CITY OF EDINBURG SOLID WASTE MANAGEMENT

PERMIT AMENDMENT APPLICATION

Part III, Attachment 4

GEOLOGY REPORT

Edinburg Regional Disposal Facility

Edinburg, Hidalgo County, Texas

TCEQ Permit MSW-956C

Submitted To: City of Edinburg
Department of Solid Waste Management
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Golder Associates

Table of Contents

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List of Tables

List of Figures

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List of Appendices

EXECUTIVE SUMMARY

This Geology Report is prepared and signed by a qualified groundwater scientist. Previously prepared documents supplement this report as necessary to provide the requested information. Sources and references for information are provided. This report summarizes available data related to regional geology and local geology and aquifers in the vicinity of the facility in accordance with 30 TAC §330.63(e). Based on a review of information gathered and on the results of subsurface, geotechnical, and hydrogeological investigations, the Edinburg Regional Disposal Facility is suitable for its continued operation and development as a municipal solid waste disposal facility.

1.0 REGIONAL GEOLOGY

The Gulf of Mexico (GOM) is a semi-enclosed ocean basin surrounded by continental shelves and coastal plains. The GOM's depositional system is a three-dimensional body of sediment deposited in a contiguous suite of process-related sedimentary environments and each sedimentary environment produces specific c facies / rock types. The stratigraphy along the GOM is composed of fluvial depositional systems created by regionally cyclic episodes of focused deposition and progradation of the shoreline followed by non-deposition and transgression of the coastal plain. The timing and cyclicity of progradational and transgressive events depends upon the interplay of sediment supply, subsidence, and sea-level change caused by both tectonic development and continental glaciation (Young, 2010).

In the Lower Rio Grande Valley (LRGV) the depositional stratigraphy described as the Gulf Coast Aquifer (GCA) are Quaternary and Neogene period sediments consisting primarily of fine to medium-grained materials deposited by fluvial and eolian processes. The outcrop of each progressively older, underlying unit is found to the west of the younger, overlying unit. Because of differential subsidence, units typically thicken and dip toward the coastline of the GOM.

1.1 Geologic Map

30 TAC §330.63(e)(1)(A)

Figure III4-1, Geologic Map presents the McAllen-Brownsville Sheet, Geologic Atlas of Texas prepared by the Bureau of Economic Geology. This map presents geologic units and structural features within the vicinity of the facility with text describing the stratigraphy and lithology of the map units. The facility is located on Neogene sediment overlain by Quaternary (Holocene) windblown (eolian) sediment.

1.2 Generalized Stratigraphic Column

30 TAC §330.63(e)(1)(B)

The generalized stratigraphic column of the area beneath the facility is presented to a depth of approximately 1,600 ft-bgs, which is the base of the Evangeline Aquifer. Based on Figure III4-1, Geologic Map and Figure III4-2, Regional Stratigraphic Cross-Section, the Goliad Formation outcrops in the vicinity and is overlain by a veneer of Holocene eolian deposits. A description of the stratigraphy, including geologic age, lithology including variations, thickness, depth, geometry, hydraulic conductivity, and depositional setting of each geologic unit, as available through current geologic information, is included in Table III4-1, Stratigraphic Units Underlying Facility.

Table III4-1: Stratigraphic Units Underlying Facility

System	Series	Age (M.Y.)	Stratigraphic Units	Lithology	Approx. Thickness (ft)	Approx. Depth (ft-bgs)	Geometry	Hydraulic Conductivity	Depositional Facies
Quaternary	Holocene	0.02	Stabilized Sand Dune Deposits	Sand; Silt	0-30	10	Sand sheets and dunes	Moderate to High	Eolian
Neogene	Miocene	4.4	Upper Goliad	Clay or Mud; Sandstone; Mudstone, Carbonate, Limestone, Conglomerate	400	400	Large planar, cross bedding, and lamination. Dips east towards GOM coastline; units thicken down dip	Moderate	Fluvial / Meander belt
		11.3	Lower Goliad		550	950			Lower Coastal Plain Fluvial / Coastal
		13.3	Upper Lagarto	Sandstone	650	1600			
		15.6	Middle Lagarto	Clay or Mud	700	2300		Low	

(Table compiled after Baker, 1979; Chowdhury and Mace, 2007; and Young et al., 2010)

1.2.1 Quaternary System

Surface deposits in the vicinity are primarily Holocene-age, eolian (windblown) deposits of the Quaternary Period. The eolian deposits are predominantly sand dunes, stabilized by vegetation, although recent blowout features are not uncommon. The dunes characteristically have moderate to very high permeability, low to moderate water-holding capacity, low shrink and swell potential, good to fair drainage, high shear strength, low plasticity, and a shallow water table where present (Barnes, 1976). Within the site, a thin veneer of eolian deposits exists across most of the area, except the north-eastern to south-eastern portion as depicted on Figure III4-1, Geologic Map.

1.2.2 Neogene System

The Neogene system underlies the Quaternary deposits and is divided into two series, the Pliocene and the Miocene. Pliocene sediments from youngest to older consist of Beaumont, Lissie, and Willis formations. Miocene sediments underlying the facility from youngest to older consist the Goliad and Lagarto Formations.

1.2.2.1 Goliad Formation

The Goliad Formation underlying the facility is further divided into upper and lower units. This formation includes fluvial deposits exhibiting large planar and trough crossbedding and horizontal lamination.

Deposits include successions of clay, marl, and caliche. Base elevations and thicknesses for the upper and lower Goliad Formation are presented on Figures III4-3 and III4-4 respectively.

The Upper Goliad's depositional facies is fluvial / meander belt. Fluvial channel-fill facies are composed mainly of medium- to coarse-grained sand and gravel, displaying large-scale cross-bedding. Inter-channel facies include sandy crevasse splays, and muddy floodplain and playa lake facies formed where flood waters breached channel levees and deposited broad aprons of sandy sediment on the floodplain. These facies surround channel-fill and crevasse-splay facies and were deposited across inter-channel areas during floods. Mottled red clays dominate floodplain successions, and secondary calichification and pedogenesis are pervasive. The Lower Goliad's depositional facies is lower coastal plain fluvial / coastal which includes small deltaic and barrier-lagoon depositional systems. Channel belt composition is sandy sediment whereas interchannel composition is calcareous mudstone (Young, 2010).

1.2.2.2 Lagarto Formation

The Lagarto Formation underlies the Goliad Formation and is divided into upper, middle, and lower units. Base elevations and thicknesses for the upper and middle Lagarto Formation are presented on Figures III4-5 and III4-6 respectively. The depositional facies underlying the facility is lower coastal plain fluvial / coastal which includes small deltaic and barrier-lagoon depositional systems. The Lagarto Formation represents a fluvial-deltaic depositional episode in which the upper Lagarto forms the upper progradational part, and the middle and lower Lagarto forms the lower retrogradational part. Therefore, the upper part is generally sand-rich, whereas the middle and lower parts are relatively more mud-rich. The mud-rich parts of the Lagarto are referred to as the Burkeville Aquitard which underlies the Evangeline Aquifer.

2.0 ACTIVE GEOLOGIC PROCESSES

30 TAC §330.63(e)(2)

A description of active geologic processes in the vicinity of the facility including identification of any faults and subsidence in the area of the facility is discussed in the following sections.

2.1 Erosion

Erosion potential caused by surface water processes such as overland flow, channeling, gullying, and wind has been evaluated.

2.1.1 Soils

Figure III4-7, Soils Map presents the distribution of six soil series, predominantly loamy, located across the facility according to the Soil Survey of Hidalgo County, Texas (Jacobs, 1981). These soil series include: the Brennan, Hebbronville (#22, #23, and #24), Hidalgo, Racombs, and Willacy Series. Table III4-2, Soil

Types lists sixteen soil types within the facility boundary, percentage of area covered, and potential for water and wind erosion.

Table III4-2: Soil Types

Soil	Unit Name	Area Covered[1] (%)	Water Erosion Hazard	Wind Blowing Hazard
3	Brennan fine sandy loam, 0 to 1 percent slopes	7.8	Slight	Moderate
9	Delfina loamy fine sand, warm, 0 to 2 percent slopes	4.2	Moderate	Severe
16	Hargill fine sandy loam, 0 to 1 percent slopes	9.5	Slight	Moderate
17	Hargill fine sandy loam, 1 to 3 percent slopes	6.6	Moderate	Moderate
22	Hebbronville sandy loam, 0 to 1 percent slopes	7.7	Slight	Moderate
23	Hebbronville sandy loam, 1 to 3 percent slopes	11.7	Moderate	Moderate
24	Hebbronville sandy loam, 3 to 5 percent slopes	8.9	Severe	Moderate
25	Hidalgo fine sandy loam, 0 to 1 percent slopes	9.1	Slight	Moderate
48	Racombes sandy clay loam	5.1	Slight	Slight
60	Rio clay loam	1.2	Moderate	Slight
70	Willacy fine sandy loam, 0 to 1 percent slopes	19.1	Slight	Moderate
71	Willacy fine sandy loam, 1 to 3 percent slopes	4.0	Moderate	Moderate

Notes:
1. The percentages do not add up to 100% due to part of the area being occupied by the landfill and ponds that are not accounted for in the data. The data is obtained from the NRCS Web Soil Survey Tool: http://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm

2.1.2 Surface Water Erosion

Surface water erosion will not adversely affect the operation of the facility. Gullying and channeling are uncommon in the area because of high infiltration rates and little relief. Soils in the area are well drained and have slopes of less than or equal to 5.2% (Jacobs et al., 1981). Sheet flow only occurs during very heavy rainfall as evident by lack of natural drainage features on or near the facility.

The soil types located in the facility are either slightly or moderately erodible by surface water with an exception of Hebbronville #24. This soil, located in the middle of the facility, exhibits severe water erosion potential and covers approximately nine percent of the facility. Most of this soil will be removed as development of the facility progresses.

An erosion and sedimentation control plan is included in Part III2, Surface Water Drainage Report of this application was developed to mitigate erosion potential along landfill embankments and sedimentation in surface water drainage features. Erosion and sediment controls will be implemented during the construction and operational periods of the facility.

2.1.3 Wind Erosion

Wind erosion will not adversely affect the operation of the facility. Prevailing winds can erode surface sediments in the area (Barnes, 1976). The soil types located in the facility are either slightly or moderately erodible by wind with an exception of Delfina #9. This soil, located in the south east corner of the facility, exhibits severe wind erosion potential and covers approximately four percent of the facility. This soil will be removed as development of the facility progresses for construction of a future perimeter berm, access road, and storm water pond.

2.2 Active Geological Faulting Assessment

30 TAC §330.555(b)

A location restriction criterion requires that new municipal solid waste landfill units and lateral expansions shall not be located within 200 feet of a fault that has had displacement in Holocene time (representing the most recent 10,000 years), referred to herein as an active fault. Sites located within areas that may be subject to differential subsidence or active geological faulting must include detailed fault studies. When an active fault is known to exist within 1/2 mile of the site, the site must be investigated for unknown faults. There is no evidence of active geological faulting or differential subsidence that would impair the integrity of any landfill component.

Salt domes cause much of the recent fault activity in the Gulf Coastal Plains. In Hidalgo County, salt domes are rare because the Jurassic salt layer, found throughout the Gulf Coast, is thin (Worral & Snelson, 1989). This occurrence has reduced recent fault activity to a minimum in Hidalgo County. The Geologic Atlas of Texas (McAllen-Brownsville Sheet) presented in Figure III4-1, Geology Map and Texas Water Development Board (TWDB) Reports (Young et al. 2010 and Mace et al. 2006) showing faults, were reviewed to determine the presence of faults within the vicinity. Based on the review of the maps and published literature, there are no faults or surface expression of Holocene faults indicated within a one-half-mile radius of the facility. As depicted on Figure III4-1, Geologic Map there are no mapped surface expressions of active or inactive faults located within at least a five-mile-radius of the facility.

