636P3E-4	DRAWN BY: JJV / KH	APPROVED BY: SMG	III	3E-4

AUS-01\P:\CADD\PROJECTS\MESQUITE CREEK LANDFILL\PERMIT EXPANSION 66C (GW8636)\04-07 DRAWINGS PARTS I-IV\GW8636P3E-4.DWG



9 (3E-1A) PLAN
EXISTING LEACHATE EVAPORATION PONDS A, B, AND C



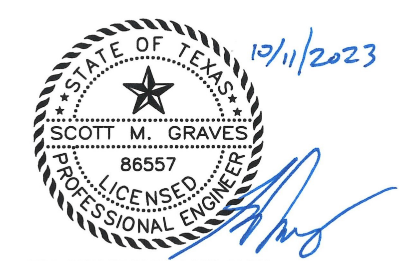
0 50' 100'
SCALE IN FEET

LEGEND

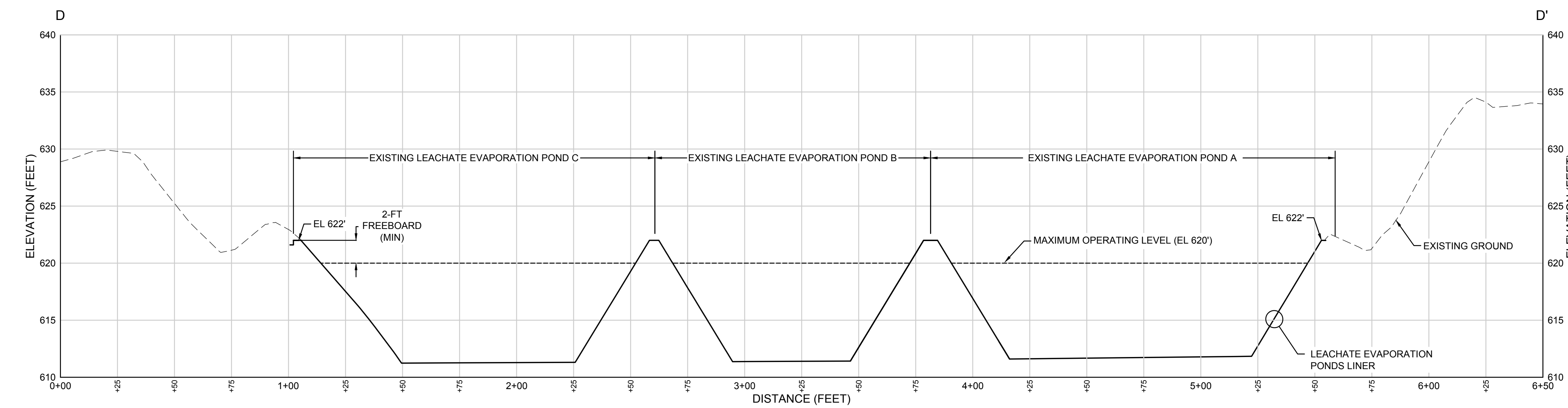
610	EXISTING GROUND ELEVATION CONTOUR (FT, MSL) (NOTES 1, 2)
620	TOP OF POND LINER ELEVATION
	PERMIT BOUNDARY
	LIMIT OF WASTE
	LIMIT OF EVAPORATION POND LINER
N 13816000 E 2278500	COORDINATE GRID (NOTE 2)
13–	SITE GRID
	100-YEAR FLOOD LIMITS (NOTE 5)

NOTES:

1. TOPOGRAPHIC BASE MAP OF EXISTING SITE CONDITIONS WAS GENERATED BY PHOTOGRAMMETRIC METHODS BASED ON AN AERIAL SURVEY FLOWN ON 15 FEBRUARY 2023 BY HYDREX ENVIRONMENTAL, AND BY DALLAS AERIAL SURVEYING (DAS) FLOWN IN 2018-2019. EXISTING TOPOGRAPHY OUTSIDE OF PROPERTY WHERE SHOWN SUPPLEMENTED WITH THE UNITED STATES GEOLOGIC SURVEY (USGS) 3DEP PROGRAM PUBLISHED IN NOVEMBER 2021.
2. ELEVATIONS ARE IN FEET ABOVE MEAN SEA LEVEL (FT, MSL). DRAWING COORDINATES ARE BASED ON TEXAS STATE PLANE SOUTH CENTRAL ZONE (4204) US FOOT COORDINATE SYSTEM, NORTH AMERICAN DATUM OF 1983 (NAD-83).
3. LEACHATE EVAPORATION PONDS A, B, AND C ARE EXISTING AND WILL CONTINUE TO BE USED.
4. LEACHATE EVAPORATION PONDS A, B, AND C ARE DOUBLE-LINED USING A GEOSYNTHETIC CLAY LINER BETWEEN TWO 60-MIL HDPE GEOMEMBRANES.
5. 100-YEAR FLOOD LIMITS TAKEN FROM AND DESCRIBED FURTHER ON DRAWING 3E-1B.



FOR PERMIT PURPOSES ONLY



D (3E-5) SECTION
EXISTING LEACHATE EVAPORATION PONDS A, B, AND C

0 30' 60'
HORIZONTAL SCALE IN FEET

0 6' 12'
VERTICAL SCALE IN FEET

PERMIT DRAWING

REV	DATE	DESCRIPTION	DRN	APP

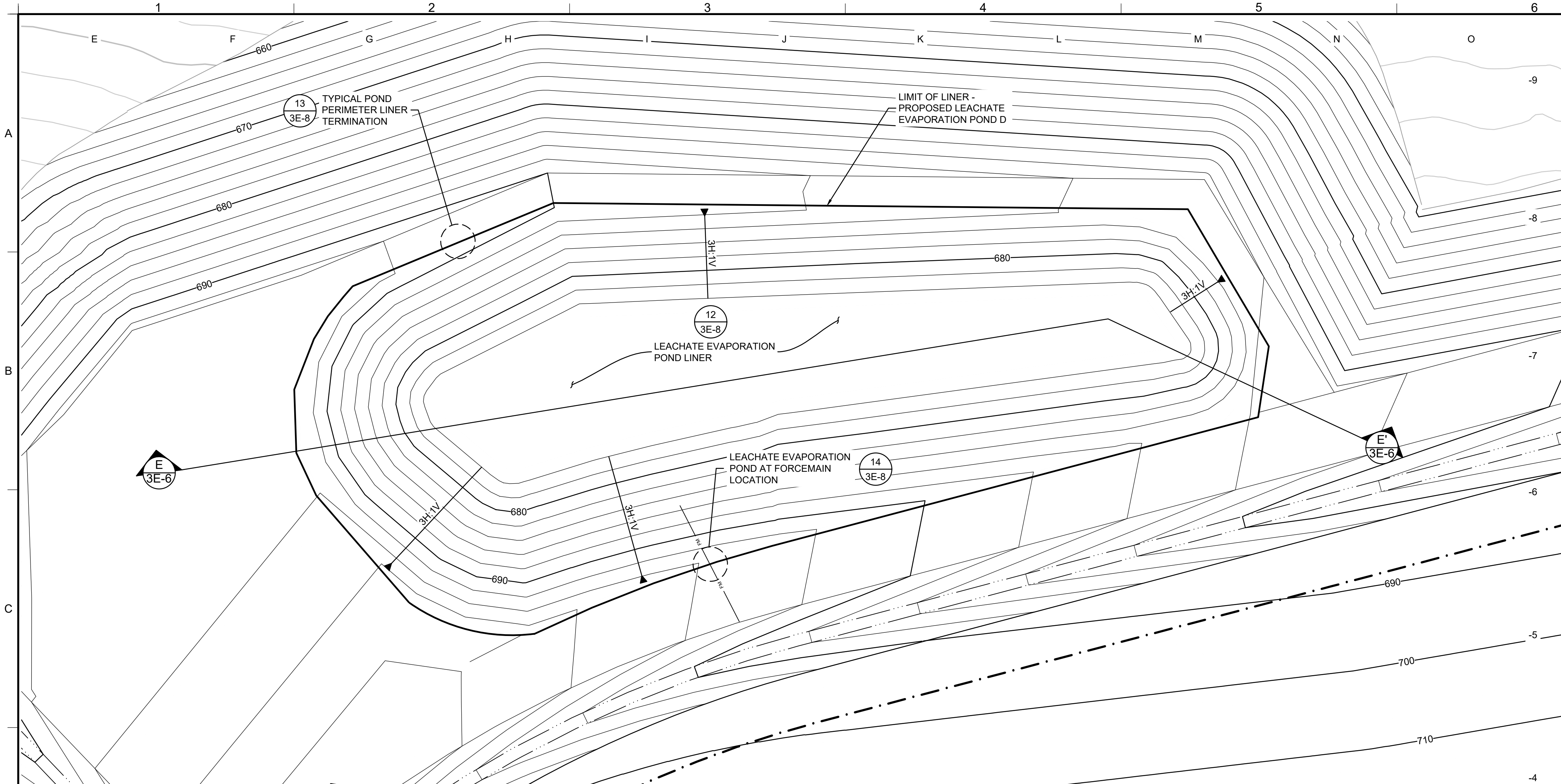
WASTE MANAGEMENT
WASTE MANAGEMENT OF TEXAS, INC.
1700 KOHLENBERG ROAD
NEW BRAUNFELS, TEXAS 78130
PHONE: 830.625.7894

Geosyntec consultants
GEOSYNTEC CONSULTANTS, INC.
TEXAS ENG. FIRM REGISTRATION NUMBER 1182
8217 SHOAL CREEK BLVD, SUITE 200
AUSTIN, TEXAS 78757
PHONE: 512.451.4003

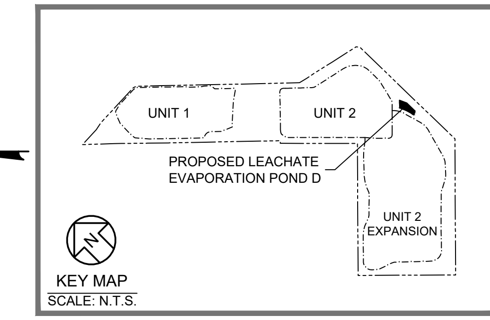
TITLE: LEACHATE EVAPORATION PONDS A, B, AND C

PROJECT: MESQUITE CREEK LANDFILL EXPANSION
PERMIT AMENDMENT APPLICATION - MSW PERMIT NO. 66C

PROJECT NO.:	GW8636	DESIGN BY:	SMG	REVIEWED BY:	YB	PART NO.: III	DRAWING: 3E-5
FILE:	GW8636P3E-5	DRAWN BY:	JJV / KH	APPROVED BY:	SMG		



10
3E-1B
PLAN
LEACHATE EVAPORATION POND D



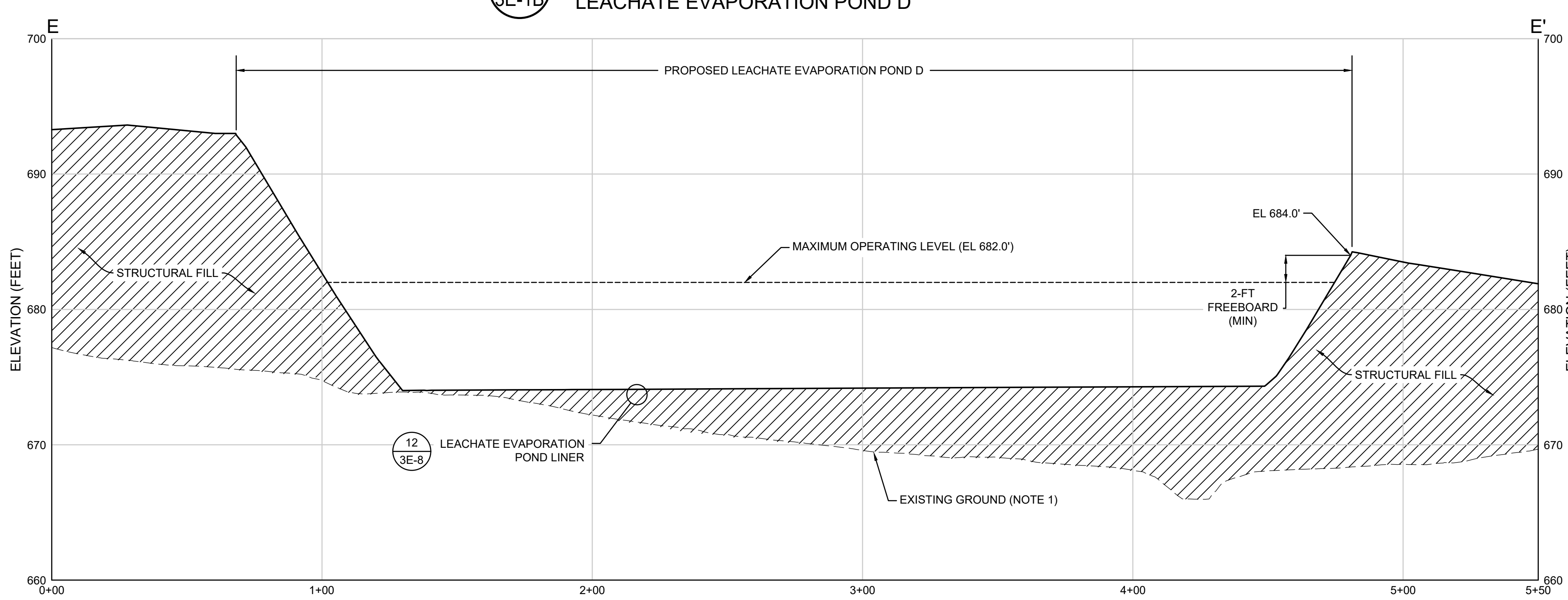
0 30' 60'
SCALE IN FEET

LEGEND

406	EXISTING GROUND ELEVATION CONTOUR (FT, MSL) (NOTES 1, 2)
620	TOP OF POND LINER ELEVATION
	LIMIT OF WASTE
	LIMIT OF EVAPORATION POND LINER
N 13816000 E 2278500	COORDINATE GRID (NOTE 2)
13 A	SITE GRID

NOTES:

1. TOPOGRAPHIC BASE MAP OF EXISTING SITE CONDITIONS WAS GENERATED BY PHOTOGRAMMETRIC METHODS BASED ON AN AERIAL SURVEY FLOWN ON 15 FEBRUARY 2023 BY HYDREX ENVIRONMENTAL, AND BY DALLAS AERIAL SURVEYING (DAS) FLOWN IN 2018-2019. EXISTING TOPOGRAPHY OUTSIDE OF PROPERTY WHERE SHOWN SUPPLEMENTED WITH THE UNITED STATES GEOLOGIC SURVEY (USGS) 3DEP PROGRAM PUBLISHED IN NOVEMBER 2021.
2. ELEVATIONS ARE IN FEET ABOVE MEAN SEA LEVEL (FT, MSL). DRAWING COORDINATES ARE BASED ON TEXAS STATE PLANE SOUTH CENTRAL ZONE (4204) US FOOT COORDINATE SYSTEM, NORTH AMERICAN DATUM OF 1983 (NAD-83).
3. PROPOSED LEACHATE EVAPORATION POND D IS OPTIONAL AND WILL BE CONSTRUCTED AS NEEDED BASED ON ACTUAL FACILITY LEACHATE GENERATION QUANTITIES.



0 30' 60'
HORIZONTAL SCALE IN FEET

0 6' 12'
VERTICAL SCALE IN FEET

E
3E-6
SECTION
LEACHATE EVAPORATION POND D

STATE OF TEXAS
SCOTT M. GRAVES
86557
LICENSED
PROFESSIONAL ENGINEER
10/11/2023

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REV	DATE	DESCRIPTION	DRN	APP

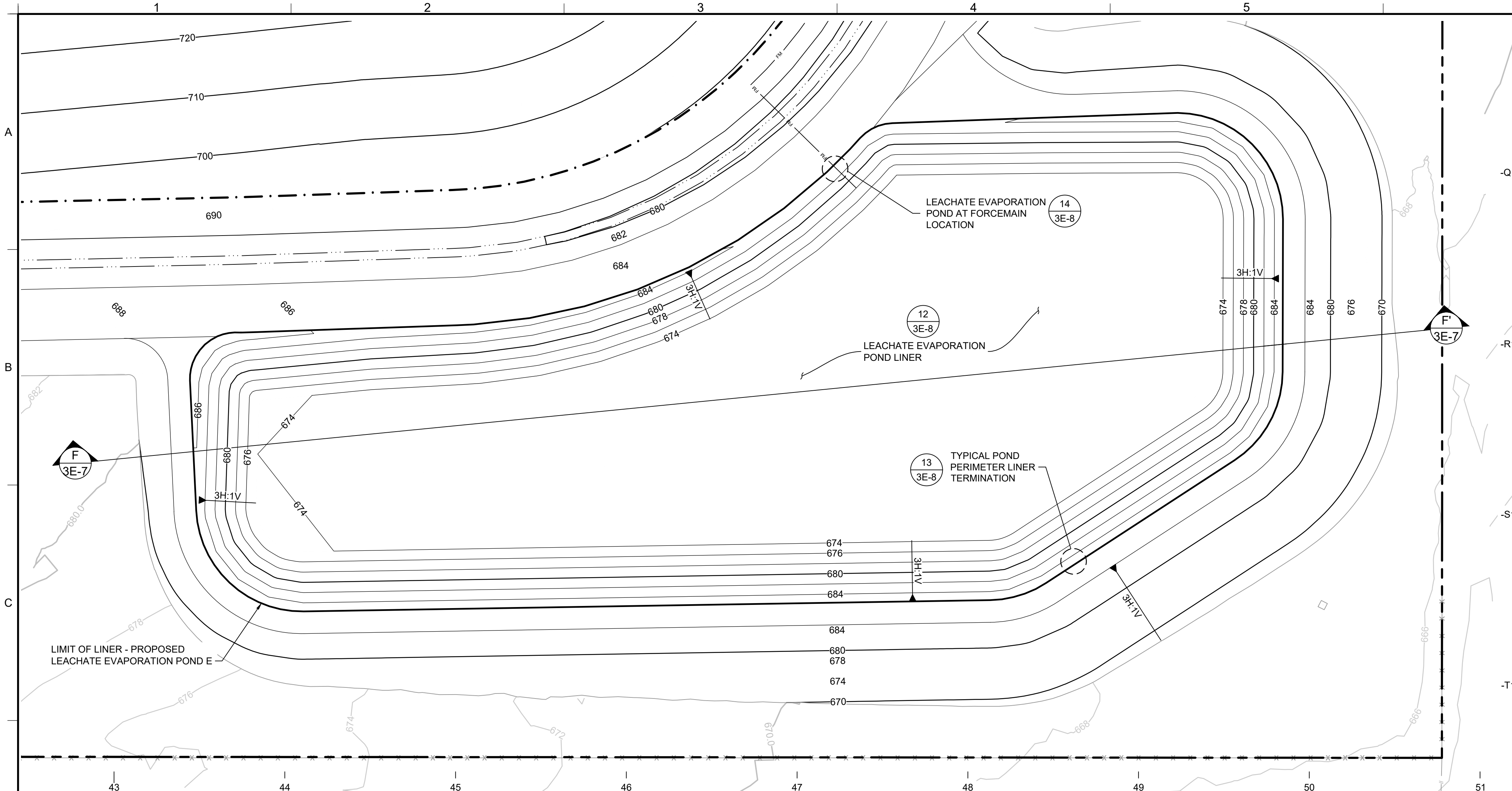
WM
WASTE MANAGEMENT
WASTE MANAGEMENT OF TEXAS, INC.
1700 KOHLENBERG ROAD
NEW BRAUNFELS, TEXAS 78130
PHONE: 830.625.7894

Geosyntec consultants
GEOSYNTEC CONSULTANTS, INC.
TEXAS ENG. FIRM REGISTRATION NUMBER 1182
8217 SHOAL CREEK BLVD, SUITE 200
AUSTIN, TEXAS 78757
PHONE: 512.451.4003

TITLE:
LEACHATE EVAPORATION POND D

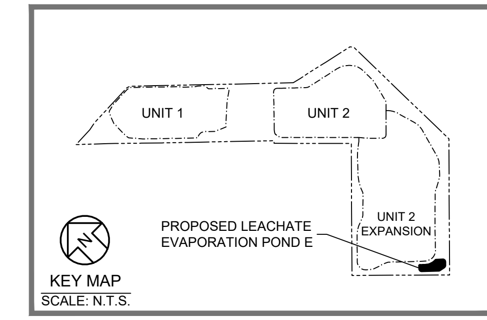
PROJECT:
MESQUITE CREEK LANDFILL EXPANSION
PERMIT AMENDMENT APPLICATION - MSW PERMIT NO. 66C

PROJECT NO.: GW8636	DESIGN BY: SMG	REVIEWED BY: YB	PART NO.: III	DRAWING: 3E-6
FILE: GW8636P3E-6	DRAWN BY: JJV / KH	APPROVED BY: SMG		



11 / 3E-1B PLAN
LEACHATE EVAPORATION POND E

0 40' 80'
SCALE IN FEET



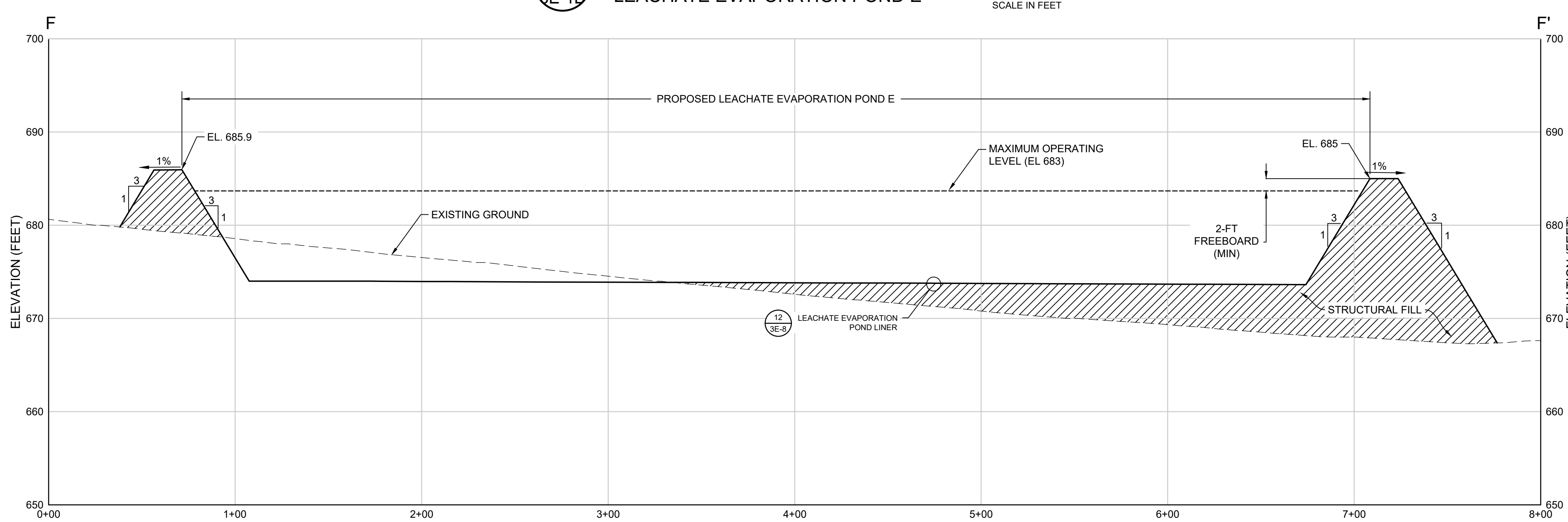
KEY MAP
SCALE: N.T.S.

LEGEND

406	EXISTING GROUND ELEVATION CONTOUR (FT, MSL) (NOTES 1, 2)
620	TOP OF POND LINER ELEVATION
	PERMIT BOUNDARY
	LIMIT OF WASTE
	LIMIT OF EVAPORATION POND LINER
N 13816000 E 2278500	COORDINATE GRID (NOTE 2)
13–A	SITE GRID

NOTES:

1. TOPOGRAPHIC BASE MAP OF EXISTING SITE CONDITIONS WAS GENERATED BY PHOTOGRAMMETRIC METHODS BASED ON AN AERIAL SURVEY FLOWN ON 01 FEBRUARY 2022 BY HYDREX ENVIRONMENTAL. EXISTING TOPOGRAPHY IN OBSCURED AREAS AND / OR OUTSIDE OF PROPERTY WHERE SHOWN SUPPLEMENTED WITH THE UNITED STATES GEOLOGIC SURVEY (USGS) 3DEP PROGRAM, 3 METER RESOLUTION LIDAR FLOWN IN 2011.
2. ELEVATIONS ARE IN FEET ABOVE MEAN SEA LEVEL (FT, MSL), AS DEFINED BY THE NORTH AMERICAN VERTICAL DATUM OF 1988. COORDINATE GRID REPRESENTS SITE COORDINATES BASED ON TEXAS CENTRAL ZONE (4203) COORDINATE SYSTEM, NORTH AMERICAN DATUM OF 1983 (NAD-83).
3. PROPOSED LEACHATE EVAPORATION POND E IS OPTIONAL AND WILL BE CONSTRUCTED AS NEEDED BASED ON ACTUAL FACILITY LEACHATE GENERATION QUANTITIES.



F / 3E-7 SECTION
LEACHATE EVAPORATION POND E

0 40' 80'
HORIZONTAL SCALE IN FEET

0 8' 16'
VERTICAL SCALE IN FEET

STATE OF TEXAS
SCOTT M. GRAVES
86557
LICENSED
PROFESSIONAL ENGINEER

10/11/2023

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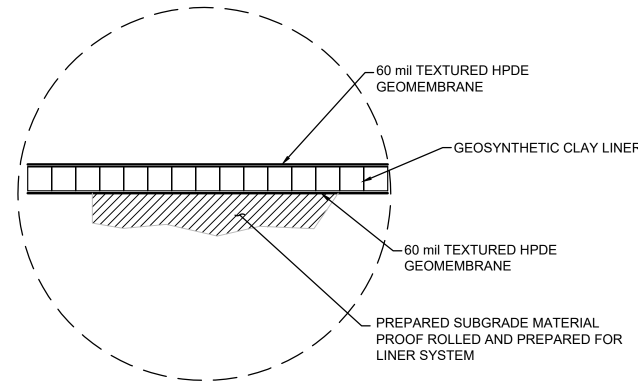
WASTE MANAGEMENT
WASTE MANAGEMENT OF TEXAS, INC.
1700 KOHLENBERG ROAD
NEW BRAUNFELS, TEXAS 78130
PHONE: 830.625.7894

Geosyntec consultants
GEOSYNTEC CONSULTANTS, INC.
TEXAS ENG. FIRM REGISTRATION NUMBER 1182
8217 SHOAL CREEK BLVD, SUITE 200
AUSTIN, TEXAS 78757
PHONE: 512.451.4003

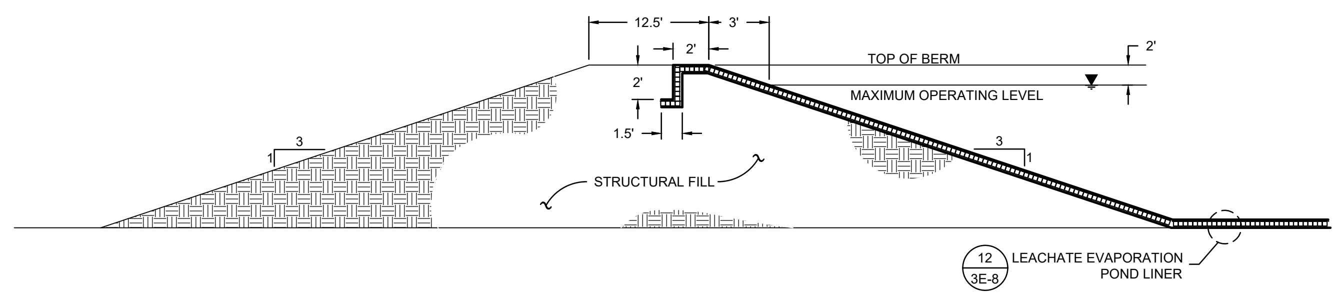
TITLE: LEACHATE EVAPORATION POND E

PROJECT: MESQUITE CREEK LANDFILL EXPANSION
PERMIT AMENDMENT APPLICATION - MSW PERMIT NO. 66C

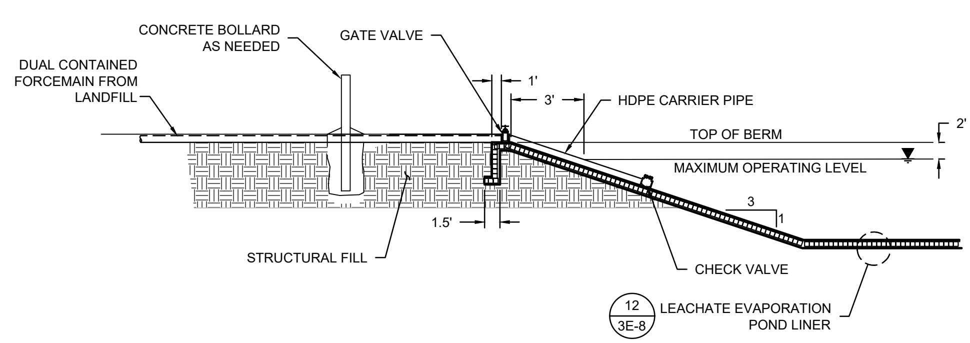
PROJECT NO.: GW8636	DESIGN BY: SMG	REVIEWED BY: YB	PART NO.: III	DRAWING: 3E-7
FILE: GW8636P3E-7	DRAWN BY: JJV / KH	APPROVED BY: SMG		



12
3E-6
DETAIL
LEACHATE EVAPORATION POND LINER
SCALE; N.T.S



13
3E-6
DETAIL
TYPICAL LEACHATE EVAPORATION POND PERIMETER LINER TERMINATION
SCALE: N.T.S.



14
3E-6
DETAIL
LEACHATE EVAPORATION POND AT FORCEMAIN LOCATION
SCALE: N.T.S.
NOTE:

1. LEACHATE TRANSFER FORCEMAIN RISER PIPE TO BE COVERED WITH STRUCTURAL FILL OR STAKED TO PREVENT EXCESSIVE MOVEMENT OF PIPE DUE TO THERMAL EXPANSION/CONTRACTION

STATE OF TEXAS
SCOTT M. GRAVES
86557
LICENSED
PROFESSIONAL ENGINEER
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1	FEB. 2024	RESPONSE TO TECHNICAL NOD 1	JJV/KH	SMG
-	OCT. 2023	INITIAL SUBMITTAL TO TCEQ	JJV/KH	SMG

WASTE MANAGEMENT
WASTE MANAGEMENT OF TEXAS, INC.
1700 KOHLENBERG ROAD
NEW BRAUNFELS, TEXAS 78130
PHONE: 830.625.7894

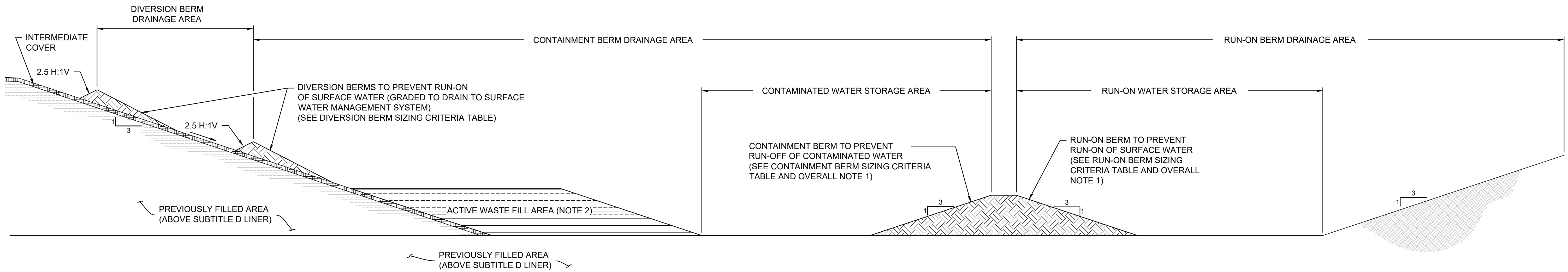
Geosyntec consultants
GEOSYNTEC CONSULTANTS, INC.
TEXAS ENG. FIRM REGISTRATION NUMBER 1182
8217 SHOAL CREEK BLVD, SUITE 200
AUSTIN, TEXAS 78757
PHONE: 512.451.4003

TITLE:
LEACHATE EVAPORATION POND DETAILS

PROJECT:
MESQUITE CREEK LANDFILL EXPANSION
PERMIT AMENDMENT APPLICATION - MSW PERMIT NO. 66C

PROJECT NO.:	GW8636	DESIGN BY:	SMG	REVIEWED BY:	YB	PART NO.:	DRAWING:	
FILE:	GW8636P3E-8	DRAWN BY:	JJV / MDN	APPROVED BY:	SMG	III	3E-8	

PERMIT DRAWING



NOT TO SCALE (N.T.S.)

DIVERSION BERM SIZING CRITERIA

DEPTH OF CHANNEL	DIVERSION BERM FLOW LINE SLOPE	MAXIMUM PREDICTED FLOW VELOCITY	MAXIMUM PREDICTED FLOW RATE	MAXIMUM DRAINAGE AREA
(FT)	(%)	(FT/S)	(CFS)	(AC)
2.5	0.5%	5.9	100.8	18.2
	1.0%	8.3	142.5	25.8
	1.5%	10.2	174.5	31.6
	2.0%	11.7	201.6	36.5

NOTES:

1. THE DIVERSION BERMS ARE SIZED TO CONTAIN SURFACE WATER FROM THE 25-YEAR, 24-HOUR RAINFALL EVENT. DRAINAGE CALCULATIONS AND SIZING DESIGN ARE PROVIDED IN PART III, ATTACHMENT 2E.
2. OPERATOR WILL USE THIS TABLE AND THE ACTUAL FLOW LINE SLOPE TO DETERMINE THE MAXIMUM ALLOWABLE DRAINAGE AREA CONTRIBUTING RUNOFF TO A GIVEN BERM.

CONTAINMENT BERM SIZING CRITERIA

CONTAINMENT BERM DRAINAGE AREA	CONTAMINATED WATER STORAGE AREA	MINIMUM REQUIRED BERM HEIGHT
(AC)	(AC)	(FT)
0.50	0.10	4.7
	0.25	2.5
	0.50	1.7
1.0	0.10	8.4
	0.25	4.0
	0.50	2.5
1.5	0.25	5.5
	0.50	3.2
	0.75	2.5
2.0	0.25	6.9
	0.50	4.0
	0.75	3.0
3.0	0.40	6.6
	0.75	4.0
	1.00	3.2
4.0	0.50	6.9
	0.75	5.0
	1.00	4.0

NOTES:

1. THE CONTAINMENT BERM HEIGHT INCLUDES 1.0 FT OF FREEBOARD, AND BERMS ARE SIZED TO CONTAIN SURFACE WATER FROM THE 25-YEAR, 24-HOUR RAINFALL EVENT. DRAINAGE CALCULATIONS AND SIZING DESIGN ARE PROVIDED IN PART III, ATTACHMENT 2E.
2. OPERATOR WILL USE THIS TABLE AND ACTUAL WORKING FACE/DRAINAGE AREA SIZE AND STORAGE AREA SIZE TO DETERMINE THE APPROPRIATE MINIMUM CONTAINMENT BERM SIZE.

RUN-ON BERM SIZING CRITERIA

RUN-ON BERM DRAINAGE AREA	RUN-ON WATER STORAGE AREA	MINIMUM REQUIRED BERM HEIGHT
(AC)	(AC)	(FT)
2.0	0.25	6.9
	0.50	4.0
	0.75	3.0
4.0	0.50	6.9
	0.75	5.0
	1.00	4.0
10.0	1.00	8.4
	2.00	4.7
	3.00	3.5
15.0	2.00	6.6
	3.00	4.7
	4.00	3.8
20.0	2.00	8.4
	3.00	5.9
	4.00	4.7
25.0	3.00	7.2
	4.00	5.6
	5.00	4.7
30.0	3.00	8.4
	4.00	6.6
	5.00	5.5

NOTES:

1. THE RUN-ON BERM HEIGHT INCLUDES 1.0 FT OF FREEBOARD AND BERMS ARE SIZED TO CONTAIN SURFACE WATER FROM THE 25-YEAR, 24-HOUR RAINFALL EVENT.DRAINAGE CALCULATIONS AND SIZING DESIGN ARE PROVIDED IN PART III, ATTACHMENT 2E.
2. OPERATOR WILL USE THIS TABLE AND ACTUAL DRAINAGE AREA SIZE AND STORAGE AREA SIZE TO DETERMINE THE APPROPRIATE MINIMUM RUN-ON BERM SIZE.

OVERALL NOTE:

1. ONE BERM MAY PROVIDE BOTH FUNCTIONS (CONTAINMENT ON ONE SIDE AND RUN-ON STORAGE/PROTECTION ON THE OTHER SIDE) PROVIDED IT IS SIZED TO THE LARGER OF THE APPLICABLE CRITERIA IN THE TABLES ON THIS DRAWING.
2. REFER TO PART IV (SITE OPERATING PLAN) FOR WORKING FACE SIZE REQUIREMENTS.

STATE OF TEXAS
SCOTT M. GRAVES
86557
LICENSED
PROFESSIONAL ENGINEER
2/19/2024

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-	OCT. 2023	INITIAL SUBMITTAL TO TCEQ	JJV/KH	SMG

WASTE MANAGEMENT
WASTE MANAGEMENT OF TEXAS, INC.
1700 KOHLENBERG ROAD
NEW BRAUNFELS, TEXAS 78130
PHONE: 830.625.7894

Geosyntec consultants
GEOSYNTEC CONSULTANTS, INC.
TEXAS ENG. FIRM REGISTRATION NUMBER 1182
8217 SHOAL CREEK BLVD, SUITE 200
AUSTIN, TEXAS 78757
PHONE: 512.451.4003

TITLE: CONTAMINATED RUN-ON AND RUNOFF DETAILS

PROJECT: MESQUITE CREEK LANDFILL EXPANSION
PERMIT AMENDMENT APPLICATION - MSW PERMIT NO. 66C

PROJECT NO.: GW8636	DESIGN BY: SMG	REVIEWED BY: YB	PART NO.: III	DRAWING: 3E-9
FILE: GW8636P3E-9	DRAWN BY: JJV / KH	APPROVED BY: SMG		

PERMIT DRAWING

ATTACHMENT 3E.2

LEACHATE GENERATION RATES AND HEAD ON LINER (*HELP* MODEL CALCULATIONS)

Written by:	Y. Bholat	Date:	2/13/23	Reviewed & Revised by:	S. Graves	Date:	8/3/23; 2/19/24
Client:	WMTX	Project:	Mesquite Creek	Project No.:	GW8636	Task No.:	05

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LEACHATE GENERATION RATES AND HEAD ON LINER
(*HELP* MODEL CALCULATIONS)

2/19/2024

STATE OF TEXAS
SCOTT M. GRAVES
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INTRODUCTION

The purposes of this analysis are to:

- estimate the design leachate collection rates in the leachate collection system for various operation conditions;
- calculate the design hydraulic conductivity and transmissivity of the leachate drainage layer in the leachate collection system;
- evaluate the maximum leachate head on the liner system for compliance with the Texas Commission on Environmental Quality (TCEQ) regulations, which require the maximum head of leachate to be less than 30 cm (12 in.) [30 TAC §330.331(a)(2)]; and
- evaluate the implementation of leachate recirculation.

METHOD OF ANALYSIS

The leachate collection rates and maximum leachate head on the liner system were estimated using the Hydrologic Evaluation of Landfill Performance (*HELP*) computer model, Version 3.95 D, developed by Dr. Klaus Berger of the University of Hamburg, Institute of Soil Science. *HELP* simulates hydrologic processes for a landfill by performing daily, sequential water balance analyses using a quasi-two-dimensional, deterministic approach (Berger and Schroeder, 2013; Schroeder et al., 1994a, 1994b).

The hydrologic processes considered in the *HELP* model include precipitation, surface-water evaporation, runoff, infiltration, plant transpiration, soil water evaporation, soil water storage, vertical drainage (saturated and unsaturated), lateral drainage (saturated), vertical drainage (saturated) through compacted soil liners, and leakage through geomembranes.

The volumetric flow rate from the leachate collection system for a given plan area of liner system was calculated as:

$$Q = q_i \times A_d \qquad (1)$$

where:

Q = volumetric flow rate of leachate from a given plan area of liner system;

q_i = unitized flow rate from the leachate collection system drainage layer as calculated using the *HELP* model (see Appendix 3E.2-1); and

A_d = plan area of liner system drained by the leachate collection system drainage layer.

ANALYSIS CASES AND SCENARIOS

The Mesquite Creek Landfill consists of two areas: referred to in this calculation package as the "New Fill (NF)" and "Existing Fill (EF)" areas. These areas are further described below.

- The New Fill is the proposed lateral expansion area and consists of Phases VII through XIV.
- The Existing Fill area consists of Unit 2 Phases I through VI.

The base grades with Unit 2 Phase designations are shown on Drawing 3E-1B. The Existing Fill area has the base grades constructed (in all areas except Phase VI South, currently under construction in Fall 2023). The New Fill area has not been constructed.

Five scenarios representing the range of configurations and conditions at the landfill over time as it is operated and closed were considered herein for the New Fill area; one additional scenario was evaluated for leachate recirculation. Additionally, one critical scenario was evaluated for the Existing Fill area. The leachate generation rate and maximum leachate head on the floor of the liner system were calculated. These conditions are as follows.

- New Fill Area
  - Case (NF1) - Initial conditions: 6-inches of daily cover soil on 10-ft of waste overlying 2-ft of protective cover on top of the liner system.
  - Case (NF2) - Intermediate conditions: 12-inches of intermediate cover soil on 75-ft of waste overlying 2-ft of protective cover on top of the liner system.
  - Case (NF2-R) - Same condition as Case NF2, except that a specified percentage of the leachate collected in the geocomposite drainage layer is recirculated back into the waste.
  - Case (NF3) - Intermediate conditions: 12-inches of daily cover soil on 150-ft of waste overlying 2-ft of protective cover on top of the liner system.
  - Case (NF4) - Final condition after to installation of final cover: standard Subtitle D final cover system on 150-ft of waste overlying 2-ft of protective cover on top of the liner system.

One additional case (NF5) was modeled to assess the required drainage layer transmissivity for the sideslope liner system. This case was the same as case NF3 for the New Fill area, except that the sideslope liner system slope and drainage length rather than the floor liner system slope and drainage length were input into the model and the average material thickness over the slope was used. Recirculation of leachate in the waste above the sideslope is not proposed, so recirculation was not considered in the *HELP* model evaluations of the sideslope liner system. The sideslope conditions is:

  - Case (NF5) - Intermediate conditions: 12-inches of intermediate cover soil on 65-ft of waste overlying 2-ft of protective cover on top of the liner system.

- Existing Fill Area
  - Case (EF1) - Initial conditions (i.e., the critical condition): 6-inches of daily cover soil on 10-ft of waste overlying 2-ft of protective cover on top of the liner system.

Case EF1 was selected to check and confirm adequate performance in existing areas of Unit 2 (previously designed and approved under the previous permit, and not being changed), and therefore only the most critical case governing head-on-liner and drainage layer design was evaluated for this area.

Case NF2-R was used to assess the maximum volume of leachate that could be recirculated without exceeding the allowable leachate head on the liner (i.e., 12 in. or the thickness of drainage layer, whichever is less). To evaluate the effects of leachate recirculation, the *HELP* model's default recirculation method was used. This method assumes that a specified percentage of leachate collected from the lateral drainage layer is stored during the day and then uniformly distributed the next day into a specified layer, assumed to be the waste layer for the calculations herein. The percentage of recirculated leachate remains constant on a daily basis (i.e., the recirculated leachate volume varies depending on how much is collected) and was calculated by varying the percentage until the allowable hydraulic head on the liner was obtained.

The allowable recirculation rates obtained from *HELP* do not consider the initially dry conditions of the waste. The initial water contents of all of the materials were calculated by *HELP* and are based on near steady-state conditions as calculated by *HELP*. The calculated recirculation rates are also based only on the criteria of not exceeding the maximum allowable head on the liner system. Other factors that may control the amount of leachate that can be recirculated, such as slope stability, preferential flow within the waste, and gas well performance, are not considered herein.

The liner system of the cells at the landfill consists of the following components, from top to bottom:

- Protective cover: 2-ft thick soil;
- Geocomposite drainage layer (Double-sided);
- 60-mil thick textured high-density polyethylene (HDPE) geomembrane liner; and
- 2-ft thick compacted clay liner.

The standard Subtitle D final cover system consists of the following components, from top to bottom:

- 0.5-ft thick topsoil layer;
- 1.5-ft thick protective cover soil layer;
- Geocomposite drainage layer (Double-sided when textured geomembrane is used);
- 40-mil thick textured LLDPE geomembrane cover; and
- 1.5-foot thick compacted soil.

PARAMETERS USED IN ANALYSIS

The *HELP* model requires the input of daily weather data, vegetation data, soils data, and landfill design data. The input data are described in this section and summarized on the *HELP* model output presented in Appendix 3E.2-1.

Weather Data

Synthetic weather data was generated for the Mesquite Creek Landfill using climate data for San Antonio, Texas and adjusted using normal mean monthly weather data for nearby New Braunfels, Texas. Simulation periods of 30 years, 40 years, and 70 years were used to synthetically generate precipitation data for initial, intermediate, and final cover conditions, respectively. The peak daily rainfall from the synthetically generated precipitation record was manually increased to model the impact of the 25-year, 24-hour storm event. The 25-year, 24-hour storm intensity was estimated to be 8.90 in. based on information from the NOAA Atlas 14 Point Precipitation Frequency Estimates (NOAA Hydrometeorological Design Studies Center, retrieved 3-Oct-2022) as shown in Table 3E.2-1.

Vegetation Data

For final cover system cases, the final cover system ground surface was assumed to have good vegetation, with a maximum leaf area index of 3.0. For intermediate conditions, poor grass with a maximum leaf index of 1.0 was assumed. For initial conditions, the vegetative cover was assumed to be bare ground with a maximum leaf index of 0. An evaporative zone depth of 10 in. was selected for all cases.

Soils Data

Cover Soil for Final Cover System

The cover soil of the final cover system was modeled as a vertical percolation layer with *HELP* material texture 24 (representative of low-density CL soil).

Geosynthetic Drainage Layer for Final Cover System

A stand-alone design calculation package for sizing of the final cover system drainage layer geocomposite is presented in Part III, Attachment 3G. The final cover geosynthetic drainage layer modeled in this package is solely for purposes of evaluating the final closure/post-closure condition of the overall landfill with final cover, as it relates to design and performance of the leachate collection system (bottom liner). The geocomposite drainage layer was modeled as a lateral drainage layer with *HELP* material texture 20 (representative of 0.2-in. thick geonet drainage layer).

Geomembrane Cover for Final Cover System

The geomembrane cover was modeled as a flexible membrane liner with *HELP* material texture 36 (representative of LLDPE geomembrane), installation condition = good, pinhole defect frequency = 2 per acre, and installation defect frequency = 2 per acre. This hole frequency is an assumption for design purposes only and is not a reflection of the expected or allowable hole density.

Compacted Soil for Final Cover System

The compacted soil cover was modeled as a vertical percolation layer with *HELP* material texture 16, representative of heavily compacted clay soil, but with the hydraulic conductivity adjusted to 1×10^{-5} cm/s based on the specified requirements for the infiltration layer of the final cover system.

Daily and Intermediate Cover Soil

The daily and intermediate cover layers were modeled as vertical percolation layers with *HELP* material texture 15 (representative of low-density CH soil).

Waste

The waste layer was modeled as a vertical percolation layer with *HELP* material texture 18 (representative of municipal solid waste with $k = 1.0 \times 10^{-3}$ cm/s).

Protective Cover Layer for Liner System

The protective cover layer is modeled as a vertical percolation layer with *HELP* material texture 25 (representative of clayey protective cover material with $k = 3.6 \times 10^{-6}$ cm/s).

Geosynthetic Drainage Layer for Liner System

The leachate collection system consists of a geocomposite drainage layer responsible for lateral drainage of percolating and collected leachate. The geocomposite drainage layer of the liner system was modeled as a lateral drainage layer with *HELP* material texture 20 (representative of 0.2-in. thick geonet drainage layer). The design hydraulic conductivity (k) of the drainage layer was back-calculated for cases NF1, NF2, NF3, and NF5 by varying k until the peak monthly average head on the geomembrane liner was such that the peak daily average head was maintained within the drainage layer (i.e., equal to or less than the thickness of the geocomposite = 0.2 in.), and the peak daily maximum head did not exceed the regulatory maximum of 12 in.

It is noted that the default *HELP* model value for the geocomposite drainage layer hydraulic conductivity was selected for the recirculation case, NF2-R, and the final cover case, NF4. Additionally, for the critical existing fill case, EF1, a hydraulic conductivity typical of that used previously at the site was used in the *HELP* model.

Geomembrane Liners for Liner System

The geomembrane layer was modeled as geomembrane liner with *HELP* material texture 35 (representative of HDPE geomembrane), installation condition = good, pinhole defect frequency = 2 per acre, and installation defect frequency = 2 per acre. This hole frequency is an assumption for design purposes only and is not a reflection of the expected or allowable hole density.

Compacted Soil Liner for Liner System

The 2-ft compacted clay liner was modeled as a barrier soil liner with *HELP* material texture 16 (representative of heavily compacted clay soil) having a hydraulic conductivity of 1.0×10^{-7} cm/s.

Landfill Design Data

The design data required by the *HELP* model consists of: (i) the slope and slope length of the surface of the top layer; (ii) the slope and slope length of lateral drainage layers (geosynthetic drainage component) in the final cover system and liner system; (iii) the percentage of runoff that can be directed off of the landfill whether as clean surface water or as leachate running off the waste to a storm water storage area; and (iv) vegetation and soil surface condition of the top layer. It was assumed that the potential runoff is zero percent for floor cases, whereas potential runoff was increased for intermediate and final cover conditions. Runoff is modeled by the *HELP* model based on the underlying principles of the USDA Soil Conservation Service (SCS) curve number method presented in Section 4 of the National Engineering Handbook (USDA, SCS, 1985) as coded into *HELP* using surface slope, slope length, material texture, and vegetation. The landfill design parameters used in the analysis are presented in Table 3E.2-2.

RESULTS OF ANALYSIS

The results of the *HELP* model analysis are summarized below. The output files are presented in Appendix 3E.2-1.

Estimated Leachate Collection Rates - With No Recirculation

The estimated leachate collection rates for cases with no recirculation are shown in Table 3E.2-3.

For the cases analyzed, the largest average annual collection rate is calculated to be 646 gallons per acre per day (gpad); this corresponds to the initial condition in the new and existing fill areas (NF1, EF1).

The maximum daily collection rate for the cases analyzed is calculated to be 12,280 gpad; this corresponds to the initial condition in the new and existing fill areas (NF1, EF1).

Estimated Leachate Collection Rates - With Recirculation

The estimated leachate collection rates for the case with recirculation are shown in Table 3E.2-4. For Case NF2-R and with 50% of the collected leachate being recirculated, the calculated annual average leachate collection is 388 gpad and the peak daily leachate collection rate is 2,184 gpad.

Drainage Layer Design Hydraulic Conductivity and Transmissivity

As discussed, the design hydraulic conductivity of the leachate drainage layer was calculated for cases NF1, NF2, NF3, and NF5 by varying hydraulic conductivity until the peak daily average head on the geomembrane liner was less than or equal to the thickness of the geosynthetic drainage layer (i.e., 0.20 in.). The transmissivity was calculated by multiplying the drainage layer hydraulic conductivity by its thickness. Results for each case are presented in Table 3E.2-5. The largest computed required design hydraulic conductivity and transmissivity are 5 cm/s and 2.5×10^{-4} m^2/s, respectively.

For the critical existing fill case, EF1, it is noted that a hydraulic conductivity and transmissivity typical of that used previously at the site was used in the *HELP* model to confirm that the computed peak daily average head on the geomembrane liner was less than or equal to the thickness of the geosynthetic drainage layer (i.e., 0.20 in.).

Head of Leachate in Drainage Layer

The hydraulic heads on top of the geomembrane calculated using the *HELP* model are summarized in Table 3E.2-6. For conditions without leachate recirculation, the calculated annual average heads on the geomembrane range from 0.0 to 0.02 in. For the case with leachate recirculation, the calculated annual average head is 0.03 in.

Considering all cases analyzed, the maximum calculated peak daily average head on the geomembrane is 0.17 inches. The maximum calculated peak daily average head (as well as the peak daily maximums) on the geomembrane is less than the allowable hydraulic head of 30 cm (12 in.). The calculated peak daily average heads are less than or equal to the thickness of a geocomposite drainage layer (0.2 in.) on the landfill floor and on the landfill sideslope. Thus, flow is predicted to occur within the drainage layer.

Recirculation of Leachate

The facility may conduct leachate recirculation. The *HELP* model for this recirculation case was run for the intermediate new fill condition (i.e., NF2-R); the annual average and peak daily *HELP* model results for this case are shown in Table 3E.2-4. The average rate of recirculation on an annual basis is 50% of the collected leachate or 388 gpad. This rate results in a calculated peak average head of 0.17 in.

SUMMARY AND CONCLUSIONS

The *HELP* model was used to estimate the design leachate collection rates, calculate the design in-plane hydraulic conductivity and transmissivity of the geosynthetic drainage layer, calculate the maximum leachate head on the liner system, and evaluate the implementation of leachate recirculation. Parameters for various design and operational/post-closure conditions that characterize the site over time were input into the model.

For cases without recirculation, (i) the average annual collection rate is calculated to be 646 gpad for the initial condition in the new fill and existing fill areas (NF1, EF1) and (ii) the maximum daily collection rate is calculated to be 12,280 gpad for the initial condition in the new fill and existing fill areas (NF1, EF1).

For the recirculation option, (i) the average annual collection rate is calculated to be 388 gpad and (ii) the maximum daily collection rate is calculated to be 2,184 gpad.

For all cases, the calculated head of leachate on the liner is less than the regulatory maximum of 30 cm (12 in.).

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Written by:	Y. Bholat	Date:	2/13/23	Reviewed by:	S. Graves	Date:	8/3/23
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TABLE 3E.2-1. POINT PRECIPITATION FREQUENCY ESTIMATE FOR THE SITE

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.440 (0.333-0.581)	0.525 (0.399-0.682)	0.660 (0.502-0.866)	0.776 (0.582-1.03)	0.940 (0.684-1.29)	1.07 (0.758-1.51)	1.21 (0.832-1.75)	1.35 (0.906-2.01)	1.54 (1.00-2.38)	1.70 (1.07-2.68)
10-min	0.699 (0.529-0.924)	0.837 (0.635-1.09)	1.05 (0.801-1.38)	1.24 (0.930-1.65)	1.50 (1.10-2.07)	1.72 (1.22-2.43)	1.93 (1.33-2.81)	2.15 (1.45-3.20)	2.44 (1.58-3.75)	2.65 (1.68-4.19)
15-min	0.894 (0.677-1.18)	1.06 (0.806-1.38)	1.32 (1.01-1.74)	1.55 (1.16-2.07)	1.87 (1.36-2.57)	2.13 (1.51-3.00)	2.39 (1.65-3.47)	2.67 (1.79-3.97)	3.05 (1.98-4.69)	3.34 (2.12-5.28)
30-min	1.26 (0.955-1.67)	1.49 (1.13-1.94)	1.86 (1.41-2.44)	2.17 (1.63-2.89)	2.61 (1.89-3.57)	2.95 (2.09-4.16)	3.31 (2.28-4.80)	3.70 (2.49-5.51)	4.26 (2.77-6.57)	4.71 (2.98-7.45)
60-min	1.63 (1.23-2.15)	1.94 (1.48-2.52)	2.44 (1.86-3.20)	2.87 (2.15-3.82)	3.48 (2.52-4.76)	3.95 (2.79-5.57)	4.46 (3.08-6.47)	5.04 (3.39-7.50)	5.87 (3.81-9.06)	6.56 (4.15-10.4)
2-hr	1.94 (1.48-2.55)	2.40 (1.81-3.05)	3.07 (2.34-3.99)	3.69 (2.78-4.89)	4.60 (3.36-6.29)	5.36 (3.81-7.54)	6.20 (4.30-8.95)	7.17 (4.83-10.6)	8.60 (5.60-13.2)	9.79 (6.22-15.4)
3-hr	2.11 (1.61-2.76)	2.66 (1.99-3.34)	3.45 (2.64-4.47)	4.21 (3.18-5.56)	5.35 (3.93-7.31)	6.33 (4.53-8.90)	7.45 (5.17-10.7)	8.73 (5.89-12.9)	10.6 (6.94-16.3)	12.2 (7.79-19.2)
6-hr	2.40 (1.85-3.13)	3.12 (2.33-3.84)	4.12 (3.15-5.28)	5.09 (3.87-6.69)	6.60 (4.89-9.00)	7.94 (5.72-11.1)	9.50 (6.63-13.6)	11.3 (7.65-16.5)	14.0 (9.15-21.3)	16.3 (10.4-25.4)
12-hr	2.72 (2.10-3.52)	3.58 (2.67-4.36)	4.76 (3.66-6.07)	5.93 (4.53-7.75)	7.75 (5.76-10.5)	9.37 (6.77-13.1)	11.3 (7.89-16.0)	13.5 (9.18-19.7)	16.9 (11.1-25.6)	19.8 (12.7-30.7)
24-hr	3.07 (2.38-3.95)	4.06 (3.05-4.92)	5.44 (4.21-6.90)	6.80 (5.22-8.83)	$\boxed{8.90 (6.65\text{-}12.0)}$	10.8 (7.81-14.9)	12.9 (9.11-18.3)	15.5 (10.6-22.5)	19.6 (12.9-29.4)	23.0 (14.8-35.5)
2-day	3.51 (2.73-4.49)	4.63 (3.52-5.61)	6.22 (4.84-7.85)	7.75 (5.98-10.0)	10.1 (7.57-13.5)	12.1 (8.85-16.7)	14.5 (10.3-20.5)	17.4 (11.9-25.1)	21.8 (14.4-32.7)	25.6 (16.5-39.3)
3-day	3.82 (2.99-4.88)	5.02 (3.84-6.08)	6.73 (5.26-8.47)	8.36 (6.48-10.8)	10.9 (8.15-14.4)	13.0 (9.48-17.8)	15.5 (11.0-21.7)	18.4 (12.7-26.5)	22.9 (15.2-34.3)	26.8 (17.4-41.0)
4-day	4.07 (3.19-5.18)	5.32 (4.08-6.45)	7.11 (5.57-8.93)	8.81 (6.84-11.3)	11.4 (8.57-15.1)	13.6 (9.94-18.6)	16.1 (11.4-22.6)	19.1 (13.2-27.4)	23.6 (15.7-35.2)	27.5 (17.8-41.9)
7-day	4.64 (3.65-5.89)	5.98 (4.63-7.26)	7.93 (6.25-9.93)	9.75 (7.60-12.5)	12.5 (9.43-16.5)	14.8 (10.9-20.1)	17.4 (12.4-24.2)	20.4 (14.1-29.1)	24.8 (16.6-36.8)	28.6 (18.6-43.4)
10-day	5.12 (4.04-6.48)	6.53 (5.09-7.95)	8.60 (6.80-10.8)	10.5 (8.21-13.4)	13.3 (10.1-17.6)	15.7 (11.6-21.3)	18.4 (13.1-25.5)	21.3 (14.8-30.4)	25.7 (17.2-38.0)	29.3 (19.1-44.4)
20-day	6.63 (5.26-8.34)	8.18 (6.50-10.1)	10.6 (8.44-13.2)	12.7 (9.97-16.1)	15.7 (11.9-20.5)	18.1 (13.3-24.3)	20.7 (14.8-28.5)	23.6 (16.4-33.4)	27.8 (18.7-40.8)	31.2 (20.4-47.0)
30-day	7.89 (6.28-9.88)	9.54 (7.65-11.8)	12.2 (9.78-15.2)	14.5 (11.4-18.3)	17.6 (13.4-22.9)	20.0 (14.8-26.8)	22.6 (16.2-31.1)	25.4 (17.8-35.9)	29.5 (19.9-43.2)	32.8 (21.5-49.2)
45-day	9.65 (7.70-12.0)	11.5 (9.27-14.2)	14.5 (11.7-18.0)	17.0 (13.4-21.4)	20.4 (15.6-26.5)	23.0 (17.0-30.7)	25.6 (18.5-35.2)	28.4 (19.9-40.1)	32.3 (21.8-47.1)	35.3 (23.2-52.7)
60-day	11.2 (8.97-14.0)	13.2 (10.7-16.3)	16.5 (13.3-20.5)	19.2 (15.2-24.2)	22.9 (17.5-29.7)	25.7 (19.1-34.3)	28.5 (20.6-39.0)	31.3 (22.0-43.9)	34.9 (23.6-50.7)	37.6 (24.7-56.0)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

Written by:	Y. Bholat	Date:	2/13/23	Reviewed & Revised by:	S. Graves	Date:	8/3/23; 2/19/24
Client:	WMTX	Project:	Mesquite Creek	Project No.:	GW8636	Task No.:	05

TABLE 3E.2-2. SUMMARY OF *HELP* MODEL INPUT DATA

Area	Case ID and Description		Simulation Period (yrs)	Waste Height (ft)	Leachate Drainage Layer Slope Length (ft)[1]	Leachate Drainage Layer Slope (%)[1]	Percent of Surface Area Allowing Runoff (%)[2]	Surface Slope Length (ft)[3]	Surface Slope (%)[3]	Vegetation Cover	SCS Runoff Curve Numbers	Evaporative Zone Depth (in)	Max leaf Index
New Fill (NF)	1	Floor	30	10	425	5	0	425	5	Bare Ground	96.6	10	0
	2	Floor	40	75	425	5	50	425	5	Poor	93.3	10	1
	2R	Floor	40	75	425	5	50	425	5	Poor	93.3	10	1
	3	Floor	40	150	425	5	50	886	5	Poor	93.1	10	1
	4	Floor	70	150	425	5	100	886	5	Good Grass	86.2	10	3
	5	Sideslope	40	65	210	33.3	50	886	5	Poor	93.1	10	1
Existing Fill (EF)	1	Floor	30	10	160	5	0	160	5	Bare Ground	96.8	10	0

Notes:

1. Leachate drainage layer slope length and slope are measured from the leachate management system design drawings (Drawing 3E-1B in Part III, Attachment 3E.1) as follows:
    a. For Cases NF1 through NF4: Phase XIV floor;
    b. For Case NF5: Phase XIV sideslope; and
    c. For Case EF1: Phase VI floor.
2. The selected values for Percent of Surface Area Allowing Runoff are judged as a conservative basis of the leachate management system analysis and design (i.e., allowing less runoff results in more leachate generation).
3. The surface slope length and slope are conservatively selected as follows.
    a. For Cases NF1 through NF2R and EF1, the values were based on filling waste in a layer of uniform thickness, oriented parallel to the liner system.
    b. For Cases NF3 through NF5, the values were based on the longest (i.e., conservative) distance from the landfill ridgeline to the crest of sideslope from the overall final cover grading plan (Drawing 3A-5B in Part III, Attachment 3A.

Written by:	Y. Bholat	Date:	2/13/23	Reviewed by:	S. Graves	Date:	8/3/23
Client:	WMTX	Project:	Mesquite Creek	Project No.:	GW8636	Task No.:	05

TABLE 3E.2-3. LEACHATE GENERATION RATES FOR CASES WITHOUT LEACHATE RECIRCULATION

(A) ANNUAL AVERAGE

Area	Case ID		Total Leachate Collected	
			(in./ac./yr)	(gpad)
New Fill (NF)	1	Floor	8.7E+00	646
	2	Floor	5.2E+00	388
	3	Floor	5.3E+00	393
	4	Floor	2.0E-05	1
	5	Sideslope	5.3E+00	393
Existing Fill (EF)	1	Floor	8.7E+00	646

(B) PEAK DAILY

Area	Case ID		Total Leachate Collected	
			(in./ac./day)	(gpad)
New Fill (NF)	1	Floor	4.5E-01	12,280
	2	Floor	1.6E-01	4,270
	3	Floor	1.6E-01	4,396
	4	Floor	0	0
	5	Sideslope	1.5E-01	4,186
Existing Fill (EF)	1	Floor	4.5E-01	12,280

Note: gpad = gallons per acre per day

Written by:	Y. Bholat	Date:	2/13/23	Reviewed by:	S. Graves	Date:	8/3/23
Client:	WMTX	Project:	Mesquite Creek	Project No.:	GW8636	Task No.:	05

TABLE 3E.2-4. LEACHATE GENERATION AND RECIRCULATION RATES FOR CASES WITH LEACHATE RECIRCULATION

(A) ANNUAL AVERAGE

Area	Case ID		Total Leachate Collected		Recirculated from Leachate Drainage Layer	
			(in./ac./yr)	(gpad)	(in./ac./yr)	(gpad)
New Fill (NF)	2R	Floor	5.2E+00	388	5.2E+00	388

(B) PEAK DAILY

Area	Case ID		Total Leachate Collected		Recirculated from Leachate Drainage Layer	
			(in./ac./day)	(gpad)	(in./ac./day)	(gpad)
New Fill (NF)	2R	Floor	8.0E-02	2,184	8.0E-02	2,184

Note: gpad = gallons per acre per day

Written by:	Y. Bholat	Date:	2/13/23	Reviewed by:	S. Graves	Date:	8/3/23
Client:	WMTX	Project:	Mesquite Creek	Project No.:	GW8636	Task No.:	05

TABLE 3E.2-5A. LEACHATE DRAINAGE LAYER DESIGN HYDRAULIC CONDUCTIVITY AND TRANSMISSIVITY

Area	Case		Design Hydraulic Conductivity (cm/s)	Leachate Drainage Layer Thickness (in.)	Design Transmissivity (m^2/s)
New Fill (NF)	1	Floor	5.0E+00	0.2	2.5E-04
	2	Floor	1.4E+00	0.2	7.1E-05
	3	Floor	1.5E+00	0.2	7.6E-05
	5	Slope	1.2E-01	0.2	6.1E-06

Notes:

1. Design hydraulic conductivities and transmissivities shown here are not specifications for the geocomposite drainage layer. The design for sizing and providing the required product specifications for the geocomposite drainage layer are presented in Attachment 3E.3.
2. Design transmissivity = design hydraulic conductivity × drainage layer thickness.

TABLE 3E.2-5B. LEACHATE DRAINAGE LAYER HYDRAULIC CONDUCTIVITY AND TRANSMISSIVITY (EXISTING FILL AREA)

Area	Case		Hydraulic Conductivity (cm/s)	Leachate Drainage Layer Thickness (in.)	Transmissivity (m^2/s)
Existing Fill (EF)	1	Floor	6.8E+00	0.25	4.3E-04

Notes:

1. Hydraulic conductivities and transmissivities shown here are typical for geocomposite material used previously at the site.
2. Transmissivity = hydraulic conductivity × drainage layer thickness.

Written by:	Y. Bholat	Date:	2/13/23	Reviewed & Revised by:	S. Graves	Date:	8/3/23; 2/19/24
Client:	WMTX	Project:	Mesquite Creek	Project No.:	GW8636	Task No.:	05

TABLE 3E.2-6. CALCULATED LEACHATE HEAD ON TOP OF GEOMEMBRANE

Area	Case		Head on Top of Geomembrane (in.)		
			Annual Average	Peak Daily Average	Peak Daily Maximum
New Fill (NF)	1	Floor	0.01	0.14	0.27
	2	Floor	0.02	0.17	0.33
	2R	Floor	0.03	0.17	0.34
	3	Floor	0.01	0.16	0.32
	4[(2)]	Floor	0.00	0.00	0.00
	5	Slope	0.02	0.16	0.32
Existing Fill (EF)	1	Floor	0.00	0.10	0.08

Notes:

1. Case EF1 uses a hydraulic conductivity value typical for geocomposite material used previously at the site.
2. Refer to Table 3E.2-3 for the Case 4 (final cover installed) leachate generation rates.

Written by:	**Y. Bholat**	Date:	**2/13/23**	Reviewed by:	**S. Graves**	Date:	**8/3/23**
Client:	**WMTX**	Project:	**Mesquite Creek**	Project No.:	**GW8636**	Task No.:	**05**

APPENDIX 3E.2-1

HELP MODEL COMPUTER PROGRAM OUTPUT FILES

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**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                                                                          **
**              HELP Version 3.95 D         (10 August 2012)                **
**                              developed at                                **
**        Institute of Soil Science, University of Hamburg, Germany         **
**                                based on                                  **
**              US HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)               **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************

TIME:  15.56     DATE:  13.02.2023

PRECIPITATION DATA FILE:      C:\PRECIP-30yr.d4
TEMPERATURE DATA FILE:        C:\TEMP-30yr.d7
SOLAR RADIATION DATA FILE:    C:\SOLAR-30yr.d13
EVAPOTRANSPIRATION DATA F. 1: C:\Evapotranspiration-LAI_0.d11
SOIL AND DESIGN DATA FILE  1: C:\SOILS - NF_01.d10
OUTPUT DATA FILE:             C:\OUT - NF_01.out


******************************************************************************

     TITLE:  Mesquite_Creek_LF - NF_01

******************************************************************************


                           WEATHER DATA SOURCES
------------------------------------------------------------------------------


         NOTE:  PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
                COEFFICIENTS FOR    SAN ANTONIO         TEXAS

                NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

     JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
     -------     -------     -------     -------     -------     -------
      2.14        1.72        2.49        2.00        3.63        3.44
      2.21        2.01        3.45        3.30        2.46        2.42
```

```
         NOTE:  TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
                COEFFICIENTS FOR    SAN ANTONIO         TEXAS

             NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

     JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
     -------     -------     -------     -------     -------     -------
      52.20       56.00       62.80       69.80       76.60       82.40
      84.50       85.10       79.90       71.30       61.00       53.50


         NOTE:  SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
                COEFFICIENTS FOR    SAN ANTONIO         TEXAS
                  AND STATION LATITUDE  =  29.70 DEGREES


******************************************************************************

                               LAYER DATA   1
------------------------------------------------------------------------------

                            VALID FOR  30 YEARS


     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  15
           THICKNESS                  =      6.00   INCHES
           POROSITY                   =      0.4750 VOL/VOL
           FIELD CAPACITY             =      0.3780 VOL/VOL
           WILTING POINT              =      0.2650 VOL/VOL
           INITIAL SOIL WATER CONTENT  =      0.3559 VOL/VOL
           EFFECTIVE SAT. HYD. CONDUCT.=      0.1700E-04 CM/SEC


                                  LAYER  2
                                  --------
```

```
                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER  18
           THICKNESS                  =    120.00   INCHES
           POROSITY                   =      0.6710 VOL/VOL
           FIELD CAPACITY             =      0.2920 VOL/VOL
           WILTING POINT              =      0.0770 VOL/VOL
           INITIAL SOIL WATER CONTENT  =      0.2936 VOL/VOL
           EFFECTIVE SAT. HYD. CONDUCT.=      0.1000E-02 CM/SEC


                                  LAYER  3
                                  --------

                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER  25
           THICKNESS                  =     24.00   INCHES
           POROSITY                   =      0.4370 VOL/VOL
           FIELD CAPACITY             =      0.3730 VOL/VOL
           WILTING POINT              =      0.2660 VOL/VOL
           INITIAL SOIL WATER CONTENT  =      0.4227 VOL/VOL
           EFFECTIVE SAT. HYD. CONDUCT.=      0.3600E-05 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  =      0.0100 VOL/VOL
           EFFECTIVE SAT. HYD. CONDUCT.=       5.000     CM/SEC
           SLOPE                      =      5.00   PERCENT
           DRAINAGE LENGTH            =    425.0    FEET


                                  LAYER  5
                                  --------

                       TYPE 4 - FLEXIBLE MEMBRANE LINER
                         MATERIAL TEXTURE NUMBER  35
           THICKNESS                  =      0.06   INCHES
           EFFECTIVE SAT. HYD. CONDUCT.=      0.2000E-12 CM/SEC
           FML PINHOLE DENSITY        =      2.00   HOLES/ACRE
```

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           FML INSTALLATION DEFECTS   =      2.00   HOLES/ACRE
           FML PLACEMENT QUALITY      =  3 - GOOD


                                  LAYER  6
                                  --------

                        TYPE 3 - BARRIER SOIL LINER
                         MATERIAL TEXTURE NUMBER  16
           THICKNESS                  =     24.00   INCHES
           POROSITY                   =      0.4270 VOL/VOL
           FIELD CAPACITY             =      0.4180 VOL/VOL
           WILTING POINT              =      0.3670 VOL/VOL
           INITIAL SOIL WATER CONTENT  =      0.4270 VOL/VOL
           EFFECTIVE SAT. HYD. CONDUCT.=      0.1000E-06 CM/SEC


******************************************************************************

                 GENERAL DESIGN AND EVAPORATIVE ZONE DATA   1
------------------------------------------------------------------------------

                            VALID FOR  30 YEARS


         NOTE:  SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
                SOIL DATA BASE USING SOIL TEXTURE #15 WITH BARE
                GROUND CONDITIONS, A SURFACE SLOPE OF  5.% AND
                A SLOPE LENGTH OF  425. FEET.

        SCS RUNOFF CURVE NUMBER            =    96.60
        FRACTION OF AREA ALLOWING RUNOFF   =      0.0    PERCENT
        AREA PROJECTED ON HORIZONTAL PLANE =      1.000  ACRES
        EVAPORATIVE ZONE DEPTH             =     10.0    INCHES
        INITIAL WATER IN EVAPORATIVE ZONE  =      3.184  INCHES
        UPPER LIMIT OF EVAPORATIVE STORAGE =      5.534  INCHES
        FIELD CAPACITY OF EVAPORATIVE ZONE =      3.436  INCHES
        LOWER LIMIT OF EVAPORATIVE STORAGE =      1.898  INCHES
        SOIL EVAPORATION ZONE DEPTH        =     10.000  INCHES
        INITIAL SNOW WATER                 =      0.122  INCHES
        INITIAL INTERCEPTION WATER         =      0.000  INCHES
        INITIAL WATER IN LAYER MATERIALS   =     57.767  INCHES
        TOTAL INITIAL WATER                =     57.889  INCHES
        TOTAL SUBSURFACE INFLOW            =      0.00   INCHES/YEAR


******************************************************************************
```

EVAPOTRANSPIRATION DATA 1

VALID FOR 30 YEARS

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
SAN ANTONIO TEXAS

STATION LATITUDE	= 29.70 DEGREES
MAXIMUM LEAF AREA INDEX	= 0.00
START OF GROWING SEASON (JULIAN DATE)	= 35
END OF GROWING SEASON (JULIAN DATE)	= 350
EVAPORATIVE ZONE DEPTH	= 10.0 INCHES
AVERAGE ANNUAL WIND SPEED	= 9.40 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	= 66.0 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	= 68.0 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	= 66.0 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	= 67.0 %

****

****

FINAL WATER STORAGE AT END OF YEAR 30

LAYER	(INCHES)	(VOL/VOL)
1	2.1784	0.3631
2	35.7973	0.2983
3	9.0548	0.3773
4	0.0020	0.0100
5	0.0000	0.0000
6	10.2480	0.4270
TOTAL WATER IN LAYERS	57.280	
SNOW WATER	0.000	
INTERCEPTION WATER	0.000	
TOTAL FINAL WATER	57.280	

****

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 30

	(INCHES)	(CU. FT.)
PRECIPITATION	8.90	32306.998
RUNOFF	0.000	0.0000
DRAINAGE COLLECTED FROM LAYER 4	0.45219	1641.45459
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.000000	0.00116
AVERAGE HEAD ON TOP OF LAYER 5	0.136	
MAXIMUM HEAD ON TOP OF LAYER 5	0.273	
LOCATION OF MAXIMUM HEAD IN LAYER 4 (DISTANCE FROM DRAIN)	0.0 FEET	
SNOW WATER	23.66	85869.7969
MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.4197	
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.1898	

*** 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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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 30

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	1.74	1.68	2.24	1.92	2.83	3.81
	2.15	1.90	4.13	3.38	2.38	2.23
STD. DEVIATIONS	1.18	0.88	1.40	1.49	1.75	2.30
	2.03	2.16	2.36	2.10	1.95	1.20
RUNOFF						
TOTALS	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATIONS	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
POTENTIAL EVAPOTRANSPIRATION						
TOTALS	3.138	3.473	5.201	6.261	7.746	8.403
	8.938	8.340	6.524	5.001	3.652	2.916
STD. DEVIATIONS	0.372	0.301	0.614	0.719	0.907	0.918
	0.943	0.890	0.727	0.604	0.424	0.286
ACTUAL EVAPOTRANSPIRATION						
TOTALS	1.453	1.461	1.776	1.655	2.180	2.580
	1.746	1.641	2.065	2.229	1.454	1.471
STD. DEVIATIONS	0.672	0.761	1.004	1.099	1.166	1.229
	1.292	1.454	1.183	1.009	0.927	0.705
LATERAL DRAINAGE COLLECTED FROM LAYER 4						
TOTALS	0.7357	0.4889	0.7264	0.5875	0.4632	0.5119
	0.9773	0.6655	0.4346	1.1946	1.0774	0.8188
STD. DEVIATIONS	0.6961	0.5495	2.0187	1.2656	0.8349	0.5798
	0.8986	0.9599	0.5817	1.2242	0.9995	0.9710
PERCOLATION/LEAKAGE THROUGH LAYER 6						
TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 5						
AVERAGES	0.0071	0.0052	0.0070	0.0059	0.0045	0.0051
	0.0095	0.0065	0.0044	0.0116	0.0108	0.0079
STD. DEVIATIONS	0.0067	0.0058	0.0196	0.0127	0.0081	0.0058
	0.0087	0.0093	0.0058	0.0119	0.0100	0.0094

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 30

	INCHES	CU. FEET	PERCENT
PRECIPITATION	30.38 (5.727)	110266.1	100.00
RUNOFF	0.000 (0.0000)	0.00	0.000
POTENTIAL EVAPOTRANSPIRATION	69.595 (6.7884)	252628.27	
ACTUAL EVAPOTRANSPIRATION	21.711 (6.2812)	78809.44	71.472
LATERAL DRAINAGE COLLECTED FROM LAYER 4	8.68196 (6.23129)	31515.498	28.58131
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.00001 (0.00000)	0.033	0.00003
AVERAGE HEAD ON TOP OF LAYER 5	0.007 (0.005)		
CHANGE IN WATER STORAGE	-0.020 (5.7034)	-73.65	-0.067

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**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                                                                          **
**              HELP Version 3.95 D          (10 August 2012)               **
**                             developed at                                 **
**        Institute of Soil Science, University of Hamburg, Germany         **
**                               based on                                   **
**              US HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)               **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************

TIME:  15.59     DATE:  13.02.2023

PRECIPITATION DATA FILE:      C:\PRECIP-40yr.d4
TEMPERATURE DATA FILE:        C:\TEMP-40yr.d7
SOLAR RADIATION DATA FILE:    C:\SOLAR-40yr.d13
EVAPOTRANSPIRATION DATA F. 1: C:\Evapotranspiration-LAI_1.d11
SOIL AND DESIGN DATA FILE  1: C:\SOILS - NF_02.d10
OUTPUT DATA FILE:             C:\OUT - NF_02.out

******************************************************************************

     TITLE:  Mesquite_Creek_LF - NF_02

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                           WEATHER DATA SOURCES
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         NOTE:  PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
                COEFFICIENTS FOR    SAN ANTONIO         TEXAS

                NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

     JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
     -------     -------     -------     -------     -------     -------
      2.14        1.72        2.49        2.00        3.63        3.44
      2.21        2.01        3.45        3.30        2.46        2.42

         NOTE:  TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
                COEFFICIENTS FOR    SAN ANTONIO         TEXAS

             NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

     JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
     -------     -------     -------     -------     -------     -------
      52.20       56.00       62.80       69.80       76.60       82.40
      84.50       85.10       79.90       71.30       61.00       53.50


         NOTE:  SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
                COEFFICIENTS FOR    SAN ANTONIO         TEXAS
                  AND STATION LATITUDE  =  29.70 DEGREES


******************************************************************************

                              LAYER DATA   1
------------------------------------------------------------------------------

                            VALID FOR  40 YEARS


     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  15
           THICKNESS                 =     12.00   INCHES
           POROSITY                  =      0.4750 VOL/VOL
           FIELD CAPACITY            =      0.3780 VOL/VOL
           WILTING POINT             =      0.2650 VOL/VOL
           INITIAL SOIL WATER CONTENT  =    0.3612 VOL/VOL
           EFFECTIVE SAT. HYD. CONDUCT.=    0.1700E-04 CM/SEC
         NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  1.80
                FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.


                                 LAYER  2
                                 --------

                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER  18
           THICKNESS                 =    900.00   INCHES
           POROSITY                  =      0.6710 VOL/VOL
           FIELD CAPACITY            =      0.2920 VOL/VOL
           WILTING POINT             =      0.0770 VOL/VOL
           INITIAL SOIL WATER CONTENT  =    0.2927 VOL/VOL
           EFFECTIVE SAT. HYD. CONDUCT.=    0.1000E-02 CM/SEC


                                 LAYER  3
                                 --------

                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER  25
           THICKNESS                 =     24.00   INCHES
           POROSITY                  =      0.4370 VOL/VOL
           FIELD CAPACITY            =      0.3730 VOL/VOL
           WILTING POINT             =      0.2660 VOL/VOL
           INITIAL SOIL WATER CONTENT  =    0.4090 VOL/VOL
           EFFECTIVE SAT. HYD. CONDUCT.=    0.3600E-05 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  =    0.0132 VOL/VOL
           EFFECTIVE SAT. HYD. CONDUCT.=     1.400      CM/SEC
           SLOPE                     =      5.00   PERCENT
           DRAINAGE LENGTH           =    425.0    FEET


                                 LAYER  5
                                 --------

                       TYPE 4 - FLEXIBLE MEMBRANE LINER
                         MATERIAL TEXTURE NUMBER  35
           THICKNESS                 =      0.06   INCHES
           EFFECTIVE SAT. HYD. CONDUCT.=    0.2000E-12 CM/SEC
           FML PINHOLE DENSITY       =      2.00   HOLES/ACRE
           FML INSTALLATION DEFECTS  =      2.00   HOLES/ACRE
           FML PLACEMENT QUALITY     =  3 - GOOD


                                 LAYER  6
                                 --------

                         TYPE 3 - BARRIER SOIL LINER
                         MATERIAL TEXTURE NUMBER  16
           THICKNESS                 =     24.00   INCHES
           POROSITY                  =      0.4270 VOL/VOL
           FIELD CAPACITY            =      0.4180 VOL/VOL
           WILTING POINT             =      0.3670 VOL/VOL
           INITIAL SOIL WATER CONTENT  =    0.4270 VOL/VOL
           EFFECTIVE SAT. HYD. CONDUCT.=    0.1000E-06 CM/SEC


******************************************************************************

                GENERAL DESIGN AND EVAPORATIVE ZONE DATA   1
------------------------------------------------------------------------------

                            VALID FOR  40 YEARS


         NOTE:  SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
                SOIL DATA BASE USING SOIL TEXTURE #15 WITH A
                POOR STAND OF GRASS, A SURFACE SLOPE OF  5.%
                AND A SLOPE LENGTH OF  425. FEET.

           SCS RUNOFF CURVE NUMBER            =     93.34
           FRACTION OF AREA ALLOWING RUNOFF   =     50.0    PERCENT
           AREA PROJECTED ON HORIZONTAL PLANE =      1.000  ACRES
           EVAPORATIVE ZONE DEPTH             =     10.0    INCHES
           INITIAL WATER IN EVAPORATIVE ZONE  =      3.579  INCHES
           UPPER LIMIT OF EVAPORATIVE STORAGE =      4.750  INCHES
           FIELD CAPACITY OF EVAPORATIVE ZONE =      3.780  INCHES
           LOWER LIMIT OF EVAPORATIVE STORAGE =      2.650  INCHES
           SOIL EVAPORATION ZONE DEPTH        =     10.000  INCHES
           INITIAL SNOW WATER                 =      0.000  INCHES
           INITIAL INTERCEPTION WATER         =      0.000  INCHES
           INITIAL WATER IN LAYER MATERIALS   =    287.868  INCHES
           TOTAL INITIAL WATER                =    287.868  INCHES
           TOTAL SUBSURFACE INFLOW            =      0.00   INCHES/YEAR


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EVAPOTRANSPIRATION DATA 1

VALID FOR 40 YEARS

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
SAN ANTONIO TEXAS

STATION LATITUDE	= 29.70 DEGREES
MAXIMUM LEAF AREA INDEX	= 1.00
START OF GROWING SEASON (JULIAN DATE)	= 35
END OF GROWING SEASON (JULIAN DATE)	= 350
EVAPORATIVE ZONE DEPTH	= 10.0 INCHES
AVERAGE ANNUAL WIND SPEED	= 9.40 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	= 66.0 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	= 68.0 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	= 66.0 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	= 67.0 %

FINAL WATER STORAGE AT END OF YEAR 40

LAYER	(INCHES)	(VOL/VOL)
1	3.7205	0.3100
2	262.8000	0.2920
3	9.3259	0.3886
4	0.0161	0.0807
5	0.0000	0.0000
6	10.2480	0.4270
TOTAL WATER IN LAYERS	286.111	
SNOW WATER	0.000	
INTERCEPTION WATER	0.000	
TOTAL FINAL WATER	286.111	

PEAK DAILY VALUES FOR YEARS 1 THROUGH 40

	(INCHES)	(CU. FT.)
PRECIPITATION	8.90	32306.998
RUNOFF	5.671	20584.7715
DRAINAGE COLLECTED FROM LAYER 4	0.15724	570.77814
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.000000	0.00142
AVERAGE HEAD ON TOP OF LAYER 5	0.169	
MAXIMUM HEAD ON TOP OF LAYER 5	0.332	
LOCATION OF MAXIMUM HEAD IN LAYER 4 (DISTANCE FROM DRAIN)	5.7 FEET	
SNOW WATER	1.68	6105.5332
MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.4649	
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.2650	

*** 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.

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 40

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	1.91	1.57	2.37	1.86	2.93	3.79
	2.14	1.91	3.84	3.47	2.35	2.25
STD. DEVIATIONS	1.31	0.84	1.48	1.39	1.72	2.83
	2.13	1.91	2.27	2.00	1.81	1.22
RUNOFF						
TOTALS	0.162	0.082	0.337	0.169	0.419	0.957
	0.485	0.264	0.686	0.592	0.301	0.234
STD. DEVIATIONS	0.247	0.095	0.518	0.311	0.517	1.189
	1.140	0.521	0.741	0.603	0.484	0.257
POTENTIAL EVAPOTRANSPIRATION						
TOTALS	3.153	3.521	5.254	6.376	7.897	8.501
	9.017	8.366	6.561	5.040	3.649	2.946
STD. DEVIATIONS	0.350	0.296	0.510	0.521	0.615	0.711
	0.827	0.776	0.663	0.538	0.374	0.274
ACTUAL EVAPOTRANSPIRATION						
TOTALS	1.455	1.281	1.673	1.744	2.179	2.314
	1.488	1.569	2.061	1.992	1.394	1.384
STD. DEVIATIONS	0.607	0.685	0.877	1.047	1.129	1.260
	1.004	1.252	1.055	0.878	0.774	0.628
LATERAL DRAINAGE COLLECTED FROM LAYER 4						
TOTALS	0.6908	0.5146	0.3833	0.3978	0.3376	0.2252
	0.5065	0.3856	0.2102	0.4221	0.6003	0.5282
STD. DEVIATIONS	0.7920	0.5277	0.6095	0.5126	0.5797	0.3063
	0.6889	0.6262	0.3512	0.5298	0.5878	0.5802
PERCOLATION/LEAKAGE THROUGH LAYER 6						
TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 5						
AVERAGES	0.0239	0.0195	0.0133	0.0142	0.0117	0.0081
	0.0175	0.0134	0.0075	0.0146	0.0215	0.0183
STD. DEVIATIONS	0.0274	0.0200	0.0211	0.0183	0.0201	0.0110
	0.0239	0.0217	0.0126	0.0183	0.0210	0.0201

AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 40

	INCHES	CU. FEET	PERCENT
PRECIPITATION	30.38 (5.616)	110285.8	100.00
RUNOFF	4.688 (1.9820)	17017.38	15.430
POTENTIAL EVAPOTRANSPIRATION	70.281 (5.2305)	255121.11	
ACTUAL EVAPOTRANSPIRATION	20.536 (5.3597)	74543.88	67.592
LATERAL DRAINAGE COLLECTED FROM LAYER 4	5.20219 (4.58375)	18883.965	17.12276
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.00002 (0.00001)	0.059	0.00005
AVERAGE HEAD ON TOP OF LAYER 5	0.015 (0.013)		
CHANGE IN WATER STORAGE	-0.044 (2.7123)	-159.52	-0.145

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**                                                                          **
**                                                                          **
**            HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE                 **
**                                                                          **
**            HELP Version 3.95 D         (10 August 2012)                  **
**                          developed at                                    **
**       Institute of Soil Science, University of Hamburg, Germany          **
**                            based on                                      **
**            US 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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TIME:  13.26     DATE:   5.04.2023

PRECIPITATION DATA FILE:      C:\PRECIP-40yr.d4
TEMPERATURE DATA FILE:        C:\TEMP-40yr.d7
SOLAR RADIATION DATA FILE:    C:\SOLAR-40yr.d13
EVAPOTRANSPIRATION DATA F. 1: C:\Evapotranspiration-LAI_1.d11
SOIL AND DESIGN DATA FILE  1: C:\SOILS - NF_02R_r1.d10
OUTPUT DATA FILE:             C:\OUT - NF_02R_r1.out

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     TITLE:  Mesquite_Creek_LF - NF_02R

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                           WEATHER DATA SOURCES
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         NOTE:  PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
                  COEFFICIENTS FOR    SAN ANTONIO          TEXAS

                  NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

     JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
     -------     -------     -------     -------     -------     -------
       2.14        1.72        2.49        2.00        3.63        3.44
       2.21        2.01        3.45        3.30        2.46        2.42

         NOTE:  TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
                  COEFFICIENTS FOR    SAN ANTONIO          TEXAS

             NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

     JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
     -------     -------     -------     -------     -------     -------
      52.20       56.00       62.80       69.80       76.60       82.40
      84.50       85.10       79.90       71.30       61.00       53.50

         NOTE:  SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
                  COEFFICIENTS FOR    SAN ANTONIO          TEXAS
                    AND STATION LATITUDE  =  29.70 DEGREES

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                               LAYER DATA   1
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                              VALID FOR  40 YEARS

     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  15
           THICKNESS                   =     12.00   INCHES
           POROSITY                    =      0.4750 VOL/VOL
           FIELD CAPACITY              =      0.3780 VOL/VOL
           WILTING POINT               =      0.2650 VOL/VOL
           INITIAL SOIL WATER CONTENT  =      0.3612 VOL/VOL
           EFFECTIVE SAT. HYD. CONDUCT.=      0.1700E-04 CM/SEC
         NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  1.80
                  FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.

                                  LAYER  2
                                  --------

                      TYPE 1 - VERTICAL PERCOLATION LAYER
                        MATERIAL TEXTURE NUMBER  18
           THICKNESS                   =    900.00   INCHES
           POROSITY                    =      0.6710 VOL/VOL
           FIELD CAPACITY              =      0.2920 VOL/VOL
           WILTING POINT               =      0.0770 VOL/VOL
           INITIAL SOIL WATER CONTENT  =      0.2930 VOL/VOL
           EFFECTIVE SAT. HYD. CONDUCT.=      0.1000E-02 CM/SEC
         NOTE:   50.00 PERCENT OF THE DRAINAGE COLLECTED FROM LAYER # 4
                  IS RECIRCULATED INTO THIS LAYER.

                                  LAYER  3
                                  --------

                      TYPE 1 - VERTICAL PERCOLATION LAYER
                        MATERIAL TEXTURE NUMBER  25
           THICKNESS                   =     24.00   INCHES
           POROSITY                    =      0.4370 VOL/VOL
           FIELD CAPACITY              =      0.3730 VOL/VOL
           WILTING POINT               =      0.2660 VOL/VOL
           INITIAL SOIL WATER CONTENT  =      0.4199 VOL/VOL
           EFFECTIVE SAT. HYD. CONDUCT.=      0.3600E-05 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  =      0.0103 VOL/VOL
           EFFECTIVE SAT. HYD. CONDUCT.=       1.400      CM/SEC
           SLOPE                       =      5.00   PERCENT
           DRAINAGE LENGTH             =    425.0     FEET
         NOTE:   50.00 PERCENT OF THE DRAINAGE COLLECTED FROM THIS
                  LAYER IS RECIRCULATED INTO LAYER #  2.

                                  LAYER  5
                                  --------

                       TYPE 4 - FLEXIBLE MEMBRANE LINER
                        MATERIAL TEXTURE NUMBER  35
           THICKNESS                   =      0.06   INCHES
           EFFECTIVE SAT. HYD. CONDUCT.=      0.2000E-12 CM/SEC
           FML PINHOLE DENSITY         =      2.00   HOLES/ACRE
           FML INSTALLATION DEFECTS    =      2.00   HOLES/ACRE
           FML PLACEMENT QUALITY       =  3 - GOOD

                                  LAYER  6
                                  --------

                         TYPE 3 - BARRIER SOIL LINER
                        MATERIAL TEXTURE NUMBER  16
           THICKNESS                   =     24.00   INCHES
           POROSITY                    =      0.4270 VOL/VOL
           FIELD CAPACITY              =      0.4180 VOL/VOL
           WILTING POINT               =      0.3670 VOL/VOL
           INITIAL SOIL WATER CONTENT  =      0.4270 VOL/VOL
           EFFECTIVE SAT. HYD. CONDUCT.=      0.1000E-06 CM/SEC

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                 GENERAL DESIGN AND EVAPORATIVE ZONE DATA   1
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                              VALID FOR  40 YEARS

         NOTE:  SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
                  SOIL DATA BASE USING SOIL TEXTURE #15 WITH A
                  POOR STAND OF GRASS, A SURFACE SLOPE OF  5.%
                  AND A SLOPE LENGTH OF  425. FEET.

           SCS RUNOFF CURVE NUMBER            =     93.34
           FRACTION OF AREA ALLOWING RUNOFF   =     50.0    PERCENT
           AREA PROJECTED ON HORIZONTAL PLANE =      1.000  ACRES
           EVAPORATIVE ZONE DEPTH             =     10.0    INCHES
           INITIAL WATER IN EVAPORATIVE ZONE  =      3.579  INCHES
           UPPER LIMIT OF EVAPORATIVE STORAGE =      4.750  INCHES
           FIELD CAPACITY OF EVAPORATIVE ZONE =      3.780  INCHES
           LOWER LIMIT OF EVAPORATIVE STORAGE =      2.650  INCHES
           SOIL EVAPORATION ZONE DEPTH        =     10.000  INCHES
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INITIAL SNOW WATER	=	0.000 INCHES
INITIAL INTERCEPTION WATER	=	0.000 INCHES
INITIAL WATER IN LAYER MATERIALS	=	288.394 INCHES
TOTAL INITIAL WATER	=	288.394 INCHES
TOTAL SUBSURFACE INFLOW	=	0.00 INCHES/YEAR

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EVAPOTRANSPIRATION DATA 1

VALID FOR 40 YEARS

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
SAN ANTONIO TEXAS

STATION LATITUDE	=	29.70 DEGREES
MAXIMUM LEAF AREA INDEX	=	1.00
START OF GROWING SEASON (JULIAN DATE)	=	35
END OF GROWING SEASON (JULIAN DATE)	=	350
EVAPORATIVE ZONE DEPTH	=	10.0 INCHES
AVERAGE ANNUAL WIND SPEED	=	9.40 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	66.0 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	68.0 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	66.0 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	67.0 %

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FINAL WATER STORAGE AT END OF YEAR 40

LAYER	(INCHES)	(VOL/VOL)
1	3.7205	0.3100
2	262.8000	0.2920
3	9.7030	0.4043
4	0.0244	0.1221
5	0.0000	0.0000
6	10.2480	0.4270
TOTAL WATER IN LAYERS	286.496	
SNOW WATER	0.000	
INTERCEPTION WATER	0.000	
TOTAL FINAL WATER	286.496	

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 40

	(INCHES)	(CU. FT.)
PRECIPITATION	8.90	32306.998
RUNOFF	5.671	20584.7715
DRAINAGE RECIRCULATED INTO LAYER 2	0.08041	291.87537
DRAINAGE COLLECTED FROM LAYER 4	0.08041	291.87537
DRAINAGE RECIRCULATED FROM LAYER 4	0.08041	291.87537
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.000000	0.00145
AVERAGE HEAD ON TOP OF LAYER 5	0.173	
MAXIMUM HEAD ON TOP OF LAYER 5	0.341	
LOCATION OF MAXIMUM HEAD IN LAYER 4 (DISTANCE FROM DRAIN)	4.6 FEET	
SNOW WATER	1.68	6105.5332
MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.4649	
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.2650	

*** 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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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 40

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	1.91	1.57	2.37	1.86	2.93	3.79
	2.14	1.91	3.84	3.47	2.35	2.25
STD. DEVIATIONS	1.31	0.84	1.48	1.39	1.72	2.83
	2.13	1.91	2.27	2.00	1.81	1.22
RUNOFF						
TOTALS	0.162	0.082	0.337	0.169	0.419	0.957
	0.485	0.264	0.686	0.592	0.301	0.234
STD. DEVIATIONS	0.247	0.095	0.518	0.311	0.517	1.189
	1.140	0.521	0.741	0.603	0.484	0.257
POTENTIAL EVAPOTRANSPIRATION						
TOTALS	3.153	3.521	5.254	6.376	7.897	8.501
	9.017	8.366	6.561	5.040	3.649	2.946
STD. DEVIATIONS	0.350	0.296	0.510	0.521	0.615	0.711
	0.827	0.776	0.663	0.538	0.374	0.274
ACTUAL EVAPOTRANSPIRATION						
TOTALS	1.455	1.281	1.673	1.744	2.179	2.314
	1.488	1.569	2.061	1.992	1.394	1.384
STD. DEVIATIONS	0.607	0.685	0.877	1.047	1.129	1.260
	1.004	1.252	1.055	0.878	0.774	0.628
LATERAL DRAINAGE RECIRCULATED INTO LAYER 2						
TOTALS	0.5724	0.5150	0.4867	0.4367	0.3795	0.3162
	0.4324	0.4003	0.2977	0.3892	0.4749	0.5044
STD. DEVIATIONS	0.4415	0.3843	0.4076	0.3844	0.3981	0.3443
	0.4270	0.4354	0.3213	0.3797	0.3877	0.3889
LATERAL DRAINAGE COLLECTED FROM LAYER 4						
TOTALS	0.5724	0.5150	0.4867	0.4367	0.3795	0.3162
	0.4324	0.4003	0.2977	0.3892	0.4749	0.5044
STD. DEVIATIONS	0.4415	0.3843	0.4076	0.3844	0.3981	0.3443
	0.4270	0.4354	0.3213	0.3797	0.3877	0.3889
LATERAL DRAINAGE RECIRCULATED FROM LAYER 4 INTO L. 2						
TOTALS	0.5724	0.5150	0.4867	0.4367	0.3795	0.3162
	0.4324	0.4003	0.2977	0.3892	0.4749	0.5044
STD. DEVIATIONS	0.4415	0.3843	0.4076	0.3844	0.3981	0.3443
	0.4270	0.4354	0.3213	0.3797	0.3877	0.3889
PERCOLATION/LEAKAGE THROUGH LAYER 6						
TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 5						
AVERAGES	0.0396	0.0392	0.0337	0.0313	0.0263	0.0226
	0.0300	0.0277	0.0213	0.0270	0.0340	0.0349
STD. DEVIATIONS	0.0306	0.0293	0.0282	0.0275	0.0276	0.0246
	0.0296	0.0302	0.0230	0.0263	0.0278	0.0269

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 40

	INCHES		CU. FEET	PERCENT
PRECIPITATION	30.38	(5.616)	110285.8	100.00
RUNOFF	4.688	(1.9820)	17017.38	15.430
POTENTIAL EVAPOTRANSPIRATION	70.281	(5.2305)	255121.11	
ACTUAL EVAPOTRANSPIRATION	20.536	(5.3597)	74543.88	67.592
DRAINAGE RECIRCULATED INTO LAYER 2	5.20538	(3.71299)	18895.516	17.13323
LATERAL DRAINAGE COLLECTED FROM LAYER 4	5.20538	(3.71299)	18895.518	17.13323
DRAINAGE RECIRCULATED FROM LAYER 4 INTO L. 2	5.20538	(3.71299)	18895.518	17.13323
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.00003	(0.00002)	0.111	0.00010
AVERAGE HEAD ON TOP OF LAYER 5	0.031	(0.022)		
CHANGE IN WATER STORAGE	-0.047	(4.7004)	-172.26	-0.156

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**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                                                                          **
**              HELP Version 3.95 D         (10 August 2012)                **
**                               developed at                               **
**         Institute of Soil Science, University of Hamburg, Germany        **
**                                 based on                                 **
**              US HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)               **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************

TIME:  16.05     DATE:  13.02.2023

PRECIPITATION DATA FILE:      C:\PRECIP-40yr.d4
TEMPERATURE DATA FILE:        C:\TEMP-40yr.d7
SOLAR RADIATION DATA FILE:    C:\SOLAR-40yr.d13
EVAPOTRANSPIRATION DATA F. 1: C:\Evapotranspiration-LAI_1.d11
SOIL AND DESIGN DATA FILE  1: C:\SOILS - NF_03.d10
OUTPUT DATA FILE:             C:\OUT - NF_03.out

******************************************************************************

     TITLE:  Mesquite_Creek_LF - NF_03

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                           WEATHER DATA SOURCES
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         NOTE:  PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
                  COEFFICIENTS FOR    SAN ANTONIO         TEXAS

                  NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

     JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
     -------     -------     -------     -------     -------     -------
       2.14        1.72        2.49        2.00        3.63        3.44
       2.21        2.01        3.45        3.30        2.46        2.42

         NOTE:  TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
                  COEFFICIENTS FOR    SAN ANTONIO         TEXAS

             NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

     JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
     -------     -------     -------     -------     -------     -------
      52.20       56.00       62.80       69.80       76.60       82.40
      84.50       85.10       79.90       71.30       61.00       53.50


         NOTE:  SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
                  COEFFICIENTS FOR    SAN ANTONIO         TEXAS
                    AND STATION LATITUDE  =  29.70 DEGREES


******************************************************************************

                               LAYER DATA   1
------------------------------------------------------------------------------

                             VALID FOR  40 YEARS


     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  15
           THICKNESS                 =    12.00   INCHES
           POROSITY                  =     0.4750 VOL/VOL
           FIELD CAPACITY            =     0.3780 VOL/VOL
           WILTING POINT             =     0.2650 VOL/VOL
           INITIAL SOIL WATER CONTENT  =     0.3617 VOL/VOL
           EFFECTIVE SAT. HYD. CONDUCT.=     0.1700E-04 CM/SEC
         NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  1.80
                  FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.


                                  LAYER  2
                                  --------

                       TYPE 1 - VERTICAL PERCOLATION LAYER
                           MATERIAL TEXTURE NUMBER  18
           THICKNESS                 =  1800.00   INCHES
           POROSITY                  =     0.6710 VOL/VOL
           FIELD CAPACITY            =     0.2920 VOL/VOL
           WILTING POINT             =     0.0770 VOL/VOL
           INITIAL SOIL WATER CONTENT  =     0.2924 VOL/VOL
           EFFECTIVE SAT. HYD. CONDUCT.=     0.1000E-02 CM/SEC


                                  LAYER  3
                                  --------

                       TYPE 1 - VERTICAL PERCOLATION LAYER
                           MATERIAL TEXTURE NUMBER  25
           THICKNESS                 =    24.00   INCHES
           POROSITY                  =     0.4370 VOL/VOL
           FIELD CAPACITY            =     0.3730 VOL/VOL
           WILTING POINT             =     0.2660 VOL/VOL
           INITIAL SOIL WATER CONTENT  =     0.4093 VOL/VOL
           EFFECTIVE SAT. HYD. CONDUCT.=     0.3600E-05 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  =     0.0122 VOL/VOL
           EFFECTIVE SAT. HYD. CONDUCT.=      1.500     CM/SEC
           SLOPE                     =      5.00   PERCENT
           DRAINAGE LENGTH           =    425.0    FEET


                                  LAYER  5
                                  --------

                        TYPE 4 - FLEXIBLE MEMBRANE LINER
                           MATERIAL TEXTURE NUMBER  35
           THICKNESS                 =      0.06   INCHES
           EFFECTIVE SAT. HYD. CONDUCT.=     0.2000E-12 CM/SEC
           FML PINHOLE DENSITY       =      2.00   HOLES/ACRE
           FML INSTALLATION DEFECTS  =      2.00   HOLES/ACRE
           FML PLACEMENT QUALITY     =  3 - GOOD


                                  LAYER  6
                                  --------

                          TYPE 3 - BARRIER SOIL LINER
                           MATERIAL TEXTURE NUMBER  16
           THICKNESS                 =    24.00   INCHES
           POROSITY                  =     0.4270 VOL/VOL
           FIELD CAPACITY            =     0.4180 VOL/VOL
           WILTING POINT             =     0.3670 VOL/VOL
           INITIAL SOIL WATER CONTENT  =     0.4270 VOL/VOL
           EFFECTIVE SAT. HYD. CONDUCT.=     0.1000E-06 CM/SEC


******************************************************************************

                   GENERAL DESIGN AND EVAPORATIVE ZONE DATA   1
------------------------------------------------------------------------------

                             VALID FOR  40 YEARS


         NOTE:  SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
                  SOIL DATA BASE USING SOIL TEXTURE #15 WITH A
                  POOR STAND OF GRASS, A SURFACE SLOPE OF  5.%
                  AND A SLOPE LENGTH OF  886. FEET.

        SCS RUNOFF CURVE NUMBER            =     93.10
        FRACTION OF AREA ALLOWING RUNOFF   =     50.0    PERCENT
        AREA PROJECTED ON HORIZONTAL PLANE =      1.000  ACRES
        EVAPORATIVE ZONE DEPTH             =     10.0    INCHES
        INITIAL WATER IN EVAPORATIVE ZONE  =      3.584  INCHES
        UPPER LIMIT OF EVAPORATIVE STORAGE =      4.750  INCHES
        FIELD CAPACITY OF EVAPORATIVE ZONE =      3.780  INCHES
        LOWER LIMIT OF EVAPORATIVE STORAGE =      2.650  INCHES
        SOIL EVAPORATION ZONE DEPTH        =     10.000  INCHES
        INITIAL SNOW WATER                 =      0.000  INCHES
        INITIAL INTERCEPTION WATER         =      0.000  INCHES
        INITIAL WATER IN LAYER MATERIALS   =    550.690  INCHES
        TOTAL INITIAL WATER                =    550.690  INCHES
        TOTAL SUBSURFACE INFLOW            =      0.00   INCHES/YEAR


******************************************************************************
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EVAPOTRANSPIRATION DATA 1

VALID FOR 40 YEARS

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
SAN ANTONIO TEXAS

STATION LATITUDE	= 29.70 DEGREES
MAXIMUM LEAF AREA INDEX	= 1.00
START OF GROWING SEASON (JULIAN DATE)	= 35
END OF GROWING SEASON (JULIAN DATE)	= 350
EVAPORATIVE ZONE DEPTH	= 10.0 INCHES
AVERAGE ANNUAL WIND SPEED	= 9.40 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	= 66.0 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	= 68.0 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	= 66.0 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	= 67.0 %

FINAL WATER STORAGE AT END OF YEAR 40

LAYER	(INCHES)	(VOL/VOL)
1	3.7183	0.3099
2	525.6000	0.2920
3	9.3291	0.3887
4	0.0153	0.0765
5	0.0000	0.0000
6	10.2480	0.4270

TOTAL WATER IN LAYERS	548.911
SNOW WATER	0.000
INTERCEPTION WATER	0.000
TOTAL FINAL WATER	548.911

PEAK DAILY VALUES FOR YEARS 1 THROUGH 40

	(INCHES)	(CU. FT.)
PRECIPITATION	8.90	32306.998
RUNOFF	5.655	20528.8066
DRAINAGE COLLECTED FROM LAYER 4	0.16185	587.50482
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.000000	0.00137
AVERAGE HEAD ON TOP OF LAYER 5	0.162	
MAXIMUM HEAD ON TOP OF LAYER 5	0.321	
LOCATION OF MAXIMUM HEAD IN LAYER 4 (DISTANCE FROM DRAIN)	0.0 FEET	
SNOW WATER	1.75	6340.7095
MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.4649	
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.2650	

*** 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.

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 40

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	1.91	1.57	2.37	1.86	2.93	3.79
	2.14	1.91	3.84	3.47	2.35	2.25
STD. DEVIATIONS	1.31	0.84	1.48	1.39	1.72	2.83
	2.13	1.91	2.27	2.00	1.81	1.22
RUNOFF						
TOTALS	0.158	0.077	0.330	0.162	0.409	0.946
	0.478	0.257	0.671	0.579	0.295	0.227
STD. DEVIATIONS	0.243	0.091	0.514	0.306	0.512	1.183
	1.137	0.515	0.732	0.600	0.483	0.253
POTENTIAL EVAPOTRANSPIRATION						
TOTALS	3.153	3.521	5.254	6.376	7.897	8.501
	9.017	8.366	6.561	5.040	3.649	2.946
STD. DEVIATIONS	0.350	0.296	0.510	0.521	0.615	0.711
	0.827	0.776	0.663	0.538	0.374	0.274
ACTUAL EVAPOTRANSPIRATION						
TOTALS	1.446	1.292	1.674	1.746	2.174	2.327
	1.497	1.565	2.073	1.985	1.392	1.389
STD. DEVIATIONS	0.608	0.690	0.878	1.052	1.126	1.263
	1.010	1.247	1.052	0.876	0.776	0.624
LATERAL DRAINAGE COLLECTED FROM LAYER 4						
TOTALS	0.6939	0.5127	0.3785	0.4002	0.3408	0.2838
	0.5161	0.3943	0.2190	0.4230	0.5975	0.5178
STD. DEVIATIONS	0.7360	0.4969	0.5934	0.5020	0.5928	0.5260
	0.6750	0.6366	0.3628	0.5323	0.5635	0.5331
PERCOLATION/LEAKAGE THROUGH LAYER 6						
TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 5						
AVERAGES	0.0224	0.0182	0.0122	0.0134	0.0110	0.0095
	0.0167	0.0127	0.0073	0.0137	0.0200	0.0167
STD. DEVIATIONS	0.0238	0.0176	0.0192	0.0168	0.0192	0.0176
	0.0218	0.0206	0.0121	0.0172	0.0188	0.0172

AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 40

	INCHES		CU. FEET	PERCENT
PRECIPITATION	30.38	(5.616)	110285.8	100.00
RUNOFF	4.590	(1.9707)	16661.23	15.107
POTENTIAL EVAPOTRANSPIRATION	70.281	(5.2305)	255121.11	
ACTUAL EVAPOTRANSPIRATION	20.559	(5.3633)	74628.43	67.668
LATERAL DRAINAGE COLLECTED FROM LAYER 4	5.27754	(4.55713)	19157.471	17.37076
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.00002	(0.00001)	0.057	0.00005
AVERAGE HEAD ON TOP OF LAYER 5	0.014	(0.012)		
CHANGE IN WATER STORAGE	-0.044	(3.1527)	-161.43	-0.146

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**                                                                          **
**                                                                          **
**           HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE                  **
**                                                                          **
**           HELP Version 3.95 D         (10 August 2012)                   **
**                          developed at                                    **
**       Institute of Soil Science, University of Hamburg, Germany          **
**                            based on                                      **
**           US 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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```

TIME: 16.06   DATE: 13.02.2023

```
PRECIPITATION DATA FILE:      C:\PRECIP-70yr.d4
TEMPERATURE DATA FILE:        C:\TEMP-70yr.d7
SOLAR RADIATION DATA FILE:    C:\SOLAR-70yr.d13
EVAPOTRANSPIRATION DATA F. 1: C:\Evapotranspiration-LAI_3.d11
SOIL AND DESIGN DATA FILE  1: C:\SOILS - NF_04.d10
OUTPUT DATA FILE:             C:\OUT - NF_04.out
```

****

TITLE: Mesquite_Creek_LF - NF_04

****

WEATHER DATA SOURCES

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR SAN ANTONIO TEXAS

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
2.14	1.72	2.49	2.00	3.63	3.44
2.21	2.01	3.45	3.30	2.46	2.42

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR SAN ANTONIO TEXAS

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
52.20	56.00	62.80	69.80	76.60	82.40
84.50	85.10	79.90	71.30	61.00	53.50

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR SAN ANTONIO TEXAS AND STATION LATITUDE = 29.70 DEGREES

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LAYER DATA 1

VALID FOR 70 YEARS

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  24
   THICKNESS                  =     24.00   INCHES
   POROSITY                   =      0.3650 VOL/VOL
   FIELD CAPACITY             =      0.3050 VOL/VOL
   WILTING POINT              =      0.2020 VOL/VOL
   INITIAL SOIL WATER CONTENT =      0.3169 VOL/VOL
   EFFECTIVE SAT. HYD. CONDUCT.=     0.2700E-05 CM/SEC
   NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  4.20
          FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.

                         LAYER  2
                         --------

              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 =      0.0323 VOL/VOL
   EFFECTIVE SAT. HYD. CONDUCT.=     10.00     CM/SEC
   SLOPE                      =      5.00   PERCENT
   DRAINAGE LENGTH            =    886.0    FEET

                         LAYER  3
                         --------

              TYPE 4 - FLEXIBLE MEMBRANE LINER
                 MATERIAL TEXTURE NUMBER  36
   THICKNESS                  =      0.04   INCHES
   EFFECTIVE SAT. HYD. CONDUCT.=     0.4000E-12 CM/SEC
   FML PINHOLE DENSITY        =      2.00   HOLES/ACRE
   FML INSTALLATION DEFECTS   =      2.00   HOLES/ACRE
   FML PLACEMENT QUALITY      =  3 - GOOD

                         LAYER  4
                         --------

              TYPE 3 - BARRIER SOIL LINER
                 MATERIAL TEXTURE NUMBER   0
   THICKNESS                  =     18.00   INCHES
   POROSITY                   =      0.4270 VOL/VOL
   FIELD CAPACITY             =      0.4180 VOL/VOL
   WILTING POINT              =      0.3670 VOL/VOL
   INITIAL SOIL WATER CONTENT =      0.4270 VOL/VOL
   EFFECTIVE SAT. HYD. CONDUCT.=     0.1000E-04 CM/SEC

                         LAYER  5
                         --------

              TYPE 1 - VERTICAL PERCOLATION LAYER
                 MATERIAL TEXTURE NUMBER  18
   THICKNESS                  =   1800.00   INCHES
   POROSITY                   =      0.6710 VOL/VOL
   FIELD CAPACITY             =      0.2920 VOL/VOL
   WILTING POINT              =      0.0770 VOL/VOL
   INITIAL SOIL WATER CONTENT =      0.2920 VOL/VOL
   EFFECTIVE SAT. HYD. CONDUCT.=     0.1000E-02 CM/SEC

                         LAYER  6
                         --------

              TYPE 1 - VERTICAL PERCOLATION LAYER
                 MATERIAL TEXTURE NUMBER  25
   THICKNESS                  =     24.00   INCHES
   POROSITY                   =      0.4370 VOL/VOL
   FIELD CAPACITY             =      0.3730 VOL/VOL
   WILTING POINT              =      0.2660 VOL/VOL
   INITIAL SOIL WATER CONTENT =      0.3730 VOL/VOL
   EFFECTIVE SAT. HYD. CONDUCT.=     0.3600E-05 CM/SEC

                         LAYER  7
                         --------

              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. CONDUCT.=     10.00     CM/SEC
   SLOPE                      =      5.00   PERCENT
   DRAINAGE LENGTH            =    425.0    FEET