2.3 Seismic Impact Zone Assessment

30 TAC §330.557

A location restriction criterion requires new municipal solid waste landfill units and lateral expansions shall not be located in seismic impact zones. A seismic impact zone is defined as an area with a 10-percent or greater probability that the maximum horizontal acceleration in lithified earth material, expressed as a percentage of the earth's gravitational pull (g), will exceed 0.10 g in 250 years.

The 2014 U.S. Geological Survey (USGS) National Seismic Hazard Maps display earthquake ground motions for various probability levels across the United States up to 50 years. According to the USGS, ground motion values having a 2% probability of exceedance in 50 years should be approximately the same as those having 10% probability of being exceeded in 250 years. Figure III4-8, Seismic Impact Zone Map shows the maximum horizontal acceleration is approximately 0.02g at the location of the facility. Because the maximum horizontal acceleration is less than 0.1g, the facility is not located in a seismic impact zone.

2.4 Unstable Area Assessment

30 TAC §330.559

An unstable area is defined to be a location that is susceptible to natural or human-induced events or forces capable of impairing the integrity of some or all of a landfill's structural components responsible for preventing releases from the landfill; unstable areas can include poor foundation conditions, areas susceptible to mass movement, and karst terrains. No unstable areas exist within the vicinity of the facility that would impair the integrity of any landfill components.

2.4.1 Local Soil Conditions

The soils within vicinity of the facility are predominantly sandy loam and have similar soil properties. They are well drained because of high infiltration rates and lack natural drainage features. No significant differential settling is anticipated.

2.4.2 Local Geologic or Geomorphologic Features

The lithology within the vicinity of the facility is moderately consistent and no indication of any karst conditions, active geological faulting, or presence of salt domes; therefore no differential subsidence is anticipated.

2.4.3 Local Human-Made Features

In Part III3, Waste Management Unit Design analyses were performed to assess the performance of the landfill with respect to slope stability and settlement using very conservation assumptions. Results of the analyses indicate slope stability and long-term settlement would not impair the performance of the leachate collection system during landfill.

3.0 EVANGELINE AQUIFER

30 TAC §330.63(e)(3)(A)

Significant regional aquifers in the vicinity of the facility are collectively grouped as the Gulf Coast Aquifer (GCA), which consists of the following aquifers listed youngest to oldest: the Chicot, the Evangeline, and the Jasper (Chowdhury and Mace 2007). Figure III4-9, Gulf Coast Aquifers in Lower Rio Grande Valley shows the outcrop areas of the different aquifers in the region.

Underlying the facility is the Evangeline Aquifer which overlies the Burkeville Confining Unit; their association with geologic units is presented in Table III4-3, Hydrogeologic Units Underlying the Facility.

Table III4-3: Hydrogeologic Units Underlying the Facility

System	Series	Stratigraphic Units	Lithology	Approx. Thickness (ft)	Approx. Depth (ft-bgs)	Hydro-stratigraphy	Water Bearing Properties
Quaternary	Holocene	Stabilized Sand Dune Deposits	Sand; Silt	0-30	10	Evangeline Aquifer	Moderate to very high permeability, low to moderate water-holding capacity.
Neogene	Miocene	Upper Goliad	Clay or Mud; Sandstone; Mudstone, Carbonate, Limestone, Conglomerate	400	400		Moderate permeability, moderate water-holding capacity. Provides water for domestic and irrigation uses.
		Lower Goliad		550	950		
		Upper Lagarto	Sandstone	650	1600		
		Middle Lagarto	Clay or Mud	700	2300	Burkeville Confining Unit	Regional aquitard, low permeability.

(Table compiled after Baker, 1979; Chowdhury and Mace, 2007; and Young et al., 2010)

3.1 Composition

30 TAC §330.63(e)(3)(B)

The Evangeline Aquifer is composed primarily of the Goliad Sand, but may also contain sections of sand and clay from the Upper Lagarto Formation. It is approximately 1,600 feet thick under the facility and dips towards the coast approaching thicknesses greater than 2,300 ft. Sand fractions in the Evangeline are observed to range from less than 0.4 to greater than 0.6 (Young et al., 2010).

3.2 Hydraulic Properties

30 TAC §330.63(e)(3)(C)

Transmissivity values are observed to range from 3,000 to 15,000 ft^2/day (Chowdhury and Mace, 2007). Average horizontal and vertical hydraulic conductivities are 80 feet/day and 1×10^{-3} feet/day, for horizontal and vertical, respectively (Ryder, 1988). The storativity of the Evangeline Aquifer ranges from 0.001 to 0.01 in the unconfined areas and 0.0004 to 0.001 in the confined areas (Chowdhury and Mace, 2007).

3.3 Under Water Table or Artesian Conditions

30 TAC §330.63(e)(3)(D)

The Evangeline Aquifer generally exists under water table conditions, however successions of clay may cause portions to behave as a semi-confined aquifer.

3.4 Hydraulic Connectivity

30 TAC §330.63(e)(3)(E)

The Evangeline Aquifer is hydraulically bounded by the underlying Burkeville Confining Unit, located at a depth of approximately 1600 ft, which separates it from the underlying Jasper Aquifer. Within the Goliad's sand-dominated fluvial systems, sand bodies are highly interconnected (Young, 2010).

3.5 Regional Water-Table Potentiometric Surface Maps

30 TAC §330.63(e)(3)(F)

Figure III4-10, Evangeline Aquifer Potentiometric Surface and Hydraulic Conductivity presents a regional potentiometric surface map which demonstrates the regional groundwater flow direction to the east/southeast.

3.6 Rate of Groundwater Flow

30 TAC §330.63(e)(3)(G)

The aquifers of the GCA dip towards the coast and groundwater flow is towards the Gulf of Mexico. The estimated average rate of horizontal groundwater flow for the Evangeline Aquifer is 80 ft/day (Ryder, 1988).

3.7 Total Dissolved Solids

30 TAC §330.63(e)(3)(H)

Typical range of values for total dissolved solids content of groundwater, mineral constituents dissolved from rocks and soils within the Evangeline Aquifer is 632 – 8,774 mg/L with a 0.0 to 0.2 fraction of aquifer thickness that is fresh water (Young, 2010). A general classification of water based on dissolved solids content is as follows; waters containing less than 1,000 mg/L of dissolved solids are considered fresh; 1,000 to 3,000 mg/L, slightly saline; 3,000 to 10,000 mg/L, moderately saline; 10,000 to 35,000 mg/L, very saline, and more than 35,000 mg/L, brine (Winslow and Kister, 1956, p.5)

3.8 Areas of Recharge

30 TAC §330.63(e)(3)(I)

The source of the water which recharges the associated hydrostratigraphic units of the GCA is from precipitation directly onto outcrops, discharging surface water in the Rio Grande and Arroyo Colorado Rivers, and irrigation return flow. According to Figure III4-9, Gulf Coast Aquifers in Lower Rio Grande Valley, the facility is located in a recharge area for the Chicot Aquifer. Figure III4-1, Geologic Map demonstrates Holocene-age eolian deposits overlying the Goliad Formation of the Evangeline Aquifer and the Lissie Formation of the Chicot Aquifer within a five-mile radius of the facility. Therefore, areas within a five-mile radius recharge both the Chicot and Evangeline Aquifers.

3.9 Local Groundwater Use

30 TAC §330.63(e)(3)(J)

The Rio Grande River is the primary source of domestic water in the Lower Rio Grande Valley. When groundwater is used, it generally comes from the thin layer of the Chicot aquifer, if present, or upper portions of the Evangeline aquifer. Groundwater wells within a one-mile-radius of the facility were located based on a water well database search of located wells from the Texas Water Development Board (TWDB) and on information supplied by the Red Sands Groundwater Conservation District (RSGCD). Figure III4-11, Water Well Location Map depicts approximate water well locations.

The TWDB database search identified six located water wells within a one-mile-radius of the facility summarized in Table III4-4A, Water Well Locations within One-Mile-Radius Provided by TWDB. From available screened depth information, total depths of these water wells range from 74 ft to 1250 ft and extend into the upper parts of the Evangeline Aquifer. In addition to the TWDB database search, RSGCD provided approximate locations for six additional water wells within a one-mile-radius of the facility summarized in Table III4-4B, Water Well Locations within One-Mile-Radius Provided by RSGCD. The locations of these additional wells or records could not be verified.

Table III4-4A: Water Well Locations within One-Mile-Radius Provided by TWDB

State Well Number	Map ID[1]	Latitude	Longitude	Surface Elev. (ft)	Total Depth (ft)	Screen Interval (ft)	Approx. Distance from site[2] (ft)	Water Use[3]
8739901	WW-1	26°24’06”N	98°08’16”W	86	258	NA	1,440	Domestic (P) Stock (S)
8739902	WW-2	26°23’41”N	98°08’29”W	84	240	160-240	2,230	Domestic (P) Stock (S)
8739903	WW-3	26°23’36”N	98°08’31”W	83	1125	NA	2,340	Irrigation

State Well Number	Map ID[1]	Latitude	Longitude	Surface Elev. (ft)	Total Depth (ft)	Screen Interval (ft)	Approx. Distance from site[2] (ft)	Water Use[3]
8740701	WW-4	26°24'48"N	98°06'25"W	87	223	124-155	4,740	Stock
8740702	WW-5	26°24'17"N	98°06'29"W	89	74	185-216	2,200	Stock
8740703	WW-6	26°24'59"N	98°06'59"W	101	1250	NA	5,150	Irrigation

1. Map ID as shown on Figure III4-7, Water Wells
2. Distances are estimated to nearest facility property boundary
3. (P) – primary water use; (S) – secondary water use (obtained from well logs)
4. NA – Information not available

Table III4-4B: Water Well Locations within One-Mile-Radius Provided by RSGCD

Well Reference/Owner Name	Map ID[1]	Latitude[2]	Longitude[2]	Approx. Distance from site[3] (ft)
E.B. Guerra Elementary School	WW-7	26°24'07"N	98°08'57"W	5,110
Garza Well	WW-8	26°24'04"N	98°08'50"W	4,480
Chandler Well	WW-9	26°24'07"N	98°08'26"W	2,390
Labus Water Well	WW-10	26°24'01"N	98°08'27"W	2,350
Gin Well	WW-11	26°24'29"N	98°08'14"W	3,200
Neal Well	WW-12	26°24'45"N	98°08'10"W	4,530

1. Map ID as shown on Figure III4-7, Water Wells
2. Well locations are approximately estimated based on hand-marked map provided by RSGCD, dated March 18, 2016
3. Distances are estimated to nearest facility property boundary.
4. Screened interval information of water wells from RSGCD are not available.

The facility's engineered design and operational groundwater monitoring mitigate potential impacts on groundwater use within the vicinity. The facility's waste disposal units are constructed with a low-permeability geosynthetic lining system to prevent potential contaminant transport into the groundwater. In an unlikely event contaminants are released, the facility's groundwater monitoring system will detect the release and corrective measures will be implemented. In addition, the closest water well has over 1,400 ft of separation from the facility property boundary; therefore, any contaminants will be attenuated or remediated prior to potential impacts on groundwater use.

4.0 SUBSURFACE INVESTIGATION

30 TAC §330.63(e)(4)

The subsurface investigation at the facility includes a description of all borings drilled on site to test soils and characterize groundwater. Geologic strata have been characterized to depths of up to 100 feet below ground surface from the current and previous subsurface investigations.

4.1 Soil Boring Plan

30 TAC §330.63(e)(4)

Presented in Appendix III4A, Soil Boring Plan (SBP) including locations and depths of all proposed borings for the expansion area was submitted to the TCEQ and approved prior to initiation of the subsurface investigation.

4.1.1 Number of Borings

30 TAC §330.63(e)(4)(A)

The SBP proposed 35 borings, a sufficient number of borings to establish subsurface stratigraphy and to determine geotechnical properties of the soils beneath the facility. The number of borings were determined based on general characteristics of the facility and on the heterogeneity of subsurface materials analyzed from previously performed subsurface investigations.