                         LAYER  8
                         --------

              TYPE 4 - FLEXIBLE MEMBRANE LINER
                 MATERIAL TEXTURE NUMBER  35
   THICKNESS                  =      0.06   INCHES
   EFFECTIVE SAT. HYD. CONDUCT.=     0.2000E-12 CM/SEC
   FML PINHOLE DENSITY        =      2.00   HOLES/ACRE
   FML INSTALLATION DEFECTS   =      2.00   HOLES/ACRE
   FML PLACEMENT QUALITY      =  3 - GOOD
```

LAYER 9

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 16

THICKNESS	=	24.00 INCHES
POROSITY	=	0.4270 VOL/VOL
FIELD CAPACITY	=	0.4180 VOL/VOL
WILTING POINT	=	0.3670 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4270 VOL/VOL
EFFECTIVE SAT. HYD. CONDUCT.	=	0.1000E-06 CM/SEC

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GENERAL DESIGN AND EVAPORATIVE ZONE DATA 1

VALID FOR 70 YEARS

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE #24 WITH A GOOD STAND OF GRASS, A SURFACE SLOPE OF 5.% AND A SLOPE LENGTH OF 886. FEET.

SCS RUNOFF CURVE NUMBER	=	86.17	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.000	ACRES
EVAPORATIVE ZONE DEPTH	=	10.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	3.060	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	3.650	INCHES
FIELD CAPACITY OF EVAPORATIVE ZONE	=	3.050	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	2.020	INCHES
SOIL EVAPORATION ZONE DEPTH	=	10.000	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL INTERCEPTION WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	560.100	INCHES
TOTAL INITIAL WATER	=	560.100	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

****

EVAPOTRANSPIRATION DATA 1

VALID FOR 70 YEARS

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
SAN ANTONIO TEXAS

STATION LATITUDE	=	29.70 DEGREES
MAXIMUM LEAF AREA INDEX	=	3.00
START OF GROWING SEASON (JULIAN DATE)	=	35
END OF GROWING SEASON (JULIAN DATE)	=	350
EVAPORATIVE ZONE DEPTH	=	10.0 INCHES
AVERAGE ANNUAL WIND SPEED	=	9.40 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	66.0 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	68.0 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	66.0 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	67.0 %

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FINAL WATER STORAGE AT END OF YEAR 70

LAYER	(INCHES)	(VOL/VOL)
1	6.6519	0.2772
2	0.0020	0.0100
3	0.0000	0.0000
4	7.6860	0.4270
5	525.6000	0.2920
6	8.9520	0.3730
7	0.0020	0.0100
8	0.0000	0.0000
9	10.2480	0.4270
TOTAL WATER IN LAYERS	559.142	
SNOW WATER	0.000	
INTERCEPTION WATER	0.000	
TOTAL FINAL WATER	559.142	

****

*** 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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PEAK DAILY VALUES FOR YEARS 1 THROUGH 70

	(INCHES)	(CU. FT.)
PRECIPITATION	8.90	32306.998
RUNOFF	8.373	30394.7441
DRAINAGE COLLECTED FROM LAYER 2	0.10984	398.72354
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.000003	0.00980
AVERAGE HEAD ON TOP OF LAYER 3	0.034	
MAXIMUM HEAD ON TOP OF LAYER 3	0.130	
LOCATION OF MAXIMUM HEAD IN LAYER 2 (DISTANCE FROM DRAIN)	0.0 FEET	
DRAINAGE COLLECTED FROM LAYER 7	0.00000	0.00968
PERCOLATION/LEAKAGE THROUGH LAYER 9	0.000000	0.00002
AVERAGE HEAD ON TOP OF LAYER 8	0.000	
MAXIMUM HEAD ON TOP OF LAYER 8	0.000	
LOCATION OF MAXIMUM HEAD IN LAYER 7 (DISTANCE FROM DRAIN)	0.0 FEET	
SNOW WATER	1.35	4913.8022
MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.3650	
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.2020	

****

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 70

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	2.04	1.52	2.36	1.83	3.15	3.86
	2.36	2.22	3.83	3.76	2.42	2.23
STD. DEVIATIONS	1.44	0.93	1.64	1.39	1.80	2.89
	2.17	2.05	2.20	2.33	1.84	1.33
RUNOFF						
TOTALS	0.545	0.309	0.987	0.554	1.262	2.038
	1.207	0.815	1.651	1.796	0.940	0.734
STD. DEVIATIONS	0.719	0.423	1.144	0.766	1.144	2.124
	1.659	1.210	1.417	1.631	1.110	0.792
POTENTIAL EVAPOTRANSPIRATION						
TOTALS	3.200	3.585	5.309	6.444	7.941	8.624
	9.168	8.483	6.698	5.171	3.685	3.031
STD. DEVIATIONS	0.213	0.258	0.324	0.324	0.311	0.305
	0.261	0.312	0.360	0.269	0.225	0.208
ACTUAL EVAPOTRANSPIRATION						
TOTALS	1.242	1.161	1.802	1.360	1.825	1.837
	1.169	1.448	2.044	1.658	1.222	1.240
STD. DEVIATIONS	0.460	0.499	0.680	0.738	0.803	0.968

	0.735	1.034	0.905	0.720	0.555	0.390

LATERAL DRAINAGE COLLECTED FROM LAYER 2

TOTALS	0.1875	0.1437	0.0943	0.0280	0.0004	0.0034
	0.0064	0.0012	0.0037	0.0191	0.1136	0.1433
STD. DEVIATIONS	0.2319	0.1931	0.1272	0.0611	0.0026	0.0209
	0.0334	0.0090	0.0164	0.0738	0.2478	0.2246

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 7

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 9

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	0.0019	0.0016	0.0010	0.0003	0.0000	0.0000
	0.0001	0.0000	0.0000	0.0002	0.0012	0.0014
STD. DEVIATIONS	0.0023	0.0022	0.0013	0.0006	0.0000	0.0002
	0.0003	0.0001	0.0002	0.0007	0.0026	0.0023

DAILY AVERAGE HEAD ON TOP OF LAYER 8

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 70

	INCHES	CU. FEET	PERCENT
PRECIPITATION	31.58 (5.884)	114630.8	100.00
RUNOFF	12.838 (3.8797)	46602.66	40.655
POTENTIAL EVAPOTRANSPIRATION	71.340 (1.0382)	258963.58	
ACTUAL EVAPOTRANSPIRATION	18.010 (2.6992)	65374.62	57.031
LATERAL DRAINAGE COLLECTED FROM LAYER 2	0.74465 (0.55290)	2703.083	2.35808
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.00002 (0.00002)	0.083	0.00007
AVERAGE HEAD ON TOP OF LAYER 3	0.001 (0.000)		
LATERAL DRAINAGE COLLECTED FROM LAYER 7	0.00002 (0.00002)	0.082	0.00007
PERCOLATION/LEAKAGE THROUGH LAYER 9	0.00000 (0.00000)	0.001	0.00000
AVERAGE HEAD ON TOP OF LAYER 8	0.000 (0.000)		
CHANGE IN WATER STORAGE	-0.014 (0.5222)	-49.70	-0.043

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******************************************************************************
**                                                                          **
**                                                                          **
**             HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE                **
**                                                                          **
**             HELP Version 3.95 D          (10 August 2012)                **
**                             developed at                                 **
**        Institute of Soil Science, University of Hamburg, Germany         **
**                               based on                                   **
**             US HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                **
**                 DEVELOPED BY ENVIRONMENTAL LABORATORY                    **
**                   USAE WATERWAYS EXPERIMENT STATION                      **
**            FOR USEPA RISK REDUCTION ENGINEERING LABORATORY               **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************

TIME:  16.07     DATE:  13.02.2023

PRECIPITATION DATA FILE:      C:\PRECIP-40yr.d4
TEMPERATURE DATA FILE:        C:\TEMP-40yr.d7
SOLAR RADIATION DATA FILE:    C:\SOLAR-40yr.d13
EVAPOTRANSPIRATION DATA F. 1: C:\Evapotranspiration-LAI_1.d11
SOIL AND DESIGN DATA FILE  1: C:\SOILS - NF_05.d10
OUTPUT DATA FILE:             C:\OUT - NF_05.out

******************************************************************************

     TITLE:  Mesquite_Creek_LF - NF_05

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                           WEATHER DATA SOURCES
------------------------------------------------------------------------------


         NOTE:  PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
                   COEFFICIENTS FOR    SAN ANTONIO         TEXAS

                   NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

     JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
     -------     -------     -------     -------     -------     -------
       2.14        1.72        2.49        2.00        3.63        3.44
       2.21        2.01        3.45        3.30        2.46        2.42

         NOTE:  TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
                   COEFFICIENTS FOR    SAN ANTONIO         TEXAS

             NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

     JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
     -------     -------     -------     -------     -------     -------
      52.20       56.00       62.80       69.80       76.60       82.40
      84.50       85.10       79.90       71.30       61.00       53.50


         NOTE:  SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
                   COEFFICIENTS FOR    SAN ANTONIO         TEXAS
                     AND STATION LATITUDE  =  29.70 DEGREES


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                              LAYER DATA   1
------------------------------------------------------------------------------

                              VALID FOR  40 YEARS


     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  15
           THICKNESS                 =     12.00   INCHES
           POROSITY                  =      0.4750 VOL/VOL
           FIELD CAPACITY            =      0.3780 VOL/VOL
           WILTING POINT             =      0.2650 VOL/VOL
           INITIAL SOIL WATER CONTENT  =    0.3617 VOL/VOL
           EFFECTIVE SAT. HYD. CONDUCT.=    0.1700E-04 CM/SEC
       NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  1.80
                FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.


                                  LAYER  2
                                  --------

                      TYPE 1 - VERTICAL PERCOLATION LAYER
                          MATERIAL TEXTURE NUMBER  18
           THICKNESS                 =    780.00   INCHES
           POROSITY                  =      0.6710 VOL/VOL
           FIELD CAPACITY            =      0.2920 VOL/VOL
           WILTING POINT             =      0.0770 VOL/VOL
           INITIAL SOIL WATER CONTENT  =    0.2928 VOL/VOL
           EFFECTIVE SAT. HYD. CONDUCT.=    0.1000E-02 CM/SEC


                                  LAYER  3
                                  --------

                      TYPE 1 - VERTICAL PERCOLATION LAYER
                          MATERIAL TEXTURE NUMBER  25
           THICKNESS                 =     24.00   INCHES
           POROSITY                  =      0.4370 VOL/VOL
           FIELD CAPACITY            =      0.3730 VOL/VOL
           WILTING POINT             =      0.2660 VOL/VOL
           INITIAL SOIL WATER CONTENT  =    0.4098 VOL/VOL
           EFFECTIVE SAT. HYD. CONDUCT.=    0.3600E-05 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  =    0.0123 VOL/VOL
           EFFECTIVE SAT. HYD. CONDUCT.=    0.1200     CM/SEC
           SLOPE                     =     33.30   PERCENT
           DRAINAGE LENGTH           =    210.0    FEET


                                  LAYER  5
                                  --------

                        TYPE 4 - FLEXIBLE MEMBRANE LINER
                          MATERIAL TEXTURE NUMBER  35
           THICKNESS                 =      0.06   INCHES
           EFFECTIVE SAT. HYD. CONDUCT.=    0.2000E-12 CM/SEC
           FML PINHOLE DENSITY       =      2.00   HOLES/ACRE
           FML INSTALLATION DEFECTS  =      2.00   HOLES/ACRE
           FML PLACEMENT QUALITY     =  3 - GOOD


                                  LAYER  6
                                  --------

                         TYPE 3 - BARRIER SOIL LINER
                          MATERIAL TEXTURE NUMBER  16
           THICKNESS                 =     24.00   INCHES
           POROSITY                  =      0.4270 VOL/VOL
           FIELD CAPACITY            =      0.4180 VOL/VOL
           WILTING POINT             =      0.3670 VOL/VOL
           INITIAL SOIL WATER CONTENT  =    0.4270 VOL/VOL
           EFFECTIVE SAT. HYD. CONDUCT.=    0.1000E-06 CM/SEC


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               GENERAL DESIGN AND EVAPORATIVE ZONE DATA   1
------------------------------------------------------------------------------

                              VALID FOR  40 YEARS


       NOTE:  SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
                SOIL DATA BASE USING SOIL TEXTURE #15 WITH A
                POOR STAND OF GRASS, A SURFACE SLOPE OF  5.%
                AND A SLOPE LENGTH OF  886. FEET.

           SCS RUNOFF CURVE NUMBER             =    93.10
           FRACTION OF AREA ALLOWING RUNOFF    =    50.0    PERCENT
           AREA PROJECTED ON HORIZONTAL PLANE  =     1.000  ACRES
           EVAPORATIVE ZONE DEPTH              =    10.0    INCHES
           INITIAL WATER IN EVAPORATIVE ZONE   =     3.584  INCHES
           UPPER LIMIT OF EVAPORATIVE STORAGE  =     4.750  INCHES
           FIELD CAPACITY OF EVAPORATIVE ZONE  =     3.780  INCHES
           LOWER LIMIT OF EVAPORATIVE STORAGE  =     2.650  INCHES
           SOIL EVAPORATION ZONE DEPTH         =    10.000  INCHES
           INITIAL SNOW WATER                  =     0.000  INCHES
           INITIAL INTERCEPTION WATER          =     0.000  INCHES
           INITIAL WATER IN LAYER MATERIALS    =   252.848  INCHES
           TOTAL INITIAL WATER                 =   252.848  INCHES
           TOTAL SUBSURFACE INFLOW             =     0.00   INCHES/YEAR


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                 EVAPOTRANSPIRATION DATA   1
------------------------------------------------------------------------------

                     VALID FOR  40 YEARS


        NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
                 SAN ANTONIO         TEXAS
            STATION LATITUDE                    =  29.70 DEGREES
            MAXIMUM LEAF AREA INDEX             =   1.00
            START OF GROWING SEASON (JULIAN DATE)  =    35
            END OF GROWING SEASON (JULIAN DATE)    =   350
            EVAPORATIVE ZONE DEPTH              =  10.0  INCHES
            AVERAGE ANNUAL WIND SPEED           =   9.40 MPH
            AVERAGE 1ST QUARTER RELATIVE HUMIDITY  =  66.0  %
            AVERAGE 2ND QUARTER RELATIVE HUMIDITY  =  68.0  %
            AVERAGE 3RD QUARTER RELATIVE HUMIDITY  =  66.0  %
            AVERAGE 4TH QUARTER RELATIVE HUMIDITY  =  67.0  %

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                 FINAL WATER STORAGE AT END OF YEAR   40
------------------------------------------------------------------------------

              LAYER        (INCHES)       (VOL/VOL)
              -----        --------       ---------
                1            3.7183         0.3099

                2          227.7600         0.2920

                3            9.3291         0.3887

                4            0.0157         0.0784

                5            0.0000         0.0000

                6           10.2480         0.4270

       TOTAL WATER IN LAYERS       251.071

       SNOW WATER                    0.000

       INTERCEPTION WATER            0.000

    TOTAL FINAL WATER           251.071
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                 PEAK DAILY VALUES FOR YEARS    1 THROUGH   40
------------------------------------------------------------------------------

                                              (INCHES)     (CU. FT.)
                                             ----------   -------------
      PRECIPITATION                             8.90        32306.998

      RUNOFF                                    5.655       20528.8066

      DRAINAGE COLLECTED FROM LAYER  4          0.15413       559.50995

      PERCOLATION/LEAKAGE THROUGH LAYER  6      0.000000        0.00134

      AVERAGE HEAD ON TOP OF LAYER  5           0.159

      MAXIMUM HEAD ON TOP OF LAYER  5           0.323

      LOCATION OF MAXIMUM HEAD IN LAYER  4
            (DISTANCE FROM DRAIN)               0.0 FEET

      SNOW WATER                                1.75         6340.7095

      MAXIMUM VEG. SOIL WATER (VOL/VOL)                 0.4649

      MINIMUM VEG. SOIL WATER (VOL/VOL)                 0.2650


       ***  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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        AVERAGE MONTHLY VALUES IN INCHES FOR YEARS    1 THROUGH   40
-------------------------------------------------------------------------------

                         JAN/JUL  FEB/AUG  MAR/SEP  APR/OCT  MAY/NOV  JUN/DEC
                         -------  -------  -------  -------  -------  -------
  PRECIPITATION
  -------------
    TOTALS                 1.91     1.57     2.37     1.86     2.93     3.79
                           2.14     1.91     3.84     3.47     2.35     2.25

    STD. DEVIATIONS        1.31     0.84     1.48     1.39     1.72     2.83
                           2.13     1.91     2.27     2.00     1.81     1.22

  RUNOFF
  ------
    TOTALS                 0.158    0.077    0.330    0.162    0.409    0.946
                           0.478    0.257    0.671    0.579    0.295    0.227

    STD. DEVIATIONS        0.243    0.091    0.514    0.306    0.512    1.183
                           1.137    0.515    0.732    0.600    0.483    0.253

  POTENTIAL EVAPOTRANSPIRATION
  ----------------------------
    TOTALS                 3.153    3.521    5.254    6.376    7.897    8.501
                           9.017    8.366    6.561    5.040    3.649    2.946

    STD. DEVIATIONS        0.350    0.296    0.510    0.521    0.615    0.711
                           0.827    0.776    0.663    0.538    0.374    0.274

  ACTUAL EVAPOTRANSPIRATION
  -------------------------
    TOTALS                 1.446    1.292    1.674    1.746    2.174    2.327
                           1.497    1.565    2.073    1.985    1.392    1.389

    STD. DEVIATIONS        0.608    0.690    0.878    1.052    1.126    1.263
                           1.010    1.247    1.052    0.876    0.776    0.624

  LATERAL DRAINAGE COLLECTED FROM LAYER  4
  ----------------------------------------
    TOTALS                 0.7148   0.5223   0.3863   0.4070   0.3289   0.2245
                           0.5027   0.3892   0.2155   0.4373   0.6083   0.5408

    STD. DEVIATIONS        0.8071   0.5255   0.6244   0.5244   0.5341   0.3056
                           0.6953   0.6338   0.3552   0.5569   0.5789   0.5987

  PERCOLATION/LEAKAGE THROUGH LAYER  6
  ------------------------------------
    TOTALS                 0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

    STD. DEVIATIONS        0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

-------------------------------------------------------------------------------
               AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)
-------------------------------------------------------------------------------


  DAILY AVERAGE HEAD ON TOP OF LAYER  5
  -------------------------------------
    AVERAGES               0.0237   0.0190   0.0128   0.0140   0.0109   0.0077
                           0.0167   0.0129   0.0074   0.0145   0.0209   0.0180

    STD. DEVIATIONS        0.0268   0.0191   0.0207   0.0180   0.0177   0.0105
                           0.0231   0.0211   0.0122   0.0185   0.0199   0.0199

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     AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS    1 THROUGH   40
-------------------------------------------------------------------------------

                                    INCHES            CU. FEET      PERCENT
                              -------------------   -------------  ---------
 PRECIPITATION                30.38    (   5.616)     110285.8     100.00

 RUNOFF                        4.590   (  1.9707)      16661.23     15.107

 POTENTIAL EVAPOTRANSPIRATION  70.281  (  5.2305)     255121.11

 ACTUAL EVAPOTRANSPIRATION     20.559  (  5.3633)      74628.43     67.668

 LATERAL DRAINAGE COLLECTED     5.27750 (  4.61820)     19157.320   17.37062
   FROM LAYER  4

 PERCOLATION/LEAKAGE THROUGH    0.00002 (  0.00001)         0.058    0.00005
   LAYER  6

 AVERAGE HEAD ON TOP            0.015   (    0.013)
   OF LAYER  5

 CHANGE IN WATER STORAGE       -0.044   (  2.6282)       -161.30     -0.146

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**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                                                                          **
**              HELP Version 3.95 D         (10 August 2012)                **
**                               developed at                               **
**          Institute of Soil Science, University of Hamburg, Germany       **
**                                 based on                                 **
**              US 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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TIME:  21.29     DATE:   8.02.2023

PRECIPITATION DATA FILE:      C:\PRECIP-30yr.d4
TEMPERATURE DATA FILE:        C:\TEMP-30yr.d7
SOLAR RADIATION DATA FILE:    C:\SOLAR-30yr.d13
EVAPOTRANSPIRATION DATA F. 1: C:\Evapotranspiration-LAI_0.d11
SOIL AND DESIGN DATA FILE  1: C:\SOILS - EF_01.d10
OUTPUT DATA FILE:             C:\OUT - EF_01.out


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     TITLE:  Mesquite_Creek_LF - EF_01

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                           WEATHER DATA SOURCES
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         NOTE:  PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
                COEFFICIENTS FOR    SAN ANTONIO         TEXAS

                NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

     JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
     -------     -------     -------     -------     -------     -------
      2.14        1.72        2.49        2.00        3.63        3.44
      2.21        2.01        3.45        3.30        2.46        2.42


         NOTE:  TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
                COEFFICIENTS FOR    SAN ANTONIO         TEXAS

             NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

     JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
     -------     -------     -------     -------     -------     -------
      52.20       56.00       62.80       69.80       76.60       82.40
      84.50       85.10       79.90       71.30       61.00       53.50


         NOTE:  SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
                COEFFICIENTS FOR    SAN ANTONIO         TEXAS
                  AND STATION LATITUDE  =  29.70 DEGREES


******************************************************************************

                               LAYER DATA   1
------------------------------------------------------------------------------

                            VALID FOR  30 YEARS


     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  15
           THICKNESS                 =      6.00   INCHES
           POROSITY                  =      0.4750 VOL/VOL
           FIELD CAPACITY            =      0.3780 VOL/VOL
           WILTING POINT             =      0.2650 VOL/VOL
           INITIAL SOIL WATER CONTENT  =      0.3559 VOL/VOL
           EFFECTIVE SAT. HYD. CONDUCT.=      0.1700E-04 CM/SEC


                                  LAYER  2
                                  --------

                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER  18
           THICKNESS                 =    120.00   INCHES
           POROSITY                  =      0.6710 VOL/VOL
           FIELD CAPACITY            =      0.2920 VOL/VOL
           WILTING POINT             =      0.0770 VOL/VOL
           INITIAL SOIL WATER CONTENT  =      0.2936 VOL/VOL
           EFFECTIVE SAT. HYD. CONDUCT.=      0.1000E-02 CM/SEC


                                  LAYER  3
                                  --------

                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER  25
           THICKNESS                 =     24.00   INCHES
           POROSITY                  =      0.4370 VOL/VOL
           FIELD CAPACITY            =      0.3730 VOL/VOL
           WILTING POINT             =      0.2660 VOL/VOL
           INITIAL SOIL WATER CONTENT  =      0.4227 VOL/VOL
           EFFECTIVE SAT. HYD. CONDUCT.=      0.3600E-05 CM/SEC


                                  LAYER  4
                                  --------

                       TYPE 2 - LATERAL DRAINAGE LAYER
                         MATERIAL TEXTURE NUMBER  20
           THICKNESS                 =      0.25   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. CONDUCT.=       6.780      CM/SEC
           SLOPE                     =      5.00   PERCENT
           DRAINAGE LENGTH           =    160.0    FEET


                                  LAYER  5
                                  --------

                       TYPE 4 - FLEXIBLE MEMBRANE LINER
                         MATERIAL TEXTURE NUMBER  35
           THICKNESS                 =      0.06   INCHES
           EFFECTIVE SAT. HYD. CONDUCT.=      0.2000E-12 CM/SEC
           FML PINHOLE DENSITY       =      2.00   HOLES/ACRE
           FML INSTALLATION DEFECTS  =      2.00   HOLES/ACRE
           FML PLACEMENT QUALITY     =  3 - GOOD


                                  LAYER  6
                                  --------

                         TYPE 3 - BARRIER SOIL LINER
                         MATERIAL TEXTURE NUMBER  16
           THICKNESS                 =     24.00   INCHES
           POROSITY                  =      0.4270 VOL/VOL
           FIELD CAPACITY            =      0.4180 VOL/VOL
           WILTING POINT             =      0.3670 VOL/VOL
           INITIAL SOIL WATER CONTENT  =      0.4270 VOL/VOL
           EFFECTIVE SAT. HYD. CONDUCT.=      0.1000E-06 CM/SEC


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                 GENERAL DESIGN AND EVAPORATIVE ZONE DATA   1
------------------------------------------------------------------------------

                            VALID FOR  30 YEARS


         NOTE:  SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
                SOIL DATA BASE USING SOIL TEXTURE #15 WITH BARE
                GROUND CONDITIONS, A SURFACE SLOPE OF  5.% AND
                A SLOPE LENGTH OF  160. FEET.

        SCS RUNOFF CURVE NUMBER            =     96.75
        FRACTION OF AREA ALLOWING RUNOFF   =      0.0    PERCENT
        AREA PROJECTED ON HORIZONTAL PLANE =      1.000  ACRES
        EVAPORATIVE ZONE DEPTH             =     10.0    INCHES
        INITIAL WATER IN EVAPORATIVE ZONE  =      3.184  INCHES
        UPPER LIMIT OF EVAPORATIVE STORAGE =      5.534  INCHES
        FIELD CAPACITY OF EVAPORATIVE ZONE =      3.436  INCHES
        LOWER LIMIT OF EVAPORATIVE STORAGE =      1.898  INCHES
        SOIL EVAPORATION ZONE DEPTH        =     10.000  INCHES
        INITIAL SNOW WATER                 =      0.122  INCHES
        INITIAL INTERCEPTION WATER         =      0.000  INCHES
        INITIAL WATER IN LAYER MATERIALS   =     57.767  INCHES
        TOTAL INITIAL WATER                =     57.890  INCHES
        TOTAL SUBSURFACE INFLOW            =      0.00   INCHES/YEAR


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                        EVAPOTRANSPIRATION DATA   1
-------------------------------------------------------------------------------

                            VALID FOR  30 YEARS


         NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
                  SAN ANTONIO         TEXAS
             STATION LATITUDE                        =  29.70 DEGREES
             MAXIMUM LEAF AREA INDEX                 =   0.00
             START OF GROWING SEASON (JULIAN DATE)   =     35
             END OF GROWING SEASON (JULIAN DATE)     =    350
             EVAPORATIVE ZONE DEPTH                  =  10.0  INCHES
             AVERAGE ANNUAL WIND SPEED               =   9.40 MPH
             AVERAGE 1ST QUARTER RELATIVE HUMIDITY   =  66.0  %
             AVERAGE 2ND QUARTER RELATIVE HUMIDITY   =  68.0  %
             AVERAGE 3RD QUARTER RELATIVE HUMIDITY   =  66.0  %
             AVERAGE 4TH QUARTER RELATIVE HUMIDITY   =  67.0  %

*******************************************************************************



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                   FINAL WATER STORAGE AT END OF YEAR   30
-------------------------------------------------------------------------------

                     LAYER        (INCHES)       (VOL/VOL)
                     -----        --------       ---------
                       1           2.1784         0.3631

                       2          35.7973         0.2983

                       3           9.0548         0.3773

                       4           0.0025         0.0100

                       5           0.0000         0.0000

                       6          10.2480         0.4270

             TOTAL WATER IN LAYERS        57.281

             SNOW WATER                    0.000

             INTERCEPTION WATER            0.000

             TOTAL FINAL WATER            57.281

*******************************************************************************



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                PEAK DAILY VALUES FOR YEARS    1 THROUGH   30
-------------------------------------------------------------------------------

                                                 (INCHES)     (CU. FT.)
                                                ----------   -------------
      PRECIPITATION                                8.90        32306.998

      RUNOFF                                       0.000           0.0000

      DRAINAGE COLLECTED FROM LAYER  4             0.45219      1641.45544

      PERCOLATION/LEAKAGE THROUGH LAYER  6         0.000000        0.00033

      AVERAGE HEAD ON TOP OF LAYER  5              0.099

      MAXIMUM HEAD ON TOP OF LAYER  5              0.076

      LOCATION OF MAXIMUM HEAD IN LAYER  4
            (DISTANCE FROM DRAIN)                  0.0 FEET

      SNOW WATER                                  23.66        85869.7969

      MAXIMUM VEG. SOIL WATER (VOL/VOL)                    0.4197

      MINIMUM VEG. SOIL WATER (VOL/VOL)                    0.1898


       ***  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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         AVERAGE MONTHLY VALUES IN INCHES FOR YEARS    1 THROUGH   30
-------------------------------------------------------------------------------

                          JAN/JUL  FEB/AUG  MAR/SEP  APR/OCT  MAY/NOV  JUN/DEC
                          -------  -------  -------  -------  -------  -------
  PRECIPITATION
  -------------
    TOTALS                  1.74     1.68     2.24     1.92     2.83     3.81
                            2.15     1.90     4.13     3.38     2.38     2.23

    STD. DEVIATIONS         1.18     0.88     1.40     1.49     1.75     2.30
                            2.03     2.16     2.36     2.10     1.95     1.20

  RUNOFF
  ------
    TOTALS                 0.000    0.000    0.000    0.000    0.000    0.000
                           0.000    0.000    0.000    0.000    0.000    0.000

    STD. DEVIATIONS        0.000    0.000    0.000    0.000    0.000    0.000
                           0.000    0.000    0.000    0.000    0.000    0.000

  POTENTIAL EVAPOTRANSPIRATION
  ----------------------------
    TOTALS                 3.138    3.473    5.201    6.261    7.746    8.403
                           8.938    8.340    6.524    5.001    3.652    2.916

    STD. DEVIATIONS        0.372    0.301    0.614    0.719    0.907    0.918
                           0.943    0.890    0.727    0.604    0.424    0.286

  ACTUAL EVAPOTRANSPIRATION
  -------------------------
    TOTALS                 1.453    1.461    1.776    1.655    2.180    2.580
                           1.746    1.641    2.065    2.229    1.454    1.471

    STD. DEVIATIONS        0.672    0.761    1.004    1.099    1.166    1.229
                           1.292    1.454    1.183    1.009    0.927    0.705

  LATERAL DRAINAGE COLLECTED FROM LAYER  4
  ----------------------------------------
    TOTALS                0.7360   0.4904   0.7235   0.5884   0.4616   0.5157
                          0.9771   0.6620   0.4365   1.1964   1.0759   0.8186

    STD. DEVIATIONS       0.6938   0.5562   2.0073   1.2753   0.8271   0.5864
                          0.8991   0.9515   0.5861   1.2280   0.9954   0.9721

  PERCOLATION/LEAKAGE THROUGH LAYER  6
  ------------------------------------
    TOTALS                0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                          0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

    STD. DEVIATIONS       0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                          0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

-------------------------------------------------------------------------------
               AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)
-------------------------------------------------------------------------------


  DAILY AVERAGE HEAD ON TOP OF LAYER  5
  -------------------------------------
    AVERAGES              0.0036   0.0027   0.0040   0.0031   0.0023   0.0026
                          0.0048   0.0033   0.0023   0.0061   0.0055   0.0039

    STD. DEVIATIONS       0.0034   0.0035   0.0123   0.0069   0.0042   0.0031
                          0.0044   0.0049   0.0030   0.0065   0.0051   0.0045

*******************************************************************************



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       AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS    1 THROUGH   30
-------------------------------------------------------------------------------

                                       INCHES            CU. FEET      PERCENT
                                 -------------------   -------------  ---------
 PRECIPITATION                     30.38   (   5.727)     110266.1    100.00

 RUNOFF                             0.000  (  0.0000)          0.00     0.000

 POTENTIAL EVAPOTRANSPIRATION      69.595  (  6.7884)     252628.27

 ACTUAL EVAPOTRANSPIRATION         21.711  (  6.2812)      78809.44    71.472

 LATERAL DRAINAGE COLLECTED       8.68196 (  6.22992)     31515.518   28.58133
   FROM LAYER  4

 PERCOLATION/LEAKAGE THROUGH      0.00000 (  0.00000)         0.009    0.00001
   LAYER  6

 AVERAGE HEAD ON TOP                0.004  (   0.003)
   OF LAYER  5

 CHANGE IN WATER STORAGE           -0.020  (  5.7028)        -73.65    -0.067

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ATTACHMENT 3E.3

LEACHATE COLLECTION SYSTEM GEOSYNTHETIC DRAINAGE LAYER DESIGN

Written by:	Y. Bholat	Date:	2/15/23	Reviewed by:	S. Graves	Date:	8/3/2023
Client:	WMTX	Project:	Mesquite Creek	Project No.:	GW8636	Task No.:	05

ATTACHMENT 3E.3
LEACHATE COLLECTION SYSTEM GEOSYNTHETIC DRAINAGE LAYER DESIGN

STATE OF TEXAS
SCOTT M. GRAVES
86557
LICENSED
PROFESSIONAL ENGINEER

10/11/2023

GEOSYNTEC CONSULTANTS, INC.
TX ENG FIRM REGISTRATION NO. F-1182

FOR PERMIT PURPOSES ONLY;
CALCULATION PAGES
3E.3-1 THROUGH 3E.3-14

PURPOSE

The purpose of this calculation package is to present the design of the geosynthetic drainage layer component of the liner system for the Mesquite Creek Landfill. The geocomposite drainage layer will be comprised of an HDPE geonet core with a needle punched non-woven geotextile bonded to its top and bottom surfaces (i.e., a double-sided geocomposite). The drainage layer will be located between a 2-ft thick protective layer (soil) and an HDPE geomembrane.

The design criteria evaluated include: (i) filtration capability and specifications for the geotextile component of the geocomposite drainage layer; (ii) survivability specifications for the geotextile component; and (iii) hydraulic capacities of the geosynthetic drainage layer and testing conditions for verifying that the required capacities are achieved.

METHOD OF ANALYSIS

Geotextile Filtration

The filtration characteristics of the geotextile component of the geocomposite layer are evaluated using a retention criterion, a permeability criterion, a porosity criterion, and a thickness criterion based on methods proposed by Holtz et al. (1998) and Giroud (2010). These criteria are summarized below in Table 1.

Written by:	Y. Bholat	Date:	2/15/23	Reviewed by:	S. Graves	Date:	8/3/2023
Client:	WMTX	Project:	Mesquite Creek	Project No.:	GW8636	Task No.:	05

Table 1. Filtration Criteria for Geotextile Components (adapted from Holtz et al., 1998; and Giroud, 2010)

1. Retention Criterion

1.1 Soils with less than 50% particles < 0.075 mm (US Sieve No. 200)

Density index of the soil (Relative density)		Linear coefficient of uniformity of the soil	
		$1 < C'_u < 3$	$C'_u > 3$
loose soil	$I_D \leq 35\%$	$O_{95} \leq (C'_u)^{0.3}\, d'_{85}$	$O_{95} < \frac{9}{(C'_u)^{1.7}}\, d'_{85}$
medium dense soil	$35\% < I_D < 65\%$	$O_{95} \leq 1.5\, (C'_u)^{0.3}\, d'_{85}$	$O_{95} < \frac{13.5}{(C'_u)^{1.7}}\, d'_{85}$
dense soil	$I_D \geq 65\%$	$O_{95} \leq 2\, (C'_u)^{0.3}\, d'_{85}$	$O_{95} < \frac{18}{(C'_u)^{1.7}}\, d'_{85}$

1.2 Soils with more than 50% particles < 0.075 mm (US Sieve No. 200)

$O_{95} \leq 210\ \mu m$ (US Sieve No. 70)

2 Permeability Criterion

$k_{geotextile} \geq \max\,(i_{soil}\, k_{soil}\,,\ k_{soil})$

3. Porosity Criterion

Nonwoven geotextiles: $n_g \geq 55\%$

4. Thickness Criterion

Nonwoven geotextiles: $N_{constrictions} \geq 25$

Notes:
- O_{95} is the apparent opening size (AOS) of the geotextile
- C'_u = linear coefficient of uniformity = $\sqrt{d'_{100}/d'_0}$ where d'_{100} and d'_0 is the top and bottom extremities, respectively, of a line drawn through the soil particle-size distribution curve and tangent at d_{50}.
- d'_{85} is the "linear particle size" for which 85% of particles are finer by weight, derived from the straight line drawn through the soil particle-size distribution curve.
- I_D = relative density or density index = $(e_{max} - e)/(e_{max} - e_{min})$, where e = soil void ratio; e_{min} = soil minimum void ratio, and e_{max} = soil maximum void ratio.
- $k_{geotextile}$ = geotextile hydraulic conductivity; k_{soil} = soil hydraulic conductivity; i_{soil} = hydraulic gradient in the soil next to the geotextile,
- porosity, n_g (dimensionless) is calculated as follows: $n_g = 1 - \mu_g/(\rho_g\, t_g)$, where: μ_g = geotextile mass per unit area, ρ_g = polymer density, and t_g = geotextile thickness
- Number of constrictions ($N_{constrictions}$) is calculated as follows: $(N_{constrictions}) = \mu_g / [\rho_g d_f \sqrt{1 - n_g}]$, where: μ_g = geotextile mass per unit area; ρ_g = polymer density; d_f = geotextile fiber diameter; and n_g = geotextile porosity.

Geotextile Survivability

Survivability requirements (grab, tear, and puncture strengths) are considered so that the geotextile component of the geocomposite will have adequate resistance to stresses applied to the geotextile during construction (i.e., when concentrated stresses should be the highest), using the method presented in GRI-GT13 (2017). The procedure involves two steps: (i) establish the required degree of survivability as a function of subgrade conditions, type of construction equipment operation above the geotextile, and lift thickness using Table 2; and (ii) establish the recommended minimum values of certain mechanical strength properties (i.e., grab strength, puncture resistance, and trapezoidal tear strength) using Table 3. The survivability requirements are then compared to characteristics of geotextile products on the current market to check that products are available to meet the calculated minimum strengths.

Drainage Layer Hydraulic Capacity

The drainage layer hydraulic capacity design evaluation is performed using the design-by-function concept presented by Koerner (2005) and based on Darcy's equation (flow rate = hydraulic conductivity × hydraulic gradient × cross-sectional area of flow) for hydraulic flow in porous, saturated media. The approach herein then follows the design methodologies presented in Giroud et al. (2000) and GRI-GC8 (2013).

The design method involves the following steps:

Step 1) Calculate the required (design) transmissivity (θ_{req}) based on results of leachate generation calculations using the USEPA Hydrologic Evaluation of Landfill Performance (*HELP*) model.

Step 2) Apply a global factor of safety (FS) to find the allowable flow rate and corresponding "Long-Term In-Soil" (LTIS) transmissivity (θ_{LTIS}).

Step 3) Apply partial reduction factors (RFs) for creep, chemical clogging, and biological clogging to account for the long-term decrease in flow capacity behavior, and calculate the baseline flow rate and corresponding baseline transmissivity (θ_{100}).

Step 4) Determine the critical operational case for θ_{100} by comparing required θ_{100} to typical θ_{100} for biplanar geocomposites at various loading conditions.

Step 5) Identify GRI-GC8 test conditions to measure θ_{100}. The resulting θ_{100} from Step 4 is a product specification for the baseline laboratory test transmissivity that should be achieved if tested in accordance with GRI-GC8, Part 6 (2013). Therefore, it is necessary to identify test conditions which simulate site-specific loading conditions and boundary conditions.

Step 6) Calculate the index transmissivity that corresponds to the baseline transmissivity from previous steps. Geocomposite manufacturers typically provide product index transmissivities based on laboratory tests in which the drainage layer is sandwiched between two steel plates as opposed to site specific boundary conditions. The index transmissivity is determined by applying a reduction factor to θ_{100} to account for geotextile/soil intrusion.

Table 2. Required Degree of Survivability as a Function of Subgrade Conditions, Construction Equipment, and Lift Thickness (GRI-GT13)*

Subgrade Conditions	Low ground-pressure equipment (≤ 3.6 psi)	Medium ground-pressure equipment (> 3.6 psi, ≤ 7.3 psi)	High ground-pressure equipment (> 7.3 psi)
Subgrade has been cleared of all obstacles except grass, leaves, and fine wood debris. Surface is smooth and level so that any shallow depressions and humps do not exceed 18 in. in depth or height. All larger depressions are filled. Alternatively, a smooth working table may be placed.	Low	Moderate	High
Subgrade has been cleared of obstacles larger than small to moderate-sized tree limbs and rocks. Tree trunks and stumps should be removed or covered with a partial working table. Depressions and humps should not exceed 18 in. in depth or height. Larger depressions should be filled.	Moderate	High	Very High
Minimal site preparation is required. Trees may be felled, delimbed, and left in place. Stumps should be cut to project not more than ± 6 in. above subgrade. Fabric may be draped directly over the tree trunks, stumps, large depressions and humps, holes, stream channels, and large boulders. Items should be removed only if placing the fabric and cover material over them will distort the finished road surface.	High	Very High	Not Recommended

* Recommendations are for 6 to 12 in. initial lift thickness. For other initial lift thicknesses:

12 to 18 in.: reduce survivability requirement one level;
18 to 24 in.: reduce survivability requirement two levels;
> 24 in.: reduce survivability requirement three levels

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Table 3. GRI-GT13 Geotextile Strength Property Requirements

			Geotextile Classification (1)					
			Class 1 (high)		**Class 2 (moderate)**		Class 3 (low)	
Tests	Test Methods	Units	Elongation < 50%	Elongation ≥ 50%	Elongation < 50%	Elongation ≥ 50%	Elongation < 50%	Elongation ≥ 50%
Grab Tensile Strength	ASTM D 4632	lb	315	203	248	158	180	113
Trapezoid Tear Strength	ASTM D 4533	lb	112	79	90	56	68	41
CBR Puncture Strength	ASTM D 6241	lb	630	440	500	320	380	230
Permittivity	ASTM D 4491	sec^{-1}	0.02	0.02	0.02	0.02	0.02	0.02
Apparent Opening Size	ASTM D 4751	in.	0.024	0.024	0.024	0.024	0.024	0.024
Ultraviolet stability (2)	ASTM D 7238	% Ret. @ 500 hrs	50	50	50	50	50	50

Notes: (1) All values are minimum average roll values (MARV) except AOS, which is a maximum average roll value (MaxARV) and UV stability which is a minimum average value.
(2) Evaluation to be on 2-in. strip tensile specimens after 500 hours exposure.

FILTRATION EVALUATION RESULTS

Geotextile Retention

The geotextile must have openings that are small enough to retain fine-grained soil particles so that they do not enter the leachate collection drainage layer, which could result in clogging or flow capacity reduction of the drainage layer. Therefore, the apparent opening size (AOS, hereafter referred to as O_{95}) of the geotextile must be less than a maximum value.

The O_{95} is calculated depending on the type of soil used for the protective cover as follows:

If the soil used for the protective cover is fine grained, i.e., more than 50 percent of particles are finer than 0.075 mm (U.S. Sieve No. 200) (e.g., a CL soil), then by applying the criterion in Table 1, O_{95} is calculated as:

$$O_{95} \leq 210\ \mu m \text{ (U.S. Sieve No. 70)}$$

This criterion will be used because the geocomposite drainage layer of the liner leachate collection system will be overlain by non-specified protective cover soil layer, expected to be relatively fine grained.

The range of geotextile mass per unit areas anticipated for use as the leachate drainage layer or drainage layer component are 6 to 16 oz/yd^2 (200 to 540 g/m^2). Typical O_{95} for 6 to 16 oz/yd^2 geotextiles on the current market range from 70 to 100 µm (IFAI, 2004); thus, products are available that can meet this specification.

Geotextile Permeability

The protective cover soil will be non-specified (i.e., no specified permeability requirement). Based on on-site soils, it is anticipated that the hydraulic conductivity of the protective cover will fall within the range of 1×10^{-7} to 1×10^{-5} cm/s. The geotextile must have openings that are large enough to allow infiltrating water to pass through the retained soil/geotextile interface without significant flow impedance. Thus, the hydraulic conductivity or permeability of the geotextile must be greater than a minimum required value. The hydraulic gradient in the protective cover is assumed to be <10 based on typical values in Giroud (2010). A hydraulic gradient of 10 will be used in the calculations.

Applying the permeability criterion, the calculated hydraulic conductivity of the geotextile, $k_{geotextile}$, is:

$$\begin{aligned} k_{geotextile} &\geq \max(i_{soil}\, k_{soil}, k_{soil}) \\ &\geq 10 \times (1 \times 10^{-5} \text{ cm/s}) = 0.0001 \text{ cm/s} \end{aligned}$$

This requirement is readily achievable by most geotextiles. Note that some manufacturers report the permeability property as a related parameter "permittivity" (Ψ), which is defined as $\Psi = k/t$ – as permittivity is the preferred industry standard for specifying water flow requirements through geotextile fabrics. Based on the range of geotextile mass per unit areas and thicknesses anticipated for the project (6 to 16 oz/yd^2 (200 to 540 g/m^2) and 1.3 to 5.7 mm, respectively), typical $k_{geotextile}$ values (calculated from typical permittivities and thicknesses) for needle punched non-woven geotextiles are 0.2 to 0.4 cm/s. Therefore, nonwoven needle punched geotextiles within the anticipated range for this project are well above the minimum required permeability value. In terms of water flow characteristics, a permittivity value of at least 0.02 sec^{-1} would be needed per Table 3, but this value has been increased to a minimum of 1.2 sec^{-1} based on typical industry standards and product capabilities.

Geotextile Porosity

The geotextile filter must have enough openings so that blocking some of them will not significantly clog the geotextile and inhibit flow into the geonet. Thus, the porosity of the geotextile must be greater than a minimum value. As shown in Table 1, for non-woven geotextiles, the geotextile porosity n_g is required to be:

$$n_g > 55\%$$

The porosity criterion requirements apply for the geotextile component of the geocomposite drainage layer. Geotextile porosity is not a property that is directly measured or reported by manufacturers, however it can be calculated as indicated in Table 1 (i.e., $n_g = 1 - \mu_g/(\rho_g\ t_g)$). Typical resulting n_g values for non-woven geotextiles are 50 to 95%. Based on the geotextile density of polypropylene or polyethylene and the range of mass per unit areas and thicknesses anticipated for the project (6 to 16 oz/yd^2 (200 to 540 g/m^2) and 1.3 to 5.7 mm, respectively), the calculated n_g values range from approximately 80% to 90%, which is well in excess of the minimum porosity required to prevent clogging.

<u>Geotextile Thickness</u>

For non-woven geotextiles, such as those proposed for the final cover system geocomposite drainage layer, the geotextile filter must be thick enough to have a sufficient number of constrictions. From Table 1, the number of constrictions, $N_{constrictions}$, needs to be at least 25.

The number of constrictions in non-woven geotextiles is a function of mass per unit area, porosity, polymer density, and geotextile fiber diameter:

$$N_{constrictions} = \mu_g / (\rho_g d_f \sqrt{1 - n_g})$$

Based on data for non-woven needlepunched geotextiles presented by Palmeira and Gardoni (2000) and Faure et al. (2006), as well as data compiled by Geosyntec from manufacturers, most non-woven needlepunched geotextiles that have at least 25 constrictions have a minimum thickness of 2.3 mm. The thickness of non-woven geotextiles is typically not measured or reported by manufacturers but tends to be correlated to mass per unit area. The minimum mass per unit area specified herein is expected to meet or exceed this thickness, and therefore have the minimum number of constrictions.

SURVIVABILITY EVALUATION RESULTS

Survivability refers to the ability of the geotextile to withstand the stresses during installation and handling in the field. The degree of survivability is first evaluated using Table 2 with the anticipated installation conditions. The following conditions are conservatively assumed to apply: (i) smooth and level subgrade condition; (ii) initial lift thickness of soil placed above geotextile is 12 in.; and (iii) maximum equipment ground pressure of 5 psi (35 kPa) (i.e., medium (per Table 2 definition) ground-pressure equipment is used). Using Table 2, a "moderate" degree of survivability is used.

In the second step, the minimum required values for the mechanical properties of the geotextile are established from Table 3 based on the "moderate" or "Class 2" survivability requirement established from Table 2. Table 3 provides minimum required values for two ranges of geotextile extensibility. Values were selected for the more extensible range because this range is applicable to non-woven materials that are required for the geotextile. These survivability requirements, which are outlined in Table 3, apply for the geotextile component of the geocomposite drainage layer.

HYDRAULIC CAPACITY EVALUATION

Step 1) Calculate Required (Design) Transmissivity, θ_{req}

As presented in Attachment 3E.2, the *HELP* model was used to calculate the required (design) in-plane hydraulic conductivity and equivalent transmissivity of the leachate drainage layer. The required transmissivity is based on maintaining the peak daily average head on the liner less than or equal to the thickness of the geocomposite and a peak daily maximum head less than 12 inches on both the floor slopes and the side slopes. The required (design) transmissivity, θ_{req}, was calculated for each condition, and the results are repeated below.

Area	Case ID	Waste + Protective Cover Depths (ft)	Soil Cover Depth (ft)	Design Transmissivity θ_{req} (m^2/s)
New Fill (NF)	NF1	12	0	2.5E-04
	NF2	77	0	7.1E-05
	NF3	152	0	7.6E-05
	NF5	67	0	6.1E-06

It is noted that NF4 was omitted from this calculation because, by inspection, it is not critical for sizing of the leachate drainage layer due to the presence of the final cover system which significantly limits infiltration and resulting flows to the leachate collection drainage layer. A stand-alone design calculation package for sizing of the final cover system drainage layer geocomposite is presented in Part III, Attachment 3G.

Step 2) Calculate Allowable "Long Term In Soil" Transmissivity, θ_{LTIS}

The allowable "Long Term In Soil" transmissivity, θ_{LTIS} is calculated by applying a factor of safety to increase the minimum required transmissivity. This factor of safety accounts for unknown loading conditions or uncertainties in design methods. For leachate drainage layers, a factor of safety (FS) of 2 was used.

$$\theta_{LTIS} = \theta_{req} \times FS \qquad (1)$$

The θ_{LTIS} was calculated for each condition, as shown below.

Area	Case ID	θ_{LTIS} (m^2/s)
New Fill (NF)	NF1	5.1E-04
	NF2	1.4E-04
	NF3	1.5E-04
	NF5	1.2E-05

Step 3) Calculate Baseline Geocomposite Transmissivity, θ_{100}

Factors which account for additional long-term transmissivity reduction due to creep, chemical clogging, and biological clogging were applied to determine the minimum baseline product transmissivity, θ_{100}, for laboratory testing results as shown in Eqns. 2 and 3.

$$\theta_{LTIS} = \frac{\theta_{100}}{RF_{CR} RF_{CC} RF_{BC}} \quad (2)$$

where RF_{CR} = reduction factor for creep, RF_{CC} = reduction factor for chemical clogging and/or precipitation of chemicals, and RF_{BC} = reduction factor for biological clogging.

Creep is the long-term reduction in thickness of the drainage layer under a sustained compressive stress. For landfill leachate collection systems, Koerner (2005) recommends that reduction factors for creep range from 1.4 to 2.0. For these design computations, the reduction factors for creep were assigned to increase from initial operational conditions through final cover conditions, since creep is a long-term phenomenon.

GRI (2013) provides guidance for clogging reduction factors for landfill leachate collection systems. Chemical and biological clogging is expected to increase over time as leachate passes through the geocomposite. Thus, the reduction factors for clogging are assumed to increase from initial operational conditions through final cover conditions. GRI (2013) recommends a chemical clogging reduction factor between 1.5 and 2.0 and a biological clogging reduction factor between 1.1 and 1.3. The selected values depend on the case being analyzed (varying from lower reduction factors to higher for short-term vs. long-term cases), as tabulated below.

Rearranging Eqn. 2 and substituting θ_{LTIS} and the reduction factors above, we obtain the following equation:

$$\theta_{100} = \theta_{LTIS} \times (RF_{CR} \times RF_{CC} \times RF_{BC}) \quad (3)$$

The θ_{100} was calculated for each condition, as shown below.

Area	Case ID	θ_{LTIS} (m^2/s)	RF_{CR}	RF_{CC}	RF_{BC}	θ_{100} (m^2/s)
New Fill (NF)	NF1	5.1E-04	1	1	1	5.1E-04
	NF2	1.4E-04	1.4	1.5	1.1	3.3E-04
	NF3	1.5E-04	1.4	1.5	1.1	3.5E-04
	NF5	1.2E-05	1.4	1.5	1.1	2.8E-05

Step 4) Calculate the Critical Operation Case for θ_{100}

Geosyntec contacted GSE Lining Technology, Inc. to obtain θ_{100} data for a common biplanar geocomposite on the market. The data correspond to the product, FabriNet, a geocomposite with non-woven geotextile on both sides of the geonet. This does not constitute a specification or endorsement of this product; it is merely intended to compare the required transmissivities to a commercially available product to check reasonableness of the design and availability of products. The FabriNet geocomposite transmissivity was measured at a gradient of 0.1 while sandwiched between sand and a geomembrane for a seating time of 100 hours under five different normal stresses.

To compare the required θ_{100} to the typical θ_{100} on the market, the expected normal stress for each condition must be calculated. The stress can be determined from the thickness of fill to be placed above the drainage layer as follows:

$$p = \gamma_{waste} \times h_{waste} + \gamma_{cover} \times h_{cover} \quad (4)$$

where: p represents the normal stress, γ_{waste} and h_{waste} represent density and thickness of the waste and the protective cover soil, respectively, and γ_{cover} and h_{cover} represent density and thickness of the final cover soil, respectively. The stress was calculated for each condition, as shown below. The unit weights were assumed as 100 pcf for waste/protective cover.

Area	Case ID	Waste + Protective Cover Depths (ft)	Stress (psf)	θ_{100} (m^2/s)
New Fill (NF)	NF1	12	1,200	5.1E-04
	NF2	77	7,700	3.3E-04
	NF3	152	15,200	3.5E-04
	NF5	67	6,700	2.8E-05

The required (minimum) θ_{100} is plotted versus the calculated stress in Figure 1. The expected θ_{100} data for a typical biplanar geocomposite is shown for reference. As shown in this figure, the required θ_{100} is less than θ_{100} for a typical biplanar geocomposite at corresponding stress conditions. Therefore, the proposed geocomposite should provide adequate hydraulic capacity for operation conditions.

As shown in Figure 1, the required θ_{100} for all cases are less than θ_{100} for typical biplanar geocomposites at corresponding stress conditions. Therefore, the proposed geocomposite should provide adequate hydraulic capacity. By inspection of Figure 1, the most critical operation condition for the geocomposite drainage layer is the intermediate condition, NF3. The critical condition occurs where the difference between required θ_{100} and measured θ_{100} is the least. The required θ_{100} is 3.5 x 10^{-4} m^2/s [use as geocomposite specification] and the applied stress is approximately 15,200 psf.

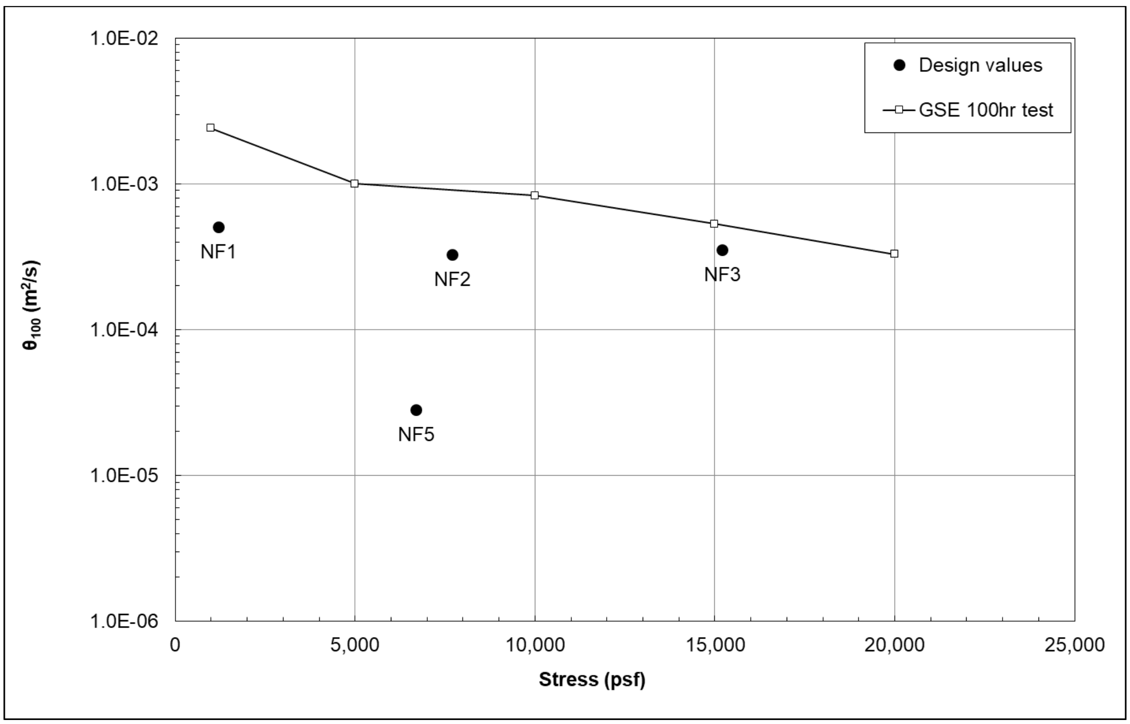

Figure 1. Comparison of Required θ_{100} to Typical θ_{100} Test Results at Various Normal Stresses.

Note: The typical product information shown does not constitute an endorsement of these products, nor does this require the use of any specific manufacturer or product. This information is presented for comparison purposes only.

Step 5) Identify Site-Specific Conditions for Evaluating θ_{100}

The testing conditions to be used in evaluating θ_{100} using GRI Standard GC8, Part 6 are: (i) the testing configuration (i.e., stratum configuration); (ii) the applied stress; and (iii) the hydraulic gradient. These conditions are specified below.

- The testing configuration for transmissivity testing of the leachate drainage layer geocomposite should consist of a 60-mil HDPE geomembrane on one side of the geocomposite specimen (to simulate site-specific liner design) and soil material consistent with the site-specific clayey soil on the other side of the geocomposite specimen (to simulate the clayey soil protective cover layer). The clayey soil material should be compacted to a dry density ranging from 85 to 95% of the standard Proctor maximum dry density, and to a moisture content of plus or minus 5% of the standard Proctor optimum moisture content of the material.
- The stress to be applied in testing the leachate drainage layer should be equivalent to the stress at the most critical condition found in Step 4. As noted in Step 4, the most critical condition for the geocomposite occurs during Case NF3. Therefore, the stress on the leachate drainage layer geocomposite material to be used in determining θ_{100} is approximately 15,200 psf (may be rounded slightly up or down).
- The leachate drainage layer slopes at about 5% on the cell floor. Therefore, the hydraulic gradient to be used in determining θ_{100} for the geocomposite is 0.05.

Step 6) Determine Index Transmissivity, θ_{INDEX}, Based on θ_{100}

Manufacturers of geocomposite and geotextile drainage materials often present the hydraulic capacities of their product by reporting the transmissivity between two steel plates for a short duration test. These transmissivities are usually higher than those obtained using the site-specific boundary condition of soil on one side and a geomembrane on the other side, because the steel plates provide minimal amounts of intrusion into the drainage layer.

To compare the specified θ_{100} of the leachate drainage layer with index values reported by the manufacturer, a factor can be applied to account for the reduction of the transmissivity that may be experienced due to intrusion when testing the drainage layer with boundary materials other than steel plates. The index transmissivity, θ_{INDEX}, which accounts for intrusion can be determined as shown in Eqn. 5:

$$\theta_{INDEX} = \theta_{100} \times RF_{INT} \tag{5}$$

where RF_{INT} is the intrusion reduction factor.

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Koerner (2005) recommends using an intrusion reduction factor (RF_{INT}) between 1.5 and 2.0. An intrusion factor of 1.75 was selected for this design computation. The index transmissivity θ_{INDEX} for the geocomposite at the critical condition specified in Step 4 (NF3) is found to be: $\theta_{INDEX} = 3.5 \times 10^{-4}\ m^2/s \times 1.75 = 6.2 \times 10^{-4}\ m^2/s$

CONCLUSIONS

Based on the evaluations herein, the following specifications are recommended for the leachate drainage layer.

- Retention, Filtration, and Water Flow of and through Geotextile:
  - Apparent Opening Size, $0_{95} \leq 210\ \mu m$ (U.S. Sieve No. 70)
  - Geotextile Permittivity, $\Psi \geq 1.2\ sec^{-1}$
- Survivability (Mechanical) Properties of Geotextile:
  - Grab Strength = 158 lbs
  - Trapezoid Tear Strength = 56 lbs
  - CBR Puncture Strength = 320 lbs
- Hydraulic Capacity of Geocomposite Drainage Layer:
  - $\theta_{100} = 3.5 \times 10^{-4}\ m^2/s$ (when tested with an applied stress of 15,200 psf at a gradient of 0.05, and using site specific clayey soils on one side of the geocomposite, and a 60-mil HDPE geomembrane on the other side of the geocomposite)
  - or $\theta_{INDEX} = 6.2 \times 10^{-4}\ m^2/s$ (when tested between two steel plates with an applied stress of approximately 15,200 psf at a gradient of 0.05).

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ATTACHMENT 3E.4

LEACHATE COLLECTION CORRIDOR AND SIDESLOPE CHIMNEY DRAIN PIPE DESIGN

Written by:	Y. Bholat	Date:	2/16/23	Reviewed by:	S. Graves	Date:	8/3/23
Client:	WMTX	Project:	Mesquite Creek	Project No.:	GW8636	Task No.:	05

ATTACHMENT 3E.4
LEACHATE COLLECTION CORRIDOR AND SIDESLOPE CHIMNEY DRAIN PIPE DESIGN

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SCOTT M. GRAVES
86557
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3E.4-1 THROUGH 3E.4-3

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PURPOSE

The purpose of this analysis is to evaluate the hydraulic flow capacity of the leachate collection corridors and sideslope chimney drains of the Mesquite Creek Landfill. The leachate collection corridor collects leachate from the floor drainage layer while the sideslope chimney drain collects leachate from the sideslope drainage layer; both the leachate collection corridor and sideslope chimney drain convey leachate to the leachate collection sump.

The leachate collection corridor is centrally located within each cell and slopes at 1% (min) towards the sump. In general, the sideslope chimney drain will be located along the toe of slope of perimeter sideslopes in the Unit 2 area and will slope at a minimum of 1%.

The leachate collection corridor and sideslope chimney drain consist of a perforated high-density polyethylene (HDPE) standard dimension ratio (SDR)-11 pipe embedded within a granular drainage media encased within a geotextile filter. For each design, the granular drainage media extends vertically through the protective cover layer to create a chimney drain.

METHODS OF ANALYSIS

The pipe flow capacity should be greater than the leachate flow entering the pipe. The pipe flow capacity is calculated using Manning's equation (from Chow, V.T., *Open Channel-Hydraulics,* McGraw-Hill, 1959) as follows:

$$Q_p = \frac{1.486 R_h^{0.66} i_p^{0.5} A_p}{n} \tag{1}$$

where:

Q_p = pipe flow capacity, cfs;

R_h = hydraulic radius, ft (i.e., ratio of the flow area to the perimeter of the wetted area, $\frac{B_i}{4}$, where B_i is pipe inner diameter, ft);

i_p = hydraulic gradient (i.e., slope of the pipe);

A_p = cross-sectional area of the pipe, ft^2; and

n = Manning's roughness coefficient.

For a pipe with a circular cross section that is flowing full, Manning's equation assumes steady uniform fully turbulent conditions.

For the leachate collection corridor, the critical condition is in Phase XIV which will have the largest contributing area of water flowing into the leachate collection pipe. The peak daily leachate generation rates for the cases analyzed in Attachment 3E.2 are presented below in gallons per acre per day (gpad), in addition to the contributing area and peak daily leachate generation of each scenario. As shown, the peak daily leachate generation rate for the leachate collection corridor is 104,520 gallons per day (gpd).

Case	Peak Daily Leachate Generation Rate (gpad)	Area	Peak Daily Leachate Generation (gpd)
NF1	12,280	1.79	21,981
NF2	4,270	3.14	13,408
NF3	4,396	7.87	34,597
NF5	4,186	8.25	34,535
		Total:	104,520

For the leachate chimney drain, the critical condition is in Phase XIV which will have the largest sideslope contributing area of water flowing into the leachate chimney drain. The peak daily leachate generation rate for Phase XIV is 4,186 gpad. With a contributing area of 5.9 acres, the peak daily leachate generation rate for the leachate chimney drain is 24,697 gpd.

Written by:	**Y. Bholat**	Date:	**2/16/23**	Reviewed by:	**S. Graves**	Date:	**8/3/23**
Client:	**WMTX**	Project:	**Mesquite Creek**	Project No.:	**GW8636**	Task No.:	**05**

CALCULATIONS

As discussed, the proposed leachate collection and sideslope chimney drain pipe is a perforated 6-inch diameter HDPE SDR-11 pipe. The flow capacity is calculated using Eqn. 1, where:

n = Manning's roughness coefficient = 0.009 s/ft$^{0.33}$ (from Chow, 1959)

i_p = hydraulic gradient = 1.0 percent

B_i = 5.42 in. / 12 in./ft = 0.4517 ft

R_h = hydraulic radius = $\dfrac{B_i}{4} = \dfrac{0.4517\ \text{ft}}{4} = 0.113$ ft

A_p = cross-sectional area of the pipe = $\dfrac{\pi B_i^2}{4} = \dfrac{\pi (0.4517\ \text{ft})^2}{4} = 0.16$ ft^2

Based on the parameters above, the flow capacity of the 6 in. diameter pipe is calculated as follows:

$$Q_p = \frac{1.486 R_h^{0.66} i_p^{0.5} A_p}{n}$$

$$Q_p = \frac{1.486(0.113)^{0.66}(0.01)^{0.5}(0.16)}{(0.009)}$$

Q_p = 0.627 ft^3/s = 405,292 gpd

Comparison between the peak daily flow rate of leachate into the leachate collection corridor and the calculated pipe flow capacity indicates that the leachate collection corridor possesses sufficient capacity to convey the peak daily leachate generated at the facility [the flow capacity far exceeds the predicted worst-case peak flow rates].

SUMMARY AND CONCLUSIONS

The highest peak daily leachate collection rates from the leachate collection corridor and the sideslope chimney drain are 104,520 and 24,697 gpd, respectively. The proposed 6-in. diameter collection pipe with a calculated flow capacity equal to 405,292 gpd has adequate hydraulic capacity to convey the peak daily leachate generated, with substantial excess capacity (i.e., the pipes have 3.9x to 16.4x, respectively, the required minimum capacity).

ATTACHMENT 3E.5

LEACHATE COLLECTION SUMP DESIGN

Written by:	**Y. Bholat**	Date:	**2/21/23**	Reviewed by:	**Scott Graves**	Date:	**8/3/23**
Client:	**WMTX**	Project:	**Mesquite Creek**	Project No.:	**GW8636**	Task No.:	**05**

ATTACHMENT 3E.5
LEACHATE COLLECTION SUMP DESIGN

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SCOTT M. GRAVES
86557
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3E.5-1 THROUGH 3E.5-5

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INTRODUCTION

The purpose of this calculation package is to provide design calculations for the leachate collection sumps that will be located at the low point of each phase of Unit 2 at the Mesquite Creek Landfill. Leachate will flow into each given sump from a leachate collection corridor, a sideslope chimney drain(s), and the floor and sideslope drainage layer immediately adjacent to the sump. Leachate will be removed from the sumps and pumped into the leachate transmission system (LTS) or directly transferred into tanker trucks. Specifically in this package, calculations are performed to compute the capacity of the leachate sumps; this information can be used to ensure that the leachate sumps provide adequate leachate storage capacity so that the selected submersible pump does not cycle on and off too frequently. The sump also effectively serves as a flow equalization element in the leachate collection system that stabilizes/attenuates leachate flows the landfill phase into the LTS.

METHOD OF ANALYSIS

The proposed sump is the shape of an inverted truncated pyramid with a square base. The volume of a truncated pyramid is:

$$V = \frac{1}{3}\left(A_1 + A_2 + \sqrt{A_1 A_2}\right)H \qquad \text{(Eqn. 1)}$$

where:

V = Volume of truncated pyramid;
A_1 = Area of base;
A_2 = Area of top; and
H = Height of truncated pyramid.

The volume of the solid particles of the granular drainage material reduces the volume available for leachate storage. The effective volume of leachate storage in the sump is:

$$V_s = Vn \qquad \text{(Eqn. 2)}$$

where:

V_s = Effective volume of sump; and
n = Porosity of granular drainage material.

The pump-on duration is equal to the amount of time it takes to pump down the leachate level from the pump turn on level to the pump turn off level. The pump-on duration is:

$$t_1 = V_s/(Q_{pump} - Q_{in}) \qquad \text{(Eqn. 3)}$$

where:

t_1 = pump-on duration;
Q_{pump} = pump flow rate; and
Q_{in} = flow rate of leachate into the sump.

The pump-off duration is equal to the amount of time it takes for the sump to fill up from the pump-off level to the pump-on level. The pump-off duration is:

$$t_2 = V_s/Q_{in} \qquad \text{(Eqn. 4)}$$

where:

t_2 = pump-off duration.

CALCULATIONS

Total Volume of Sump

The proposed leachate collection sump will be 4 ft deep and will have a 20 ft x 20 ft square base with a sideslope of 3 horizontal to 1 vertical (3H:1V) to meet the landfill floor, as shown in Figure 3E.5-1 below. The submersible pump “turn off” level is typically 18 inches above the base of the sump, so the operating depth of the sump is 2.5 ft. Based on this, these calculations are performed assuming the lower 18 inches of the sump will not contribute to the operating storage volume of the sump.

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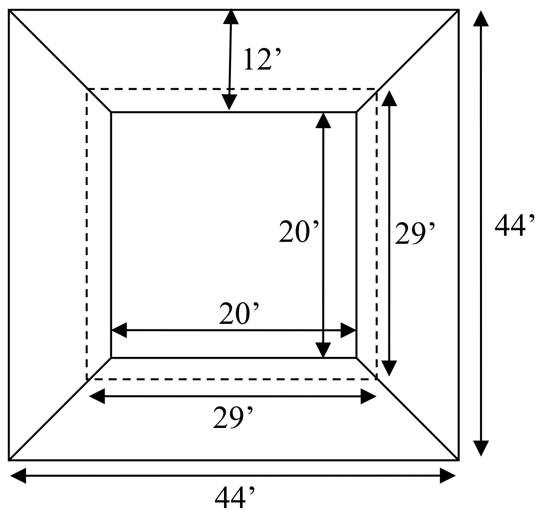
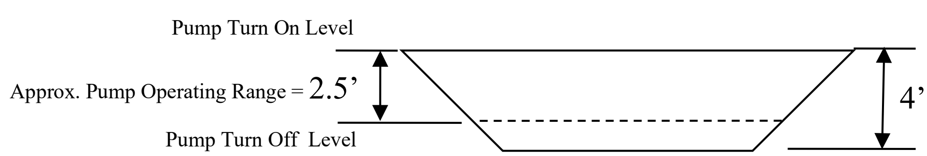
Client:	WMTX	Project:	Mesquite Creek	Project No.:	GW8636	Task No.:	05



Plan View



Elevation View

Figure 3E.5-1. Proposed Leachate Collection Sump Configuration.

From the figure above, the operating parameters are:

$$A_1 = 29' \times 29' = 841\ ft^2;$$
$$A_2 = 44' \times 44' = 1936\ ft^2; \text{ and}$$
$$H = 2.5'.$$

Therefore, the total operating volume of the sump is:

$$V = \frac{1}{3}\left(A_1 + A_2 + \sqrt{A_1 A_2}\right)H$$

$$V = (0.333)(841\ ft^2 + 1936\ ft^2 + [(841\ ft^2)(1936\ ft^2)]^{0.5})(2.5')$$

$$\underline{V = 3378\ ft^3}$$

Effective Volume of Sump

The sump will be filled with granular drainage media with particle diameters ranging from 3/8 inches (D_5) to 3 inches (D_{100}). The porosity of the granular drainage material is assumed to be 0.3. Therefore, the effective volume of the sump is:

$$V_s = V\ n$$
$$V_s = (3378\ ft^3)(0.3)$$
$$\underline{V_s = 1013\ ft^3}$$
$$V_s = (1013\ ft^3)\ (7.48\ gal/ft^3)$$
$$\underline{V_s = 7577\ gallons}$$

Pump-on/Pump-off Duration

From Attachment 3E.4, the calculated maximum peak daily leachate generation rate (Q_{in}) is approximately 104,520 gpd (72.6 gpm) and occurs in Phase XIV. A typical submersible leachate sump pump operates at (Q_{pump}) approximately 80 gpm. Therefore, for the peak daily case, the pump-on duration is:

$$t_1 = V_s/(Q_{pump} - Q_{in})$$
$$t_1 = 7577\ gal/(80\ gpm - 72.6\ gpm)$$
$$t_1 = 1{,}022\ min$$
$$t_1 = 17\ hr$$

and the pump-off duration is:

$$t_2 = V_s/Q_{in}$$
$$t_2 = 7577\ gal/72.6\ gpm$$
$$t_2 = 104\ min$$
$$t_2 = 1.7\ hr$$

With a pump-on duration of 17 hrs and a pump-off duration of 1.7 hrs, a full on and off pump cycle is 18.7 hr. Most pump manufacturers recommend that the sump pump cycle time be more than 15 min, so a cycle time of 18.7 hrs is an acceptable cycle time for the peak daily condition.

For the average daily case, the pump-on duration is:

$$t_1 = V_s/(Q_{pump} - Q_{in})$$
$$t_1 = 7577\ gal/(80\ gpm - 7\ gpm)$$
$$t_1 = 104\ min$$
$$t_1 = 1.7\ hr$$

and the pump-off duration is:

$$t_2 = V_s/Q_{in}$$
$$t_2 = 7577 \text{ gal}/7 \text{ gpm}$$
$$t_2 = 1082 \text{ min}$$
$$t_2 = 18.0 \text{ hr}$$

With a pump-on duration of 1.7 hrs and a pump-off duration of 18.0 hrs, a full on and off pump cycle is 19.7 hr. Since most pump manufacturers recommend that sump pump cycle times be more than 15 min, a cycle time of 19.7 hrs is an acceptable cycle time for the average daily condition.

CONCLUSIONS

Calculation presented herein indicate that, for a given submersible sump pump of 80 gpm, the proposed leachate sump has adequate storage capacity to provide acceptable pump cycle times considering peak and average daily operation rates. This does not represent a required or minimum pump size, but merely is an indication of predicted flows and operating conditions based on HELP modeling, to facilitate pump selection and operational expectations.

ATTACHMENT 3E.6

LEACHATE COLLECTION AND RISER PIPE STRENGTH DESIGN

Written by:	Y. Bholat	Date:	2/21/23	Reviewed by:	S. Graves	Date:	8/3/23
Client:	WMTX	Project:	Mesquite Creek	Project No.:	GW8636	Task No.:	05

ATTACHMENT 3E.6
LEACHATE COLLECTION AND RISER PIPE STRENGTH DESIGN

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SCOTT M. GRAVES
86557
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INTRODUCTION

The purpose of this analysis is to evaluate the ability of the leachate collection and riser pipes at the Mesquite Creek Landfill to resist applied loads with adequate factors of safety. The leachate collection pipes within the landfill phases are evaluated for 6" diameter standard dimension ratio (SDR)-11 perforated high-density polyethylene (HDPE). The riser pipes within these phases are evaluated for 24" diameter SDR-11 HDPE.

The function of leachate collection pipes is to convey leachate collected by the leachate drainage layer to the sump. The riser pipes extend from the sump to the top of the perimeter sideslope with a pump placed inside the riser pipe in each sump to transfer the liquid out of the sump (e.g., to the leachate transmission system (LTS) forcemain). The collection and riser pipes must have adequate structural resistance to withstand the applied loads.

METHODS OF ANALYSES

Four potential strength failure mechanisms are considered for plastic pipes: (i) wall crushing; (ii) wall buckling; (iii) excessive ring deflection; and (iv) excessive bending strain. These mechanisms are evaluated below using methods presented in the technical literature for flexible plastic pipes [Uni-Bell PVC Pipe Association (Unibell), 1991; and Chevron Phillips Chemical Company (CPChem), 2002]. The design methods for flexible plastic pipe are applicable for both PVC and HDPE pipes (U.S. Army Corps of Engineers, 1997).

Stresses on Leachate Collection Pipe and Riser Pipe

Stresses applied to the pipes are estimated for the post-closure condition. Stresses during construction are expected to be significantly lower than the post-closure stresses. During post-closure condition, the stress applied to the pipe is due to the overburden materials above the pipe (i.e., waste material and daily, intermediate, and final cover soils). This stress is calculated as follows:

$$\sigma_{\max} = \gamma_p D_p \qquad \text{(Eqn. 1)}$$

where:

σ_{max} = stress on the pipe, psf;

γ_p = average unit weight of the overburden materials, pcf; and

D_p = thickness of the overburden materials, ft.

The influence of holes on the pipe stress is not normally accounted for in the design process (Bonaparte et al., 2002) and is not done so here. Instead, perforation locations that have been demonstrated to be less critical in terms of stress concentrations (Brachman and Krushelnitzky, 2002) have been specified (i.e., perforations are located at the pipe shoulders and haunches).

The structural resistance of the 6" diameter leachate collection pipes is evaluated under loading from 190 ft of waste (the greatest waste thickness) and liner system and cover system materials. This is also a representative loading condition for the leachate chimney drain pipes.

The structural resistance of the 24" diameter riser pipes is evaluated under loading from 140 ft of waste (the greatest waste thickness at sump) and liner system and cover system materials.

Wall Crushing

Wall crushing can occur when the stress in the pipe wall, due to external vertical pressure, exceeds the compressive strength of the pipe material. The factor of safety against pipe wall crushing may be calculated using the following equation (Phillips 66, 1991):

$$FS_{wc} = \frac{2\sigma_y}{(SDR-1)\sigma_{max}} \qquad \text{(Eqn. 2)}$$

where:

FS_{wc} = factor of safety against pipe wall crushing;

σ_y = compressive yield strength of the pipe, psf;

SDR = standard dimension ratio of the pipe; and

σ_{max} = maximum stress applied to the pipe, psf.

Wall Buckling

Wall buckling (a longitudinal wrinkling in the pipe wall) can occur when the external vertical pressure exceeds the critical buckling pressure of the pipe/bedding aggregate system. The factor of safety against pipe wall buckling may be calculated using the following equation:

$$FS_{wb} = \frac{1.2}{\sigma_{max}}\left[\frac{E'E}{(SDR)^3}\right]^{1/2} \qquad \text{(Eqn. 3)}$$

where:

FS_{wb} = factor of safety against pipe wall buckling;

σ_{max} = maximum stress applied to the pipe, psi;

E' = f (E_s, ν, k) = modulus of soil reaction for pipe bedding material, psi;

E = modulus of elasticity of the pipe material, psi; and

SDR = standard dimension ratio of the pipe.

The modulus of soil reaction, E′, for pipe bedding material is a representative parameter of soil stiffness, which is related to the overburden stress. The modulus of soil reaction is calculated using the Young's modulus of the pipe bedding material (E_s), Poisson's ratio of the pipe bedding material (ν), and an empirical factor (k) based on test data.

The following equation was used to calculate the constrained modulus of the bedding material:

$$M_s = \frac{E_s(1-\nu)}{(1+\nu)(1-2\nu)} \qquad \text{(Eqn. 4)}$$

where:

M_s = constrained modulus, psi;

E_s = Young's modulus, psi; and

ν = Poisson's ratio.

The Young's modulus and Poisson's ratio were taken from data presented by Selig (1990) for soils at various overburden stress levels. The values are based on a sand or gravel (having a classification of SP, SW, GP, or GW as defined by the Unified Soil Classification System (USCS)) bedding material compacted to 85% ASTM D698 at a stress level of 60 psi, the highest stress considered in the Selig (1990) table (Table 3E.6-1). It is assumed that this material will be an AASHTO No. 57 stone or similar material. It is noted that the maximum applied stresses on the pipes are higher than 60 psi, as shown in the calculations below. It is therefore anticipated that the constrained modulus will be even higher than the values calculated for a stress level of 60 psi.

The modulus of soil reaction can then be calculated based on the constrained modulus of the bedding material (M_s) and an empirically derived factor (k).

$$E' = k \times M_s \qquad \text{(Eqn. 5)}$$

The value of k may vary from 0.7 to 2.3 (Selig, 1990). For the analysis herein, an average value of k = 1.5 is used.

<u>Ring Deflection</u>

Excessive ring deflection is a horizontal over-deflection of the pipe causing a reversal of curvature of the pipe wall. This can occur if large external vertical pressures are applied to the pipe/bedding aggregate system. Excessive ring deflection can also lead to substantial loss in flow capacity. Ring deflection is calculated using the Modified Iowa Equation (Mosher, 1990; Koerner, 1998):

$$\Delta X = \frac{D_L K W_c}{\left(EI / r^3\right) + \left(0.061E'\right)} \qquad \text{(Eqn. 6)}$$

where:

ΔX = horizontal deflection or change in diameter, in.;

D_L = deflection lag factor;

K = bedding constant;

W_c = Marston's prism load per unit length of pipe, psi;

E = short-term modulus of elasticity of the pipe, psi;

E' = modulus of soil reaction for bedding material, psi;

I = moment of inertia of the pipe wall per unit length, in.^{4}/in.; and

r = mean radius of the pipe $\left[\frac{D_{od} - t}{2}\right]$, in.

For non-pressure heavy wall HDPE pipe, CPChem (2002) does not recommend a specific "allowable deflection," but instead recommends the bending strain at the predicted deflection be calculated and compared to the allowable strain.

Bending Strain

When a pipe deflects under load, bending strains are induced in the pipe wall. Bending strain occurs in the pipe wall as external pressures are applied to the pipe/bedding aggregate system. Bending strain is calculated using the following equation (Mosher, 1990):

$$\varepsilon_b = f_d \times \frac{t \cdot \Delta y}{D^2} \qquad \text{(Eqn. 7)}$$

where:

ε_b= bending strain, percent;

f_d = deformation shape factor (CPChem, 2002) recommends a value of 6 for elliptical cross-sections);

t = minimum wall thickness, in.;

Δy = vertical deflection, in.; and

D = mean pipe diameter, in.

The following are recommendations for allowable bending strain from the literature and manufacturers:

- A maximum allowable bending strain of 5% is recommended in Wilson-Fahmy and Koerner (1994), based on ASSHTO guidelines for long term use of smooth polyethylene pipes;
- A maximum allowable bending strain of 4.2% is recommended as conservative in CPChem (2002) [it is noted that allowable strains up to 8% are reported in literature as acceptable for a design period of 50 years]; and

Based on the above information, a maximum allowable strain of 4.2% is selected for the HDPE leachate collection system and riser pipes on this project.

CALCULATIONS

Calculations were carried out for the 6" leachate collection pipe; and 24" leachate riser pipe under expected maximum loads at landfill final grades (i.e., design loading). In addition, the maximum heights of waste that the leachate collection and riser pipes can accommodate with adequate factors of safety and allowable strains were calculated (i.e., hypothetical heights even greater than those proposed, to give a sense for the additional capacity that the pipes could withstand). The input parameters and calculated and allowable factors of safety, deflections, and strains are presented in the following calculation sheets.

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6"ϕ SDR-11 HDPE Leachate Corridor (design loading)

Mesquite Creek Landfill - Pipe Strength Design

Input Parameters

Waste

d_c = 190 ft
γ_{avg} = 100 pcf

Pipe

SDR = 11
D_{od} = 6.625 in.
t_{min} = 0.602 in.
E = 31,648 psi
σ_y = 1500 psi
D_L = 1.25
K = 0.11
k = 1.5

Bedding Soil

E_s = 4700 psi
ν = 0.28

Calculated Parameters

σ_{max} = 131.9 psi
M_s = 6009 psi
E' = 9013 psi
W_c = 874 lb/in.
I = 0.01818 $in.^4$/in.
r_{mean} = 3.01 in.
SA = 659.7 psi

Strength Checks

Wall Crushing

$$FS_{WC} = \frac{2\sigma_y}{(SDR-1)\sigma_{max}}$$

FS_{WC} = 2.3 ≥ 1.5

Wall Buckling

$$FS_{wb} = \frac{1.2}{\sigma_{max}}\left[\frac{E'E}{SDR^3}\right]^{1/2}$$

FS_{wb} = 4.2 ≥ 1.5

Ring deflection (Modified Iowa Equation):

$$\Delta X = \frac{D_L K W_c}{(EI/r^3)+(0.061\,E')}$$

Change in diameter, ΔX = 0.211 in.
Ring deflection, ΔX% = 3.18 %

Pipe wall bending strain, ε_b.

$$\varepsilon_b = 6\cdot\frac{t_{min}\cdot\Delta y}{D^2}$$

Δy = 0.211 in.
D = 6.02 in.

Bending strain, ε_b = 2.10 %

Allowable wall ring bending strain: from 4.2 to 8% (8% for 50 year design life) - [CPChem, 2002]

Varaiable Definition

d_c = maximum thickness of overlying materials, ft;
γ_{avg} = average unit weight of overlying materials (waste, liner and cover), pcf;
SDR = standard dimension ratio of the pipe;
D_{od} = outer diameter of pipe, in [CPChem, 2002];
t_{min} = minimum thickness of the pipe, in. [CPChem, 2002]
E = long-term modulus of elasticity of the pipe material [after 50 years based on S_A, Phillips 66, 1991], psi;
σ_y = compressive yield strength of the pipe;
D_L = deflection lag factor (assume 1.25) [Wilson-Fahmy and Koerner, 1994];
K = bedding constant (0º => 0.110) [Wilson-Fahmy and Koerner, 1994; Figure 2];
k = an empirically derived factor for calculating E' (ranges between 0.7 and 2.3, Selig, 1990);
E_s = Young's modulus of the bedding material, psi;
ν = Poisson's ratio of the bedding material;
σ_{max} = maximum stress applied to the pipe, psi;
M_s = constrained modulus of the bedding material;
E' = the modulus of soil reaction for pipe bedding material [Selig, 1990; Table 2], psi;
W_c = Marston's prism load per unit length of pipe, lb/in. [Wilson -Fahmy and Koerner, 1994] = (γ_{avg}) (d_c) (D_{od});
I = the moment of inertia of the pipe wall per unit length (t_{min}^3/12), $in.^4$/in.;
r_{mean} = mean radius = (D_{od} - t_{min})/2 , in.
S_A = =(SDR-1)σ_{max} /2
FS_{WC} = factor of safety against wall crushing
FS_{wb} = factor of safety against wall buckling
ΔX = maximum horizontal deflection or change in diameter, in;
ΔX% = the ring deflection, %. = 100(ΔX/D_{od})
ε_b = Bending strain, %;
Δy = Vertical deflection, in. = ΔX;
D = diameter = Mean diameter (D_{od}-t_{min}), in.;

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6"ϕ SDR-11 HDPE Leachate Corridor (maximum allowable loading)

Mesquite Creek Landfill - Pipe Strength Design

Input Parameters

Waste

$d_c =$ 288 ft

$\gamma_{avg} =$ 100 pcf

Pipe

SDR = 11

$D_{od} =$ 6.625 in.

$t_{min} =$ 0.602 in.

E = 28,286 psi

$\sigma_y =$ 1500 psi

$D_L =$ 1.25

K = 0.11

k = 1.5

Bedding Soil

$E_s =$ 4700 psi

$\nu =$ 0.28

Calculated Parameters

$\sigma_{max} =$ 200.0 psi

$M_s =$ 6009 psi

E' = 9013 psi

$W_c =$ 1,325 lb/in.

I = 0.01818 $in.^4/in.$

$r_{mean} =$ 3.01 in.

SA = 1,000.0 psi

Strength Checks

Wall Crushing

$$FS_{WC} = \frac{2\sigma_y}{(SDR - 1)\sigma_{max}}$$

$FS_{WC} =$ 1.5 ≥ 1.5

Wall Buckling

$$FS_{wb} = \frac{1.2}{\sigma_{max}}\left[\frac{E'E}{SDR^3}\right]^{1/2}$$

$FS_{wb} =$ 2.6 ≥ 1.5

Ring deflection (Modified Iowa Equation):

$$\Delta X = \frac{D_L K W_c}{(EI / r^3) + (0.061\,E')}$$

Change in diameter, $\Delta X =$ 0.320 in.

Ring deflection, $\Delta X\% =$ 4.84 %

Pipe wall bending strain, ε_b.

$$\varepsilon_b = 6 \cdot \frac{t_{min} \cdot \Delta y}{D^2}$$

$\Delta y =$ 0.320 in.

D = 6.02 in.

Bending strain, $\varepsilon_b =$ 3.19 %

Allowable wall ring bending strain: from 4.2 to 8% (8% for 50 year design life) - [CPChem, 2002]

Varaiable Definition

d_c = maximum thickness of overlying materials, ft;

γ_{avg} = average unit weight of overlying materials (waste, liner and cover), pcf;

SDR = standard dimension ratio of the pipe;

D_{od} = outer diameter of pipe, in [CPChem, 2002];

t_{min} = minimum thickness of the pipe, in. [CPChem, 2002]

E = long-term modulus of elasticity of the pipe material [after 50 years based on S_A, Phillips 66, 1991], psi;

σ_y = compressive yield strength of the pipe;

D_L = deflection lag factor (assume 1.25) [Wilson-Fahmy and Koerner, 1994];

K = bedding constant (0º => 0.110) [Wilson-Fahmy and Koerner, 1994; Figure 2];

k = an empirically derived factor for calculating E' (ranges between 0.7 and 2.3, Selig, 1990);

E_s = Young's modulus of the bedding material, psi;

ν = Poisson's ratio of the bedding material;

σ_{max} = maximum stress applied to the pipe, psi;

M_s = constrained modulus of the bedding material;

E' = the modulus of soil reaction for pipe bedding material [Selig, 1990; Table 2], psi;

W_c = Marston's prism load per unit length of pipe, lb/in. [Wilson -Fahmy and Koerner, 1994] $= (\gamma_{avg})(d_c)(D_{od})$;

I = the moment of inertia of the pipe wall per unit length $(t_{min}^3/12)$, $in.^4/in.$;

r_{mean} = mean radius = $(D_{od} - t_{min})/2$, in.

S_A = =(SDR-1)σ_{max} /2

FS_{WC} = factor of safety against wall crushing

FS_{wb} = factor of safety against wall buckling

ΔX = maximum horizontal deflection or change in diameter, in;

$\Delta X\%$ = the ring deflection, %. $= 100(\Delta X/D_{od})$

ε_b = Bending strain, %;

Δy = Vertical deflection, in. = ΔX;

D = diameter = Mean diameter $(D_{od}-t_{min})$, in.;

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24”ϕ SDR-11 HDPE Riser Pipe (design loading)

Mesquite Creek Landfill - Pipe Strength Design

Input Parameters

Waste

d_c = 140 ft
γ_{avg} = 100 pcf

Pipe

SDR = 17
D_{od} = 18.000 in.
t_{min} = 1.059 in.
E = 33,604 psi
σ_y = 1500 psi
D_L = 1.25
K = 0.11
k = 1.5

Bedding Soil

E_s = 4700 psi
ν = 0.28

Calculated Parameters

σ_{max} = 97.2 psi
M_s = 6009 psi
E' = 9013 psi
W_c = 1,750 lb/in.
I = 0.09892 in.^{4}/in.
r_{mean} = 8.47 in.
SA = 777.8 psi

Strength Checks

Wall Crushing

$$FS_{WC} = \frac{2\sigma_y}{(SDR-1)\sigma_{max}}$$

FS_{WC} = 1.9 ≥ 1.5

Wall Buckling

$$FS_{wb} = \frac{1.2}{\sigma_{max}}\left[\frac{E'E}{SDR^3}\right]^{1/2}$$

FS_{wb} = 3.1 ≥ 1.5

Ring deflection (Modified Iowa Equation):

$$\Delta X = \frac{D_L K W_c}{(EI/r^3)+(0.061\,E')}$$

Change in diameter, ΔX = 0.433 in.
Ring deflection, ΔX% = 2.41 %

Pipe wall bending strain, ε_b.

$$\varepsilon_b = 6 \cdot \frac{t_{min} \cdot \Delta y}{D^2}$$

Δy = 0.433 in.
D = 16.94 in.

Bending strain, ε_b = 0.96 %

Allowable wall ring bending strain: from 4.2 to 8% (8% for 50 year design life) - [CPChem, 2002]

Varaiable Definition

d_c = maximum thickness of overlying materials, ft;
γ_{avg} = average unit weight of overlying materials (waste, liner and cover), pcf;
SDR = standard dimension ratio of the pipe;
D_{od} = outer diameter of pipe, in [CPChem, 2002];
t_{min} = minimum thickness of the pipe, in. [CPChem, 2002]
E = long-term modulus of elasticity of the pipe material [after 50 years based on S_A, Phillips 66, 1991], psi;
σ_y = compressive yield strength of the pipe;
D_L = deflection lag factor (assume 1.25) [Wilson-Fahmy and Koerner, 1994];
K = bedding constant (0º => 0.110) [Wilson-Fahmy and Koerner, 1994; Figure 2];
k = an empirically derived factor for calculating E' (ranges between 0.7 and 2.3, Selig, 1990);
E_s = Young's modulus of the bedding material, psi;
ν = Poisson's ratio of the bedding material;
σ_{max} = maximum stress applied to the pipe, psi;
M_s = constrained modulus of the bedding material;
E' = the modulus of soil reaction for pipe bedding material [Selig, 1990; Table 2], psi;
W_c = Marston's prism load per unit length of pipe, lb/in. [Wilson -Fahmy and Koerner, 1994] = (γ_{avg}) (d_c) (D_{od});
I = the moment of inertia of the pipe wall per unit length (t_{min}^3/12), in.^{4}/in.;
r_{mean} = mean radius = (D_{od} - t_{min})/2 , in.
S_A = (SDR-1)σ_{max} /2
FS_{WC} = factor of safety against wall crushing
FS_{wb} = factor of safety against wall buckling
ΔX = maximum horizontal deflection or change in diameter, in;
ΔX% = the ring deflection, %. = 100(ΔX/D_{od})
ε_b = Bending strain, %;
Δy = Vertical deflection, in. = ΔX;
D = diameter = Mean diameter (D_{od}-t_{min}), in.;

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24”ϕ SDR-11 HDPE Riser Pipe (maximum allowable loading)

Mesquite Creek Landfill - Pipe Strength Design

Input Parameters

Waste

$d_c =$ 180 ft

$\gamma_{avg} =$ 100 pcf

Pipe

SDR = 17

$D_{od} =$ 18.000 in.

$t_{min} =$ 1.059 in.

E = 32,025 psi

$\sigma_y =$ 1500 psi

$D_L =$ 1.25

K = 0.11

k = 1.5

Bedding Soil

$E_s =$ 4700 psi

$\nu =$ 0.28

Calculated Parameters

$\sigma_{max} =$ 125.0 psi

$M_s =$ 6009 psi

E' = 9013 psi

$W_c =$ 2,250 lb/in.

I = 0.09892 in.^{4}/in.

$r_{mean} =$ 8.47 in.

SA = 1,000.0 psi

Strength Checks

Wall Crushing

$$FS_{WC} = \frac{2\sigma_y}{(SDR - 1)\sigma_{max}}$$

$FS_{WC} =$ 1.5 ≥ 1.5

Wall Buckling

$$FS_{wb} = \frac{1.2}{\sigma_{max}}\left[\frac{E'E}{SDR^3}\right]^{1/2}$$

$FS_{wb} =$ 2.3 ≥ 1.5

Ring deflection (Modified Iowa Equation):

$$\Delta X = \frac{D_L K W_c}{(EI / r^3) + (0.061\,E')}$$

Change in diameter, ΔX = 0.557 in.

Ring deflection, ΔX% = 3.10 %

Pipe wall bending strain, ε_b.

$$\varepsilon_b = 6 \cdot \frac{t_{min} \cdot \Delta y}{D^2}$$

Δy = 0.557 in.

D = 16.94 in.

Bending strain, ε_b = 1.23 %

Allowable wall ring bending strain: from 4.2 to 8% (8% for 50 year design life) - [CPChem, 2002]

Varaiable Definition

d_c = maximum thickness of overlying materials, ft;

γ_{avg} = average unit weight of overlying materials (waste, liner and cover), pcf;

SDR = standard dimension ratio of the pipe;

D_{od} = outer diameter of pipe, in [CPChem, 2002];

t_{min} = minimum thickness of the pipe, in. [CPChem, 2002]

E = long-term modulus of elasticity of the pipe material [after 50 years based on S_A, Phillips 66, 1991], psi;

σ_y = compressive yield strength of the pipe;

D_L = deflection lag factor (assume 1.25) [Wilson-Fahmy and Koerner, 1994];

K = bedding constant (0° => 0.110) [Wilson-Fahmy and Koerner, 1994; Figure 2];

k = an empirically derived factor for calculating E' (ranges between 0.7 and 2.3, Selig, 1990);

E_s = Young's modulus of the bedding material, psi;

ν = Poisson's ratio of the bedding material;

σ_{max} = maximum stress applied to the pipe, psi;

M_s = constrained modulus of the bedding material;

E' = the modulus of soil reaction for pipe bedding material [Selig, 1990; Table 2], psi;

W_c = Marston's prism load per unit length of pipe, lb/in. [Wilson -Fahmy and Koerner, 1994] = (γ_{avg}) (d_c) (D_{od});

I = the moment of inertia of the pipe wall per unit length (t_{min}^3/12), in.^{4}/in.;

r_{mean} = mean radius = (D_{od} - t_{min})/2 , in.

S_A = =(SDR-1)σ_{max} /2

FS_{WC} = factor of safety against wall crushing

FS_{wb} = factor of safety against wall buckling

ΔX = maximum horizontal deflection or change in diameter, in;

ΔX% = the ring deflection, %.
= 100(ΔX/D_{od})

ε_b = Bending strain, %;

Δy = Vertical deflection, in. = ΔX;

D = diameter = Mean diameter (D_{od}-t_{min}), in.;

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SUMMARY AND CONCLUSIONS

6”ϕ SDR-11 HDPE Leachate Collection Pipes

Under the design loading resulting from a total waste height of 190 ft on top of the leachate corridor pipe in Unit 2, Phase VI, the pipe strength evaluation is summarized as follows:

- Factor of safety against pipe wall crushing, FS_{wc} = 2.3 (OK)
- Factor of safety against pipe wall buckling, FS_{wb} = 4.2 (OK)
- Ring deflection = 3.18 % (OK)
- Bending strain = 2.10 % (OK)

The back-calculated maximum height of waste over the corridor that would result in acceptable factors of safety and allowable strains is 288 ft. This is in excess of that proposed but is provided here as an indication of the tallest waste height that the design could tolerate.

24”ϕ SDR-11 HDPE Riser Pipes

Under the design loading resulting from a total waste height of 140 ft on top of the riser pipe in Unit 2, Phase VI, the pipe strength evaluation is summarized as follows:

- Factor of safety against pipe wall crushing, FSwc = 1.9 (OK)
- Factor of safety against pipe wall buckling, FSwb = 3.1 (OK)
- Ring deflection = 2.41 % (OK)
- Bending strain = 0.96 % (OK)

The back-calculated maximum height of waste over the riser pipes that would result in acceptable factors of safety and allowable strains is 180 ft. This is in excess of that proposed but is provided here as an indication of the tallest waste height that the design could tolerate.

Based on the above results, the specified pipes are anticipated to perform as designed.

Written by:	**Y. Bholat**	Date:	**2/21/23**	Reviewed by:	**S. Graves**	Date:	**8/3/23**
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TABLES

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Table 3E.6-1. Modulus of Soil Reaction for Pipe Bedding Material (from Selig, 1990)

Soil Type: SW, SP, GW, GP

Stress level psi (kPa)	95% D698 E_s	95% D698 B	95% D698 v_s	85% D698 E_s	85% D698 B	85% D698 v_s
1 (7)	1600 (11)	2800 (19)	0.40	1300 (9)	900 (6)	0.26
5 (34)	4100 (28)	3300 (23)	0.29	2100 (14)	1200 (8)	0.21
10 (70)	6000 (41)	3900 (27)	0.24	2600 (18)	1400 (10)	0.19
20 (140)	8600 (59)	5300 (37)	0.23	3300 (23)	1800 (12)	0.19
40 (280)	13000 (90)	8700 (60)	0.25	4100 (28)	2500 (17)	0.23
60 (410)	16000 (110)	13000 (90)	0.29	4700 (32)	3500 (24)	0.28

Soil Type: GM, SM, ML, and GC, SC with < 20% fines

Stress level psi (kPa)	95% D698 E_s	95% D698 B	95% D698 v_s	85% D698 E_s	85% D698 B	85% D698 v_s
1 (7)	1800 (12)	1900 (13)	0.34	600 (4)	400 (3)	0.25
5 (34)	2500 (17)	2000 (14)	0.29	700 (5)	450 (3)	0.24
10 (70)	2900 (20)	2100 (14)	0.27	800 (6)	500 (3)	0 23
20 (140)	3200 (22)	2500 (17)	0.29	850 (6)	700 (5)	0.30
40 (280)	3700 (25)	3400 (23)	0.32	900 (6)	1200 (8)	0.38
60 (410)	4100 (28)	4500 (31)	0.35	1000 (7)	1800 (12)	0.41

Soil Type: CL, MH, GC, SC

Stress level psi (kPa)	95% D698 E_s	95% D698 B	95% D698 v_s	85% D698 E_s	85% D698 B	85% D698 v_s
1 (7)	400 (3)	800 (6)	0.42	100 (1)	100 (1)	0.33
5 (34)	800 (6)	900 (6)	0.35	250 (2)	200 (1)	0.29
10 (70)	1100 (8)	1000 (7)	0.32	400 (3)	300 (2)	0.28
20 (140)	1300 (9)	1100 (8)	0.30	600 (4)	400 (3)	0.25
40 (280)	1400 (10)	1600 (11)	0.35	700 (5)	800 (6)	0.35
60 (410)	1500 (10)	2100 (14)	0.38	800 (6)	1300 (9)	0.40

Note: Units of E_s and B are psi (MPa).

FIGURES

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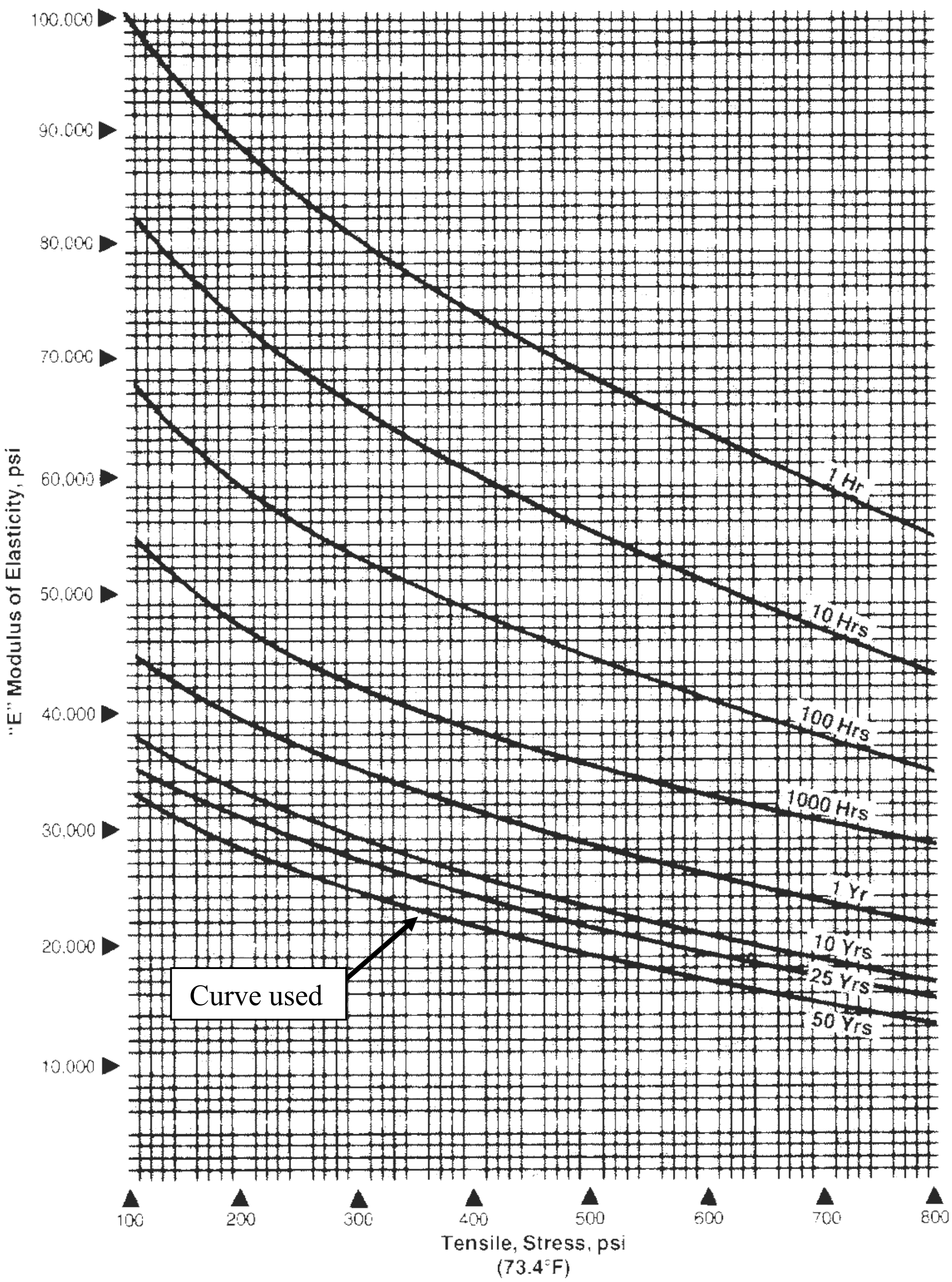

Figure 3E.6-1. Time Dependent Modulus of Elasticity for Polyethylene Pipe (from Phillips 66, 1991)

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Values of Bedding Constant

Bedding Angle (degrees)	K
0	0.110
30	0.108
45	0.105
60	0.102
90	0.096
120	0.090
180	0.083

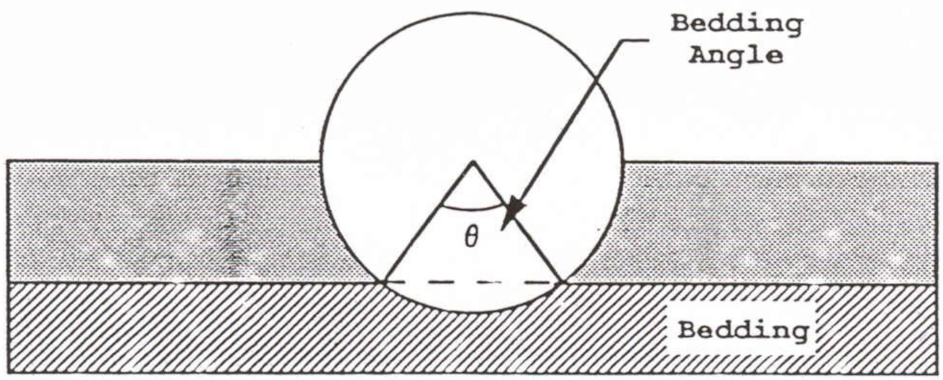

Figure 3E.6-2. Bedding Constant
(from Wilson-Fahmy and Koerner, 1994)

ATTACHMENT 3E.7

EVALUATION OF LEACHATE COLLECTION SYSTEM MATERIALS COMPATIBILITY WITH MUNICIPAL SOLID WASTE LEACHATE

Written by:	Y. Bholat	Date:	2/21/23	Reviewed by:	S. Graves	Date:	8/3/23
Client:	WMTX	Project:	Mesquite Creek	Project No.:	GW8636	Task No.:	05

ATTACHMENT 3E.7
EVALUATION OF LEACHATE COLLECTION SYSTEM MATERIALS COMPATIBILITY WITH MUNICIPAL SOLID WASTE LEACHATE

STATE OF TEXAS
SCOTT M. GRAVES
86557
LICENSED
PROFESSIONAL ENGINEER

10/11/2023

FOR PERMIT PURPOSES ONLY;
CALCULATION PAGES
3E.7-1 THROUGH 3E.7-6

GEOSYNTEC CONSULTANTS, INC.
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INTRODUCTION

The purpose of this attachment is to evaluate and demonstrate the chemical compatibility (resistance to degradation) of the specified leachate collection system (LCS) and associated removal system materials with the expected leachate to be generated. This evaluation addresses compatibility of: (i) high-density polyethylene (HDPE) (which in addition to being used in the geonet of the geocomposite drainage layer of the LCS and in LCS piping, is also a component of the liner system (i.e., the geomembrane liner)); (ii) polypropylenes and polyesters (geotextile components used in the LCS); and (iii) coarse aggregates that will be used in the LCS.

TYPICAL MSW LEACHATE

Table 1 provides typical municipal solid waste (MSW) leachate constituents and their respective concentration ranges. The data were compiled by the United States Environmental Protection Agency (USEPA) [2002] in a study of leachates from MSW across the country. The concentrations of constituents in the leachate generated at the Mesquite Creek Landfill are expected to be comparable to the concentrations presented in the USEPA [2002] study.

PROPOSED LEACHATE COLLECTION SYSTEM COMPONENTS

The following materials are proposed for use in the LCS:

- HDPE, to be used for the geomembrane liner, the geonet component of LCS geocomposite, and LCS piping;

- polypropylene (PP) or polyester (PET), to be used for the geotextile component of the LCS geocomposite; and
- coarse aggregate, to be used for leachate collection corridors, sumps, and related LCS features.

COMPATIBILITY INFORMATION

HDPE (Geomembranes, Geonets, and Pipes)

Geomembranes, geonets, and pipes proposed for use in the liner system and LCS at the facility will be composed of Polyethylene (i.e., HDPE). HDPE is by far the most widely used compound for these components of MSW landfills and is routinely recommended or specified in EPA guidance documents on landfills, associated rules and regulations, and published technical literature. HDPE is the industry standard for such components of MSW landfills, and is widely recognized as the recommended choice for use according to the current state of engineering practice, based in part on its good compatibility with MSW leachates.

Polyethylene used for producing geomembranes, geonets, and pipes is essentially chemically inert [Apse, 1989]. Polyethylene does not react, i.e., undergo a change in its molecular structure, with organic chemicals such as solvents [USEPA, 1988; Apse, 1989]. In fact, it reacts only with some inorganic chemicals, such as sulfuric acid, nitric acid, and oxygen; however, such reactions can take place only with a very high concentration of the chemical and a significant source of energy. These conditions are not present in MSW waste disposal facilities [Haxo and Haxo, 1989]. Also, polyethylene can absorb solvents, which cause it to swell, but the solvents (e.g., trichloroethylene, methylene chloride, benzene, etc.) must be present at a high concentration to cause appreciable swelling [Brydson, 1982; Harper, 1975; Seymour and Carraher, 1981; and Billmeyer, 1984]. At the concentration levels typically observed in MSW landfills, i.e., very low to trace concentrations, swelling of polyethylene materials is generally not expected to occur.

In an early study, Haxo et al. [1985] immersed for up to 31 months several different polymeric materials in MSW leachate. (It should be noted that USEPA 9090 compatibility tests typically last for 4 months.) Of the materials tested, the polyethylene material exhibited the least property change by immersion in the leachate. In fact, hardness of the material did not change. (Hardness is a test used to indicate whether the material has been softened by a leachate. The absence of change indicates that the material has not absorbed leachate.) In addition, consistent with the absence of absorption of leachate, the modulus of the sample did not change after 31 months of exposure. The results support the compatibility of polyethylene material with MSW leachate.

An extensive literature survey was conducted by Schwope et al. [1985] on the chemical resistance of different polymeric materials used for producing geomembranes. The survey indicates that polyethylene materials are compatible with MSW leachates. This conclusion is supported by testing performed by Geosyntec in the 1980s and 1990s, when for various past projects, Geosyntec oversaw the laboratory testing of numerous USEPA 9090 compatibility tests on HDPE geomembranes exposed to MSW leachates. These tests reveal that HDPE geomembranes are chemically compatible with MSW leachates.

The chemical characteristics of typical MSW leachate, such as that expected to be generated by a Type I MSW landfill such as this facility, are presented in Table 1 of this package. Inspection of the constituents and concentrations of typical MSW leachate reveals that the constituents have very low (trace) concentrations, in comparison to the types of chemicals for which HDPE would be potentially incompatible when present in very high concentrations or their pure chemical (undiluted) form.

In summary, the results of extensive chemical compatibility testing of HDPE with a wide range of MSW leachates and related chemical constituents as reported in technical literature demonstrate that the properties of HDPE polymer that is used in geomembranes, geonets, and pipes is not affected by exposure to MSW leachates, indicating that HDPE materials are chemically compatible with the wastes and MSW leachate expected to be generated at the landfill.

Polypropylene and Polyester (Geotextiles)

Most geotextiles are composed of polypropylene (PP); some geotextiles (or geotextile seaming threads) are composed of polyester (PET), and geotextiles made of these polymers are the industry standard for such components of MSW landfill LCSs. They are widely recognized as the recommended choice for use according to the current state of engineering practice, based in part on their good compatibility with MSW leachates.

For example, both PP and PET geotextiles are resistant to organic chemicals at the concentration levels that are typically present in MSW landfill leachates. Neither PP nor PET react (i.e., undergo a change in molecular structure) with organic chemicals. Only when they are exposed to organic chemicals at very high concentrations may they absorb the chemicals and be affected [Brydson, 1982; Harper, 1975; Seymour and Carraher, 1981; Schneider, 1989; and Billmeyer, 1984]. Such absorption leads to the swelling of the fibers of the geotextiles, causing the geotextiles to weaken, compromising their performance. Importantly, geotextiles are not exposed to highly concentrated or pure (undiluted) organic chemicals in an MSW landfill environment. Instead, there may be dilute, very low (trace) concentrations of organic constituents.

Written by:	**Y. Bholat**	Date:	**2/21/23**	Reviewed by:	**S. Graves**	Date:	**8/3/23**
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In summary, the results of chemical compatibility testing of PP and PET with a wide range of chemicals as reported in technical literature demonstrate that the properties of PP and PET polymers that are used in geotextiles would not be affected by exposure to the low concentrations present in MSW leachates. As such, the geotextiles proposed for use in the LCS at this facility are chemically compatible with the wastes and leachate expected to be generated at the landfill.

Coarse Aggregate

The LCS will include drainage stone (i.e., coarse aggregate) in certain features, such as leachate collection corridors, chimney drains, and sumps. The specifications for coarse aggregate are provided in the Liner Quality Control Plan (LQCP). The typical consideration when selecting drainage stone for LCS components of MSW landfills is to avoid material with excessive calcium carbonate content (e.g., limestone), due to the possibility of dissolution over time when exposed to the somewhat acidic environment of an MSW landfill. For the LCS of this landfill, the coarse aggregate material will be natural granular drainage stone material specified (and confirmed by testing) to have less than 15% calcium carbonate content as determined in accordance with ASTM D 3042 using a pH of 4.0 (to simulate an acidic environment as can be observed in MSW leachate). To be conservative, this specified pH is harsher (i.e., more acidic) by more than an order of magnitude below the minimum pH of MSW landfill leachates measured by USEPA [2002].

Thus, provisions are in place for evaluating chemical compatibility of the coarse aggregate for each liner construction project. Only material meeting the specifications shall be used.

Written by:	**Y. Bholat**	Date:	**2/21/23**	Reviewed by:	**S. Graves**	Date:	**8/3/23**
Client:	**WMTX**	Project:	**Mesquite Creek**	Project No.:	**GW8636**	Task No.:	**05**

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Written by:	Y. Bholat	Date:	2/21/23	Reviewed by:	S. Graves	Date:	8/3/23
Client:	WMTX	Project:	Mesquite Creek	Project No.:	GW8636	Task No.:	05

Table 1. Summary of MSW Landfill Leachate Chemistry [after USEPA, 2002]

		Waste Type	MSW							
		Number of Landfills	10 Pre-1990				26 Post-1990			
Parameter	Units	MCLs	Average	Minimum	Maximum	No. of Landfills	Average	Minimum	Maximum	No. of Landfills
pH	pH units		6.62	6.30	7.20	8	6.79	5.90	8.09	22
Specific conductance	μmhos/cm		6,588	3,438	8,983	8	3,693	597	13,548	22
TDS	mg/l		5,487	2,740	8,640	9	2,758	480	8,621	21
COD	mg/l		3,878	804	8,267	9	1,939	< 10	6,800	22
BOD_5	mg/l		2,281	< 2	4,510	10	976	< 2	4,700	18
TOC	mg/l		1,509	4	2,852	8	527	24	2,609	21
Alkalinity	mg/l		2,295	1,508	3,278	7	1,536	203	5,800	22
Chloride	mg/l		801	199	2,263	10	463	5	1,625	25
Sulfate	mg/l		274	< 23	1,943	10	205	< 7	1,376	24
Calcium	mg/l		444	261	610	6	398	66	1,994	22
Magnesium	mg/l		153	84	279	6	83	10	191	21
Sodium	mg/l		532	225	1,115	8	282	3	1,219	23
Arsenic	μg/l	50	19	< 4	78	10	23	< 2	236	21
Cadmium	μg/l	5	< 8	< 1	< 17	8	< 7	< 1	< 20	22
Chromium	μg/l	100	68	5	320	10	38	3	90	21
Lead	μg/l		36	1	90	7	15	1	50	22
Nickel	μg/l		56	27	98	9	82	10	220	20
Benzene	μg/l	5	< 17	< 3	< 36	7	< 19	< 2	< 100	21
1,1-Dichloroethane	μg/l		88	< 5	294	8	66	< 2	260	22
1,2-Dichloroethane	μg/l	5	< 33	< 4	< 100	6	< 16	< 1	< 100	20
cis-1,2-Dichloroethylene	μg/l	70	< 64	< 53	< 75	2	< 57	< 1	436	13
trans-1,2-Dichloroethylene	μg/l	100	< 51	< 32	< 100	4	< 18	< 1	< 110	16
Ethylbenzene	μg/l	700	40	< 5	87	7	35	< 1	118	22
Methylene chloride	μg/l		435	< 5	1,303	8	334	< 1	4,150	22
1,1,1-Trichloroethane	μg/l	200	< 68	< 5	100	6	< 55	< 1	270	20
Trichloroethylene	μg/l	5	< 56	< 5	114	7	< 24	< 1	100	19
Toluene	μg/l	1,000	491	< 5	959	7	228	< 1	740	22
Vinyl chloride	μg/l	2	< 49	< 7	< 100	6	< 34	< 3	< 300	20
Xylenes	μg/l	10,000	117	< 5	277	6	83	< 5	220	20

Notes: (1) " " = not analyzed; < = more than 50% of measurements reported as non-detect.

ATTACHMENT 3F

FINAL COVER EROSION ANALYSIS

Written by:	**P. Pandey**	Date:	**8/4/2023**	Reviewed & Revised by:	**S. Graves**	Date:	**8/9/2023; 2/19/2024**
Client:	**WMTX**	Project:	**Mesquite Creek LF**	Project No.:	**GW8636**	Phase No.:	**05**

FINAL COVER EROSION ANALYSIS
MESQUITE CREEK LANDFILL

2/19/2024

STATE OF TEXAS
SCOTT M. GRAVES
86557
LICENSED
PROFESSIONAL ENGINEER

FOR PERMIT PURPOSES ONLY;
CALCULATION PAGES 1
THROUGH 20

GEOSYNTEC CONSULTANTS, INC.
TX ENG FIRM REGISTRATION NO. F-1182

1 PURPOSE

The purpose of this calculation package is to present the evaluation of the long-term effects of erosion and soil loss for the completed landfill final cover system of the Mesquite Creek Landfill (site) in the New Braunfels, Texas area. This package provides calculations for the annual soil loss from the final cover top deck surfaces sloped with a maximum grade of 5% and the external final cover sideslopes with a maximum grade of 3H:1V (horizontal: vertical) (i.e., 33.3%) as shown on the overall final cover grading plan (Drawing 3A-5B of the Landfill Design Drawings in Part III, Attachment 3A). The estimated amount of erosion was calculated using the Revised Universal Soil Loss Equation (RUSLE). Flow velocities on final cover surfaces are also calculated and compared to permissible velocity values as another approach to assessing potential erodibility.

2 CALCULATION METHODOLOGY

The method to calculate the soil erosion loss over the project area was obtained from the guidance document *Predicting Soil Erosion by Water: A Guide to Conservation Planning With the Revised Universal Soil Loss Equation (RUSLE)* [United States Department of Agriculture (USDA), 1997], as well as previously published information provided by USDA. This document presents the RUSLE methodology and guidance for each of the equation's parameters. The RUSLE is described as follows:

$$A = R \times K \times LS \times C \times P$$

where: A = the computed spatial average annual soil loss (tons/acre/year), R = the average annual rainfall runoff erosivity factor,

K = the soil erodibility factor,

LS = the topographic factor,

C = the cover management factor, and

P = the erosion control practice factor.

To assess whether flow velocities are within permissible ranges, the velocities are estimated using guidance provided by Texas Department of Transportation (TxDOT) (2019) and USDA (2010), for sheet flow and shallow concentrated flow, respectively. TxDOT (2019) indicates that sheet flow velocities (for distances up to 100 ft) may be estimated based on slope and surface conditions using Manning's kinematic solution [adopted from USDA's (1986) TR-55 *Urban Hydrology for Small Watersheds*] to estimate sheet flow travel time:

$$T_t = \frac{0.007(nL)^{0.8}}{P^{0.5}S^{0.4}}$$

where: T_t = travel time for sheet flow (hr.);

n = roughness coefficient;

L = flow length (ft);

P = rainfall (in.); and

S = slope of hydraulic grade line (land slope, ft/ft).

The sheet flow velocity (V) is computed from the travel time for sheet flow using:

$$V = L / T_t$$

where: V = sheet flow velocity (ft);

L = flow length (ft); and

T_t = travel time for sheet flow (hr).

Roughness coefficient values for sheet flow are provided in Table 3F-1. A rainfall depth of 8.9 inches is selected based on the 25-year, 24-hour event obtained from the Atlas 14 point-precipitation frequency estimate for the site (NOAA, 2018). It is noted that the selection of the 25-year, 24-hour rainfall depth is a minor deviation from the sheet flow velocity calculation method presented in TxDOT (2019) (and derived from USDA's (1986) TR-55), and was made by Geosyntec for these velocity calculation purposes to add more conservatism to the analysis. The selection of a larger rainfall depth will result in a faster travel time (i.e., a higher velocity over a given length) relative to what would be calculated by adhering to the aforementioned references' methodology, which call for the use of a smaller (2-year, 24-hour) storm event to compute sheet flow velocities using this Manning's kinematic solution.

For shallow concentrated flow, the velocity is estimated using the equation provided by USDA (2010), as follows:

$$V = K_v \times S^{1/2}$$

where:

V = shallow concentrated flow velocity (ft/s),

K_v = velocity factor (ft/s), and

S = slope (ft/ft).

The velocity factor (K_v) is selected from the description of the surface cover as provided in Table 3F-2. The estimates of sheet flow and shallow concentrated flow velocities are compared to a permissible non-erodible velocity, which was selected based on recommendations from USDA for soil channels lined with Bermudagrass, a vegetation locally-adapted to the Comal/Guadalupe County areas of Texas and that is representative of the grass type/characteristics that may be used as permanent landfill cover vegetation. For channels with slopes greater than 10%, a velocity of four (4) ft/sec in easily eroded soils and six (6) ft/sec in erosion-resistant soils are recommended (USDA, 2007). An average value of five (5) ft/sec was selected as the permissible non-erodible velocity for this analysis – considered appropriate and somewhat conservative given that the topsoil available for use at the site are primarily cohesive and more erosion-resistant, which could potentially justify selection of 6 ft/sec as being permissible.

3 RUSLE INPUT PARAMETERS

3.1 Rainfall Runoff Erosivity Factor (R)

The rainfall runoff erosivity factor is defined as the average annual rainfall erosion index specific for the project area. Based on USDA (1997), the value was determined to be approximately 265 for the site location on the border of Comal and Guadalupe Counties, Texas, as shown in Figure 3F-1 at the end of this document.

3.2 Soil Erodibility Factor (K)

The soil erodibility factor is a function of the physical and chemical properties of the soil and is specific to the source of the cover material. The soil erodibility factor can be thought of as the ease with which soil is detached by splash during rainfall or by surface flow. The soils to be used for the final cover system of the landfill are expected to come from native surficial soils available at the project site or from similar local off-site sources. For soil loss calculation purposes, assessments were made of on-site soils and those nearby, using the Comal, Guadalupe, and Hays County soil surveys (USDA,2023). This information shows that the site and nearby area have soils of a number of soil classifications of native soils, with by far the most prevalent being Ferris and Heiden soils (map symbol FhF3) in the existing Unit 2 area and Heiden clay (map symbol HeC3 and HeD3) and Houston black clay (map symbol HoB) in the proposed expansion area. A soil survey map of the site vicinity is provided as Figure 3F-2 at the end of this document.

The Web Soil Survey tool operated by the USDA Natural Resources Conservation Service (NRCS) [USDA (2023)] was consulted for information on the corresponding soil erodibility factors of these soils. The value of K for soils near the surface of the project location (candidate soils that may be used to construct the final cover system) varies from 0.20 to 0.32 – but is almost entirely dominated by soils with a K factor of 0.24. The value reflects the erodibility of the fine-earth fraction for material less than two mm in size (using the Kf erosion factors provided in Table 3F-3). A K factor of 0.24 was selected for the analysis based on such soils being by far the most prevalent soil types on-site and in the immediate vicinity.

3.3 Topographic Factor (LS)

The slope length factor and slope steepness factor are typically combined into one topographic factor, LS, to facilitate field application of these equation components. USDA (1997) presents values of the LS factor for slope lengths in feet up to 1,000 feet and percent slopes up to 60%, as shown in Table 3F-4, for soils with vegetated cover with consolidated soil conditions.

The longest slope lengths for the sideslope and top deck surfaces of the final cover system were used to select the LS factor for each area, and these lengths were applied to compute the soil loss for both portions of the landfill. The top deck surface will consist of a 5% slope with the maximum design slope length (i.e., between terraces) not exceeding 250 ft in both the existing Unit 2 area and the proposed expansion area. For the sideslopes, there will be drainage benches/terraces with a typical design spacing at a horizontal interval of 90 ft in both the areas (rounded up to a maximum spacing of 120-ft to check and account for a greater potential spacing should minor adjustments become necessary). Also, the critical scenario for the sideslopes is at the 3H:1V (33.3%) slopes in the existing Unit 2 area, because they are steeper than the 3.5H:1V (28.6%) slopes in the expansion area (and the steeper slope will result in a larger LS factor for a given slope length). If it can be demonstrated that the maximum sideslope bench/terrace spacing on the steeper 3H:1V slopes can result in acceptably low soil loss, then by definition the soil loss would be even less (i.e., also acceptable) on 3.5H:1V slopes with such bench/terrace spacing. Based on these slope lengths; the following LS factors were selected from Table 3F-4 (by interpolation):

- Sideslopes – 3H:1V (33.3%) over the maximum landfill design slope length (between benches/terraces) of 120 ft, LS = 6.14.

- Top Deck – 5% slope over the maximum landfill design slope length (between terraces) of 250 ft, LS = 0.78.

3.4 Cover Management Factor (C)

The cover management factor is a function of the type of land cover, based on three factors: (i) the vegetal material in direct contact with the soil surface, (ii) the canopy cover, and (iii) the effects at and beneath the surface. The final cover is categorized as having no appreciable canopy with a ground cover of grass, grass-like plants, decaying compacted duff or litter ("litter" is an agronomic term which refers to mulch, leaves, and similar organic matter) at least 2 inches deep. For the "base case" (which represents a reasonable expectation of the long-term post-closure ground cover condition) there is assumed to be 92% ground cover. This is considered a reasonable and appropriate long-term condition because of the climate and the Post-Closure Plan's requirements for ongoing inspections, maintenance and mowing, and repairs. This results in a C value interpolated from Table 3F-5 (USDA, 1977) of C = 0.005.

Also, a computation was performed for hypothetical scenarios on the top deck to assess whether the soil loss would be tolerable on top deck areas having only 70% ground cover (i.e., a C value of 0.028 at 70% cover, from Table 3F-5). Even though the expected long-term post-closure condition is the "base case" with 92% ground cover, this additional case was performed for comparison purposes and to evaluate sensitivity of this parameter to variation, as discussed subsequently in the conclusions and recommendations.

3.5 Erosion Control Practice Factor (P)

The erosion control practice factor considers topographical practices that will reduce erosion by altering runoff drainage patterns. This factor generally applies to agricultural cropping practices and usually not taken into account for landfill design. Therefore, a P factor of one (1) is selected, which is the largest (worst-case) value.

3.6 Tolerable Soil Loss (T)

The calculated soil loss should be compared to the tolerable (i.e., permissible) soil loss (T). Several sources of information exist to select the permissible soil loss. TCEQ guidance (2018) suggests that landfill final cover designs should have a permissible soil loss rate based on information provided by the NRCS for major soil types, but that permissible soil loss for a landfill final cover should not exceed 3 tons/acre/year. The USDA soil-specific survey of Comal, Guadalupe, and Hays County soils (USDA, 2023) lists the "T" factors recommended for each soil type. This value represents the maximum average annual rate of soil erosion "*that can occur without affecting crop productivity over a sustained period*." For the landfill case, the term "crop productivity" refers to vegetation sustainability (lack of excessive erosion).

According to the USDA (2023) Soil Survey of the site area, USDA's recommended permissible soil loss rate for the soils located at and near the site is predominantly between 3 and 5 tons/acre/year. To be conservative and maintain consistency with recommendations in the TCEQ (2018) guidance, the lower permissible soil loss value of 3 tons/acre/year will be used as the comparison criteria for this evaluation. However, it is important to recognize that the area/site-specific USDA soil survey indicates the properties of these soils can potentially tolerate even greater soil loss without affecting long term conditions.

4 FLOW VELOCITY PARAMETERS

4.1 Watercourse (i.e., Surface) Slope

The slopes for estimating the maximum flow velocities on final cover slopes are as follows:

- Top Deck – 5% slope;
- Sideslopes – 3H:1V (33.3%) slope.

4.2 Surface Condition

For sheet flow velocity calculation purposes, the surface condition of the cover is assumed to be grass or grass-like plants bearing the most resemblance to a "short grass prairie" condition for the basis of selecting the roughness coefficient (Table 3F-1). From Table 3F-1, a roughness coefficient of 0.15 would be recommended for short grass prairie. However, to add conservatism to the sheet flow velocity analysis, an even lower roughness coefficient of 0.139 was selected– corresponding to a weighted average between short grass prairie and bare soil based on the assumed long-term ground coverage percentage presented previously. This is particularly conservative compared to the possible selection of much higher roughness coefficients for dense grass or Bermudagrass in Table 3F-1 that could be justifiably used to as the basis for the long-term condition (which if used, would result in lower calculated velocities).

To estimate shallow concentrated flow velocities for flow distances more than 100 ft using USDA (2010), a velocity factor (K_v) of 6.962 is selected from Table 3F-2 for a "short-grass pasture" condition, considered appropriate yet conservative given the surface condition/roughness to which this condition correlates. The velocity factor is applied with the slope to estimate the velocity of shallow concentrated flow over the final cover condition (after 100 ft of sheet flow).

5 RESULTS

5.1 RUSLE

Applying the RUSLE with the parameters defined above, the computed soil loss in tons/acre/year is calculated as follows:

$$A = R \times K \times LS \times C \times P$$

- Sideslopes, Base Design Case (92% ground cover, maximum spacing of 120 ft between benches/terraces):
  A = 265 × 0.24 × 6.14 × 0.005 × 1 = 1.95 tons/acre/year.
- Top Deck, Base Design Case with 92% ground cover, maximum landfill design spacing of 250 ft between terraces:
  A = 265 × 0.24 × 0.78 × 0.005 × 1 = 0.25 tons/acre/year.
- Top Deck, Hypothetical Case with 70% ground cover, maximum landfill design spacing of 250 ft between terraces:
  A = 265 × 0.24 × 0.78 × 0.028 × 1 = 1.36 tons/acre/year.

As shown above, the estimated soil losses for all cases are less than the tolerable soil loss of 3 tons/acre/year.

5.2 Erodible Velocity

The estimated velocities are as follows:

Top Deck Slopes (5%): For sheet flow (length up to 100 ft)

- $V = L / T_t = 100 / [0.007\times (0.139\times100)^{0.8} / (8.9^{0.5}\times0.05^{0.4})] = 0.4$ ft/s.

For distances greater than 100-ft on the top deck, where flow becomes shallow concentrated flow, the velocity estimates are calculated as:

- $V = K_v \times S^{1/2} = 6.962\times0.05^{1/2} = 1.6$ ft/s.

Sideslopes (33.3%): For sheet flow (length up to 100 ft)

- $V = L / T_t = 100 / [0.007\times (0.139\times100)^{0.8} / (8.9^{0.5}\times0.333^{0.4})] = 0.9$ ft/s.

For distances greater than 100-ft on the sideslopes, where flow becomes shallow concentrated flow, the velocity estimates are calculated as:

- $V = K_v \times S^{1/2} = 6.962\times0.333^{1/2} = 4.0$ ft/s.

As shown above, the estimated flow velocities for all cases are less than the permissible non-erosive velocity of 5 ft/s.

6 CONCLUSIONS

Conclusions: Based on the analyses presented herein, the following conclusions are drawn:

- Overall, the calculated soil loss from top deck and sideslope areas of the final cover system design is below the permissible soil loss values (T) recommended by USDA (2023) for the area/site-specific soils and is also below the permissible soil loss value of 3 tons/acre/year suggested by TCEQ (2018).

- The calculated velocities for the top deck and sideslope final cover ground surfaces are less than the permissible non-erosive velocity of five (5) ft/sec, which is acceptable.

- To provide effective erosional stability against soil loss, a maximum slope length (i.e., horizontal spacing between terraces) of 250-ft on the 5% top deck was checked and confirmed to be acceptable, and the results show that an even greater spacing could be tolerated. The design layout has been prepared to use a nominal top deck terrace horizontal spacing of about 250 feet.

- To provide effective erosional stability against soil loss, the maximum horizontal spacing of the final cover sideslope drainage benches/terraces on the 3H:1V (as well as the less critical 3.5H:1V) external sideslopes is recommended as 120 ft or less. The design layout has been prepared to meet this spacing.

Recommendations: As discussed, in addition to the base case (expected long-term conditions), another hypothetical scenario was evaluated to assess the effect of changes to the top deck ground cover on the calculated annual soil loss. Based on this assessment, the following practical recommendations are provided for long-term cover final at the facility:

- It is recommended that the minimum percentage of ground cover of the external sideslopes of the landfill final cover should be 92%. The basis for this recommendation is that the calculations resulted in an estimated acceptable soil loss within the tolerable range with a 92% ground cover. Please see the discussion in the subsection below for further clarification on the intended usage of results.

- It is recommended that the minimum percentage of ground cover of the top deck of the landfill final cover should be 70%. The basis for this recommendation is that the calculations resulted in an estimated acceptable soil loss below the tolerable range with a 70% ground cover. Please see the discussion in the subsection below for further clarification on the intended usage of results.

Discussion - Use of Results: The following discussion was added to clarify the calculated soil loss and soil stabilization (ground cover) practices and to further explain the basis for the calculation and the intended usage of results. For context, as indicated in Chapter 1 of the RUSLE Handbook, (USDA (1997):

> *The erosion rate for a given site results from a combination of many physical and management variables. Actual field measurements of soil loss would not be feasible for each level of these factors that occurs under field conditions. Soil-loss equations were developed to enable conservation planners, environmental scientists, and others concerned with soil erosion to extrapolate limited erosion data to the many localities and conditions that have not been directly represented in the research.*
>
> *RUSLE is an erosion model designed to predict the longtime average annual soil loss (A)* [emphasis added] *carried by runoff from a specific field slope in specified cropping management systems as well as from rangeland… RUSLE users need to be aware that A (in addition to being a longtime average annual soil loss) is the average loss over a field slope and that the losses at various points on the slope may vary differently from one another* [emphasis added].

The above limitations and clarifications from USDA should be kept in mind by field inspection personnel when reviewing site conditions and deciding on whether to take any corrective actions to take at a given point in time. Under long-term conditions after final closure, the Post-Closure Plan's requirements for ongoing inspections and for maintenance/repairs will be followed.

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TABLES

Table 3F-1. Sheet Flow Roughness Coefficients for Calculating Sheet Flow Travel Time (from TxDOT, 2019)

Surface description		n_{ol}
Smooth surfaces (concrete, asphalt, gravel, or bare soil)		0.011
Fallow (no residue)		0.05
Cultivated soils:	Residue cover $\leq 20\%$	0.06
	Residue cover > 20%	0.17
Grass:	Short grass prairie	0.15
	Dense grasses	0.24
	Bermuda	0.41
Range (natural):		0.13
Woods:	Light underbrush	0.40
	Dense underbrush	0.80

Table 3F-2. Equations and Assumptions Relating Shallow Concentrated Flow Velocity to Surface Slope (from USDA, 2010)

Flow type	Depth (ft)	Manning's *n*	Velocity equation (ft/s)
Pavement and small upland gullies	0.2	0.025	$V = 20.328(s)^{0.5}$
Grassed waterways	0.4	0.050	$V=16.135(s)^{0.5}$
Nearly bare and untilled (overland flow); and alluvial fans in western mountain regions	0.2	0.051	$V=9.965(s)^{0.5}$
Cultivated straight row crops	0.2	0.058	$V=8.762(s)^{0.5}$
Short-grass pasture	0.2	0.073	$V=6.962(s)^{0.5}$
Minimum tillage cultivation, contour or strip-cropped, and woodlands	0.2	0.101	$V=5.032(s)^{0.5}$
Forest with heavy ground litter and hay meadows	0.2	0.202	$V=2.516(s)^{0.5}$

Table 3F-3. Soil Erodibility Factor K for Site Soils (from USDA, 2023)

Summary by Map Unit — Comal and Hays Counties, Texas (TX604)

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
Summary by Map Unit — Comal and Hays Counties, Texas (TX604)				
Map unit symbol	**Map unit name**	**Rating**	**Acres in AOI**	**Percent of AOI**
DAM	Dams		1.0	0.0%
FeF4	Ferris clay, 5 to 20 percent slopes, severely eroded	.24	37.2	1.8%
HeB	Heiden clay, 1 to 3 percent slopes	.24	16.3	0.8%
HeC3	Heiden clay, 3 to 5 percent slopes, eroded	.24	168.1	8.3%
HeD3	Heiden clay, 5 to 8 percent slopes, eroded	.24	17.2	0.8%
HoB	Houston Black clay, 1 to 3 percent slopes	.24	179.2	8.9%
HvB	Houston Black gravelly clay, 1 to 3 percent slopes	.24	82.7	4.1%
HvD	Houston Black gravelly clay, 3 to 8 percent slopes	.24	108.6	5.4%
Pt	Pits		39.4	2.0%
TaB	Tarpley clay, 1 to 3 percent slopes	.28	0.2	0.0%
Tn	Tinn clay, 0 to 1 percent slopes, frequently flooded	.24	28.9	1.4%
W	Water		8.3	0.4%
Subtotals for Soil Survey Area			**687.1**	**34.0%**
Summary by Map Unit — Guadalupe County, Texas (TX187)				
Map unit symbol	**Map unit name**	**Rating**	**Acres in AOI**	**Percent of AOI**
AlE3	Altoga silty clay, 5 to 12 percent slopes, eroded	.32	12.2	0.6%
BrA	Branyon clay, 0 to 1 percent slopes	.20	34.6	1.7%
DAM	Dams		1.9	0.1%
FhF3	Ferris and Heiden soils, 5 to 20 percent slopes, eroded	.24	328.9	16.3%
HeC	Heiden clay, 3 to 5 percent slopes	.24	52.1	2.6%
HeC3	Heiden clay, 3 to 5 percent slopes, eroded	.24	102.2	5.1%
HeD3	Heiden clay, 5 to 8 percent slopes, eroded	.24	135.8	6.7%
HoB	Houston Black clay, 1 to 3 percent slopes	.24	525.3	26.0%
HpB	Houston Black gravelly clay, 1 to 3 percent slopes	.24	20.8	1.0%
HpC	Houston Black gravelly clay, 3 to 5 percent slopes	.24	19.1	0.9%
QeF	Queeny gravelly loam, 5 to 20 percent slopes	.28	8.6	0.4%
QgC	Quihi soils, 1 to 5 percent slopes	.32	25.1	1.2%
Tr	Tinn clay, 0 to 1 percent slopes, occasionally flooded	.24	8.0	0.4%
Tw	Tinn clay, 0 to 1 percent slopes, frequently flooded	.24	38.1	1.9%
W	Water		21.0	1.0%
Subtotals for Soil Survey Area			**1,333.8**	**66.0%**
Totals for Area of Interest			**2,020.9**	**100.0%**

Description — K Factor, Rock Free

Table 3F-4. Values for Topographic Factor, LS, for Low Ratio of Rill to Interrill Erosion[1]

(from USDA, 1997)

Values for topographic factor, LS, for low ratio of rill to interrill erosion.[1]

Slope (%)	Horizontal slope length (ft) <3	6	9	12	15	25	50	75	100	150	200	250	300	400	600	800	1000
0.2	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
0.5	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
1.0	0.12	0.12	0.12	0.12	0.12	0.13	0.13	0.14	0.14	0.15	0.15	0.15	0.15	0.16	0.16	0.17	0.17
2.0	0.20	0.20	0.20	0.20	0.20	0.21	0.23	0.25	0.26	0.27	0.28	0.29	0.30	0.31	0.33	0.34	0.35
3.0	0.26	0.26	0.26	0.26	0.26	0.29	0.33	0.36	0.38	0.40	0.43	0.44	0.46	0.48	0.52	0.55	0.57
4.0	0.33	0.33	0.33	0.33	0.33	0.36	0.43	0.46	0.50	0.54	0.58	0.61	0.63	0.67	0.74	0.78	0.82
5.0	0.38	0.38	0.38	0.38	0.38	0.44	0.52	0.57	0.62	0.68	0.73	0.78	0.81	0.87	0.97	1.04	1.10
6.0	0.44	0.44	0.44	0.44	0.44	0.50	0.61	0.68	0.74	0.83	0.90	0.95	1.00	1.08	1.21	1.31	1.40
8.0	0.54	0.54	0.54	0.54	0.54	0.64	0.79	0.90	0.99	1.12	1.23	1.32	1.40	1.53	1.74	1.91	2.05
10.0	0.60	0.63	0.65	0.66	0.68	0.81	1.03	1.19	1.31	1.51	1.67	1.80	1.92	2.13	2.45	2.71	2.93
12.0	0.61	0.70	0.75	0.80	0.83	1.01	1.31	1.52	1.69	1.97	2.20	2.39	2.56	2.85	3.32	3.70	4.02
14.0	0.63	0.76	0.85	0.92	0.98	1.20	1.58	1.85	2.08	2.44	2.73	2.99	3.21	3.60	4.23	4.74	5.18
16.0	0.65	0.82	0.94	1.04	1.12	1.38	1.85	2.18	2.46	2.91	3.28	3.60	3.88	4.37	5.17	5.82	6.39
20.0	0.68	0.93	1.11	1.26	1.39	1.74	2.37	2.84	3.22	3.85	4.38	4.83	5.24	5.95	7.13	8.10	8.94
25.0	0.73	1.05	1.30	1.51	1.70	2.17	3.00	3.63	4.16	5.03	5.76	6.39	6.96	7.97	9.65	11.04	12.26
30.0	0.77	1.16	1.48	1.75	2.00	2.57	3.60	4.40	5.06	6.18	7.11	7.94	8.68	9.99	12.19	14.04	15.66
40.0	0.85	1.36	1.79	2.17	2.53	3.30	4.73	5.84	6.78	8.37	9.71	10.91	11.99	13.92	17.19	19.96	22.41
50.0	0.91	1.52	2.06	2.54	3.00	3.95	5.74	7.14	8.33	10.37	12.11	13.65	15.06	17.59	21.88	25.55	28.82
60.0	0.97	1.67	2.29	2.86	3.41	4.52	6.63	8.29	9.72	12.16	14.26	16.13	17.84	20.92	26.17	30.68	34.71

[1]Such as for rangeland and other consolidated soil conditions with cover (applicable to thawing soil where both interrill and rill erosion are significant).

Table 3F-5. C Factor Cover Values for Permanent Pasture, Rangeland, Idle Land, and Grazed Woodland[1]
(from USDA, 1977)

Vegetal Canopy		Cover That Contacts the Surface						
Type and Height of Raised Canopy 2/	Canopy Cover 3/ %	Type 4/	Percent Ground Cover					
			0	20	40	60	80	95-100
No appreciable canopy		G	.45	.20	.10	.042	.013	.003
		W	.45	.24	.15	.090	.043	.011
Canopy of tall weeds or short brush (0.5 m fall ht.)	25	G	.36	.17	.09	.038	.012	.003
		W	.36	.20	.13	.082	.041	.011
	50	G	.26	.13	.07	.035	.012	.003
		W	.26	.16	.11	.075	.039	.011
	75	G	.17	.10	.06	.031	.011	.003
		W	.17	.12	.09	.067	.038	.011
Appreciable brush or bushes (2 m fall ht.)	25	G	.40	.18	.09	.040	.013	.003
		W	.40	.22	.14	.085	.042	.011
	50	G	.34	.16	.085	.038	.012	.003
		W	.34	.19	.13	.081	.041	.011
	75	G	.28	.14	.08	.036	.012	.003
		W	.28	.17	.12	.077	.040	.011
Trees but no appreciable low brush (4 m fall ht.)	25	G	.42	.19	.10	.041	.013	.003
		W	.42	.23	.14	.087	.042	.011
	50	G	.39	.18	.09	.040	.013	.003
		W	.39	.21	.14	.085	.042	.011
	75	G	.36	.17	.09	.039	.012	.003
		W	.36	.20	.13	.083	.041	.011

1/ All values shown assume: (1) random distribution of mulch or vegetation, and (2) mulch of appreciable depth where it exists. Idle land refers to land with undisturbed profiles for at least a period of three consecutive years. Also to be used for burned forest land and forest land that has been harvested less than three years ago.

2/ Average fall height of waterdrops from canopy to soil surface: m = meters.

3/ Portion of total-area surface that would be hidden from view by canopy in a vertical projection, (a bird's-eye view).

4/ G: Cover at surface is grass, grasslike plants, decaying compacted duff, or litter at least 2 inches deep.

W: Cover at surface is mostly broadleaf herbaceous plants (as weeds with little lateral-root network near the surface), and/or undecayed residue.

FIGURES

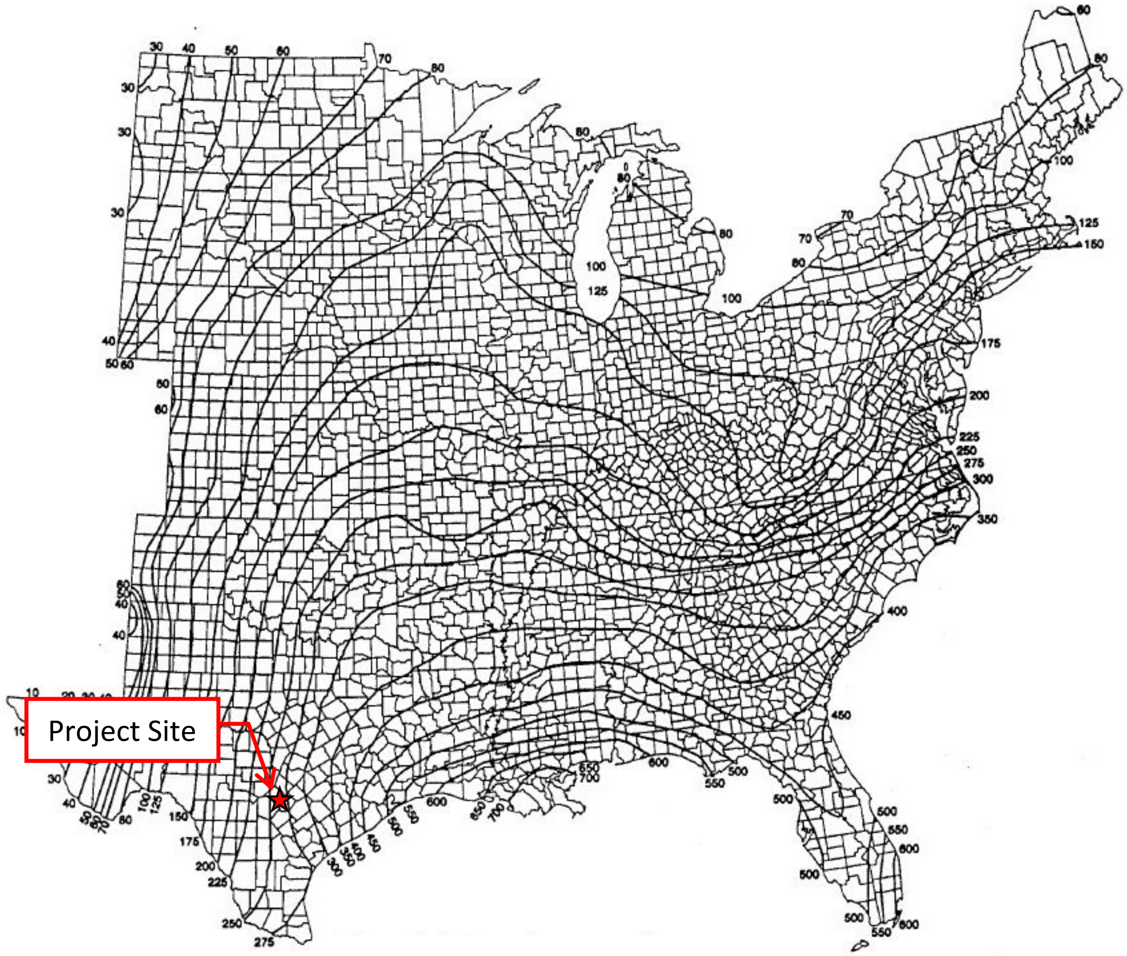

Figure 3F-1. Average Annual Rainfall Runoff Erosivity Factor, R, Isoerodent Map (from USDA, 1997)

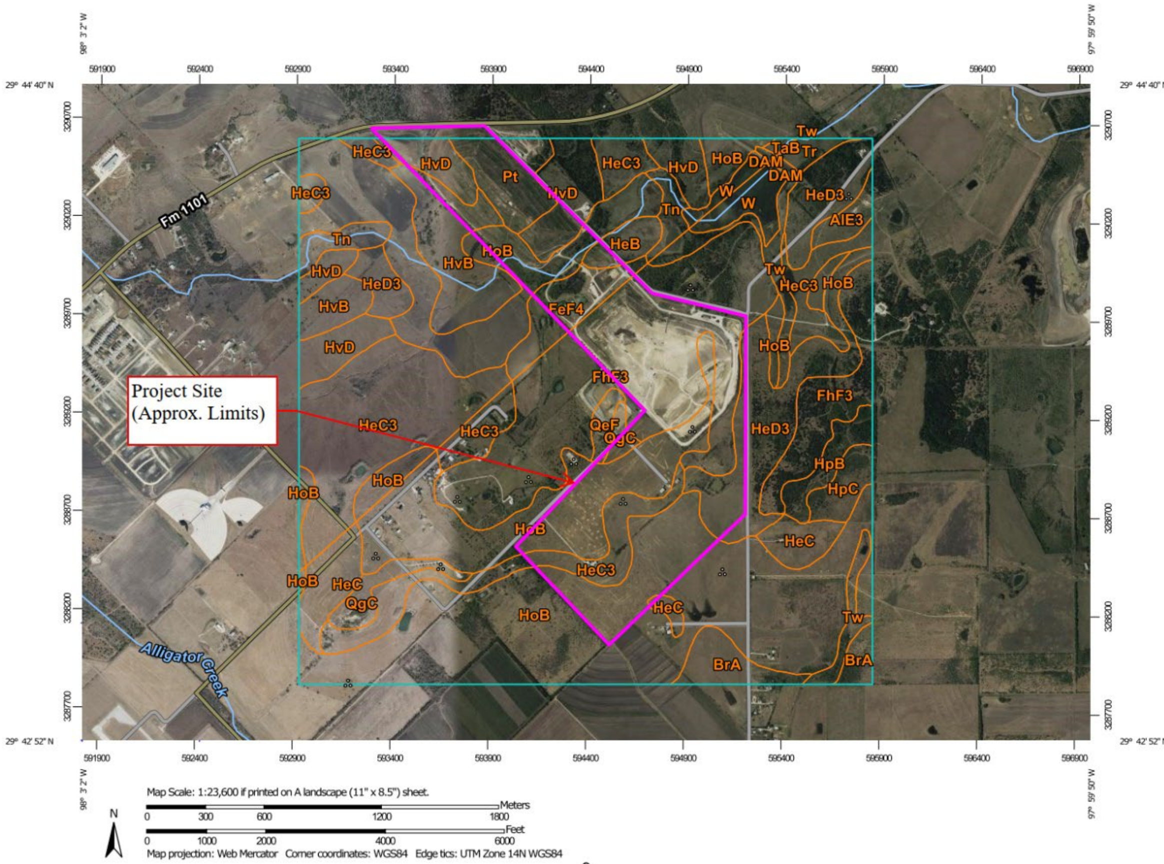

Figure 2F-2-1. USDA Soil Survey Map

ATTACHMENT 3G

FINAL COVER SYSTEM DRAINAGE LAYER DESIGN

Written by:	**Y. Bholat**	Date:	**02/13/23**	Reviewed by:	**Scott Graves**	Date:	**8/4/23**
Client:	**WMTX**	Project:	**Mesquite Creek**	Project No.:	**GW8636**	Task No.:	**05**

ATTACHMENT 3G
FINAL COVER SYSTEM DRAINAGE LAYER DESIGN

STATE OF TEXAS
SCOTT M. GRAVES
86557
LICENSED
PROFESSIONAL ENGINEER

10/11/2023

GEOSYNTEC CONSULTANTS, INC.
TX ENG FIRM REGISTRATION NO. F-1182

FOR PERMIT PURPOSES ONLY

SEALED FOR CALCULATION PAGES 1 THROUGH 21

PURPOSE

The purpose of this calculation package is to present the design of the geocomposite drainage layer of the standard Subtitle D final cover system at the Mesquite Creek Landfill. The geocomposite drainage layer will be located between a 2-ft thick layer of overlying soil (i.e., the vegetated erosion layer) and a 40-mil (minimum) thick linear low-density polyethylene (LLDPE) geomembrane beneath the geocomposite. The geocomposite drainage layer will be composed of a high-density polyethylene (HDPE) geonet core with a needle punched nonwoven geotextile bonded to one or both sides. On final cover sideslopes (3.5H:1V slopes), because textured geomembrane will be used, the drainage layer will be a double-sided geocomposite (geotextiles bonded to both sides). On final cover top slopes, the flatter (5%) slopes enable use of either a smooth or a textured geomembrane, and accordingly, the drainage layer may be either a single-sided or double-sided geocomposite. The computations presented herein are applicable to the final cover drainage layer, irrespective of whether it is a single-sided or double-sided geocomposite.

The design criteria evaluated herein include: (i) filtration capability and specifications for the geotextile component of the geocomposite drainage layer; (ii) survivability specifications for the geotextile component; and (iii) hydraulic capacities and drainage lengths of the geosynthetic drainage layer and testing conditions for verifying that the required capacities are achieved.

METHOD OF ANALYSIS

Geotextile Filtration

The filtration characteristics of the geotextile component of the geocomposite layer are evaluated using a retention criterion, a permeability criterion, a porosity criterion, and a thickness criterion based on methods proposed by Holtz et al. (1998) and Giroud (2010). These criteria are summarized below in Table 1.

Table 1. Filtration Criteria for Geotextile Components (adapted from Holtz et al., 1998; and Giroud, 2010)

1. Retention Criterion

1.1 Soils with less than 50% particles < 0.075 mm (US Sieve No. 200)

Density index of the soil (Relative density)		Linear coefficient of uniformity of the soil	
		$1 < C'_u < 3$	$C'_u > 3$
loose soil	$I_D \leq 35\%$	$O_{95} \leq (C'_u)^{0.3}\, d'_{85}$	$O_{95} < \frac{9}{(C'_u)^{1.7}}\, d'_{85}$
medium dense soil	$35\% < I_D < 65\%$	$O_{95} \leq 1.5\,(C'_u)^{0.3}\, d'_{85}$	$O_{95} < \frac{13.5}{(C'_u)^{1.7}}\, d'_{85}$
dense soil	$I_D \geq 65\%$	$O_{95} \leq 2\,(C'_u)^{0.3}\, d'_{85}$	$O_{95} < \frac{18}{(C'_u)^{1.7}}\, d'_{85}$

1.2 Soils with more than 50% particles < 0.075 mm (US Sieve No. 200)

$O_{95} \leq 210\ \mu m$ (US Sieve No. 70)

2 Permeability Criterion

$k_{geotextile} \geq \max\,(i_{soil}\, k_{soil}\,,\, k_{soil})$

3. Porosity Criterion

Nonwoven geotextiles: $n_g \geq 55\%$

Table 1 (Continued). Filtration Criteria for Geotextile Components (adapted from Holtz et al., 1998; and Giroud, 2010)

4. Thickness Criterion

Nonwoven geotextiles: $N_{constrictions} \geq 25$

Notes:
- O_{95} is the apparent opening size (AOS) of the geotextile
- C'_u = linear coefficient of uniformity = $\sqrt{d'_{100}/d'_0}$
  where d'_{100} and d'_0 is the top and bottom extremities, respectively, of a line drawn through the soil particle-size distribution curve and tangent at $d_{50.}$
- d'_{85} is the "linear particle size" for which 85% of particles are finer by weight, derived from the straight line drawn through the soil particle-size distribution curve.
- I_D = relative density or density index = $(e_{max} - e)/(e_{max} - e_{min})$, where e = soil void ratio; e_{min} = soil minimum void ratio, and e_{max} = soil maximum void ratio.
- $k_{geotextile}$ = geotextile hydraulic conductivity; k_{soil} = soil hydraulic conductivity; i_{soil} = hydraulic gradient in the soil next to the geotextile
- porosity, n_g (dimensionless) is calculated as follows: $n_g = 1 - \mu_g/(\rho_g\ t_g)$, where: μ_g = geotextile mass per unit area, ρ_g = polymer density, and t_g = geotextile thickness
- Number of constrictions ($N_{constrictions}$) is calculated as follows: ($N_{constrictions}$) $=\mu_g/[\rho_g d_f \sqrt{1-n_g}]$, where: μ_g = geotextile mass per unit area; ρ_g = polymer density; d_f = geotextile fiber diameter; and n_g = geotextile porosity.

Geotextile Survivability

Survivability requirements (grab, tear, and puncture strengths) are considered so that the geotextile component of the geocomposite will have adequate resistance to stresses applied to the geotextile during construction (i.e., when concentrated stresses should be the highest), using the method presented in GRI-GT13 (2017). The procedure involves two steps: (i) establish the required degree of survivability as a function of subgrade conditions, type of construction equipment operation above the geotextile, and lift thickness using Table 2; and (ii) establish the recommended minimum values of certain mechanical strength properties (i.e., grab strength, puncture resistance, and trapezoidal tear strength) using Table 3. The survivability requirements are then compared to characteristics of geotextile products on the current market to check that products are available to meet the calculated minimum strengths.

Drainage Layer Hydraulic Capacity and Drainage Length Determination

The drainage layer hydraulic capacity design evaluation is performed using the design-by-function concept presented by Koerner (2005) and based on Darcy's equation (flow rate = hydraulic conductivity × hydraulic gradient × cross-sectional area of flow) for hydraulic flow in porous, saturated media. The approach herein is based on the design methodologies presented in Giroud et al. (2000) and GRI-GC8 (2013).

The hydraulic design method involves the following steps:

Step 1) Identify a candidate geocomposite product that represents a commonly-used or readily-available biplanar geocomposite material on the market that also meets the various other (e.g, type, filtration, and survivability) property requirements specified herein. Obtain the baseline transmissivity (θ_{100}) that such a product is reported to achieve at boundary conditions representative of those that will be experienced for this final cover.

Step 2) Apply partial reduction factors (RFs) for creep, chemical clogging, and biological clogging to the θ_{100} to account for the potential long-term decrease in flow capacity, resulting in the "Long-Term In-Soil" (LTIS) transmissivity (θ_{LTIS}).

Step 3) Divide the θ_{LTIS} by a global factor of safety (FS) to obtain the required design transmissivity (θ_{req}) to be used in the USEPA Hydrologic Evaluation of Landfill Performance (HELP) model.

Step 4) Run the HELP model using the required design transmissivity (θ_{req}) and for the site-specific conditions (climate, overlying soil layers, slope angles, and slope lengths between drainage exit points of the geocomposite).

Step 5) Compare the calculated peak daily average head in the geocomposite drainage layer to the thickness of the layer.

Step 6) If the peak daily average head exceeds the thickness of the drainage layer, reduce the drainage length of the layer and repeat Steps 4 and 5 by varying the drainage length in an iterative process until acceptable results are obtained. This will result in a determination of the maximum allowable drainage lengths (i.e., the maximum distance between required geocomposite "daylighting" (i.e., exit points) along the slope, such as at surface drainage features).

Step 7) After acceptable results are confirmed, prepare the recommended specified index transmissivity value for the geocomposite, and associated boundary conditions, for inclusion in the Final Cover Quality Control Plan (FCQCP).

Written by: **Y. Bholat** Date: **02/13/23** Reviewed by: **Scott Graves** Date: **8/4/23**

Client: **WMTX** Project: **Mesquite Creek** Project No.: **GW8636** Task No.: **05**

Table 2. Required Degree of Survivability as a Function of Subgrade Conditions, Construction Equipment, and Lift Thickness (GRI-GT13)*

Subgrade Conditions	**Low ground-pressure equipment (≤ 3.6 psi)**	**Medium ground-pressure equipment (> 3.6 psi, ≤ 7.3 psi)**	**High ground-pressure equipment (> 7.3 psi)**
Subgrade has been cleared of all obstacles except grass, weeds, leaves, and fine wood debris. Surface is smooth and level so that any shallow depressions and humps do not exceed 18 in. in depth or height. All larger depressions are filled. Alternatively, a smooth working table may be placed.	Low	Moderate	High
Subgrade has been cleared of obstacles larger than small to moderate-sized tree limbs and rocks. Tree trunks and stumps should be removed or covered with a partial working table. Depressions and humps should not exceed 18 in. in depth or height. Larger depressions should be filled.	Moderate	High	Very High
Minimal site preparation is required. Trees may be felled, delimbed, and left in place. Stumps should be cut to project not more than ± 6 in. above subgrade. Fabric may be draped directly over the tree trunks, stumps, large depressions and humps, holes, stream channels, and large boulders. Items should be removed only if placing the fabric and cover material over them will distort the finished road surface.	High	Very High	Not Recommended

* Recommendations are for 6 to 12 in. initial lift thickness. For other initial lift thicknesses:

12 to 18 in.: reduce survivability requirement one level;
18 to 24 in.: reduce survivability requirement two levels;
> 24 in.: reduce survivability requirement three levels

Table 3. GRI-GT13 Geotextile Strength Property Requirements

			Geotextile Classification (1)					
			Class 1 (high)		Class 2 (moderate)		Class 3 (low)	
Tests	Test Methods	Units	Elongation < 50%	Elongation ≥ 50%	Elongation < 50%	Elongation ≥ 50%	Elongation < 50%	Elongation ≥ 50%
Grab Tensile Strength	ASTM D 4632	lb	315	203	248	158	180	113
Trapezoid Tear Strength	ASTM D 4533	lb	112	79	90	56	68	41
CBR Puncture Strength	ASTM D 6241	lb	630	440	500	320	380	230
Permittivity	ASTM D 4491	sec^{-1}	0.02	0.02	0.02	0.02	0.02	0.02
Apparent Opening Size	ASTM D 4751	in.	0.024	0.024	0.024	0.024	0.024	0.024
Ultraviolet stability (2)	ASTM D 7238	% Ret. @ 500 hrs	80	80	70	70	60	60

Notes: (1) All values are minimum average roll values (MARV) except AOS, which is a maximum average roll value (MaxARV) and UV stability which is a minimum average value.
(2) Evaluation to be on 2-in. strip tensile specimens after 500 hours exposure.

FILTRATION EVALUATION RESULTS

Geotextile Retention

The geotextile must have openings that are small enough to retain fine-grained soil particles so that they do not enter the geocomposite drainage layer, which could result in clogging or flow capacity reduction of the drainage layer. Therefore, the apparent opening size (AOS, hereafter referred to as O_{95}) of the geotextile must be less than a maximum value.

The geocomposite drainage layer in the final cover system will be overlain by a layer of cover soil. At least the upper 6-in. of this soil layer will be topsoil, and the lower portion will be protective cover. The typical Unified Soil Classifications specified for the protective cover, based on material availability on-site, are CL or CH. The soil layer will be spread over the cover system geosynthetics with a low ground-pressure bulldozer. It is anticipated that the soil placed with this technique will have a medium-dense relative density (i.e., it will not be heavily compacted).

The O_{95} is calculated depending on the type of soil used for the protective cover as follows.

If the soil used for the protective cover is fine grained, i.e., more than 50% of particles are finer than 0.075 mm (U.S. Sieve No. 200) (e.g., a CL soil), then by applying the criterion in Table 1, O_{95} is calculated as:

$$O_{95} \leq 210\ \mu m \text{ (U.S. Sieve No. 70)}$$

The range of geotextile mass per unit areas anticipated for use as a filtration layer or drainage layer component are 6 to 16 oz/yd^2 (200 to 540 g/m^2). Typical O_{95} values for 6 to 16 oz/yd^2 geotextiles on the current market range from 90 to 850 µm (IFAI, 2015); thus, products are available that can meet this specification.

Geotextile Permeability

The top side of the geotextile will be in contact with protective cover soil (fine-grained clayey on-site soil). Based on the Unified Soil Classifications specified for the protective cover, it is anticipated that the hydraulic conductivity of the protective cover will fall within the range of 1×10^{-7} to 1×10^{-4} cm/s (more likely at the lower range of permeability). The geotextile must have openings that are large enough to allow infiltrating water to pass through the retained soil/geotextile interface without significant flow impedance. Thus, the hydraulic conductivity or permeability of the geotextile must be greater than a minimum required value. The hydraulic gradient in the protective cover is assumed to be <10 based on typical values in Giroud (2010). A hydraulic gradient of 10 will be used in the calculations.

Applying the permeability criterion of Table 1, and using the governing case (largest potential permeability in the anticipated range) the calculated hydraulic conductivity of the geotextile, $k_{geotextile}$, is:

$$k_{geotextile} \geq \max(i_{soil}\, k_{soil}, k_{soil})$$
$$\geq 10 \times (1 \times 10^{-4} \text{ cm/s}) = 1 \times 10^{-3} \text{ cm/s}$$

This requirement is achievable by most geotextiles. Note that some manufacturers report the permeability property as "permittivity" (Ψ), which is defined as Ψ=k/t. Based on the range of geotextile mass per unit areas and thicknesses anticipated for the project (6 to 16 oz/yd^2 (200 to 540 g/m^2) and 1.3 to 5.7 mm, respectively), typical $k_{geotextile}$ values (calculated from typical permittivities and thicknesses) for needle punched nonwoven geotextiles are 0.2 to 0.4 cm/s. Therefore, nonwoven needle punched geotextiles within the anticipated range for this project are well above the minimum required permeability value.

Geotextile Porosity

The geotextile filter must have enough openings so that blocking some of them will not significantly clog the geotextile and inhibit flow into the geonet. Thus, the porosity of the geotextile must be greater than a minimum value. As shown in Table 1, for nonwoven geotextiles, the geotextile porosity n_g is required to be:

$$n_g > 55\%$$

The porosity criterion requirements apply for the geotextile component of the geocomposite drainage layer. Geotextile porosity is not a property that is directly measured or reported by manufacturers, however it can be calculated as indicated in Table 1 (i.e., $n_g = 1 - \mu_g/(\rho_g\ t_g)$). Typical resulting n_g values for nonwoven geotextiles are 50% to 95%. Based on the geotextile density of polypropylene or polyethylene and the range of mass per unit areas and thicknesses anticipated for the project (6 to 16 oz/yd^2 (200 to 540 g/m^2) and 1.3 to 5.7 mm, respectively), the calculated n_g values range from approximately 80% to 90%, which is well in excess of the minimum porosity required to prevent clogging.

Geotextile Thickness

For nonwoven geotextiles, such as those proposed for the final cover system geocomposite drainage layer, the geotextile filter must be thick enough to have a sufficient number of constrictions. From Table 1, the number of constrictions, $N_{constrictions}$, needs to be at least 25.

The number of constrictions in nonwoven geotextiles is a function of mass per unit area, porosity, polymer density, and geotextile fiber diameter:

$$N_{constrictions} = \mu_g / (\rho_g d_f \sqrt{1 - n_g})$$

Based on data for nonwoven needle punched geotextiles presented by Palmeira and Gardoni (2000) and Faure et al. (2006), as well as data compiled by Geosyntec from manufacturers, most nonwoven needle punched geotextiles that have at least 25 constrictions have a minimum thickness of 2.3 mm. The thickness of nonwoven geotextiles is typically not measured or reported by manufacturers but tends to be correlated to mass per unit area. The minimum mass per unit area specified herein is expected to meet or exceed this thickness, and therefore have the minimum number of constrictions.

SURVIVABILITY EVALUATION RESULTS

Survivability refers to the ability of the geotextile to withstand the stresses during installation and handling in the field. The degree of survivability is first evaluated using Table 2 with the anticipated installation conditions. The following conditions are conservatively assumed to apply: (i) smooth and level subgrade condition; (ii) initial lift thickness of protective cover placed above geotextile is 12 in.; and (iii) maximum equipment ground pressure of 5 psi (i.e., use the middle column for equipment from Table 2 is used). Using Table 2, a "moderate" degree of survivability is used.

In the second step, the minimum required values for the mechanical properties of the geotextile are established from Table 3 based on the "moderate" or "Class 2" survivability requirement. The chart provides minimum required values for two ranges of geotextile extensibility. Values were selected for the more extensible range because this range is applicable to nonwoven materials that are required for the geotextile. These survivability requirements, which are outlined in Table 3, apply for the geotextile component of the geocomposite drainage layer.

HYDRAULIC CAPACITY EVALUATION

Step 1) Identify θ_{100} of Geocomposite

Geosyntec contacted the geocomposite manufacturer, SKAPS Industries, to obtain typical θ_{100} data for a common biplanar geocomposite on the market. The data correspond to the product, TN 270-2-8, a geocomposite with nonwoven geotextile on both sides of the geonet. This does not constitute a recommendation of this product, nor a requirement for its use; it is merely intended as a starting point for the design calculation. The TN 270-2-8 geocomposite transmissivity was measured at a gradient of 0.1 while sandwiched between soil and a geomembrane for a seating time of 100 hours under four different normal stresses. This information is presented on Figure 1. The project-specific stresses on the final cover geocomposite due to the overlying soil layers will be approximately 120 pcf × 2 ft = 240 psf.

Using Figure 1, the product is capable of achieving a θ_{100} under very low stresses and similar boundary conditions of approximately 9×10^{-4} m^2/s. To add more conservatism, reduce this value to 5×10^{-4} m^2/s before proceeding to the steps below (which effectively will add another factor of safety to the computation).

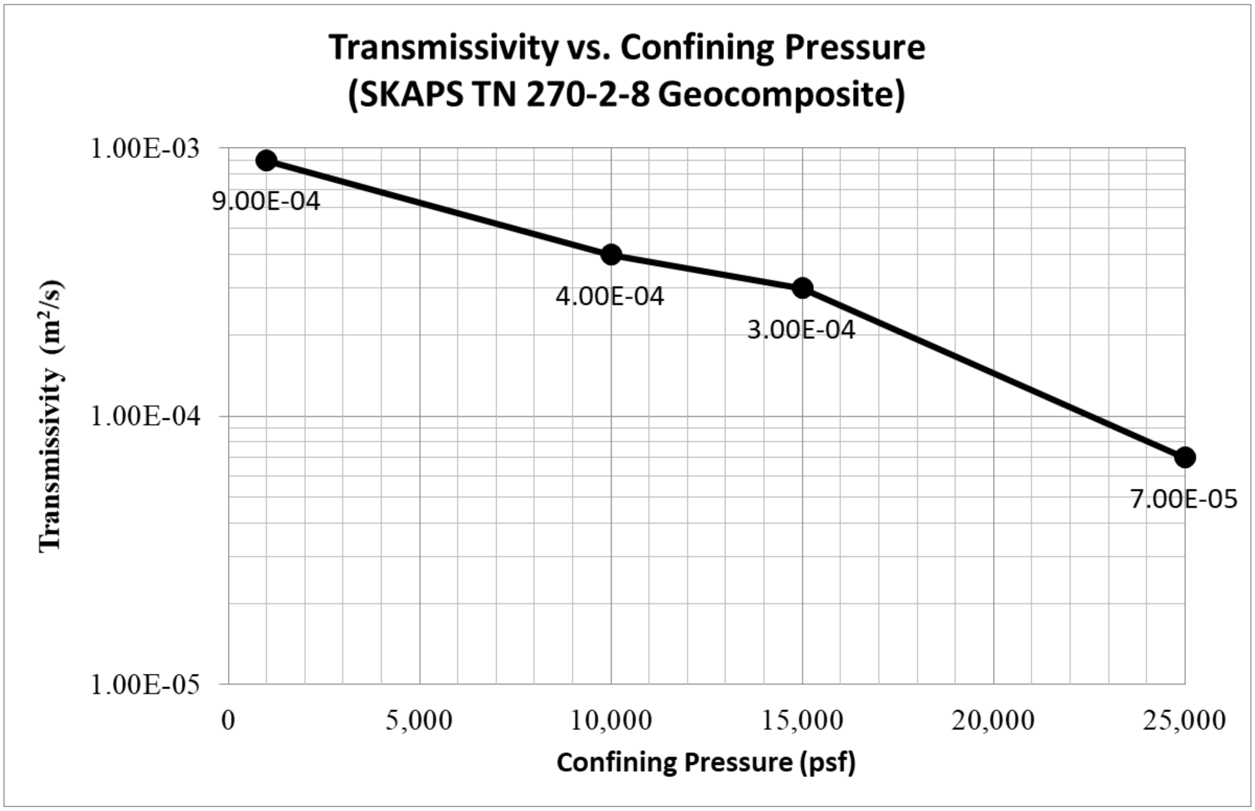

Figure 1. Typical θ_{100} Test Results at Various Normal Stresses.

Note: The typical product information shown does not constitute an endorsement of these products, nor does this require the use of any specific manufacturer or product. This information is presented for design purposes only.

Step 2) Apply Reduction Factors to Convert to θ_{LTIS}

The θ_{100} was converted to θ_{LTIS} using the equation below to account for potential long-term transmissivity reduction due to creep, chemical clogging, and biological clogging.

$$\theta_{LTIS} = \frac{\theta_{100}}{RF_{CR}RF_{CC}RF_{BC}}$$

Where RF_{CR} = reduction factor for creep, RF_{CC} = reduction factor for chemical clogging and/or precipitation of chemicals, and RF_{BC} = reduction factor for biological clogging.

Creep is the long-term reduction in thickness of the drainage layer under a sustained compressive stress. For landfill final cover systems, Koerner (2005) recommends that reduction factors for creep range from 1.2 to 1.4. The reduction factor for creep for the final cover system geocomposite of this analysis was selected as 1.3.

GRI (2013) provides guidance for clogging reduction factors for landfill final cover systems. Chemical and biological clogging can increase over time as infiltrating water passes through the geocomposite. GRI (2013) recommends a chemical clogging reduction factor between 1.0 and 1.2 and a biological clogging reduction factor between 1.2 and 3.5 at final conditions. Based on recommendations by GRI, a chemical clogging reduction factor of 1.2 is selected. The final cover geocomposite is potentially susceptible to biological clogging due to root penetrations from the vegetative cover; therefore, a biological clogging factor of 3.0 is selected, which is close to the upper bound of the recommended range.

Case Designation	θ_{100} (m^2/s)	RF_{CR}	RF_{CC}	RF_{BC}	RF_{total}	θ_{LTIS} (m^2/s)
Final Cover Drainage Layer	5×10^{-4}	1.3	1.2	3.0	4.7	1.1×10^{-4}

Step 3) Obtain Required Design Transmissivity (θ_{req}) for Use in HELP Model

In addition to the reduction factors applied above, a global (overall) factor of safety of 2.0 will be used for this design. Dividing θ_{LTIS} by the FS yields a θ_{req} of 5.5 x 10^{-5} m^2/s to be used in the HELP model runs.

Steps 4 through 6) HELP Model Runs

The HELP model (version 3.95 D) was used to evaluate drainage layer design under a 30-year post-closure simulation of the following final cover cases used as initial trials:

- Case F_TOP. Landfill top-deck (5% slope at longest top-deck drainage length of approximately 886 ft);
- Case F_SIDE1. Landfill sideslope (3.5H:1V slope at longest sideslope drainage length established for the design between geocomposite daylight points of 410 ft); and
- Case F_SIDE2. Identical to Case F_SIDE1, but with the peak daily drainage collected from the drainage layer of Case F_TOP added as subsurface inflow [0.048 in/day * 365 days/yr = 17.6 in/yr (rounded up)] into the drainage layer of Case F_SIDE2; this generates a worst-case combined flow to assess whether the sideslope can receive peak daily drainage flow from the top deck in addition to that generated on the sideslopes.

The input factors were consistent with those used for the final cover layers and general site conditions used in the leachate generation HELP modeling presented in Part III, Attachment 3E, with the exception that: (i) the design transmissivity was established as described above; and (ii) the drainage lengths were set as described above.

As Step 5, comparison of the results of these initial trials revealed that peak average daily heads in the drainage layer did not exceed the thickness of the drainage layer for all cases, which is acceptable. Therefore, no iterations are needed for trials with different drainage lengths (i.e., no Step 6).

Step 7) Provide Recommendations for Geocomposite Specification

The results of the above evaluation demonstrate that a θ_{100} value of 5×10^{-4} m^2/s is acceptable for the final cover conditions, including slopes and drainage lengths indicated above. Thus, the final cover system geocomposite should meet or exceed a θ_{100} value of 5×10^{-4} m^2/s when tested for transmissivity as indicated below.

- Testing configuration using 40-mil LLDPE geomembrane on one side of the geocomposite specimen (to simulate site-specific final cover design) and soil representative of the protective cover on the other side of the geocomposite specimen.
- The stress to be applied for the test is approximately 240 psf, and the hydraulic gradient should be 0.05 (or may be 0.28 if testing a product that will only be used on the sideslopes).

Alternatively, as part of a construction-phase quality control and quality assurance testing process, it is more practical to conduct a short-term transmissivity test on the order of 15 minutes in duration, on a geocomposite sandwiched between two steel plates. These transmissivities are higher than those that would be obtained using the site-specific boundary conditions because the short duration test does not experience the time-delayed intrusion of the geotextile into the transmissive core resulting from the deformation of the geotextile under sustained loading. Additionally, the steel plate boundary condition of the short duration test will not experience as much reduction in transmissivity due to particle migration into the transmissive core.

To obtain the index transmissivity, θ_{INDEX}, which accounts for intrusion and particulate clogging, can be determined using the following equation:

$$\theta_{INDEX} = \theta_{100} * RF_{INT}\ RF_{PC}$$

Koerner (2005) recommends using an intrusion reduction factor (RF_{INT}) between 1.3 and 1.5. An intrusion factor of 1.4 is selected for the final cover geocomposite drainage layer. The geotextile is expected to adequately retain particulates to avoid potential clogging of the transmissive core; however, a particulate clogging reduction factor (RF_{PC}) of 1.1 is applied. The index transmissivity, θ_{INDEX}, for the final cover geocomposite drainage layer is found to be:

$$\theta_{INDEX} = 5\times10^{-4}\ (m^2/s) \times 1.4 \times 1.1$$

$$\theta_{INDEX} = 7.7 \times 10^{-4} \text{ m}^2/\text{s}$$

CONCLUSIONS

Based on the evaluations herein, the final cover drainage layer design will meet the relevant design criteria when the following final cover system drainage layer geocomposite specification is used.

- Filtration of Geotextile Components:
  - Apparent Opening Size, $O_{95} \leq 210$ µm (U.S. Sieve No. 70)
  - Geotextile Water Permeability, $k_{geotextile} \geq 1 \times 10^{-3}$ cm/s for geotextile component of the geocomposite overlain by the protective cover
- Survivability (Mechanical) Properties of Geotextile Components:
  - Grab Tensile Strength = 158 lbs
  - Trapezoid Tear Strength = 56 lbs
  - CBR Puncture Strength = 320 lbs
- Hydraulic Capacity (Transmissivity) of Geocomposite Drainage Layer
  - $\theta_{INDEX} = 7.7 \times 10^{-4}$ m²/s (when tested between two steel plates with an applied stress of 240 psf at a gradient of 0.05 (or may use gradient of 0.28 if testing a product that will only be used on the sideslopes).
- Evaluated for a maximum drainage length of top-deck (5%) areas between geocomposite daylight points of 886-ft.
- Evaluated for a maximum drainage length of sideslope (3.5H:1V) areas between geocomposite daylight points of 410-ft.

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Kim, B., Prezzi, M., Salgado, R., "Geotechnical Properties of Fly and Bottom Ash Mixtures for Use in Highway Embankments", *Journal of Geotechnical and Geoenvironmental Engineering*, July 2005, pp. 914-924.

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Written by:	**Y. Bholat**	Date:	**02/13/23**	Reviewed by:	**Scott Graves**	Date:	**8/4/23**
Client:	**WMTX**	Project:	**Mesquite Creek**	Project No.:	**GW8636**	Task No.:	**05**

APPENDIX 3G-1

HELP MODEL COMPUTER PROGRAM OUTPUT FILES

```
******************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
**          HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE                   **
**                                                                          **
**          HELP Version 3.95 D          (10 August 2012)                   **
**                           developed at                                   **
**      Institute of Soil Science, University of Hamburg, Germany           **
**                             based on                                     **
**          US HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                   **
**              DEVELOPED BY ENVIRONMENTAL LABORATORY                       **
**                USAE WATERWAYS EXPERIMENT STATION                         **
**         FOR USEPA RISK REDUCTION ENGINEERING LABORATORY                  **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************

TIME:  20.51     DATE:  13.02.2023

PRECIPITATION DATA FILE:      C:\PRECIP-30yr.d4
TEMPERATURE DATA FILE:        C:\TEMP-30yr.d7
SOLAR RADIATION DATA FILE:    C:\SOLAR-30yr.d13
EVAPOTRANSPIRATION DATA F. 1: C:\Evapotranspiration-LAI_3-EVAP24.d11
SOIL AND DESIGN DATA FILE  1: C:\SOILS - F_TOP.d10
OUTPUT DATA FILE:             C:\OUT - F_TOP.out

******************************************************************************

     TITLE:  Mesquite_Creek_LF - F_TOP

******************************************************************************

                        WEATHER DATA SOURCES
------------------------------------------------------------------------------

         NOTE:  PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
                  COEFFICIENTS FOR    SAN ANTONIO         TEXAS

                  NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

     JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
     -------     -------     -------     -------     -------     -------
       2.14        1.72        2.49        2.00        3.63        3.44
       2.21        2.01        3.45        3.30        2.46        2.42

         NOTE:  TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
                  COEFFICIENTS FOR    SAN ANTONIO         TEXAS

                NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

     JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
     -------     -------     -------     -------     -------     -------
      52.20       56.00       62.80       69.80       76.60       82.40
      84.50       85.10       79.90       71.30       61.00       53.50

         NOTE:  SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
                  COEFFICIENTS FOR    SAN ANTONIO         TEXAS
                    AND STATION LATITUDE  =  29.70 DEGREES

******************************************************************************

                              LAYER DATA   1
------------------------------------------------------------------------------

                           VALID FOR  30 YEARS

     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  24
           THICKNESS                  =     24.00  INCHES
           POROSITY                   =      0.3650 VOL/VOL
           FIELD CAPACITY             =      0.3050 VOL/VOL
           WILTING POINT              =      0.2020 VOL/VOL
           INITIAL SOIL WATER CONTENT  =      0.2963 VOL/VOL
           EFFECTIVE SAT. HYD. CONDUCT.=      0.2700E-05 CM/SEC
         NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  4.20
                  FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.

                                  LAYER  2
                                  --------

                     TYPE 2 - LATERAL DRAINAGE LAYER
                       MATERIAL TEXTURE NUMBER   0
           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. CONDUCT.=       1.080      CM/SEC
           SLOPE                      =      5.00   PERCENT
           DRAINAGE LENGTH            =    886.0    FEET

                                  LAYER  3
                                  --------

                     TYPE 4 - FLEXIBLE MEMBRANE LINER
                       MATERIAL TEXTURE NUMBER  36
           THICKNESS                  =      0.04   INCHES
           EFFECTIVE SAT. HYD. CONDUCT.=      0.4000E-12 CM/SEC
           FML PINHOLE DENSITY        =      2.00   HOLES/ACRE
           FML INSTALLATION DEFECTS   =      2.00   HOLES/ACRE
           FML PLACEMENT QUALITY      =  3 - GOOD

                                  LAYER  4
                                  --------

                       TYPE 3 - BARRIER SOIL LINER
                       MATERIAL TEXTURE NUMBER   0
           THICKNESS                  =     18.00   INCHES
           POROSITY                   =      0.4270 VOL/VOL
           FIELD CAPACITY             =      0.4180 VOL/VOL
           WILTING POINT              =      0.3670 VOL/VOL
           INITIAL SOIL WATER CONTENT  =      0.4270 VOL/VOL
           EFFECTIVE SAT. HYD. CONDUCT.=      0.1000E-04 CM/SEC

******************************************************************************

                GENERAL DESIGN AND EVAPORATIVE ZONE DATA   1
------------------------------------------------------------------------------

                           VALID FOR  30 YEARS

         NOTE:  SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
                  SOIL DATA BASE USING SOIL TEXTURE #24 WITH AN
                  EXCELLENT STAND OF GRASS, A SURFACE SLOPE OF  5.%
                  AND A SLOPE LENGTH OF  886. FEET.

        SCS RUNOFF CURVE NUMBER            =    83.29
        FRACTION OF AREA ALLOWING RUNOFF   =   100.0    PERCENT
        AREA PROJECTED ON HORIZONTAL PLANE  =     1.000  ACRES
        EVAPORATIVE ZONE DEPTH             =    24.0    INCHES
        INITIAL WATER IN EVAPORATIVE ZONE   =     7.112  INCHES
        UPPER LIMIT OF EVAPORATIVE STORAGE  =     8.760  INCHES
        FIELD CAPACITY OF EVAPORATIVE ZONE  =     7.320  INCHES
        LOWER LIMIT OF EVAPORATIVE STORAGE  =     4.848  INCHES
        SOIL EVAPORATION ZONE DEPTH        =    24.000  INCHES
        INITIAL SNOW WATER                 =     0.000  INCHES
        INITIAL INTERCEPTION WATER         =     0.000  INCHES
        INITIAL WATER IN LAYER MATERIALS    =    14.800  INCHES
        TOTAL INITIAL WATER                =    14.800  INCHES
        TOTAL SUBSURFACE INFLOW            =     0.00   INCHES/YEAR

******************************************************************************

                         EVAPOTRANSPIRATION DATA   1
------------------------------------------------------------------------------

                           VALID FOR  30 YEARS

         NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
                  SAN ANTONIO         TEXAS
             STATION LATITUDE                      =  29.70 DEGREES
             MAXIMUM LEAF AREA INDEX               =   3.00
             START OF GROWING SEASON (JULIAN DATE)  =     35
             END OF GROWING SEASON (JULIAN DATE)    =    350
             EVAPORATIVE ZONE DEPTH                =  24.0  INCHES
             AVERAGE ANNUAL WIND SPEED             =   9.40 MPH
             AVERAGE 1ST QUARTER RELATIVE HUMIDITY  =  66.0  %
             AVERAGE 2ND QUARTER RELATIVE HUMIDITY  =  68.0  %
             AVERAGE 3RD QUARTER RELATIVE HUMIDITY  =  66.0  %
             AVERAGE 4TH QUARTER RELATIVE HUMIDITY  =  67.0  %