4.1.2 Depth of Borings

30 TAC §330.63(e)(4)(B)

The approved SBP proposed borings that are sufficiently deep enough to allow identification of the uppermost aquifer and underlying hydraulically interconnected aquifers. They penetrate the uppermost aquifer and are deep enough to identify the aquiclude at the lower boundary. All the borings are at least five feet deeper than the elevation of the deepest excavation, 70 ft-msl, and 18 of the 35 borings are at least thirty feet below the deepest excavation.

4.1.3 Established Field Exploration Methods

30 TAC §330.63(e)(4)(C)

All borings were conducted in accordance with established field exploration methods detailed in the approved SBP. The subsurface investigation, borings, and plugging and abandonment were conducted in accordance with applicable rules in 16 TAC §76 – Water Well Drillers and Water Well Pump Installers including the preparation and submittal of well installation and plugging reports. The drilling and sampling program of the SBP includes drilling methods, sampling plan, and boring log documentation.

4.2 Soil Boring Logs

30 TAC §330.63(e)(4)

Appendix III4B, Soil Boring Logs include a boring logs from the current and previous subsurface investigations. Boring logs from the current investigation outlined in the SBP include detailed description of materials encountered including any discontinuities such as fractures, fissures, slickensides, lenses, or seams. Each boring is presented in the form of a log that contains, at a minimum, the boring number; surface elevation and location coordinates; and a columnar section with text showing the elevation of all contacts between soil and rock layers, description of each layer using the unified soil classification, color, degree of compaction, and moisture content. A key explaining the symbols used on the boring logs and the classification terminology for soil type, consistency, and structure is provided. Water levels observed during drilling are indicated on the boring logs.

The current and previous subsurface investigations of the geology, geotechnical properties, and hydrogeology of the facility have resulted in a total of 99 borings including piezometers and monitoring wells. Figure III4-12A, Boring Location Map depicts the surveyed locations and elevation of all borings.

4.2.1 Previous Subsurface Investigations

The following previous investigations were prepared for the site in support of previous permitting activities:

- 1976 – Langley-Pittman Lab drilled a total of six borings (No.1 through No.6) within the then existing 100-acre facility, to characterize the original site. Borings were advanced to a depth of 40 ft. bgs.
- 1993 – Borings B-1 through B-5 were drilled by Professional Services Industries, Inc. (PSI) in 1993. B-5 was drilled to a depth of 100 feet BGS, while the each of the other boreholes went to a depth of 50 feet. This investigation included standard penetration test values (SPT) and pocket penetrometer shear strength values obtained during the field investigation. Further, index texting was performed in the laboratory for soil classification. This investigation was followed by the installation of groundwater monitoring wells MW-1 through MW-4 adjacent to B-1 to B-4.
- 1996 – Five soil borings, SB-01 through SB-05 were advanced to characterize the western portion of the contemporary expansion area during the geotechnical investigation conducted by Rust Environment and Infrastructure as part of the 100-acre expansion. Boreholes SB-01 to SB-04 were 40 feet deep, while SB-05 was drilled to a depth of 100 feet at the middle of the facility. SPT and pocket penetrometer values were obtained during the field investigation. Laboratory testing was performed to classify the soil and determine its permeability.
- 1996 – Four monitoring wells – MW-5 through MW-8 - were installed, each to a depth of 35 feet BGS, by Raba-Kistner-Brytest Consultants. The wells were installed to complete the groundwater monitoring system proposed in Permit No. 956A.
- 1999 – As part of the Permit Amendment No. 956B for landfill expansion, fourteen borings G-1 through G-14 were drilled by PSI. Golder performed oversight, logging, and laboratory testing. Thirteen of these borings were drilled to at least 30 feet, while the shallowest borings extended to at least 5 feet below the lowest excavation grades. SPT and pocket penetrometer values were obtained in the field and index tests were performed in the lab for soil classification. In addition permeability tests (ASTM D5084), unconfined compressive strength tests (ASTM D2166) and consolidation tests (ASTM D2435) were performed. In borings G-8 and G-9, groundwater piezometers, P-1 and P-2 were installed.
- 2000 – Geologic Drilling Inc. drilled six monitoring wells – MW-9 through MW-14, and Southern Ecology Management performed oversight and logging. The monitoring well screen intervals determined the depth of the borings.

- 2003 – CCI EnviroDrilling, Inc. plugged and re-installed monitoring wells MW-1 through MW-4. The wells were renamed MW-1R through MW-4R. Golder provided oversight.
- 2004 – EnviroCore, Inc. replaced the damaged MW-3R to installed MW-3RA. Golder provided oversight.
- 2005 – EnviroCore, Inc. installed MW-15 through MW-18 under Golder's oversight.
- 2009 – Lewis Environmental drilled three new wells – MW-22, MW-23, and MW-24. Several old wells were redrilled/replaced including MW-3A, MW-4A, MW-7R through MW-10R, MW-15R, MW-16R, and MW-18R. Golder provided oversight.
- 2013 – EnviroCore drilled two monitoring wells MWD-6 and MWD-7. Golder provided oversight.

Table III4-5A: Coordinates and Elevations of Previously Advanced Borings (ft)

Boring	Northing[2] (ft)	Easting[2] (ft)	Ground Elevation (ft-msl)	Depth (ft-bgs)	Bottom Elevation (ft-msl)
Langley-Pitman Testing Lab, 1976 (Soil Borings)					
No.1	16,668,336.87	1,105,717.33	91	40	51
No.2	16,669,135.55	1,105,455.21	86	40	46
No.3	16,669,867.66	1,105,398.98	87	40	47
No.4	16,670,296.17	1,104,238.29	86	40	46
No.5	16,668,738.00	1,104,072.69	91	40	51
No.6	16,668,807.16	1,105,020.81	91	40	51
Professional Services Industries, 1993 (Soil Borings and Monitoring Wells)					
B-1	16,670,435.62	1,104,102.38	85	50	35
B-2	16,668,479.69	1,103,794.80	85	50	35
B-3	16,668,153.82	1,105,849.69	91	50	41
B-4	16,670,034.21	1,106,143.67	88	50	38
B-5	16,669,351.49	1,105,106.22	90	100	-10
MW-1	16,670,435.62	1,104,102.38	85	27	58
MW-2	16,668,479.69	1,103,794.80	86	27	59
MW-3	16,668,153.82	1,105,849.69	90	30	60
MW-4	16,670,034.21	1,106,143.67	88	27	61
Rust Environment & Infrastructure, March 1996 (Soil Borings)					
SB-01	16,669,568.08	1,106,617.13	87	40	47
SB-02	16,668,575.32	1,106,460.78	83	40	43
SB-03	16,668,404.19	1,107,547.38	87	40	47
SB-04	16,669,396.95	1,107,703.73	91	40	51
SB-05	16,669,045.31	1,107,108.28	88	100	-12
Raba-Kistner-Brytest Consultants, December 1996 (Monitoring Wells)					

Boring	Northing[2] (ft)	Easting[2] (ft)	Ground Elevation (ft-msl)	Depth (ft-bgs)	Bottom Elevation (ft-msl)
MW-5	16,668,819.18	1,105,953.07	87	35	52
MW-6	16,669,467.10	1,106,057.05	84	35	49
MW-7	16,670,228.55	1,105,449.97	84	35	49
MW-8	16,670,327.25	1,104,791.54	84	35	49
Golder Associates/ PSI, 1999 (Soil Borings and Piezometers)					
G-1	16,670,047.99	1,106,483.70	87	50	37
G-2	16,669,792.20	1,107,218.82	88	50	38
G-3	16,669,634.68	1,108,135.47	96	58	38
G-4	16,669,719.89	1,108,864.82	100	62.5	38
G-5	16,669,445.90	1,107,174.40	88	25	63
G-6	16,669,189.68	1,108,692.02	106	68.5	38
G-7	16,669,169.33	1,106,288.59	83	45	38
G-8 (P-1)	16,668,919.88	1,107,855.10	87	50	37
G-9 (P-2)	16,668,473.27	1,107,013.57	83	45	38
G-10	16,668,500.43	1,108,575.37	98	60	38
G-11	16,668,298.65	1,108,146.76	86	48.5	38
G-12	16,668,075.59	1,106,168.70	88	50	38
G-13	16,668,028.30	1,107,311.54	84	46.5	38
G-14	16,667,706.94	1,108,555.69	87	50	37
Southern Ecology Management/ PSI, 2000 (Monitoring Wells)					
MW-9	16,669,138.78	1,103,896.60	88	37.7	50
MW-10	16,669,758.36	1,104,000.04	89	37.7	51
MW-11	16,670,047.99	1,106,483.70	88	37	51
MW-12	16,668,075.59	1,106,168.70	90	39.2	51
MW-14	16,669,719.89	1,108,864.82	100	55	46
Golder Associates/ CCI EnviroDrilling, Inc., 2003 (Monitoring Wells)					
MW-1R	16,670,499.43	1,104,230.98	85	29.5	55
MW-2R	16,668,462.15	1,103,807.64	87	31.5	55
MW-3R	N/A	N/A	NA	37	NA
MW-4R	16,670,139.26	1,106,060.54	89	37.5	51
Golder Associates/ EnviroCore, Inc., 2004 (Monitoring Well)					
MW-3RA	16,629,881.403	1,093,651.047	92	38	54
Golder Associates/ EnviroCore, Inc., 2005 (Monitoring Wells)					
MW-15	16,669,968.26	1,107,279.30	91	45	46

Boring	Northing[2] (ft)	Easting[2] (ft)	Ground Elevation (ft-msl)	Depth (ft-bgs)	Bottom Elevation (ft-msl)
MW-18	16,667,905.72	1,107,198.44	88	36.5	52
Golder Associates/ Lewis Environmental, April 2009 (Monitoring Wells)					
MW-3A	16,668,160.24	1,105,577.78	96	42.5	53
MW-4A	16,670,154.21	1,105,936.63	88	38	49
MW-7R	16,670,243.18	1,105,343.73	86	37	49
MW-8R	16,670,342.18	1,104,749.81	85	37	48
MW-9R	16,669,020.21	1,103,870.99	87	38	50
MW-10R	16,669,614.74	1,103,959.80	88	39	49
MW-15R	16,670,029.73	1,107,082.63	88	37.5	51
MW-16	16,669,910.05	1,107,645.48	86	34	53
MW-18R	16,667,889.53	1,107,351.67	85	33	52
MW-22	16,668,246.95	1,104,990.12	93	39	54
MW-23	16,668,348.50	1,104,397.05	88	28	60
MW-24	16,670,205.18	1,104,058.59	87	37	51
Golder Associates (2013) (Monitoring Wells)					
MWD-6	16,667,942.38	1,106,762.85	91	45	46
MWD-7	16,667,796.19	1,107,944.36	85	31	54

Notes: 1. NA – Information not available
2. Boring coordinates provided in Texas State Plane South Zone NAD83

4.2.2 Current Subsurface Investigation

The current subsurface investigation was performed in accordance with the approved SBP. A total of 35 borings were advanced in expansion area where all the borings are at least five feet deeper than the elevation of the deepest excavation, 70 ft-msl, and 18 of the 35 borings are at least thirty feet below the deepest excavation. Twelve borings were completed as piezometers to provide groundwater elevation data. The boreholes are identified as 101 through 135 with a prefix of ‘B-‘ for the boreholes and ‘PZ-‘ for the piezometers.