******************************************************************************
```

****

FINAL WATER STORAGE AT END OF YEAR 30

LAYER	(INCHES)	(VOL/VOL)
1	6.2794	0.2616
2	0.0020	0.0100
3	0.0000	0.0000
4	7.6860	0.4270

TOTAL WATER IN LAYERS	13.967
SNOW WATER	0.000
INTERCEPTION WATER	0.000
TOTAL FINAL WATER	13.967

****

****

PEAK DAILY VALUES FOR YEARS 1 THROUGH 30

	(INCHES)	(CU. FT.)
PRECIPITATION	8.90	32306.998
RUNOFF	8.343	30283.5547
DRAINAGE COLLECTED FROM LAYER 2	0.04816	174.82446
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.000010	0.03461
AVERAGE HEAD ON TOP OF LAYER 3	0.140	
MAXIMUM HEAD ON TOP OF LAYER 3	0.274	
LOCATION OF MAXIMUM HEAD IN LAYER 2		
(DISTANCE FROM DRAIN)	0.0 FEET	
SNOW WATER	1.30	4720.1436
MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.3403	
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.2020	

*** 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.

****

****

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 30

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	1.74	1.68	2.24	1.92	2.83	3.81
	2.15	1.90	4.13	3.38	2.38	2.23
STD. DEVIATIONS	1.18	0.88	1.40	1.49	1.75	2.30
	2.03	2.16	2.36	2.10	1.95	1.20
RUNOFF						
TOTALS	0.395	0.290	0.837	0.598	1.129	2.023
	1.052	0.713	1.775	1.431	0.871	0.673
STD. DEVIATIONS	0.533	0.320	0.912	0.819	1.128	1.724
	1.657	1.328	1.477	1.276	1.141	0.646
POTENTIAL EVAPOTRANSPIRATION						
TOTALS	3.216	3.519	5.305	6.439	7.948	8.629
	9.186	8.564	6.682	5.124	3.734	2.987
STD. DEVIATIONS	0.209	0.225	0.319	0.283	0.278	0.258
	0.301	0.296	0.329	0.301	0.220	0.222
ACTUAL EVAPOTRANSPIRATION						
TOTALS	1.111	1.199	2.266	2.180	1.617	1.772
	1.116	1.292	2.025	1.668	1.129	1.138
STD. DEVIATIONS	0.413	0.469	0.494	0.790	0.716	0.897
	0.687	1.033	0.953	0.718	0.562	0.367
LATERAL DRAINAGE COLLECTED FROM LAYER 2						
TOTALS	0.0310	0.0421	0.0298	0.0021	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0013
STD. DEVIATIONS	0.1450	0.1230	0.0793	0.0109	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0071
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

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 3						
AVERAGES	0.0029	0.0043	0.0028	0.0002	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001
STD. DEVIATIONS	0.0136	0.0125	0.0074	0.0011	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0007

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 30

	INCHES	CU. FEET	PERCENT
PRECIPITATION	30.38 (5.727)	110266.1	100.00
RUNOFF	11.785 (3.7537)	42778.28	38.795
POTENTIAL EVAPOTRANSPIRATION	71.333 (0.9604)	258939.95	
ACTUAL EVAPOTRANSPIRATION	18.513 (2.9419)	67202.67	60.946
LATERAL DRAINAGE COLLECTED FROM LAYER 2	0.10627 (0.27691)	385.776	0.34986
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.00002 (0.00006)	0.086	0.00008
AVERAGE HEAD ON TOP OF LAYER 3	0.001 (0.002)		
CHANGE IN WATER STORAGE	-0.028 (0.8701)	-100.72	-0.091

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******************************************************************************
**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                                                                          **
**              HELP Version 3.95 D         (10 August 2012)                **
**                               developed at                               **
**        Institute of Soil Science, University of Hamburg, Germany         **
**                                 based on                                 **
**              US 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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TIME:  20.53     DATE:  13.02.2023


PRECIPITATION DATA FILE:      C:\PRECIP-30yr.d4
TEMPERATURE DATA FILE:        C:\TEMP-30yr.d7
SOLAR RADIATION DATA FILE:    C:\SOLAR-30yr.d13
EVAPOTRANSPIRATION DATA F. 1: C:\Evapotranspiration-LAI_3-EVAP24.d11
SOIL AND DESIGN DATA FILE  1: C:\SOILS - F_SIDE1.d10
OUTPUT DATA FILE:             C:\OUT - F_SIDE1.out


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     TITLE:  Mesquite_Creek_LF - F_SIDE1

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                           WEATHER DATA SOURCES
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         NOTE:  PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
                  COEFFICIENTS FOR    SAN ANTONIO         TEXAS

                  NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

     JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
     -------     -------     -------     -------     -------     -------
       2.14        1.72        2.49        2.00        3.63        3.44
       2.21        2.01        3.45        3.30        2.46        2.42


         NOTE:  TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
                  COEFFICIENTS FOR    SAN ANTONIO         TEXAS

             NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

     JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
     -------     -------     -------     -------     -------     -------
      52.20       56.00       62.80       69.80       76.60       82.40
      84.50       85.10       79.90       71.30       61.00       53.50


         NOTE:  SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
                  COEFFICIENTS FOR    SAN ANTONIO         TEXAS
                    AND STATION LATITUDE  =  29.70 DEGREES


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                              LAYER DATA   1
------------------------------------------------------------------------------

                           VALID FOR  30 YEARS


     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  24
           THICKNESS                  =     24.00   INCHES
           POROSITY                   =      0.3650 VOL/VOL
           FIELD CAPACITY             =      0.3050 VOL/VOL
           WILTING POINT              =      0.2020 VOL/VOL
           INITIAL SOIL WATER CONTENT  =     0.2963 VOL/VOL
           EFFECTIVE SAT. HYD. CONDUCT.=     0.2700E-05 CM/SEC
         NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  4.20
                  FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.


                                 LAYER  2
                                 --------

                       TYPE 2 - LATERAL DRAINAGE LAYER
                         MATERIAL TEXTURE NUMBER   0
           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. CONDUCT.=      1.080     CM/SEC
           SLOPE                      =     28.60   PERCENT
           DRAINAGE LENGTH            =    410.0    FEET


                                 LAYER  3
                                 --------

                       TYPE 4 - FLEXIBLE MEMBRANE LINER
                         MATERIAL TEXTURE NUMBER  36
           THICKNESS                  =      0.04   INCHES
           EFFECTIVE SAT. HYD. CONDUCT.=     0.4000E-12 CM/SEC
           FML PINHOLE DENSITY        =      2.00   HOLES/ACRE
           FML INSTALLATION DEFECTS   =      2.00   HOLES/ACRE
           FML PLACEMENT QUALITY      =  3 - GOOD


                                 LAYER  4
                                 --------

                         TYPE 3 - BARRIER SOIL LINER
                         MATERIAL TEXTURE NUMBER   0
           THICKNESS                  =     18.00   INCHES
           POROSITY                   =      0.4270 VOL/VOL
           FIELD CAPACITY             =      0.4180 VOL/VOL
           WILTING POINT              =      0.3670 VOL/VOL
           INITIAL SOIL WATER CONTENT  =     0.4270 VOL/VOL
           EFFECTIVE SAT. HYD. CONDUCT.=     0.1000E-04 CM/SEC


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                  GENERAL DESIGN AND EVAPORATIVE ZONE DATA   1
------------------------------------------------------------------------------

                           VALID FOR  30 YEARS


         NOTE:  SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
                  SOIL DATA BASE USING SOIL TEXTURE #24 WITH AN
                  EXCELLENT STAND OF GRASS, A SURFACE SLOPE OF 29.%
                  AND A SLOPE LENGTH OF  410. FEET.

        SCS RUNOFF CURVE NUMBER            =    84.68
        FRACTION OF AREA ALLOWING RUNOFF   =   100.0    PERCENT
        AREA PROJECTED ON HORIZONTAL PLANE  =     1.000  ACRES
        EVAPORATIVE ZONE DEPTH             =    24.0    INCHES
        INITIAL WATER IN EVAPORATIVE ZONE  =     7.111  INCHES
        UPPER LIMIT OF EVAPORATIVE STORAGE  =     8.760  INCHES
        FIELD CAPACITY OF EVAPORATIVE ZONE  =     7.320  INCHES
        LOWER LIMIT OF EVAPORATIVE STORAGE  =     4.848  INCHES
        SOIL EVAPORATION ZONE DEPTH        =    24.000  INCHES
        INITIAL SNOW WATER                 =     0.000  INCHES
        INITIAL INTERCEPTION WATER         =     0.000  INCHES
        INITIAL WATER IN LAYER MATERIALS   =    14.799  INCHES
        TOTAL INITIAL WATER                =    14.799  INCHES
        TOTAL SUBSURFACE INFLOW            =     0.00   INCHES/YEAR


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                         EVAPOTRANSPIRATION DATA   1
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                           VALID FOR  30 YEARS


         NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
                  SAN ANTONIO         TEXAS
             STATION LATITUDE                        =  29.70 DEGREES
             MAXIMUM LEAF AREA INDEX                 =   3.00
             START OF GROWING SEASON (JULIAN DATE)   =     35
             END OF GROWING SEASON (JULIAN DATE)     =    350
             EVAPORATIVE ZONE DEPTH                  =  24.0  INCHES
             AVERAGE ANNUAL WIND SPEED               =   9.40 MPH
             AVERAGE 1ST QUARTER RELATIVE HUMIDITY   =  66.0  %
             AVERAGE 2ND QUARTER RELATIVE HUMIDITY   =  68.0  %
             AVERAGE 3RD QUARTER RELATIVE HUMIDITY   =  66.0  %
             AVERAGE 4TH QUARTER RELATIVE HUMIDITY   =  67.0  %

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FINAL WATER STORAGE AT END OF YEAR 30

LAYER	(INCHES)	(VOL/VOL)
1	6.2792	0.2616
2	0.0020	0.0100
3	0.0000	0.0000
4	7.6860	0.4270

TOTAL WATER IN LAYERS	13.967
SNOW WATER	0.000
INTERCEPTION WATER	0.000
TOTAL FINAL WATER	13.967

PEAK DAILY VALUES FOR YEARS 1 THROUGH 30

	(INCHES)	(CU. FT.)
PRECIPITATION	8.90	32306.998
RUNOFF	8.343	30283.5684
DRAINAGE COLLECTED FROM LAYER 2	0.06946	252.14235
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.000001	0.00537
AVERAGE HEAD ON TOP OF LAYER 3	0.018	
MAXIMUM HEAD ON TOP OF LAYER 3	0.246	
LOCATION OF MAXIMUM HEAD IN LAYER 2 (DISTANCE FROM DRAIN)	0.0 FEET	
SNOW WATER	1.30	4720.1436
MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.3403	
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.2020	

*** 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.

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 30

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	1.74	1.68	2.24	1.92	2.83	3.81
	2.15	1.90	4.13	3.38	2.38	2.23
STD. DEVIATIONS	1.18	0.88	1.40	1.49	1.75	2.30
	2.03	2.16	2.36	2.10	1.95	1.20
RUNOFF						
TOTALS	0.395	0.290	0.837	0.598	1.129	2.023
	1.052	0.713	1.775	1.431	0.871	0.673
STD. DEVIATIONS	0.532	0.320	0.912	0.819	1.128	1.724
	1.657	1.328	1.477	1.277	1.141	0.646
POTENTIAL EVAPOTRANSPIRATION						
TOTALS	3.216	3.519	5.305	6.439	7.948	8.629
	9.186	8.564	6.682	5.124	3.734	2.987
STD. DEVIATIONS	0.209	0.225	0.319	0.283	0.278	0.258
	0.301	0.296	0.329	0.301	0.220	0.222
ACTUAL EVAPOTRANSPIRATION						
TOTALS	1.111	1.199	2.267	2.178	1.616	1.772
	1.116	1.292	2.025	1.668	1.129	1.138
STD. DEVIATIONS	0.413	0.469	0.495	0.789	0.715	0.897
	0.687	1.033	0.953	0.718	0.562	0.367
LATERAL DRAINAGE COLLECTED FROM LAYER 2						
TOTALS	0.0313	0.0466	0.0248	0.0009	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0015
STD. DEVIATIONS	0.1476	0.1354	0.0669	0.0051	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0082
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

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 3						
AVERAGES	0.0003	0.0004	0.0002	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0012	0.0012	0.0005	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001

AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 30

	INCHES	CU. FEET	PERCENT
PRECIPITATION	30.38 (5.727)	110266.1	100.00
RUNOFF	11.787 (3.7528)	42788.33	38.805
POTENTIAL EVAPOTRANSPIRATION	71.333 (0.9604)	258939.95	
ACTUAL EVAPOTRANSPIRATION	18.512 (2.9412)	67196.79	60.941
LATERAL DRAINAGE COLLECTED FROM LAYER 2	0.10512 (0.27510)	381.586	0.34606
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.00000 (0.00001)	0.009	0.00001
AVERAGE HEAD ON TOP OF LAYER 3	0.000 (0.000)		
CHANGE IN WATER STORAGE	-0.028 (0.8700)	-100.63	-0.091

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**                                                                          **
**                                                                          **
**          HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE                   **
**                                                                          **
**          HELP Version 3.95 D         (10 August 2012)                    **
**                           developed at                                   **
**      Institute of Soil Science, University of Hamburg, Germany          **
**                             based on                                     **
**          US 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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TIME:  21.02    DATE:  13.02.2023


PRECIPITATION DATA FILE:      C:\PRECIP-30yr.d4
TEMPERATURE DATA FILE:        C:\TEMP-30yr.d7
SOLAR RADIATION DATA FILE:    C:\SOLAR-30yr.d13
EVAPOTRANSPIRATION DATA F. 1: C:\Evapotranspiration-LAI_3-EVAP24.d11
SOIL AND DESIGN DATA FILE  1: C:\SOILS - F_SIDE2.d10
OUTPUT DATA FILE:             C:\OUT - F_SIDE2.out


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     TITLE:  Mesquite_Creek_LF - F_SIDE2

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                           WEATHER DATA SOURCES
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         NOTE:  PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
                  COEFFICIENTS FOR    SAN ANTONIO         TEXAS

                  NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

     JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
     -------     -------     -------     -------     -------     -------
      2.14        1.72        2.49        2.00        3.63        3.44
      2.21        2.01        3.45        3.30        2.46        2.42


         NOTE:  TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
                  COEFFICIENTS FOR    SAN ANTONIO         TEXAS

              NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

     JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
     -------     -------     -------     -------     -------     -------
      52.20       56.00       62.80       69.80       76.60       82.40
      84.50       85.10       79.90       71.30       61.00       53.50


         NOTE:  SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
                  COEFFICIENTS FOR    SAN ANTONIO         TEXAS
                    AND STATION LATITUDE  =  29.70 DEGREES


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                              LAYER DATA   1
------------------------------------------------------------------------------

                           VALID FOR  30 YEARS


     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  24
            THICKNESS                =    24.00   INCHES
            POROSITY                 =     0.3650 VOL/VOL
            FIELD CAPACITY           =     0.3050 VOL/VOL
            WILTING POINT            =     0.2020 VOL/VOL
            INITIAL SOIL WATER CONTENT  =     0.2963 VOL/VOL
            EFFECTIVE SAT. HYD. CONDUCT.=     0.2700E-05 CM/SEC
          NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  4.20
                   FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.


                                 LAYER  2
                                 --------

                    TYPE 2 - LATERAL DRAINAGE LAYER
                      MATERIAL TEXTURE NUMBER   0
            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  =     0.0612 VOL/VOL
            EFFECTIVE SAT. HYD. CONDUCT.=     1.080      CM/SEC
            SLOPE                    =    28.60   PERCENT
            DRAINAGE LENGTH          =   410.0    FEET
            SUBSURFACE INFLOW        =    17.60   INCHES/YR


                                 LAYER  3
                                 --------

                    TYPE 4 - FLEXIBLE MEMBRANE LINER
                      MATERIAL TEXTURE NUMBER  36
            THICKNESS                =     0.04   INCHES
            EFFECTIVE SAT. HYD. CONDUCT.=     0.4000E-12 CM/SEC
            FML PINHOLE DENSITY      =     2.00   HOLES/ACRE
            FML INSTALLATION DEFECTS =     2.00   HOLES/ACRE
            FML PLACEMENT QUALITY    =  3 - GOOD


                                 LAYER  4
                                 --------

                    TYPE 3 - BARRIER SOIL LINER
                      MATERIAL TEXTURE NUMBER   0
            THICKNESS                =    18.00   INCHES
            POROSITY                 =     0.4270 VOL/VOL
            FIELD CAPACITY           =     0.4180 VOL/VOL
            WILTING POINT            =     0.3670 VOL/VOL
            INITIAL SOIL WATER CONTENT  =     0.4270 VOL/VOL
            EFFECTIVE SAT. HYD. CONDUCT.=     0.1000E-04 CM/SEC


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                GENERAL DESIGN AND EVAPORATIVE ZONE DATA   1
------------------------------------------------------------------------------

                           VALID FOR  30 YEARS


          NOTE:  SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
                   SOIL DATA BASE USING SOIL TEXTURE #24 WITH AN
                   EXCELLENT STAND OF GRASS, A SURFACE SLOPE OF 29.%
                   AND A SLOPE LENGTH OF  410. FEET.

        SCS RUNOFF CURVE NUMBER            =    84.68
        FRACTION OF AREA ALLOWING RUNOFF   =   100.0    PERCENT
        AREA PROJECTED ON HORIZONTAL PLANE =     1.000  ACRES
        EVAPORATIVE ZONE DEPTH             =    24.0    INCHES
        INITIAL WATER IN EVAPORATIVE ZONE  =     7.111  INCHES
        UPPER LIMIT OF EVAPORATIVE STORAGE =     8.760  INCHES
        FIELD CAPACITY OF EVAPORATIVE ZONE =     7.320  INCHES
        LOWER LIMIT OF EVAPORATIVE STORAGE =     4.848  INCHES
        SOIL EVAPORATION ZONE DEPTH        =    24.000  INCHES
        INITIAL SNOW WATER                 =     0.000  INCHES
        INITIAL INTERCEPTION WATER         =     0.000  INCHES
        INITIAL WATER IN LAYER MATERIALS   =    14.809  INCHES
        TOTAL INITIAL WATER                =    14.809  INCHES
        TOTAL SUBSURFACE INFLOW            =    17.60   INCHES/YEAR


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                          EVAPOTRANSPIRATION DATA   1
------------------------------------------------------------------------------

                           VALID FOR  30 YEARS


          NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
                   SAN ANTONIO         TEXAS
              STATION LATITUDE                      =  29.70 DEGREES
              MAXIMUM LEAF AREA INDEX               =   3.00
              START OF GROWING SEASON (JULIAN DATE) =     35
              END OF GROWING SEASON (JULIAN DATE)   =    350
              EVAPORATIVE ZONE DEPTH                =  24.0  INCHES
              AVERAGE ANNUAL WIND SPEED             =   9.40 MPH
              AVERAGE 1ST QUARTER RELATIVE HUMIDITY =  66.0  %
              AVERAGE 2ND QUARTER RELATIVE HUMIDITY =  68.0  %
              AVERAGE 3RD QUARTER RELATIVE HUMIDITY =  66.0  %
              AVERAGE 4TH QUARTER RELATIVE HUMIDITY =  67.0  %

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FINAL WATER STORAGE AT END OF YEAR 30

LAYER	(INCHES)	(VOL/VOL)
1	6.2792	0.2616
2	0.0122	0.0612
3	0.0000	0.0000
4	7.6860	0.4270
TOTAL WATER IN LAYERS	13.977	
SNOW WATER	0.000	
INTERCEPTION WATER	0.000	
TOTAL FINAL WATER	13.977	

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 30

	(INCHES)	(CU. FT.)
PRECIPITATION	8.90	32306.998
RUNOFF	8.343	30283.5684
DRAINAGE COLLECTED FROM LAYER 2	0.11763	427.00015
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.000002	0.00861
AVERAGE HEAD ON TOP OF LAYER 3	0.030	
MAXIMUM HEAD ON TOP OF LAYER 3	0.243	
LOCATION OF MAXIMUM HEAD IN LAYER 2 (DISTANCE FROM DRAIN)	0.0 FEET	
SNOW WATER	1.30	4720.1436
MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.3403	
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.2020	

*** 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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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 30

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	1.74	1.68	2.24	1.92	2.83	3.81
	2.15	1.90	4.13	3.38	2.38	2.23
STD. DEVIATIONS	1.18	0.88	1.40	1.49	1.75	2.30
	2.03	2.16	2.36	2.10	1.95	1.20
RUNOFF						
TOTALS	0.395	0.290	0.837	0.598	1.129	2.023
	1.052	0.713	1.775	1.431	0.871	0.673
STD. DEVIATIONS	0.532	0.320	0.912	0.819	1.128	1.724
	1.657	1.328	1.477	1.277	1.141	0.646
POTENTIAL EVAPOTRANSPIRATION						
TOTALS	3.216	3.519	5.305	6.439	7.948	8.629
	9.186	8.564	6.682	5.124	3.734	2.987
STD. DEVIATIONS	0.209	0.225	0.319	0.283	0.278	0.258
	0.301	0.296	0.329	0.301	0.220	0.222
ACTUAL EVAPOTRANSPIRATION						
TOTALS	1.111	1.199	2.267	2.178	1.616	1.772
	1.116	1.292	2.025	1.668	1.129	1.138
STD. DEVIATIONS	0.413	0.469	0.495	0.789	0.715	0.897
	0.687	1.033	0.953	0.718	0.562	0.367
SUBSURFACE INFLOW INTO LAYER 2						
TOTALS	1.4948	1.3614	1.4948	1.4466	1.4948	1.4466
	1.4948	1.4948	1.4466	1.4948	1.4466	1.4948
LATERAL DRAINAGE COLLECTED FROM LAYER 2						
TOTALS	1.5246	1.4066	1.5181	1.4460	1.4933	1.4451
	1.4933	1.4933	1.4451	1.4933	1.4451	1.4948
STD. DEVIATIONS	0.1476	0.1407	0.0669	0.0051	0.0000	0.0004
	0.0000	0.0000	0.0004	0.0000	0.0004	0.0081
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

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 3						
AVERAGES	0.0125	0.0126	0.0124	0.0122	0.0122	0.0122
	0.0122	0.0122	0.0122	0.0122	0.0122	0.0122
STD. DEVIATIONS	0.0012	0.0012	0.0005	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001

****

****

AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 30

	INCHES	CU. FEET	PERCENT
PRECIPITATION	30.38 (5.727)	110266.1	100.00
RUNOFF	11.787 (3.7528)	42788.33	38.805
POTENTIAL EVAPOTRANSPIRATION	71.333 (0.9604)	258939.95	
ACTUAL EVAPOTRANSPIRATION	18.512 (2.9412)	67196.79	60.941
SUBSURFACE INFLOW INTO LAYER 2	17.61126	63928.855	57.97690
LATERAL DRAINAGE COLLECTED FROM LAYER 2	17.69844 (0.27557)	64245.332	58.26390
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.00039 (0.00001)	1.426	0.00129
AVERAGE HEAD ON TOP OF LAYER 3	0.012 (0.000)		
CHANGE IN WATER STORAGE	-0.028 (0.8700)	-100.63	-0.091

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ATTACHMENT 4

GEOLOGY REPORT

PART III – ATTACHMENT 4
GEOLOGY REPORT

MESQUITE CREEK LANDFILL
COMAL AND GUADALUPE COUNTIES, TEXAS
PERMIT AMENDMENT APPLICATION
MSW PERMIT NO. 66C

Prepared for:
Waste Management of Texas, Inc.

Prepared by:

Geosyntec consultants

Texas Board of Professional Geoscientists Firm Registration No. 50256
8217 Shoal Creek Blvd, Suite 200
Austin, Texas 78757
(512) 451-4003

STATE OF TEXAS
MATTHEW WISSLER
GEOLOGY
13242
LICENSED
PROFESSIONAL GEOSCIENTIST

10/10/2023

October 2023

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MATTHEW WISSLER
GEOLOGY
13242
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10/10/2023
GEOSYNTEC CONSULTANTS, INC.
TEXAS GEOSCIENCE FIRM REGISTRATION #50256

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GEOLOGY
13242
LICENSED
PROFESSIONAL GEOSCIENTIST
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GEOSYNTEC CONSULTANTS, INC.
TEXAS GEOSCIENCE FIRM REGISTRATION #50256

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STATE OF TEXAS
MATTHEW WISSLER
GEOLOGY
13242
LICENSED
PROFESSIONAL GEOSCIENTIST
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GEOSYNTEC CONSULTANTS, INC.
TEXAS GEOSCIENCE FIRM REGISTRATION #50256

1. INTRODUCTION

1.1 Scope

This Geology Report was prepared for the Mesquite Creek Landfill (the "Site") in conjunction with municipal solid waste (MSW) permit amendment application No. 66C, which proposes to laterally expand the existing landfill. The facility is an existing Type I MSW disposal facility (landfill) located in Comal and Guadalupe Counties, Texas, approximately 5 miles northeast of the central business district of the City of New Braunfels. This Geology Report has been prepared by a qualified professional geoscientist (PG), who is also a qualified groundwater scientist, and presents the information required by 30 TAC §330.63(e) regarding geological and hydrogeological information for the region and for the Site (and provides reference to where the geotechnical information is provided in a stand-alone Geotechnical Report within the permit amendment application). This report includes site-specific subsurface data collected by Geosyntec Consultants, Inc. (Geosyntec) in 2022-2023 as part of this proposed lateral expansion project. This report also incorporates and includes relevant data from previous subsurface investigation studies, as prepared by Geosyntec (2005) or otherwise compiled and included in MSW Permit No. 66B.

1.2 Report Organization

The remainder of this attachment is organized as follows:

- regional geology and hydrogeology and history is presented in Section 2;
- the geologic processes, including a discussion of fault and seismic data as well as unstable areas, are discussed in Section 3;
- regional aquifers are described in Section 4;
- the subsurface investigation report, outlining historical and recent investigations as well as a summary of the underlying Site stratigraphy, is presented in Section 5;
- Section 6 provides a reference to geotechnical data;
- groundwater occurrence, water levels, and the Site's hydrogeology is presented in Section 7; and
- references are listed in Section 8.

Additionally, tables are embedded in the report as relevant and other attachments, including drawings, are at the end of this report.

2. REGIONAL GEOLOGY AND HYDROGEOLOGY

2.1 Regional Physiography and Topography

The Site straddles the Comal-Guadalupe County-line (eastern Comal County and north-northwestern Guadalupe County). As shown on Drawing 4A-1, the Site is located in the Blackland Belt (Texas Almanac, 2021), hereafter called the "Blackland Prairie" sub-province after Wermund (1996), southeast of the Balcones Escarpment sub-province. The Blackland Prairie is the westernmost sub-province of the Gulf Coastal Plain physiographic province of Texas and is characterized by a rolling surface terrain covering deep black, fertile clayey soils. Native vegetation types include grasses, brush, and mesquite trees (and much of the Blackland Prairie has been cleared of natural vegetation and cultivated for crops).

The Gulf Coastal Plain is characterized by a heterogeneous mixture of sand, silt, clay, and gravel sediments that pinches out northwest of this province along the Balcones Escarpment (approximately 5 to 10 miles west-northwest of the Site) and thickens to a cumulative thickness exceeding 10,000 ft near the Texas coastline (Spearing, 1991). The Balcones Escarpment marks an abrupt change in topography between the Gulf Coastal Plain and Edwards Plateau physiographic provinces. It was formed in the Cretaceous Period (144 to 65 million years ago) when the rocks comprising the Edwards Plateau were uplifted. The escarpment is superimposed on a curved band of normal faults along the eastern and southern boundaries of the Edwards Plateau (see Drawing 4A-1). This regional-scale faulting occurs in a generally northeastward trending line across central Texas.

The overall topography is related to the geologic structure of the region. The Balcones Fault Zone bisects Comal County and separates the Edwards Plateau in the northwest part of the county (upthrown side of the fault zone) from the Gulf Coastal Plain in the southeast part of Comal County and continuing in Guadalupe County and further to the southeast (downthrown side of the fault zone). The Edwards Plateau is a relatively flat-lying area with southward dipping beds of limestones and dolomites. Streams incise the limestone formations to form rugged hills. Elevations in the Edwards Plateau range from approximately 3,000 to 450 ft above mean sea level (ft, MSL) (Wermund, 1996). The Balcones Fault Zone is characterized by fault blocks and stair-step topography. To the south and east of this zone (including the Site location), the Blackland Prairie physiographic sub-province has a gentle undulating terrain, regionally sloping to the south and having elevations ranging from 1,000 to 450 ft, MSL (Wermund, 1996).

The regional topography of eastern Comal County and north-northwestern Guadalupe County ranges in elevation from approximately 1,000 ft, MSL to 500 ft, MSL, and is drained by tributaries of the Guadalupe and Blanco Rivers (both part of the Guadalupe River Basin). The main drainage streams of the area generally flow to the southeast. In the immediate Site vicinity, Mesquite Creek crosses through the central portion of the Site flowing north-northeast and passes through a surface water body (pond) identified on USGS maps as the "Soil Conservation Service Site 4 Reservoir" (also known locally as "Freedom Lake") approximately 0.3 miles north-northeast of the Site.

Beyond Freedom Lake, Mesquite Creek enters York Creek at a point approximately three miles northeast of the Site. York Creek is a tributary of the San Marcos River, part of the Guadalupe River Basin. A portion of the proposed expansion area (east-southeast of the topographic ridge on the expansion property) is part of the Alligator Creek watershed. Alligator Creek passes approximately one mile south of the Site and flows southeast, where it enters Geronimo Creek at a point approximately four miles southeast of the Site. Geronimo Creek is also part of the Guadalupe River Basin (joining the Guadalupe River about three miles southeast of Seguin).

2.2 Regional Geologic Setting and Structural Geology

This section presents an overview of the regional geologic setting/history and structural geology at the Site and its nearby vicinity, based primarily on the published geology map and report by Collins (2000), supplemented by other references where cited. Regionally, Cretaceous (144 to 65 million years old), Tertiary (65 to 1.8 million years old), and Quaternary (1.8 million years to present) limestone, marls, calcareous marine clays, and fluvial deposits comprise the primary rock types that outcrop in the area.

The geologic setting is dominated by Cretaceous carbonate rocks deposited in a marine environment on the San Marcos Platform depositional province, a southeastern-trending platform area of the broader Texas Platform between the East Texas and Maverick Basins. Northwest of the Balcones Escarpment belt, the outcrop belt consists mostly of cyclic, shallow, subtidal to tidal-flat limestones, dolomitic limestones and dolomite. Southeast of the Balcones Escarpment (i.e., on the downthrown side of the Balcones Fault Zone where the Site is situated), the outcrop belt is made up of poorly exposed shelf limestone, argillaceous limestone, marl, and claystone to mudstone of the Cretaceous-age Taylor and Navarro Groups and lower Tertiary Midway Group. The Taylor, Navarro, and Midway units are commonly covered by Quaternary sand and gravel of the Leona Formation, locally deposited older gravel, and younger sand and gravel of terraces of main drainageways.

Comal County is bisected to the west of the Site by the Balcones Fault Zone. This zone is approximately 175 miles long and up to 20 miles wide, located in a southwest-to-northeast trending band on the eastern edge of the Edwards Plateau along the Balcones Escarpment. The Site is on the eastern edge of this inactive fault zone (or could be considered just outside the Balcones Fault Zone, as mapping of the specific lateral extents are inexact). Further south in Guadalupe County and south of San Antonio, a second fault zone, the inactive Luling Fault Zone, is present. These fault zones are inactive. The last episode of movement of the Balcones Fault Zone is thought to have occurred approximately 15-20 million years ago [Collins (2000); Jones et al. (2011)].

The sedimentary rock units in Comal County and Guadalupe County strike northeast and dip south-southeast toward the Gulf of Mexico at a rate slightly greater than the dip of the land surface approximately 100 feet (ft) per mile in southeastern Comal County and northern Guadalupe County; increasing to approximately 180 ft per mile in the southeastern part of Guadalupe County (Shafer, 1966).

2.3 Regional Geology and Lithology

The Site is largely located on outcrops (where present) of fine-grained Quaternary deposits and gravelly-clayey Quaternary-Tertiary alluvium deposits, underlain by Cretaceous Taylor Group clay/claystone sediments. The Collins (2000) map [published as Bureau of Economic Geology, New Braunfels 30 x 60 Minute Quadrangle], with identification of the Site location shown, is presented on Drawing 4A-2 of this report. It was constructed by Collins (2000) using field mapping, interpretation of aerial photographs, review of existing maps and reports, and digitization of map data. The stratigraphic relationships of these and underlying formations are shown in Table 4-1, which presents a generalized stratigraphic column for the geologic units in the facility area, from the land surface of Quaternary deposits down to the Cow Creek Formation [which represents the oldest Cretaceous Formation in the Collins (2000) study, at a depth of over approximately 1,850 ft below ground surface (bgs) in the Site vicinity]. A regional geologic cross section by Collins (2000) is presented on Drawing 4A-3.

TABLE 4-1
REGIONAL STRATIGRAPHIC COLUMN IN SITE VICINITY
[from Collins (2000), Shafer (1966)]

Period/ Epoch	Stratigraphic Unit (Group or Formation)	Approx. Typical Depth of Occurrence (ft, bgs)	Approx. Thickness Beneath Site (ft)	Depositional Facies	Character of Material
Quaternary	Stream, terrace and undivided alluvium	0 (at surface)	15 (where present)	Fluvial	Locally – clay. Regionally - silt, sand, gravel, and/or clay.
Quaternary -Tertiary	Undifferentiated gravelly alluvium (possibly equivalent to Uvalde Gravel)	0 (at surface) to 7	10 (where present)	Fluvial	Locally – clayey gravel to gravelly clay. Regionally - pebble-to-cobble-sized chert and limestone, commonly cemented by caliche
Upper Cretaceous	Upper Taylor Group (includes Navarro Group)	0 (at surface) to 10	50 (where present)	Shelf	Clay-claystone and mud-mudstone, some thin siltstone and sandstone beds.
	Lower Taylor Group (includes undivided Anacacho and Pecan Gap Formations)	10 to 15	290	Shelf	Marl, argillaceous limestone, limestone, some chalky, clay-claystone and mud-mudstone.
	Austin Group (Undivided)	300	100	Open shelf	Thin to thick bedded chalk, limestone and argillaceous limestone.
Upper Cretaceous	Eagle Ford Formation (Undivided)	400	30	Shelf	Calcareous and sandy shale and some argillaceous limestone.
	Buda Limestone	430	65	Open shelf	Dense, hard limestone.
	Del Rio Formation	495	50	Shelf mud and silt; prodelta	Blue clay, weathering greenish and yellowish brown.
Lower Cretaceous	Georgetown Formation	545	30	Open shelf	Argillaceous limestone and marl.
	Edwards Group Limestone (Undivided)	575	470	Shallow-marine subtidal to tidal-flat cycles	Hard semi-crystalline massive limestone and dolomite and some thin-bedded limestone and marly limestone.
	Walnut Formation	1045	50	Shelf	Walnut limestone, marl
	Glen Rose Formation	1095	720	Shallow-marine subtidal to tidal-flat cycles; local reefs	Massive limestone with alternating beds of less resistant marly limestone.
	Hensell Formation	1815	80	Nearshore marine	Sandy limestone, some also dolomitic.
	Cow Creek Limestone	1895	75	High-energy	Fossiliferous limestone

The regional stratigraphic units above the basement (pre-Cretaceous) rocks are described below, based on Collins (2000) and others where cited. Note that not all stratigraphic units mentioned below are present beneath the Site (some are nearby but not on-site – e.g., see Drawings 4A-2 and 3), but their information is included for a more complete description of the regional geologic stratigraphic units in the region.

Lower Cretaceous rocks include the Cow Creek Formation, the Hensell Formation, the Glen Rose Formation, the Walnut Formation, the Edwards Group Limestone, and the Georgetown Formation. The Cow Creek, Hensell, and lower member of the Glen Rose are part of the middle Trinity Aquifer group (Jones et al., 2011) (described in more detail in Section 4 of this report). The Edwards Group and Georgetown Formation comprise the Edwards Aquifer (described in more detail in Section 4 of this report).

The Cow Creek Formation is primarily a fossiliferous limestone, and is more clayey with sandy and dolomitic intervals in the lower part of the unit. The upper part is well indurated with massive to thick beds (Collins, 2000). Limited amounts of groundwater in Comal and Guadalupe Counties have been obtained from the Cow Creek Formation (Maclay and Small, 1986).

The Hensell Formation is composed of sandy limestone and sandy dolomitic limestone, and regionally can yield water to wells. The Hensell deposits thin downdip by laterally grading and interfingering into marine Glen Rose deposits.

The Glen Rose Formation is characterized by limestone, dolomitic limestone, argillaceous limestone, and some marl. Outcrops of the Glen Rose form a stair-step topography characterized by alternating resistant and recessive beds (Collins, 2000). The Glen Rose is divided into lower and upper units; the lower unit is more permeable (part of the middle Trinity Aquifer, yielding sufficient groundwater for stock and domestic use where it outcrops), contains localized massive beds, and is fossiliferous. Fossils include mollusks, rudistids, oysters, and echinods. Between the lower and upper units is a fossiliferous nodular limestone containing the echinoid *Salenia texana*. The upper unit of the Glen Rose is a confining bed, with little vertical permeability, composed of limestone, dolomite, shale, and marl.

The Walnut Formation is a limestone, marl, and dolomitic formation sometimes included with the Kainer Formation (lower Edwards Group), or referred to as the nodular member of the Edwards Aquifer (Maclay and Small, 1986). Contact with the underlying Glen Rose is gradational.

The Cretaceous-age Edwards Aquifer and associated units include the Edwards Group Limestone and the overlying Georgetown Formation. These formations were deposited in open deep marine to restricted evaporite dominated supratidal flat environments (Maclay and Small, 1986). The formations are generally described as a gray to white, hard, dense, semi-crystalline limestone and dolomite. The thickness increases downdip and varies from approximately 450 ft to over 600 ft (Hamilton et al., 2004). In many places, partial solution of the limestone has occurred resulting in irregularly distributed voids. These voids are often interconnected and form conduits which follow fractures that are associated with and parallel to faults. The Georgetown Formation unconformably overlies the Edwards Limestone and both have very similar lithologies, and are best distinguished by faunal differences. The Georgetown Formation is thin across the San Marcos Arch, generally less than 30 ft, and consists primarily of open, marine-shelf limestone and some marl (Collins, 2000), having negligible porosity and little permeability (Maclay and Small, 1986). The Edwards Group limestones have significant porosity and high permeabilities and in the outcrop zones located approximately 4 miles or more northwest of the Site (i.e., the recharge zone), can yield groundwater in significant quantities to springs and wells.

Overlying the Georgetown Formation are Upper Cretaceous strata, which represent marine shelf deposition. Regional regression and transgression during the beginning of the Late Cretaceous resulted in deposition of the Del Rio Formation clay and the Buda Limestone, respectively (Collins, 2000). The Del Rio Formation conformably overlies the Georgetown Formation. It is comprised of calcareous, fossiliferous clay-claystone to mud-mudstone, pyrite and contains less gypsum with depth. It weathers light gray to yellowish gray; and the Del Rio is a confining bed with negligible permeability (Maclay and Small, 1986).

Buda Limestone conformably overlies the Del Rio Formation clay, and the contact is marked by distinct lithologic differences. The Buda Limestone thickens slightly to the west and downdip with thicknesses ranging from approximately 40 ft to a maximum thickness of 65 ft (Collins, 2000). The Buda Limestone was deposited in a marine shelf environment and is composed of hard, dense limestone in the upper part and soft, chalky limestone in the lower part (Collins, 2000). Glauconite and fossils are common.

Overlying the Buda Limestone is the Eagle Ford Formation (often referred to as “Eagle Ford Shale”). The Eagle Ford is a low-permeability confining bed composed of shale to mudstone, siltstone, and limestone. The lower part of the unit is siltstone and some very fine-grained sandstone, which is overlain by dark gray shale to mudstone.

The Austin Group (often referred to as “Austin Chalk”) unconformably overlies the Eagle Ford Formation. The Austin Group consists of thin-to thick bedded chalk, limestone, and argillaceous limestone. The chalk is mostly microgranular calcite, along with some foraminiferal tests (Collins, 2000). Fossils are abundant in particular beds. The Austin Group may yield small quantities of groundwater to wells in the general San Marcos Platform/Balcones Fault Zone region (although no such wells are known to exist locally).

The Taylor and Navarro Groups are the uppermost thick shelf and prodelta deposits of the lowermost Upper Cretaceous, which unconformably overlies the Austin Group. The Taylor Group is subdivided into the Lower and Upper Taylor Groups. The Lower Taylor Group includes marls, and limestones, clay-claystones, and mud-mudstones that weathers to black clayey soil, and is usually unsaturated. Collins (2000) also assigned the Pecan Gap and Anacacho Formations, not divided or separately identified, to the Lower Taylor Group, while Maclay and Small (1986) identified the Anacacho Limestone as a separate unit underlying the Taylor Group. Shafer (1966) grouped the Anacacho Limestone and Taylor Marl (Group) together. The Anacacho Formation thins toward the east, while the Pecan Gap thins toward the west (Collins, 2000). The Anacacho Limestone is generally a brittle, white, marly chalk with marine megafossils and shell fragments. The Lower Taylor Group is low-permeability, not known to yield usable quantities of groundwater to wells, and functions as a confining bed, noted by Maclay and Small (1986) as being a "major barrier to vertical cross-formational flow".

Where present in the area, Upper Taylor Group (including Navarro) strata overlie the Lower Taylor Group. These Upper Taylor Group sediments and are deeper water marine deposits (Maclay and Small, 1986), and are undivided on geologic maps because they have similar lithologies and soils, making them extremely difficult to differentiate (Collins, 2000). The material is composed of clay-claystone and mud-mudstone, weathering to black clayey soil, and is usually unsaturated. The Upper Taylor Group is low-permeability, not known to yield usable quantities of groundwater to wells, and functions as a confining bed, noted by Maclay and Small (1986) as being a "major barrier to vertical cross-formational flow".

Topographic high areas at and around the Site have surficial deposits of Quaternary-Upper Tertiary (Pliocene-Pleistocene) gravels and sands, attributed by Collins (2000) as possibly equivalent to the upper Tertiary-Quaternary Uvalde Gravel. Thicknesses generally range from several ft to more than 10 ft. This formation consists of pebble to cobble-sized chert and limestone, although quartz and metamorphic rock also exist at some locations, and often contained within a silty/clayey matrix. Regionally, these deposits are commonly cemented by caliche. The formation is of low to moderate permeability, generally unsaturated, and is not known to yield usable quantities of groundwater to wells.

Quaternary alluvial deposits at the ground surface in the region include the Pleistocene-age Leona Formation, probable Holocene terrace alluvium and stream-bed alluvium, and undivided slope-wash and terrace alluvium. These deposits have variable composition, made up of silt, sand, gravel, and/or clay. Where composed of sands and gravels, the permeabilities are moderate to high; and if the deposit is broad and thick enough (generally adjacent to larger streams) areas of saturation can form and function as a local aquifer that can produce usable groundwater from shallow water wells. The Leona Formation can be 60-ft thick in some locations and may represent older Quaternary fluvial deposits. Younger stream terraces are inset against the Leona Formation and older Tertiary and Cretaceous strata. Terrace deposits along the larger streams such as the Blanco and Guadalupe Rivers may be as thick as 20 ft. Stream-bed alluvium is generally very thin and areas mapped as such commonly include local bedrock outcrops.

3. GEOLOGIC PROCESSES

3.1 Fault and Seismic Data

3.1.1 Fault Data

Fault evaluations have been conducted previously for this Site by McBride and Ratliff (1988), Rust Environment & Infrastructure (1994), and Geosyntec (2005), who investigated: (i) published geologic maps and information on the structural and seismic history of the Comal and Guadalupe County areas; (ii) evidence of displacement of surficial deposits observed during field reconnaissance and review of boring logs; and (iii) evaluation of lineaments on aerial photographs and topographic maps. One inactive subsurface fault was observed in the field during construction in the 1990 timeframe near the northern Site boundary (Unit 1), in an area excavated for landfill development at that time. The area was investigated and documented by Hydro-Search and MFG (1990) and showed no displacement of overlying strata, demonstrating that movement of the fault ceased before deposition of the strata in late Tertiary to early Quaternary time about 2.5 million years ago. The outcome of the previous site-specific evaluations cited above are that no Holocene faults were identified.

For this permit amendment application, Geosyntec reviewed relevant published information and site-specific data, including the previous evaluations by others. More specifically, Geosyntec's fault area evaluation was conducted to check for evidence of faulting at the Site and in the vicinity, to assess whether: (i) the Site is situated in an area that could potentially be subject to differential subsidence or active geologic faulting; (ii) the landfill units and lateral expansion areas are located within 200 ft of a fault that has had displacement in Holocene time; and (iii) there are any active faults known to exist within ½ mile of the Site. The evaluation indicated the facility is not situated in a fault area, there are no faults that have displaced in Holocene time within 200 ft of the solid waste units and lateral expansion area, and there no active faults known to exist within ½ mile of the Site. Therefore, the Site is in compliance with 30 TAC §330.555 (and without the need for demonstrations or detailed fault studies). The basis for this finding is elaborated on below.

As mentioned, the regional structural geologic setting of the Site is on or just outside of the eastern edge of the inactive Balcones Fault Zone, and not within the inactive Luling Fault Zone (which is further to the east). Faults associated with the Balcones Fault Zone are generally normal faults with the downthrown side to the east or southeast. Inspection of the geologic map (Drawing 4A-2) shows the location of mapped or inferred faults being more prevalent in areas three or more miles to the west of the Site. According to Collins (2000), most movement of the Balcones Fault Zone occurred during the late Oligocene or early Miocene epochs (around 20 million years ago). Similarly, Jones et al. (2011) (citing Young, 1972) indicate that the last episode of movement in the fault zone is thought to have occurred in the late early Miocene, approximately 15 million years ago.

The published regional geologic map on Drawing 4A-2 also indicates the presence of an inferred normal fault on the extreme eastern edge of the Site. During Geosyntec's 2022-2023 hydrogeologic site investigation (discussed in more detail subsequently in Section 5 of this report), borings were drilled on both sides of this line, and no evidence of this potential fault was detected at the depths investigated. For example, comparison of the strata thicknesses/contact elevations and material composition on either side of this inferred feature did not reveal stratigraphic offsets or differences in strata composition/physical properties. Thus, this inferred fault on the published map could not be confirmed by the site-specific investigation, and even if it were to be present at or near the Site, the large body of knowledge on area geology and faulting indicate that the geologic age and origin of such a fault would make it inactive.

A fault search using the United States Geological Survey (USGS) interactive mapping tool for U.S. Quaternary Faults (differentiating between Latest Quaternary <15,000 years through Late and Undifferentiated Quaternary <1.6 million years) revealed no such faults at or near the Site, nor is the Site located in a classified area (Class A, B, or C) of potential tectonic faults or deformation. This was corroborated by inspection of the published USGS map of young faults in the United States by Howard et al. (1978), which reveal no geologically-recent faulting in the area. Furthermore, the seismic impact zone evaluation described subsequently in this report also provides evidence of the lack of seismicity in this area, helping support the aseismic nature of this region, and inactivity of ancient faults in the area; and inability for reactivation of old faults due to natural or human-induced activities.

Aerial photographs of the Site and surrounding area were also reviewed by Geosyntec. No unusual ground-expressions of scarps or lineaments were interpreted within 200 ft of the Site, nor are there other indications of active faulting evident from comparisons of current and historical aerial photographs. No evidence of structural damage to buildings on the property potentially indicative of vertical subsurface displacement was identified. No evidence of faulting was found by examination of area roadways for vertical offsets or profile anomalies; no structural influence of stream courses was found; and no unusual relief or topographic features such as sag ponds or truncated alluvial spurs were observed on the Site.

As part of Geosyntec's site investigation for this permit amendment application, integrated with previous data, no evidence of vertical displacement or stratigraphic offsets indicative of faults was identified from the Site borings and resulting geologic cross-sections and layer maps generated from these data and included in Attachment 4A of this report, other than the aforementioned inactive subsurface fault identified at Unit 1.

The area on-site and nearby the facility also has very few groundwater withdrawal wells, and no active oil and gas wells (as mapped and noted on Drawing 4A-8 in Attachment 4A of this report). From this, it is apparent that here are no known mineral withdrawal activities occurring on-site and in the nearby area. Published information from local groundwater conservation districts indicate the Site and nearby region is not in an area known to experience subsidence, due to the well-compacted and rigid geologic framework in the region [Comal Trinity Groundwater Conservation District (2018); Guadalupe County Groundwater Conservation District (2018)]. Accordingly, differential subsidence or faulting from such activities that would adversely impact the integrity of the landfill liners is not expected. Additionally, none of the previous site-specific subsurface investigations have revealed evidence of subsidence beneath the facility.

3.1.2 Seismic Data

A seismic impact zone is defined as an area with a 10% or greater probability that the maximum horizontal acceleration in lithified earth material (i.e., the peak ground acceleration (PGA)), expressed as a percentage of the earth's gravitational pull (g), will exceed 0.10g in 250 years. The USGS publishes seismic hazard maps which present PGA values for a seismic risk level of 2% probability that the PGA will be exceeded in 50 years (i.e., probability of exceedance (PE) of 2% in 50 years). This is approximately statistically equivalent to a PE of 10% in 250 years. Drawing 4A-4 in Attachment 4A of this report presents a USGS seismic hazard map that includes PGA contours, and from this one is able to identify the location of seismic impact zones (i.e., those areas on the PE of 2% in 50 years-map located within PGA contours of 0.10g or greater). The Site location is shown on Drawing 4A-4. As indicated, the Site is located in an area with an approximate PGA of 0.0243g, and accordingly the Site in not located in a seismic impact zone.

3.1.3 Erosion Potential

An assessment was made of the potential for the geologic process of erosion at the Site and its vicinity. In general, the process of potential erosion stems from overland surface water flow causing soil loss and gully formation, or from fluvial action (meandering streams changing course). This assessment was not an engineering evaluation of the surface water drainage design and engineered erosion-resistant features of the landfill itself (which are addressed in Part III, Attachment 2), but rather for the geologic processes of potential erosion. From this assessment, it is concluded that there is minimal potential for active geologic erosion occurring in and around the Site. The area terrain is rolling to flat, with low relief (ground surface generally sloping at 3% to 10% or flatter in some areas). With this gentle topography and the near-surface Taylor Group stiff to very hard clay and claystone materials (resistant to erosion), excessive erosion due to surface-water processes such as overland flow, channeling, and gullying is not anticipated. Examination of aerial photographs over time did not reveal significant changes in the drainage patterns or stream alignments of Mesquite Creek or other tributaries/drainageways on-site or nearby, and revealed good vegetation coverage in the area to provide resistance against widespread or significant erosion. Furthermore, the Site is not located in a Federal Emergency Management Agency (FEMA) mapped 100-year floodway or floodplain, as addressed in the Part I/II Report (e.g., Section 11.1 and on Drawing I/IIA-16). The existing and proposed development of the waste disposal areas are at elevations above (and set-back from) streams and creeks (e.g., Mesquite Creek), thus providing a margin of safety and protection against potential stream migration and associated bank erosion towards the Site.

3.2 Unstable Areas

Based on the soils and geology discussed in this report, and the geotechnical characteristics of the subsurface as described in the Geotechnical Report in Part III, Attachment 3D.1, the underlying soils at the facility are not soft or weak, and are not expected to exhibit poor foundation conditions, nor landslides, nor experience any meaningful differential settlement. Collins (2000) descriptions and mapping of regional geology reveals no karst terrain (exposed or near-surface soluble bedrock that can experience dissolution leading to formation of sinkholes, cover-collapses, or similar features) at the Site or nearby. This is corroborated by the Comal County Regional Habitat Conservation Plan map of potential karst habitat zones, which indicates the nearest potential karst area being the Edwards Aquifer recharge (outcrop) zone located west of the City of New Braunfels, 4 miles or more west of the Site. The Site is not in an area susceptible to mass movement such as landslides because of the relatively low relief of the topography and the stiff cohesive nature and consistency of the soils.

Furthermore, there are also no on-site or local geomorphologic features, nor human-made features/events that could be indicative of unstable areas or likely to lead to erosion, collapse, or other instability. As described above in the fault discussion, the Site is not in an area known to experience subsidence or of a geologic characteristic that could be subject to subsidence, there is minimal groundwater withdrawal in the immediate area, and there are no active oil and/or gas wells in the vicinity. Additionally, Part III, Attachment 3D presents slope stability and settlement analyses, showing adequate calculated factors of safety against sliding of the waste mass and foundation and minimal foundation settlement beneath the Site due to the loads induced by the landfill – indicating that mass movement of the landfill is not expected. The stiff clays underlain by claystones that are the predominant soil/rock type encountered at the facility will provide a stable foundation for cell construction. For the foregoing reasons, the Site is in compliance with 30 TAC §330.559, and is not located in an unstable area.

4. REGIONAL AQUIFERS

The Texas Water Development Board (TWDB) recognizes nine (9) major aquifers and 22 minor aquifers in Texas. From evaluation of TWDB maps of these regional major and minor aquifers, there are two (2) regional aquifers in the general Site vicinity: (i) the Edwards Aquifer (a major aquifer of the State of Texas); and (ii) the Trinity Aquifer (a major aquifer of the State of Texas); The location of the Site in relation to these aquifers is presented below in Figures 4-1 and 4-2 for the Edwards Aquifer and Trinity Aquifer, respectively. These figures show that according to the TWDB, neither regional aquifer (i.e., the outcrop or subsurface portion of the aquifer) is present beneath the Site (discussed in more detail in Sections 4.1 and 4.2).

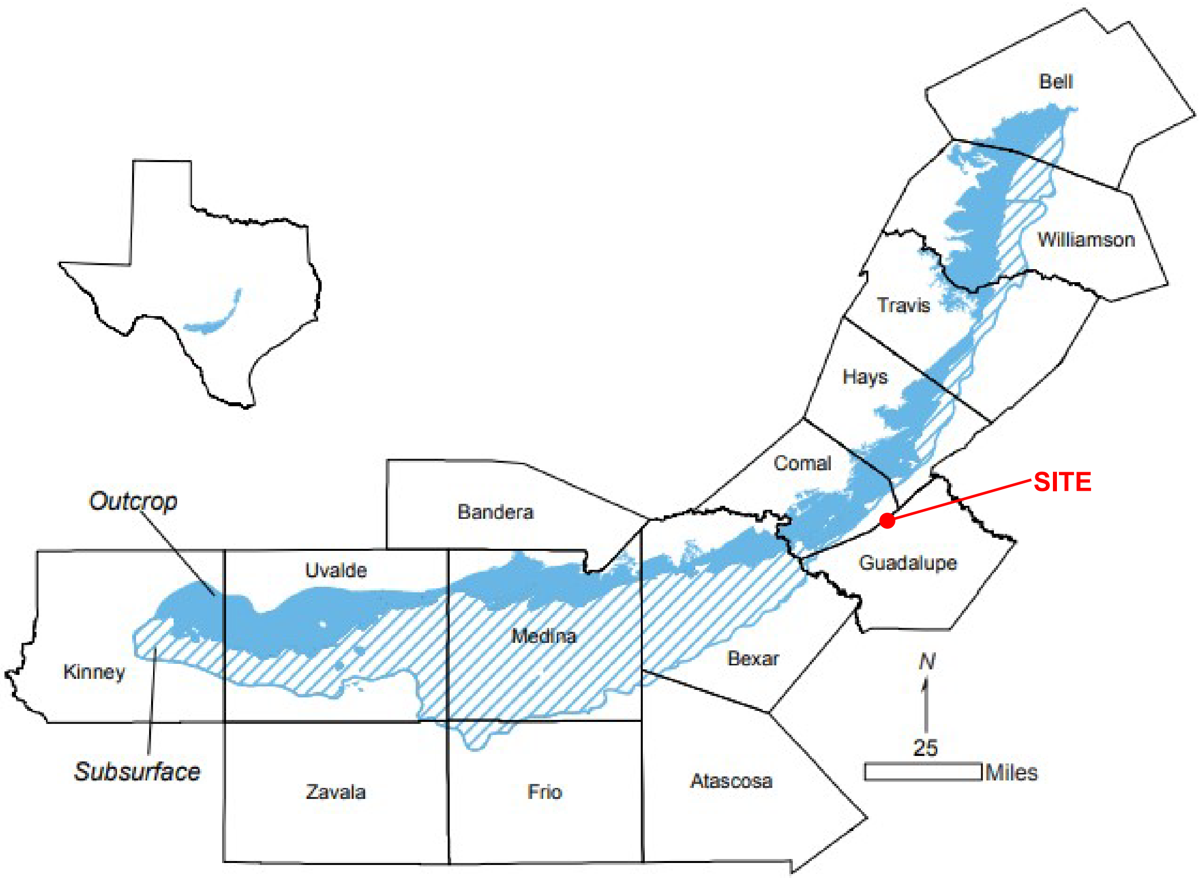

Figure 4-1. Map of Edwards Aquifer (Balcones Fault Zone Portion) [from TWDB, George et al. (2011)]

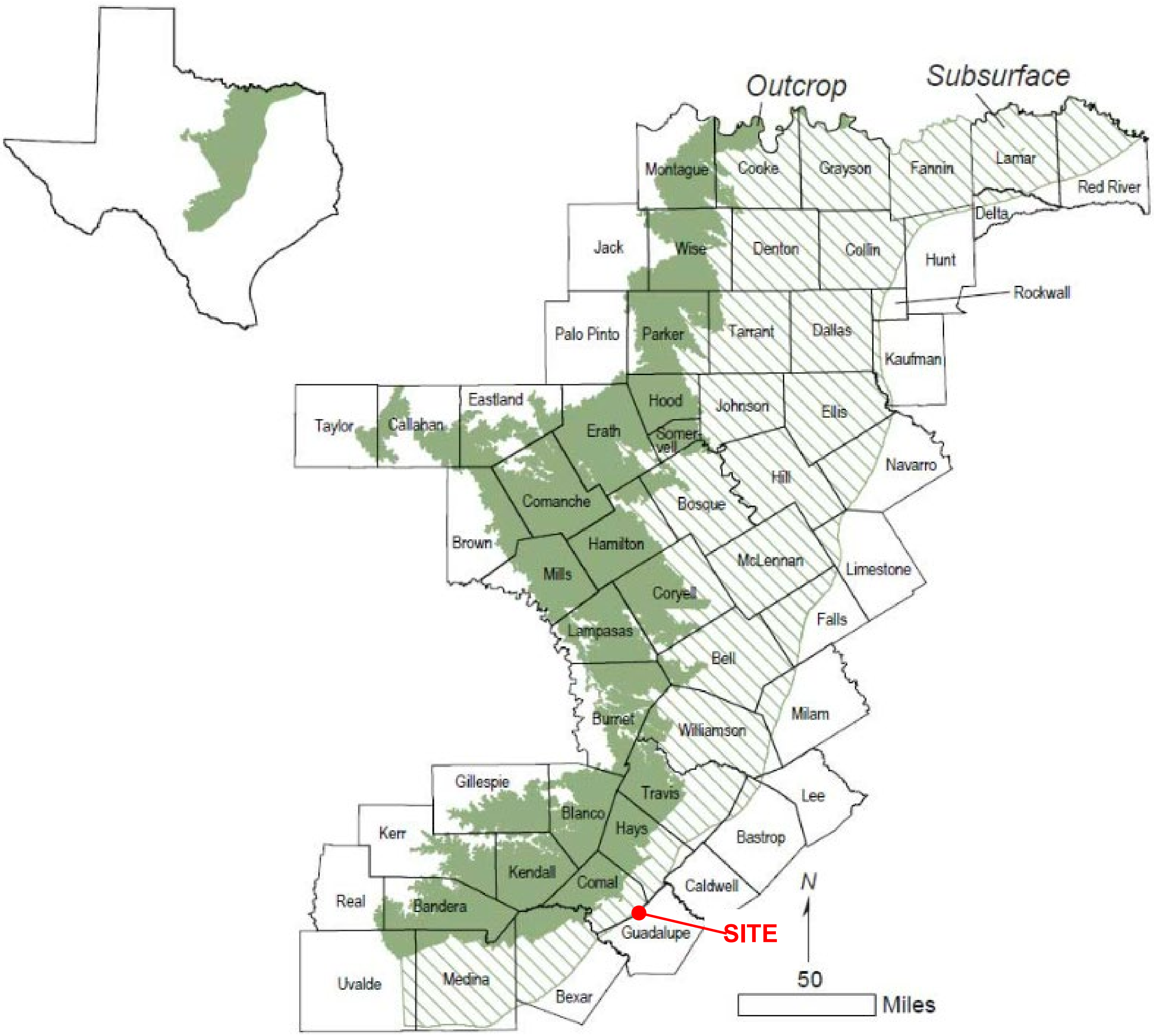

Figure 4-2. Map of Trinity Aquifer [from TWDB, George et al. (2011)]

4.1 Edwards Aquifer

The principal perennial aquifer in the region is the Edwards Aquifer (Balcones Fault Zone). The Edwards Aquifer comprises the Edwards Group Limestone and the overlying Georgetown Formation limestone. As shown on Figure 4-1, the nearest portion of the Edwards Aquifer is approximately 4 miles or more northwest of the Site (i.e., the outcrop, or recharge zone). The TWDB-mapped extent of this regional aquifer is not present beneath the Site, even though the Edwards formations continue in the subsurface beneath the Site, dipping to the southeast under confined conditions.

The aquifer is primarily recharged via infiltration along the outcrop of the formations approximately 4 miles or more northwest of the Site. There, in the Balcones Fault Zone, a series of faults have exposed the aquifer at the surface. Approximately 85% of surface recharge to the aquifer is derived from streams draining the Edwards Plateau (Hamilton et al., 2004). These streams lose all or most of their base-flow as they cross the recharge zone, where stream beds are composed of porous and fractured limestone. The remaining 15% of surface recharge is derived from direct precipitation on the recharge zone (Hamilton et al., 2004).

The flow system of the Edwards aquifer is complex, particularly during periods of heavy recharge to the aquifer or discharge from the aquifer. Water levels are typically highest in the spring and then decline during the summer before rebounding in the fall and winter (Hamilton et al., 2004). The aquifer may reach more average conditions of equilibrium during winters when the recharge and discharge are small. A published potentiometric surface map for the Edwards Aquifer was presented by Maclay and Small (1986) and is based on July 1974 water levels (see Drawing 4A-6). An updated potentiometric surface map of the Edwards Aquifer was published by Lindgren et al. (2004) using 2001 potentiometric data, and is presented in Drawing 4A-7. As shown, groundwater flow direction in the Edwards Aquifer, while variable, is generally to the northeast in the unconfined (recharge) areas in the general area.

In the region, the Edwards Aquifer is under both unconfined and confined conditions, depending on location, and contains both a fresh water and saline water zone, the interface of which is known as the "bad-water" line. The bad-water line is determined by the concentration of total dissolved solids (TDS) in the groundwater. The fresh-water zone up-dip from this boundary is defined where TDS concentrations are less than 1,000 milligrams per liter (mg/L), and the saline zone down-dip from the boundary is defined where TDS concentrations exceed 1,000 mg/L. The saline portion of the aquifer formations have water of marginal quality for usage. Additional characteristics of the Edwards Aquifer are presented below in Table 4-2.

The Site is down-dip from the bad-water line in an area where the subsurface Edwards formations are confined and the water is characterized as saline with high sulfate and dissolved solids concentrations (Maclay and Small, 1986) (i.e., the Site is on the "bad water" side of the aquifer). At the Site, the top of the Edwards formations are approximately 500 to 600 feet below ground surface (ft bgs) (see Table 4-1 and Drawing 4A-3). Here, the upper Glen Rose Formation and Del Rio Formation serve as lower and upper confining layers, respectively. As described by Maclay and Small (1986), the upper Glen Rose Formation generally has little vertical permeability and is a confining bed, with vertical groundwater movement restricted by marls with negligible permeability. The Del Rio Formation also has little permeability as it is composed of clay and includes beds of thin, nearly impermeable limestone in the lower portion of the unit. Furthermore, the formations above the Glen Rose at the Site include overlying low-permeability and non-water-bearing strata (including but not limited to the clays/claystones of the Taylor Group). As such, the Edwards formations are confined above and below, and not hydraulically connected to any other aquifer beneath the Site.

4.2 Trinity Aquifer

Formations attributed to the middle Trinity Aquifer (lower Glen Rose Limestone, Hensell Sand, Cow Creek Formation) are present in the general Site area, further below (i.e., deeper than) the Edwards Aquifer. As shown on Figure 4-2, the closest portion of the Trinity Aquifer to the Site is the subsurface zone located near the northwestern tip of the facility permit boundary and in locations further west-northwestward in the central Texas Hill Country. The TWDB-mapped extent of this regional aquifer is not present beneath the Site, even though the Trinity formations continue to dip to the southeast under confined conditions. Relative to the Edwards Aquifer, only limited amounts of groundwater in Comal and Guadalupe Counties have been obtained from the Cow Creek Formation and the lower section of the Glen Rose Limestone underlying the Edwards Aquifer (Maclay and Small, 1986). As noted above, the Glen Rose Limestone generally has little permeability, and vertical movement is restricted by marls with negligible permeability. This maintains a lack of hydraulic connection between the overlying Edwards Aquifer and underlying Trinity Aquifer formations in the Site area. Additional characteristics of the Trinity Aquifer are presented below in Table 4-2.

TABLE 4-2
HYDRAULIC PROPERTIES OF REGIONAL AQUIFERS IN SITE VICINITY
from George et al. (2011); Maclay and Small (1986); Jones et al. (2011); Kelley et al. (2014)

Parameter	Edwards Aquifer (Major Aquifer)	Trinity Aquifer (Major Aquifer) [“Hill Country” portion near Site]
Composition	Limestone, dolomite, marl	Limestone, marl, sand, shale
Transmissivity (typical range)	$1.2 \times 10^6 - 1.6 \times 10^6$ ft^2/d	$100 - 5.8 \times 10^4$ ft^2/d
Hydraulic Conductivity (typical range)	50 – 1,000 ft/d	5 – 150 ft/d
Water Table/Confined	Confined	Confined
Aquifer Interconnectivity	None (Maclay and Small, 1986)	None (Maclay and Small, 1986)
Regional Water Table or Potentiometric Surface Map	See Drawing 4A-6 and 4A-7 in Attachment 4A	Not provided
Groundwater Flow Rate (typical range)	2 – 31 ft/d	Published flow velocity data of aquifer in Site area not available (estimated spring discharges in northwest Comal Country over 20 miles away from Site are about 150-300 gpm).
Water Quality	Slightly to moderately saline	Slightly to moderately saline
Total Dissolved Solids (typical range)	1,000 – 5,000 mg/L	1,000 – 3,000 mg/L
Areas of Recharge Within 5-Miles	Edwards Aquifer recharge zone (outcrop) at ≥ 4 miles west-northwest of Site	None
Present Primary Use of Groundwater Within 5-Miles	Public Supply, Domestic, Irrigation	None within 5-miles
Identification of Water Wells Within 1-Mile	Two (2) unused & abandoned wells (See Drawing 4A-8 in Attachment 4A)	None

Notes: ft^2/d = feet squared per day; ft/d = feet per day; mg/L = milligrams per liter.

4.3 Other Aquifers

For information, it is also noted that according to the TWDB, the outcrop (i.e., recharge zone) of the Carrizo-Wilcox Aquifer occurs in southeastern portions of Guadalupe County, more than approximately nine (9) miles away from the Site. The Site is not above or near the outcrop (recharge) zone or subsurface zone of the Carrizo-Wilcox Aquifer, nor the recharge zone of any other aquifer classified by the TWDB as a major or minor aquifer of Texas. The published regional geologic map shows the presence of the Leona Formation (a Quaternary sand, silt, and gravel alluvial formation) over 1,200 ft south of the Site. While this formation is not a TWDB recognized aquifer, there are a few shallow water wells completed in gravels of this formation in the general area (discussed in the next section of this report), indicating that it is a local aquifer south of the Site.

4.4 Nearby Well Information and Local Groundwater Use

4.4.1 Water Wells and Local Groundwater Usage

A water well search of the available records from the TWDB and the Texas Commission on Environmental Quality (TCEQ) revealed that a total of nine (9) water wells were located within a one-mile radius of the facility permit boundary. The locations of these wells are shown on Drawing 4A-8; as shown, one water well (unused/abandoned) is located on-site in the southern portion of the expansion area, and there are no other water wells within 500-ft of the Site. Information about each of the nearby wells within one mile of the facility, including the type of well (i.e., groundwater usage) is summarized below in Table 4-3.

TABLE 4-3
WATER WELLS WITHIN A ONE-MILE RADIUS OF THE SITE

Map ID	Depth Drilled (ft bgs)	Type of Well	Completion Material/Formation[1]
6824301	650	Unused/Abandoned	Edwards
6824302	600	Oil Test Well (Unused/Abandoned)	Edwards
6824303	Not reported	Domestic, Stock	Gravel (Leona)
6824304	38	Domestic, Stock, Irrigation	Gravel (Leona)
6824305	32	Domestic, Stock	Gravel (Leona)
68-24-3	44	Domestic	Gravel (Leona)
291255	56	Domestic	Leona
68-24-2A	100	Domestic	Limestone (unknown, possibly claystones of Taylor Group)
6824610	36	Domestic	Gravel (Leona)

Note:

1. Completion formation was not reported on the State of Texas well logs, but was inferred based on drilled depth, material description (if noted), and local hydrogeology.

Of these nearby wells, the predominant groundwater usage locally is from wells south of the Site in shallow gravel deposits likely to be part of the Leona Formation, which is not present on-site. The two (2) deep wells drilled to the Edwards Aquifer as noted in Table 4-3 are unused and appear to have been abandoned, which is consistent with their locations being on the "bad-water" side of the aquifer where the water quality is saline and typically unusable for domestic, stock, or irrigation.

4.4.2 Oil and Gas Wells Within One Mile

An oil and gas well search was conducted by reviewing available records from the Railroad Commission of Texas (RRC). There are no known oil and gas wells on-site or within 500-ft of the facility, nor are they any known active oil and gas wells within a one-mile radius of the facility permit boundary. As shown on Drawing 4A-8, RRC records show is one oil and gas well (Map ID 187) located along Schwarzlose Road approximately 2,500 ft southeast of the Site; the wellhead could not be located by pedestrian survey, confirming it is inactive or otherwise may have been plugged/abandoned.

5. SUBSURFACE INVESTIGATION REPORT

5.1 Drilling and Sampling

Investigations of subsurface geology and geotechnical conditions at the Site have been conducted over time as described in the following sections of this report. Boreholes advanced at the Site are summarized in Table 4-4 below. Additionally, the location of each borehole is presented on Drawing 4A-9A and 4A-9B and the boring logs are included in Attachment 4C. Results of laboratory tests performed on samples as part of these investigations to characterize the geotechnical properties of the subsurface strata can be found in the Geotechnical Report (Part III, Attachment 3D.1).

TABLE 4-4
SUMMARY OF BORINGS

Boring	Northing[3]	Easting[3]	Surface Elevation (ft, MSL)	Total Depth of Boring (ft)	Bottom of Boring Elevation (ft, MSL)	Depth Below EDE[1] (ft)	Drilled by[2]
Unit 1 Area							
CB-1	13818690.8	2274791.0	670.0	60.0	610.0	-50.0	MRA [1987]
CB-2	13817699.1	2275753.2	623.0	40.0	583.0	-23.0	MRA [1987]
CB-3	13817202.0	2277006.0	632.0	60.0	572.0	-12.0	MRA [1987]
CB-4	13816510.4	2277509.9	604.0	60.0	544.0	16.0	MRA [1987]
CB-5	13817118.0	2278151.8	605.0	60.0	545.0	15.0	MRA [1987]
B-6/P-6	13817869.5	2277502.9	638.0	80.0	558.0	2.0	MRA [1987]
B-7/P-7	13818645.6	2276699.7	664.0	80.0	584.0	-24.0	MRA [1987]
B-8	13818827.8	2275873.5	638.0	80.0	558.0	2.0	MRA [1987]
B-9	13818810.5	2275359.3	640.0	80.0	560.0	0.0	MRA [1987]
B-10/P-10	13818187.4	2275250.2	642.0	80.0	562.0	-2.0	MRA [1987]
B-11	13818273.3	2275758.9	628.0	75.5	552.5	7.5	MRA [1987]
B-12	13817701.1	2276456.4	642.0	80.0	562.0	-2.0	MRA [1987]
B-13	13817132.6	2276308.5	626.0	80.0	546.0	14.0	MRA [1987]
B-14/P-14	13816748.3	2276753.3	604.0	50.0	554.0	6.0	MRA [1987]
B-15	13817062.0	2277640.3	606.0	80.0	526.0	34.0	MRA [1987]
PZ-1	13818483.1	2276848.2	662.6	57.0	605.6	-45.6	MFG [1990]
PZ-2	13818510.9	2275457.0	633.2	70.5	562.7	-2.7	MFG [1990]
PZ-3	13818828.2	2275991.9	643.9	32.5	611.4	-51.4	MFG [1990]
PZ-4	13817665.5	2277682.0	627.5	50.4	577.1	-17.1	MFG [1990]
PZ-5	13817073.4	2277530.2	614.0	51.4	562.6	-2.6	MFG [1990]
GP-1	13818826.2	2275954.2	641.9	24.0	617.9	-57.9	FM [1991]
GP-2	13818783.0	2276542.2	662.8	35.0	627.8	-67.8	FM [1991]
GP-3	13817930.8	2277413.0	641.0	22.0	619.0	-59.0	FM [1991]
GP-4	13817122.7	2278237.6	602.8	36.0	566.8	-6.8	FM [1991]
GP-5	13816548.8	2277564.5	602.5	37.0	565.5	-5.5	FM [1991]
GP-6	13817111.4	2276368.4	623.9	44.0	579.9	-19.9	FM [1991]

TABLE 4-4
SUMMARY OF BORINGS

Boring	Northing[3]	Easting[3]	Surface Elevation (ft, MSL)	Total Depth of Boring (ft)	Bottom of Boring Elevation (ft, MSL)	Depth Below EDE[1] (ft)	Drilled by[2]
PZ-6	13816630.1	2277407.7	602.7	24.0	578.7	-18.7	MFG [1991]
PZ-7	13816846.0	2277914.4	601.7	28.0	573.7	-13.7	MFG [1991]
PZ-8	13816851.8	2277922.8	600.7	63.5	537.2	22.9	MFG [1991]
PZ-9	13817410.2	2276071.5	621.9	56.0	565.9	-5.9	MFG [1991]
PZ-10	13817418.6	2276066.0	622.0	80.0	542.0	18.0	MFG [1991]
PZ-11	13818288.0	2277059.1	659.7	50.0	609.7	-49.7	MFG [1991]
PZ-12	13818280.2	2277068.5	660.1	68.0	592.1	-32.1	MFG [1991]
SB-1/MW-1	13818827.6	2276471.6	662.4	45.0	617.4	-57.4	SD [1992]
SB-2/MW-2	13817476.5	2277889.5	615.6	35.0	580.6	-20.6	SD [1992]
SB-3/MW-3	13816695.3	2277745.6	603.5	34.0	569.5	-9.5	SD [1992]
SB-4/MW-4	13816747.5	2276733.9	605.3	30.0	575.3	-15.3	SD [1992]
SB-5/MW-5	13818768.9	2274725.7	670.5	60.0	610.5	-50.5	SD [1992]
PZ-1M	13817724.3	2277295.5	644.2	45.0	599.2	-39.2	SD [1992]
SB-6/MW-6	13817972.8	2275468.2	632.9	63.5	569.4	-9.4	REI [1995]
GP-6R	13817050.8	2276398.8	623.5	43.3	580.2	-20.2	REI [1995]
Investigations Generally Covering the Existing Unit 2 Area							
GB-01	13816876.5	2278393.2	595.4	95.0	500.4	83.6	GC [2004]
GB-02	13816525.6	2277962.4	599.5	70.5	529.0	55.0	GC [2004]
GB-03	13815970.6	2277506.7	607.7	104.5	503.2	80.8	GC [2004]
GB-04	13814602.4	2278766.5	668.2	145.0	523.2	60.8	GC [2004]
GB-05	13815229.1	2279182.7	640.5	115.0	525.5	58.5	GC [2004]
GB-06	13815883.3	2279871.8	646.0	124.0	522.0	62.0	GC [2004]
GB-07	13816405.0	2278500.4	602.9	59.0	543.9	40.1	GC [2004]
GB-08	13816002.2	2278101.0	623.8	71.5	552.3	31.7	GC [2004]
GB-09	13815699.8	2279256.0	638.7	89.0	549.7	34.3	GC [2004]
GB-10	13815451.5	2278556.9	648.7	99.0	549.7	34.3	GC [2004]
GB-11	13815865.0	2278665.3	617.2	90.0	527.2	56.8	GC [2004]
GB-12	13815351.5	2278055.8	639.6	119.0	520.6	63.4	GC [2004]
GB-13	13816271.9	2279036.3	618.8	95.0	523.8	60.3	GC [2004]
GB-14	13815300.7	2279853.7	679.8	136.0	543.8	40.2	GC [2004]
GB-15/MW-16	13815626.5	2280863.5	643.4	144.0	499.4	84.6	GC [2004]
GB-16	13815064.2	2280568.1	679.5	139.0	540.5	43.5	GC [2004]
GB-17	13814631.0	2280885.4	654.4	134.0	520.4	63.6	GC [2004]
GB-18	13814753.6	2280137.3	694.2	149.0	545.2	38.8	GC [2004]
GB-19	13814291.2	2279905.5	688.7	150.0	538.7	45.3	GC [2004]
GB-20	13814134.9	2279345.2	675.9	169.0	506.9	77.1	GC [2004]
GB-21	13813671.2	2280075.2	709.0	187.0	522.0	62.0	GC [2004]
GB-22	13814811.4	2279501.0	656.5	140.0	516.5	67.5	GC [2004]
GB-23	13814122.2	2280492.8	689.5	185.0	504.5	79.5	GC [2004]

TABLE 4-4
SUMMARY OF BORINGS

Boring	Northing[3]	Easting[3]	Surface Elevation (ft, MSL)	Total Depth of Boring (ft)	Bottom of Boring Elevation (ft, MSL)	Depth Below EDE[1] (ft)	Drilled by[2]
GB-24	13815567.3	2280399.1	677.5	155.0	522.5	61.5	GC [2004]
GP-7	13817956.2	2275490.2	632.0	22.0	610.0	-26.0	GC [2005]
MW-7	13816870.1	2277942.3	589.8	40.0	549.8	34.2	MFG [2006]
MW-8	13816463.6	2277485.6	588.8	40.0	548.8	35.2	MFG [2006]
GP-5A	13815940.0	2277535.0	609.1	52.0	557.1	26.9	GC [2009]
GP-8	13816.6	2277112.0	605.3	49.0	556.3	27.7	GC [2009]
GP-9	13817505.0	2275964.0	625.0	48.0	577.0	7.0	GC [2009]
GP-10	13818348.0	2276992.0	663.9	47.5	616.4	-32.4	GC [2009]
GP-11	13817459.0	2277906.0	615.9	57.0	558.9	25.1	GC [2009]
GP-12	13816475.0	2278886.0	610.0	31.0	579.0	5.0	GC [2009]
GP-13	13816023.0	2279585.0	639.9	62.0	577.9	6.1	GC [2009]
GP-20	13814695.0	2278675.0	664.2	65.0	599.2	-15.2	GC [2009]
GP-21	13815429.0	2277985.0	637.8	49.0	588.8	-4.8	GC [2009]
MW-2A	13817069.0	2278162.0	609.0	37.0	572.0	12.0	GC [2009]
MW-7A	13816498.0	2277256.0	603.4	27.0	576.4	7.6	GC [2009]
MW-8A	13817143.0	2276302.0	625.5	55.0	570.5	13.5	GC [2009]
MW-9	13817565.0	2275906.0	626.0	50.0	576.0	8.0	GC [2009]
MW-10	13814602.0	2278767.0	670.5	57.0	613.5	-29.5	GC[2009]
MW-11	13814064.0	2279299.0	679.0	63.0	616.0	-32.0	GC [2009]
MW-18	13815985.8	2279745.5	635.1	60.0	575.1	8.9	GC [2009]
MW-19	13816167.0	2279219.0	633.2	55.0	578.2	5.8	GC [2009]
MW-20	13816584.0	2278784.0	606.3	40.0	566.3	17.7	GC [2009]
MW-21	13816481.0	2278358.0	606.8	43.0	563.8	20.2	GC [2009]
MW-22	13816113.0	2278083.0	612.2	37.0	575.2	8.8	GC [2009]
MW-23	13816006.0	2277841.0	621.2	35.0	586.2	-2.2	GC [2009]
GP-14	13815798.2	2280540.8	657.7	56.0	601.7	-17.7	TT [2013]
GP-19	13814102.7	2279257.6	676.5	56.0	620.5	-36.5	TT [2013]
GP-15	13815411.4	2280910.4	637.7	33.0	604.7	-20.7	TT [2016]
MW-17	13815851.0	2280330.0	655.4	63.0	592.4	-8.4	TT [2016]
GP-16	13814396.7	2280879.4	654.8	31.5	623.3	-39.3	TT [2018]
GP-17	13813948.3	2280401.6	699.8	77.5	622.3	-38.3	TT [2018]
GP-18	13813461.0	2279899.2	708.7	75.0	633.7	-49.7	TT [2018]
MW-12	13813666.3	2280080.1	709.3	76.0	633.3	-49.3	TT [2018]
MW-13	13814058.7	2280515.9	688.7	56.0	632.7	-48.7	TT [2018]
MW-14	13814514.5	2280890.1	654.0	57.5	596.5	-12.5	TT [2018]
MW-15	13815072.8	2280885.4	647.2	53.0	594.2	-10.2	TT [2018]
MW-4A	13813671.2	2280075.2	609.4	30.0	579.4	4.6	BBA [2020]

TABLE 4-4

SUMMARY OF BORINGS

Boring	Northing[3]	Easting[3]	Surface Elevation (ft, MSL)	Total Depth of Boring (ft)	Bottom of Boring Elevation (ft, MSL)	Depth Below EDE[1] (ft)	Drilled by[2]
Investigations Generally Covering the Unit 2 Expansion Area							
GB-25	13813774.9	2280750.8	661.7	87.0	574.7	35.3	GC [2022-2023]
GB-26	13813561.9	2280316.8	702.3	102.0	600.3	9.7	GC [2022-2023]
GB-27	13813170.6	2280703.6	662.4	113.0	549.4	60.6	GC [2022-2023]
GB-28	13814021.3	2279217.2	685.2	85.0	600.2	9.8	GC [2022-2023]
GB-29	13813630.3	2279604.1	712.2	112.0	600.2	9.8	GC [2022-2023]
GB-30	13813239.2	2279990.9	696.1	96.0	600.1	9.9	GC [2022-2023]
GB-31	13812797.3	2280376.2	669.0	69.0	600.0	10.0	GC [2022-2023]
GB-32	13812557.9	2280894.4	651.9	77.0	574.9	35.1	GC [2022-2023]
GB-33	13813500.9	2278691.2	702.2	153.0	549.2	60.8	GC [2022-2023]
GB-34	13813081.8	2279095.1	711.0	142.0	569.0	41.0	GC [2022-2023]
GB-35	13812718.9	2279464.8	709.7	110.0	599.7	10.3	GC [2022-2023]
GB-36	13812327.8	2279851.6	681.8	107.0	574.8	35.2	GC [2022-2023]
GB-37	13811937.0	2280238.4	668.8	120.0	548.8	61.2	GC [2022-2023]
GB-38	13812980.5	2278165.1	707.6	133.0	574.6	35.4	GC [2022-2023]
GB-39	13812552.5	2278572.8	707.4	115.0	592.4	17.6	GC [2022-2023]
GB-40	13812198.5	2278938.7	693.0	144.0	549.0	61.0	GC [2022-2023]
GB-41	13811767.5	2279327.5	676.8	77.0	599.8	10.2	GC [2022-2023]
GB-42	13811416.4	2279712.4	663.2	88.0	575.2	34.8	GC [2022-2023]
GB-43	13812460.1	2277639.1	709.3	109.0	600.3	9.7	GC [2022-2023]
GB-44	13812069.0	2278025.9	711.7	137.0	574.7	35.3	GC [2022-2023]
GB-45	13811716.4	2278424.5	711.5	112.0	599.5	10.5	GC [2022-2023]
GB-46	13811287.2	2278799.4	685.2	110.0	575.2	34.8	GC [2022-2023]
GB-47	13810896.1	2279186.2	670.9	71.0	599.9	10.1	GC [2022-2023]
GB-48	13811939.7	2277113.0	707.9	159.0	548.9	61.1	GC [2022-2023]
GB-49	13811548.7	2277499.8	703.2	103.0	600.2	9.8	GC [2022-2023]
GB-50	13811157.6	2277886.6	688.6	114.0	574.6	35.4	GC [2022-2023]
GB-51	13810766.7	2278273.4	676.5	76.0	600.5	9.5	GC [2022-2023]
GB-52	13810376.6	2278659.2	667.6	119.0	548.6	61.4	GC [2022-2023]

[SEE NEXT PAGE FOR TABLE 4-4 NOTES]

Table 4-4 Notes:

1. EDE = Elevation of Deepest Excavation. Negative values indicate depth above the EDE. The EDEs specific to each area, used as the basis for this table, are presented below. For the Unit 2 expansion area, the basis for the depths of new borings in the approved Soil Boring Plan were based on a preliminary estimate of the deepest planned excavation in the expansion area. However, the subsequent landfill design prepared for this area of the Site (as presented in this permit amendment application) will result in a shallower actual landfill excavation depth. Thus, the elevation listed below is the drilling basis EDE, and not the actual landfill design EDE for the Unit 2 expansion area.
    a. Existing Unit 1 approximate EDE (including sumps) = 560 ft, MSL
    b. Existing Unit 2 approximate EDE (including sumps) = 584 ft, MSL
    c. Unit 2 Expansion Area preliminary design-basis EDE = 610 ft, MSL
2. MRA = McBride-Ratcliff and Associates; MFG = McCulley, Frick & Gilman; SD = SEC Donahue; REI = Rust E&I; FM = Fugro-McClelland; GC = Geosyntec Consultants, Inc.; TT = TetraTech; BBA = Bullock, Bennett & Associates
3. Coordinates refer to Texas State Plane, North American Datum (NAD)-83, Texas Central Zone.

5.1.1 Geosyntec 2022-2023 Subsurface Investigation

A field subsurface exploration program to investigate the geotechnical and hydrogeologic characteristics of the expansion area of the Site was conducted by Geosyntec between and December 2022 and February 2023 (with ongoing water level monitoring thereafter), in accordance with the Soil Boring Plan approved by TCEQ on 4 October 2022. A copy of the approved Soil Boring Plan is provided in Attachment 4B of this report. Per the approved Soil Boring Plan, 28 borings were drilled to investigate and characterize the subsurface of the expansion area (see above Table 4-4):

- all 28 borings were drilled to at least five (5) ft below elevation 610 ft, MSL (the basis for the depths of new borings in the approved Soil Boring Plan based on a preliminary estimate of the deepest planned excavation in the expansion area, even though the subsequent landfill design prepared for this area of the Site as presented in this permit amendment application) will result in a shallower landfill excavation depth);
- 15 of 28 borings were drilled to at least 30 ft below elevation 610 ft, MSL; and
- of the 15 deeper borings, six (6) were drilled to a depth of at least 30-ft below the existing Unit 2 elevation of deepest excavation (EDE) of 584 ft, MSL.

Consistent with 30 TAC §330.63(e)(4)(B) and the approved Soil Boring Plan, the borings were sufficiently deep to allow identification of the uppermost aquifer and the aquiclude at the lower boundary (with no interconnected aquifers identified).

30 TAC §330.63(e)(4)(B) further notes that aquifers more than 300 ft below the EDE and where travel times for constituents to the aquifer are in excess of 30 years plus the estimated life of the Site need not to be identified by borings. According to published TWDB maps, there are no usable regional or local aquifers beneath the Site – as described in Section 4, and given the poor water quality of formations associated with the Edwards Aquifer beneath the Site; and the much deeper confined and not hydraulically connected Trinity formations. The first perennial aquifer below

the Site is the Edwards Aquifer, as described in Section 4.1, whose water-bearing formations are located approximately 500 to 600-ft below ground surface (i.e., more than 400-ft below the overall facility EDE of elevation 560 ft, MSL which occurs in the now complete and final-covered Unit 1). As part of this investigation, no soil borings were advanced to the top of the Edwards formations based on: (i) the sufficiency of regional data that exists to accurately locate the formation; and (ii) the low-permeability confining formations that separate the bottom of the facility from the Edwards Aquifer; and (iii) studies that indicate groundwater in this part of the Edwards Aquifer does not recharge from above; instead it is recharged from areas northwest of the Site.

The 28 borings of Geosyntec's 2022-2023 subsurface exploration program, designated as Borings B-25 through B-52, were drilled to depths ranging from 69 ft bgs to 159 ft bgs using established field exploration methods. Specifically, the borings were advanced using a combination of (i) 6-inch diameter hollow-stem auger; and (ii) and 2-inch (approx.) diameter NQ/NQ2 coring. Samples were collected using a combination of Shelby tubes, split spoons, and NQ/NQ2 core barrels. Additionally, pocket penetrometer and standard penetration tests (SPTs) were performed in the field. Lithology was logged by a qualified geologist or engineer in accordance with 30 TAC §330.63(e)(4) and consistent with established description procedures. After completing the drilling and sampling at each boring, the borehole was plugged in accordance with appropriate rules, namely in accordance with the abandonment requirements in 16 TAC §76.72 and the plugging standards in 16 TAC §76.104 (as applicable).

As noted in Table 4-7, no groundwater was observed during drilling in any of the recent borings. Also, after-equilibrium (i.e., static) groundwater level measurements in the boreholes were not possible for this program because of the wet coring/wash rotary methods used during drilling; however, piezometers were installed to obtain static/ongoing groundwater levels at select locations – providing an indication of longer term static/after-equilibrium groundwater levels in the area investigated. Specifically, piezometers were installed at twelve (12) of the boring locations (GB-25, GB-30, GB-32, GB-33, GB-35, GB-37, GB-39, GB-41, GB-45, GB-48, GB-50, and GB-52). These are described in more detail in Section 7. Monitor Well Data Sheets for the newly installed piezometers are provided in Attachment 4D.

5.1.2 Previous Site Investigations

The Mesquite Creek Landfill has been characterized based on a number of previous investigations at the Site over time, as summarized below in chronological order.

- In 1987, 15 borings (CB-1 to CB-5; B-6 to B-15) were drilled at the Site by McBride-Ratcliff to characterize the stratigraphy and assess the soils for use as in-situ or constructed liners (Hydro-Search and MFG, 1990, revised 1991). Piezometers were installed in four of the borings.

- Between April 1990, September 1991, and October 1991, McCulley, Frick, and Gilman (MFG) installed a total of 12 piezometers (PZ-1 to PZ-12). The data from the piezometers would be used to develop a groundwater monitoring system for the Site (Geosyntec, 2006).
- In 1991, Fugro-McClelland installed 6 gas monitoring probes (GP-1, GP-2, GP-3, GP-4, GP-5, GP-6).
- In February 1992, SEC Donohue installed five (5) groundwater monitoring wells (MW-1, MW-2, MW-3, MW-4, and MW-5) and one (1) piezometer (PZ-1M) at the Site.
- One (1) additional groundwater monitoring well (MW-6), and one (1) replacement gas monitoring probe (GP-6R) were installed in November 1995 by Rust E&I.
- In 2004, 24 borings (GB-1 through GB-24) were drilled at the Site by Geosyntec as a part of a soil boring plan associated with the permit amendment application MSW-66B. Fifteen (15) piezometers were installed during this investigation at the corresponding boring locations of: GB-01, GB-02, GB-03, GB-04, GB-05, GB-06, GB-09, GB-11, GB-12, GB-13, GB-15, GB-17, GB-20, GB-21 and, GB-22.
- In October 2005, Geosyntec installed one (1) gas monitoring probe (GP-7).
- In March 2009, Geosyntec installed nine (9) gas monitoring probes (GP-5A, GP-8 through GP-13, GP-20 and GP-21) and eleven (11) groundwater monitoring wells (MW-2A, MW-7A, MW-8A, MW-9, MW-11, MW-18 TO MW-23).
- In December 2013, Tetra Tech installed two (2) gas monitoring probes (GP-14 and GP-19).
- In January 2016, Tetra Tech installed one (1) gas monitoring probe (GP-15) and one (1) groundwater monitoring well (MW-17).
- In April 2018, Tetra Tech installed three (3) gas monitoring probes (GP-16, GP-17, GP-18) and three (3) groundwater monitoring wells (MW-13, MW-14, MW-15) at the Site. Also, one (1) groundwater monitoring well (MW-12) was installed in May 2018 to replace the previous MW-12 which had been using the GB-21 location.
- In 2020, Bullock, Bennett & Associates, LLC installed one (1) groundwater monitoring well (MW-4A) to replace monitoring well MW-4.

5.2 Site Stratigraphy and Structure

Eight (8) geologic cross-sections were developed for this Geology Report based on observations and conclusions interpreted from borehole logs, from the previously-described subsurface investigations, and from the findings from Geosyntec's 2022-2023 site investigation. Drawing 4A-10 presents a plan view of the locations where the cross-sections are located, and the geologic cross-sections are presented on Drawings 4A-11 through 4A-16. Based on the data and consistent with past characterizations, the subsurface stratigraphy at the Site has been subdivided into four strata referred to as Stratum I through IV. The generalized Site stratigraphy of the subsurface strata is summarized in Table 4-5 below and is discussed in more detail subsequently. Hydrogeologic characteristics of these strata are addressed in Section 7.

TABLE 4-5
GENERALIZED SITE STRATIGRAPHY

Stratum	Geologic Description	Physical Description	Thickness (ft)
Stratum I	Surficial soil layer (fine-grained Quaternary weathered deposits)	Brown to dark gray, medium to high plasticity clay (with occasional thin gravelly zones), stiff to hard in consistency	0 – 14.5
Stratum II	Quaternary-Tertiary alluvium (possibly equivalent to Uvalde Gravel)[1]	Dark brown clay matrix with white or gray limestone and/or chert gravel, clayey gravel to gravelly clay, commonly cemented by caliche, firm in consistency	0 – 16
Stratum III	Weathered Lower Taylor Group (Clay)	Brownish yellow to light gray calcareous clay, weathered and oxidized very stiff to hard in consistency	13.5 – 73.5
Stratum IV	Unweathered Lower Taylor Group (Claystone)	Green to dark gray calcareous claystone, unweathered/ unoxidized, very hard in consistency	Note 1

Notes:
1. Site borings did not completely penetrate Stratum IV because the drilling depths terminated before the bottom of the stratum was reached. The maximum thickness that has been investigated at the Site to-date is approximately 130 ft into Stratum IV. Stratum IV is part of the Lower Taylor Group that is estimated to be approximately 290-ft thick beneath the Site. Stratum IV acts as an aquiclude that confines groundwater (to the extent present) above it and prevents hydraulic interconnection with deeper aquifers.

From the Site data, Strata I and II were not found at all areas of the Site. Strata III and IV are continuously present across the Site (present beneath all investigated locations). The top and bottom surfaces of Stratum III generally mimic the surface topography. Structure maps (Top of Stratum III and Top of Stratum IV contour maps) are provided as Drawings 4A-17 and 4A-18.

5.2.1 Stratum I: Fine-Grained Quaternary Soil Deposits

Stratum I is typified by an unsaturated brown to dark gray, medium to high plasticity clay, which is stiff to hard in consistency. At the ground surface, the material appearance is that of a rich clayey topsoil typical of the Blackland Prairie of this area. The cross-sections (Drawings 4A-11 to 4A-16) indicate that, prior to landfill development, Stratum I was mostly present across the Site, though sometimes not encountered in the Unit 2 existing and proposed expansion areas. Within the footprint of the existing landfill, Stratum I has been completely removed by landfill development. Similarly, the planned depth of the phases in the expansion area will completely remove Stratum I from within the footprint of the Unit 2 landfill expansion area. Hydrogeologic characteristics of this stratum are addressed in Section 7.

5.2.2 Stratum II: Quaternary-Tertiary Alluvium

Stratum II is a surficial layer of pebble to cobble-sized chert and limestone embedded within a soil matrix of dark brown clay (and commonly cemented by caliche). Under natural (pre-development) conditions, this stratum was sporadically absent or present across the existing Site; but is notably present on the natural topographic ridges (highs) along much of the east-southeastern portions of the Unit 2 area. These observations correlate well to Collins' (2000) descriptions and mapped extent of alluvial outcrops along topographic highs, possibly equivalent to the upper Tertiary-Quaternary Uvalde Gravel, in this part of the Site. It is also noted that in discrete areas associated with the Mesquite Creek stream and its tributaries, deposits of Quaternary alluvium are present – composed of silt, sand, gravel, and some clay. In previous site investigations and maintained in this permit amendment application for continuity, these localized, discrete alluvial deposits have been assigned to Stratum II based on similar geologic age and morphology. Similar to Stratum I, Stratum II (where present) has been completely removed by landfill development within the footprint of the existing landfill and will be completely removed within the footprint of the Unit 2 expansion area. Hydrogeologic characteristics of this stratum are addressed in Section 7.

5.2.3 Stratum III: Weathered Clay - Lower Taylor Group

Stratum III corresponds to weathered and oxidized Lower Taylor Group material (weathered into a clayey soil, and with thin bedding planes). A contour map of the top of Stratum III is included as Drawing 4A-17. As shown, the top of the Stratum III surface exhibits undulations, but generally follows a pattern that resembles natural surface topography. The base of Stratum III and top of Stratum IV is transitional as the material grades from being clay (soil-like) to claystone (rock-like). A color change from a lighter yellowish brown to green-gray to dark gray, with varying amounts of mottling (color variegation), provides evidence of the transition and downward limit of oxidation. The color change, presence, density of secondary features, and hardness were used as the markers for defining what was designated as the base of Stratum III for mapping and cross-section development purposes, and generally coincided with where the drilling methods switched from hollow stem augers to rock coring. Secondary features such as variations in cementation, and presence of high angle gypsum-filled clay fractures and calcite seams, are more prevalent near the bottom of Stratum III. Some of the fractures and calcite seams appeared to be water-bearing, or at least have the potential to transmit water, in contrast to the tighter (less fractured or weathered, more cemented and rock-like) Stratum IV claystone described subsequently. The base of the landfill is keyed-in to (i.e., founded within) Stratum III in a large majority of the landfill areas, with the few exceptions being localized instances where the base grades encountered and are founded on the upper portion of the Stratum IV claystone. Hydrogeologic characteristics of Stratum III are addressed in Section 7.

5.2.4 Stratum IV: Unweathered Claystone - Lower Taylor Group

Stratum IV corresponds to the homogenous, unweathered, primarily unoxidized, dry, green-gray to dark gray claystone of the Lower Taylor Group. A contour map of the top of Stratum IV is included as Drawing 4A-18. As shown, the top of Stratum IV surface exhibits undulations, but generally follows a pattern that resembles natural surface topography. Stratum III and Stratum IV are from the same geologic formation, and only differ based on their degree of oxidation and weathering. The Bottom of Stratum III / Top of Stratum IV for mapping and cross-section development was interpreted based on the aforementioned change in color, density of secondary features, and hardness. Stratum IV differed from Stratum III in that secondary features such as heterogeneous cementation; and presence of fractures, seams, and fissures; became less frequent at the interpreted top of Stratum IV (and decreasing in frequency with depth into Stratum IV where the claystone was harder, more massive, and more rock-like).

The deepest boring from Site subsurface investigations penetrated approximately 130 ft into this stratum at boring GB-23. Occasionally, deeper parts of the landfill base are founded on Stratum IV, but excavation into Stratum IV has generally been avoided (i.e., most of the liner grades are in Stratum III, above the top of Stratum IV, to the extent practicable). Hydrogeologic characteristics of this stratum are addressed in Section 7.

6. GEOTECHNICAL DATA

The geotechnical report, data, and analyses that address the information required by 30 TAC §330.63(e)(5) and that describe the geotechnical properties of the subsurface soil materials and presents conclusions about the suitability of the soils and strata for the uses for which they are intended are presented in Part III, Attachment 3D.

7. GROUNDWATER INVESTIGATION REPORT

This section provides the groundwater investigation report, which discusses groundwater occurrence at the Site and presents the hydrogeologic characteristics of the stratigraphic layers beneath the Site based on previous and recent site investigations.

7.1 Overview of Hydrogeologic Findings – Previous Site Investigations

Previous site investigations have been conducted under MSW Permits 66, 66A, and 66B as summarized in Section 5.1.2. The interpretation of these results (hydrogeologic site characterization) is provided in the Geology Report and Groundwater Characterization Report, both by Geosyntec (2005). Geosyntec's Groundwater Characterization Report (2005, last revised February 2021) also presents the groundwater monitoring system for the existing facility as approved by TCEQ in accordance with 30 TAC Chapter 330, Subchapter J under MSW Permit No. 66B. An overview of the hydrogeologic findings from previous site investigations is as follows:

- Strata I and II (recent fine-grained deposits and alluvium) are first encountered at the ground surface and are described as a dark gray to brown medium to high plasticity clay, and a clayey gravel to a gravelly clay, respectively. Previous site investigations have indicated that Strata I and II are consistently dry to moist (but in all cases, unsaturated). These strata have low hydraulic conductivity, and neither Stratum I nor Stratum II readily yield or transmit water (only small localized seeps have been occasionally observed during construction excavations). These strata have been entirely excavated and removed from within the landfill footprint. As such, their discontinuous nature and lack of a zone of saturation (groundwater) results in Strata I and II not behaving as, nor being designated as, the uppermost aquifer at the Site.

- Stratum III consists of weathered/oxidized clays of the Lower Taylor Group. The lower part of Stratum III exhibits a greater occurrence of secondary features (e.g., higher density of fractures, seams, and fissures), allowing it to contain and transmit groundwater. Notwithstanding this, Stratum III is a low-permeability formation even within its more fractured and potentially water-bearing zone, with investigations usually reporting initial observations of moist to dry soil and minimal notably wet or saturated material; there may not be a distinct, continuous zone of saturation within Stratum III.

- Groundwater is first encountered in the lower part of Stratum III, and piezometers and monitoring wells screened at the base of Stratum III generally contain sufficient quantities of groundwater for gauging and/or sampling and analysis purposes. As such, Stratum III is the groundwater-bearing zone where groundwater is first encountered at the Site, that has been designated under the current permit (66B) as the uppermost aquifer for the groundwater monitoring program. Groundwater occurs as unconfined conditions in the lower part of Stratum III, where it is perched above the lower confining unit (aquiclude) of the thick, massive, less-fractured, and very low permeability Stratum IV unweathered claystone.

The groundwater monitoring system in effect under MSW Permit No. 66B was developed and approved based on the hydrogeologic framework summarized above, and is described in more detail in Attachment 5 (Groundwater Monitoring Plan). In brief, the current Unit 1 system is composed of one (1) background upgradient monitoring well and seven (7) downgradient wells, and the current Unit 2 monitoring system is composed of two (2) background upgradient monitoring wells and twelve (12) downgradient wells – all of which are screened at the base of Stratum III.

7.2 Geosyntec (2022-2023) Site Investigation

Twelve (12) piezometers were installed in the expansion area as part of Geosyntec's 2022-2023 site investigation (GB-25(P), GB-30(P), GB-32(P), GB-33(P), GB-35(P), GB-37(P), GB-39(P), GB-41(P), GB-45(P), GB-48(P), GB-50(P), and GB-52(P)). The lithology of each boring was used to determine the screened intervals of the piezometers. The field observations and hydrostratigraphic data from the piezometers installed in 2023 revealed that Stratum III is the uppermost continuous water-bearing zone, and all twelve (12) piezometers were installed accordingly, to screen the lower portion of Stratum III. This is consistent with the approved Soil Boring Plan for this project (Attachment 4B), and these observations agree with earlier reports and findings used to characterize the Site and develop the groundwater monitoring program.

The piezometers installed by Geosyntec were constructed using flush threaded 2-in. diameter schedule 40 PVC, with a 10-ft long, 0.010-in. slotted screen and a flush threaded bottom cap. The filter pack, consisting of 20/40 sand, generally extended from just below the screen to about 2-ft above the screen. The annular space above the filter pack between the PVC and the borehole was backfilled using a bentonite grout slurry tremied in a bottom to top manner. Metal protective casings with locking caps were cemented in place after completion of the piezometer(s). Additional piezometer construction details are shown on the piezometer data sheets in Attachment 4D.

The piezometers were developed utilizing surging and purging techniques. Each piezometer was surged at least once, followed by purging with a bailer or submersible pump. Any water added to the piezometer to facilitate development was removed by pumping or bailing. Surging and purging continued until the groundwater was visibly less turbid. After development, water levels were taken in these piezometers (along with currently existing monitoring wells in the Unit 2 area) on a monthly basis between March and August 2023.

7.3 Monitoring Well and Piezometer Construction Details

Groundwater monitoring well and piezometer construction details are summarized in Tables 4-6a (data for wells and piezometers that are currently in existence) and 4-6b (data for wells and piezometers that have been decommissioned and are no longer in existence) – both of which are included at the end of this section. Piezometer and monitoring well installation logs/data sheets are provided in Attachment 4D. Monitoring well and piezometer locations at the Site are presented on Drawing 4A-9A and 4A-9B.

7.4 Groundwater Observations

7.4.1 Water Levels During Drilling – Soil Borings

Water level measurements during drilling observed in soil borings are tabulated in Table 4-7a, presented at the end of this section. These data were obtained from field observations, as noted on boring logs (Attachment 4C). Initial water levels represent the elevation where water was initially observed (if present) during drilling. Static water levels, where noted, represent the measured water elevation after a more extended period of time. As previously explained in Section 5.1.1, after-equilibrium (i.e., static) groundwater level measurements were not always possible because of the wet coring/wash rotary methods used during drilling; however, piezometers were installed to take static/ongoing groundwater levels at select locations as discussed below.

7.4.2 Water Levels During Drilling and After Installation – Wells and Piezometers

Initial and static water level measurements in piezometers and monitoring wells observed are tabulated in Table 4-7b, presented at the end of this section. These data were obtained from field observations, as noted on boring logs of the boreholes at which the piezometers/monitoring wells were installed (Attachment 4C), or from piezometer/well installation logs (Attachment 4D). Initial water levels represent the elevation where water was initially observed during installation or development (pre-installation or pre-development). Static water levels, where noted in Table 4-7b, represent the latest available water level measurement at each location.

7.4.3 Historical Water Levels in Monitoring Wells and Piezometers

Historical water level measurements from groundwater monitoring events at Site monitoring wells between are presented in Tables 4-8a and 4-8b, for wells around Unit 1 and Unit 2, respectively. Also note that Unit 2 wells were gauged monthly between March and August 2023 as part of Geosyntec's site investigation; these measurements are included in Table 4-8b.

Table 4-8c presents historical water level measurements in each of the twelve (12) piezometers installed by Geosyntec to characterize groundwater flow characteristics in the expansion area.

Historical and recently-developed groundwater maps are presented in Attachment 4E.

7.4.4 Groundwater Quality Data

Groundwater monitoring analytical data of the groundwater quality, obtained from chemical analysis of groundwater samples collected over the past several years (representative of recent conditions and latest available information) during semi-annual monitoring events under the current-permitted program are provided in Attachment 4F. This groundwater quality information as it relates to the current status of groundwater monitoring at the Site, and design of the groundwater monitoring program is discussed further in Attachment 5 (Groundwater Monitoring Plan).

7.5 Hydraulic Conductivity of Site Soils

The hydraulic conductivity of each of the four strata (Stratum I through IV) encountered in the subsurface was measured from undisturbed samples (Shelby tube specimens). A summary of the laboratory hydraulic conductivity test results are tabulated in Table 4-9a (with full laboratory test results for tests performed by Geosyntec [2022-2023] provided in Part III, Attachment 3D.1, Appendix 1).

The in-situ field permeability of the water-bearing zones beneath the Site was measured by performing slug tests. The slug test results are summarized in Table 4-9b, with backup data included in Attachment 4G. Inspection of Tables 4-9a and 4-9b reveals the following:

- Laboratory-scale vertical hydraulic conductivity of Stratum I was measured; results from four samples were in the 10^{-8} to 10^{-9} cm/s range and had an average of 1.0 x 10^{-8} cm/s. Three samples oriented on the horizontal axis were in the 10^{-8} to 10^{-10} cm/s range and had an average of 9.6 x 10^{-10} cm/s.

- One laboratory-scale vertical hydraulic conductivity test of Stratum II was measured at 3.1 x 10^{-8} cm/s. Two samples oriented on the horizontal axis had an average of 1.1 x 10^{-8} cm/s. Note that these samples were composed of mostly clay (with gravel) from which an undisturbed specimen could be obtained, and it is possible based on its composition that on a macro-scale (field-scale), the Stratum II formation may have an in-situ hydraulic conductivity greater than was obtained from the laboratory samples. However, the absence of groundwater during the various site investigations and the observations that the gravel sized particles are embedded within a clay matrix (thus filling most available pore space with low-permeability material) provide a sound indication that Stratum II does not contain, transmit, or yield groundwater to any appreciable degree.

- Laboratory-scale vertical hydraulic conductivity of Stratum III was measured; results from five samples were in the 10^{-9} cm/s range and had an average of 1.8 x 10^{-9} cm/s. Five samples oriented on the horizontal axis were in the 10^{-8} to 10^{-9} cm/s range and had an average of 4.2 x 10^{-9} cm/s. These samples did not specifically target fractured zones of Stratum III (which were instead tested via slug tests as discussed below), and provide an indication of the hydraulic conductivity of the formation at locations where few secondary features are present.

- Field-scale hydraulic conductivity of the water-bearing zone (i.e., bottom portions) of Stratum III from slug testing was measured as being substantially more permeable than the results from the lab tests – with an average measured value of 1.5 x 10^{-6} cm/s. As these slug tests were performed in the water-bearing zones within the formation that were observed to have a greater density of secondary features, the results appear sound and logical. The slug tests were influenced by a larger volume of surrounding formation materials (i.e., a larger equivalent sample size was characterized), and thus the measured values are considered more representative of the field-scale behavior that would affect groundwater movement.

- Laboratory-scale vertical hydraulic conductivity of Stratum IV was measured; results from three samples were in the 10^{-8} to 10^{-9} cm/s range and had an average of 1.3 x 10^{-8} cm/s. Samples oriented on the horizontal axis were attempted to be prepared from undisturbed specimens, but could not be reliably obtained tested due to the rock-like nature of the material and the associated difficulty in trimming a testable sample (resulting in excessive disturbance of the sample during the attempts to trim the hard rock-like specimen). However, field-scale hydraulic conductivity of the upper portion of Stratum IV from slug testing in piezometers in the Unit 1 area was able to be measured by MFG (1991) – with reported results in the 10^{-6} to 10^{-7} cm/s range with an average of 7.1 x 10^{-7} cm/s.

The hydraulic conductivity data were used to prepare the hydrogeologic interpretation of the Site as discussed subsequently.

7.6 Hydrogeologic Interpretation

7.6.1 Strata I and II – Discontinuous and Unsaturated Site Soils

As previously discussed, investigations of Strata I and II revealed conditions that are consistently dry to moist (unsaturated) and layers that are discontinuous across the Site. During construction of existing landfill cells, occasional small pockets of seepage were sometimes observed on excavation sideslopes at Stratum II, but only in isolated instances (not in an interconnected, recurring, or widespread manner). As the landfill continues to be developed, more and more areas of Strata I and/or II will be removed via excavations for cell construction. These conditions will limit the ability for surface water and precipitation to infiltrate and migrate downward to supply recharge into Strata I and/or II. For these reasons, Strata I and II are not groundwater-bearing zones, and do not contain, transmit, or yield groundwater to any appreciable degree.

7.6.2 Stratum III – Uppermost Aquifer

Consistent with previous investigations by Geosyntec and others, the recent data collected during the site investigation of the expansion area have confirmed that Stratum III is the uppermost water-bearing zone where groundwater is first encountered beneath the Site (i.e., uppermost aquifer for groundwater monitoring purposes). The lower part of Stratum III exhibits a greater occurrence of secondary features (e.g., higher density of fractures, seams, and fissures), allowing it to contain and transmit groundwater. Furthermore, piezometers and monitoring wells screened at the base of Stratum III generally contain sufficient quantities of groundwater for gauging and/or sampling and analysis purposes – i.e., the presence of groundwater has been observed and measured over time. Groundwater occurs as unconfined conditions at the lower part of Stratum III, where it is perched above the lower confining unit (aquiclude) of the thick, massive, less-fractured, and very low permeability Stratum IV unweathered claystone.

Notwithstanding the above, it should be recognized that Stratum III is a clay formation, and in a relative sense to other types of more granular soils typically thought of as usable aquifers, Stratum III has low permeability. Even within its more fractured and potentially water-bearing zone, site investigations have usually reported initial observations of generally moist to dry soil conditions (few indications of wet or saturated material). Installed piezometers generally have been slow to fill with groundwater, indicating there is slow rate of groundwater movement, and that there may not be a distinct, continuous zone of saturation within Stratum III.

The presence of groundwater and capacity for water movement within Stratum III is likely dependent on secondary features, notably degree of cementation, fracture density, interconnection (or lack thereof), orientation, and the extent that the fractures have been filled by secondary mineralization. Slug tests in Stratum III show a comparatively higher average hydraulic conductivity (1.5×10^{-6} cm/s) relative to the underlying aquiclude – about two orders of magnitude (i.e., 100x) greater than the measured vertical hydraulic conductivity of underlying Stratum IV. This helps explain the observed flow regime, with groundwater in Stratum III accumulating in a perched manner above the lower confining unit, preferentially flowing laterally following the slopes and orientation of the confining unit surface (and also generally mimicking patterns of surface topography, albeit in a subdued manner).

7.6.3 Stratum IV – Lower Confining Unit

Stratum IV is the lower confining unit (aquiclude) beneath the Site, and is part of the approximately 290-ft thick low-permeability claystone of the Lower Taylor Group. The formation is composed of unweathered, primarily unoxidized, minimally fractured (and decreasing fracture density with depth), continuous, tight claystone, dry/unsaturated, and with low hydraulic conductivity. As such, Stratum IV acts as an aquiclude that confines groundwater above it and prevents hydraulic interconnection with deeper aquifers.

7.6.4 Groundwater Flow Patterns

Groundwater maps are provided in Attachment 4E. These maps in Attachment 4E include historically-generated groundwater table/potentiometric contours from previous hydrogeologic investigations and from the ongoing groundwater monitoring program. Attachment 4E maps also include recently-generated potentiometric contours of water levels in Stratum III from readings taken on a monthly basis between March 2023 and August 2023 using a measurement dataset that includes both existing Unit 2 monitoring wells (screened in Stratum III) and expansion-area piezometers (also screened in Stratum III), to provide an illustration of groundwater flow patterns across all of Unit 2.

As discussed previously, the surface of the lower confining unit (top of Stratum IV) generally mimics natural surface topography. The resulting flow regime for groundwater perched in the unconfined uppermost water-bearing zone of Stratum III is strongly influenced by the top of Stratum IV contours – generating groundwater flow patterns in directions that generally follow the slopes and orientation of the confining unit surface (and also generally mimicking patterns of surface topography, albeit in a subdued manner).

The groundwater flow direction at Unit 1 is south-southeasterly (towards Mesquite Creek). The groundwater flow direction at existing areas of Unit 2 is primarily north-northwesterly (towards Mesquite Creek), with minor components of flow on the east side of existing Unit 2 being towards the northeast and east. The groundwater flow direction at the Unit 2 expansion area is primarily towards the east, and based on the flow regime described above it is possible there could be a component of flow towards the southeast (flowing away from the natural topographic (high) ridge located on the northwest edge of the expansion area). The flow patterns and directions of groundwater flow in Stratum III appear to be relatively consistent (stable) over time.

7.6.5 Groundwater Flow Gradient and Seepage Velocity

Horizontal groundwater flow (i.e., seepage) velocity is calculated using the following equation derived from Darcy's Law [Freeze and Cherry, 1979]:

$$v_s = k * i / n_e$$

where: v_s = seepage velocity (cm/s);
k = hydraulic conductivity (cm/s);
i = hydraulic gradient (ft/ft); and
n_e = effective porosity (-).

The hydraulic gradient (ft/ft), which also can be expressed as percent (%) is the difference in hydraulic head (ft) between a pair of wells selected for the computation, divided by the distance (ft) between the pair of wells selected for the computation. Using the hydraulic conductivity data and potentiometric maps, the groundwater flow gradients and seepage velocities in the uppermost aquifer (i.e., Stratum III) are presented below for several cases (in order to provide a range of representative conditions).

- The average hydraulic conductivity of Stratum III from slug tests taken at the Site is 1.5×10^{-6} cm/s (see Table 4-9b). Examination of groundwater potentiometric maps presented in Attachment 4E reveals typical hydraulic gradients across the Site generally range from about 0.015 to 0.03 ft/ft. Effective porosity values for clay can range from 0.01 to 0.18 and average 0.06, as reported by McWhorter and Sunada (1977). An effective porosity of

0.05 (slightly below this reported average, but a typical value used in various investigations for the Site, and reasonable for such clays) is used in this calculation. Input of these hydraulic conductivity and effective porosity values into the equation above, and using a hydraulic gradient of 0.03 ft/ft (3%) [taken as the July 2023 groundwater map difference in groundwater levels at the existing Unit 2 area of about 72.6-ft between MW-11 and MW-21, located about 2,593-ft apart – and rounded up slightly from 0.028 ft/ft to 0.03 ft/ft], the average seepage velocity of groundwater in the water-bearing zone of Stratum III at the Site is approximately 9.0 x 10^{-7} cm/s (2.6 x 10^{-3} ft/d), or about 0.9 feet per year (ft/yr).

- Focusing on the existing Unit 1 area, using the December 2022 groundwater map provided in Attachment 4E, a typical recent average hydraulic gradient across the existing Unit 1 landfill area is about 0.015 ft/ft (1.5%) [taken as the difference in groundwater levels of about 37.3-ft between MW-01 and MW-07A, located about 2,458-ft apart]. As noted above, a hydraulic conductivity of 1.5 x 10^{-6} cm/s and a porosity of 0.05 were also selected. Input of these values into the equation above, the average seepage velocity of Stratum III groundwater at the existing Unit 1 landfill area is approximately 4.6 x 10^{-7} cm/s (1.3 x 10^{-3} ft/d), or about 0.5 ft/yr.
- Focusing on the proposed Unit 2 expansion area south-southeast of existing Unit 2, using a subset of data representative of the expansion area, Stratum III has a slightly higher average measured hydraulic conductivity of 4.6 x 10^{-6} cm/s from slug tests in that portion of the Site. Using the July 2023 groundwater map provided in Attachment 4E, a typical recent average hydraulic gradient across the Unit 2 expansion area is about 0.029 ft/ft (2.9%) [taken as the difference in groundwater levels of about 69.2-ft between GB-33(P) and GB-32(P), located about 2,394-ft apart]. Input of these values into the equation above and using a porosity of 0.05, the average seepage velocity of Stratum III groundwater at the Unit 2 expansion area is approximately 2.7 x 10^{-6} cm/s (7.5 x 10^{-3} ft/d), or about 2.8 ft/yr.

7.6.6 Potential Impact of Landfill on Groundwater Flow Regime

As the landfill has been and continues to be developed across the Site, the engineering controls (liner system, surface-water management system, final cover system) will be robust and long-term hydraulic barriers and management systems that will effectively eliminate the possibility of Stratum III from being recharged from areas directly above the landfill footprint. The potential impact on the groundwater flow regime in Stratum III would be a lowering of the potentiometric surface in Stratum III, which may also flatten (decrease) the hydraulic gradient, ultimately reducing the groundwater flow rate and seepage velocity in the water-bearing zone at the Site (particularly in Unit 2 areas) – but following flow directions similar to those presented herein. This is elaborated on further below.

With respect to recharge potentially occurring from areas beyond the limits of the landfill units, Strata I and II are not water-bearing zones and are already discontinuous across the Site (outcropping at the ground surface in certain areas of the Site), and will eventually be completely removed from within the landfill footprint as development progresses. As a result, less water will ultimately infiltrate into (recharge) Strata I and/or II, and less water will be available to potentially accumulate within or migrate through these layers.

In the Unit 1 and adjacent areas, Stratum III may receive some of its recharge from up-gradient (off-site) areas to the north. Since Unit 1 was the first area constructed many decades ago and is now completed and final-covered, the long-term groundwater flow regime and any affects caused by the landfill have already developed (as evidenced by the generally consistent groundwater flow trends over time at Unit 1) and groundwater conditions in this area are expected to remain consistent in the future.

At Unit 2 and its proposed expansion area, there are very limited up-gradient (off-site) areas expected to contribute recharge to Stratum III. As described herein, Unit 2 will be constructed on topographic high ridges that fall-off (slope downward) in various directions away from Unit 2. The flow regime described in this report is groundwater flowing in the lower part of Stratum III following patterns based on the impermeable top of Stratum IV that resemble natural topography. Under natural (pre-development) conditions at Unit 2, the source of groundwater and its ongoing recharge into Stratum III was essentially from the overlying land (vertical infiltration, which eventually reached the confining layer, built up a hydraulic head, and started migrating laterally due to the preferentially higher permeability in the horizontal direction). As such, that source and mechanism of groundwater recharge will be essentially removed at Unit 2 via the aforementioned landfill engineering controls and hydraulic barriers (liner system, etc.). In the Unit 2 areas of the Site, Stratum III may continue receiving some recharge, albeit in lesser amounts, from perimeter Site areas that are not lined, and also potentially from limited up-gradient (off-site) areas in the extreme southwest corner of the Unit 2 expansion where the natural topographic high ridgeline will still exist. These conditions explain the rationale for the expected lowering over time of the potentiometric surface in Stratum III at Unit 2, flattening (decreasing) the hydraulic gradient, and ultimately a reduction in the groundwater flow rate and seepage velocity in the water-bearing zone at the Site (but maintaining similar flow directions as those presented herein).

The groundwater monitoring program (presented in Attachment 5) for Stratum III, the uppermost aquifer at the Site, has been designed in consideration of any potential impacts to the groundwater flow regime due to the presence of the landfill, as described above.

7.6.7 Most Likely Pathway for Potential Pollutant Migration

An analysis of the most likely pathway for potential pollutant migration is presented in Attachment 5, in conjunction with the explanation of the basis for the design of the groundwater monitoring program. The resulting proposed groundwater monitoring program and groundwater sampling and analysis plan (GWSAP) required by 30 TAC §330.63(f) is provided in Attachment 5.

7.7 Arid Exemption (Not Requested)

An arid exemption is not being requested for this facility, and as such, the information required by 30 TAC §330.63(e)(6) is not applicable to this report.

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TABLES 4-6 THROUGH 4-9

[Tables 4-1 to 4-5 were presented earlier, embedded within the narrative text]

TABLE 4-6a

SUMMARY OF EXISTING MONITORING WELL AND PIEZOMETER CONSTRUCTION DETAILS

Well ID	Installation Date	Ground Surface Elev. (ft, MSL)	Top of Casing Elev. (ft, MSL)	Total Depth (ft, BGS)	Filter Pack		Screen			Stratum Screened
					Top Elev.	Bottom Elev.	Top Elev.	Bottom Elev.	Length (ft)	
Unit 1 Area										
MW-1	2/20/1992	662.4	664.9	45.0	635.9	619.4	631.9	621.9	10	III
MW-2A	3/17/2009	609.0	611.8	37.0	585.0	572.0	583.0	572.9	10	III
MW-3	2/18/1992	603.5	606.0	34.0	591.0	574.5	587.0	577.0	10	III
MW- 4A	5/11/2020	609.4	610.9	30.0	592.4	579.4	590.4	580.4	10	III
MW-6	11/8/1995	632.9	635.3	63.5	593.9	567.9	591.9	581.9	10	III
MW-7A	3/11/2009	603.4	606.3	27.0	592.9	576.4	591.4	581.4	10	III
MW-8A	3/19/2009	625.5	628.5	55.0	585.5	570.5	583.5	573.5	10	III
MW-9	3/24/2009	626.0	629.1	50.0	592.0	576.0	589.5	579.5	10	III
Unit 2 Existing Area										
MW-10	11/4/2009	670.5	673.5	57.0	627.0	613.5	625.0	615.0	10	III
MW-11	3/5/2009	679.0	682.1	63.0	635.0	616.0	633.0	618.0	15	III
MW-12	5/23/2018	709.3	712.2	76.0	647.8	633.3	645.8	635.8	10	III
MW-13	4/10/2018	688.7	691.4	56.0	648.7	632.7	645.7	635.7	10	III
MW-14	4/10/2018	654.0	656.7	57.5	615.0	596.5	612.0	602.0	10	III
MW-15	4/11/2018	647.2	650.2	53.0	608.2	594.2	604.7	594.7	10	III
MW-16	1/21/2005	643.4	646.5	58.0	597.7	585.4	595.7	585.7	10	III
MW-17	1/25/2016	655.4	659.1	63.0	608.4	592.4	605.4	595.4	10	III