Table III4-5B: Coordinates and Elevations of Borings Advanced in the Expansion Area (ft)

Boring	Northing[1] (ft)	Easting[1] (ft)	Ground Elevation (ft-msl)	Depth (ft-bgs)	Bottom Elevation (ft-msl)
PZ-101	16,672,192.55	1,106,495.22	97.8	60	37.8
B-102	16,672,066.31	1,107,318.56	95.3	35	60.3
B-103	16,671,938.34	1,108,124.57	94.4	55	39.4
PZ-104	16,671,821.46	1,108,965.02	95.5	35	60.5

Boring	Northing[1] (ft)	Easting[1] (ft)	Ground Elevation (ft-msl)	Depth (ft-bgs)	Bottom Elevation (ft-msl)
B-105	16,671,681.02	1,109,781.78	88.7	50	38.7
PZ-106	16,671,555.69	1,110,594.81	84.8	30	54.8
B-107	16,671,516.22	1,106,392.87	87.9	25	62.9
B-108	16,671,377.05	1,107,210.46	98.3	60	38.3
B-109	16,671,251.10	1,108,033.90	87.9	25	62.9
B-110	16,671,136.94	1,108,850.76	92.1	55	37.1
B-111	16,671,002.92	1,109,671.86	89.1	30	59.1
B-112	16,670,874.68	1,110,498.71	86.8	50	36.8
PZ-113	16,670,843.25	1,106,277.71	85.8	50	35.8
B-114	16,670,703.98	1,107,109.34	91.6	30	61.6
B-115	16,670,592.78	1,107,899.67	99.3	62	37.3
PZ-116	16,670,444.83	1,108,755.73	93.2	30	63.2
B-117	16,670,335.07	1,109,568.12	91.8	55	36.8
PZ-118	16,670,193.76	1,110,392.83	89.4	35	54.4
B-119	16,669,643.34	1,109,465.29	84.3	25	59.3
B-120	16,669,515.09	1,110,285.15	92.8	55	37.8
B-121	16,669,413.56	1,111,072.66	94.5	32	62.5
PZ-122	16,669,091.56	1,111,975.25	92.2	55	37.2
B-123	16,668,982.12	1,109,304.96	83	45	38
PZ-124	16,668,836.59	1,110,178.48	97.6	40	57.6
B-125	16,668,708.21	1,111,001.47	94.9	60	34.9
B-126	16,668,443.85	1,111,760.57	93.3	30	63.3
B-127	16,668,290.12	1,109,248.44	94.3	45	49.3
B-128	16,668,168.26	1,110,069.45	98.2	60	38.2
B-129	16,668,024.21	1,110,893.17	100	35.3	64.7
PZ-130	16,667,916.49	1,111,609.19	100.5	65	35.5
PZ-131	16,667,606.90	1,109,142.73	96.3	60	36.3
B-132	16,667,493.43	1,109,964.91	94.9	35	59.9
PZ-133	16,667,399.31	1,110,759.32	98.2	60	38.2
PZ-134	16,670,873.39	1,104,174.27	82.4	45	37.4
B-135	16,670,700.05	1,105,208.90	83.1	22	61.1

Note: 1. Boring coordinates provided in Texas State Plane South Zone NAD83

4.2.3 Boring Installation, Abandonment, and Plugging

30 TAC §330.63(e)(4)(D)

Twelve borings were completed as piezometers in accordance with applicable rules in 16 TAC §76 – Water Well Drillers and Water Well Pump Installers to provide groundwater elevation data. The remaining borings were plugged with a cement-bentonite grout.

4.3 Interpretive Geologic Cross-Sections

30 TAC §330.63(e)(4)(G)

Interpretive geologic cross-sections are presented on Figures III4-12B through III4-12H and include a key map of the cross-section locations depicted on Figure III4-12A, Soil Boring Map. These cross-sections utilized boring information gathered from the current and previous subsurface investigations to show boring profiles relative to existing ground and interpretive soil stratum boundaries. The boring profiles include corresponding soil classifications, any static and initial water levels, and well screen locations for any piezometers and monitoring wells.

4.4 Subsurface Stratigraphy

30 TAC §330.63(e)(4)(H)

The results of the subsurface investigation is consistent with previous studies at the facility. The facility is underlain by three distinct strata, identified below in order from ground surface down:

- Stratum I: sandy clays or clayey sands, with layers of silty clay, silty sand, or clayey silt.
- Stratum II: sands/silty sands, fine, poorly graded, and is the uppermost water-bearing unit (uppermost aquifer).
- Stratum III: predominantly clay, with some amounts of sandy clay or silty clay, high plasticity, hard, brown, and dry, and is the confining unit underlying the uppermost water-bearing unit (lower confining unit).

5.0 GEOTECHNICAL PROPERTIES

30 TAC §330.63(e)(5)

5.1 Laboratory Testing

30 TAC §330.63(e)(5)(A)&(B)

Multiple samples were collected in accordance with the approved SBP including both Shelby tube and split-spoon samples. All soil samples were observed to determine the stratigraphy; a total of 81 soil samples were used for laboratory testing. Laboratory testing was performed on the selected samples in accordance with commonly accepted methods and practices of American Society for Testing and Materials (ASTM).

Falling head permeability tests were performed according to ASTM D5084, Standard Test Methods for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter, on undisturbed soil samples using tap water as the permeant. Five undisturbed samples that represent the sidewall of cell excavation were tested for the coefficient of permeability on the sample's in-situ horizontal axis; all others were tested on the in-situ vertical axis. Calculations for the final coefficient of permeability test results for each sample tested indicate the type of test used and the orientation of each tested sample.

Sieve analysis were performed using ASTM D422 and D1140; Atterberg limits per ASTM D4318; moisture content per ASTM D2216; the unit weight per ASTM D7263; and specific gravity per ASTM D854. Shear strength testing consisted of unconsolidated-undrained (UU) triaxial compression tests per ASTM D2850 and consolidation testing was performed per ASTM D2435.

Appendix III4C, Soil Laboratory Testing Data includes the aforementioned testing for the selected samples. A summary of the soil samples and their corresponding tests is provided in Table III4-6, Soil Sample Laboratory Testing Summary. Collectively, 61 samples from Stratum I, 10 samples from Stratum II, and 10 samples from Stratum III were tested. These strata collectively represent the bottom and side of the proposed excavation, as well as the 30 feet below the lowest elevation of excavation. Laboratory testing data from previous investigations are included in Appendix III4D, Previous Geotechnical Testing Data.

Table III4-6: Soil Sample Laboratory Testing Summary

Boring	Sample Depth (ft-bgs)	Stratum	ASTM Test Method							
			D 2216	D 4318	D 1140	D 7263	D 854	D 2850	D 2435	D 5084
			Water Content	Atterberg Limits	Sieve Analysis	Unit Weight	Specific Gravity	Triaxial U/U	Consolidation (ILC)	Permeability
B-102	3-5	I	✓	✓		✓				
B-102	15-17	I	✓							
B-102	23-25	I	✓	✓	✓			✓		
B-103	0-2	I	✓							
B-103	10-12	I	✓							
B-103	18-20	I	✓							
B-103	40-42	II	✓							
B-105	0-2	I	✓							
B-105	38-40	II			✓					
B-107	5-7	I	✓							
B-107	8-10	I	✓	✓	✓					
B-108	13-15	I	✓	✓	✓					

Boring	Sample Depth (ft-bgs)	Stratum	ASTM Test Method							
			D 2216	D 4318	D 1140	D 7263	D 854	D 2850	D 2435	D 5084
			Water Content	Atterberg Limits	Sieve Analysis	Unit Weight	Specific Gravity	Triaxial U/U	Consolidation (ILC)	Permeability
B-108	23-25	I	✓	✓			✓	✓		
B-108	53-55	II			✓					
B-109	0-2	I	✓	✓						
B-109	10-12	I	✓							
B-109	13-15	I	✓	✓	✓					✓(V)
B-110	6.5-8.5	I	✓		✓					
B-110	23-25	I	✓							✓(H)
B-110	30-32	I	✓	✓	✓					
B-111	0-2	I	✓							
B-111	18-20	I							✓	
B-112	0-2	I	✓	✓	✓					
B-112	10-12	I	✓							
B-112	43-45	II			✓					✓(V)
B-114	20-22	I	✓							
B-114	28-30	I			✓					
B-115	25-27	I	✓							
B-115	28-30	I	✓	✓	✓					
B-115	45-47	III	✓							
B-115	53-55	III	✓		✓					✓(H)
B-117	0-2	I	✓							
B-117	8-10	I		✓						
B-117	10-12	I	✓		✓					
B-117	30-32	II	✓							
B-117	53-55	III								✓(V)
B-119	10-12	I	✓							
B-119	13-15	I	✓	✓						
B-120	20-22	I	✓							
B-120	25-27	I	✓							
B-120	50-52	III	✓							
B-121	30-32	I	✓							
B-123	13-15	I	✓	✓	✓					
B-123	15-17	I	✓							
B-125	10-12	I	✓							
B-125	38-40	III		✓	✓			✓		✓(V)
B-125	43-45	III	✓		✓				✓	✓(H)
B-125	55-57	III	✓							
B-126	0-2	I	✓							
B-126	25-27	I	✓	✓						
B-127	0-2	I	✓							
B-127	25-27	I	✓							
B-127	38-40	II			✓					
B-128	45-47	II	✓	✓						
B-128	55-57	III	✓							

Boring	**Sample Depth (ft-bgs)**	**Stratum**	**ASTM Test Method**							
			D 2216	**D 4318**	**D 1140**	**D 7263**	**D 854**	**D 2850**	**D 2435**	**D 5084**
			Water Content	**Atterberg Limits**	**Sieve Analysis**	**Unit Weight**	**Specific Gravity**	**Triaxial U/U**	**Consolidation (ILC)**	**Permeability**
B-129	0-2	I	✓	✓	✓					
B-129	8-10	I	✓							
B-129	33-35	I	✓						✓	
B-132	18-20	I	✓	✓						
B-132	20-22	I	✓							
B-135	0-2	I	✓							
PZ-101	8-10	I	✓	✓	✓					
PZ-101	33-35	I			✓					
PZ-104	13-15	I	✓	✓	✓					
PZ-106	8-10	I	✓	✓	✓					
PZ-113	3-5	I	✓							
PZ-116	3-5	I	✓	✓	✓					
PZ-118	3-5	I								✓(H)
PZ-118	23-25	I	✓	✓	✓					
PZ-122	8-10	I								✓(H)
PZ-122	18-20	I	✓	✓	✓					
PZ-122	20-22	I	✓							
PZ-122	33-35	II			✓					
PZ-122	38-40	II	✓							
PZ-124	8-10	I	✓	✓	✓					
PZ-124	28-30	I	✓	✓	✓					
PZ-130	38-40	I	✓	✓	✓					
PZ-130	58-60	III	✓							
PZ-131	8-10	I	✓	✓	✓					
PZ-133	58-60	III	✓	✓	✓					
PZ-134	33-35	II	✓	✓	✓					

✓$_{(H)}$ denotes tested for the coefficient of permeability on the sample's in-situ horizontal axis.
✓$_{(V)}$ denotes tested for the coefficient of permeability on the sample's in-situ vertical axis.

5.2 Geotechnical Properties of the Subsurface Soil Materials

30 TAC §330.63(e)(5)

5.2.1 Stratum I

This stratum is described as sandy clays or clayey sands, with layers of silty clay, silty sand, or clayey silt that ranges in thickness from approximately 18 to 45 ft. The water table generally lies within the lower part of Stratum I. This Stratum roughly corresponds to the uppermost soil layer described in previous subsurface investigations. Table III4-7A summarizes the geotechnical properties of Stratum I.

Table III4-7A: Geotechnical Properties of Stratum I

	Minimum Value	Maximum Value	Average Value	Number of Tests	Test Method
Water Content (%)	3.7	33.5	13.6	55	ASTM D2216
Liquid Limit	20	58	30.5	22	ASTM D4318
Plastic Limit	10	19	13.25	16	ASTM D4318
Plasticity Index	9	43	19.88	16	ASTM D4318
Liquidity Index	-1	0.2	-0.10	16	ASTM D4318
Unconsolidated Undrained Compressive Strength (tsf)	1.6	3.7	2.6	2	ASTM D2850
Vertical Permeability (cm/s)	--	--	6.38×10^{-8}	1	ASTM D5084
Horizontal Permeability (cm/s)	5.78×10^{-7}	5.30×10^{-6}	1.32×10^{-6} *	3	ASTM D5084

Note: * = Geometric mean

5.2.2 Stratum II

Stratum II consists mainly of fine, poorly graded, sands or silty sand as encountered in most boreholes that were drilled past Stratum I. However, there were some boreholes containing more clayey sands than silty sands. This second layer ranges in thickness from approximately 5 to 30 ft and corresponds to the uppermost water-bearing unit (uppermost aquifer) described in previous subsurface investigations. Because the presence of overlying clayey soils in Stratum I, Stratum II can be a locally confined water-bearing unit. The minimum elevation where the top of Stratum II was encountered was approximately 51 ft-msl. The average top of the layer is approximately at elevation 62 ft-msl.

Table III4-7B summarizes the geotechnical properties of Stratum II. The geometric mean of the horizontal permeability measured from field slug tests presented in Appendix III4G, Slug Test data is 1.65×10^{-4} cm/s. The vertical permeability from laboratory soil testing is 1.91×10^{-4} cm/s.

Table III4-7B: Geotechnical Properties of Stratum II

	Minimum Value	Maximum Value	Average Value	Number of Tests	Test Method
Water Content (%)	4.3	24.1	17.9	5	ASTM D2216
Liquid Limit	–	–	–	–	ASTM D4318
Plastic Limit	–	–	–	–	ASTM D4318
Plasticity Index	–	–	–	–	ASTM D4318
Liquidity Index	–	–	–	–	ASTM D4318
Vertical Permeability (cm/s)	–	–	1.91×10^{-4}	1	ASTM D5084
Horizontal Permeability (cm/s)	3.74×10^{-6}	4.40×10^{-3}	1.65×10^{-4} *	–	ASTM D4044

Note: * = Geometric mean is presented for the permeability measured from slug tests performed as discussed in §6.5.2

5.2.3 Stratum III

Stratum III consists of predominantly high plasticity, hard, brown, dry clay with minor amounts of sandy clay or silty clay; caliche has been observed within the plastic clay. Stratum III corresponds to the lower confining unit described in previous subsurface investigations and hydraulically separates uppermost water-bearing unit from lower aquifers. The top of Stratum III was found between an approximate elevation of 39 ft-msl and 70 ft-msl with an average of approximately 50 ft-msl. The bottom of this stratum was only encountered in one historical boring. Borehole B-5, drilled by PSI in 1993, encountered a lower fourth stratum composed of clayey sand at an elevation 7 ft-msl to -5 ft-msl followed by fine sand down to -10 ft-msl. The thickness of Stratum III from this borehole is approximately 36 ft.

Table III4-7C summarizes the geotechnical properties of Stratum III. Based on the laboratory soil testing, the vertical and horizontal permeability of this layer are estimated to be 8.84×10^{-9} cm/s and 1.63×10^{-7} cm/s, respectively. The average permeability of Stratum III soil materials is three orders of magnitude lower than that of Stratum II. Hence, Stratum III acts as an aquiclude, restricting groundwater flow from vertical movement into underlying units.

Table III4-7C: Geotechnical Properties of Stratum III

	Minimum Value	Maximum Value	Average Value	Number of Tests	Test Method
Water Content (%)	17.6	33.9	24.2	8	ASTM D2216
Liquid Limit	56	60	58	2	ASTM D4318
Plastic Limit	16	18	17	2	ASTM D4318
Plasticity Index	38	44	41	2	ASTM D4318
Liquidity Index	-0.47	0.16	-0.16	2	ASTM D4318
Unconsolidated Undrained Compressive Strength (tsf)	5.0	--	--	1	ASTM D2850
Vertical Permeability (cm/s)	8.84×10^{-9}	6.84×10^{-5}	7.78×10^{-7} *	2	ASTM D5084
Horizontal Permeability (cm/s)	1.92×10^{-8}	1.38×10^{-6}	1.63×10^{-7} *	2	ASTM D5084

Note: * = Geometric mean

5.2.4 Suitability of Soils

On-site soils will be required for construction of the protective cover component of the liner system, for construction of the cohesive soil cover layer and erosion layer components of the final cover system, for daily and intermediate cover, and for general fill.

The construction of cohesive soil cover layers must be from compacted soils with hydraulic permeability less than 1×10^{-5} cm/s; laboratory soil testing demonstrate that excavated surface soils should meet this requirement. Also, excavated soils are suitable for operational and protective cover, erosion layer component of the final cover system, daily and intermediate cover, and general fill.

Part III3, Waste Management Unit Design Report includes detailed engineering evaluations and analyses using the geotechnical properties of on-site soils. The analyses indicate that the soils at the facility are suitable for the intended purpose.

6.0 GROUNDWATER INVESTIGATION

6.1 Local Hydrogeology

The second stratigraphic layer, Stratum II, which is composed of sands/silty sands, is the upper water bearing unit at the site (uppermost aquifer). As mentioned in §5.2.2, the thickness of Stratum II varies from 5 to 30 feet, except in portions of the northwest corner of the proposed expansion area where it was not encountered. The extent of this stratum can be seen in Figures III4-12B through III4-12H, which depicts the monitoring wells, borings and sub-surface profiles obtained from the soil investigations at the site. Groundwater occurs primarily within Stratum II, separated from lower aquifers by underlying Stratum III, which acts as an aquiclude. The groundwater within Stratum II is also locally, partially confined by the clayey soils encountered in Stratum I. In other areas, recharge could occur through vertical flows through overlying sandy soils. Recharge areas for the Gulf Coast Aquifers are shown in Figure III4-9, Gulf Coast Aquifers in Lower Rio Grande Valley. A detailed discussion of the groundwater conditions in the site area is presented in Part III5, Groundwater Characterization Report.

6.2 Groundwater Investigation

30 TAC §330.63(e)(5)(C)

Numerous subsurface investigations have been carried out at the facility for purposes related to geological and hydrogeological characterization, groundwater monitoring, and gas monitoring, as detailed in §4.2.1, Previous Subsurface Investigations. Initial and static water level data for these borings are compiled in Table III4-8.

Table III4-8: Summary of Initial and Static Water Level Data

Boring	Groundwater Elevation (ft-msl)		Boring	Groundwater Elevation (ft-msl)		Boring	Groundwater Elevation (ft-msl)		Boring	Groundwater Elevation (ft-msl)	
	Initial	Static		Initial	Static		Initial	Static		Initial	Static
No.1	18	NR	G-4	37.0	NR	GP-27	NR	NR	GP-46	NR	NR
No.2	21	NR	G-5	20.0	20.5	MW-3A	26.0	24.5	GP-47	NR	NR
No.3	21	NR	G-6	43.0	43.0	MW-4A	20.0	17.7	PZ-113	17.5	15.4
No.4	19.5	NR	G-7	20.0	19.7	MW-7R	26.0	19.3	B-114	23.0	NR
No.5	17	NR	G-8	18.0	23.5	MW-8R	6.0	4.1	B-115	35.0	NR
No.6	19	NR	G-9	20.5	20.0	MW-9R	13.0	16.6	PZ-116	25.0	23.5
B-1	18	NR	G-10	36.0	39.5	MW-10R	14.0	15.8	B-117	30.0	NR

Boring	Groundwater Elevation (ft-msl)		Boring	Groundwater Elevation (ft-msl)		Boring	Groundwater Elevation (ft-msl)		Boring	Groundwater Elevation (ft-msl)	
	Initial	Static		Initial	Static		Initial	Static		Initial	Static
B-2	23	NR	G-11	23.0	24.0	MW-15R	20.5	17.1	PZ-118	30.0	27.4
B-3	NR	20.5	G-12	22.0	21.5	MW-16	20.0	16.2	B-119	15.0	NR
B-4	25	21.5	G-13	19.5	20.0	MW-18R	10.6	14.9	B-120	30.0	NR
B-5	NR	20.8	G-14	23.0	22.0	MW-22	24.5	24.5	B-121	NE	NR
MW-1	NR	19.7	P-1 (G-8)	18.0	23.5	MW-23	16.8	17.1	PZ-122	40.0	35.9
MW-2	NR	20.81	P-2 (G-9)	20.5	20.0	MW-24	15.8	16.6	B-123	15.0	NR
MW-3	NR	NR	MW-9	NR	NR	MWD-7	17.0	19.0	PZ-124	35.0	30.2
MW-4	NR	NR	MW-10	NR	NR	MWD-6	NR	NR	B-125	40.0	NR
SB-01	22.5	22.6	MW-11	NR	NR	PZ-101	28.0	29.2	B-126	NE	NR
SB-02	16.4	17	MW-12	NR	NR	B-102	28.0	NR	B-127	35.0	NR
SB-03	24	20.9	MW-13	NR	NR	B-103	25.0	NR	B-128	30.0	NR
SB-04	25.2	25.2	MW-14	NR	NR	PZ-104	29.0	28.5	B-129	NE	NR
SB-05	26.5	21	MW-1R	20.0	14.2	B-105	23.0	NR	PZ-130	30.0	34.1
MW-5	26	NR	MW-2R	19.0	23.2	PZ-106	24.5	25.8	PZ-131	33.0	25.9
MW-6	24	NR	MW-3R	30.0	28.2	B-107	18.0	NR	B-132	30.0	NR
MW-7	26	NR	MW-4R	23	NR	B-108	30.0	NR	PZ-133	34.0	19.9
MW-8	30	NR	MW-3RA	30.0	NR	B-109	22.5	NR	PZ-134	15.0	10.4
G-1	20	22.5	MW-15	22.5	24.4	B-110	31.5	NR	B-135	NE	NR
G-2	20.0	23.5	MW-18	22.0	22.3	B-111	20.0	NR			
G-3	37.5	34.5	GP-37	25.0	NR	B-112	25.0	NR			

Note: NR – Not recorded; NE – Not encountered in borehole
Piezometer readings were measured during the first groundwater level monitoring event following their installation.

6.3 Historical Water-Level Measurements in Monitoring Wells

30 TAC §330.63(e)(5)(D)

Water level data collected from April 1993 to December 2016 for 21 existing monitoring wells and 12 newly installed piezometers. Historic water-level measurements made during any previous groundwater monitoring are presented in a table for each monitoring well and piezometer in Appendix III4E, Historic Groundwater Elevations.

Using data from February 2015 to December 2016, potentiometric maps of the uppermost aquifer present on-site were prepared and are included as Figures III4-13A through III4-13N. A seasonal high potentiometric surface is presented in Figure III4-13O.

6.4 Tabulation of Groundwater Monitoring Data

30 TAC §330.63(e)(5)(E)

A tabulation of all relevant groundwater monitoring data from wells on site is presented in Appendix III4F, Historic Groundwater Quality Testing Data. The groundwater monitoring data includes results of all semi-annual and applicable quarterly groundwater monitoring events since 1999. Verification resamples, if collected as part of the statistical analysis, are also included.

6.5 Uppermost Aquifer

30 TAC §330.63(e)(5)(F)

Based upon an evaluation of the soil boring and groundwater data from subsurface investigations, the uppermost water-bearing unit (uppermost aquifer) is identified as Stratum II. Based on hydrogeologic investigations of the facility area, vertical flow is restricted by underlying low permeability Stratum III clays that act as a local aquiclude dividing the uppermost water-bearing unit from lower aquifers.

6.5.1 Groundwater Flow Direction

Figures III4-13A through III4-13N, Potentiometric Surfaces demonstrate groundwater flow direction across the facility. Groundwater within the currently permitted area of TCEQ Permit MSW-956B has a very low hydraulic gradient with variable flow directions. The hydraulic gradients range from 0.000003 to 0.012 with an average gradient of 0.0013. Within the expansion area to be included in TCEQ Permit MSW-956C, groundwater flow is predominantly towards the east, northeast, or southeast in subdued conformance to topography. The hydraulic gradients range from 0.0001 to 0.012 with an average gradient of 0.0040.