MW-18	3/18/2009	635.1	638.2	60.0	588.1	575.1	586.1	576.1	10	III
MW-19	3/2/2009	633.2	636.3	55.0	600.2	578.2	598.7	578.7	20	III
MW-20	3/3/2009	606.3	609.5	40.0	583.3	566.3	581.8	566.8	15	III
MW-21	3/10/2009	606.8	609.6	43.0	575.8	563.8	574.3	564.3	10	III
MW-22	3/10/2009	612.2	615.8	37.0	587.7	575.2	586.2	576.2	10	III
MW-23	3/6/2009	621.2	624.2	35.0	600.2	586.2	597.2	587.2	10	III
Unit 2 Expansion Area										
GB-25(P)	2/6/2023	662.6	665.8	58.0	617.6	604.6	614.6	604.6	10	III
GB-30(P)	2/7/2023	695.1	698.4	45.0	663.1	650.1	660.1	650.1	10	III
GB-32(P)	1/27/2023	652.3	655.2	50.0	615.3	602.3	612.3	602.3	10	III
GB-33(P)	2/8/2023	702.9	705.7	64.0	651.9	638.9	648.9	638.9	10	III
GB-35(P)	2/8/20023	709.0	711.7	60.0	662.0	649.0	659.0	649.0	10	III
GB-37(P)	1/26/2023	668.9	671.1	55.0	626.9	613.9	623.9	613.9	10	III
GB-39(P)	1/30/2023	707.4	709.9	60.0	660.4	647.4	657.4	647.4	10	III
GB-41(P)	1/26/2023	676.2	678.4	60.0	629.2	616.2	626.2	616.2	10	III
GB-45(P)	2/9/2023	711.4	713.7	62.0	662.4	649.4	659.4	649.4	10	III
GB-48(P)	2/10/2023	708.5	710.8	60.0	661.5	648.5	658.5	648.5	10	III
GB-50(P)	2/1/2023	689.6	691.4	65.0	637.6	624.6	634.6	624.6	10	III
GB-52(P)	1/31/2023	668.0	670.2	60.0	621.0	608.0	618.0	608.0	10	III

Notes:

1. ft, MSL indicates feet below mean sea level, ft, BGS indicates feet below ground surface.

TABLE 4-6b

SUMMARY OF OLD (NO LONGER IN EXISTENCE) MONITORING WELL AND PIEZOMETER CONSTRUCTION DETAILS

Well ID	Installation Date	Ground Surface Elev. (ft, MSL)	Top of Casing Elev. (ft, MSL)	Total Depth (ft, BGS)	Filter Pack		Screen			Stratum Screened
					Top Elev.	Bottom Elev.	Top Elev.	Bottom Elev.	Length (ft)	
P-6	12/5/1987	638.5	641.8	45.0	618.5	593.5	598.5	593.5	5	III
P-7	12/5/1987	664.0	666.0	78.0	611.0	586.0	591.0	586.0	5	IV
P-10	12/7/1987	642.0	644.0	74.0	582.0	568.0	573.0	568.0	5	IV
P-14	12/7/1987	604.0	606.0	27.0	592.0	577.0	582.0	577.0	5	III
PZ-2	4/25/1990	633.6	635.6	62.5	585.8	571.1	583.6	573.6	10	IV
PZ-3	4/24/1990	643.9	646.3	27.5	630.9	617.9	628.9	618.9	10	III
PZ-4	4/27/1990	627.5	629.6	44.5	607.8	585.5	605.5	590.5	15	III
PZ-5	4/27/1990	614.0	616.1	27.5	600.6	588.0	599.0	589.0	10	III
PZ-6	9/26/1991	602.7	605.6	23.0	594.7	580.7	593.2	583.2	10	III
PZ-7	9/25/1991	601.7	604.4	28.0	589.2	574.4	587.2	577.2	10	III
PZ-8	9/25/1991	600.7	604.8	63.5	553.7	538.7	551.2	541.2	10	IV
PZ-9	9/27/1991	621.9	625.3	56.0	582.9	569.9	579.9	569.9	10	III
PZ-10	9/27/1991	622.0	624.9	80.0	557.0	542.5	555.0	545.0	10	IV
PZ-11	10/1/1991	659.7	662.8	50.0	626.7	613.7	623.7	613.7	10	III
PZ-12	9/30/1991	660.1	663.0	68.0	608.1	593.6	606.1	596.1	10	IV
MW-2	2/19/1992	615.6	618.7	35.0	599.1	582.6	595.1	585.1	10	III
MW-4	2/19/1992	605.3	608.3	30.0	593.8	577.3	589.8	579.8	10	III
PZ-1M	2/18/1992	644.9	647.0	45.0	616.9	600.9	612.9	602.9	10	III
MW-5	2/21/1992	668.2	671.4	60.0	622.2	608.2	618.2	608.2	10	IV
MW-7	4/5/2006	589.8	592.2	36.6	568.8	553.2	565.2	553.2	12	III
MW-8	4/5/2006	588.8	591.5	38.1	565.8	550.7	563.2	550.7	12.5	III
GB-01 (P)	12/20/2004	595.4	598.8	26.0	581.6	569.4	579.4	569.4	10	III
GB-02 (P)	12/17/2004	599.6	602.7	27.0	584.6	572.6	582.6	572.6	10	III
GB-03 (P)	12/15/2004	607.6	610.9	27.0	592.9	580.6	590.6	580.6	10	III
GB-04 (P)	12/17/2004	668.2	671.3	62.0	618.3	606.2	616.2	606.2	10	III
GB-05 (P)	1/5/2005	640.5	643.3	65.0	587.5	575.5	585.5	575.5	10	III
GB-06 (P)	1/28/2005	646.0	649.3	45.0	613.0	601.0	611.0	601.0	10	III
GB-09 (P)	12/22/2004	638.7	641.7	54.0	596.7	584.7	594.7	584.7	10	III
GB-11 (P)	12/20/2004	617.2	620.2	45.0	583.5	572.2	582.2	572.2	10	III
GB-12 (P)	12/16/2004	639.6	642.8	60.0	591.8	579.6	589.6	579.6	10	III
GB-13 (P)	1/21/2005	619.5	621.9	61.5	570.0	558.0	568.0	558.0	10	III
GB-17 (P)	1/24/2005	654.4	657.3	64.0	602.4	590.4	600.4	590.4	10	III
GB-20 (P)	12/13/2004	675.8	678.7	69.0	619.3	606.8	616.8	606.8	10	III
GB-21 (P)	1/10/2005	709.1	712.2	73.5	647.9	635.6	645.6	635.6	10	III
GB-22 (P)	1/10/2005	657.8	659.4	69.0	601.3	588.8	598.8	588.8	10	III

Notes:

1. No record on the construction details was located for previous piezometer PZ-1.

TABLE 4-7a
WATER LEVEL MEASUREMENTS DURING DRILLING - SOIL BORINGS

Boring	Surface Elevation (ft, MSL)	Total Depth (ft)	Initial Water Level (ft, MSL)[1]	Static Water Level (ft, MSL)[2]
Unit 1 Area				
CB-1	670.0	60.0	DRY	DRY
CB-2	623.0	40.0	DRY	DRY
CB-3	632.0	60.0	DRY	DRY
CB-4	604.0	60.0	DRY	DRY
CB-5	605.0	60.0	DRY	DRY
B-6	638.0	80.0	DRY	626.0
B-7	664.0	80.0	DRY	635.1
B-8	638.0	80.0	DRY	595.0
B-9	640.0	80.0	DRY	581.6
B-10	642.0	80.0	DRY	572
B-11	628.0	75.5	DRY	DRY
B-12	642.0	80.0	DRY	632.5
B-13	626.0	80.0	DRY	DRY
B-14	604.0	50.0	DRY	556
B-15	606.0	80.0	DRY	544.6
GP-1	641.9	24.0	DRY	NA
GP-2	662.8	35.0	DRY	NA
GP-3	641.0	22.0	DRY	NA
GP-4	602.8	36.0	DRY	NA
GP-5	602.5	37.0	DRY	NA
GP-6	623.9	44.0	DRY	NA
SB-1	662.4	45.0	DRY	DRY
SB-2	615.6	35.0	DRY	591.0
SB-3	603.5	34.0	593.6	597.2
SB-4	605.3	30.0	DRY	576.6
SB-5	670.5	60.0	DRY	DRY
SB-6	632.9	63.5	DRY	DRY
GP-6R	623.5	43.3	DRY	NA
Unit 2 Existing Area				
GB-01	595.4	95.0	DRY	DRY
GB-02	599.5	70.5	DRY	DRY
GB-03	607.7	104.5	DRY	DRY
GB-04	668.2	145.0	DRY	DRY
GB-05	640.5	115.0	601.5	DRY
GB-06	646.0	124.0	607.4	DRY
GB-07	602.9	59.0	DRY	DRY
GB-08	623.8	71.5	DRY	DRY

TABLE 4-7a
WATER LEVEL MEASUREMENTS DURING DRILLING - SOIL BORINGS

Boring	Surface Elevation (ft, MSL)	Total Depth (ft)	Initial Water Level (ft, MSL)[1]	Static Water Level (ft, MSL)[2]
GB-09	638.7	89.0	604.7	DRY
GB-10	648.7	99.0	608.7	DRY
GB-11	617.2	90.0	DRY	DRY
GB-12	639.6	119.0	DRY	DRY
GB-13	618.8	95.0	573.8	DRY
GB-14	679.8	136.0	DRY	DRY
GB-15	643.4	144.0	603.1	DRY
GB-16	679.5	139.0	DRY	DRY
GB-17	654.4	134.0	DRY	DRY
GB-18	694.2	149.0	653.2	DRY
GB-19	688.7	150.0	DRY	DRY
GB-20	675.9	169.0	621.7	DRY
GB-21	709.0	187.0	654.0	DRY
GB-22	656.5	140.0	DRY	DRY
GB-23	689.5	185.0	DRY	DRY
GB-24	677.5	155.0	652.5	DRY
GP-5A	609.1	52.0	DRY	NA
GP-8	605.3	49.0	DRY	NA
GP-9	625.0	48.0	DRY	NA
GP-10	663.9	47.5	DRY	NA
GP-11	615.9	57.0	DRY	NA
GP-12	610.0	31.0	DRY	NA
GP-13	639.9	62.0	DRY	NA
GP-20	664.2	65.0	DRY	NA
GP-21	637.8	49.0	DRY	NA
GP-14	657.7	56.0	DRY	NA
GP-19	676.5	56.0	DRY	NA
GP-15	637.7	33.0	DRY	NA
GP-16	654.8	31.5	DRY	NA
GP-17	699.8	77.5	DRY	NA
GP-18	708.7	75.0	DRY	NA
Unit 2 Expansion Area				
GB-25	662.5	86.7	DRY	DRY
GB-26	702.4	102.3	DRY	DRY
GB-27	662.8	113.4	DRY	DRY
GB-28	685.5	85.2	DRY	DRY
GB-29	712.5	112.2	DRY	DRY
GB-30	696.6	96.1	DRY	DRY
GB-31	668.2	69.0	DRY	DRY

TABLE 4-7a
WATER LEVEL MEASUREMENTS DURING DRILLING - SOIL BORINGS

Boring	Surface Elevation (ft, MSL)	Total Depth (ft)	Initial Water Level (ft, MSL)[1]	Static Water Level (ft, MSL)[2]
GB-32	652.7	76.9	DRY	DRY
GB-33	702.9	153.2	DRY	DRY
GB-34	711.6	142.5	DRY	DRY
GB-35	709.3	109.7	DRY	DRY
GB-36	681.7	106.8	DRY	DRY
GB-37	668.3	119.8	DRY	DRY
GB-38	708.0	132.6	DRY	DRY
GB-39	707.9	111.1	DRY	DRY
GB-40	692.8	144.0	DRY	DRY
GB-41	679.8	76.8	DRY	DRY
GB-42	663.1	88.2	DRY	DRY
GB-43	710.0	109.3	DRY	DRY
GB-44	710.0	136.7	DRY	DRY
GB-45	710.0	111.5	DRY	DRY
GB-46	686.8	110.2	DRY	DRY
GB-47	671.3	70.9	DRY	DRY
GB-48	707.5	158.9	DRY	DRY
GB-49	704.1	103.2	DRY	DRY
GB-50	689.1	113.6	DRY	DRY
GB-51	677.5	76.5	DRY	DRY
GB-52	667.1	118.6	DRY	DRY

Notes:

1. Observed water level during borehole advancement.
2. Static water level (after-equilibrium measurements) during or shortly after borehole advancement.

TABLE 4-7b

WATER LEVEL MEASUREMENTS DURING DRILLING AND AFTER INSTALLATION - PIEZOMETERS AND MONITORING WELLS

Well /Piez. ID	Surface Elev. (ft, MSL)	Total Depth (ft)	Initial Water Level (ft, MSL)[1]	Static Water Level (ft, MSL)[2]	Status
P-6	638.0	80.0	DRY	634.6	Decommissioned
P-7	664.0	80.0	DRY	635.1	Decommissioned
P-10	642.0	80.0	DRY	566.7	Decommissioned
P-14	604.0	50.0	DRY	DRY	Decommissioned
PZ-1	662.6	57.0	DRY	655.0	Decommissioned
PZ-2	633.2	70.5	DRY	DRY	Decommissioned
PZ-3	643.9	32.5	DRY	637.5	Decommissioned
PZ-4	627.5	50.4	DRY	623.7	Decommissioned
PZ-5	614.0	51.4	DRY	603.2	Decommissioned
PZ-6	602.7	24.0	DRY	598.8	Decommissioned
PZ-7	601.7	28.0	DRY	594.4	Decommissioned
PZ-8	600.7	63.5	DRY	573.7	Decommissioned
PZ-9	621.9	56.0	DRY	DRY	Decommissioned
PZ-10	622.0	80.0	DRY	543.5	Decommissioned
PZ-11	659.7	50.0	575.6	653.0	Decommissioned
PZ-12	660.1	68.0	DRY	655.0	Decommissioned
MW-1	662.4	45.0	DRY	629.7	Existing Unit 1 Area
MW-2	615.6	35.0	DRY	602.2	Decommissioned
MW-3	603.5	34.0	593.6	597.9	Existing Unit 1 Area
MW-4	605.3	30.0	DRY	594.8	Decommissioned
MW-5	670.5	60.0	DRY	612.0	Decommissioned
MW-7	589.8	36.6	DRY	NA	Decommissioned
MW-8	588.8	38.1	DRY	NA	Decommissioned
PZ-1M	644.2	45.0	605.4	636.6	Decommissioned
MW-6	632.9	63.5	DRY	DRY	Existing Unit 1 Area
GB-01 (P)	595.4	26.0	DRY	588.0	Decommissioned
GB-02 (P)	599.6	27.0	DRY	593.1	Decommissioned
GB-03 (P)	607.6	27.0	DRY	601.2	Decommissioned
GB-04 (P)	668.2	62.0	DRY	657.6	Decommissioned
GB-05 (P)	640.5	65.0	601.5	621.1	Decommissioned
GB-06 (P)	646.0	45.0	607.4	632.9	Decommissioned
GB-09 (P)	638.7	54.0	604.7	631.3	Decommissioned
GB-11 (P)	617.2	45.0	DRY	597.6	Decommissioned
GB-12 (P)	639.6	60.0	DRY	609.3	Decommissioned
GB-13 (P)	619.5	61.5	573.8	603.9	Decommissioned
GB-15 (P)/ MW-16	643.4	57.7	603.1	632.3	Existing Unit 2 Area
GB-17 (P)	654.4	64.0	DRY	597.5	Decommissioned
GB-20 (P)	675.8	69.0	621.7	664.1	Decommissioned

TABLE 4-7b

WATER LEVEL MEASUREMENTS DURING DRILLING AND AFTER INSTALLATION - PIEZOMETERS AND MONITORING WELLS

Well /Piez. ID	Surface Elev. (ft, MSL)	Total Depth (ft)	Initial Water Level (ft, MSL)[1]	Static Water Level (ft, MSL)[2]	Status
GB-21 (P)	709.1	73.5	654.0	653.5	Decommissioned
GB-22 (P)	657.8	69.0	DRY	639.9	Decommissioned
MW-2A	609.0	37.0	572.7	595.4	Existing Unit 1 Area
MW-7A	603.4	27.0	582.2	593.7	Existing Unit 1 Area
MW-8A	625.5	55.0	573.5	DRY	Existing Unit 1 Area
MW-9	626.0	50.0	580.1	583.3	Existing Unit 1 Area
MW-11	679.0	63.0	617.8	666.3	Existing Unit 2 Area
MW-18	635.1	60.0	576.8	629.2	Existing Unit 2 Area
MW-19	633.2	55.0	579.6	596.0	Existing Unit 2 Area
MW-20	606.3	40.0	575.3	594.3	Existing Unit 2 Area
MW-21	606.8	43.0	564.7	594.2	Existing Unit 2 Area
MW-22	612.2	37.0	577.8	DRY	Existing Unit 2 Area
MW-23	621.2	35.0	587.8	600.0	Existing Unit 2 Area
MW-10	670.5	57.0	616.0	658.1	Existing Unit 2 Area
MW-17	655.4	35.0	DRY	637.2	Existing Unit 2 Area
MW-13	688.7	56.0	DRY	653.2	Existing Unit 2 Area
MW-14	654.0	57.5	DRY	602.7	Existing Unit 2 Area
MW-15	647.2	53.0	559.6	635.2	Existing Unit 2 Area
MW-12	709.3	76.0	DRY	651.6	Existing Unit 2 Area
MW-4A	609.4	30.0	583.9	595.3	Existing Unit 1 Area
GB-25(P)	662.6	58.0	609.3	618.8	Unit 2 Expansion Area
GB-30(P)	695.1	45.0	656.1	DRY	Unit 2 Expansion Area
GB-32(P)	652.3	50.0	603.2	605.9	Unit 2 Expansion Area
GB-33(P)	702.9	64.0	646.0	675.4	Unit 2 Expansion Area
GB-35(P)	709.0	60.0	649.2	650.4	Unit 2 Expansion Area
GB-37(P)	668.9	55.0	613.9	DRY	Unit 2 Expansion Area
GB-39(P)	707.4	60.0	650.8	651.9	Unit 2 Expansion Area
GB-41(P)	676.2	60.0	633.6	647.3	Unit 2 Expansion Area
GB-45(P)	711.4	62.0	649.6	DRY	Unit 2 Expansion Area
GB-48(P)	708.5	60.0	657.9	679.8	Unit 2 Expansion Area
GB-50(P)	689.6	65.0	665.4	664.3	Unit 2 Expansion Area
GB-52(P)	668.0	60.0	638.7	642.4	Unit 2 Expansion Area

Notes:

1. Observed water level during well and piezometer installation and/or initial development.
2. Static water level (after-equilibrium measurements) is last reading taken. The static water level in newly installed piezometers [GB-25(P) through GB-52(P)] was obtained in August 2023.
3. NA= Not Available

TABLE 4-8a

**MONITORING WELL WATER LEVEL MEASUREMENTS
(EXISTING WELLS IN UNIT 1 - SCREENED IN STRATUM III)**

Date	MW-1	MW-2A	MW-3	MW-4	MW-4A	MW-6	MW-7A	MW-8A	MW-9
3/1992	N/A	N/A	591.6	586.8	N/A	N/A	N/A	N/A	N/A
5/1992	641.8	N/A	598.4	589.0	N/A	N/A	N/A	N/A	N/A
7/1992	628.3	N/A	597.8	593.0	N/A	N/A	N/A	N/A	N/A
11/1992	629.8	N/A	596.1	592.2	N/A	N/A	N/A	N/A	N/A
3/1993	645.0	N/A	601.7	593.1	N/A	N/A	N/A	N/A	N/A
7/1993	644.7	N/A	599.0	593.6	N/A	N/A	N/A	N/A	N/A
10/1993	644.5	N/A	595.0	592.6	N/A	N/A	N/A	N/A	N/A
4/1994	644.5	N/A	594.3	592.1	N/A	N/A	N/A	N/A	N/A
7/1994	644.5	N/A	595.8	591.9	N/A	N/A	N/A	N/A	N/A
10/1994	645.5	N/A	601.6	592.4	N/A	N/A	N/A	N/A	N/A
1/1995	645.8	N/A	601.9	593.0	N/A	N/A	N/A	N/A	N/A
4/1995	644.8	N/A	601.8	593.5	N/A	N/A	N/A	N/A	N/A
11/1995	646.7	N/A	596.4	592.9	N/A	N/A	N/A	N/A	N/A
12/1995	631.5	N/A	583.1	589.0	N/A	N/A	N/A	N/A	N/A
5/1996	645.5	N/A	594.8	592.4	N/A	N/A	N/A	N/A	N/A
11/1996	645.5	N/A	596.4	592.8	N/A	N/A	N/A	N/A	N/A
2/1997	645.2	N/A	595.6	593.5	N/A	N/A	N/A	N/A	N/A
5/1997	642.7	N/A	595.2	593.3	N/A	N/A	N/A	N/A	N/A
11/1997	646.0	N/A	594.4	593.3	N/A	N/A	N/A	N/A	N/A
5/1998	647.3	N/A	595.3	589.3	N/A	N/A	N/A	N/A	N/A
6/1999	648.4	N/A	592.4	589.5	N/A	DRY	N/A	N/A	N/A
12/1999	648.2	N/A	589.2	589.4	N/A	DRY	N/A	N/A	N/A
6/2000	645.0	N/A	585.7	589.4	N/A	DRY	N/A	N/A	N/A
11/2000	644.8	N/A	585.0	589.2	N/A	DRY	N/A	N/A	N/A
6/2001	649.2	N/A	592.6	593.4	N/A	NM	N/A	N/A	N/A
9/2001	NM	N/A	592.3	NM	N/A	NM	N/A	N/A	N/A
12/2001	648.3	N/A	593.0	597.6	N/A	NM	N/A	N/A	N/A
2/2022	NM	N/A	592.0	NM	N/A	NM	N/A	N/A	N/A
5/2002	647.7	N/A	590.3	593.0	N/A	NM	N/A	N/A	N/A
7/2002	NM	N/A	580.8	NM	N/A	NM	N/A	N/A	N/A
12/2002	649.4	N/A	593.8	596.3	N/A	NM	N/A	N/A	N/A
1/2003	NM	N/A	589.7	NM	N/A	NM	N/A	N/A	N/A
4/2003	650.6	N/A	593.7	595.6	N/A	NM	N/A	N/A	N/A
10/2003	649.4	N/A	592.2	595.9	N/A	NM	N/A	N/A	N/A
5/2004	649.0	N/A	592.9	595.9	N/A	NM	N/A	N/A	N/A
11/2004	649.2	N/A	594.4	596.5	N/A	585.5	N/A	N/A	N/A
3/2005	649.6	N/A	594.4	598.5	N/A	DRY	N/A	N/A	N/A
5/2005	649.4	N/A	593.2	597.7	N/A	589.6	N/A	N/A	N/A
6/2005	649.6	N/A	593.1	597.9	N/A	588.6	N/A	N/A	N/A
11/2005	649.2	N/A	594.2	597.5	N/A	NM	N/A	N/A	N/A
6/2006	647.5	N/A	594.2	596.5	N/A	NM	N/A	N/A	N/A
12/2006	645.5	N/A	594.6	596.2	N/A	NM	N/A	N/A	N/A

TABLE 4-8a

MONITORING WELL WATER LEVEL MEASUREMENTS
(EXISTING WELLS IN UNIT 1 - SCREENED IN STRATUM III)

Date	MW-1	MW-2A	MW-3	MW-4	MW-4A	MW-6	MW-7A	MW-8A	MW-9
7/2007	631.2	N/A	598.3	598.6	N/A	NM	N/A	N/A	N/A
12/2007	647.8	N/A	594.8	597.6	N/A	NM	N/A	N/A	N/A
6/2008	647.0	N/A	593.6	596.9	N/A	NM	N/A	N/A	N/A
12/2008	645.6	N/A	592.1	595.7	N/A	NM	N/A	N/A	N/A
7/2009	644.5	NM	595.7	594.1	N/A	NM	N/A	N/A	N/A
11/2009	642.6	NM	597.0	594.1	N/A	NM	N/A	N/A	N/A
12/2009	632.2	NM	598.2	594.2	N/A	NM	N/A	N/A	N/A
6/2010	643.4	NM	594.7	595.1	N/A	NM	N/A	N/A	N/A
12/2010	642.6	NM	592.7	595.5	N/A	NM	N/A	N/A	N/A
9/2011	642.0	594.4	592.6	594.3	N/A	NM	592.8	DRY	DRY
12/2011	641.6	595.5	597.2	593.5	N/A	NM	592.3	DRY	DRY
3/2012	640.1	599.2	596.2	593.8	N/A	NM	600.6	DRY	DRY
5/2012	639.1	599.7	594.4	594.1	N/A	NM	600.1	DRY	587.6
11/2012	NM	596.4	NM	NM	N/A	NM	595.1	DRY	584.5
3/2013	638.9	596.4	594.8	594.0	N/A	NM	596.4	DRY	581.5
6/2013	NM	NM	NM	NM	N/A	NM	597.9	DRY	DRY
10/2013	632.7	597.4	591.9	593.5	N/A	DRY	599.0	DRY	DRY
6/2014	637.7	595.1	594.6	593.8	N/A	DRY	599.5	DRY	DRY
11/2014	636.3	593.3	591.7	592.7	N/A	DRY	593.8	DRY	DRY
5/2015	637.3	598.4	596.2	594.1	N/A	DRY	600.2	DRY	592.0
12/2015	635.6	595.2	594.8	593.3	N/A	DRY	595.7	DRY	587.2
6/2016	633.8	598.3	596.6	594.4	N/A	DRY	600.4	DRY	602.1
9/2016	630.8	596.4	594.1	594.4	N/A	DRY	595.3	DRY	589.5
3/2017	645.6	598.9	597.3	594.7	N/A	DRY	600.5	DRY	603.0
10/2017	632.9	596.9	595.8	591.5	N/A	DRY	598.9	DRY	587.5
4/2018	631.1	596.0	596.5	594.4	N/A	DRY	598.7	DRY	594.8
10/2018	632.8	597.2	594.7	593.9	N/A	DRY	596.8	DRY	585.7
5/2019	630.9	598.2	596.6	594.8	N/A	DRY	599.5	DRY	598.8
11/2019	630.8	595.8	591.8	N/A	N/A	DRY	592.0	DRY	585.6
5/2020	632.1	598.3	595.7	N/A	588.3	DRY	594.5	DRY	585.0
12/2020	632.7	596.3	594.4	N/A	593.2	DRY	589.6	DRY	582.0
4/2021	632.5	598.1	595.5	N/A	592.1	DRY	588.9	DRY	DRY
11/2021	630.1	597.9	599.1	N/A	597.2	DRY	600.1	DRY	586.2
7/2022	629.7	595.4	597.9	N/A	595.3	DRY	593.7	DRY	583.3

Notes:
1. Measurements are in feet above mean sea level (ft MSL)
2. N/A = Not Available (e.g., date is prior to well construction, well damaged/replaced, etc.).
3. NM = Not measured

TABLE 4-8b
MONITORING WELL WATER LEVEL MEASUREMENTS
(EXISTING WELLS IN UNIT 2 - SCREENED IN STRATUM III)

Date	MW-10	MW-11	MW-12	MW-13	MW-14	MW-15	MW-16	MW-17	MW-18	MW-19	MW-20	MW-21	MW-22	MW-23
9/2011	654.3	666.7	N/A	N/A	N/A	N/A	N/A	N/A	614.8	591.0	592.0	593.9	591.2	595.9
12/2011	653.3	666.3	N/A	N/A	N/A	N/A	N/A	N/A	620.8	591.9	596.8	593.9	591.2	596.1
3/2012	652.3	674.1	N/A	N/A	N/A	N/A	N/A	N/A	618.2	588.9	599.1	595.1	587.0	608.2
5/2012	652.8	672.7	N/A	N/A	N/A	N/A	N/A	N/A	623.7	594.8	598.9	596.0	591.3	610.1
11/2012	652.9	669.3	N/A	N/A	N/A	N/A	N/A	N/A	622.6	595.5	597.1	594.6	589.0	604.8
3/2013	652.9	667.6	N/A	N/A	N/A	N/A	N/A	N/A	623.2	591.3	595.8	594.6	588.1	602.3
6/2013	653.4	668.9	N/A	N/A	N/A	N/A	N/A	N/A	625.9	596.6	596.8	594.3	590.6	605.6
10/2013	651.2	663.0	N/A	N/A	N/A	N/A	N/A	N/A	618.5	592.1	596.0	593.1	586.7	606.5
6/2014	653.9	668.4	N/A	N/A	N/A	N/A	N/A	N/A	627.3	597.8	596.3	594.6	589.7	606.6
11/2014	652.4	664.8	N/A	N/A	N/A	N/A	N/A	N/A	625.5	594.0	590.3	593.5	586.7	600.0
5/2015	655.5	672.7	N/A	N/A	N/A	N/A	N/A	N/A	627.9	594.8	598.4	599.9	604.0	609.7
12/2015	651.6	670.9	N/A	N/A	N/A	N/A	N/A	N/A	627.7	595.7	597.2	594.6	587.6	602.9
6/2016	652.7	673.2	N/A	N/A	N/A	N/A	N/A	N/A	628.4	595.4	599.7	599.7	606.1	608.1
9/2016	653.2	670.1	N/A	N/A	N/A	N/A	N/A	N/A	627.1	592.9	598.6	595.6	587.3	605.0
3/2017	655.3	677.2	N/A	N/A	N/A	N/A	N/A	N/A	629.3	593.8	600.5	600.3	607.3	612.7
10/2017	656.0	673.2	N/A	N/A	N/A	N/A	632.1	636.7	629.2	594.6	598.8	596.7	589.2	604.9
4/2018	657.8	676.3	N/A	DRY	DRY	NM	634.4	639.5	630.6	595.1	599.6	598.7	602.0	607.7
10/2018	656.9	668.5	DRY	638.7	DRY	635.8	634.0	637.4	629.6	592.9	598.2	594.8	580.7	602.8
5/2019	658.7	674.1	DRY	655.2	DRY	638.0	637.1	641.9	630.8	595.9	599.5	598.9	600.6	607.9
11/2019	657.1	668.3	DRY	646.9	DRY	635.6	635.9	641.6	628.7	597.3	597.4	594.0	584.2	601.7
5/2020	656.4	669.8	648.1	647.9	DRY	642.7	634.8	641.9	630.1	595.2	600.8	599.9	586.8	609.7
12/2020	658.4	672.5	649.5	652.0	DRY	636.0	632.0	635.3	629.4	597.3	594.1	595.5	594.3	604.8
4/2021	657.2	667.4	649.0	650.5	DRY	637.5	632.4	644.8	630.2	592.4	596.1	594.1	584.6	599.4
11/2021	658.5	669.2	652.1	660.0	DRY	635.4	629.2	642.6	630.8	622.7	599.3	598.0	584.1	604.2
7/2022	659.4	667.3	647.5	654.4	DRY	636.4	633.1	642.6	627.2	595.4	594.7	595.5	585.6	601.6
3/2023	658.2	666.9	651.0	650.0	DRY	635.8	632.3	640.2	627.8	596.5	596.6	594.1	DRY	597.9
3/2023	658.0	666.9	651.2	649.9	DRY	635.2	632.5	639.9	628.8	596.6	597.0	594.3	DRY	598.1
5/2023	657.8	666.9	651.3	649.9	DRY	635.6	632.8	640.0	629.3	596.6	598.6	594.8	DRY	599.3
6/2023	657.5	669.8	651.6	657.3	602.6	635.9	633.8	640.0	629.7	596.6	598.7	595.8	DRY	604.9
7/2023	657.7	667.5	651.5	654.4	602.7	635.0	633.7	638.5	629.5	595.9	596.6	594.9	DRY	600.9
8/2023	658.1	666.3	651.6	653.2	DRY	635.2	632.3	637.2	629.2	596.0	594.3	594.2	DRY	600.0

Notes:
1. Measurements are in feet above mean sea level (ft MSL)
2. N/A = Not Available (e.g., date is prior to well construction, replacement well, etc.).
3. NM = Not measured

TABLE 4-8c
PIEZOMETER WATER LEVEL MEASUREMENTS
(PIEZOMETERS SCREENED IN STRATUM III)
[GEOSYNTEC, 2023 PIEZOMETERS]

Date	GB-25 (P)	GB-30 (P)	GB-32 (P)	GB-33 (P)	GB-35 (P)	GB-37 (P)	GB-39 (P)	GB-41 (P)	GB-45 (P)	GB-48 (P)	GB-50 (P)	GB-52 (P)
3/2023	609.4	653.1	605.9	647.9	651.6	615.2	652.3	628.6	650.6	664.8	665.0	635.7
4/2023	612.1	652.1	605.9	665.3	651.2	614.7	652.2	639.1	650.2	673.7	665.4	640.0
5/2023	613.4	651.5	605.9	670.2	651.1	614.5	652.2	641.9	650.3	676.0	665.5	641.2
6/2023	615.1	650.8	605.9	674.1	651.0	614.4	652.2	644.8	653.6	678.2	665.6	642.2
7/2023	617.4	DRY	605.9	675.1	650.6	DRY	652.0	646.2	DRY	679.2	664.7	642.3
8/2023	618.8	DRY	605.9	675.4	650.4	DRY	651.9	647.3	DRY	679.8	664.3	642.4

Note:
1. Measurements are in feet above mean sea level (ft MSL).

TABLE 4-9a
SUMMARY OF HYDRAULIC CONDUCTIVITY TESTS - LABORATORY (UNDISTURBED SAMPLES)

Boring Number	Strata	Horizontal Hydraulic Conductivity[2] k_h (cm/s)	Vertical Hydraulic Conductivity[2] k_v (cm/s)
STRATUM I			
GB-36	I	3.4E-10	8.8E-09
GB-40	I		8.8E-08
GB-41	I	1.1E-08	1.4E-08
GB-52	I	2.4E-10	1.1E-09
Stratum I Average[3] (Geosyntec, 2023)		9.6E-10	1.0E-08
STRATUM II			
GB-33	II	1.3E-09	3.1E-08
GB-37	II	9.7E-08	
Stratum II Average[3] (Geosyntec, 2023)		1.1E-08	3.1E-08
STRATUM III			
GB-33	III		1.2E-09
GB-37	III	1.6E-09	2.1E-09
GB-40	III	1.0E-08	1.4E-09
GB-41	III	3.7E-09	
GB-48	III	2.9E-09	1.1E-09
GB-52	III	7.2E-09	4.7E-09
Stratum III Average[3] (Geosyntec, 2023)		4.2E-09	1.8E-09
MFG (1991) and Geosyntec (2005) Stratum III Average[3]			3.2E-08
STRATUM IV			
GB-27	IV		8.7E-09
GB-40	IV		5.5E-08
GB-48	IV		4.6E-09
Stratum IV Average[3] (Geosyntec, 2023)			1.3E-08
Geosyntec (2005) Stratum IV Average[3]			6.1E-09

Notes:
1. Conductivity values by Geosyntec [2023] measured in accordance with ASTM D 5084F.
2. The average hydraulic conductivities reported above were calculated as the geometric mean, based on recommendations by Domenico and Schwartz, Physical and Chemical Hydrogeology, 1990 [who state: "*...the "average" conductivity...is better described by the geometric mean...*"], because of the tendency of hydraulic conductivity properties of a formation to vary as a log-normal distribution.
3. Shaded table entries indicate parameters that were not obtained/tested at that Boring Number.

TABLE 4-9b

SUMMARY OF HYDRAULIC CONDUCTIVITY TESTS - FIELD PERMEABILITY (SLUG TESTING)

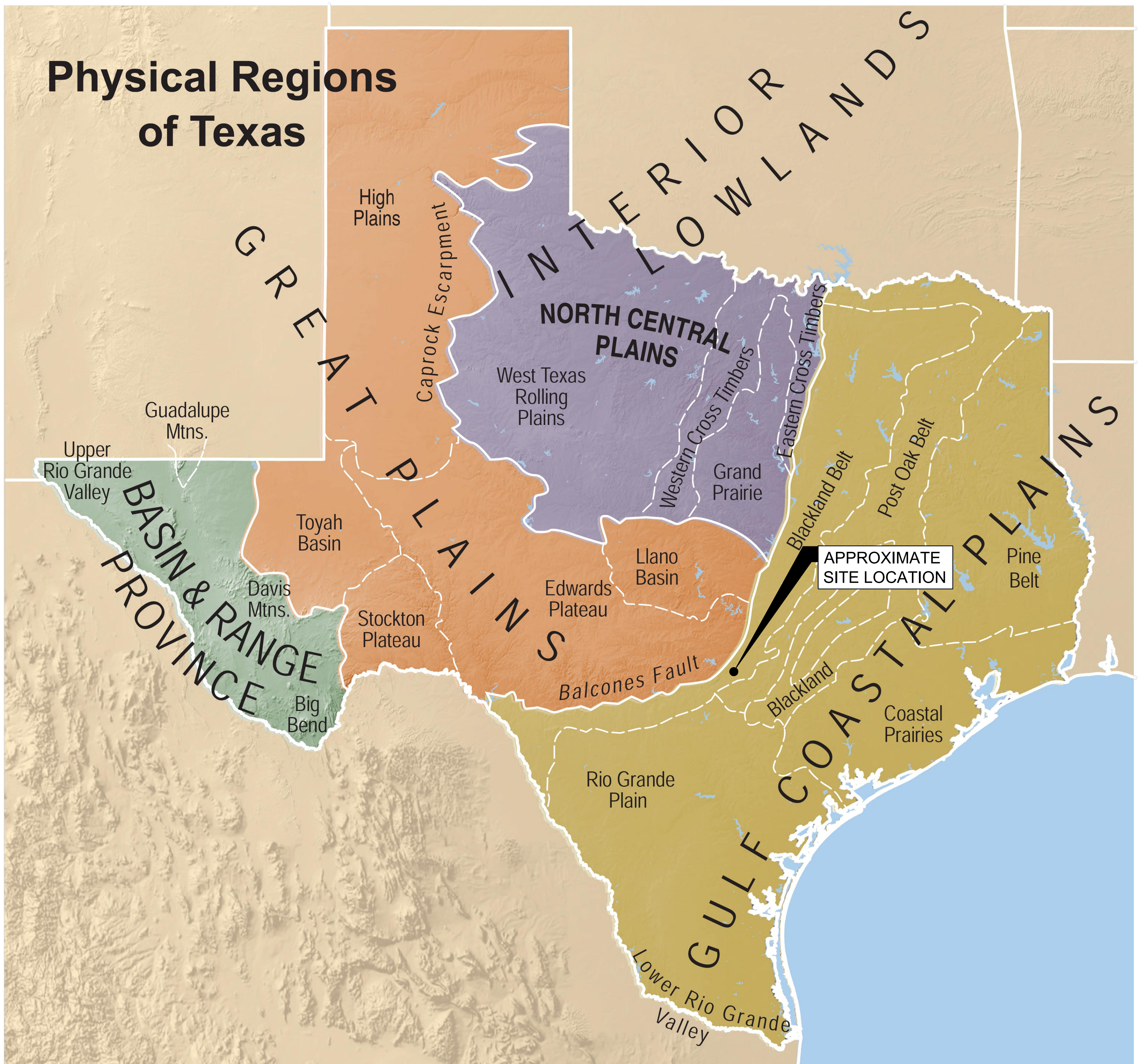
Boring Number	Hydraulic permeability, k (cm/s)			Source
	Test Type	Bouwer and Rice (1976)	KGS Model (1994)	
STRATUM III				
PZ-4	Slug In	4.7E-07		MFG (1991)
PZ-4	Slug Out	4.4E-07		MFG (1991)
P-6	Slug In	2.6E-06		MFG (1991)
P-6	Slug Out	3.0E-06		MFG (1991)
PZ-1	Slug Out	1.2E-07		MFG (1991)
PZ-3	Slug In	2.8E-08		MFG (1991)
PZ-3	Slug Out	4.5E-08		MFG (1991)
PZ-5	Slug In	4.1E-07		MFG (1991)
PZ-5	Slug Out	5.4E-07		MFG (1991)
PZ-6	Slug Out	1.3E-05		MFG (1991)
PZ-7	Slug Out	2.3E-06		MFG (1991)
PZ-11	Slug Out	4.9E-06		MFG (1991)
GB-01	Slug Out	1.1E-06		Geosyntec (2005)
GB-03	Slug Out	9.3E-06		Geosyntec (2005)
GB-04	Slug Out	6.7E-06		Geosyntec (2005)
GB-11	Slug Out	6.3E-06		Geosyntec (2005)
GB-13	Slug Out	3.1E-06		Geosyntec (2005)
GB-15	Slug Out	4.0E-07		Geosyntec (2005)
GB-21	Slug Out	3.1E-05		Geosyntec (2005)
GB-22	Slug Out	4.8E-07		Geosyntec (2005)
GB-33	Slug Out	5.9E-06	6.2E-06	Geosyntec (2023)
GB-41	Slug Out	5.1E-06	4.3E-06	Geosyntec (2023)
GB-50	Slug In	5.4E-06	4.1E-06	Geosyntec (2023)
GB-51	Slug Out	3.3E-06	3.6E-06	Geosyntec (2023)
STRATUM III AVERAGE[2]	1.5E-06			
STRATUM IV				
P-7	Slug Out	2.0E-07		MFG (1991)
P-10	Slug Out	3.9E-07		MFG (1991)
PZ-12	Slug Out	4.5E-06		MFG (1991)
STRATUM IV AVERAGE[2]	7.1E-07			

Notes:
1. Hydraulic Conductivity values measured via slug testing procedures and evaluated using Bouwer and Rice (1976) or KGS (1994).
2. The average hydraulic conductivities reported above were calculated as the geometric mean, based on recommendations by Domenico and Schwartz, Physical and Chemical Hydrogeology, 1990 [who state: "*...the "average" conductivity...is better described by the geometric mean...*"], because of the tendency of hydraulic conductivity properties of a formation to vary as a log-normal distribution.
3. Shaded table entries indicate parameters that were not obtained/tested at that Boring Number.

ATTACHMENT 4A

GEOLOGY REPORT DRAWINGS

LIST OF DRAWINGS		
Drawing No.	**Title**	**Drawing Date (latest revision)**
4A-1	Physical Regions of Texas Map	October 2023
4A-2	Geologic Vicinity Map	October 2023
4A-3	Regional Geologic Cross Section	October 2023
4A-4	Seismic Hazards Map	October 2023
4A-5	Location and Extent of Edwards Aquifer	October 2023
4A-6	Potentiometric Surface of Edwards Aquifer (July 1974)	October 2023
4A-7	Potentiometric Surface of Edwards Aquifer (November 2001)	October 2023
4A-8	Map of Area Wells	October 2023
4A-9A	Boring and Well Location Map Unit 1	October 2023
4A-9B	Boring and Well Location Map Unit 2	October 2023
4A-10	Geologic Cross Section Location Map	February 2024
4A-11	Geologic Cross Section A-A’	February 2024
4A-12	Geologic Cross Section B-B’	February 2024
4A-13	Geologic Cross Section C-C’	February 2024
4A-14	Geologic Cross Section D-D’ and E-E’	February 2024
4A-15	Geologic Cross Section F-F’	February 2024
4A-16	Geologic Cross Section G-G’ and H-H’	February 2024
4A-16A	Geologic Cross Section I-I’	February 2024
4A-17	Top of Stratum III Map	October 2023
4A-18	Top of Stratum IV Map	October 2023



MAP SOURCE: TEXAS ALMANAC, PHYSICAL REGIONS OF TEXAS, HTTPS://TEXASALMANAC.COM/TOPICS/ENVIRONMENT/PHYSICAL-REGIONS-TEXAS, REVIEWED BY BUTLER, DAVID. R, TEXAS STATE UNIVERSITY.

0 40 80
APPROXIMATE SCALE IN MILES

STATE OF TEXAS
MATTHEW WISSLER
GEOLOGY
13242
LICENSED
PROFESSIONAL GEOSCIENTIST
10/10/2023
FOR PERMIT PURPOSES ONLY

REV	DATE	DESCRIPTION	DRN	APP

WASTE MANAGEMENT
WASTE MANAGEMENT OF TEXAS, INC.
1700 KOHLENBERG ROAD
NEW BRAUNFELS, TEXAS 78130
PHONE: 830.625.7894

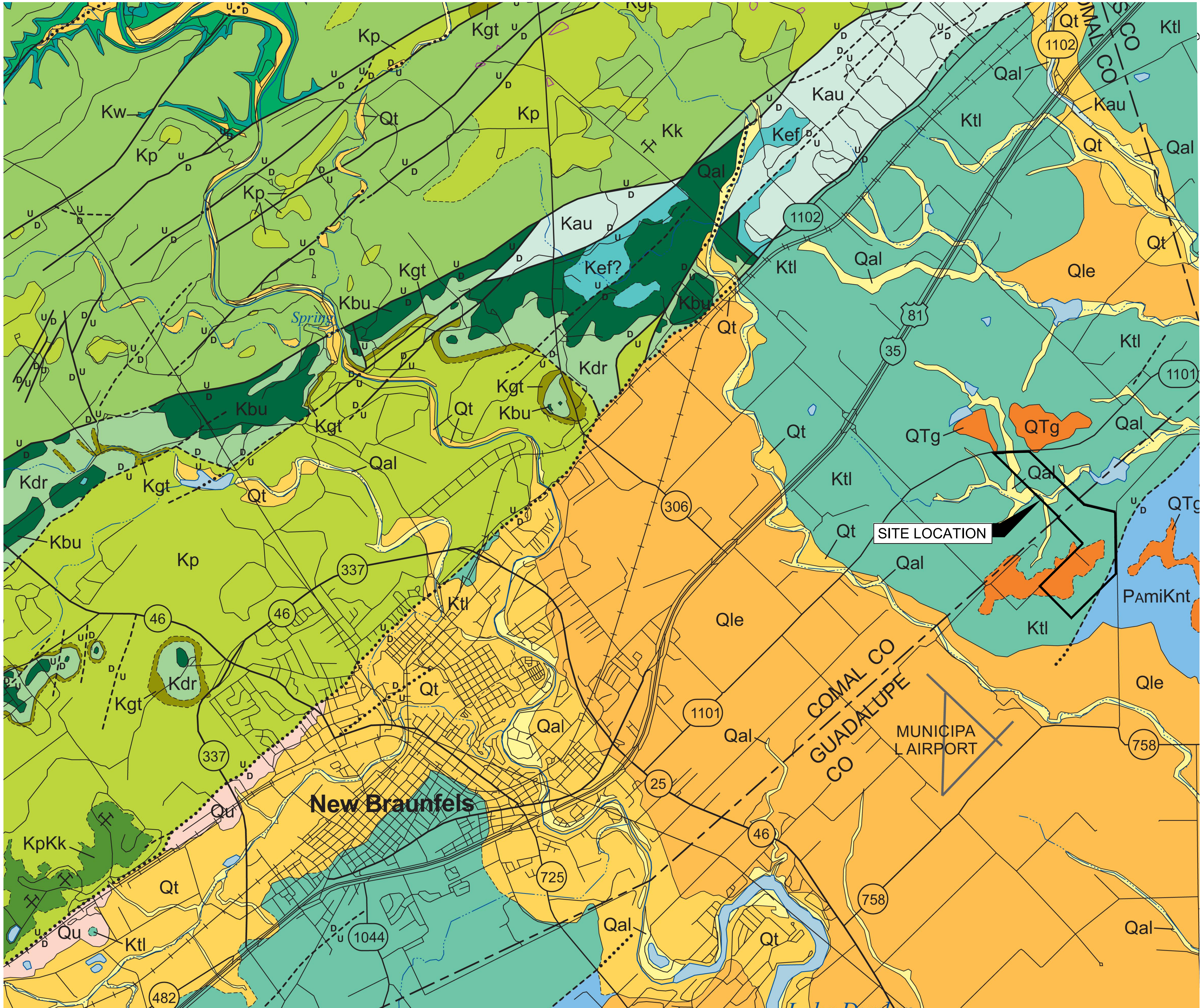
Geosyntec consultants
GEOSYNTEC CONSULTANTS, INC.
TEXAS PROF. GEOSCIENTISTS FIRM REG. NO. 50256
8217 SHOAL CREEK BLVD, SUITE 200
AUSTIN, TEXAS 78757
PHONE: 512.451.4003

TITLE:
PHYSICAL REGIONS OF TEXAS MAP

PROJECT:
MESQUITE CREEK LANDFILL EXPANSION
PERMIT AMENDMENT APPLICATION - MSW PERMIT NO. 66C

PERMIT DRAWING

PROJECT NO.:	GW8636	DESIGN BY:	MW	REVIEWED BY:	PP/YB	PART NO.:	DRAWING:
FILE:	GW8636P4A-1	DRAWN BY:	JJV / KH	APPROVED BY:	MW	III	4A-1



LEGEND

- Kau - AUSTIN CHAULK
- Kbu - BUDA LIMESTONE
- Kdr - DEL RIO CLAY
- Kef - EAGLE FORD GROUP
- Kk - KAINER FORMATION
- Kp - PERSON FORMATION
- Ktl - LOWER TAYLOR GROUP
- PAmiKnt - TAYLOR / NAVARRO / PALEOCENE MIDWAY GROUP
- Qal - ALLUVIUM
- Qle - LEONA FORMATION
- Qt - TERRACE ALLUVIUM
- QTg - OLDER GRAVELLY ALLUVIUM
- TEXAS DOT ROADWAY
- NORMAL FAULT; U = UPTHROWN BLOCK, D = DOWNTHROWN BLOCK (NOTE 1)

N

0 .5 1
SCALE IN MILES

MAP SOURCE: THE UNIVERSITY OF TEXAS AT AUSTIN BUREAU OF ECONOMIC GEOLOGY (TX BEG) IN COOPERATION WITH THE STATEMAP COMPONENT OF THE NATIONAL COOPERATIVE GEOLOGIC MAPPING PROGRAM, ADMINISTERED BY THE U.S. GEOLOGICAL SURVEY, OBTAINED JUNE 2022. MAPPING INFORMATION SHOWN IS FROM TX BEG MISCELLANEOUS MAP NO. 39, "GEOLOGIC MAP OF THE NEW BRAUNFELS, TEXAS, 30 X 60 MINUTE QUADRANGLE", E.W. COLLINS, 2000.

NOTE:

1. THIS PUBLISHED COLLINS (2000) MAP INDICATES THAT FAULTS SHOWN AS SOLID LINES ARE RELATIVELY MORE DISTINCT IN THE FIELD AND ON AERIAL PHOTOGRAPHS THAN WHERE THEY ARE DRAWN AS DASHED LINES.

STATE OF TEXAS
MATTHEW WISSLER
GEOLOGY
13242
LICENSED
PROFESSIONAL GEOSCIENTIST
10/10/2023

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REV	DATE	DESCRIPTION	DRN	APP

WASTE MANAGEMENT
WASTE MANAGEMENT OF TEXAS, INC.
1700 KOHLENBERG ROAD
NEW BRAUNFELS, TEXAS 78130
PHONE: 830.625.7894

Geosyntec consultants
GEOSYNTEC CONSULTANTS, INC.
TEXAS PROF. GEOSCIENTISTS FIRM REG. NO. 50256
8217 SHOAL CREEK BLVD, SUITE 200
AUSTIN, TEXAS 78757
PHONE: 512.451.4003

TITLE: GEOLOGIC VICINITY MAP

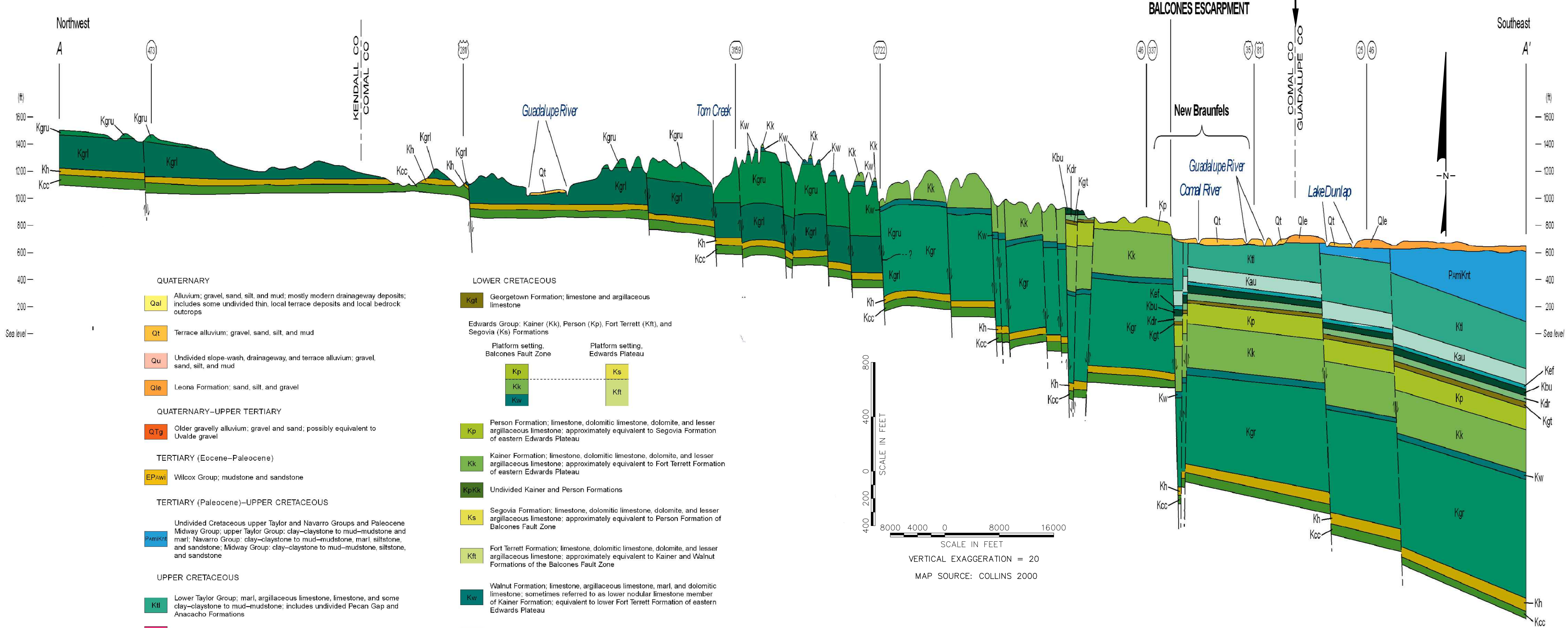
PROJECT: MESQUITE CREEK LANDFILL EXPANSION
PERMIT AMENDMENT APPLICATION - MSW PERMIT NO. 66C

PROJECT NO.: GW8636	DESIGN BY: MW	REVIEWED BY: SMG/MW	PART NO.: III	DRAWING: 4A-2
FILE: GW8636P4A-2	DRAWN BY: JJV / KH	APPROVED BY: MW		

PERMIT DRAWING

AUS-01\P:\CADD\PROJECTS\MESQUITE CREEK LANDFILL\PERMIT EXPANSION 66C (GW8636)\04-07 DRAWINGS PARTS I-IV\GW8636P4A-2.DWG

CROSS SECTION A–A'



QUATERNARY

- Qal — Alluvium; gravel, sand, silt, and mud; mostly modern drainageway deposits; includes some undivided thin, local terrace deposits and local bedrock outcrops
- Qt — Terrace alluvium; gravel, sand, silt, and mud
- Qu — Undivided slope-wash, drainageway, and terrace alluvium; gravel, sand, silt, and mud
- Qle — Leona Formation; sand, silt, and gravel

QUATERNARY–UPPER TERTIARY

- QTg — Older gravelly alluvium; gravel and sand; possibly equivalent to Uvalde gravel

TERTIARY (Eocene–Paleocene)

- EPAwi — Wilcox Group; mudstone and sandstone

TERTIARY (Paleocene)–UPPER CRETACEOUS

- PzmKnt — Undivided Cretaceous upper Taylor and Navarro Groups and Paleocene Midway Group; upper Taylor Group: clay–claystone to mud–mudstone and marl; Navarro Group: clay–claystone to mud–mudstone, marl, siltstone, and sandstone; Midway Group: clay–claystone to mud–mudstone, siltstone, and sandstone

UPPER CRETACEOUS

- Ktl — Lower Taylor Group; marl, argillaceous limestone, limestone, and some clay–claystone to mud–mudstone; includes undivided Pecan Gap and Anacacho Formations
- Kb — Basalt; minor occurrences
- Kau — Austin Group; chalk, limestone, and argillaceous limestone
- KtlKau — Undivided Austin and lower Taylor Groups
- Kef — Eagle Ford Formation; shale to mudstone, siltstone, and flaggy limestone
- Kbu — Buda Formation; limestone
- Kdr — Del Rio Formation; clay–claystone to mud–mudstone

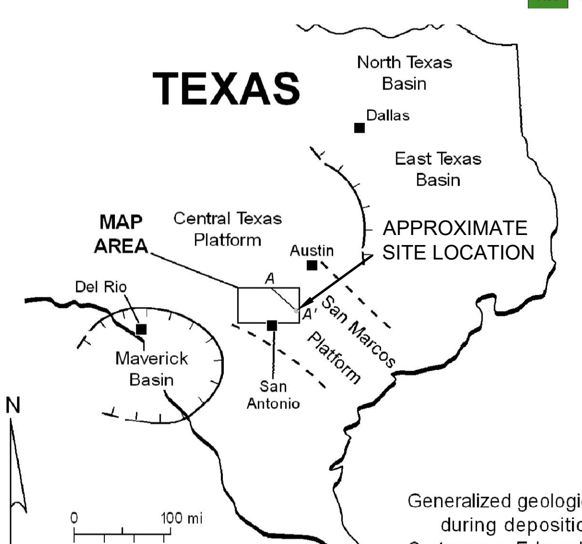
LOWER CRETACEOUS

- Kgt — Georgetown Formation; limestone and argillaceous limestone

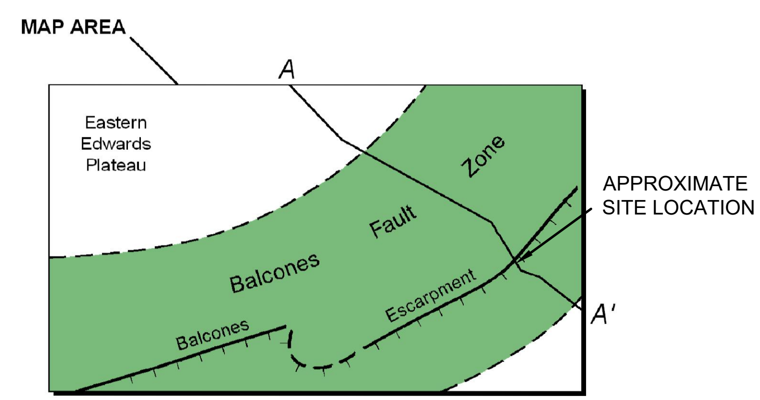
Edwards Group: Kainer (Kk), Person (Kp), Fort Terrett (Kft), and Segovia (Ks) Formations

Platform setting, Balcones Fault Zone	Platform setting, Edwards Plateau
Kp	Ks
Kk	Kft
Kw	

- Kp — Person Formation; limestone, dolomitic limestone, dolomite, and lesser argillaceous limestone; approximately equivalent to Segovia Formation of eastern Edwards Plateau
- Kk — Kainer Formation; limestone, dolomitic limestone, dolomite, and lesser argillaceous limestone; approximately equivalent to Fort Terrett Formation of eastern Edwards Plateau
- KpKk — Undivided Kainer and Person Formations
- Ks — Segovia Formation; limestone, dolomitic limestone, dolomite, and lesser argillaceous limestone; approximately equivalent to Person Formation of Balcones Fault Zone
- Kft — Fort Terrett Formation; limestone, dolomitic limestone, dolomite, and lesser argillaceous limestone; approximately equivalent to Kainer and Walnut Formations of the Balcones Fault Zone
- Kw — Walnut Formation; limestone, argillaceous limestone, marl, and dolomitic limestone; sometimes referred to as lower nodular limestone member of Kainer Formation; equivalent to lower Fort Terrett Formation of eastern Edwards Plateau
- Kgru — Upper Glen Rose Formation; limestone, dolomitic limestone, argillaceous limestone, and some marl
- Kgrl — Lower Glen Rose Formation; limestone, dolomitic limestone, argillaceous limestone, and some marl; top of unit marked by *Corbula* interval; letter C indicates where *Corbula* interval was observed in field
- Kgr — Undivided Glen Rose Formation on east part of cross section
- Kh — Hensell Formation; sandy limestone and sandy dolomitic limestone (Canyon Lake area)
- Kcc — Cow Creek Formation; sandy limestone and argillaceous limestone



Generalized geologic setting during deposition of Cretaceous Edwards Group



Geomorphic elements

STATE OF TEXAS
MATTHEW WISSLER
GEOLOGY
13242
LICENSED
PROFESSIONAL GEOSCIENTIST
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REV	DATE	DESCRIPTION	DRN	APP

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WASTE MANAGEMENT OF TEXAS, INC.
1700 KOHLENBERG ROAD
NEW BRAUNFELS, TEXAS 78130
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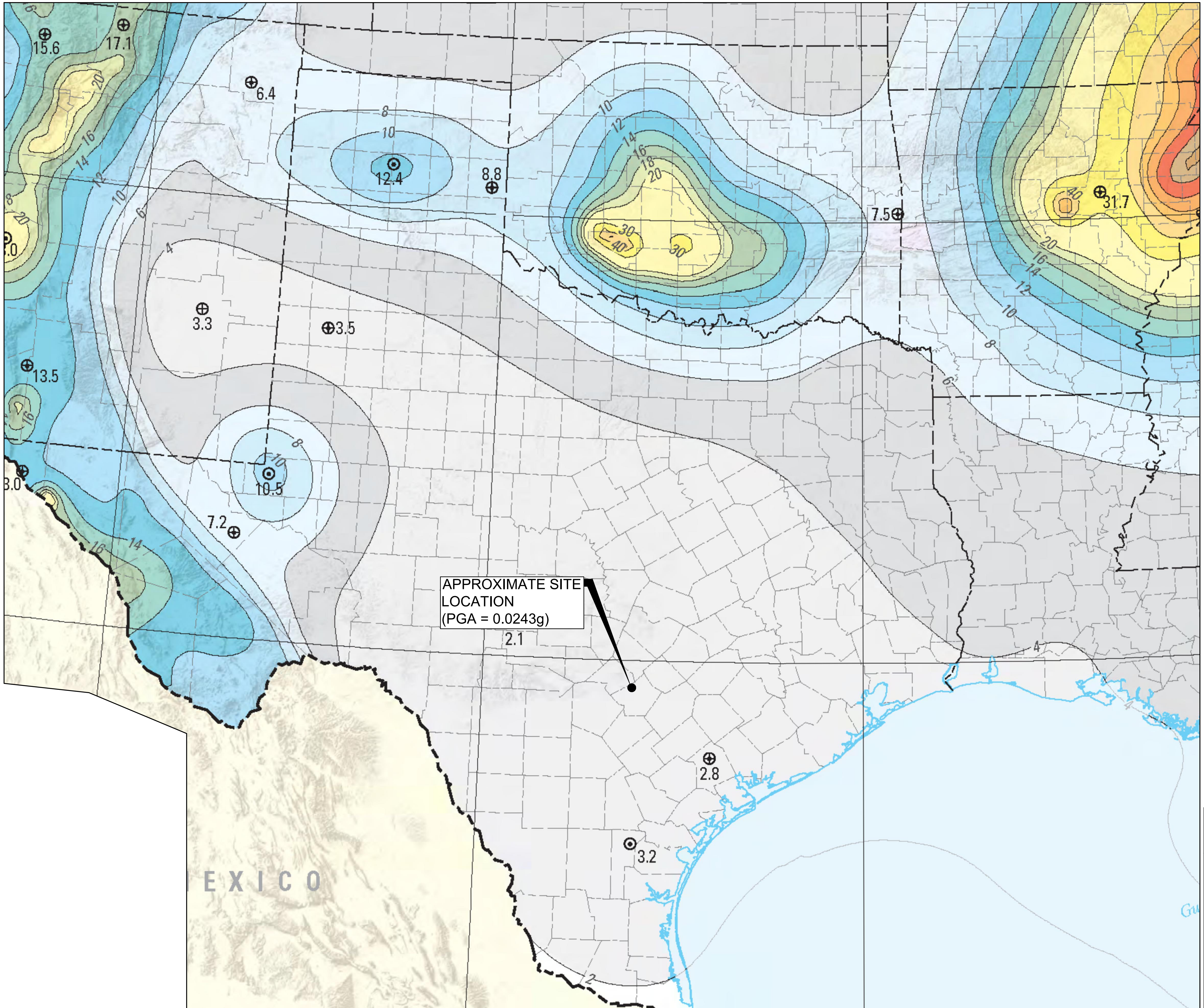
TEXAS PROF. GEOSCIENTISTS FIRM REG. NO. 50256
8217 SHOAL CREEK BLVD, SUITE 200
AUSTIN, TEXAS 78757
PHONE: 512.451.4003

TITLE: REGIONAL GEOLOGIC CROSS SECTION

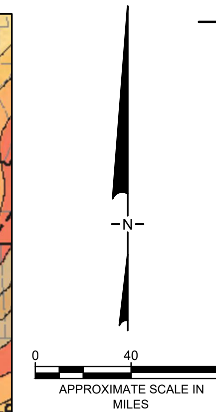
PROJECT: MESQUITE CREEK LANDFILL EXPANSION
PERMIT AMENDMENT APPLICATION - MSW PERMIT NO. 66C

PERMIT DRAWING

PROJECT NO.: GW8636	DESIGN BY: MW	REVIEWED BY: PP/YB	PART NO.: III	DRAWING: 4A-3
FILE: GW8636P4A-3	DRAWN BY: JJV / KH	APPROVED BY: MW		



PERMIT DRAWING



LEGEND

AREAS WHERE SUSPECTED NONTECTONIC EARTHQUAKES HAVE BEEN DELETED

PEAK ACCELERATION, EXPRESSED AS A FRACTION OF STANDARD GRAVITY (g)

%g
≥200
160–200
120–160
80–120
60–80
50–60
40–50
30–40
20–30
18–20
16–18
14–16
12–14
10–12
8–10
6–8
4–6
2–4
≤2

Contours of peak acceleration expressed as a percent of gravity (%g)

10 — Onshore

10 — Offshore

Point values of peak acceleration expressed as a percent of gravity (%g)

3.2 Local maximum

6.9 Local minimum

8.8 Saddle point

MAP OF PEAK GROUND ACCELERATION (%g) WITH 2% PROBABILITY OF EXCEEDANCE IN 50 YEARS. BASE MAP SOURCE: USGS SEISMIC-HAZARD MAPS FOR THE CONTERMINOUS UNITED STATES, 2014. PEAK HORIZONTAL ACCELERATION WITH 2 PERCENT PROBABILITY OF EXCEEDANCE IN 50 YEARS. BY MARK D. PETERSEN, MORGAN P. MOSCHETTI, PETER M. POWERS, CHARLES S. MUELLER, KATHLEEN M. HALLER, ARTHUR D. FRANKEL, YUEHUA ZENG, SANAZ REZAEIAN, STEPHEN C. HARMSEN, OLIVER S. BOYD, EDWARD H. FIELD, RUI CHEN, NICOLAS LUCO, RUSSELL L. WHEELER, ROBERT A. WILLIAMS, ANNA H. OLSEN, AND KENNETH S. RUKSTALES.(https://www.usgs.gov/maps/seismic-hazard-maps-conterminous-united-states-2014).

STATE OF TEXAS
MATTHEW WISSLER
GEOLOGY
13242
LICENSED
PROFESSIONAL GEOSCIENTIST

10/10/2023

FOR PERMIT PURPOSES ONLY

REV	DATE	DESCRIPTION	DRN	APP

WASTE MANAGEMENT
WASTE MANAGEMENT OF TEXAS, INC.
1700 KOHLENBERG ROAD
NEW BRAUNFELS, TEXAS 78130
PHONE: 830.625.7894

Geosyntec consultants
GEOSYNTEC CONSULTANTS, INC.
TEXAS PROF. GEOSCIENTISTS FIRM REG. NO. 50256
8217 SHOAL CREEK BLVD, SUITE 200
AUSTIN, TEXAS 78757
PHONE: 512.451.4003

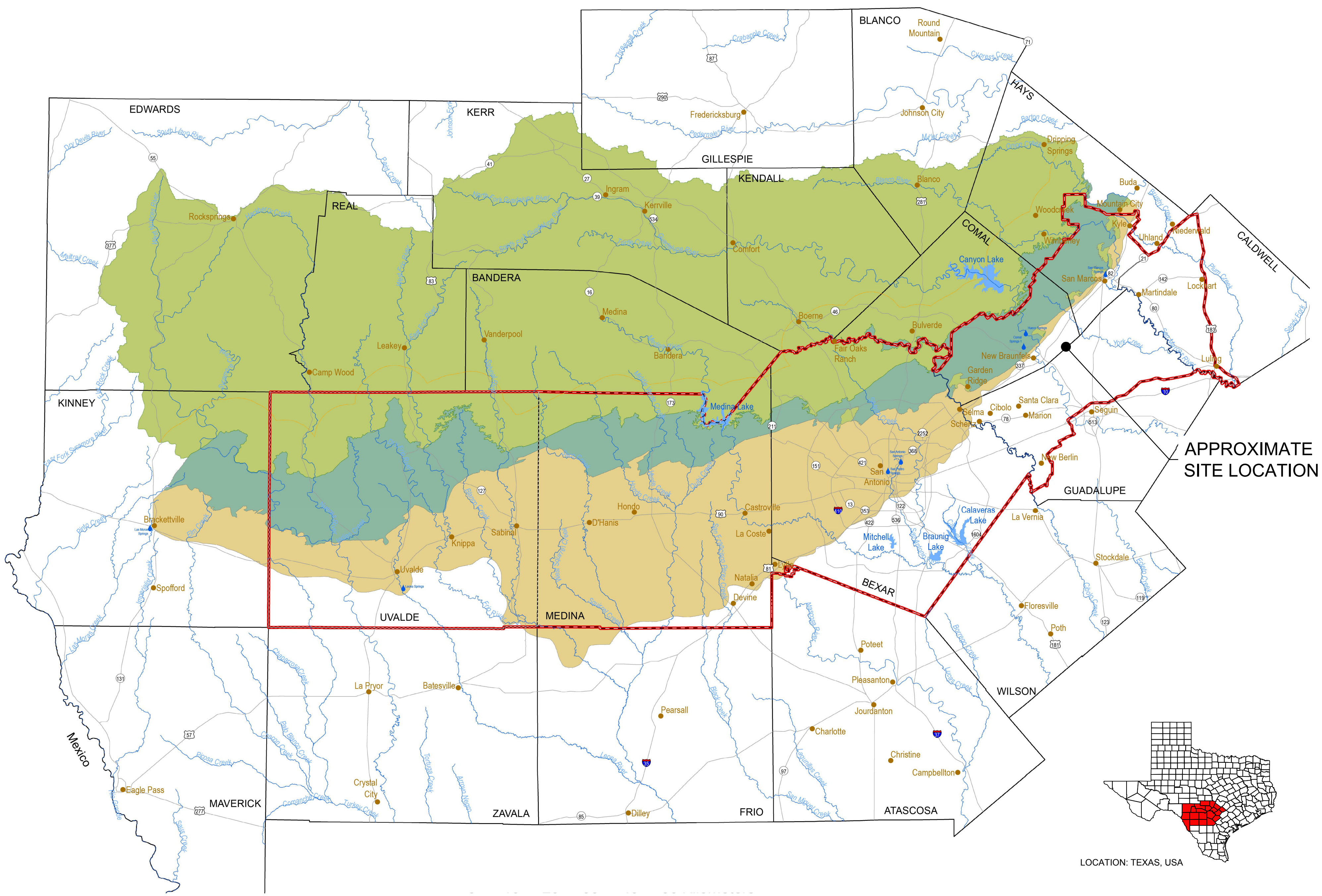
TITLE:

SEISMIC HAZARDS MAP

PROJECT:

MESQUITE CREEK LANDFILL EXPANSION
PERMIT AMENDMENT APPLICATION - MSW PERMIT NO. 66C

PROJECT NO.:	GW8636	DESIGN BY:	MW	REVIEWED BY:	SMG/MW	PART NO.: III	DRAWING: 4A-4
FILE:	GW8636P4A-4	DRAWN BY:	JJV / KH	APPROVED BY:	MW		



MAP SOURCE: EDWARDS AQUIFER AUTHORITY, HTTPS://WWW.EDWARDSAQUIFER.ORG/WP-CONTENT/UPLOADS/2021/08/EDWARDSAQUIFERSYSTEMPOOLSLARGEPRINTFORMAT.PDF.

N

0 1 2
SCALE IN MILES

LEGEND

- CONTRIBUTING ZONE
- RECHARGE ZONE
- ARTESIAN ZONE

LOCATION: TEXAS, USA

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MATTHEW WISSLER
GEOLOGY
13242
LICENSED
PROFESSIONAL GEOSCIENTIST
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WASTE MANAGEMENT
WASTE MANAGEMENT OF TEXAS, INC.
1700 KOHLENBERG ROAD
NEW BRAUNFELS, TEXAS 78130
PHONE: 830.685.7894

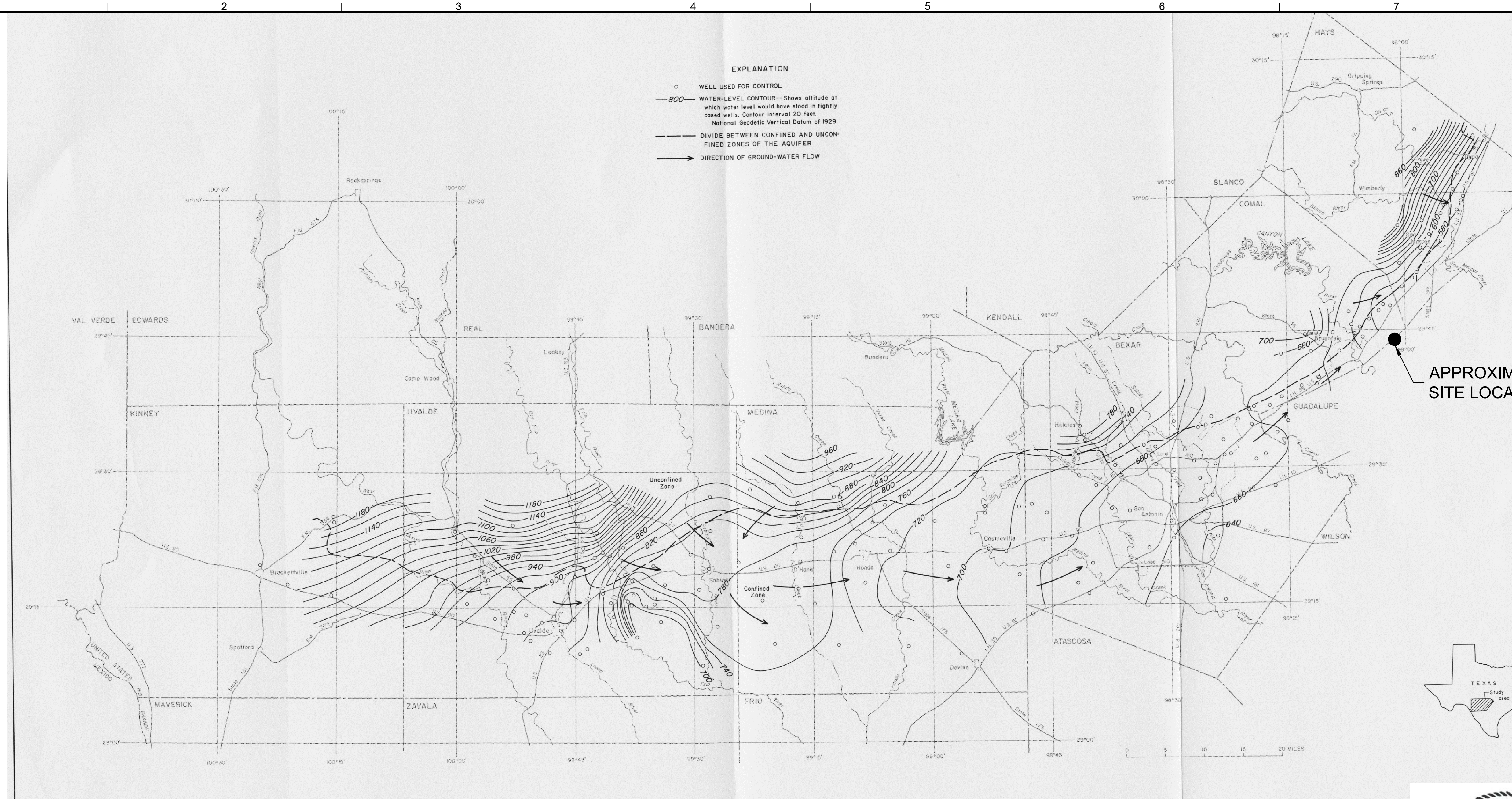
Geosyntec consultants
GEOSYNTEC CONSULTANTS, INC.
TEXAS PROF. GEOSCIENTISTS FIRM REG. NO. 50256
8217 SHOAL CREEK BLVD, SUITE 200
AUSTIN, TEXAS 78757
PHONE: 512.451.4003

TITLE:
LOCATION AND EXTENT OF EDWARDS AQUIFER

PROJECT:
MESQUITE CREEK LANDFILL EXPANSION
PERMIT AMENDMENT APPLICATION - MSW PERMIT NO. 66C

PROJECT NO.: GW8636	DESIGN BY: MW	REVIEWED BY: PP/YB	PART NO.: III	DRAWING: 4A-5
FILE: GW8636P4A-5	DRAWN BY: JJV / KH	APPROVED BY: MW		

PERMIT DRAWING



SOURCE: MACLAY AND SMALL, 1986

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GEOLOGY
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WASTE MANAGEMENT
WASTE MANAGEMENT OF TEXAS, INC.
1700 KOHLENBERG ROAD
NEW BRAUNFELS, TEXAS 78130
PHONE: 830.625.7894

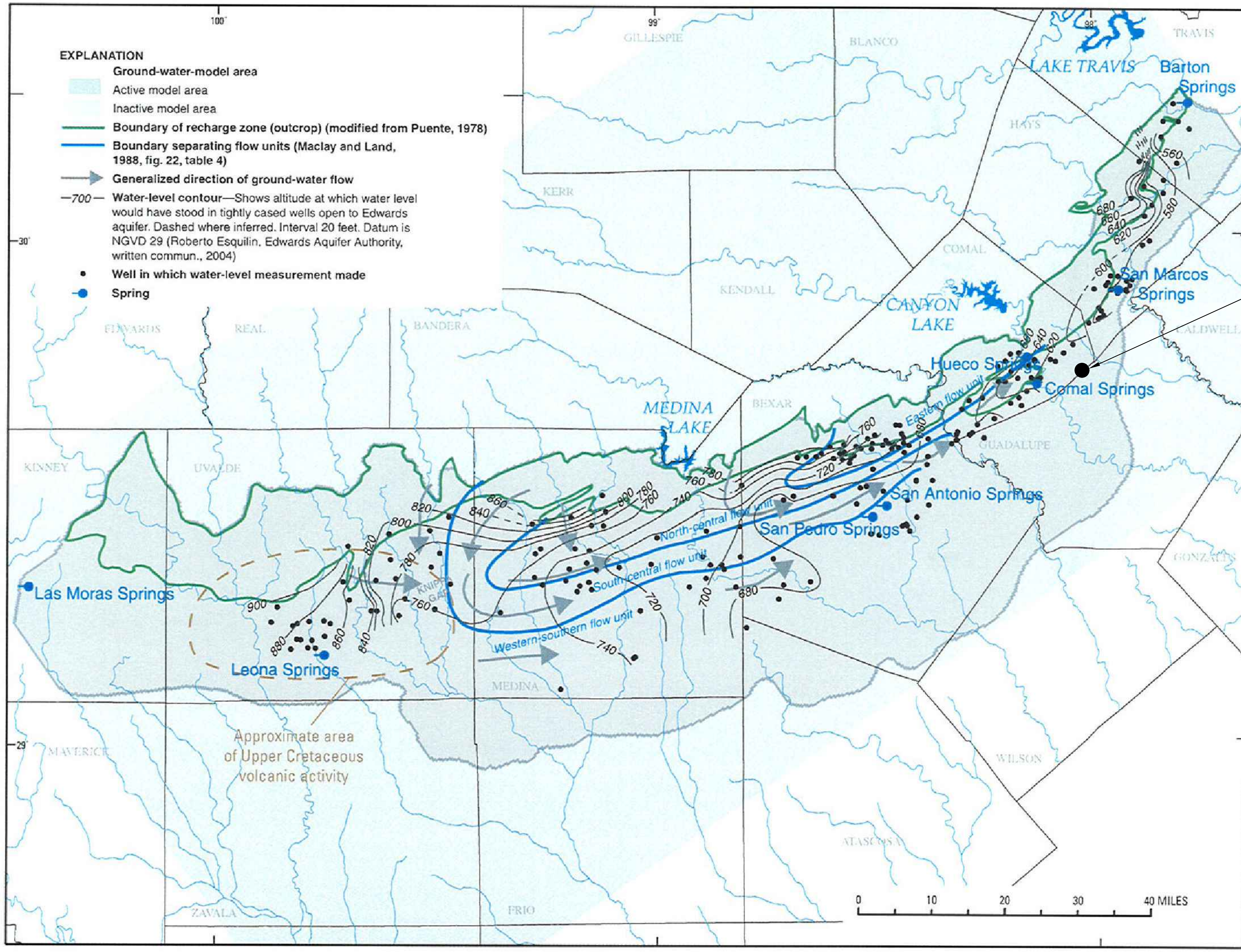
Geosyntec consultants
GEOSYNTEC CONSULTANTS, INC.
TEXAS PROF. GEOSCIENTISTS FIRM REG. NO. 50256
8217 SHOAL CREEK BLVD, SUITE 200
AUSTIN, TEXAS 78757
PHONE: 512.451.4003

TITLE: POTENTIOMETRIC SURFACE OF EDWARDS AQUIFER (JULY 1974)

PROJECT: MESQUITE CREEK LANDFILL EXPANSION
PERMIT AMENDMENT APPLICATION - MSW PERMIT NO. 66C

PROJECT NO.: GW8636	DESIGN BY: MW	REVIEWED BY: PP/YB	PART NO.: III	DRAWING: 4A-6
FILE: GW8636P4A-6	DRAWN BY: JJV / KH	APPROVED BY: MW		

PERMIT DRAWING



SOURCE: LINDGREN ET AL. (2004), BASED ON DATA FROM OCTOBER 27 TO NOVEMBER 2, 2001.

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MATTHEW WISSLER
GEOLOGY
13242
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PROFESSIONAL GEOSCIENTIST
10/10/2023

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WASTE MANAGEMENT
WASTE MANAGEMENT OF TEXAS, INC.
1700 KOHLENBERG ROAD
NEW BRAUNFELS, TEXAS 78130
PHONE: 830.685.7894

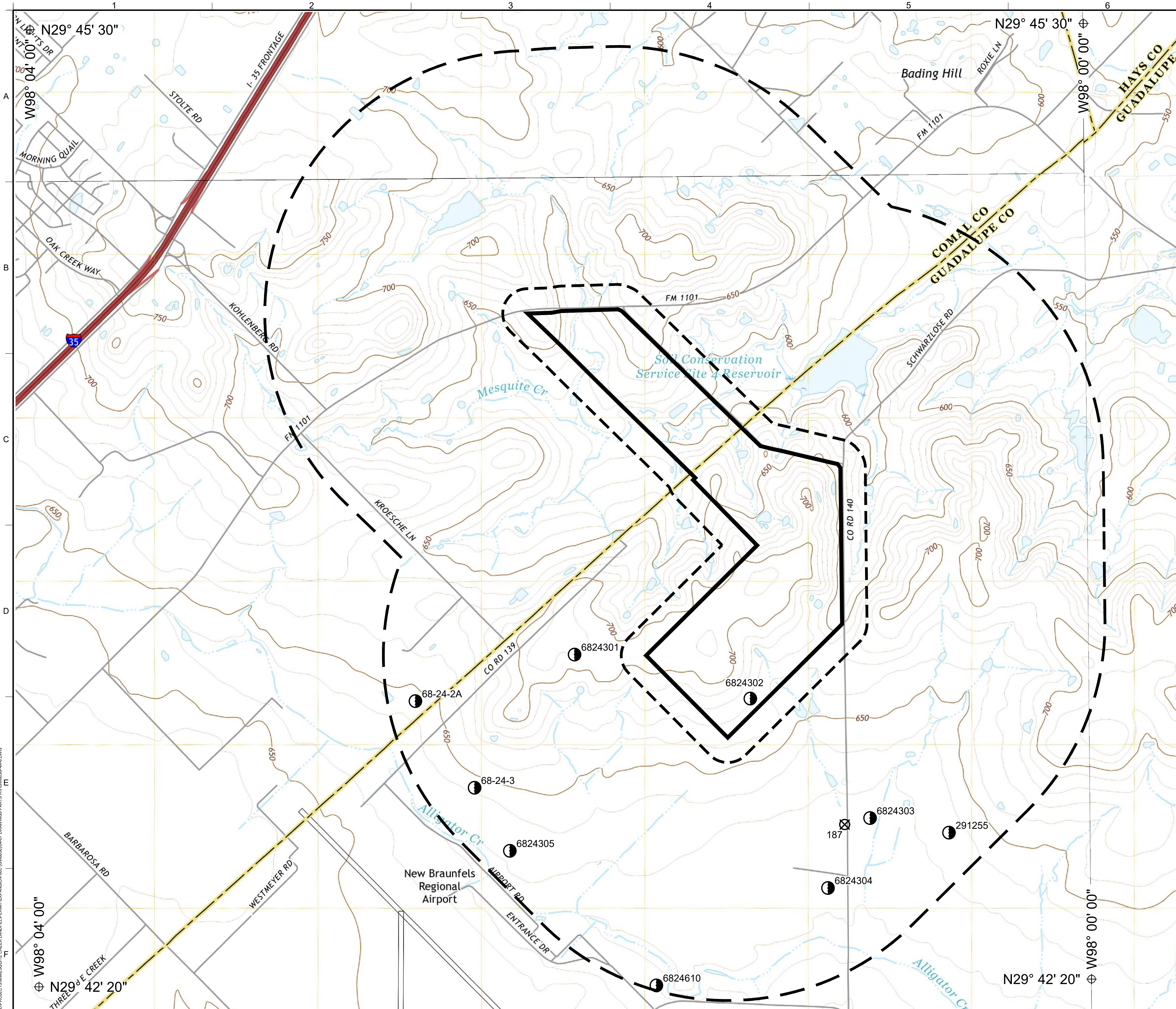
Geosyntec consultants
GEOSYNTEC CONSULTANTS, INC.
TEXAS PROF. GEOSCIENTISTS FIRM REG. NO. 50256
8217 SHOAL CREEK BLVD, SUITE 200
AUSTIN, TEXAS 78757
PHONE: 512.451.4003

TITLE: POTENTIOMETRIC SURFACE OF EDWARDS AQUIFER (NOVEMBER 2001)

PROJECT: MESQUITE CREEK LANDFILL EXPANSION
PERMIT AMENDMENT APPLICATION - MSW PERMIT NO. 66C

PERMIT DRAWING

PROJECT NO.: GW8636	DESIGN BY: MW	REVIEWED BY: PP/YB	PART NO.: III	DRAWING: 4A-7
FILE: GW8636P4A-7	DRAWN BY: JJV / KH	APPROVED BY: MW		



LEGEND

- PERMIT BOUNDARY
- ONE MILE RADIUS FROM PERMIT BOUNDARY
- 500 FOOT RADIUS FROM PERMIT BOUNDARY
- WATER WELL (NOTE 2)
- OIL OR GAS WELL (NOTE 3)
- STREAM
- SURFACE WATER BODY

ROAD CLASSIFICATION

Expressway — Local Connector
Secondary Hwy — Local Road
Ramp — 4WD
Interstate Route — US Route — State Route

0 1000' 2000'
SCALE IN FEET

NOTES:

1. MAP SOURCE: UNITED STATES DEPARTMENT OF THE INTERIOR, GEOLOGICAL SURVEY (USGS), 7 1/2 MINUTE SERIES QUADRANGLE TOPOGRAPHIC MAP OF GERONIMO, HUNTER, NEW BRAUNFELS AND SAN MARCOS, TEXAS DATED 2019.
2. WATER WELL DATA PROVIDED BY BANKS ENVIRONMENTAL DATA (BANKS, 2022). BANKS RESEARCHED PUBLICLY-AVAILABLE STATE WELL RECORDS OF THE TEXAS WATER DEVELOPMENT BOARD (TWDB). THE TEXAS COMMISSION ON ENVIRONMENTAL QUALITY (TCEQ), AND THE U.S. GEOLOGICAL SURVEY. THE SEARCH COVERED THE AREA WITHIN ONE MILE FROM THE PROPOSED PERMIT BOUNDARY. WATER WELL ID NUMBER REFERS TO TWDB STATE WELL NUMBER OR TCEQ WELL ID NUMBER DEPENDING ON THE SOURCE OF INFORMATION.
3. OIL AND GAS WELL DATA PROVIDED BY BANKS ENVIRONMENTAL DATA (BANKS 2022), FROM A SEARCH OF AVAILABLE RECORDS MADE PUBLIC BY THE TEXAS RAILROAD COMMISSION (RRC) AND TWDB WITHIN ONE MILE FROM THE PROPOSED PERMIT BOUNDARY. OIL AND GAS WELL ID NUMBER REFERS TO RRC WELL (API) NUMBER.
4. REFER TO THE GEOLOGY REPORT (PART III, ATTACHMENT 4) FOR MORE INFORMATION ON THE WELL(S) WITHIN 1 MILE OF THE SITE.
5. ON-SITE WELL ID 6824302 IS LISTED IN THE TWDB WATER WELL RECORDS AS AN "OIL TEST WELL" DRILLED IN 1957 AND ABANDONED BECAUSE IT DID NOT PRODUCE OIL.
6. THERE ARE NO EXISTING OIL OR GAS EXPLORATION OR PRODUCTION WELLS ON-SITE OR WITHIN 500-FT OF THE SITE.

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MATTHEW WISSLER
GEOLOGY
13242
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PROFESSIONAL GEOSCIENTIST
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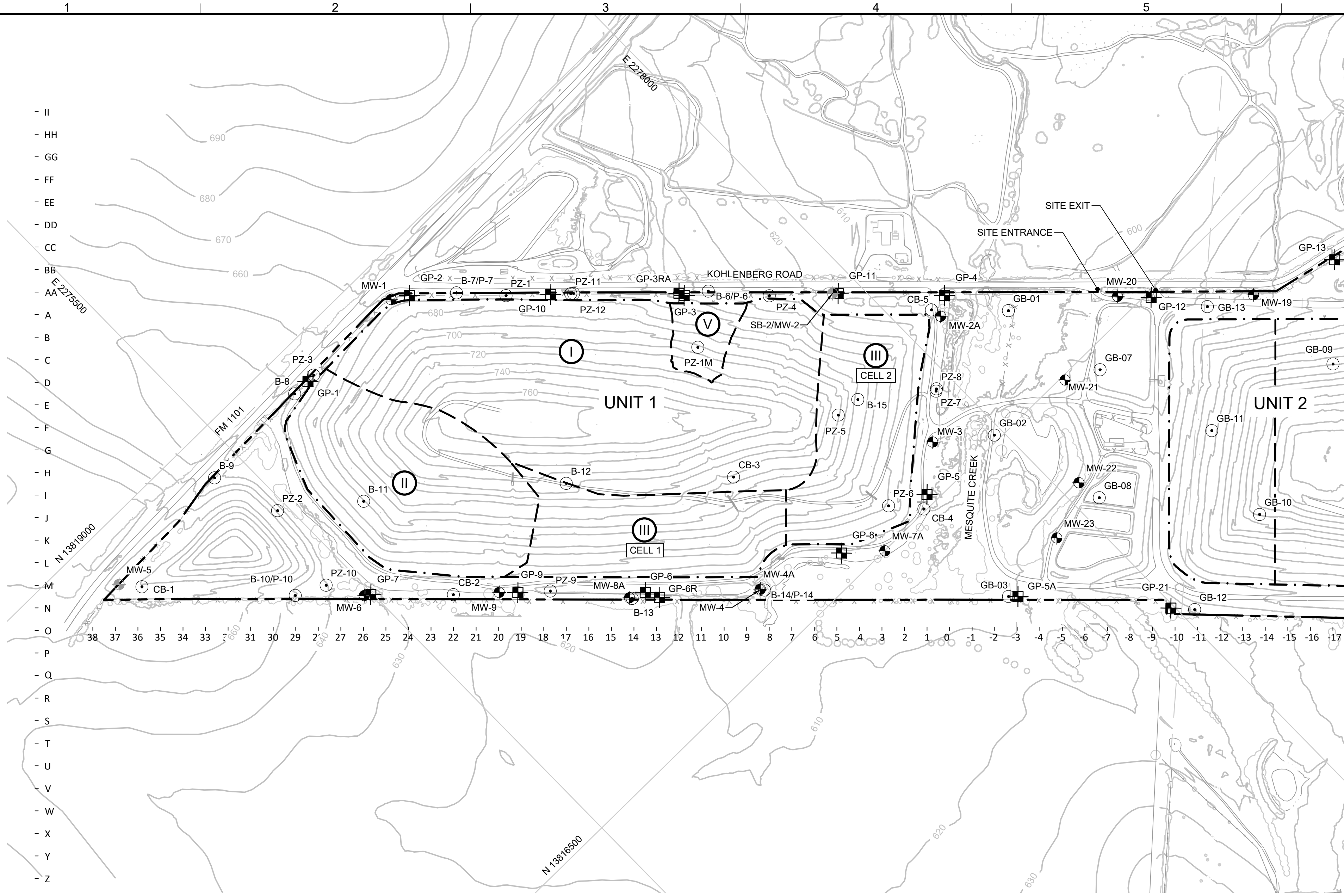
WASTE MANAGEMENT
WASTE MANAGEMENT OF TEXAS, INC.
1700 KOHLENBERG ROAD
NEW BRAUNFELS, TEXAS 78130
PHONE: 830.625.7894

Geosyntec consultants
GEOSYNTEC CONSULTANTS, INC.
TEXAS PROF. GEOSCIENTISTS FIRM REG. NO. 50256
8217 SHOAL CREEK BLVD, SUITE 200
AUSTIN, TEXAS 78757
PHONE: 512.451.4003

TITLE: MAP OF AREA WELLS

PROJECT: MESQUITE CREEK LANDFILL EXPANSION
PERMIT AMENDMENT APPLICATION - MSW PERMIT NO. 66C

PROJECT NO.:	GW8636	DESIGN BY:	MW	REVIEWED BY:	PP/YB	PART NO.: III	DRAWING: 4A-8
FILE:	GW8636P4A-8	DRAWN BY:	JJV / KH	APPROVED BY:	MW		



LEGEND

580	EXISTING GROUND ELEVATION CONTOUR (FT, MSL) (NOTES 1, 2)
	EXISTING ROAD
	EXISTING VEGETATION / TREE
x x	EXISTING FENCE
	EXISTING BUILDING
	EXISTING WATER LINE
13 A	SITE GRID
	PERMIT BOUNDARY
	LIMIT OF WASTE
	PHASE BOUNDARY
III	PHASE DESIGNATION
MW-18	EXISTING MONITORING WELL
MW-4	PLUGGED MONITORING WELL
GP-2	GAS MONITORING PROBE
CB-2	PREVIOUS SOIL BORING

NOTES:

1. TOPOGRAPHIC BASE MAP OF EXISTING SITE CONDITIONS WAS GENERATED BY PHOTOGRAMMETRIC METHODS BASED ON AN AERIAL SURVEY FLOWN ON 15 FEBRUARY 2023 BY HYDREX ENVIRONMENTAL, AND BY DALLAS AERIAL SURVEYING (DAS) FLOWN IN 2018-2019. EXISTING TOPOGRAPHY OUTSIDE OF PROPERTY WHERE SHOWN SUPPLEMENTED WITH THE UNITED STATES GEOLOGIC SURVEY (USGS) 3DEP PROGRAM PUBLISHED IN NOVEMBER 2021.
2. ELEVATIONS ARE IN FEET ABOVE MEAN SEA LEVEL (FT, MSL). DRAWING COORDINATES ARE BASED ON TEXAS STATE PLANE SOUTH CENTRAL ZONE (4204) US FOOT COORDINATE SYSTEM, NORTH AMERICAN DATUM OF 1983 (NAD-83).

0 300' 600'
SCALE IN FEET

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PROFESSIONAL GEOSCIENTIST
10/10/2023

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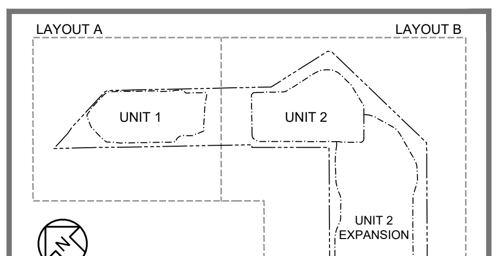


KEY MAP
SCALE: N.T.S.

PERMIT DRAWING

REV	DATE	DESCRIPTION	DRN	APP

WASTE MANAGEMENT
WASTE MANAGEMENT OF TEXAS, INC.
1700 KOHLENBERG ROAD
NEW BRAUNFELS, TEXAS 78130
PHONE: 830.625.7894

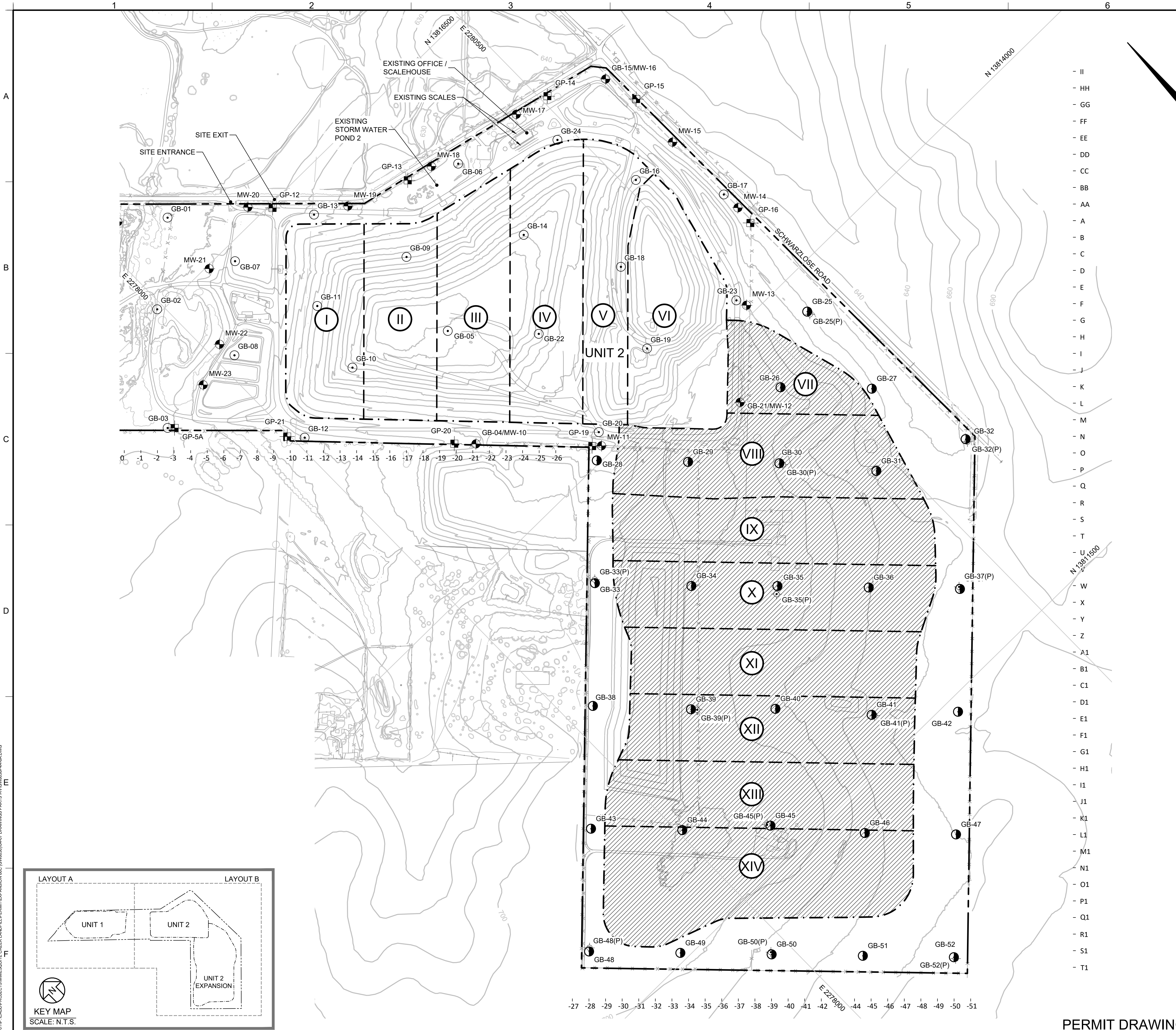
Geosyntec consultants
GEOSYNTEC CONSULTANTS, INC.
TEXAS PROF. GEOSCIENTISTS FIRM REG. NO. 50256
8217 SHOAL CREEK BLVD, SUITE 200
AUSTIN, TEXAS 78757
PHONE: 512.451.4003

TITLE: BORING AND WELL LOCATION MAP UNIT 1

PROJECT: MESQUITE CREEK LANDFILL EXPANSION
PERMIT AMENDMENT APPLICATION - MSW PERMIT NO. 66C

PROJECT NO.: GW8636	DESIGN BY: MW	REVIEWED BY: PP/YB	PART NO.: III	DRAWING: 4A-9A
FILE: GW8636P4A-8B	DRAWN BY: JJV / KH	APPROVED BY: MW		

AUS-01\P:\CADD\PROJECTS\MESQUITE CREEK LANDFILL\PERMIT EXPANSION 66C (GW8636)\04-07 DRAWINGS PARTS I-IV\GW8636P4A-8B.DWG



LEGEND

580	EXISTING GROUND ELEVATION CONTOUR (FT, MSL) (NOTES 1, 2)
	EXISTING ROAD
	EXISTING VEGETATION / TREE
x x	EXISTING FENCE
	EXISTING BUILDING
	EXISTING WATER LINE
13 A	SITE GRID
	PERMIT BOUNDARY
	LIMIT OF WASTE
	PHASE BOUNDARY
	EXPANSION AREA
III	PHASE DESIGNATION
MW-18	EXISTING MONITORING WELL
GP-2	GAS MONITORING PROBE
CB-2	PREVIOUS SOIL BORING
GB-37	2022/2023 GEOSYNTEC SOIL BORING
GB-37(P)	2022/2023 GEOSYNTEC SOIL BORING COMPLETED AS PIEZOMETER

NOTES:

1. TOPOGRAPHIC BASE MAP OF EXISTING SITE CONDITIONS WAS GENERATED BY PHOTOGRAMMETRIC METHODS BASED ON AN AERIAL SURVEY FLOWN ON 15 FEBRUARY 2023 BY HYDREX ENVIRONMENTAL, AND BY DALLAS AERIAL SURVEYING (DAS) FLOWN IN 2018-2019. EXISTING TOPOGRAPHY OUTSIDE OF PROPERTY WHERE SHOWN SUPPLEMENTED WITH THE UNITED STATES GEOLOGIC SURVEY (USGS) 3DEP PROGRAM PUBLISHED IN NOVEMBER 2021.
2. ELEVATIONS ARE IN FEET ABOVE MEAN SEA LEVEL (FT, MSL). DRAWING COORDINATES ARE BASED ON TEXAS STATE PLANE SOUTH CENTRAL ZONE (4204) US FOOT COORDINATE SYSTEM, NORTH AMERICAN DATUM OF 1983 (NAD-83).

0 300' 600'
SCALE IN FEET

STATE OF TEXAS
MATTHEW WISSLER
GEOLOGY
13242
LICENSED
PROFESSIONAL GEOSCIENTIST
10/10/2023

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REV	DATE	DESCRIPTION	DRN	APP

WASTE MANAGEMENT
WASTE MANAGEMENT OF TEXAS, INC.
1700 KOHLENBERG ROAD
NEW BRAUNFELS, TEXAS 78130
PHONE: 830.625.7894

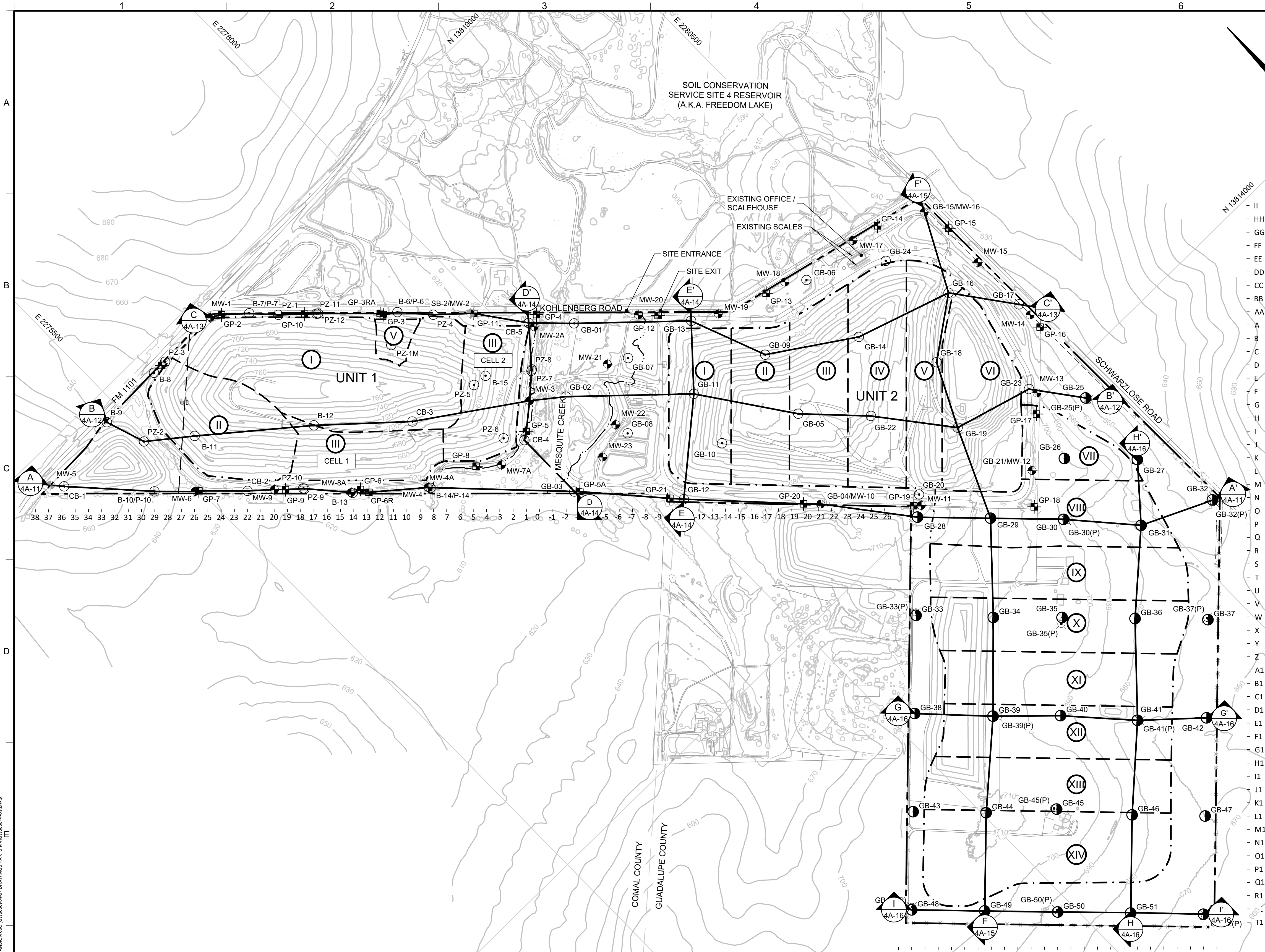
Geosyntec consultants
GEOSYNTEC CONSULTANTS, INC.
TEXAS PROF. GEOSCIENTISTS FIRM REG. NO. 50256
8217 SHOAL CREEK BLVD, SUITE 200
AUSTIN, TEXAS 78757
PHONE: 512.451.4003

TITLE:
BORING AND WELL LOCATION MAP UNIT 2

PROJECT:
MESQUITE CREEK LANDFILL EXPANSION
PERMIT AMENDMENT APPLICATION - MSW PERMIT NO. 66C

PROJECT NO.: GW8636	DESIGN BY: MW	REVIEWED BY: PP/YB	PART NO.: III	DRAWING: 4A-9B
FILE: GW8636P4A-8A	DRAWN BY: JJV / KH	APPROVED BY: MW		

PERMIT DRAWING



LEGEND

- EXISTING GROUND ELEVATION CONTOUR (FT, MSL) (NOTES 1, 2)
- EXISTING ROAD
- EXISTING VEGETATION / TREE
- EXISTING FENCE
- EXISTING BUILDING
- EXISTING WATER LINE
- N 13814000 E 2280000 — COORDINATE GRID (NOTE 2)
- SITE GRID
- PROPOSED PERMIT BOUNDARY (PERMIT 66C)
- LIMIT OF WASTE
- PHASE/CELL BOUNDARY
- III — PHASE DESIGNATION
- U / D — FAULT WITH UPTHROWN (U) AND DOWNTHROWN (D) SIDES
- MW-18 — EXISTING MONITORING WELL
- MW-4 — PLUGGED MONITORING WELL
- GP-2 — GAS MONITORING PROBE
- CB-2 — PREVIOUS SOIL BORING
- GB-37 — 2022/2023 GEOSYNTEC SOIL BORING
- GB-37(P) — 2022/2023 GEOSYNTEC SOIL BORING COMPLETED AS PIEZOMETER

NOTES:

1. TOPOGRAPHIC BASE MAP OF EXISTING SITE CONDITIONS WAS GENERATED BY PHOTOGRAMMETRIC METHODS BASED ON AN AERIAL SURVEY FLOWN ON 15 FEBRUARY 2023 BY HYDREX ENVIRONMENTAL, AND BY DALLAS AERIAL SURVEYING (DAS) FLOWN IN 2018-2019. EXISTING TOPOGRAPHY OUTSIDE OF PROPERTY WHERE SHOWN SUPPLEMENTED WITH THE UNITED STATES GEOLOGIC SURVEY (USGS) 3DEP PROGRAM PUBLISHED IN NOVEMBER 2021.
2. ELEVATIONS ARE IN FEET ABOVE MEAN SEA LEVEL (FT, MSL). DRAWING COORDINATES ARE BASED ON TEXAS STATE PLANE SOUTH CENTRAL ZONE (4204) US FOOT COORDINATE SYSTEM, NORTH AMERICAN DATUM OF 1983 (NAD-83).

STATE OF TEXAS
MATTHEW WISSLER
GEOLOGY
13242
LICENSED
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02/16/2024

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REV	DATE	DESCRIPTION	DRN	APP
1	FEB. 2024	RESPONSE TO TECHNICAL NOD 1	JJV/KH	MW
-	OCT. 2023	INITIAL SUBMITTAL TO TCEQ	JJV/KH	MW

WASTE MANAGEMENT
WASTE MANAGEMENT OF TEXAS, INC.
1700 KOHLENBERG ROAD
NEW BRAUNFELS, TEXAS 78130
PHONE: 830.625.7894

Geosyntec consultants
GEOSYNTEC CONSULTANTS, INC.
TEXAS PROF. GEOSCIENTISTS FIRM REG. NO. 50256
8217 SHOAL CREEK BLVD, SUITE 200
AUSTIN, TEXAS 78757
PHONE: 512.451.4003

TITLE:

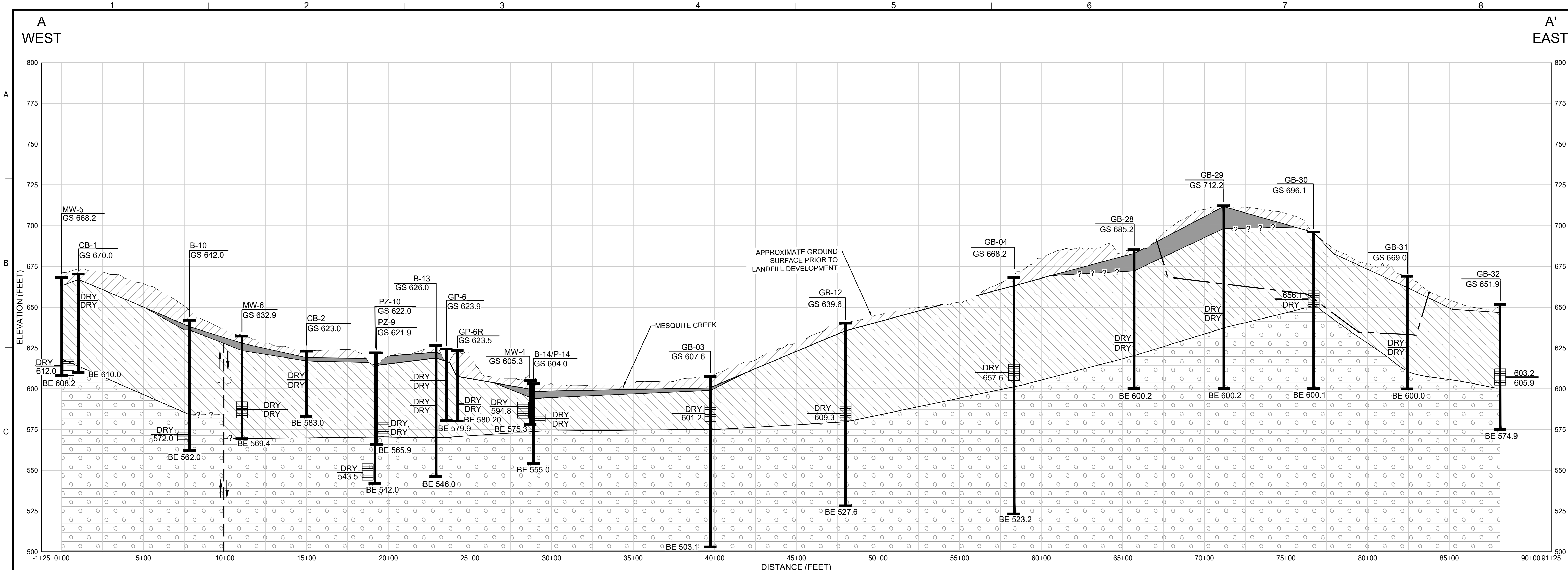
GEOLOGIC CROSS SECTION LOCATION MAP

PROJECT:

MESQUITE CREEK LANDFILL EXPANSION
PERMIT AMENDMENT APPLICATION - MSW PERMIT NO. 66C

PERMIT DRAWING

PROJECT NO.:	GW8636	DESIGN BY:	MW	REVIEWED BY:	PP/YB	PART NO.:	DRAWING:
FILE:	GW8636P4A-9	DRAWN BY:	JJV / KH	APPROVED BY:	MW	III	4A-10



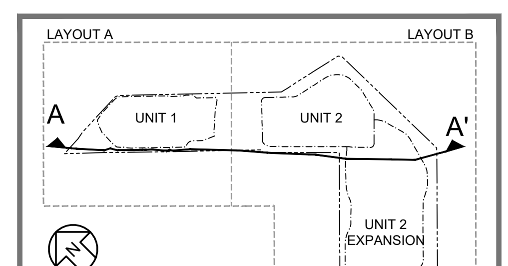
LEGEND

B-9	WELL/PIEZOMETER OR BORING DESIGNATION
GS 640.0	GROUND SURFACE ELEVATION (FT, MSL)
WELL SCREEN	
DRY	FIRST ENCOUNTERED WATER ELEVATION (FT, MSL)
581.6	FINAL RECORDED WATER ELEVATION (FT, MSL)
NA	WATER ELEVATION NOT AVAILABLE
BE 560	BOTTOM ELEVATION OF BORING (FT, MSL)

- STRATUM I - UNSATURATED BROWN TO DARK GRAY CLAY WITH OCCASIONAL THIN GRAVEL STRATUM
- STRATUM II - UNSATURATED CLAYEY GRAVEL OR GRAVELLY CLAY
- STRATUM III - OXIDIZED CLAY OR CLAYSTONE WITH FRACTURES, BROWNISH YELLOW TO GRAY
- STRATUM IV - UNOXIDIZED DARK GRAY CLAY OR CLAYSTONE
- U / D — FAULT WITH UPTHROWN (U) AND DOWNTHROWN (D) SIDES (NOTE 5)
- — ? — ? — INFERRED (EXTRAPOLATED) STRATUM CONTACT (NOTE 3)
- EXISTING GROUND (NOTE 2)
- APPROXIMATE GROUND SURFACE PRIOR TO LANDFILL DEVELOPMENT (NOTE 2)
- BOTTOM OF LANDFILL LINER SYSTEM (NOTE 4)

NOTES:

1. THE SOIL BORING/ROCK CORING INFORMATION IS REPRESENTATIVE OF SUBSURFACE CONDITIONS AT THE RESPECTIVE BORING LOCATIONS. SUBSURFACE CONDITIONS INTERPOLATED BETWEEN BORINGS ARE ESTIMATED, BASED ON ACCEPTED SOIL ENGINEERING PRINCIPALS AND GEOLOGIC JUDGMENT.
2. GROUND SURFACE ELEVATIONS IN UNDISTURBED AREAS ARE TAKEN FROM TOPOGRAPHIC MAP AS PRESENTED ON DRAWING 4A-9. IN AREAS WHERE SOIL OR WASTE FILLING HAS TAKEN PLACE, PREVIOUS GROUND SURFACE ELEVATIONS OF DISTURBED AREA WERE DERIVED USING CONTOUR MAP DEVELOPED USING PRE-LANDFILL TOPOGRAPHIC MAPS, USGS QUADRANGLES, AND BORING LOG SURFACE ELEVATIONS.
3. PORTIONS OF CROSS SECTIONS MAY BE EXTRAPOLATED BENEATH OR BETWEEN AVAILABLE BORING INFORMATION BASED ON GEOLOGIC JUDGMENT OF SUBSURFACE TRENDS CONSIDERING INTERSECTING CROSS SECTIONS.
4. BOTTOM OF LANDFILL LINER SYSTEM AND LIMIT OF LANDFILL (WASTE) OBTAINED FROM ATTACHMENT III, DRAWING 3A-3A AND DRAWING 3A-3B WHERE THEY INTERSECT THE CROSS SECTIONS. IF LANDFILL LIMITS AND BOTTOM OF LINER SYSTEM ARE NOT SHOWN, THEN GEOLOGIC SECTION IS BEYOND THE EXTENT OF THE LANDFILL.
5. FAULT DISPLACEMENT NOT ALWAYS APPARENT DUE TO STRATUM CLASSIFICATION CRITERIA.



KEY MAP
SCALE: N.T.S.

0 30' 60'
VERTICAL SCALE IN FEET

0 300' 600'
HORIZONTAL SCALE IN FEET

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GEOLOGY
13242
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-	OCT. 2023	INITIAL SUBMITTAL TO TCEQ	JJV/KH	MW

WASTE MANAGEMENT
WASTE MANAGEMENT OF TEXAS, INC.
1700 KOHLENBERG ROAD
NEW BRAUNFELS, TEXAS 78130
PHONE: 830.685.7894

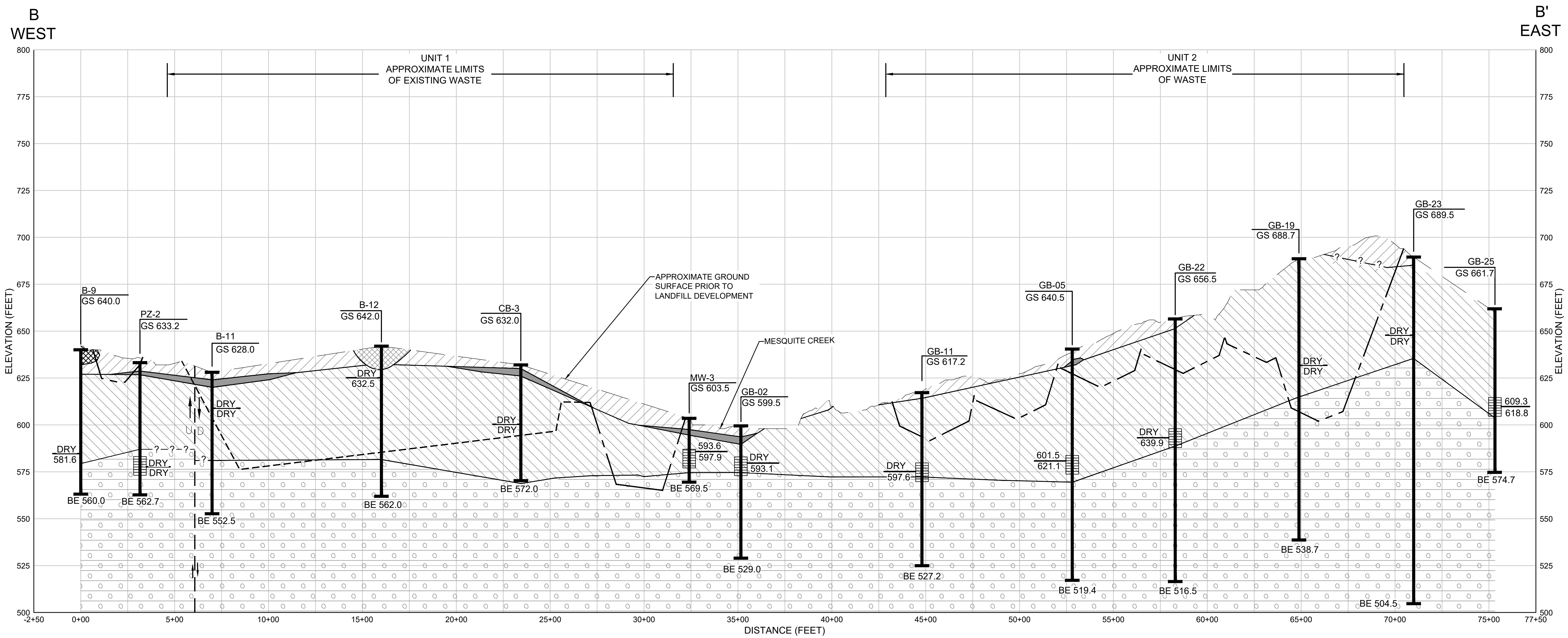
Geosyntec consultants
GEOSYNTEC CONSULTANTS, INC.
TEXAS PROF. GEOSCIENTISTS FIRM REG. NO. 50256
8217 SHOAL CREEK BLVD, SUITE 200
AUSTIN, TEXAS 78757
PHONE: 512.354.3280

TITLE:
GEOLOGIC CROSS SECTION A-A'

PROJECT:
MESQUITE CREEK LANDFILL EXPANSION
PERMIT AMENDMENT APPLICATION - MSW PERMIT NO. 66C

PERMIT DRAWING

PROJECT NO.:	GW8636	DESIGN BY:	MW	REVIEWED BY:	PP/YB	PART NO.:	DRAWING:
FILE:	GW8636P4A-10	DRAWN BY:	JJV / KH	APPROVED BY:	MW	III	4A-11



LEGEND

B-9 — WELL/PIEZOMETER OR BORING DESIGNATION

GS 640.0 — GROUND SURFACE ELEVATION (FT, MSL)

WELL SCREEN

DRY — FIRST ENCOUNTERED WATER ELEVATION (FT, MSL)

581.6 — FINAL RECORDED WATER ELEVATION (FT, MSL)

NA — WATER ELEVATION NOT AVAILABLE

BE 560 — BOTTOM ELEVATION OF BORING (FT, MSL)

FILL

STRATUM I - UNSATURATED BROWN TO DARK GRAY CLAY WITH OCCASIONAL THIN GRAVEL STRATUM

STRATUM II - UNSATURATED CLAYEY GRAVEL OR GRAVELLY CLAY

STRATUM III - OXIDIZED CLAY OR CLAYSTONE WITH FRACTURES, BROWNISH YELLOW TO GRAY

STRATUM IV - UNOXIDIZED DARK GRAY CLAY OR CLAYSTONE

U / D — FAULT WITH UPTHROWN (U) AND DOWNTHROWN (D) SIDES (NOTE 5)

BOTTOM OF LANDFILL LINER SYSTEM (NOTE 4)

ESTIMATE LOCATION OF EXISTING LANDFILL LINER SYSTEM IN UNIT 1 (NOTE 6)

—?—?— INFERRED (EXTRAPOLATED) STRATUM CONTACT (NOTE 3)

APPROXIMATE GROUND SURFACE PRIOR TO LANDFILL DEVELOPMENT (NOTE 2)

NOTES:

1. THE SOIL BORING/ROCK CORING INFORMATION IS REPRESENTATIVE OF SUBSURFACE CONDITIONS AT THE RESPECTIVE BORING LOCATIONS. SUBSURFACE CONDITIONS INTERPOLATED BETWEEN BORINGS ARE ESTIMATED, BASED ON ACCEPTED SOIL ENGINEERING PRINCIPALS AND GEOLOGIC JUDGMENT.
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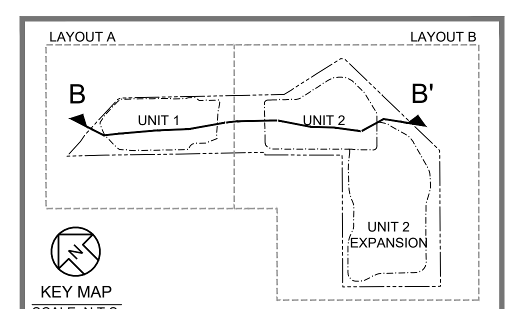
3. PORTIONS OF CROSS SECTIONS MAY BE EXTRAPOLATED BENEATH OR BETWEEN AVAILABLE BORING INFORMATION BASED ON GEOLOGIC JUDGMENT OF SUBSURFACE TRENDS CONSIDERING INTERSECTING CROSS SECTIONS.
4. BOTTOM OF LANDFILL LINER SYSTEM AND LIMIT OF LANDFILL (WASTE) OBTAINED FROM ATTACHMENT III, DRAWING 3A-3A AND DRAWING 3A-3B WHERE THEY INTERSECT THE CROSS SECTIONS. IF LANDFILL LIMITS AND BOTTOM OF LINER SYSTEM ARE NOT SHOWN, THEN GEOLOGIC SECTION IS BEYOND THE EXTENT OF THE LANDFILL.
5. FAULT DISPLACEMENT NOT ALWAYS APPARENT DUE TO STRATUM CLASSIFICATION CRITERIA.
6. WHERE LANDFILL SUBGRADE IS SHOWN AS A DASHED LINE, THE BASE GRADE ELEVATIONS ARE INTERPRETATIONS THAT WERE ESTIMATED FROM INFORMATION CONTAINED IS MSW-66A SITE DEVELOPMENT PLAN, PREPARED BY METROPLEX INDUSTRIES, INC. JULY, 2002.



0 30' 60'
VERTICAL SCALE IN FEET

0 300' 600'
HORIZONTAL SCALE IN FEET

STATE OF TEXAS
MATTHEW WISSLER
GEOLOGY
13242
LICENSED
PROFESSIONAL GEOSCIENTIST

02/16/2024

FOR PERMIT PURPOSES ONLY

REV	DATE	DESCRIPTION	DRN	APP
1	FEB. 2024	RESPONSE TO TECHNICAL NOD 1	JJV/KH	MW
-	OCT. 2023	INITIAL SUBMITTAL TO TCEQ	JJV/KH	MW

WASTE MANAGEMENT
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1700 KOHLENBERG ROAD
NEW BRAUNFELS, TEXAS 78130
PHONE: 830.685.7894

Geosyntec consultants
GEOSYNTEC CONSULTANTS, INC.
TEXAS PROF. GEOSCIENTISTS FIRM REG. NO. 50256
8217 SHOAL CREEK BLVD, SUITE 200
AUSTIN, TEXAS 78757
PHONE: 512.354.3280

TITLE:

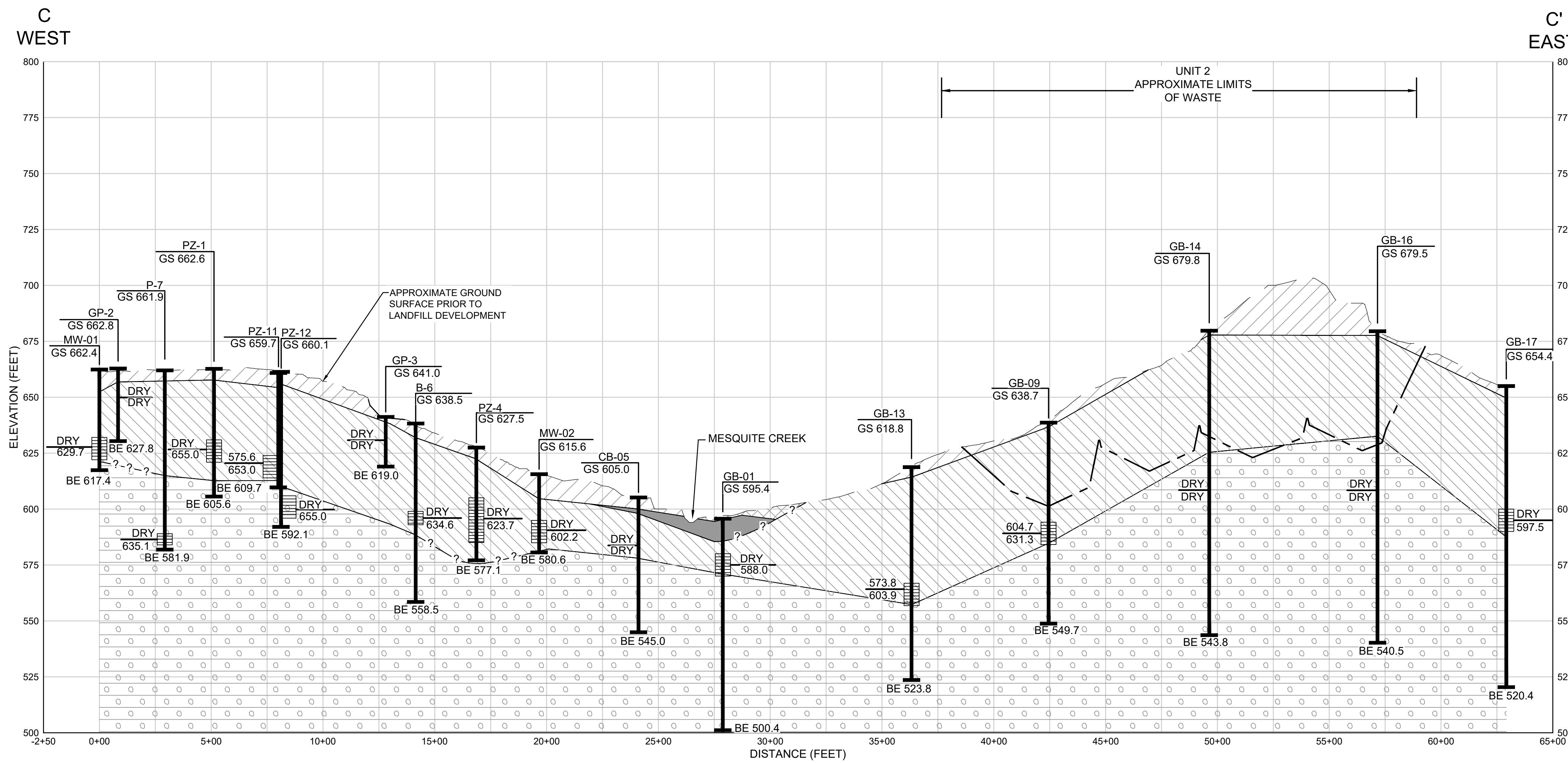
GEOLOGIC CROSS SECTION B-B'

PROJECT:

MESQUITE CREEK LANDFILL EXPANSION
PERMIT AMENDMENT APPLICATION - MSW PERMIT NO. 66C

PERMIT DRAWING

PROJECT NO.: GW8636	DESIGN BY: MW	REVIEWED BY: PP/YB	PART NO.: III	DRAWING: 4A-12
FILE: GW8636P4A-11	DRAWN BY: JJV / KH	APPROVED BY: MW		



LEGEND

Symbol	Description
B-9	WELL/PIEZOMETER OR BORING DESIGNATION
GS 640.0	GROUND SURFACE ELEVATION (FT, MSL)
WELL SCREEN	
DRY	FIRST ENCOUNTERED WATER ELEVATION (FT, MSL)
581.6	FINAL RECORDED WATER ELEVATION (FT, MSL)
NA	WATER ELEVATION NOT AVAILABLE
BE 560	BOTTOM ELEVATION OF BORING (FT, MSL)

- STRATUM I - UNSATURATED BROWN TO DARK GRAY CLAY WITH OCCASIONAL THIN GRAVEL STRATUM
- STRATUM II - UNSATURATED CLAYEY GRAVEL OR GRAVELLY CLAY
- STRATUM III - OXIDIZED CLAY OR CLAYSTONE WITH FRACTURES, BROWNISH YELLOW TO GRAY
- STRATUM IV - UNOXIDIZED DARK GRAY CLAY OR CLAYSTONE
- BOTTOM OF LANDFILL LINER SYSTEM (NOTE 4)
- —?—?— INFERRED (EXTRAPOLATED) STRATUM CONTACT (NOTE 3)
- APPROXIMATE GROUND SURFACE PRIOR TO LANDFILL DEVELOPMENT

NOTES:

1. THE SOIL BORING/ROCK CORING INFORMATION IS REPRESENTATIVE OF SUBSURFACE CONDITIONS AT THE RESPECTIVE BORING LOCATIONS. SUBSURFACE CONDITIONS INTERPOLATED BETWEEN BORINGS ARE ESTIMATED, BASED ON ACCEPTED SOIL ENGINEERING PRINCIPALS AND GEOLOGIC JUDGMENT.
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5. FAULT DISPLACEMENT NOT ALWAYS APPARENT DUE TO STRATUM CLASSIFICATION CRITERIA.

VERTICAL SCALE IN FEET: 0 30' 60'

HORIZONTAL SCALE IN FEET: 0 300' 600'

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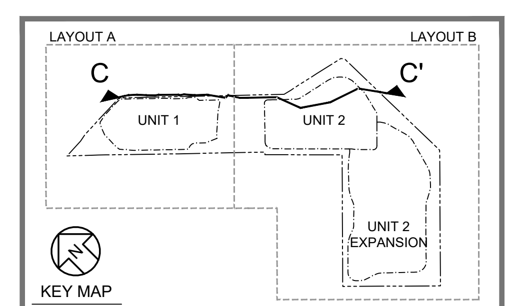

PERMIT DRAWING

REV	DATE	DESCRIPTION	DRN	APP
1	FEB. 2024	RESPONSE TO TECHNICAL NOD 1	JJV/KH	MW
-	OCT. 2023	INITIAL SUBMITTAL TO TCEQ	JJV/KH	MW

WASTE MANAGEMENT
WASTE MANAGEMENT OF TEXAS, INC.
1700 KOHLENBERG ROAD
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PHONE: 830.685.7894

Geosyntec consultants
GEOSYNTEC CONSULTANTS, INC.
TEXAS PROF. GEOSCIENTISTS FIRM REG. NO. 50256
8217 SHOAL CREEK BLVD, SUITE 200
AUSTIN, TEXAS 78757
PHONE: 512.354.3280

TITLE: GEOLOGIC CROSS SECTION C-C'

PROJECT: MESQUITE CREEK LANDFILL EXPANSION
PERMIT AMENDMENT APPLICATION - MSW PERMIT NO. 66C

PROJECT NO.:	GW8636	DESIGN BY:	MW	REVIEWED BY:	PP/YB	PART NO.:	DRAWING:
FILE:	GW8636P4A-12	DRAWN BY:	JJV / KH	APPROVED BY:	MW	III	4A-13

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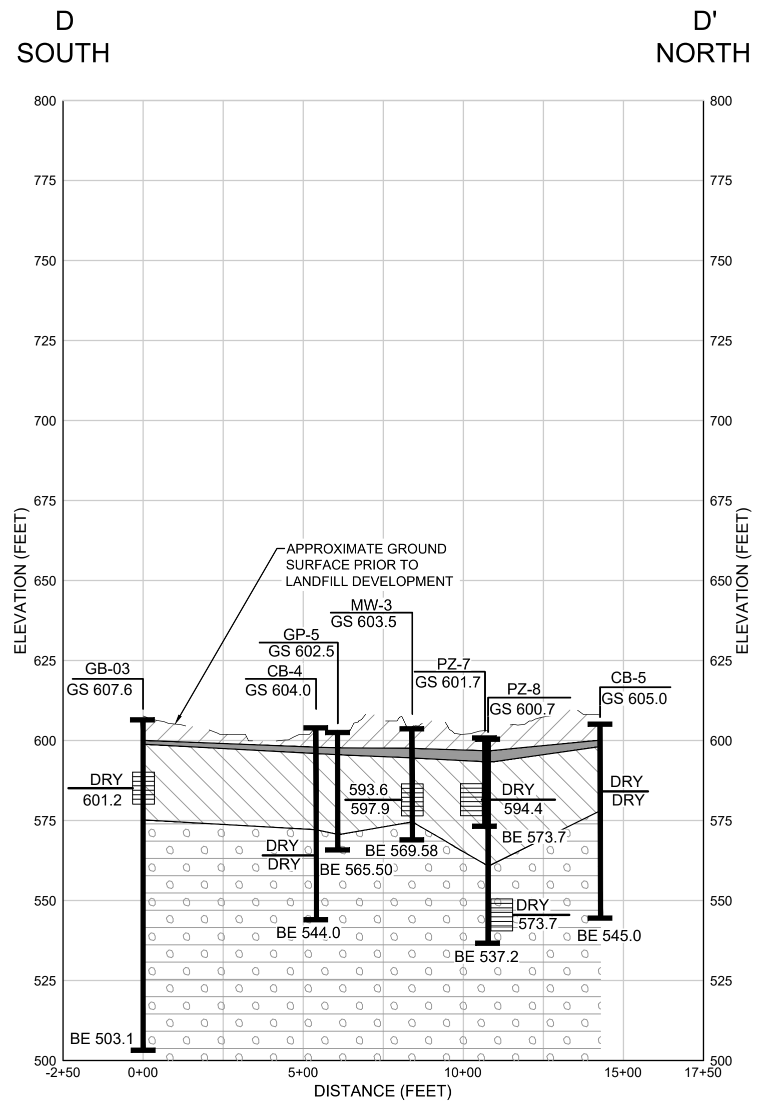

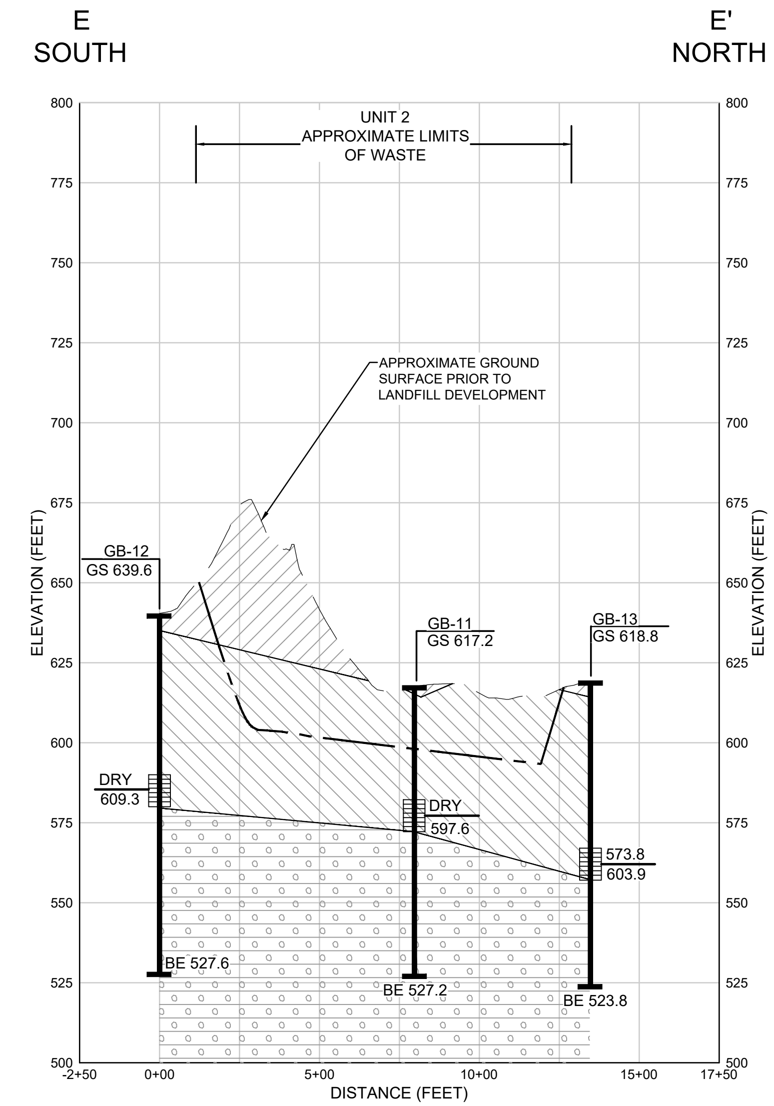

LEGEND

B-9 — WELL/PIEZOMETER OR BORING DESIGNATION

GS 640.0 — GROUND SURFACE ELEVATION (FT, MSL)

WELL SCREEN

DRY — FIRST ENCOUNTERED WATER ELEVATION (FT, MSL)

581.6 — FINAL RECORDED WATER ELEVATION (FT, MSL)

NA — WATER ELEVATION NOT AVAILABLE

BE 560 — BOTTOM ELEVATION OF BORING (FT, MSL)

STRATUM I - UNSATURATED BROWN TO DARK GRAY CLAY WITH OCCASIONAL THIN GRAVEL STRATUM

STRATUM II - UNSATURATED CLAYEY GRAVEL OR GRAVELLY CLAY

STRATUM III - OXIDIZED CLAY OR CLAYSTONE WITH FRACTURES, BROWNISH YELLOW TO GRAY

STRATUM IV - UNOXIDIZED DARK GRAY CLAY OR CLAYSTONE

BOTTOM OF LANDFILL LINER SYSTEM (NOTE 4)

APPROXIMATE GROUND SURFACE PRIOR TO LANDFILL DEVELOPMENT (NOTE 2)

NOTES:

1. THE SOIL BORING/ROCK CORING INFORMATION IS REPRESENTATIVE OF SUBSURFACE CONDITIONS AT THE RESPECTIVE BORING LOCATIONS. SUBSURFACE CONDITIONS INTERPOLATED BETWEEN BORINGS ARE ESTIMATED, BASED ON ACCEPTED SOIL ENGINEERING PRINCIPALS AND GEOLOGIC JUDGMENT.
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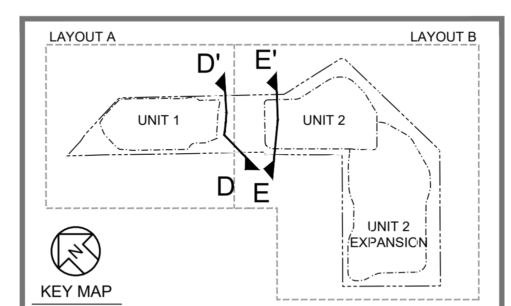

KEY MAP
SCALE: N.T.S.

0 30' 60'
VERTICAL SCALE IN FEET

0 300' 600'
HORIZONTAL SCALE IN FEET

STATE OF TEXAS
MATTHEW WISSLER
GEOLOGY
13242
LICENSED
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02/16/2024

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1	FEB. 2024	RESPONSE TO TECHNICAL NOD 1	JJV/KH	MW
-	OCT. 2023	INITIAL SUBMITTAL TO TCEQ	JJV/KH	MW

WASTE MANAGEMENT
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1700 KOHLENBERG ROAD
NEW BRAUNFELS, TEXAS 78130
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Geosyntec consultants
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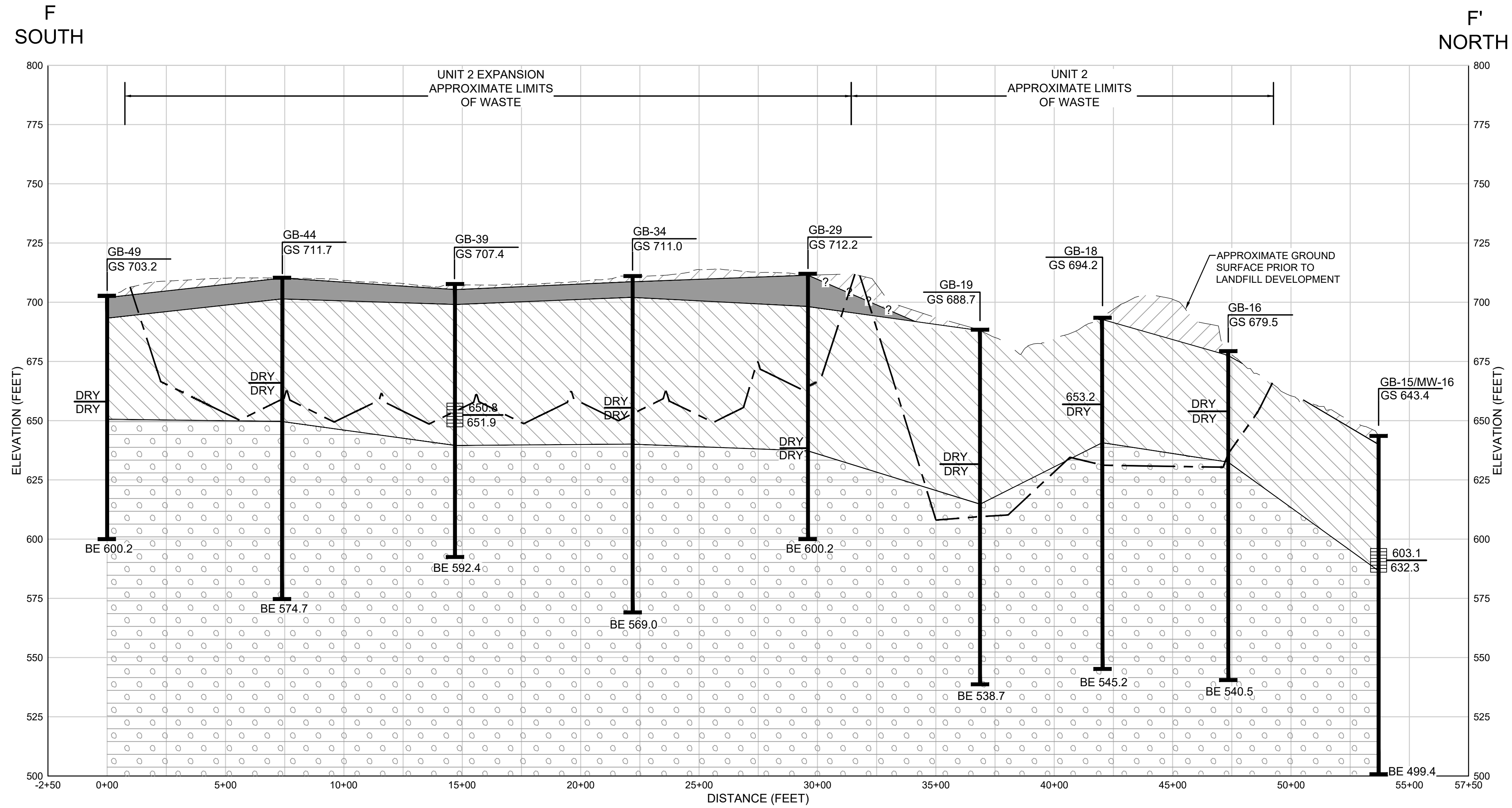
TEXAS PROF. GEOSCIENTISTS FIRM REG. NO. 50256
8217 SHOAL CREEK BLVD, SUITE 200
AUSTIN, TEXAS 78757
PHONE: 512.354.3280

TITLE:
GEOLOGIC CROSS SECTIONS D-D' AND E-E'

PROJECT:
MESQUITE CREEK LANDFILL EXPANSION
PERMIT AMENDMENT APPLICATION - MSW PERMIT NO. 66C

PERMIT DRAWING

PROJECT NO.: GW8636	DESIGN BY: MW	REVIEWED BY: PP/YB	PART NO.: III	DRAWING: 4A-14
FILE: GW8636P4A-13	DRAWN BY: JJV / KH	APPROVED BY: MW		



LEGEND

B-9	WELL/PIEZOMETER OR BORING DESIGNATION
GS 640.0	GROUND SURFACE ELEVATION (FT, MSL)
WELL SCREEN	
DRY	FIRST ENCOUNTERED WATER ELEVATION (FT, MSL)
581.6	FINAL RECORDED WATER ELEVATION (FT, MSL)
NA	WATER ELEVATION NOT AVAILABLE
BE 560	BOTTOM ELEVATION OF BORING (FT, MSL)

- STRATUM I - UNSATURATED BROWN TO DARK GRAY CLAY WITH OCCASIONAL THIN GRAVEL STRATUM
- STRATUM II - UNSATURATED CLAYEY GRAVEL OR GRAVELLY CLAY
- STRATUM III - OXIDIZED CLAY OR CLAYSTONE WITH FRACTURES, BROWNISH YELLOW TO GRAY
- STRATUM IV - UNOXIDIZED DARK GRAY CLAY OR CLAYSTONE
- BOTTOM OF LANDFILL LINER SYSTEM (NOTE 4)
- EXISTING GROUND (NOTE 2)
- APPROXIMATE GROUND SURFACE PRIOR TO LANDFILL DEVELOPMENT (NOTE 2)

NOTES:

1. THE SOIL BORING/ROCK CORING INFORMATION IS REPRESENTATIVE OF SUBSURFACE CONDITIONS AT THE RESPECTIVE BORING LOCATIONS. SUBSURFACE CONDITIONS INTERPOLATED BETWEEN BORINGS ARE ESTIMATED, BASED ON ACCEPTED SOIL ENGINEERING PRINCIPALS AND GEOLOGIC JUDGMENT.
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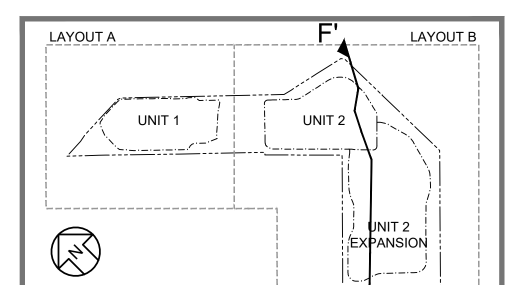

KEY MAP
SCALE: N.T.S.

0 30' 60'
VERTICAL
SCALE IN FEET

0 300' 600'
HORIZONTAL
SCALE IN FEET

STATE OF TEXAS
MATTHEW WISSLER
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1	FEB. 2024	RESPONSE TO TECHNICAL NOD 1	JJV/KH	MW
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WM
WASTE MANAGEMENT
WASTE MANAGEMENT OF TEXAS, INC.
1700 KOHLENBERG ROAD
NEW BRAUNFELS, TEXAS 78130
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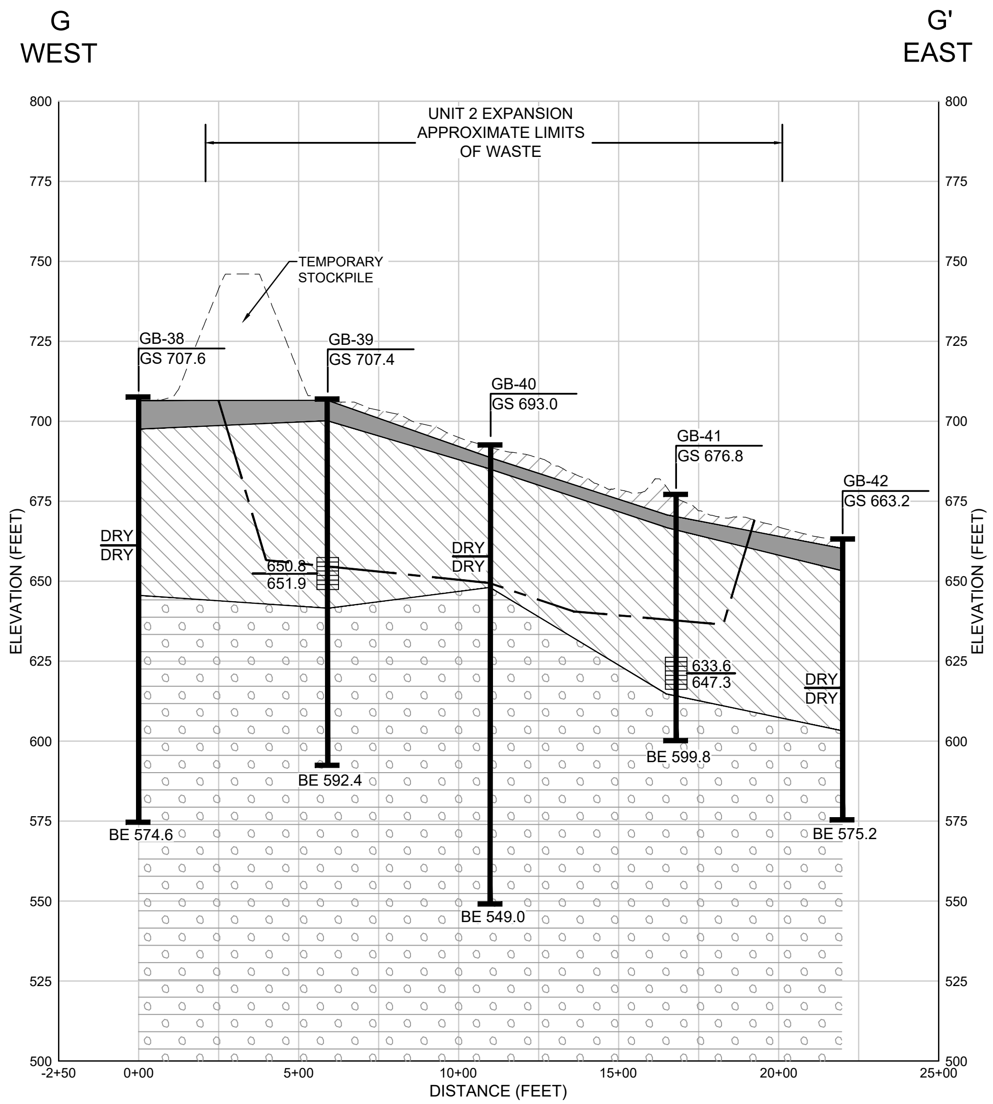
TEXAS PROF. GEOSCIENTISTS FIRM REG. NO. 50256
8217 SHOAL CREEK BLVD, SUITE 200
AUSTIN, TEXAS 78757
PHONE: 512.354.3280

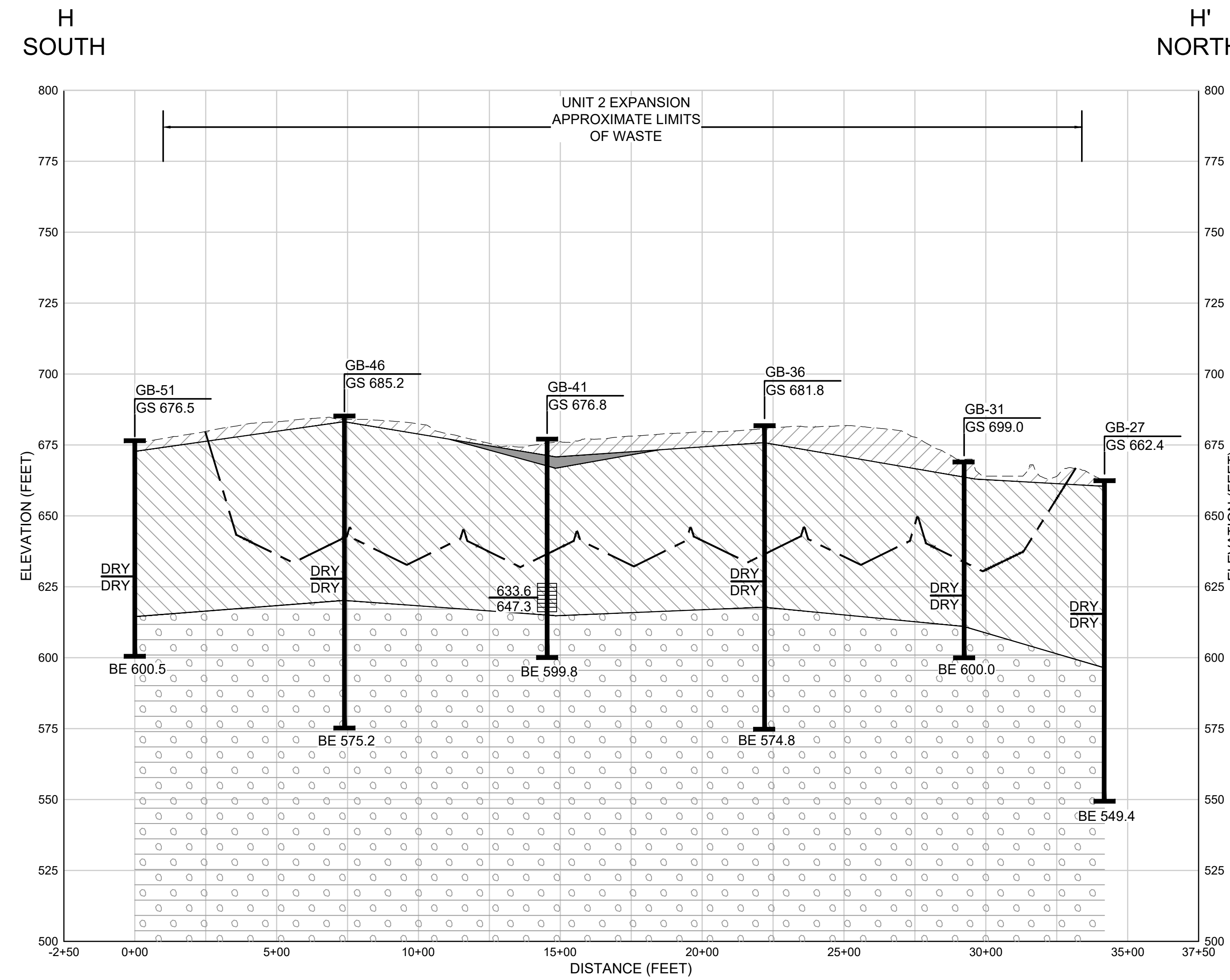
TITLE:
GEOLOGIC CROSS SECTION F-F'

PROJECT:
MESQUITE CREEK LANDFILL EXPANSION
PERMIT AMENDMENT APPLICATION - MSW PERMIT NO. 66C

PERMIT DRAWING

PROJECT NO.:	GW8636	DESIGN BY:	MW	REVIEWED BY:	PP/YB	PART NO.:	III	DRAWING:	4A-15
FILE:	GW8636P4A-14	DRAWN BY:	JJV / KH	APPROVED BY:	MW				





LEGEND

B-9 — WELL/PIEZOMETER OR BORING DESIGNATION

GS 640.0 — GROUND SURFACE ELEVATION (FT, MSL)

WELL SCREEN

DRY — FIRST ENCOUNTERED WATER ELEVATION (FT, MSL)

581.6 — FINAL RECORDED WATER ELEVATION (FT, MSL)

NA — WATER ELEVATION NOT AVAILABLE

BE 560 — BOTTOM ELEVATION OF BORING (FT, MSL)

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STRATUM IV - UNOXIDIZED DARK GRAY CLAY OR CLAYSTONE

BOTTOM OF LANDFILL LINER SYSTEM (NOTE 4)

APPROXIMATE GROUND SURFACE PRIOR TO LANDFILL DEVELOPMENT (NOTE 2)

NOTES:

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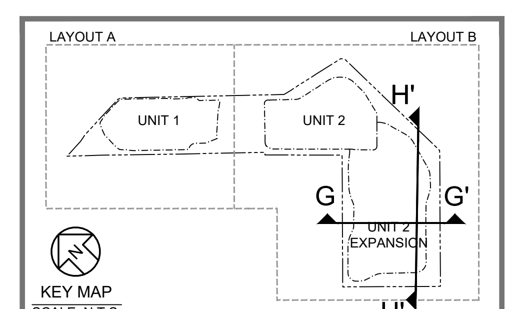

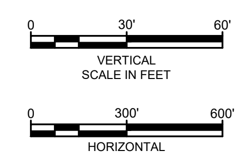

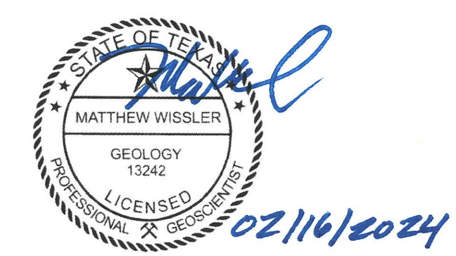

FOR PERMIT PURPOSES ONLY

REV	DATE	DESCRIPTION	DRN	APP
1	FEB. 2024	RESPONSE TO TECHNICAL NOD 1	JJV/KH	MW
-	OCT. 2023	INITIAL SUBMITTAL TO TCEQ	JJV/KH	MW

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8217 SHOAL CREEK BLVD, SUITE 200
AUSTIN, TEXAS 78757
PHONE: 512.354.3280

TITLE: GEOLOGIC CROSS SECTION G-G' AND H-H'

PROJECT: MESQUITE CREEK LANDFILL EXPANSION
PERMIT AMENDMENT APPLICATION - MSW PERMIT NO. 66C

PERMIT DRAWING

PROJECT NO.: GW8636	DESIGN BY: MW	REVIEWED BY: PP/YB	PART NO.: III	DRAWING: 4A-16
FILE: GW8636P4A-15	DRAWN BY: JJV / KH	APPROVED BY: MW		

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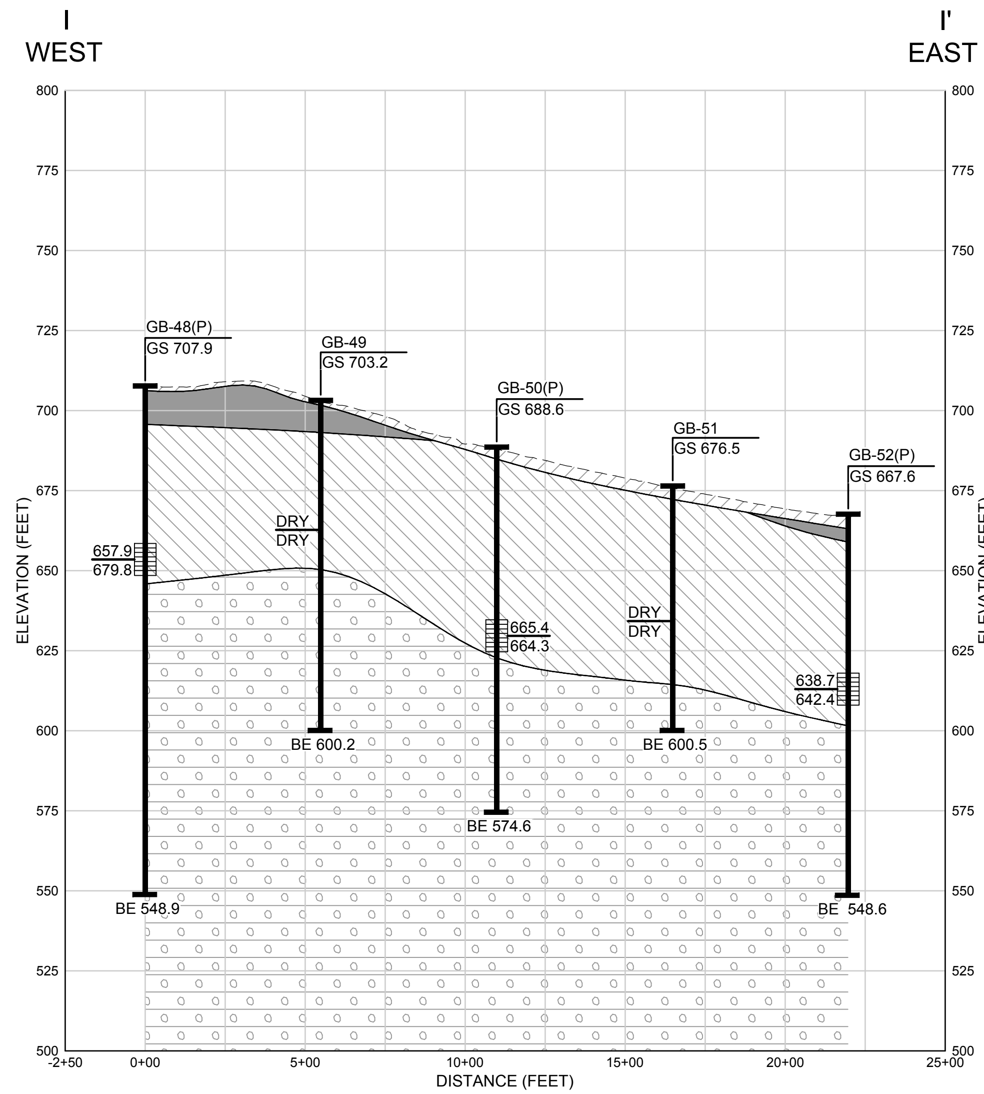

LEGEND

B-9 WELL/PIEZOMETER OR BORING DESIGNATION

GS 640.0 GROUND SURFACE ELEVATION (FT, MSL)

WELL SCREEN

DRY FIRST ENCOUNTERED WATER ELEVATION (FT, MSL)

581.6 FINAL RECORDED WATER ELEVATION (FT, MSL)

NA WATER ELEVATION NOT AVAILABLE

BE 560 BOTTOM ELEVATION OF BORING (FT, MSL)

STRATUM I - UNSATURATED BROWN TO DARK GRAY CLAY WITH OCCASIONAL THIN GRAVEL STRATUM

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STRATUM IV - UNOXIDIZED DARK GRAY CLAY OR CLAYSTONE

APPROXIMATE GROUND SURFACE PRIOR TO LANDFILL DEVELOPMENT (NOTE 2)

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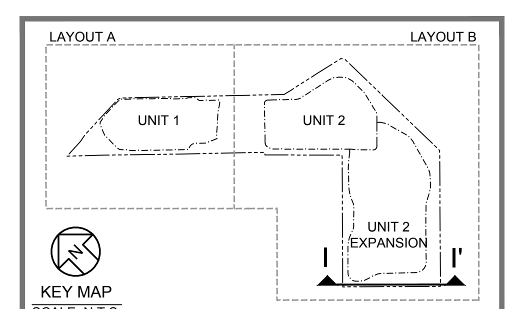
2. GROUND SURFACE ELEVATIONS IN UNDISTURBED AREAS ARE TAKEN FROM TOPOGRAPHIC MAP AS PRESENTED ON DRAWING 4A-9. IN AREAS WHERE SOIL OR WASTE FILLING HAS TAKEN PLACE, PREVIOUS GROUND SURFACE ELEVATIONS OF DISTURBED AREA WERE DERIVED USING CONTOUR MAP DEVELOPED USING PRE-LANDFILL TOPOGRAPHIC MAPS, USGS QUADRANGLES, AND BORING LOG SURFACE ELEVATIONS.
3. PORTIONS OF CROSS SECTIONS MAY BE EXTRAPOLATED BENEATH OR BETWEEN AVAILABLE BORING INFORMATION BASED ON GEOLOGIC JUDGMENT OF SUBSURFACE TRENDS CONSIDERING INTERSECTING CROSS SECTIONS.



VERTICAL SCALE IN FEET: 0, 30', 60'

HORIZONTAL SCALE IN FEET: 0, 300', 600'

STATE OF TEXAS MATTHEW WISSLER GEOLOGY 13242 LICENSED PROFESSIONAL GEOSCIENTIST

02/16/2024

FOR PERMIT PURPOSES ONLY

REV	DATE	DESCRIPTION	DRN	APP
-	FEB. 2024	RESPONSE TO TECHNICAL NOD 1	JJV/KH	MW

WASTE MANAGEMENT
WASTE MANAGEMENT OF TEXAS, INC.
1700 KOHLENBERG ROAD
NEW BRAUNFELS, TEXAS 78130
PHONE: 830.685.7894

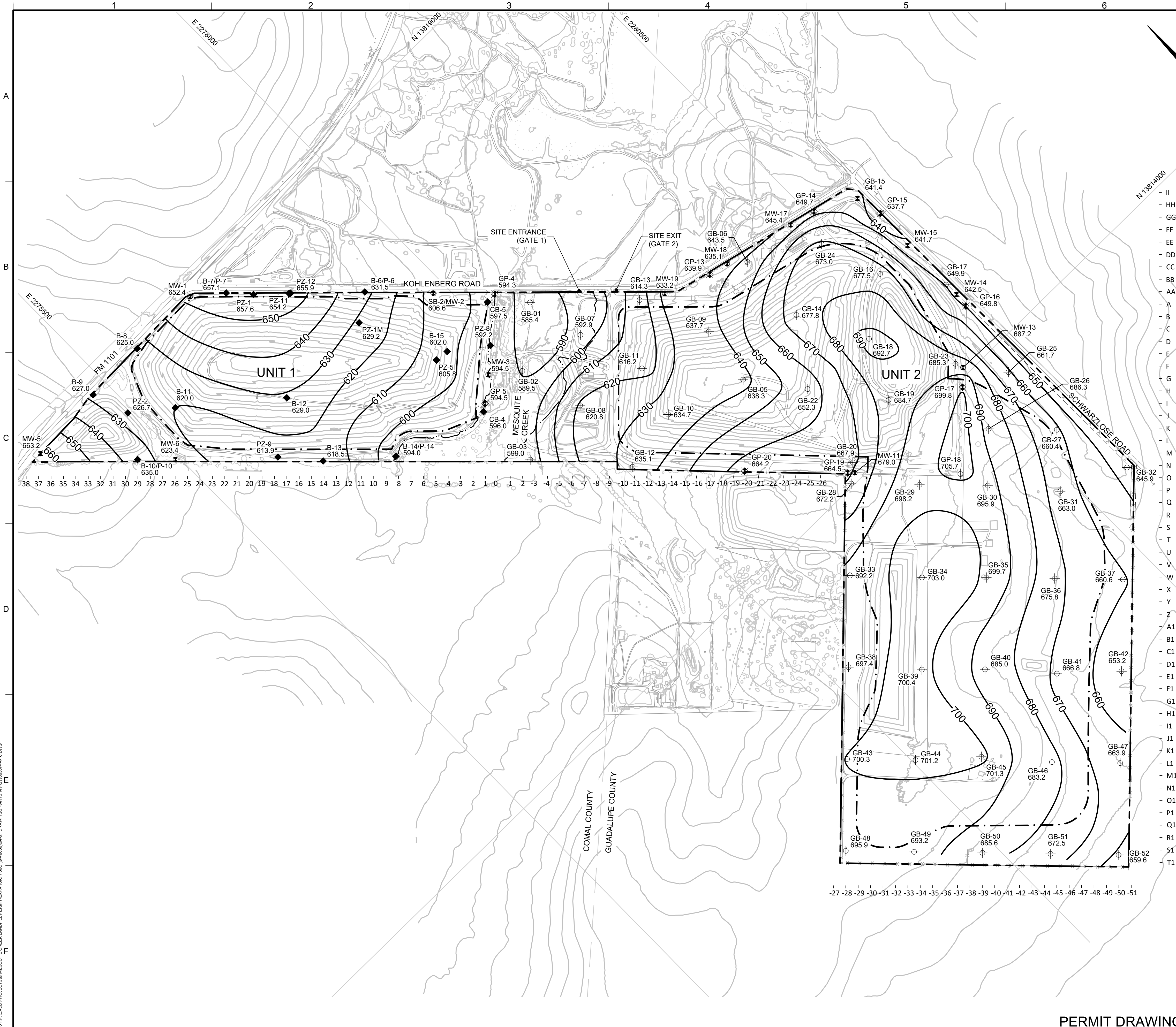
Geosyntec consultants
GEOSYNTEC CONSULTANTS, INC.
TEXAS PROF. GEOSCIENTISTS FIRM REG. NO. 50256
8217 SHOAL CREEK BLVD, SUITE 200
AUSTIN, TEXAS 78757
PHONE: 512.354.3280

TITLE: GEOLOGIC CROSS SECTION I-I'

PROJECT: MESQUITE CREEK LANDFILL EXPANSION
PERMIT AMENDMENT APPLICATION - MSW PERMIT NO. 66C

PERMIT DRAWING

PROJECT NO.: GW8636	DESIGN BY: MW	REVIEWED BY: PP/YB	PART NO.: III	DRAWING: 4A-16A
FILE: GW8636P4A-16A	DRAWN BY: JJV / KH	APPROVED BY: MW		



LEGEND

N 13814000 E 2280000	COORDINATE GRID
A 13	SITE GRID
	PERMIT BOUNDARY
	LIMIT OF WASTE
670	TOP OF STRATUM III ELEVATION
MW-15	DATA POINT
641.7	TOP OF STRATUM IV

NOTES:

1. STRATUM IV ELEVATION CONTOURS ARE GENERATED USING AN INTERPOLATION OF AVAILABLE BORING LOG DATA.
2. PERMIT BOUNDARY AND PROPERTY BOUNDARY COINCIDE.

STATE OF TEXAS
MATTHEW WISSLER
GEOLOGY
13242
LICENSED
PROFESSIONAL GEOSCIENTIST
10/10/2023

FOR PERMIT PURPOSES ONLY

REV	DATE	DESCRIPTION	DRN	APP

WASTE MANAGEMENT
WASTE MANAGEMENT OF TEXAS, INC.
1700 KOHLENBERG ROAD
NEW BRAUNFELS, TEXAS 78130
PHONE: 830.625.7894

Geosyntec consultants
GEOSYNTEC CONSULTANTS, INC.
TEXAS PROF. GEOSCIENTISTS FIRM REG. NO. 50256
8217 SHOAL CREEK BLVD, SUITE 200
AUSTIN, TEXAS 78757
PHONE: 512.451.4003

TITLE:

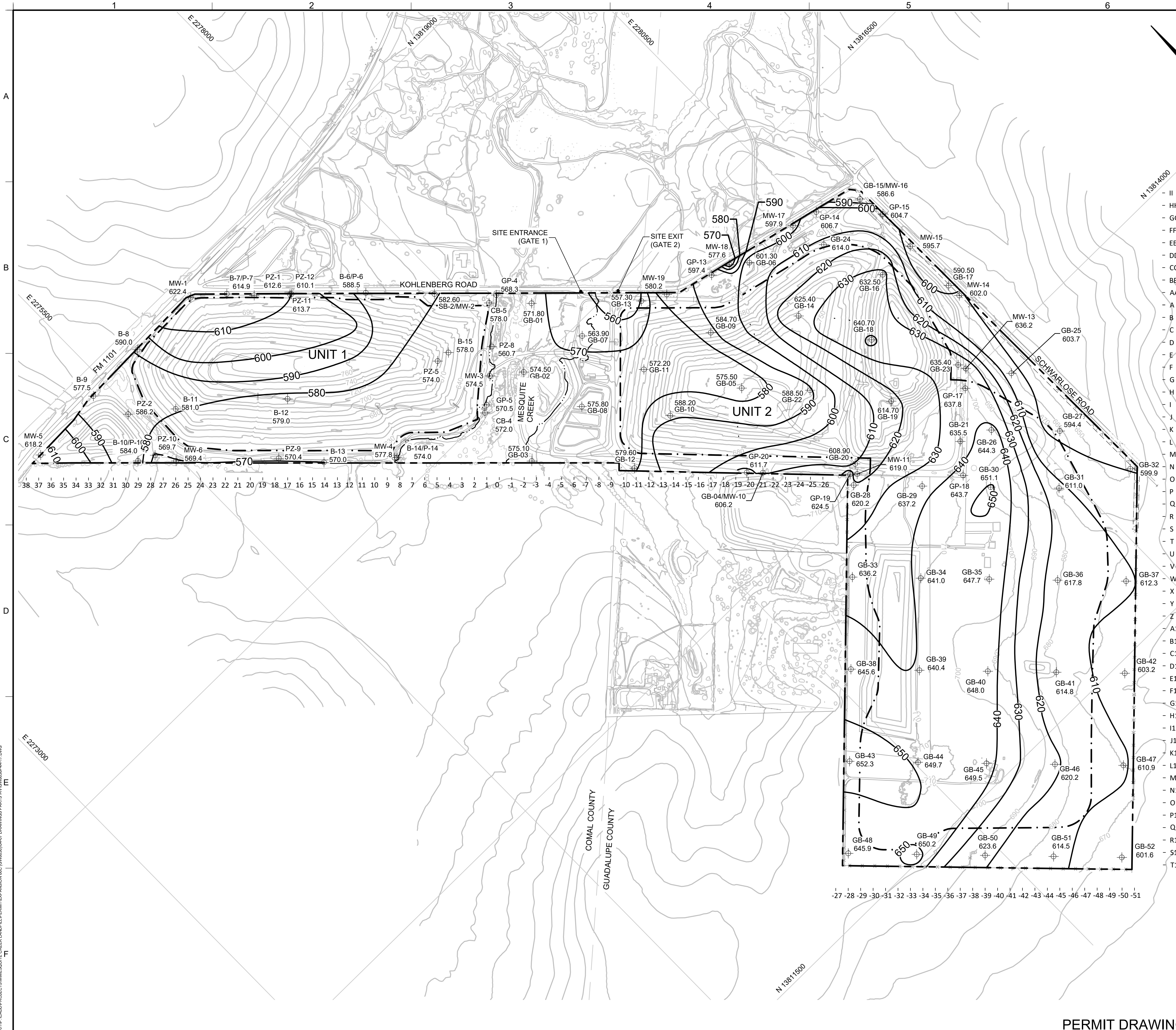
TOP OF STRATUM III MAP

PROJECT:

MESQUITE CREEK LANDFILL EXPANSION
PERMIT AMENDMENT APPLICATION - MSW PERMIT NO. 66C

PERMIT DRAWING

PROJECT NO.: GW8636	DESIGN BY: MW	REVIEWED BY: PP/YB	PART NO.: III	DRAWING: 4A-17
FILE: GW8636P4A-16	DRAWN BY: JJV / KH	APPROVED BY: MW		



LEGEND

N 13814000 E 2280000	COORDINATE GRID
A 13	SITE GRID
	PERMIT BOUNDARY
	LIMIT OF WASTE
670	TOP OF STRATUM IV ELEVATION
MW-15	DATA POINT
641.7	TOP OF STRATUM IV

NOTES:

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STATE OF TEXAS
MATTHEW WISSLER
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FOR PERMIT PURPOSES ONLY

REV	DATE	DESCRIPTION	DRN	APP

WASTE MANAGEMENT
WASTE MANAGEMENT OF TEXAS, INC.
1700 KOHLENBERG ROAD
NEW BRAUNFELS, TEXAS 78130
PHONE: 830.625.7894

Geosyntec consultants
GEOSYNTEC CONSULTANTS, INC.
TEXAS PROF. GEOSCIENTISTS FIRM REG. NO. 50256
8217 SHOAL CREEK BLVD, SUITE 200
AUSTIN, TEXAS 78757
PHONE: 512.451.4003

TITLE: TOP OF STRATUM IV MAP

PROJECT: MESQUITE CREEK LANDFILL EXPANSION
PERMIT AMENDMENT APPLICATION - MSW PERMIT NO. 66C

PERMIT DRAWING

PROJECT NO.: GW8636	DESIGN BY: MW	REVIEWED BY: PP/YB	PART NO.: III	DRAWING: 4A-18
FILE: GW8636P4A-17	DRAWN BY: JJV / KH	APPROVED BY: MW		

ATTACHMENT 4B

SOIL BORING PLAN

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

Protecting Texas by Reducing and Preventing Pollution

October 4, 2022

Mr. Steve Jacobs
Director of Landfill Operations
Waste Management of Texas, Inc.
Mesquite Creek Landfill
1700 Kohlenberg Road
New Braunfels, Texas 78130-3936

Via email

Subject: Mesquite Creek Landfill – Comal and Guadalupe Counties
Municipal Solid Waste – Permit No. 66B
Proposed Site Investigation – Revised Soil Boring Plan – Approval
Tracking No. 27826700; RN100218676/CN600127856

Dear Mr. Jacobs:

On July 5, 2022, we received a soil boring plan (SBP) dated June 30, 2022, for a proposed expansion of the referenced municipal solid waste (MSW) Type I landfill facility. On September 14, 2022, we received revisions to the SBP, dated September 13, 2022, in response to comments in our email dated August 24, 2022. The original SBP and revisions were submitted on your behalf by Mr. Scott Graves, P.E., of Geosyntec Consultants, Inc., Austin, Texas. Our review of the revised plan indicates that it complies with the MSW regulations. This letter constitutes approval of your plan.

The revised SBP proposes 28 borings in an approximately 191-acre project area for a lateral expansion of existing Unit 2. All 28 borings will be drilled to depths at least 5 feet below the lowest elevation of the expansion area (lowest excavation elevation 610 feet above sea level). Eight of the 28 borings will be drilled to depths at least 30 feet below the lowest elevation of the expansion area excavation, and six of the 28 borings will be drilled to depths at least 30 feet below the Unit 2 elevation of deepest excavation (EDE, 584 feet above sea level).

Please be advised that under Title 30 Texas Administrative Code, Chapter 330, Section 330.63(e)(4)(B), the uppermost aquifer and any hydraulically interconnected aquifers below the site must be identified, as well as the underlying confining unit. It is anticipated that this SBP, when implemented, will accurately characterize the in-situ geologic, hydrologic, and engineering properties of the surface and subsurface strata at this site. Although this plan appears to comply with the MSW regulations concerning site investigations, additional soil borings and piezometers could be required should the data generated by this SBP prove to be inconclusive.

If you should find it necessary to modify this approved plan, another plan detailing any proposed modifications must be submitted for approval before implementation of the modifications.

If you have questions regarding this letter, please contact Mr. Danuel Gonzalez by telephone at (512) 239-0551, by email to [redacted] or in writing at the address on our letterhead (please include mail code MC 124 on the first line of our address).

Sincerely,

Arten Avakian, P.G., Project Manager
Municipal Solid Waste Permits Section
Waste Permits Division
Texas Commission on Environmental Quality

AJA/DG/gg

cc: Mr. Scott Graves, P.E., Geosyntec Consultants, Inc., Austin

Geosyntec consultants

engineers | scientists | innovators

WM WASTE MANAGEMENT

SOIL BORING PLAN

Mesquite Creek Landfill
New Braunfels,
Comal and Guadalupe Counties, Texas

Physical Site Address

1700 Kohlenberg Road
New Braunfels, TX 78130
(830) 625-7894

Prepared for

Waste Management of Texas, Inc.

Prepared by

Geosyntec Consultants, Inc.
8217 Shoal Creek Blvd, Suite 200
Austin, TX 78757
Texas Board of Professional Engineers Firm Registration No. F-1182
Texas Board of Professional Geoscientists Firm Registration No. 50256

STATE OF TEXAS
MATTHEW WISSLER
GEOLOGY
13242
LICENSED
PROFESSIONAL GEOSCIENTIST

9/12/2022

GEOSYNTEC CONSULTANTS, INC.
TEXAS GEOSCIENCE FIRM REGISTRATION #50256

Project Number GW8636

Submitted June 2022
Revised September 2022

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9/12/2022

GEOSYNTEC CONSULTANTS, INC.
TEXAS GEOSCIENCE FIRM REGISTRATION #50256

1. INTRODUCTION

1.1 Terms of Reference

This Soil Boring Plan (SBP) was prepared by Geosyntec Consultants, Inc. (Geosyntec) at the request of Waste Management of Texas, Inc. (WMTX) for an expansion (and resulting increase in waste disposal capacity and site life) being considered for the Mesquite Creek Landfill (current Texas Commission on Environmental Quality (TCEQ) municipal solid waste (MSW) Permit No. 66B), located in Comal and Guadalupe Counties, Texas. The facility is an existing Type I MSW landfill that is currently in operation and has two disposal units: Unit 1 and Unit 2. Unit 1 has been closed with certified and approved final cover; Unit 2 is the active landfill unit. A Site Location Map is presented on Figure 1, and a Regional Geology Map is presented on Figure 2. As shown, the site is approximately two miles east of the I-35 Kohlenberg Road exit, northeast of the city of New Braunfels.

Under MSW Permit No. 66B, the current permit boundary area is 244.13 acres, and the current-permitted landfill footprint area is approximately 157.2 acres. The main objective of the proposed expansion being considered is to increase disposal capacity by laterally expanding to the south-southeast of the current permitted Unit 2 disposal footprint. Figures 3 and 4 present site layout plans that highlight the expansion area being considered. This proposed expansion would add approximately 191.4 acres of property, resulting in an increase of the permit boundary acreage from approximately 244.13 acres to approximately 435.5 acres. As shown on Figure 4, the waste disposal footprint of Unit 2 would be increased by up to approximately 163.9 acres, bringing the expanded Unit 2 waste disposal footprint to approximately 248.8 acres. This would result in a revised facility-wide landfill waste disposal footprint area (Unit 1 plus expanded Unit 2) of approximately 321.1 acres. Unit 1 would be unaffected/unchanged by this expansion. Note that the reported expansion acreages may change slightly as property boundary surveys are completed and the landfill expansion layout/design is prepared and finalized.

This SBP was prepared by Geosyntec in accordance with requirements set forth in Title 30 of the Texas Administrative Code (TAC), Chapter 330, Section §330.63(e)(4), to obtain the applicable information to establish the subsurface stratigraphy and geotechnical properties of the underlying strata beneath the proposed expansion area of the facility. The remainder of this SBP is organized as follows:

- an overview of the site subsurface conditions is presented in Section 1.2;
- a summary of the regional geology and hydrogeology is presented in Section 2;
- a summary of previous site investigations, along with a list of borings and their depth and bottom elevation, is presented in Section 3;
- a description of the site geology and hydrogeology based on results from previous site investigations is presented in Section 4;

- an evaluation of the required number of borings for the expansion area and resulting recommendations for this SBP are presented in Section 5;
- references are listed in Section 6; and
- figures and appendices of supporting information are included at the end of this plan.

1.2 Site Subsurface Overview

From the regional geology map presented on Figure 2, the majority of the site overlies the Cretaceous-aged Lower Taylor Group. The extreme eastern portion of the site is mapped as being on the Cretaceous-aged Upper Taylor Group. In places, these Taylor Group materials are overlain by Quaternary/Tertiary deposits. This includes deposits of Quaternary alluvium present in discrete areas where stream tributaries have flowed through the existing facility generally in and associated with the valley of Mesquite Creek between the landfill units. This also includes older Quaternary-Tertiary gravelly alluvium possibly equivalent to Uvalde Gravel.

From previous site-specific investigations, the site stratigraphy has been characterized into the following four (4) strata from the ground surface down:

- Stratum I – uppermost fine-grained Quaternary weathered soil deposits, generally dry, brown to dark gray medium to high-plasticity clay, stiff to hard in consistency;
- Stratum II - Quaternary-Tertiary gravelly alluvium possibly equivalent to Uvalde Gravel, generally dry, white or gray limestone gravel within a dark brown clay matrix, commonly cemented by caliche and firm in consistency;
- Stratum III – oxidized Lower Taylor Group, gray or brownish yellow to yellow weathered clay with thin bedding planes, very stiff to hard in consistency, with water-filled fractures near its base (i.e., a water-bearing zone); and
- Stratum IV – unoxidized Lower Taylor Group, dry, calcareous green-gray to dark gray un-weathered clay/claystone, hard in consistency.

2. REGIONAL GEOLOGY AND HYDROGEOLOGY

The information presented in this section is summarized from the Geology Report and Groundwater Characterization Report [Geosyntec (2006)] of the current approved permit, in which the regional information is based on published geologic and hydrogeologic reports, including Collins (2000). The Collins (2000) geologic map and its accompanying report was developed from many previous geologic investigations done within and near the study area, represents the latest available published regional geologic information of the vicinity.

2.1 Regional Setting and Geology

The facility is located in the Blackland Prairies sub-province, the most western sub-province of the Gulf Coastal Plain physiographic province of Texas. The Blackland Prairies sub-province is characterized by a hilly to rolling prairie surface covering deep clayey soils. Vegetation types include grasses, brush, and mesquite trees. The Gulf Coastal Plain is characterized by a heterogeneous mixture of sand, silt, clay, and gravel that pinches out northwest of this province along the Balcones Escarpment and thickens to a cumulative thickness exceeding 10,000 ft near the Texas coastline.

In terms of surface water drainage patterns, the site area is predominantly situated in the watershed of Mesquite Creek. Mesquite Creek crosses through the site and passes through Freedom Lake approximately 0.3 miles north-northeast of the site, where it continues flowing to the northeast and enters York Creek at a point approximately three miles northeast of the site. York Creek is a tributary of the San Marcos River, part of the Guadalupe River Basin. A portion of the proposed expansion area (east-southeast of the topographic ridge on the expansion property) is part of the Alligator Creek watershed. Alligator Creek passes approximately one mile south of the site and flows southeast, where it enters Geronimo Creek at a point approximately four miles southeast of the site. Geronimo Creek is part of the Guadalupe River Basin (joining the Guadalupe River about three miles southeast of Seguin).

Regional geology in the vicinity of the site, taken from the Geologic Map of the New Braunfels, Texas, 30 x 60-minute quadrangle by the Bureau of Economic Geology (Collins, 2000), is shown on Figure 2. From these maps, the geologic outcrops in this region in and around the site include Lower Taylor Group, Upper Taylor Group, older Alluvium (possibly Uvalde Gravel), younger Alluvium, further to the south (off-site), Leona Formation. The geologic setting of the site is within the Balcones Fault Zone, where movement occurred during late the Oligocene or early Miocene epochs (Collins, 2000). The published regional geologic map on Figure 2 also indicates the presence of an inferred normal fault on the eastern edge of the site. As addressed by Geosyntec (2006) as part of the previous permit amendment application, from the robust body of knowledge of this geologic setting, supported by stratigraphic evidence in and around the site (namely, the presence of Pliocene and younger deposits that do not show evidence of off-set at the faults), such a potential fault would certainly be inactive, with no movement having occurred within the last approximately 16 million years at a minimum.

The generalized local stratigraphic column for geologic units in the site vicinity, from the Quaternary deposits down to the Cow Creek Formation [which represents the oldest Cretaceous Formation in the Collins (2000) study], is presented in Table 1.

Table 1
Local Stratigraphic Column in Site Vicinity
[From Geosyntec (2006) based on Collins (2000) and Shafer (1966)]

SYSTEM		STRATIGRAPHIC UNIT	APPROX. MAXIMUM THICKNESS BELOW SITE (FT)	APPROX. TYPICAL DEPTH OF OCCURRENCE (FT BELOW GROUND SURFACE)	CHARACTER OF MATERIAL	WATER-SUPPLY PROPERTIES
Quaternary		Stream, terrace and undivided alluvium	15	0	Locally – clay. Regionally - silt, sand, gravel, and some clay.	No wells known to yield water for stock and domestic needs.
Quaternary - Tertiary		Undifferentiated gravelly alluvium (possibly equivalent to Uvalde Gravel)	9	0 to 7	Locally – clayey gravel to gravelly clay. Regionally - pebble-to-cobble-sized chert and limestone, commonly cemented by caliche	Not known to yield significant quantities of water to wells.
		Upper Taylor Group (includes Navarro Group)	50 (est.)	0 to 10 (est.)	Clay-claystone and mud-mudstone, some thin siltstone and sandstone beds.	Not known to yield water to wells
		Lower Taylor Group (includes undivided Anacacho and Pecan Gap Formations)	290	10	Marl, argillaceous limestone, limestone, some chalky, clay-claystone and mud-mudstone.	Not known to yield water to wells
Cretaceous	Upper	Austin Chalk (Undivided)	100	300	Thin to thick bedded chalk, limestone and argillaceous limestone.	May yield small to moderate supplies of fresh to slightly saline water.
		Eagle Ford Shale (Undivided)	30	400	Calcareous and sandy shale and some argillaceous limestone.	Not known to yield water to wells
		Buda Limestone	65	430	Dense, hard limestone.	Not known to yield water to wells
		Del Rio Formation	50	495	Blue clay, weathering greenish and yellowish brown.	Not known to yield water to wells

SYSTEM		STRATIGRAPHIC UNIT	APPROX. MAXIMUM THICKNESS BELOW SITE (FT)	APPROX. TYPICAL DEPTH OF OCCURRENCE (FT BELOW GROUND SURFACE)	CHARACTER OF MATERIAL	WATER-SUPPLY PROPERTIES
	Lower	Georgetown Formation	30	545	Argillaceous limestone and marl .	Yields water to wells
		Edwards Group Limestone (Undivided)	470	575	Hard semi-crystalline massive limestone and dolomite and some thin-bedded limestone and marly limestone.	Yields water for municipal, industrial, and irrigation supplies. Is the principal aquifer (Edwards Aquifer) in western Comal County, minor aquifer in Guadalupe County.
		Walnut Formation	50	1045	Walnut limestone, marl	Unknown
		Glen Rose Limestone	720	1095	Massive limestone with alternating beds of less resistant marly limestone.	Lower part- generally yields sufficient water in the outcrop for stock and domestic use. Water from deeper wells generally is more highly mineralized than is water from shallow wells.
		Hensell Formation	80	1815	Sandy limestone, some also dolomitic.	Yields water to wells
		Cow Creek Formation	75	1895	Fossiliferous limestone	Yields water to wells

2.2 Regional Hydrogeology

Typical water-supply properties of the stratigraphic units in the area are presented above in Table 1. The principal perennial aquifer in the region is the Edwards Aquifer, classified by the Texas Water Development Board (TWDB) as a major aquifer of Texas. The Edwards Aquifer comprises the Edwards Limestone and the overlying Georgetown Limestone. This aquifer is primarily recharged via infiltration along the outcrop of the formations approximately 5 miles or more northwest of the site (i.e., the recharge zone).

The Edwards Aquifer is under both unconfined and confined conditions, depending on location, and contains both a fresh water and saline water zone, the interface of which is known as the “bad-water” line. The bad-water line is determined by the concentration of total dissolved solids (TDS) in the groundwater. The fresh-water zone up-dip from this boundary is defined where TDS concentrations are less than 1,000 milligrams per liter (mg/L), and the saline zone down-dip from the boundary is defined where TDS concentrations exceed 1,000 mg/L.

The top of the Edwards Aquifer is approximately 500 to 600-ft below the site, and is down-dip from the bad-water line in an area where the Edwards Aquifer is confined and the water is saline (Geosyntec, 2006). Beneath the site, the Glen Rose Limestone and Del Rio Clay serve as lower and upper confining layers, respectively. As such, this indicates that the site is not over the recharge zone of the Edwards Aquifer, and that the Edwards Aquifer is confined above and below, and not hydraulically connected to any other aquifer beneath the site.

It is also noted that according to the TWDB, the outcrop (i.e., recharge zone) of the Carrizo-Wilcox Aquifer occurs in southeastern portions of Guadalupe County, more than 10 miles away from the site. The Mesquite Creek Landfill site is not above or near the recharge zone of the Carrizo-Wilcox Aquifer, nor the recharge zone of any other aquifer classified by the TWDB as a major or minor aquifer of Texas.

3. PREVIOUS SITE EXPLORATIONS

The Mesquite Creek Landfill has been characterized based on a number of previous investigations at the site over time, as summarized below in chronological order.

- In 1987, 15 borings (CB-1 to CB-5; B-6 to B-15) were drilled at the site by McBride-Ratcliff to characterize the site stratigraphy and assess the soils for use as in-situ or constructed liners (Hydro-Search and MFG, 1990, revised 1991). Piezometers were installed in four of the borings.
- Between April 1990, September 1991, and October 1991, McCulley, Frick, and Gilman (MFG) installed a total of 12 piezometers (PZ-1 to PZ-12). The data from the piezometers would be used to develop a groundwater monitoring system for the site (Geosyntec, 2006).
- In 1991, Fugro-McClelland installed 6 gas monitoring probes (GP-1, GP-2, GP-3, GP-4, GP-5, GP-6).
- In February 1992, SEC Donohue installed five (5) groundwater monitoring wells (MW-1, MW-2, MW-3, MW-4, and MW-5) and one (1) piezometer (PZ-1M) at the site.
- One (1) additional groundwater monitoring well (MW-6), and one (1) replacement gas monitoring probe (GP-6R) were installed in November 1995 by Rust E&I.
- In 2004, 24 borings (GB-1 through GB-24) were drilled at the site by Geosyntec as a part of a soil boring plan associated with the permit amendment application MSW-66B. Fifteen (15) piezometers were installed during this investigation at the corresponding boring locations of: GB-01, GB-02, GB-03, GB-04, GB-05, GB-06, GB-09, GB-11, GB-12, GB-13, GB-15, GB-17, GB-20, GB-21 and, GB-22.
- In October 2005, Geosyntec installed one (1) gas monitoring probe (GP-7).
- In March 2009, Geosyntec installed nine (9) gas monitoring probes (GP-5A, GP-8 through GP-13, GP-20 and GP-21) and eleven (11) groundwater monitoring wells (MW-2A, MW-7A, MW-8A, MW-9, MW-11, MW-18 TO MW-23).
- In December 2013, Tetra Tech installed two (2) gas monitoring probes (GP-14 and GP-19).
- In January 2016, Tetra Tech installed one (1) gas monitoring probe (GP-15) and one (1) groundwater monitoring well (MW-17).
- In April 2018, Tetra Tech installed three (3) gas monitoring probes (GP-16, GP-17, GP-18) and three (3) groundwater monitoring wells (MW-13, MW-14, MW-

15) at the site. Also, one (1) groundwater monitoring well (MW-12) was installed in May 2018 to replace the previous MW-12 which had been using the GB-21 location.

- In 2020, Bullock, Bennett & Associates, LLC installed one (1) groundwater monitoring well (MW-4A) to replace damaged monitoring well MW-4.

It is noted that many of the site piezometers and monitoring wells listed above have been plugged and abandoned over time. The current groundwater monitoring system at the site is described in Section 4.2.3.

The locations of the previously drilled (historical) borings listed above are shown on Figure 3, and the coordinates, depths, and bottom elevations of the borings are listed in Tables 2 a and 2b for borings in the vicinity of existing Units 1 and 2, respectively.

Table 2a
Historical Borings – Unit 1 Area

Boring No.	Northing	Easting	Surface Elevation (ft, MSL)	Total Depth of Boring (ft bgs)	Bottom of Boring Elevation (ft, MSL)	Depth Below Unit 1 EDE[1] (ft)
Investigations generally covering the Unit 1 Area						
McBride-Ratcliff and Associates (MRA) 1987 Borings						
CB-1	13818690.8	2274791.0	670.0	60	610	-50
CB-2	13817699.1	2275753.2	623.0	40	583	-23
CB-3	13817202.0	2277006.0	632.0	60	572	-12
CB-4	13816510.4	2277509.9	604.0	60	544	16
CB-5	13817118.0	2278151.8	605.0	60	545	15
B-6/P-6	13817869.5	2277502.9	638.0	80	558	2
B-7/P-7	13818645.6	2276699.7	664.0	80	584	-24
B-8	13818827.8	2275873.5	638.0	80	558	2
B-9	13818810.5	2275359.3	640.0	80	560	0
B-10/ P-10	13818187.4	2275250.2	642.0	80	562	-2
B-11	13818273.3	2275758.9	628.0	75.5	552.5	8
B-12	13817701.1	2276456.4	642.0	80	562	-2
B-13	13817132.6	2276308.5	626.0	80	546	14
B-14/ P-14	13816748.3	2276753.3	604.0	50	554	6
B-15	13817062.0	2277640.3	606.0	80	526	34
McCulley, Frick & Gilman (MFG) 1990 Borings						
PZ-1	13818483.1	2276848.2	662.6	57	605.6	-45.6
PZ-2	13818510.9	2275457.0	633.2	70.5	562.7	-2.7
PZ-3	13818828.2	2275991.9	643.9	32.5	611.4	-51.4

Boring No.	Northing	Easting	Surface Elevation (ft, MSL)	Total Depth of Boring (ft bgs)	Bottom of Boring Elevation (ft, MSL)	Depth Below Unit 1 EDE[1] (ft)
PZ-4	13817665.5	2277682.0	627.5	50.4	577.1	-17.1
PZ-5	13817073.4	2277530.2	614.0	51.4	562.6	-2.6
Fugro-McClelland 1991 Borings						
GP-1	13818826.2	2275954.2	641.9	24	617.9	-57.9
GP-2	13818783.0	2276542.2	662.8	35	627.8	-67.8
GP-3	13817930.8	2277413.0	641.0	22	619.0	-59.0
GP-4	13817122.7	2278237.6	602.8	36	566.8	-6.8
GP-5	13816548.8	2277564.5	602.5	37	565.5	-5.5
GP-6	13817111.4	2276368.4	623.9	44	579.9	-19.9
MFG 1991 Borings						
PZ-6	13816630.1	2277407.7	602.7	24	578.7	-18.7
PZ-7	13816846.0	2277914.4	601.7	28	573.7	-13.7
PZ-8	13816851.8	2277922.8	600.7	63.5	537.2	22.9
PZ-9	13817410.2	2276071.5	621.9	56	565.9	-5.9
PZ-10	13817418.6	2276066.0	622.0	80	542.0	18.0
PZ-11	13818288.0	2277059.1	659.7	50	609.7	-49.7
PZ-12	13818280.2	2277068.5	660.1	68	592.1	-32.1
SEC Donahue 1992 Borings						
SB-1/MW-1	13818827.6	2276471.6	662.4	45	617.4	-57.4
SB-2/MW-2	13817476.5	2277889.5	615.6	35	580.6	-20.6
SB-3/MW-3	13816695.3	2277745.6	603.5	34	569.5	-9.5
SB-4/MW-4	13816747.5	2276733.9	605.3	30	575.3	-15.3
SB-5/MW-5	13818768.9	2274725.7	670.5	60	610.5	-50.5
PZ-1M	13817724.3	2277295.5	644.2	45	599.2	-39.2
Rust E&I 1995 Borings						
SB-6/MW-6	13817972.8	2275468.2	632.9	63.5	569.4	-9.4
GP-6R	13817050.8	2276398.8	623.5	43.25	580.2	-20.2

Notes:

1. Unit 1 EDE = Elevation of Deepest Excavation at Unit 1. Unit 1 EDE (including sumps) is approximately 560 ft, MSL. Negative values indicate depth above EDE.
2. Coordinates (northings and eastings) correspond to Texas State Plane, Texas Central Zone (4203), North American Datum 83 (NAD 83). See Figure 3 for a site map showing the locations of these borings.
3. CB, B, SB, and GB refer to soil borings. P and PZ refer to piezometers. GP refers to gas monitoring probes. MW refers to groundwater monitoring wells.

Table 2b
Historical Borings – Current Unit 2 Area

Boring No.	Northing	Easting	Surface Elevation (ft, MSL)	Total Depth of Boring (ft bgs)	Bottom of Boring Elevation (ft, MSL)	Depth Below Unit 2 EDE[1] (ft)
Investigations generally covering the current Unit 2 Area						
Geosyntec 2004 Borings						
GB-01	13816876.5	2278393.2	595.4	95	500.4	83.6
GB-02	13816525.6	2277962.4	599.5	70.5	529.0	55.0
GB-03	13815970.6	2277506.7	607.7	104.5	503.2	80.8
GB-04	13814602.4	2278766.5	668.2	145	523.2	60.8
GB-05	13815229.1	2279182.7	640.5	115	525.5	58.5
GB-06	13815883.3	2279871.8	646.0	124	522.0	62.0
GB-07	13816405.0	2278500.4	602.9	59	543.9	40.1
GB-08	13816002.2	2278101.0	623.8	71.5	552.3	31.7
GB-09	13815699.8	2279256.0	638.7	89	549.7	34.3
GB-10	13815451.5	2278556.9	648.7	99	549.7	34.3
GB-11	13815865.0	2278665.3	617.2	90	527.2	56.8
GB-12	13815351.5	2278055.8	639.6	119	520.6	63.4
GB-13	13816271.9	2279036.3	618.8	95	523.8	60.3
GB-14	13815300.7	2279853.7	679.8	136	543.8	40.2
GB-15	13815626.5	2280863.5	643.4	144	499.4	84.6
GB-16	13815064.2	2280568.1	679.5	139	540.5	43.5
GB-17	13814631.0	2280885.4	654.4	134	520.4	63.6
GB-18	13814753.6	2280137.3	694.2	149	545.2	38.8
GB-19	13814291.2	2279905.5	688.7	150	538.7	45.3
GB-20	13814134.9	2279345.2	675.9	169	506.9	77.1
GB-21	13813671.2	2280075.2	709.0	187	522.0	62.0
GB-22	13814811.4	2279501.0	656.5	140	516.5	67.5
GB-23	13814122.2	2280492.8	689.5	185	504.5	79.5
GB-24	13815567.3	2280399.1	677.5	155	522.5	61.5
Geosyntec 2005 Boring						
GP-7	13817956.2	2275490.2	632.0	22	610.0	-26.0
Geosyntec 2009 Borings						
GP-5A	13815940.0	2277535.0	609.1	52	557.1	26.9
GP-8	13816.6	2277112.0	605.3	49	556.3	27.7

Boring No.	Northing	Easting	Surface Elevation (ft, MSL)	Total Depth of Boring (ft bgs)	Bottom of Boring Elevation (ft, MSL)	Depth Below Unit 2 EDE[1] (ft)
GP-9	13817505.0	2275964.0	625.0	48	577.0	7.0
GP-10	13818348.0	2276992.0	663.9	47.5	616.4	-32.4
GP-11	13817459.0	2277906.0	615.9	57	558.9	25.1
GP-12	13816475.0	2278886.0	610.0	31	579.0	5.0
GP-13	13816023.0	2279585.0	639.9	62	577.9	6.1
GP-20	13814695.0	2278675.0	664.2	65	599.2	-15.2
GP-21	13815429.0	2277985.0	637.8	49	588.8	-4.8
MW-2A	13817069.0	2278162.0	609.0	37	572.0	12.0
MW-7A	13816498.0	2277256.0	603.4	27	576.4	7.6
MW-8A	13817143.0	2276302.0	625.5	55	570.5	13.5
MW-9	13817565.0	2275906.0	626.0	50	576.0	8.0
MW-11	13814064.0	2279299.0	679.0	63	616.0	-32.0
MW-18	13815985.8	2279745.5	635.1	60	575.1	8.9
MW-19	13816167.0	2279219.0	633.2	55	578.2	5.8
MW-20	13816584.0	2278784.0	606.3	40	566.3	17.7
MW-21	13816481.0	2278358.0	606.8	43	563.8	20.2
MW-22	13816113.0	2278083.0	612.2	37	575.2	8.8
MW-23	13816006.0	2277841.0	621.2	35	586.2	-2.2
TetraTech 2013 Borings						
GP-14	13815798.2	2280540.8	657.7	56	601.7	-17.7
GP-19	13814102.7	2279257.6	676.5	56	620.5	-36.5
TetraTech 2016 Borings						
GP-15	13815411.4	2280910.4	637.66	33.0	604.7	-20.7
MW-17	13815851.0	2280330.0	655.42	63.0	592.4	-8.4
TetraTech 2018 Borings						
GP-16	13814396.7	2280879.4	654.8	31.5	623.3	-39.3
GP-17	13813948.3	2280401.6	699.8	77.5	622.3	-38.3
GP-18	13813461.0	2279899.2	708.7	75	633.7	-49.7
MW-13	13814058.7	2280515.9	688.7	56	632.7	-48.7
MW-14	13814514.5	2280890.1	654.0	57.5	596.5	-12.5
MW-15	13815072.8	2280885.4	647.2	53	594.2	-10.2
MW-12	13813666.3	2280080.1	709.3	76	633.3	-49.3
Bullock, Bennett & Associates 2020 Boring						
MW-4A	13813671.2	2280075.2	609.4	30	579.4	4.6

Notes:

1. Unit 2 EDE = Elevation of Deepest Excavation at Unit 2. Unit 2 EDE (including sumps) is approximately 584 ft, MSL. Negative values indicate depth above EDE.
2. Coordinates (northings and eastings) correspond to Texas State Plane, Texas Central Zone (4203), North American Datum 83 (NAD 83). See Figure 3 for a site map showing the locations of these borings.
3. CB, B, SB, and GB refer to soil borings. P and PZ refer to piezometers. GP refers to gas monitoring probes. MW refers to groundwater monitoring wells.

From the above Tables 2a and 2b, at least 98 borings have been drilled previously at the site.

Because this proposed future expansion would be adjacent to (and connected to) Unit 2, focusing on the current-permitted Unit 2 area of approximately 148.1 acres, the following takeaways are noted:

- the Unit 2 EDE is 584 ft, MSL;
- 57 borings have been drilled previously at the current Unit 2 area;
- 38 of these borings were drilled to a depth at least 5-ft below the Unit 2 EDE; and
- 24 of these borings were drilled to a depth least 30-ft below the Unit 2 EDE.

Boring logs for the items tabulated above, taken from information contained in the approved permit amendment application MSW-66B (Geosyntec, 2006), are provided in Appendix A. Copies of geologic cross-sections developed for permit amendment application MSW-66B (Geosyntec, 2006) are provided in Appendix B.

4. SITE STRATIGRAPHY AND HYDROGEOLOGY

4.1 Site Setting and Stratigraphy

The topography of the area surrounding the existing facility is composed of two natural hillsides with a valley associated with Mesquite Creek in the middle of the site. Pre-development highest natural ground elevations range from approximately 665 ft, MSL on the northern portion of the site (i.e., Unit 1) to 712 ft, MSL on the southern side (i.e. Unit 2). The lowest natural ground surface elevation of approximately elevation 585 ft, MSL occurs in the middle of the site, along the northern property boundary (i.e., point at which Mesquite Creek leaves the property). The proposed lateral expansion area located south-southeast of Unit 2 is generally situated on a topographic ridge having a peak elevation of approximately 717 ft, MSL, sloping down to a lowest elevation to the southeast of approximately elevation 640 ft, MSL.

The general soil stratigraphy at the site based on previous investigations is presented below in Table 3.

Table 3
Generalized Site Stratigraphy

Stratigraphic Layer	Description	Approx. Thickness Characterized To-Date (ft)
Stratum I- Fine grained Quaternary Deposits	Unsaturated brown to dark gray, stiff to hard clay	0-14.5
Stratum II- Quaternary- Tertiary Alluvium (possibly Uvalde Gravel)	Clayey gravel to gravelly clay.	0 to 9
Stratum III- Weathered clay/claystone of the Lower Taylor Group	Very stiff to hard oxidized clay/claystone	18- 58.5 ft
Stratum IV- Un-weathered claystone of the Lower Taylor Group	Green to dark gray very hard unoxidized claystone	Note 1

Note:
1. Previously installed site borings did not completely penetrate Stratum IV. Stratum IV is the lower confining unit at the site. Stratum IV is part of the lower Taylor Group that is estimated to be about 290 feet thick beneath the site.

4.2 Site Hydrogeology

4.2.1 Stratum I and II (Unsaturated Zone)

Stratum I and II (recent fine-grained deposits and alluvium possibly equivalent to Uvalde Gravel) are encountered at the ground surface and are described as a dark gray to brown medium to high plasticity clay, and a clayey gravel to a gravelly clay, respectively. Stratum I is mostly continuous in the existing site except where removed by landfill excavation activities. Stratum II was less prevalent in existing site areas, but geologic maps (e.g., see Figure 2) suggest there are surficial deposits of this material on the topographic ridge of the proposed expansion area. Previous site investigations have indicated, Stratum I and II as being consistently dry (unsaturated) and no water bearing intervals within these strata.

4.2.2 Stratum III (Includes Uppermost Water Bearing Zone)

Stratum III consists of oxidized clays and claystone of the Lower Taylor Group, and the weathered and fractured lower portion of Stratum III is the uppermost water bearing zone at the facility. It ranges in thickness from about 15 to 63 feet across the entire site. The groundwater elevations in Stratum III generally mimic the natural ground surface topography at the site, as well as the elevation changes of the top of Stratum IV.

As groundwater is first encountered in secondary features within the lower part of Stratum III perched above Stratum IV, it is defined as the uppermost water-bearing zone (i.e., aquifer) at the site. Stratum III is directly underlain by the lower hydraulic conductivity and un-weathered tight clay/claystone of Stratum IV, which represents a lower confining unit to Stratum III, preventing potential hydraulic interconnectivity with other aquifers. Because the occurrence of groundwater in Stratum III is mainly dependent on secondary features, the depth to groundwater and extent of saturation within Stratum III is variable.

4.2.3 Stratum IV (Aquiclude)

The oxidized clays of Stratum III are underlain by Stratum IV, which is comprised of unoxidized claystone of the Lower Taylor Group. The full thickness of Stratum IV was not determined at this site because the drilling depths of previous investigations terminated before the bottom of the unit was reached. However, regional geologic information, as discussed herein, suggests that the thickness of this stratum exceeds 290 ft. The formation is composed of primarily unweathered, unfractured, tight claystone with low yield and low hydraulic conductivity, and as such, acts as an aquiclude that confines groundwater above it and prevents hydraulic interconnection with deeper aquifers.

4.2.4 Groundwater Monitoring System

As discussed, Stratum III is considered the uppermost water bearing zone beneath the site. The groundwater monitoring program at the facility in accordance with the current permit MSW-66B is composed of a system of 23 groundwater monitoring wells, screened at the base of Stratum III.

5. PROPOSED SITE EXPLORATION

5.1 Proposed Borings

For the proposed expansion, the permit boundary area will be increased by approximately 191.4 acres, as shown on Figures 3 and 4. As specified in 30 TAC §330.63(e)(4)(B), the minimum number of borings required by the TCEQ to characterize an area of 150-200 acres is twenty-three (23) to twenty-six (26) borings, with all borings drilled to at least 5 ft below the EDE and thirteen (13) to fifteen (15) borings drilled to at least 30 ft below the EDE. The deepest excavation depth of the proposed expansion area will be substantially shallower, with the expansion area designed with an EDE (including sumps) at no deeper than 610 ft, MSL.

To address the number and depth requirements, the following borings are proposed to characterize the approximately 191.4 acre expansion area:

- twenty-eight (28) new borings (GB-25 to GB-52);
- all 28 of which will be drilled to at least five (5) feet below the expansion area EDE;
- 15 of which will be drilled deeper, to a depth of at least 30 ft below the expansion area EDE; and
- of these deeper borings, six (6) will be extended even deeper, to reach a depth of at least 30-ft below the existing Unit 2 EDE of 584 ft, MSL.

The locations of the proposed borings are shown on Figure 4 (note that these proposed boring locations are approximate and may be adjusted based on actual site conditions such as drill rig accessibility). The target boring depth, target bottom elevation, and estimated depth below the EDE of the proposed expansion area design are summarized in Table 4.

As designed and based on the hydro stratigraphic units beneath the site previously investigated as described herein, the borings will be sufficiently deep enough to allow identification of the uppermost aquifer (30 TAC §330.63(e)(4)(B)) (i.e., the water-bearing zone of the lower part of Stratum III), and to identify the aquiclude (Stratum IV) at the lower boundary (which prevents hydraulic interconnection with deeper aquifers) .

Focusing on the combined/expanded Unit 2 area (since this is the landfill unit being expanded) the acreage of the permit boundary of the existing and proposed expanded Unit 2 areas will be approximately 340 acres. Although the expansion area will be constructed substantially shallower than the existing landfill, when counting both previous and new proposed borings, this plan would result in a total of 44 borings drilled to at least 5-ft below the overall Unit 2 EDE, and of these, 30 borings drilled to at least 30-ft below the overall Unit 2 EDE. This will provide ample data to establish subsurface stratigraphy and geotechnical properties, especially given the good understanding of the geologic framework below the site from the extensive investigations that have taken place and the thorough understanding of the regional and site-specific subsurface conditions.

Table 4
Proposed New Borings – Unit 2 Expansion Area

Boring No.	Northing[2]	Easting[2]	Estimated Surface Elevation (ft, MSL)	Minimum Depth[3] (ft, bgs)	Minimum Bottom Elevation[3] (ft, MSL)	Depth Below Expansion Area EDE[1] (ft)
Proposed Borings						
GB-25	13813775	2280751	663	83	580	30
GB-26	13813562	2280317	702	97	605	5
GB-27[4]	13813171	2280704	663	109	554	56
GB-28	13814021	2279217	685	80	605	5
GB-29	13813630	2279604	712	107	605	5
GB-30	13813239	2279991	697	92	605	5
GB-31	13812848	2280378	668	63	605	5
GB-32	13812558	2280894	653	73	580	30
GB-33[4]	13813501	2278691	703	149	554	56
GB-34	13813110	2279078	712	132	580	30
GB-35	13812719	2279465	709	104	605	5
GB-36	13812328	2279852	682	102	580	30
GB-37[4]	13811937	2280238	668	114	554	56
GB-38	13812980	2278165	708	128	580	30
GB-39	13812589	2278552	708	103	605	5
GB-40[4]	13812198	2278939	693	139	554	56
GB-41	13811807	2279326	680	75	605	5
GB-42	13811416	2279712	663	83	580	30
GB-43	13812460	2277639	710	105	605	5
GB-44	13812069	2278026	710	130	580	30
GB-45	13811678	2278413	710	105	605	5
GB-46	13811287	2278799	687	107	580	30
GB-47	13810896	2279186	671	66	605	5

Boring No.	Northing[2]	Easting[2]	Estimated Surface Elevation (ft, MSL)	Minimum Depth[3] (ft, bgs)	Minimum Bottom Elevation[3] (ft, MSL)	Depth Below Expansion Area EDE[1] (ft)
GB-48[4]	13811940	2277113	708	154	554	56
GB-49	13811549	2277500	704	99	605	5
GB-50	13811158	2277887	689	109	580	30
GB-51	13810767	2278273	677	72	605	5
GB-52[4]	13810377	2278659	667	113	554	56

Notes:

1. The proposed expansion area design will have an EDE (including sumps) no deeper than 610 ft, MSL.
2. Coordinates (northings and eastings) correspond to Texas State Plane, Texas Central Zone (4203), North American Datum 83 (NAD 83). See Figure 4 for a site map showing the locations of these proposed borings. Borehole coordinates/locations are preliminary and based on an initial assessment of layout and drill rig accessibility; final as-drilled locations may be field adjusted but will be generally consistent with those shown on Figure 4. Final, as-installed boring locations will be surveyed, and that information will be included in the Geology Report.
3. Boring bottom elevations are minimums. The depths are also termed minimums, but are based on the difference between the surface elevation vs. the minimum bottom elevation. All borings should extend deep enough to identify the uppermost aquifer lower confining layer (expected to be the lower part of Stratum III, and Stratum IV, respectively).
4. The six (6) deepest proposed borings indicated above will be drilled first in the sequence of drilling.

5.2 Site Investigation Details

Drilling operations will be supervised by a professional geologist or engineer who is familiar with the geology of the area and licensed to practice in the state of Texas.

5.2.1 Borings

Twenty-eight (28) soil borings (GB-25 to GB-52) will be drilled as a part of the proposed site exploration program of the expansion area. Borings will be conducted in accordance with 30 TAC §330.63(e)(4)(C) using established field exploration methods (e.g., drilled using hollow stem augers, direct-push technology, air or mud rotary methods, sonic drilling, and/or by coring in harder clay-shale or rock materials). Sampling methods will include pushing thin-walled tubes, driving split spoons or similar sampling devices, coring, and collecting drill cuttings as appropriate. Lithology will be logged by a qualified geologist or engineer in accordance with 30 TAC §330.63(e)(4) and consistent with established description procedures. Boring logs prepared as part of a report of the investigation (i.e., included in a Geology Report for a permit amendment application) must include a detailed description of materials encountered including any discontinuities such as fractures, fissures, slickensides, lenses, or seams. Except for borings in which piezometers will be installed (i.e., those which will be used for taking ongoing water level measurements), each boring will be plugged in accordance with rules of the commission (TCEQ), namely in accordance with the abandonment requirements in 16 TAC §76.72 and the plugging standards in 16 TAC §76.104 (as applicable).

5.2.2 Piezometers

To characterize the groundwater in the expansion area, several piezometers are planned to be installed. The anticipated screened zone for each piezometer will be in the lower weathered portion of Stratum III where groundwater is anticipated to be encountered at depths of about 35 ft below ground surface. Based on preliminary planning, it is estimated that piezometers may be installed in up to twelve (12) borehole locations as part of the proposed site exploration program. However, the number and location of piezometers, as well as the screened depth/interval(s), may change based on observations made during drilling.

5.2.3 Water Levels

Observations of groundwater encountered in the proposed borings will be noted, and the depth at which groundwater was first encountered will be recorded. After-equilibrium (or just prior to plugging) groundwater depth measurements in the proposed borings will also be taken when possible (e.g., if drilling using wet coring or mud rotary methods, groundwater depth measurements in the borehole will not be possible). Groundwater levels in the new piezometers will also be measured.

Groundwater levels and flow directions/conditions around the existing landfill have been characterized, measured, and mapped since the initial groundwater monitoring wells were installed. Thus, groundwater conditions are well understood. Groundwater levels from the existing monitoring well network, along with information from the proposed piezometers, will be used for groundwater characterization in the permit amendment application in accordance with 30 TAC §330.63(e)(5)(C) and (e)(5)(D).

5.2.4 Slug Tests

Horizontal hydraulic conductivities of Stratum III and IV have been measured from slug tests conducted by Geosyntec (2006) and MFG (1991). MFG performed slug tests at six (6) piezometers screened in Stratum III in the area of Unit 1. Geosyntec performed slug tests at eight (8) piezometers screened in Stratum III in the area of Unit 2. Given this availability of site-specific slug test data, additional slug tests may or may not be performed in newly installed piezometers. Performing additional slug test(s) in one (1) or more of the proposed piezometers will be considered if lithologies appear to be significantly different than those previously characterized.

The previous data, supplemented by relevant data collected during this proposed investigation, will be used to provide the hydrogeologic characterization of the site for design of an appropriate groundwater monitoring system, and to provide an analysis of the most likely potential pathways for pollutant migration.

5.2.5 Soils Laboratory Testing

Geotechnical laboratory testing was conducted during the previous investigations at the site, with results compiled and presented in the Geotechnical Report section of the Geology Report of the current permit MSW-66B.

For the proposed soil boring program, laboratory testing sufficient to provide the required testing and characterization of site soils in the expansion area will be completed in accordance with 30 TAC §330.63(e)(5). The laboratory testing conducted on soils from the previous investigations will be supplemented with additional tests such that at least one (1) sample from each soil layer that will form the bottom and side of the proposed excavation and from soils layers that are less than 30 feet below the expansion area EDE has been evaluated in the new expansion area.

5.3 Summary of Proposed Site Exploration

In summary, data obtained from the proposed borings will supplement data from the previous site investigation and will be incorporated in the landfill design and forthcoming anticipated permit amendment application for the proposed expansion of the facility. Twenty-eight (28) additional borings (GB-25 to GB-52) will be drilled to address the requirements of 30 TAC §330.63(e)(4) for characterization of the expansion area, and to prepare the related contents of the permit amendment application regarding soil, geology, geotechnical, and groundwater monitoring topics. This new site subsurface investigation, along with the previously submitted geologic cross-sections and available data, will be used to confirm the uppermost groundwater bearing zone and lower confining unit at the site and adequately address the hydrogeologic characterization (e.g., hydraulic conductivities and lower confining unit and lack of any hydraulically interconnected aquifers), and establish the geotechnical properties of the soils and rocks beneath the facility.

5.4 Rationale for Sufficiency of Proposed Number of Borings and Depths

The rationale for the sufficiency of the proposed number of borings and depths, discussing how the Rule requirements of 30 TAC §330.63(e)(4)(A) and (B) are met, is presented below.

- There have already been 57 borings drilled at various locations and depths in the existing Unit 2 area, with 38 drilled to at least 5-ft below the existing Unit 2 EDE, and 24 drilled at least 30-ft below the existing Unit 2 EDE. The conceptual site model of the hydrogeologic setting, stratigraphy, presence of groundwater, uppermost aquifer, and lower confining unit at the site is well understood and is documented in the approved Permit 66B Geology Report. Per 30 TAC §330.63(e)(4)(A), the "general characteristics of a site" have been analyzed, as has "the heterogeneity of subsurface materials". No stratigraphic complexities were identified.

- The requirements of the graphic table in 30 TAC §330.63(e)(4)(B) for the number of borings and depths will be met for Unit 2, as illustrated below.

    - Considering Unit 2 in-total, for an approximately 340-acre area having an overall EDE of 584 ft, MSL, the total proposed plus existing borings meeting the graphic table requirements on a site-wide basis will be as follows:

TABLE OF BORINGS

Size of Area in Acres	Number of Borings	Min. No. of Borings 30 Feet below the Elev. of Deepest Excavation	# OF BORINGS (EXISTING + PROPOSED) >5-FT BELOW EDE	# OF BORINGS (EXISTING + PROPOSED) >30-FT BELOW EDE
5 or less	2-4	2		
5-10	4-6	3		
10-20	6-10	5		
20-50	10-15	7		
50-100	15-20	7-12		
100-150	20-23	12-13		
150-200	23-26	13-15		
200-250	26-29	15-16		
250-300	29-32	16-17		
300-350	32-35	17-18	44	30
350-400	35-38	18-20		
400-450	38-42	20-21		
450-500	42-44	21-22		
500-550	44-47	22-24		
550-600	47-50	24-26		
More than 600	Determined in consultation with the executive director			

* The executive director may approve different boring depths if site-specific conditions justify variances.

- Considering the Unit 2 expansion area as a stand-alone investigation for the planned landfill that will be situated on that parcel of property, for a 191.4 acre area with an EDE of 610 ft, MSL, the proposed new borings meeting the graphic table requirements will be as follows:

TABLE OF BORINGS

Size of Area in Acres	Number of Borings	Min. No. of Borings 30 Feet below the Elev. of Deepest Excavation	# OF PROPOSED BORINGS >5-FT BELOW EXPANSION AREA EDE	# OF PROPOSED BORINGS >30-FT BELOW EXPANSION AREA EDE
5 or less	2-4	2		
5-10	4-6	3		
10-20	6-10	5		
20-50	10-15	7		
50-100	15-20	7-12		
100-150	20-23	12-13		
150-200	23-26	13-15	28	15
200-250	26-29	15-16		
250-300	29-32	16-17		
300-350	32-35	17-18		
350-400	35-38	18-20		
400-450	38-42	20-21		
450-500	42-44	21-22		
500-550	44-47	22-24		
550-600	47-50	24-26		
More than 600	Determined in consultation with the executive director			

* The executive director may approve different boring depths if site-specific conditions justify variances.

- It is also noted that the rules allow the executive director to approve different boring depths if site-specific conditions justify variances, per the footnote included in the graphical table (and shown above). Although the above illustrations were prepared to demonstrate compliance with the graphic table in 30 TAC §330.63(e)(4)(B) when the program is considered in two different ways, to the extent that the proposed program could be considered a "hybrid" condition, the ability of the executive director to approve alternatives from the prescribed boring frequency and depths is noted; the information provided herein is believed to provide thorough justification on the sufficiency of the proposed soil boring plan.

- Specific to the Unit 2 expansion area, six (6) proposed borings will be drilled to a depth of at least 30-ft below the overall Unit 2 EDE. These borings are generally located near the corners and in the middle of the expansion area, so as to provide completeness of coverage (i.e., bound the new area) of deep borings, to help supplement the existing information to depths >30-ft below the Unit 2 EDE regarding presence of groundwater and confining layer(s).

- These six (6) deepest proposed borings will be drilled first in the sequence of drilling, to allow for assessment of the observed conditions vs. expectations down to the deepest elevations of the investigation early-on in the program, so that modifications to the program can be made if conditions differ from the current conceptual site model described herein (described further below).
- Based on the extensive site data and characterized hydrogeologic setting, the uppermost aquifer is expected to be at the lower part of Stratum III, and Stratum IV has been well documented as a confining layer. The top of Stratum IV surface mimics the surface topography, and is at a relatively constant depth below ground surface of about 60-ft.
  - All of the borings in the Unit 2 expansion area were designed based on this, so as to ensure that the uppermost aquifer and the lower confining unit are reliably located and characterized.
  - As required by Table 4, all borings should extend deep enough to identify the uppermost aquifer lower confining layer (expected to be the lower part of Stratum III, and Stratum IV, respectively). Table 4 provides further provisions, requiring drilling deeper if these respective features are not encountered when the minimum depth is reached.

Also, although not foreseen at this time, additional borings may be added if supplemental design data is needed during the course of the site exploration program or preparing the upcoming permit amendment application. If so, those additional borings (over and above the minimums specified in this plan) will be performed in a manner consistent with the methodology specified herein (Section 5.2) without the need to submit a revision to this SBP. For example, if discontinuities or stratigraphic complexities are encountered to the extent that they require further investigation in order to describe them on boring logs and integrate the information into the site characterization of stratigraphy, groundwater occurrence and interconnectivity, and lower confining layer(s), additional borings may be added, or borings may extend deeper than the minimums.

If, after this SBP is approved, it becomes necessary because of site conditions to make modifications to the number of borings and/or depths presented herein (other than the discretionary addition of supplemental borings over and above the specified minimums, or drilling one or more proposed borings deeper than the specified minimums, as described in the preceding paragraph), details the proposed modifications will be provided to TCEQ for approval by the executive director pursuant to 30 TAC §330.63(e)(4)(E).

6. REFERENCES

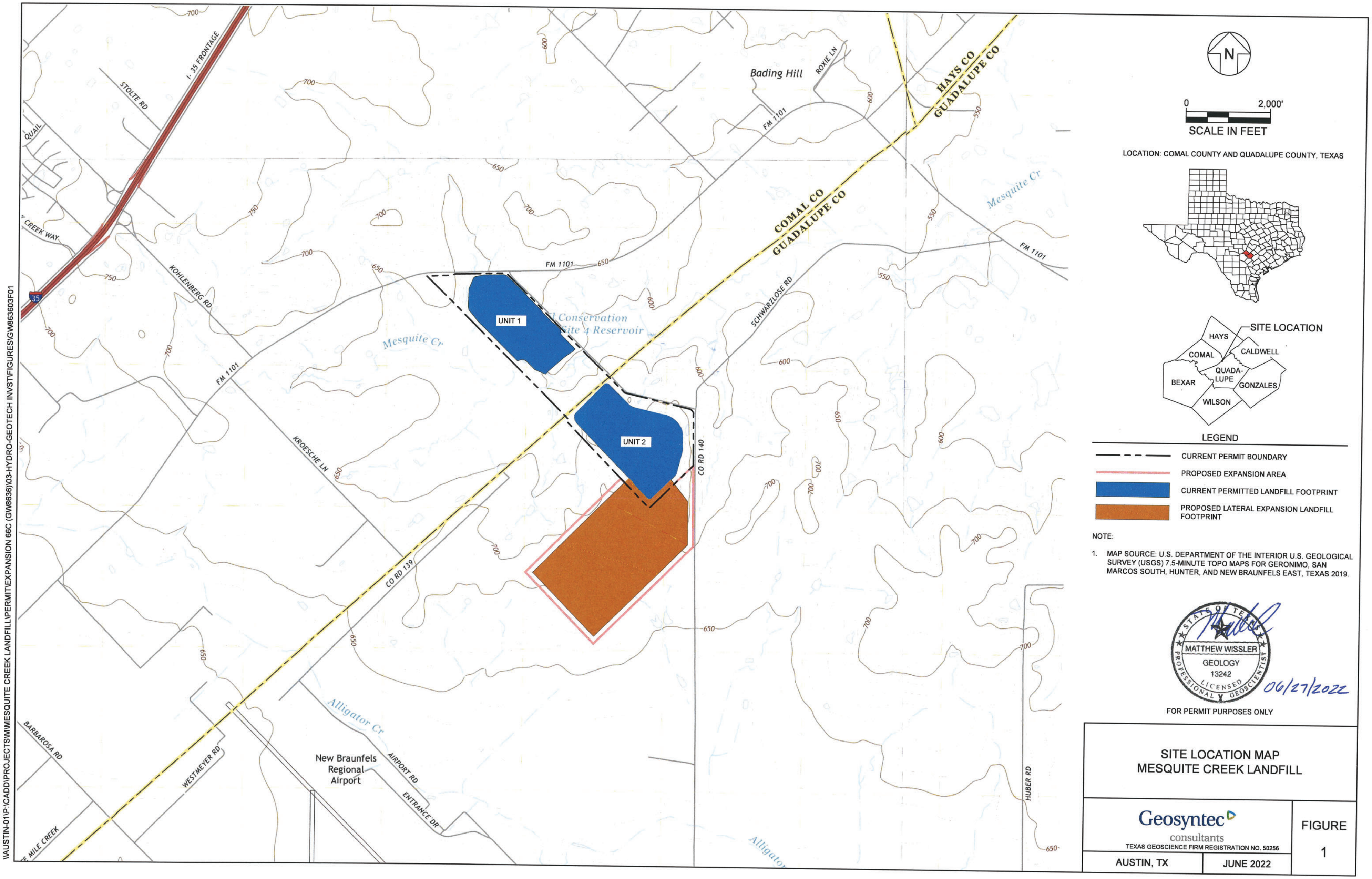
Collins, E.W., *"Geologic Map of the New Braunfels, Texas, 30 x 60 Minute Quadrangle: Geologic Framework of an Urban-Growth Corridor along the Edwards Aquifer, South-Central Texas"*, Bureau of Economic Geology Miscellaneous Map No. 39, 2000.

Geosyntec Consultants, Inc., "*Permit Amendment Application, Mesquite Creek Landfill, TCEQ MSW Permit No. 66B,* prepared for Waste Management of Texas, Inc., Technically Complete July 14, 2006.

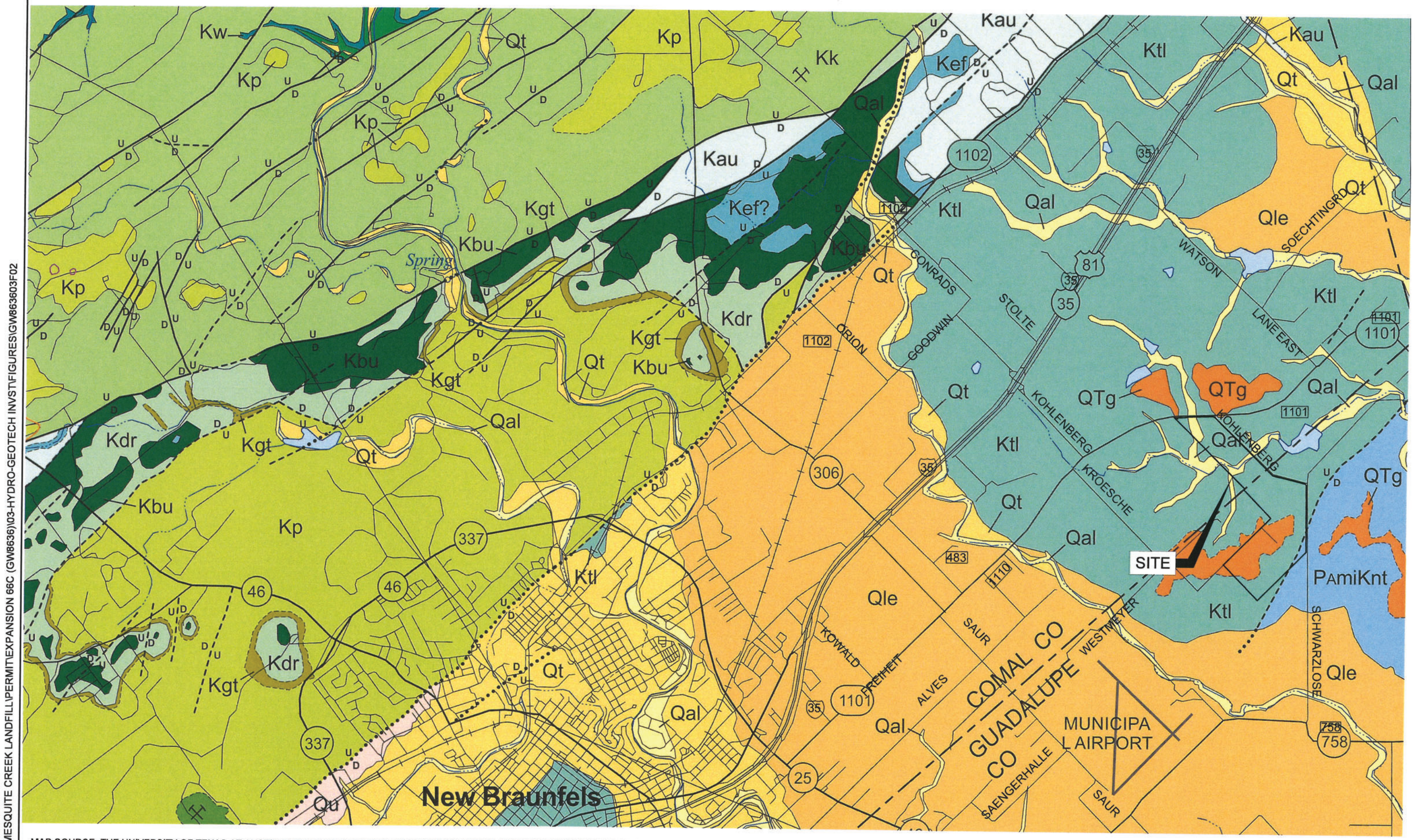
Hydro-Search, Inc., and McCulley, Frick & Gilman, Inc, (MFG), *"Comal County Landfill Phase II Hydrogeological Report"*, prepared for Waste Management of Texas Inc., Irving, Texas, August 1990 (revised July, 1991).

Shafer, G.H., *"Ground-Water Resources of Guadalupe County, Texas"* Texas Water Development Board, Report 19, prepared by the U.S. Geological Survey in cooperation with the Texas Water Development Board, Guadalupe-Blanco River Authority, and the Guadalupe County Commissioner's Court, 1966, 95 p.

FIGURES



\\AUSTIN-01\P:\CADD\PROJECTS\M\MESQUITE CREEK LANDFILL\PERMIT\EXPANSION 66C (GW8636)\03-HYDRO-GEOTECH INVST\FIGURES\GW863603F01
N
0
2,000'
SCALE IN FEET
LOCATION: COMAL COUNTY AND QUADALUPE COUNTY, TEXAS
SITE LOCATION
HAYS
CALDWELL
COMAL
QUADA-LUPE
BEXAR
GONZALES
WILSON
LEGEND
CURRENT PERMIT BOUNDARY
PROPOSED EXPANSION AREA
CURRENT PERMITTED LANDFILL FOOTPRINT
PROPOSED LATERAL EXPANSION LANDFILL FOOTPRINT
NOTE:
1. MAP SOURCE: U.S. DEPARTMENT OF THE INTERIOR U.S. GEOLOGICAL SURVEY (USGS) 7.5-MINUTE TOPO MAPS FOR GERONIMO, SAN MARCOS SOUTH, HUNTER, AND NEW BRAUNFELS EAST, TEXAS 2019.
STATE OF TEXAS
MATTHEW WISSLER
GEOLOGY
13242
LICENSED
PROFESSIONAL GEOSCIENTIST
06/27/2022
FOR PERMIT PURPOSES ONLY
SITE LOCATION MAP
MESQUITE CREEK LANDFILL
Geosyntec
consultants
TEXAS GEOSCIENCE FIRM REGISTRATION NO. 50256
FIGURE
1
AUSTIN, TX
JUNE 2022
UNIT 1
UNIT 2
Conservation
Site 4 Reservoir
Mesquite Cr
Bading Hill
ROXIE LN
FM 1101
HAYS CO
GUADALUPE CO
COMAL CO
GUADALUPE CO
I- 35 FRONTAGE
STOLTE RD
QUAIL
CREEK WAY
KOHLENBERG RD
KROESCHE LN
SCHWARZLOSE RD
CO RD 140
CO RD 139
Alligator Cr
New Braunfels
Regional
Airport
AIRPORT RD
ENTRANCE DR
BARBAROSA RD
WESTMEYER RD
HUBER RD
35



MAP SOURCE: THE UNIVERSITY OF TEXAS AT AUSTIN BUREAU OF ECONOMIC GEOLOGY (TX BEG) IN COOPERATION WITH THE STATEMAP COMPONENT OF THE NATIONAL COOPERATIVE GEOLOGIC MAPPING PROGRAM, ADMINISTERED BY THE U.S. GEOLOGICAL SURVEY, OBTAINED JUNE 2022. MAPPING INFORMATION SHOWN IS FROM TX BEG MISCELLANEOUS MAP NO. 39, "GEOLOGIC MAP OF THE NEW BRAUNFELS, TEXAS, 30 X 60 MINUTE QUADRANGLE", E.W. COLLINS, 2000.

N

LEGEND

- TEXAS DOT ROADWAY
- FAULT - INFERRED NORMAL
- Kau - AUSTIN CHALK
- Kbu - BUDA LIMESTONE
- Kdr - DEL RIO CLAY
- Kef - EAGLE FORD GROUP
- Kk - KAINER FORMATION
- Kp - PERSON FORMATION
- Ktl - LOWER TAYLOR GROUP
- PAmiKnt - TAYLOR / NAVARRO / PALEOCENE MIDWAY GROUP
- Qal - ALLUVIUM
- Qle - LEONA FORMATION
- Qt - TERRACE ALLUVIUM
- QTg - OLDER GRAVELLY ALLUVIUM

0 1

SCALE: MILES

STATE OF TEXAS
MATTHEW WISSLER
GEOLOGY
13242
LICENSED
PROFESSIONAL GEOSCIENTIST
06/27/2022

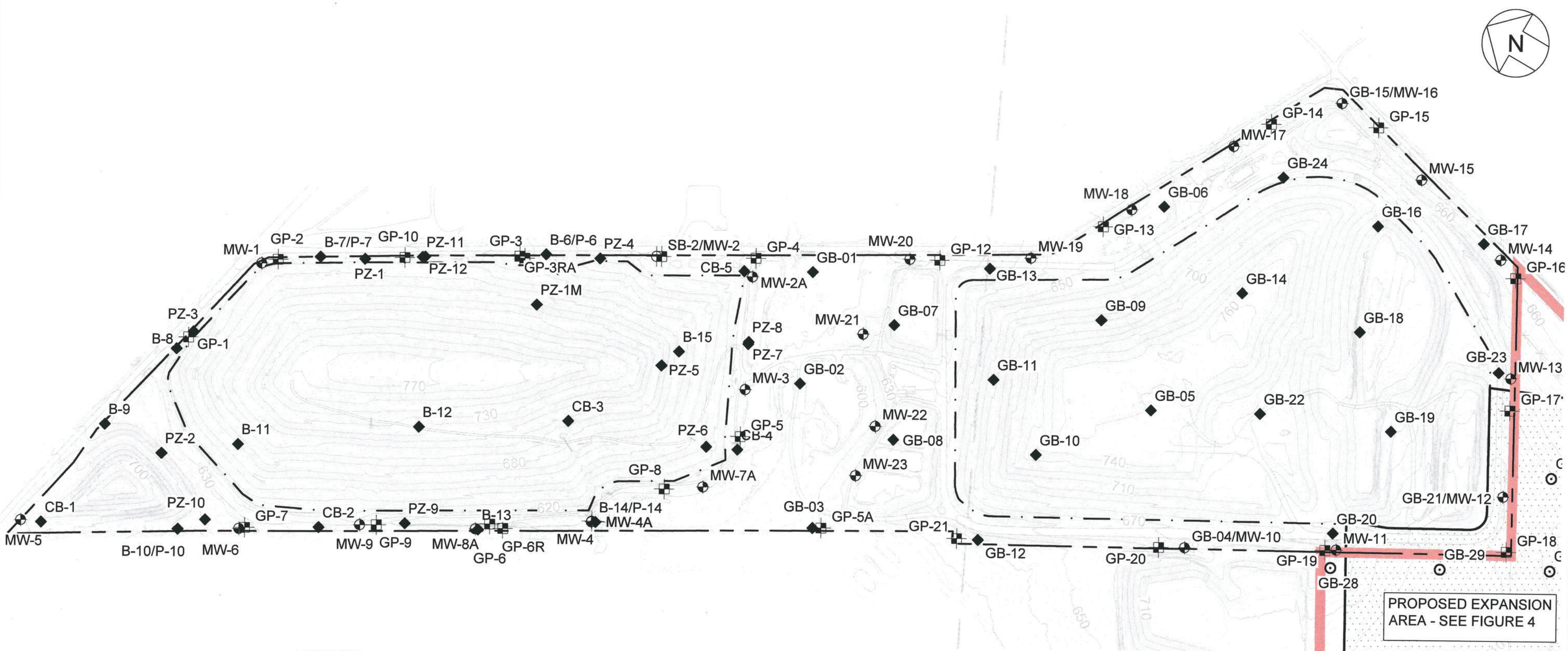
FOR PERMIT PURPOSES ONLY

REGIONAL GEOLOGY MAP
MESQUITE CREEK LANDFILL

Geosyntec consultants
TEXAS GEOSCIENCE FIRM REGISTRATION NO. 50256

AUSTIN, TX	JUNE 2022	FIGURE 2

\\AUSTIN-01P:\CADD\PROJECTS\MESQUITE CREEK LANDFILL\PERMIT\EXPANSION 66C (GW8636)\03-HYDRO-GEOTECH INVST\FIGURES\GW863603F02



LEGEND

EXISTING GROUND ELEVATION CONTOUR (FT, MSL) (NOTE 1)		B-21/GB21	PREVIOUS BORING
EXISTING FENCE		GB-26	GEOSYNTEC CONSULTANTS PROPOSED BORING
EXISTING ROAD		MW-12	GROUNDWATER MONITORING WELL
EXISTING BUILDING		GP-6	GAS MONITORING PROBE
CURRENT PERMIT BOUNDARY (APPROX. 244.13 ACRES)			
CURRENT PERMITTED LANDFILL FOOTPRINT (APPROX. 157.2 ACRES)			
PROPOSED EXPANSION AREA (APPROX. 191.4 ACRES)			
PROPOSED LATERAL EXPANSION LANDFILL FOOTPRINT (APPROX. 163.9 ACRES)			

NOTES:

1. TOPOGRAPHIC BASE MAP OF EXISTING SITE CONDITIONS WAS COMPILED FROM PHOTOGRAMMETRIC METHODS BASED ON AN AERIAL SURVEYS FLOWN ON 28 FEBRUARY 2022 AND 29 APRIL 2022 BY HYDREX ENVIRONMENTAL AND A LAND TITLE SURVEY PERFORMED BY SURVEYING AND MAPPING (SAM) DATED 27 SEPTEMBER 2021.
2. PROPOSED SOIL BORING LOCATIONS ARE TO EXPLORE EXPANSION AREA, AND HAVE BEEN LOCATED BASED ON INITIAL ASSESSMENT OF DRILL RIG ACCESSIBILITY. ACTUAL BORING LOCATIONS MAY BE FIELD ADJUSTED, BUT WILL BE GENERALLY CONSISTENT WITH THOSE SHOWN.

0 500'

SCALE IN FEET

STATE OF TEXAS
MATTHEW WISSLER
GEOLOGY
13242
LICENSED
PROFESSIONAL GEOSCIENTIST
06/27/2022

FOR PERMIT PURPOSES ONLY

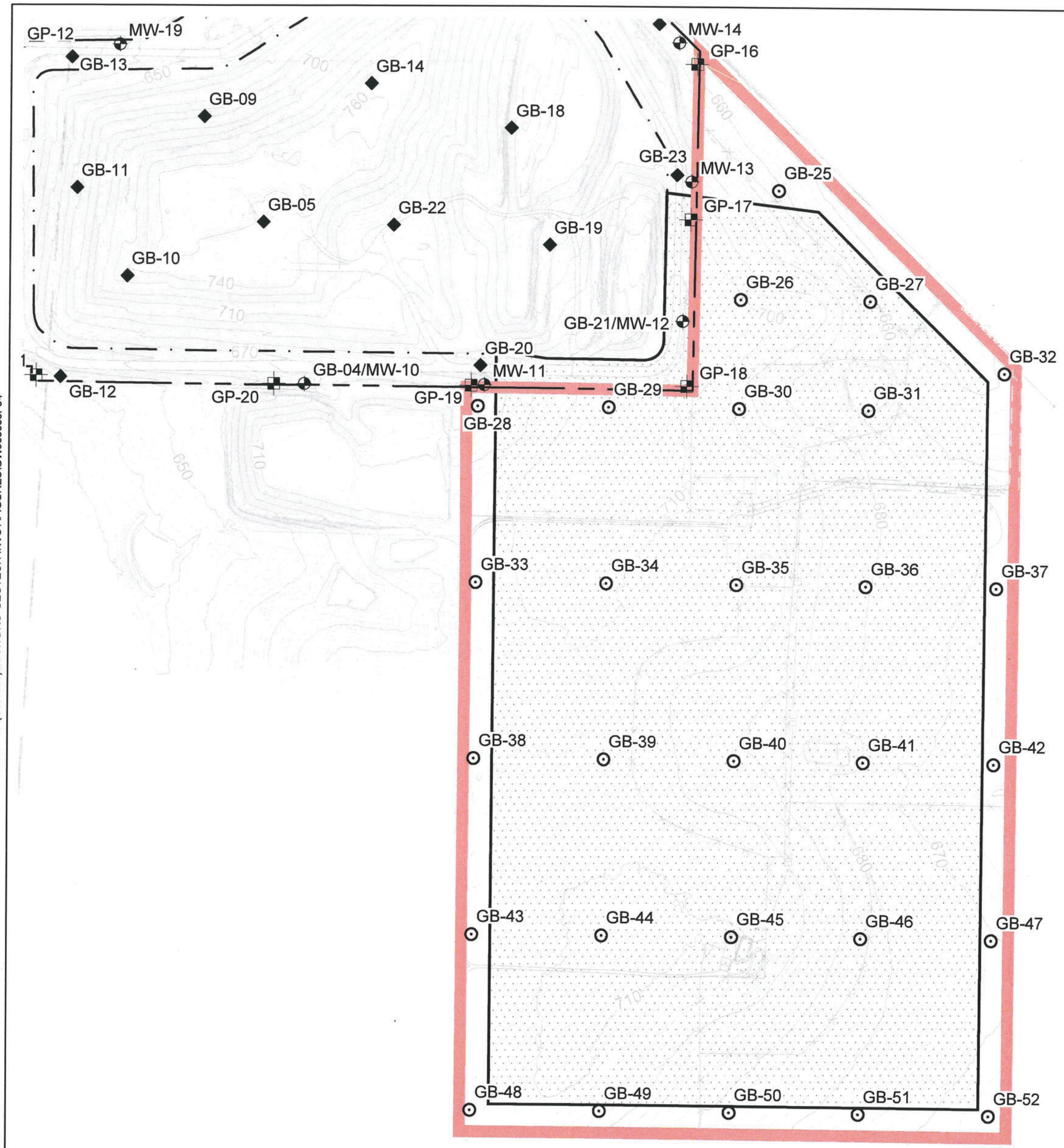
LOCATION MAP OF PREVIOUSLY DRILLED BORINGS
MESQUITE CREEK LANDFILL

Geosyntec consultants
TEXAS GEOSCIENCE FIRM REGISTRATION NO. 50256

AUSTIN, TX | JUNE 2022

FIGURE 3

\\AUSTIN-01\P:\CADD\PROJECTS\MESQUITE CREEK LANDFILL\PERMIT\EXPANSION 66C (GW8636)\03-HYDRO-GEOTECH INVST\FIGURES\GW863603F04



LEGEND

	EXISTING GROUND ELEVATION CONTOUR (FT, MSL) (NOTE 1)
	EXISTING FENCE
	EXISTING ROAD
	EXISTING BUILDING
	CURRENT PERMIT BOUNDARY (APPROX. 244.13 ACRES)
	CURRENT PERMITTED LANDFILL FOOTPRINT (APPROX. 157.2 ACRES)
	PROPOSED EXPANSION AREA (APPROX. 191.4 ACRES)
	PROPOSED LATERAL EXPANSION LANDFILL FOOTPRINT (APPROX. 163.9 ACRES)
B-21/GB21	PREVIOUS BORING
GB-26	GEOSYNTEC CONSULTANTS PROPOSED BORING
MW-12	GROUNDWATER MONITORING WELL
GP-6	GAS MONITORING PROBE

NOTES:

1. TOPOGRAPHIC BASE MAP OF EXISTING SITE CONDITIONS WAS COMPILED FROM PHOTOGRAMMETRIC METHODS BASED ON AN AERIAL SURVEYS FLOWN ON 28 FEBRUARY 2022 AND 29 APRIL 2022 BY HYDREX ENVIRONMENTAL AND A LAND TITLE SURVEY PERFORMED BY SURVEYING AND MAPPING (SAM) DATED 27 SEPTEMBER 2021.
2. PROPOSED SOIL BORING LOCATIONS ARE TO EXPLORE EXPANSION AREA, AND HAVE BEEN LOCATED BASED ON INITIAL ASSESSMENT OF DRILL RIG ACCESSIBILITY. ACTUAL BORING LOCATIONS MAY BE FIELD ADJUSTED, BUT WILL BE GENERALLY CONSISTENT WITH THOSE SHOWN.

STATE OF TEXAS
MATTHEW WISSLER
GEOLOGY
13242
LICENSED PROFESSIONAL GEOSCIENTIST
06/27/2022

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LOCATION MAP OF PROPOSED BORINGS
MESQUITE CREEK LANDFILL

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AUSTIN, TX | JUNE 2022

FIGURE 4

\\AUSTIN-01\P:\CADD\PROJECTS\MESQUITE CREEK LANDFILL\PERMIT\EXPANSION 66C (GW8636)\03-HYDRO-GEOTECH INVST\FIGURES\GW863603F04

SOIL BORING PLAN APPENDICES A AND B
LOGS OF PREVIOUSLY DRILLED BORINGS
and GEOLOGIC CROSS SECTIONS

[These Soil Boring Plan appendices are omitted from MSW Permit Amendment Application No. 66C to avoid repetition because they present copies of items/data already included in Attachments 4C and 4A, respectively, of this Geology Report]

ATTACHMENT 4C

BORING LOGS

BORING LOGS FROM

2022-2023 Geosyntec (GB-25 to GB-52)

STATE OF TEXAS
MATTHEW WISSLER
GEOLOGY
13242
LICENSED
PROFESSIONAL GEOSCIENTIST
10/10/2023

Geosyntec Consultants, Inc.
Texas Board of Professional Geoscientists
Firm Registration No. 50256

Geosyntec consultants
8217 Shoal Creek Blvd
Suite 200
Austin, TX 78757
Phone: (512) 451-4003
www.geosyntec.com

PROJECT Mesquite Creek Landfill
PROJECT LOCATION New Braunfels
PROJECT NUMBER GW8636

KEY SHEET - CLASSIFICATIONS AND SYMBOLS

GS FORM: 01-KEY/SYMBOLS BF

EMPIRICAL CORRELATIONS WITH STANDARD PENETRATION RESISTANCE N VALUES *

FINE GRAINED SOILS

N VALUE * (BLOWS/FT)	CONSISTENCY	UNCONFINED COMPRESSIVE STRENGTH (TONS/SQ FT)
0 - 2	VERY SOFT	<0.25
3 - 4	SOFT	0.25 - 0.50
5 - 8	FIRM	0.50 - 1.00
9 - 15	STIFF	1.00 - 2.00
16 - 30	VERY STIFF	2.00 - 4.00
31 - 50	HARD	>4.00
>50	VERY HARD	

COARSE GRAINED SOILS

N VALUE * (BLOWS/FT)	RELATIVE DENSITY
0 - 4	VERY LOOSE
5 - 10	LOOSE
11 - 30	MEDIUM DENSE
31 - 50	DENSE
>50	VERY DENSE

* ASTM D 1586; NUMBER OF BLOWS OF 140 POUND HAMMER FALLING 30 INCHES TO DRIVE A 2 IN. O.D., 1.4 IN. I.D. SAMPLER ONE FOOT.

UNIFIED SOIL CLASSIFICATION AND SYMBOL CHART

MAJOR DIVISIONS			SYMBOLS	DESCRIPTIONS
COARSE GRAINED SOILS MORE THAN 50% OF MATERIAL COARSER THAN NO. 200 SIEVE SIZE	GRAVEL AND GRAVELLY SOILS MORE THAN 50% OF COARSE FRACTION RETAINED ON NO.4 SIEVE	CLEAN GRAVELS LITTLE OR NO FINES	GW	WELL-GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES
			GP	POORLY GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES
		GRAVELS WITH FINES APPRECIABLE AMOUNT OF FINES	GM	SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES
			GC	CLAYEY GRAVELS, GRAVEL -SAND-CLAY MIXTURES
	SAND AND SANDY SOILS MORE THAN 50% OF COARSE FRACTION PASSING NO.4 SIEVE	CLEAN SANDS LITTLE OR NO FINES	SW	WELL GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
			SP	POORLY GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
		SANDS WITH FINES APPRECIABLE AMOUNT OF FINES	SM	SILTY SANDS, SAND-SILT MIXTURES
			SC	CLAYEY SANDS, SAND-CLAY MIXTURES
FINE GRAINED SOILS MORE THAN 50% OF MATERIAL FINER THAN NO. 200 SIEVE SIZE	SILTS AND CLAYS	LIQUID LIMIT LESS THAN 50	ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY
			CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
			OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
	SILTS AND CLAYS	LIQUID LIMIT GREATER THAN 50	MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SANDY OR SILTY SOILS, ELASTIC SILT
			CH	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS
			OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
HIGHLY ORGANIC SOILS			PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENT

NOTE: DUAL SYMBOLS USED FOR BORDERLINE CLASSIFICATIONS

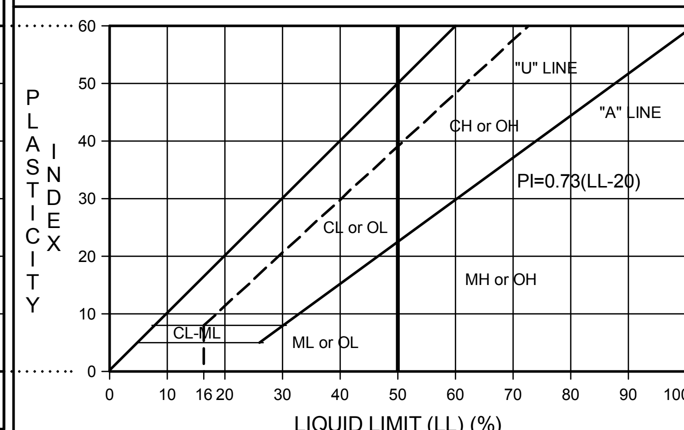
PARTICLE SIZE IDENTIFICATION

USCS (SOILS ONLY) *		SEDIMENTARY (ROCK ONLY)	
BOULDER	>300 mm	BOULDER	>256 mm
COBBLE	75 - 300 mm	COBBLE	64 - 256 mm
GRAVEL: COARSE	20 - 75 mm	PEBBLE	4 - 64 mm
GRAVEL: FINE	4.75 - 20 mm	GRANULE	2 - 4 mm
		SAND: V. COARSE	1 - 2 mm
SAND: COARSE	2 - 4.75 mm	SAND: COARSE	0.5 - 1 mm
SAND: MEDIUM	0.42 - 2 mm	SAND: MEDIUM	0.25 - 0.5 mm
SAND: FINE	0.074 - 0.42 mm	SAND: FINE	0.125 - 0.25 mm
		SAND: V. FINE	0.063 - 0.125 mm
SILT/CLAY	<0.074 mm	SILT	0.004 - 0.063 mm
		CLAY	<0.004 mm

* WELL GRADED - HAVING WIDE RANGE OF GRAIN SIZES AND APPRECIABLE AMOUNTS OF ALL INTERMEDIATE PARTICLE SIZES
* POORLY GRADED - PREDOMINANTLY ONE GRAIN SIZE, OR HAVING A RANGE OF SIZES WITH SOME INTERMEDIATE SIZES MISSING

PERCENTAGE OF PARTICLE TYPE IN DECREASING ORDER OF PARTICLE SIZE (GRAVEL,SAND,FINES)

PLASTICITY CHART



OTHER MATERIAL SYMBOLS

- Caliche
- Sandstone
- Silty Sandstone
- CL-ML
- GP-GC
- Clay-Claystone
- Claystone
- Shale
- Sandy Claystone
- Partially Weathered Rock
- Schist
- Gneiss
- Limestone
- Dolomite
- Glacial Till
- Landslide Debris
- Granitic/Intrusive
- Artificial Fill
- Topsoil
- Concrete/Asphalt
- Coal

WELL SYMBOLS

- CONCRETE
- GROUT
- BENTONITE SEAL
- TRANSITION SAND
- SAND/GRAVEL PACK
- NATIVE/SLUFF
- CENTRALIZER

SAMPLE TYPE AND OTHER SYMBOLS

- BULK SAMPLE
- STANDARD PENETRATION TEST
- MODIFIED CALIFORNIA SAMPLE
- CORE SAMPLE
- SHELBY TUBE
- DRIVE SAMPLE

- Water Level at Time Drilling, or as Shown
- Static Water Level
- Pump Inlet
- Loss of Drilling Fluid
- MSL: Mean Sea Level
- AGS: Above Ground Surface
- BGS: Below Ground Surface
- BTOC: Below Top of Casing
- HSA: Hollow Stem Auger

Geosyntec consultants

8217 Shoal Creek Blvd
Suite 200
Austin, TX 78757
Phone: (512) 451-4003
www.geosyntec.com

GS FORM: 03-GEOTECH3 BF

BOREHOLE LOG

BORING: GB-25 **SHEET** 1 **OF** 3
START DATE: 1/6/2023
FINISH DATE: 1/9/2023 **GROUND SURFACE:** 661.7 ft MSL
LOCATION: New Braunfels **TOTAL DEPTH:** 87 ft bgs
PROJECT: Mesquite Creek Landfill **DEPTH TO WATER:** Not Observed
PROJECT NUMBER: GW8636 **BORING BACKFILL:** Bentonite Grout

DESCRIPTION: 1) Soil Name (USCS) 2) Color 3) Moisture 4) Grain Size 5) Percentage 6) Plasticity 7) Density/Consistency 8) Other (Mineral Content, Discoloration, Odor, etc.)

DEPTH (ft-bgs)	ELEVATION (ft)	DESCRIPTION	STRATUM	SAMPLE: BLOWS PER 6"	SAMPLE: RECOVERY (in)	PERCENT FINES (%)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTICITY INDEX
0		(0') CLAY; dark olive brown (2.5Y 3/3) to olive yellow (2.5Y 6/8) with light gray clay and caliche at some locations; hard to very hard; very stiff (PP > 4 tsf); moist to dry (dry at caliche lenses)	Stratum III	3, 5, 9, 11	17.5				
	660								
5					22.5				
	655	(6') Caliche lenses		8, 15, 22, 25	18.5				
10				8, 13, 18, 20	19				
	650								
15		(15') Some mottling from 15 to 20 ft bgs		6, 12, 18, 23	20				
	645								
					17				
20				19, 22, 26, 31	24				
	640								
25									
	635				14				
		(28') Some chert nodules; trace shell		9, 15, 18, 22	22.5				
30									

CONTRACTOR: Texplor of Dallas, Inc. **NORTHING:** 13813774.9
EQUIPMENT: CME 75 Truck Mounted **EASTING:** 2280750.8
DRILL MTHD: HSA / Coring
SAMPLING MTHD: SPT, Shelby Tube, Core
DRILL BIT SIZE/TYPE: HSA 6" - NQ2

LOGGER: L. Varner **REVIEWER:** W. Burke
NOTES:

SEE KEY SHEET FOR SYMBOLS AND ABBREVIATIONS

Geosyntec consultants
8217 Shoal Creek Blvd
Suite 200
Austin, TX 78757
Phone: (512) 451-4003
www.geosyntec.com

GS FORM: 03-GEOTECH3 BF

BOREHOLE LOG

BORING: GB-25 **SHEET** 2 **OF** 3
START DATE: 1/6/2023
FINISH DATE: 1/9/2023 **GROUND SURFACE:** 661.7 ft MSL
LOCATION: New Braunfels **TOTAL DEPTH:** 87 ft bgs
PROJECT: Mesquite Creek Landfill **DEPTH TO WATER:** Not Observed
PROJECT NUMBER: GW8636 **BORING BACKFILL:** Bentonite Grout

DESCRIPTION: 1) Soil Name (USCS) 2) Color 3) Moisture 4) Grain Size 5) Percentage 6) Plasticity 7) Density/Consistency 8) Other (Mineral Content, Discoloration, Odor, etc.)

DEPTH (ft-bgs)	ELEVATION (ft)	DESCRIPTION	STRATUM	SAMPLE TYPE	BLOWS PER 6"	RECOVERY (in)	PERCENT FINES (%)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTICITY INDEX
		(0') CLAY; dark olive brown (2.5Y 3/3) to olive yellow (2.5Y 6/8) with light gray clay and caliche at some locations; hard to very hard; very stiff (PP > 4 tsf); moist to dry (dry at caliche lenses) *(cont.)*	Stratum III							
	630									
35										
	625									
				Core		17.5				
40		(40') Moderate mottling; shell & chert observed; some caliche; fractures w/ calcite infill; moderate iron staining		SPT	9, 16, 17, 19	22				
	620									
45				Core		24				
	615									
				SPT	11, 21, 27, 32	24				
50										
	610									
55										
	605									
		(58') CLAY to CLAYSTONE; very dark greenish gray (GLEY1 3/10GY); very hard; moist to dry	Stratum IV	Core		24				
60										

CONTRACTOR: Texplor of Dallas, Inc. **NORTHING:** 13813774.9
EQUIPMENT: CME 75 Truck Mounted **EASTING:** 2280750.8
DRILL MTHD: HSA / Coring
SAMPLING MTHD: SPT, Shelby Tube, Core
DRILL BIT SIZE/TYPE: HSA 6" - NQ2

LOGGER: L. Varner **REVIEWER:** W. Burke
NOTES:

SEE KEY SHEET FOR SYMBOLS AND ABBREVIATIONS

Geosyntec consultants

8217 Shoal Creek Blvd
Suite 200
Austin, TX 78757
Phone: (512) 451-4003
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GS FORM: 03-GEOTECH3 BF

BOREHOLE LOG

BORING: GB-25 **SHEET** 3 **OF** 3
START DATE: 1/6/2023
FINISH DATE: 1/9/2023 **GROUND SURFACE:** 661.7 ft MSL
LOCATION: New Braunfels **TOTAL DEPTH:** 87 ft bgs
PROJECT: Mesquite Creek Landfill **DEPTH TO WATER:** Not Observed
PROJECT NUMBER: GW8636 **BORING BACKFILL:** Bentonite Grout

DEPTH (ft-bgs)	ELEVATION (ft)	DESCRIPTION 1) Soil Name (USCS) 2) Color 3) Moisture 4) Grain Size 5) Percentage 6) Plasticity 7) Density/Consistency 8) Other (Mineral Content, Discoloration, Odor, etc.)	STRATUM	GRAPHIC LOG	SAMPLE: TYPE	SAMPLE: BLOWS PER 6"	SAMPLE: RECOVERY (in)	LAB RESULTS: PERCENT FINES (%)	LAB RESULTS: MOISTURE CONTENT (%)	LAB RESULTS: LIQUID LIMIT	LAB RESULTS: PLASTICITY INDEX
	600	(58') CLAY to CLAYSTONE; very dark greenish gray (GLEY1 3/10GY); very hard; moist to dry *(cont.)*	Stratum IV			12 15 22 27	22.5				
		(62') Moderate fracturing from 62 to 80 ft with significant weathering at fracture planes and clay (weathered claystone) at fractures zones					24				
65	595										
70	590						118				
75	585						60				
80	580						83				
85	575										
		(87') Boring terminated.									
90											

CONTRACTOR: Texplor of Dallas, Inc. **NORTHING:** 13813774.9
EQUIPMENT: CME 75 Truck Mounted **EASTING:** 2280750.8
DRILL MTHD: HSA / Coring
SAMPLING MTHD: SPT, Shelby Tube, Core
DRILL BIT SIZE/TYPE: HSA 6" - NQ2

LOGGER: L. Varner **REVIEWER:** W. Burke
NOTES:

SEE KEY SHEET FOR SYMBOLS AND ABBREVIATIONS

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Suite 200
Austin, TX 78757
Phone: (512) 451-4003
www.geosyntec.com

GS FORM: 03-GEOTECH3 BF

BOREHOLE LOG

BORING: GB-26 **SHEET** 1 **OF** 4
START DATE: 1/16/2023
FINISH DATE: 1/16/2023
LOCATION: New Braunfels
PROJECT: Mesquite Creek Landfill
PROJECT NUMBER: GW8636
GROUND SURFACE: 702.3 ft MSL
TOTAL DEPTH: 102 ft bgs
DEPTH TO WATER: Not Observed
BORING BACKFILL: Bentonite Grout

DESCRIPTION: 1) Soil Name (USCS) 2) Color 3) Moisture 4) Grain Size 5) Percentage 6) Plasticity 7) Density/Consistency 8) Other (Mineral Content, Discoloration, Odor, etc.)

DEPTH (ft-bgs)	ELEVATION (ft)	DESCRIPTION	STRATUM	BLOWS PER 6"	RECOVERY (in)	PERCENT FINES (%)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTICITY INDEX
0		(0') Sandy/Clayey calcareous GRAVEL (sub rounded to sub angular) and CALICHE with chert fragments; trace moist to dry	Stratum II	4, 5, 8, 9	24				
	700			7, 12, 14, 15	24				
5	695			13, 21, 12, 12	12				
10	690								
15									
16	685	(16') CLAY; light olive brown (2.5Y 5/4) to light yellowish brown (2.5Y 6/4) with light gray clay mottling at some locations; firm to very hard; trace moist to dry	Stratum III	9, 9, 11, 18	24				
					24				
20	680								
25	675								
30					24				

CONTRACTOR: Texplor of Dallas, Inc.
EQUIPMENT: CME 75 Truck Mounted
DRILL MTHD: HSA / Coring
SAMPLING MTHD: SPT, Shelby Tube, Core
DRILL BIT SIZE/TYPE: HSA 6" - NQ2
NORTHING: 13813561.9
EASTING: 2280316.8
LOGGER: J. Geesin
REVIEWER: W. Burke
NOTES:

SEE KEY SHEET FOR SYMBOLS AND ABBREVIATIONS

DESCRIPTION: 1) Soil Name (USCS) 2) Color 3) Moisture 4) Grain Size 5) Percentage 6) Plasticity 7) Density/Consistency 8) Other (Mineral Content, Discoloration, Odor, etc.)

DEPTH (ft-bgs)	ELEVATION (ft)	DESCRIPTION	STRATUM	GRAPHIC LOG	SAMPLE TYPE	BLOWS PER 6"	RECOVERY (in)	PERCENT FINES (%)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTICITY INDEX
		(16') CLAY; light olive brown (2.5Y 5/4) to light yellowish brown (2.5Y 6/4) with light gray clay mottling at some locations; firm to very hard; trace moist to dry *(cont.)* (30') Gray mottling and trace caliche	Stratum III		SPT	9 10 14 18	24				
	670										
35											
	665										
40					SPT	6 10 15 22	24				
	660										
45											
	655				Shelby Tube		24				
50					SPT	11 19 25 32	24				
	650	(52') Crystallization; possibly calcite or selenite									
55											
	645										
		(58') CLAY to CLAYSTONE; dark gray (2.5Y 4/1); very hard and generally competent; moist to dry	Stratum IV		Shelby Tube		24				
60											

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GS FORM: 03-GEOTECH3 BF	**BOREHOLE LOG**

BORING: GB-26
START DATE: 1/16/2023
FINISH DATE: 1/16/2023
LOCATION: New Braunfels
PROJECT: Mesquite Creek Landfill
PROJECT NUMBER: GW8636
GROUND SURFACE: 702.3 ft MSL
TOTAL DEPTH: 102 ft bgs
DEPTH TO WATER: Not Observed
BORING BACKFILL: Bentonite Grout

DESCRIPTION: 1) Soil Name (USCS) 2) Color 3) Moisture 4) Grain Size 5) Percentage 6) Plasticity 7) Density/Consistency 8) Other (Mineral Content, Discoloration, Odor, etc.)

DEPTH (ft-bgs)	ELEVATION (ft)	DESCRIPTION	STRATUM	GRAPHIC LOG	SAMPLE: TYPE	SAMPLE: BLOWS PER 6"	SAMPLE: RECOVERY (in)	LAB RESULTS: PERCENT FINES (%)	LAB RESULTS: MOISTURE CONTENT (%)	LAB RESULTS: LIQUID LIMIT	LAB RESULTS: PLASTICITY INDEX
		(58') CLAY to CLAYSTONE; dark gray (2.5Y 4/1); very hard and generally competent; moist to dry *(cont.)* (60') Moderate fracturing from 60 to 102 ft bgs				23 34 42 45					
	640										
							36				
65		(65') Occasionally clay lenses from 65 to 78.5 ft bgs									
	635										
70							120				
	630										
75			Stratum IV								
	625										
80							120				
	620										
85											
	615						120				
90											

CONTRACTOR: Texplor of Dallas, Inc.
NORTHING: 13813561.9
EQUIPMENT: CME 75 Truck Mounted
EASTING: 2280316.8
DRILL MTHD: HSA / Coring
SAMPLING MTHD: SPT, Shelby Tube, Core
DRILL BIT SIZE/TYPE: HSA 6" - NQ2

LOGGER: J. Geesin
REVIEWER: W. Burke
NOTES:

SEE KEY SHEET FOR SYMBOLS AND ABBREVIATIONS

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Suite 200
Austin, TX 78757
Phone: (512) 451-4003
www.geosyntec.com

GS FORM: 03-GEOTECH3 BF

BOREHOLE LOG

BORING: GB-26
START DATE: 1/16/2023
FINISH DATE: 1/16/2023
LOCATION: New Braunfels
PROJECT: Mesquite Creek Landfill
PROJECT NUMBER: GW8636
GROUND SURFACE: 702.3 ft MSL
TOTAL DEPTH: 102 ft bgs
DEPTH TO WATER: Not Observed
BORING BACKFILL: Bentonite Grout

DESCRIPTION: 1) Soil Name (USCS) 2) Color 3) Moisture 4) Grain Size 5) Percentage 6) Plasticity 7) Density/Consistency 8) Other (Mineral Content, Discoloration, Odor, etc.)

DEPTH (ft-bgs)	ELEVATION (ft)	DESCRIPTION	STRATUM	GRAPHIC LOG	SAMPLE: TYPE	SAMPLE: BLOWS PER 6"	SAMPLE: RECOVERY (in)	LAB RESULTS: PERCENT FINES (%)	LAB RESULTS: MOISTURE CONTENT (%)	LAB RESULTS: LIQUID LIMIT	LAB RESULTS: PLASTICITY INDEX
		(58') CLAY to CLAYSTONE; dark gray (2.5Y 4/1); very hard and generally competent; moist to dry *(cont.)*	Stratum IV								
	610						120				
95											
	605						84				
100											
	600	(102') Boring terminated.									
105											
	595										
110											
	590										
115											
	585										
120											

CONTRACTOR: Texplor of Dallas, Inc.
EQUIPMENT: CME 75 Truck Mounted
DRILL MTHD: HSA / Coring
SAMPLING MTHD: SPT, Shelby Tube, Core
DRILL BIT SIZE/TYPE: HSA 6" - NQ2
NORTHING: 13813561.9
EASTING: 2280316.8
LOGGER: J. Geesin
REVIEWER: W. Burke
NOTES:

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GS FORM: 03-GEOTECH3 BF	**BOREHOLE LOG**

BORING: GB-27 | **SHEET** 1 **OF** 4

START DATE: 12/7/2022

FINISH DATE: 12/8/2023 | **GROUND SURFACE:** 662.4 ft MSL

LOCATION: New Braunfels | **TOTAL DEPTH:** 113 ft bgs

PROJECT: Mesquite Creek Landfill | **DEPTH TO WATER:** Not Observed

PROJECT NUMBER: GW8636 | **BORING BACKFILL:** Bentonite Grout

DESCRIPTION: 1) Soil Name (USCS) 2) Color 3) Moisture 4) Grain Size 5) Percentage 6) Plasticity 7) Density/Consistency 8) Other (Mineral Content, Discoloration, Odor, etc.)

DEPTH (ft-bgs)	ELEVATION (ft)	DESCRIPTION	STRATUM	GRAPHIC LOG	SAMPLE: TYPE	SAMPLE: BLOWS PER 6"	SAMPLE: RECOVERY (in)	LAB: PERCENT FINES (%)	LAB: MOISTURE CONTENT (%)	LAB: LIQUID LIMIT	LAB: PLASTICITY INDEX
		(0') CLAY; very dark grey (2.5Y 3/1); organic; grasses and rootlets; few coarse to fine gravel; trace coarse to fine sand; firm; very stiff (PP > 4.5 tsf); moist	Stratum I			2 3 7 14	18	95.7	18	78	52
	660	(2') CLAY; light olive brown (2.5Y 5/3) to pale brown (2.5Y 7/3); with trace silt and fine sand; occasional iron staining; fractures with some crystalline mineralization/lamination (possibly calcite); very stiff (PP > 4.5 tsf); trace moist	Stratum III								
5						6 11 13 13	20				
	655										
10						10 14 16 20	23				
		(11') Trace gray clay lamination									
	650						15				
15		(14.6') Horizontal fracture with calcite mineralization				19 13 18 22	24				
							12				
	645					27 32 50	23				
20							13				
	640					19 16 17 22	22				
							20.5				
25						8 17 42 24	23				
	635						17				
30		(29') Some fractures from 29 to 31 ft bgs with calcite mineralization				10 15	24				

CONTRACTOR: Texplor of Dallas, Inc. | **NORTHING:** 13813170.6

EQUIPMENT: CME 75 Truck Mounted | **EASTING:** 2280703.6

DRILL MTHD: HSA / Coring

SAMPLING MTHD: SPT, Shelby Tube, Core

DRILL BIT SIZE/TYPE: HSA 6" - NQ2

LOGGER: G. Kumar; P. Pandey | **REVIEWER:** W. Burke

NOTES:

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GS FORM: 03-GEOTECH3 BF	**BOREHOLE LOG**

BORING: GB-27 —
START DATE: 12/7/2022
FINISH DATE: 12/8/2023 — **GROUND SURFACE:** 662.4 ft MSL
LOCATION: New Braunfels — **TOTAL DEPTH:** 113 ft bgs
PROJECT: Mesquite Creek Landfill — **DEPTH TO WATER:** Not Observed
PROJECT NUMBER: GW8636 — **BORING BACKFILL:** Bentonite Grout

DESCRIPTION: 1) Soil Name (USCS) 2) Color 3) Moisture 4) Grain Size 5) Percentage 6) Plasticity 7) Density/Consistency 8) Other (Mineral Content, Discoloration, Odor, etc.)

DEPTH (ft-bgs)	ELEVATION (ft)	DESCRIPTION	STRATUM	TYPE (SAMPLE)	BLOWS PER 6"	RECOVERY (in)	PERCENT FINES (%)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTICITY INDEX
		(2') CLAY; light olive brown (2.5Y 5/3) to pale brown (2.5Y 7/3); with trace silt and fine sand; occasional iron staining; fractures with some crystalline mineralization/lamination (possibly calcite); very stiff (PP > 4.5 tsf); trace moist *(cont.)*	Stratum III		21, 26	24				
	630					20				
		(33') Increased gravel content			7, 12, 18, 27					
		(34') Significant iron staining								
35						8.5				
	625	(37') Some fractures from 37 to 47 ft bgs with calcite infilling			8, 11, 14, 16	24				
40						24				
	620				18, 36, 30, 33	24				
						24				
45					8, 11, 14, 18	24				
	615					20				
50		(50') Calcite inclusions from 50 to 55 ft bgs			10, 15, 17, 25	24				
	610					26				
					11, 16, 18, 24	24				
55		(55') Grades to dark greenish gray from 55 to 66 ft bgs				20				
	605				14, 17, 22, 25	24				
60										

CONTRACTOR: Texplor of Dallas, Inc. — **NORTHING:** 13813170.6
EQUIPMENT: CME 75 Truck Mounted — **EASTING:** 2280703.6
DRILL MTHD: HSA / Coring
SAMPLING MTHD: SPT, Shelby Tube, Core
DRILL BIT SIZE/TYPE: HSA 6" - NQ2

LOGGER: G. Kumar; P. Pandey — **REVIEWER:** W. Burke
NOTES:

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October 2023

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8217 Shoal Creek Blvd
Suite 200
Austin, TX 78757
Phone: (512) 451-4003
www.geosyntec.com

GS FORM: 03-GEOTECH3 BF

BOREHOLE LOG

BORING: GB-27 | **SHEET** 3 **OF** 4
START DATE: 12/7/2022
FINISH DATE: 12/8/2023 | **GROUND SURFACE:** 662.4 ft MSL
LOCATION: New Braunfels | **TOTAL DEPTH:** 113 ft bgs
PROJECT: Mesquite Creek Landfill | **DEPTH TO WATER:** Not Observed
PROJECT NUMBER: GW8636 | **BORING BACKFILL:** Bentonite Grout

DESCRIPTION: 1) Soil Name (USCS) 2) Color 3) Moisture 4) Grain Size 5) Percentage 6) Plasticity 7) Density/Consistency 8) Other (Mineral Content, Discoloration, Odor, etc.)

DEPTH (ft-bgs)	ELEVATION (ft)	DESCRIPTION	STRATUM	TYPE	BLOWS PER 6"	RECOVERY (in)	PERCENT FINES (%)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTICITY INDEX
		(2') CLAY; light olive brown (2.5Y 5/3) to pale brown (2.5Y 7/3); with trace silt and fine sand; occasional iron staining; fractures with some crystalline mineralization/lamination (possibly calcite); very stiff (PP > 4.5 tsf); trace moist *(cont.)*	Stratum III							
	600									
				SPT	13, 19, 22, 26	24				
65										
		(66') CLAYSTONE; dark greenish gray (GLEY1 4/10Y); occasional fractures with crystallized/mineralized infills; very hard; trace moist	Stratum IV	Core						
	595						99.6	15.8	83	51
70										
		(70.7') Iron staining								
	590									
75						109				
	585									
80										
	580									
85						120				
	575									
90										

CONTRACTOR: Texplor of Dallas, Inc. **NORTHING:** 13813170.6
EQUIPMENT: CME 75 Truck Mounted **EASTING:** 2280703.6
DRILL MTHD: HSA / Coring
SAMPLING MTHD: SPT, Shelby Tube, Core
DRILL BIT SIZE/TYPE: HSA 6" - NQ2

LOGGER: G. Kumar; P. Pandey **REVIEWER:** W. Burke
NOTES:

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BOREHOLE LOG

BORING: GB-27
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FINISH DATE: 12/8/2023
GROUND SURFACE: 662.4 ft MSL
LOCATION: New Braunfels
TOTAL DEPTH: 113 ft bgs
PROJECT: Mesquite Creek Landfill
DEPTH TO WATER: Not Observed
PROJECT NUMBER: GW8636
BORING BACKFILL: Bentonite Grout

DESCRIPTION: 1) Soil Name (USCS) 2) Color 3) Moisture 4) Grain Size 5) Percentage 6) Plasticity 7) Density/Consistency 8) Other (Mineral Content, Discoloration, Odor, etc.)

DEPTH (ft-bgs)	ELEVATION (ft)	DESCRIPTION	STRATUM	GRAPHIC LOG	SAMPLE TYPE	BLOWS PER 6"	RECOVERY (in)	PERCENT FINES (%)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTICITY INDEX
		(66') CLAYSTONE; dark greenish gray (GLEY1 4/10Y); occasional fractures with crystallized/mineralized infills; very hard; trace moist *(cont.)*	Stratum IV								
	570										
95							120				
	565										
100											
	560						60				
105											
	555										
							96				
110											
	550										
		(113') Boring terminated.									
115											
	545										
120											

CONTRACTOR: Texplor of Dallas, Inc.
NORTHING: 13813170.6
EQUIPMENT: CME 75 Truck Mounted
EASTING: 2280703.6
DRILL MTHD: HSA / Coring
SAMPLING MTHD: SPT, Shelby Tube, Core
DRILL BIT SIZE/TYPE: HSA 6" - NQ2

LOGGER: G. Kumar; P. Pandey
REVIEWER: W. Burke
NOTES:

SEE KEY SHEET FOR SYMBOLS AND ABBREVIATIONS

03-GEOTECH3 BF GEOS BRAUNFELS.GPJ GEOSNTEC.GDT 05/09/23

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Phone: (512) 451-4003
www.geosyntec.com

GS FORM: 03-GEOTECH3 BF

BOREHOLE LOG

BORING: GB-28

START DATE: 1/12/2023
FINISH DATE: 1/13/2023
LOCATION: New Braunfels
PROJECT: Mesquite Creek Landfill
PROJECT NUMBER: GW8636
GROUND SURFACE: 685.2 ft MSL
TOTAL DEPTH: 85 ft bgs
DEPTH TO WATER: Not Observed
BORING BACKFILL: Bentonite Grout

DESCRIPTION: 1) Soil Name (USCS) 2) Color 3) Moisture 4) Grain Size 5) Percentage 6) Plasticity 7) Density/Consistency 8) Other (Mineral Content, Discoloration, Odor, etc.)

DEPTH (ft-bgs)	ELEVATION (ft)	DESCRIPTION	STRATUM	BLOWS PER 6"	RECOVERY (in)	PERCENT FINES (%)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTICITY INDEX
0	685	(0') CLAY; black (2.5Y 2.5/1); organic; some silt and roots; trace gravel; soft (PP = 1.75 tsf); moist	Stratum I	3, 4, 5, 5	12.5				
2		(2') Sandy/Clayey calcareous GRAVEL (angular) and CALICHE with some chert fragments; moist to dry	Stratum II		12				
					9.5				
				11, 11, 15, 17	19				
13		(13') CLAY; pale brown (2.5Y 7/3), olive yellow (2.5Y 6/6), and dark gray (2.5Y 4/1); light gray clay inclusion at some locations; firm to very hard; very stiff (PP > 4.5 tsf); moist to dry; low to medium plasticity	Stratum III	9, 23, 31, 36	21.5				
					17				
20	665	(20') Moderate iron staining		9, 11, 15, 30	24				
				11, 17, 22, 28	24				

Depth scale: 5, 10, 15, 20, 25, 30; Elevation scale: 685, 680, 675, 670, 665, 660

CONTRACTOR: Texplor of Dallas, Inc.
EQUIPMENT: CME 75 Truck Mounted
DRILL MTHD: HSA / Coring
SAMPLING MTHD: SPT, Shelby Tube, Core
DRILL BIT SIZE/TYPE: HSA 6" - NQ2
NORTHING: 13814021.3
EASTING: 2279217.2
LOGGER: L. Varner; J. Geesin
REVIEWER: W. Burke
NOTES:

SEE KEY SHEET FOR SYMBOLS AND ABBREVIATIONS

BOREHOLE LOG

BORING: GB-28 **SHEET** 2 **OF** 3
START DATE: 1/12/2023
FINISH DATE: 1/13/2023 **GROUND SURFACE:** 685.2 ft MSL
LOCATION: New Braunfels **TOTAL DEPTH:** 85 ft bgs
PROJECT: Mesquite Creek Landfill **DEPTH TO WATER:** Not Observed
PROJECT NUMBER: GW8636 **BORING BACKFILL:** Bentonite Grout

DESCRIPTION: 1) Soil Name (USCS) 2) Color 3) Moisture 4) Grain Size 5) Percentage 6) Plasticity 7) Density/Consistency 8) Other (Mineral Content, Discoloration, Odor, etc.)

DEPTH (ft-bgs)	ELEVATION (ft)	DESCRIPTION	STRATUM	GRAPHIC LOG	SAMPLE TYPE	BLOWS PER 6"	RECOVERY (in)	PERCENT FINES (%)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTICITY INDEX
	655	(13') CLAY; pale brown (2.5Y 7/3), olive yellow (2.5Y 6/6), and dark gray (2.5Y 4/1); light gray clay inclusion at some locations; firm to very hard; very stiff (PP > 4.5 tsf); moist to dry; low to medium plasticity *(cont.)*	Stratum III								
35	650										
					SPT	10, 15, 20, 22	24				
40	645										
45	640										
					SPT	18, 15, 22, 23	23				
		(49') 45-degree fracture with significant selenite infilling									
50	635										
		(53') Alternating olive and dark gray from 53 to 75 ft bgs									
55	630										
					Shelby Tube		24				
					SPT	15, 21, 25, 38					
60											

CONTRACTOR: Texplor of Dallas, Inc. **NORTHING:** 13814021.3
EQUIPMENT: CME 75 Truck Mounted **EASTING:** 2279217.2
DRILL MTHD: HSA / Coring
SAMPLING MTHD: SPT, Shelby Tube, Core
DRILL BIT SIZE/TYPE: HSA 6" - NQ2

LOGGER: L. Varner; J. Geesin **REVIEWER:** W. Burke
NOTES:

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GS FORM: 03-GEOTECH3 BF

BOREHOLE LOG

BORING: GB-28 — **SHEET** 3 **OF** 3
START DATE: 1/12/2023
FINISH DATE: 1/13/2023 — **GROUND SURFACE:** 685.2 ft MSL
LOCATION: New Braunfels — **TOTAL DEPTH:** 85 ft bgs
PROJECT: Mesquite Creek Landfill — **DEPTH TO WATER:** Not Observed
PROJECT NUMBER: GW8636 — **BORING BACKFILL:** Bentonite Grout

DESCRIPTION: 1) Soil Name (USCS) 2) Color 3) Moisture 4) Grain Size 5) Percentage 6) Plasticity 7) Density/Consistency 8) Other (Mineral Content, Discoloration, Odor, etc.)

DEPTH (ft-bgs)	ELEVATION (ft)	DESCRIPTION	STRATUM	GRAPHIC LOG	SAMPLE TYPE	BLOWS PER 6"	RECOVERY (in)	PERCENT FINES (%)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTICITY INDEX
	625	(13') CLAY; pale brown (2.5Y 7/3), olive yellow (2.5Y 6/6), and dark gray (2.5Y 4/1); light gray clay inclusion at some locations; firm to very hard; very stiff (PP > 4.5 tsf); moist to dry; low to medium plasticity *(cont.)*	Stratum III				18				
						20 30 31 46	24				
65	620	(65') CLAYSTONE; dark gray (2.5Y 4/1); very hard; trace moist to dry (65.5') Crystallized deposition along fracture plane	Stratum IV								
70	615						115				
		(73') Weathered zone from 73 to 73.5 ft bgs									
75	610										
80	605						120				
85	600	(85') Boring terminated.									
90											

CONTRACTOR: Texplor of Dallas, Inc. — **NORTHING:** 13814021.3
EQUIPMENT: CME 75 Truck Mounted — **EASTING:** 2279217.2
DRILL MTHD: HSA / Coring
SAMPLING MTHD: SPT, Shelby Tube, Core
DRILL BIT SIZE/TYPE: HSA 6" - NQ2

LOGGER: L. Varner; J. Geesin — **REVIEWER:** W. Burke
NOTES:

SEE KEY SHEET FOR SYMBOLS AND ABBREVIATIONS

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GS FORM: 03-GEOTECH3 BF

BOREHOLE LOG

BORING: GB-29

START DATE: 1/12/2023
FINISH DATE: 1/12/2023
LOCATION: New Braunfels
PROJECT: Mesquite Creek Landfill
PROJECT NUMBER: GW8636
GROUND SURFACE: 712.2 ft MSL
TOTAL DEPTH: 112 ft bgs
DEPTH TO WATER: Not Observed
BORING BACKFILL: Bentonite Grout

DESCRIPTION
1) Soil Name (USCS)
2) Color
3) Moisture
4) Grain Size
5) Percentage
6) Plasticity
7) Density/Consistency
8) Other (Mineral Content, Discoloration, Odor, etc.)

DEPTH (ft-bgs)	ELEVATION (ft)	DESCRIPTION	STRATUM
0	712.2	(0') CLAY; light olive brown (2.5Y 5/4); some chert fragments; grasses and rootlets; few coarse to fine gravel; trace coarse to fine sand; firm; moist	SI
0.5		(0.5') Sandy/Clayey calcareous GRAVEL (sub rounded to angular) and CALICHE with some chert fragments; loose; dry	Stratum II
14		(14') CLAY; light gray (2.5Y 7/2) to light olive brown (2.5Y 5/3), caliche lenses at shallow depths; occasional iron staining; light gray clay inclusion at some locations; hard; very stiff (PP > 4.25 tsf); moist to dry; low to high plasticity	Stratum III
17		(17') Significant iron staining	Stratum III

Depth scale: 5, 10, 15, 20, 25, 30. Elevation scale: 710, 705, 700, 695, 690, 685.

SAMPLE / LAB RESULTS

Approx. Depth (ft)	BLOWS PER 6"	RECOVERY (in)	PERCENT FINES (%)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTICITY INDEX
0–2	12, 15, 17, 18	14.5				
2–4	9, 5, 11, 10	20				
6–8	11, 14, 20, 21	23				
8–9.3	18, 31, 50	17				
14–16		20				
16–18	12, 16, 19, 22	24				
20–22	5, 10, 13, 15	24				
28–30		22				

CONTRACTOR: Texplor of Dallas, Inc.
EQUIPMENT: CME 75 Truck Mounted
DRILL MTHD: HSA / Coring
SAMPLING MTHD: SPT, Shelby Tube, Core
DRILL BIT SIZE/TYPE: HSA 6" - NQ2
NORTHING: 13813630.3
EASTING: 2279604.1
LOGGER: L. Varner
REVIEWER: W. Burke
NOTES: SI - Stratum I

SEE KEY SHEET FOR SYMBOLS AND ABBREVIATIONS

BOREHOLE LOG

BORING: GB-29 | **SHEET** 2 **OF** 4
START DATE: 1/12/2023
FINISH DATE: 1/12/2023
LOCATION: New Braunfels
PROJECT: Mesquite Creek Landfill
PROJECT NUMBER: GW8636
GROUND SURFACE: 712.2 ft MSL
TOTAL DEPTH: 112 ft bgs
DEPTH TO WATER: Not Observed
BORING BACKFILL: Bentonite Grout

DESCRIPTION: 1) Soil Name (USCS) 2) Color 3) Moisture 4) Grain Size 5) Percentage 6) Plasticity 7) Density/Consistency 8) Other (Mineral Content, Discoloration, Odor, etc.)

DEPTH (ft-bgs)	ELEVATION (ft)	DESCRIPTION	STRATUM	BLOWS PER 6"	RECOVERY (in)	PERCENT FINES (%)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTICITY INDEX
		(14') CLAY; light gray (2.5Y 7/2) to light olive brown (2.5Y 5/3), caliche lenses at shallow depths; occasional iron staining; light gray clay inclusion at some locations; hard; very stiff (PP > 4.25 tsf); moist to dry; low to high plasticity *(cont.)*	Stratum III	9, 13, 20, 26	22				
	680								
35	675								
		(38') Partially cemented and dry from 38 to 38.5 ft bgs		15, 17, 20, 23	24				
40	670				24				
45	665								
		(48') Calcite mineralization		6, 10, 13, 18	23				
50	660								
55	655								
		(58') Fractures with significant selenite mineralization;		9, 11, 16, 23	22.5				
60									

CONTRACTOR: Texplor of Dallas, Inc.
EQUIPMENT: CME 75 Truck Mounted
DRILL MTHD: HSA / Coring
SAMPLING MTHD: SPT, Shelby Tube, Core
DRILL BIT SIZE/TYPE: HSA 6" - NQ2
NORTHING: 13813630.3
EASTING: 2279604.1
LOGGER: L. Varner
REVIEWER: W. Burke
NOTES: SI - Stratum I

SEE KEY SHEET FOR SYMBOLS AND ABBREVIATIONS

Geosyntec consultants

8217 Shoal Creek Blvd
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Austin, TX 78757
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www.geosyntec.com

GS FORM: 03-GEOTECH3 BF

BOREHOLE LOG

BORING: GB-29
START DATE: 1/12/2023
FINISH DATE: 1/12/2023 **GROUND SURFACE:** 712.2 ft MSL
LOCATION: New Braunfels **TOTAL DEPTH:** 112 ft bgs
PROJECT: Mesquite Creek Landfill **DEPTH TO WATER:** Not Observed
PROJECT NUMBER: GW8636 **BORING BACKFILL:** Bentonite Grout

DESCRIPTION: 1) Soil Name (USCS) 2) Color 3) Moisture 4) Grain Size 5) Percentage 6) Plasticity 7) Density/Consistency 8) Other (Mineral Content, Discoloration, Odor, etc.)

DEPTH (ft-bgs)	ELEVATION (ft)	DESCRIPTION	STRATUM	GRAPHIC LOG	SAMPLE TYPE	BLOWS PER 6"	RECOVERY (in)	PERCENT FINES (%)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTICITY INDEX
60		(14') CLAY; light gray (2.5Y 7/2) to light olive brown (2.5Y 5/3), caliche lenses at shallow depths; occasional iron staining; light gray clay inclusion at some locations; hard; very stiff (PP > 4.25 tsf); moist to dry; low to high plasticity *(cont.)*	Stratum III								
	650										
65							24				
	645					10, 10, 19, 22	24				
		(68.2') 45-degree fracture with significant selenite infilling									
70	640										
75		(75') CLAY to CLAYSTONE; dark gray (2.5Y 4/1); generally competent but several fractures with weathered clay; very hard; moist to dry	Stratum IV								
	635										
80	630						120				
85	625						120				
90											

CONTRACTOR: Texplor of Dallas, Inc. **NORTHING:** 13813630.3
EQUIPMENT: CME 75 Truck Mounted **EASTING:** 2279604.1
DRILL MTHD: HSA / Coring
SAMPLING MTHD: SPT, Shelby Tube, Core
DRILL BIT SIZE/TYPE: HSA 6" - NQ2

LOGGER: L. Varner **REVIEWER:** W. Burke
NOTES: SI - Stratum I

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GS FORM: 03-GEOTECH3 BF

BOREHOLE LOG

BORING: GB-29

START DATE: 1/12/2023
FINISH DATE: 1/12/2023
LOCATION: New Braunfels
PROJECT: Mesquite Creek Landfill
PROJECT NUMBER: GW8636
GROUND SURFACE: 712.2 ft MSL
TOTAL DEPTH: 112 ft bgs
DEPTH TO WATER: Not Observed
BORING BACKFILL: Bentonite Grout

DESCRIPTION: 1) Soil Name (USCS) 2) Color 3) Moisture 4) Grain Size 5) Percentage 6) Plasticity 7) Density/Consistency 8) Other (Mineral Content, Discoloration, Odor, etc.)

DEPTH (ft-bgs)	ELEVATION (ft)	DESCRIPTION	STRATUM	GRAPHIC LOG	SAMPLE: TYPE	SAMPLE: BLOWS PER 6"	SAMPLE: RECOVERY (in)	LAB RESULTS: PERCENT FINES (%)	LAB RESULTS: MOISTURE CONTENT (%)	LAB RESULTS: LIQUID LIMIT	LAB RESULTS: PLASTICITY INDEX
		(75') CLAY to CLAYSTONE; dark gray (2.5Y 4/1); generally competent but several fractures with weathered clay; very hard; moist to dry *(cont.)*	Stratum IV								
	620						120				
95											
	615										
100							116				
	610										
105											
	605						84				
110											
	600	(112') Boring terminated.									
115											
	595										
120											

CONTRACTOR: Texplor of Dallas, Inc.
EQUIPMENT: CME 75 Truck Mounted
DRILL MTHD: HSA / Coring
SAMPLING MTHD: SPT, Shelby Tube, Core
DRILL BIT SIZE/TYPE: HSA 6" - NQ2
NORTHING: 13813630.3
EASTING: 2279604.1
LOGGER: L. Varner
REVIEWER: W. Burke
NOTES: SI - Stratum I

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GS FORM: 03-GEOTECH3 BF

BOREHOLE LOG

BORING: GB-30

START DATE: 1/5/2023
FINISH DATE: 1/6/2023
LOCATION: New Braunfels
PROJECT: Mesquite Creek Landfill
PROJECT NUMBER: GW8636
GROUND SURFACE: 696.1 ft MSL
TOTAL DEPTH: 96 ft bgs
DEPTH TO WATER: Not Observed
BORING BACKFILL: Bentonite Grout

DESCRIPTION
1) Soil Name (USCS)
2) Color
3) Moisture
4) Grain Size
5) Percentage
6) Plasticity
7) Density/Consistency
8) Other (Mineral Content, Discoloration, Odor, etc.)

DEPTH (ft-bgs)	ELEVATION (ft)	DESCRIPTION	STRATUM	GRAPHIC LOG	SAMPLE TYPE	BLOWS PER 6"	RECOVERY (in)	PERCENT FINES (%)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTICITY INDEX
0		(0') SILT and CLAY; light yellowish brown (2.5Y 6/4); organic; some coarse gravel and roots; firm; very stiff (PP > 4.5 tsf); dry	I		SPT	4, 3, 3, 9	14				
	695	(0.25') CLAY; olive yellow (2.5Y 6/6) to pale brown (2.5Y 8/2); some mottling and caliche lenses at shallow depths; occasional iron staining; occasional fractures with calcite infilling; hard; very stiff (PP > 4.5 tsf); trace moist to dry	Stratum III								
5					Shelby Tube		16.5				
	690				SPT	8, 11, 14, 17	18				
10	685				SPT	8, 13, 17, 21	21				
15	680										
					Shelby Tube		21				
20	675				SPT	12, 15, 20, 25	23.5				
25	670										
					Shelby Tube		4				
30											

CONTRACTOR: Texplor of Dallas, Inc.
NORTHING: 13813239.2
EQUIPMENT: CME 75 Truck Mounted
EASTING: 2279990.9
DRILL MTHD: HSA / Coring
SAMPLING MTHD: SPT, Shelby Tube, Core
DRILL BIT SIZE/TYPE: HSA 6" - NQ2

LOGGER: L. Varner; G. Kumar
REVIEWER: W. Burke
NOTES: I - Stratum I

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GS FORM: 03-GEOTECH3 BF

BOREHOLE LOG

BORING: GB-30 **SHEET** 2 **OF** 4
START DATE: 1/5/2023
FINISH DATE: 1/6/2023 **GROUND SURFACE:** 696.1 ft MSL
LOCATION: New Braunfels **TOTAL DEPTH:** 96 ft bgs
PROJECT: Mesquite Creek Landfill **DEPTH TO WATER:** Not Observed
PROJECT NUMBER: GW8636 **BORING BACKFILL:** Bentonite Grout

DESCRIPTION: 1) Soil Name (USCS) 2) Color 3) Moisture 4) Grain Size 5) Percentage 6) Plasticity 7) Density/Consistency 8) Other (Mineral Content, Discoloration, Odor, etc.)

DEPTH (ft-bgs)	ELEVATION (ft)	DESCRIPTION	STRATUM	BLOWS PER 6"	RECOVERY (in)	PERCENT FINES (%)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTICITY INDEX
	665	(0.25') CLAY; olive yellow (2.5Y 6/6) to pale brown (2.5Y 8/2); some mottling and caliche lenses at shallow depths; occasional iron staining; occasional fractures with calcite infilling; hard; very stiff (PP > 4.5 tsf); trace moist to dry *(cont.)* (30') Partially cemented lenses from 30 to 32 ft bgs; dry; friable; weathered voids	Stratum III	16, 34, 31, 45	24				
35	660								
		(38') Dark greenish gray clay lens			24				
40	655	(40') Fractures with calcite infill at 40 and 41.5 ft bgs		21, 26, 27, 31	24				
45	650	(45') CLAYSTONE; dark greenish gray (GLEY1 4/10Y); occassional fractures; moist to dry	Stratum IV						
50	645				118				
55	640								
					120				
60									

CONTRACTOR: Texplor of Dallas, Inc. **NORTHING:** 13813239.2
EQUIPMENT: CME 75 Truck Mounted **EASTING:** 2279990.9
DRILL MTHD: HSA / Coring
SAMPLING MTHD: SPT, Shelby Tube, Core
DRILL BIT SIZE/TYPE: HSA 6" - NQ2

LOGGER: L. Varner; G. Kumar **REVIEWER:** W. Burke
NOTES: I - Stratum I

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GS FORM: 03-GEOTECH3 BF

BOREHOLE LOG

BORING: GB-30 **SHEET** 3 **OF** 4
START DATE: 1/5/2023
FINISH DATE: 1/6/2023 **GROUND SURFACE:** 696.1 ft MSL
LOCATION: New Braunfels **TOTAL DEPTH:** 96 ft bgs
PROJECT: Mesquite Creek Landfill **DEPTH TO WATER:** Not Observed
PROJECT NUMBER: GW8636 **BORING BACKFILL:** Bentonite Grout

DESCRIPTION: 1) Soil Name (USCS) 2) Color 3) Moisture 4) Grain Size 5) Percentage 6) Plasticity 7) Density/Consistency 8) Other (Mineral Content, Discoloration, Odor, etc.)

DEPTH (ft-bgs)	ELEVATION (ft)	DESCRIPTION	STRATUM	GRAPHIC LOG	SAMPLE TYPE	BLOWS PER 6"	RECOVERY (in)	PERCENT FINES (%)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTICITY INDEX
		(45') CLAYSTONE; dark greenish gray (GLEY1 4/10Y); occassional fractures; moist to dry *(cont.)*	Stratum IV								
	635										
							120				
65											
	630										
70		(70') Significant fracturing with moist, soft fat clay (weathered claystone) at fracture zones from 70 to 80 ft bgs (45-degree and horizontal)					115				
	625										
75											
	620										
80							116.5				
	615										
85											
	610										
							60				
90											

CONTRACTOR: Texplor of Dallas, Inc. **NORTHING:** 13813239.2
EQUIPMENT: CME 75 Truck Mounted **EASTING:** 2279990.9
DRILL MTHD: HSA / Coring
SAMPLING MTHD: SPT, Shelby Tube, Core
DRILL BIT SIZE/TYPE: HSA 6" - NQ2

LOGGER: L. Varner; G. Kumar **REVIEWER:** W. Burke
NOTES: I - Stratum I

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GS FORM: 03-GEOTECH3 BF

BOREHOLE LOG

BORING: GB-30
START DATE: 1/5/2023
FINISH DATE: 1/6/2023
LOCATION: New Braunfels
PROJECT: Mesquite Creek Landfill
PROJECT NUMBER: GW8636
GROUND SURFACE: 696.1 ft MSL
TOTAL DEPTH: 96 ft bgs
DEPTH TO WATER: Not Observed
BORING BACKFILL: Bentonite Grout

DESCRIPTION: 1) Soil Name (USCS) 2) Color 3) Moisture 4) Grain Size 5) Percentage 6) Plasticity 7) Density/Consistency 8) Other (Mineral Content, Discoloration, Odor, etc.)

DEPTH (ft-bgs)	ELEVATION (ft)	DESCRIPTION	STRATUM	GRAPHIC LOG	SAMPLE TYPE	BLOWS PER 6"	RECOVERY (in)	PERCENT FINES (%)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTICITY INDEX
	605	(45') CLAYSTONE; dark greenish gray (GLEY1 4/10Y); occassional fractures; moist to dry *(cont.)*	Stratum IV				72				
95	600	(96') Boring terminated.									
100	595										
105	590										
110	585										
115	580										
120											

CONTRACTOR: Texplor of Dallas, Inc.
EQUIPMENT: CME 75 Truck Mounted
DRILL MTHD: HSA / Coring
SAMPLING MTHD: SPT, Shelby Tube, Core
DRILL BIT SIZE/TYPE: HSA 6" - NQ2
NORTHING: 13813239.2
EASTING: 2279990.9
LOGGER: L. Varner; G. Kumar
REVIEWER: W. Burke
NOTES: I - Stratum I

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October 2023

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Austin, TX 78757
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GS FORM: 03-GEOTECH3 BF

BOREHOLE LOG

BORING: GB-31 **SHEET** 1 **OF** 3
START DATE: 1/25/2023
FINISH DATE: 1/25/2023 **GROUND SURFACE:** 669 ft MSL
LOCATION: New Braunfels **TOTAL DEPTH:** 69 ft bgs
PROJECT: Mesquite Creek Landfill **DEPTH TO WATER:** Not Observed
PROJECT NUMBER: GW8636 **BORING BACKFILL:** Bentonite Grout

DESCRIPTION: 1) Soil Name (USCS) 2) Color 3) Moisture 4) Grain Size 5) Percentage 6) Plasticity 7) Density/Consistency 8) Other (Mineral Content, Discoloration, Odor, etc.)

DEPTH (ft-bgs)	ELEVATION (ft)	DESCRIPTION	STRATUM	GRAPHIC LOG	SAMPLE TYPE	BLOWS PER 6"	RECOVERY (in)	PERCENT FINES (%)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTICITY INDEX
0	669	(0') CLAY; black (2.5Y 2.5/1); organic; trace silt and sand; some white mottling; hard; very stiff (PP > 4.5 tsf); dry	Stratum I				10				
						7 9 10 11	12				
	665										
5											
		(6') CLAY; pale brown (2.5Y 8/2) to light yellowish brown (2.5Y 6/4); fine to coarse sand, trace silt; occasional iron staining; light gray clay inclusion at some locations; fractures with calcite infilling; hard; very stiff (PP > 4.5 tsf); trace moist to dry	Stratum III				14				
	660					8 11 12 14	18				
10		(9.5') Trace iron staining									
	655										
15											
	650					5 12 19 23	24				
20											
	645										
25											
	640					8 12 15 25	24				
30		(29.25') Horizontal fracture with calcite mineralization									

CONTRACTOR: Texplor of Dallas, Inc. **NORTHING:** 13812797.3
EQUIPMENT: CME 75 Truck Mounted **EASTING:** 2280376.2
DRILL MTHD: HSA / Coring
SAMPLING MTHD: SPT, Shelby Tube, Core
DRILL BIT SIZE/TYPE: HSA 6" - NQ2

LOGGER: P. Pandey **REVIEWER:** W. Burke
NOTES:

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GS FORM: 03-GEOTECH3 BF

BOREHOLE LOG

BORING: GB-31
START DATE: 1/25/2023
FINISH DATE: 1/25/2023
LOCATION: New Braunfels
PROJECT: Mesquite Creek Landfill
PROJECT NUMBER: GW8636
GROUND SURFACE: 669 ft MSL
TOTAL DEPTH: 69 ft bgs
DEPTH TO WATER: Not Observed
BORING BACKFILL: Bentonite Grout

DESCRIPTION
1) Soil Name (USCS)
2) Color
3) Moisture
4) Grain Size
5) Percentage
6) Plasticity
7) Density/Consistency
8) Other (Mineral Content, Discoloration, Odor, etc.)

DEPTH (ft-bgs)	ELEVATION (ft)	DESCRIPTION	STRATUM
30–58	639–611	(6') CLAY; pale brown (2.5Y 8/2) to light yellowish brown (2.5Y 6/4); fine to coarse sand, trace silt; occasional iron staining; light gray clay inclusion at some locations; fractures with calcite infilling; hard; very stiff (PP > 4.5 tsf); trace moist to dry *(cont.)*	Stratum III
38		(38') Significant iron staining (38.25') Calcite mineralization and chert inclusion from 38 to 39.25 ft bgs (39') Dry, friable, weathered zone	Stratum III
48		(48') Grades to dark gray clay from 38 to 58 ft bgs	Stratum III
58		(58') CLAY to CLAYSTONE; very dark grey (5Y 3/1); occasional fractures and mineralization; very stiff	Stratum IV

Depth scale: 35, 40, 45, 50, 55, 60. Elevation scale: 635, 630, 625, 620, 615, 610.

SAMPLE DEPTH (ft-bgs)	TYPE	BLOWS PER 6"	RECOVERY (in)	PERCENT FINES (%)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTICITY INDEX
36–38	Shelby Tube		7				
38–40	SPT	15, 22, 26, 32					
48–50	SPT	10, 14, 20, 26	24				
52–54	Shelby Tube		24				
58–60	SPT	14, 18, 23, 33					

CONTRACTOR: Texplor of Dallas, Inc.
NORTHING: 13812797.3
EQUIPMENT: CME 75 Truck Mounted
EASTING: 2280376.2
DRILL MTHD: HSA / Coring
SAMPLING MTHD: SPT, Shelby Tube, Core
DRILL BIT SIZE/TYPE: HSA 6" - NQ2
LOGGER: P. Pandey
REVIEWER: W. Burke
NOTES:

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GS FORM: 03-GEOTECH3 BF

BOREHOLE LOG

BORING: GB-31 — **SHEET** 3 **OF** 3
START DATE: 1/25/2023
FINISH DATE: 1/25/2023 — **GROUND SURFACE:** 669 ft MSL
LOCATION: New Braunfels — **TOTAL DEPTH:** 69 ft bgs
PROJECT: Mesquite Creek Landfill — **DEPTH TO WATER:** Not Observed
PROJECT NUMBER: GW8636 — **BORING BACKFILL:** Bentonite Grout

DESCRIPTION: 1) Soil Name (USCS) 2) Color 3) Moisture 4) Grain Size 5) Percentage 6) Plasticity 7) Density/Consistency 8) Other (Mineral Content, Discoloration, Odor, etc.)

DEPTH (ft-bgs)	ELEVATION (ft)	DESCRIPTION	STRATUM	GRAPHIC LOG	SAMPLE: TYPE	SAMPLE: BLOWS PER 6"	SAMPLE: RECOVERY (in)	LAB RESULTS: PERCENT FINES (%)	LAB RESULTS: MOISTURE CONTENT (%)	LAB RESULTS: LIQUID LIMIT	LAB RESULTS: PLASTICITY INDEX
	605	(58') CLAY to CLAYSTONE; very dark grey (5Y 3/1); occasional fractures and mineralization; very stiff *(cont.)*	Stratum IV								
65											
					SPT	11 12 27 29					
	600	(69') Boring terminated.									
70											
	595										
75											
	590										
80											
	585										
85											
	580										
90											

CONTRACTOR: Texplor of Dallas, Inc. — **NORTHING:** 13812797.3
EQUIPMENT: CME 75 Truck Mounted — **EASTING:** 2280376.2
DRILL MTHD: HSA / Coring
SAMPLING MTHD: SPT, Shelby Tube, Core
DRILL BIT SIZE/TYPE: HSA 6" - NQ2

LOGGER: P. Pandey — **REVIEWER:** W. Burke
NOTES:

SEE KEY SHEET FOR SYMBOLS AND ABBREVIATIONS

GS FORM: 03-GEOTECH3 BF

BOREHOLE LOG

BORING: GB-32 **SHEET** 1 **OF** 3
START DATE: 1/5/2023
FINISH DATE: 1/5/2023 **GROUND SURFACE:** 651.9 ft MSL
LOCATION: New Braunfels **TOTAL DEPTH:** 77 ft bgs
PROJECT: Mesquite Creek Landfill **DEPTH TO WATER:** Not Observed
PROJECT NUMBER: GW8636 **BORING BACKFILL:** Bentonite Grout

DESCRIPTION: 1) Soil Name (USCS) 2) Color 3) Moisture 4) Grain Size 5) Percentage 6) Plasticity 7) Density/Consistency 8) Other (Mineral Content, Discoloration, Odor, etc.)

DEPTH (ft-bgs)	ELEVATION (ft)	DESCRIPTION	STRATUM	GRAPHIC LOG	SAMPLE TYPE	BLOWS PER 6"	RECOVERY (in)	PERCENT FINES (%)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTICITY INDEX
0		(0') CLAY; very dark gray (2.5Y 3/1); organic; grasses and rootlets; trace coarse gravel; very stiff (PP > 4.5 tsf); moist	Stratum I			2, 5, 10, 11	16				
	650										
5											
6		(6') CLAY; light olive brown (2.5Y 5/6) to pale olive (5Y 6/4) with some caliche; several vertical laminations and 45-degree fracture planes (~1mm) with calcite infill; occasional iron staining; very stiff (PP > 4.5 tsf); trace moist to dry	Stratum III				11				
	645										
8		(8') Some calcite and chert inclusions				6, 8, 9, 9	21				
10											
	640										
15											
	635										
18							19				
20		(20') Vertical fracture with calcite infilling				6, 9, 12, 16	21				
	630										
25											
	625										
28							23				
30											

CONTRACTOR: Texplor of Dallas, Inc. **NORTHING:** 13812557.9
EQUIPMENT: CME 75 Truck Mounted **EASTING:** 2280894.4
DRILL MTHD: HSA / Coring
SAMPLING MTHD: SPT, Shelby Tube, Core
DRILL BIT SIZE/TYPE: HSA 6" - NQ2

LOGGER: L. Varner; G. Kumar **REVIEWER:** W. Burke
NOTES:

SEE KEY SHEET FOR SYMBOLS AND ABBREVIATIONS

BOREHOLE LOG

BORING: GB-32 | **SHEET** 2 **OF** 3
START DATE: 1/5/2023
FINISH DATE: 1/5/2023 | **GROUND SURFACE:** 651.9 ft MSL
LOCATION: New Braunfels | **TOTAL DEPTH:** 77 ft bgs
PROJECT: Mesquite Creek Landfill | **DEPTH TO WATER:** Not Observed
PROJECT NUMBER: GW8636 | **BORING BACKFILL:** Bentonite Grout

DESCRIPTION: 1) Soil Name (USCS) 2) Color 3) Moisture 4) Grain Size 5) Percentage 6) Plasticity 7) Density/Consistency 8) Other (Mineral Content, Discoloration, Odor, etc.)

DEPTH (ft-bgs)	ELEVATION (ft)	DESCRIPTION	STRATUM	GRAPHIC LOG	SAMPLE TYPE	BLOWS PER 6"	RECOVERY (in)	PERCENT FINES (%)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTICITY INDEX
		(6') CLAY; light olive brown (2.5Y 5/6) to pale olive (5Y 6/4) with some caliche; several vertical laminations and 45-degree fracture planes (~1mm) with calcite infill; occasional iron staining; very stiff (PP > 4.5 tsf); trace moist to dry *(cont.)*	Stratum III		SPT	8, 9, 13, 15	22				
	620	(31') Calcite mineralization									
35											
	615										
		(38') Grades to dark gray clay from 38 to 52 ft bgs with iron staining at some locations			Shelby Tube		24				
40					SPT	10, 14, 18, 22	24				
	610										
45											
	605										
					Shelby Tube		24				
50					SPT	15, 18, 22, 26	24				
	600	(52') CLAY to CLAYSTONE; dark greenish gray (GLEY1 4/5GY); minor fracturing with mineralized infills (calcite and muscovite); very hard; trace moist to dry	Stratum IV		Core		92				
55											
	595										
60											

CONTRACTOR: Texplor of Dallas, Inc. | **NORTHING:** 13812557.9
EQUIPMENT: CME 75 Truck Mounted | **EASTING:** 2280894.4
DRILL MTHD: HSA / Coring
SAMPLING MTHD: SPT, Shelby Tube, Core
DRILL BIT SIZE/TYPE: HSA 6" - NQ2

LOGGER: L. Varner; G. Kumar | **REVIEWER:** W. Burke
NOTES:

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GS FORM: 03-GEOTECH3 BF

BOREHOLE LOG

BORING: GB-32 **SHEET** 3 **OF** 3
START DATE: 1/5/2023
FINISH DATE: 1/5/2023
LOCATION: New Braunfels
PROJECT: Mesquite Creek Landfill
PROJECT NUMBER: GW8636
GROUND SURFACE: 651.9 ft MSL
TOTAL DEPTH: 77 ft bgs
DEPTH TO WATER: Not Observed
BORING BACKFILL: Bentonite Grout

DESCRIPTION: 1) Soil Name (USCS) 2) Color 3) Moisture 4) Grain Size 5) Percentage 6) Plasticity 7) Density/Consistency 8) Other (Mineral Content, Discoloration, Odor, etc.)

DEPTH (ft-bgs)	ELEVATION (ft)	DESCRIPTION	STRATUM	GRAPHIC LOG	SAMPLE: TYPE	SAMPLE: BLOWS PER 6"	SAMPLE: RECOVERY (in)	LAB RESULTS: PERCENT FINES (%)	LAB RESULTS: MOISTURE CONTENT (%)	LAB RESULTS: LIQUID LIMIT	LAB RESULTS: PLASTICITY INDEX
		(52') CLAY to CLAYSTONE; dark greenish gray (GLEY1 4/5GY); minor fracturing with mineralized infills (calcite and muscovite); very hard; trace moist to dry *(cont.)*	Stratum IV								
	590										
65							113				
	585										
70											
	580						79				
75											
	575	(77') Boring terminated.									
80											
	570										
85											
	565										
90											

CONTRACTOR: Texplor of Dallas, Inc.
EQUIPMENT: CME 75 Truck Mounted
DRILL MTHD: HSA / Coring
SAMPLING MTHD: SPT, Shelby Tube, Core
DRILL BIT SIZE/TYPE: HSA 6" - NQ2
NORTHING: 13812557.9
EASTING: 2280894.4
LOGGER: L. Varner; G. Kumar
REVIEWER: W. Burke
NOTES:

SEE KEY SHEET FOR SYMBOLS AND ABBREVIATIONS

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GS FORM: 03-GEOTECH3 BF

BOREHOLE LOG

BORING: GB-33

START DATE: 12/9/2022
FINISH DATE: 12/13/2022
LOCATION: New Braunfels
PROJECT: Mesquite Creek Landfill
PROJECT NUMBER: GW8636
GROUND SURFACE: 702.2 ft MSL
TOTAL DEPTH: 153 ft bgs
DEPTH TO WATER: Not Observed
BORING BACKFILL: Bentonite Grout

DESCRIPTION: 1) Soil Name (USCS) 2) Color 3) Moisture 4) Grain Size 5) Percentage 6) Plasticity 7) Density/Consistency 8) Other (Mineral Content, Discoloration, Odor, etc.)

DEPTH (ft-bgs)	ELEVATION (ft)	DESCRIPTION	STRATUM	BLOWS PER 6"	RECOVERY (in)	PERCENT FINES (%)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTICITY INDEX
0		(0') CLAY; black (2.5Y 2.5/1); organic; grasses and rootlets; trace fine gravel; trace medium sand; soft (PP = 1.75 tsf); trace moist; highly plastic	Stratum I	2, 3, 3, 6	14	93.4	35.7	81	62
2	700	(2') Clayey GRAVEL with chert; medium dense to loose; dry	Stratum II		10		27.4		
5				17, 14, 8, 9		19.4	6.1	59	31
	695						9.6		
8		(8') Significant white caliche from 8 to 10 ft bgs; friable; dry		8, 8, 9, 9	11.5				
10		(10') Silty CLAY to CLAY; pale brown (2.5Y 8/2) to brownish yellow (10YR 6/8) and light olive gray (5Y 6/2); trace chert fragments; trace coarse to fine gravel; iron staining and occasional iron nodules; gray clay inclusions at some locations; some fractures with calcite mineralization/lamination; very stiff (PP > 4.5 tsf); hard; trace moist	Stratum III		12				
	690			11, 13, 15, 19					
15					16		19.9		
	685			8, 9, 13, 15	22	98.5	20.4	90	63
					15		20.3		
20				4, 9, 10, 13					
	680				21				
25				13, 22, 37, 44					
	675								
30									

CONTRACTOR: Texplor of Dallas, Inc.
NORTHING: 13813500.9
EQUIPMENT: CME 75 Truck Mounted
EASTING: 2278691.2
DRILL MTHD: HSA / Coring
SAMPLING MTHD: SPT, Shelby Tube, Core
DRILL BIT SIZE/TYPE: HSA 6" - NQ2
LOGGER: P. Pandey; G. Kumar
REVIEWER: W. Burke
NOTES:

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GS FORM: 03-GEOTECH3 BF

BOREHOLE LOG

BORING: GB-33 **SHEET** 2 **OF** 6
START DATE: 12/9/2022
FINISH DATE: 12/13/2022 **GROUND SURFACE:** 702.2 ft MSL
LOCATION: New Braunfels **TOTAL DEPTH:** 153 ft bgs
PROJECT: Mesquite Creek Landfill **DEPTH TO WATER:** Not Observed
PROJECT NUMBER: GW8636 **BORING BACKFILL:** Bentonite Grout

DEPTH (ft-bgs)	ELEVATION (ft)	DESCRIPTION 1) Soil Name (USCS) 2) Color 3) Moisture 4) Grain Size 5) Percentage 6) Plasticity 7) Density/Consistency 8) Other (Mineral Content, Discoloration, Odor, etc.)	STRATUM	GRAPHIC LOG	SAMPLE: TYPE	SAMPLE: BLOWS PER 6"	SAMPLE: RECOVERY (in)	LAB RESULTS: PERCENT FINES (%)	LAB RESULTS: MOISTURE CONTENT (%)	LAB RESULTS: LIQUID LIMIT	LAB RESULTS: PLASTICITY INDEX
		(10') Silty CLAY to CLAY; pale brown (2.5Y 8/2) to brownish yellow (10YR 6/8) and light olive gray (5Y 6/2); trace chert fragments; trace coarse to fine gravel; iron staining and occasional iron nodules; gray clay inclusions at some locations; some fractures with calcite mineralization/lamination; very stiff (PP > 4.5 tsf); hard; trace moist *(cont.)*	Stratum III		SPT	19 21 35 37					
	670				Shelby Tube		16				
35					SPT	15 20 26 32					
	665										
40					SPT	13 21 25 30					
	660				Shelby Tube		18				
45					SPT	13 14 26 38	24				
	655										
50					SPT	13 15 21 25	24				
	650				Shelby Tube		17				
		(54') Significant calcite inclusions from 54 to 56 ft bgs			SPT	18 25 37 50	24				
55											
	645										
60											

CONTRACTOR: Texplor of Dallas, Inc. **NORTHING:** 13813500.9
EQUIPMENT: CME 75 Truck Mounted **EASTING:** 2278691.2
DRILL MTHD: HSA / Coring
SAMPLING MTHD: SPT, Shelby Tube, Core
DRILL BIT SIZE/TYPE: HSA 6" - NQ2

LOGGER: P. Pandey; G. Kumar **REVIEWER:** W. Burke
NOTES:

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GS FORM: 03-GEOTECH3 BF

BOREHOLE LOG

BORING: GB-33
SHEET 3 **OF** 6
START DATE: 12/9/2022
FINISH DATE: 12/13/2022
GROUND SURFACE: 702.2 ft MSL
LOCATION: New Braunfels
TOTAL DEPTH: 153 ft bgs
PROJECT: Mesquite Creek Landfill
DEPTH TO WATER: Not Observed
PROJECT NUMBER: GW8636
BORING BACKFILL: Bentonite Grout

DESCRIPTION: 1) Soil Name (USCS) 2) Color 3) Moisture 4) Grain Size 5) Percentage 6) Plasticity 7) Density/Consistency 8) Other (Mineral Content, Discoloration, Odor, etc.)

DEPTH (ft-bgs)	ELEVATION (ft)	DESCRIPTION	STRATUM	BLOWS PER 6"	RECOVERY (in)	PERCENT FINES (%)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTICITY INDEX
		(10') Silty CLAY to CLAY; pale brown (2.5Y 8/2) to brownish yellow (10YR 6/8) and light olive gray (5Y 6/2); trace chert fragments; trace coarse to fine gravel; iron staining and occasional iron nodules; gray clay inclusions at some locations; some fractures with calcite mineralization/lamination; very stiff (PP > 4.5 tsf); hard; trace moist *(cont.)*	Stratum III	16, 23, 28, 35					
	640	(60.7') Horizontal fracture with some calcite inclusion (61') Grades to dark gray clay from 61 to 66 ft bgs			17				
65				26, 30, 40, 50					
	635	(66') CLAYSTONE; very dark greenish gray (GLEY1 3/10Y); very hard; trace moist	Stratum IV		48	97.8	6.5	50	25
70		(70') Discoloration and fracture with calcite lamination							
	630								
75					120				
	625								
80									
	620								
85					120				
	615								
90									

CONTRACTOR: Texplor of Dallas, Inc.
NORTHING: 13813500.9
EQUIPMENT: CME 75 Truck Mounted
EASTING: 2278691.2
DRILL MTHD: HSA / Coring
SAMPLING MTHD: SPT, Shelby Tube, Core
DRILL BIT SIZE/TYPE: HSA 6" - NQ2

LOGGER: P. Pandey; G. Kumar
REVIEWER: W. Burke
NOTES:

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GS FORM: 03-GEOTECH3 BF	**BOREHOLE LOG**

BORING: GB-33 | **SHEET** 4 **OF** 6

START DATE: 12/9/2022

FINISH DATE: 12/13/2022 | **GROUND SURFACE:** 702.2 ft MSL

LOCATION: New Braunfels | **TOTAL DEPTH:** 153 ft bgs

PROJECT: Mesquite Creek Landfill | **DEPTH TO WATER:** Not Observed

PROJECT NUMBER: GW8636 | **BORING BACKFILL:** Bentonite Grout

DESCRIPTION: 1) Soil Name (USCS) 2) Color 3) Moisture 4) Grain Size 5) Percentage 6) Plasticity 7) Density/Consistency 8) Other (Mineral Content, Discoloration, Odor, etc.)

DEPTH (ft-bgs)	ELEVATION (ft)	DESCRIPTION	STRATUM	GRAPHIC LOG	SAMPLE: TYPE	SAMPLE: BLOWS PER 6"	SAMPLE: RECOVERY (in)	LAB RESULTS: PERCENT FINES (%)	LAB RESULTS: MOISTURE CONTENT (%)	LAB RESULTS: LIQUID LIMIT	LAB RESULTS: PLASTICITY INDEX
		(66') CLAYSTONE; very dark greenish gray (GLEY1 3/10Y); very hard; trace moist *(cont.)*	Stratum IV								
	610										
95							120				
	605										
100											
	600										
105							110				
	595										
110											
	590										
115							120				
	585										
120											

CONTRACTOR: Texplor of Dallas, Inc. | **NORTHING:** 13813500.9

EQUIPMENT: CME 75 Truck Mounted | **EASTING:** 2278691.2

DRILL MTHD: HSA / Coring

SAMPLING MTHD: SPT, Shelby Tube, Core

DRILL BIT SIZE/TYPE: HSA 6" - NQ2

LOGGER: P. Pandey; G. Kumar | **REVIEWER:** W. Burke

NOTES:

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GS FORM: 03-GEOTECH3 BF

BOREHOLE LOG

BORING: GB-33

START DATE: 12/9/2022
FINISH DATE: 12/13/2022
GROUND SURFACE: 702.2 ft MSL
LOCATION: New Braunfels
TOTAL DEPTH: 153 ft bgs
PROJECT: Mesquite Creek Landfill
DEPTH TO WATER: Not Observed
PROJECT NUMBER: GW8636
BORING BACKFILL: Bentonite Grout

DEPTH (ft-bgs)	ELEVATION (ft)	DESCRIPTION 1) Soil Name (USCS) 2) Color 3) Moisture 4) Grain Size 5) Percentage 6) Plasticity 7) Density/Consistency 8) Other (Mineral Content, Discoloration, Odor, etc.)	STRATUM	GRAPHIC LOG	SAMPLE: TYPE	SAMPLE: BLOWS PER 6"	SAMPLE: RECOVERY (in)	LAB RESULTS: PERCENT FINES (%)	LAB RESULTS: MOISTURE CONTENT (%)	LAB RESULTS: LIQUID LIMIT	LAB RESULTS: PLASTICITY INDEX
		(66') CLAYSTONE; very dark greenish gray (GLEY1 3/10Y); very hard; trace moist *(cont.)*	Stratum IV								
	580										
125							120				
	575										
130											
	570										
135							120				
	565										
140											
	560							60				
145											
	555							96				
150											

CONTRACTOR: Texplor of Dallas, Inc.
NORTHING: 13813500.9
EQUIPMENT: CME 75 Truck Mounted
EASTING: 2278691.2
DRILL MTHD: HSA / Coring
SAMPLING MTHD: SPT, Shelby Tube, Core
DRILL BIT SIZE/TYPE: HSA 6" - NQ2

LOGGER: P. Pandey; G. Kumar
REVIEWER: W. Burke
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GS FORM: 03-GEOTECH3 BF

BOREHOLE LOG

BORING: GB-33
START DATE: 12/9/2022
FINISH DATE: 12/13/2022
LOCATION: New Braunfels
PROJECT: Mesquite Creek Landfill
PROJECT NUMBER: GW8636

GROUND SURFACE: 702.2 ft MSL
TOTAL DEPTH: 153 ft bgs
DEPTH TO WATER: Not Observed
BORING BACKFILL: Bentonite Grout

DESCRIPTION: 1) Soil Name (USCS) 2) Color 3) Moisture 4) Grain Size 5) Percentage 6) Plasticity 7) Density/Consistency 8) Other (Mineral Content, Discoloration, Odor, etc.)

DEPTH (ft-bgs)	ELEVATION (ft)	DESCRIPTION	STRATUM	GRAPHIC LOG	SAMPLE: TYPE	SAMPLE: BLOWS PER 6"	SAMPLE: RECOVERY (in)	LAB RESULTS: PERCENT FINES (%)	LAB RESULTS: MOISTURE CONTENT (%)	LAB RESULTS: LIQUID LIMIT	LAB RESULTS: PLASTICITY INDEX
	550	(66') CLAYSTONE; very dark greenish gray (GLEY1 3/10Y); very hard; trace moist *(cont.)*	Stratum IV				96				
155	545	(153') Boring terminated.									
160	540										
165	535										
170	530										
175	525										
180											

CONTRACTOR: Texplor of Dallas, Inc.
EQUIPMENT: CME 75 Truck Mounted
DRILL MTHD: HSA / Coring
SAMPLING MTHD: SPT, Shelby Tube, Core
DRILL BIT SIZE/TYPE: HSA 6" - NQ2

NORTHING: 13813500.9
EASTING: 2278691.2

LOGGER: P. Pandey; G. Kumar
REVIEWER: W. Burke
NOTES:

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GS FORM: 03-GEOTECH3 BF

BOREHOLE LOG

BORING: GB-34 **SHEET** 1 **OF** 5

START DATE: 12/21/2022

FINISH DATE: 12/22/2022

LOCATION: New Braunfels

PROJECT: Mesquite Creek Landfill

PROJECT NUMBER: GW8636

GROUND SURFACE: 711.0 ft MSL

TOTAL DEPTH: 142 ft bgs

DEPTH TO WATER: Not Observed

BORING BACKFILL: Bentonite Grout

DESCRIPTION: 1) Soil Name (USCS) 2) Color 3) Moisture 4) Grain Size 5) Percentage 6) Plasticity 7) Density/Consistency 8) Other (Mineral Content, Discoloration, Odor, etc.)

DEPTH (ft-bgs)	ELEVATION (ft)	DESCRIPTION	STRATUM	BLOWS PER 6"	RECOVERY (in)
0		(0') CLAY; black (10YR 2/1); organic; grasses and rootlets; little coarse to fine gravel; few coarse to fine sand; firm; soft (PP = 1 tsf); moist	SI	1, 3, 3, 10	15.5
	710	(1.25') Clayey GRAVEL (rounded to sub angular) with CALICHE and chert; trace coarse to fine sand; loose; dry	Stratum II		
				5, 8, 10, 10	2
5	705	(6') White caliche intermixed with sand and clay from 8 to 10 ft bgs; friable	Stratum II	7, 4, 8, 9	22.5
		(8') CLAY; pale brown (2.5Y 8/3), olive yellow (2.5Y 6/6) to grayish brown (2.5Y 5/2), and dark olive gray (5Y 3/2); some caliche lenses at shallow depths; trace silt and fine sand; trace coarse to fine gravel; iron staining and occasional iron nodules; occasional fractures with heavy iron staining and/or calcite mineralization; hard; stiff to very stiff (PP > 3 tsf); trace moist	Stratum III		13.5
10	700	(10') Moist and soft light gray clay inclusion/lamination from 10 to 27 ft bgs with occasional iron staining	Stratum III	7, 10, 11, 13	20.5
					14.5
15	695			8, 15, 20, 20	21.5
20	690			5, 7, 11, 22	23
					16
25	685	(25.2') Iron nodules		5, 8, 10, 12	23
30					

CONTRACTOR: Texplor of Dallas, Inc.

EQUIPMENT: CME 75 Truck Mounted

DRILL MTHD: HSA / Coring

SAMPLING MTHD: SPT, Shelby Tube, Core

DRILL BIT SIZE/TYPE: HSA 6" - NQ2

NORTHING: 13813081.8

EASTING: 2279095.1

LOGGER: G. Kumar

REVIEWER: W. Burke

NOTES: SI - Stratum I

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03-GEOTECH3 BF GEOS BRAUNFELS.GPJ GEOSNTEC.GDT 05/09/23

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GS FORM: 03-GEOTECH3 BF

BOREHOLE LOG

BORING: GB-34 | **SHEET** 2 **OF** 5
START DATE: 12/21/2022
FINISH DATE: 12/22/2022 | **GROUND SURFACE:** 711.0 ft MSL
LOCATION: New Braunfels | **TOTAL DEPTH:** 142 ft bgs
PROJECT: Mesquite Creek Landfill | **DEPTH TO WATER:** Not Observed
PROJECT NUMBER: GW8636 | **BORING BACKFILL:** Bentonite Grout

DESCRIPTION: 1) Soil Name (USCS) 2) Color 3) Moisture 4) Grain Size 5) Percentage 6) Plasticity 7) Density/Consistency 8) Other (Mineral Content, Discoloration, Odor, etc.)

DEPTH (ft-bgs)	ELEVATION (ft)	DESCRIPTION	STRATUM	GRAPHIC LOG	SAMPLE TYPE	BLOWS PER 6"	RECOVERY (in)	PERCENT FINES (%)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTICITY INDEX
	680	(8') CLAY; pale brown (2.5Y 8/3), olive yellow (2.5Y 6/6) to grayish brown (2.5Y 5/2), and dark olive gray (5Y 3/2); some caliche lenses at shallow depths; trace silt and fine sand; trace coarse to fine gravel; iron staining and occasional iron nodules; occasional fractures with heavy iron staining and/or calcite mineralization; hard; stiff to very stiff (PP > 3 tsf); trace moist *(cont.)*	Stratum III		SPT	6, 9, 11, 15	24	97.3	31.2	92	51
35	675										
					Shelby Tube		24				
40	670	(40') Some calcite veins from 40 to 42 ft bgs			SPT	10, 15, 16, 22	22				
45	665										
50	660				SPT	11, 14, 15, 23	24				
55	655										
					Shelby Tube		22.5				
60											

CONTRACTOR: Texplor of Dallas, Inc. **NORTHING:** 13813081.8
EQUIPMENT: CME 75 Truck Mounted **EASTING:** 2279095.1
DRILL MTHD: HSA / Coring
SAMPLING MTHD: SPT, Shelby Tube, Core
DRILL BIT SIZE/TYPE: HSA 6" - NQ2

LOGGER: G. Kumar **REVIEWER:** W. Burke
NOTES: SI - Stratum I

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GS FORM: 03-GEOTECH3 BF	**BOREHOLE LOG**	**GROUND SURFACE:** 711.0 ft MSL **TOTAL DEPTH:** 142 ft bgs **DEPTH TO WATER:** Not Observed **BORING BACKFILL:** Bentonite Grout

DESCRIPTION: 1) Soil Name (USCS) 2) Color 3) Moisture 4) Grain Size 5) Percentage 6) Plasticity 7) Density/Consistency 8) Other (Mineral Content, Discoloration, Odor, etc.)

DEPTH (ft-bgs)	ELEVATION (ft)	DESCRIPTION	STRATUM	GRAPHIC LOG	SAMPLE: TYPE	SAMPLE: BLOWS PER 6"	SAMPLE: RECOVERY (in)	LAB RESULTS: PERCENT FINES (%)	LAB RESULTS: MOISTURE CONTENT (%)	LAB RESULTS: LIQUID LIMIT	LAB RESULTS: PLASTICITY INDEX
	650	(8') CLAY; pale brown (2.5Y 8/3), olive yellow (2.5Y 6/6) to grayish brown (2.5Y 5/2), and dark olive gray (5Y 3/2); some caliche lenses at shallow depths; trace silt and fine sand; trace coarse to fine gravel; iron staining and occasional iron nodules; occasional fractures with heavy iron staining and/or calcite mineralization; hard; stiff to very stiff (PP > 3 tsf); trace moist *(cont.)* (61.6') Heavy calcite precipitation from 50 to 62 ft bgs	Stratum III			12 16 18 28	24				
65	645										
		(68') Grades to dark gray from 68 to 70 ft bgs					22				
70	640	(70') CLAYSTONE; very dark gray (5Y 3/1); occasional fractures with crystallized/mineralized infills; some weathering; very hard; dry	Stratum IV								
75	635						113				
80	630										
85	625						117				
90											

CONTRACTOR: Texplor of Dallas, Inc. **NORTHING:** 13813081.8 **EQUIPMENT:** CME 75 Truck Mounted **EASTING:** 2279095.1 **DRILL MTHD:** HSA / Coring **SAMPLING MTHD:** SPT, Shelby Tube, Core **DRILL BIT SIZE/TYPE:** HSA 6" - NQ2	**LOGGER:** G. Kumar **REVIEWER:** W. Burke **NOTES:** SI - Stratum I SEE KEY SHEET FOR SYMBOLS AND ABBREVIATIONS

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GS FORM: 03-GEOTECH3 BF

BOREHOLE LOG

BORING: GB-34 — **SHEET** 4 **OF** 5
START DATE: 12/21/2022
FINISH DATE: 12/22/2022
LOCATION: New Braunfels
PROJECT: Mesquite Creek Landfill
PROJECT NUMBER: GW8636
GROUND SURFACE: 711.0 ft MSL
TOTAL DEPTH: 142 ft bgs
DEPTH TO WATER: Not Observed
BORING BACKFILL: Bentonite Grout

DESCRIPTION: 1) Soil Name (USCS) 2) Color 3) Moisture 4) Grain Size 5) Percentage 6) Plasticity 7) Density/Consistency 8) Other (Mineral Content, Discoloration, Odor, etc.)

DEPTH (ft-bgs)	ELEVATION (ft)	DESCRIPTION	STRATUM	GRAPHIC LOG	TYPE	BLOWS PER 6"	RECOVERY (in)	PERCENT FINES (%)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTICITY INDEX
	620	(70') CLAYSTONE; very dark gray (5Y 3/1); occasional fractures with crystallized/mineralized infills; some weathering; very hard; dry *(cont.)*	Stratum IV								
95	615						120				
100	610										
105	605						71.5				
110	600										
115	595						97				
120											

CONTRACTOR: Texplor of Dallas, Inc.
EQUIPMENT: CME 75 Truck Mounted
DRILL MTHD: HSA / Coring
SAMPLING MTHD: SPT, Shelby Tube, Core
DRILL BIT SIZE/TYPE: HSA 6" - NQ2
NORTHING: 13813081.8
EASTING: 2279095.1
LOGGER: G. Kumar
REVIEWER: W. Burke
NOTES: SI - Stratum I

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03-GEOTECH3 BF GEOS BRAUNFELS.GPJ GEOSNTEC.GDT 05/09/23

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GS FORM: 03-GEOTECH3 BF

BOREHOLE LOG

BORING: GB-34 | **SHEET** 5 **OF** 5

START DATE: 12/21/2022
FINISH DATE: 12/22/2022 | **GROUND SURFACE:** 711.0 ft MSL
LOCATION: New Braunfels | **TOTAL DEPTH:** 142 ft bgs
PROJECT: Mesquite Creek Landfill | **DEPTH TO WATER:** Not Observed
PROJECT NUMBER: GW8636 | **BORING BACKFILL:** Bentonite Grout

DESCRIPTION: 1) Soil Name (USCS) 2) Color 3) Moisture 4) Grain Size 5) Percentage 6) Plasticity 7) Density/Consistency 8) Other (Mineral Content, Discoloration, Odor, etc.)

DEPTH (ft-bgs)	ELEVATION (ft)	DESCRIPTION	STRATUM	GRAPHIC LOG	SAMPLE TYPE	BLOWS PER 6"	RECOVERY (in)	PERCENT FINES (%)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTICITY INDEX
	590	(70') CLAYSTONE; very dark gray (5Y 3/1); occasional fractures with crystallized/mineralized infills; some weathering; very hard; dry *(cont.)*	Stratum IV								
125	585						117				
130	580						60				
135	575						80				
140	570										
		(142') Boring terminated.									
145	565										
150											

CONTRACTOR: Texplor of Dallas, Inc. | **NORTHING:** 13813081.8
EQUIPMENT: CME 75 Truck Mounted | **EASTING:** 2279095.1
DRILL MTHD: HSA / Coring
SAMPLING MTHD: SPT, Shelby Tube, Core
DRILL BIT SIZE/TYPE: HSA 6" - NQ2

LOGGER: G. Kumar | **REVIEWER:** W. Burke
NOTES: SI - Stratum I

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GS FORM: 03-GEOTECH3 BF

BOREHOLE LOG

BORING: GB-35

START DATE: 1/11/2023
FINISH DATE: 1/12/2023
LOCATION: New Braunfels
PROJECT: Mesquite Creek Landfill
PROJECT NUMBER: GW8636
GROUND SURFACE: 709.7 ft MSL
TOTAL DEPTH: 110 ft bgs
DEPTH TO WATER: Not Observed
BORING BACKFILL: Bentonite Grout

DESCRIPTION: 1) Soil Name (USCS) 2) Color 3) Moisture 4) Grain Size 5) Percentage 6) Plasticity 7) Density/Consistency 8) Other (Mineral Content, Discoloration, Odor, etc.)

DEPTH (ft-bgs)	ELEVATION (ft)	DESCRIPTION	STRATUM	BLOWS PER 6"	RECOVERY (in)	PERCENT FINES (%)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTICITY INDEX
0	709.7	(0') CLAY; black (5Y 2.5/1); organic; grasses and rootlets; some gravel and silt; very stiff (PP > 4.25 tsf); moist	SI	3, 4, 6, 14	12				
0.75		(0.75') Sandy/Clayey calcareous GRAVEL (sub rounded and sub angular) and CALICHE with chert fragments; dense to loose; dry	Stratum II	9, 16, 20, 20	18				
5	705			40, 48, 40, 49	17				
10	700	(10') CLAY; light olive brown (2.5Y 5/4) to light yellowish brown (2.5Y 6/4); iron staining at some locations; some mineralization and calcite infill; firm to very hard; very stiff (PP > 4 tsf); moist to dry; low plasticity to friable	Stratum III		13.5				
				10, 14, 15, 20	21				
15	695								
					20				
20	690			7, 10, 14, 18	24				
21		(21') Moist and soft light gray clay lamination from 21 to 32 ft bgs							
25	685								
					21				
30	680								

CONTRACTOR: Texplor of Dallas, Inc.
EQUIPMENT: CME 75 Truck Mounted
DRILL MTHD: HSA / Coring
SAMPLING MTHD: SPT, Shelby Tube, Core
DRILL BIT SIZE/TYPE: HSA 6" - NQ2
NORTHING: 13812718.9
EASTING: 2279464.8
LOGGER: L. Varner
REVIEWER: W. Burke
NOTES: SI - Stratum I

SEE KEY SHEET FOR SYMBOLS AND ABBREVIATIONS

Geosyntec consultants

8217 Shoal Creek Blvd
Suite 200
Austin, TX 78757
Phone: (512) 451-4003
www.geosyntec.com

GS FORM: 03-GEOTECH3 BF

BOREHOLE LOG

BORING: GB-35
START DATE: 1/11/2023
FINISH DATE: 1/12/2023 **GROUND SURFACE:** 709.7 ft MSL
LOCATION: New Braunfels **TOTAL DEPTH:** 110 ft bgs
PROJECT: Mesquite Creek Landfill **DEPTH TO WATER:** Not Observed
PROJECT NUMBER: GW8636 **BORING BACKFILL:** Bentonite Grout

DESCRIPTION: 1) Soil Name (USCS) 2) Color 3) Moisture 4) Grain Size 5) Percentage 6) Plasticity 7) Density/Consistency 8) Other (Mineral Content, Discoloration, Odor, etc.)

DEPTH (ft-bgs)	ELEVATION (ft)	DESCRIPTION	STRATUM	GRAPHIC LOG	SAMPLE TYPE	BLOWS PER 6"	RECOVERY (in)	PERCENT FINES (%)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTICITY INDEX
		(10') CLAY; light olive brown (2.5Y 5/4) to light yellowish brown (2.5Y 6/4); iron staining at some locations; some mineralization and calcite infill; firm to very hard; very stiff (PP > 4 tsf); moist to dry; low plasticity to friable *(cont.)*	Stratum III			6, 11, 13, 18	24				
35	675										
40	670					8, 14, 21, 26	24				
45	665										
							16.5				
50	660	(50') Calcite in filled fractures from 50 to 52 ft bgs; gravelly lenses				18, 20, 34, 33	24				
55	655										
		(58') Grades to dark greenish gray clay from 58 to 62 ft bgs					21				
60	650										

CONTRACTOR: Texplor of Dallas, Inc. **NORTHING:** 13812718.9
EQUIPMENT: CME 75 Truck Mounted **EASTING:** 2279464.8
DRILL MTHD: HSA / Coring
SAMPLING MTHD: SPT, Shelby Tube, Core
DRILL BIT SIZE/TYPE: HSA 6" - NQ2

LOGGER: L. Varner **REVIEWER:** W. Burke
NOTES: SI - Stratum I

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GS FORM: 03-GEOTECH3 BF

BOREHOLE LOG

BORING: GB-35 **SHEET** 3 **OF** 4
START DATE: 1/11/2023
FINISH DATE: 1/12/2023
LOCATION: New Braunfels
PROJECT: Mesquite Creek Landfill
PROJECT NUMBER: GW8636
GROUND SURFACE: 709.7 ft MSL
TOTAL DEPTH: 110 ft bgs
DEPTH TO WATER: Not Observed
BORING BACKFILL: Bentonite Grout

DESCRIPTION: 1) Soil Name (USCS) 2) Color 3) Moisture 4) Grain Size 5) Percentage 6) Plasticity 7) Density/Consistency 8) Other (Mineral Content, Discoloration, Odor, etc.)

DEPTH (ft-bgs)	ELEVATION (ft)	DESCRIPTION	STRATUM	GRAPHIC LOG	SAMPLE TYPE	BLOWS PER 6"	RECOVERY (in)	PERCENT FINES (%)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTICITY INDEX
		(10') CLAY; light olive brown (2.5Y 5/4) to light yellowish brown (2.5Y 6/4); iron staining at some locations; some mineralization and calcite infill; firm to very hard; very stiff (PP > 4 tsf); moist to dry; low plasticity to friable *(cont.)*	Stratum III			20 23 41 50	24				
		(62') CLAY to CLAYSTONE; dark greenish gray (GLEY1 4/10Y); several fractured zones with some calcite infilling and trace pyrite; very hard	Stratum IV				36				
65	645	(65') Significant iron staining/yellow discoloration from 65 to 80 ft bgs									
70	640						117.5				
75	635										
80	630						120				
85	625										
							120				
90	620										

CONTRACTOR: Texplor of Dallas, Inc.
EQUIPMENT: CME 75 Truck Mounted
DRILL MTHD: HSA / Coring
SAMPLING MTHD: SPT, Shelby Tube, Core
DRILL BIT SIZE/TYPE: HSA 6" - NQ2
NORTHING: 13812718.9
EASTING: 2279464.8
LOGGER: L. Varner
REVIEWER: W. Burke
NOTES: SI - Stratum I

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GS FORM: 03-GEOTECH3 BF

BOREHOLE LOG

BORING: GB-35

START DATE: 1/11/2023
FINISH DATE: 1/12/2023
LOCATION: New Braunfels
PROJECT: Mesquite Creek Landfill
PROJECT NUMBER: GW8636
GROUND SURFACE: 709.7 ft MSL
TOTAL DEPTH: 110 ft bgs
DEPTH TO WATER: Not Observed
BORING BACKFILL: Bentonite Grout

DEPTH (ft-bgs)	ELEVATION (ft)	DESCRIPTION 1) Soil Name (USCS) 2) Color 3) Moisture 4) Grain Size 5) Percentage 6) Plasticity 7) Density/Consistency 8) Other (Mineral Content, Discoloration, Odor, etc.)	STRATUM	GRAPHIC LOG	SAMPLE: TYPE	SAMPLE: BLOWS PER 6"	SAMPLE: RECOVERY (in)	LAB RESULTS: PERCENT FINES (%)	LAB RESULTS: MOISTURE CONTENT (%)	LAB RESULTS: LIQUID LIMIT	LAB RESULTS: PLASTICITY INDEX
		(62') CLAY to CLAYSTONE; dark greenish gray (GLEY1 4/10Y); several fractured zones with some calcite infilling and trace pyrite; very hard *(cont.)*	Stratum IV				120				
95	615										
							51				
100	610										
105	605						120				
110	600	(110') Boring terminated.									
115	595										
120	590										

CONTRACTOR: Texplor of Dallas, Inc.
EQUIPMENT: CME 75 Truck Mounted
DRILL MTHD: HSA / Coring
SAMPLING MTHD: SPT, Shelby Tube, Core
DRILL BIT SIZE/TYPE: HSA 6" - NQ2
NORTHING: 13812718.9
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GS FORM: 03-GEOTECH3 BF

BOREHOLE LOG

BORING: GB-36
START DATE: 1/17/2023
FINISH DATE: 1/17/2023
LOCATION: New Braunfels
PROJECT: Mesquite Creek Landfill
PROJECT NUMBER: GW8636
GROUND SURFACE: 681.8 ft MSL
TOTAL DEPTH: 107 ft bgs
DEPTH TO WATER: Not Observed
BORING BACKFILL: Bentonite Grout

DESCRIPTION: 1) Soil Name (USCS) 2) Color 3) Moisture 4) Grain Size 5) Percentage 6) Plasticity 7) Density/Consistency 8) Other (Mineral Content, Discoloration, Odor, etc.)

DEPTH (ft-bgs)	ELEVATION (ft)	DESCRIPTION	STRATUM	GRAPHIC LOG	SAMPLE: TYPE	SAMPLE: BLOWS PER 6"	SAMPLE: RECOVERY (in)	LAB RESULTS: PERCENT FINES (%)	LAB RESULTS: MOISTURE CONTENT (%)	LAB RESULTS: LIQUID LIMIT	LAB RESULTS: PLASTICITY INDEX
0		(0') CLAY; very dark gray (2.5Y 3/1); organic; grasses and rootlets; some gravel and silt; stiff; moist	Stratum I		Shelby Tube		24		24.9		
	680				SPT	10, 10, 12, 16	24				
5											
6	675	(6') CLAY; light olive brown (2.5Y 5/4) to light yellowish brown (2.5Y 6/4); orange and/or gray mottling; occasional iron staining; trace gravel; some occasional mineralization and infilling; very stiff; moist to dry	Stratum III		Shelby Tube		24				
					SPT	5, 8, 11, 13	24				
10	670										
15	665										
					SPT	5, 10, 15, 20	24				
20	660										
25	655										
30											

CONTRACTOR: Texplor of Dallas, Inc.
EQUIPMENT: CME 75 Truck Mounted
DRILL MTHD: HSA / Coring
SAMPLING MTHD: SPT, Shelby Tube, Core
DRILL BIT SIZE/TYPE: HSA 6" - NQ2
NORTHING: 13812327.8
EASTING: 2279851.6
LOGGER: J. Geesin
REVIEWER: W. Burke
NOTES:

SEE KEY SHEET FOR SYMBOLS AND ABBREVIATIONS

03-GEOTECH3 BF GEOS BRAUNFELS.GPJ GEOSNTEC.GDT 05/09/23

Geosyntec consultants	8217 Shoal Creek Blvd Suite 200 Austin, TX 78757 Phone: (512) 451-4003 www.geosyntec.com	**BORING:** GB-36	**SHEET** 2 **OF** 4
GS FORM: 03-GEOTECH3 BF	**BOREHOLE LOG**	**START DATE:** 1/17/2023 **FINISH DATE:** 1/17/2023 **LOCATION:** New Braunfels **PROJECT:** Mesquite Creek Landfill **PROJECT NUMBER:** GW8636	**GROUND SURFACE:** 681.8 ft MSL **TOTAL DEPTH:** 107 ft bgs **DEPTH TO WATER:** Not Observed **BORING BACKFILL:** Bentonite Grout

DESCRIPTION: 1) Soil Name (USCS) 2) Color 3) Moisture 4) Grain Size 5) Percentage 6) Plasticity 7) Density/Consistency 8) Other (Mineral Content, Discoloration, Odor, etc.)

DEPTH (ft-bgs)	ELEVATION (ft)	DESCRIPTION	STRATUM	GRAPHIC LOG	SAMPLE: TYPE	SAMPLE: BLOWS PER 6"	SAMPLE: RECOVERY (in)	LAB RESULTS: PERCENT FINES (%)	LAB RESULTS: MOISTURE CONTENT (%)	LAB RESULTS: LIQUID LIMIT	LAB RESULTS: PLASTICITY INDEX
		(6') CLAY; light olive brown (2.5Y 5/4) to light yellowish brown (2.5Y 6/4); orange and/or gray mottling; occasional iron staining; trace gravel; some occasional mineralization and infilling; very stiff; moist to dry *(cont.)*	Stratum III				24				
	650	(32') Sand lens from 32 to 33 ft bgs; mineralization				29 27 38 39	24				
35	645										
40	640	(40') Trace crystallization				16 20 28 36	24				
45	635										
50	630						24				
		(52') Selenite lamination from 52 to 54 ft bgs				7 10 14 19	24				
55	625										
60											

CONTRACTOR: Texplor of Dallas, Inc. **NORTHING:** 13812327.8
EQUIPMENT: CME 75 Truck Mounted **EASTING:** 2279851.6
DRILL MTHD: HSA / Coring
SAMPLING MTHD: SPT, Shelby Tube, Core
DRILL BIT SIZE/TYPE: HSA 6" - NQ2

LOGGER: J. Geesin **REVIEWER:** W. Burke
NOTES:

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GS FORM: 03-GEOTECH3 BF

BOREHOLE LOG

BORING: GB-36
START DATE: 1/17/2023
FINISH DATE: 1/17/2023 **GROUND SURFACE:** 681.8 ft MSL
LOCATION: New Braunfels **TOTAL DEPTH:** 107 ft bgs
PROJECT: Mesquite Creek Landfill **DEPTH TO WATER:** Not Observed
PROJECT NUMBER: GW8636 **BORING BACKFILL:** Bentonite Grout

DESCRIPTION: 1) Soil Name (USCS) 2) Color 3) Moisture 4) Grain Size 5) Percentage 6) Plasticity 7) Density/Consistency 8) Other (Mineral Content, Discoloration, Odor, etc.)

DEPTH (ft-bgs)	ELEVATION (ft)	DESCRIPTION	STRATUM	TYPE	BLOWS PER 6"	RECOVERY (in)	PERCENT FINES (%)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTICITY INDEX
		(6') CLAY; light olive brown (2.5Y 5/4) to light yellowish brown (2.5Y 6/4); orange and/or gray mottling; occasional iron staining; trace gravel; some occasional mineralization and infilling; very stiff; moist to dry *(cont.)*	Stratum III	Shelby Tube		24				
	620	(60') Grades to dark gray from 60 to 64 ft bgs	Stratum III							
		(63') Fracture with infilling	Stratum III	SPT	12, 17, 25, 36	24				
65		(64') CLAY to CLAYSTONE; very dark gray (2.5Y 3/1); moderate fractures and few weathered zones; very hard	Stratum IV	Core						
	615	(67.5') Iron staining	Stratum IV	Core						
70			Stratum IV	Core		120				
	610									
75										
	605									
80			Stratum IV	Core		120				
	600									
85										
	595		Stratum IV	Core		120				
90										

CONTRACTOR: Texplor of Dallas, Inc. **NORTHING:** 13812327.8
EQUIPMENT: CME 75 Truck Mounted **EASTING:** 2279851.6
DRILL MTHD: HSA / Coring
SAMPLING MTHD: SPT, Shelby Tube, Core
DRILL BIT SIZE/TYPE: HSA 6" - NQ2

LOGGER: J. Geesin **REVIEWER:** W. Burke
NOTES:

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GS FORM: 03-GEOTECH3 BF

BOREHOLE LOG

BORING: GB-36

START DATE: 1/17/2023
FINISH DATE: 1/17/2023
LOCATION: New Braunfels
PROJECT: Mesquite Creek Landfill
PROJECT NUMBER: GW8636
GROUND SURFACE: 681.8 ft MSL
TOTAL DEPTH: 107 ft bgs
DEPTH TO WATER: Not Observed
BORING BACKFILL: Bentonite Grout

DESCRIPTION
1) Soil Name (USCS)
2) Color
3) Moisture
4) Grain Size
5) Percentage
6) Plasticity
7) Density/Consistency
8) Other (Mineral Content, Discoloration, Odor, etc.)

DEPTH (ft-bgs)	ELEVATION (ft)	DESCRIPTION	STRATUM	GRAPHIC LOG	SAMPLE: TYPE	SAMPLE: BLOWS PER 6"	SAMPLE: RECOVERY (in)	LAB RESULTS: PERCENT FINES (%)	LAB RESULTS: MOISTURE CONTENT (%)	LAB RESULTS: LIQUID LIMIT	LAB RESULTS: PLASTICITY INDEX
		(64') CLAY to CLAYSTONE; very dark gray (2.5Y 3/1); moderate fractures and few weathered zones; very hard *(cont.)*	Stratum IV								
	590						120				
95	585						60				
100	580						84				
105	575										
		(107') Boring terminated.									
110	570										
115	565										
120											

CONTRACTOR: Texplor of Dallas, Inc.
EQUIPMENT: CME 75 Truck Mounted
DRILL MTHD: HSA / Coring
SAMPLING MTHD: SPT, Shelby Tube, Core
DRILL BIT SIZE/TYPE: HSA 6" - NQ2
NORTHING: 13812327.8
EASTING: 2279851.6
LOGGER: J. Geesin
REVIEWER: W. Burke
NOTES:

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03-GEOTECH3 BF GEOS BRAUNFELS.GPJ GEOSNTEC.GDT 05/09/23

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GS FORM: 03-GEOTECH3 BF

BOREHOLE LOG

BORING: GB-37
START DATE: 12/8/2022
FINISH DATE: 12/9/2022
LOCATION: New Braunfels
PROJECT: Mesquite Creek Landfill
PROJECT NUMBER: GW8636
GROUND SURFACE: 668.8 ft MSL
TOTAL DEPTH: 120 ft bgs
DEPTH TO WATER: Not Observed
BORING BACKFILL: Bentonite Grout

DESCRIPTION: 1) Soil Name (USCS) 2) Color 3) Moisture 4) Grain Size 5) Percentage 6) Plasticity 7) Density/Consistency 8) Other (Mineral Content, Discoloration, Odor, etc.)

DEPTH (ft-bgs)	ELEVATION (ft)	DESCRIPTION	STRATUM	BLOWS PER 6"	RECOVERY (in)	PERCENT FINES (%)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTICITY INDEX
0		(0') CLAY; very dark gray (2.5Y 3/1) to light olive brown (2.5Y 5/4); organics; grasses and rootlets; few coarse to fine gravel; few coarse to fine sand; some silt; firm; soft to very stiff (PP = 1.5 and PP > 4.5 tsf); moist	Stratum I	2, 2, 4, 6	14				
			Stratum I		13	93.1	25.3	75	44
	665		Stratum I						
5			Stratum I	7, 7, 9, 9	16				
			Stratum I			88.6	18.2	118	85
		(6.5') Sandy/Clayey calcareous GRAVEL (sub rounded and sub angular) with chert fragments; some caliche; dense to loose; dry	Stratum II		6				
	660	(8.25') CLAY; pale brown (2.5Y 8/4), olive yellow (2.5Y 6/6), and dark grayish brown (2.5Y 4/2); trace gravel and chert fragments; occasional iron staining and orange mottling; several fractures (horizontal and 45-degree) with calcite mineralization/lamin	Stratum III	9, 12, 14, 16	18				
10			Stratum III		15				
			Stratum III	6, 9, 13, 17	24				
	655		Stratum III						
15		(15.5') 2" thick weathered zone; friable	Stratum III	18, 18, 16, 19					
			Stratum III		17.5		17		
	650	(19') Heavy iron staining	Stratum III	5, 9, 11, 14	24	95.5	21.3	60	32
20			Stratum III						
	645		Stratum III						
25		(25') Some fractures from 26 to 47 ft bgs with calcite mineralization	Stratum III	4, 6, 9, 12	21.5				
			Stratum III		17	97.8	29	72	47
	640		Stratum III	7, 14					
30									

CONTRACTOR: Texplor of Dallas, Inc.
NORTHING: 13811937.0
EQUIPMENT: CME 75 Truck Mounted
EASTING: 2280238.4
DRILL MTHD: HSA / Coring
SAMPLING MTHD: SPT, Shelby Tube, Core
DRILL BIT SIZE/TYPE: HSA 6" - NQ2
LOGGER: P. Pandey; G. Kumar
REVIEWER: W. Burke
NOTES:

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GS FORM: 03-GEOTECH3 BF

BOREHOLE LOG

BORING: GB-37

START DATE: 12/8/2022
FINISH DATE: 12/9/2022
LOCATION: New Braunfels
PROJECT: Mesquite Creek Landfill
PROJECT NUMBER: GW8636
GROUND SURFACE: 668.8 ft MSL
TOTAL DEPTH: 120 ft bgs
DEPTH TO WATER: Not Observed
BORING BACKFILL: Bentonite Grout

DESCRIPTION

1) Soil Name (USCS)
2) Color
3) Moisture
4) Grain Size
5) Percentage
6) Plasticity
7) Density/Consistency
8) Other (Mineral Content, Discoloration, Odor, etc.)

DEPTH (ft-bgs)	ELEVATION (ft)	DESCRIPTION	STRATUM	SAMPLE: BLOWS PER 6"	SAMPLE: RECOVERY (in)	LAB RESULTS: PERCENT FINES (%)	LAB RESULTS: MOISTURE CONTENT (%)	LAB RESULTS: LIQUID LIMIT	LAB RESULTS: PLASTICITY INDEX
		(8.25') CLAY; pale brown (2.5Y 8/4), olive yellow (2.5Y 6/6), and dark grayish brown (2.5Y 4/2); trace gravel and chert fragments; occasional iron staining and orange mottling; several fractures (horizontal and 45-degree) with calcite mineralization/lamin *(cont.)*	Stratum III	22, 29					
	635								
35				6, 9, 11, 13	21				
					21	99.8	33.3	84	49
	630								
40				17, 12, 16, 19	24				
	625								
45				7, 12, 14, 18					
					23				
	620								
50				8, 12, 16, 18					
	615				23.5				
55		(55') Weathered claystone from 55 to 56.5 ft bgs; iron staining and orange mottling from 56.5 to 65 ft bgs							
		(56.5') CLAY TO CLAYSTONE; greenish black (GLEY1 2.5/10Y); moderate fractures with calcite mineralization and/or iron staining; very hard; trace moist	Stratum IV						
	610								
60									

CONTRACTOR: Texplor of Dallas, Inc.
EQUIPMENT: CME 75 Truck Mounted
DRILL MTHD: HSA / Coring
SAMPLING MTHD: SPT, Shelby Tube, Core
DRILL BIT SIZE/TYPE: HSA 6" - NQ2
NORTHING: 13811937.0
EASTING: 2280238.4
LOGGER: P. Pandey; G. Kumar
REVIEWER: W. Burke
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GS FORM: 03-GEOTECH3 BF

BOREHOLE LOG

BORING: GB-37
START DATE: 12/8/2022
FINISH DATE: 12/9/2022
GROUND SURFACE: 668.8 ft MSL
LOCATION: New Braunfels
TOTAL DEPTH: 120 ft bgs
PROJECT: Mesquite Creek Landfill
DEPTH TO WATER: Not Observed
PROJECT NUMBER: GW8636
BORING BACKFILL: Bentonite Grout

DESCRIPTION: 1) Soil Name (USCS) 2) Color 3) Moisture 4) Grain Size 5) Percentage 6) Plasticity 7) Density/Consistency 8) Other (Mineral Content, Discoloration, Odor, etc.)

DEPTH (ft-bgs)	ELEVATION (ft)	DESCRIPTION	STRATUM	GRAPHIC LOG	SAMPLE TYPE	BLOWS PER 6"	RECOVERY (in)	PERCENT FINES (%)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTICITY INDEX
		(56.5') CLAY TO CLAYSTONE; greenish black (GLEY1 2.5/10Y); moderate fractures with calcite mineralization and/or iron staining; very hard; trace moist *(cont.)*	Stratum IV								
		(60.5') Calcite precipitate (~ 3 mm)									
		(63') Friable, shears easily from 63 to 65 ft bgs; significant weathering from 63 to 68 ft bgs									
	605										
65											
	600										
70							120	97.9	21.1	97	59
	595										
75											
	590										
80											
	585										
85											
							116				
	580										
90											

CONTRACTOR: Texplor of Dallas, Inc.
NORTHING: 13811937.0
EQUIPMENT: CME 75 Truck Mounted
EASTING: 2280238.4
DRILL MTHD: HSA / Coring
SAMPLING MTHD: SPT, Shelby Tube, Core
DRILL BIT SIZE/TYPE: HSA 6" - NQ2

LOGGER: P. Pandey; G. Kumar
REVIEWER: W. Burke
NOTES:

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GS FORM: 03-GEOTECH3 BF

BOREHOLE LOG

BORING: GB-37
START DATE: 12/8/2022
FINISH DATE: 12/9/2022
GROUND SURFACE: 668.8 ft MSL
LOCATION: New Braunfels
TOTAL DEPTH: 120 ft bgs
PROJECT: Mesquite Creek Landfill
DEPTH TO WATER: Not Observed
PROJECT NUMBER: GW8636
BORING BACKFILL: Bentonite Grout

DESCRIPTION: 1) Soil Name (USCS) 2) Color 3) Moisture 4) Grain Size 5) Percentage 6) Plasticity 7) Density/Consistency 8) Other (Mineral Content, Discoloration, Odor, etc.)

DEPTH (ft-bgs)	ELEVATION (ft)	DESCRIPTION	STRATUM	GRAPHIC LOG	SAMPLE: TYPE	SAMPLE: BLOWS PER 6"	SAMPLE: RECOVERY (in)	LAB RESULTS: PERCENT FINES (%)	LAB RESULTS: MOISTURE CONTENT (%)	LAB RESULTS: LIQUID LIMIT	LAB RESULTS: PLASTICITY INDEX
		(56.5') CLAY TO CLAYSTONE; greenish black (GLEY1 2.5/10Y); moderate fractures with calcite mineralization and/or iron staining; very hard; trace moist *(cont.)*	Stratum IV								
							116				
	575										
95											
	570										
100							115				
	565										
105											
							60				
	560										
110											
	555										
115							109				
	550										
120		(120') Boring terminated.									

CONTRACTOR: Texplor of Dallas, Inc. **NORTHING:** 13811937.0
EQUIPMENT: CME 75 Truck Mounted **EASTING:** 2280238.4
DRILL MTHD: HSA / Coring
SAMPLING MTHD: SPT, Shelby Tube, Core
DRILL BIT SIZE/TYPE: HSA 6" - NQ2

LOGGER: P. Pandey; G. Kumar **REVIEWER:** W. Burke
NOTES:

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GS FORM:
03-GEOTECH3 BF

BOREHOLE LOG

BORING: GB-38
START DATE: 12/19/2022
FINISH DATE: 12/20/2022 **GROUND SURFACE:** 707.6 ft MSL
LOCATION: New Braunfels **TOTAL DEPTH:** 133 ft bgs
PROJECT: Mesquite Creek Landfill **DEPTH TO WATER:** Not Observed
PROJECT NUMBER: GW8636 **BORING BACKFILL:** Bentonite Grout

DESCRIPTION
1) Soil Name (USCS)
2) Color
3) Moisture
4) Grain Size
5) Percentage
6) Plasticity
7) Density/Consistency
8) Other (Mineral Content, Discoloration, Odor, etc.)

DEPTH (ft-bgs)	ELEVATION (ft)	DESCRIPTION	STRATUM	SAMPLE: BLOWS PER 6"	SAMPLE: RECOVERY (in)	PERCENT FINES (%)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTICITY INDEX
0		(0') CLAY; very dark grey (10YR 3/1) to black (10YR 2/1); organic; grasses and rootlets; coarse to fine gravel; firm; soft (PP = 1.75 tsf); moist	SI	2, 2, 15, 16	18				
1		(1') Sandy/Clayey GRAVEL to Gravelly CLAY with chert and caliche; coarse to fine sand and gravel; loose; dry	Stratum II						
2	705			18, 19, 15, 17	16				
5					9		5.4		
7	700	(7') White caliche intermixed with silty clay from 3 to 10.25 ft bgs		19, 23, 22, 27	20				
10									
10.25		(10.25') CLAY; olive yellow (2.5Y 6/6) to pale olive (5Y 6/3); trace iron staining and mottling; occasional trace chert fragments; hard; very stiff (PP > 4.5 tsf); trace moist	Stratum III	13, 19, 28, 28	21				
	695								
15		(15') Moist and soft light gray clay inclusion/lamination from 15 to 22 ft bgs		5, 9, 11, 14	18				
17	690				16.5				
20				5, 8, 12, 16	22.5				
	685								
25		(25.5') Light grey clay inclusion with oxidized iron lamination		8, 17, 35, 45	24				
		(26.5') Dry, friable, weathered zone							
	680								
30									

CONTRACTOR: Texplor of Dallas, Inc. **NORTHING:** 13812980.5
EQUIPMENT: CME 75 Truck Mounted **EASTING:** 2278165.1
DRILL MTHD: HSA / Coring
SAMPLING MTHD: SPT, Shelby Tube, Core
DRILL BIT SIZE/TYPE: HSA 6" - NQ2

LOGGER: G. Kumar **REVIEWER:** W. Burke
NOTES: SI - Stratum I

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GS FORM: 03-GEOTECH3 BF

BOREHOLE LOG

BORING: GB-38 — **SHEET** 2 **OF** 5
START DATE: 12/19/2022
FINISH DATE: 12/20/2022 — **GROUND SURFACE:** 707.6 ft MSL
LOCATION: New Braunfels — **TOTAL DEPTH:** 133 ft bgs
PROJECT: Mesquite Creek Landfill — **DEPTH TO WATER:** Not Observed
PROJECT NUMBER: GW8636 — **BORING BACKFILL:** Bentonite Grout

DESCRIPTION: 1) Soil Name (USCS) 2) Color 3) Moisture 4) Grain Size 5) Percentage 6) Plasticity 7) Density/Consistency 8) Other (Mineral Content, Discoloration, Odor, etc.)

DEPTH (ft-bgs)	ELEVATION (ft)	DESCRIPTION	STRATUM	GRAPHIC LOG	SAMPLE TYPE	BLOWS PER 6"	RECOVERY (in)	PERCENT FINES (%)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTICITY INDEX
		(10.25') CLAY; olive yellow (2.5Y 6/6) to pale olive (5Y 6/3); trace iron staining and mottling; occasional trace chert fragments; hard; very stiff (PP > 4.5 tsf); trace moist *(cont.)*	Stratum III		SPT	13 20 24 35	24				
		(30') Iron staining with iron nodules									
	675				Shelby Tube		18				
35											
	670										
40					SPT	12 17 21 24	24				
		(41') Iron staining from 41 to 41.5 ft bgs; some gray mottling from 41 to 51 ft bgs									
	665										
45											
	660										
50					SPT	11 16 21 26	24				
		(50.25') 45-degree fracture plane with calcite precipitation from 50 to 52 ft bgs									
	655										
55											
	650										
60											

CONTRACTOR: Texplor of Dallas, Inc. — **NORTHING:** 13812980.5
EQUIPMENT: CME 75 Truck Mounted — **EASTING:** 2278165.1
DRILL MTHD: HSA / Coring
SAMPLING MTHD: SPT, Shelby Tube, Core
DRILL BIT SIZE/TYPE: HSA 6" - NQ2

LOGGER: G. Kumar — **REVIEWER:** W. Burke
NOTES: SI - Stratum I

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GS FORM: 03-GEOTECH3 BF

BOREHOLE LOG

BORING: GB-38

START DATE: 12/19/2022
FINISH DATE: 12/20/2022
LOCATION: New Braunfels
PROJECT: Mesquite Creek Landfill
PROJECT NUMBER: GW8636
GROUND SURFACE: 707.6 ft MSL
TOTAL DEPTH: 133 ft bgs
DEPTH TO WATER: Not Observed
BORING BACKFILL: Bentonite Grout

DESCRIPTION: 1) Soil Name (USCS) 2) Color 3) Moisture 4) Grain Size 5) Percentage 6) Plasticity 7) Density/Consistency 8) Other (Mineral Content, Discoloration, Odor, etc.)

DEPTH (ft-bgs)	ELEVATION (ft)	DESCRIPTION	STRATUM	SAMPLE: BLOWS PER 6"	SAMPLE: RECOVERY (in)	PERCENT FINES (%)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTICITY INDEX
		(10.25') CLAY; olive yellow (2.5Y 6/6) to pale olive (5Y 6/3); trace iron staining and mottling; occasional trace chert fragments; hard; very stiff (PP > 4.5 tsf); trace moist *(cont.)* (60') Grades to gray clay from 60 to 62 ft bgs	Stratum III	25, 27, 30, 40	23				
	645	(62') CLAYSTONE; grey (5Y 5/1); occasional chert fragments; very hard; trace moist	Stratum IV		36				
65									
	640								
70					118.5				
	635								
75									
		(76.5') 4 mm wide silver (lustrous) inclusion							
	630								
80					114.5				
		(81.25') 45-degree fracture plane w/ relatively soft and moist gray clay deposition (~ 1 mm); iron staining							
	625								
85									
	620				111.5				
90									

CONTRACTOR: Texplor of Dallas, Inc.
NORTHING: 13812980.5
EQUIPMENT: CME 75 Truck Mounted
EASTING: 2278165.1
DRILL MTHD: HSA / Coring
SAMPLING MTHD: SPT, Shelby Tube, Core
DRILL BIT SIZE/TYPE: HSA 6" - NQ2

LOGGER: G. Kumar
REVIEWER: W. Burke
NOTES: SI - Stratum I

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GS FORM: 03-GEOTECH3 BF

BOREHOLE LOG

BORING: GB-38 **SHEET** 4 **OF** 5
START DATE: 12/19/2022
FINISH DATE: 12/20/2022 **GROUND SURFACE:** 707.6 ft MSL
LOCATION: New Braunfels **TOTAL DEPTH:** 133 ft bgs
PROJECT: Mesquite Creek Landfill **DEPTH TO WATER:** Not Observed
PROJECT NUMBER: GW8636 **BORING BACKFILL:** Bentonite Grout

DESCRIPTION: 1) Soil Name (USCS) 2) Color 3) Moisture 4) Grain Size 5) Percentage 6) Plasticity 7) Density/Consistency 8) Other (Mineral Content, Discoloration, Odor, etc.)

DEPTH (ft-bgs)	ELEVATION (ft)	DESCRIPTION	STRATUM	GRAPHIC LOG	SAMPLE: TYPE	SAMPLE: BLOWS PER 6"	SAMPLE: RECOVERY (in)	LAB RESULTS: PERCENT FINES (%)	LAB RESULTS: MOISTURE CONTENT (%)	LAB RESULTS: LIQUID LIMIT	LAB RESULTS: PLASTICITY INDEX
		(62') CLAYSTONE; grey (5Y 5/1); occasional chert fragments; very hard; trace moist *(cont.)*	Stratum IV								
	615						111.5				
95											
	610										
100							120				
	605										
105											
	600										
110							120				
	595										
115											
	590						117				
120											

CONTRACTOR: Texplor of Dallas, Inc. **NORTHING:** 13812980.5
EQUIPMENT: CME 75 Truck Mounted **EASTING:** 2278165.1
DRILL MTHD: HSA / Coring
SAMPLING MTHD: SPT, Shelby Tube, Core
DRILL BIT SIZE/TYPE: HSA 6" - NQ2

LOGGER: G. Kumar **REVIEWER:** W. Burke
NOTES: SI - Stratum I

SEE KEY SHEET FOR SYMBOLS AND ABBREVIATIONS

BOREHOLE LOG

BORING: GB-38 **SHEET** 5 **OF** 5
START DATE: 12/19/2022
FINISH DATE: 12/20/2022 **GROUND SURFACE:** 707.6 ft MSL
LOCATION: New Braunfels **TOTAL DEPTH:** 133 ft bgs
PROJECT: Mesquite Creek Landfill **DEPTH TO WATER:** Not Observed
PROJECT NUMBER: GW8636 **BORING BACKFILL:** Bentonite Grout

DESCRIPTION
1) Soil Name (USCS)
2) Color
3) Moisture
4) Grain Size
5) Percentage
6) Plasticity
7) Density/Consistency
8) Other (Mineral Content, Discoloration, Odor, etc.)

DEPTH (ft-bgs)	ELEVATION (ft)	DESCRIPTION	STRATUM	GRAPHIC LOG	SAMPLE: TYPE	SAMPLE: BLOWS PER 6"	SAMPLE: RECOVERY (in)	LAB RESULTS: PERCENT FINES (%)	LAB RESULTS: MOISTURE CONTENT (%)	LAB RESULTS: LIQUID LIMIT	LAB RESULTS: PLASTICITY INDEX
		(62') CLAYSTONE; grey (5Y 5/1); occasional chert fragments; very hard; trace moist *(cont.)*	Stratum IV								
	585						117				
125											
	580										
							96				
130											
	575										
		(133') Boring terminated.									
135											
	570										
140											
	565										
145											
	560										
150											

CONTRACTOR: Texplor of Dallas, Inc. **NORTHING:** 13812980.5
EQUIPMENT: CME 75 Truck Mounted **EASTING:** 2278165.1
DRILL MTHD: HSA / Coring
SAMPLING MTHD: SPT, Shelby Tube, Core
DRILL BIT SIZE/TYPE: HSA 6" - NQ2

LOGGER: G. Kumar **REVIEWER:** W. Burke
NOTES: SI - Stratum I

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BOREHOLE LOG

BORING: GB-39 | **SHEET** 1 **OF** 4
START DATE: 12/20/2022
FINISH DATE: 12/21/2022
LOCATION: New Braunfels
PROJECT: Mesquite Creek Landfill
PROJECT NUMBER: GW8636
GROUND SURFACE: 707.4 ft MSL
TOTAL DEPTH: 115 ft bgs
DEPTH TO WATER: Not Observed
BORING BACKFILL: Bentonite Grout

DESCRIPTION: 1) Soil Name (USCS) 2) Color 3) Moisture 4) Grain Size 5) Percentage 6) Plasticity 7) Density/Consistency 8) Other (Mineral Content, Discoloration, Odor, etc.)

DEPTH (ft-bgs)	ELEVATION (ft)	DESCRIPTION	STRATUM	BLOWS PER 6"	RECOVERY (in)	PERCENT FINES (%)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTICITY INDEX
0		(0') CLAY; black (10YR 2/1); organic; grasses and rootlets; few coarse to fine gravel; trace coarse to fine sand; soft (PP = 0.75 tsf); moist	SI	1, 3, 11, 11	15				
1		(1') Clayey GRAVEL; coarse to fine grained (sub rounded to angular); loose; trace moist	Stratum II	9, 10, 9, 11	0				
	705								
5				8, 11, 9, 8	0				
7	700	(7') CLAY; light olive grey (5Y 6/2) and olive yellow (2.5Y 6/8) to grayish brown (2.5Y 5/2); occasional iron staining and mottling; hard; medium stiff to very stiff (PP > 2.75 tsf); trace moist	Stratum III		16				
10		(10.25') Significant caliche lenses and iron staining		4, 6, 7, 9	18				
		(11') Moist and soft light olive gray clay inclusion from 10 to 20.25 ft bgs							
	695				13				
15				3, 4, 6, 8	21				
	690				15.5				
20				8, 11, 15, 17	24				
	685								
25				5, 8, 10, 13	24				
		(26') Several fracture from 26 to 52 ft bgs with some calcite mineralization/lamination and/or iron staining							
	680				27.5				
30									

CONTRACTOR: Texplor of Dallas, Inc.
EQUIPMENT: CME 75 Truck Mounted
DRILL MTHD: HSA / Coring
SAMPLING MTHD: SPT, Shelby Tube, Core
DRILL BIT SIZE/TYPE: HSA 6" - NQ2
NORTHING: 13812552.5
EASTING: 2278572.8
LOGGER: G. Kumar
REVIEWER: W. Burke
NOTES: SI - Stratum I

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GS FORM: 03-GEOTECH3 BF

BOREHOLE LOG

BORING: GB-39
START DATE: 12/20/2022
FINISH DATE: 12/21/2022
LOCATION: New Braunfels
PROJECT: Mesquite Creek Landfill
PROJECT NUMBER: GW8636

GROUND SURFACE: 707.4 ft MSL
TOTAL DEPTH: 115 ft bgs
DEPTH TO WATER: Not Observed
BORING BACKFILL: Bentonite Grout

DESCRIPTION: 1) Soil Name (USCS) 2) Color 3) Moisture 4) Grain Size 5) Percentage 6) Plasticity 7) Density/Consistency 8) Other (Mineral Content, Discoloration, Odor, etc.)

DEPTH (ft-bgs)	ELEVATION (ft)	DESCRIPTION	STRATUM	GRAPHIC LOG	SAMPLE: TYPE	SAMPLE: BLOWS PER 6"	SAMPLE: RECOVERY (in)	LAB RESULTS: PERCENT FINES (%)	LAB RESULTS: MOISTURE CONTENT (%)	LAB RESULTS: LIQUID LIMIT	LAB RESULTS: PLASTICITY INDEX
		(7') CLAY; light olive grey (5Y 6/2) and olive yellow (2.5Y 6/8) to grayish brown (2.5Y 5/2); occasional iron staining and mottling; hard; medium stiff to very stiff (PP > 2.75 tsf); trace moist *(cont.)*	Stratum III		SPT	9, 14, 15, 17	23				
	675										
35											
	670										
40					SPT	8, 11, 12, 17	24				
	665										
45											
	660				Shelby Tube		22				
50		(50.25') Soft and moist greenish gray clay deposition			SPT	9, 12, 15, 20	24				
	655										
55											
	650										
60											

CONTRACTOR: Texplor of Dallas, Inc.
EQUIPMENT: CME 75 Truck Mounted
DRILL MTHD: HSA / Coring
SAMPLING MTHD: SPT, Shelby Tube, Core
DRILL BIT SIZE/TYPE: HSA 6" - NQ2
NORTHING: 13812552.5
EASTING: 2278572.8

LOGGER: G. Kumar
REVIEWER: W. Burke
NOTES: SI - Stratum I

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GS FORM: 03-GEOTECH3 BF

BOREHOLE LOG

BORING: GB-39

START DATE: 12/20/2022
FINISH DATE: 12/21/2022
LOCATION: New Braunfels
PROJECT: Mesquite Creek Landfill
PROJECT NUMBER: GW8636
GROUND SURFACE: 707.4 ft MSL
TOTAL DEPTH: 115 ft bgs
DEPTH TO WATER: Not Observed
BORING BACKFILL: Bentonite Grout

DESCRIPTION: 1) Soil Name (USCS) 2) Color 3) Moisture 4) Grain Size 5) Percentage 6) Plasticity 7) Density/Consistency 8) Other (Mineral Content, Discoloration, Odor, etc.)

DEPTH (ft-bgs)	ELEVATION (ft)	DESCRIPTION	STRATUM	SAMPLE: BLOWS PER 6"	SAMPLE: RECOVERY (in)	PERCENT FINES (%)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTICITY INDEX
		(7') CLAY; light olive grey (5Y 6/2) and olive yellow (2.5Y 6/8) to grayish brown (2.5Y 5/2); occasional iron staining and mottling; hard; medium stiff to very stiff (PP > 2.75 tsf); trace moist *(cont.)* (60') Grades to very dark gray from 60 to 67 ft bgs	Stratum III	13, 15, 19, 22	24				
	645								
65					22.5				
	640	(67') CLAYSTONE; very dark gray (5Y 3/1); occasional fractures with iron staining and crystallized/mineralized infills (calcite); very hard	Stratum IV		36				
70									
	635								
75					119				
	630								
80									
	625								
85					107.5				
	620								
90									

CONTRACTOR: Texplor of Dallas, Inc.
EQUIPMENT: CME 75 Truck Mounted
DRILL MTHD: HSA / Coring
SAMPLING MTHD: SPT, Shelby Tube, Core
DRILL BIT SIZE/TYPE: HSA 6" - NQ2
NORTHING: 13812552.5
EASTING: 2278572.8
LOGGER: G. Kumar
REVIEWER: W. Burke
NOTES: SI - Stratum I

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GS FORM: 03-GEOTECH3 BF

BOREHOLE LOG

BORING: GB-39 **SHEET** 4 **OF** 4
START DATE: 12/20/2022
FINISH DATE: 12/21/2022 **GROUND SURFACE:** 707.4 ft MSL
LOCATION: New Braunfels **TOTAL DEPTH:** 115 ft bgs
PROJECT: Mesquite Creek Landfill **DEPTH TO WATER:** Not Observed
PROJECT NUMBER: GW8636 **BORING BACKFILL:** Bentonite Grout

DESCRIPTION: 1) Soil Name (USCS) 2) Color 3) Moisture 4) Grain Size 5) Percentage 6) Plasticity 7) Density/Consistency 8) Other (Mineral Content, Discoloration, Odor, etc.)

DEPTH (ft-bgs)	ELEVATION (ft)	DESCRIPTION	STRATUM	GRAPHIC LOG	SAMPLE: TYPE	SAMPLE: BLOWS PER 6"	SAMPLE: RECOVERY (in)	LAB RESULTS: PERCENT FINES (%)	LAB RESULTS: MOISTURE CONTENT (%)	LAB RESULTS: LIQUID LIMIT	LAB RESULTS: PLASTICITY INDEX
		(67') CLAYSTONE; very dark gray (5Y 3/1); occasional fractures with iron staining and crystallized/mineralized infills (calcite); very hard *(cont.)*	Stratum IV								
	615										
95							103				
	610										
100											
	605						60				
105											
	600										
110							82				
	595										
115		(115') Boring terminated.									
	590										
120											

CONTRACTOR: Texplor of Dallas, Inc. **NORTHING:** 13812552.5
EQUIPMENT: CME 75 Truck Mounted **EASTING:** 2278572.8
DRILL MTHD: HSA / Coring
SAMPLING MTHD: SPT, Shelby Tube, Core
DRILL BIT SIZE/TYPE: HSA 6" - NQ2

LOGGER: G. Kumar **REVIEWER:** W. Burke
NOTES: SI - Stratum I

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GS FORM: 03-GEOTECH3 BF

BOREHOLE LOG

BORING: GB-40
START DATE: 12/15/2022
FINISH DATE: 12/19/2022
LOCATION: New Braunfels
PROJECT: Mesquite Creek Landfill
PROJECT NUMBER: GW8636
GROUND SURFACE: 693 ft MSL
TOTAL DEPTH: 144 ft bgs
DEPTH TO WATER: Not Observed
BORING BACKFILL: Bentonite Grout

DESCRIPTION: 1) Soil Name (USCS) 2) Color 3) Moisture 4) Grain Size 5) Percentage 6) Plasticity 7) Density/Consistency 8) Other (Mineral Content, Discoloration, Odor, etc.)

DEPTH (ft-bgs)	ELEVATION (ft)	DESCRIPTION	STRATUM	BLOWS PER 6"	RECOVERY (in)	PERCENT FINES (%)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTICITY INDEX
0	693	(0') CLAY; black (10YR 2/1); organic; grasses and rootlets; trace coarse gravel; few medium to fine sand; soft to very stiff (PP > 1 tsf); moist to dry	Stratum I	1, 2, 3, 3	12.5	95.8	30.2	126	93
	690				17	95.2	17.8	67	40
5		(4.25') CALICHE mixed with olive clay; trace chert fragments; friable	Stratum II	12, 13, 15, 16	18				
					17				
10	685	(8') CLAY; pale olive (5Y 6/4) to olive (5Y 5/6) and light olive brown (2.5Y 5/6) to pale brown (2.5Y 7/4); few coarse gravel; little coarse to fine sand; some calcite infills and chert fragments; occasional iron staining and mottling; several fractures with crystalline mineralization/lamination (calcite); hard; very stiff (PP > 4.5 tsf); trace moist (9') Moist and soft pale olive clay inclusion from 8 to 22 ft bgs	Stratum III	5, 8, 10, 12	21				
					15				
	680			16, 10, 12, 16	23				
15					13				
				5, 8, 10, 13	22				
	675				18				
20				6, 7, 12, 16	23				
	670	(22') Mineralized calcite infill			16				
25		(24') Thick silica based mineralization coated with caliche from 24 to 26 ft bgs; iron staining		8, 11, 16, 27	24				
30	665								

CONTRACTOR: Texplor of Dallas, Inc.
EQUIPMENT: CME 75 Truck Mounted
DRILL MTHD: HSA / Coring
SAMPLING MTHD: SPT, Shelby Tube, Core
DRILL BIT SIZE/TYPE: HSA 6" - NQ2
NORTHING: 13812198.5
EASTING: 2278938.7
LOGGER: P. Pandey; G. Kumar
REVIEWER: W. Burke
NOTES:

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GS FORM: 03-GEOTECH3 BF

BOREHOLE LOG

BORING: GB-40
START DATE: 12/15/2022
FINISH DATE: 12/19/2022 **GROUND SURFACE:** 693 ft MSL
LOCATION: New Braunfels **TOTAL DEPTH:** 144 ft bgs
PROJECT: Mesquite Creek Landfill **DEPTH TO WATER:** Not Observed
PROJECT NUMBER: GW8636 **BORING BACKFILL:** Bentonite Grout

DESCRIPTION: 1) Soil Name (USCS) 2) Color 3) Moisture 4) Grain Size 5) Percentage 6) Plasticity 7) Density/Consistency 8) Other (Mineral Content, Discoloration, Odor, etc.)

DEPTH (ft-bgs)	ELEVATION (ft)	DESCRIPTION	STRATUM	BLOWS PER 6"	RECOVERY (in)	PERCENT FINES (%)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTICITY INDEX
		(8') CLAY; pale olive (5Y 6/4) to olive (5Y 5/6) and light olive brown (2.5Y 5/6) to pale brown (2.5Y 7/4); few coarse gravel; little coarse to fine sand; some calcite infills and chert fragments; occasional iron staining and mottling; several fractures with crystalline mineralization/lamination (calcite); hard; very stiff (PP > 4.5 tsf); trace moist *(cont.)*	Stratum III	12, 15, 18, 25	24	94.5	20.8	58	32
	660				19		30.7		
35				29, 24, 25, 30	24				
		(35.5') Thick silica based mineralization							
	655								
40				22, 26, 50					
		(41') Color grades to dark gray from 41 ft bgs and alternating light olive brown and dark gray from 41 to 65 ft bgs							
	650				7				
45		(45') CLAYSTONE; greenish black (GLEY1 2.5/10Y) with alternating light olive brown (2.5Y 5/6) from 45 to 60 ft bgs; trace chert fragments; multiple fractures with crystallized/mineralized infills; very hard; trace moist	Stratum IV						
	645								
50					120				
	640								
55									
	635				120				
60									

CONTRACTOR: Texplor of Dallas, Inc. **NORTHING:** 13812198.5
EQUIPMENT: CME 75 Truck Mounted **EASTING:** 2278938.7
DRILL MTHD: HSA / Coring
SAMPLING MTHD: SPT, Shelby Tube, Core
DRILL BIT SIZE/TYPE: HSA 6" - NQ2

LOGGER: P. Pandey; G. Kumar **REVIEWER:** W. Burke
NOTES:

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GS FORM: 03-GEOTECH3 BF

BOREHOLE LOG

BORING: GB-40
START DATE: 12/15/2022
FINISH DATE: 12/19/2022
LOCATION: New Braunfels
PROJECT: Mesquite Creek Landfill
PROJECT NUMBER: GW8636
GROUND SURFACE: 693 ft MSL
TOTAL DEPTH: 144 ft bgs
DEPTH TO WATER: Not Observed
BORING BACKFILL: Bentonite Grout

DESCRIPTION: 1) Soil Name (USCS) 2) Color 3) Moisture 4) Grain Size 5) Percentage 6) Plasticity 7) Density/Consistency 8) Other (Mineral Content, Discoloration, Odor, etc.)

DEPTH (ft-bgs)	ELEVATION (ft)	DESCRIPTION	STRATUM	GRAPHIC LOG	TYPE	BLOWS PER 6"	RECOVERY (in)	PERCENT FINES (%)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTICITY INDEX
		(45') CLAYSTONE; greenish black (GLEY1 2.5/10Y) with alternating light olive brown (2.5Y 5/6) from 45 to 60 ft bgs; trace chert fragments; multiple fractures with crystallized/mineralized infills; very hard; trace moist *(cont.)*	Stratum IV					89.7	11.8	71	44
							120				
	630										
65											
	625										
70							118				
	620										
75											
	615										
80							111				
	610										
85											
							113				
	605										
90											

CONTRACTOR: Texplor of Dallas, Inc.
NORTHING: 13812198.5
EQUIPMENT: CME 75 Truck Mounted
EASTING: 2278938.7
DRILL MTHD: HSA / Coring
SAMPLING MTHD: SPT, Shelby Tube, Core
DRILL BIT SIZE/TYPE: HSA 6" - NQ2
LOGGER: P. Pandey; G. Kumar
REVIEWER: W. Burke
NOTES:

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GS FORM: 03-GEOTECH3 BF

BOREHOLE LOG

BORING: GB-40
START DATE: 12/15/2022
FINISH DATE: 12/19/2022
LOCATION: New Braunfels
PROJECT: Mesquite Creek Landfill
PROJECT NUMBER: GW8636
GROUND SURFACE: 693 ft MSL
TOTAL DEPTH: 144 ft bgs
DEPTH TO WATER: Not Observed
BORING BACKFILL: Bentonite Grout

DESCRIPTION: 1) Soil Name (USCS) 2) Color 3) Moisture 4) Grain Size 5) Percentage 6) Plasticity 7) Density/Consistency 8) Other (Mineral Content, Discoloration, Odor, etc.)

DEPTH (ft-bgs)	ELEVATION (ft)	DESCRIPTION	STRATUM	GRAPHIC LOG	SAMPLE: TYPE	SAMPLE: BLOWS PER 6"	SAMPLE: RECOVERY (in)	LAB RESULTS: PERCENT FINES (%)	LAB RESULTS: MOISTURE CONTENT (%)	LAB RESULTS: LIQUID LIMIT	LAB RESULTS: PLASTICITY INDEX
		(45') CLAYSTONE; greenish black (GLEY1 2.5/10Y) with alternating light olive brown (2.5Y 5/6) from 45 to 60 ft bgs; trace chert fragments; multiple fractures with crystallized/mineralized infills; very hard; trace moist *(cont.)*	Stratum IV								
							113				
	600										
95											
	595										
100							117.5				
	590										
105											
	585										
110							117				
	580										
115											
	575						118				
120											

CONTRACTOR: Texplor of Dallas, Inc.
NORTHING: 13812198.5
EQUIPMENT: CME 75 Truck Mounted
EASTING: 2278938.7
DRILL MTHD: HSA / Coring
SAMPLING MTHD: SPT, Shelby Tube, Core
DRILL BIT SIZE/TYPE: HSA 6" - NQ2
LOGGER: P. Pandey; G. Kumar
REVIEWER: W. Burke
NOTES:

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GS FORM: 03-GEOTECH3 BF

BOREHOLE LOG

BORING: GB-40
START DATE: 12/15/2022
FINISH DATE: 12/19/2022
LOCATION: New Braunfels
PROJECT: Mesquite Creek Landfill
PROJECT NUMBER: GW8636
GROUND SURFACE: 693 ft MSL
TOTAL DEPTH: 144 ft bgs
DEPTH TO WATER: Not Observed
BORING BACKFILL: Bentonite Grout

DESCRIPTION: 1) Soil Name (USCS) 2) Color 3) Moisture 4) Grain Size 5) Percentage 6) Plasticity 7) Density/Consistency 8) Other (Mineral Content, Discoloration, Odor, etc.)

DEPTH (ft-bgs)	ELEVATION (ft)	DESCRIPTION	STRATUM	GRAPHIC LOG	SAMPLE: TYPE	SAMPLE: BLOWS PER 6"	SAMPLE: RECOVERY (in)	LAB RESULTS: PERCENT FINES (%)	LAB RESULTS: MOISTURE CONTENT (%)	LAB RESULTS: LIQUID LIMIT	LAB RESULTS: PLASTICITY INDEX
		(45') CLAYSTONE; greenish black (GLEY1 2.5/10Y) with alternating light olive brown (2.5Y 5/6) from 45 to 60 ft bgs; trace chert fragments; multiple fractures with crystallized/mineralized infills; very hard; trace moist *(cont.)*	Stratum IV								
							118				
	570										
125											
	565										
130							120				
	560										
135											
	555										
							103				
140											
	550										
		(144') Boring terminated.									
145											
	545										
150											

CONTRACTOR: Texplor of Dallas, Inc.
NORTHING: 13812198.5
EQUIPMENT: CME 75 Truck Mounted
EASTING: 2278938.7
DRILL MTHD: HSA / Coring
SAMPLING MTHD: SPT, Shelby Tube, Core
DRILL BIT SIZE/TYPE: HSA 6" - NQ2

LOGGER: P. Pandey; G. Kumar
REVIEWER: W. Burke
NOTES:

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GS FORM: 03-GEOTECH3 BF

BOREHOLE LOG

BORING: GB-41 | **SHEET** 1 **OF** 3

START DATE: 1/10/2023
FINISH DATE: 1/11/2023
LOCATION: New Braunfels
PROJECT: Mesquite Creek Landfill
PROJECT NUMBER: GW8636
GROUND SURFACE: 676.8 ft MSL
TOTAL DEPTH: 77 ft bgs
DEPTH TO WATER: Not Observed
BORING BACKFILL: Bentonite Grout

DESCRIPTION: 1) Soil Name (USCS) 2) Color 3) Moisture 4) Grain Size 5) Percentage 6) Plasticity 7) Density/Consistency 8) Other (Mineral Content, Discoloration, Odor, etc.)

DEPTH (ft-bgs)	ELEVATION (ft)	DESCRIPTION	STRATUM	BLOWS PER 6"	RECOVERY (in)	PERCENT FINES (%)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTICITY INDEX
0		(0') CLAY; very dark gray (2.5Y 3/1); organics; some gravels, roots and chert fragments; soft to very stiff (PP > 1.25); moist; highly plastic	Stratum I	3, 5, 8, 7	7				
	675								
					12.5	87.2	23.2	88	60
5									
6		(6') CALICHE with some calcareous gravel and chert fragments, dry.	Stratum II	16, 18, 22, 15	16.5				
	670								
10		(10') CLAY; light olive brown (2.5Y 5/4) to light yellowish brown (2.5Y 6/4), trace iron staining and chert fragments; occasional calcite mineralization/lamination; firm to very hard; very stiff (PP > 4 tsf); moist to dry	Stratum III		17				
	665	(11') Moist and soft pale olive clay inclusion from 10 to 25 ft bgs							
		(12') Some calcite mineralization and iron staining		6, 9, 12, 14	22				
		(13.5') Fracture with calcite infilling							
15									
	660								
					16				
20				7, 11, 21, 22	21.5				
	655	(21.75') Iron precipitate in fracture							
25				7, 13, 15, 18	24				
		(26') Calcite mineralization							
	650								
30									

CONTRACTOR: Texplor of Dallas, Inc.
EQUIPMENT: CME 75 Truck Mounted
DRILL MTHD: HSA / Coring
SAMPLING MTHD: SPT, Shelby Tube, Core
DRILL BIT SIZE/TYPE: HSA 6" - NQ2
NORTHING: 13811767.5
EASTING: 2279327.5
LOGGER: L. Varner
REVIEWER: W. Burke
NOTES:

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GS FORM: 03-GEOTECH3 BF	**BOREHOLE LOG**	**START DATE:** 1/10/2023 **FINISH DATE:** 1/11/2023 **LOCATION:** New Braunfels **PROJECT:** Mesquite Creek Landfill **PROJECT NUMBER:** GW8636	**GROUND SURFACE:** 676.8 ft MSL **TOTAL DEPTH:** 77 ft bgs **DEPTH TO WATER:** Not Observed **BORING BACKFILL:** Bentonite Grout

DESCRIPTION: 1) Soil Name (USCS) 2) Color 3) Moisture 4) Grain Size 5) Percentage 6) Plasticity 7) Density/Consistency 8) Other (Mineral Content, Discoloration, Odor, etc.)

DEPTH (ft-bgs)	ELEVATION (ft)	DESCRIPTION	STRATUM	GRAPHIC LOG	SAMPLE TYPE	BLOWS PER 6"	RECOVERY (in)	PERCENT FINES (%)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTICITY INDEX
		(10') CLAY; light olive brown (2.5Y 5/4) to light yellowish brown (2.5Y 6/4), trace iron staining and chert fragments; occasional calcite mineralization/lamination; firm to very hard; very stiff (PP > 4 tsf); moist to dry *(cont.)*	Stratum III		Shelby Tube		9	80	19.6	48	27
	645				SPT	22 22 34 32	24				
		(34') Dry, friable zone									
35	640										
40	635				SPT	25 22 25 33	23				
45	630										
50					SPT	9 12 18 22	24				
	625	(51') Fracture with light gray clay and coarse sand infill; some iron staining									
55	620										
60											

CONTRACTOR: Texplor of Dallas, Inc. **NORTHING:** 13811767.5
EQUIPMENT: CME 75 Truck Mounted **EASTING:** 2279327.5
DRILL MTHD: HSA / Coring
SAMPLING MTHD: SPT, Shelby Tube, Core
DRILL BIT SIZE/TYPE: HSA 6" - NQ2

LOGGER: L. Varner **REVIEWER:** W. Burke
NOTES:

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GS FORM: 03-GEOTECH3 BF

BOREHOLE LOG

BORING: GB-41 | **SHEET** 3 **OF** 3
START DATE: 1/10/2023
FINISH DATE: 1/11/2023 | **GROUND SURFACE:** 676.8 ft MSL
LOCATION: New Braunfels | **TOTAL DEPTH:** 77 ft bgs
PROJECT: Mesquite Creek Landfill | **DEPTH TO WATER:** Not Observed
PROJECT NUMBER: GW8636 | **BORING BACKFILL:** Bentonite Grout

DESCRIPTION: 1) Soil Name (USCS) 2) Color 3) Moisture 4) Grain Size 5) Percentage 6) Plasticity 7) Density/Consistency 8) Other (Mineral Content, Discoloration, Odor, etc.)

DEPTH (ft-bgs)	ELEVATION (ft)	DESCRIPTION	STRATUM	GRAPHIC LOG	SAMPLE TYPE	BLOWS PER 6"	RECOVERY (in)	PERCENT FINES (%)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTICITY INDEX
	615	(10') CLAY; light olive brown (2.5Y 5/4) to light yellowish brown (2.5Y 6/4), trace iron staining and chert fragments; occasional calcite mineralization/lamination; firm to very hard; very stiff (PP > 4 tsf); moist to dry *(cont.)*	Stratum III								
		(62') CLAY to CLAYSTONE; greenish black (GLEY1 2.5/10Y); very hard; moist to dry	Stratum IV		SPT	11 20 20 22	24				
65					Shelby Tube		24				
	610										
70	605										
75					SPT	14 18 23 20	24				
	600	(77') Boring terminated.									
80	595										
85	590										
90											

CONTRACTOR: Texplor of Dallas, Inc. | **NORTHING:** 13811767.5
EQUIPMENT: CME 75 Truck Mounted | **EASTING:** 2279327.5
DRILL MTHD: HSA / Coring
SAMPLING MTHD: SPT, Shelby Tube, Core
DRILL BIT SIZE/TYPE: HSA 6" - NQ2

LOGGER: L. Varner | **REVIEWER:** W. Burke
NOTES:

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GS FORM: 03-GEOTECH3 BF	**BOREHOLE LOG**	

START DATE: 1/23/2023	
FINISH DATE: 1/24/2023	**GROUND SURFACE:** 663.2 ft MSL
LOCATION: New Braunfels	**TOTAL DEPTH:** 88 ft bgs
PROJECT: Mesquite Creek Landfill	**DEPTH TO WATER:** Not Observed
PROJECT NUMBER: GW8636	**BORING BACKFILL:** Bentonite Grout

DESCRIPTION: 1) Soil Name (USCS) 2) Color 3) Moisture 4) Grain Size 5) Percentage 6) Plasticity 7) Density/Consistency 8) Other (Mineral Content, Discoloration, Odor, etc.)

DEPTH (ft-bgs)	ELEVATION (ft)	DESCRIPTION	STRATUM	GRAPHIC LOG	SAMPLE: TYPE	SAMPLE: BLOWS PER 6"	SAMPLE: RECOVERY (in)	LAB RESULTS: PERCENT FINES (%)	LAB RESULTS: MOISTURE CONTENT (%)	LAB RESULTS: LIQUID LIMIT	LAB RESULTS: PLASTICITY INDEX
		(0') CLAY; black (2.5Y 2.5/1); organic; fine to coarse sand; soft to very stiff (PP > 1.5 tsf); moist; medium plastic	Stratum I				9				
						4 7 16 20	21				
	660	(3') Calcareous GRAVEL intermixed with dry clay and silt; chert fragments, dry	Stratum II								
5											
						9 17 9 11					
	655										
10		(10') CLAY; pale brown (2.5Y 7/4) to olive brown (2.5Y 4/4); trace silt; orange mottling; occasional calcite mineralization/deposition; hard; very stiff (PP > 4.5 tsf); trace moist	Stratum III				18				
	650										
15											
	645	(18') Soft and moist light pale olive clay inclusion				3 5 7 10	24				
20											
	640										
25											
							21				
	635	(28') Iron staining and occasional iron nodules from 28 to 50 ft bgs; calcite veins				6 9 11 15	24				
30											

CONTRACTOR: Texplor of Dallas, Inc.	**NORTHING:** 13811416.4
EQUIPMENT: CME 75 Truck Mounted	**EASTING:** 2279712.4
DRILL MTHD: HSA / Coring	
SAMPLING MTHD: SPT, Shelby Tube, Core	
DRILL BIT SIZE/TYPE: HSA 6" - NQ2	

LOGGER: P. Pandey **REVIEWER:** W. Burke

NOTES:

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GS FORM: 03-GEOTECH3 BF

BOREHOLE LOG

BORING: GB-42
START DATE: 1/23/2023
FINISH DATE: 1/24/2023
GROUND SURFACE: 663.2 ft MSL
LOCATION: New Braunfels
TOTAL DEPTH: 88 ft bgs
PROJECT: Mesquite Creek Landfill
DEPTH TO WATER: Not Observed
PROJECT NUMBER: GW8636
BORING BACKFILL: Bentonite Grout

DESCRIPTION
1) Soil Name (USCS)
2) Color
3) Moisture
4) Grain Size
5) Percentage
6) Plasticity
7) Density/Consistency
8) Other (Mineral Content, Discoloration, Odor, etc.)

DEPTH (ft-bgs)	ELEVATION (ft)	DESCRIPTION	STRATUM	GRAPHIC LOG	SAMPLE TYPE	BLOWS PER 6"	RECOVERY (in)	PERCENT FINES (%)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTICITY INDEX
		(10') CLAY; pale brown (2.5Y 7/4) to olive brown (2.5Y 4/4); trace silt; orange mottling; occasional calcite mineralization/deposition; hard; very stiff (PP > 4.5 tsf); trace moist *(cont.)*	Stratum III								
	630										
35											
		(37') Significant calcite mineralization from 37 to 38 ft bgs; iron staining			SPT	8, 12, 16, 19	24				
	625										
40											
	620										
45											
					Shelby Tube		24				
	615				SPT	11, 13, 18, 24	24				
50		(50') Grades to dark gray from 50 to 60 ft bgs									
	610										
55					Shelby Tube		23				
	605				SPT	13, 16, 24, 29	24				
		(59') Calcite mineralization along 45-degree plane									
60											

CONTRACTOR: Texplor of Dallas, Inc.
NORTHING: 13811416.4
EQUIPMENT: CME 75 Truck Mounted
EASTING: 2279712.4
DRILL MTHD: HSA / Coring
SAMPLING MTHD: SPT, Shelby Tube, Core
DRILL BIT SIZE/TYPE: HSA 6" - NQ2

LOGGER: P. Pandey
REVIEWER: W. Burke
NOTES:

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GS FORM: 03-GEOTECH3 BF

BOREHOLE LOG

BORING: GB-42 **SHEET** 3 **OF** 3
START DATE: 1/23/2023
FINISH DATE: 1/24/2023
LOCATION: New Braunfels
PROJECT: Mesquite Creek Landfill
PROJECT NUMBER: GW8636
GROUND SURFACE: 663.2 ft MSL
TOTAL DEPTH: 88 ft bgs
DEPTH TO WATER: Not Observed
BORING BACKFILL: Bentonite Grout

DESCRIPTION: 1) Soil Name (USCS) 2) Color 3) Moisture 4) Grain Size 5) Percentage 6) Plasticity 7) Density/Consistency 8) Other (Mineral Content, Discoloration, Odor, etc.)

DEPTH (ft-bgs)	ELEVATION (ft)	DESCRIPTION	STRATUM	GRAPHIC LOG	SAMPLE TYPE	BLOWS PER 6"	RECOVERY (in)	PERCENT FINES (%)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTICITY INDEX
60		(60') CLAYSTONE; very dark greenish gray (GLEY1 3/10Y); moderate fractures with iron staining at some locations; very hard; moist to dry	Stratum IV								
	600										
64		(64') Weathered with iron staining									
65		(65') Yellow discoloration along 45-degree fracture plane					120				
	595										
70											
	590										
75							120				
	585										
80											
	580										
							87				
85											
88	575	(88') Boring terminated.									
90											

CONTRACTOR: Texplor of Dallas, Inc.
EQUIPMENT: CME 75 Truck Mounted
DRILL MTHD: HSA / Coring
SAMPLING MTHD: SPT, Shelby Tube, Core
DRILL BIT SIZE/TYPE: HSA 6" - NQ2
NORTHING: 13811416.4
EASTING: 2279712.4
LOGGER: P. Pandey
REVIEWER: W. Burke
NOTES:

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GS FORM: 03-GEOTECH3 BF

BOREHOLE LOG

BORING: GB-43
START DATE: 1/19/2023
FINISH DATE: 1/20/2023
LOCATION: New Braunfels
PROJECT: Mesquite Creek Landfill
PROJECT NUMBER: GW8636
GROUND SURFACE: 709.3 ft MSL
TOTAL DEPTH: 109 ft bgs
DEPTH TO WATER: Not Observed
BORING BACKFILL: Bentonite Grout

DESCRIPTION: 1) Soil Name (USCS) 2) Color 3) Moisture 4) Grain Size 5) Percentage 6) Plasticity 7) Density/Consistency 8) Other (Mineral Content, Discoloration, Odor, etc.)

DEPTH (ft-bgs)	ELEVATION (ft)	DESCRIPTION	STRATUM	BLOWS PER 6"	RECOVERY (in)	PERCENT FINES (%)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTICITY INDEX
0		(0') CLAY; black (2.5Y 2.5/1); organic; fine to coarse sand; moist; medium plastic	Stratum I	2, 2, 5, 18	18				
		(1.75') Sandy/Clayey calcareous GRAVEL and CALICHE with some chert fragments; hard; dry	Stratum II	22, 17, 11, 15	20				
5	705								
					24				
		(8') Significant white caliche mixed with clay;							
10	700	(9') CLAY; light yellowish brown (2.5Y 6/4); trace silt and iron nodules; gray mottling; occasional iron staining and mineralization; hard; very stiff (PP > 4.5 tsf); trace moist	Stratum III		24				
15	695								
				8, 8, 9, 12	24				
					24				
20	690								
25	685								
30	680			12, 20, 24, 33	24				

CONTRACTOR: Texplor of Dallas, Inc. **NORTHING:** 13812460.1
EQUIPMENT: CME 75 Truck Mounted **EASTING:** 2277639.1
DRILL MTHD: HSA / Coring
SAMPLING MTHD: SPT, Shelby Tube, Core
DRILL BIT SIZE/TYPE: HSA 6" - NQ2

LOGGER: J. Geesin; P. Pandey **REVIEWER:** W. Burke
NOTES:

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DEPTH (ft-bgs)	ELEVATION (ft)	DESCRIPTION 1) Soil Name (USCS) 2) Color 3) Moisture 4) Grain Size 5) Percentage 6) Plasticity 7) Density/Consistency 8) Other (Mineral Content, Discoloration, Odor, etc.)	STRATUM	GRAPHIC LOG	SAMPLE TYPE	BLOWS PER 6"	RECOVERY (in)	PERCENT FINES (%)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTICITY INDEX
		(9') CLAY; light yellowish brown (2.5Y 6/4); trace silt and iron nodules; gray mottling; occasional iron staining and mineralization; hard; very stiff (PP > 4.5 tsf); trace moist *(cont.)*	Stratum III								
	675										
35											
					SPT	11 18 22 27	24				
	670										
40											
	665										
45											
					Shelby Tube		24				
	660										
50		(50') Selenite crystal deposition			SPT	17 19 26 34	24				
	655										
55											
		(57') CLAYSTONE; very dark gray (2.5Y 3/1); minor fracturing with yellowish brown discoloration at some locations; very hard; moist to dry	Stratum IV		Core		24				
	650										
60											

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GS FORM: 03-GEOTECH3 BF

BOREHOLE LOG

BORING: GB-43

START DATE: 1/19/2023
FINISH DATE: 1/20/2023
LOCATION: New Braunfels
PROJECT: Mesquite Creek Landfill
PROJECT NUMBER: GW8636
GROUND SURFACE: 709.3 ft MSL
TOTAL DEPTH: 109 ft bgs
DEPTH TO WATER: Not Observed
BORING BACKFILL: Bentonite Grout

DESCRIPTION: 1) Soil Name (USCS) 2) Color 3) Moisture 4) Grain Size 5) Percentage 6) Plasticity 7) Density/Consistency 8) Other (Mineral Content, Discoloration, Odor, etc.)

DEPTH (ft-bgs)	ELEVATION (ft)	DESCRIPTION	STRATUM	GRAPHIC LOG	SAMPLE: TYPE	SAMPLE: BLOWS PER 6"	SAMPLE: RECOVERY (in)	LAB RESULTS: PERCENT FINES (%)	LAB RESULTS: MOISTURE CONTENT (%)	LAB RESULTS: LIQUID LIMIT	LAB RESULTS: PLASTICITY INDEX
		(57') CLAYSTONE; very dark gray (2.5Y 3/1); minor fracturing with yellowish brown discoloration at some locations; very hard; moist to dry *(cont.)*	Stratum IV								
		(63.2') Yellowish brown discoloration with selenite crystallization									
	645										
65							120				
	640										
70											
	635										
75							120				
		(76.2') Weathered and yellowish brown discoloration/ iron staining									
	630										
80											
	625										
85							120				
	620										
90											

CONTRACTOR: Texplor of Dallas, Inc.
EQUIPMENT: CME 75 Truck Mounted
DRILL MTHD: HSA / Coring
SAMPLING MTHD: SPT, Shelby Tube, Core
DRILL BIT SIZE/TYPE: HSA 6" - NQ2
NORTHING: 13812460.1
EASTING: 2277639.1
LOGGER: J. Geesin; P. Pandey
REVIEWER: W. Burke
NOTES:

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GS FORM: 03-GEOTECH3 BF

BOREHOLE LOG

BORING: GB-43
START DATE: 1/19/2023
FINISH DATE: 1/20/2023
LOCATION: New Braunfels
PROJECT: Mesquite Creek Landfill
PROJECT NUMBER: GW8636
GROUND SURFACE: 709.3 ft MSL
TOTAL DEPTH: 109 ft bgs
DEPTH TO WATER: Not Observed
BORING BACKFILL: Bentonite Grout

DESCRIPTION: 1) Soil Name (USCS) 2) Color 3) Moisture 4) Grain Size 5) Percentage 6) Plasticity 7) Density/Consistency 8) Other (Mineral Content, Discoloration, Odor, etc.)

DEPTH (ft-bgs)	ELEVATION (ft)	DESCRIPTION	STRATUM	GRAPHIC LOG	SAMPLE TYPE	BLOWS PER 6"	RECOVERY (in)	PERCENT FINES (%)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTICITY INDEX
		(57') CLAYSTONE; very dark gray (2.5Y 3/1); minor fracturing with yellowish brown discoloration at some locations; very hard; moist to dry *(cont.)*	Stratum IV								
	615										
95							118				
	610										
100											
	605						90				
105											
	600	(109') Boring terminated.									
110											
	595										
115											
	590										
120											

CONTRACTOR: Texplor of Dallas, Inc.
EQUIPMENT: CME 75 Truck Mounted
DRILL MTHD: HSA / Coring
SAMPLING MTHD: SPT, Shelby Tube, Core
DRILL BIT SIZE/TYPE: HSA 6" - NQ2
NORTHING: 13812460.1
EASTING: 2277639.1
LOGGER: J. Geesin; P. Pandey
REVIEWER: W. Burke
NOTES:

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GS FORM: 03-GEOTECH3 BF

BOREHOLE LOG

BORING: GB-44 —
START DATE: 1/4/2023
FINISH DATE: 1/4/2023 — **GROUND SURFACE:** 711.7 ft MSL
LOCATION: New Braunfels — **TOTAL DEPTH:** 137 ft bgs
PROJECT: Mesquite Creek Landfill — **DEPTH TO WATER:** Not Observed
PROJECT NUMBER: GW8636 — **BORING BACKFILL:** Bentonite Grout

DESCRIPTION
1) Soil Name (USCS)
2) Color
3) Moisture
4) Grain Size
5) Percentage
6) Plasticity
7) Density/Consistency
8) Other (Mineral Content, Discoloration, Odor, etc.)

DEPTH (ft-bgs)	ELEVATION (ft)	DESCRIPTION	STRATUM
0	711.7	(0') Sandy/Clayey calcareous GRAVEL and CALICHE with some chert fragments; some organic black clay; medium dense; hard; moist to dry	Stratum II
2		(2') White dry caliche from 2 to 9 ft bgs intermixed with clay	Stratum II
10.5		(10.5') CLAY; olive brown (2.5Y 4/3) to olive yellow (2.5Y 6/6), olive (5Y 5/3); trace silt and chert fragments; minor fracture planes with calcite mineralization/infilling and iron staining; soft to very stiff (PP > 1.5 tsf); moist	Stratum III
29		(29') Heavy iron staining	Stratum III

SAMPLE DEPTH (ft)	TYPE	BLOWS PER 6"	RECOVERY (in)	PERCENT FINES (%)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTICITY INDEX
0–2	SPT	1, 6, 11, 27	5				
2–4	SPT	7, 6, 7, 6	19				
5–7	Shelby Tube		10				
7–9	SPT	9, 7, 10, 9	18				
10–12	Shelby Tube		18				
12–14	SPT	4, 5, 7, 10	19				
17–19	SPT	4, 6, 9, 11	22				
19–21	Shelby Tube		20				
22–24	SPT	5, 8, 11, 13	23				
27–29	SPT	6, 11, 14, 14	24				
29–30	Shelby Tube		24				

CONTRACTOR: Texplor of Dallas, Inc. — **NORTHING:** 13812069.0
EQUIPMENT: CME 75 Truck Mounted — **EASTING:** 2278025.9
DRILL MTHD: HSA / Coring
SAMPLING MTHD: SPT, Shelby Tube, Core
DRILL BIT SIZE/TYPE: HSA 6" - NQ2

LOGGER: L. Varner; G. Kumar — **REVIEWER:** W. Burke
NOTES:

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GS FORM: 03-GEOTECH3 BF

BOREHOLE LOG

BORING: GB-44 — **SHEET** 2 **OF** 5
START DATE: 1/4/2023
FINISH DATE: 1/4/2023 — **GROUND SURFACE:** 711.7 ft MSL
LOCATION: New Braunfels — **TOTAL DEPTH:** 137 ft bgs
PROJECT: Mesquite Creek Landfill — **DEPTH TO WATER:** Not Observed
PROJECT NUMBER: GW8636 — **BORING BACKFILL:** Bentonite Grout

DESCRIPTION: 1) Soil Name (USCS) 2) Color 3) Moisture 4) Grain Size 5) Percentage 6) Plasticity 7) Density/Consistency 8) Other (Mineral Content, Discoloration, Odor, etc.)

DEPTH (ft-bgs)	ELEVATION (ft)	DESCRIPTION	STRATUM	GRAPHIC LOG	SAMPLE TYPE	BLOWS PER 6"	RECOVERY (in)	PERCENT FINES (%)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTICITY INDEX
		(10.5') CLAY; olive brown (2.5Y 4/3) to olive yellow (2.5Y 6/6), olive (5Y 5/3); trace silt and chert fragments; minor fracture planes with calcite mineralization/infilling and iron staining; soft to very stiff (PP > 1.5 tsf); moist *(cont.)*	Stratum III		Shelby Tube		24				
	680										
35											
	675										
40		(40.5') 45-degree fracture with calcite infilling			SPT	7, 10, 13, 17	24				
	670										
45											
	665										
50					SPT	15, 21, 25, 50	21				
	660										
55											
	655										
60											

CONTRACTOR: Texplor of Dallas, Inc. — **NORTHING:** 13812069.0
EQUIPMENT: CME 75 Truck Mounted — **EASTING:** 2278025.9
DRILL MTHD: HSA / Coring
SAMPLING MTHD: SPT, Shelby Tube, Core
DRILL BIT SIZE/TYPE: HSA 6" - NQ2

LOGGER: L. Varner; G. Kumar — **REVIEWER:** W. Burke
NOTES:

SEE KEY SHEET FOR SYMBOLS AND ABBREVIATIONS

DESCRIPTION: 1) Soil Name (USCS) 2) Color 3) Moisture 4) Grain Size 5) Percentage 6) Plasticity 7) Density/Consistency 8) Other (Mineral Content, Discoloration, Odor, etc.)

DEPTH (ft-bgs)	ELEVATION (ft)	DESCRIPTION	STRATUM	GRAPHIC LOG	SAMPLE TYPE	BLOWS PER 6"	RECOVERY (in)	PERCENT FINES (%)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTICITY INDEX
	650	(10.5') CLAY; olive brown (2.5Y 4/3) to olive yellow (2.5Y 6/6), olive (5Y 5/3); trace silt and chert fragments; minor fracture planes with calcite mineralization/infilling and iron staining; soft to very stiff (PP > 1.5 tsf); moist *(cont.)* (60') Color grades to dark greenish gray (61.75') Heavy iron staining	Stratum III			15 22 28 34	24				
		(62') CLAYSTONE; dark greenish gray (GLEY1 4/10Y); trace chert fragments inclusion; minor fracture with calcite infilling in some locations; dry	Stratum IV				36				
65	645										
70	640						120				
75	635										