6.5.2 Groundwater Flow Rate

Previous investigations performed slug testing within the currently permitted area of TCEQ Permit MSW-956B to determine hydraulic properties of Stratum II, uppermost water-bearing unit (uppermost aquifer), resulting in a hydraulic conductivity of 1.80×10^{-3} cm/s. Slug testing was performed on the twelve piezometers installed during the latest subsurface investigation as well within the expansion area to be included in TCEQ Permit MSW-956C to determine hydraulic properties of Stratum II. These tests were conducted using the falling and rising head methods, whereby the water levels were displaced by introducing a “slug” into the water column. The drop and subsequent rise (following removal of the slug) in water level were monitored with respect to time to determine the horizontal hydraulic conductivity for each piezometer. Hydraulic conductivity values determined using AqteSolv Pro® software for each slug test is included in Appendix III4G, Slug Tests. The geometric mean of the resulting hydraulic conductivity values is 1.65×10^{-4} cm/s.

Groundwater flow rates were estimated for Stratum II, uppermost water-bearing unit (uppermost aquifer), using estimated hydraulic gradients, estimated hydraulic conductivities, and effective porosity for silty sand using the following formula: $V = (ki)/n_e$.

Where: V = velocity
k = horizontal permeability
i = gradient
n_e = effective porosity

Table III4-9: Groundwater Flow Rates

Area of Evaluation	Hydraulic Conductivity (k) (cm/s)	Hydraulic Gradient (i) (ft/ft)*	Effective Porosity (n_e)**	Groundwater flow rate (V) (ft/yr)
Currently Permitted Area (TCEQ Permit MSW-956B)	1.80×10^{-3}	0.0013	0.33	7.4
Expansion Area (Included in TCEQ Permit MSW-956C)	1.65×10^{-4}	0.0040	0.33	2.0

* Gradient estimated from monthly potentiometric maps from February 2015 to December 2016.
** Assumed for fine sands with some silt based on Freeze and Cherry (1979).

7.0 REFERENCES

Baker, E.T., Jr. 1979. Stratigraphic and hydrogeologic framework of part of the coastal plain of Texas. (Water Resources Report 236). Austin, TX. Texas Department of Water Resources, 43 pp. https://www.twdb.state.tx.us/publications/reports/numbered_reports/doc/R236/R236.pdf (accessed October 2014)

Barnes, Virgil E. 1976. Geologic Atlas of Texas, McAllen-Brownsville Sheet. University of Texas at Austin, Bureau of Economic Geology.

Chowdhury, Ali and Robert E. Mace. 2007. Groundwater Resource Evaluation and Availability Model of the Gulf Coast Aquifer in the Lower Rio Grande Valley of Texas. (Report 368). Austin, TX. Texas Water Development Board, 129 pp. Available online at the following address: http://www.twdb.state.tx.us/publications/reports/numbered_reports/doc/R368/R368_GulfCoastGAM.pdf (accessed October 2014)

Freeze, R. A. and J. A. Cherry. Groundwater. Prentice-Hall, Englewood Cliffs, NJ, 604 p, 1979.

Jacobs, Jerry L. 1981. Soil Survey of Hidalgo County, Texas, United States Department of Agriculture, National Cooperative Soil Survey, 171 pp.

Maxcy, K.F. 1950. Report of the Relation of Nitrate Concentration in Well Waters to the Occurance of Methemoglobinemia in Infants. National Research Council Bulletin, Sanitary Engineering and Environment, Appendix D., 271 pp.

McCoy, Wesley. T. 1990. Evaluation of Ground-Water Resources In the Lower Rio-Grande Valley, Texas. Texas Water Development Board, Report 316.

Meier, F.J.1950. Fluoridation of Public Water Supplies. American Water Works Association Journal 42(12): pp. 1120-1132.

Natural Resources Conservation Service, United States Department of Agriculture. Web Soil Survey. Available online at http://websoilsurvey.nrcs.usda.gov/. Accessed June 2015.

Price, W.A. 1934. Lissie Formation and Beaumont Clay in South Texas. *Bulletin of the American Association of Petroleum Geologists* v.18, no.7: pp. 948-959

Ryder, Paul D. 1988. Hydrogeology and Predevelopment Flow in the Texas Gulf Coast Aquifer Systems. (USGS Water Resources Investigations Report 87-4248). Austin, TX: US Geological Survey, 116 pp. Available on the Web at: http://pubs.er.usgs.gov/publication/wri874248 (accessed October 2014)

Southern Ecology Management. 2008, Groundwater Characterization Report, Permit Amendment Application No. 956-B, Edinburg Sanitary Landfill, Hidalgo County, Texas.

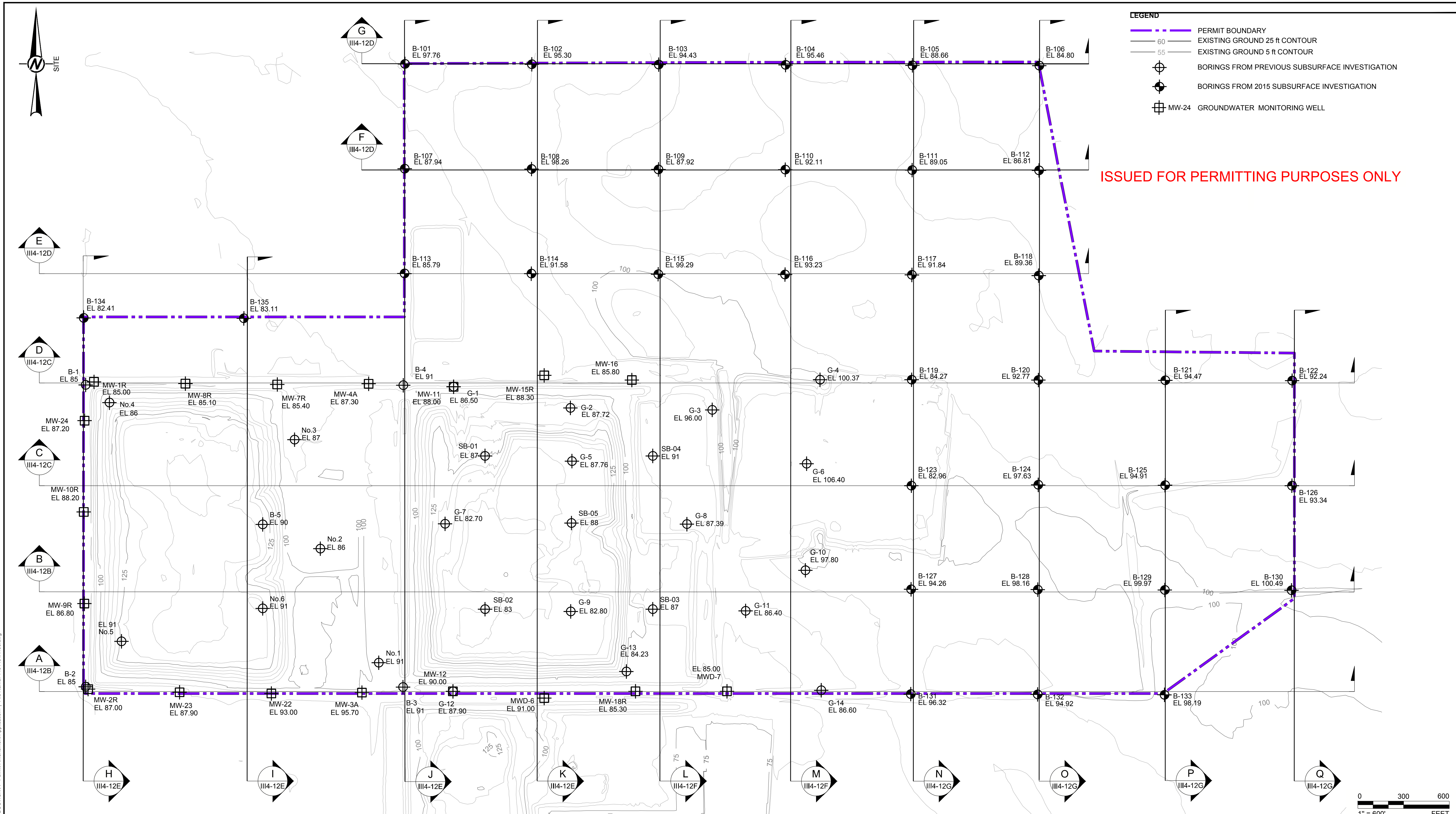
Texas Department of Health. 1977. Drinking Water Standards Governing Drinking Water Quality and Reporting Requirements for Public Water Supply Systems (November 1980 Revision). Austin, TX: Texas Department of Health, Division of Water Hygiene, 20 pp.

U.S. Salinity Laboratory Staff. 1954. Diagnosis and Improvement of Saline and Alkali Soils, in Agriculture Handbook No. 60, edited by L.A. Richards. Washington D.C.: US Department of Agriculture, 166 pp. http://www.ars.usda.gov/sp2UserFiles/Place/53102000/hb60_pdf/hb60complete.pdf (accessed October 2014)

Winslow, A.G. and L.R. Kister. 1956. Saline-water Resources of Texas. (USGS Water Supply Paper 1365). Washington, DC: US Geological Survey, 114 pp. Available on the web at: http://pubs.usgs.gov/wsp/1365/report.pdf (Accessed October 2014)

Worral, D.M. and S. Snelson. 1989. Evolution of the Northern Gulf of Mexico, with an Emphasis on Cenozoic Growth Faulting and the Role of Salt, in The Geology of North America - An Overview, edited by A.W. Bally and A.R. Palmer. Boulder, CO: Geological Society of America, 97-138 pp.

Young, Steven C., Trevor Budge, Paul R. Knox, Robert Kalbouss, Ernie Baker, Scott Hamlin, Bill Galloway, and Neil Deeds. 2010. Hydrostratigraphy of the Gulf Coast Aquifer from the Brazos River to the Rio Grande. (Contracted Report 0804830795). Austin, TX: Texas Water Development Board, 213 pp. Available online at: http://www.twdb.state.tx.us/publications/reports/contracted_reports/doc/0804830795_Gulf_coast_hydrostratigraphy_wcover.pdf (accessed October 2014)



REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
1	2017-11-07	RESPONSE TO TCEQ FIRST NOTICE OF DEFICIENCY	CEI	TNB	CGD	CEI
0	2017-07-21	ISSUED FOR CLIENT REVIEW	CEI	AA	JAW	CEI

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PROJECT
EDINBURG REGIONAL DISPOSAL FACILITY
PERMIT AMENDMENT APPLICATION TCEQ PERMIT MSW-956C
EDINBURG, HIDALGO COUNTY, TEXAS

TITLE
BORING LOCATION MAP

PROJECT NO.	APPLICATION SECTION	REV.		FIGURE
1401491	III4	1	12 of 33	III4-12A

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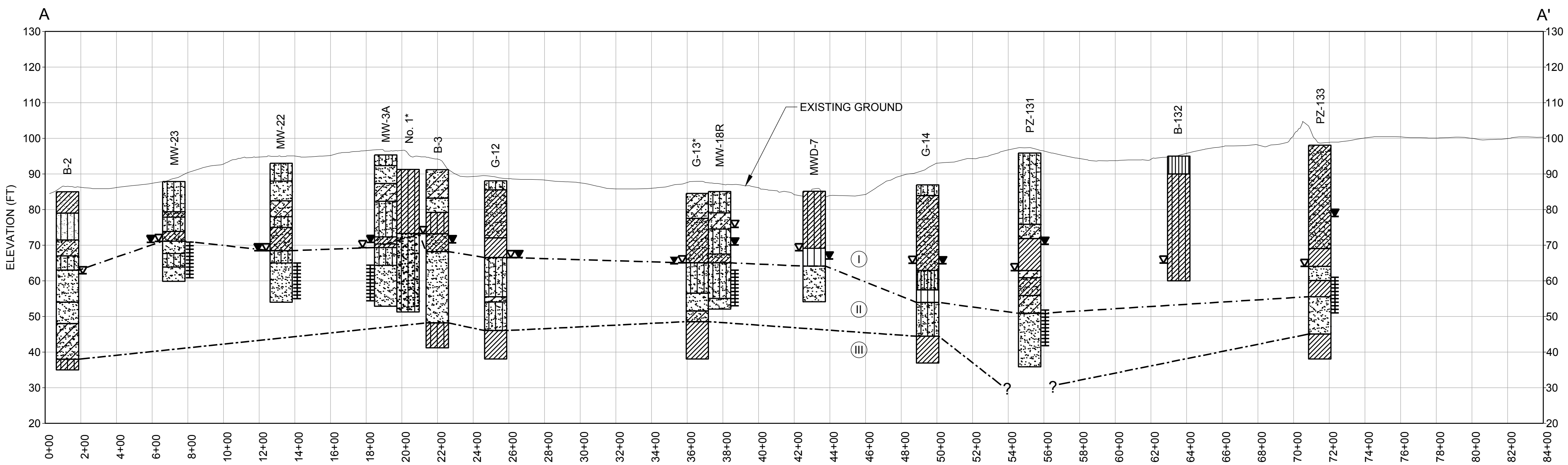