80	630						118				
85	625						120				
90											

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GS FORM: 03-GEOTECH3 BF

BOREHOLE LOG

BORING: GB-44
START DATE: 1/4/2023
FINISH DATE: 1/4/2023
GROUND SURFACE: 711.7 ft MSL
LOCATION: New Braunfels
TOTAL DEPTH: 137 ft bgs
PROJECT: Mesquite Creek Landfill
DEPTH TO WATER: Not Observed
PROJECT NUMBER: GW8636
BORING BACKFILL: Bentonite Grout

DEPTH (ft-bgs)	ELEVATION (ft)	DESCRIPTION 1) Soil Name (USCS) 2) Color 3) Moisture 4) Grain Size 5) Percentage 6) Plasticity 7) Density/Consistency 8) Other (Mineral Content, Discoloration, Odor, etc.)	STRATUM	GRAPHIC LOG	SAMPLE: TYPE	SAMPLE: BLOWS PER 6"	SAMPLE: RECOVERY (in)	LAB RESULTS: PERCENT FINES (%)	LAB RESULTS: MOISTURE CONTENT (%)	LAB RESULTS: LIQUID LIMIT	LAB RESULTS: PLASTICITY INDEX
		(62') CLAYSTONE; dark greenish gray (GLEY1 4/10Y); trace chert fragments inclusion; minor fracture with calcite infilling in some locations; dry *(cont.)*	Stratum IV								
	620										
							120				
95											
	615										
100							120				
	610										
105											
	605										
110							120				
	600										
115											
	595										
							120				
120											

CONTRACTOR: Texplor of Dallas, Inc.
NORTHING: 13812069.0
EQUIPMENT: CME 75 Truck Mounted
EASTING: 2278025.9
DRILL MTHD: HSA / Coring
SAMPLING MTHD: SPT, Shelby Tube, Core
DRILL BIT SIZE/TYPE: HSA 6" - NQ2

LOGGER: L. Varner; G. Kumar
REVIEWER: W. Burke
NOTES:

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GS FORM: 03-GEOTECH3 BF

BOREHOLE LOG

BORING: GB-44
SHEET 5 **OF** 5
START DATE: 1/4/2023
FINISH DATE: 1/4/2023
GROUND SURFACE: 711.7 ft MSL
LOCATION: New Braunfels
TOTAL DEPTH: 137 ft bgs
PROJECT: Mesquite Creek Landfill
DEPTH TO WATER: Not Observed
PROJECT NUMBER: GW8636
BORING BACKFILL: Bentonite Grout

DESCRIPTION: 1) Soil Name (USCS) 2) Color 3) Moisture 4) Grain Size 5) Percentage 6) Plasticity 7) Density/Consistency 8) Other (Mineral Content, Discoloration, Odor, etc.)

DEPTH (ft-bgs)	ELEVATION (ft)	DESCRIPTION	STRATUM	GRAPHIC LOG	SAMPLE: TYPE	SAMPLE: BLOWS PER 6"	SAMPLE: RECOVERY (in)	LAB RESULTS: PERCENT FINES (%)	LAB RESULTS: MOISTURE CONTENT (%)	LAB RESULTS: LIQUID LIMIT	LAB RESULTS: PLASTICITY INDEX
	590	(62') CLAYSTONE; dark greenish gray (GLEY1 4/10Y); trace chert fragments inclusion; minor fracture with calcite infilling in some locations; dry *(cont.)*	Stratum IV				120				
125	585						60				
130	580						79				
135	575										
		(137') Boring terminated.									
140	570										
145	565										
150											

CONTRACTOR: Texplor of Dallas, Inc.
NORTHING: 13812069.0
EQUIPMENT: CME 75 Truck Mounted
EASTING: 2278025.9
DRILL MTHD: HSA / Coring
SAMPLING MTHD: SPT, Shelby Tube, Core
DRILL BIT SIZE/TYPE: HSA 6" - NQ2

LOGGER: L. Varner; G. Kumar
REVIEWER: W. Burke
NOTES:

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8217 Shoal Creek Blvd
Suite 200
Austin, TX 78757
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GS FORM: 03-GEOTECH3 BF

BOREHOLE LOG

BORING: GB-45
START DATE: 1/3/2023
FINISH DATE: 1/3/2023
LOCATION: New Braunfels
PROJECT: Mesquite Creek Landfill
PROJECT NUMBER: GW8636
GROUND SURFACE: 711.5 ft MSL
TOTAL DEPTH: 112 ft bgs
DEPTH TO WATER: Not Observed
BORING BACKFILL: Bentonite Grout

DESCRIPTION
1) Soil Name (USCS) 2) Color 3) Moisture 4) Grain Size 5) Percentage 6) Plasticity 7) Density/Consistency 8) Other (Mineral Content, Discoloration, Odor, etc.)

DEPTH (ft-bgs)	ELEVATION (ft)	DESCRIPTION	STRATUM
0	711.5	(0') CLAY to Silty CLAY; black (10YR 2/1); organic; trace coarse to fine gravel and chert nodules; soft (PP = 1 tsf); moist	SI
1	710	(1') Sandy/Clayey calcareous GRAVEL and CALICHE with some chert fragments; medium dense; hard; dry	Stratum II
3.5		(3.5') Dry caliche intermixed with clay and gravel from 3.5 to 10.25 ft bgs	Stratum II
10.25		(10.25') CLAY; olive yellow (2.5Y 6/8) to light olive brown (2.5Y 5/4); with trace gravel and calcite veins at some locations; some iron mottling; very stiff (PP > 4.5 tsf); trace moist to dry	Stratum III

Depth scale: 5, 10, 15, 20, 25, 30 ft-bgs; Elevation scale: 710, 705, 700, 695, 690, 685 ft.

Sample depth (ft, approx.)	BLOWS PER 6"	RECOVERY (in)	PERCENT FINES (%)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTICITY INDEX
0–2	2, 3, 5, 13	16				
3–5	8, 8, 8, 8	18				
5–7	8, 9, 9, 9	22				
7–9		12.5	88.9	21	37	17
10–12	5, 7, 9, 10	19				
12–14		13.25				
15–17	4, 6, 9, 15	24				
18–20		16				
20–22	7, 12, 15, 18	23				
25–27	5, 10, 13, 18	24				
28–30		20				

CONTRACTOR: Texplor of Dallas, Inc.
EQUIPMENT: CME 75 Truck Mounted
DRILL MTHD: HSA / Coring
SAMPLING MTHD: SPT, Shelby Tube, Core
DRILL BIT SIZE/TYPE: HSA 6" - NQ2
NORTHING: 13811716.4
EASTING: 2278424.5
LOGGER: L. Varner; G. Kumar
REVIEWER: W. Burke
NOTES: SI - Stratum I

SEE KEY SHEET FOR SYMBOLS AND ABBREVIATIONS

BOREHOLE LOG

START DATE: 1/3/2023
FINISH DATE: 1/3/2023
LOCATION: New Braunfels
PROJECT: Mesquite Creek Landfill
PROJECT NUMBER: GW8636
GROUND SURFACE: 711.5 ft MSL
TOTAL DEPTH: 112 ft bgs
DEPTH TO WATER: Not Observed
BORING BACKFILL: Bentonite Grout

DESCRIPTION: 1) Soil Name (USCS) 2) Color 3) Moisture 4) Grain Size 5) Percentage 6) Plasticity 7) Density/Consistency 8) Other (Mineral Content, Discoloration, Odor, etc.)

DEPTH (ft-bgs)	ELEVATION (ft)	DESCRIPTION	STRATUM	GRAPHIC LOG	SAMPLE TYPE	BLOWS PER 6"	RECOVERY (in)	PERCENT FINES (%)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTICITY INDEX
		(10.25') CLAY; olive yellow (2.5Y 6/8) to light olive brown (2.5Y 5/4); with trace gravel and calcite veins at some locations; some iron mottling; very stiff (PP > 4.5 tsf); trace moist to dry *(cont.)*	Stratum III			7, 13, 15, 20	23				
	680										
35	675										
40		(40') Calcite veins from 40 to 42 ft bgs				6, 11, 15, 20	24				
	670										
45	665						22				
50		(50') Some cemented lenses from 50 to 52 ft bgs				30, 26, 50	23				
	660										
55	655										
60											

CONTRACTOR: Texplor of Dallas, Inc. **NORTHING:** 13811716.4
EQUIPMENT: CME 75 Truck Mounted **EASTING:** 2278424.5
DRILL MTHD: HSA / Coring
SAMPLING MTHD: SPT, Shelby Tube, Core
DRILL BIT SIZE/TYPE: HSA 6" - NQ2

LOGGER: L. Varner; G. Kumar **REVIEWER:** W. Burke
NOTES: SI - Stratum I

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Suite 200
Austin, TX 78757
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GS FORM: 03-GEOTECH3 BF

BOREHOLE LOG

BORING: GB-45 **SHEET** 3 **OF** 4
START DATE: 1/3/2023
FINISH DATE: 1/3/2023 **GROUND SURFACE:** 711.5 ft MSL
LOCATION: New Braunfels **TOTAL DEPTH:** 112 ft bgs
PROJECT: Mesquite Creek Landfill **DEPTH TO WATER:** Not Observed
PROJECT NUMBER: GW8636 **BORING BACKFILL:** Bentonite Grout

DESCRIPTION: 1) Soil Name (USCS) 2) Color 3) Moisture 4) Grain Size 5) Percentage 6) Plasticity 7) Density/Consistency 8) Other (Mineral Content, Discoloration, Odor, etc.)

DEPTH (ft-bgs)	ELEVATION (ft)	DESCRIPTION	STRATUM	GRAPHIC LOG	SAMPLE: TYPE	SAMPLE: BLOWS PER 6"	SAMPLE: RECOVERY (in)	LAB RESULTS: PERCENT FINES (%)	LAB RESULTS: MOISTURE CONTENT (%)	LAB RESULTS: LIQUID LIMIT	LAB RESULTS: PLASTICITY INDEX
	650	(10.25') CLAY; olive yellow (2.5Y 6/8) to light olive brown (2.5Y 5/4); with trace gravel and calcite veins at some locations; some iron mottling; very stiff (PP > 4.5 tsf); trace moist to dry *(cont.)* (61') Calcite vein at 45-degree	Stratum III			8 22 28 45	24				
		(62') CLAYSTONE; dark gray (2.5Y 4/1); pale olive yellow color mottling/discoloration at some locations; fractures with calcite/gray clay infilling; very hard; trace moist (63.5') Multiple fractures from 63.5 to 67.5 ft bgs with olive yellow discoloration and/or calcite based mineralization	Stratum IV				36				
65	645										
70	640						119.5	87.3	2.9	61	41
75	635										
80	630						118				
		(83.25') Iron staining from 83.25 to 89 ft bgs									
85	625										
90											

CONTRACTOR: Texplor of Dallas, Inc. **NORTHING:** 13811716.4
EQUIPMENT: CME 75 Truck Mounted **EASTING:** 2278424.5
DRILL MTHD: HSA / Coring
SAMPLING MTHD: SPT, Shelby Tube, Core
DRILL BIT SIZE/TYPE: HSA 6" - NQ2

LOGGER: L. Varner; G. Kumar **REVIEWER:** W. Burke
NOTES: SI - Stratum I

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GS FORM: 03-GEOTECH3 BF

BOREHOLE LOG

BORING: GB-45
START DATE: 1/3/2023
FINISH DATE: 1/3/2023
LOCATION: New Braunfels
PROJECT: Mesquite Creek Landfill
PROJECT NUMBER: GW8636
GROUND SURFACE: 711.5 ft MSL
TOTAL DEPTH: 112 ft bgs
DEPTH TO WATER: Not Observed
BORING BACKFILL: Bentonite Grout

DESCRIPTION: 1) Soil Name (USCS) 2) Color 3) Moisture 4) Grain Size 5) Percentage 6) Plasticity 7) Density/Consistency 8) Other (Mineral Content, Discoloration, Odor, etc.)

DEPTH (ft-bgs)	ELEVATION (ft)	DESCRIPTION	STRATUM	GRAPHIC LOG	SAMPLE TYPE	BLOWS PER 6"	RECOVERY (in)	PERCENT FINES (%)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTICITY INDEX
		(62') CLAYSTONE; dark gray (2.5Y 4/1); pale olive yellow color mottling/discoloration at some locations; fractures with calcite/gray clay infilling; very hard; trace moist *(cont.)*	Stratum IV								
	620										
95											
	615						54				
100											
	610										
105							109				
	605										
110											
	600										
		(112') Boring terminated.									
115											
	595										
120											

CONTRACTOR: Texplor of Dallas, Inc.
EQUIPMENT: CME 75 Truck Mounted
DRILL MTHD: HSA / Coring
SAMPLING MTHD: SPT, Shelby Tube, Core
DRILL BIT SIZE/TYPE: HSA 6" - NQ2
NORTHING: 13811716.4
EASTING: 2278424.5
LOGGER: L. Varner; G. Kumar
REVIEWER: W. Burke
NOTES: SI - Stratum I

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October 2023

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GS FORM: 03-GEOTECH3 BF

BOREHOLE LOG

BORING: GB-46 **SHEET** 1 **OF** 4
START DATE: 1/18/2023
FINISH DATE: 1/19/2023 **GROUND SURFACE:** 685.2 ft MSL
LOCATION: New Braunfels **TOTAL DEPTH:** 110 ft bgs
PROJECT: Mesquite Creek Landfill **DEPTH TO WATER:** Not Observed
PROJECT NUMBER: GW8636 **BORING BACKFILL:** Bentonite Grout

DESCRIPTION: 1) Soil Name (USCS) 2) Color 3) Moisture 4) Grain Size 5) Percentage 6) Plasticity 7) Density/Consistency 8) Other (Mineral Content, Discoloration, Odor, etc.)

DEPTH (ft-bgs)	ELEVATION (ft)	DESCRIPTION	STRATUM	GRAPHIC LOG	SAMPLE TYPE	BLOWS PER 6"	RECOVERY (in)	PERCENT FINES (%)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTICITY INDEX
0	685	(0') CLAY; very dark gray (5Y 3/1); organics; some gravel; few medium to fine sand; stiff; moist; medium plastic	Stratum I				24				
2		(2') CLAY; light olive brown (2.5Y 5/4) to light yellowish brown (2.5Y 6/4); occasional iron staining and nodules; trace sand; some crystalline mineralization/lamination (selenite); hard; very stiff; moist	Stratum III			10 15 21 26	24				
5	680										
6							24				
8						7 11 16 20	24				
10	675										
15	670										
20	665	(20') Sand lenses				5 10 15 21	24				
25	660										
30											

CONTRACTOR: Texplor of Dallas, Inc. **NORTHING:** 13811287.2
EQUIPMENT: CME 75 Truck Mounted **EASTING:** 2278799.4
DRILL MTHD: HSA / Coring
SAMPLING MTHD: SPT, Shelby Tube, Core
DRILL BIT SIZE/TYPE: HSA 6" - NQ2

LOGGER: J. Geesin **REVIEWER:** W. Burke
NOTES:

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Suite 200
Austin, TX 78757
Phone: (512) 451-4003
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GS FORM: 03-GEOTECH3 BF

BOREHOLE LOG

BORING: GB-46
START DATE: 1/18/2023
FINISH DATE: 1/19/2023
LOCATION: New Braunfels
PROJECT: Mesquite Creek Landfill
PROJECT NUMBER: GW8636
GROUND SURFACE: 685.2 ft MSL
TOTAL DEPTH: 110 ft bgs
DEPTH TO WATER: Not Observed
BORING BACKFILL: Bentonite Grout

DESCRIPTION: 1) Soil Name (USCS) 2) Color 3) Moisture 4) Grain Size 5) Percentage 6) Plasticity 7) Density/Consistency 8) Other (Mineral Content, Discoloration, Odor, etc.)

DEPTH (ft-bgs)	ELEVATION (ft)	DESCRIPTION	STRATUM	GRAPHIC LOG	SAMPLE TYPE	BLOWS PER 6"	RECOVERY (in)	PERCENT FINES (%)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTICITY INDEX
	655	(2') CLAY; light olive brown (2.5Y 5/4) to light yellowish brown (2.5Y 6/4); occasional iron staining and nodules; trace sand; some crystalline mineralization/lamination (selenite); hard; very stiff; moist *(cont.)*	Stratum III		SPT	7, 13, 17, 25	24				
		(31') Calcareous gravel lenses and crystalline mineralization									
35	650										
					Shelby Tube		24				
40	645	(40') Selenite deposition			SPT	15, 20, 26, 50	24				
		(42') Heavy selenite crystals deposition									
45	640										
50	635	(50') Vertical crystalline lamination from 50 to 51 ft bgs; friable and dry from 51 to 52 ft bgs			SPT	23, 23, 50	12				
55	630										
					Shelby Tube		24				
60											

CONTRACTOR: Texplor of Dallas, Inc.
EQUIPMENT: CME 75 Truck Mounted
DRILL MTHD: HSA / Coring
SAMPLING MTHD: SPT, Shelby Tube, Core
DRILL BIT SIZE/TYPE: HSA 6" - NQ2
NORTHING: 13811287.2
EASTING: 2278799.4
LOGGER: J. Geesin
REVIEWER: W. Burke
NOTES:

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GS FORM: 03-GEOTECH3 BF

BOREHOLE LOG

BORING: GB-46 **SHEET** 3 **OF** 4

START DATE: 1/18/2023
FINISH DATE: 1/19/2023 **GROUND SURFACE:** 685.2 ft MSL
LOCATION: New Braunfels **TOTAL DEPTH:** 110 ft bgs
PROJECT: Mesquite Creek Landfill **DEPTH TO WATER:** Not Observed
PROJECT NUMBER: GW8636 **BORING BACKFILL:** Bentonite Grout

DESCRIPTION: 1) Soil Name (USCS) 2) Color 3) Moisture 4) Grain Size 5) Percentage 6) Plasticity 7) Density/Consistency 8) Other (Mineral Content, Discoloration, Odor, etc.)

DEPTH (ft-bgs)	ELEVATION (ft)	DESCRIPTION	STRATUM	BLOWS PER 6"	RECOVERY (in)	PERCENT FINES (%)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTICITY INDEX
	625	(2') CLAY; light olive brown (2.5Y 5/4) to light yellowish brown (2.5Y 6/4); occasional iron staining and nodules; trace sand; some crystalline mineralization/lamination (selenite); hard; very stiff; moist *(cont.)*	Stratum III	17 23 29 50	22				
		(61') Fracture with heavy crystalline mineralization			24				
65	620	(65') CLAYSTONE; dark gray (2.5Y 3/1) with heavy iron staining and yellow discoloration in upper zones; minor fracturing; some weathering; very hard; dry	Stratum IV						
		(69') Heavy iron staining from 69 to 70 ft bgs							
70	615				120				
75	610								
80	605				120				
85	600								
					110				
90									

CONTRACTOR: Texplor of Dallas, Inc. **NORTHING:** 13811287.2
EQUIPMENT: CME 75 Truck Mounted **EASTING:** 2278799.4
DRILL MTHD: HSA / Coring
SAMPLING MTHD: SPT, Shelby Tube, Core
DRILL BIT SIZE/TYPE: HSA 6" - NQ2

LOGGER: J. Geesin **REVIEWER:** W. Burke
NOTES:

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8217 Shoal Creek Blvd
Suite 200
Austin, TX 78757
Phone: (512) 451-4003
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GS FORM: 03-GEOTECH3 BF

BOREHOLE LOG

BORING: GB-46 — **SHEET** 4 **OF** 4
START DATE: 1/18/2023
FINISH DATE: 1/19/2023
LOCATION: New Braunfels
PROJECT: Mesquite Creek Landfill
PROJECT NUMBER: GW8636
GROUND SURFACE: 685.2 ft MSL
TOTAL DEPTH: 110 ft bgs
DEPTH TO WATER: Not Observed
BORING BACKFILL: Bentonite Grout

DESCRIPTION: 1) Soil Name (USCS) 2) Color 3) Moisture 4) Grain Size 5) Percentage 6) Plasticity 7) Density/Consistency 8) Other (Mineral Content, Discoloration, Odor, etc.)

DEPTH (ft-bgs)	ELEVATION (ft)	DESCRIPTION	STRATUM	GRAPHIC LOG	SAMPLE: TYPE	SAMPLE: BLOWS PER 6"	SAMPLE: RECOVERY (in)	LAB: PERCENT FINES (%)	LAB: MOISTURE CONTENT (%)	LAB: LIQUID LIMIT	LAB: PLASTICITY INDEX
	595	(65') CLAYSTONE; dark gray (2.5Y 3/1) with heavy iron staining and yellow discoloration in upper zones; minor fracturing; some weathering; very hard; dry *(cont.)*	Stratum IV				110				
95	590						60				
100	585										
105	580						120				
110	575	(110') Boring terminated.									
115	570										
120											

CONTRACTOR: Texplor of Dallas, Inc.
EQUIPMENT: CME 75 Truck Mounted
DRILL MTHD: HSA / Coring
SAMPLING MTHD: SPT, Shelby Tube, Core
DRILL BIT SIZE/TYPE: HSA 6" - NQ2
NORTHING: 13811287.2
EASTING: 2278799.4
LOGGER: J. Geesin
REVIEWER: W. Burke
NOTES:

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Geosyntec consultants

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Suite 200
Austin, TX 78757
Phone: (512) 451-4003
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GS FORM: 03-GEOTECH3 BF

BOREHOLE LOG

BORING: GB-47
START DATE: 1/10/2023
FINISH DATE: 1/10/2023
LOCATION: New Braunfels
PROJECT: Mesquite Creek Landfill
PROJECT NUMBER: GW8636
GROUND SURFACE: 670.9 ft MSL
TOTAL DEPTH: 71 ft bgs
DEPTH TO WATER: Not Observed
BORING BACKFILL: Bentonite Grout

DESCRIPTION: 1) Soil Name (USCS) 2) Color 3) Moisture 4) Grain Size 5) Percentage 6) Plasticity 7) Density/Consistency 8) Other (Mineral Content, Discoloration, Odor, etc.)

DEPTH (ft-bgs)	ELEVATION (ft)	DESCRIPTION	STRATUM	GRAPHIC LOG	SAMPLE TYPE	BLOWS PER 6"	RECOVERY (in)	PERCENT FINES (%)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTICITY INDEX
0	670	(0') CLAY; greenish black (GLEY1 2.5/10Y); organic; some coarse gravel, fine sand and silt; trace caliche; soft (PP = 1 tsf); moist	Stratum I		SPT	2, 2, 5, 5	16				
					Shelby Tube		16				
5	665										
7		(7') CLAY; light yellowish brown (2.5Y 6/4) to light olive brown (2.5Y 5/3); trace mica and iron nodules; iron staining; some fractures with calcite mineralization/lamination; very hard; very stiff (PP > 4.5 tsf); moist to dry; low to high plasticity	Stratum III		SPT	5, 9, 12, 18	21				
10	660										
					SPT	5, 7, 10, 13	21.5				
15	655										
					Shelby Tube		14				
18		(18') Trace dry caliche lenses			SPT	9, 10, 15, 20	24				
20	650										
25	645										
					Shelby Tube		18				
28		(28') Calcite infilling from 28 to 29.5 ft bgs			SPT	9, 14, 17, 28	24				
30											

CONTRACTOR: Texplor of Dallas, Inc.
NORTHING: 13810896.1
EQUIPMENT: CME 75 Truck Mounted
EASTING: 2279186.2
DRILL MTHD: HSA / Coring
SAMPLING MTHD: SPT, Shelby Tube, Core
DRILL BIT SIZE/TYPE: HSA 6" - NQ2

LOGGER: L. Varner
REVIEWER: W. Burke
NOTES:

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Geosyntec consultants	8217 Shoal Creek Blvd Suite 200 Austin, TX 78757 Phone: (512) 451-4003 www.geosyntec.com	**BORING:** GB-47 **START DATE:** 1/10/2023 **FINISH DATE:** 1/10/2023 **LOCATION:** New Braunfels **PROJECT:** Mesquite Creek Landfill **PROJECT NUMBER:** GW8636	**SHEET** 2 **OF** 3 **GROUND SURFACE:** 670.9 ft MSL **TOTAL DEPTH:** 71 ft bgs **DEPTH TO WATER:** Not Observed **BORING BACKFILL:** Bentonite Grout

GS FORM: 03-GEOTECH3 BF

BOREHOLE LOG

DEPTH (ft-bgs)	ELEVATION (ft)	DESCRIPTION 1) Soil Name (USCS) 2) Color 3) Moisture 4) Grain Size 5) Percentage 6) Plasticity 7) Density/Consistency 8) Other (Mineral Content, Discoloration, Odor, etc.)	STRATUM	GRAPHIC LOG	SAMPLE: TYPE	SAMPLE: BLOWS PER 6"	SAMPLE: RECOVERY (in)	LAB RESULTS: PERCENT FINES (%)	LAB RESULTS: MOISTURE CONTENT (%)	LAB RESULTS: LIQUID LIMIT	LAB RESULTS: PLASTICITY INDEX
	640	(7') CLAY; light yellowish brown (2.5Y 6/4) to light olive brown (2.5Y 5/3); trace mica and iron nodules; iron staining; some fractures with calcite mineralization/lamination; very hard; very stiff (PP > 4.5 tsf); moist to dry; low to high plasticity *(cont.)*	Stratum III								
35	635										
					Core		20.5				
		(38') Some heavy calcite mineralization from 38 to 40 ft bgs			SPT	9 11 16 23	24				
40	630										
45	625										
		(48') Color grades to greenish gray from 48 to 60 ft bgs			Core		24				
50	620				SPT	9 11 14 21	24				
55	615										
					Core		24				
60											

CONTRACTOR: Texplor of Dallas, Inc. **EQUIPMENT:** CME 75 Truck Mounted **DRILL MTHD:** HSA / Coring **SAMPLING MTHD:** SPT, Shelby Tube, Core **DRILL BIT SIZE/TYPE:** HSA 6" - NQ2	**NORTHING:** 13810896.1 **EASTING:** 2279186.2
LOGGER: L. Varner **NOTES:**	**REVIEWER:** W. Burke

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GS FORM: 03-GEOTECH3 BF

BOREHOLE LOG

BORING: GB-47 **SHEET** 3 **OF** 3
START DATE: 1/10/2023
FINISH DATE: 1/10/2023 **GROUND SURFACE:** 670.9 ft MSL
LOCATION: New Braunfels **TOTAL DEPTH:** 71 ft bgs
PROJECT: Mesquite Creek Landfill **DEPTH TO WATER:** Not Observed
PROJECT NUMBER: GW8636 **BORING BACKFILL:** Bentonite Grout

DESCRIPTION: 1) Soil Name (USCS) 2) Color 3) Moisture 4) Grain Size 5) Percentage 6) Plasticity 7) Density/Consistency 8) Other (Mineral Content, Discoloration, Odor, etc.)

DEPTH (ft-bgs)	ELEVATION (ft)	DESCRIPTION	STRATUM	GRAPHIC LOG	SAMPLE TYPE	BLOWS PER 6"	RECOVERY (in)	PERCENT FINES (%)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTICITY INDEX
	610	(60') CLAY; greenish gray (GLEY1 5/10Y) to very dark greenish gray (GLEY1 3/10Y); some weathered/ brittle zones; very hard; trace moist to dry	Stratum IV		SPT	16, 17, 21, 26	24				
65	605										
70					SPT	14, 19, 22, 30					
	600	(71') Boring terminated.									
75	595										
80	590										
85	585										
90											

CONTRACTOR: Texplor of Dallas, Inc. **NORTHING:** 13810896.1
EQUIPMENT: CME 75 Truck Mounted **EASTING:** 2279186.2
DRILL MTHD: HSA / Coring
SAMPLING MTHD: SPT, Shelby Tube, Core
DRILL BIT SIZE/TYPE: HSA 6" - NQ2

LOGGER: L. Varner **REVIEWER:** W. Burke
NOTES:

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Geosyntec consultants 8217 Shoal Creek Blvd Suite 200 Austin, TX 78757 Phone: (512) 451-4003 www.geosyntec.com	**BORING:** GB-48 **SHEET** 1 **OF** 6 **START DATE:** 12/13/2022 **FINISH DATE:** 12/14/2022 **LOCATION:** New Braunfels **PROJECT:** Mesquite Creek Landfill **PROJECT NUMBER:** GW8636
GS FORM: 03-GEOTECH3 BF	**GROUND SURFACE:** 707.9 ft MSL **TOTAL DEPTH:** 159 ft bgs **DEPTH TO WATER:** Not Observed **BORING BACKFILL:** Bentonite Grout

BOREHOLE LOG

DESCRIPTION: 1) Soil Name (USCS) 2) Color 3) Moisture 4) Grain Size 5) Percentage 6) Plasticity 7) Density/Consistency 8) Other (Mineral Content, Discoloration, Odor, etc.)

DEPTH (ft-bgs)	ELEVATION (ft)	DESCRIPTION	STRATUM
0	707.9	(0') CLAY; black (10YR 2/1); organic; grasses and rootlets; little coarse to medium grained gravel; trace coarse to fine sand; soft (PP = 1.25 tsf); moist	Stratum I
2		(2') Silty GRAVEL with Sand (round to sub angular); caliche with some chert fragments; moist to dry	Stratum II
10.25		(10.25') Significant white, dry caliche intermixed with clay from 10.25 to 12 ft bgs	Stratum II
12		(12') CLAY; yellow (2.5Y 8/6) to light yellowish brown (2.5Y 6/4), and to pale olive (5Y 6/4); trace coarse rounded gravel; iron staining/nodules and orange mottling; thin gray clay lamination; hard; very stiff (PP > 4.5 tsf); trace moist	Stratum III
14.7		(14.7') Heavy iron staining at some locations from 14.7 to 23 ft bgs	Stratum III
18		(18') Vertical thin grey clay lamination from 18 to 45 ft bgs	Stratum III

Depth scale: 5, 10, 15, 20, 25, 30. Elevation scale: 705, 700, 695, 690, 685, 680.

SAMPLE DEPTH (ft)	BLOWS PER 6"	RECOVERY (in)	PERCENT FINES (%)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTICITY INDEX
0–2	1, 1, 3, 2	14	95.7	33.8	71	39
2–4		15		37.7		
4–6	16, 13, 14, 15	20				
6–8	12, 15, 13, 10	22	46.7	8.4	18	-
8–10	20, 30, 40, 41	22				
10–12	10, 20, 22, 25	24				
12–14		19.5				
14–16	8, 15, 18, 18	24				
16–18		11				
18–20	10, 17, 22, 31	24				
20–22		15				
22–24	12, 21, 25, 34	24				
24–26		16				
26–28	14, 23, 29, 33	24				

CONTRACTOR: Texplor of Dallas, Inc.	**NORTHING:** 13811939.7
EQUIPMENT: CME 75 Truck Mounted	**EASTING:** 2277113.0
DRILL MTHD: HSA / Coring	
SAMPLING MTHD: SPT, Shelby Tube, Core	
DRILL BIT SIZE/TYPE: HSA 6" - NQ2	

LOGGER: G. Kumar; P. Pandey **REVIEWER:** W. Burke
NOTES:

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Austin, TX 78757
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GS FORM: 03-GEOTECH3 BF

BOREHOLE LOG

BORING: GB-48 — **SHEET** 2 **OF** 6
START DATE: 12/13/2022
FINISH DATE: 12/14/2022 — **GROUND SURFACE:** 707.9 ft MSL
LOCATION: New Braunfels — **TOTAL DEPTH:** 159 ft bgs
PROJECT: Mesquite Creek Landfill — **DEPTH TO WATER:** Not Observed
PROJECT NUMBER: GW8636 — **BORING BACKFILL:** Bentonite Grout

DESCRIPTION: 1) Soil Name (USCS) 2) Color 3) Moisture 4) Grain Size 5) Percentage 6) Plasticity 7) Density/Consistency 8) Other (Mineral Content, Discoloration, Odor, etc.)

DEPTH (ft-bgs)	ELEVATION (ft)	DESCRIPTION	STRATUM	BLOWS PER 6"	RECOVERY (in)	PERCENT FINES (%)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTICITY INDEX
		(12') CLAY; yellow (2.5Y 8/6) to light yellowish brown (2.5Y 6/4), and to pale olive (5Y 6/4); trace coarse rounded gravel; iron staining/nodules and orange mottling; thin gray clay lamination; hard; very stiff (PP > 4.5 tsf); trace moist *(cont.)*	Stratum III	14, 19, 25, 29	24				
	675				17				
35				12, 19, 25, 30	24				
	670								
40				8, 13, 20, 20	24				
	665				20		17.4		
45		(44.5') Chert fragments; trace coarse rounded gravel with iron nodules		10, 13, 21, 20	24				
	660					98.7	19.1	50	26
50		(51.3') Horizontal fracture with 5 mm moist grey inclusion		10, 15, 18, 23	24				
	655				20		17.3		
55		(54.3') Iron staining; grey mottling		13, 20, 25, 30	24				
	650								
60									

CONTRACTOR: Texplor of Dallas, Inc. — **NORTHING:** 13811939.7
EQUIPMENT: CME 75 Truck Mounted — **EASTING:** 2277113.0
DRILL MTHD: HSA / Coring
SAMPLING MTHD: SPT, Shelby Tube, Core
DRILL BIT SIZE/TYPE: HSA 6" - NQ2

LOGGER: G. Kumar; P. Pandey — **REVIEWER:** W. Burke
NOTES:

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GS FORM: 03-GEOTECH3 BF

BOREHOLE LOG

BORING: GB-48

START DATE: 12/13/2022
FINISH DATE: 12/14/2022
LOCATION: New Braunfels
PROJECT: Mesquite Creek Landfill
PROJECT NUMBER: GW8636
GROUND SURFACE: 707.9 ft MSL
TOTAL DEPTH: 159 ft bgs
DEPTH TO WATER: Not Observed
BORING BACKFILL: Bentonite Grout

DESCRIPTION: 1) Soil Name (USCS) 2) Color 3) Moisture 4) Grain Size 5) Percentage 6) Plasticity 7) Density/Consistency 8) Other (Mineral Content, Discoloration, Odor, etc.)

DEPTH (ft-bgs)	ELEVATION (ft)	DESCRIPTION	STRATUM	SAMPLE: BLOWS PER 6"	SAMPLE: RECOVERY (in)	PERCENT FINES (%)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTICITY INDEX
		(12') CLAY; yellow (2.5Y 8/6) to light yellowish brown (2.5Y 6/4), and to pale olive (5Y 6/4); trace coarse rounded gravel; iron staining/nodules and orange mottling; thin gray clay lamination; hard; very stiff (PP > 4.5 tsf); trace moist *(cont.)* (60') Grades to dark gray clay from 60 to 62 ft bgs	Stratum III	26, 33, 34, 45	24				
	645	(62') CLAYSTONE; dark greenish gray (GLEY1 4/10Y); some weathered zones; very hard; trace moist to dry	Stratum IV		36				
65	640								
70	635								
75	630								
80	625								
85	620				120				
90									

CONTRACTOR: Texplor of Dallas, Inc.
EQUIPMENT: CME 75 Truck Mounted
DRILL MTHD: HSA / Coring
SAMPLING MTHD: SPT, Shelby Tube, Core
DRILL BIT SIZE/TYPE: HSA 6" - NQ2
NORTHING: 13811939.7
EASTING: 2277113.0
LOGGER: G. Kumar; P. Pandey
REVIEWER: W. Burke
NOTES:

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BOREHOLE LOG

BORING: GB-48
START DATE: 12/13/2022
FINISH DATE: 12/14/2022
LOCATION: New Braunfels
PROJECT: Mesquite Creek Landfill
PROJECT NUMBER: GW8636
GROUND SURFACE: 707.9 ft MSL
TOTAL DEPTH: 159 ft bgs
DEPTH TO WATER: Not Observed
BORING BACKFILL: Bentonite Grout

DEPTH (ft-bgs)	ELEVATION (ft)	DESCRIPTION 1) Soil Name (USCS) 2) Color 3) Moisture 4) Grain Size 5) Percentage 6) Plasticity 7) Density/Consistency 8) Other (Mineral Content, Discoloration, Odor, etc.)	STRATUM	GRAPHIC LOG	SAMPLE: TYPE	SAMPLE: BLOWS PER 6"	SAMPLE: RECOVERY (in)	LAB RESULTS: PERCENT FINES (%)	LAB RESULTS: MOISTURE CONTENT (%)	LAB RESULTS: LIQUID LIMIT	LAB RESULTS: PLASTICITY INDEX
		(62') CLAYSTONE; dark greenish gray (GLEY1 4/10Y); some weathered zones; very hard; trace moist to dry *(cont.)*	Stratum IV								
	615						120				
95											
	610										
100							119	98.9	10.2	54	23
	605										
105											
	600										
110							116				
	595										
115											
	590						120				
120											

CONTRACTOR: Texplor of Dallas, Inc.
EQUIPMENT: CME 75 Truck Mounted
DRILL MTHD: HSA / Coring
SAMPLING MTHD: SPT, Shelby Tube, Core
DRILL BIT SIZE/TYPE: HSA 6" - NQ2
NORTHING: 13811939.7
EASTING: 2277113.0
LOGGER: G. Kumar; P. Pandey
REVIEWER: W. Burke
NOTES:

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DEPTH (ft-bgs)	ELEVATION (ft)	DESCRIPTION 1) Soil Name (USCS) 2) Color 3) Moisture 4) Grain Size 5) Percentage 6) Plasticity 7) Density/Consistency 8) Other (Mineral Content, Discoloration, Odor, etc.)	STRATUM	GRAPHIC LOG	SAMPLE TYPE	BLOWS PER 6"	RECOVERY (in)	PERCENT FINES (%)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTICITY INDEX
		(62') CLAYSTONE; dark greenish gray (GLEY1 4/10Y); some weathered zones; very hard; trace moist to dry *(cont.)*	Stratum IV								
	585						120				
125											
	580										
130							115				
	575										
135											
	570										
140							117				
	565										
145											
	560						60				
150											

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8217 Shoal Creek Blvd
Suite 200
Austin, TX 78757
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BORING: GB-48
SHEET 6 **OF** 6
START DATE: 12/13/2022
FINISH DATE: 12/14/2022
GROUND SURFACE: 707.9 ft MSL
LOCATION: New Braunfels
TOTAL DEPTH: 159 ft bgs
PROJECT: Mesquite Creek Landfill
DEPTH TO WATER: Not Observed
PROJECT NUMBER: GW8636
BORING BACKFILL: Bentonite Grout

GS FORM: 03-GEOTECH3 BF

BOREHOLE LOG

DEPTH (ft-bgs)	ELEVATION (ft)	DESCRIPTION	STRATUM	GRAPHIC LOG	SAMPLE: TYPE	SAMPLE: BLOWS PER 6"	SAMPLE: RECOVERY (in)	LAB RESULTS: PERCENT FINES (%)	LAB RESULTS: MOISTURE CONTENT (%)	LAB RESULTS: LIQUID LIMIT	LAB RESULTS: PLASTICITY INDEX
		(62') CLAYSTONE; dark greenish gray (GLEY1 4/10Y); some weathered zones; very hard; trace moist to dry *(cont.)*	Stratum IV				101				
		(159') Boring terminated.									

DESCRIPTION key: 1) Soil Name (USCS) 2) Color 3) Moisture 4) Grain Size 5) Percentage 6) Plasticity 7) Density/Consistency 8) Other (Mineral Content, Discoloration, Odor, etc.)

Depth scale: 155, 160, 165, 170, 175, 180
Elevation scale: 555, 550, 545, 540, 535, 530

CONTRACTOR: Texplor of Dallas, Inc.
NORTHING: 13811939.7
EQUIPMENT: CME 75 Truck Mounted
EASTING: 2277113.0
DRILL MTHD: HSA / Coring
SAMPLING MTHD: SPT, Shelby Tube, Core
DRILL BIT SIZE/TYPE: HSA 6" - NQ2

LOGGER: G. Kumar; P. Pandey
REVIEWER: W. Burke
NOTES:

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GS FORM: 03-GEOTECH3 BF

BOREHOLE LOG

BORING: GB-49 — **SHEET** 1 **OF** 4

START DATE: 1/20/2023
FINISH DATE: 1/23/2023
LOCATION: New Braunfels
PROJECT: Mesquite Creek Landfill
PROJECT NUMBER: GW8636
GROUND SURFACE: 703.2 ft MSL
TOTAL DEPTH: 103 ft bgs
DEPTH TO WATER: Not Observed
BORING BACKFILL: Bentonite Grout

DESCRIPTION: 1) Soil Name (USCS) 2) Color 3) Moisture 4) Grain Size 5) Percentage 6) Plasticity 7) Density/Consistency 8) Other (Mineral Content, Discoloration, Odor, etc.)

DEPTH (ft-bgs)	ELEVATION (ft)	DESCRIPTION	STRATUM	SAMPLE: BLOWS PER 6"	SAMPLE: RECOVERY (in)	PERCENT FINES (%)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTICITY INDEX
0		(0') CLAY; black (10YR 2/1); organics; grasses and rootlets; trace coarse gravel; few medium to fine sand; very stiff (PP > 4.5 tsf); moist to dry	SI	2, 3, 5, 14	12				
0.75		(0.75') Sandy/Clayey calcareous GRAVEL and CALICHE with some chert fragments; medium dense to loose; friable; dry	Stratum II	17, 14, 15, 12					
	700								
5									
					11				
8	695	(8') Significant white, dry caliche intermixed with clay from 8 to 10 ft bgs		3, 3, 5, 6	20				
10		(10') CLAY; yellowish brown (10YR 5/6), olive (5Y 5/6) to light olive brown (2.5Y 5/4); trace silt; gray clay lamination at some locations; some calcite mineralization/lamination; hard; stiff to very stiff (PP > 3.25 tsf); trace moist	Stratum III						
	690								
15									
				4, 7, 8, 12	24				
	685								
					18				
20									
	680								
25									
	675								
					24				
30									

CONTRACTOR: Texplor of Dallas, Inc.
EQUIPMENT: CME 75 Truck Mounted
DRILL MTHD: HSA / Coring
SAMPLING MTHD: SPT, Shelby Tube, Core
DRILL BIT SIZE/TYPE: HSA 6" - NQ2
NORTHING: 13811548.7
EASTING: 2277499.8
LOGGER: P. Pandey; J. Geesin
REVIEWER: W. Burke
NOTES: SI - Stratum I

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GS FORM: 03-GEOTECH3 BF

BOREHOLE LOG

BORING: GB-49 | **SHEET** 2 **OF** 4
START DATE: 1/20/2023
FINISH DATE: 1/23/2023
LOCATION: New Braunfels
PROJECT: Mesquite Creek Landfill
PROJECT NUMBER: GW8636
GROUND SURFACE: 703.2 ft MSL
TOTAL DEPTH: 103 ft bgs
DEPTH TO WATER: Not Observed
BORING BACKFILL: Bentonite Grout

DESCRIPTION: 1) Soil Name (USCS) 2) Color 3) Moisture 4) Grain Size 5) Percentage 6) Plasticity 7) Density/Consistency 8) Other (Mineral Content, Discoloration, Odor, etc.)

DEPTH (ft-bgs)	ELEVATION (ft)	DESCRIPTION	STRATUM	SAMPLE: BLOWS PER 6"	SAMPLE: RECOVERY (in)	PERCENT FINES (%)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTICITY INDEX
		(10') CLAY; yellowish brown (10YR 5/6), olive (5Y 5/6) to light olive brown (2.5Y 5/4); trace silt; gray clay lamination at some locations; some calcite mineralization/lamination; hard; stiff to very stiff (PP > 3.25 tsf); trace moist *(cont.)* (30') Vertical calcite lamination	Stratum III						
	670								
35									
	665	(38') Calcite mineralization from 38 to 40 ft bgs		7 8 12 18					
40									
	660								
45									
	655	(48') Friable; grades to gray clay from 48 to 53 ft bgs		33 50	16				
50									
	650	(53') CLAYSTONE; greenish black (GLEY1 2.5/10Y) with some iron staining/yellow discoloration in upper zones ; trace chert fragments; very hard; trace moist	Stratum IV		7				
55		(54.25') Heavy iron staining							
					120				
	645								
60									

CONTRACTOR: Texplor of Dallas, Inc.
EQUIPMENT: CME 75 Truck Mounted
DRILL MTHD: HSA / Coring
SAMPLING MTHD: SPT, Shelby Tube, Core
DRILL BIT SIZE/TYPE: HSA 6" - NQ2
NORTHING: 13811548.7
EASTING: 2277499.8
LOGGER: P. Pandey; J. Geesin
REVIEWER: W. Burke
NOTES: SI - Stratum I

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GS FORM: 03-GEOTECH3 BF

BOREHOLE LOG

BORING: GB-49 **SHEET** 3 **OF** 4
START DATE: 1/20/2023
FINISH DATE: 1/23/2023 **GROUND SURFACE:** 703.2 ft MSL
LOCATION: New Braunfels **TOTAL DEPTH:** 103 ft bgs
PROJECT: Mesquite Creek Landfill **DEPTH TO WATER:** Not Observed
PROJECT NUMBER: GW8636 **BORING BACKFILL:** Bentonite Grout

DEPTH (ft-bgs)	ELEVATION (ft)	DESCRIPTION 1) Soil Name (USCS) 2) Color 3) Moisture 4) Grain Size 5) Percentage 6) Plasticity 7) Density/Consistency 8) Other (Mineral Content, Discoloration, Odor, etc.)	STRATUM	GRAPHIC LOG	SAMPLE: TYPE	SAMPLE: BLOWS PER 6"	SAMPLE: RECOVERY (in)	LAB RESULTS: PERCENT FINES (%)	LAB RESULTS: MOISTURE CONTENT (%)	LAB RESULTS: LIQUID LIMIT	LAB RESULTS: PLASTICITY INDEX
		(53') CLAYSTONE; greenish black (GLEY1 2.5/10Y) with some iron staining/yellow discoloration in upper zones ; trace chert fragments; very hard; trace moist *(cont.)*	Stratum IV				120				
	640										
65											
	635										
70											
	630										
75											
	625										
80											
	620										
85							106				
	615										
90											

CONTRACTOR: Texplor of Dallas, Inc. **NORTHING:** 13811548.7
EQUIPMENT: CME 75 Truck Mounted **EASTING:** 2277499.8
DRILL MTHD: HSA / Coring
SAMPLING MTHD: SPT, Shelby Tube, Core
DRILL BIT SIZE/TYPE: HSA 6" - NQ2

LOGGER: P. Pandey; J. Geesin **REVIEWER:** W. Burke
NOTES: SI - Stratum I

SEE KEY SHEET FOR SYMBOLS AND ABBREVIATIONS

Geosyntec consultants

8217 Shoal Creek Blvd
Suite 200
Austin, TX 78757
Phone: (512) 451-4003
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GS FORM: 03-GEOTECH3 BF

BOREHOLE LOG

BORING: GB-49
START DATE: 1/20/2023
FINISH DATE: 1/23/2023
LOCATION: New Braunfels
PROJECT: Mesquite Creek Landfill
PROJECT NUMBER: GW8636
GROUND SURFACE: 703.2 ft MSL
TOTAL DEPTH: 103 ft bgs
DEPTH TO WATER: Not Observed
BORING BACKFILL: Bentonite Grout

DESCRIPTION: 1) Soil Name (USCS) 2) Color 3) Moisture 4) Grain Size 5) Percentage 6) Plasticity 7) Density/Consistency 8) Other (Mineral Content, Discoloration, Odor, etc.)

DEPTH (ft-bgs)	ELEVATION (ft)	DESCRIPTION	STRATUM	GRAPHIC LOG	SAMPLE TYPE	BLOWS PER 6"	RECOVERY (in)	PERCENT FINES (%)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTICITY INDEX
		(53') CLAYSTONE; greenish black (GLEY1 2.5/10Y) with some iron staining/yellow discoloration in upper zones ; trace chert fragments; very hard; trace moist *(cont.)*	Stratum IV				106				
	610										
95											
	605										
100											
	600	(103') Boring terminated.									
105											
	595										
110											
	590										
115											
	585										
120											

CONTRACTOR: Texplor of Dallas, Inc.
EQUIPMENT: CME 75 Truck Mounted
DRILL MTHD: HSA / Coring
SAMPLING MTHD: SPT, Shelby Tube, Core
DRILL BIT SIZE/TYPE: HSA 6" - NQ2
NORTHING: 13811548.7
EASTING: 2277499.8
LOGGER: P. Pandey; J. Geesin
REVIEWER: W. Burke
NOTES: SI - Stratum I

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8217 Shoal Creek Blvd
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GS FORM: 03-GEOTECH3 BF

BOREHOLE LOG

BORING: GB-50 **SHEET** 1 **OF** 4
START DATE: 1/9/2023
FINISH DATE: 1/10/2023 **GROUND SURFACE:** 688.6 ft MSL
LOCATION: New Braunfels **TOTAL DEPTH:** 114 ft bgs
PROJECT: Mesquite Creek Landfill **DEPTH TO WATER:** Not Observed
PROJECT NUMBER: GW8636 **BORING BACKFILL:** Bentonite Grout

DESCRIPTION: 1) Soil Name (USCS) 2) Color 3) Moisture 4) Grain Size 5) Percentage 6) Plasticity 7) Density/Consistency 8) Other (Mineral Content, Discoloration, Odor, etc.)

DEPTH (ft-bgs)	ELEVATION (ft)	DESCRIPTION	STRATUM	GRAPHIC LOG	SAMPLE TYPE	BLOWS PER 6"	RECOVERY (in)	PERCENT FINES (%)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTICITY INDEX
0	688.6	(0') CLAY; bluish black (GLEY2 2.5/10B); organic; some silt and roots; trace fine sand; soft (PP = 1 tsf); moist	Stratum I		SPT	1, 2, 3, 4	12				
3	685	(3') CLAY; olive gray (5Y 4/2) and light yellowish brown (2.5Y 6/4) to olive brown (2.5Y 4/4); significant mottling; caliche lenses at shallow zones; some fracturing with calcite infill and/or iron staining; very hard; very stiff (PP > 4.5 tsf); dry to moist; low to medium plastic	Stratum III		Shelby Tube		13				
5		(5') Some caliche lenses from 5 to 7 ft bgs			SPT	5, 6, 6, 7	16				
10	680				SPT	5, 7, 8, 12	20.5				
15	675				Shelby Tube		17				
17	670				SPT	4, 6, 9, 14	24				
26	665				Shelby Tube		18				
28	660				SPT	9, 16, 18, 20	23				
30											

CONTRACTOR: Texplor of Dallas, Inc. **NORTHING:** 13811157.6
EQUIPMENT: CME 75 Truck Mounted **EASTING:** 2277886.6
DRILL MTHD: HSA / Coring
SAMPLING MTHD: SPT, Shelby Tube, Core
DRILL BIT SIZE/TYPE: HSA 6" - NQ2

LOGGER: L. Varner **REVIEWER:** W. Burke
NOTES:

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GS FORM: 03-GEOTECH3 BF	**BOREHOLE LOG**

BORING: GB-50 — **SHEET** 2 **OF** 4
START DATE: 1/9/2023
FINISH DATE: 1/10/2023 — **GROUND SURFACE:** 688.6 ft MSL
LOCATION: New Braunfels — **TOTAL DEPTH:** 114 ft bgs
PROJECT: Mesquite Creek Landfill — **DEPTH TO WATER:** Not Observed
PROJECT NUMBER: GW8636 — **BORING BACKFILL:** Bentonite Grout

DESCRIPTION: 1) Soil Name (USCS) 2) Color 3) Moisture 4) Grain Size 5) Percentage 6) Plasticity 7) Density/Consistency 8) Other (Mineral Content, Discoloration, Odor, etc.)

DEPTH (ft-bgs)	ELEVATION (ft)	DESCRIPTION	STRATUM	GRAPHIC LOG	SAMPLE TYPE	BLOWS PER 6"	RECOVERY (in)	PERCENT FINES (%)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTICITY INDEX
		(3') CLAY; olive gray (5Y 4/2) and light yellowish brown (2.5Y 6/4) to olive brown (2.5Y 4/4); significant mottling; caliche lenses at shallow zones; some fracturing with calcite infill and/or iron staining; very hard; very stiff (PP > 4.5 tsf); dry to moist; low to medium plastic *(cont.)*	Stratum III								
	655										
35		(34') Fracture with heavy calcite mineralization			SPT	7, 13, 19, 24	22.5				
	650				Shelby Tube		13				
40					SPT	17, 39, 44, 49	24				
		(41.5') Trace calcite mineralization									
	645										
45											
	640				SPT	35, 39, 37, 50	22.5				
50		(49') Vertical fracture with heavy iron staining from 49 to 50 ft bgs									
	635										
55											
	630				Shelby Tube		24				
60											

CONTRACTOR: Texplor of Dallas, Inc. — **NORTHING:** 13811157.6
EQUIPMENT: CME 75 Truck Mounted — **EASTING:** 2277886.6
DRILL MTHD: HSA / Coring
SAMPLING MTHD: SPT, Shelby Tube, Core
DRILL BIT SIZE/TYPE: HSA 6" - NQ2

LOGGER: L. Varner — **REVIEWER:** W. Burke
NOTES:

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Austin, TX 78757
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GS FORM: 03-GEOTECH3 BF

BOREHOLE LOG

BORING: GB-50
START DATE: 1/9/2023
FINISH DATE: 1/10/2023
LOCATION: New Braunfels
PROJECT: Mesquite Creek Landfill
PROJECT NUMBER: GW8636
GROUND SURFACE: 688.6 ft MSL
TOTAL DEPTH: 114 ft bgs
DEPTH TO WATER: Not Observed
BORING BACKFILL: Bentonite Grout

DESCRIPTION: 1) Soil Name (USCS) 2) Color 3) Moisture 4) Grain Size 5) Percentage 6) Plasticity 7) Density/Consistency 8) Other (Mineral Content, Discoloration, Odor, etc.)

DEPTH (ft-bgs)	ELEVATION (ft)	DESCRIPTION	STRATUM	GRAPHIC LOG	SAMPLE: TYPE	SAMPLE: BLOWS PER 6"	SAMPLE: RECOVERY (in)	LAB RESULTS: PERCENT FINES (%)	LAB RESULTS: MOISTURE CONTENT (%)	LAB RESULTS: LIQUID LIMIT	LAB RESULTS: PLASTICITY INDEX
		(3') CLAY; olive gray (5Y 4/2) and light yellowish brown (2.5Y 6/4) to olive brown (2.5Y 4/4); significant mottling; caliche lenses at shallow zones; some fracturing with calcite infill and/or iron staining; very hard; very stiff (PP > 4.5 tsf); dry to moist; low to medium plastic *(cont.)* (60') Lens of dark gray clay (61.5') 45-degree fracture with calcite infilling	Stratum III			8 14 20 24	24				
	625										
65		(65') CLAYSTONE; dark greenish gray (GLEY1 4/10Y), several fracture zones with calcite mineralization and iron precipitation at some locations; very hard	Stratum IV								
	620										
70							120				
	615										
75											
	610										
80							112				
	605										
85											
							110.5				
	600										
90											

CONTRACTOR: Texplor of Dallas, Inc.
EQUIPMENT: CME 75 Truck Mounted
DRILL MTHD: HSA / Coring
SAMPLING MTHD: SPT, Shelby Tube, Core
DRILL BIT SIZE/TYPE: HSA 6" - NQ2
NORTHING: 13811157.6
EASTING: 2277886.6
LOGGER: L. Varner
REVIEWER: W. Burke
NOTES:

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GS FORM: 03-GEOTECH3 BF

BOREHOLE LOG

BORING: GB-50

START DATE: 1/9/2023
FINISH DATE: 1/10/2023
LOCATION: New Braunfels
PROJECT: Mesquite Creek Landfill
PROJECT NUMBER: GW8636
GROUND SURFACE: 688.6 ft MSL
TOTAL DEPTH: 114 ft bgs
DEPTH TO WATER: Not Observed
BORING BACKFILL: Bentonite Grout

DESCRIPTION: 1) Soil Name (USCS) 2) Color 3) Moisture 4) Grain Size 5) Percentage 6) Plasticity 7) Density/Consistency 8) Other (Mineral Content, Discoloration, Odor, etc.)

DEPTH (ft-bgs)	ELEVATION (ft)	DESCRIPTION	STRATUM	GRAPHIC LOG	SAMPLE: TYPE	SAMPLE: BLOWS PER 6"	SAMPLE: RECOVERY (in)	LAB RESULTS: PERCENT FINES (%)	LAB RESULTS: MOISTURE CONTENT (%)	LAB RESULTS: LIQUID LIMIT	LAB RESULTS: PLASTICITY INDEX
		(65') CLAYSTONE; dark greenish gray (GLEY1 4/10Y), several fracture zones with calcite mineralization and iron precipitation at some locations; very hard *(cont.)* (91') Moderately weathered fracture zones	Stratum IV				110.5				
95	595										
100	590						113.5				
105	585										
110	580						108				
114	575	(114') Boring terminated.									
115											
120	570										

CONTRACTOR: Texplor of Dallas, Inc.
EQUIPMENT: CME 75 Truck Mounted
DRILL MTHD: HSA / Coring
SAMPLING MTHD: SPT, Shelby Tube, Core
DRILL BIT SIZE/TYPE: HSA 6" - NQ2
NORTHING: 13811157.6
EASTING: 2277886.6
LOGGER: L. Varner
REVIEWER: W. Burke
NOTES:

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GS FORM: 03-GEOTECH3 BF

BOREHOLE LOG

BORING: GB-51
SHEET 1 **OF** 3
START DATE: 1/25/2023
FINISH DATE: 1/25/2023
LOCATION: New Braunfels
PROJECT: Mesquite Creek Landfill
PROJECT NUMBER: GW8636
GROUND SURFACE: 676.5 ft MSL
TOTAL DEPTH: 76 ft bgs
DEPTH TO WATER: Not Observed
BORING BACKFILL: Bentonite Grout

DESCRIPTION: 1) Soil Name (USCS) 2) Color 3) Moisture 4) Grain Size 5) Percentage 6) Plasticity 7) Density/Consistency 8) Other (Mineral Content, Discoloration, Odor, etc.)

DEPTH (ft-bgs)	ELEVATION (ft)	DESCRIPTION	STRATUM	GRAPHIC LOG	SAMPLE TYPE	BLOWS PER 6"	RECOVERY (in)	PERCENT FINES (%)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTICITY INDEX
0		(0') CLAY; black (2.5Y 2.5/1); organic; grasses and rootlets; trace fine to coarse sand; soft to very stiff (PP > 1.25 tsf); moist	Stratum I		SPT	1 2 5 6	21				
	675										
4		(4') CLAY; light olive brown (2.5Y 5/3) to olive yellow (2.5Y 6/6); soft gray clay inclusion at some location; trace iron staining; occasional trace chert fragments; some fractures with calcite mineralization/lamination; very stiff (PP > 4.5 tsf); trace moist	Stratum III		Shelby Tube		10				
5											
	670										
8					Shelby Tube		13				
10					SPT	5 8 10 15	20				
	665										
15											
	660										
20		(20') Calcite mineralization at some locations (along horizontal and 45-degree planes) from 20 to 44 ft bgs			SPT	7 9 11 14	24				
	655										
25											
	650										
28					Shelby Tube						
30											

CONTRACTOR: Texplor of Dallas, Inc.
NORTHING: 13810766.7
EQUIPMENT: CME 75 Truck Mounted
EASTING: 2278273.4
DRILL MTHD: HSA / Coring
SAMPLING MTHD: SPT, Shelby Tube, Core
DRILL BIT SIZE/TYPE: HSA 6" - NQ2

LOGGER: P. Pandey
REVIEWER: W. Burke
NOTES:

SEE KEY SHEET FOR SYMBOLS AND ABBREVIATIONS

BOREHOLE LOG

BORING: GB-51 —
START DATE: 1/25/2023
FINISH DATE: 1/25/2023
LOCATION: New Braunfels
PROJECT: Mesquite Creek Landfill
PROJECT NUMBER: GW8636
GROUND SURFACE: 676.5 ft MSL
TOTAL DEPTH: 76 ft bgs
DEPTH TO WATER: Not Observed
BORING BACKFILL: Bentonite Grout

DESCRIPTION: 1) Soil Name (USCS) 2) Color 3) Moisture 4) Grain Size 5) Percentage 6) Plasticity 7) Density/Consistency 8) Other (Mineral Content, Discoloration, Odor, etc.)

DEPTH (ft-bgs)	ELEVATION (ft)	DESCRIPTION	STRATUM	GRAPHIC LOG	SAMPLE TYPE	BLOWS PER 6"	RECOVERY (in)	PERCENT FINES (%)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTICITY INDEX
	645	(4') CLAY; light olive brown (2.5Y 5/3) to olive yellow (2.5Y 6/6); soft gray clay inclusion at some location; trace iron staining; occasional trace chert fragments; some fractures with calcite mineralization/lamination; very stiff (PP > 4.5 tsf); trace moist *(cont.)*	Stratum III								
35	640				SPT	11, 18, 22, 27	24				
40	635										
		(42.5') Significant calcite crystals; chert fragments; fine to coarse sand; trace silt			SPT	11, 21, 21, 29	24				
45	630										
50	625	(50') Alternating dark gray and light olive brown from 50 to 62 ft bgs			SPT	21, 30, 37, 46	24				
		(52') Calcite deposition									
55	620										
60											

CONTRACTOR: Texplor of Dallas, Inc.
NORTHING: 13810766.7
EQUIPMENT: CME 75 Truck Mounted
EASTING: 2278273.4
DRILL MTHD: HSA / Coring
SAMPLING MTHD: SPT, Shelby Tube, Core
DRILL BIT SIZE/TYPE: HSA 6" - NQ2
LOGGER: P. Pandey
REVIEWER: W. Burke
NOTES:

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Geosyntec consultants

8217 Shoal Creek Blvd
Suite 200
Austin, TX 78757
Phone: (512) 451-4003
www.geosyntec.com

GS FORM: 03-GEOTECH3 BF

BOREHOLE LOG

BORING: GB-51
START DATE: 1/25/2023
FINISH DATE: 1/25/2023
LOCATION: New Braunfels
PROJECT: Mesquite Creek Landfill
PROJECT NUMBER: GW8636
GROUND SURFACE: 676.5 ft MSL
TOTAL DEPTH: 76 ft bgs
DEPTH TO WATER: Not Observed
BORING BACKFILL: Bentonite Grout

DESCRIPTION: 1) Soil Name (USCS) 2) Color 3) Moisture 4) Grain Size 5) Percentage 6) Plasticity 7) Density/Consistency 8) Other (Mineral Content, Discoloration, Odor, etc.)

DEPTH (ft-bgs)	ELEVATION (ft)	DESCRIPTION	STRATUM	GRAPHIC LOG	SAMPLE TYPE	BLOWS PER 6"	RECOVERY (in)	PERCENT FINES (%)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTICITY INDEX
	615	(4') CLAY; light olive brown (2.5Y 5/3) to olive yellow (2.5Y 6/6); soft gray clay inclusion at some location; trace iron staining; occasional trace chert fragments; some fractures with calcite mineralization/lamination; very stiff (PP > 4.5 tsf); trace moist *(cont.)*	Stratum III		SPT	14 23 25 28	24				
65	610	(62') CLAY to CLAYSTONE; dark gray (5Y 4/1); very hard; very stiff (PP > 4.5 tsf); trace moist	Stratum IV								
70	605				SPT	12 18 22 24					
75					SPT	15 17 23 33					
	600	(76') Boring terminated.									
80	595										
85	590										
90											

CONTRACTOR: Texplor of Dallas, Inc.
EQUIPMENT: CME 75 Truck Mounted
DRILL MTHD: HSA / Coring
SAMPLING MTHD: SPT, Shelby Tube, Core
DRILL BIT SIZE/TYPE: HSA 6" - NQ2
NORTHING: 13810766.7
EASTING: 2278273.4
LOGGER: P. Pandey
REVIEWER: W. Burke
NOTES:

SEE KEY SHEET FOR SYMBOLS AND ABBREVIATIONS

Geosyntec consultants 8217 Shoal Creek Blvd Suite 200 Austin, TX 78757 Phone: (512) 451-4003 www.geosyntec.com	**BORING:** GB-52 — **SHEET** 1 **OF** 4 **START DATE:** 12/14/2022 **FINISH DATE:** 12/15/2022 — **GROUND SURFACE:** 667.6 ft MSL **LOCATION:** New Braunfels — **TOTAL DEPTH:** 119 ft bgs **PROJECT:** Mesquite Creek Landfill — **DEPTH TO WATER:** Not Observed **PROJECT NUMBER:** GW8636 — **BORING BACKFILL:** Bentonite Grout
GS FORM: 03-GEOTECH3 BF	**BOREHOLE LOG**

DESCRIPTION: 1) Soil Name (USCS) 2) Color 3) Moisture 4) Grain Size 5) Percentage 6) Plasticity 7) Density/Consistency 8) Other (Mineral Content, Discoloration, Odor, etc.)

DEPTH (ft-bgs)	ELEVATION (ft)	DESCRIPTION	STRATUM	BLOWS PER 6"	RECOVERY (in)	PERCENT FINES (%)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTICITY INDEX
0		(0') CLAY; black (10YR 2/1); organic; grasses and rootlets; few medium to fine gravel; little coarse to fine sand; some caliche lenses; soft to very stiff (PP > 1.25 tsf); moist	Stratum I	1, 2, 3, 5	12				
	665				16.5	95.8	23.1	58	32
4.5		(4.5') CALICHE mixed with clay; trace sand; friable	Stratum II	7, 11, 12, 14	18				
	660				15		14.2		
8		(8') CLAY; light yellowish brown (2.5Y 6/4) to light olive brown (2.5Y 5/6), and pale olive (5Y 6/4); trace fine sand; iron staining and mottling; gray clay inclusions/lamination; some fractures and mineralization; hard; very stiff (PP > 4.5 tsf); trace moist	Stratum III	7, 9, 10, 15	18	97.4	18.6	56	31
8.5		(8.5') Iron nodules and staining							
					14		28.7		
	655			12, 12, 14, 20	24				
15					7				
16		(16') Large chert fragment		10, 11, 13, 18	24				
	650				20.5				
20				7, 20, 18, 23	24				
21.75	645	(21.75') 1/2" iron nodule with heavy iron staining			13.5				
25				17, 16, 16, 18	22				
30	640								

CONTRACTOR: Texplor of Dallas, Inc. **NORTHING:** 13810376.6
EQUIPMENT: CME 75 Truck Mounted **EASTING:** 2278659.2
DRILL MTHD: HSA / Coring
SAMPLING MTHD: SPT, Shelby Tube, Core
DRILL BIT SIZE/TYPE: HSA 6" - NQ2

LOGGER: G. Kumar; P. Pandey **REVIEWER:** W. Burke
NOTES:

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8217 Shoal Creek Blvd
Suite 200
Austin, TX 78757
Phone: (512) 451-4003
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GS FORM: 03-GEOTECH3 BF

BOREHOLE LOG

BORING: GB-52
START DATE: 12/14/2022
FINISH DATE: 12/15/2022 **GROUND SURFACE:** 667.6 ft MSL
LOCATION: New Braunfels **TOTAL DEPTH:** 119 ft bgs
PROJECT: Mesquite Creek Landfill **DEPTH TO WATER:** Not Observed
PROJECT NUMBER: GW8636 **BORING BACKFILL:** Bentonite Grout

DESCRIPTION: 1) Soil Name (USCS) 2) Color 3) Moisture 4) Grain Size 5) Percentage 6) Plasticity 7) Density/Consistency 8) Other (Mineral Content, Discoloration, Odor, etc.)

DEPTH (ft-bgs)	ELEVATION (ft)	DESCRIPTION	STRATUM	GRAPHIC LOG	TYPE	BLOWS PER 6"	RECOVERY (in)	PERCENT FINES (%)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTICITY INDEX
		(8') CLAY; light yellowish brown (2.5Y 6/4) to light olive brown (2.5Y 5/6), and pale olive (5Y 6/4); trace fine sand; iron staining and mottling; gray clay inclusions/lamination; some fractures and mineralization; hard; very stiff (PP > 4.5 tsf); trace moist *(cont.)* (30') Trace coarse to fine sand and chert fragments; iron staining	Stratum III		SPT	4 8 14 13	23				
	635				Shelby Tube		18				
35		(34') Thick silica based mineralization from 34 to 36 ft bgs; thin grey clay lamination along vertical plane			SPT	8 12 12 16	23				
	630										
40		(41.25') 3/4" iron nodule with heavy iron staining			SPT	9 11 13 18	24				
	625				Shelby Tube		24				
45					SPT	9 12 16 16	24				
	620										
50					SPT	7 9 12 15	24				
	615				Shelby Tube		22.5				
55					SPT	8 12 13 10	24				
	610										
60											

CONTRACTOR: Texplor of Dallas, Inc. **NORTHING:** 13810376.6
EQUIPMENT: CME 75 Truck Mounted **EASTING:** 2278659.2
DRILL MTHD: HSA / Coring
SAMPLING MTHD: SPT, Shelby Tube, Core
DRILL BIT SIZE/TYPE: HSA 6" - NQ2

LOGGER: G. Kumar; P. Pandey **REVIEWER:** W. Burke
NOTES:

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Phone: (512) 451-4003
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GS FORM: 03-GEOTECH3 BF

BOREHOLE LOG

BORING: GB-52 — SHEET 3 OF 4
START DATE: 12/14/2022
FINISH DATE: 12/15/2022
LOCATION: New Braunfels
PROJECT: Mesquite Creek Landfill
PROJECT NUMBER: GW8636
GROUND SURFACE: 667.6 ft MSL
TOTAL DEPTH: 119 ft bgs
DEPTH TO WATER: Not Observed
BORING BACKFILL: Bentonite Grout

DESCRIPTION: 1) Soil Name (USCS) 2) Color 3) Moisture 4) Grain Size 5) Percentage 6) Plasticity 7) Density/Consistency 8) Other (Mineral Content, Discoloration, Odor, etc.)

DEPTH (ft-bgs)	ELEVATION (ft)	DESCRIPTION	STRATUM	GRAPHIC LOG	SAMPLE: TYPE	SAMPLE: BLOWS PER 6"	SAMPLE: RECOVERY (in)	LAB: PERCENT FINES (%)	LAB: MOISTURE CONTENT (%)	LAB: LIQUID LIMIT	LAB: PLASTICITY INDEX
		(8') CLAY; light yellowish brown (2.5Y 6/4) to light olive brown (2.5Y 5/6), and pale olive (5Y 6/4); trace fine sand; iron staining and mottling; gray clay inclusions/lamination; some fractures and mineralization; hard; very stiff (PP > 4.5 tsf); trace moist *(cont.)*	Stratum III		SPT	9, 14, 15, 23	22				
	605				Shelby Tube		22				
65					SPT	12, 16, 22, 27	23.5				
		(66') CLAYSTONE; greenish black (GLEY1 2.5/10Y); moderate fractures with iron staining, crystallized/mineralized infills and gray clay lamination; very hard; some weathering; trace moist to dry	Stratum IV		Core		45	98.7	16	66	32
	600										
70											
	595										
75					Core		95				
	590										
80											
	585										
85					Core		120				
	580										
90											

CONTRACTOR: Texplor of Dallas, Inc. **NORTHING:** 13810376.6
EQUIPMENT: CME 75 Truck Mounted **EASTING:** 2278659.2
DRILL MTHD: HSA / Coring
SAMPLING MTHD: SPT, Shelby Tube, Core
DRILL BIT SIZE/TYPE: HSA 6" - NQ2

LOGGER: G. Kumar; P. Pandey **REVIEWER:** W. Burke
NOTES:

SEE KEY SHEET FOR SYMBOLS AND ABBREVIATIONS

Geosyntec consultants	8217 Shoal Creek Blvd Suite 200 Austin, TX 78757 Phone: (512) 451-4003 www.geosyntec.com
GS FORM: 03-GEOTECH3 BF	**BOREHOLE LOG**

BORING: GB-52 **SHEET** 4 **OF** 4
START DATE: 12/14/2022
FINISH DATE: 12/15/2022 **GROUND SURFACE:** 667.6 ft MSL
LOCATION: New Braunfels **TOTAL DEPTH:** 119 ft bgs
PROJECT: Mesquite Creek Landfill **DEPTH TO WATER:** Not Observed
PROJECT NUMBER: GW8636 **BORING BACKFILL:** Bentonite Grout

DEPTH (ft-bgs)	ELEVATION (ft)	DESCRIPTION 1) Soil Name (USCS) 2) Color 3) Moisture 4) Grain Size 5) Percentage 6) Plasticity 7) Density/Consistency 8) Other (Mineral Content, Discoloration, Odor, etc.)	STRATUM	GRAPHIC LOG	SAMPLE: TYPE	SAMPLE: BLOWS PER 6"	SAMPLE: RECOVERY (in)	LAB RESULTS: PERCENT FINES (%)	LAB RESULTS: MOISTURE CONTENT (%)	LAB RESULTS: LIQUID LIMIT	LAB RESULTS: PLASTICITY INDEX
		(66') CLAYSTONE; greenish black (GLEY1 2.5/10Y); moderate fractures with iron staining, crystallized/mineralized infills and gray clay lamination; very hard; some weathering; trace moist to dry *(cont.)*	Stratum IV								
	575										
95							111				
	570										
100											
	565										
105							112				
	560										
110											
	555										
115							72				
	550										
		(119') Boring terminated.									
120											

CONTRACTOR: Texplor of Dallas, Inc. **NORTHING:** 13810376.6
EQUIPMENT: CME 75 Truck Mounted **EASTING:** 2278659.2
DRILL MTHD: HSA / Coring
SAMPLING MTHD: SPT, Shelby Tube, Core
DRILL BIT SIZE/TYPE: HSA 6" - NQ2

LOGGER: G. Kumar; P. Pandey **REVIEWER:** W. Burke
NOTES:

SEE KEY SHEET FOR SYMBOLS AND ABBREVIATIONS

HISTORICAL BORING LOGS
UNDER PERMIT 66B

1987 McBride-Ratcliff and Associates (CB-1 to CB-5; B-6 to B-15)

1990-1991 McCulley, Frick & Gilman (PZ-1 to PZ-12)

1991 Fugro-McClelland (GP-1 to GP-6)

1992 SEC Donahue (SB-1 to SB-5; PZ-1M)

1996 RUST (MW-6; GP-6R)

2004-2005 Geosyntec (GB-1 to GB-24)

2006 McCulley, Frick & Gilman (MW-7 and MW-8)

2009 Geosyntec (GP-5A; GP-07 to GP-13; GP-20; GP-21; MW-2A; MW-7A; MW-8A; MW-9 to MW-11; MW-18 to MW-23)

2013 Tetra Tech (GP-14; GP-19)

2016 Tetra Tech (GP-15; MW-17)

2018 Tetra Tech (GP-16 to GP-18; MW-12 to MW-15)

2020 Bullock, Bennett & Associates (MW-4A)

LOG OF BORING

PROJECT: New Braunfels Landfill
Comal County, Texas

CLIENT: Waste Management of North America
Houston, Texas

BORING NO. CB-1
FILE NO. 87-051
DATE 2-11-87

DRY AUGERED 0 TO 40 FEET
WASH BORED 40 TO 60 FEET

FREE WATER ENCOUNTERED YES NO

AT FT. DEPTH.

WATER AT FT. AFTER

Depth (feet)	Penetration Resistance (N) or TSF	Moisture Content %	Dry Density, PCF	Compressive Strength TSF	Failure Strain %	Liquid LL	Plastic PL	Plasticity Index PI	Minus No. 200 Sieve - %	Description of Stratum
	1.25	42								Stiff, dark gray, CLAY (CH)
5	2.00					63	33	40		Very stiff to hard, tan, CLAY (CH)
										Hard, tan, SILTY CLAY (CL)
10	4.5+	20								
15	4.5+					43	22	21		
20	4.5+	14								
25	4.5+	15								
30	4.5+	19								
35	4.5+					41	18	23		
40	4.5+	18								

* SLICKENSIDED FAILURE
( ) CONFINING PRESSURE, PSI
G.S. GRAIN SIZE

PENETRATION RESISTANCE
(N) - STANDARD PENETRATION RESISTANCE (SPT)
TSF - POCKET PENETROMETER OR TORVANE ESTIMATED UNCONFINED COMPRESSIVE STRENGTH, TONS PER SQ. FOOT

McBride-Ratcliff and Associates, Inc.

LOG OF BORING

PROJECT: New Braunfels Landfill
Comal County, Texas

CLIENT: Waste Management of North America
Houston, Texas

BORING NO. CB-1
FILE NO. 87-051
DATE 2-18-87

DRY AUGERED 0 TO 40 FEET
WASH BORED 40 TO 60 FEET

FREE WATER ENCOUNTERED YES NO

AT FT. DEPTH.

WATER AT FT. AFTER

SOIL SYMBOL	DEPTH (feet)	SAMPLES	Penetration Resistance (N) or TSF	Moisture Content %	Dry Density, PCF	Compressive Strength TSF	Failure Strain %	Atterberg Limits Liquid LL	Plastic PL	Plasticity Index PI	Minus No. 200 Sieve - %	DESCRIPTION OF STRATUM
												Hard, tan, SILTY CLAY (CL)
	45		4.5+	21				41	20	21		
	50		4.5+	16				55	21	34		
	55		4.5+									
	60		4.5+	18								-tan & gray @ 59'
												Completion Depth 60'

- • SLICKENSIDED FAILURE
- ( ) CONFINING PRESSURE, PSI
- G.S. GRAIN SIZE

PENETRATION RESISTANCE

(N) - STANDARD PENETRATION RESISTANCE (SPT)
TSF - POCKET PENETROMETER OR TORVANE ESTIMATED UNCONFINED COMPRESSIVE STRENGTH, TONS PER SQ. FOOT

LOG OF BORING

PROJECT: New Braunfels Landfill
Comal County, Texas

CLIENT: Waste Management of North America
Houston, Texas

BORING NO. CB-2
FILE NO. 87-051
DATE 2-11-87

DRY AUGERED 0 TO 40 FEET
WASH BORED TO FEET

FREE WATER ENCOUNTERED YES NO

AT FT. DEPTH.

WATER AT FT. AFTER

DEPTH (feet)	Penetration Resistance (N) or TSF	Moisture Content %	Dry Density, PCF	Compressive Strength TSF	Failure Strain %	Liquid LL	Plastic PL	Plasticity Index PI	Minus No. 200 Sieve - %	DESCRIPTION OF STRATUM
	3.0	29								Very stiff, dark gray, CLAY (CH)
	2.75	30								-gravelly below 4'
5										Firm clayey GRAVEL
	2.75	22								Very stiff, tan & gray CLAY (CH) w/scattered seams of gypsum
10										-hard below 13'
	4.5+	31								
15										
	4.5+	36				105	39	66		
20										
	4.5+	30								
25										
	4.5+	30				87	32	55		
30										
	4.5+	29								
35										
	4.5+	29								
40										

* SLICKENSIDED FAILURE
( ) CONFINING PRESSURE, PSI
G.S. GRAIN SIZE

PENETRATION RESISTANCE
(N) - STANDARD PENETRATION RESISTANCE (SPT)
TSF - POCKET PENETROMETER OR TORVANE ESTIMATED UNCONFINED COMPRESSIVE STRENGTH, TONS PER SQ. FOOT

McBride-Ratcliff and Associates, Inc.

LOG OF BORING

PROJECT: New Braunfels Landfill
Comal County, Texas

CLIENT: Waste Management of North America
Houston, Texas

BORING NO. CB-3
FILE NO. 87-051
DATE 2-9-87

DRY AUGERED 0 TO 40 FEET
WASH BORED 40 TO 60 FEET

FREE WATER ENCOUNTERED YES **NO**

AT FT. DEPTH.

WATER AT FT. AFTER

Depth (feet)	Penetration Resistance (N) or TSF	Moisture Content %	Dry Density, PCF	Compressive Strength TSF	Failure Strain %	Liquid LL	Plastic PL	Plasticity Index PI	Minus No. 200 Sieve - %	Description of Stratum
0–2	2.5					104	40	64		Very stiff, black, CLAY (CH) -becomes gravelly below 2'
4		16								
5										Firm clayey GRAVEL
6										Very stiff, tan and gray, CLAY (CH)
9	2.5	33								
14	3.75	37								
19	4.0	35				93	37	56		-hard below 18'
24	4.5+	34								
29	4.5+	32				89	38	51		
34	4.5+	31								-w/gypsum
39	4.5+	31								

• SLICKENSIDED FAILURE
( ) CONFINING PRESSURE, PSI
G.S. GRAIN SIZE

PENETRATION RESISTANCE
(N) - STANDARD PENETRATION RESISTANCE (SPT)
TSF - POCKET PENETROMETER OR TORVANE ESTIMATED UNCONFINED COMPRESSIVE STRENGTH, TONS PER SQ. FOOT

McBride-Ratcliff and Associates Inc.

LOG OF BORING

PROJECT: New Braunfels Landfill
Comal County, Texas

CLIENT: Waste Management of North America
Houston, Texas

BORING NO. CB-3
FILE NO. 87-051
DATE 2-9-87

DRY AUGERED 0 TO 40 FEET
WASH BORED 40 TO 60 FEET

FREE WATER ENCOUNTERED YES NO

AT FT. DEPTH.

WATER AT FT. AFTER

SOIL SYMBOL	DEPTH (feet)	SAMPLES	Penetration Resistance (N) or TSF	Moisture Content %	Dry Density, PCF	Compressive Strength TSF	Failure Strain %	Atterberg Limits: Liquid LL	Atterberg Limits: Plastic PL	Atterberg Limits: Plasticity Index PI	Minus No. 200 Sieve - %	DESCRIPTION OF STRATUM
												Hard, tan and gray, CLAY (CH) w/gypsum seams
	45		4.5+	31								
	50		4.5+					83	37	46		
	55		4.5+	30								
	60		4.5+					79	39	40		
												Completion Depth 60'

* SLICKENSIDED FAILURE
( ) CONFINING PRESSURE, PSI
G.S. GRAIN SIZE

PENETRATION RESISTANCE
(N) - STANDARD PENETRATION RESISTANCE (SPT)
TSF - POCKET PENETROMETER OR TORVANE ESTIMATED UNCONFINED COMPRESSIVE STRENGTH, TONS PER SQ. FOOT

McBride-Ratcliff and Associates, Inc.

LOG OF BORING

PROJECT: New Braunfels Landfill
Comal County, Texas

CLIENT: Waste Management of North America
Houston, Texas

BORING NO. CB-4
FILE NO. 87-051
DATE 2-9-87

DRY AUGERED 0 TO 13 FEET
WASH BORED 13 TO 40 FEET

FREE WATER ENCOUNTERED YES NO

AT FT. DEPTH.

WATER AT FT. AFTER

Depth (feet)	Penetration Resistance (N) or TSF	Moisture Content %	Dry Density, PCF	Compressive Strength TSF	Failure Strain %	Liquid LL	Plastic PL	Plasticity Index PI	Minus No. 200 Sieve - %	DESCRIPTION OF STRATUM
	2.25	34				71	27	44		Very stiff, black, CLAY (CH) w/calcareous modules
5	1.50	30								
										Firm, black, clayey GRAVEL
10	4.5+	13								Hard, tan and light gray, SILTY CLAY (CL)
15	N=50+									
20	4.5+	15								
25	4.5+					41	19	22		
30	4.5+	17								
										-dark gray, fissile
35	4.5+	17								
40	4.5+					39	19	20		

• SLICKENSIDED FAILURE
( ) CONFINING PRESSURE, PSI
G.S. GRAIN SIZE

PENETRATION RESISTANCE
(N) - STANDARD PENETRATION RESISTANCE (SPT)
TSF - POCKET PENETROMETER OR TORVANE ESTIMATED UNCONFINED COMPRESSIVE STRENGTH, TONS PER SQ. FOOT

PROJECT: New Braunfels Landfill
Comal County, Texas

CLIENT: Waste Management of North America
Houston, Texas

BORING NO. CB-4
FILE NO. 87-051
DATE 2-9-87

DRY AUGERED 0 TO 13 FEET
WASH BORED 13 TO 60 FEET

FREE WATER ENCOUNTERED YES NO

AT FT. DEPTH.

WATER AT FT. AFTER

SOIL SYMBOL	DEPTH (feet)	SAMPLES	Penetration Resistance (N) or TSF	Moisture Content %	Dry Density, PCF	Compressive Strength TSF	Failure Strain %	Liquid LL	Plastic PL	Plasticity Index PI	Minus No. 200 Sieve - %	DESCRIPTION OF STRATUM
												Hard, dark gray, SILTY CLAY (CL)
	45		4.5+	16								
	50		4.5+	17								
	55		4.5+	15								
	60		4.5+	16								Completion Depth 60'

* SLICKENSIDED FAILURE
( ) CONFINING PRESSURE, PSI
G.S. GRAIN SIZE

PENETRATION RESISTANCE
(N) - STANDARD PENETRATION RESISTANCE (SPT)
TSF - POCKET PENETROMETER OR TORVANE ESTIMATED UNCONFINED COMPRESSIVE STRENGTH, TONS PER SQ. FOOT

McBride-Ratcliff and Associates, Inc.

PROJECT: New Braunfels Landfill
Comal County, Texas

CLIENT: Waste Management of North America
Houston, Texas

BORING NO. CB-5
FILE NO. 87-051
DATE 2-10-87

DRY AUGERED 0 TO 15 FEET
WASH BORED 15 TO 60 FEET

FREE WATER ENCOUNTERED YES NO

AT FT. DEPTH.

WATER AT FT. AFTER

Depth (feet)	Penetration Resistance (N) or TSF	Moisture Content %	Dry Density, PCF	Compressive Strength TSF	Failure Strain %	Liquid LL	Plastic PL	Plasticity Index PI	Minus No. 200 Sieve - %	Description of Stratum
0–5	1.5	40				89	35	54		Stiff, black, CLAY (CH)
	1.5	17								
5–7.5										Firm, black, clayey, GRAVEL
7.5–40	4.5+	16								Hard, tan and light gray, SILTY CLAY (CL)
	4.5+					29	17	12		
	4.5+									
	4.5+	15								
										-dark gray below 27'
	4.5+					40	18	22		
	4.5+	16								
	4.5+	18								

* SLICKENSIDED FAILURE
( ) CONFINING PRESSURE, PSI
G.S. GRAIN SIZE

PENETRATION RESISTANCE
(N) - STANDARD PENETRATION RESISTANCE (SPT)
TSF - POCKET PENETROMETER OR TORVANE ESTIMATED UNCONFINED COMPRESSIVE STRENGTH, TONS PER SQ. FOOT

McBride-Ratcliff and Associates, Inc.

PROJECT: New Braunfels Landfill
Comal County, Texas

CLIENT: Waste Management of North America
Houston, Texas

BORING NO. CB-5
FILE NO. 87-051
DATE 2-11-87

DRY AUGERED 0 TO 40 FEET
WASH BORED 15 TO 60 FEET

FREE WATER ENCOUNTERED YES NO

AT FT. DEPTH.

WATER AT FT. AFTER

Depth (feet)	Penetration Resistance (N) or TSF	Moisture Content %	Dry Density, PCF	Compressive Strength TSF	Failure Strain %	Liquid LL	Plastic PL	Plasticity Index PI	Minus No. 200 Sieve - %	Description of Stratum
										Hard, dark gray, SILTY CLAY (CL)
44	4.5+					37	17	20		
45										
49–50	N=50+ 4.5 +	16 •								
54–55	N=50+ 4.5+					43	19	24		
59	4.5+	14								
60										Completion Depth 60'

• SLICKENSIDED FAILURE
( ) CONFINING PRESSURE, PSI
G.S. GRAIN SIZE

PENETRATION RESISTANCE
(N) - STANDARD PENETRATION RESISTANCE (SPT)
TSF - POCKET PENETROMETER OR TORVANE ESTIMATED UNCONFINED COMPRESSIVE STRENGTH, TONS PER SQ. FOOT

McBride-Ratcliff and Associates, Inc.

SOIL BOREHOLE LOG

SITE NAME AND LOCATION Comal Co. Landfill South of FM 1101 on Kohlenberg Ln. #2 New Braunfels, Texas	DRILLING METHOD: Dry Auger 0-80.0' SAMPLING METHOD: 0-10' Continuous 10-80' @ 5' intervals	BORING NO. B-6 SHEET 1 OF 3

DRILLING	START	FINISH
TIME	7:30	3:45
DATE	11/17/	11/17/87

WATER LEVEL				
TIME				
DATE				
CASING DEPTH				

DATUM MSL ELEVATION 638

DRILL RIG SIMCO 2800

ANGLE Level BEARING ENE

SAMPLE HAMMER TORQUE FT.-LBS

SURFACE CONDITIONS Damp tan & light gray, black CLAY w/chert gravel & cobbles. No vegetation.

DEPTH IN FEET (ELEVATION)	BLOWS/ 6 IN. ON SAMPLER (RECOVERY)	SYMBOL	SAMPLE NUMBER AND DESCRIPTION OF MATERIAL	SAMPLER AND BIT	CASING TYPE	BLOWS/FOOT ON CASING	WATER CONTENT %	LIQUID LIMIT %	PLASTIC LIMIT %	SPECIFIC GRAVITY	~~OTHER TESTS~~ -200
	(27%)		#1 Medium tan & light gray CLAY (CH) "FILL" below 2" of soft black clay								
	(27%)		#2 Medium black CLAY								
5	(27%)		#3 Medium black CLAY				40	103	38		
	(24%)		#4 Very stiff tan & light gray CLAY (CH)								
10	(64%)		#5 Hard tan & light gray CLAY w/occasional silt partings & verticle gypsum partings				30				
15	(56%)		#6 Very stiff tan & light gray CLAY w/gypsum partings & pockets								
20	(60%)		#7 Hard tan & light gray CLAY w/occasional gypsum partings				33	82	38		
25	(68%)		#8 Very stiff gray & tan CLAY w/frequent ferrous partings & occasional gypsum partings								
30	(76%)		#9 Hard black CLAY w/frequent gypsum & occasional silt partings				32				
35	(76%)		#10 Hard tan & gray CLAY w/frequent gypsum & occasional ferrous partings, slickensides								

DRILLING CONTR Coretech Sam Ramirez

LOGGED BY Jeff Thompson CHK'D BY

DATE 11-17-87

SL03951

SOIL BOREHOLE LOG

SITE NAME AND LOCATION	~~C~~omal Co. Landfill ~~S~~outh of FM 1101 on Kohlenberg Ln. #2 ~~N~~ew Braunfels, Texas
DRILLING METHOD:	Dry Auger 0-80'
SAMPLING METHOD:	0-10' Continuous 10-80' @ 5' intervals
BORING NO.	B-6
SHEET	2 OF 3
DRILLING START TIME / DATE	7:30am / 11-17
DRILLING FINISH TIME / DATE	3:45pm / 11-17-87
WATER LEVEL / TIME / DATE / CASING DEPTH	
DATUM	MSL
ELEVATION	638
DRILL RIG	SIMCO 2800
SURFACE CONDITIONS	see page 1
ANGLE	Level
BEARING	ENE
SAMPLE HAMMER TORQUE	FT.-LBS

DEPTH IN FEET (ELEVATION)	BLOWS/ 6 IN. ON SAMPLER (RECOVERY)	SYMBOL	SAMPLE NUMBER AND DESCRIPTION OF MATERIAL	SAMPLER AND BIT	CASING TYPE	BLOWS/FOOT ON CASING	WATER CONTENT %	LIQUID LIMIT %	PLASTIC LIMIT %	SPECIFIC GRAVITY	OTHER TESTS
40	(56%)		#11 Hard black to dark gray CLAY (CH) w/ occasional gypsum & ferrous partings, slickensides				31	97	34		
45	(78%)		#12 Hard black to tan & gray CLAY w/frequent ferrous & occasional gypsum partings, slickensides								
50	(78%)		#13 Hard black CLAY (CH) w/occasional ferrous partings, laminated				30				
55	(65%)		#14 Hard black CLAY w/frequent silt partings, laminated				28	97	40		
60	(48%)		#15 Hard black CLAY w/occasional silt partings & laminated, slickensides				29				
65	(52%)		#16 Hard black CLAY w/frequent silt partings, laminated, slickensides								
70	(22%)		#17 Hard black CLAY w/frequent silt partings, laminated, slickensides				25	87	31		

DRILLING CONTR. Sam Ramirez Coretech

SL03952

LOGGED BY Jeff Thompson CHK'D BY

DATE 11-17-87

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SOIL BOREHOLE LOG

SITE NAME AND LOCATION	DRILLING METHOD:	BORING NO.
Comal Co. Landfill South of FM 1101 on Kohlenberg Ln. #3 New Braunfels, Texas	Dry Auger 0-80'	B-6
	SAMPLING METHOD: 0-10' Continuous 10-80' @ 5' intervals	SHEET 3 OF 3

WATER LEVEL				
TIME				
DATE				
CASING DEPTH				

DRILLING	START	FINISH
TIME	7:30am	3:45pm
DATE	11-17	11-17-87

DATUM MSL ELEVATION 638

DRILL RIG SIMCO

SURFACE CONDITIONS See page 1

ANGLE Level BEARING ENE

SAMPLE HAMMER TORQUE FT.-LBS

DEPTH IN FEET (ELEVATION)	BLOWS/ 6 IN. ON SAMPLER (RECOVERY)	SYMBOL	SAMPLE NUMBER AND DESCRIPTION OF MATERIAL	SAMPLER AND BIT	CASING TYPE	BLOWS/FOOT ON CASING	WATER CONTENT %	LIQUID LIMIT %	PLASTIC LIMIT %	SPCIFIC GRAVITY	~~OTHER TESTS~~ 200
75	(61%)		#18 Hard black CLAY (CH) w/slickensides & laminae								
80	(30%)		#19 Hard gray sandy CLAY (CL) w/frequent gypsum partings, laminae				12	39	19		82%
			Bottom @ 80'								

DRILLING CONTR Sam Ramirez

LOGGED BY Jeff Thompson

Printed on recycled paper.

SOIL BOREHOLE LOG

SITE NAME AND LOCATION al Co. Landfill th of FM 1101 on Kohlenberg Ln. #2 w Braunfels, Texas	DRILLING METHOD: Dry Auger 0-80' SAMPLING METHOD: 0-10' Continuous 10-80' @ 5' intervals	BORING NO. B-7 SHEET 1 OF 3
DATUM MSL ELEVATION 664	WATER LEVEL / TIME / DATE / CASING DEPTH	DRILLING START TIME 3:55pm DATE 11-17; FINISH TIME 11:20am DATE 11-18-87
DRILL RIG SIMCO	SURFACE CONDITIONS Damp tan & gray CLAY w/limestone & chert cobbles	
ANGLE Level BEARING NW		
SAMPLE HAMMER TORQUE FT.-LBS		

DEPTH IN FEET (ELEVATION)	BLOWS/ 6 IN. ON SAMPLER (RECOVERY)	SYMBOL	SAMPLE NUMBER AND DESCRIPTION OF MATERIAL	SAMPLER AND BIT	CASING TYPE	BLOWS/FOOT ON CASING	WATER CONTENT %	LIQUID LIMIT %	PLASTIC LIMIT %	SPECIFIC GRAVITY	~~OTHER TESTS~~ 200
	(39%)		#1 Hard tan & light gray CLAY (CH) w/gravel FILL				30				
	(39%)		#2 Very stiff black CLAY w/sand & gravel-FILL								
5	(39%)		#3 Stiff light gray CLAY w/sand & gravel & calcareous pockets. Tan CLAY @ 6'				40				
	(52%)		#4 Stiff tan CLAY (CH) w/occasional calcareous pockets. Tan & light gray CLAY @ 8'								
10	(52%)		#5 Very stiff tan CLAY w/gypsum seams & calcareous nodules, slickensides				38				
15	(52%)		#6 Very stiff tan CLAY					76	36		
20	(65%)		#7 Very stiff tan CLAY w/frequent gypsum partings, slickensides				34				
25	(78%)		#8 Very stiff tan CLAY w/frequent gypsum partings, slickensides								
30	(78%)		#9 Very stiff tan CLAY w/frequent gypsum partings, slickensides				35	93	38		
35	(83%)		#10 Hard tan & light gray CLAY w/frequent gypsum partings, slickensides								

DRILLING CONTR. Sam Ramirez Coretech

LOGGED BY Jeff Thompson CHK'D BY

DATE 11-17-87

SL03954

Printed on recycled paper.

SOIL BOREHOLE LOG

SITE NAME AND LOCATION
Comal Co. Landfill
South of FM 1101 on Kohlenberg Ln. #2
New Braunfels, Texas

DATUM MSL ELEVATION 664

DRILLING METHOD: Dry Auger 0-80'

SAMPLING METHOD: 0-10' Continuous
10-80' @ 5' intervals

BORING NO. B-7

SHEET 2 OF 3

DRILLING	
START	FINISH
TIME 3:55pm	TIME 11:20am
DATE 11-17	DATE 11-18-87

WATER LEVEL				
TIME				
DATE				
CASING DEPTH				

DRILL RIG SIMCO 2800

SURFACE CONDITIONS See page 1

ANGLE Level BEARING NW

SAMPLE HAMMER TORQUE FT.-LBS

DRILLING CONTR. Sam Ramirez Coretech

LOGGED BY Jeff Thompson

DEPTH IN FEET (ELEVATION)	BLOWS/ 6 IN. ON SAMPLER (RECOVERY)	SYMBOL	SAMPLE NUMBER AND DESCRIPTION OF MATERIAL	SAMPLER AND BIT	CASING TYPE	BLOWS/FOOT ON CASING	WATER CONTENT %	LIQUID LIMIT %	PLASTIC LIMIT %	SPECIFIC GRAVITY	~~OTHER TESTS~~ -200
40	(83%)		#11 Hard brown CLAY (CH) w/frequent silt partings				32				
45	(83%)		#12 Hard brown CLAY w/frequent silt partings & occasional gypsum partings				--	97	40		
50	(83%)		#13 Hard dark gray CLAY (CH) w/frequent silt partings, occasional ferrous partings, laminae, slickensides				30				
55	(74%)		#14 Hard dark gray CLAY w/frequent silt partings,				29	107	34		
60	(74%)		#15 Hard gray CLAY w/slickensides from 58' to 59.5'. Dark gray CLAY w/occasional silt partings from 59.5' - 60'. Separated by 1" ferrous seam.				29				
65	(61%)		#16 Hard gray CLAY					105	34		
70	(35%)		#17 Hard gray CLAY				28				

Printed on recycled paper.

SOIL BOREHOLE LOG

SITE NAME AND LOCATION	Comal Co. Landfill South of FM 1101 on Kohlenberg Ln. #2 New Braunfels, Texas
DRILLING METHOD:	Dry Auger 0-80'
SAMPLING METHOD:	0-10' Continuous 10-80' @ 5' intervals
BORING NO.	B-7
SHEET	3 OF 3
DRILLING START TIME	3:55pm
DRILLING FINISH TIME	11:20am
START DATE	11-17
FINISH DATE	11-18-87
WATER LEVEL	
TIME	
DATE	
CASING DEPTH	
DATUM	MSL
ELEVATION	664
DRILL RIG	SIMCO 2800
SURFACE CONDITIONS	See page 1
ANGLE	Level
BEARING	NW
SAMPLE HAMMER TORQUE	FT.-LBS
DRILLING CONTR	Sam Ramirez
LOGGED BY	Jeff Thompson

DEPTH IN FEET (ELEVATION)	BLOWS/6 IN. ON SAMPLER (RECOVERY)	SYMBOL	SAMPLE NUMBER AND DESCRIPTION OF MATERIAL	SAMPLER AND BIT	CASING TYPE	BLOWS/FOOT ON CASING	WATER CONTENT %	LIQUID LIMIT %	PLASTIC LIMIT %	SPECIFIC GRAVITY	~~OTHER TESTS~~ 200
75	(35%)		#18 Hard gray CLAY (CH) laminated, slickensides								
80	(29%)		#19 Hard gray CLAY, laminated & slickensides								
			Bottom @ 80'								

Printed on recycled paper.

SOIL BOREHOLE LOG

SITE NAME AND LOCATION	·mal Co. Landfill South of FM 1101 on Kohlenberg Ln. #2 New Braunfels, Texas
DRILLING METHOD:	Dry Auger 0-70' NX coring 70'-80'
SAMPLING METHOD:	0-10' Continuous 10'-80' @ 5' intervals
BORING NO.	B-8
SHEET	1 OF 3
DRILLING START TIME	9:10am
DRILLING START DATE	11-21
DRILLING FINISH TIME	11:15am
DRILLING FINISH DATE	11-24-87
WATER LEVEL	
TIME	
DATE	
CASING DEPTH	
DATUM	MSL
ELEVATION	638
DRILL RIG	SIMCO 2800
ANGLE	Level
BEARING	E
SAMPLE HAMMER TORQUE	FT.-LBS
SURFACE CONDITIONS	Dry black CLAY w/chert gravel & cobbles. FILL
DRILLING CONTR.	Sam Ramirez Coretech
LOGGED BY	Jeff Thompson

DEPTH IN FEET (ELEVATION)	BLOWS/6 IN. ON SAMPLER (RECOVERY)	SYMBOL	SAMPLE NUMBER AND DESCRIPTION OF MATERIAL	SAMPLER AND BIT	CASING TYPE	BLOWS/FOOT ON CASING	WATER CONTENT %	LIQUID LIMIT %	PLASTIC LIMIT %	SPECIFIC GRAVITY	200
	(94%)		#1 Hard black & tan CLAY (CH) FILL from 0-1'				31				
	(46%)		#2 Hard tan & gray CLAY (CH)					95	34		
5	12/30 28(94%)		#3 Very dense chert GRAVEL (GW) w/minor amounts of clay								
	4/5/9 (83%)		#4 Very stiff tan & light gray silty CLAY w/gravel (CL)				18				
10	(94%)		#5 Hard tan & light gray silty CLAY w/chalk pockets								
15	(29%)		#6 Hard tan & light gray CLAY (CH) w/frequent chalk pockets				31				
20	(46%)		#7 Hard light gray CLAY w/occasional chalk pockets				18				
25	(69%)		#8 Hard light gray & light tan CLAY				19	58	20		
30	(71%)		#9 Hard light gray & light tan CLAY				18				
35	(66%)		#10 Hard light gray & light tan CLAY				18	58	19		

SOIL BOREHOLE LOG

SITE NAME AND LOCATION	DRILLING METHOD: Dry Auger 0-70' NX coring 70'-80'	BORING NO. B-8
mal Co. Landfill uth of FM 1101 on Kohlenberg Ln. #2 New Braunfels, Texas	SAMPLING METHOD: 0-10' Continuous 10'-80' @ 5' intervals	SHEET 2 OF 3
DATUM MSL ELEVATION 638	WATER LEVEL / TIME / DATE / CASING DEPTH	DRILLING START TIME 9:10am, DATE 11-21; FINISH TIME 11:15am, DATE 11-24-87
DRILL RIG SIMCO 2800	SURFACE CONDITIONS See page 1	
ANGLE Level BEARING E		
SAMPLE HAMMER TORQUE FT.-LBS		

DEPTH IN FEET (ELEVATION)	BLOWS/ 6 IN. ON SAMPLER (RECOVERY)	SYMBOL	SAMPLE NUMBER AND DESCRIPTION OF MATERIAL	SAMPLER AND BIT	CASING TYPE	BLOWS/FOOT ON CASING	WATER CONTENT %	LIQUID LIMIT %	PLASTIC LIMIT %	SPECIFIC GRAVITY	~~OTHER TESTS~~ 200
40	(69%)		#11 Hard light tan CLAY (CH) laminated				20				
45	(74%)		#12 Hard tan CLAY, laminated, w/gypsum seams				23				
50	(29%)		#13 Hard gray CLAY (CH) laminated, very dry				17				
55	(17%)		#14 Hard gray CLAY					57	18		
60	(0%)		NO RECOVERY								
65	(0%)		NO RECOVERY								
70	(0%)		NO RECOVERY								

DRILLING CONTR. Coretech Sam Ramirez

LOGGED BY Jeff Thompson CHK'D BY

DATE 11-21-87

SL03974

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SOIL BOREHOLE LOG

SITE NAME AND LOCATION	DRILLING METHOD: Dry Auger 0-80'	BORING NO. .B-8
omal Co. Landfill outh of FM 1101 on Kohlenberg Ln. #2 New Braunfels, Texas	SAMPLING METHOD: 0-10' Continuous 10'-80' @ 5' intervals	SHEET 3 OF 3
DATUM MSL ELEVATION 638	WATER LEVEL / TIME / DATE / CASING DEPTH	DRILLING START TIME 9:10am, DATE 11-21; FINISH TIME 11:15am, DATE 11-24-87
DRILL RIG SIMCO 2800	SURFACE CONDITIONS See page 1	
ANGLE Level BEARING E		
SAMPLE HAMMER TORQUE FT.-LBS		

DRILLING CONTR Sam Ramirez

DEPTH IN FEET (ELEVATION)	BLOWS/ 6 IN. ON SAMPLER (RECOVERY)	SYMBOL	SAMPLE NUMBER AND DESCRIPTION OF MATERIAL	SAMPLER AND BIT	CASING TYPE	BLOWS/FOOT ON CASING	WATER CONTENT %	LIQUID LIMIT %	PLASTIC LIMIT %	SPCIFIC GRAVITY	OTHER TESTS 200
75	(100%		#15 Hard gray CLAY (CH) w/strong organic or hydrocarbon odor								
80	(100%		#16 Hard gray CLAY								
			Bottom @ 80'								

LOGGED BY Jeff Thompson

Printed on recycled paper.

SOIL BOREHOLE LOG

SITE NAME AND LOCATION	al Co. Landfill ch of FM 1101 on Kohlenberg Ln. #2 New Braunfels, Texas
DRILLING METHOD:	Dry Auger 0-58' NX coring 58'-80'
SAMPLING METHOD:	0-10' Continuous 10'-80' @ 5' intervals
BORING NO.	B-9
SHEET	1 OF 3
DRILLING START TIME	11:55am
DRILLING FINISH TIME	1:15pm
START DATE	11-24
FINISH DATE	11-25-87
WATER LEVEL	
TIME	
DATE	
CASING DEPTH	
DATUM	MSL
ELEVATION	640
DRILL RIG	SIMCO 2800
ANGLE	5°
BEARING	W
SAMPLE HAMMER TORQUE	FT.-LBS
SURFACE CONDITIONS	Dry black clay FILL w/chert gravel & cobbles

DEPTH IN FEET (ELEVATION)	BLOWS/6 IN ON SAMPLER (RECOVERY)	SYMBOL	SAMPLE NUMBER AND DESCRIPTION OF MATERIAL	SAMPLER AND BIT	CASING TYPE	BLOWS/FOOT ON CASING	WATER CONTENT %	LIQUID LIMIT %	PLASTIC LIMIT %	SPECIFIC GRAVITY	OTHER TESTS 200
	(100%)		#1 Hard black CLAY (CH) FILL w/chert gravel & cobbles				17				
	(88%)		#2 Hard black CLAY FILL w/chert gravel & cobbles								
5	(18%)		#3 Hard black CLAY FILL to 5'								
	(76%)		#4 Hard black CLAY (CH)								
	(65%)		#5 Hard dark gray CLAY w/sand, gravel, & cobbles								
10											
15	(18%)		#6 Hard dry light tan silty CLAY (CL) w/frequent chalk partings								
20	(71%)		#7 Hard light tan & light gray CLAY (CH)								
25	(88%)		#8 Hard light tan & light gray CLAY				18	54	19		
30	(65%)		#9 Hard light tan CLAY w/minute ferrous particles				19				
35	(71%)		#10 Hard light tan CLAY w/minute ferrous particles				17				

DRILLING CONTR. Coretech Sam Ramirez

SL03973

LOGGED BY Jeff Thompson CHK'D BY

DATE 11-24-87

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SOIL BOREHOLE LOG

SITE NAME AND LOCATION	Comal Co. Landfill South of FM 1101 on Kohlenberg Ln. #2 New Braunfels, Texas
DRILLING METHOD:	Dry Auger 0-58' NX coring 58'-80'
SAMPLING METHOD:	0-10' Continuous 10'-80' @ 5' intervals
BORING NO.	B-9
SHEET	2 OF 3
DRILLING START TIME	11:55am
DRILLING FINISH TIME	1:15pm
START DATE	11-24
FINISH DATE	11-25-87
WATER LEVEL	
TIME	
DATE	
CASING DEPTH	
DATUM	MSL
ELEVATION	640
DRILL RIG	SIMCO 2800
SURFACE CONDITIONS	See page 1
ANGLE	5°
BEARING	W
SAMPLE HAMMER TORQUE	FT.-LBS

DRILLING CONTR Sam Ramirez

LOGGED BY Jeff Thompson

DEPTH IN FEET (ELEVATION)	BLOWS/ 6 IN. ON SAMPLER (RECOVERY)	SYMBOL	SAMPLE NUMBER AND DESCRIPTION OF MATERIAL	SAMPLER AND BIT	CASING TYPE	BLOWS/FOOT ON CASING	WATER CONTENT %	LIQUID LIMIT %	PLASTIC LIMIT %	SPCIFIC GRAVITY	200
40	(65%)		#11 Hard tan CLAY (CH) w/occasional gypsum pockets				18	60	21		
45	(47%)		#12 Stiff tan & gray CLAY				33	72	25		
50	(36%)		#13 Hard tan & gray CLAY (CH) very thinly bedded				19	63	23		
55	(0%)		NO RECOVERY								
60	(100%)		#14 Hard gray CLAY, massively bedded								
65	(100%)		#15 Hard gray CLAY, massive, structureless								
70	(100%)		#16 Hard gray CLAY w/occasional gypsum partings								

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SOIL BOREHOLE LOG

SITE NAME AND LOCATION	omal Co. Landfill South of FM 1101 on Kohlenberg Ln. #2 New Braunfels, Texas
DRILLING METHOD:	Dry Auger 0-58' NX coring 58'-80'
SAMPLING METHOD:	0-10' Continuous 10'-80' @ 5' intervals
BORING NO.	B-9
SHEET	3 OF 3
DRILLING START TIME	11:55am
DRILLING FINISH TIME	1:15pm
START DATE	11-24
FINISH DATE	11-25-87
WATER LEVEL / TIME / DATE / CASING DEPTH	
DATUM	MSL
ELEVATION	640
DRILL RIG	SIMCO 2800
SURFACE CONDITIONS	See page 1
ANGLE	5°
BEARING	W
SAMPLE HAMMER TORQUE	FT.-LBS

DRILLING CONTR Sam Ramirez

DEPTH IN FEET (ELEVATION)	BLOWS/ 6 IN. ON SAMPLER (RECOVERY)	SYMBOL	SAMPLE NUMBER AND DESCRIPTION OF MATERIAL	SAMPLER AND BIT	CASING TYPE	BLOWS/FOOT ON CASING	WATER CONTENT %	LIQUID LIMIT %	PLASTIC LIMIT %	SPCIFIC GRAVITY	~~OTHER TESTS~~ 200
75	(100%)		#17 Hard gray CLAY (CH) massive w/occasional gypsum parting								
80	(100%)		#18 Hard gray CLAY								
			Bottom @ 80'								

LOGGED BY Jeff Thompson

Printed on recycled paper.

SOIL BOREHOLE LOG

SITE NAME AND LOCATION	ɔmal Co. Landfill ɔouth of FM 1101 on Kohlenberg Ln. #2 New Braunfels, Texas
DRILLING METHOD:	Dry Auger 0-68' NX coring 68'-80'
SAMPLING METHOD:	
BORING NO.	B-10
SHEET	1 OF 3
DRILLING START TIME	1:55pm
DRILLING FINISH TIME	12:45pm
START DATE	11-25
FINISH DATE	12-1-87
WATER LEVEL / TIME / DATE / CASING DEPTH	
DATUM	MSL
ELEVATION	642
DRILL RIG	SIMCO 2800
SURFACE CONDITIONS	Dry black CLAY w/chert cobbles. Abundant grass & shrubs w/2" of topsoil.
ANGLE	< 5°
BEARING	NW
SAMPLE HAMMER TORQUE	FT.-LBS

DEPTH IN FEET (ELEVATION)	BLOWS/6 IN ON SAMPLER (RECOVERY)	SYMBOL	SAMPLE NUMBER AND DESCRIPTION OF MATERIAL	SAMPLER AND BIT	CASING TYPE	BLOWS/FOOT ON CASING	WATER CONTENT %	LIQUID LIMIT %	PLASTIC LIMIT %	SPECIFIC GRAVITY	~~OTHER TESTS~~ 200
	(100%)		#1 Hard black CLAY (CH) w/sand & gravel & calcareous nodules				17	70	27		
	(54%)		#2 Hard dark brown CLAY w/sand & gravel								
5	(17%)		#3 Hard light tan CLAY w/sand, gravel, & cobbles, & frequent calcareous pockets								
	(46%)		#4 Hard light tan CLAY (CH) w/calcareous nodules								
	(38%)		#5 Hard light tan & light gray CLAY w/silt pockets				15				
10											
15	(46%)		#6 Hard light tan & light gray CLAY					56	19		
20	(56%)		#7 Hard light tan CLAY				14				
25	(61%)		#8 Hard light gray & tan CLAY				16	59	20		
30	(77%)		#9 Hard light tan & gray CLAY				18				
35	(56%)		#10 Hard light gray & tan CLAY								

DRILLING CONTR. Coretech

Sam Ramirez

LOGGED BY Jeff Thompson

CHK'D BY

DATE 11-25-87

SL 03976

SOIL BOREHOLE LOG

SITE NAME AND LOCATION	ᴐmal Co. Landfill outh of FM 1101 on Kohlenberg Ln. #2 New Braunfels, Texas
DATUM	MSL
ELEVATION	642
DRILLING METHOD:	Dry Auger 0-68' NX coring 68'-80'
SAMPLING METHOD:	0-10' Continuous 10'-80' @ 5' intervals
BORING NO.	B-10
SHEET	2 OF 3
DRILLING START TIME	11:55pm
DRILLING FINISH TIME	12:45pm
DRILLING START DATE	11-25
DRILLING FINISH DATE	12-1-87
WATER LEVEL / TIME / DATE / CASING DEPTH	
DRILL RIG	SIMCO 2800
ANGLE	< 5°
BEARING	NW
SAMPLE HAMMER TORQUE	FT.-LBS
SURFACE CONDITIONS	See page 1
DRILLING CONTR	Sam Ramirez
LOGGED BY	Jeff Thompson

DEPTH IN FEET (ELEVATION)	BLOWS/ 6 IN. ON SAMPLER (RECOVERY)	SYMBOL	SAMPLE NUMBER AND DESCRIPTION OF MATERIAL	SAMPLER AND BIT	CASING TYPE	BLOWS/FOOT ON CASING	WATER CONTENT %	LIQUID LIMIT %	PLASTIC LIMIT %	SPCIFIC GRAVITY	~~OTHER TESTS~~ 200
40	(56%)		#11 Hard tan & gray CLAY (CH)				18	59	20		
45	(22%)		#12 Very stiff tan & gray CLAY				20				
50	(33%)		#13 Hard tan & gray CLAY				16				
55	(44%)		#14 Hard tan & gray CLAY w/occasional gypsum seams				20	68	23		
60	(44%)		#15 Hard gray CLAY (CH)				18				
65	(0%)										
70	(100%)		#16 Hard gray CLAY, slickensided				11	54	24		

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SOIL BOREHOLE LOG

SITE NAME AND LOCATION: ...mal Co. Landfill ...outh of FM 1101 on Kohlenberg Ln. #2 New Braunfels, Texas	DRILLING METHOD: Dry Auger 0-68' NX coring 68'-80' SAMPLING METHOD: 0-10' Continuous 10'-80' @ 5' intervals	BORING NO. B-10 SHEET 3 OF 3

WATER LEVEL				
TIME				
DATE				
CASING DEPTH				

DRILLING	
START	FINISH
TIME 1:55pm	TIME 12:45pm
DATE 11-25	DATE 12-1-87

DATUM MSL ELEVATION 642

DRILL RIG SIMCO 2800

ANGLE < 5° BEARING NW

SAMPLE HAMMER TORQUE FT.-LBS

SURFACE CONDITIONS See page 1

DEPTH IN FEET (ELEVATION)	BLOWS/ 6 IN. ON SAMPLER (RECOVERY)	SYMBOL	SAMPLE NUMBER AND DESCRIPTION OF MATERIAL	SAMPLER AND BIT	CASING TYPE	BLOWS/FOOT ON CASING	WATER CONTENT %	LIQUID LIMIT %	PLASTIC LIMIT %	SPECIFIC GRAVITY	~~OTHER~~ TESTS 200
75	(100%)		#17 Hard gray CLAY (CH) massive, slickensided								
80	(100%)		#18 Hard gray CLAY, massive, slickensided								
			Bottom @ 80'								

DRILLING CONTR. Sam Ramirez Coretech

SL113964

LOGGED BY Jeff Thompson CHK'D BY

DATE 12-1-87

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SOIL BOREHOLE LOG

SITE NAME AND LOCATION

.al Co. Landfill
.th of FM 1101 on Kohlenberg Ln. #2
New Braunfels, Texas

DRILLING METHOD: Dry Auger 0-75'

SAMPLING METHOD: 0-10' Continuous
10'-75' @ 5' intervals

BORING NO. B-11

SHEET 1 OF 3

DRILLING	
START	FINISH
TIME 3:25pm	TIME 11:50am
DATE 11-19	DATE 11-19-87

WATER LEVEL				
TIME				
DATE				
CASING DEPTH				

DATUM MSL ELEVATION 628

DRILL RIG SIMCO 2800

ANGLE Level BEARING W

SAMPLE HAMMER TORQUE FT.-LBS

SURFACE CONDITIONS Dry black CLAY @ surface w/ approximately 1" of dry loose top soil. Trees, shrubs & tall grass.

DEPTH IN FEET (ELEVATION)	BLOWS/ 6 IN. ON SAMPLER (RECOVERY)	SYMBOL	SAMPLE NUMBER AND DESCRIPTION OF MATERIAL	SAMPLER AND BIT	CASING TYPE	BLOWS/FOOT ON CASING	WATER CONTENT %	LIQUID LIMIT %	PLASTIC LIMIT %	SPECIFIC GRAVITY	~~OTHER TESTS~~ -200
	(59%)		#1 Hard black CLAY (CH) coarse gravel @ 1'								
	(59%)		#2 Hard black CLAY, w/fine to coarse sand & gravel				21	92	28		
5	13/24 18/32 26 (60)		#3 Very dense chert GRAVEL (GW)								
			#4 Very dense chert GRAVEL				8				20%
10	(59%)		#5 Very stiff tan CLAY (CH) w/frequent calcareous nodules				24				
15	(82%)		#6 Hard tan to brown CLAY w/frequent calcareous chalk pockets					106	32		
20	(94%)		#7 Hard tan & brown CLAY w/light gray clay partings & slickensides				28				
25	(94%)		#8 Hard tan & brown CLAY w/frequent gypsum partings & chalk seams, slickensides, occasional silt partings				31				
30	(94%)		#9 Hard tan & brown CLAY w/frequent gypsum partings								
35	(94%)		#10 Hard tan & brown CLAY w/frequent gypsum partings & frequent silt partings				30	110	36		

DRILLING CONTR Coretech Sam Ramirez

LOGGED BY Jeff Thompson CHK'D BY

DATE 11-19-87

SL03957

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SOIL BOREHOLE LOG

SITE NAME AND LOCATION	DRILLING METHOD:	BORING NO.
[?]omal Co. Landfill [S]outh of FM 1101 on Kohlenberg Ln. #2 New Braunfels, Texas	Dry Auger 0-75.5'	B-11
	SAMPLING METHOD: 0-10' Continuous 10'-85.5' @ 5' intervals	SHEET 2 OF 3

DRILLING START TIME	DRILLING FINISH TIME	START DATE	FINISH DATE
3:25pm	11:50am	11-19	11-20-87

WATER LEVEL				
TIME				
DATE				
CASING DEPTH				

DATUM MSL ELEVATION 628

DRILL RIG SIMCO 2800

SURFACE CONDITIONS See page 1

ANGLE Level BEARING W

SAMPLE HAMMER TORQUE FT.-LBS

DRILLING CONTR. Sam Ramirez

LOGGED BY Jeff Thompson

DATE 11-19-87

CHK'D BY

DEPTH IN FEET (ELEVATION)	BLOWS/ 6 IN. ON SAMPLER (RECOVERY)	SYMBOL	SAMPLE NUMBER AND DESCRIPTION OF MATERIAL	SAMPLER AND BIT	CASING TYPE	BLOWS/FOOT ON CASING	WATER CONTENT %	LIQUID LIMIT %	PLASTIC LIMIT %	SPECIFIC GRAVITY	OTHER TESTS 200
40	(82%)		#11 Hard brown CLAY (CH) w/frequent gypsum partings & occasional silt partings				29				
45	(65%)		#12 Hard tan & gray CLAY w/frequent silt partings & occasional gypsum partings								
50	(29%)		#13 Hard gray CLAY (CH) slickensided				17				
55	(41%)		#14 Hard gray CLAY, slickensided & crudely laminated				18	67	22		
60	(41%)		#15 Hard gray CLAY, slickensided & crudely laminated								
65	(35%)		#16 Hard gray CLAY, slickensided, crudely laminated w/organic or hydrocarbon odor					69	22		
70	(35%)		#17 Hard gray CLAY, slickensided & crudely laminated				17				

SL02050

SOIL BOREHOLE LOG

SITE NAME AND LOCATION	mal Co. Landfill uth of FM 1101 on Kohlenberg Ln. #2 New Braunfels, Texas
DRILLING METHOD:	Dry Auger 0-75.5'
SAMPLING METHOD:	0-10' Continuous 10'-75.5' @ 5' intervals
BORING NO.	B-11
SHEET	3 OF 3
DRILLING START TIME	3:55pm
DRILLING START DATE	11-19
DRILLING FINISH TIME	11:50am
DRILLING FINISH DATE	11-20-87
WATER LEVEL	
TIME	
DATE	
CASING DEPTH	
DATUM	MSL
ELEVATION	628
DRILL RIG	SIMCO 2800
SURFACE CONDITIONS	See page 1
ANGLE	Level
BEARING	W
SAMPLE HAMMER TORQUE	FT.-LBS

DEPTH IN FEET (ELEVATION)	BLOWS/ 6 IN. ON SAMPLER (RECOVERY)	SYMBOL	SAMPLE NUMBER AND DESCRIPTION OF MATERIAL	SAMPLER AND BIT	CASING TYPE	BLOWS/FOOT ON CASING	WATER CONTENT %	LIQUID LIMIT %	PLASTIC LIMIT %	SPCIFIC GRAVITY	~~OTHER TESTS~~ 200
75	50 Blows for 2.5"		No recovery. One small (½ square inch) piece of very hard CLAY (CH)								
			Bottom @ 75.5'								

DRILLING CONTR. Sam Ramirez Coratech

SL03959

LOGGED BY Jeff Thompson

CHK'D BY

DATE 11-20-87

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SOIL BOREHOLE LOG

SITE NAME AND LOCATION	Comal Co. Landfill South of FM 1101 on Kohlenberg Ln. #2 New Braunfels, Texas
DATUM	MSL
ELEVATION	642
DRILL RIG	SIMCO 2800
ANGLE	Level
BEARING	N
SAMPLE HAMMER TORQUE	FT.-LBS
DRILLING METHOD:	Dry Auger 0-80'
SAMPLING METHOD:	0-10' Continuous 10'-80' @ 5' intervals
BORING NO.	B-12
SHEET	1 OF 3
SURFACE CONDITIONS	Black clay & tan clay w/sand, gravel, & trash materials. Damp soil w/zero vegetation.

WATER LEVEL				
TIME				
DATE				
CASING DEPTH				

DRILLING	START	FINISH
TIME	12:15pm	6:05pm
DATE	11-20	11-20-87

Sam Ramirez

DRILLING CONTR

LOGGED BY Jeff Thompson

DEPTH IN FEET (ELEVATION)	BLOWS/6 IN. ON SAMPLER (RECOVERY)	SYMBOL	SAMPLE NUMBER AND DESCRIPTION OF MATERIAL	SAMPLER AND BIT	CASING TYPE	BLOWS/FOOT ON CASING	WATER CONTENT %	LIQUID LIMIT %	PLASTIC LIMIT %	SPECIFIC GRAVITY	~~OTHER TESTS~~ 200
	(0%)		#1 Auger sample, no recovery from shelby tube. Loose black & brown CLAY (CH) w/limestone sand, gravel & cobbles FILL								
	(35%)		#2 Medium black CLAY w/sand, gravel, & organics FILL				34				
5	(27%)		#3 Medium black CLAY w/sand, gravel, & organics FILL								
	(76%)		#4 Medium gray CLAY (CH) w/sand, gravel & cobbles w/1" calcareous chalk seam @ 8'				29				
10	(70%)		#5 Stiff gray CLAY (CH) w/frequent chalk partings & seams. Tan CLAY @ 9.5'								
15	(29%)		#6 Very stiff tan & light gray CLAY (CH) w/chert cobbles				32	78	26		
20	(41%)		#7 Very stiff tan & light gray CLAY (CH)								
25	(59%)		#8 Very stiff light brown CLAY w/occasional ferrous parting @ 20'				27				
30	(76%)		#9 Hard brown CLAY w/frequent gypsum partings & ferrous partings, slickensided					112	35		
35	(94%)		#10 Very stiff tan & light gray CLAY w/frequent gypsum partings & slickensided				36				

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SOIL BOREHOLE LOG

SITE NAME AND LOCATION Comal Co. Landfill South of FM 1101 on Kohlenberg Ln. #2 New Braunfels, Texas	DRILLING METHOD: Dry Auger 0-80' SAMPLING METHOD: 0-10' Continuous 10'-80' @ 5' intervals	BORING NO. B-12 SHEET 2 OF 3
DATUM MSL ELEVATION 642	WATER LEVEL / TIME / DATE / CASING DEPTH	DRILLING START TIME 11:55am, DATE 11-18; FINISH TIME 3:00pm, DATE 11-19-87
DRILL RIG SIMCO 2800	SURFACE CONDITIONS See page 1	
ANGLE Level BEARING N		
SAMPLE HAMMER TORQUE FT.-LBS		

DEPTH IN FEET (ELEVATION)	BLOWS/ 6 IN. ON SAMPLER (RECOVERY)	SYMBOL	SAMPLE NUMBER AND DESCRIPTION OF MATERIAL	SAMPLER AND BIT	CASING TYPE	BLOWS/FOOT ON CASING	WATER CONTENT %	LIQUID LIMIT %	PLASTIC LIMIT %	SPECIFIC GRAVITY	-200
40	(88%)		#11 Hard tan & brown CLAY (CH) slickensides w/ a single 1" thick gypsum seam					99	32		
45	(94%)		#12 Hard tan & brown CLAY w/frequent gypsum seams				38				
50	(88%)		#13 Hard tan & brown CLAY w/frequent gypsum seams & occasional silt partings				31	91	32		
55	(88%)		#14 Very stiff light brown & tan CLAY w/ frequent gypsum partings, many ferrous partings & slickensided					90	30		
60	(88%)		#15 Hard light brown & tan CLAY w/slickensides & frequent gypsum partings				29				
65	(41%)		#16 Hard black CLAY (CH) crudely laminated w/ occasional silt partings								
70	(15%)		#17 Hard gray CLAY, crudely laminated w/ occasional silt partings				34				

DRILLING CONTR Sam Ramirez

LOGGED BY Jeff Thompson

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SOIL BOREHOLE LOG

SITE NAME AND LOCATION	·mal Co. Landfill ·uth of FM 1101 on Kohlenberg Ln. #2 New Braunfels, Texas
DRILLING METHOD:	Dry Auger 0-80'
SAMPLING METHOD:	0-10' Continuous 10'-80' @ 5' intervals
BORING NO.	B-12
SHEET	3 OF 3
DRILLING START TIME	11:55am
DRILLING FINISH TIME	3:00pm
START DATE	11-18
FINISH DATE	11-19-87
DATUM	MSL
ELEVATION	642
DRILL RIG	SIMCO 2800
ANGLE	Level
BEARING	N
SAMPLE HAMMER TORQUE	FT.-LBS
SURFACE CONDITIONS	See page 1

WATER LEVEL				
TIME				
DATE				
CASING DEPTH				

DRILLING CONTR. Sam Ramirez Coretech

DEPTH IN FEET (ELEVATION)	BLOWS/6 IN. ON SAMPLER (RECOVERY)	SYMBOL	SAMPLE NUMBER AND DESCRIPTION OF MATERIAL	SAMPLER AND BIT	CASING TYPE	BLOWS/FOOT ON CASING	WATER CONTENT %	LIQUID LIMIT %	PLASTIC LIMIT %	SPCIFIC GRAVITY	~~OTHER TESTS~~ 200
75	(59%)		#18 Hard dark gray CLAY (CH) w/crude laminae, slickensided								
80	(35%)		#19 Hard dark gray CLAY w/crude laminae, slickesided				31				
			Bottom @ 80.0'								

SL03050

LOGGED BY Jeff Thompson CHK'D BY

DATE 11-19-87

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SOIL BOREHOLE LOG

SITE NAME AND LOCATION	nal Co. Landfill ıth of FM 1101 on Kohlenberg Ln. #2 New Braunfels, Texas
DATUM	MSL
ELEVATION	626
DRILL RIG	SIMCO 2800
ANGLE	Level
BEARING	ENE
SAMPLE HAMMER TORQUE	FT.-LBS
DRILLING METHOD:	Dry Auger 0-80'
SAMPLING METHOD:	0-10' Continuous 10'-80' @ 5' intervals
WATER LEVEL	
TIME	
DATE	
CASING DEPTH	
BORING NO.	;B-13
SHEET	1 OF 3
DRILLING START TIME	12:15pm
DRILLING FINISH TIME	6:05pm
DRILLING START DATE	11-20
DRILLING FINISH DATE	11-20-87
SURFACE CONDITIONS	Dry black clay supporting 3' tall grass shrubs & trees. Chert gravel & cobbles within the clay.

DEPTH IN FEET (ELEVATION)	BLOWS/ 6 IN. ON SAMPLER (RECOVERY)	SYMBOL	SAMPLE NUMBER AND DESCRIPTION OF MATERIAL	SAMPLER AND BIT	CASING TYPE	BLOWS/FOOT ON CASING	WATER CONTENT %	LIQUID LIMIT %	PLASTIC LIMIT %	SPECIFIC GRAVITY	~~OTHER TESTS~~ 200
	(94%)		#1 Stiff black CLAY (CH) w/organics & sand particles								
	(88%)		#2 Hard gray CLAY w/chert sand, gravel & cobbles				24				
5	17/19 24		#3 Dense chert GRAVEL (GW) cobbles w/chalk								
	4/5/7		#4 Firm chert GRAVEL & cobbles w/chalk								
	(88%)		#5 Very stiff tan CLAY (CH) w/frequent chalk partings. Light gray & tan CLAY @ 10'				26	86	27		
10											
15	(88%)		#6 Hard tan & brown CLAY w/slickensides					116	32		
20	(94%)		#7 Hard brown CLAY, friable, slickensided, occasional silt partings				32				
25	(94%)		#8 Hard brown CLAY, friable, slickensides occasional silt partings								
30	(94%)		#9 Very stiff brown & tan CLAY, slickensided w/occasional silt or gypsum partings				34	113	42		
35	(94%)		#10 Hard gray & brown CLAY, slickensided w/ occasional silt or gypsum partings				36				

DRILLING CONTR. Coretech Sam Ramirez

LOGGED BY Jeff Thompson

CHK'D BY

DATE 11-20-87

SL 03970

SOIL BOREHOLE LOG

SITE NAME AND LOCATION 'omal Co. Landfill .outh of FM 1101 on Kohlenberg Ln. #2 New Braunfels, Texas	DRILLING METHOD: Dry Auger 0-80' SAMPLING METHOD: 0-10' Continuous 10'-80' @ 5' intervals	BORING NO. B-13 SHEET 2 OF 3
DATUM MSL ELEVATION 626	WATER LEVEL / TIME / DATE / CASING DEPTH	DRILLING START TIME 12:15pm DATE 11-20 FINISH TIME 6:05pm DATE 11-20-87
DRILL RIG SIMCO 2800	SURFACE CONDITIONS See page 1	
ANGLE Level BEARING ENE		
SAMPLE HAMMER TORQUE FT.-LBS		

DEPTH IN FEET (ELEVATION)	BLOWS/6 IN. ON SAMPLER (RECOVERY)	SYMBOL	SAMPLE NUMBER AND DESCRIPTION OF MATERIAL	SAMPLER AND BIT	CASING TYPE	BLOWS/FOOT ON CASING	WATER CONTENT %	LIQUID LIMIT %	PLASTIC LIMIT %	SPECIFIC GRAVITY	OTHER TESTS 200
40	(94%)		#11 Hard brown & tan CLAY (CH) crudely laminated, w/frequent silt partings & gypsum seams.								
45	(94%)		#12 Hard brown & tan CLAY, crudely laminated, w/frequent silt partings & gypsum seams								
50	(94%)		#13 Very stiff brown CLAY w/frequent ferrous partings, silt partings & gypsum partings also slickensides				33				
55	(66%)		#14 Hard dark gray CLAY				32	97	37		
60	(66%)		#15 Hard dark gray CLAY (CH) crudely laminated w/occasional silt pockets				29	108	44		
65	(71%)		#16 Hard dark gray CLAY, very thinly bedded				27				
70	(56%)		#17 Hard dark gray CLAY, very thinly bedded								

DRILLING CONTR. Sam Ramirez

LOGGED BY Jeff Thompson

DATE 11-20-87

SL 02071

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SOIL BOREHOLE LOG

SITE NAME AND LOCATION Comal Co. Landfill uth of FM 1101 on Kohlenberg Ln. #2 w Braunfels, Texas	DRILLING METHOD: Dry Auger 0-80' SAMPLING METHOD: 0-10' Continuous 10'-80' @ 5' intervals	BORING NO. B-13 SHEET 3 OF 3
DATUM MSL	ELEVATION 626	

WATER LEVEL				
TIME				
DATE				
CASING DEPTH				

DRILLING	
START	FINISH
TIME 12:15pm	TIME 6:05pm
DATE 11-20	DATE 11-20-87

DRILL RIG SIMCO 2800 — SURFACE CONDITIONS See page 1

ANGLE Level — BEARING ENE

SAMPLE HAMMER TORQUE FT.-LBS

DEPTH IN FEET (ELEVATION)	BLOWS/ 6 IN ON SAMPLER (RECOVERY)	SYMBOL	SAMPLE NUMBER AND DESCRIPTION OF MATERIAL	SAMPLER AND BIT	CASING TYPE	BLOWS/FOOT ON CASING	WATER CONTENT %	LIQUID LIMIT %	PLASTIC LIMIT %	SPECIFIC GRAVITY	~~OTHER TESTS~~ 200
75	(53%)		#18 Hard dark gray CLAY (CH) very thinly bedded								
80	(53%)		#19 Hard dark gray CLAY, very thinly bedded				24				
			Bottom @ 80'								

DRILLING CONTR Coretech Sam Ramirez

SL03961

LOGGED BY Jeff Thompson CHK'D BY

DATE 11-20-87

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SOIL BOREHOLE LOG

SITE NAME AND LOCATION: 'omal Co. Landfill South of FM 1101 on Kohlenberg Ln. #2 New Braunfels, Texas	DRILLING METHOD: Dry Auger 0-28' NX coring 28'-50' SAMPLING METHOD: 0-10' Continuous 10'-50' @ 5' intervals	BORING NO. :B-14 SHEET 1 OF 2
DATUM MSL ELEVATION 604	WATER LEVEL / TIME / DATE / CASING DEPTH	DRILLING START: TIME 12:40pm, DATE 12-3 FINISH: TIME 9:00am, DATE 12-4-87
DRILL RIG SIMCO 2800 ANGLE Level BEARING E SAMPLE HAMMER TORQUE FT.-LBS	SURFACE CONDITIONS Dry black clay w/trees & tall grass. 20' W of creekbed. Conditions similar to those @ CB-11.	

DRILLING CONTR. Sam Ramirez

LOGGED BY Jeff Thompson

DEPTH IN FEET (ELEVATION)	BLOWS/ 6 IN. ON SAMPLER (RECOVERY)	SYMBOL	SAMPLE NUMBER AND DESCRIPTION OF MATERIAL	SAMPLER AND BIT	CASING TYPE	BLOWS/FOOT ON CASING	WATER CONTENT %	LIQUID LIMIT %	PLASTIC LIMIT %	SPECIFIC GRAVITY	~~OTHER TESTS~~ 200
	(71%)		#1 Stiff black CLAY (CH) below 1" of topsoil				26				
	(71%)		#2 Hard black CLAY w/sand pockets				20				
5	(65%)		#3 Hard black CLAY w/calcareous nodules				23	87	31		
	10/13 13		#4 Firm chert GRAVEL (GW) w/calcareous nodules & clay layers								
	24/23 20		#5 Dense chert GRAVEL w/minor calcareous material. Finer than # 4.				15				
10											
15	(76%)		#6 Very stiff tan & gray CLAY (CH) w/occasional chalk pockets				35	101	32		
20	(44%)		#7 Hard brown & light gray CLAY				32	91	28		
25	(94%)		#8 Hard tan silty CLAY w/frequent gypsum partings				15				
30	(10%)		#9 Hard gray SANDSTONE (SW) extremely fine				12				
35	(100%)		#10 Hard gray silty CLAY (CL) w/frequent mollusc shells & occasional pyrite veinlets				14	41	18		

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SOIL BOREHOLE LOG

SITE NAME AND LOCATION	...l Co. Landfill ...h of FM 1101 on Kohlenberg Ln. #2 New Braunfels, Texas
DRILLING METHOD:	Dry Auger 0-28' NX coring 28'-50'
SAMPLING METHOD:	0-10' Continuous 10-50' @ 5' intervals
BORING NO.	B-14
SHEET	2 OF 2

DRILLING	START	FINISH
TIME	12:40pm	9:00am
DATE	12-3	12-4-87

WATER LEVEL				
TIME				
DATE				
CASING DEPTH				

DATUM MSL ELEVATION 604

DRILL RIG SIMCO 2800

SURFACE CONDITIONS See page 1

ANGLE Level BEARING E

SAMPLE HAMMER TORQUE FT.-LBS

DEPTH IN FEET (ELEVATION)	BLOWS/ 6 IN. ON SAMPLER (RECOVERY)	SYMBOL	SAMPLE NUMBER AND DESCRIPTION OF MATERIAL	SAMPLER AND BIT	CASING TYPE	BLOWS/FOOT ON CASING	WATER CONTENT %	LIQUID LIMIT %	PLASTIC LIMIT %	SPCIFIC GRAVITY	~~OTHER TESTS~~ 200
40	(90%)		#11 Hard gray silty CLAY (CL) very fossilferrous (predominately mollusc shells)				14	41	18		
45	(100%)		#12 Hard gray silty CLAY, very fossilferrous								
50	(100%)		#13 Hard gray silty CLAY, very fossilferrous w/occasional pyrite veinlets				15				
			Bottom @ 50'								

DRILLING CONTR. Coretech Sam Ramirez

LOGGED BY Jeff Thompson CHK'D BY

DATE 12-4-87

SL039655

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SOIL BOREHOLE LOG

SITE NAME AND LOCATION	DRILLING METHOD	BORING NO.
Comal Co. Landfill South of FM 1101 on Kohlenberg Ln. #2 New Braunfels, Texas	Dry Auger 0-38' NX coring 38'-80'	B-15
	SAMPLING METHOD: 0-10' Continuous 10'-80' @ 5' intervals	SHEET 1 OF 3
DATUM MSL	ELEVATION 606	

WATER LEVEL				
TIME				
DATE				
CASING DEPTH				

DRILLING	START	FINISH
TIME	2:10pm	2:10pm
DATE	12-1	12-2-87

DRILL RIG SIMCO 2800

ANGLE Level BEARING W

SAMPLE HAMMER TORQUE FT.-LBS

SURFACE CONDITIONS Very damp barren tan & black clay silty clay w/abundant chert sand, gravel & cobbles

DRILLING CONTR. Sam Ramirez

LOGGED BY Jeff Thompson

DEPTH IN FEET (ELEVATION)	BLOWS/6 IN ON SAMPLER (RECOVERY)	SYMBOL	SAMPLE NUMBER AND DESCRIPTION OF MATERIAL	SAMPLER AND BIT	CASING TYPE	BLOWS/FOOT ON CASING	WATER CONTENT %	LIQUID LIMIT %	PLASTIC LIMIT %	SPECIFIC GRAVITY	~~OTHER TESTS~~ 200
	(0%)		#1 Damp tan & black CLAY (CH) w/chert gravel								
	(33%)		#2 Medium tan CLAY w/chert sand & gravel & cobbles				15				
5	(89%)		#3 Hard tan CLAY (CH) slickensided, chalk pockets					102	37		
	(100%)		#4 Very stiff tan & gray CLAY w/calcareous nodules & gypsum								
10	(100%)		#5 Very stiff tan & gray CLAY w/calcareous nodules & gypsum partings				33				
15	(100%)		#6 Hard light gray & tan CLAY w/mollusc shells				31	50	17		
20	(17%)		#7 Hard tan CLAY; disturbed sample								
	(50%)		#8 Hard tan silty CLAY (CL) w/mollusc shells				15	38	17		
25	(31%)		#9 Hard gray & tan slightly silty CLAY				18				
30	(44%)		#10 Very stiff tan & gray slightly silty CLAY w/frequent mollusc shells				17				
35	(19%)		#11 Very stiff gray silty CLAY (CL) very thinly bedded				16	40	18		

SOIL BOREHOLE LOG

SITE NAME AND LOCATION	ɔmal Co. Landfill ɔuth of FM 1101 on Kohlenberg Ln. #2 New Braunfels, Texas
DRILLING METHOD:	Dry Auger 0-38' NX coring 38'-80'
SAMPLING METHOD:	0-10' Continuous 10'-80' @ 5' intervals
BORING NO.	B-15
SHEET	2 OF 3
DRILLING START TIME / DATE	2:10pm / 12-1
DRILLING FINISH TIME / DATE	2:10pm / 12-2-87
WATER LEVEL / TIME / DATE / CASING DEPTH	
DATUM	MSL
ELEVATION	606
DRILL RIG	SIMCO 2800
SURFACE CONDITIONS	See page 1
ANGLE	Level
BEARING	W
SAMPLE HAMMER TORQUE	FT.-LBS
DRILLING CONTR.	Sam Ramirez
LOGGED BY	Jeff Thompson

DEPTH IN FEET (ELEVATION)	BLOWS/ 6 IN. ON SAMPLER (RECOVERY)	SYMBOL	SAMPLE NUMBER AND DESCRIPTION OF MATERIAL	SAMPLER AND BIT	CASING TYPE	BLOWS/FOOT ON CASING	WATER CONTENT %	LIQUID LIMIT %	PLASTIC LIMIT %	SPECIFIC GRAVITY	OTHER TESTS - 200
40	(100%)		#12 Hard gray silty CLAY (CL) massive, frequent small mollusc shells				13	42	19		
45	(100%)		#13 Hard gray CLAY (CH)								
50	(95%)		#14 Hard gray CLAY, massive, frequent small mollusc shells				17				
55	(100%)		#15 Hard gray CLAY								
60	(95%)		#16 Hard gray silty CLAY (CL) w/frequent mollusc shell & pyrite veinlets				13				
65	(83%)		#17 Hard gray CLAY (CH)								
70	(100%)		#18 Hard gray CLAY w/frequent small mollusc shells & veinlets of pyrite								

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SOIL BOREHOLE LOG

SITE NAME AND LOCATION	DRILLING METHOD: Dry Auger 0-38' NX coring 38'-80'	BORING NO. B-15
ɔmal Co. Landfill South of FM 1101 on Kohlenberg Ln. #2 New Braunfels, Texas	SAMPLING METHOD: 0-10' Continuous 10'-80' @ 5' intervals	SHEET 3 OF 3
DATUM MSL ELEVATION 606	WATER LEVEL / TIME / DATE / CASING DEPTH	DRILLING START TIME 2:10pm DATE 12-1; FINISH TIME 2:10pm DATE 12-2-87
DRILL RIG SIMCO 2800	SURFACE CONDITIONS See page 1	
ANGLE Level BEARING W		
SAMPLE HAMMER TORQUE FT.-LBS		

DEPTH IN FEET (ELEVATION)	BLOWS/ 6 IN. ON SAMPLER (RECOVERY)	SYMBOL	SAMPLE NUMBER AND DESCRIPTION OF MATERIAL	SAMPLER AND BIT	CASING TYPE	BLOWS/FOOT ON CASING	WATER CONTENT %	LIQUID LIMIT %	PLASTIC LIMIT %	SPECIFIC GRAVITY	~~OTHER TESTS~~ 200
75	(100%)		#19 Hard gray CLAY (CH) massive, frequent small mollusc shells & pyrite veinlets								
80	(100%)		#20 Hard gray CLAY, massive w/mollusc shells & pyrite veinlets								
			Bottom @ 80'								

DRILLING CONTR Sam Ramirez Caratech

SL02066

LOGGED BY Jeff Thompson CHK'D BY

DATE 12-2-87

WASTE MANAGEMENT OF NORTH AMERICA COMAL COUNTY LANDFILL	GEOLOGIC LOG OF CORE LOCATION NO. PZ-1

BORING LOCATION N: 726,500 ; E: 1,965,000		ELEVATION AND DATUM 662.63 ft NGVD	
DRILLING AGENCY Jones Environmental	DRILLER Ric Jones	DATE STARTED 4/23/90	DATE FINISHED 4/23/90
DRILLING METHOD Hollow stem auger		DRILL BIT 9 inch	COMPLETION DEPTH 57 ft
SIZE AND TYPE OF CASING 1 1/4" Triloc PVC		LOGGED BY R.C. Smyth	CHECKED BY T.M. Scanlon
SAMPLING METHOD continuous coring			
SAMPLER TYPE split barrell	LENGTH 2.5 ft DROP —		

DEPTH (FEET)	DESCRIPTION	LITHOLOGY U.S.C.S. CLASS	LITHOLOGY GRAPHIC LOG	PIEZOMETER COMPLETION	DEPTH (FEET)	CORING RUN NO.	CORING PERCENT RECOVERY	CORING PERCENT RQD	REMARKS
0–2	0.0-2.1 Fill Material: mixture of CH clay (very dark gray (10YR3/1) and CL clay (olive brown (2.5Y 5/4)); extremely soft; flat chert pebble (1.5 inches in diameter) at 0.75 feet BGL; layer of caliche at base (1.9 to 2.1 ft BGL); no apparent bedding.	CH			1	1	96		Fill 0.0'-2.1'
2–5	2.1-5.0 CH Clay: very dark gray (10YR 3/1); extremely soft; medium plasticity; non-swelling; moderate reaction to 10% HCl; blocky texture.	CH			4	2	92		Layer I 2.1'-5.0'
5–6	5.0-6.0 CH Clay: light olive brown (2.5Y 5/4) and brownish yellow (10YR 6/8); extremely soft; unconsolidated; high plasticity; 20-30% oxidized clay pebbles and 1-5% chert pebbles up to 5mm in diameter; caliche layers up 0.1 foot thick.	CH			6	3	96		Layer IIa 5.0'-6.0'
6–10	6.0-10.0 CH Clay: brownish yellow (10R 6/8) and light olive brown (2.5y 5/4); extremely soft; high plasticity; very thinly laminated bedding planes (fissile texture) broken apart due to cracking and swelling of montmorillionitic clays giving cores a block texture; organic material or manganese oxides concentrated along small, high angle fractures usually near gypsum-filled fractures; crystalline gypsum in nearly vertical fractures up to 1.0 foot long; broken fracture spacing.	CH			8–9	4	92		Layer III 6.0'-42.0'
10–12	10.0-15.0 CH Clay: same description as 6.0-10.0. 10.0-11.6 Split spoon sample taken for laboratory. Same material as above. Blow counts = 5,8,9,12. Lab results: LL(%)=98, PI(%)=68, MC(%)=35.6; Percent passing #200 sieve = 99.7.	CH			11	5	80		Split spoon taken for lab analysis.
12					12	6	100		
13–14					14	7	88		

COMAL COUNTY LANDFILL	LOCATION NO. PZ- 1

DEPTH (FEET)	DESCRIPTION	LITHOLOGY U.S.C.S. CLASS
15	15.0-20.0 CH Clay: olive brown (2.5Y 4/4) and brownish yellow (10YR 6/8); extremely soft; high plasticity; very thinly laminated bedding planes (fissile texture) broken apart due to cracking and swelling of montmorillonite clays giving cores a blocky texture; organic material or manganese oxides concentrated along small, high angle fractures usually near gypsum-filled fractures; crystalline gypsum in nearly vertical fractures up to 1.0 foot long; broken fracture spacing.	CH
20	20.0-22.5 CH Clay: same description as above. Fracture spacing = 2 to 7 inches (broken to unbroken).	CH
	22.5-25.0 CH Clay: same description as 15.0-20.0. Fracture spacing = 2 to 5.5 inches (slightly broken to broken).	CH
25	25.0-27.5 CH Clay: same description as 15.0-20.0. Fracture spacing = 3 to 5 inches (slightly broken).	CH
	27.5-30.0 CH Clay: same description as 15.0-20.0. Very oxidized layer from 28.2-29.0 feet with abundant gypsum-filled fractures; Fracture spacing = 4 to 6 inches (slightly broken).	CH
30	30.0-32.0 CH Clay: same description as 15.0-20.0. Fracture spacing = 8 to 10 inches (unbroken). Split spoon sample taken for laboratory analysis. Blow counts = 10,12,13,17. Lab results: LL(%) = 103, PI(%) = 70, MC(%) = 34.2; Percent passing #200 sieve = 99.7.	CH

PIEZOMETER COMPLETION	DEPTH (FEET)	CORING RUN NO.	PERCENT RECOVERY	PERCENT RQD	REMARKS
	15	8	96		Layer III 6.0'-42.0'
		9	92		
	20	10	96		
		11	88		
	25	12	96		
		13	88		
	30	14	80		Split spoon taken for lab analysis.

COMAL COUNTY LANDFILL	LOCATION NO. PZ-1

DEPTH (FEET)	DESCRIPTION	LITHOLOGY U.S.C.S. CLASS
33	32.0-35.0 CH Clay: brownish yellow (10YR 6/8) and light olive brown (2.5Y 5/4); extremely soft; high plasticity; trace inoceramus shells; very thinly laminated bedding planes (fissile texture) broken apart due to cracking and swelling of montmorillonitic clays giving cores a block texture; organic material or manganese oxides concentrated along small, high angle fractures usually near gypsum-filled fractures; 33.5-34.0 foot interval is highly oxidized with a 0.03 foot wide, horizontal gypsum filled fracture in center; other fractures are up to 4 inches long and are nearly vertical to 45 degrees; Feature spacing = 0.5 to 5 inches (slightly broken to very broken).	CH
35	35.0-37.5 CH Clay: same lithologic description as 32.0-35.0; 1.5 inch wide gypsum layer in base cap of sampler; 0.05 foot wide, 45 degree gypsum layer in center of oxidized layer = 0.4 feet wide; 5-10% mm wide clay-filled fractures; Fracture spacing = 8 to 10 inches (unbroken).	CH
	37.5-40.0 CH Clay: same lithologic description as 32.0-35.0. 45-60° gypsum layers up to 3 inches long (i.e., across sampling tube); oxidized layer up to 1 foot long with gypsum layer in middle; Fracture spacing = 8 to 10 inches (unbroken).	CH
40	40.0-42.0 CH Clay: pushed a Shelby Tube sampler for laboratory analyses. Same lithologic descriptions 32.0-35.0. Laboratory results: not analyzed.	CH
	42.0-45.0 CH Clay: dark grayish brown (2.5y 4/2); extremely soft; high plasticity; oxidation is confined to thin layers instead of occurring throughout the interval as in clay above; swelling and cracking on surface of core is not as apparent as above; wide (0.07 foot) gypsum filled fracture with very little oxidization on either size.	CH
45	45.0-47.5 CH Clay: dark olive gray (5Y 3/2) with minor localized brownish yellow (10YR 6/8) in oxidized zones; very soft; high plasticity; gypsum filled fracture (45°) from 46.5 - 46.8 feet BGL with minor (0.2 foot thick) oxidized material on either side.	CH
	47.5-50.0 CH Clay: dark olive gray (5y 3/2) and dark grayish brown (2.5y 4/2); highly compacted; soft; medium plasticity; 0.4 foot thick, slightly oxidized layer with thin (2mm) wide gypsum vein in center.	CH
50		

CORING RUN NO.	PERCENT RECOVERY	PERCENT RQD
15	100	
16	92	
17	96	
18	92	
19	80	
20	100	
21	92	
22	92	
23	96	

REMARKS:

Layer III 6.0'-42.0'

Shelby tube taken for lab analysis.

Layer IV 42.0'-57.0'

COMAL COUNTY LANDFILL									LOCATION NO. PZ-1
DEPTH (FEET)	DESCRIPTION	LITHOLOGY U.S.C.S. CLASS	LITHOLOGY GRAPHIC LOG	PIEZOMETER COMPLETION	DEPTH (FEET)	CORING RUN NO.	CORING PERCENT RECOVERY	CORING PERCENT RQD	REMARKS
	50.0-55.0 CH Clay: dark olive gray (5Y 3/2) and dark grayish brown (2.5Y 4/2); highly compacted; soft; medium plasticity; completely unoxidized; fissile texture.	CH							
51					51	24	92		Layer-V 42.0'-57.0'
						25	92		
55	55.0-57.0 CH Clay: dark olive gray (5Y 3/2) and dark grayish brown (2.5Y 4/2); highly compacted; soft; medium plasticity; completely unoxidized; fissile texture. Blow counts = 12, 22, 23, 30.	CH			55	26	80		Split spoon taken for lab analysis
57					57				

WASTE MANAGEMENT OF NORTH AMERICA COMAL COUNTY LANDFILL	GEOLOGIC LOG OF CORE LOCATION NO. PZ-2

BORING LOCATION N: 733,800 ; E: 1,823,200		ELEVATION AND DATUM 633.22 ft NGVD	
DRILLING AGENCY Jones Environmental	DRILLER Ric Jones	DATE STARTED 4/24/90	DATE FINISHED 4/25/90
DRILLING METHOD Hollow stem auger		DRILL BIT 9 inch	COMPLETION DEPTH 70.5 ft
SIZE AND TYPE OF CASING 1 1/4" Triloc PVC		LOGGED BY	CHECKED BY
SAMPLING METHOD continuous coring (0-12.5') s.s. every 5' (12.5-70.5)		R.C. Smyth	T.M. Scanlon
SAMPLER TYPE split barrell	LENGTH 2.5, 2.0 DROP ≈ 5 ft		

DEPTH (FEET)	DESCRIPTION	U.S.C.S. CLASS	RUN NO.	PERCENT RECOVERY	PERCENT RQD	REMARKS
0–2.5	0.0-2.5 CH Clay: very dark gray (10YR 3/1); medium plasticity; extremely soft; moderate reaction to 10% HCl; trace limestone and chert gravel; abundant roots.	CH	1	68		Layer I 0.0'-2.5'
2.5–4.5	2.5-4.5 CH silty Clay: dark grayish brown (2.5Y 4/2) and brownish yellow (10YR 6/8); extremely soft; high plasticity; moderate reaction to 10% HCl; trace very fine-grained to fine-grained quartz sand; 1-5% granule-sized oxidized clay and chert pebbles; trace inoceramus fragments; abundant roots.	CH	2	96		Layer IIa 2.5'-4.5'
4.5–6.5	4.5-6.5 GW Gravel: white and gray (10YR 8/1 and 6/1); coarse limestone and chert gravel; angular to subangular; flat; size range is 5 to 50 mm; completely unconsolidated; 1-5% very sticky clay matrix; abundant roots.	GW	3	84		Layer II 4.5'-6.5'
6.5–7.5	6.5-7.5 No recovery; Driller noted that we were out of the gravel layer. Probably in the calichified claystone.					
7.5–8.5	7.5-8.5 split-spoon samples (2-6") wrapped in foil in brass for laboratory. Blow counts = 19,50. Laboratory results: LL(%)=36, PI(%)=19, MC(%)= 7.5, Percent passing #200 sieve = 98.5.	CL	4	100		Split spoon taken for lab analysis.
8.5–10.0	8.5-10.0 CL caliche Claystone: white (10YR 8/1); very soft; chalky; strong reaction to 10% HCl; no apparent bedding.	CL	5	100		
10.0–12.5	10.0-12.5 CL calcareous Claystone: yellow (2.5Y 7/6); very soft; strong reaction to 10% HCl; pocket penetrometer >4.5;	CL	6	32		Layer V 6.5'-46.5'
12.5–13.0	12.5-13.0 CL calcareous Claystone: same description as above; sampled with split-spoon. Blow counts = 50/5 inches.	CL	7	80		
13.0–15.0	13.0-15.0 drilled		8	—		

COMAL COUNTY LANDFILL

LOCATION NO. PZ-2

DEPTH (FEET)	DESCRIPTION	LITHOLOGY U.S.C.S. CLASS	LITHOLOGY GRAPHIC LOG	PIEZOMETER COMPLETION	DEPTH (FEET)	CORING RUN NO.	CORING PERCENT RECOVERY	CORING PERCENT RQD	REMARKS
16	15.0-16.0 CL calcareous Claystone: yellow (2.5Y 7/6); very soft; strong reaction to 10% HCl; pocket penetrometer >4.5. Blow counts = 38, 50/5 inches.	CL			16	9	90		Hammered split spoon sampler.
	15.0-20.0 drilled					10			
20	20.0-21.5 CL calcareous Claystone: yellow (2.5Y 7/6) and pale yellow (2.5Y 7/4); change from more oxidized to less oxidized claystone emphasized by change in color; very soft; strong reaction to 10% HCl; rock expands in split spoon sampler and makes it difficult to get "shoes" off; Blow counts = 22,35,46.	CL			20	11	100		Hammered split spoon sampler.
	20.0-25.0 drilled					12			Layer: 6.5'-46.5'
25	25.0-26.5 CL calcareous Claystone: pale yellow (2.5Y 7/4) very soft; strong reaction to 10% HCL; rock expands in split spoon sampler; Blow counts = 22,32,37.	CL			25	13	100		Hammered split spoon sampler.
	25.0-30.0 drilled					14			
30	30.0-31.5 CL calcareous Claystone: pale yellow (2.5Y 7/4) very soft; strong reaction to 10% HCL; rock expands in split spoon sampler; Blow counts = 23,35,41.	CL			30	15	100		Hammer split sp sampler.
	30.0-35.0 drilled								
32					32				

* Since split-spoon samplers are only one-inch in diameter, the same interval was subsequently drilled out; therefore, there is some overlap between sampled and drilled intervals.

COMAL COUNTY LANDFILL	LOCATION NO. PZ-2

DEPTH (FEET)	DESCRIPTION	LITHOLOGY U.S.C.S. CLASS	GRAPHIC LOG	PIEZOMETER COMPLETION	DEPTH (FEET)	CORING RUN NO.	PERCENT RECOVERY	PERCENT RQD	REMARKS
	30.0-35.0 drilled					16			
35	35.0-36.5 CL calerous Claystone: 80% pale yellow (2.5Y 7/4) and 20% greenish gray (5GY 5/1); very soft; strong reaction to 10% HCl; Fracture spacing is greater than one foot (unbroken). Blow counts = 19,27,33.	CL			35	17	100		Hammered split spoon sampler.
	35.0-40.0 drilled; greenish gray cuttings feel greasy.					18			Layer V 6.5'-46.5'
40	40.0-41.5 CL calerous Claystone: 80% pale yellow (2.5Y 7/4) and 20% greenish gray (5GY 5/1);very soft; strong reaction to 10% HCl; Fracture spacing is greater than one foot (unbroken); horizontal, 0.02 foot wide calcite-filled fracture. Blow counts = 26,45,50/5 inches.	CL			40	19	100		Hammered split spoon sampler.
	40.0-45.0 drilled					20			
45	45.0-46.5 Cl calcareous Claystone: greenish gray (5GY 5/1); very soft; strong reaction to 10% HCl; fissile; no fractures present. Blow counts = 32,47.	CL			45	21	100		Hammered split spoon sampler
	45.0-50.0 drilled								
	50.0-51.5 CL calcareous Claystone: greenish gray (5GY 5/1) and minor pale yellow (2.5Y 7/4); strong reaction to 10% HCl; fissile greenish gray claystone is of average hardness and zbreaks up into 0.02 to 0.05 foot wide "chips" when split spoon sampler is hammered in, whereas the thinner layers of yellow claystone are softer and more cohesive. Fracture spacing is greater than one foot (unbroken); contains a 0.3 foot thick layer of pale yellow claystone bounding a 0.05 foot wide calcite filled fracture. Blow counts = 36,46.					22			Layer VI 46.5'-70.5'
50		CL			50	23	93		Hammered split spoon

COMAL COUNTY LANDFILL	LOCATION NO. PZ-2

DEPTH (FEET)	DESCRIPTION	LITHOLOGY U.S.C.S. CLASS	LITHOLOGY GRAPHIC LOG	PIEZOMETER COMPLETION	DEPTH (FEET)	CORING RUN NO.	CORING PERCENT RECOVERY	CORING PERCENT RQD	REMARKS
53	50.0-55.0 drilled				53	24			
55	55.0-55.5 CL calcareous Claystone: greenish gray (5GY 5/1); average hardness; strong reaction to 10% HCl; fissile texture; Blow counts = 50.	CL			55	25	100		Hammered split-spoon
	55.0-60.0 drilled (time = 1845-1915); drilling got easier at 56.5 feet BGL (probably in softer yellow claystone).					26			Layer VI 46.5'-70.5'
60	60.0-61.0 CL calcareous Claystone: greenish gray (5GY 5/1) and pale yellow (2.5Y 7/4); average hardness; strong reaction to 10% HCl; fissile texture; Blow counts = 40,50/3 inches.	CL			60	27	100		Hammered split spoon
	60.0-65.0 drilled					28			
65	65.0-65.5 CL calcareous Claystone: greenish gray (5GY 5/1); average hardness; breaks up into 0.2 to 0.5 foot wide "chips" when split spoon sampler is hammered in; strong reaction to 10% HCl; trace Inoceramus and oyster shells; fissile and greasy textures; hydrocarbon odor. Blow counts = 50/6 inches.	CL			65	29	100		Hammered split spoon
	65.0-70.0 drilled; strong hydrocarbon odor in cuttings.					30			
	70.0-70.5 CL calcareous Claystone: same description as 65.0-65.5; Blow counts = 50/6 inches.								
70		CL			70	31	100		

WASTE MANAGEMENT OF NORTH AMERICA COMAL COUNTY LANDFILL	GEOLOGIC LOG OF CORE LOCATION NO. PZ-3	
BORING LOCATION N: 764,000; E: 1,877,000	ELEVATION AND DATUM 643.86 ft NGVD	
DRILLING AGENCY Jones Environmental; DRILLER Ric Jones	DATE STARTED 4/24/90	DATE FINISHED 4/24/90
DRILLING METHOD Hollow stem auger	DRILL BIT 9 inch	COMPLETION DEPTH 32.5 ft
SIZE AND TYPE OF CASING 1 1/4" Triloc PVC	LOGGED BY R.C. Smyth	CHECKED BY T.M. Scanlon
SAMPLING METHOD continuous coring		
SAMPLER TYPE split barrel; LENGTH 2.5 ft; DROP —		

DEPTH (FEET)	DESCRIPTION	U.S.C.S. CLASS	REMARKS
0.0-0.15	Fill: mottled, very dark grayish brown (10YR 3/2) and white (10YR 8/1); extremely soft; strong reaction to 10% HCl; calcareous sandy clay with trace chert pebbles; sand: very fine-grained quartz.	FI	Fill 0.0-0.15
0.15-0.5	CH Clay: very dark gray (10YR 3/1); extremely soft; moderate reaction to 10% HCl; medium plasticity; 5-10% chert and limestone pebbles (size: 10 to 50 mm).	CH	Layer I 0.15-0.5
0.5-4.1	CH Clay: light olive brown (2.5Y 5/4) and brownish yellow (10YR 6/8); extremely soft; abundant granule sized, oxidized clay pebbles and trace chert pebbles in silty clay matrix; high plasticity; pocket penetrometer reading = 1.75.	CH	Layer IIa 0.5'-4.1'
4.1-6.3	GW Gravel: white and gray (10YR 8/1 and 6/1); coarse limestone and chert gravel with trace fossil fragments, gravel ranges from 5 to 50 mm in sized and consists of angular (almost looks brecciated), flat pebbles; totally unconsolidated; clay matrix is <20%.	GW	Layer II 4.1'-7.0'
6.3-7.5	No recovery. Limestone gravel jammed split-barrel sampler.		
7.5-10.0	CL caliche Claystone: yellow (2.5Y 7/6) dominant with white (10YR 8/1) filling in fractures; very soft; much more altered than underlying similar rock; chalky; strong reaction to 10% HCl; low to medium plasticity; unbroken fracture spacing; pocket penetrometer = 2.25.	CL	Layer V 7.0'-32.5'
10.0-15.0	CL calcareous Claystone: yellow (2.5Y 7/6) and pale yellow (2.5Y 7/4) with occasional white (10YR 8/1) and yellow (10YR 7/8) filling in fractures; very soft to soft; low to medium plasticity; strong reaction to 10% HCl; pocket penetrometer is off scale (>4.5); fractures are nearly vertical to horizontal and range from 0.01 to 0.05 inches in diameter; Fracture spacing = 2 to 10 inches (unbroken to broken).	CL	

CORING: RUN NO.	PERCENT RECOVERY	PERCENT RQD
1	96	
2	96	
3	52	
4	96	
5	100	
6	100	

COMAL COUNTY LANDFILL	LOCATION NO. PZ-3

DEPTH (FEET)	DESCRIPTION	LITHOLOGY U.S.C.S. CLASS	DEPTH (FEET)	CORING RUN NO.	PERCENT RECOVERY	PERCENT RQD	REMARKS
16	15.0-17.5 CL calcareous Claystone: yellow (2.5Y 7/6) and pale yellow (2.5Y 7/4) with occasional white (10YR 8/1) and yellow (10YR 7/8) filling in fractures; very soft to soft; low to medium plasticity; strong reaction to 10% HCl; pocket penetrometer is off scale (>4.5); 0.1 foot diameter fracture filled with white clay and surrounded by more oxidized orange material occurs at 15.5-16.0 feet BGL; Fracture spacing >6 inches (unbroken).	CL	16	7	100		
	17.5-18.0 Shelby Tube Sample pushed for laboratory vertical hydraulic conductivity measurement. Lithology is same as above. Kv = 8 x 10^{-8} cm/sec LL(%)=38, PL(%)=18, PI(%)=20	CL		8	100		Shelby tube
				9	100		split spoon for lab analysis.
				10	50		
20	18.0-19.0 Split Spoon Sample; Blow counts = 28,50; Lithology is same as above. Laboratory results: LL(%)=43, PI(%)=19, MC(%)=15.2; Percent passing #200 sieve = 98.9.		20				
	19.0-22.5 CL calcareous Claystone: yellow (2.5Y 7/6) and pale yellow (2.5Y 7/4) with occasional white (10YR 8/1) and yellow (10YR 7/8) filling in fractures; very soft to soft; low to medium plasticity; strong reaction to 10% HCl; white clay-filled vertical fracture from 20.0-22.5 that is lined with a network of reddish roots.	CL		11	96		Layer V 7.0-32.5
	22.5-25.0 Sampler not latching on or disengaging too soon so just got cuttings in sampler; same lithloogic description as above; cuttings felt damp.			12	0		
25	25.0-27.5 No recovery in sampler during first run; augers are jammed with claystone that fell out of sampler on previous run. Went back in hole and picked up 0.5 feet (CL calcareous Claystone): same lithology as 19.0-22.5.	CL	25	13	20		
	27.5-32.5 CL calcareous Claystone: pale yellow (2.5Y 7/4); same unit as above but less oxidized; very soft; low to medium plasticity; strong reaction to 10% HCl; more highly oxidized yellow layer (10YR 7/8) from 30.0-30.5 lined with white (10YR 8/1), this is probably a sealed fracture; Fracture spacing > 6 inches (unbroken).	CL		14	96		
30			30	15	96		
32			32				

WASTE MANAGEMENT OF NORTH AMERICA COMAL COUNTY LANDFILL	GEOLOGIC LOG OF CORE LOCATION NO. PZ-4

BORING LOCATION N: 645,800; E: 2,044,500		ELEVATION AND DATUM 627.45 ft NGVD	
DRILLING AGENCY Jones Environmental	DRILLER Ric Jones	DATE STARTED 4/27/90	DATE FINISHED 4/27/90
DRILLING METHOD Hollow stem auger		DRILL BIT 9 inch	COMPLETION DEPTH 50.4 ft
SIZE AND TYPE OF CASING 1 1/4" Triloc PVC		LOGGED BY	CHECKED BY
SAMPLING METHOD continuous coring		R.C. Smyth	T.M. Scanlon
SAMPLER TYPE split barrel	LENGTH 2.5 ft DROP —		

DEPTH (FEET)	DESCRIPTION	LITHOLOGY U.S.C.S. CLASS	LITHOLOGY GRAPHIC LOG	PIEZOMETER COMPLETION	DEPTH (FEET)	CORING RUN NO.	CORING PERCENT RECOVERY	CORING PERCENT RQD	REMARKS
1	0.0-2.5 Fill:CL Clay: light olive brown (2.5Y 5/4) and brownish yellow (10YR 6/8); extremely soft; oxidized clay pebbles and chert pebbles in a silty clay matrix; not well laminated as in other intervals.	FI			1	1	40		Fill 0.2'-2.5'
2					2				
3	2.5-5.0 CH Clay: very dark gray (10YR 3/1); extremely soft; medium plasticity; moderate reaction to 10% HCl; blocky; trace limestone pebbles ranging in size from 2 to 5 mm.	CH			3	2	100		Layer I 2.5'-5.0'
4					4				
5	5.0-7.5 CH Clay: light olive brown (2.5Y 5/4) and brownish yellow (10YR 6/8); extremely soft; unconsolidated; high plasticity; 20-30% oxidized clay pebbles and 1-5% chert pebbles up to 5mm in diameter in a silty clay matrix; caliche layers at 6 and 7 feet BGL.	CH			5				
6					6	3	96		Layer IIa 5.0'-7.5'
7	7.5-10.0 CH Clay: brownish yellow (10R 6/8) and light olive brown (2.5Y 5/4); extremely soft; high plasticity; very thinly laminated bedding planes (fissile texture) broken apart due to cracking and swelling of montmorillionitic clays giving clay a block texture; organic material or manganese oxides concentrated along small, high angle fractures usually near gypsum-filled fractures; crystalline gypsum in nearly vertical fractures up to 1.0 foot long; fracture spacing > 6 inches (unbroken).	CH			7				
8					8	4	76		Layer III/IV 7.5'-49.2'
9					9				
10	10.0-11.5 Shelby tube sample pushed for laboratory vertical hydraulic conductivity measurements. Same lithology as above. Kv = not analyzed.				10				Shelby tube for lab analyses,
11					11	5	100		
12	11.5-12.5 CH Clay: same lithology as 7.5-10.0.	CH			12				
13	12.5-15.0 Lost sample on fist run, recovered 0.6 feet. Lithology same as 7.5-10.0.				13	6	100		
14					14	7	40		

COMAL COUNTY LANDFILL	LOCATION NO. PZ-4

DEPTH (FEET)	DESCRIPTION	LITHOLOGY U.S.C.S. CLASS	DEPTH (FEET)	CORING RUN NO.	PERCENT RECOVERY	PERCENT RQD	REMARKS
16	15.0-17.5 CH Clay: brownish yellow (10R 6/8) and light olive brown (2.5Y 5/4); extremely soft; high plasticity; very thinly laminated bedding planes (fissile texture) broken apart due to cracking and swelling of montmorillionitic clays giving clay a block texture; organic material or manganese oxides concentrated along small, high angle fractures usually near gypsum-filled fractures; highly oxidized fracture from 16.1-16.3 feet BGL, width of highly oxidized zone is about 30 mm; fracture spacing >6 inches (unbroken).	CH	16	8	92		
	17.5-19.0 Shelby tube sample pushed for vertical hydraulic conductivity measurement; Same lithology as above. Kv = 1.5 x 10^{-8}; LL(%)=107, PL(%)=29, PI(%)=78. Percent passing #200 sieve = 99.8.	CH		9	100		Shelby Tube taken for lab analysis.
				10	100		
20	19.0-22.5 CH Clay: brownish yellow (10R 6/8) and light olive brown (2.5Y 5/4); extremely soft; high plasticity; very thinly laminated bedding planes (fissile texture) broken apart due to cracking and swelling of montmorillionitic clays giving clay a block texture; organic material or manganese oxides concentrated along small, high angle fractures usually near gypsum-filled fractures; gypsum-filled fracture from 19.0-20.0; 1 inch diameter gypsum-filled pockets from 20.0-22.5; fracture spacing = 2.5 inches (broken).	CH	20	11	84		Layer III/IV 7.5'-49.2'
	22.5-25.0 CH Clay: Same lithology as above. 0.5 foot long gypsum-filled fracture that is 0.03 feet wide from 22.7-23.2 feet BGL; From 23.2 to 24.8 feet BGL, interval is very oxidized and and fractured with numerous high angle (45-60 degree) fractures; broken fracture spacing.	CH		12	96		
25	25.0-26.75 Shelby tube sample pushed for laboratory vertical hydraulic conductivity measurement. Same lithology as above. Kv = 5 x 10^{-7} cm/sec; LL(%)=103, PL(%)=30, PI(%)=73. Percent passing #200 sieve = 98.3.	CH	25	13	100		Shelby Tube taken for lab analysis.
	26.75-28.25 Split spoon samples; Blow counts = 11,12,19. LL(%)=101, PI(%)=69, MC(%)=36.8; Percent passing #200 sieve = 99.1.			14	100		Split spoons taken for lab analysis.
	28.25-30.0 No recovery.						
30	30.0-32.5 CH Clay: brownish yellow (10R 6/8) and light olive brown (2.5Y 5/4); extremely soft; high plasticity; very thinly laminated bedding planes (fissile texture) broken apart due to cracking and swelling of montmorillionitic clays giving clay a block texture; organic material or manganese oxides concentrated along small, high angle fractures usually near gypsum-filled fractures; two 1-inch wide oxidized zones with 0.01 inch wide, gypsum-filled fracture in center; fracture spacing = 2 to 3 inches (broken); pocket penetrometer = 3.5.	CH	30	15	96		
32			32				

COMAL COUNTY LANDFILL

LOCATION NO. PZ-4

DEPTH (FEET)	DESCRIPTION	U.S.C.S. CLASS
	32.5-35.0 CH Clay: Same lithology as above; fractures are oriented from 45 degrees to horizontally; fractue spacing = 2.5 inches (broken); pocket penetrometer is off scale (>4.5).	CH
35	35.0-37.5 CH Clay: Same lithology as above; 1% gypsum-filled fractures from horizontal to 60 degrees; fracture spacing = 2.5 inches (broken); oxidized at base; top of shoe had wet clay in it, could have been false; pocket penetrometer >4.5.	CH
	37.5-40.0 CH Clay: Same lithology as above; 1-5% gypsum-filled fractures running vertically (up to 0.3' wide); trace of oxidation staining.	
	40.0-42.5 CH Clay: Same lithology as above; gypsum-impregnated zone from 40.3-40.8'; fracture spacing = 1 to 2.7 inches (very broken to broken); associated minor oxidation just below gypsum area.	CH
40	42.5-45.0 CH Clay: light olive brown (2.5Y 5/4) and minor yellowish brown (10YR 6/8); very soft; high plasticity; trace organic filled laminae; very thinly laminated bedding planes (fissile texture) broken apart due to cracking and swelling of montmorillionitic clays giving clay a block texture; organic material or manganese oxides concentrated along small, high angle fractures; trace oxidation; no gypsum; rounded clay pebble at base; fracture spacing = 2.5 feet (unbroken).	CH
	45.0-47.5 CH Clay: Same lithology as above; three 0.02 foot wide gypsum-filled fractures; fracture spacing = 0.5 feet (unbroken).	CH
45	47.5-48.8 CH Clay: Same lithology as above; vertical gypsum-filled fracture 0.5 feet long and 0.04 feet wide; 0.1 foot thick horizontal gypsum layer at base of interval, directly on top of siltstone layer.	CH
	48.8-49.2 ML clayey Siltstone: yellow (2.5Y 7/6); soft; low plasticity; strong reaction to 10% HCl; 1-10% fossil fragments (mollusks); trace very fine-grained quartz sand.	ML
50	49.2-50.4 CL calcareous Claystone: greenish gray (5GY 5/1); average hardness; strong reaction to 10% HCl; trace mollusk shells; Blow counts = 50/5 inches.	CL

Note: Near the T.D., sampler got jammed in lead auger when being retracted so all augers came out of the hole. The last 2.5 foot sample was obtained with split-spoon sampler.

RUN NO.	PERCENT RECOVERY	PERCENT RQD
16	92	
17	92	
18	88	
19	92	
20	88	
21	92	
22	92	
23	100	

REMARKS:

Layer III/IV 7.5'-49.2'

Layer V 49.2'-50.4'

WASTE MANAGEMENT OF NORTH AMERICA
COMAL COUNTY LANDFILL

GEOLOGIC LOG OF CORE LOCATION NO. PZ-5

BORING LOCATION N: 587,800 ; E: 2,032,000		ELEVATION AND DATUM 614.00 ft NGVD	
DRILLING AGENCY Jones Environmental	DRILLER Ric Jones	DATE STARTED 4/25/90	DATE FINISHED 4/27/90
DRILLING METHOD Hollow stem auger		DRILL BIT 9 inch	COMPLETION DEPTH 51.4 ft
SIZE AND TYPE OF CASING 1 1/4" Triloc PVC		LOGGED BY	CHECKED BY
SAMPLING METHOD cont. coring (0-32 ft); s.s. every 5' (32-51.4 ft)		R. C. Smyth	T. M. Scanlon
SAMPLER TYPE split barrel	LENGTH 2.5, 2.0 / DROP ≈ 5 ft		

DEPTH (FEET)	DESCRIPTION	LITHOLOGY U.S.C.S. CLASS	PIEZOMETER COMPLETION	CORING RUN NO.	PERCENT RECOVERY	PERCENT RQD	REMARKS
0-5.0	Fill: CL Clay: light olive brown (2.5Y 5/4) and brownish yellow (10YR 6/8); extremely soft; oxidized clay pebbles and chert pebbles in a silty clay matrix; not well laminated as in other intervals.	FI		1	96		Fill 0.0'-7.3'
				2	96		
5.0-7.3	Fill: CL Clay: light olive brown (2.5Y 5/4) and brownish yellow (10YR 6/8); extremely soft; oxidized clay pebbles and chert pebbles in a silty clay matrix; not well laminated as in other intervals.	FI		3	96		
7.3-8.2	GW Gravel: white (10YR 8/1), light gray (10YR 6/1) and olive brown (2.5Y 5/4); coarse limestone and chert gravel; angular to subangular; flat pebbles; size range is 2 to 60 mm; 75-80% pebbles in 20% caliche and clay matrix; trace Inoceramus shells;	GW					Layer II 7.3'-8.2'
8.2-10.5	CH Clay: brownish yellow (10R 6/8) & light olive brown (2.5Y 5/4); extremely soft; high plasticity; strong reaction to 10% HCl; very thinly laminated bedding planes (fissile texture) broken apart due to cracking and swelling of montmorillionitic clays giving cores a block texture; organic material or manganese oxides concentrated along small, high angle fractures usually near gypsum-filled fractures; 5-10% caliche pockets dispersed throughout.	CH		4	56		Layer III/IV 8.2-28.3
				5	100		
10.5-12.5	Split spoon samples; Same lithology as above. LL(%)=97, PI(%)=69, MC(%)=34.2; Percent passing #200 sieve = 99.2. Blow counts = 6,9,10,14.			6	100		Split spoon samples taken for lab analysis.
12.5-18.0	CH Clay: brownish yellow (10R 6/8) & light olive brown (2.5Y 5/4); extremely soft; high plasticity; strong reaction to 10% HCl; very thinly laminated bedding planes (fissile texture) broken apart due to cracking and swelling of montmorillionitic clays giving cores a block texture; organic material or manganese oxides concentrated along small, high angle fractures usually near gypsum-filled fractures; gypsum fractures; fracture spacing = 1.1 feet (unbroken).	CH		7	96		

COMAL COUNTY LANDFILL	LOCATION NO. PZ-5

DEPTH (FEET)	DESCRIPTION	LITHOLOGY U.S.C.S. CLASS	PIEZOMETER COMPLETION	DEPTH (FEET)	CORING RUN NO.	PERCENT RECOVERY	PERCENT RQD	REMARKS
17.5	18.0-28.3 ML clayey Siltstone: yellow (2.5y 7/6); extremely soft to soft; low to medium plasticity; strong reaction to 10% HCl; 1-5% fossils (mega mollusk shells and inoceramus fragments); trace limonite nodules, amount of silt increases downwards.	ML		17.5	8	52		Layer III/IV 8.2'-28.3'
20				20	9	28		
					10	84		
					11	28		
					12	72		
	28.3-32.0 CL calcareous Claystone: greenish gray (5GY 5/1) and yellow (2.5Y 7/6); very soft; strong reaction to 10% HCl; trace small and mega mollusk fragments.	CL			13	96		Layer V/VI 28.3'-51.4'
30	32.0-35.0 Drilled			30	14	100		
	35.0-36.0 Split spoon sample; Same lithology as above; Blow counts = 24,28; LL(%)=39, PI(%)=23, MC(%)=13.3; Percent passing #200 sieve = 88.8.				15	—		
		CL			16	100		splitspoon for lab.
	35.0-40.0 Drilled				17	–		
40	40.0-40.85 CL calcareous Claystone: greenish gray (5GY 5/1); very soft; strong reaction to 10% HCl; trace small and mega mollusk fragments. Blow counts = 39, 50/3 inches.	CL		40	18	85		splitspoon
	40.0-45.0 Drilled				19	—		
	45.0-45.5 CL calcareous Claystone: greenish gray (5GY 5/1); very soft; strong reaction to 10% HCl; trace small and mega mollusk fragments. Blow counts = 50/5 inches.	CL			20	75		splitspoon
	45.0-50.0 Drilled				21	—		
50	50.0-51.4 CL calcareous Claystone: greenish gray (5GY 5/1); very soft; strong reaction to 10% HCl; trace small and mega mollusk fragments. Blow counts = 25, 50/6 inches.	CL		50	22	100		split spoon

LOG OF BORING GP-1

FUGRO McClelland

Gas Migration Monitor Well Installation
Comal County Landfill
Comal County, Texas

TYPE: 8" Hollow Stem Auger

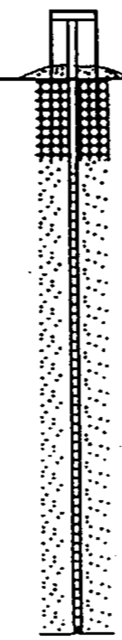
LOCATION:
North: C+90
East: 28+46

SURF. EL. 641.9 ft±

Job No. 1001-1466

DEPTH, FT	STRATUM DESCRIPTION	LAYER DEPTH/ ELEV. (ft)
0–4	Dark brown fat CLAY, w/ few limestone fragments. (Residual soil)	637.9 / 4.0
4–8	Brown CLAYEY GRAVEL. (Alluvium)	633.9 / 8.0
8–12	Light tan fat CLAY, w/ some gravel, calcareous pockets. (Pecan Gap)	629.9 / 12.0
12–24	Tan fat CLAY, moist. (Pecan Gap)	617.9 / 24.0

GAS MIGRATION MONITOR WELL



COMPLETION DEPTH: 24.0 ft
DATE: 7-24-91

DEPTH TO WATER: Dry
DATE: 7-24-91

PLATE 1

LOG OF BORING GP-2

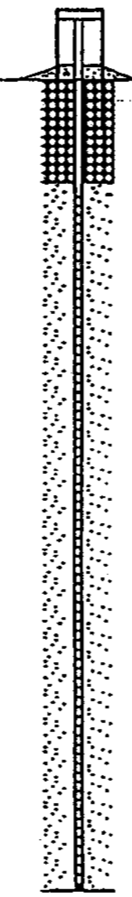
Fugro McClelland

Gas Migration Monitor Well Installation
Comal County Landfill
Comal County, Texas

TYPE: 8" Hollow Stem Auger

LOCATION:
North: Fence+10
East: 23+95

DEPTH, FT	SYMBOL	SAMPLES	STRATUM DESCRIPTION	LAYER DEPTH/ ELEV. (ft)	GAS MIGRATION MONITOR WELL
			SURF. EL. 662.8 ft± Job No. 1001-1466		
			Dark brown fat CLAY, w/ few limestone fragments and calcareous particles. (Residual soil)		
5			- lighter and more calcareous below 5.0 ft.	656.8 6.0	
			Tan CLAY w/ gravel. (Alluvium)	655.8 7.0	
			Tan fat CLAY, moist. (Pecan Gap)		
10					
15					
20					
25					
30					
35				627.8 35.0	
40					
45					



COMPLETION DEPTH: 35.0 ft
DATE: 7-23-91

DEPTH TO WATER: Dry
DATE: 7-24-91

PLATE 2

LOG OF BORING GP-3

Fugro McClelland

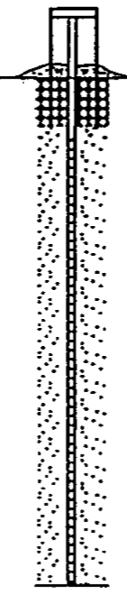
Gas Migration Monitor Well Installation
Comal County Landfill
Comal County, Texas

TYPE: **8" Hollow Stem Auger**

LOCATION:
North: Fence+13
East: 11+68

SURF. EL. 641.0 ft± Job No. 1001-1466

DEPTH, FT	SYMBOL	SAMPLES	STRATUM DESCRIPTION	LAYER DEPTH/ ELEV. (ft)	GAS MIGRATION MONITOR WELL
			Dark brown fat CLAY, w/ some limestone and chert fragments, and calcareous particles. (Residual Soil)	638.0 3.0	
5			Light brown fat CLAY. (Pecan Gap)		
10					
20				619.0 22.0	
25					
30					
35					
40					
45					



COMPLETION DEPTH: 22.0 ft
DATE: 7-24-91

DEPTH TO WATER: Dry
DATE: 7-24-91

PLATE 3

LOG OF BORING GP-4

FUGRO McClelland

Gas Migration Monitor Well Installation
Comal County Landfill
Comal County, Texas

TYPE: 8" Hollow Stem Auger

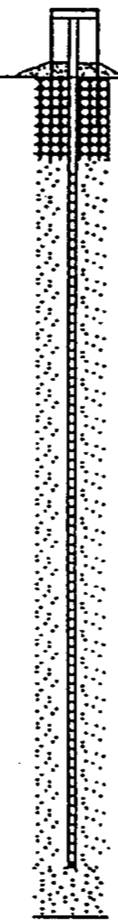
LOCATION:
North: Fence+15
East: 0+22

SURF. EL. 602.8 ft±

Job No. 1001-1466

DEPTH, FT	STRATUM DESCRIPTION	LAYER DEPTH/ ELEV. (ft)
0	Very dark brown fat CLAY. (Residual soil)	
4.5	Brown CLAYEY GRAVEL. (Alluvium)	598.3 / 4.5
8.5	Tan fat CLAY. (Pecan Gap) - dry and hard at 11.0 ft - slight amount of water added to soften the clay. - interbedded tan and gray clay transitional zone below 27.0 ft.	594.3 / 8.5
34.5	Gray CLAYSTONE. (Pecan Gap)	568.3 / 34.5
36.0		566.8 / 36.0

GAS MIGRATION MONITOR WELL



COMPLETION DEPTH: 36.0 ft
DATE: 7-22-91

DEPTH TO WATER: Dry
DATE: 7-22-91

PLATE 4

LOG OF BORING GP-5

FUGRO McClelland

Gas Migration Monitor Well Installation
Comal County Landfill
Comal County, Texas

TYPE: 8" Hollow Stem Auger

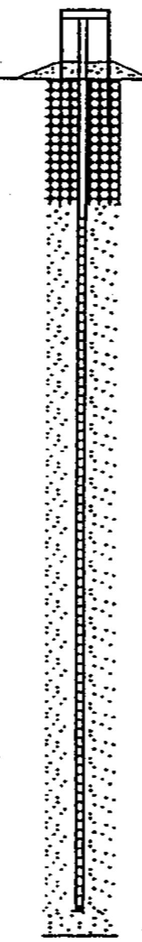
LOCATION:
North: H+96
East: 1+03

SURF. EL. 602.5 ft±

Job No. 1001-1466

DEPTH, FT	STRATUM DESCRIPTION	LAYER DEPTH/ ELEV. (ft)
0	Dark brown fat CLAY, w/ some limestone fragments and particles. (Residaul soil)	
6.0	Tan CLAYEY GRAVEL. (Alluvium)	596.5 6.0
8.0	Brown fat CLAY. (Pecan Gap) - interbedded tan and gray clay transitional zone below 28.0 ft.	594.5 8.0
32.0	Gray CLAYSTONE. (Pecan Gap)	570.5 32.0
37.0		565.5 37.0

GAS MIGRATION MONITOR WELL



COMPLETION DEPTH: 37.0 ft
DATE: 7-23-91

DEPTH TO WATER: Dry
DATE: 7-23-91
PLATE 5

LOG OF BORING GP-6

FUGRO McClelland

Gas Migration Monitor Well Installation
Comal County Landfill
Comal County, Texas

TYPE: **8" Hollow Stem Auger**

LOCATION:
North: M+38
East: 13+46

SURF. EL. 623.9 ft±

Job No. 1001-1466

DEPTH, FT	SYMBOL	SAMPLES	STRATUM DESCRIPTION	LAYER DEPTH / ELEV. (ft)	GAS MIGRATION MONITOR WELL
0			Dark brown fat CLAY, w/ some limestone fragments. (Resdiual Soil)	619.4 / 4.5	
5			Brown CLAYEY GRAVEL. (Alluvium)	616.4 / 7.5	
10			Tan fat CLAY. (Pecan Gap)		
			- transition to darker clay at 28.0 ft	593.9 / 30.0	
30			Grayish brown fat CLAY, moist. (Pecan Gap)	579.9 / 44.0	

Depth scale: 5, 10, 15, 20, 25, 30, 35, 40, 45

DECOMISIONED 1/26/95

COMPLETION DEPTH: 44.0 ft
DATE: 7-23-91

DEPTH TO WATER: Dry
DATE: 7-23-91

PLATE 6

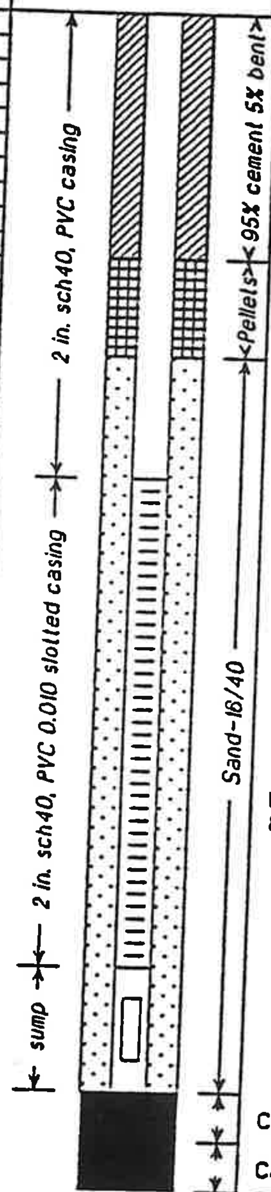
WASTE MANAGEMENT OF NORTH AMERICA

LOG OF BORING PZ-6

BORING LOCATION: *Comal County Landfill*	COORDINATES, N-E : *I + 49 - 2 + 7*
DRILLING COMPANY: *Jones Environmental Drilling Inc.*	ELEVATION, GL (ft.NGVD): *602.66* / ELEVATION, TOC (ft.NGVD): *605.57*
DRILLER: *K. Seevers, L. Taylor*	DATE STARTED: *9-26-91* / DATE COMPLETED: *9-26-91*
DRILLING METHOD: *Mobile B-61 Hollow Stem Auger*	DRILL BIT: *9 in. OD, 3 3/8 in. ID* / TOTAL DEPTH (ft.BGL): *24*
SIZE AND TYPE OF CASING: *2 in. sch.40, PVC, flush-threaded*	DRILL FLUID: *none* / GEOPHYS. LOG: *no*
SAMPLING METHOD: *2' Split Barrel (SB)*	GEOLOGIST: *B. Beveridge* / LOGGER: *none*

DEPTH (feet)	DESCRIPTION	USCS CLASS	SAMPLING METHOD	SAMPLING % REC	REMARKS
0–3.2	CL CLAY, black (7.5YR,N2); silty; organic; roots; soft; no reaction to 10% HCL; dry; sparse chert cobbles	CL	SB	55	Layer I, 0.0ft - 3.2ft
3.2–4.2	CH CLAY, dark olive gray (5Y,3/2); reactive to HCL 10%	CH	SB	100	
4.2–8	GW GRAVEL, white (10YR,8/1), light gray (10YR,6/1), and olive brown (2.5Y,5/4); coarse limestone and chert gravel, angular to subangular, 2-60mm; 75-80% pebbles in clay/chalk matrix; strong reaction to 10% HCL	GW	SB	100	Layer II, 3.2ft - 8.0ft
			SB	80	
8–9.5	CH CLAY, pale yellow (2.5Y,7/4); sparse FeO2 stain; chert pebbles, <1cm, v. sparse	CH	SB	50	Layer III/IV, 8.0ft - 24.0ft
9.5–22	CH CLAY, pale yellow (2.5Y,7/4); light gray (10YR,7/1) on inside & limonite stained yellow (2.5Y,7/6) on outside of fracture planes; v. strong reaction to 10% HCL; soft; some FeO2 nodules,<2cm; gypsum in fracture planes; some black organic or manganese oxide staining in fractures; some chalky calc nodules; v. sparse mollusk shells, <1cm	CH	SB	100	
			SB	100	
			SB	100	
			SB	100	
			SB	100	
			SB	100	
22–24	CH CLAY, light yellowish brown (2.5Y,6/4) blocked w/ gray (5Y,6/1); reacts to 10% HCL; soft but harder than clays above	CH	SB	40	Chips 22-23ft; Cave-in 23-24ft
24	Total Depth = 24ft BGL				

PIEZOMETER/WELL CONSTRUCTION



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WASTE MANAGEMENT OF NORTH AMERICA

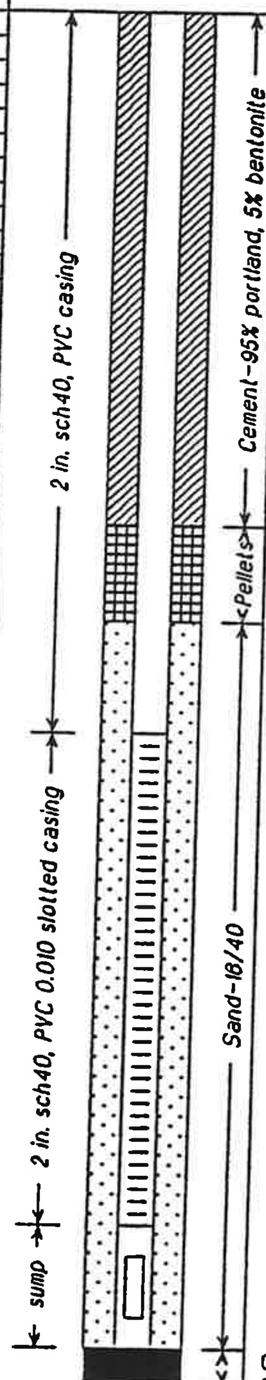
LOG OF BORING PZ-7

BORING LOCATION: *Comal County Landfill*	COORDINATES, N-E : *0 + 40 – 0 + 63*
DRILLING COMPANY: *Jones Environmental Drilling Inc.*	ELEVATION, GL (ft.NGVD): *601.72* / ELEVATION, TOC (ft.NGVD): 39
DRILLER: *K. Seevers, L. Taylor*	DATE STARTED: *9-25-91* / DATE COMPLETED: *9-25-91*
DRILLING METHOD: *Mobile B-61 Hollow Stem Auger*	DRILL BIT: *9 in. OD, 3 3/8 in. ID* / TOTAL DEPTH (ft.BGL): *28*
SIZE AND TYPE OF CASING: *2 in. sch.40, PVC, flush threaded*	DRILL FLUID: *none* / GEOPHYS. LOG: *no*
SAMPLING METHOD: *Split Barrel (SB), Split Spoon (SS)*	GEOLOGIST: *B. Beveridge* / LOGGER: *none*

DEPTH (feet)	DESCRIPTION	USCS CLASS
0–0.5	CL CLAY, pale yellow (2.5Y,7/4); roots; strong reaction to 10% HCL; soft; moist	CL
0.5–3.5	CL CLAY, black (7.5YR,N2); silty; organic; roots; rich; no reaction to 10% HCL; soft; dry; sparse chert cobbles, < 4cm	CL
3.5–4.8	CH CLAY, dark olive gray (5Y,3/2); calc & chert fragments & nodules; strongly reactive to 10% HCL; plastic; moist; soft; roots	CH
4.8–8.5	GW GRAVEL, white (10YR,8/1), light gray (10YR,6/1), and olive brown (2.5Y,5/4); coarse limestone and chert gravel; dry; poorly sorted; 2-60mm; 75-85% pebbles in caliche/clay matrix; strong reaction to 10% HCL	GW
8.5–11.3	CH CLAY, pale yellow (2.5Y,7/4); 2-50mm mollusk fragments; some organic laminations; tr. FeO2 staining; tr. limonite; reacts to 10% HCL	CH
11.3–27.3	CH CLAY, pale yellow (2.5Y,7/4); fractures filled w/ lt.gray (10YR,7/1) on inside and limonite yellow (2.5y,7/6) on outside of fracture planes ; tr. FeO2 staining; strong reaction to 10% HCL	CH
27.3–28	CH CLAY, light yellowish brown (2.5Y,6/4), blocked w/ gray (5Y,5/1), 70/30; clay reacts to 10% HCL; SS sample = 100 blows	CH
	Total Depth = 28ft BGL	

DEPTH (feet)	SAMPLING METHOD	% REC
0–2	SB	100
2–4	SB	70
4–6	SB	100
6–8	SB	100
8–10	SB	90
10–12	SB	100
12–14	SB	100
14–16	SB	100
16–18	SB	100
18–20	SB	100
20–22	SB	100
22–24	SB	90
24–26	SB	50
26–28	SS	100

PIEZOMETER/WELL CONSTRUCTION



REMARKS
Layer I, 0.0ft – 4.8ft
Layer II, 4.8ft – 8.5ft
Layer III/IV, 8.5ft – 28.0ft
Chips/Cave-in, 27.3-28.0ft

Project No. 91-2221 | McCulley, Frick & Gilman, Inc. | *Sheet 1 of 1*

WASTE MANAGEMENT OF NORTH AMERICA

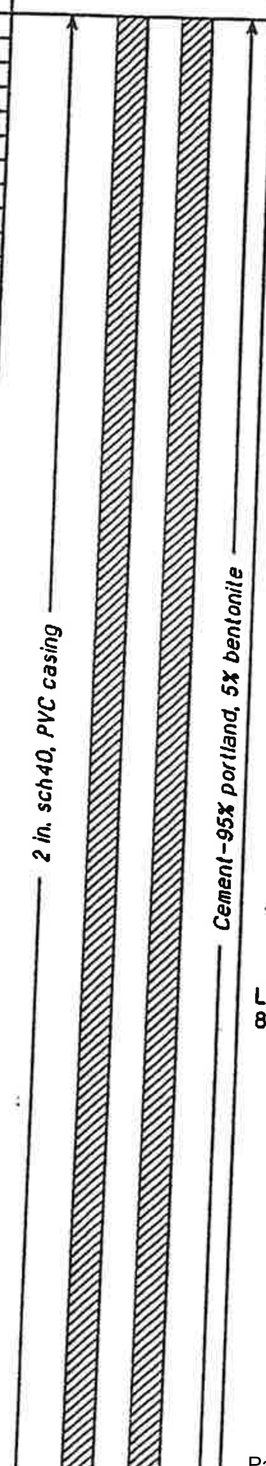
LOG OF BORING PZ-8

BORING LOCATION: *Comal County Landfill*	COORDINATES, N-E : *D + 30 - 0 + 61*
DRILLING COMPANY: *Jones Environmental Drilling Inc.*	ELEVATION, GL (ft.NGVD): *600.65* / ELEVATION, TOC (ft.NGVD): *604.8*
DRILLER: *K. Seevers, L. Taylor*	DATE STARTED: *9-23-91* / DATE COMPLETED: *9-25-91*
DRILLING METHOD: *Mobile B-61 Hollow Stem Auger*	DRILL BIT: *9 in. OD, 3 3/8 in. ID* / TOTAL DEPTH (ft.BGL): *83.5*
SIZE AND TYPE OF CASING: *2 in. sch.40, PVC, flush threaded*	DRILL FLUID: *none* / GEOPHYS. LOG: *no*
SAMPLING METHOD: *Split Barrel (SB), Split Spoon (SS)*	GEOLOGIST: *B. Beveridge* / LOGGER: *none*

DEPTH (feet)	DESCRIPTION	USCS CLASS	REMARKS
0–1	CL CLAY, pale yellow (2.5Y,7/4); roots; strong reaction to 10% HCL; soft; chert cobbles	CL	Layer I, 0.0ft - 4.0ft
1–2.5	CL CLAY, black (7.5YR,N2); silty; organic; roots; soft; no reaction to 10% HCL	CL	
2.5–4	CH CLAY, dark olive gray (5Y,3/2); 5% calc fragments; slight response to 10% HCL; soft	CH	
4–8.5	GW GRAVEL, white (10YR,8/1), light gray (10YR,6/1), and olive brown (2.5Y,5/4); coarse limestone and chert gravel, angular to subangular, 2-60mm; 75-85% pebbles in caliche/clay matrix; strong reaction to 10% HCL	GW	Layer II, 4.0ft - 8.5ft
8.5–28	CH CLAY, pale yellow (2.5Y,7/4), mottled with light gray (10YR,7/1); limonite stain, yellow (2.5Y,7/6); light gray in fractures; v. sparse FeO2 nodules; v. sparse calc nodules; v. strong reaction to 10% HCL; trace mollusk fragments; soft	CH	Layer III/IV, 8.5ft - 40.1ft
28–	CH CLAY, light yellowish brown (2.5Y,6/4), blocked w/ gray (5Y,5/1), 60/40%; vertical fractures filled w/ gypsum; clay reacts to 10% HCL; sparse FeO2 nodules; soft		

SAMPLING DEPTH (feet)	METHOD	% REC
0–2	SB	100
2–4	SB	100
4–6	SB	100
6–8	SB	100
8–10	SB	100
10–12	SB	100
12–14	SB	100
14–16	SB	100
16–18	SB	100
18–20	SB	100
20–22	SB	100
22–24	SB	100
24–26	SB·	100
26–28	SB	100
28–30	SB	50

PIEZOMETER/WELL CONSTRUCTION



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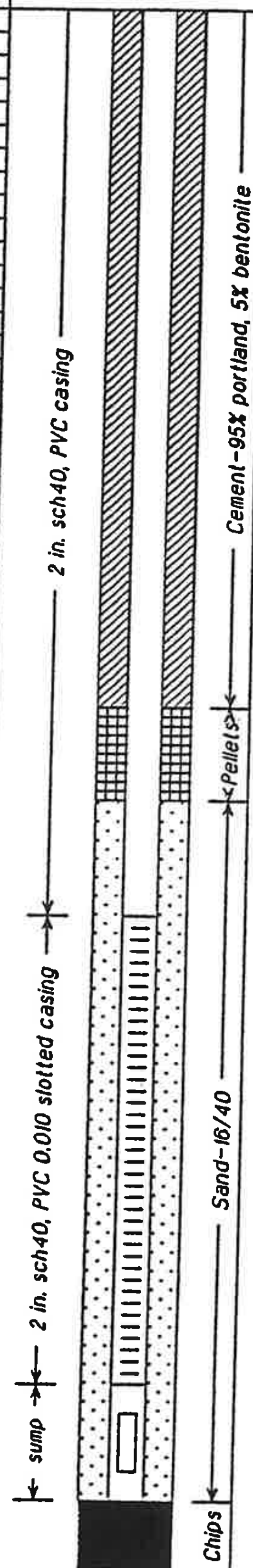
WASTE MANAGEMENT OF NORTH AMERICA — LOG OF BORING PZ-8

DEPTH (feet)	DESCRIPTION	USCS CLASS	SAMPLING METHOD	SAMPLING % REC	REMARKS
31.5	see above description		SB	0	
32.5			SB	100	
34.5			SB	100	Layer III/IV, 8.5ft – 40.1ft
36.5			SB	10	
38.5			SB	0	
40.1	CH CALCAREOUS CLAYSTONE, gray (5Y,5/1); strong reaction to 10% HCL; trace mollusk fragments; friable but harder than clays above; each SS sample = 100 blows w/ hammer	CH	SS	100	Layer V/VI, 40.1ft – 63.5ft
45			SS	100	
52			SS	100	
55			SS	100	
60			SS	100	

Total Depth = 63.5ft BGL



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WASTE MANAGEMENT OF NORTH AMERICA

LOG OF BORING PZ-9

BORING LOCATION: *Comal County Landfill*
DRILLING COMPANY: *Jones Environmental Drilling Inc.*
DRILLER: *K. Seevers, L. Taylor*
DRILLING METHOD: *Mobile B-61 Hollow Stem Auger*
SIZE AND TYPE OF CASING: *2 in. sch.40, PVC, flush threaded*
SAMPLING METHOD: *Split Barrel (SB)*

COORDINATES, N-E : *M + 33 - 17 + 67*
ELEVATION, GL (ft.NGVD): *621.93* | ELEVATION, TOC (ft.NGVD): 625.3(
DATE STARTED: *9-27-91* | DATE COMPLETED: *9-27-91*
DRILL BIT: *9 in. OD, 3 3/8 in. ID* | TOTAL DEPTH (ft.BGL): *58*
DRILL FLUID: *none* | GEOPHYS. LOG: *no*
GEOLOGIST: *B. Beveridge* | LOGGER: *none*

DEPTH (feet)	DESCRIPTION	USCS CLASS	SAMPLING METHOD	SAMPLING % REC	DEPTH (feet)	PIEZOMETER/WELL CONSTRUCTION	REMARKS
0–2	CH CLAY, black (7.5YR,N2); silty; organic; roots; soft; some chert pebbles <4cm, angular subangular; moist; elastic	CH	SB	100	0–2	2 in. sch40, PVC casing; Cement-93% portland, 7% bentonite	Layer I, 0.0ft - 2.7ft
2–2.7	CH CLAY, v. dark gray (5Y,3/1); silty; chert pebbles, angular to subangular, more chert towards bottom		SB	100	2–4		
2.7–8	GW GRAVEL, white (10YR,8/1), light gray (10YR,6/1), and olive brown (2.5Y,5/4); coarse limestone and chert gravel, angular to subangular, 0.2-6cm; 80% pebbles in clay & chalk matrix; strong reaction to 10% HCL	GW	SB	100	4–6		Layer II, 2.7ft - 8.0ft
			SB	70	6–8		
8–9	CH CLAY W/ CHALK, pale olive (5Y,6/3) w/ 20% calc chalk	CH	SB	100	8–10		Layer III/IV, 8.0ft - 51.8ft
9–	CH CLAY, pale olive (5Y,6/3) w/ 5-10% oxidation, brownish yellow (10YR,6/6); tr. black organic staining; friable; soft; mod. reaction to 10% HCL; v. sparse calc chalk nodules; vertical & high angle fractures filled w/ lt. gray clay (10YR,6/1) and gypsum in fracture planes; more oxidation towards bottom of layer		SB	25	10–12		
			SB	0	12–14		
			SB	100	14–16		
			SB	100	16–18		
			SB	100	18–20		
			SB	100	20–22		
			SB	100	22–24		
			SB	100	24–26		
			SB	100	26–28		
			SB	100	28–30		

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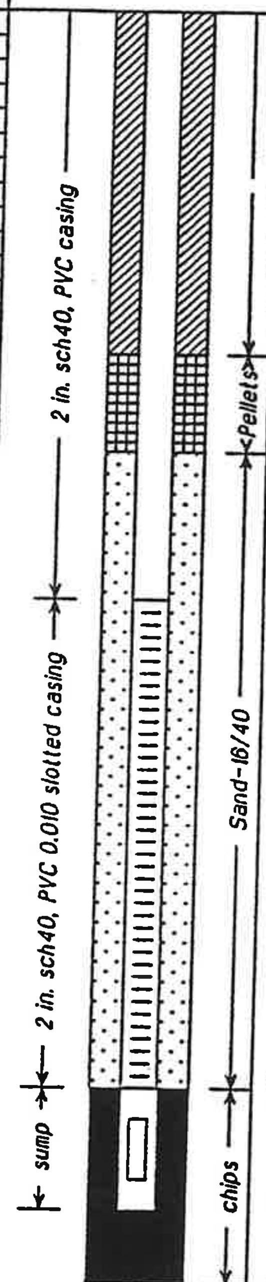
WASTE MANAGEMENT OF NORTH AMERICA — LOG OF BORING PZ-9

DEPTH (feet)	DESCRIPTION	USCS CLASS	SAMPLING METHOD	SAMPLING % REC	DEPTH (feet)	REMARKS
30–32		CH	SB	100	30–32	
32–34	CH CLAY, olive gray (5Y,5/2), gray (5Y,5/1); friable; lt. gray (2.5Y,N6) and yellowish brown (10YR,5/8) oxidation w/ gypsum in high angle fractures; reacts to 10% HCL	CH	SB	100	32–34	
34–36		CH	SB	100	34–36	
36–38		CH	SB	100	36–38	
38–40		CH	SB	100	38–40	Layer III/IV, 8.0ft - 51.8ft
40–42		CH	SB	100	40–42	
42–44		CH	SB	100	42–44	
44–46		CH	SB	100	44–46	
46–48		CH	SB	0	46–48	
48–50		CH	SB	100	48–50	
50–52		CH	SB	100	50–52	
52–54	CH CLAYSTONE, dark gray (5Y,4/1); reacts to 10% HCL; soft but harder than clays above; massive	CH	SB	100	52–54	
54–56		CH	SB	100	54–56	Layer V/VI, 51.8ft - 56.0ft
56	Total Depth = 56ft BGL				56	

PIEZOMETER/WELL CONSTRUCTION



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WASTE MANAGEMENT OF NORTH AMERICA — LOG OF BORING PZ-10

BORING LOCATION: *Comal County Landfill*	COORDINATES, N-E : *M+31 - 17+77*
DRILLING COMPANY: *Jones Environmental Drilling Inc.*	ELEVATION, GL (ft.NGVD): *622.00* — ELEVATION, TOC (ft.NGVD): *824.94*
DRILLER: *K. Seevers, L. Taylor*	DATE STARTED: *9-26-91* — DATE COMPLETED: *9-27-91*
DRILLING METHOD: *Mobile B-61 Hollow Stem Auger*	DRILL BIT: *9 in. OD, 3 3/8 in. ID* — TOTAL DEPTH (ft.BGL): *80*
SIZE AND TYPE OF CASING: *2 in. sch.40, PVC, flush threaded*	DRILL FLUID: *none* — GEOPHYS. LOG: *no*
SAMPLING METHOD: *Split Barrel (SB)*	GEOLOGIST: *B. Beveridge* — LOGGER: *none*

DEPTH (feet)	DESCRIPTION	USCS CLASS	SAMPLING METHOD	SAMPLING % REC	DEPTH (feet)	PIEZOMETER/WELL CONSTRUCTION	REMARKS
0–2.5	CH CLAY, black (7.5YR,N2); silty; organic; roots; soft; some chert pebbles <4cm, angular subangular; moist; elastic	CH	SB	100	0–2	2 in. sch40, PVC casing; Cement-95% portland, 5% bentonite	Layer I, 0.0ft - 2.5ft
2.5–3.5	CH CLAY, v. dark gray (5Y,3/1); silty; chert pebbles, angular to subangular; more chert towards bottom of layer		SB	100	2–4		Layer II, 2.5ft - 6.1ft
3.5–6	GW GRAVEL, white (10YR,8/1), light gray (10YR,6/1), and olive brown (2.5Y,5/4); coarse limestone and chert gravel, angular to subangular, 2-60mm; 75-85% pebbles in clay & chalk matrix; strong reaction to 10% HCL	GW	SB	100	4–6		
6–7	CH CLAY W/ CHALK, pale olive (5Y,6/3), w/ 20% calc chalk		SB	100	6–8		Layer III/IV, 6.1ft - 52.5ft
7–	CH CLAY, pale olive (5Y,6/3) w/ 5-10% oxidation, brownish yellow (10YR,6/6); tr. black organic staining; friable; soft; mod. reaction to 10% HCL; v. sparse calc chalk nodules	CH	SB	100	8–10		
			SB	100	10–12		
			SB	100	12–14		
			SB	100	14–16		
			SB	100	16–18		
			SB	100	18–20		
			SB	100	20–22		
22	fracturing begins at 22' filled w/ lt. gray clay (10YR,6/1) and gypsum in fracture planes, more oxidation towards bottom		SB	100	22–24		
			SB	100	24–26		
			SB	100	26–28		
			SB	100	28–30		

WASTE MANAGEMENT OF NORTH AMERICA	LOG OF BORING	PZ-10

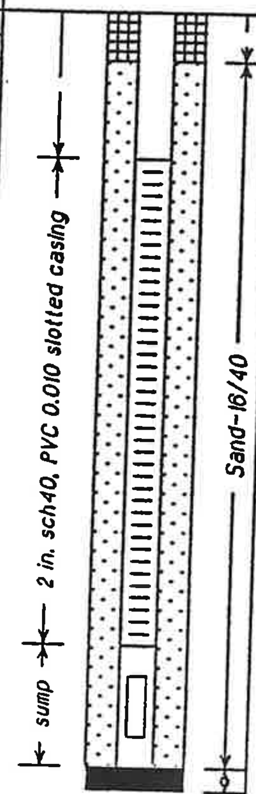
DEPTH (feet)	DESCRIPTION	USCS CLASS	SAMPLING METHOD	SAMPLING % REC	DEPTH (feet)	PIEZOMETER/WELL CONSTRUCTION	REMARKS
	CH CLAY, olive gray (5Y,5/2), gray (5Y,5/1); friable; lt. gray (2.5Y,N6) and yellowish brown (10YR,5/8) oxidation w/ gypsum in high angle fractures; reacts to 10% HCL	CH	SB	100		2 in. sch40, PVC casing; Cement-95% portland, 5% bentonite	Layer III/IV, 8.1ft - 52.5ft
32			SB	85	32		
34			SB	60	34		
36			SB	100	36		
38			SB	100	38		
40			SB	65	40		
42			SB	100	42		
44			SB	0	44		
46			SB	100	46		
48			SB	100	48		
50			SB	100	50		
52	CH CLAYSTONE, dark gray (5Y,4/1); reacts to 10% HCL; soft but harder than clays above; massive		SB	100	52		Layer V/VI, 52.5ft - 80.0ft
54			SB	100	54		
56			SB	100	56		
58			SB	100	58		
60			SB	100	60		
62			SB	100	62		
64					64		Pellets, 63-65ft

Project No. 91-2221	McCulley, Frick & Gilman, Inc.	Sheet 2 of 3

WASTE MANAGEMENT OF NORTH AMERICA — LOG OF BORING PZ-10

DEPTH (feet)	DESCRIPTION	USCS CLASS	SAMPLING METHOD	SAMPLING % REC	REMARKS
65–66	see above description	CH	SB	100	Pellets, 63-65ft
66–67			SB	100	
67–68			SB	100	
68–69			SB	100	Layer V/VI, 52.5ft - 80.0ft
69–70			SB	100	
70–71			SB	100	
71–72			SB	100	
72–73			SB	100	
80	Total Depth = 80ft BGL				Chips, 79.5-80ft

PIEZOMETER/WELL CONSTRUCTION



October 2023
Page No. 4C-182

WASTE MANAGEMENT OF NORTH AMERICA

LOG OF BORING PZ-11

BORING LOCATION: *Comal County Landfill*	COORDINATES, N-E : *ZERO + 7 - 16 + 77*
DRILLING COMPANY: *Jones Environmental Drilling Inc.*	ELEVATION, GL (ft.NGVD): *659.74* / ELEVATION, TOC (ft.NGVD):
DRILLER: *K. Seevers, L. Taylor*	DATE STARTED: *9-30-91* / DATE COMPLETED: *10-1-91*
DRILLING METHOD: *Mobile B-61 Hollow Stem Auger*	DRILL BIT: *9 in. OD, 3 3/8 in. ID* / TOTAL DEPTH (ft.BGL): *50*
SIZE AND TYPE OF CASING: *2 in. sch.40, PVC, flush threaded*	DRILL FLUID: *none* / GEOPHYS. LOG: *no*
SAMPLING METHOD: *Split Barrel (SB)*	GEOLOGIST: *B. Beveridge* / LOGGER: *none*

DEPTH (feet)	DESCRIPTION	USCS CLASS	SAMPLING METHOD	SAMPLING % REC	DEPTH (feet)	PIEZOMETER/WELL CONSTRUCTION	REMARKS
0–2	CL CLAY, organic, dark gray (5Y,4/1); roots; limestone & chert pebbles .2-2cm; reacts to 10% HCL	CL	SB	40	0–2		
2–5.5	CH CLAY, dark gray (10YR,4/1); limestone cobbles & pebbles, subangular (5cm) at 2ft; slight reaction to 10% HCL	CH	SB	10	2–4		Layer I/II, 0.0ft - 5.5ft
			SB	100	4–6		
5.5–	CH CLAY, light yellowish brown (2.5Y,6/3,4), olive yellow (2.5Y,6/6); intermittent limonite esp. at hi angle fractures; brownish yellow (10YR,6/8) outside fractures; lt. gray (2.5Y,N7/) in fracture planes; v. sparse black organic staining; v. soft; friable; slight reaction to 10% HCL		SB	100	6–8		Layer III/IV, 5.5ft - 46.0ft
			SB	100	8–10		
			SB	100	10–12		
			SB	100	12–14		
			SB	100	14–16		
			SB	100	16–18		
			SB	100	18–20		
			SB	100	20–22		
			SB	100	22–24		
			SB	100	24–26		
			SB	80	26–28		
			SB	95	28–30		

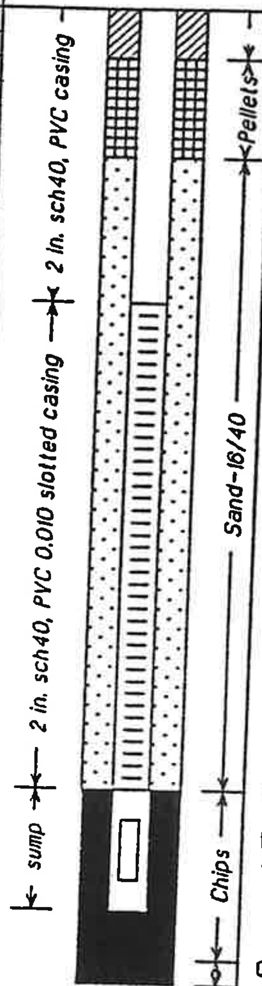
Piezometer/well construction: 2 in. sch40, PVC casing; Cement-95% portland, 5% bentonite

Project No. 91-2221	McCulley, Frick & Gilman, Inc.	*Sheet 1 of 2*

WASTE MANAGEMENT OF NORTH AMERICA — LOG OF BORING PZ-11

DEPTH (feet)	DESCRIPTION	USCS CLASS	SAMPLING METHOD	SAMPLING % REC	REMARKS
30–32			SB	100	
32–34			SB	100	
34–36			SB	100	
36–38			SB	100	
38–40			SB	100	Layer III/IV, 5.5ft – 46.0ft
40.5	CH CLAYSTONE, dark gray (5Y,4/1); soft but harder than clays above; wet from 41.9 to 42.0ft	CH	SB	100	
42	CH CLAY, limonite oxidized brownish yellow (10YR,6/6); gypsum in fractures; soft		SB	100	
44			SB	100	
46	CH CLAYSTONE, dark gray (5Y,4/1); soft but harder than other clays above; massive		SB	100	Layer V/VI, 46.0ft – 50.0ft
48			SB	100	
50	Total Depth = 50ft BGL				Cave-in 49.5–50ft

PIEZOMETER/WELL CONSTRUCTION



October 2023
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WASTE MANAGEMENT OF NORTH AMERICA	LOG OF BORING PZ-12	
BORING LOCATION: *Comal County Landfill*	COORDINATES, N-E : *ZERO + 7 - 16 + 65*	
DRILLING COMPANY: *Jones Environmental Drilling Inc.*	ELEVATION, GL (ft.NGVD): *660.12*	ELEVATION, TOC (ft.NGVD):
DRILLER: *K. Seevers, L. Taylor*	DATE STARTED: *9-30-91*	DATE COMPLETED: *9-30-91*
DRILLING METHOD: *Mobile B-61 Hollow Stem Auger*	DRILL BIT: *9 in. OD, 3 3/8 in. ID*	TOTAL DEPTH (ft.BGL): *68*
SIZE AND TYPE OF CASING: *2 in. sch.40, PVC, flush threaded*	DRILL FLUID: *none*	GEOPHYS. LOG: *no*
SAMPLING METHOD: *Split Barrel (SB)*	GEOLOGIST: *B. Beveridge*	LOGGER: *none*

DEPTH (feet)	DESCRIPTION	USCS CLASS	SAMPLING METHOD	SAMPLING % REC	DEPTH (feet)	PIEZOMETER/WELL CONSTRUCTION	REMARKS
0–2	CL CLAY, organic, dark gray (5Y,4/1); roots; limestone & chert pebbles (.2-2cm); reacts to 10% HCL	CL	SB	100	0–2	2 in. sch40, PVC casing; Cement-95% portland, 5% bentonite	
2–4	CL CLAY, pale yellow (2.5Y,5/3) & oxidized brownish yellow (10YR,6/8); calc chalk nodules; reacts to 10% HCL		SB	100	2–4		Layer I/II, 0.0ft - 4.2ft
4–6	CH CLAY, dark gray (10YR,4/1); sparse limestone pebbles, subangular, <1cm; slight reaction to 10% HCL	CH	SB	100	4–6		Layer III/IV, 4.2ft - 46.2ft
6–8	CH CLAY, light yellowish brown (2.5Y,6/3,4), olive yellow (2.5Y,6/6); intermittent limonite esp. at hi angle fractures; brownish yellow (10YR,6/8) outside fractures, lt. gray (2.5Y,N7/) in fracture planes; v. sparse black organic staining; v. soft; friable; slight reaction to 10% HCL		SB	100	6–8		
8–10			SB	100	8–10		
10–12			SB	100	10–12		
12–14			SB	100	12–14		
14–16			SB	100	14–16		
16–18			SB	100	16–18		
18–20			SB	100	18–20		
20–22			SB	80	20–22		
22–24			SB	100	22–24		
24–26			SB	100	24–26		
26–28			SB	100	26–28		
28–30			SB	100	28–30		

October 2023
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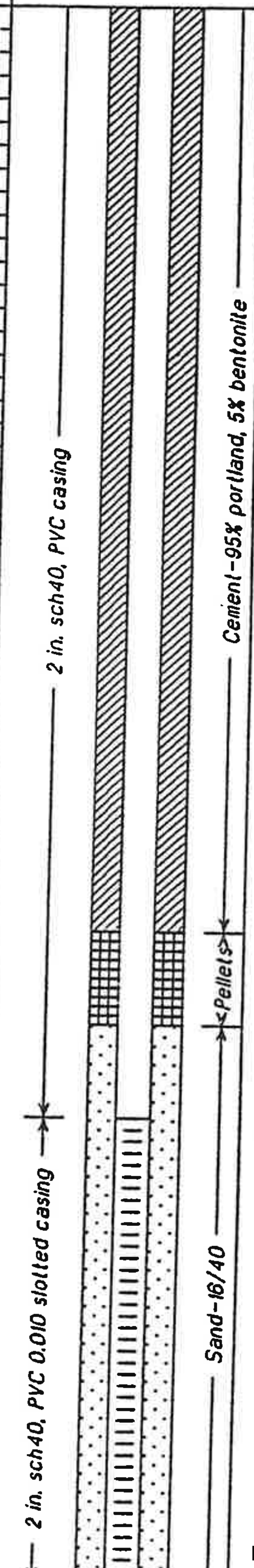
WASTE MANAGEMENT OF NORTH AMERICA | LOG OF BORING PZ-12

DEPTH (feet)	DESCRIPTION	USCS CLASS
	see above description	
46	CH CLAYSTONE, dark gray (5Y,4/1); tr. gypsum in fracture; soft but harder than clays above; reacts to 10% HCL	CH
48	CH CLAY, limonite oxidized brownish yellow (10YR,6/6);some pale yellow (2.5Y,8/3) caliche; soft; reacts to 10% HCL	
50	CH CLAYSTONE, dark gray (5Y,4/1); reacts to 10% HCL, massive	

SAMPLING METHOD	% REC
SB	100
SB	100
SB	100
SB	100
SB	100
SB	100
SB	100
SB	100
SB	100
SB	20
SB	100
SB	100
SB	95
SB	85
SB	50
SB	95
SB	85

PIEZOMETER/WELL CONSTRUCTION



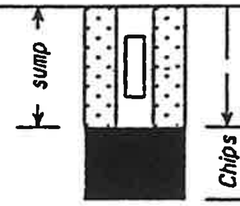
REMARKS

Layer V/VI, 46.2ft - 68.0ft

Project No. 91-2221 | McCulley, Frick & Gilman, Inc. | *Sheet 2 of 3*

WASTE MANAGEMENT OF NORTH AMERICA | LOG OF BORING PZ-12

DEPTH (feet)	DESCRIPTION	USCS CLASS	SAMPLING METHOD	SAMPLING % REC	DEPTH (feet)	PIEZOMETER/WELL CONSTRUCTION	REMAR
			SB	85			
66	see above description	CH			66		Layer V/VI, 46.2ft - 68.0ft
			SB	50			
68	Total Depth = 68ft BGL				68		



DEPTH (feet): 66, 68, 70, 72, 74, 76, 78, 80, 82, 84, 86, 88, 90, 92, 94, 96, 98

Project No. 91-2221 | McCulley, Frick & Gilman, Inc. | Sheet 3 of 3

SOIL BOREHOLE LOG

NAME AND LOCATION

...nagement, Inc. - Comal County ...ll, New Braunfels, Texas ...ca..d approximately eight miles ...rtheast of New Braunfels, Texas, ...ong FM 1101 and Kohlenberg Lane.

DRILLING METHOD: Hollow - Stem Auger. w/8.25 Augers

BORING NO. SB - 1

SHEET 1 OF 1

SAMPLING METHOD: Continuous w/5' Split-spoon

WATER LEVEL	Dry	Dry	Dry	Dry
TIME	12:00	1:00	9:00	4:00
DATE	2/20	2/21	2/24	2/26
CASING DEPTH	0	43'	43'	43'

DRILLING	
START	FINISH
TIME 10:47	TIME 12:00
DATE 2/20	DATE 2/20

...MSL ELEVATION 662.36

RIG Failing F-6

...E Vertical BEARING

...LE HAMMER TORQUE FT.-LBS

SURFACE CONDITIONS Damp, tan clay, soft ground

BLOWS/ ... ON SAMPLER (RECOVERY)	SYMBOL	SAMPLE NUMBER AND DESCRIPTION OF MATERIAL	SAMPLER AND OD	CASING TYPE	BLOWS/FOOT ON CASING	WATER CONTENT %	LIQUID LIMIT %	PLASTIC LIMIT %	SPECIFIC GRAVITY	OTHER TESTS
		0 -.5' FILL MATERIAL: mixture of clay (CH) very dary gray (10 YR 3/1) and olive brown (2.5 Y 5/4); w/chert pebbles; no reaction to 10% HCL.								
		.5 - 1.5' CLAY (CL): black (7.5 R, N2); silty soft; moderate reaction to 10% HCL.								
		1.5 - 3.5' CLAY (CH): light olive brown and brownish yellow (10 YR 6/8) soft; plastic.								
		3.5 - 9.5' CLAY (CH): black (7.5 YR, N2) manganese oxides, 2 mm average, moderate reaction to 10% HCL.								
		9.5 - 10' CLAY,CALICHE MIX (CL): (2.5 Y 5/4) and (10 YR 8/1), strong reaction to 10% HCL.								
55		10 - 30 ' CLAY (CH): light olive brown (2.5 Y 5/4) and brownish yellow (10 YR 6/8); soft; limonite stains; gypsum crystals along fracture voids; reacts to HCL. (15'-24' no split-spoon recovery cuttings only; as above).								
		30 - 40' CLAY (CH): light olive brown (2.5 Y 5/4) and brownish yellow (10 R 6/3); soft; strong HCL reaction; verticle fractures								
		40 - 45' CLAYSTONE (CH), CALCAREOUS: gray (5 Y, 5/2); hard, strong reaction to 10% HCL; trace mollusca fragments.								

DRILLING CONTR. Enviro - Drill, New Braunfels

SL 10941

LOGGED BY E. Hudson CHK'D BY

DATE 2/20/92

SOIL BOREHOLE LOG

NAME AND LOCATION	DRILLING METHOD:	BORING NO.
...Management, Inc. - Comal County ...fill, New Braunfels, Texas ...ocated approximately eight miles ...ortheast of New Braunfels, Texas, ...long FM 1101 and Kohlenberg Lane.	Hollow - Stem Auger, w/8.25 Augers	SB - 2
	SAMPLING METHOD: Continuous w/5' Split-spoon	SHEET 1 OF 1

WATER LEVEL	Dry	31.70	29.8	24.63	DRILLING START TIME	FINISH TIME
TIME	12:45	8:00	8:30	9:00	11:12	12:45
DATE	2/19	2/20	2/23	2/24	DATE	DATE
CASING DEPTH	0	33'	33'	33'	2/19	2/19

...M MSL ELEVATION 615.63

...L RIG Failing F-6 SURFACE CONDITIONS Damp, tan clay, soft ground

...LE Vertical BEARING

...PLE HAMMER TORQUE FT.-LBS

DEPTH	BLOWS/ ... ON SAMPLER (RECOVERY)	SYMBOL	SAMPLE NUMBER AND DESCRIPTION OF MATERIAL	SAMPLER AND BIT	CASING TYPE	BLOWS/FOOT ON CASING	WATER CONTENT %	LIQUID LIMIT %	PLASTIC LIMIT %	SPECIFIC GRAVITY	OTHER TESTS
			0 - 9' CLAY (CL): black, (7.5 R, N2); silty; roots; occassional pebble.								
0			9 - 17.5' CLAY (CH): brownish yellow (10 YR 6/8) and light olive brown (2.5 Y 5/4); soft; plastic; crystalline gypsum - filled fractures; slightly moist.								
0	52		17.5 - 19' NO RECOVERY: gravel jammed 5' recovery system.								
5			19 - 30.5' CLAY (CH): brownish yellow and light olive brown; soft; plastic; crystalline gypsum - filled fractures.								
0											
5	55		30.5 - 33' SILTSTONE (ML): clayey; yellow; low plasticity; strong reaction to 10% HCL.								
0											
5			33 - 35' CLAYSTONE (CH), CALCAREOUS: gray (5 Y, 5/1); hard; strong reaction to 10% HCL.								
0											
5											

DRILLING CONTR. Enviro - Drill, New Braunfels

SL 1 J941

LOGGED BY E. Hudson CHK'D BY

DATE 2/19/92

SOIL BOREHOLE LOG

NAME AND LOCATION: anagement, Inc. - Comal County ill, New Braunfels, Texas ocated approximately eight miles ortheast of New Braunfels, Texas, long FM 1101 and Kohlenberg Lane.	DRILLING METHOD: Hollow - Stem Auger, w/8.25 Augers					BORING NO. SB - 3	
	SAMPLING METHOD: Continuous w/5' Split-spoon					SHEET 1 OF 1	
						DRILLING	
						START	FINISH
	WATER LEVEL	9.81	6.36	6.37	6.29	TIME	TIME
	TIME	11:05	8:10	8:30	9:00	8:30	9:00
UM MSL	DATE	2/18	2/19	2/21	2/24	DATE	DATE
ELEVATION 603.48	CASING DEPTH	0	29'	29'	29'	2/18	2/18

L RIG Failing F-6 — SURFACE CONDITIONS: Damp, tan clay, soft ground

LE Vertical — BEARING

PLE HAMMER TORQUE — FT.-LBS

ELEVATION	BLOWS/ FT. ON SAMPLER (RECOVERY)	SYMBOL	SAMPLE NUMBER AND DESCRIPTION OF MATERIAL		SAMPLER AND BIT	CASING TYPE	BLOWS/FOOT ON CASING	WATER CONTENT %	LIQUID LIMIT %	PLASTIC LIMIT %	SPECIFIC GRAVITY	OTHER TESTS
			0 - 4'	CLAY (CL): pale yellow, (2.5 Y, 7/4); silty, organic; roots; soft; moist.								
0	50		4 - 6'	CLAY (CL): black (7.5 R, N2); organic; roots, no reaction to HCL.								
0			6 - 9'	GRAVEL (GW): olive brown (2.5 Y, 5/4); coarse chert and limestone; angular to subangular; 5 - 40mm, 50% pebbles in clay matrix; saturated; reaction HCL.								
5												
0	53		9 - 26.5'	CLAY (CH): pale yellow (2.5 Y, 7/4), light gray (10 YR, 7/1), ferrous staining; soft; alternating saturated/dry, strong reaction to HCL; vertical fractures.								
5												
0			26.5 - 29'	CLAY (CH): light yellowish brown (2.5 Y, 6/4), and light olive brown (2.5 Y, 5/4), hard, reaction to HCL; vertical fractures.								
5												
0			29 - 34'	CLAYSTONE (CH), CALCAREOUS: gray (5 Y, 5/1); hard, strong reaction to 10% HCL; mollusca fragments, casts, and molds.								
5												

DRILLING CONTR. Enviro - Drill, New Braunfels

SL 10941

LOGGED BY E. Hudson CHK'D BY

DATE 2/18/92

SOIL BOREHOLE LOG

NAME AND LOCATION	DRILLING METHOD: Hollow - Stem Auger. w/8.25 Augers	BORING NO. SB - 4
Management, Inc. - Comal County ...fill, New Braunfels, Texas ocated approximately eight miles ortheast of New Braunfels, Texas, long FM 1101 and Kohlenberg Lane.	SAMPLING METHOD: Continuous w/5' Split-spoon	SHEET 1 OF 1

					DRILLING	
					START	FINISH
WATER LEVEL	Dry	Dry	26.90	28.75	TIME	TIME
TIME	8:15	8:40	9:30	10:18	4:00	5:30
DATE	2/19	2/21	2/24	2/26	DATE	DATE
CASING DEPTH	0	28'	28'	28'	2/19	2/19

DATUM MSL ELEVATION 605.32

RIG Failing F-6

SURFACE CONDITIONS Damp, tan clay, soft ground

ANGLE Vertical BEARING

SAMPLE HAMMER TORQUE FT.-LBS

ELEVATION	BLOWS/FT. ON SAMPLER (RECOVERY)	SYMBOL	SAMPLE NUMBER AND DESCRIPTION OF MATERIAL		SAMPLER AND BIT	CASING TYPE	BLOWS/FOOT ON CASING	WATER CONTENT %	LIQUID LIMIT %	PLASTIC LIMIT %	SPECIFIC GRAVITY	OTHER TESTS
0			0 - 6'	CLAY (CL): black (7.5 R, N2); organic; roots; stiff, no reaction to HCL.								
5	58											
10			6 - 9'	GRAVEL (GW): white and gray (10 YR 8/1 and 6/1); coarse limestone and chert gravel; angular to subangular; 2-60 mm, unconsolidated in less than 20% clay matrix.								
20			9 - 15'	NO RECOVERY: sampling system/bit jammed by reworking of gravel cobbles above; bit changed.								
25												
30	50		15 - 27.5'	CLAY (CH): light olive brown (2.5 Y 5/4) and brownish yellow (10 R 6/8), ferrous staining; soft, plastic; moist; reaction to HCL.								
35												
40			27.5 - 30'	CLAYSTONE (CH), CALCAREOUS: gray (5 Y, 5/1); hard strong reaction to HCL; (Augers stuck at 30').								
45												
50												
55												

DRILLING CONTR. Enviro - Drill, New Braunfels

SL 1J941

LOGGED BY E. Hudson CHK'D BY

DATE 2/19/92

SOIL BOREHOLE LOG

NAME AND LOCATION: ...nagement, Inc. - Comal County ...ll, New Braunfels, Texas ...cated approximately eight miles ...rtheast of New Braunfels, Texas, ...ong FM 1101 and Kohlenberg Lane.	DRILLING METHOD: Hollow - Stem Auger. w/8.25 Augers				BORING NO. SB - 5	
	SAMPLING METHOD: Continuous w/5' Split-spoon				SHEET 1 OF 1	
					DRILLING	
					START	FINISH
	WATER LEVEL	Dry	Dry	Dry	TIME	TIME
	TIME	11:45	12:00	5:58	7:30	11:45
...MSL ELEVATION 644.24	DATE	2/21	2/21	3/5	DATE	DATE
	CASING DEPTH	0	60'	60'	2/21	2/21

...RIG Failing F-6	SURFACE CONDITIONS Damp, tan clay, soft ground
...E Vertical BEARING	
...LE HAMMER TORQUE FT.-LBS	

BLOWS/ ... ON SAMPLER (RECOVERY)	SYMBOL	SAMPLE NUMBER AND DESCRIPTION OF MATERIAL		SAMPLER AND ...	CASING TYPE	BLOWS/FOOT ON CASING	WATER CONTENT %	LIQUID LIMIT %	PLASTIC LIMIT %	SPECIFIC GRAVITY	OTHER TESTS
		0 - 5'	CLAY (CL): black (7.5 R, N2); organic; roots, w/chert gravel and cobbles								
		5 - 10'	CLAY (CL): light olive brown (2.5 Y, 5/4); silty; ferrous staining; plastic, slightly moist.								
		10 - 44.5'	CLAY (CL): light olive brown, (2.5 Y, 5/4); friable, dry, ferrous staining; frequent light gray (5 Y, 5/1), partings, occassional black partings.								
		44.5 - 49'	CLAYSTONE (CH), CALCAREOUS: gray (5 Y, 5/2), hard, strong reaction to HCL.								
		49 - 50'	CLAY (CH): light olive brown (2.5 Y, 5/4); hard; dry; reaction to HCL, verticle fractures								
		50 - 60'	CLAYSTONE (CH), CALCAREOUS: gray (5 Y, 5/1); hard; dry; thin bedded (50' - 52').								

DRILLING CONTR. Enviro - Drill, New Braunfels

SL 10941

LOGGED BY E. Hudson

DATE 2/21/92 CHK'D BY

SOIL BOREHOLE LOG

NAME AND LOCATION
... Management, Inc. - Comal County
...ll, New Braunfels, Texas
...ed approximately eight miles
...rtheast of New Braunfels, Texas,
...ong FM 1101 and Kohlenberg Lane.

DRILLING METHOD: Hollow - Stem Auger. w/8.25 Augers

BORING NO. PZ - 1M

SHEET 1 OF 1

SAMPLING METHOD: Continuous w/5' Split-spoon

WATER LEVEL	39.75	16.84	12.41	12.20
TIME	5:15	7:49	9:00	9:25
DATE	2/18	2/19	2/25	2/26
CASING DEPTH	0	44.5'	44.5'	44.5'

DRILLING	START	FINISH
TIME	2:30	5:00
DATE	2/18	2/18

...M MSL ELEVATION 644.24

...RIG Failing F-6

...E Vertical BEARING

...PLE HAMMER TORQUE FT.-LBS

SURFACE CONDITIONS Damp, tan clay, soft ground

BLOWS/ ... ON SAMPLER (RECOVERY)	SYMBOL	SAMPLE NUMBER AND DESCRIPTION OF MATERIAL	SAMPLER AND BIT	CASING TYPE	BLOWS/FOOT ON CASING	WATER CONTENT %	LIQUID LIMIT %	PLASTIC LIMIT %	SPECIFIC GRAVITY	OTHER TESTS
		0 - 1.5' FILL MATERIAL: mixture of clay (CH) black (7.5 R, N2); and gravel.								
		1.5 - 15' FILL MATERIAL: clay, brownish yellow, (10 YR 6/8) and light gray (5 Y, 5/1); ferrous staining; soft; moist.								
		15 - 44.5' CLAY (CH): light olive brown (2.5 Y 5/4) with brownish yellow, (10 YR 6/8) along bedding planes; stiff; dry 15' - 34.5'; saturated 34.5' - 39.75'.								
		44.5 - 45' CLAYSTONE (CH), CALCAREOUS: gray (5 Y, 5/1); hard; strong reaction to 10% HCL; dry.								

DRILLING CONTR. Enviro - Drill, New Braunfels

SL 10941

LOGGED BY E. Hudson

CHK'D BY

DATE 2/18/92

SOIL BOREHOLE LOG

SITE NAME AND LOCATION: Comal County Landfill, New Braunfels, Texas, Monitoring System Upgrade, Project # 88680.400	DRILLING METHOD: Hollowstem Auger - 8 5/8-inch diameter OD with tooth-bit
	SAMPLING METHOD: Continuous Five-foot split barrel sampler
BORING NUMBER:	MW-6
	Sheet 1 of 4

	INI			STATIC	DRILLING START	DRILLING FINISH
WATER LEVEL	DRY	DRY	DRY	DRY	TIME 11:30	TIME 8:45
TIME	9:45	7:14	7:19	12:18		
DATE	11/8/95	11/9/95	11/10/95	11/13/95	DATE 11/7/95	DATE 11/8/95
CASING DEPTH						

DATUM:

ELEVATION: 632.88

DRILL RIG: CME - 75, Truck mounted

ANGLE:

BEARING:

SAMPLE HAMMER TORQUE: ft.-lbs.

SURFACE CONDITIONS: Flat, clay surface at edge of road southwestern perimeter of landfill

DEPTH IN FEET (ELEVATION)	BLOWS/6" ON SAMPLER	RECOVERY %	SYMBOL	DESCRIPTION OF MATERIAL	SAMPLER AND BIT	SAMPLE TYPE	BLOWS/FT ON CASING	WATER CONTENT %	LIQUID LIMIT %	PLASTIC LIMIT %	SPECIFIC GRAVITY	OTHER TESTS
0–0.8				CLAY; moderate olive brown (5Y 4/4), with roots								
1				GRAVEL; w/ Clay infill, 0.5 - 2-inch diameter, primarily chert, clay is olive black (5Y 2/1)								
2		72		CLAY (CH); w/ some rock fragments, dark yellowish orange (10YR 6/6) white caliche, roots, very stiff, dry								
4				: as above w/ color change to olive black (5Y 2/1), w/ FeO_2 nodules and staining								
5				GRAVEL; white nodules, chert, intermixed w/ dk. yel. or. (10YR 6/6), clay, dry								
7		54										
9.5				CLAY (CH); moderate olive brown (5Y 4/4) and dk. yel. or. (10YR 6/6) mottled, MnO_2 and FeO_2 staining, blocky structure, dry								
12		100		: color change to light olive gray (5Y 6/1), slickensided cleavage planes, minor FeO_2 staining, dry								
15				: as above, primarily lt. olive gray w/ some dk. yel. or. staining, MnO_2 staining, friable, dry								
17		100										
18				: FeO_2 stain 1-inch thick @ 18.5 ft.								
20		100										

DRILLING CONTRACTOR Jack B Holt & Associates, Austin, Texas

LOGGED BY David Smith CHECKED BY Theresa Slone

DATE 11/8/95

SOIL BOREHOLE LOG

NAME AND LOCATION: Comal County Landfill, New Braunfels, Texas, Monitoring System Upgrade, Project # 88680.400	DRILLING METHOD: Hollowstem Auger - 8 5/8-inch diameter OD with tooth-bit	BORING NUMBER: MW-6
	SAMPLING METHOD: Continuous Five-foot split barrel sampler	Sheet 2 of 4

	INI			STATIC	DRILLING START	DRILLING FINISH
WATER LEVEL	DRY	DRY	DRY	DRY	TIME	TIME
TIME	9:45	7:14	7:19	12:18	11:30	9:45
DATE	11/8/95	11/9/95	11/10/95	11/13/95	DATE	DATE
CASING DEPTH					11/7/95	11/8/95

DATUM: ELEVATION: 632.88

DRILL RIG: CME - 75, Truck mounted

SURFACE CONDITIONS: Flat, clay surface at edge of road southwestern perimeter of landfill

ANGLE: BEARING:

SAMPLE HAMMER TORQUE: ft.-lbs.

DEPTH IN FEET (ELEVATION)	BLOWS/6" ON SAMPLER	RECOVERY %	SYMBOL	DESCRIPTION OF MATERIAL	SAMPLER AND BIT	SAMPLE TYPE	BLOWS/FT ON CASING	WATER CONTENT %	LIQUID LIMIT %	PLASTIC LIMIT %	SPECIFIC GRAVITY	OTHER TESTS
				: as above w/ minor MnO_2 staining, dry								
21												
22		100		: FeO_2 staining along fracture planes - sub-horizontal from 22 to 22.5								
				: 2-inch thick dark yellowish orange staining								
24												
25				: clay becoming more cohesive								
26												
27		100		: secondary gypsum mineralization (2° min.) along 20° fracture zone 0.5-inch thick @ 27.25 ft, 60° @ 28 ft and sub-horizontal @ 28.5 ft, with oxidation into the lithology surrounding the fractures - dry								
28												
29				: 2° min. along vertical fracture from 29.5 to 30.5 ft - dry								
30												
31		100		: 2° min. & oxidation along 60° fracture from 31.8 to 31.9 ft dry								
32												
33				: 2° min. along sub-horizontal fracture with bright FeO_2 staining @ 33 ft - dry								
34				: 2° min. along vertical fracture from 33.5 to 34.2 ft - dry								
35												
36		100		: iron concretions - lt. brown (5YR 5/6) with oxidation from 36 to 37 ft - dry								
37				CLAY: as above, olive gray (5Y 4/1), friable, dry								
38												
39		100		: near vertical fracture w/ 2° min. from 39.5 to 40, dry								
40												

DRILLING CONTRACTOR Jack B Holt & Associates Austin, Texas

LOGGED BY David Smith CHECKED BY Theresa Stone

DATE 11/8/95

SOIL BOREHOLE LOG

SITE NAME AND LOCATION: Comal County Landfill, New Braunfels, Texas, Monitoring System Upgrade, Project # 88680.400	DRILLING METHOD: Hollowstem Auger - 8 5/8-inch diameter OD with tooth-bit
	SAMPLING METHOD: Continuous Five-foot split barrel sampler
BORING NUMBER:	MW-6
	Sheet 3 of 4

	INI			STATIC
WATER LEVEL	DRY	DRY	DRY	DRY
TIME	9:45	7:14	7:19	12:18
DATE	11/8/95	11/9/95	11/10/95	11/13/95
CASING DEPTH				

DRILLING	START	FINISH
TIME	11:30	9:45
DATE	11/7/95	11/8/95

DATUM: ELEVATION: 632.88

DRILL RIG: CME - 75, Truck mounted

ANGLE: BEARING:

SAMPLE HAMMER TORQUE: ft.-lbs.

SURFACE CONDITIONS: Flat, clay surface at edge of road southwestern perimeter of landfill

DRILLING CONTRACTOR *Jack B Holt & Associates* *Austin, Texas*

DEPTH IN FEET (ELEVATION)	BLOWS/6" ON SAMPLER	RECOVERY %	SYMBOL	DESCRIPTION OF MATERIAL	SAMPLER AND BIT	SAMPLE TYPE	BLOWS/FT ON CASING	WATER CONTENT %	LIQUID LIMIT %	PLASTIC LIMIT %	SPECIFIC GRAVITY	OTHER TESTS
41		100		: sub horizontal fracture w. 2" min. & oxidation from 41.3 to 42, dry								
42				: color - olive gray w/ dark yellowish orange staining 2" min. & oxidation along fracture at 42.75								
43				: color chaange to greenish black (5GY 2/1), friable, dry								
44												
45		100										
46				: 2" min. w/ oxidation from 46 to 46.25 ft - dry								
47				CLAY (CH): becoming harder w/ alternating zones of dark greenish black (5GY 2/1) w/ isolated layers of dk. yel. or. (10YR 6/6) oxidized clay.								
48												
49		100										
50												
51				CLAYSTONE: very soft (in terms of rock hardness), greenish black (5GY 2/1), tissil								
52				: oxidized zones w/ 2" min. @ 51.75 to 52 and 52.9 to 53 ft								
53		100										
54												
55				: as above with oxidized zones @ 54.5 to 55 ft, 55.75 to 56 ft and 56.3 to 56.5 ft								
56												
57		100										
58												
59		100		: color change to olive black (5Y 2/1)								
60												

LO... *David Smith* DA... */95* CHECKED BY *Theresa Stone*

SOIL BOREHOLE LOG

SITE NAME AND LOCATION: Comal County Landfill, New Braunfels, Texas, Monitoring System Upgrade, Project # 88680.400	DRILLING METHOD: Hollowstem Auger - 8 5/8-inch diameter OD with tooth-bit				BORING NUMBER: MW-6	
	SAMPLING METHOD: Continuous Five-foot split barrel sampler				Sheet 4 of 4	
		INI			STATIC	DRILLING	
	WATER LEVEL	DRY	DRY	DRY	DRY	START TIME 11:30	FINISH TIME 8:45
	TIME	8:45	7:14	7:19	12:18	START DATE 11/7/95	FINISH DATE 11/8/95
	DATE	11/8/95	11/9/95	11/10/95	11/13/95		
DATUM: ELEVATION: 632.88	CASING DEPTH						

DRILL RIG: CME - 75, Truck mounted

SURFACE CONDITIONS: Flat, clay surface at edge of road southwestern perimeter of landfill

ANGLE: BEARING:

SAMPLE HAMMER TORQUE: ft.-lbs.

DRILLING CONTRACTOR: Jack B Holt & Associates, Austin, Texas

DEPTH IN FEET (ELEVATION)	BLOWS/6" ON SAMPLER	RECOVERY %	SYMBOL	DESCRIPTION OF MATERIAL	SAMPLER AND BIT	SAMPLE TYPE	BLOWS/FT ON CASING	WATER CONTENT %	LIQUID LIMIT %	PLASTIC LIMIT %	SPECIFIC GRAVITY	OTHER TESTS
61				: dk. yel. or. weathered zone around fracture w/ 2" min. @ 60 to 60.5								
62		100		: fracture w/ crystalization & oxidation along fracture plane and in bedding planes								
63				: long 80° fracture from 62.5 to 63.5 w/ oxidation along fracture plane but not in bedding planes - surrounding rock not weathered								
64				: TD @ 63.5 feet; hole caves to 58.25								
65												
66												
67												
68												
69												
70												
71												
72												
73												
74												
75												
76												
77												
78												
79												
80												

LOGGED BY David Smith DATE 11/8/95 CHECKED BY Theresa Slone

WELL No. GP-6R

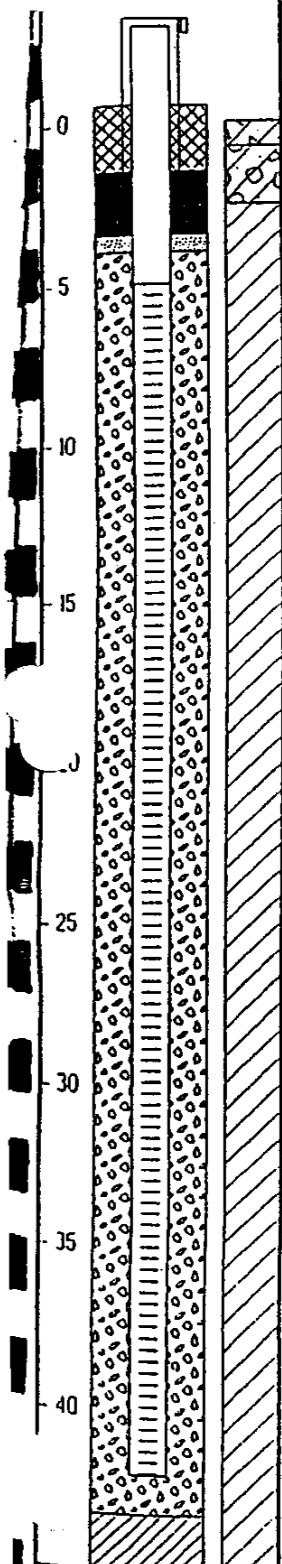
Boring No X-Ref. GP-6R

LANDFILL GAS MONITORING PROBE CONSTRUCTION SUMMARY

Survey Coords N= 13,817,050.79
E= 2,276,398.79

Elevation Ground Level 623.45

Pin Elevation 624.07 Top of Casing 626.55



T.D. = 43.25 ft.

Drilling Summary

Total Depth (ft): 43.25
Borehole Diameter (In): 6 5/8-inch
Casing Stickup Height (ft): 3.10
Driller: Jack Holt & Associates
John Webb, Driller
License # 3023M
Rig: Truck mounted CME-75
Bit (s): Hollowstem Auger - 6 5/8-inch diameter tooth bit
Drilling Fluid: NONE

Protective Casing: 4-inch anodized aluminum (square)

Construction Time Log

Task	Start Date	Start Time	Finish Date	Finish Time
Drilling HSA 0 - 45 feet	11/8/95	14:50	11/8/95	15:54
Casing:				
C_1 Prot.:	11/9/95	15:20	11/9/95	15:35
C_2 1" PVC and S_1 1" PVC:	11/8/95	16:21	11/8/95	16:35
Filter Placement:	11/9/95	9:04	11/9/95	9:17
Bentonite Seal:	11/9/95	9:17	11/9/95	9:22
Cementing/pad:	11/9/95	15:20	11/9/95	15:45
Development: N/A				

Probe Design & Specifications

Basis: Geologic Log ☒ Geophysical Log ☐
Casing String (s): C = Casing S = Screen

Depth	String (s)	Elevation
+3.71 - 1.29	C_1	627.16 -622.16
+3.10 - 5.0	C_2	626.55 -618.45
5.0 - 42.0	S_1	618.45 -581.45
-		-
-		-

Casing: C1

Casing: C2 1-inch diameter PVC, Sch. 40, flush joint, Trilock (+3.1 to 5.0 ft)
Screen: S1 1-inch diameter PVC, Sch.40, flush joint, Trilock 0.020-inch Slot (5.0 to 42 ft)

Grout Seal: Concrete (0 - 1.5 ft.)

Bentonite Seal: 1/4-inch bentonite pellets (1.5 - 3.5 ft.)

Filter Pack: 3/8-inch pea gravel (4 - 43.25 ft.)
20/40 colorado Silica Sand (3.5 - 4.0 ft.)

Probe Comments

Original Hole drilled to 45 feet, hole caved to 43.2

SITE NAME Comal County Recycling and Disposal Center

SUPERVISED BY D. Smith

Project: WMTX - Mesquite Creek Landfill	Key to Log
Project Location: New Braunfels, TX	Sheet 1 of 1
Project Number: GT 3435	

Elevation, feet	Depth, feet	Sample Type	Consistency	Sampling Resistance, blows/foot	Stratum	Field USCS	Graphic Log	MATERIAL DESCRIPTION	Driven/Rec	Permeability (cm/s)	Pocket Pen.	LL, %	PI%	Moisture Content %	Piezometer Completion
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

COLUMN DESCRIPTIONS

1. **Elevation, feet:** Elevation (MSL, feet)
2. **Depth, feet:** Depth in feet below the ground surface.
3. **Sample Type:** Type of soil sample collected at the depth interval shown.
4. **Consistency:** Relative consistency of the subsurface material.
5. **Sampling Resistance, blows/foot:** Number of blows to advance driven sampler foot (or distance shown) beyond seating interval using the hammer identified on the boring log.
6. **Stratum:** Stratum designation based on site stratigraphy
7. **Field USCS:** USCS symbol of the subsurface material.
8. **Graphic Log:** Graphic depiction of the subsurface material encountered.
9. **MATERIAL DESCRIPTION:** Description of material encountered. May include consistency, moisture, color, and other descriptive text.
10. **Driven/Rec:** Sampler Driven/Recovered (inches)
11. **Permeability (cm/s):** Vertical hydraulic conductivity determined in accordance with ASTM D5084
12. **Pocket Pen.:** The reading from a hand held tool used for measuring unconfined compressive strength of cohesive soils
13. **LL, %:** Liquid Limit, expressed as a water content
14. **PI%:** Plasticity index
15. **Moisture Content %:** Moisture Content
16. **Piezometer Completion:** Graphical representation of piezometer installed upon completion of drilling and sampling.

FIELD AND LABORATORY TEST ABBREVIATIONS

LL: Liquid Limit, percent
PI: Plasticity Index, percent

TYPICAL MATERIAL GRAPHIC SYMBOLS

- Claystone
- Well graded GRAVEL (GW)
- Clayey GRAVEL (GC)
- Silty SAND (SM)
- Lean CLAY, CLAY w/SAND, SANDY CLAY (CL)
- Fat CLAY, CLAY w/SAND, SANDY CLAY (CH)
- Lean-Fat CLAY, CLAY w/SAND, SANDY CLAY (CL-CH)
- SILTY CLAY (CL-ML)
- Clayey GRAVEL to Gravelly CLAY (GC-CL)
- Clayey GRAVEL to Gravelly CLAY (GC-CH)
- Clayey SAND to Sandy CLAY (SC-CL)
- Clayey SAND to Sandy CLAY (SC-CH)
- SILT to CLAY (CL/ML)

TYPICAL SAMPLER GRAPHIC SYMBOLS

- 2-inch-OD unlined split spoon (SPT)
- Shelby Tube (Thin-walled, fixed head)
- Core

OTHER GRAPHIC SYMBOLS

- Water level (at time of drilling, ATD)
- Water level (after waiting a given time)
- Minor change in material properties within a stratum
- Inferred or gradational contact between strata
- ? Queried contact between strata

GENERAL NOTES

1. Soil classifications are based on the Unified Soil Classification System. Descriptions and stratum lines are interpretive, and actual lithologic changes may be gradual.
2. Descriptions on these logs apply only at the specific boring locations and at the time the borings were advanced. They are not warranted to be representative of subsurface conditions at other locations or times.

Project: WMTX-Mesquite Creek Landfill
Project Location: New Braunfels, TX
Project Number: GT 3435

Boring GB-01

Date(s) Drilled	11/02-11/03/04	Logged By	Taylor Johnston	Checked By	Janet Meaux
Drilling Method	Hollow Stem Auger/Core	Drill Bit Size/Type	8 inch	Total Depth of Borehole	95 feet bgs
Drill Rig Type	CME 75	Drilling Contractor	GeoProjects/ Jose Landezos 2551W	Approximate Surface Elevation	595.38 feet MSL
Groundwater Level and Date Measured	NA	Sampling Method(s)	SPT, Tube, Other	Hammer Data	140 lb, 30 in drop, auto trip
Borehole Backfill	Grout to 27'	Location	Northing 13,816,876.45, Easting 2,278,393.23		

Elevation, feet	Depth, feet	Consistency	Sampling Resistance, blows/foot	Stratum	Field USCS	MATERIAL DESCRIPTION	Driven/Rec	Permeability (cm/s)	Pocket Pen.	LL, %	PI%	Moisture Content %
595.4	0			I	CH	Grass						
		soft	1 1 1 6	II	GC-CH	dark brown, fat, wet clay (10YR 3/1)	17/24		.75			
						dark brown clay with gravel (large to trace), moist (10YR 3/1)						
		soft	1 1 3 3				21/24		2.5			
590.4	5	soft	1 2 3 5				22/24		1.5			
		hard	1 15 53 31	II	GC	gravel with some dark brown clay moist	26/24		4.5+			
		hard	8 16 10 22	II	GC-CH	dark brown moist clay	19/24		4.5+	104	77	9.3
				II	GC	gravel with some dark brown clay, moist						
585.4	10			III	CL	light brownish yellow, lean clay moist (10YR6/4)						
		hard	3 10 17 30				22/24		4.5+			
		hard	8 17 21 25				22/24		4.5+			
580.4	15		NA					2.5E-9				
				III	CL	light yellowish brown (25Y 6/3) moist						
		hard	5 15 16 25				25/24		4.5+			
		hard	5 13 18 22				23/24		4.5+			
575.4	20	hard	4 12 18 24				24/24		4.5+			
		hard	5 16 22 31				24/24		4.5+			
				IV	CL	gray clay (2.5Y 5/1), dry						
570.4	25		9 33 50/5"				17/18		4.5+	53	36	14.1
		hard	35 50/3.5"	IV	Claystone	claystone, dry (2.5Y 5/1)	12/12?		4.5+			
		very hard	core				85/84					
565.4	30											

Elevation, feet	Depth, feet	Sample Type	Consistency	Sampling Resistance, blows/foot	Stratum	Field USCS	Graphic Log	MATERIAL DESCRIPTION	Driven/Rec	Permeability (cm/s)	Pocket Pen.	LL, %	PI%	Moisture Content %	Piezometer Completion
565.4	30				IV	Claystone		claystone, dry (2.5Y 5/1) (cont.)							
			very hard	core					85/84						
560.4	35		very hard	core					60/60						
555.4	40		very hard	core					60/60						
					IV	Claystone		claystone, grading to dark gray (2.5Y 4/1)							
550.4	45		very hard	core					60/60						
545.4	50		very hard	core					60/60						
540.4	55		very hard	core					59/60						
535.4	60		very hard	core					59/60						
					IV	Claystone		shell fragments	59/60						
			very hard	core											
530.4	65														

Elevation, feet	Depth, feet	Sample Type	Consistency	Sampling Resistance, blows/foot	Stratum	Field USCS	Graphic Log	MATERIAL DESCRIPTION	Driven/Rec	Permeability (cm/s)	Pocket Pen.	LL, %	PI%	Moisture Content %	Piezometer Completion
530.4	65				IV	Claystone		calcite vein							
			very hard	core					59/60						
525.4	70		very hard	core					60/60						
520.4	75		very hard	core					60/60						
515.4	80		very hard	core					60/60						
510.4	85		very hard	core					59/60						
505.4	90		very hard	core					72/72	2.1E-9					
500.4	95				IV			Bottom of Boring at 95 feet bgs							
495.4	100														

Project: WMTX - Mesquite Creek Landfill **Project Location: New Braunfels, TX** **Project Number: GT 3435**	**Boring GB-02** Sheet 1 of 3

Date(s) Drilled **10/04-10/06/04**	Logged By **Taylor Johnston**	Checked By **Janet Meaux**
Drilling Method **Hollow Stem Auger, Core**	Drill Bit Size/Type **4 1/4 inch ID, Hollow Stem Auger**	Total Depth of Borehole **70.5 feet bgs**
Drill Rig Type **CME 75**	Drilling Contractor **Geoprojects/ Jose Landezos 2551W**	Approximate Surface Elevation **599.54 feet MSL**
Groundwater Level and Date Measured **NA**	Sampling Method(s) **SPT, Grab, Other**	Hammer Data **140 lb, 30 in drop, auto trip**
Borehole Backfill **Grout to 28'**	Location **Northing 13,816,525.58 Easting 2,277,962.38**	

Elevation, feet	Depth, feet	Consistency	Sampling Resistance, blows/foot	Stratum	Field USCS	MATERIAL DESCRIPTION	Driven/Rec	Permeability (cm/s)	Pocket Pen.	LL, %	PI%	Moisture Content %
599.5	0			I	CH	grass, dark brown CLAY						
		soft	NA			dark brown fat CLAY, moist						
			NA							77	52	24.2
594.5	5											
		hard	10 20 26 50/4"	II	GW	A 2.5" section of GRAVEL in sample, white, some dark brown clay						
		hard	50/5"							43	27	14.0
589.5	10	hard	18 19 21 32	III	CL	yelllow mottled light gray CLAY (10YR 7/8 and 10YR 7/1), gravel at 10.5', becoming pale brown at 14 feet, moist						
		hard	9 14 22 28					2.3E-8		52	35	14.7
		hard	22 50/5".5"									
584.5	15	hard	42 44 43 45									
		hard	9 22 27 31	III	CL	brownish yellow (10YR 6/8) CLAY, moist						
579.5	20	hard	7 15 28 31	III	CL	brownish yellow (10YR 6/8) CLAY, mottled with light gray (10YR 7/1), moist						
		hard	6 16 21 25									
		hard	5 16 24 28	III	CL	yellowish brown CLAY (10YR 5/4) and light gray (10YR 7/1), crystallized calcite seams, dry				60	41	19.2
574.5	25	hard	12 21 32 41	IV	CL	dark gray CLAY (10YR 4/1) and light gray calcite seams no water on 10/5/04						
		hard	13 33 50/4.5"	IV	Claystone	CLAYSTONE, friable, dry, greenish gray (Gley 10 5/1), some silt						
		hard	35 50/5"	IV	Claystone	more silt with depth						
569.5	30											

Project: WMTX - Mesquite Creek Landfill	Boring GB-02
Project Location: New Braunfels, TX	Sheet 2 of 3
Project Number: GT 3435	

Elevation, feet	Depth, feet	Sample Type	Consistency	Sampling Resistance, blows/foot	Stratum	Field USCS	Graphic Log	MATERIAL DESCRIPTION	Driven/Rec	Permeability (cm/s)	Pocket Pen.	LL, %	PI%	Moisture Content %	Piezometer Completion
569.5	30		hard	33 50/4"	IV	Claystone		CLAYSTONE, friable, dry, greenish gray (Gley 10 5/1), some silt (cont.)							
			hard	31 50/4"								42	25	12.1	
					IV	Claystone		start coring at 32 feet greenish gray CLAYSTONE, dry	24/25						
564.5	35														
									60/60						
559.5	40								36/32			53	34	11.7	
									60/60						
554.5	45														
									60/60, 60/49			50	32	11.4	
549.5	50														
									24/25	1.8E-9				11.9	
544.5	55								36/25						
					IV	Claystone		greenish gray CLAYSTONE (Gley /10Y 5/1), hard, some silt							
									[illegible]			56	37	13.3	
539.5	60														
					IV	Claystone		No recovery from 62-67 -lost the core down the hole and a rock caved in on top of it-have to drill it out to 67 ft	60/0						
534.5	65														

Project: WMTX - Mesquite Creek Landfill
Project Location: New Braunfels, TX
Project Number: GT 3435

Boring GB-02

Elevation, feet	Depth, feet	Sample Type	Consistency	Sampling Resistance, blows/foot	Stratum	Field USCS	Graphic Log	MATERIAL DESCRIPTION	Driven/Rec	Permeability (cm/s)	Pocket Pen.	LL, %	PI%	Moisture Content %	Piezometer Completion
534.5	65				IV	Claystone		CLAYSTONE, friable, dry, greenish gray (Gley 10 5/1), some silt (cont.)	60/0						
					IV	Claystone		No recovery - a large gravel was all that came up with some mud cuttings on it.	60/0						
529.5	70			50/5"	IV IV	Claystone		greenish gray CLAYSTONE (Gley 10Y5/1), some silt							
								Bottom of Boring at 70.5 feet bgs							
524.5	75														
519.5	80														
514.5	85														
509.5	90														
504.5	95														
499.5	100														

Project: WMTX - Mesquite Creek Landfill	Boring GB-03
Project Location: New Braunfels, TX	Sheet 1 of 4
Project Number: GT 3435	

Date(s) Drilled: 11/04-11/05/04	Logged By: Taylor Johnston	Checked By: Janet Meaux
Drilling Method: Hollow Stem Auger/Core	Drill Bit Size/Type: 4 1/4 inch ID, Hollow Stem Auger	Total Depth of Borehole: 104.5 feet bgs
Drill Rig Type: CME 75	Drilling Contractor: Geoprojects/ Jose Landezos 2551W	Approximate Surface Elevation: 607.74 feet MSL
Groundwater Level and Date Measured: NA	Sampling Method(s): SPT, Tube, Other	Hammer Data: 140 lb, 30 in drop, auto trip
Borehole Backfill: Grout	Location: Northing 13,815,970.63 Easting 2,277,506.65	

Elevation, feet	Depth, feet	Sample Type	Consistency	Sampling Resistance, blows/foot	Stratum	Field USCS	Graphic Log	MATERIAL DESCRIPTION	Driven/Rec	Permeability (cm/s)	Pocket Pen.	LL, %	PI%	Moisture Content %	Piezometer Completion
607.7	0				I	CH		GRASS							
			medium stiff	1 3 5 7				wet, dark brown, fat, CLAY (10YR 3/3)	24/20		1.5				
			stiff	1 4 6 8					24/20		2.0				
602.7	5		stiff	2 4 7 9					24/17		NR	69	46	28	
			very stiff	2 6 13 23					24/24		2.25				
					II	GC		gravel, some CLAY, dark brown, moist							
			very stiff	4 12 12 18	III	CL		light yellowish brown lean CLAY, moist	24/19		4.5+				
597.7	10														
			hard	6 17 24 36					24/23		4.5+				
					III	CL		trace shell fragments, gray root seam at 13'							
			hard	7 18 27 28					24/23		4.5+				
592.7	15		hard	7 17 24 30					24/22		4.5+				
									18/18	3.7E-9		38	21	14.5	
					III	CL		light yellowish brown CLAY, dry							
			hard	8 20 27 33					24/24		4.5+				
587.7	20														
			hard	8 16 24 32					24/23		4.5+				
			hard	9 18 25 31					24/26		4.5+				
582.7	25		hard	7 17 25 32					24/20		4.5+	61	41	19	
						CL		dark gray CLAY (2.5YR 4/1), dry, possible fracture at 25.75 feet, 20 degrees, no water							
			hard	15 28 42 40	III	CL Claystone		light yellowish brown (25Y 6/3) CLAY, moist	24/25		4.5+				
								dark gray CLAYSTONE, some silt (2.5Y 5/1), dry							
			very hard	core	III	Claystone		dark gray CLAYSTONE, (0.5Y 4/1), weathered, some silt	78/70						
577.7	30														

Project: WMTX - Mesquite Creek Landfill
Project Location: New Braunfels, TX
Project Number: GT 3435

Boring GB-03

Elevation, feet	Depth, feet	Sample Type	Consistency	Sampling Resistance, blows/foot	Stratum	Field USCS	Graphic Log	MATERIAL DESCRIPTION	Driven/Rec	Permeability (cm/s)	Pocket Pen.	LL, %	PI%	Moisture Content %	Piezometer Completion
577.7	30					Claystone		dark gray CLAYSTONE, some silt (2.5Y 5/1), dry (cont.)							
			very hard	core					78/70						
					IV	Claystone		dark gray CLAYSTONE three possible horizontal fractures, 2 inches apart							
					IV	Claystone		same as above, left some in the hole, unweathered							
572.7	35		very hard	core					60/41						
					IV	Claystone		recovered what was in hole, unweathered							
567.7	40		very hard	core					60/78						
562.7	45		very hard	core					60/58						
557.7	50		very hard	core					60/59	2.6E-9				11.8	
552.7	55		very hard	core					60/61						
547.7	60				IV	Claystone		CLAYSTONE, dry, dark gray (2.5Y4/1), some silt							
			very hard	core					60/59						
542.7	65		very hard	core					60/63						

Project: WMTX - Mesquite Creek Landfill
Project Location: New Braunfels, TX
Project Number: GT 3435

Boring GB-03

Elevation, feet	Depth, feet	Sample Type	Consistency	Sampling Resistance, blows/foot	Stratum	Field USCS	Graphic Log	MATERIAL DESCRIPTION	Driven/Rec	Permeability (cm/s)	Pocket Pen.	LL, %	PI%	Moisture Content %	Piezometer Completion
542.7	65				IV	Claystone		same as above							
			very hard	core					60/63						
537.7	70														
			very hard	core					60/59						
532.7	75														
			very hard	core					60/60						
527.7	80														
			very hard	core					60/59						
522.7	85														
			very hard	core					60/59						
517.7	90														
			very hard	core					60/60						
512.7	95														
			very hard	core					60/59						
			very hard	core					60/54	6.3E-9				12.2	
507.7	100														

Project: WMTX - Mesquite Creek Landfill
Project Location: New Braunfels, TX
Project Number: GT 3435

Boring GB-03

Elevation, feet	Depth, feet	Sample Type	Consistency	Sampling Resistance, blows/foot	Stratum	Field USCS	Graphic Log	MATERIAL DESCRIPTION	Driven/Rec	Permeability (cm/s)	Pocket Pen.	LL, %	PI%	Moisture Content %	Piezometer Completion
507.7	100				IV	Claystone		same as above							
			very hard	core					60/54	6.3E-9				12.2	
					IV	Claystone		Bottom of Boring at 104.5 feet bgs							
502.7	105														
497.7	110														
492.7	115														
487.7	120														
482.7	125														
477.7	130														
472.7	135														

Project: WMTX - Mesquite Creeek Landfill Project Location: New Braunfels, TX Project Number: GT 3435	Boring GB-04 Sheet 1 of 5

Date(s) Drilled	10/12-10/18/04	Logged By	Taylor Johnston/Trent McDaniel	Checked By	Janet Meaux
Drilling Method	Hollow Stem Auger/Core	Drill Bit Size/Type	4 1/4 inch ID, Hollow Stem Auger	Total Depth of Borehole	145 feet bgs
Drill Rig Type	CME 75	Drilling Contractor	Geoprojects/ Jose Landezos 2551W	Approximate Surface Elevation	668.17 feet MSL
Groundwater Level and Date Measured	NA	Sampling Method(s)	SPT, Tube, Other	Hammer Data	140 lb, 30 in drop, auto trip
Borehole Backfill	grout to 63'	Location	Northing 13,814,621.77 Easting 2,278,786.32		

Elevation, feet	Depth, feet	Consistency	Sampling Resistance, blows/foot	Stratum	Field USCS	MATERIAL DESCRIPTION	Driven/Rec	Permeability (cm/s)	Pocket Pen.	LL, %	PI%	Moisture Content %
668.2	0	very stiff	5 8 14 21	I	CH	Dark grayish brown fat CLAY (10YR 4/2) moist, roots						
		hard	18 17 14 14	I	CL	wet, dark brown, fat CLAY (10YR 3/3)				51	30	19.7
663.2	5	very stiff	5 10 13 22	I III	CH CL	dark brown fat CLAY (10YR 3/3) moist, some gravel grades to a light yellowish brown clay, moist, stiff						
		hard	10 20 33 40	III	CL	pale yellow (5Y 8/4) CLAY, moist, lean. some white chalk grading to very stiff, dry CLAY, no chalk, yellow (2.5 Y7/6)				47	29	12.0
		hard	6 17 26 41									
658.2	10	hard	7 12 27 41	III	CL	yellow CLAY, lean, dry (2.5Y 7/6)						
		hard	13 24 37 49									
653.2	15	hard	10 27 35 47									
				III	CL	grading brownish yellow (10YR 6/6) and some iron staining, dry						
		hard	15 27 36 44	III	CL	some mottled light gray CLAY (7.5 YR 7/1) dry				49	30	16.2
648.2	20	hard	11 31 35 42	III	CL	pale yellow (5Y 7/3) dry						
		hard	8 16 24 39	III	CL	pale yellow						
643.2	25	hard	9 20 26 39	III	CL	pale yellow						
		hard	10 18 24 30	III	CL	pale yellow CLAY (2.5Y 7/4), dry						
		hard	8 24 30 38							58	38	15.4
638.2	30											

Elevation, feet	Depth, feet	Consistency	Sampling Resistance, blows/foot	Stratum	Field USCS	MATERIAL DESCRIPTION	Driven/Rec	Permeability (cm/s)	Pocket Pen.	LL, %	PI%	Moisture Content %
638.2	30	hard	9 23 27 33	III	CL	pale yellow (5Y 8/4) CLAY, moist, lean. some white chalk (cont.)						
		hard	22 23 31									
633.2	35	hard	8 19 34 38									
		hard	17 27 39 50/5"	III	Claystone	large vertical calcite seam, 6 inches long						
		hard	11 24 34 44			calcite seam at 40.5 ft						
628.2	40	hard	12 30 40 50/5"									
		hard	17 39 50/5.5"	III	CL	some gray color (Gley 1N 5/0), stiff, still gray from 42-48'						
623.2	45	hard	14 30 40 50/4.5"									
		hard	20 36 41 50/5"							56	37	18.0
		hard	11 46 50 50/6"	III	CL	hard, pale yellow (2.5Y 7/3)						
618.2	50	hard	14 39 50/4.5"		CL	calcite seam, horizontal, 0.25 inch thick 51.8' gray CLAY						
		hard	17 34 41 50/4"	III	CL	alternating pale yellow and gray calcite vein at 54.4 ft vertical calcite seam at 56.3 ft						
613.2	55	hard	14 30 40 50/5.5"									
		hard	26 36 50/5.5"									
		hard	13 50/5.5"	III	CL	turns gray						
608.2	60	hard	17 40 50/5"	III	CL	pale yellow to 61 ft 61.2 ft - horizontal calcite vein 61.5 ft gray clay						
		hard	21 40 50/4.5"	IV	Claystone	CLAYSTONE, dry, dark gray (2.5Y4/1), some silt						
603.2	65	hard	16 41 50/5"							62	42	14.9

Elevation, feet	Depth, feet	Consistency	Sampling Resistance, blows/foot	Stratum	Field USCS	MATERIAL DESCRIPTION	Driven/Rec	Permeability (cm/s)	Pocket Pen.	LL, %	PI%	Moisture Content %
603.2	65	hard	[illegible]	IV	Claystone	CLAYSTONE, dry, dark gray (2.5Y4/1), some silt (cont.)				62	42	14.9
		hard	30 50/5.5"									
				IV	Claystone	some silt						
598.2	70			IV	Claystone	large shell (bivalve w/partial calcite replacement), some shell fragments	84/82		4.5+	56	38	7.8
593.2	75											
							60/60		4.5+			
588.2	80			IV	Claystone	possible 60 and 45 degree fractures, clay filled, no water						
							60/60		4.5+			
				IV	Claystone	same as above - grading dary gray (Gley 1N 4/0)						
583.2	85											
							60/60		4.5+			
578.2	90											
							60/60		4.5+			
573.2	95											
							60/60		4.5+	65	45	15.9
							60/60		4.5+			
568.2	100											

Project: WMTX - Mesquite Creeek Landfill
Project Location: New Braunfels, TX
Project Number: GT 3435

Boring GB-04

Elevation, feet	Depth, feet	Sample Type	Consistency	Sampling Resistance, blows/foot	Stratum	Field USCS	Graphic Log	MATERIAL DESCRIPTION	Driven/Rec	Permeability (cm/s)	Pocket Pen.	LL, %	PI%	Moisture Content %	Piezometer Completion
568.2	100				IV	Claystone		CLAYSTONE, dry, dark gray (2.5Y4/1), some silt (cont.)	60/60		4.5+				
563.2	105				IV	Claystone		same as above	60/60		4.5+	58	38	15.6	
558.2	110								60/58	2.8E-9	4.5+	69	48	15.1	
553.2	115								60/60		4.5+				
548.2	120				IV	Claystone		same as above, trace pyrite at 120.5 feet trace shell fragments at 121 ft	60/60		4.5+				
543.2	125				IV	Claystone		same as above - trace shell fragments trace small discontinouous silt lenses at 128.5 ft	60/60		4.5+				
538.2	130								60/57		4.5+				
533.2	135								60/60		4.5+				

Elevation, feet	Depth, feet	Sample Type	Consistency	Sampling Resistance, blows/foot	Stratum	Field USCS	Graphic Log	MATERIAL DESCRIPTION	Driven/Rec	Permeability (cm/s)	Pocket Pen.	LL, %	PI%	Moisture Content %	Piezometer Completion
533.2	135				IV	Claystone		CLAYSTONE, dry, dark gray (2.5Y4/1), some silt (cont.)							
									60/60		4.5+				
528.2	140														
									72/72		4.5+	50	32	12.9	
523.2	145				IV	Claystone		Bottom of Boring at 145 feet bgs							
518.2	150														
513.2	155														
508.2	160														
503.2	165														
498.2	170														

Project: WMTX - Mesquite Creek Landfill	Boring GB-05
Project Location: New Braunfels, TX	Sheet 1 of 4
Project Number: GT 3435	

Date(s) Drilled	10/19-10/20/04	Logged By	Trent McDaniel	Checked By	Janet Meaux
Drilling Method	Hollow Stem Auger, Core	Drill Bit Size/Type	4 1/4 inch ID, Hollow Stem Auger	Total Depth of Borehole	115 feet bgs
Drill Rig Type	CME 75	Drilling Contractor	Geoprojects/ Jose Landezos 2551W	Approximate Surface Elevation	640.54 feet MSL
Groundwater Level and Date Measured	39' in fractures	Sampling Method(s)	SPT, Other	Hammer Data	140 lb, 30 in drop, auto trip
Borehole Backfill	Grout	Location	Northing 13,815,207.26 Easting 2,279,121.48		

Elevation, feet	Depth, feet	Sample Type	Consistency	Sampling Resistance, blows/foot	Stratum	Field USCS	Graphic Log	MATERIAL DESCRIPTION	Driven/Rec	Permeability (cm/s)	Pocket Pen.	LL, %	PI%	Moisture Content %	Piezometer Completion
640.5	0				I	CL		GRAVEL, some grass, some dark brown fat clay, moist							
			hard	3 11 21 14	II	GC		CLAY, some silt, moist, moderate stiff, very dark gray (Gley1 N3/0)	24/16		1.75				
								grayish brown GRAVEL, some clay (10YR5/2) quartz gravel							
			stiff	5 5 6 4	III	CL		CLAY, some silt and chalk, moist, trace gravel, light gray (Gley1N7/0) mottled with brownish yellow (10YR6/8)	24/21		1.75	68	45	18.5	
635.5	5		stiff	4 6 7 11	stiff				24/19		2.0				
			very stiff	5 10 15 20					24/24		4.0	53	35	18	
			very stiff	4 12 17 21	III	CL		no chalk	24/24		4.0				
630.5	10		very stiff	4 10 16 22	III	CL		grading light gray (Gley1N7/0) mottled with olive yellow (2.5Y6/6)	24/24		4.0	62	43	20.4	
					III	CL		possible vertical fracture							
			very stiff	4 11 17 26	III	CL		possible 70 degree fracture, some iron statining, hard	24/24		4.5				
					III	CL		some black staining							
625.5	15		hard	6 16 23 34					24/24		4.5+				
			hard	8 18 26 42	III	CL		possible 70 degree fracture clay filled no water, grading light yellowish brown (2.5Y6/4)	24/24		4.5+				
			very stiff	5 11 17 23					24/24		4.5				
620.5	20				III	CL		possible 70 degree and 20 degree fractures, clay filled, no water							
			hard	7 17 23 27					24/23		4.5				
			hard	18 20 26 27	III	CL		possible 70 degree fracture, clay filled, no water, trace calcite, some black staining	24/24		4.5+				
615.5	25		hard	7 17 24 27	III	CL		possible 80 degree fracture, clay filled, no water, grading light gray (Gley1N7/0) with brownish yellow mottle (10YR6/6)	24/23		4.5+	55	36	19.7	
					III	CL		some iron staining							
			hard	10 15 24 33					24/24		4.5+				
					III	CL		trace calcite							
			hard	11 20 24 30					24/23		4.5+				
610.5	30														

Elevation, feet	Depth, feet	Sample Type	Consistency	Sampling Resistance, blows/foot	Stratum	Field USCS	Graphic Log	MATERIAL DESCRIPTION	Driven/Rec	Permeability (cm/s)	Pocket Pen.	LL, %	PI%	Moisture Content %	Piezometer Completion
610.5	30		hard	7 16 21 29	III III	CL CL		CLAY, some silt and chalk, moist, trace gravel, light gray (Gley1N7/0) mottled with brownish yellow (10YR6/8) (cont.) possible 20 degree fracture, hematite filled, no water	24/23		4.5+				
			hard	9 21 26 32	III	CL		possible 10 degree and horizontal fractures, calcite filled, no water	24/23		4.5+				
605.5	35		hard	10 19 25 35	III	CL		possible horizontal fracture, calcite filled, no water	24/23		4.5+				
			hard	12 23 30 43	III	CL		grading light yellowish brown (10YR6/4), possible 30 degree, 10 degree and horizontal fractures, calcite filled, no water	24/24		4.5+	60	40	18.5	
			hard	12 24 33 40	III	CL		possible 30 degree horizontal fractures, calcite filled, water present in fractures	24/24		4.5+				
600.5	40		hard	10 33 33 38	III	CL		alternating layers 6" to 8" of light yellowish brown (10YR6/4) and dark gray (Gley1N4/0), some silt, possible 30 degree fracture at 40.75' calcite filled, water present.	24/24		4.5+				
			hard	14 29 30 42	III	CL		possible 30 degree fracture, calcite filled, water present	24/24		4.5+				
595.5	45		hard	12 26 33 40	III	CL		possible 45 degree and 30 degree fractures, calcite filled, water present	24/24		4.5+				
			hard	13 34 39 50/5	III	CL		Driller Reports 2.5' of water in borehole, possible 30 degree and horizontal fractures, calcite filled and water present	23/24		4.5+				
			hard	13 25 29 38	III	CL		light yellowish brown (10YR6/4), possible horizontal fracture at 48.75', calcite filled, water present	24/24		4.5+				
590.5	50		hard	14 27 42 50/5.5	III	CL		grades olive yellow (2.5Y6/6) at 50', possible 70 degree fracture, calcite filled, trace water present 7" length, 51.4' grades dark gray (Gley1N4/0)	23.5/24		4.5+	60	41	13.8	
			hard	11 50/6"					12/12		4.5+				
			hard	13 50/5.5"					[illegible]		4.5+				
585.5	55			core					48/60						
					III	CL		grading olive (5Y5/4), possible 80 degree fracture, calcite filled, 60 to 61' in length							
580.5	60			core					60/59			58	38	18.3	
575.5	65			core	III	CL		possible 80 degree fracture at 64', calcite filled	60/60						

Project: WMTX - Mesquite Creek Landfill
Project Location: New Braunfels, TX
Project Number: GT 3435

Boring GB-05

Elevation, feet	Depth, feet	Sample Type	Consistency	Sampling Resistance, blows/foot	Stratum	Field USCS	Graphic Log	MATERIAL DESCRIPTION	Driven/Rec	Permeability (cm/s)	Pocket Pen.	LL, %	PI%	Moisture Content %	Piezometer Completion
575.5	65				IV	Claystone		dark gray (Gley1N4/0) CLAYSTONE, trace iron staining							
				core					60/60						
570.5	70			core					60/60						
565.5	75			core					60/60			65	43	18.1	
560.5	80			core					60/60						
555.5	85			core					60/60						
550.5	90			core					60/58						
545.5	95			core					60/60						
				core	IV	Claystone		trace silt lens	60/60						
540.5	100														

Elevation, feet	Depth, feet	Sample Type	Consistency	Sampling Resistance, blows/foot	Stratum	Field USCS	Graphic Log	MATERIAL DESCRIPTION	Driven/Rec	Permeability (cm/s)	Pocket Pen.	LL, %	PI%	Moisture Content %	Piezometer Completion
540.5	100			core	IV	Claystone		dark gray (Gley1N4/0) CLAYSTONE, trace iron staining (cont.)	60/60						
535.5	105			core	IV	Claystone		trace shell fragments	60/60						
530.5	110			core					72/72						
525.5	115				IV	Claystone		Bottom of Boring at 115 feet bgs							
520.5	120														
515.5	125														
510.5	130														
505.5	135														

Project: WMTX - Mesquite Creek Landfill Project Location: New Braunfels, TX Project Number: GT 3435	Boring GB-06 Sheet 1 of 4

Date(s) Drilled	01/24-01/26/05	Logged By	Taylor Johnston	Checked By	Janet Meaux
Drilling Method	Hollow Stem Auger, Core	Drill Bit Size/Type	4 1/4 inch ID, Hollow Stem Auger	Total Depth of Borehole	124 feet bgs
Drill Rig Type	CME 75	Drilling Contractor	Geoprojects/ Jose Landezos 2551W	Approximate Surface Elevation	645.97 feet MSL
Groundwater Level and Date Measured	39.29	Sampling Method(s)	SPT, Tube, Other	Hammer Data	140 lb, 30 in drop, auto trip
Borehole Backfill	Grout to 48' from Total Depth	Location	Northing 13,815,883.30 Easting 2,279,871.78		

Elevation, feet	Depth, feet	Sample Type	Consistency	Sampling Resistance, blows/foot	Stratum	Field USCS	Graphic Log	MATERIAL DESCRIPTION	Driven/Rec	Permeability (cm/s)	Pocket Pen.	LL, %	PI%	Moisture Content %	Piezometer Completion
646	0				I	CH		GRASS							
			very stiff	3 7 12 17	I	CH		very dark brown (10YR2/2), fat CLAY, moist, roots present	24/17		3.75				
								grades to brown (10YR4/3)							
			stiff	4 6 7 11	III	CL		lean CLAY, moist, brownish yellow (10YR6/6)	24/20		3.5				
641	5		very stiff	2 7 11 15	III	CL		grades yellow (2.5Y7/6) lean CLAY	24/20		3.0				
			hard	6 17 26 35	III	CL-ML		grades light yellowish brown (2.5Y6/4), lean CLAY, moist, some silt	24/26		4.5+	40	22	14.8	
			hard	5 21 31 45					24/23.5		4.5+				
636	10		hard	8 19 28 38	III	CL		grades mottled light gray (2.5Y7/1) and light yellowish brown (2.5Y6/4), lean CLAY, some silt, moist	24/24.5		4.5+				
			hard	6 22 34 41					24/25		4.5				
631	15		hard	6 20 30 38					24/26		4.5+	57	39	18.7	
			hard	4 15 31 22					24/26		4.5+				
			hard	2 12 23 35					24/23.5		4.5+				
626	20								24/20						
			hard	6 20 27 37					24/25		4.5+				
621	25		hard	11 22 27 33					24/25		4.5+				
			hard	19 27 31 47					24/27		4.5+				
			hard	11 17 25 30					24/25.5		4.5+				
616	30														

Project: WMTX - Mesquite Creek Landfill
Project Location: New Braunfels, TX
Project Number: GT 3435

Boring GB-06

Elevation, feet	Depth, feet	Consistency	Sampling Resistance, blows/foot	Stratum	Field USCS	MATERIAL DESCRIPTION	Driven/Rec	Permeability (cm/s)	Pocket Pen.	LL, %	PI%	Moisture Content %
616	30			III	CL	lean CLAY, moist, brownish yellow (10YR6/6) (cont.)						
		hard	10 19 27 33	III	CL	possible horizontal fracture, dry	24/25		4.5+			
				III	CL	possible horizontal fracture, dry						
		hard	11 25 42 50/6	III	CL	possible horizontal fracture, dry	24/25		4.5+			
				III	CL	calcite seam, 80 degree, 1.3" in length						
611	35	hard	12 30 43 50/4.5			calcite seam, 85 degree, 1.6" in length	22.5/27		4.5+			
		hard	22 37 49 50/4				22/27		4.5+	53	36	16.6
		hard	16 36 44 50/5.5	III	CL	horizontal calcite seam, wet, possible fracture	23.5/26		4.5+			
606	40			III	CL	horizontal calcite seam, wet, possible fracture, grades gray (5Y5/1) lean CLAY						
		hard	15 32 50/5.5	III	CL	grades light yellowish brown (10YR6/4), lean CLAY	17.5/18		4.5+			
				III	CL	grades gray (Y5/1), lean CLAY						
		hard	16 49 50/4.5				18.5/18		4.5+			
601	45			IV	CL / Claystone	possible 45 degree fracture, calcite lined, dry, grades light yellowish brown (2.5Y6/4)						
			core			Gray (5Y5/1) CLAYSTONE	66/68			59	44	17.5
				IV	Claystone	Mechanical Fractures, all 50 degree on the same side, probably from the core barrel.						
596	50		core				60/64					
591	55		core				60/63					
586	60		core				60/63					
581	65		core				60/60					

Project: WMTX - Mesquite Creek Landfill
Project Location: New Braunfels, TX
Project Number: GT 3435

Boring GB-06

Elevation, feet	Depth, feet	Sample Type	Consistency	Sampling Resistance, blows/foot	Stratum	Field USCS	Graphic Log	MATERIAL DESCRIPTION	Driven/Rec	Permeability (cm/s)	Pocket Pen.	LL, %	PI%	Moisture Content %	Piezometer Completion
581	65			core	IV	Claystone		Gray (5Y5/1) CLAYSTONE (cont.)	60/60						
576	70			core					60/63						
571	75			core					60/60						
566	80			core					60/60	1.1E-8				18.1	
561	85			core					60/64						
556	90			core					60/63						
551	95			core					60/63						
546	100			core					60/61						

Project: WMTX - Mesquite Creek Landfill
Project Location: New Braunfels, TX
Project Number: GT 3435

Boring GB-06

Elevation, feet	Depth, feet	Sample Type	Consistency	Sampling Resistance, blows/foot	Stratum	Field USCS	Graphic Log	MATERIAL DESCRIPTION	Driven/Rec	Permeability (cm/s)	Pocket Pen.	LL, %	PI%	Moisture Content %	Piezometer Completion
546	100				IV	Claystone		Gray (5Y5/1) CLAYSTONE (cont.)							
				core					60/61						
541	105			core					60/63						
536	110			core					60/63						
531	115			core					60/60						
526	120			core					60/61						
	124							Bottom of Boring at 124 feet bgs							
521	125														
516	130														
511	135														

Project: WMTX - Mesquite Creek Landfill	**Boring GB-07**
Project Location: New Braunfels, TX	Sheet 1 of 2
Project Number: GT 3435	

Date(s) Drilled	11/03-11/04/04	Logged By	Taylor Johnston	Checked By	Janet Meaux
Drilling Method	Hollow Stem Auger/Core	Drill Bit Size/Type	4 1/4 inch ID, Hollow Stem Auger	Total Depth of Borehole	59 feet bgs
Drill Rig Type	CME 75	Drilling Contractor	Geoprojects/ Jose Landezos 2551W	Approximate Surface Elevation	602.86 feet MSL
Groundwater Level and Date Measured	NA	Sampling Method(s)	SPT, Tube, Grab, Other	Hammer Data	140 lb, 30 in drop, auto trip
Borehole Backfill	Grout	Location	Northing 13,816,404.97 Easting 2,278,500.35		

Elevation, feet	Depth, feet	Consistency	Sampling Resistance, blows/foot	Stratum	Field USCS	MATERIAL DESCRIPTION	Driven/Rec	Permeability (cm/s)	Pocket Pen.	LL, %	PI%	Moisture Content %	Piezometer Completion
602.9	0			I	CH	GRASS							
		stiff	1 3 5 8			very dark brown CLAY (2.5Y3/1), moist, some gravel	24/14		1.0				
				I	CL	light olive brown (2.5Y5/6), lean CLAY, moist							
597.9	5		6 8 10 10				24/19		3.75				
										75	53	11	
		hard	20 50/5"		GC	GRAVEL, some light olive brown (2.5Y5/6), lean clay, moist	11/10		3.75				
592.9	10			III	CL	olive yellow(2.5Y6/6), lean CLAY, moist							
										48	31	15.4	
587.9	15	hard	14 22 33 44				24/20		4.5+				
				III	CL	some gravel							
		hard	29 50/5.8"	III	CL	grades light yellowish brown (2.5Y6/3), lean CLAY, some gravel, moist	[illegible]		4.5+				
582.9	20												
				III	CL	grades light yellowish brown (2.5Y6/3), lean CLAY, moist, no gravel							
577.9	25	hard	12 23 36 50/5"				23/24		4.5+				
										49	32	16	
		hard	12 23 44 50/5				23/23		4.5+				
572.9	30												

Elevation, feet	Depth, feet	Consistency	Sampling Resistance, blows/foot	Stratum	Field USCS	MATERIAL DESCRIPTION	Driven/Rec	Permeability (cm/s)	Pocket Pen.	LL, %	PI%	Moisture Content %	Piezometer Completion
572.9	30	hard	12 23 44 50/5	III	CL	olive yellow(2.5Y6/6), lean CLAY, moist (cont.)	23/23		4.5+				
567.9	35							6.6E-6	na	48	28	15.6	
		hard	21 50/4"	IV	Claystone	dark gray (2.5Y4/1), very hard, dry, 40 - 45' no recovery	10/12		4.5+				
562.9	40												
			core				60/0, 60/0						
557.9	45		core				12/0, 12/0						
			core				36/36, 36/36						
552.9	50												
			core				60/60, 60/59						
547.9	55												
			core				60/60, 60/60						
				IV		Bottom of Boring at 59 feet bgs							
542.9	60												
537.9	65												

Project: WMTX - Mesquite Creek Landfill	Boring GB-08
Project Location: New Braunfels, TX	Sheet 1 of 3
Project Number: GT 3435	

Date(s) Drilled 10/06-10/07/04	Logged By Taylor Johnston	Checked By Janet Meaux
Drilling Method Hollow Stem Auger, Core	Drill Bit Size/Type 4 1/4 inch ID, Hollow Stem Auger	Total Depth of Borehole 71.5 feet bgs
Drill Rig Type CME 75	Drilling Contractor Geoprojects/ Jose Landezos 2551W	Approximate Surface Elevation 623.83 feet MSL
Groundwater Level and Date Measured dry at drilling	Sampling Method(s) SPT, Grab, Other	Hammer Data 140 lb, 30 in drop, auto trip
Borehole Backfill Grout	Location Northing 13,816,002.19 Easting 2,278,101.00	

Elevation, feet	Depth, feet	Consistency	Sampling Resistance, blows/foot	Stratum	Field USCS	MATERIAL DESCRIPTION	Driven/Rec	Permeability (cm/s)	Pocket Pen.	LL, %	PI%	Moisture Content %	Piezometer Completion
623.8	0			I	CH	GRASS							
		stiff	1 5 6 9			Brown (10YR4/3), wet, fat CLAY							
				II	GC-CL	GRAVEL, some lean clay, light yellowish brown (2.5Y6/3), moist							
				III	CL	yellow (2.5Y7/8), lean CLAY, moist							
618.8	5	hard	7 27 50/3.5"										
		hard	7 27 50/6"	III	CL	grades few shell fragments, yellow (2.5Y7/6), moist							
613.8	10												
		hard	20 50/5"	III	CL	grades pale yellow (2.5Y7/4), moist							
608.8	15									33	19	7.9	
		hard	10 20 29 31	III	CL	grades dry							
603.8	20	hard	16 32 50/5.5										
		hard	5 25 29 32										
598.8	25	hard	4 15 27 27										
		hard	20 30 42 50/5.5										
		hard	11 20 33 38										
593.8	30												

Elevation, feet	Depth, feet	Sample Type	Consistency	Sampling Resistance, blows/foot	Stratum	Field USCS	Graphic Log	MATERIAL DESCRIPTION	Driven/Rec	Permeability (cm/s)	Pocket Pen.	LL, %	PI%	Moisture Content %	Piezometer Completion
593.8	30		hard	11 19 32 34	III	CL		yellow (2.5Y7/8), lean CLAY, moist (cont.)							
			hard	3 17 25 36											
					III	CL		iron stained seam							
588.8	35														
			hard	25 50/5"											
583.8	40											45	30	8.3	
			hard	48 50/4"	III	Claystone		greenish gray, CLAYSTONE (Gley1 10Y5/1), dry							
			hard	41 50/4.5"											
578.8	45		hard	50/4"								60	42	10.8	
				core	III	Claystone		grades greenish gray (Gley1 5GY5/1), mottled with olive yellow (2.5Y6/6)	12/10						
					III	Claystone		vertical calcite seam, dry							
					IV	Claystone		grades greenish gray (Gley1 10Y6/1) CLAYSTONE, some silt							
				core					60/61						
573.8	50														
				core					60/58, 60/52						
568.8	55														
				core					60/55, 60/31						
563.8	60														
				core					60/60						
558.8	65														

Project: WMTX - Mesquite Creek Landfill
Project Location: New Braunfels, TX
Project Number: GT 3435

Boring GB-08

Sheet 3 of 3

Elevation, feet	Depth, feet	Sample Type	Consistency	Sampling Resistance, blows/foot	Stratum	Field USCS	Graphic Log	MATERIAL DESCRIPTION	Driven/Rec	Permeability (cm/s)	Pocket Pen.	LL, %	PI%	Moisture Content %	Piezometer Completion
558.8	65			core	IV	Claystone		grades greenish gray (Gley1 10Y6/1) CLAYSTONE, some silt (cont.)	60/60						
				core					60/60						
553.8	70														
					IV	Claystone		Bottom of Boring at 71.5 feet bgs							
548.8	75														
543.8	80														
538.8	85														
533.8	90														
528.8	95														
523.8	100														

Project: WMTX - Mesquite Creek Landfill **Project Location: New Braunfels, TX** **Project Number: GT 3435**	**Boring GB-09** Sheet 1 of 3

Date(s) Drilled **10/21-10/22/04**	Logged By **Trent McDaniel**	Checked By **Janet Meaux**
Drilling Method **Hollow Stem Auger, Core**	Drill Bit Size/Type **4/14 inch ID, Hollow Stem Auger**	Total Depth of Borehole **89 feet bgs**
Drill Rig Type **CME 75**	Drilling Contractor **Geoprojects/ Jose Landezos 2551W**	Approximate Surface Elevation **638.66 feet MSL**
Groundwater Level and Date Measured **water present in fractures at 34'**	Sampling Method(s) **SPT, Grab, Other**	Hammer Data **140 lb, 30 in drop, auto trip**
Borehole Backfill **Grout**	Location **Northing 13,815,699.84 Easting 2,279,256.03**	

Elevation, feet	Depth, feet	Sample Type	Consistency	Sampling Resistance, blows/foot	Stratum	Field USCS	Graphic Log	MATERIAL DESCRIPTION	Driven/Rec	Permeability (cm/s)	Pocket Pen.	LL, %	PI%	Moisture Content %	Piezometer Completion
638.7	0				I	CL		grass covered CLAY							
			stiff	5 4 5 6	III	CL		Brown (10YR4/3), lean CLAY, some silt, trace gravel, moist, rootlets	24/23		1.5	46	27	13.2	
								grades to pale yellow (5Y7/4), some chalk, some calcareous gravel, moist							
633.7	5		very stiff	4 11 17 25	III	CL		grades pale yellow (5Y8/4), mottled with light gray (5Y7/1), some chalk, moist	24/23		1.75				
												50	33	13.1	
628.7	10		hard	8 15 17 23	III	CL		grades olive yellow (2.5Y6/6), mottled with gray (2.5Y6/1), trace chalk, moist	24/24		4.0				
623.7	15		very stiff	3 13 14 21	III	CL		possible 70 degree fracture, clay filled, no water	24/24		4.5+	55	38	18	
618.7	20		very stiff	4 12 17 25	III	CL		possible 70 degree fracture, clay and organic filled, no water	24/23		4.5+				
613.7	25		hard	8 17 27 24	III	CL		possible 80 degree fracture, clay and organic filled, no water, some iron staining	24/24		4.5+				
			hard	12 23 31 42	III	CL		grading light yellowish brown (2.5Y6/4), slightly moist to dry	24/24		4.5+				
608.7	30														

Elevation, feet	Depth, feet	Sample Type	Consistency	Sampling Resistance, blows/foot	Stratum	Field USCS	Graphic Log	MATERIAL DESCRIPTION	Driven/Rec	Permeability (cm/s)	Pocket Pen.	LL, %	PI%	Moisture Content %	Piezometer Completion
608.7	30		hard	12 23 31 42	III	CL		grades to pale yellow (5Y7/4), some chalk, some calcareous gravel, moist (cont.)	24/24		4.5+				
												64	43	13.8	
603.7	35		hard	10 23 35 46	III	CL		grading light brownish gray (2.5Y6/5), some iron staining, possible 70 degree fractures, calcite filled, water present	24/24		4.5+				
598.7	40		hard	8 24 33 33	III	CL		possible 30 degree fracture, calcite filled, water present, trace shell fragments							
593.7	45		hard	11 30 50/6"	III III	CL CL		dark gray (Gley1N4/0), lean CLAY, some silt, mottled light yellowish brown (2.5Y6/4), wet possible 45 degree fracture calcite filled, water present	18/20		4.5+				
588.7	50		hard	12 26 32 46	III III III	CL CL CL		grades dark gray CLAY possible 45 degree fracture, clacite filled, water present grades light yellowish brown (2.5Y6/4), CLAY	24/24		4.5+				
583.7	55		hard	13 33 50/6"	IV	Claystone		dark gray (Gley1N4/0), CLAYSTONE	18/18		4.5+				
												61	43	14.3	
578.7	60		hard	14 50/6"					12/12		4.5+				
												55	37	16.9	
573.7	65			core					60/58		4.5+				

Project: WMTX - Mesquite Creek Landfill
Project Location: New Braunfels, TX
Project Number: GT 3435

Boring GB-09

Elevation, feet	Depth, feet	Sample Type	Consistency	Sampling Resistance, blows/foot	Stratum	Field USCS	Graphic Log	MATERIAL DESCRIPTION	Driven/Rec	Permeability (cm/s)	Pocket Pen.	LL, %	PI%	Moisture Content %	Piezometer Completion
573.7	65				IV	Claystone		dark gray (Gley1N4/0), CLAYSTONE (cont.)							
				core					60/58		4.5+				
568.7	70			core					60/58		4.5+				
563.7	75			core					60/59		4.5+				
558.7	80			core					60/60	1.9E-9	4.5+	65	44	16.6	
553.7	85			core					60/60		4.5+				
					IV	Claystone		Bottom of Boring at 89 feet bgs							
548.7	90														
543.7	95														
538.7	100														

Project: WMTX - Mesquite Creek Landfill
Project Location: New Braunfels, TX
Project Number: GT 3435

Boring GB-10

Date(s) Drilled **10/22-10/26/04**	Logged By **Trent McDaniel, Taylor Johnston**	Checked By **Janet Meaux**
Drilling Method **Hollow Stem Auger, Core**	Drill Bit Size/Type **4 1/4 inch ID, Hollow Stem Auger**	Total Depth of Borehole **99 feet bgs**
Drill Rig Type **CME 75**	Drilling Contractor **Geoprojects/ Jose Landezos 2551W**	Approximate Surface Elevation **648.65 feet MSL**
Groundwater Level and Date Measured **NA**	Sampling Method(s) **SPT, Grab, Other**	Hammer Data **140 lb, 30 in drop, auto trip**
Borehole Backfill **Grout**	Location **Northing 13,815,451.54 Easting 2,278,556.87**	

Elevation, feet	Depth, feet	Sample Type	Consistency	Sampling Resistance, blows/foot	Stratum	Field USCS	Graphic Log	MATERIAL DESCRIPTION	Driven/Rec	Permeability (cm/s)	Pocket Pen.	LL, %	PI%	Moisture Content %	Piezometer Completion
648.6	0		very stiff	2 3 6 10	I	CL		GRASS greenish gray (Gley15/1), CLAY, some silt, moist	24/24		1.5				
												46	28	15.3	
643.6	5		very stiff	6 9 12 15	I	CL		grading gray (Gley1N6/0), mottled with brownish yellow (10YR6/6), some chalk	24/24		3.0				
638.6	10		hard	6 22 50/6"	I	CL		grading trace chalk, some black staining	18/18		4.5+				
												48	31	14.6	
633.6	15		hard	7 18 30 33	III	CL		grading light yellowish brown (2.5Y6/4), possible 70 degree fracture, clay filled, no water	24/24		4.5+				
628.6	20		hard	7 16 26 35	III	CL		possible 70 degree fracture, clay filled, no water	24/24	4.5+					
623.6	25		hard	8 18 23 33	III	CL		possible 70 degree fracture, clay filled, no water, trace iron staining, trace black staining	24/24		4.5+				
												57	40	16.4	
			hard	6 16 25 37	III	CL		grades trace calcite, trace iron staining, trace black staining	24/23		4.5+				
618.6	30														

Elevation, feet	Depth, feet	Sample Type	Consistency	Sampling Resistance, blows/foot	Stratum	Field USCS	Graphic Log	MATERIAL DESCRIPTION	Driven/Rec	Permeability (cm/s)	Pocket Pen.	LL, %	PI%	Moisture Content %	Piezometer Completion
618.6	30		hard	6 16 25 37	III	CL		grading light yellowish brown (2.5Y6/4), possible 70 degree fracture, clay filled, no water (cont.)	24/23		4.5+				
613.6	35		hard	7 21 32 37	III	CL		grades trace calcite							
608.6	40		hard	11 30 42 50/5.5	III	CL		possible 45 degree fracture, calcite filled, water present	23.5/24		4.5+				
					III	CL		grades dark gray (Gley1N4/0), lean CLAY, some silt							
603.6	45		hard	10 27 42 50/5	III	CL		grades alternating layers of dark gray CLAY (Gley1N4/0), and light yellowish brown (2.5Y6/4)	23/24		4.5+				
598.6	50		hard	20 45 50/4"	III	CL		grades dark gray (GleyN4/0), CLAY, some silt	17/17		4.5+				
			hard	17 43 50/4.5	III	CL		grades brownish yellow (10YR6/6), calcite seam from 52-52.3'	16.5/17		4.5+	49	31	13.6	
					III	CL		grades dark gray (Gley1N4/0), CLAY							
					III	CL		grades brownish yellow (10YR6/6), CLAY							
593.6	55			core	III	Claystone		dark gray (GleyN4/0), CLAYSTONE, some silt	66/39, 66/36						
588.6	60			core	III	Claystone		grades yellowish brown (10YR5/4), CLAYSTONE							
					IV	Claystone		grades to dark gray CLAYSTONE, (GleyN4/0), possible 50 degree fracture	60/86, 60/93						
583.6	65			core					60/60, 60/58						

Elevation, feet	Depth, feet	Sample Type	Consistency	Sampling Resistance, blows/foot	Stratum	Field USCS	Graphic Log	MATERIAL DESCRIPTION	Driven/Rec	Permeability (cm/s)	Pocket Pen.	LL, %	PI%	Moisture Content %	Piezometer Completion
583.6	65				IV	Claystone		grades to dark gray CLAYSTONE, (GleyN4/0), possible 50 degree fracture (cont.)							
				core					60/60, 60/58						
578.6	70														
				core					60/53, 60/53						
573.6	75														
				core					60/61, 60/61						
568.6	80														
				core					60/60, 60/60						
563.6	85														
				core					60/60, 60/60						
558.6	90														
				core					60/57, 60/53						
553.6	95														
				core					60/60, 60/59						
					IV	Claystone		Bottom of Boring at 99 feet bgs							
548.6	100														

Project: WMTX - Mesquite Creek Landfill
Project Location: New Braunfels, TX
Project Number: GT 3435

Boring GB-11

Date(s) Drilled: **10/27-10/28/04**	Logged By: **Taylor Johnston**	Checked By: **Janet Meaux**
Drilling Method: **Hollow Stem Auger, Core**	Drill Bit Size/Type: **4 1/4 inch ID, Hollow Stem Auger**	Total Depth of Borehole: **90 feet bgs**
Drill Rig Type: **CME 75**	Drilling Contractor: **Geoprojects/ Jose Landezos 2551W**	Approximate Surface Elevation: **617.2 feet MSL**
Groundwater Level and Date Measured: **NA**	Sampling Method(s): **SPT, Grab, Other**	Hammer Data: **140 lb, 30 in drop, auto trip**
Borehole Backfill: **Grout**	Location: **Northing 13,815,865.03 Easting 2,278,665.34**	

Elevation, feet	Depth, feet	Sample Type	Consistency	Sampling Resistance, blows/foot	Stratum	Field USCS	Graphic Log	MATERIAL DESCRIPTION	Driven/Rec	Permeability (cm/s)	Pocket Pen.	LL, %	PI%	Moisture Content %	Piezometer Completion
617.2	0					CH		topsoil							
			hard	3 9 16 19	III	CL		Yellow (10YR7/6) mottled with white, lean CLAY, moist	24/24		4.5+				
												65	45	22.1	
					III	CL		brownish yellow (10YR6/6), lean CLAY, moist							
612.2	5		very hard	6 16 23 36					24/24		4.5+				
					III	CL		grades some chert gravel, moist							
					III	CL		grades brownish yellow (10YR6/6), lean CLAY, moist							
			very hard	6 50/5"					11/12		4.5+				
607.2	10														
602.2	15		very hard	9 22 32 43					24/24		4.5+				
597.2	20		very hard	7 14 21 27					24/24		4.5+				
												52	35	18.9	
592.2	25		very hard	4 17 20 33					24/24		4.5+				
			very hard	9 28 36 50/5.5					23.5/24		4.5+				
587.2	30														

Elevation, feet	Depth, feet	Sample Type	Consistency	Sampling Resistance, blows/foot	Stratum	Field USCS	Graphic Log	MATERIAL DESCRIPTION	Driven/Rec	Permeability (cm/s)	Pocket Pen.	LL, %	PI%	Moisture Content %	Piezometer Completion
587.2	30		very hard	9 28 36 50/5.5	III	CL		brownish yellow lean CLAY	23.5/24		4.5+				
582.2	35		very hard	14 43 50/5"					17/17		4.5+				
577.2	40		very hard	14 39 50/4"	III	CL		grades gray (10YR5/1), moist	16/18		4.5+				
					III	CL		grades brownish yellow (10YR6/6), lean CLAY, moist							
					III	CL		horizontal calcite seam							
								vertical calcite seam				60	43	16.4	
572.2	45		very hard	11 29 50/5"	III	CL		grades grayish brown (10YR5/2), CLAY	17/19		4.5+				
					IV	Claystone		very dark gray (Gley1 3/N), CLAYSTONE, dry							
			very hard	18 35 50/5.5					17.5/17		4.5+				
567.2	50			core					60/53, 60/53	2.4E-9				9.8	
					IV	SC-CL		tan layer							
					IV	Claystone		tan layer ends, gray claystone							
562.2	55				IV	Claystone		Very dark gray (Gley1 3/N), CLAYSTONE, dry, some silt							
				core					60/59, 60/59						
557.2	60														
				core					60/59, 60/59						
552.2	65			core					60/59, 60/59						

Project: WMTX - Mesquite Creek Landfill
Project Location: New Braunfels, TX
Project Number: GT 3435

Boring GB-11

Elevation, feet	Depth, feet	Sample Type	Consistency	Sampling Resistance, blows/foot	Stratum	Field USCS	Graphic Log	MATERIAL DESCRIPTION	Driven/Rec	Permeability (cm/s)	Pocket Pen.	LL, %	PI%	Moisture Content %	Piezometer Completion
552.2	65				IV	Claystone		very dark gray (Gley1 3/N), CLAYSTONE, dry (cont.)							
				core					60/59, 60/59						
547.2	70			core					60/59, 60/59						
542.2	75			core					60/59, 60/59						
537.2	80			core					60/58, 60/58						
532.2	85			core					72/68, 72/64						
527.2	90				IV	Claystone		Bottom of Boring at 90 feet bgs							
522.2	95														
517.2	100														

Project: WMTX - Mesquite CreekLandfill **Project Location: New Braunfels, TX** **Project Number: GT 3435**	**Boring GB-12** Sheet 1 of 4

Date(s) Drilled **10/8-10/12/04**	Logged By **Taylor Johnston**	Checked By **Janet Meaux**
Drilling Method **Hollow Stem Auger, Core**	Drill Bit Size/Type **4 1/4 inch ID, Hollow Stem Auger**	Total Depth of Borehole **119 feet bgs**
Drill Rig Type **CME 75**	Drilling Contractor **Geoprojects/ Jose Landezos 2551W**	Approximate Surface Elevation **639.61 feet MSL**
Groundwater Level and Date Measured **NA**	Sampling Method(s) **SPT, Grab, Other**	Hammer Data **140 lb, 30 in drop, auto trip**
Borehole Backfill **Grout**	Location **Northing 13,815,315.49 Easting 2,278,055.83**	

Elevation, feet	Depth, feet	Sample Type	Consistency	Sampling Resistance, blows/foot	Stratum	Field USCS	Graphic Log	MATERIAL DESCRIPTION	Driven/Rec	Permeability (cm/s)	Pocket Pen.	LL, %	PI%	Moisture Content %	Piezometer Completion
639.6	0				I	CH		GRASS							
								dark grayish brown (2.5Y4/2) fat CLAY, moist							
634.6	5		very hard	10 18 29 36	III	CL		pale yellow (5Y7/4), lean CLAY, moist, some calcite							
629.6	10		very hard	9 19 31 46	III	CL		grades olive yellow (2.5Y6/6), lean CLAY, moist							
												57	40	12.6	
624.6	15		very hard	9 23 35 42	III	CL		grades pale yellow (5Y7/4), lean CLAY, moist							
619.6	20		very hard	9 19 33 40	III	CL		pale yellow (2.5Y7/4), mottled with light gray (2.5Y7/1), lean CLAY, moist							
614.6	25		very hard	7 24 34 49											
609.6	30		very hard	7 22 30 34											

Project: WMTX - Mesquite CreekLandfill
Project Location: New Braunfels, TX
Project Number: GT 3435

Boring GB-12

Elevation, feet	Depth, feet	Sample Type	Consistency	Sampling Resistance, blows/foot	Stratum	Field USCS	Graphic Log	MATERIAL DESCRIPTION	Driven/Rec	Permeability (cm/s)	Pocket Pen.	LL, %	PI%	Moisture Content %	Piezometer Completion
609.6	30		very hard	7 22 30 34	III	CL		pale yellow (5Y7/4), lean CLAY, moist, some calcite (cont.)							
												63	47	18.2	
604.6	35		very hard	6 17 26 35											
					III	CL		calcite nodules present							
599.6	40		very hard	8 21 29 37											
					III	CL		calcite seam horizontal							
594.6	45		very hard	8 22 28 39	III	CL		calcite seams at 45' and 45.5', dry, no water							
					III	CL		dark greenish gray (Gley1 4/1), moist, CLAY							
								pale yellow (2.5Y7/4), CLAY, moist							
					III	CL		dark greenish gray CLAY (Gley1 4/1)							
			very hard	8 26 38 46				pale yellow (2.5Y7/4), CLAY, moist				72	54	18.5	
					III	CL		dark greenish gray (Gley1 4/1), CLAY, moist, calcite seam							
589.6	50		very hard	8 24 42 50/4.2				calcite seam							
								pale yellow (2.5Y7/4), CLAY, moist							
					III	CL		dark greenish gray (Gley1 4/1), CLAY, dry							
								bluish gray (Gley2 5/1), CLAY							
					III	CL		pale olive (5Y6/3), CLAY, dry							
								greenish gray (Gley2 5/1 5BG), CLAY, dry, calcite seam	93/93, 93/88						
584.6	55			core											
								grades to pale olive (5Y6/3), CLAY, dry							
								possible 30 degree fracture, calcite lined, dry							
					III	CL		grades to greenish gray (Gley2 5/1 5BG)							
								grades to pale olive (5Y6/3), CLAY, dry							
					III	CL		possible 70 degree calcite seam, horizontal calcite seam							
								possible 85 degree fracture, dry							
579.6	60				IV	Claystone		two possible 70 degree fractures, dry							
								greenish gray (Gley2 6/1 5BG), CLAYSTONE, dry	120/132, 120/132						
				core											
574.6	65														

Project: WMTX - Mesquite CreekLandfill
Project Location: New Braunfels, TX
Project Number: GT 3435

Boring GB-12

Elevation, feet	Depth, feet	Sample Type	Consistency	Sampling Resistance, blows/foot	Stratum	Field USCS	Graphic Log	MATERIAL DESCRIPTION	Driven/Rec	Permeability (cm/s)	Pocket Pen.	LL, %	PI%	Moisture Content %	Piezometer Completion
574.6	65				IV	Claystone		greenish gray (Gley2 6/1 5BG), CLAYSTONE, dry (cont.)							
				core					120/132, 120/132						
569.6	70			core					60/77, 60/77						
564.6	75														
				core					120/121, 120/121						
559.6	80														
554.6	85			core					48/48, 48/39						
				core					60/60, 60/12						
549.6	90														
544.6	95			core					120/87, 120/87						
539.6	100														

Project: WMTX - Mesquite CreekLandfill
Project Location: New Braunfels, TX
Project Number: GT 3435

Boring GB-12

Elevation, feet	Depth, feet	Sample Type	Consistency	Sampling Resistance, blows/foot	Stratum	Field USCS	Graphic Log	MATERIAL DESCRIPTION	Driven/Rec	Permeability (cm/s)	Pocket Pen.	LL, %	PI%	Moisture Content %	Piezometer Completion
539.6	100			core	IV	Claystone		greenish gray (Gley2 6/1 5BG), CLAYSTONE, dry (cont.)	120/87 120/87						
				core					60/61, 60/58						
534.6	105														
529.6	110			core					90/92, 90/92						
524.6	115			core					66/61, 66/61						
					IV			Bottom of Boring at 119 feet bgs							
519.6	120														
514.6	125														
509.6	130														
504.6	135														

Project: WMTX - Mesquite Creek Landfill	Boring GB-13
Project Location: New Braunfels, TX	Sheet 1 of 3
Project Number: GT 3435	

Date(s) Drilled: 10/28-10/29/04	Logged By: Taylor Johnston	Checked By: Janet Meaux
Drilling Method: Hollow Stem Auger, Core	Drill Bit Size/Type: 4 1/4 inch ID, Hollow Stem Auger	Total Depth of Borehole: 95 feet bgs
Drill Rig Type: CME 75	Drilling Contractor: Geoprojects/ Jose Landezos 2551W	Approximate Surface Elevation: 618.75 feet MSL
Groundwater Level and Date Measured: 45' on 10/29/05	Sampling Method(s): SPT, Grab, Other	Hammer Data: 140 lb, 30 in drop, auto trip
Borehole Backfill: Grout	Location: Northing 13,816,217.85 Easting 2,279,036.29	

Elevation, feet	Depth, feet	Consistency	Sampling Resistance, blows/foot	Stratum	Field USCS	MATERIAL DESCRIPTION	Driven/Rec	Permeability (cm/s)	Pocket Pen.	LL, %	PI%	Moisture Content %
618.8	0					GRASS						
		Firm	1 2 6 12	I	CH	very dark brown (10YR3/1), fat CLAY, moist, weathered, few roots	24/18		0.25			
				I	CH	grades dark yellowish brown(10YR4/6), fat CLAY						
613.8	5	hard	2 7 12 14	III	CL	brownish yellow (10YR6/6), lean CLAY, moist to wet, some calcite	24/26		3.5			
										54	37	18.8
608.8	10	hard	4 10 14 20	III	CL	grades no calcite	24/24		4.5+			
603.8	15	very hard	11 35 42 50/4	III	CL	grading light yellowish brown (10YR6/4), lean CLAY, dry	22/27		4.5+			
										42	27	15.1
598.8	20	very hard	12 34 48 50/4				24/24		4.5+			
593.8	25	very hard	12 30 47 50/4				22/26		4.5+			
		very hard	18 37 50/6"				18/21		4.5+			
588.8	30											

Elevation, feet	Depth, feet	Consistency	Sampling Resistance, blows/foot	Stratum	Field USCS	MATERIAL DESCRIPTION	Driven/Rec	Permeability (cm/s)	Pocket Pen.	LL, %	PI%	Moisture Content %
588.8	30	very hard	[illegible]	III	CL	brownish yellow (10YR6/6), lean CLAY, moist to wet, some calcite (cont.)	18/21		4.5+			
583.8	35	very hard	15 37 50/5.5				17.5/19		4.5+			
578.8	40	very hard	15 32 38 50/5..5				23.5/24		4.5+			
										52	32	17.3
573.8	45	very hard	10 27 50/6"	III	CL	horizontal calcite seam	18/19		4.5+			
				III	CL	dark greenish gray (Gley1 4/1), wet, CLAY						
		very hard	15 48 50/3"			water in hole sample is wet at 46', grades light yelloiwsh brown (10YR6/4), wet, CLAY at 46.4'	15/18		4.5+			
						grades dark greenish gray (Gley1 4/1), wet, CLAY						
		very hard	17 48 50/4"				16/18		4.5+			
				III	CL	light yellowish brown (10YR6/4), wet, CLAY						
568.8	50					calcite seam 30 degrees 6" in length, 50.5 grades to dark greenish gray (Gley1 4/1), CLAY, wet						
			core				54/43, 54/42					
563.8	55			III	CL	grades light yellowish brown (10YR6/4), CLAY, wet at 55', 70 degree calcite seam at 56'						
			core				60/72, 60/72					
				III	CL	dark greenish gray (Gley1 4/1), CLAY, wet						
558.8	60					light yellowish brown (10YR6/4), CLAY, wet						
			core	IV	Claystone	dark greenish gray (Gley1 4/1), CLAYSTONE	60/58, 60/58					
			core				60/60, 60/60	1.3E-8				17.0
553.8	65											

Elevation, feet	Depth, feet	Sample Type	Consistency	Sampling Resistance, blows/foot	Stratum	Field USCS	Graphic Log	MATERIAL DESCRIPTION	Driven/Rec	Permeability (cm/s)	Pocket Pen.	LL, %	PI%	Moisture Content %	Piezometer Completion
553.8	65				IV	Claystone		dark greenish gray (Gley1 4/1), CLAYSTONE (cont.)							
				core					60/60, 60/60	1.0E-8				17.0	
548.8	70														
				core					60/60, 60/60						
543.8	75														
				core					60/58, 60/58						
538.8	80														
				core					60/61, 60/59						
533.8	85														
				core					120/119, 120/116						
528.8	90														
				core					12/13, 12/13						
523.8	95				IV	Claystone		Bottom of Boring at 95 feet bgs							
518.8	100														

Project: WMTX - Mesquite Creek Landfill Project Location: New Braunfels, TX Project Number: GT 3435	**Boring GB-14** Sheet 1 of 5

Date(s) Drilled	11/8-11/10/05	Logged By	Taylor Johnston	Checked By	Janet Meaux
Drilling Method	Hollow Stem Auger, Core	Drill Bit Size/Type	4 1/4 inch ID, Hollow Stem Auger	Total Depth of Borehole	136 feet bgs
Drill Rig Type	CME 75	Drilling Contractor	Geoprojects/ Jose Landezos 2551W	Approximate Surface Elevation	679.76 feet MSL
Groundwater Level and Date Measured	NA	Sampling Method(s)	SPT, Grab, Other	Hammer Data	140 lb, 30 in drop, auto trip
Borehole Backfill	Grout	Location	Northing 13,815,300.71 Easting 2,279,853.74		

Elevation, feet	Depth, feet	Sample Type	Consistency	Sampling Resistance, blows/foot	Stratum	Field USCS	Graphic Log	MATERIAL DESCRIPTION	Driven/Rec	Permeability (cm/s)	Pocket Pen.	LL, %	PI%	Moisture Content %	Piezometer Completion
679.8	0				I	CH		GRASS							
			hard	2 10 9 8		GC		dark brown (10YR3/3), fat, CLAY, moist	24/18		2.75				
					I	CH		chert gravel, some dark brown (10YR3/3), CLAY, moist							
					III	CL		light olive brown (2.5Y5/6/), fat CLAY, moist							
								light yellowish brown (2.5Y6/4), lean CLAY, moist, some chalk, white							
674.8	5		hard	10 13 10 12					24/21		3.0				
669.8	10		very hard	8 13 22 23					24/18		2.0				
												69	49	20.6	
664.8	15		very hard	9 20 30 50/6					24/24		4.5+				
659.8	20		very hard	34 46 50/6"	III	CL		grades yellow (2.5Y7/4), lean CLAY, moist	18/21		4.5+				
654.8	25		very hard	11 49 50/4.5					16.5/18		4.5+				
649.8	30		very hard	16 37 40 50/5					23/24		4.5+				

Project: WMTX - Mesquite Creek Landfill
Project Location: New Braunfels, TX
Project Number: GT 3435

Boring GB-14

Elevation, feet	Depth, feet	Sample Type	Consistency	Sampling Resistance, blows/foot	Stratum	Field USCS	Graphic Log	MATERIAL DESCRIPTION	Driven/Rec	Permeability (cm/s)	Pocket Pen.	LL, %	PI%	Moisture Content %	Piezometer Completion
649.8	30		very hard	16 37 40 50/5	III	CL		light yellowish brown (2.5Y6/4), lean CLAY, moist, some chalk, white (cont.)	23/24		4.5+				
644.8	35		very hard	14 41 50/5"					17/20		4.5+				
639.8	40		very hard	12 48 50/5.5					17.5/19		4.5+				
												52	36	14.8	
634.8	45		very hard	8 26 42 50/5.5					23.5/24		4.5+				
629.8	50		very hard	4 45 50/5"	III	CL		calcite seam 70 degree, grades dark gray (2.5Y4/1), dry	17/20		4.5+				
												57	35	12.4	
			very hard	15 50/5.5"	IV	Claystone		dark gray (2.5Y4/1), dry, CLAYSTONE	11.5/14		4.5+				
624.8	55														
				core	IV	Claystone		possible horizontal fracture, dry	48/46, 48/46						
619.8	60														
				core					60/64, 60/64						
				core					60/62, 60/62						
614.8	65														

Elevation, feet	Depth, feet	Sample Type	Consistency	Sampling Resistance, blows/foot	Stratum	Field USCS	Graphic Log	MATERIAL DESCRIPTION	Driven/Rec	Permeability (cm/s)	Pocket Pen.	LL, %	PI%	Moisture Content %	Piezometer Completion
614.8	65			core	IV	Claystone		few shell fragments in sample	60/62, 60/62						
					IV	Claystone		dark gray (2.5Y4/1), dry, CLAYSTONE							
609.8	70			core					60/59, 60/59						
604.8	75			core					60/60, 60/59						
599.8	80			core					60/59, 60/59						
594.8	85			core					60/47, 60/46						
589.8	90			core					60/72, 60/72						
584.8	95			core					60/59, 60/59						
				core					60/60, 60/60						
579.8	100														

Elevation, feet	Depth, feet	Sample Type	Consistency	Sampling Resistance, blows/foot	Stratum	Field USCS	Graphic Log	MATERIAL DESCRIPTION	Driven/Rec	Permeability (cm/s)	Pocket Pen.	LL, %	PI%	Moisture Content %	Piezometer Completion
579.8	100			core	IV	Claystone		dark gray (2.5Y4/1), dry, CLAYSTONE (cont.)	60/60, 60/60						
574.8	105			core					60/60, 60/60						
569.8	110			core					60/58, 60/58						
564.8	115			core					60/54, 60/54						
559.8	120			core					60/65, 60/65						
554.8	125			core					60/59, 60/59						
549.8	130			core					72/72, 72/72						
544.8	135														

Project: WMTX - Mesquite Creek Landfill
Project Location: New Braunfels, TX
Project Number: GT 3435

Boring GB-14

Elevation, feet	Depth, feet	Sample Type	Consistency	Sampling Resistance, blows/foot	Stratum	Field USCS	Graphic Log	MATERIAL DESCRIPTION	Driven/Rec	Permeability (cm/s)	Pocket Pen.	LL, %	PI%	Moisture Content %	Piezometer Completion
544.8	135				IV	Claystone		dark gray (2.5Y4/1), dry, CLAYSTONE (cont.)							
					IV			Bottom of Boring at 136 feet bgs							
539.8	140														
534.8	145														
529.8	150														
524.8	155														
519.8	160														
514.8	165														
509.8	170														

Project: WMTX - Mesquite Creek Landfill	Boring GB-15
Project Location: New Braunfels, TX	Sheet 1 of 5
Project Number: GT 3435	

Date(s) Drilled	12/06-12/08/04	Logged By	Amy Howard	Checked By	Janet Meaux
Drilling Method	Hollow Stem Auger, Core	Drill Bit Size/Type	4 1/4 inch ID, Hollow Stem Auger	Total Depth of Borehole	144 feet bgs
Drill Rig Type	CME 75	Drilling Contractor	Geoprojects/ Jose Landezos 2551W	Approximate Surface Elevation	643.39 feet MSL
Groundwater Level and Date Measured	40'	Sampling Method(s)	SPT, Tube, Other	Hammer Data	140 lb, 30 in drop, auto trip
Borehole Backfill	Grout	Location	Northing 13,815,626.49 Easting 2,280,863.47		

Elevation, feet	Depth, feet	Sample Type	Consistency	Sampling Resistance, blows/foot	Stratum	Field USCS	Graphic Log	MATERIAL DESCRIPTION	Driven/Rec	Permeability (cm/s)	Pocket Pen.	LL, %	PI%	Moisture Content %	Piezometer Completion
643.4	0		very stiff	7 9 9 14	I	CH		GRASS brown (10YR4/3), fat CLAY, some silt, slightly moist	24/17		1.5				
			stiff	2 5 9 13	III	CL		pale yellow (2.5Y8/3), lean CLAY, few silt, dry, some calcite, friable	24/23		2.0				
638.4	5		very stiff	3 8 10 14				grades few iron staining	24/21		3.0	50	36	17.0	
			very hard	8 12 18 24	III	CL		grades no calcite, dry to slightly moist, trace iron fragments	24/26		4.5+				
			hard	6 8				grades some iron nodules, moist to dry	12/12		4.5+				
633.4	10		very stiff	5 9 16 19					24/24		2.5				
			very stiff	6 9 12 23					24/24		4.5+				
628.4	15		hard	14 13 24 26					24/24		4.5+				
					III	CL		possible 80 degree fracture at 15.5', clay filled							
			hard	11 32 38 50/3.5				grades yellow (10YR7/6), trace silt, trace calcareous nodules and shale fragments	21 5/26		4.5+				
									24/15	1.0E-8		40	24	14.9	
623.4	20		hard	34 36 50/6"	III	CL		grades light greenish gray (Gley1 8/1), dry, friable	18/24		3.0				
			hard	14 32 50/6"					18/20		4.5+				
				core	III	CL		calcite fragments grades no calcite, trace iron nodules	4.5/6, 4.5/6						
618.4	25							grades light yellowish brown (2.5Y6/4), lean CLAY, some silt, dry, some iron nodules							
				core	III	CL		possible fracture at 26.5', organic filled	60/64, 60/61						
				core					60/48, 60/34						
613.4	30														

Project: WMTX - Mesquite Creek Landfill	Boring GB-15
Project Location: New Braunfels, TX	Sheet 2 of 5
Project Number: GT 3435	

Elevation, feet	Depth, feet	Sample Type	Consistency	Sampling Resistance, blows/foot	Stratum	Field USCS	Graphic Log	MATERIAL DESCRIPTION	Driven/Rec	Permeability (cm/s)	Pocket Pen.	LL, %	PI%	Moisture Content %	Piezometer Completion
613.4	30				III	CL		pale yellow (2.5Y8/3), lean CLAY, few silt, dry, some calcite, friable (cont.)							
				core				possible 80 degree fracture at 32', 3" length, moist	60/48, 60/34						
608.4	35														
				core					60/61, 60/57						
					III	CL		possible 60 degree fracture at 38', calcite filled, moist							
								possible horizontal fracture, calcite filled, 39.7' possible 80 degree fracture calcite filled, moist , possible 15" vertical fracture at 40.3', calcite filled, wet at 42.8'							
603.4	40														
				core					60/59, 60/51			61	41	18.7	
					III	CL		dark greenish gray (Gley1 4/1), CLAY, moist							
								grades yellowish brown(2.5Y6/4), CLAY, dry							
598.4	45				III	CL		possible 80 degree fracture at 44.8' , calcite filled							
				core				possible 80 degree fracture at 46 - 46.2', calcite filled, 2" length, moist	60/58, 60/58						
					III	CL		greenish gray (Gley1 5/1), CLAYSTONE, dry to slighly moist							
								yellowish brown (2.5Y6/4), CLAY							
					III	CL		greenish gray (Gley1 5/1), CLAY							
593.4	50														
				core					60/63, 60/58						
								yellowish brown (2.5Y6/4), CLAY							
					III	CL		possible 10 degree fracture, 2 " length, wet, calcite filled							
588.4	55							greenish gray (Gley1 5/1), dry to moist, CLAY							
				core					60/59, 60/59						
					III IV	CL Claystone		possible fracture 85 degree, calcite filled							
								greenish gray (Gley1 5/1), CLAYSTONE, dry to moist							
583.4	60														
				core					60/59, 60/58						
				core					60/58, 60/58						
578.4	65														

Elevation, feet	Depth, feet	Sample Type	Consistency	Sampling Resistance, blows/foot	Stratum	Field USCS	Graphic Log	MATERIAL DESCRIPTION	Driven/Rec	Permeability (cm/s)	Pocket Pen.	LL, %	PI%	Moisture Content %	Piezometer Completion
578.4	65			core	IV	Claystone		greenish gray (Gley1 5/1), CLAYSTONE, dry to moist (cont.)	60/58, 60/58						
573.4	70			core					60/50, 60/50						
568.4	75			core					60/62, 60/59.5						
563.4	80			core					60/60, 60/59						
558.4	85			core					60/60, 60/60	2.9E-9				15.2	
553.4	90			core					60/60, 60/60						
548.4	95			core					60/63, 60/59						
				core					60/61, 60/59						
543.4	100														

Project: WMTX - Mesquite Creek Landfill
Project Location: New Braunfels, TX
Project Number: GT 3435

Boring GB-15

Elevation, feet	Depth, feet	Sample Type	Consistency	Sampling Resistance, blows/foot	Stratum	Field USCS	Graphic Log	MATERIAL DESCRIPTION	Driven/Rec	Permeability (cm/s)	Pocket Pen.	LL, %	PI%	Moisture Content %	Piezometer Completion
543.4	100				IV	Claystone		greenish gray (Gley1 5/1), CLAYSTONE, dry to moist (cont.)							
				core					60/51, 60/59						
538.4	105			core					60/59.5 60/59						
533.4	110			core					60/61, 60/60						
528.4	115			core					60/60, 60/60						
523.4	120			core					60/59.5, 60/59.5						
518.4	125			core					60/60, 60/58						
513.4	130			core					60/64, 60/62						
				core					60/62, 60/55						
508.4	135														

Project: WMTX - Mesquite Creek Landfill
Project Location: New Braunfels, TX
Project Number: GT 3435

Boring GB-15

Elevation, feet	Depth, feet	Sample Type	Consistency	Sampling Resistance, blows/foot	Stratum	Field USCS	Graphic Log	MATERIAL DESCRIPTION	Driven/Rec	Permeability (cm/s)	Pocket Pen.	LL, %	PI%	Moisture Content %	Piezometer Completion
508.4	135				IV	Claystone		greenish gray (Gley1 5/1), CLAYSTONE, dry to moist (cont.)							
				core					60/52, 60/55						
					IV	Claystone		grades trace iron nodules							
					IV	Claystone		grades no trace iron nodules							
503.4	140														
				core					60/61, 60/58						
					IV	Claystone		Bottom of Boring at 144 feet bgs							
498.4	145														
493.4	150														
488.4	155														
483.4	160														
478.4	165														
473.4	170														

Project: WMTX - Mesquite Creek Landfill	**Boring GB-16**
Project Location: New Braunfels, TX	Sheet 1 of 5
Project Number: GT 3435	

Date(s) Drilled	12/08-12/10/04	Logged By	Amy Howard	Checked By	Janet Meaux
Drilling Method	Hollow Stem Auger, Core	Drill Bit Size/Type	4 1/4 inch ID, Hollow Stem Auger	Total Depth of Borehole	139 feet bgs
Drill Rig Type	CME 75	Drilling Contractor	Geoprojects/ Jose Landezos 2551W	Approximate Surface Elevation	679.51 feet MSL
Groundwater Level and Date Measured	NA	Sampling Method(s)	SPT, Grab, Other	Hammer Data	140 lb, 30 in drop, auto trip
Borehole Backfill	Grout	Location	Northing 13,815,064.25 Easting 2,280,568.09		

Elevation, feet	Depth, feet	Sample Type	Consistency	Sampling Resistance, blows/foot	Stratum	Field USCS	Graphic Log	MATERIAL DESCRIPTION	Driven/Rec	Permeability (cm/s)	Pocket Pen.	LL, %	PI%	Moisture Content %	Piezometer Completion
679.5	0				I	CH		GRASS							
			medium	2 3 5 6				dark gray (10YR4/1) CLAY, moist, rootlets, few gravel	24/18.5		1.5				
					III	CL		dark grayish brown (10YR4/2), lean CLAY, moist,							
					III	CL		grades grayish brown (2.5Y5/2), moist, some iron staining, few calcite nodules, some silt							
674.5	5		stiff	2 4 6 10					24/26		1.5				
					III	CL		grades trace iron staining							
												101	72	36.4	
669.5	10		stiff	4 11 16 20					24/17		4.5+				
					III	CL		grades some iron staining							
664.5	15		stiff	5 10 14 20					24/28		3.0				
659.5	20		stiff	4 10 15 23					24/25		3.0				
					III	CL		possible horizontal fracture at 20.6', calcite filled, dry							
					III	CL		light yellowish brown (2.5YR6/3), moist, CLAY, some silt							
												93	69	32.7	
					III	CL		yellow (10YR7/6), CLAY, dry, some silt, some iron nodules, trace calcite nodules							
654.5	25		hard	4 11 23 50/4					22/24		4.5+				
649.5	30		hard	21 32 40 50/6					24/27		4.5+				

Elevation, feet	Depth, feet	Sample Type	Consistency	Sampling Resistance, blows/foot	Stratum	Field USCS	Graphic Log	MATERIAL DESCRIPTION	Driven/Rec	Permeability (cm/s)	Pocket Pen.	LL, %	PI%	Moisture Content %	Piezometer Completion
649.5	30		hard	21 32 40 50/6	III	CL		dark grayish brown (10YR4/2), lean CLAY, moist, (cont.)	24/27		4.5+				
					III	CL		grades trace silt, dry							
			hard	24 50/6"					12/15		4.5+				
644.5	35														
			hard	23 50/6"	III	CL		dark greenish (Gley1 4/1), CLAY, dry,	12/13		4.5+				
639.5	40														
				core					48/58, 48/54.5						
634.5	45														