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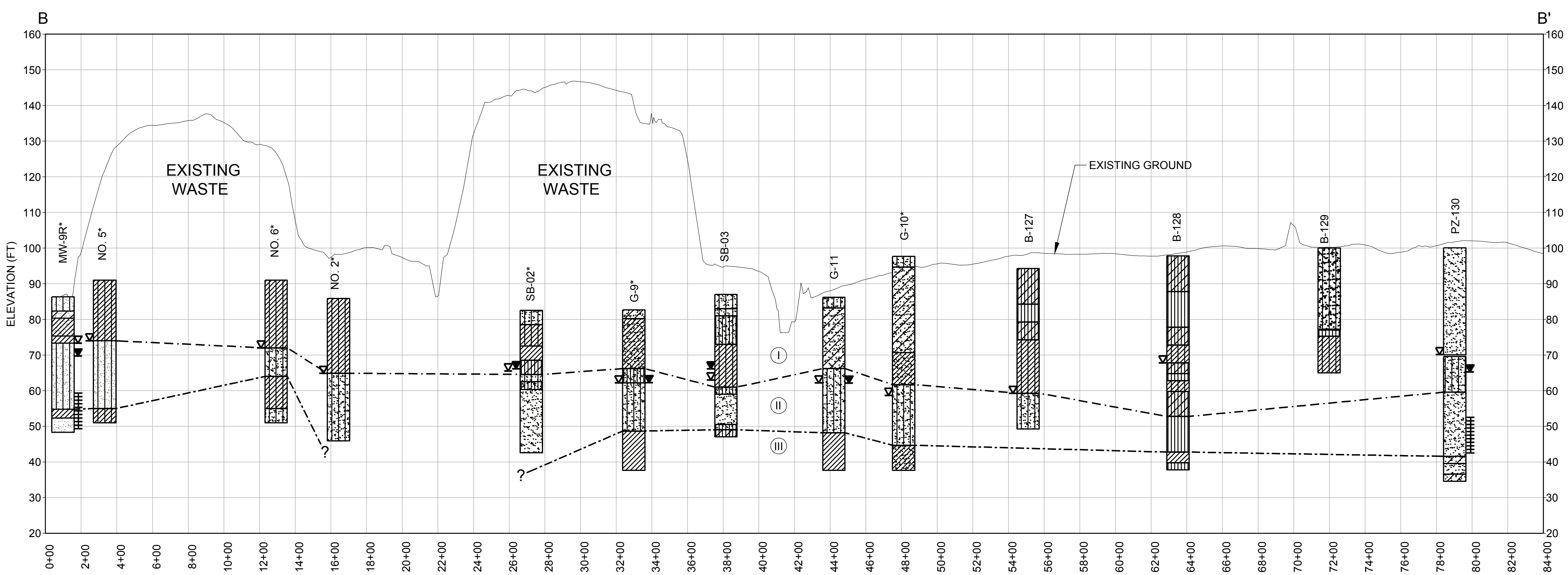

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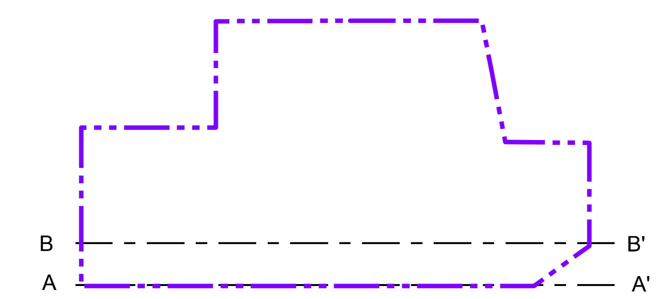
KEY MAP



LEGEND

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- ? END OF DATA FOR TOP OF STRATUM II
- ? END OF DATA FOR TOP OF STRATUM III
- No. 2 LANGLEY-PITMAN 1976 BORINGS
- B-3 PSI 1993 BORINGS
- SB-01 RUST 1996 BORINGS
- PZ-101/B-103 GOLDER 2015 BORINGS
- STATIC WATER LEVEL
- INITIAL WATER LEVEL
- SCREENED INTERVAL
- I II III STRATUM IDs

SOIL CLASSIFICATION

TOP SOIL, SILTY SAND, CLAYEY SAND, NO RECOVERY, SILT, SILTY CLAY, CLAYEY SILT, SAND, SANDY SILT, SANDY SILTY CLAY, CLAY, SANDY CLAY, SILTY CLAYEY SAND

* BORINGS EXTRAPOLATED TO THE LINE OF CROSS-SECTION

BORING	EXTRAPOLATED DISTANCE (ft) AND OFFSET DIRECTION
No. 1	189.1 N
No. 2	283.5 S
No. 5	325.5 S
No. 6	108.5 S
G-9	130.0 S
G-10	142.0 N
G-13	131.5 N
MW-9R	77.1 S
SB-02	113.3 S

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0 400 800
1" = 800' FEET

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1	2017-11-07	RESPONSE TO TCEQ FIRST NOTICE OF DEFICIENCY	CEI	TNB	CGD	CEI
0	2017-07-21	ISSUED FOR CLIENT REVIEW	CEI	AA	JAW	CEI

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EDINBURG, HIDALGO COUNTY, TEXAS

TITLE
INTERPRETIVE GEOLOGIC CROSS-SECTION I

PROJECT NO.	APPLICATION SECTION	REV.	13 of 33	FIGURE
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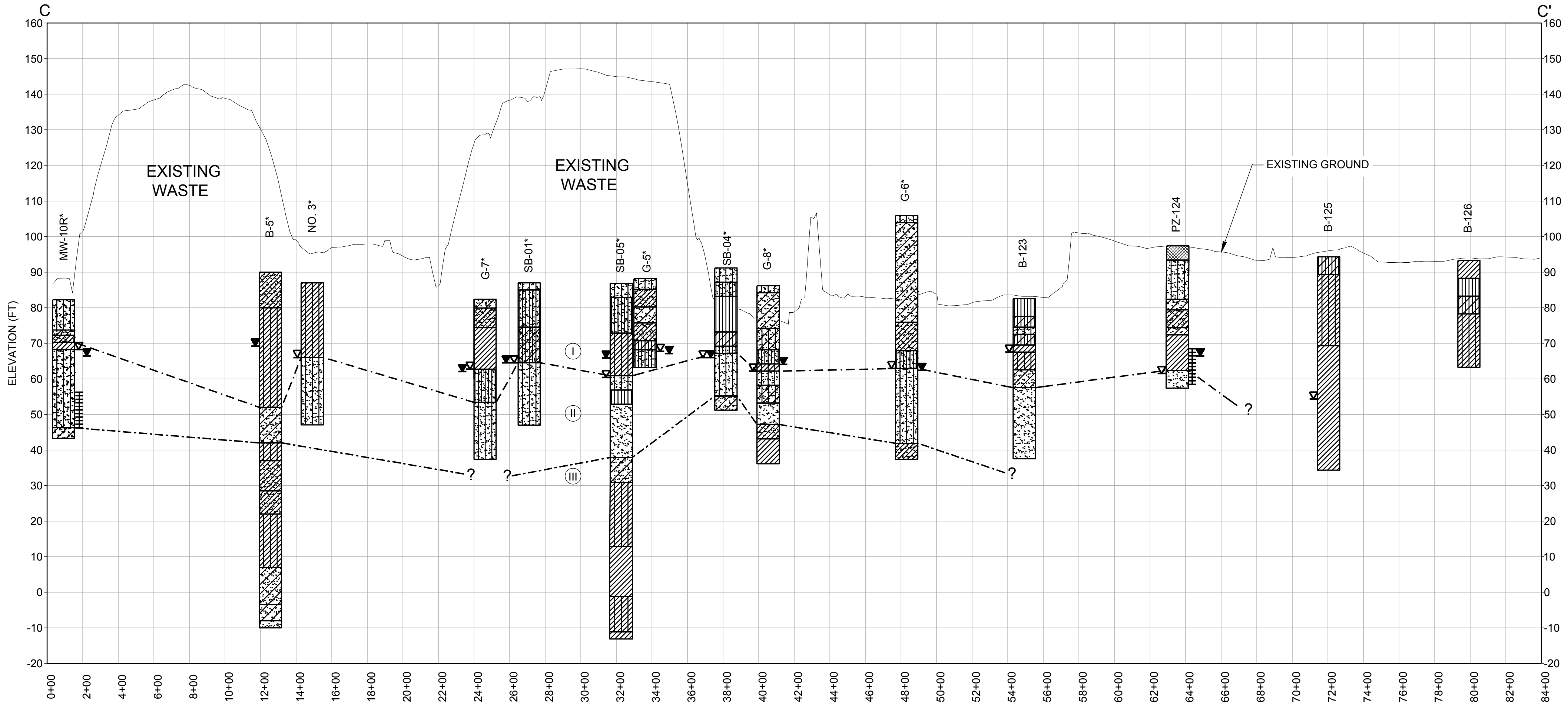

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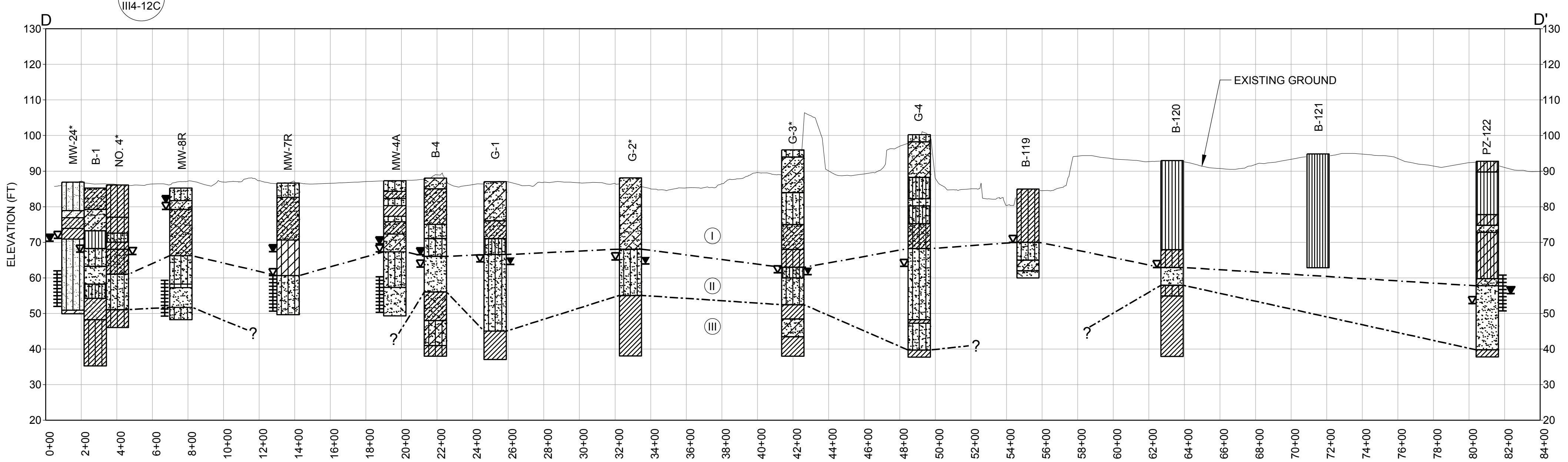