				core	III	CL		yellow (10YR7/6). CLAY, dry, some iron staining	60/59, 60/59			51	36	11.6	
					IV	Claystone		dark greenish gray (Gley1 4/), CLAYSTONE, dry							
					IV	Claystone		possible 60 degree fracture, CLAY filled, dry							
629.5	50														
				core					60/59, 60/54.5						
					IV	Claystone		grades greenish gray (Gley1 5/1), CLAYSTONE, dry							
624.5	55														
				core					60/57, 60/57						
619.5	60														
				core					60/22, 60/20						
				core	IV	Claystone			60/78, 60/78						
614.5	65														

Elevation, feet	Depth, feet	Sample Type	Consistency	Sampling Resistance, blows/foot	Stratum	Field USCS	Graphic Log	MATERIAL DESCRIPTION	Driven/Rec	Permeability (cm/s)	Pocket Pen.	LL, %	PI%	Moisture Content %	Piezometer Completion
614.5	65				IV	Claystone		grades greenish gray (Gley1 5/1), CLAYSTONE, dry (cont.)							
				core					60/78, 60/78						
609.5	70			core					60/58, 60/58						
604.5	75			core					60/61.5, 60/58.5						
599.5	80			core					60/57.5, 60/57.5						
594.5	85			core					60/61, 60/60						
					IV	Claystone		shell fragments present							
					IV	Claystone		grades dark greenish gray (Gley1 4/1), CLAYSTONE, dry							
589.5	90			core					60/62, 60/58						
584.5	95			core					60/67, 60/62						
				core	IV	Claystone		grades shell fragments	60/62, 60/60						
579.5	100														

Elevation, feet	Depth, feet	Sample Type	Consistency	Sampling Resistance, blows/foot	Stratum	Field USCS	Graphic Log	MATERIAL DESCRIPTION	Driven/Rec	Permeability (cm/s)	Pocket Pen.	LL, %	PI%	Moisture Content %	Piezometer Completion
579.5	100				IV	Claystone		grades greenish gray (Gley1 5/1), CLAYSTONE, dry (cont.)							
				core					60/62, 60/60						
574.5	105			core					60/63, 60/61						
569.5	110			core					60/60, 60/58						
					IV	Claystone		grades no shell fragments							
564.5	115			core					60/60, 60/60						
559.5	120			core					60/60, 60/60						
					IV	Claystone		grades trace iron nodules							
554.5	125			core					60/63, 60/62						
					IV	Claystone		no iron nodules							
549.5	130			core					60/58, 60/58						
				core					50/51, 60/60						
544.5	135														

Project: WMTX - Mesquite Creek Landfill
Project Location: New Braunfels, TX
Project Number: GT 3435

Boring GB-16

Elevation, feet	Depth, feet	Sample Type	Consistency	Sampling Resistance, blows/foot	Stratum	Field USCS	Graphic Log	MATERIAL DESCRIPTION	Driven/Rec	Permeability (cm/s)	Pocket Pen.	LL, %	PI%	Moisture Content %	Piezometer Completion
544.5	135			core	IV	Claystone		grades greenish gray (Gley1 5/1), CLAYSTONE, dry (cont.)	60/61, 60/60						
					IV	Claystone		Bottom of Boring at 139 feet bgs							
539.5	140														
534.5	145														
529.5	150														
524.5	155														
519.5	160														
514.5	165														
509.5	170														

Project: WMTX - Mesquite Creek Landfill	Boring GB-17
Project Location: New Braunfels, TX	Sheet 1 of 4
Project Number: GT 3435	

Date(s) Drilled: 01/18-01/20/05	Logged By: Taylor Johnston	Checked By: Janet Meaux
Drilling Method: Hollow Stem Auger, Core	Drill Bit Size/Type: 4 1/4 inch ID, Hollow Stem Auger	Total Depth of Borehole: 134 feet bgs
Drill Rig Type: CME 75	Drilling Contractor: Geoprojects/ Jose Landezos 2551W	Approximate Surface Elevation: 654.41 feet MSL
Groundwater Level and Date Measured: NA	Sampling Method(s): SPT, Other	Hammer Data: 140 lb, 30 in drop, auto trip
Borehole Backfill: Grout	Location: Northing 13,814,630.98 Easting 2,280,885.41	

Elevation, feet	Depth, feet	Consistency	Sampling Resistance, blows/foot	Stratum	Field USCS	MATERIAL DESCRIPTION	Driven/Rec	Permeability (cm/s)	Pocket Pen.	LL, %	PI%	Moisture Content %
654.4	0			I	CH	GRASS						
		stiff	2 6 9 14			very dark gray (2.5Y3/1), moist to wet, fat CLAY, few gravel	24/22		2.5			
		very stiff	5 13 17 14				24/23		4.5+			
649.4	5	stiff	2 6 8 10	III	CL	light yellowish brown (2.5Y6/4), lean CLAY, wet	24/22		2.25			
		very stiff	5 10 14 18	III	CL	grades moist	24/25		3.75	59	43	22.7
644.4	10											
		very stiff	2 10 10 15				24/24		2.75			
		very stiff	3 7 9 13				24/25		4.0			
639.4	15	stiff	2 6 8 11				24/25		3.0			
		very stiff	6 9 12 15	III	CL	grades olive yellow (2.5Y6/6), moist, lean CLAY	24/27		3.5	78	62	25.7
		very stiff	3 6 11 16				24/24		4.5+			
		stiff	2 6 9 13				24/25		3.0			
634.4	20			III	CL	horizontal calcite vein, moist						
		very stiff	5 8 22 36				24/27		4.5+			
		very stiff	7 12 15 19	III	CL	grades light olive brown (2.5Y5/3), lean CLAY, some silt, moist	24/27		4.5+			
629.4	25	very stiff	5 10 16 17				24/24		4.5+	94	57	35.5
		very stiff	8 13 17 21	III	CL	grades dark grayish brown (2.5Y4/2), lean CLAY, dry	24/27		4.5+			
				III	CL	horizontal calcite seam, dry						
		hard	14 18 20 22	III	CL	horizontal calcite seam	24/27		4.5+			
624.4	30			III	CL							

Elevation, feet	Depth, feet	Sample Type	Consistency	Sampling Resistance, blows/foot	Stratum	Field USCS	Graphic Log	MATERIAL DESCRIPTION	Driven/Rec	Permeability (cm/s)	Pocket Pen.	LL, %	PI%	Moisture Content %	Piezometer Completion
624.4	30		very stiff	4 13 16 24	III III	CL CL		light yellowish brown (2.5Y6/4), lean CLAY, wet (cont.) vertical calcite seam, 12" length, dry	24/26		4.5+				
			hard	8 16 21 24	III III	CL CL		Vertical calcite seam, 6" length, dry vertical calcite seam, 12" length	24/26		4.5+				
619.4	35		hard	5 19 24 30	III III	CL CL		calcite seam 20 degree, dry calcite seam 30 degree, dry	24/26		4.5+				
			hard	8 16 24 26	III	CL		calcite seam, 45 degree, dry	24/27		4.5+				
			hard	7 16 22 22	III III III III III	CL CL CL CL CL		Horizontal calcite seam, dry horizontal calcite seam, dry horizontal calcite seam 1/4" thick	24/26		4.5+				
614.4	40		hard	10 18 21 22				calcite seam 45 degree calcite seam, 45 degree, dry	24/27		4.5+				
			hard	11 17 23 25	III III III	CL CL CL		vertical and horizontal calcite seams horizontal calcite seam, dry calcite seam, 45 degree, dry	24/27		4.5+	97	69	33.1	
609.4	45		hard	7 16 21 25	III III	CL CL		horizontal calcite seam, dry horizontal calcite seam, dry	24/26		4.5+				
			hard	12 20 28 35	III III	CL CL		horizontal calcite seam, 47.3 horizontal calcite seam	24/26		4.5+				
			hard	12 22 26 30	III	CL		grades strong brown (7.5YR5/8), and alternates dark grayish brown (2.5Y4.2) mottle with dark gray (10YR4/1) calcite seam, 50 degree, dry	24/27		4.5+				
604.4	50		hard	8 19 25 33	III	CL		calcite seam, 50 degree, dry	24/27		4.5+				
			hard	9 19 20 26	III III	CL CL		grades dark grayish brown (2.5Y4/2) and alternates to gray (2.5Y5/1) mottled with light olive brown (2.5Y5/3), dry, CLAY calcite seam 45 degree, dry	24/27		4.5+				
599.4	55		hard	9 20 25 30	III	CL		grades dark grayish brown (2.5Y4/2), CLAY, dry, vertical calcite seam, 10" length	24/27		4.5+				
			hard	16 22 27 43	III	CL		calcite seam, 60 degree, dry	24/28		4.5+				
			hard	7 18 26 40	III III	CL CL		calcite seam, 20 degree, dry grades very dark gray (5Y3/1), CLAY, dry	24/27		4.5+				
594.4	60		hard	14 26 32 36	III	CL		grades olive (5Y4/2), CLAY	24/26		4.5+				
			hard	6 14 20 32	III III IV	CL CL Claystone		grades light olive brown (2.5Y5/4), CLAY, dry horizontal calcite seam, dry	24/26		4.5+				
			hard	15 28 35 43					24/27		4.5+	96	66	23.8	
589.4	65														

Elevation, feet	Depth, feet	Sample Type	Consistency	Sampling Resistance, blows/foot	Stratum	Field USCS	Graphic Log	MATERIAL DESCRIPTION	Driven/Rec	Permeability (cm/s)	Pocket Pen.	LL, %	PI%	Moisture Content %	Piezometer Completion
589.4	65		hard	15 28 35 43	IV	Claystone		very dark gray (5Y3/1) CLAYSTONE, dry, 63.7 possible fracture, calcite filled (cont.)	24/27		4.5+	96	66	23.8	
				core					36/35, 36/27						
584.4	70			core					60/16, 60/16						
579.4	75			core					60/51, 60/43						
					IV	Claystone		highly fractured zone 24" in length							
574.4	80			core	IV	Claystone		possible vertical fracture, 13" in length	60/66, 60/33						
569.4	85			core					60/0, 60/0						
564.4	90			core					60/0, 60/0						
					IV	Claystone		highly fractured zone, 12"							
559.4	95			core					24/81, 24/77						
				core					36/32, 36/26						
554.4	100			core					60/60, 60/58	5.6E-6				26.0	

Project: WMTX - Mesquite Creek Landfill
Project Location: New Braunfels, TX
Project Number: GT 3435

Boring GB-17

Elevation, feet	Depth, feet	Sample Type	Consistency	Sampling Resistance, blows/foot	Stratum	Field USCS	Graphic Log	MATERIAL DESCRIPTION	Driven/Rec	Permeability (cm/s)	Pocket Pen.	LL, %	PI%	Moisture Content %	Piezometer Completion
554.4	100			core	IV	Claystone		very dark gray (5Y3/1) CLAYSTONE, dry, 63.7 possible fracture, calcite filled (cont.)	60/60, 60/56	5.6E-8				26.0	
549.4	105			core	IV	Claystone		grades gray (5Y6/1), CLAYSTONE, highly fractured zone, 6" in length	60/25, 60/9						
544.4	110			core					42/27, 42/22						
539.4	115			core					66/38, 66/14						
534.4	120			core	IV	Claystone		highly fractured	60/54, 60/0						
529.4	125			core					60/56, 60/38						
524.4	130			core					60/11, 60/11						
519.4	135				IV	Claystone		Bottom of Boring at 134 feet bgs							

Project: WMTX - Mesquite Creek Landfill	Boring GB-18
Project Location: New Braunfels, TX	Sheet 1 of 5
Project Number: GT 3435	

Date(s) Drilled: 11/29/-12/01/04	Logged By: Taylor Johnston	Checked By: Janet Meaux
Drilling Method: Hollow Stem Auger, Core	Drill Bit Size/Type: 4 1/4 inch ID, Hollow Stem Auger	Total Depth of Borehole: 149 feet bgs
Drill Rig Type: CME 75	Drilling Contractor: Geoprojects/ Jose Landezos 2551W	Approximate Surface Elevation: 694.21 feet MSL
Groundwater Level and Date Measured: NA	Sampling Method(s): SPT, Grab, Other	Hammer Data: 140 lb, 30 in drop, auto trip
Borehole Backfill: Grout	Location: Northing 13,814,753.59 Easting 2,280,137.34	

Elevation, feet	Depth, feet	Sample Type	Consistency	Sampling Resistance, blows/foot	Stratum	Field USCS	Graphic Log	MATERIAL DESCRIPTION	Driven/Rec	Permeability (cm/s)	Pocket Pen.	LL, %	PI%	Moisture Content %	Piezometer Completion
694.2	0		stiff	2 4 11 8	I	CH		GRASS strong brown (7.5YR3/4), fat CLAY, moist	24/18		2.0				
					III	CL		yellow (10YR8/8), lean CLAY, moist, some chert gravel							
689.2	5		stiff	1 3 5 8	III	CL		grades wet, no gravel	24/15		0.5				
												59	33	34.6	
684.2	10		hard	9 20 32 42	III	CL		grades moist	24/22		4.5+				
679.2	15		hard	10 22 25 41					24/25		4.5+				
674.2	20		hard	13 26 36 45					24/26		4.5+				
669.2	25		hard	12 27 37 43					24/25		4.5+				
664.2	30		hard	10 22 29 41					24/25		4.5+				

Project: WMTX - Mesquite Creek Landfill
Project Location: New Braunfels, TX
Project Number: GT 3435

Boring GB-18

Elevation, feet	Depth, feet	Sample Type	Consistency	Sampling Resistance, blows/foot	Stratum	Field USCS	Graphic Log	MATERIAL DESCRIPTION	Driven/Rec	Permeability (cm/s)	Pocket Pen.	LL, %	PI%	Moisture Content %	Piezometer Completion
664.2	30		hard	10 22 29 41	III	CL		yellow (10YR8/8), lean CLAY, moist, some chert gravel (cont.)	24/25		4.5+				
659.2	35		hard	12 37 50/4.5"					16.5/20		4.5+				
654.2	40		hard	24	III	CL		problems with hammer, could not get a second blow count, hit it 12" anyway to help get a sample	12/14		4.5+				
649.2	45		hard	19 49 50/5.5"	III	CL		grades wet	17.5/17		4.5+				
				core					42/46, 42/46						
644.2	50			core					60/59, 60/59			48	29	13.2	
					IV	Claystone		greenish gray (Gley1 5/1), CLAYSTONE							
639.2	55			core	IV	Claystone		possible 70 degree hairline fracture, dry	60/59, 60/59						
634.2	60			core	IV	Claystone			60/60, 60/59						
629.2	65			core					60/59, 60/59						

Elevation, feet	Depth, feet	Sample Type	Consistency	Sampling Resistance, blows/foot	Stratum	Field USCS	Graphic Log	MATERIAL DESCRIPTION	Driven/Rec	Permeability (cm/s)	Pocket Pen.	LL, %	PI%	Moisture Content %	Piezometer Completion
629.2	65			core	IV	Claystone		same as above	60/59, 60/59						
624.2	70			core					60/59, 60/59						
619.2	75			core					60/60, 60/60						
614.2	80			core					60/59, 60/59						
609.2	85			core					60/60, 60/60						
604.2	90			core					60/59, 60/59						
599.2	95			core					60/59, 60/59						
				core					60/59, 60/59						
594.2	100														

Project: WMTX - Mesquite Creek Landfill
Project Location: New Braunfels, TX
Project Number: GT 3435

Boring GB-18

Elevation, feet	Depth, feet	Sample Type	Consistency	Sampling Resistance, blows/foot	Stratum	Field USCS	Graphic Log	MATERIAL DESCRIPTION	Driven/Rec	Permeability (cm/s)	Pocket Pen.	LL, %	PI%	Moisture Content %	Piezometer Completion
594.2	100			core	IV	Claystone		same as above	60/59, 60/59						
589.2	105			core					60/59, 60/59						
584.2	110			core					60/59, 60/59						
579.2	115			core					60/50, 60/50						
574.2	120														
569.2	125			core					120/117 120/0						
564.2	130			core					60/61, 60/60						
				core					60/59, 60/59						
559.2	135														

Elevation, feet	Depth, feet	Sample Type	Consistency	Sampling Resistance, blows/foot	Stratum	Field USCS	Graphic Log	MATERIAL DESCRIPTION	Driven/Rec	Permeability (cm/s)	Pocket Pen.	LL, %	PI%	Moisture Content %	Piezometer Completion
559.2	135				IV	Claystone		greenish gray (Gley1 5/1), CLAYSTONE (cont.)							
				core					60/59, 60/59						
554.2	140														
				core					60/60, 60/60						
549.2	145														
				core					60/54, 60/54	4.2E-9				16.2	
					IV	Claystone		Bottom of Boring at 149 feet bgs							
544.2	150														
539.2	155														
534.2	160														
529.2	165														
524.2	170														

Project: WMTX - Mesquite Creek Landfill Project Location: New Braunfels, TX Project Number: GT 3435	Boring GB-19 Sheet 1 of 5

Date(s) Drilled: 11/16-11/17/04	Logged By: Trent McDaniel	Checked By: Janet Meaux
Drilling Method: Hollow Stem Auger, Core	Drill Bit Size/Type: 4 1/4 inch ID, Hollow Stem Auger	Total Depth of Borehole: 150 feet bgs
Drill Rig Type: CME 75	Drilling Contractor: Geoprojects/ Jose Landezos 2551W	Approximate Surface Elevation: 688.73 feet MSL
Groundwater Level and Date Measured: NA	Sampling Method(s): SPT, Tube, Grab, Other	Hammer Data: 140 lb, 30 in drop, auto trip
Borehole Backfill: Grout	Location: Northing 13,814,291.18 Easting 2,279,905.54	

Elevation, feet	Depth, feet	Consistency	Sampling Resistance, blows/foot	Stratum	Field USCS	MATERIAL DESCRIPTION	Driven/Rec	Permeability (cm/s)	Pocket Pen.	LL, %	PI%	Moisture Content %	Piezometer Completion
688.7	0			I	CL	GRASS							
		medium	1 2 3 4			dark gray (Gley1N4/0), CLAY, some silt, moist to wet, few small calcareous nodules	24/18		0.5				
										104	70	39.3	
683.7	5	very stiff	3 5 12 17	III	CL	grades dark gray (Gley1N4/0) mottled with yellowish brown (10YR5/6), CLAY, moist, few silt	24/24		4.0				
678.7	10	very stiff	6 9 14 18	III	CH	greenish gray (GLey1 5/1), CLAY, no silt, moist	24/24		4.5				
673.7	15	very stiff	7 11 14 19	III	CL	greenish gray (Gley1 5/1), mottled with brownish yellow (10YR6/8), CLAY, few silt, possible 80 degree fracture, calcite filled, no water	24/24		4.5+				
										89	57	32.0	
668.7	20	hard	10 26 50/4	III	SM	pale yellow (2.5Y7/4), SAND, some silt, very fine grained sand, dry, friable	16/16		4.5+				
663.7	25	hard	12 15 36 49	III	CL	light gray (5Y7/2), CLAY, some silt, trace sand, moist to dry	24/24		4.5+				
		hard	9 11 28 50/5	III	CL	grades no sand	23/24		4.5+				
658.7	30												

Elevation, feet	Depth, feet	Sample Type	Consistency	Sampling Resistance, blows/foot	Stratum	Field USCS	Graphic Log	MATERIAL DESCRIPTION	Driven/Rec	Permeability (cm/s)	Pocket Pen.	LL, %	PI%	Moisture Content %	Piezometer Completion
658.7	30		hard	9 11 28 50/5	III	CL		light gray (5Y7/2), CLAY, some silt, trace sand, moist to dry (cont.)	23/24		4.5+				
												43	27	16.6	
653.7	35		hard	10 28 39 47	III	CL		grades trace iron nodules, trace very fine grained sand, possible 80 degree fracture at 34.5', organic and clay filled, no water	24/24		4.5+				
648.7	40		hard	10 30 40 49	III	CL		grades pale yellow (2.5Y7/4), no sand, possible 80 degree fracture at 39.5', clay and organic filled, no water	24/24		4.5+				
643.7	45		hard	21 50/5"	III	CL		grades dark gray (Gley1N4/0), CLAY, some silt, dry	11/12		4.5+				
				core					48/51						
638.7	50			core					60/60			60	40	16.2	
633.7	55			core					60/60						
628.7	60			core					60/60						
623.7	65			core					60/60						

Elevation, feet	Depth, feet	Sample Type	Consistency	Sampling Resistance, blows/foot	Stratum	Field USCS	Graphic Log	MATERIAL DESCRIPTION	Driven/Rec	Permeability (cm/s)	Pocket Pen.	LL, %	PI%	Moisture Content %	Piezometer Completion
623.7	65				III	CL		light gray (5Y7/2), CLAY, some silt, trace sand, moist to dry (cont.)							
				core	III	CL		grades light olive brown (2.5Y5/6), possible vertical fracture from 67' to 69'	60/60						
618.7	70			core	III	CL		sample is divided vertically, possible fracture, one half is olive brown (2.5Y5/6), the other half is dark gray (Gley1N4/0), contact is very sharp, no indications of filling or water, trace ironite nodules in sample	60/62			60	38	19.0	
613.7	75			core	IV	Claystone		dark gray (Gley1N4/0), CLAYSTONE, dry	60/60						
608.7	80			core					60/60						
603.7	85			core	IV	Claystone		grades trace shell fragments	60/60						
598.7	90			core					60/60						
593.7	95			core					60/60						
				core	IV	Claystone		driller reports loss of water pressure at 98 feet	60/60						
588.7	100														

Elevation, feet	Depth, feet	Sample Type	Consistency	Sampling Resistance, blows/foot	Stratum	Field USCS	Graphic Log	MATERIAL DESCRIPTION	Driven/Rec	Permeability (cm/s)	Pocket Pen.	LL, %	PI%	Moisture Content %	Piezometer Completion
588.7	100			core	IV	Claystone		dark gray (Gley1N4/0), CLAYSTONE, dry	60/60						
583.7	105			core					60/60						
578.7	110			core					60/60						
573.7	115			core					60/60						
568.7	120			core					60/60						
563.7	125			core					60/60						
558.7	130			core					60/60						
				core					60/60						
553.7	135														

Project: WMTX - Mesquite Creek Landfill
Project Location: New Braunfels, TX
Project Number: GT 3435

Boring GB-19

Elevation, feet	Depth, feet	Sample Type	Consistency	Sampling Resistance, blows/foot	Stratum	Field USCS	Graphic Log	MATERIAL DESCRIPTION	Driven/Rec	Permeability (cm/s)	Pocket Pen.	LL, %	PI%	Moisture Content %	Piezometer Completion
553.7	135				IV	Claystone		dark gray (Gley1N4/0), CLAYSTONE, dry (cont.)							
				core					60/60						
548.7	140			core					60/60						
543.7	145			core					72/74						
538.7	150				IV	Claystone		Bottom of Boring at 150 feet bgs							
533.7	155														
528.7	160														
523.7	165														
518.7	170														

Project: WMTX - Mesquite Creek Landfill
Project Location: New Braunfels, TX
Project Number: GT 3435

Boring GB-20

Sheet 1 of 5

Date(s) Drilled	11/11-11/15/04	Logged By	Trent McDaniel, Taylor Johnston	Checked By	Janet Meaux
Drilling Method	Hollow Stem Auger, Core	Drill Bit Size/Type	4 1/4 inch ID, Hollow Stem Auger	Total Depth of Borehole	169 feet bgs
Drill Rig Type	CME 75	Drilling Contractor	Geoprojects/ Jose Landezos 2551W	Approximate Surface Elevation	675.86 feet MSL
Groundwater Level and Date Measured	NA	Sampling Method(s)	SPT, Grab, Other	Hammer Data	140 lb, 30 in drop, auto trip
Borehole Backfill	Grout	Location	Northing 13,814,134.94 Easting 2,279,345.16		

Elevation, feet	Depth, feet	Sample Type	Consistency	Sampling Resistance, blows/foot	Stratum	Field USCS	Graphic Log	MATERIAL DESCRIPTION	Driven/Rec	Permeability (cm/s)	Pocket Pen.	LL, %	PI%	Moisture Content %	Piezometer Completion
675.9	0				I	CH		GRASS							
			medium	1 3 5 8				Black (10YR2/1), fat CLAY, some roots, moist	24/15		1.75				
			very stiff	7 12 11 16	I	GC		white (10YR8/1), gravel, some black (10YR2/1), CLAY, moist	24/6		2.5				
					I	CH		very dark brown (10YR2/2), fat CLAY, moist							
670.9	5		stiff	8 10 3 3					24/3.5		2.25				
			hard	9 17 24 30	I	CH		grades brown (10YR5/3), fat CLAY, moist, some gravel	24/4		.5				
			hard	8 32 43 50/5.5"	III	CL		pale yellow (2.5Y7/3), lean CLAY, moist	23.5/6		2.5				
665.9	10														
660.9	15		hard	11 47 50/3"					15/4		2.25				
			hard	43 50/3"	III	CL		grades brown (10YR4/3), lean CLAY, moist	9/4		4.5+				
655.9	20														
			hard	12 30 43 50/5.5"	III			grades pale yellow (2.5Y7/3), lean CLAY, moist	23.5/25		4.5+				
650.9	25		hard	9 32 44 50/6"					24/		4.5+				
			hard	10 24 40 50/6"					24/25		4.5+				
645.9	30														

Elevation, feet	Depth, feet	Sample Type	Consistency	Sampling Resistance, blows/foot	Stratum	Field USCS	Graphic Log	MATERIAL DESCRIPTION	Driven/Rec	Permeability (cm/s)	Pocket Pen.	LL, %	PI%	Moisture Content %	Piezometer Completion
645.9	30		hard	10 24 40 50/6"	III	CL		grades brown (10YR4/3), lean CLAY, moist (cont.)	24/25		4.5+				
640.9	35		hard	7 22 37 46					24/25		4.5+				
					III	CL		horizontal calcite seam							
635.9	40		hard	8 26 36 45					24/25		4.5+				
					III	CL		horizontal calcite seam							
630.9	45		hard	9 30 42 50/6"					24/25		4.5+				
					III	CL		calcite nodule							
625.9	50		hard	13 35 44 50/4.5"					22.5/26		4.5+				
					III	CL		calcite seam, 25 degree							
620.9	55		hard	10 36 50/5"	III	CL		54.2' grades grayish brown (10YR5/2), 54.7' grades brownish yellow (10YR6/6), wet, 54.9' horizontal calcite seam, 55.3' grayish brown (10YR5/2), clay, wet, 55.5' grades brownish yellow (10YR6/6) clay, 55.7' grades grayish brown (10YR5/2)	17/20		4.5+				
				core					42/43, 42/43						
					III	CL		58.5 grades brownish yellow (10YR6/6), clay, 58.6' grayish brown (10YR5/2), clay, 59' brownish yellow (10YR6/6), clay, horizontal calcite seam, 59.1' grades gray (2.5Y5/1), clay, 60.1' grades brownish yellow (10YR6/6), 60.2' grades gray (2.5Y5/1), CLAY							
615.9	60														
				core					60/59, 60/58						
				core					60/59, 60/59						
610.9	65														

Elevation, feet	Depth, feet	Sample Type	Consistency	Sampling Resistance, blows/foot	Stratum	Field USCS	Graphic Log	MATERIAL DESCRIPTION	Driven/Rec	Permeability (cm/s)	Pocket Pen.	LL, %	PI%	Moisture Content %	Piezometer Completion
610.9	65			core	III	CL		grades brownish yellow (10YR6/6), CLAY	60/59, 60/59						
					IV	Claystone		gray (2.5Y5/1), CLAYSTONE, dry, unweathered							
605.9	70			core					60/59, 60/59						
600.9	75			core					60/59, 60/59						
595.9	80			core					60/56, 60/56						
590.9	85			core					60/62, 60/62						
585.9	90			core					60/59, 60/57						
580.9	95			core					60/58, 60/58						
				core					60/59						
575.9	100														

Elevation, feet	Depth, feet	Sample Type	Consistency	Sampling Resistance, blows/foot	Stratum	Field USCS	Graphic Log	MATERIAL DESCRIPTION	Driven/Rec	Permeability (cm/s)	Pocket Pen.	LL, %	PI%	Moisture Content %	Piezometer Completion
575.9	100			core	IV	Claystone		gray (2.5Y5/1), CLAYSTONE, dry, unweathered (cont.)	60/59						
570.9	105			core					60/60						
565.9	110			core					60/60						
560.9	115			core					60/60						
555.9	120			core					60/60						
550.9	125			core					60/60						
545.9	130			core					60/60						
				core					60/60						
540.9	135														

Elevation, feet	Depth, feet	Sample Type	Consistency	Sampling Resistance, blows/foot	Stratum	Field USCS	Graphic Log	MATERIAL DESCRIPTION	Driven/Rec	Permeability (cm/s)	Pocket Pen.	LL, %	PI%	Moisture Content %	Piezometer Completion
540.9	135			core	IV	Claystone		gray (2.5Y5/1), CLAYSTONE, dry, unweathered (cont.)	60/60						
535.9	140			core					60/60						
530.9	145			core					60/60						
525.9	150			core					60/60						
520.9	155			core					60/60						
515.9	160			core					60/60						
510.9	165			core					60/60						
					IV	Claystone		Bottom of Boring at 169 feet bgs							
505.9	170														

Project: WMTX - Mesquite Creek Landfill
Project Location: New Braunfels, TX
Project Number: GT 3435

Boring GB-21

Date(s) Drilled	12/10/04-01/04/05	Logged By	Amy Howard, Trent McDaniel, Ed Dolan, Taylor Johnston	Checked By	Janet Meaux
Drilling Method	Hollow Stem Auger, Core	Drill Bit Size/Type	4 1/4 inch ID, Hollow Stem Auger	Total Depth of Borehole	187 feet bgs
Drill Rig Type	CME 75	Drilling Contractor	Geoprojects/ Jose Landezos 2551W	Approximate Surface Elevation	709 feet MSL
Groundwater Level and Date Measured	55'	Sampling Method(s)	SPT, Other	Hammer Data	140 lb, 30 in drop, auto trip
Borehole Backfill	Grout	Location	Northing 13,813,671.19 Easting 2,280,075.19		

Elevation, feet	Depth, feet	Sample Type	Consistency	Sampling Resistance, blows/foot	Stratum	Field USCS	Graphic Log	MATERIAL DESCRIPTION	Driven/Rec	Permeability (cm/s)	Pocket Pen.	LL, %	PI%	Moisture Content %	Piezometer Completion
709	0				III	CL		GRASS							
			very stiff	2 6 16 16	III	CL		very dark brown (1.5YR2.5/2), CLAY, few silt, trace gravel, few rootlets, moist	24/24		1.0				
			hard	3 20 26 32				grades very pale brown (10YR8/3), CLAY, dry, friable	24/21		2.0				
704	5		hard	4 31 40 50/3"	III	CL		grades some iron staining	21/20		0.25				
			hard	21 50/6"					12/12		0.5				
			hard	24 46 41 50/4	III	CL		grades olive yellow (2.5Y6/8), CLAY, few silt, moist	24/22		0.0	25	10	7.1	
699	10		hard	14 39 41 17					24/22		1.0				
					III III	CL CL		4" calcareous layer, wet							
			hard	4 6 26 32				grades light yellowish brown (2.5Y6/3), CLAY, few silt, moist	24/22		1.75				
694	15		hard	12 24 40 40	III	CL		grades light olive gray (5Y6/2), CLAY, few silt, trace iron nodules, trace chert fragments, moist	24/22		4.5+	69	46	21.5	
			hard	16 36 43 50/3"					21/17		4.5+				
689	20			core					72/0						
					III	CL		grades light olive brown (2.5Y5/3), CLAY, some silt, few gravel							
					III	CL		no gravel							
684	25			core					60/56						
				core					60/24						
679	30														

Elevation, feet	Depth, feet	Sample Type	Consistency	Sampling Resistance, blows/foot	Stratum	Field USCS	Graphic Log	MATERIAL DESCRIPTION	Driven/Rec	Permeability (cm/s)	Pocket Pen.	LL, %	PI%	Moisture Content %	Piezometer Completion
679	30			core	III	CL		very dark brown (1.5YR2.5/2), CLAY, few silt, trace gravel, few rootlets, moist (cont.)	60/24						
674	35			core	III	CL		possible horizontal fracture, ironite filled	60/65						
669	40			core					60/31			81	59	23.2	
664	45			core	III	CL		grades light olive brown (2.5Y5/3) mottled and light gray (Gley1 7/N), some iron nodules	60/44						
659	50			core					60/78						
654	55			core	III	CL		possible horizontal fracture, two possible 30 degree fractures, calcite filled, water present	60/60						
649	60			core	III	CL		possible horizontal, 30 degree, and 80 degree fractures, calcite filled, water present	60/64	3.6E-9		76	54	22.7	
644	65			core	III	CL		grades alternating 6" thick layers of light olive brown (2.5Y5/3) and ~~dark gray (Gley1 4/N), possible horizontal fractures, calcite filled,~~ moist, may contain water	60/73						

Project: WMTX - Mesquite Creek Landfill
Project Location: New Braunfels, TX
Project Number: GT 3435

Boring GB-21

Elevation, feet	Depth, feet	Sample Type	Consistency	Sampling Resistance, blows/foot	Stratum	Field USCS	Graphic Log	MATERIAL DESCRIPTION	Driven/Rec	Permeability (cm/s)	Pocket Pen.	LL, %	PI%	Moisture Content %	Piezometer Completion
644	65			core	III	CL		very dark brown (1.5YR2.5/2), CLAY, few silt, trace gravel, few rootlets, moist (cont.)	60/73						
639	70			core	III	CL		grades dark gray (Gley1 4/N), CLAY with several thin layers of light olive brown (2.5Y5/3)trace shell fragments	60/53						
634	75			core	IV	Claystone		dark gray (Gley1 4/N), CLAYSTONE, some silt, possible 30 degree fracture, ironite filled, water possible	60/30						
629	80			core					60/4	6.4E-8				28.2	
624	85			core	IV	Claystone		SAA trace shell fragments	60/72						
619	90			core					60/60						
614	95			core					60/0						
				core	IV	Claystone		From 99'-102' sample very weathered, soft, broken into many small pieces	60/57						
609	100														

Project: WMTX - Mesquite Creek Landfill
Project Location: New Braunfels, TX
Project Number: GT 3435

Boring GB-21

Elevation, feet	Depth, feet	Sample Type	Consistency	Sampling Resistance, blows/foot	Stratum	Field USCS	Graphic Log	MATERIAL DESCRIPTION	Driven/Rec	Permeability (cm/s)	Pocket Pen.	LL, %	PI%	Moisture Content %	Piezometer Completion
609	100			core	IV	Claystone			60/57						
604	105			core	IV	Claystone		trace shell fragments	60/59						
599	110			core	IV	Claystone		possible 45 degree and 60 degree fractures, not filled, possible slickensides in fracture plane	60/54						
594	115			core	IV	Claystone		driller reports loss of water in formation	36/36						
589	120			core					60/29						
				core					36/36						
584	125				IV	Claystone		Sample broken into small pieces at 124'-125'							
				core					24/4, 24/4						
579	130			core					60/0, 60/0						
574	135			core					48/60, 48/52						

Elevation, feet	Depth, feet	Sample Type	Consistency	Sampling Resistance, blows/foot	Stratum	Field USCS	Graphic Log	MATERIAL DESCRIPTION	Driven/Rec	Permeability (cm/s)	Pocket Pen.	LL, %	PI%	Moisture Content %	Piezometer Completion
574	135				IV	Claystone									
				core	IV	Claystone		highly weathered claystone, little silt	48/60, 48/52						
569	140			core	IV	Claystone		dark gray moderately unweathered claystone, little silt	65/67, 65/67						
564	145			core					54/51, 54/51						
					IV	Claystone		At 147.5 feet possible 40 degree fracture							
					IV	Claystone		From 148.5-148.75 soft, weathered to clay							
559	150			core					48/45, 45/20	2.7E-8				22.7	
					IV	Claystone		From 150.2-150.8 soft, weathered to clay							
					IV	Claystone		potential horizontal fracture							
554	155			core					78/0, 78/0						
					IV	Claystone		soft, completely weathered							
549	160			core					36/68, 68/56						
				core					66/45, 66/45						
544	165														
					IV	Claystone		dark gray, moderately weak, slightly weathered siltstone							
				core					30/30, 30/21						
				core	IV	Claystone		From 169.5 - 172, 60 degree fracture, 30 degree fracture, 40 degree fracture, SAA	30/30, 30/25						
539	170														

Project: WMTX - Mesquite Creek Landfill
Project Location: New Braunfels, TX
Project Number: GT 3435

Boring GB-21

Elevation, feet	Depth, feet	Sample Type	Consistency	Sampling Resistance, blows/foot	Stratum	Field USCS	Graphic Log	MATERIAL DESCRIPTION	Driven/Rec	Permeability (cm/s)	Pocket Pen.	LL, %	PI%	Moisture Content %	Piezometer Completion
539	170			core		Claystone			30/30, 30/25						
534	175			core					60/60, 60/60						
529	180			core					60/37, 60/37						
524	185			core					60/0, 60/0						
					IV			Bottom of Boring at 187 feet bgs							
519	190														
514	195														
509	200														
504	205														

Project: WMTX - Mesquite Creek Landfill
Project Location: New Braunfels, TX
Project Number: GT 3435

Boring GB-22

Date(s) Drilled	11/10-11/11/04	Logged By	Taylor Johnston	Checked By	Janet Meaux
Drilling Method	Hollow Stem Auger, Core	Drill Bit Size/Type	4 1/4 inch ID, Hollow Stem Auger	Total Depth of Borehole	140 feet bgs
Drill Rig Type	CME 75	Drilling Contractor	Geoprojects/ Jose Landezos 2551W	Approximate Surface Elevation	656.53 feet MSL
Groundwater Level and Date Measured	NA	Sampling Method(s)	SPT, Tube, Grab, Other	Hammer Data	140 lb, 30 in drop, auto trip
Borehole Backfill	Grout	Location	Northing 13,814,811.40 Easting 2,279,501.03		

Elevation, feet	Depth, feet	Sample Type	Consistency	Sampling Resistance, blows/foot	Stratum	Field USCS	Graphic Log	MATERIAL DESCRIPTION	Driven/Rec	Permeability (cm/s)	Pocket Pen.	LL, %	PI%	Moisture Content %	Piezometer Completion
656.5	0				I	CH		GRASS							
			very stiff	3 4 8 11				very dark brown (10YR2/2), fat CLAY, moist, trace roots	24/23		2.5				
					I	CL		grades yellowish brown (10YR4/4), fat CLAY							
					I	CL		light yellowish brown (2.5Y6/4), lean CLAY, moist							
					I	CH		dark brown (10YR3/3), fat CLAY, moist							
651.5	5		very stiff	4 10 13 17	III	CL		light yellowish brown (2.5Y6/4), lean CLAY, moist	24/25		4.5+				
												47	32	17.6	
646.5	10		hard	8 19 29 44	III	CL		grades light yellowish brown (2.5Y6/4) mottled with white (10YR8/1), lean CLAY, moist	24/25		4.5+				
641.5	15		hard	7 19 28 38	III	CL		grades light yellowish brown (2.5Y6/4), lean CLAY, moist	24/26		4.5+				
636.5	20		hard	7 17 27 32					24/26		4.5+				
631.5	25								24/24						
			hard	6 16 26 32	III	CL		grades pale yellow (2.5Y7/3), CLAY, moist	24/25		4.5+				
626.5	30														

Project: WMTX - Mesquite Creek Landfill
Project Location: New Braunfels, TX
Project Number: GT 3435

Boring GB-22

Elevation, feet	Depth, feet	Sample Type	Consistency	Sampling Resistance, blows/foot	Stratum	Field USCS	Graphic Log	MATERIAL DESCRIPTION	Driven/Rec	Permeability (cm/s)	Pocket Pen.	LL, %	PI%	Moisture Content %	Piezometer Completion
626.5	30		hard	6 16 26 32	III	CL		light yellowish brown (2.5Y6/4), lean CLAY, moist (cont.)	24/25		4.5+				
												52	36	19.2	
621.5	35		hard	9 26 35 43					24/27		4.5+				
					III	CL		possible 45 degree fractures, 35.5', and 36'							
			hard	12 40 50/6"					18/19		4.5+				
616.5	40				III	CL		grades gray (2.5Y5/1), dry							
					III	CL		grades pale yellow (2.5Y7/3)							
				core	III	CL		possible horizontal fracture, 70 degree calcite seam, 1/4" thick, moist	42/43, 42/38						
					III	CL		grades gray							
					III	CL		grades pale yellow							
					III	CL		grades gray, dry							
611.5	45														
				core	III	CL		horizontal calcite seam, possible fracture, dry	60/60, 60/60						
606.5	50														
				core	III	CL		grades pale yellow, possible horizontal fracture at 51.2, calcite lined	60/59, 60/59						
					III	CL		grades pale yellow							
					III	CL		grades gray, possible horizontal fracture at 52.5', calcite lined							
					III	CL		grades pale yellow							
					III	CL		grades gray							
601.5	55														
				core					60/59, 60/59			67	46	20.2	
596.5	60				III	CL		grades pale yellow							
				core	III	CL		grades gray, possible 60 degree, 6" in length, fracture, calcite lined	60/59, 60/59						
				core					60/60, 60/60						
591.5	65														

Elevation, feet	Depth, feet	Sample Type	Consistency	Sampling Resistance, blows/foot	Stratum	Field USCS	Graphic Log	MATERIAL DESCRIPTION	Driven/Rec	Permeability (cm/s)	Pocket Pen.	LL, %	PI%	Moisture Content %	Piezometer Completion
591.5	65				III	CL		light yellowish brown (2.5Y6/4), lean CLAY, moist (cont.)							
				core	III	CL		grades pale yellow	60/60, 60/60						
					IV	Claystone		gray (2.5Y5/1), CLAYSTONE, dry							
586.5	70			core					60/36, 60/36						
581.5	75			core					60/58, 60/58						
					IV	Claystone		possible horizontal fracture							
576.5	80			core					60/59, 60/59						
					IV	Claystone		possible horizontal fracture							
571.5	85			core					60/73, 60/67						
566.5	90			core					60/59, 60/58						
561.5	95			core					60/64, 60/60						
				core					60/59, 60/59						
556.5	100														

Elevation, feet	Depth, feet	Sample Type	Consistency	Sampling Resistance, blows/foot	Stratum	Field USCS	Graphic Log	MATERIAL DESCRIPTION	Driven/Rec	Permeability (cm/s)	Pocket Pen.	LL, %	PI%	Moisture Content %	Piezometer Completion
556.5	100			core	IV	Claystone		gray CLAYSTONE	60/59, 60/59						
551.5	105			core					60/59, 60/59						
546.5	110			core					60/59, 60/59						
541.5	115			core					60/59, 60/59						
536.5	120			core					60/59, 60/59						
531.5	125			core					60/59, 60/59						
526.5	130			core					60/0, 60/0						
				core					60/59, 60/59						
521.5	135														

Project: WMTX - Mesquite Creek Landfill
Project Location: New Braunfels, TX
Project Number: GT 3435

Boring GB-22

Elevation, feet	Depth, feet	Sample Type	Consistency	Sampling Resistance, blows/foot	Stratum	Field USCS	Graphic Log	MATERIAL DESCRIPTION	Driven/Rec	Permeability (cm/s)	Pocket Pen.	LL, %	PI%	Moisture Content %	Piezometer Completion
521.5	135				IV	Claystone		gray CLAYSTONE (cont.)							
				core					60/59, 60/59						
				core	IV	Claystone		picked up the missing core from above	12/81, 12/81						
516.5	140				IV			Bottom of Boring at 140 feet bgs							
511.5	145														
506.5	150														
501.5	155														
496.5	160														
491.5	165														
486.5	170														

Project: WMTX - Mesquite Creek Landfill **Project Location: New Braunfels, TX** **Project Number: GT 3435**	**Boring GB-23** Sheet 1 of 6

Date(s) Drilled **01/11-01/13/05**	Logged By **Taylor Johnston**	Checked By **Janet Meaux**
Drilling Method **Hollow Stem Auger, Core**	Drill Bit Size/Type **4 1/4 inch ID, Hollow Stem Auger**	Total Depth of Borehole **185 feet bgs**
Drill Rig Type **CME 75**	Drilling Contractor **Geoprojects/ Jose Landezos 2551W**	Approximate Surface Elevation **689.5 feet MSL**
Groundwater Level and Date Measured **NA**	Sampling Method(s) **SPT, Tube, Grab, Other**	Hammer Data **140 lb, 30 in drop, auto trip**
Borehole Backfill **Grout**	Location **Northing 13,814,122.25 Easting 2,280,492.82**	

Elevation, feet	Depth, feet	Consistency	Sampling Resistance, blows/foot	Stratum	Field USCS	MATERIAL DESCRIPTION	Driven/Rec	Permeability (cm/s)	Pocket Pen.	LL, %	PI%	Moisture Content %	Piezometer Completion
689.5	0	stiff	2 3 8 4	I	CH	GRASS very dark brown (10YR2/2), fat CLAY, some gravel, moist	24/11		1.0				
684.5	5	stiff	2 4 5 10	III	CL	yellow (2.57/6), lean CLAY, some white chalky, calcite, moist	24/23		1.0				
679.5	10	very stiff	3 9 13 22	III	CL	grades to chalky, calcite	24/25		3.5				
										60	43	20.8	
674.5	15	very hard	12 28 26 31	III	CL	grades dry	24/28		4.5+				
669.5	20						24/22						
664.5	25	hard	7 15 25 32				24/26		4.5+				
659.5	30	hard	5 15 23 33				24/26		4.5+				

Elevation, feet	Depth, feet	Sample Type	Consistency	Sampling Resistance, blows/foot	Stratum	Field USCS	Graphic Log	MATERIAL DESCRIPTION	Driven/Rec	Permeability (cm/s)	Pocket Pen.	LL, %	PI%	Moisture Content %	Piezometer Completion
659.5	30		hard	5 15 23 33	III	CL		yellow (2.57/6), lean CLAY, some white chalky, calcite, moist (cont.)	24/26		4.5+				
										3.9E-9		75	53	27.4	
					III	CL		light yellowish brown (2.5Y6/4), dry, lean CLAY							
654.5	35		hard	7 23 30 40					24/25		4.5+				
649.5	40		hard	16 32 50/4"					16/22		4.5+				
					III	CL		grades light olive brown (2.5Y5/4), lean CLAY, dry							
644.5	45		hard	3 16 22 28					24/27		4.5+				
639.5	50		hard	9 21 27 39					24/24		4.5+				
					III	CL		possible 70 degree fracture, 51.8' horizontal calcite seam							
												82	58	25.1	
					IV	Claystone		dark gray (Gley1 4/N), CLAYSTONE, dry							
634.5	55		hard	5 25 42 50/4.5					22.5/26		4.5+				
				core					36/36, 36/22						
					IV	Claystone		highly fractured zone, for 6"							
629.5	60														
				core					60/0, 60/0						
				core					60/54, 60/39						
624.5	65														

Project: WMTX - Mesquite Creek Landfill
Project Location: New Braunfels, TX
Project Number: GT 3435

Boring GB-23

Sheet 3 of 6

Elevation, feet	Depth, feet	Sample Type	Consistency	Sampling Resistance, blows/foot	Stratum	Field USCS	Graphic Log	MATERIAL DESCRIPTION	Driven/Rec	Permeability (cm/s)	Pocket Pen.	LL, %	PI%	Moisture Content %	Piezometer Completion
624.5	65				IV	Claystone		dark gray (Gley1 4/N), CLAYSTONE, dry (cont.)							
				core	IV	Claystone		possible 40 degree fracture, 67.5' possible 70 degree fracture	60/54, 60/39						
					IV	Claystone		possible 55 degree fracture at 69', possible 55 degree fracture at 69.5'							
619.5	70			core					60/54, 60/32						
					IV	Claystone		possible horizontal fracture							
614.5	75			core					60/20, 60/20						
					IV	Claystone		highly fractured, weathered, zone, 12" in length							
609.5	80			core					60/0, 60/0						
604.5	85			core					60/58, 60/58						
599.5	90			core					60/58, 60/56						
					IV	Claystone		possible 70 degree fracture at 93.1', possible 70 degree fracture at 93.3'							
594.5	95			core					60/18, 60/17						
				core	IV	Claystone		possible 20 degree fracture	60/28, 60/28						
589.5	100														

Elevation, feet	Depth, feet	Sample Type	Consistency	Sampling Resistance, blows/foot	Stratum	Field USCS	Graphic Log	MATERIAL DESCRIPTION	Driven/Rec	Permeability (cm/s)	Pocket Pen.	LL, %	PI%	Moisture Content %	Piezometer Completion
589.5	100				IV	Claystone		dark gray (Gley1 4/N), CLAYSTONE, dry (cont.)							
				core					60/28, 60/28						
584.5	105			core					24/68, 24/62						
				core					36/28, 36/28						
579.5	110														
				core					60/50, 60/52						
					IV	Claystone		possible 45 degree fractures at 114.2', 114.7', and 115.3'							
574.5	115														
				core					60/19, 60/19						
					IV	Claystone		very weathered, soft spot, wet and sticky, 6" in length							
569.5	120														
				core					60/12, 60/6						
564.5	125				IV	Claystone		possible 70 degree fracture							
				core					60/108, 60/108						
559.5	130														
				core					60/45, 60/43	1.8E-8				25.8	
				core					60/22, 60/22						
554.5	135														

Elevation, feet	Depth, feet	Sample Type	Consistency	Sampling Resistance, blows/foot	Stratum	Field USCS	Graphic Log	MATERIAL DESCRIPTION	Driven/Rec	Permeability (cm/s)	Pocket Pen.	LL, %	PI%	Moisture Content %	Piezometer Completion
554.5	135				IV	Claystone		dark gray (Gley1 4/N), CLAYSTONE, dry (cont.)							
				core	IV	Claystone		highly fractured, weathered zone, 12" in length	60/22, 60/22						
549.5	140			core	IV	Claystone		possible 20 degree fracture	60/58, 60/42						
544.5	145			core					60/33, 60/33						
					IV	Claystone		possible 70 degree fracture							
539.5	150			core					60/107 60/107						
534.5	155			core					60/57, 60/57						
529.5	160			core					84/54, 84/29						
524.5	165			core					60/50, 60/50						
519.5	170														

Elevation, feet	Depth, feet	Sample Type	Consistency	Sampling Resistance, blows/foot	Stratum	Field USCS	Graphic Log	MATERIAL DESCRIPTION	Driven/Rec	Permeability (cm/s)	Pocket Pen.	LL, %	PI%	Moisture Content %	Piezometer Completion
519.5	170			core	IV	Claystone		dark gray (Gley1 4/N), CLAYSTONE, dry (cont.)	60/50, 60/50						
				core					36/0, 36/0						
514.5	175			core					48/69, 48/63						
509.5	180			core					60/0, 60/0						
				core					24/53, 24/27						
504.5	185				IV			Bottom of Boring at 185 feet bgs							
499.5	190														
494.5	195														
489.5	200														
484.5	205														

Project: WMTX - Mesquite Creek Landfill **Project Location: New Braunfels, TX** **Project Number: GT 3435**	**Boring GB-24** Sheet 1 of 5

Date(s) Drilled **12/01-12/03/04**	Logged By **Taylor Johnston**	Checked By **Janet Meaux**
Drilling Method **Hollow Stem Auger, Core**	Drill Bit Size/Type **4 1/4 inch ID, Hollow Stem Auger**	Total Depth of Borehole **155 feet bgs**
Drill Rig Type **CME 75**	Drilling Contractor **Geoprojects/ Jose Landezos 2551W**	Approximate Surface Elevation **677.47 feet MSL**
Groundwater Level and Date Measured **NA**	Sampling Method(s) **SPT, Tube, Grab, Other**	Hammer Data **140 lb, 30 in drop, auto trip**
Borehole Backfill **Grout**	Location **Northing 13,815,567.29 Easting 2,280,399.13**	

Elevation, feet	Depth, feet	Sample Type	Consistency	Sampling Resistance, blows/foot	Stratum	Field USCS	Graphic Log	MATERIAL DESCRIPTION	Driven/Rec	Permeability (cm/s)	Pocket Pen.	LL, %	PI%	Moisture Content %	Piezometer Completion
677.5	0		very stiff	1 11 14 11	I	CH		GRASS strong brown (7.5YR3/1), fat CLAY, moist, few gravel	24/14		2.0				
672.5	5		stiff	3 5 6 7	III	CL		very pale brown (10YR8/4), lean CLAY, moist	24/22		1.0				
												37	21	18.8	
667.5	10		hard	7 13 18 23	III	CL		grades some chalky calcite	24/25		4.5+				
662.5	15		very stiff	5 11 17 24					24/20		4.5+				
657.5	20								24/20						
652.5	25		hard	12 36 42 50/4"	III	CL		grades wet	22/23		4.5+				
			hard	10 33 49 50/3.5"					20.5/23		4.5+	66	46	19.5	
647.5	30														

Elevation, feet	Depth, feet	Sample Type	Consistency	Sampling Resistance, blows/foot	Stratum	Field USCS	Graphic Log	MATERIAL DESCRIPTION	Driven/Rec	Permeability (cm/s)	Pocket Pen.	LL, %	PI%	Moisture Content %	Piezometer Completion
647.5	30		hard	10 33 49 50/3.5"	III	CL		very pale brown (10YR8/4), lean CLAY, moist (cont.)	20.5/23		4.5+	66	46	19.5	
					III	CL		grades pale yellow (2.5Y8/4), lean CLAY, wet							
642.5	35		hard	10 28 49 50/3"					21/23		4.5+				
					III	CL		possible 70 degree and 30 degree fractures organic filled, no water							
				core					36/37, 36/37						
					III	CL		grades very pale brown (10YR8/3), possible vertical fracture, no calcite, no water, 6' in length							
637.5	40														
				core					60/60, 60/59						
632.5	45														
				core					60/58, 60/59						
					III	CL		possible horizontal fracture, calcite filled, no water							
627.5	50														
				core	III	CL		possible 85 degree fracture 1/4" thick and 2' in length, calcite filled, no water	60/59, 60/59						
622.5	55														
				core					60/59, 60/59			63	45	17.2	
					III	CL		possible vertical fracture, 6" in length							
					III	CL		possible vertical fracture 2' in length, calcite filled							
617.5	60														
				core					60/59, 60/59						
					IV	Claystone		grayish green (Gley1 5/1), CLAYSTONE							
				core					60/59, 60/59			54	38	14.0	
612.5	65														

Project: WMTX - Mesquite Creek Landfill
Project Location: New Braunfels, TX
Project Number: GT 3435

Boring GB-24

Elevation, feet	Depth, feet	Sample Type	Consistency	Sampling Resistance, blows/foot	Stratum	Field USCS	Graphic Log	MATERIAL DESCRIPTION	Driven/Rec	Permeability (cm/s)	Pocket Pen.	LL, %	PI%	Moisture Content %	Piezometer Completion
612.5	65				IV	Claystone		grayish green (Gley1 5/1), CLAYSTONE (cont.)							
				core					60/59, 60/59			54	38	14.0	
607.5	70			core					60/60, 60/60						
					IV	Claystone		grades light yellowish brown (2.5Y6/4), possible vertical fracture, calcite filled							
602.5	75				IV	Claystone		possible vertical fracture, 6" in length, calcite filled, no water							
				core					60/59, 60/57						
597.5	80			core					60/60, 60/60						
592.5	85			core					60/60, 60/60						
587.5	90			core					60/60, 60/60						
582.5	95			core					60/60, 60/60						
				core					60/59, 60/59						
577.5	100														

Elevation, feet	Depth, feet	Sample Type	Consistency	Sampling Resistance, blows/foot	Stratum	Field USCS	Graphic Log	MATERIAL DESCRIPTION	Driven/Rec	Permeability (cm/s)	Pocket Pen.	LL, %	PI%	Moisture Content %	Piezometer Completion
577.5	100			core	IV	Claystone		same as above	60/59, 60/59						
572.5	105			core					60/64, 60/64						
567.5	110			core					60/59, 60/59						
562.5	115			core					60/60, 60/58						
557.5	120			core					60/58, 60/58						
552.5	125			core					60/59, 60/59						
547.5	130			core					60/59, 60/59						
				core					60/61, 60/61						
542.5	135														

Project: WMTX - Mesquite Creek Landfill
Project Location: New Braunfels, TX
Project Number: GT 3435

Boring GB-24

Elevation, feet	Depth, feet	Sample Type	Consistency	Sampling Resistance, blows/foot	Stratum	Field USCS	Graphic Log	MATERIAL DESCRIPTION	Driven/Rec	Permeability (cm/s)	Pocket Pen.	LL, %	PI%	Moisture Content %	Piezometer Completion
542.5	135			core	IV	Claystone		grayish green (Gley1 5/1), CLAYSTONE (cont.)	60/61, 60/61						
537.5	140			core					60/60, 60/60						
532.5	145			core					60/59, 60/59						
527.5	150			core					72/72, 72/70						
522.5	155				IV	Claystone		Bottom of Boring at 155 feet bgs							
517.5	160														
512.5	165														
507.5	170														

LOG OF BORING MW - 7

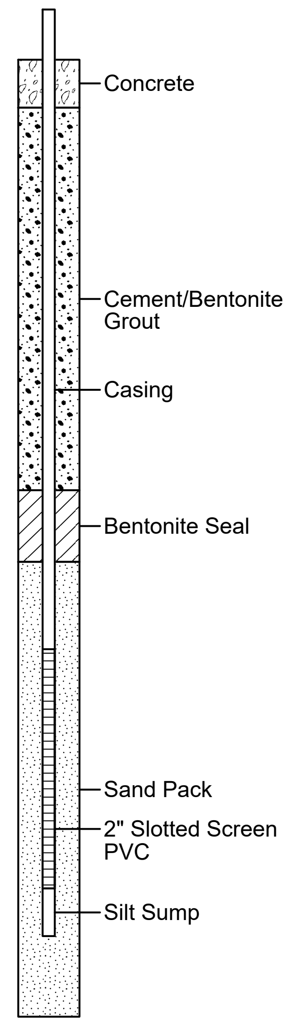
WM - Comal County Landfill
1000 Kohlenberg Rd.
New Braunfels, Texas 78130

Project No.020685

Date	: 4/5/2006	Drilling Company	: Vortex Drilling Co.
Borehole Diameter	: 8.25 inch	Driller	: John Egan Talbot
Drilling Method	: Hollow Stem Auger	Driller License No.	: 3180-M
Sampling Method	: 2" x 2.5' Split Spoon	Northing	: 13816870.0700
Geologist	: Roger Gomez, MFG	Easting	: 2277942.3430

Depth in Feet	Surf. Elev.589.80	DESCRIPTION	USCS	GRAPHIC	Samples	Recovery (ft/ft)	OVM (ppmv)
0	589.8	(0-5.0) - FILL, engineering fill, yellow-tan, silt to gravel size mixture, slightly moist, firm, low to medium plasticity.	FILL			Grab	
5	584.8	(5.0-7.5) - SOIL, OH, silty clay, black, organic rich, slightly moist, soft, medium plasticity.	SOIL			1.5/2.5	
		(7.5-27.5) - SILTY CLAY, CL, yellow to dark tan, dry, firm to hard towards base, some clay fractures with silt in-filling, low to medium plasticity.	CL			1.6/2.5	
10	579.8					1.5/2.5	
						1.5/2.5	
15	574.8					1.4/2.5	
						1.8/2.5	
20	569.8					2.0/2.5	
						2.2/2.5	
25	564.8					1.7/2.5	
		(27.5-30.0) - WEATHERED CLAYSTONE, brown to gray, calcareous,clay partings, brittle, hard, dry to slightly moist, oxidize to unoxidizing transition zone, no plasticity, fizzes in HCl.	CLAYST(				
30	559.8	(30-40) - CLAYSTONE, gray to dark gray, calcareous, unoxidized, fissile, dry, very hard, massive, consolidated, fizzes in HCl.					
35	554.8						
40	549.8						
45	544.8						
50							

Well: MW-7
Elev. (TOC): 592.23



Well Completion:
0 - 2.0' bgs Concrete
2.0 - 18.0' bgs Cement/Bentonite Grout,
18.0 - 21.0' bgs Bentonite chips, hydrated, PDSCo
21.0 - 40.0' bgs 10/20 Grade Filter Sand, Southern Filter Media

0 - 24.64' bgs 2" FTJ Sch. 40 PVC
24.64 - 34.64' bgs FTJ Sch 40 PVC, 0.010" slots
34.64 - 36.64' bgs 2" FTJ Sch. 40 PVC: Silt Sump

LOG OF BORING MW - 8

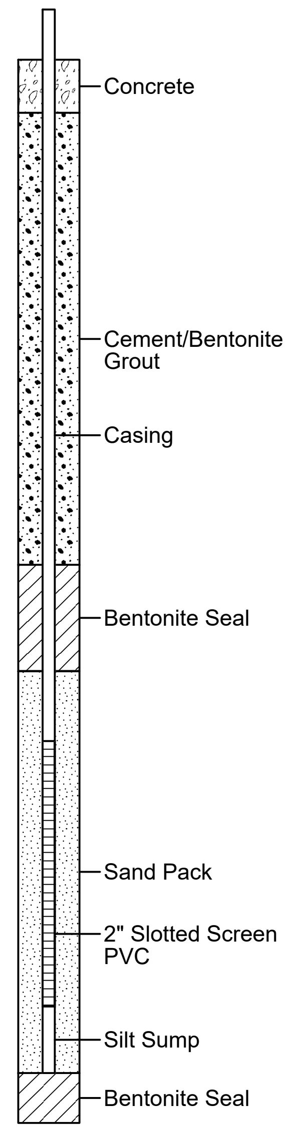
WM - Comal County Landfill
1000 Kohlenberg Rd.
New Braunfels, Texas 78130

Project No.020685

Date	: 4/5/2006	Drilling Company	: Vortex Drilling Co.
Borehole Diameter	: 8.25 inch	Driller	: John Egan Talbot
Drilling Method	: Hollow Stem Auger	Driller License No.	: 3180-M
Sampling Method	: 2" x 2.5' Split Spoon	Northing	: 13816463.5700
Geologist	: Roger Gomez, MFG	Easting	: 2277485.6410

Depth in Feet	Surf. Elev.588.78	DESCRIPTION	USCS	GRAPHIC	Samples	Recovery (ft/ft)	OVM (ppmv)
0	588.78	(0-2.0) - SOIL, OH, silty clay, black, organic rich, slightly moist, soft, medium plasticity.	FILL			Grab	
5	583.78	(3.0-7.5) - FILL, engineering fill, yellow-tan, silt to gravel size mixture, slightly moist, firm, low to medium plasticity.	SOIL			0.6/2.5	
10	578.78	(7.5-25.0) - SILTY CLAY, CL, yellow to dark tan, dry, firm to hard towards base, some clay fractures with silt in-filling, low to medium plasticity.	CL			1.0/2.5 1.5/2.5 1.7/2.5 1.6/2.5 1.5/2.5 1.7/2.5 1.7/2.5	
15	573.78						
20	568.78						
25	563.78	(25.0-32.5) - WEATHERED CLAYSTONE, brown to gray, clay partings, brittle, hard, dry, oxidize to unoxidizing transition zone, no plasticity.	CLAYSTO			2.0/2.5	
30	558.78						
35	553.78	(32.5-40.0) - CLAYSTONE, gray to dark gray, unoxidized, fissile, dry, massive, consolidated, very hard,.					
40	548.78						
45							

Well: MW-8
Elev. (TOC): 591.48



Well Completion:
0 - 2.0' bgs Concrete
2.0 - 19.0' bgs Cement/Bentonite Grout,
19.0 - 23.0' bgs Bentonite chips, hydrated, PDSCo
23.0 - 37.0' bgs 10/20 Grade Filter Sand, Southern Filter Media
37.0 - 40.0' bgs Bentonite chips

0 - 25.62' bgs 2" FTJ Sch. 40 PVC
25.62 - 35.62' bgs FTJ sch 40 PVC, 0.010" slots
35.62 - 38.12' bgs 2" FTJ Sch. 40 PVC: Silt Sump

Project: Gas Probe Installation,Mesquite Creek Landfill.	Log of Boring GP-5A
Project Location: 1000 Kohlenberg Lane, New Braunfels, TX	Sheet 1 of 2
Project Number: TXL0054-01	

Date(s) Drilled 03/09/2009	Logged By Mohammad Z. Islam	Checked By Scott M. Graves, P.E.
Drilling Method Rotary Wash	Drill Bit Size/Type 6 inch	Total Depth of Borehole 52 feet bgs
Drill Rig Type Mobil B59	Drilling Contractor Total Support Services, Inc.	Approximate Surface Elevation 609.07 feet MSL
Groundwater Level and Date Measured Not Encountered	Sampling Method(s) SPT	Hammer Data 140 lb, 30 in drop, safety
Borehole Backfill Well Completion	Location N 13,815,940, E 2,277,535	

Elevation, feet	Depth, feet	Sample Type	Sample Number	Sampling Resistance, blows/foot	Relative Consistency	USCS Symbol	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	REMARKS AND OTHER TESTS
609.1	0					CH		Mud appears to be dark grey color.		
604.1	5					CH		Mud appears to be light tan color.		
599.1	10					CH		Mud appears to be tan color.		
594.1	15					CH		Same as above.		
589.1	20					CH		Same as above.		
584.1	25					CH		Same as above		
579.1	30									

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Project: Gas Probe Installation,Mesquite Creek Landfill.
Project Location: 1000 Kohlenberg Lane, New Braunfels, TX
Project Number: TXL0054-01

Log of Boring GP-5A

Elevation, feet	Depth, feet	Sample Type	Sample Number	Sampling Resistance, blows/foot	Relative Consistency	USCS Symbol	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	REMARKS AND OTHER TESTS
579.1	30					CH		Mud appears to be light grey color.		
574.1	35					CH		Mud appears to be grey color		
569.1	40					CH		Same as above		
564.1	45		1	39, 50/5", 50/3", 50/2.5".		Claystone		Hard and dark grey CLYSTONE with trace silt.		
559.1	50		50/2.5"	50/2.3", 50/2.3", 50/2.3".		Claystone		Same as above.		
								Bottom of Boring at 52 feet bgs.		
554.1	55									
549.1	60									
544.1	65									

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Gas Probe Data Sheet

Permittee or Site Name: WMTX – Mesquite Creek Landfill

County: Comal

Date of Gas Probe Installation: 10/06/05

Gas Probe Latitude: 29 44' 24.77" Longitude: 98 01' 57.38"

Northing: 13817956.20 Easting: 2275490.16

MSW Permit No. 66A

Gas Probe I.D. No.: GP-07

Monitor Well Driller

Name: GeoProjects/ Lee Gebbert

License No.: 2525W

NOTES:

Report all depths from Surface Elevation and all Elevations relative to Mean Sea Level (MSL), to nearest hundredth of a foot.

Diameter of boring should be at least 4 inches larger than diameter of well casing.

Use flush screw joint casing only, 2-inch diameter or larger, with o-rings or PTFE tape in joints (4-inch diameter recommend).

Well development should continue until water is clear, and pH and conductivity are stable.

Geologist, Hydrologist, or Engineer Supervising Gas Probe Installation: Janet Meaux

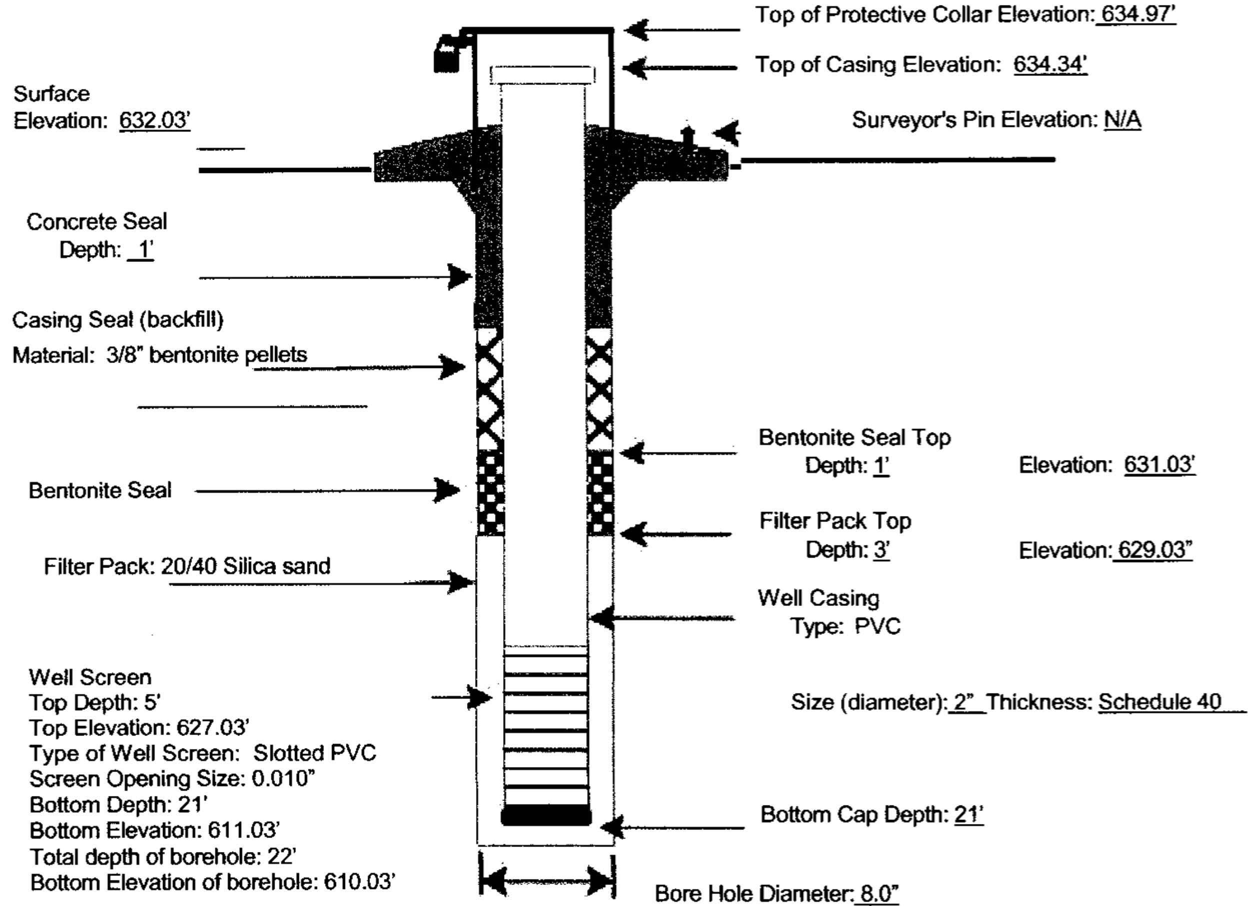
Static Water Level Elevation (with respect to MSL) after Well Development: NA

Name of Geologic Formation(s) in which Well is completed: Lower Taylor Group (Stratum III of site-specific characterization)

Type of Locking Device: Padlock

Type of Casing Protection: Metal Stick-Up

Concrete Surface Pad (with steel reinforcement) Dimensions: 4'x4'



TCEQ-10308

Project: Mesquite Creek Landfill, Gas Probe Installation Project Location: 1000 Kohlenberg Lane, New Braunfels, TX Project Number: TXL0054-01	Log of Boring GP-8 Sheet 1 of 2

Date(s) Drilled 03/16/2009	Logged By Mohammad Z. Islam	Checked By Scott M. Graves, P.E.
Drilling Method Hollow Stem Auger	Drill Bit Size/Type 8 inch	Total Depth of Borehole 49 feet bgs
Drill Rig Type Mobil B59	Drilling Contractor Total Support Services, Inc.	Approximate Surface Elevation 605.34 feet MSL
Groundwater Level and Date Measured Not Encountered	Sampling Method(s) Other	Hammer Data N/A
Borehole Backfill Well Completion	Location N 13,816,626, E 2,277,112	

Elevation, feet	Depth, feet	Sample Type	Sampling Resistance, blows/foot	USCS Symbol	Graphic Log	MATERIAL DESCRIPTION	Well Log	REMARKS AND OTHER TESTS
605.3	0			CH		Grass Light tan and black CLAY mix with trace silt		
600.3	5			CH		Black CLAY with some gravel		
595.3	10			CH		Tan and light grey CLAY mix with calcite seam		
590.3	15			CH		Tan CLAY with trace silt		
585.3	20			CH		Tan CLAY with trace silt		
580.3	25			CH		Tan and grey CLAY mix with trace silt		
575.3	30							

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Project: Mesquite Creek Landfill, Gas Probe Installation
Project Location: 1000 Kohlenberg Lane, New Braunfels, TX
Project Number: TXL0054-01

Log of Boring GP-8

Elevation, feet	Depth, feet	Sample Type	Sampling Resistance, blows/foot	USCS Symbol	Graphic Log	MATERIAL DESCRIPTION	Well Log	REMARKS AND OTHER TESTS
575.3	30			CH		Same as above		
				Claystone		Hard and dry dark grey CLAYSTONE with trace silt		
570.3	35			Claystone		Same as above		
				Claystone		Same as above		
565.3	40			Claystone		Same as above		
				Claystone		Same as above		
560.3	45			Claystone		Same as above		
				Claystone		Same as above		
						Bottom of Boring at 49 feet bgs		
555.3	50							
550.3	55							
545.3	60							
540.3	65							

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Project: Gas Probe Installation,Mesquite Creek Landfill. **Project Location: 1000 Kohlenberg Lane, New Braunfels, TX** **Project Number: TXL0054-01**	**Log of Boring GP-9** Sheet 1 of 2

Date(s) Drilled **03/25/2009**	Logged By **Mohammad Z. Islam**	Checked By **Scott M. Graves, P.E.**
Drilling Method **Hollow Stem Auger**	Drill Bit Size/Type **8 inch**	Total Depth of Borehole **48 feet bgs**
Drill Rig Type **Mobil B59**	Drilling Contractor **Total Support Services, Inc.**	Approximate Surface Elevation **624.98 feet MSL**
Groundwater Level and Date Measured **Not Encountered**	Sampling Method(s) **Core**	Hammer Data **N/A**
Borehole Backfill **Well Completion**	Location **N 13,817,505, E 2,275,964**	

Elevation, feet	Depth, feet	Sample Type	Sampling Resistance, blows/foot	USCS Symbol	Graphic Log	MATERIAL DESCRIPTION	Well Log	REMARKS AND OTHER TESTS
625	0		Core	CH		Medium stiff light grey CLAY between 0 and 3 ft, medium stiff black CLAY between 3 and 5 ft, few gravel.		
620	5		Core	CH		No sample recovered, drill cutting appears to be light grey CLAY.		No sample recovered, a 3.5 in. gravel plugged at the sampler tip.
615	10		Core	CH		Medium stiff light tan CLAY with trace silt.		2 ft sample recovered.
610	15		Core	CH		Medium stiff tan and light grey CLAY with trace silt		
605	20		Core	CH		Same as above		
			Core	CH		Same as above		
600	25		Core	CH		Same as above		
			Core	CH		Same as above		
595	30							

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Project: Gas Probe Installation,Mesquite Creek Landfill.
Project Location: 1000 Kohlenberg Lane, New Braunfels, TX
Project Number: TXL0054-01

Log of Boring GP-9

Sheet 2 of 2

Elevation, feet	Depth, feet	Sample Type	Sampling Resistance, blows/foot	USCS Symbol	Graphic Log	MATERIAL DESCRIPTION	Well Log	REMARKS AND OTHER TESTS
595	30		Core	CH		Same as above		
			Core	CH		Same as above		
590	35		Core	CH		Same as above		
			Core	CH		Same as above		
585	40		Core	CH		Same as above		
			Core	CH		Same as above		
580	45		Core	CH		Dark grey and tan CLAY with trace silt.		
						Bottom of Boring at 48 feet bgs		
575	50							
570	55							
565	60							
560	65							

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Project: Gas Probe Installation,Mesquite Creek Landfill.	**Log of Boring GP-10**
Project Location: 1000 Kohlenberg Lane, New Braunfels, TX	Sheet 1 of 2
Project Number: TXL0054-01	

Date(s) Drilled **03/24/2009**	Logged By **Mohammad Z. Islam**	Checked By **Scott M. Graves, P.E.**
Drilling Method **Hollow Stem Auger**	Drill Bit Size/Type **8 inch**	Total Depth of Borehole **47.5 feet bgs**
Drill Rig Type **Mobil B59**	Drilling Contractor **Total Support Services, Inc.**	Approximate Surface Elevation **663.94 feet MSL**
Groundwater Level and Date Measured **Not Encountered**	Sampling Method(s) **Core**	Hammer Data **N/A**
Borehole Backfill **Well Completion**	Location **N 13,818,348, E 2,276,992**	

Elevation, feet	Depth, feet	Sample Type	Sampling Resistance, blows/foot	USCS Symbol	Graphic Log	MATERIAL DESCRIPTION	Well Log	REMARKS AND OTHER TESTS
663.9	0		Core	CH		Medium stiff light grey CLAY between 0 and 3 ft, medium stiff black CLAY between 3 and 5 ft.		[illegible] calcite seam near 3 ft bgs
658.9	5		Core	CH		Medium stiff light grey and tan CLAY with trace silt		3 ft sample recovered
653.9	10		Core	CH		Medium stiff light grey and tan CLAY with trace silt, occassional calcite seam		4 ft sample recovered
648.9	15		Core	CH		Same as above		3 ft sample recovered
643.9	20		Core	CH		Same as above		
638.9	25		Core	CH		Same as above		
			Core	CH		Medium stiff light grey and tan CLAY with trace silt, occassional calcite mix, damp		
633.9	30							

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Project: Gas Probe Installation,Mesquite Creek Landfill.
Project Location: 1000 Kohlenberg Lane, New Braunfels, TX
Project Number: TXL0054-01

Log of Boring GP-10

Elevation, feet	Depth, feet	Sample Type	Sampling Resistance, blows/foot	USCS Symbol	Graphic Log	MATERIAL DESCRIPTION	Well Log	REMARKS AND OTHER TESTS
633.9	30		Core	CH		Same as above		
			Core	CH		Same as above		
628.9	35		Core	CH		Same as above		
			Core	CH		Same as above		
623.9	40		Core	CH		Same as above		
			Core	CH		Same as above		
618.9	45		Core	Claystone		Medium stiff grey CLAYSTONE with trace silt, damp.		
						Bottom of Boring at 47.5 feet bgs		
613.9	50							
608.9	55							
603.9	60							
598.9	65							

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Project: Gas Probe Installation,Mesquite Creek Landfill.
Project Location: 1000 Kohlenberg Lane, New Braunfels, TX
Project Number: TXL0054-01

Log of Boring GP-11

Date(s) Drilled **03/16/2009**	Logged By **Mohammad Z. Islam**	Checked By **Scott M. Graves, P.E.**
Drilling Method **Hollow Stem Auger**	Drill Bit Size/Type **8 inch**	Total Depth of Borehole **57 feet bgs**
Drill Rig Type **Mobil B59**	Drilling Contractor **Total Support Services, Inc.**	Approximate Surface Elevation **615.86 feet MSL**
Groundwater Level and Date Measured **Not Encountered**	Sampling Method(s) **Other**	Hammer Data **N/A**
Borehole Backfill **Well Completion**	Location **N 13,817,459, E 2,277,906**	

Elevation, feet	Depth, feet	Sample Type	Sampling Resistance, blows/foot	USCS Symbol	Graphic Log	MATERIAL DESCRIPTION	Well Log	REMARKS AND OTHER TESTS
615.9	0			CH		Grass		
						Light tan and black CLAY mix with trace silt		
610.9	5			CH		Medium stiff light tan CLAY with trace silt		
605.9	10			CH		Medium stiff tan CLAY mix with trace silt		
600.9	15			CH		Stiff tan CLAY with trace silt		
				CH		Same as above		
595.9	20			CH		Tan and grey CLAY mix with trace silt		
				CH		Light tan CLAY with trace silt, medium stiff		
590.9	25			CH		Hard and dry tan CLAY with trace silt		
				CH		Same as above		
585.9	30							

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Project: Gas Probe Installation,Mesquite Creek Landfill.
Project Location: 1000 Kohlenberg Lane, New Braunfels, TX
Project Number: TXL0054-01

Log of Boring GP-11

Elevation, feet	Depth, feet	Sample Type	Sampling Resistance, blows/foot	USCS Symbol	Graphic Log	MATERIAL DESCRIPTION	Well Log	REMARKS AND OTHER TESTS
585.9	30			CH		Same as above		
				CH		Same as above		
580.9	35			CH		Hard dry grey and tan CLAY with trace silt		
				Claystone		Hard grey CLAYSTONE with trace silt		
575.9	40			Claystone		Same as above		
				Claystone		Same as above		
570.9	45			Claystone		Same as above		
				Claystone		Same as above		
565.9	50			Claystone				
				Claystone		Same as above		
560.9	55			Claystone		Same as above		
						Bottom of Boring at 57 feet bgs.		
555.9	60							
550.9	65							

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Project: Gas Probe Installation,Mesquite Creek Landfill.	**Log of Boring GP-12**
Project Location: 1000 Kohlenberg Lane, New Braunfels, TX	Sheet 1 of 2
Project Number: TXL0054-01	

Date(s) Drilled **03/18/2009**	Logged By **Mohammad Z. Islam**	Checked By **Scott M. Graves, P.E.**
Drilling Method **Hollow Stem Auger**	Drill Bit Size/Type **8 inch**	Total Depth of Borehole **31 feet bgs**
Drill Rig Type **Mobil B59**	Drilling Contractor **Total Support Services, Inc.**	Approximate Surface Elevation **610.03 feet MSL**
Groundwater Level and Date Measured **Not Encountered**	Sampling Method(s) **Core**	Hammer Data **N/A**
Borehole Backfill **Well Completion**	Location **N 13,816,475, E 2,278,886**	

Elevation, feet	Depth, feet	Sample Type	Sampling Resistance, blows/foot	USCS Symbol	Graphic Log	MATERIAL DESCRIPTION	Well Log	REMARKS AND OTHER TESTS
610	0		Core	CH		Medium stiff tan and light grey CLAY with calcite mix		Only 1.5 ft sample recovered
605	5		Core	CH		Appeares to be light grey CLAY with occassional gravel mix		Very small amount of sample recovered
600	10		Core	CH		Hard and dry tan CLAY with calcite mix, occassional gravel		Only 1 ft of sample recovered, a 3-in gravel piece came out with the sample.
595	15		Core	CH		Hard and dry tan CLAY with calcite mix, trace silt		
			Core	CH		Same as above		
590	20		Core	CH		Same as above		
			Core	CH		Same as above		
585	25		Core	CH		Same as above		
			Core	CH		Same as above		
580	30							

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Project: Gas Probe Installation,Mesquite Creek Landfill.
Project Location: 1000 Kohlenberg Lane, New Braunfels, TX
Project Number: TXL0054-01

Log of Boring GP-12

Elevation, feet	Depth, feet	Sample Type	Sampling Resistance, blows/foot	USCS Symbol	Graphic Log	MATERIAL DESCRIPTION	Well Log	REMARKS AND OTHER TESTS
580	30		Core	CH		Same as above (cont.)		
						Bottom of Boring at 31 feet bgs		
575	35							
570	40							
565	45							
560	50							
555	55							
550	60							
545	65							

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Project: Gas Probe Installation,Mesquite Creek Landfill. Project Location: 1000 Kohlenberg Lane, New Braunfels, TX Project Number: TXL0054-01	Log of Boring GP-13 Sheet 1 of 2

Date(s) Drilled 03/23/2009	Logged By Mohammad Z. Islam	Checked By Scott M. Graves, P.E.
Drilling Method Hollow Stem Auger	Drill Bit Size/Type 8 inch	Total Depth of Borehole 62 feet bgs
Drill Rig Type Mobil B59	Drilling Contractor Total Support Services, Inc.	Approximate Surface Elevation 639.87 feet MSL
Groundwater Level and Date Measured Not Encountered	Sampling Method(s) Core	Hammer Data N/A
Borehole Backfill Well Completion	Location N 13,816,023, E 2,279,585	

Elevation, feet	Depth, feet	Sample Type	Sampling Resistance, blows/foot	USCS Symbol	Graphic Log	MATERIAL DESCRIPTION	Well Log	REMARKS AND OTHER TESTS
639.9	0		Core	CH		Dry light grey clay with some silt, occassional gravel mix		Only about 2 ft sample recovered
634.9	5		Core	CH		Dry and stiff tan CLAY with trace silt		
629.9	10		Core	CH		Dry and stiff tan CLAY with calcite mix		
624.9	15		Core	CH		Stiff tan CLAY with trace silt		
			Core	CH		Same as above		
619.9	20		Core	CH		Same as above		
			Core	CH		Same as above		
614.9	25		Core	CH		Same as above		
			Core	CH		Same as above		
609.9	30							

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Project: Gas Probe Installation,Mesquite Creek Landfill.
Project Location: 1000 Kohlenberg Lane, New Braunfels, TX
Project Number: TXL0054-01

Log of Boring GP-13

Elevation, feet	Depth, feet	Sample Type	Sampling Resistance, blows/foot	USCS Symbol	Graphic Log	MATERIAL DESCRIPTION	Well Log	REMARKS AND OTHER TESTS
609.9	30		Core	CH		Same as above		
			Core	CH		Same as above		
604.9	35		Core	CH		Tan CLAY with ocassional calcite seam		
			Core	CH		Tan CLAY with trace silt		
599.9	40		Core	CH		Tan CLAY with trace silt, occassional calcite seam		
			Core	Claystone		Hard dark grey CLAYSTONE with trace silt, dry		
594.9	45		Core	Claystone		Same as above		
			Core	Claystone		Same as above		
589.9	50		Core	Claystone		Same as above		
			Core	Claystone		Same as above		
584.9	55		Core	Claystone		Same as above		
			Core	Claystone		Same as above		
579.9	60		Core	Claystone		Same as above		
				Claystone		Bottom of Boring at 62 feet bgs		
574.9	65							

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Project: Gas Probe Installation,Mesquite Creek Landfill. **Project Location: 1000 Kohlenberg Lane, New Braunfels, TX** **Project Number: TXL0054-01**	**Log of Boring GP-20** Sheet 1 of 2

Date(s) Drilled **03/25/2009**	Logged By **Mohammad Z. Islam**	Checked By **Scott M. Graves, P.E.**
Drilling Method **Hollow Stem Auger**	Drill Bit Size/Type **8 inch**	Total Depth of Borehole **65 feet bgs**
Drill Rig Type **Mobil B59**	Drilling Contractor **Total Support Services, Inc.**	Approximate Surface Elevation **664.17 feet MSL**
Groundwater Level and Date Measured **Not Encountered**	Sampling Method(s) **Core**	Hammer Data **N/A**
Borehole Backfill **Well Completion**	Location **N 13,814,695, E 2,278,675**	

Elevation, feet	Depth, feet	Sample Type	Sampling Resistance, blows/foot	USCS Symbol	Graphic Log	MATERIAL DESCRIPTION	Well Log	REMARKS AND OTHER TESTS
664.2	0		Core	CH		Medium stiff black clay with some silt.		About 2.5 ft sample recovered
659.2	5		Core	CH		Dry and hard tan CLAY with trace silt		Drilling very hard at 8 ft.
654.2	10		Core	CH		Dry and stiff tan CLAY with calcite mix		
649.2	15		Core	CH		Same as above.		
			Core	CH		Medium stiff tan CLAY with trace silt, occassional calcite seam.		
644.2	20		Core	CH		Same as above		
			Core	CH		Same as above		
639.2	25		Core	CH		Same as above		
			Core	CH		Same as above		
634.2	30							

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Project: Gas Probe Installation,Mesquite Creek Landfill.
Project Location: 1000 Kohlenberg Lane, New Braunfels, TX
Project Number: TXL0054-01

Log of Boring GP-20

Elevation, feet	Depth, feet	Sample Type	Sampling Resistance, blows/foot	USCS Symbol	Graphic Log	MATERIAL DESCRIPTION	Well Log	REMARKS AND OTHER TESTS
634.2	30		Core	CH		Same as above		
			Core	CH		Same as above		
629.2	35		Core	CH		Same as above		
			Core	CH		Same as above		
624.2	40		Core	CH		Same as above		
			Core	CH		Same as above		
619.2	45		Core	CH		Same as above		
			Core	CH		Same as above		
614.2	50		Core	CH		Same as above		
			Core	Claystone		Hard tan CLAY with trace silt between 52.5 and 53.5 ft, hard dark grey CLAYSTONE with trace silt between 53.5 and 55 ft.		
609.2	55		Core	Claystone		Hard tan CLAY with trace silt between 55 and 56 ft, hard dark grey CLAYSTONE with trace silt between 56 and 57.5 ft.		
			Core	Claystone		Grey and tan CLAY mix with trace silt		
604.2	60		Core	Claystone		Same as above		
			Core	Claystone		Hard dark grey CLAY with trace silt		
599.2	65					Bottom of Boring at 65 feet bgs		

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Project: Gas Probe Installation,Mesquite Creek Landfill. Project Location: 1000 Kohlenberg Lane, New Braunfels, TX Project Number: TXL0054-01	Log of Boring GP-21 Sheet 1 of 2

Date(s) Drilled 03/18/2009	Logged By Mohammad Z. Islam	Checked By Scott M. Graves, P.E.
Drilling Method Hollow Stem Auger	Drill Bit Size/Type 8 inch	Total Depth of Borehole 49 feet bgs
Drill Rig Type Mobil B59	Drilling Contractor Total Support Services, Inc.	Approximate Surface Elevation 637.79 feet MSL
Groundwater Level and Date Measured Not Encountered	Sampling Method(s) Core	Hammer Data N/A
Borehole Backfill Well Completion	Location N 13,815,429, E 2,277,985	

Elevation, feet	Depth, feet	Sample Type	Sampling Resistance, blows/foot	USCS Symbol	Graphic Log	MATERIAL DESCRIPTION	Well Log	REMARKS AND OTHER TESTS
637.8	0		Core	CH		Medium stiff tan CLAY with occassional gravel mix		Only 1.5 ft sample recovered
632.8	5		Core	CH		Stiff tan CLAY with occassional calcite seam		
627.8	10		Core	CH		Stiff tan CLAY with trace silt		Only 2.5 ft sample recovered
622.8	15		Core	CH		Stiff tan CLAY with trace silt		
			Core	CH		Same as above		
617.8	20		Core	CH		Same as above		
			Core	CH		Same as above		
612.8	25		Core	CH		Same as above		
			Core	CH		Same as above		
607.8	30							

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Project: Gas Probe Installation,Mesquite Creek Landfill.
Project Location: 1000 Kohlenberg Lane, New Braunfels, TX
Project Number: TXL0054-01

Log of Boring GP-21

Elevation, feet	Depth, feet	Sample Type	Sampling Resistance, blows/foot	USCS Symbol	Graphic Log	MATERIAL DESCRIPTION	Well Log	REMARKS AND OTHER TESTS
607.8	30		Core	CH		Same as above		
			Core	CH		Same as above		
602.8	35		Core	CH		Same as above		
			Core	CH		Same as above		
597.8	40		Core	CH		Same as above		
			Core	Claystone		Hard grey CLAYSTONE with trace silt.		
				CH		Tan CLAY with trace silt, occassional calcite seam.		
592.8	45		Core	CH		Hard tan and grey CLAY mix with trace silt		
				CH		Same as above		
						Bottom of Boring at 49 feet bgs		
587.8	50							
582.8	55							
577.8	60							
572.8	65							

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Project: Ground Water Monitoring Well Installation, Mesquite Creek Landfill. **Project Location:** 1000 Kohlenberg Lane, New Braunfels, TX **Project Number:** TXL0054-01	# Log of Boring MW-2A

Date(s) Drilled **03/17/2009**	Logged By **Mohammad Z. Islam**	Checked By **Edward B. Dolan, P.G.**
Drilling Method **Hollow Stem Auger**	Drill Bit Size/Type **8 inch HSA**	Total Depth of Borehole **37 feet bgs**
Drill Rig Type **Mobil B59**	Drilling Contractor **Total Support Services, Inc.**	Approximate Surface Elevation **608.97 feet MSL**
Groundwater Level and Date Measured **Not yet measured**	Sampling Method(s) **SPT**	Hammer Data **140 lb, 30 in drop, safety**
Borehole Backfill **Well Completion**	Location **N 13,817,069, E 2,278,182**	

Elevation, feet	Depth, feet	Sample Type	Sampling Resistance, blows/foot	USCS Symbol	Graphic Log	MATERIAL DESCRIPTION	Well Log	REMARKS AND OTHER TESTS
609	0			CH		Light tan CLAY with some gravel.		
604	5			CH		Same as above.		
599	10			CH		Grading tan.		
594	15			CH		Same as above.		
			9, 26, 34, 34.	CH		Grading stiff tan CLAY with trace silt, occassional calcite mix.		
589	20							
584	25		22, 35, 44, 50/6".	CH		Same as above.		
			18, 26, 38, 46.	CH		Same as above.		
579	30							

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Project: Ground Water Monitoring Well Installation, Mesquite Creek Landfill.

Project Location: 1000 Kohlenberg Lane, New Braunfels, TX

Project Number: TXL0054-01

Log of Boring MW-2A

Elevation, feet	Depth, feet	Sample Type	Sampling Resistance, blows/foot	USCS Symbol	Graphic Log	MATERIAL DESCRIPTION	Well Log	REMARKS AND OTHER TESTS
579	30			CH		Same as above. (cont.)		
			19, 29, 34, 39.	CH		Tan and grey CLAY mix with trace silt.		
				CH		Medium stiff tan CLAY with trace silt.		
574	35		14, 17, 31, 38.	Claystone		Dark grey CLAYSTONE with trace silt.		
				Claystone		Bottom of Boring at 37 feet bgs.		
569	40							
564	45							
559	50							
554	55							
549	60							
544	65							

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Log of Boring MW-7A

Sheet 1 of 1

Project: Ground Water Monitoring Well Installation, Mesquite Creek Landfill.
Project Location: 1000 Kohlenberg Lane, New Braunfels, TX
Project Number: TXL0054-01

Date(s) Drilled: 03/11/2009	Logged By: Mohammad Z. Islam	Checked By: Edward B. Dolan, P.G.
Drilling Method: Rotary Wash	Drill Bit Size/Type: 6 inch tricone bit	Total Depth of Borehole: 27 feet bgs
Drill Rig Type: Mobil B59	Drilling Contractor: Total Support Services, Inc.	Approximate Surface Elevation: 603.4 feet MSL
Groundwater Level and Date Measured: Not yet measured	Sampling Method(s): SPT	Hammer Data: 140 lb, 30 in drop, safety
Borehole Backfill: Well Completion	Location: N 13,816,498, E 2,277,256	

Elevation, feet	Depth, feet	Sample Type	Sampling Resistance, blows/foot	USCS Symbol	Graphic Log	MATERIAL DESCRIPTION	Well Log	REMARKS AND OTHER TESTS
603.4	0			CH		(Mud appears to be blackish color.)		
598.4	5			CH		Same as above.		
593.4	10			CH		(Mud appears to be light tan color, broken stone chips came out with the mud slurry.)		
588.4	15			CH		(Mud appears to be tan color.)		
583.4	20		40, 50/4", 50/5", 50/4.3".	CH		Stiff tan and grey CLAY mix with trace silt.		
				Claystone		Hard grey CLAYSTONE with trace silt.		
				Claystone		Same as above.		
578.4	25		25, 50/5.5", 50/3.5", 50/2.5".					
				Claystone		Same as above.		
						Bottom of Boring at 27 feet bgs.		
573.4	30							

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Project: Ground Water Monitoring Well Installation, Mesquite Creek Landfill. Project Location: 1000 Kohlenberg Lane, New Braunfels, TX Project Number: TXL0054-01	# Log of Boring MW-8A Sheet 1 of 2

Date(s) Drilled 03/19/2009	Logged By Mohammed Z. Islam	Checked By Edward B. Dolan, P.G.
Drilling Method Hollow Stem Auger	Drill Bit Size/Type 8 inch HSA	Total Depth of Borehole 55 feet bgs
Drill Rig Type Mobil B59	Drilling Contractor Total Support Services, Inc.	Approximate Surface Elevation 625.52 feet MSL
Groundwater Level and Date Measured Not yet measured	Sampling Method(s) Core	Hammer Data N/A
Borehole Backfill Well Completion	Location N 13,817,143, E 2,276,302	

Elevation, feet	Depth, feet	Sample Type	Sampling Resistance, blows/foot	USCS Symbol	Graphic Log	MATERIAL DESCRIPTION	Well Log	REMARKS AND OTHER TESTS
625.5	0		Core	CH		Dry light tan CLAY with some gravel between 0 and 2.5 ft, black grey clay with trace silt between 2.5 and 5 ft.		
620.5	5		Core	CH		Dry and stiff light tan CLAY with some gravel and trace silt.		3 ft sample recovered.
615.5	10		Core	CH		Dry and stiff tan CLAY with trace silt, occassional calcite mix.		2.5 ft sample recovered.
610.5	15		Core	CH		Same as above.		2.5 ft sample recovered.
605.5	20		Core	CH		Same as above.		
600.5	25		Core	CH		Same as above.		
			Core	CH		Same as above.		
595.5	30							

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Project: Ground Water Monitoring Well Installation, Mesquite Creek Landfill.
Project Location: 1000 Kohlenberg Lane, New Braunfels, TX
Project Number: TXL0054-01

Log of Boring MW-8A

Elevation, feet	Depth, feet	Sampling Resistance, blows/foot	USCS Symbol	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS
595.5	30	Core	CH	Same as above.	
		Core	CH	Same as above.	
590.5	35	Core	CH	Same as above.	
		Core	CH	Same as above.	
585.5	40	Core	CH	Tan CLAY with trace silt.	
		Core	CH	Same as above.	
580.5	45	Core	CH	Tan CLAY with trace silt, occassional calcite seam.	
		Core	CH	Same as above.	
575.5	50	Core	CH	Same as above.	
		Core	Claystone	Hard and dark grey CLAYSTONE with trace silt.	
570.5	55			Bottom of Boring at 55 feet bgs.	
565.5	60				
560.5	65				

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Project: Ground Water Monitoring Well Installation, Mesquite Creek Landfill. Project Location: 1000 Kohlenberg Lane, New Braunfels, TX Project Number: TXL0054-01	**Log of Boring MW-9** Sheet 1 of 2

Date(s) Drilled 03/24/2009	Logged By Mohammad Z. Islam	Checked By Edward B. Dolan, P.G.
Drilling Method Hollow Stem Auger	Drill Bit Size/Type 8 inch HSA	Total Depth of Borehole 50 feet bgs
Drill Rig Type Mobil B59	Drilling Contractor Total Support Services, Inc.	Approximate Surface Elevation 626 feet MSL
Groundwater Level and Date Measured Not yet measured	Sampling Method(s) Core	Hammer Data N/A
Borehole Backfill Well Completion	Location N 13,617,565, E 2,275,906	

Elevation, feet	Depth, feet	Sample Type	Sampling Resistance, blows/foot	USCS Symbol	Graphic Log	MATERIAL DESCRIPTION	Well Log	REMARKS AND OTHER TESTS
626	0		Core	CH		Medium stiff black CLAY with some gravel.		4 ft sample recovered.
621	5		Core	CH		Same as above.		
616	10		Core	CH		Medium stiff light tan CLAY with trace silt, occassional calcite mix.		
611	15		Core	CH		Same as above.		
606	20		Core	CH		Grading light grey and tan, occassional calcite mix.		
601	25		Core	CH		Same as above.		
596	30							

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Elevation, feet	Depth, feet	Sample Type	Sampling Resistance, blows/foot	USCS Symbol	Graphic Log	MATERIAL DESCRIPTION	Well Log	REMARKS AND OTHER TESTS
596	30		Core	CH		Same as above.		
			Core	CH		Same as above.		
591	35		Core	CH		Light tan CLAY with occassional calcite seam.		
			Core	CH		Same as above.		
586	40		Core	CH		Same as above.		
			Core	CH		Tan CLAY with calcite mix, trace silt, a 4 in. CLAYSTONE seam at about 44 ft.		
581	45		Core	Claystone		Dark grey CLAYSTONE with trace silt.		
				CH		Tan CLAY with calcite mix.		
				Claystone		Dark grey CLAYSTONE with trace silt.		
			Core	Claystone		Same as above.		
576	50					Bottom of Boring at 50 feet bgs.		
571	55							
566	60							
561	65							

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Project: WMTX Mesquite Creek Landfill. Project Location: 1700 Kohlenberg Lane, New Braunfels, TX Project Number: TXL0076-02	**Log of Boring MW-10** Sheet 1 of 2

Date(s) Drilled	11/04/2009	Logged By	Mohammad Z. Islam	Checked By	Scott M. Graves, P.E.
Drilling Method	Hollow Stem Auger	Drill Bit Size/Type		Total Depth of Borehole	57 feet bgs
Drill Rig Type	Mobil B57	Drilling Contractor	Total Support Services, Inc.	Approximate Surface Elevation	670.48 feet MSL
Groundwater Level and Date Measured	28.5 feet measured on 11/06/2009	Sampling Method(s)	SPT	Hammer Data	140 lb, 30 in drop, safety
Borehole Backfill	Well Completion	Location	N 13,814,602, E 2,278,767		

Elevation, feet	Depth, feet	Sample Type	Sampling Resistance, blows/foot	USCS Symbol	Graphic Log	MATERIAL DESCRIPTION	Well Log	REMARKS AND OTHER TESTS
670.5	0			CH		(Drill cuttings appear to be black CLAY, damp.)		
665.5	5			CH		(Drill cuttings appear light tan CLAY, medium stiff, trace silt, dry.)		
660.5	10			CH		(Drill cuttings appear to be tan CLAY, trace silt, dry.)		
655.5	15			CH		Same as above		
650.5	20		12, 14, 27	CH		Tan CLAY with trace silt, medium stiff and dry.		
645.5	25			CH		(Drill cuttings appear to be medium stiff tan CLAY.)		
						11/06/2009		
640.5	30							

P:\Projects\Comal Co\2009 MW and GP Installation\MW-10\Installation Report\Boring Log MW-10.bgs [Well log.a.tpl]

Elevation, feet	Depth, feet	Sample Type	Sampling Resistance, blows/foot	USCS Symbol	Graphic Log	MATERIAL DESCRIPTION	Well Log	REMARKS AND OTHER TESTS
640.5	30			CH		~~Same as above.~~		
635.5	35		8, 10, 16	CH		Tan CLAY with calcite seams at 36 and 36.5 ft, medium stiff and dry.		
630.5	40			CH		(Drill cuttings appear to be tan CLAY.)		
625.5	45		12, 17, 22	CH		Tan CLAY with a calcite seam at 46 ft oriented at 45 degree, hard and dry.		
620.5	50			CH		(Drill cuttings appear to be light grey CLAY.)		
615.5	55			CH		Tan CLAY with trace silt, medium stiff, damp.		
			14, 18, 31	Claystone		Dark Grey CLAYSTONE with trace silt, medium stiff, damp.		
			19, 26, 34	Claystone		Stiff grey CLAYSTONE with trace silt, water level at approximately 58 ft.		
						Bottom of boring at 57 ft bgs.		
610.5	60							
605.5	65							

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Project: Ground Water Monitoring Well Installation, Mesquite Creek Landfill.	# Log of Boring MW-11
Project Location: 1000 Kohlenberg Lane, New Braunfels, TX	Sheet 1 of 2
Project Number: TXL0054-01	

Date(s) Drilled: 03/05/2009	Logged By: Mohammad Z. Islam	Checked By: Edward B. Dolan, P.G.
Drilling Method: Rotary Wash	Drill Bit Size/Type: 6 inch tricone bit	Total Depth of Borehole: 63 feet bgs
Drill Rig Type: Mobil B59	Drilling Contractor: Total Support Services, Inc.	Approximate Surface Elevation: 679 feet MSL
Groundwater Level and Date Measured: Not yet measured	Sampling Method(s): SPT	Hammer Data: 140 lb, 30 in drop, safety
Borehole Backfill: Well Completion	Location: N 13,814,064, E 2,279,299	

Elevation, feet	Depth, feet	Sample Type	Sampling Resistance, blows/foot	USCS Symbol	Graphic Log	MATERIAL DESCRIPTION	Well Log	REMARKS AND OTHER TESTS
679	0			CH		[Mud appears to be dark and black color (top soil)].		
674	5			CH		(Mud appears to be light tan color.)		
669	10			CH		Same as above.		
664	15			CH		(Mud appears to be tan color.)		
659	20			CH		Same as above.		
654	25			CH		Same as above.		
649	30							

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Project: Ground Water Monitoring Well Installation, Mesquite Creek Landfill.
Project Location: 1000 Kohlenberg Lane, New Braunfels, TX
Project Number: TXL0054-01

Log of Boring MW-11

Elevation, feet	Depth, feet	Sample Type	Sampling Resistance, blows/foot	USCS Symbol	Graphic Log	MATERIAL DESCRIPTION	Well Log	REMARKS AND OTHER TESTS
649	30			CH		Same as above.		
				CH		Same as above.		
639	40			CH		Same as above.		
634	45			CH		Same as above.		
629	50		22, 36, 50/6", 50/6".	CH		Stiff tan and grey CLAY mix with trace silt, occassional calcite seam.		
624	55		29/6", 50/5.5", 50/4", 50/6".	CH		Same as above.		
619	60		26/6", 50/5", 50/5.5", 50/4".	Claystone		Hard grey CLAYSTONE with trace silt.		
			50/6", 50/3", 50/3", 50/3.5".	Claystone		Same as above.		
						Bottom of Boring at 63 feet bgs.		
614	65							

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Project: Ground Water Monitoring Well Installation, Mesquite Creek Landfill.
Project Location: 1000 Kohlenberg Lane, New Braunfels, TX
Project Number: TXL0054-01

Log of Boring MW-18

Date(s) Drilled	03/20/2009-	Logged By	Mohammad Z. Islam	Checked By	Edward B. Dolan, P.G.
Drilling Method	Hollow Stem Auger	Drill Bit Size/Type	8 inch HSA	Total Depth of Borehole	60 feet bgs
Drill Rig Type	Mobil B59	Drilling Contractor	Total Support Services, Inc.	Approximate Surface Elevation	635.12 feet MSL
Groundwater Level and Date Measured	Not yet measured	Sampling Method(s)	Core	Hammer Data	N/A
Borehole Backfill	Well Completion	Location	N 13,815,968, E 2,279,746		

Elevation, feet	Depth, feet	Sample Type	Sampling Resistance, blows/foot	USCS Symbol	Graphic Log	MATERIAL DESCRIPTION	Well Log	REMARKS AND OTHER TESTS
635.1	0		Core	CH		Damp and black CLAY with some gravel.		
630.1	5		Core	CH		Damp and light grey CLAY with trace silt between 5 and 4 ft, dry and tan CLAY with trace silt between 4 and 5 ft.		
625.1	10		Core	CH		Medium stiff tan CLAY with occassional calcite mix.		
620.1	15		Core	CH		Same as above.		
615.1	20		Core	CH		Dry medium stiff tan CLAY with trace silt.		
610.1	25		Core	CH		Moist medium stiff tan CLAY with trace silt, occassional calcite mix.		
			Core	CH		Same as above.		
605.1	30							

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Project: Ground Water Monitoring Well Installation, Mesquite Creek Landfill.
Project Location: 1000 Kohlenberg Lane, New Braunfels, TX
Project Number: TXL0054-01

Log of Boring MW-18

Elevation, feet	Depth, feet	Sample Type	Sampling Resistance, blows/foot	USCS Symbol	Graphic Log	MATERIAL DESCRIPTION	Well Log	REMARKS AND OTHER TESTS
605.1	30		Core	CH		Same as above.		
			Core	CH		Stiff tan CLAY with horizontal calcite seam.		
600.1	35		Core	CH		Same as above.		
			Core	CH		Same as above.		
595.1	40		Core	CH		Tan CLAY with trace silt between 40.0 and 41.5 ft, dark grey CLAY between 41.5 ft and 42.5 ft.		
			Core	CH		Mixture of tan and grey CLAY with trace silt.		
590.1	45		Core	CH		Tan CLAY with trace silt, occassional calcite seam.		
			Core	CH		Same as above.		
585.1	50		Core	CH		Same as above.		
			Core	CH		Same as above.		
580.1	55		Core	CH		Tan CLAY with trace silt between 55.0 and 55.5 ft, dark grey CLAY with trace silt between 55.5 and 52.5 ft.		
				Claystone		Hard dark grey CLAYSTONE with trace silt.		
			Core	CH		Stiff tan CLAY with calcite seam.		
				Claystone		Hard dark grey CLAYSTONE with trace silt.		
575.1	60					Bottom of Boring at 60 feet bgs		
570.1	65							

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Project: Ground Water Monitoring Well Installation, Mesquite Creek Landfill.
Project Location: 1000 Kohlenberg Lane, New Braunfels, TX
Project Number: TXL0054-01

Log of Boring MW-19

Date(s) Drilled: 03/02/2009	Logged By: Mohammad Z. Islam	Checked By: Edward B. Dolan, P.G.
Drilling Method: Hollow Stem Auger	Drill Bit Size/Type: 8 inch HSA	Total Depth of Borehole: 55 feet bgs
Drill Rig Type: Mobil B59	Drilling Contractor: Total Support Services, Inc.	Approximate Surface Elevation: 633.19 feet MSL
Groundwater Level and Date Measured: Not yet measured	Sampling Method(s): SPT	Hammer Data: 140 lb, 30 in drop, safety
Borehole Backfill: Well Completion	Location: N 13,816,167, E 2,279,219	

Elevation, feet	Depth, feet	Sample Type	Sampling Resistance, blows/foot	USCS Symbol	Graphic Log	MATERIAL DESCRIPTION	Well Log	REMARKS AND OTHER TESTS
633.2	0			CH		(Drill cuttings appear to be dry light tan CLAY.)		
628.2	5			CH		Same as above.		
623.2	10			CH		(Drill cuttings appear to be stiff tan CLAY.)		
618.2	15			CH		Same as above.		
613.2	20		15, 20, 25	CH		Light tan CLAY with trace silt, occassional calcite mix, dry.		Sampler was pushed 6 in. at 22 ft and blow count started at 20.5 ft.
608.2	25		17, 40, 50/5", 50/4".	CH		Same as above.		
603.2	30							

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Project: Ground Water Monitoring Well Installation, Mesquite Creek Landfill.
Project Location: 1000 Kohlenberg Lane, New Braunfels, TX
Project Number: TXL0054-01

Log of Boring MW-19

Elevation, feet	Depth, feet	Sample Type	Sampling Resistance, blows/foot	USCS Symbol	Graphic Log	MATERIAL DESCRIPTION	Well Log	REMARKS AND OTHER TESTS
603.2	30			CH		(Drill cuttings appear to be hard tan CLAY.)		
598.2	35		13, 29, 34, 35.	CH		Tan CLAY with trace silt, a near vertical calcite seam at 36 ft 2 in.		
593.2	40		11, 38, 50/5.5", 50/5".	CH		Damp tan CLAY with occassional calcite mix.		
588.2	45							
			14, 32, 34, 44.	CH		Same as above.		
583.2	50							
			50, 50/4.5".	Claystone		Hard dark grey CLAYSTONE with trace silt.		
578.2	55					Bottom of Boring at 55 feet bgs.		
573.2	60							
568.2	65							

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Project: Ground Water Monitoring Well Installation, Mesquite Creek Landfill. Project Location: 1000 Kohlenberg Lane, New Braunfels, TX Project Number: TXL0054-01	**Log of Boring MW-20** Sheet 1 of 2

Date(s) Drilled: 03/03/2009	Logged By: Mohammad Z. Islam	Checked By: Edward B. Dolan, P.G.
Drilling Method: Rotary Wash	Drill Bit Size/Type: 10 inch drag bit	Total Depth of Borehole: 40 feet bgs
Drill Rig Type: Mobil B59	Drilling Contractor: Total Support Services, Inc.	Approximate Surface Elevation: 606.32 feet MSL
Groundwater Level and Date Measured: Not yet measured	Sampling Method(s): SPT	Hammer Data: 140 lb, 30 in drop, safety
Borehole Backfill: Well Completion	Location: N 13,816,684, E 2,278,784	

Elevation, feet	Depth, feet	Sample Type	Sampling Resistance, blows/foot	USCS Symbol	Graphic Log	MATERIAL DESCRIPTION	Well Log	REMARKS AND OTHER TESTS
606.3	0			CH		[Mud appears to be dark and black color (top soil).]		
601.3	5			CH		(Mud appears to be black color.)		
596.3	10			CH		(Mud appears to be light tan color.)		
591.3	15			CH		(Mud appears to be tan CLAY.)		
586.3	20			CH		Same as above.		
581.3	25			CH		Same as above.		
576.3	30							

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Project: Ground Water Monitoring Well Installation, Mesquite Creek Landfill.
Project Location: 1000 Kohlenberg Lane, New Braunfels, TX
Project Number: TXL0054-01

Log of Boring MW-20

Elevation, feet	Depth, feet	Sample Type	Sampling Resistance, blows/foot	USCS Symbol	Graphic Log	MATERIAL DESCRIPTION	Well Log	REMARKS AND OTHER TESTS
576.3	30		8, 26, 34, 36.	CH		Stiff tan CLAY with trace silt, calcite mix.		
571.3	35							
			36, 50/4", 50/5.5", 50/5".	CH		Stiff tan CLAY with trace silt, occassional calcite seam.		
				Claystone		Hard dark grey CLAYSTONE with trace silt.		
566.3	40					Bottom of Boring at 40 feet bgs.		
561.3	45							
556.3	50							
551.3	55							
546.3	60							
541.3	65							

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Project: Ground Water Monitoring Well Installation, Mesquite Creek Landfill.	# Log of Boring MW-21
Project Location: 1000 Kohlenberg Lane, New Braunfels, TX	Sheet 1 of 2
Project Number: TXL0054-01	

Date(s) Drilled: 03/10/2009	Logged By: Mohammad Z. Islam	Checked By: Edward B. Dolan, P.G.
Drilling Method: Rotary Wash	Drill Bit Size/Type: 6 inch tricone bit	Total Depth of Borehole: 43 feet bgs
Drill Rig Type: Mobil B59	Drilling Contractor: Total Support Services, Inc.	Approximate Surface Elevation: 606.84 feet MSL
Groundwater Level and Date Measured: Not yet measured	Sampling Method(s): SPT	Hammer Data: 140 lb, 30 in drop, safety
Borehole Backfill: Well Completion	Location: N 13,816,481, E 2,278,358	

Elevation, feet	Depth, feet	Sample Type	Sampling Resistance, blows/foot	USCS Symbol	Graphic Log	MATERIAL DESCRIPTION	Well Log	REMARKS AND OTHER TESTS
606.8	0			CH		(Mud appears to be light tan color.)		
601.8	5			CH		(Mud appears to be tan color.)		
596.8	10			CH		Same as above.		
591.8	15			CH		Same as above.		
586.8	20			CH		Same as above.		
581.8	25		6, 15, 21, 27.	CH		Medium stiff tan CLAY with trace silt.		
576.8	30							

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Project: Ground Water Monitoring Well Installation, Mesquite Creek Landfill.
Project Location: 1000 Kohlenberg Lane, New Braunfels, TX
Project Number: TXL0054-01

Log of Boring MW-21

Elevation, feet	Depth, feet	Sample Type	Sampling Resistance, blows/foot	USCS Symbol	Graphic Log	MATERIAL DESCRIPTION	Well Log	REMARKS AND OTHER TESTS
576.8	30		26, 46, 50/5", 50/4".	CH		Same as above.		
571.8	35		43, 50/4.8", 50/4.5", 50/3.5".	CH		Hard tan and grey CLAY mix with trace silt.		
566.8	40		38, 46, 50/5.5", 50/5".	CH		Same as above.		
			50, 50/3.3", 50/3.3", 50/3".	Claystone		Hard grey CLAYSTONE with trace silt.		
						Bottom of Boring at 43 feet bgs		
561.8	45							
556.8	50							
551.8	55							
546.8	60							
541.8	65							

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Project: Ground Water Monitoring Well Installation, Mesquite Creek Landfill. **Project Location:** 1000 Kohlenberg Lane, New Braunfels, TX **Project Number:** TXL0054-01	**Log of Boring MW-22** Sheet 1 of 2

Date(s) Drilled 03/10/2009	Logged By Mohammad Z. Islam	Checked By Edward B. Dolan, P.G.
Drilling Method Rotary Wash	Drill Bit Size/Type 6 inch tricone bit	Total Depth of Borehole 37 feet bgs
Drill Rig Type Mobil B59	Drilling Contractor Total Support Services, Inc.	Approximate Surface Elevation 612.21 feet MSL
Groundwater Level and Date Measured Not yet measured	Sampling Method(s) SPT	Hammer Data 140 lb, 30 in drop, safety
Borehole Backfill Well Completion	Location N 13,816,113, E 2,278,083	

Elevation, feet	Depth, feet	Sample Type	Sampling Resistance, blows/foot	USCS Symbol	Graphic Log	MATERIAL DESCRIPTION	Well Log	REMARKS AND OTHER TESTS
612.2	0			CH		(Mud appears to be light tan color.)		
607.2	5			CH		(Mud appears to be tan color.)		
602.2	10			CH		Same as above.		
597.2	15			CH		Same as above.		
592.2	20			CH		Same as above.		
587.2	25			CH		Same as above.		
582.2	30							

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Elevation, feet	Depth, feet	Sample Type	Sampling Resistance, blows/foot	USCS Symbol	Graphic Log	MATERIAL DESCRIPTION	Well Log	REMARKS AND OTHER TESTS
582.2	30		[illegible], 50/0.5".	CH		Hard tan CLAY with trace silt.		
			50/5", 50/5.6", 50/4", 50/3.5".	CH		Same as above.		
577.2	35							
			50, 50/3.5", 50/2.8", 50/3".	Claystone		Hard grey CLAYSTONE with trace silt.		
				Claystone		Hard dark grey CLAYSTONE with trace silt.		
			48/6", 50/4.3", 50/4", 40/4".			Bottom of Boring at 37 feet bgs.		
572.2	40							
567.2	45							
562.2	50							
557.2	55							
552.2	60							
547.2	65							

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Project: Ground Water Monitoring Well Installation, Mesquite Creek Landfill.	**Log of Boring MW-23**
Project Location: 1000 Kohlenberg Lane, New Braunfels, TX	Sheet 1 of 2
Project Number: TXL0054-01	

Date(s) Drilled **03/06/2009**	Logged By **Mohammad Z. Islam**	Checked By **Edward B. Dolan, P.G.**
Drilling Method **Rotary Wash**	Drill Bit Size/Type **6 inch tricone bit**	Total Depth of Borehole **35 feet bgs**
Drill Rig Type **Mobil B59**	Drilling Contractor **Total Support Services, Inc.**	Approximate Surface Elevation **621.21 feet MSL**
Groundwater Level and Date Measured **Not yet measured**	Sampling Method(s) **SPT**	Hammer Data **140 lb, 30 in drop, safety**
Borehole Backfill **Well Completion**	Location **N 13,816,006, E 2,277,841**	

Elevation, feet	Depth, feet	Sample Type	Sampling Resistance, blows/foot	USCS Symbol	Graphic Log	MATERIAL DESCRIPTION	Well Log	REMARKS AND OTHER TESTS
621.2	0			CH		(Mud appears to be light tan color.)		
616.2	5			CH		(Mud appears to be tan color.)		
611.2	10			CH		Same as above.		
606.2	15			CH		Same as above.		
601.2	20		33, 38, 43, 50/5".	CH		Stiff tan CLAY with trace silt.		
596.2	25		14, 27, 37, 40.	CH		Same as above.		
591.2	30							

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Project: Ground Water Monitoring Well Installation, Mesquite Creek Landfill.
Project Location: 1000 Kohlenberg Lane, New Braunfels, TX
Project Number: TXL0054-01

Log of Boring MW-23

Elevation, feet	Depth, feet	Sample Type	Sampling Resistance, blows/foot	USCS Symbol	Graphic Log	MATERIAL DESCRIPTION	Well Log	REMARKS AND OTHER TESTS
591.2	30		12, 26, 31, 39.	CH		Tan and grey CLAY mix with trace silt.		
			20, 36, 37, 50/6".	Claystone		Dark grey CLAYSTONE with trace silt.		
				CH		Tan CLAY with trace silt, calcite mix.		
586.2	35			Claystone		Dark grey CLAYSTONE with trace silt.		
						Bottom of Boring at 35 feet bgs.		
581.2	40							
576.2	45							
571.2	50							
566.2	55							
561.2	60							
556.2	65							

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TETRA TECH, INC.
8911 N. Capital of Tx Hwy
Bldg. 2, Suite 2310
Austin, Texas 78759
(512) 338-1667

Mesquite Creek Landfill

MSW Permit 66B

New Braunfels/Comal/Guadalupe Counties

LOG OF BORING: GP-14

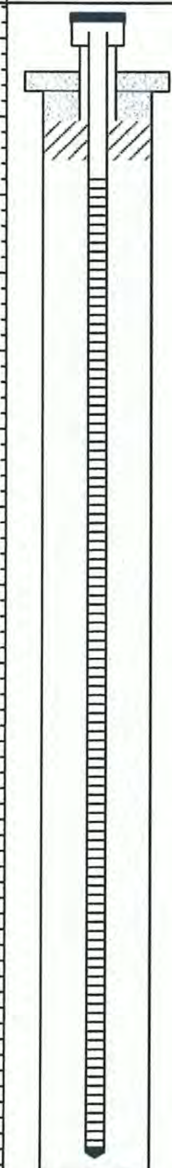
DATE:	12/4/13	**DRILLING COMPANY:**	Vortex Drilling, Inc.	**TOTAL DEPTH:**	56'
HOLE DIAMETER:	8"	**DRILLER:**	Jim Neal	**TOP OF CASING:**	660.57'
DRILLING METHOD:	HSA	**DRILLER'S LICENSE #:**	4868 WPKT	**SURFACE ELEVATION:**	657.72'
SAMPLING METHOD:	SPT	**DRILLING RIG:**	Mobile Drill B59	**DEPTH TO WATER:**	Dry @ Completion
LOGGED BY:	Samantha K. Abbott	**LATITUDE:**	29.734163	**CASING DIAMETER:**	2"
		LONGITUDE:	-98.016748	**SURFACE COMPLETION:**	Anodized Riser

FIELD DATA

Depth (feet)	Sample	Sampler Type	Recovery %	MATERIAL DESCRIPTION
0	0-2.5	Split Spoon	20%	FAT CLAY (CH) medium stiff to stiff, dark brown, with silt and roots, moist.
	2.5-5	Split Spoon	100%	FAT CLAY (CH) very stiff, dark brown, with calcareous material and gravel.
5	5-7.5	Split Spoon	100%	SILT (ML) stiff, light tan to white, heavily calcareous, loosely cemented/friable, dry.
	7.5-10	Split Spoon	100%	SILTY CLAY (CL) stiff, tan to light brown, with some calcareous material; mineralization (black and red flecks in shear zones), with some gray weathered zones.
10	10-12.5	Split Spoon	100%	
	12.5-15	Split Spoon	100%	
15	15-17.5	Split Spoon	100%	
	17.5-20	Split Spoon	100%	
20	20-22.5	Split Spoon	100%	SILTY CLAY (CL) very stiff, tan, with zones of oxidation and mineralization, gray weathered zones, damp.
	22.5-25	Split Spoon	100%	
25	25-27.5	Split Spoon	100%	
	27.5-30	Split Spoon	100%	
30	30-32.5	Split Spoon	100%	-- medium stiff to very stiff @ 32', more FAT CLAY (CH), damp.
	32.5-35	Split Spoon	100%	
35	35-37.5	Split Spoon	100%	
	37.5-40	Split Spoon	100%	
40	40-42.5	Split Spoon	100%	-- calcite mineralization zone @ 40.5' - 46'.
	42.5-45	Split Spoon	100%	
45	45-47.5	Split Spoon	100%	FAT CLAY (CH) stiff to very stiff, gray brown, some SILT (CL).
	47.5-50	Split Spoon	100%	
50	50-52.5	Split Spoon	100%	CLAYSTONE very stiff to hard, dark gray, with some silt, homogenous.
	52.5-55	Split Spoon	100%	
55				
60				

Elevation (feet MSL): 660, 656, 652, 648, 644, 640, 636, 632, 628, 624, 620, 616, 612, 608, 604, 600

WELL CONSTRUCTION DETAILS AND/OR DRILLING REMARKS



- Anodized Aluminum Riser
- 4'x4'x6" Reinforced Concrete Surface Pad
- Concrete Seal
- Bentonite Chip Seal
- 2" diameter Schedule 40 PVC Casing
- 20/40 Sand Filter Pack
- 2" diameter Schedule 40 PVC 0.010" Slotted Screen
- Bottom Cap @ 55'

Ground Water Level Data

▽ Free water first encountered ▼ Water Level after 15 minutes

Sampler Type

Split Spoon, Auger, Shelby Tube, No Recovery, Cuttings

TETRA TECH, INC.
8911 N. Capital of Tx Hwy
Bldg. 2, Suite 2310
Austin, Texas 78759
(512) 338-1667

Mesquite Creek Landfill

MSW Permit 66B

New Braunfels/Comal/Guadalupe Counties

LOG OF BORING: GP-19

DATE:	12/4/13	**DRILLING COMPANY:**	Vortex Drilling, Inc.	**TOTAL DEPTH:**	56'
HOLE DIAMETER:	8"	**DRILLER:**	Jim Neal	**TOP OF CASING:**	679.18'
DRILLING METHOD:	HSA	**DRILLER'S LICENSE #:**	4868 WPKT	**SURFACE ELEVATION:**	676.52'
SAMPLING METHOD:	SPT	**DRILLING RIG:**	Mobile Drill B59	**DEPTH TO WATER:**	Dry @ Completion
LOGGED BY:	Samantha K. Abbott	**LATITUDE:**	29.729532	**CASING DIAMETER:**	2"
		LONGITUDE:	-98.020837	**SURFACE COMPLETION:**	Anodized Riser

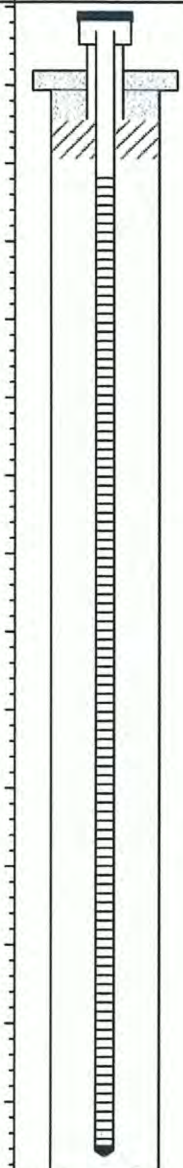
FIELD DATA

Depth (feet)	Sample	Sampler Type	Recovery %	MATERIAL DESCRIPTION
0	0-2.5	Split Spoon	100%	FAT CLAY (CH) soft to medium stiff, very dark brown, with gravel (medium) and abundant roots.
	2.5-5	Split Spoon	100%	FAT CLAY (CH) medium stiff, gray brown, with zones of calcareous silt/chalk, with some oxidation, with medium gravel.
5	5-7.5	Split Spoon	100%	
	7.5-10	Split Spoon	100%	SILT (ML) stiff, light tan to white, with abundant calcareous material, with some CLAY, with gravel (transition).
10	10-12.5	Split Spoon	100%	
	12.5-15	Split Spoon	100%	CLAYEY SILT (ML) loose to medium stiff, light tan and white, friable, heavily calcareous/chalky, with common oxidation staining.
15	15-17.5	Split Spoon	100%	SILTY CLAY (CL) very stiff, light brown, with occasional weathered gray zones.
	17.5-20	Split Spoon	100%	
20	20-22.5	Split Spoon	100%	
	22.5-25	Split Spoon	100%	
25	25-27.5	Split Spoon	100%	
	27.5-30	Split Spoon	100%	
30	30-32.5	Split Spoon	100%	-- very stiff to hard, more FAT CLAY (CH)/less SILT (ML) @ 31'.
	32.5-35	Split Spoon	100%	
35	35-37.5	Split Spoon	100%	-- horizontal zones of calcite mineralization/crystallization, wet @ 35'-51'.
	37.5-40	Split Spoon	100%	
40	40-42.5	Split Spoon	100%	
	42.5-45	Split Spoon	100%	
45	45-47.5	Split Spoon	100%	
	47.5-50	Split Spoon	100%	FAT CLAY (CH) stiff to medium stiff, gray-brown, with some SILT.
50	50-52.5	Split Spoon	100%	-- transition zone 50'-52.5'.
	52.5-55	Split Spoon	100%	CLAYSTONE hard, dark gray, homogenous.
55				
60				

Depth (feet): 0, 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60

Elevation (feet MSL): 680, 676, 672, 668, 664, 660, 656, 652, 648, 644, 640, 636, 632, 628, 624, 620

WELL CONSTRUCTION DETAILS AND/OR DRILLING REMARKS



Anodized Aluminum Riser

4'x4'x6" Reinforced Concrete Surface Pad

Concrete Seal

Bentonite Chip Seal

2" diameter Schedule 40 PVC Casing

20/40 Sand Filter Pack

2" diameter Schedule 40 PVC 0.010" Slotted Screen

Bottom Cap @ 55'

Ground Water Level Data

▽ Free water first encountered ▼ Water Level after 15 minutes

Sampler Type

Split Spoon, Auger, Shelby Tube, No Recovery, Cuttings

TETRA TECH, INC. 8911 N. Capital of Tx Hwy Bldg. 2, Suite 2310 Austin, Texas 78759 (512) 338-1667	**Mesquite Creek Landfill** ***MSW Permit 66B*** **New Braunfels/Comal/Guadalupe Counties**	**LOG OF BORING:** GP-15

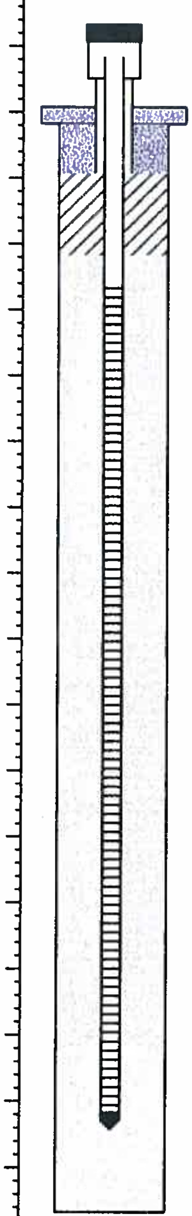
DATE:	1/25/16	**DRILLING COMPANY:**	Vortex Drilling, Inc.	**TOTAL DEPTH:**	33'
HOLE DIAMETER:	8"	**DRILLER:**	Jim Neal	**TOP OF CASING:**	640.88'
DRILLING METHOD:	HSA	**DRILLER'S LICENSE #:**	4868 WKPT	**SURFACE ELEVATION:**	637.66'
SAMPLING METHOD:	SPT	**DRILLING RIG:**	Mobile Drill B59	**DEPTH TO WATER:**	Dry @ Completion
LOGGED BY:	Ryan C. Dickerson	**LATITUDE:**	29.73309	**CASING DIAMETER:**	2"
		LONGITUDE:	-98.0156	**SURFACE COMPLETION:**	Anodized Riser

FIELD DATA

Depth (feet)	MATERIAL DESCRIPTION
0 – 6	FAT CLAY (CH) medium stiff, tan and gray, with yellowish-brown mottling, roots @ 0'-6.0', moist.
6 – 22.5	SILTY CLAY (CL) medium stiff, tan and gray, with yellowish-brown mottling, occasional crystallization, trace root material @ 6.0' - 10.0', trace shell fragments @ 6.0' - 10.0'. -- oxidation staining throughout @ 12.0'. -- large shell fragments @ 21.0' - 21.5'.
22.5 – 29	SILTY CLAY (CL) medium stiff, light tan and light gray, with occasional oxidation staining throughout, trace shell fragments, moist.
29 – 33	SILTY CLAY (CL) soft to medium stiff, tan and yellowish-brown, with occasional oxidation staining throughout, friable, trace calcareous material.

STATE OF TEXAS
CHRISTIAN M. LLULL
GEOLOGY
No. 5884
LICENSED
PROFESSIONAL GEOSCIENTIST
2-26-16

WELL CONSTRUCTION DETAILS AND/OR DRILLING REMARKS



- Anodized Aluminum Riser
- 4'x4'x6" Reinforced Concrete Surface Pad
- Concrete Seal
- Bentonite Chip Seal
- 2" diameter Schedule 40 PVC Casing
- 20/40 Sand Filter Pack
- 2" diameter Schedule 40 PVC 0.010" Slotted Screen
- Bottom Cap @ 30'

Ground Water Level Data
▽ Free water first encountered ▼ Water Level after 15 minutes

Sampler Type
Split Spoon, Auger, Shelby Tube, No Recovery, Cuttings

Project No. 114-021770 Tetra Tech, Inc. Update: 2/18/2016 Page 1 of 1

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(512) 338-1667

Mesquite Creek Landfill

MSW Permit 66B

New Braunfels/Comal/Guadalupe Counties

LOG OF BORING: MW-17

DATE:	1/25/16	**DRILLING COMPANY:**	Vortex Drilling, Inc.	**TOTAL DEPTH:**	63'
HOLE DIAMETER:	8"	**DRILLER:**	Jim Neal	**TOP OF CASING:**	658.69'
DRILLING METHOD:	HSA	**DRILLER'S LICENSE #:**	4868 WKPT	**SURFACE ELEVATION:**	655.42'
SAMPLING METHOD:	SPT	**DRILLING RIG:**	Mobile Drill B59	**DEPTH TO WATER:**	Dry @ Completion
LOGGED BY:	Ryan C. Dickerson	**LATITUDE:**	29.73431	**CASING DIAMETER:**	2"
		LONGITUDE:	-98.01741	**SURFACE COMPLETION:**	Anodized Riser

FIELD DATA

Depth (feet)	Sample	Sampler Type	Recovery %	Lithology	MATERIAL DESCRIPTION	Depth (feet)	Elevation (feet MSL)	WELL CONSTRUCTION DETAILS AND/OR DRILLING REMARKS
0					FAT CLAY (CH) stiff, dark brown, with some silt, grading to light brown.	0		Anodized Aluminum Riser; 4'x4'x6" Reinforced Concrete Surface Pad; Concrete Seal
5					SILTY CLAY (CL) medium stiff, light brown, abundant calcareous material.	5		Cement/Bentonite Grout
10					SILT (ML) medium stiff to stiff, tan, light gray mottling, grading to SILTY CLAY (CL).	10		
					SILTY CLAY (CL) medium stiff, tan and gray, occasional yellowish-brown mottling.			
15					SILTY CLAY (CL) stiff, tan and gray, blocky, occasional oxidation staining throughout, trace shell fragments. -- organic material @ 15.0' - 17.5'. -- black streaks throughout @ 22.0' - 36.0'. -- zones of FAT CLAY (CH) @ 30.5'. -- moist @ 37.0'. -- 0.5" crystalline lenses throughout @ 38.5' - 50.0'.	15		2" diameter Schedule 40 PVC Casing
45						45		Bentonite Chip Seal; 20/40 Sand Filter Pack
50					SILTY CLAY (CL) medium stiff to stiff, tan with dark gray bands and layers, with oxidation staining, common crystalline lenses (0.5") within tan layers, transition zone. -- dark gray layers @ 50.0' - 50.5', 51.2' - 52.0' & 57.0' - 57.5'. -- 4" crystalline lense @ 54.5'.	50		2" diameter Schedule 40 PVC 0.010" Slotted Screen
60					CLAYSTONE very stiff to hard, dark gray, uniform.	60		Sump/Silt Trap @ 60'-61.5'; Bottom Cap @ 61.5'-62'

STATE OF TEXAS
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No. 5884
LICENSED PROFESSIONAL GEOSCIENTIST

2-26-16

Ground Water Level Data: ▽ Free water first encountered ▼ Water Level after 15 minutes

Sampler Type: Split Spoon, Auger, Shelby Tube, No Recovery, Cuttings

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Mesquite Creek Landfill

MSW Permit 66B

New Braunfels/Comal/Guadalupe Counties

LOG OF BORING: GP-16

DATE:	4/10/18	**DRILLING COMPANY:**	Vortex Drilling, Inc.	**TOTAL DEPTH:**	31.5'
HOLE DIAMETER:	8"	**DRILLER:**	Jim Neal	**TOP OF CASING:**	657.54'
DRILLING METHOD:	HSA	**DRILLER'S LICENSE #:**	4868 WKPT	**SURFACE ELEVATION:**	654.81'
SAMPLING METHOD:	SPT	**DRILLING RIG:**	Mobile Drill B59	**DEPTH TO WATER:**	Dry @ Completion
LOGGED BY:	Ryan C. Dickerson	**LATITUDE:**	-98.00565857	**CASING DIAMETER:**	2"
		LONGITUDE:	29.43490904	**SURFACE COMPLETION:**	Anodized Riser

FIELD DATA

Depth (feet)	Sample	Sampler Type	Recovery %	Lithology	MATERIAL DESCRIPTION	Depth (feet)	Elevation (feet MSL)
							658
							656
0					FAT CLAY: Dark brown, soft to medium stiff, with abundant chert gravel and plant material, trace brown SILT, slightly moist.	0	654
					FAT CLAY: Brown with tan mottling, soft to medium stiff, with calcareous material throughout, slightly moist.		652
5					SILTY CLAY: Light brown with gray and yellowish brown mottling, stiff, with occasional calcareous material and oxidation staining, slightly moist.	5	650 / 648
10						10	646 / 644
15					-- Slightly moist @ 15'	15	642 / 640 / 638
20					-- Shell fragment @ 19.5' -- Abundant iron oxidation @ 19.75'	20	636 / 634
					-- Light tan SILT @ 22.25'-22.5' (dry) -- Large shell fragment @ 23.75'		632 / 630
25					-- Abundant calcite crystallization @ 25'-29' -- Abundant iron oxidation @ 25'-28'	25	628 / 626
30						30	624

STATE OF TEXAS
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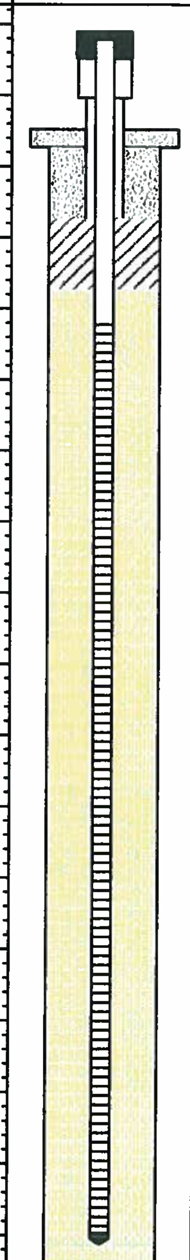
6-6-18

WELL CONSTRUCTION DETAILS AND/OR DRILLING REMARKS



Anodized Aluminum Riser

Concrete Seal

Bentonite Chip Seal

2" diameter Schedule 40 PVC Casing

20/40 Sand Filter Pack

2" diameter Schedule 40 PVC 0.010" Slotted Screen

Bottom Cap @ 30.5'

Ground Water Level Data

▽ Free water first encountered ▼ Water Level after 15 minutes

Sampler Type

Split Spoon Auger Shelby Tube No Recovery Cuttings

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MSW Permit 66B

New Braunfels/Comal/Guadalupe Counties

LOG OF BORING: GP-17

DATE:	4/9/18	**DRILLING COMPANY:**	Vortex Drilling, Inc.	**TOTAL DEPTH:**	77.5'
HOLE DIAMETER:	8"	**DRILLER:**	Jim Neal	**TOP OF CASING:**	701.98'
DRILLING METHOD:	HSA	**DRILLER'S LICENSE #:**	4868 WKPT	**SURFACE ELEVATION:**	699.78'
SAMPLING METHOD:	SPT	**DRILLING RIG:**	Mobile Drill B59	**DEPTH TO WATER:**	Dry @ Completion
LOGGED BY:	Ryan C. Dickerson	**LATITUDE:**	-98.01020465	**CASING DIAMETER:**	2"
		LONGITUDE:	29.43446891	**SURFACE COMPLETION:**	Anodized Riser

FIELD DATA

Depth (feet)	Sample	Sampler Type	Recovery %	Lithology	MATERIAL DESCRIPTION	Depth (feet)	Elevation (feet MSL)
0		Split Spoon			FAT CLAY: Dark brown, medium stiff, with abundant gravel and plant material.	0	700
					SILT: Light tan, loose, with trace brown silt, abundant calcareous layers.		696
5					SILTY CLAY: Tan with gray and yellowish brown mottling, medium stiff, blocky, with occasional iron and manganese oxidation staining, occasional iron nodules, occasional shell fragments.	5	692
10						10	688
15						15	684
20						20	680
25						25	676
					– Light tan SILT @ 26.5'-26.75' – Occasional thin, brown SILT layers @ 27'-40'		672
30						30	668
35					– Small shell fragments becoming more abundant @ 34.5'	35	664
40						40	660
					– Large shell fragment @ 42.25'		656
45						45	652
					SILTY CLAY: Dark gray and light brown, very stiff, with iron oxidation staining, slightly moist.		
50					SILTY CLAY: Light brown with gray and yellowish brown mottling, medium stiff, blocky, with occasional iron and manganese oxidation staining, occasional iron nodules, occasional shell fragments, slightly moist.	50	648
55					– Abundant calcite crystallization @ 56'-60'	55	644
60					– Transition zone @ 59.75'-62': Alternating layers of light brown and dark gray clay.	60	640
					CLAYSTONE: Dark gray, very stiff to hard, brittle, with calcareous material, homogeneous.		636
65						65	632
					– Weathered bands @ 67' and 68.5'		
70						70	628
75						75	624
80						80	620

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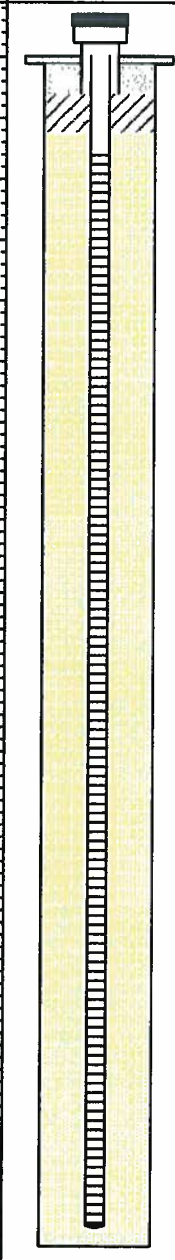
6-6-18

WELL CONSTRUCTION DETAILS AND/OR DRILLING REMARKS



Anodized Aluminum Riser

Concrete Seal

Bentonite Chip Seal

2" diameter Schedule 40 PVC Casing

20/40 Sand Filter Pack

2" diameter Schedule 40 PVC 0.010" Slotted Screen

Bottom Cap @76'

Ground Water Level Data

▽ Free water first encountered ▼ Water Level after 15 minutes

Sampler Type

Split Spoon | Auger | Shelby Tube | No Recovery | Cuttings

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Mesquite Creek Landfill

MSW Permit 66B

New Braunfels/Comal/Guadalupe Counties

LOG OF BORING: GP-18

DATE:	4/9/18	**DRILLING COMPANY:**	Vortex Drilling, Inc.	**TOTAL DEPTH:**	75'
HOLE DIAMETER:	8"	**DRILLER:**	Jim Neal	**TOP OF CASING:**	710.61'
DRILLING METHOD:	HSA	**DRILLER'S LICENSE #:**	4868 WKPT	**SURFACE ELEVATION:**	708.69'
SAMPLING METHOD:	SPT	**DRILLING RIG:**	Mobile Drill B59	**DEPTH TO WATER:**	Dry @ Completion
LOGGED BY:	Ryan C. Dickerson	**LATITUDE:**	-98.01077945	**CASING DIAMETER:**	2"
		LONGITUDE:	29.43399063	**SURFACE COMPLETION:**	Anodized Riser

FIELD DATA

Depth (feet)	Sample	Sampler Type	Recovery %	Lithology	MATERIAL DESCRIPTION	Depth (feet)	Elevation (feet MSL)
0–3		Split Spoon			FAT CLAY: Dark brown, stiff, with calcareous material throughout.	0	708
3–7.5		Split Spoon			SILTY CLAY: Light gray and yellowish-brown, with occasional dark brown mottling, soft, abundant chert gravel throughout.	5	704
7.5–10		Split Spoon			SILTY CLAY: Light tan, soft, with abundant white calcareous layers throughout.	10	700
10–43.5		Split Spoon			SILTY CLAY: Tan, with gray and yellowish-brown mottling, very stiff, with occasional calcareous material, manganese staining, iron oxidation staining, slightly moist. -- Occasional calcite crystallization @ 33'-43'	15–40	696–668
43.5–46		Split Spoon			SILTY CLAY: Dark gray, very stiff, with occasional light tan streaking.	45	664
46–49		Split Spoon			SILTY CLAY: Tan, with gray mottling, very stiff, weathered, occasional calcareous material throughout.		660
49–66		Split Spoon			SILTY CLAY: Light brown, with gray and yellowish-brown mottling, very stiff, with occasional calcareous material, manganese staining, iron oxidation staining, shell fragments @ 46.25'-51', slightly moist. -- Shell fragments @ 56'-63'	50–65	656–644
66–68.5		Split Spoon			CLAYSTONE: Dark gray, very stiff to hard, with trace tan silt, homogeneous.	65	640
68.5–70		Split Spoon			SILT: Dark gray and tan, clayey, with iron oxidation staining, dry.	70	
70–75		Split Spoon			CLAYSTONE: Dark gray, very stiff to hard, with trace tan silt, homogeneous.	75	636

STATE OF TEXAS
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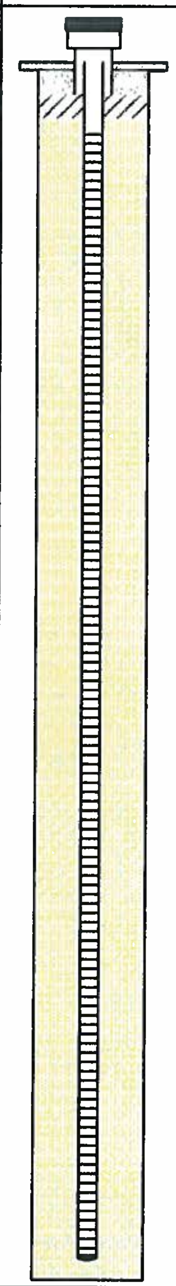
6-6-18

WELL CONSTRUCTION DETAILS AND/OR DRILLING REMARKS



Anodized Aluminum Riser
Concrete Seal
Bentonite Chip Seal
2" diameter Schedule 40 PVC Casing
20/40 Sand Filter Pack
2" diameter Schedule 40 PVC 0.010" Slotted Screen
Bottom Cap @ 74'

Ground Water Level Data
▽ Free water first encountered ▼ Water Level after 15 minutes

Sampler Type
Split Spoon, Auger, Shelby Tube, No Recovery, Cuttings

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Mesquite Creek Landfill

MSW Permit 66B

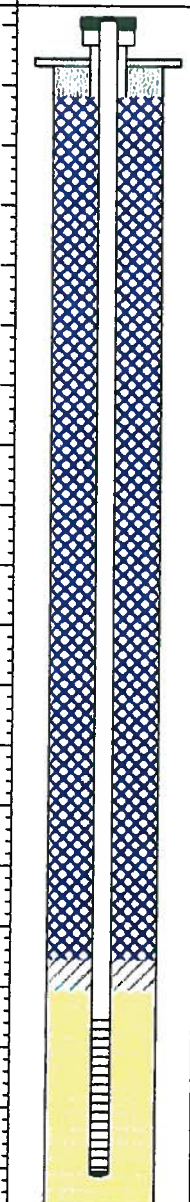
New Braunfels/Comal/Guadalupe Counties

LOG OF BORING: MW-12

DATE:	5/23/18	**DRILLING COMPANY:**	Vortex Drilling, Inc.	**TOTAL DEPTH:**	76'
HOLE DIAMETER:	8"	**DRILLER:**	Jim Neal	**TOP OF CASING:**	712.22'
DRILLING METHOD:	HSA	**DRILLER'S LICENSE #:**	4868 WKPT	**SURFACE ELEVATION:**	709.31'
SAMPLING METHOD:	SPT	**DRILLING RIG:**	Mobile Drill B59	**DEPTH TO WATER:**	Dry @ Completion
LOGGED BY:	Ryan C. Dickerson	**LATITUDE:**	-98.018257	**CASING DIAMETER:**	2"
		LONGITUDE:	29.728313	**SURFACE COMPLETION:**	Anodized Riser

FIELD DATA

Depth (feet)	Sample	Sampler Type	Recovery %	Lithology	MATERIAL DESCRIPTION	Depth (feet)	Elevation (feet MSL)	WELL CONSTRUCTION DETAILS AND/OR DRILLING REMARKS
0					FAT CLAY: Dark brown, stiff, calcareous material, some chert gravel.	0	712, 708	Anodized Aluminum Riser; Concrete Seal
5					SILTY CLAY: Yellowish-brown to light gray, with dark brown mottling, soft to medium stiff.	5	704	2" diameter Schedule 40 PVC Casing
					SILTY CLAY: Light tan, heavily calcareous.			
10					SILTY CLAY: Tan and light brown with gray mottling, medium stiff to stiff, occasionally heavily calcareous zones, manganese and iron oxide staining, occasional shell fragments throughout.	10	700, 696	
15–40						15–40	692, 688, 684, 680, 676, 672, 668	Cement/Bentonite Grout
					– Abundant small shell fragments @ 42'-42.5' – Very stiff @ 43'			
45					SILTY CLAY: Light brown, very stiff, weathered, occasional calcareous material.	45	664	
50					SILTY CLAY: Light brown with gray mottling, medium stiff to stiff, occasionally heavily calcareous zones, manganese and iron oxide staining, occasional shell fragments throughout. – Slightly moist @ 47.75' – Large shell fragments @ 48' – Occasional calcite crystallization @ 49.75'	50	660, 656	
55–60						55–60	652, 648	Bentonite Chip Seal
65					– Transition zones alternating layers of brown and gray clay @ 66'-72.5' – Calcite crystallization @ 66.75' – Pyrite nodule @ 67'	65	644, 640	20/40 Sand Filter Pack; 2" diameter Schedule 40 PVC 0.010" Slotted Screen
75					CLAYSTONE: Dark gray, very stiff to hard, homogeneous.	75	636, 632	Bottom Cap @ 73.5'-73.8'
80						80		



STATE OF TEXAS
CHRISTIAN M. LLULL
GEOLOGY
No. 5884
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PROFESSIONAL GEOSCIENTIST

7-13-18

Ground Water Level Data: ▽ Free water first encountered ▼ Water Level after 15 minutes

Sampler Type: Split Spoon, Auger, Shelby Tube, No Recovery, Cuttings

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Mesquite Creek Landfill

MSW Permit 66B

New Braunfels/Comal/Guadalupe Counties

LOG OF BORING: MW-13

DATE:	4/10/18	**DRILLING COMPANY:**	Vortex Drilling, Inc.	**TOTAL DEPTH:**	56'
HOLE DIAMETER:	8"	**DRILLER:**	Jim Neal	**TOP OF CASING:**	691.38'
DRILLING METHOD:	HSA	**DRILLER'S LICENSE #:**	4868 WKPT	**SURFACE ELEVATION:**	688.70'
SAMPLING METHOD:	SPT	**DRILLING RIG:**	Mobile Drill B59	**DEPTH TO WATER:**	Dry @ Completion
LOGGED BY:	Ryan C. Dickerson	**LATITUDE:**	-98.01007379	**CASING DIAMETER:**	2"
		LONGITUDE:	29.43457739	**SURFACE COMPLETION:**	Anodized Riser

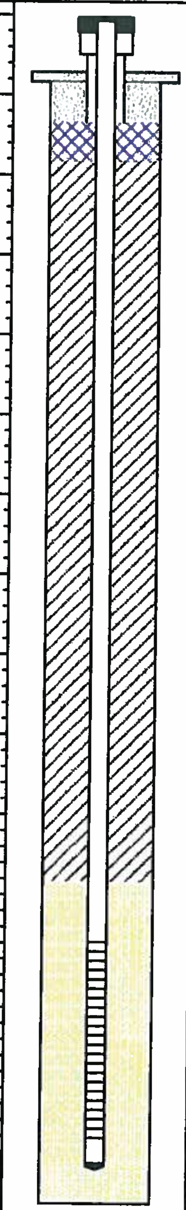
FIELD DATA

Depth (feet)	Sample	Sampler Type	Recovery %	Lithology	MATERIAL DESCRIPTION	Depth (feet)	Elevation (feet MSL)
0–1					FAT CLAY: Dark brown, soft, with abundant large chert gravel, abundant plant material, slightly moist.	0	688
1–6					SILTY CLAY: Light tan and white, soft, with abundant calcareous layers, very moist.	5	684
6–20					SILTY CLAY: Light brown to tan with gray and yellowish-brown mottling, medium stiff to stiff, with occasional calcareous layers, occasional claystone gravel and iron oxidation staining thoughout.	10, 15	680, 676, 672
20–52.5					SILTY CLAY: Light brown with gray and yellowish-brown mottling, very stiff, with occasional iron oxidation staining and calcareous material throughout, gray weathering and manganese staining along fracture planes. – Occasional shell fragments @ 32'-37.5' – Occasional shell fragments @ 41.5'-45' – Transition zone @ 45'-52.5': Alternating layers of light brown and dark gray clay. – Abundant calcite crystallization @ 45.5'-49.5'	20–50	668–636
52.5–56					CLAYSTONE: Dark gray, very stiff to hard, with occasional calcareous material and shell fragments, homogeneous.	55	632

Depth scale: 0, 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60

Elevation scale: 692, 688, 684, 680, 676, 672, 668, 664, 660, 656, 652, 648, 644, 640, 636, 632

WELL CONSTRUCTION DETAILS AND/OR DRILLING REMARKS



- Anodized Aluminum Riser
- Concrete Seal
- Cement/Bentonite Grout
- Bentonite Chip Seal
- 2" diameter Schedule 40 PVC Casing
- 20/40 Sand Filter Pack
- 2" diameter Schedule 40 PVC 0.010" Slotted Screen
- Sump/Silt Trap @ 53'-54'
- Bottom Cap @ 54'

STATE OF TEXAS
CHRISTIAN M. LLULL
GEOLOGY
No. 5884
LICENSED
PROFESSIONAL GEOSCIENTIST
6-6-18

Ground Water Level Data: ▽ Free water first encountered ▼ Water Level after 15 minutes

Sampler Type: Split Spoon, Auger, Shelby Tube, No Recovery, Cuttings

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Mesquite Creek Landfill

MSW Permit 66B

New Braunfels/Comal/Guadalupe Counties

LOG OF BORING: MW-14

DATE:	4/10/18	**DRILLING COMPANY:**	Vortex Drilling, Inc.	**TOTAL DEPTH:**	57.5'
HOLE DIAMETER:	8"	**DRILLER:**	Jim Neal	**TOP OF CASING:**	656.69'
DRILLING METHOD:	HSA	**DRILLER'S LICENSE #:**	4868 WKPT	**SURFACE ELEVATION:**	654.012'
SAMPLING METHOD:	SPT	**DRILLING RIG:**	Mobile Drill B59	**DEPTH TO WATER:**	Dry @ Completion
LOGGED BY:	Ryan C. Dickerson	**LATITUDE:**	-98.0056449	**CASING DIAMETER:**	2"
		LONGITUDE:	29.43502577	**SURFACE COMPLETION:**	Anodized Riser

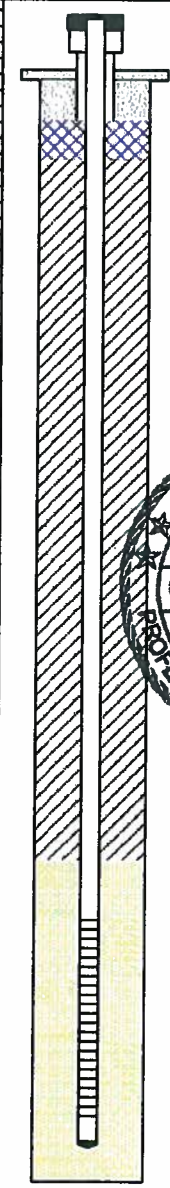
FIELD DATA

Depth (feet)	Sample	Sampler Type	Recovery %	Lithology	MATERIAL DESCRIPTION
0–7.5		Split Spoon			FAT CLAY: Dark brown, medium stiff, with abundant chert gravel, abundant plant material, abundant calcareous material.
7.5–11.5		Split Spoon			SILT: Light tan to white, loose, with tan SILTY CLAY throughout, with trace crushed claystone, heavily calcareous.
11.5–25		Split Spoon			SILTY CLAY: Light brown to tan with gray and yellowish-brown mottling, stiff, with occasional oxidation staining, calcareous material and shell fragments throughout, gray weathering along fracture planes. -- Abundant shell fragments @ 18'-22.5'
25–26.5		Split Spoon			SILT: Light tan, loose.
26.5–52		Split Spoon			SILTY CLAY: Light brown with tan mottling, medium stiff, with occasional iron oxidation staining, trace shell fragments, slightly moist. -- Abundant calcite crystallization @ 30'-42.5' -- Transition zone @ 42'-52': Alternating layers of light brown and dark gray clay.
52–57.5		Split Spoon / Cuttings			CLAYSTONE: Dark gray, very stiff to hard, with occasional calcareous material, homogeneous.

Depth (feet): 0, 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60

Elevation (feet MSL): 656, 652, 648, 644, 640, 636, 632, 628, 624, 620, 616, 612, 608, 604, 600, 596

WELL CONSTRUCTION DETAILS AND/OR DRILLING REMARKS



Anodized Aluminum Riser

Concrete Seal

Cement/Bentonite Grout

Bentonite Chip Seal

2" diameter Schedule 40 PVC Casing

20/40 Sand Filter Pack

2" diameter Schedule 40 PVC 0.010" Slotted Screen

Sump/Silt Trap @ 52'-53'
Bottom Cap @ 53'

STATE OF TEXAS
CHRISTIAN M. LLULL
GEOLOGY
No. 5884
LICENSED
PROFESSIONAL GEOSCIENTIST

6-6-18

Ground Water Level Data: ▽ Free water first encountered ▼ Water Level after 15 minutes

Sampler Type: Split Spoon, Auger, Shelby Tube, No Recovery, Cuttings

TETRA TECH, INC.
8911 N. Capital of Tx Hwy
Bldg. 2, Suite 2310
Austin, Texas 78759
(512) 338-1667

Mesquite Creek Landfill

MSW Permit 66B

New Braunfels/Comal/Guadalupe Counties

LOG OF BORING: MW-15

DATE:	4/11/18	**DRILLING COMPANY:**	Vortex Drilling, Inc.	**TOTAL DEPTH:**	53'
HOLE DIAMETER:	8"	**DRILLER:**	Jim Neal	**TOP OF CASING:**	650.24'
DRILLING METHOD:	HSA	**DRILLER'S LICENSE #:**	4868 WKPT	**SURFACE ELEVATION:**	647.19'
SAMPLING METHOD:	SPT	**DRILLING RIG:**	Mobile Drill B59	**DEPTH TO WATER:**	Dry @ Completion
LOGGED BY:	Ryan C. Dickerson	**LATITUDE:**	-98.00564535	**CASING DIAMETER:**	2"
		LONGITUDE:	29.43557832	**SURFACE COMPLETION:**	Anodized Riser

FIELD DATA

Depth (feet)	Sample	Sampler Type	Recovery %	Lithology	MATERIAL DESCRIPTION	Depth (feet)	Elevation (feet MSL)
0		Split Spoon			FAT CLAY: Dark brown, soft, with abundant plant material, occasional chert gravel and calcareous material.	0	648
5		Split Spoon			SILTY CLAY: Light brown to tan with gray mottling, soft to medium stiff, with occasional calcareous material, oxidation staining, common calcite crystallization throughout, occasional yellowish brown mottling, gray weathering along fracture planes, moist.	5	644
17		Split Spoon			SILTY CLAY: Light brown, medium stiff to stiff, with gray mottling and iron staining along fracture planes, occasional yellowish-brown mottling, slightly moist.		
45		Split Spoon			-- Transition zone @ 45'-51.75': Alternating layers of light brown and dark gray clay.	45	
52		Split Spoon			CLAYSTONE: Dark gray, very stiff to hard, with occasional calcareous material, homogeneous.		

Depth scale: 0, 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60

Elevation scale: 648, 644, 640, 636, 632, 628, 624, 620, 616, 612, 608, 604, 600, 596, 592, 588

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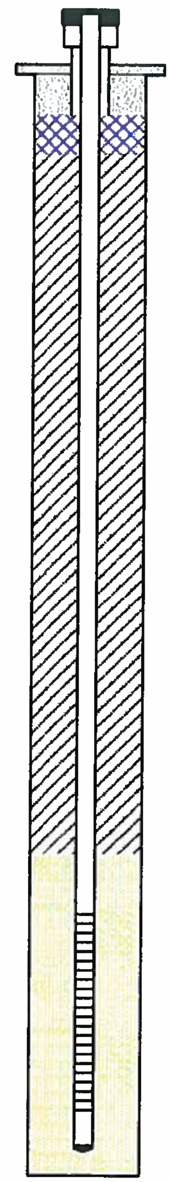
WELL CONSTRUCTION DETAILS AND/OR DRILLING REMARKS



- Anodized Aluminum Riser
- Concrete Seal
- Cement/Bentonite Grout
- Bentonite Chip Seal
- 2" diameter Schedule 40 PVC Casing
- 20/40 Sand Filter Pack
- 2" diameter Schedule 40 PVC 0.010" Slotted Screen
- Sump/Silt Trap @ 52.5'-53.5'
- Bottom Cap @ 53.5'

Ground Water Level Data

▽ Free water first encountered ▼ Water Level after 15 minutes

Sampler Type

Split Spoon | Auger | Shelby Tube | No Recovery | Cuttings

Bullock, Bennett & Associates, LLC
165 N. Lampasas Street
Bertram, TX 78605

LOG OF BORING MW-4A

MESQUITE CREEK LANDFILL

Project No.19338-20

Date :	5/11/2020	Drilling Company :	Vortex Drilling
Easting :	2276742.96	Driller :	James E Neal
Northing :	13816763.87	License No. :	4868
Top of Casing Elev :	610.87	Drilling Method :	Hollow Stem Auger - 8.25"
Logger :	CRF	Sampling Method :	Cuttings

DEPTH (feet)	Surface Elevation 609.4	DESCRIPTION	USCS	Recovery (ft/ft)	GRAPHIC	WELL DIAGRAM/REMARKS
0.0 – 12.0	609.4 – 597.4	(0-12) - Clay (CL), Firm, Moderate, Dark Brown, Rounded, Medium Plasticity, Low Toughness, Moist	CL	5/5, 5/5, 5/5		Well Construction: Riser ~3' AGL - 19' BGL Cement: 0' - 2' BGL Bentonite chips seal: 2 - 17' BGL Screen: 19' - 29' BGL 20/40 Silica Sand: 17' - 30' BGL Sump: 29' - 30' BGL
12.0 – 18.0		(12-18) - Clay (CL), Firm, Moderate Cementation, Light Brown, Rounded, Medium Plasticity, Low Toughness, Moist	CL	5/5, 5/5		
18.0 – 27.0		(18-27) - Clay (CL), Firm, Moderate Cementation, Tan, Round, Medium Plasticity, Low Toughness, Moist	CL	5/5		
27.0 – 30.0	580	(27-30) - Clay (CL) Moderate Cementation, Gray, More Angular, Medium Plasticity, Low Toughness, Slightly Moist	CL	5/5		

Depth scale (feet): 0.0, 2.0, 4.0, 6.0, 8.0, 10.0, 12.0, 14.0, 16.0, 18.0, 20.0, 22.0, 24.0, 26.0, 28.0, 30.0

Elevation scale: 608, 606, 604, 602, 600, 598, 596, 594, 592, 590, 588, 586, 584, 582, 580

STATE OF TEXAS
CRAIG E. BENNETT
GEOLOGY
LIC #1205
LICENSED
PROFESSIONAL GEOSCIENTIST

Craig E Bennett
06/12/2020

Note: Northing and Easting coordinates are State Plane Zone 4 South Central. Elevations are North American Vertical Datum of 1988.