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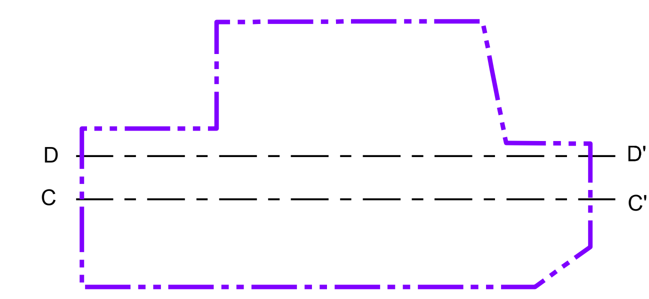
KEY MAP



LEGEND

- EXISTING GROUND
- END OF DATA FOR TOP OF STRATUM II
- END OF DATA FOR TOP OF STRATUM III
- No. 2 LANGLEY-PITMAN 1976 BORINGS
- B-3 PSI 1993 BORINGS
- SB-01 RUST 1996 BORINGS
- PZ-101/B-103 GOLDER 2015 BORINGS
- STATIC WATER LEVEL
- INITIAL WATER LEVEL
- SCREENED INTERVAL
- I II III STRATUM IDs

SOIL CLASSIFICATION

TOP SOIL, SILTY SAND, CLAYEY SAND, NO RECOVERY, SILT, SILTY CLAY, CLAYEY SILT, SAND, SANDY SILT, SANDY SILTY CLAY, CLAY, SANDY CLAY, SILTY CLAYEY SAND

* BORINGS EXTRAPOLATED TO THE LINE OF CROSS-SECTION

BORING	EXTRAPOLATED DISTANCE (ft) AND OFFSET DIRECTION
No. 3	301.5 N
No. 4	130.0 S
B-5	254.0 S
G-2	164.0 S
G-3	177.0 N
G-5	161.0 N
G-6	106.4 N
G-7	250.0 S
G-8	252.7 S

BORING	EXTRAPOLATED DISTANCE (ft) AND OFFSET DIRECTION
MW-10R	189.1 N
MW-24	283.5 S
SB-01	325.5 S
SB-04	108.5 S
SB-05	130.0 S

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0 400 800
1" = 800' FEET

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1	2017-11-07	RESPONSE TO TCEQ FIRST NOTICE OF DEFICIENCY	CEI	TNB	CGD	CEI
0	2017-07-21	ISSUED FOR CLIENT REVIEW	CEI	AA	JAW	CEI

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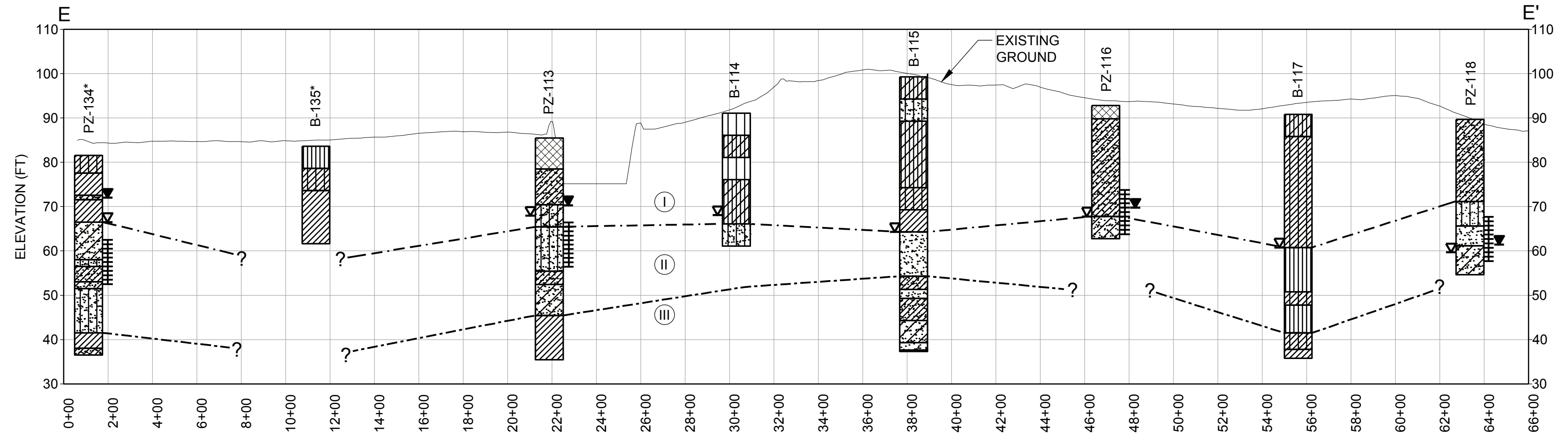
EDINBURG, HIDALGO COUNTY, TEXAS

TITLE
INTERPRETIVE GEOLOGIC CROSS-SECTION II

PROJECT NO.	APPLICATION SECTION	REV.		FIGURE
1401491	III4	1	14 of 33	III4-12C



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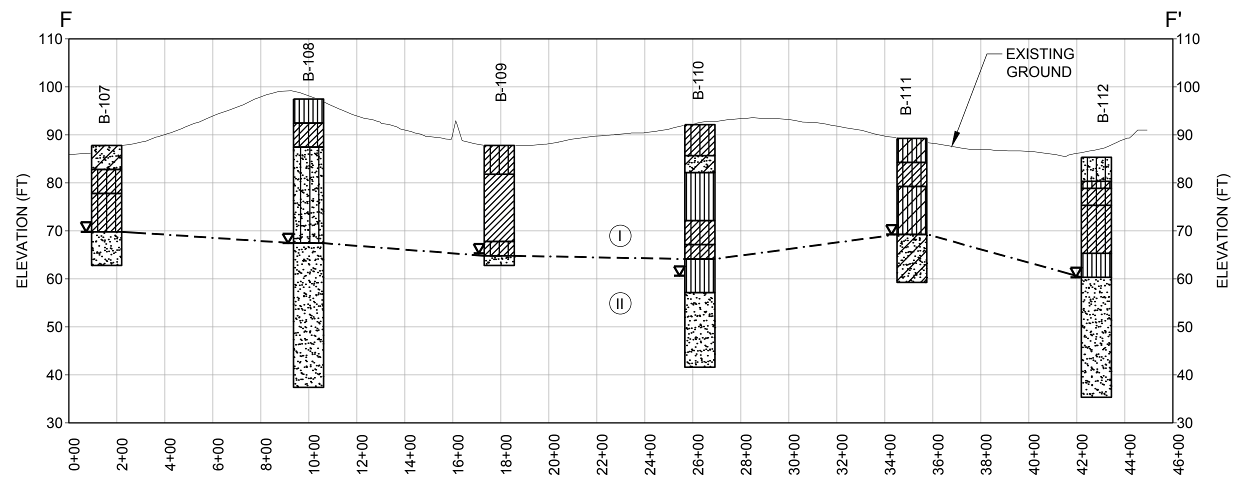

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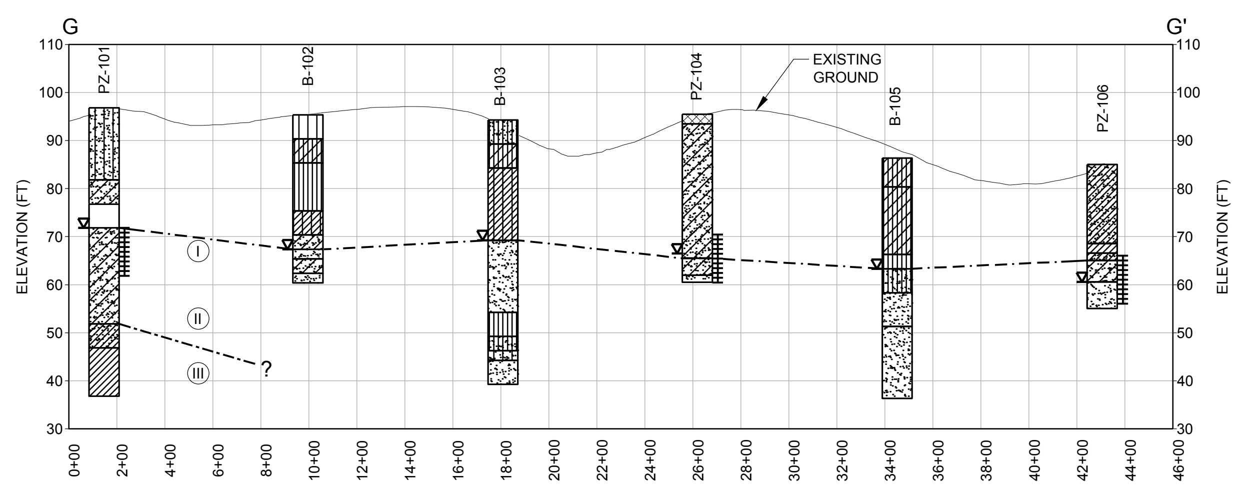

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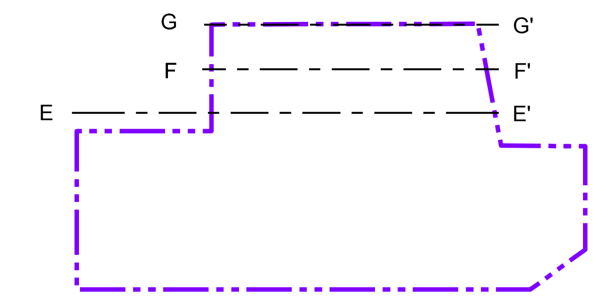
KEY MAP



LEGEND

- EXISTING GROUND
- END OF DATA FOR TOP OF STRATUM II
- END OF DATA FOR TOP OF STRATUM III
- No. 2 LANGLEY-PITMAN 1976 BORINGS
- B-3 PSI 1993 BORINGS
- SB-01 RUST 1996 BORINGS
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- STATIC WATER LEVEL
- INITIAL WATER LEVEL
- SCREENED INTERVAL
- I II III STRATUM IDs

SOIL CLASSIFICATION

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*** BORINGS EXTRAPOLATED TO THE LINE OF CROSS-SECTION**

BORING	EXTRAPOLATED DISTANCE (ft) AND OFFSET DIRECTION
B-134	290.0 S
B-135	292.9 S

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0 400 800
1" = 800' FEET

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
1	2017-11-07	RESPONSE TO TCEQ FIRST NOTICE OF DEFICIENCY	CEI	TNB	CGD	CEI
0	2017-07-21	ISSUED FOR CLIENT REVIEW	CEI	AA	JAW	CEI

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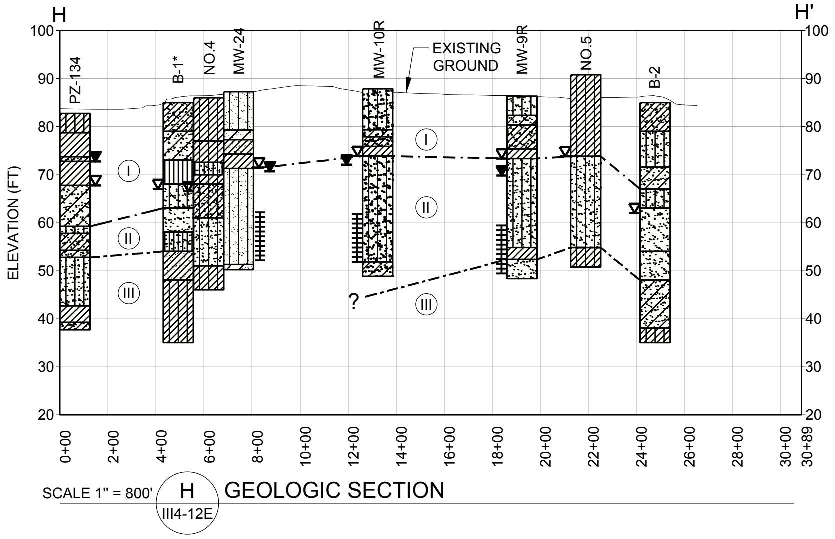
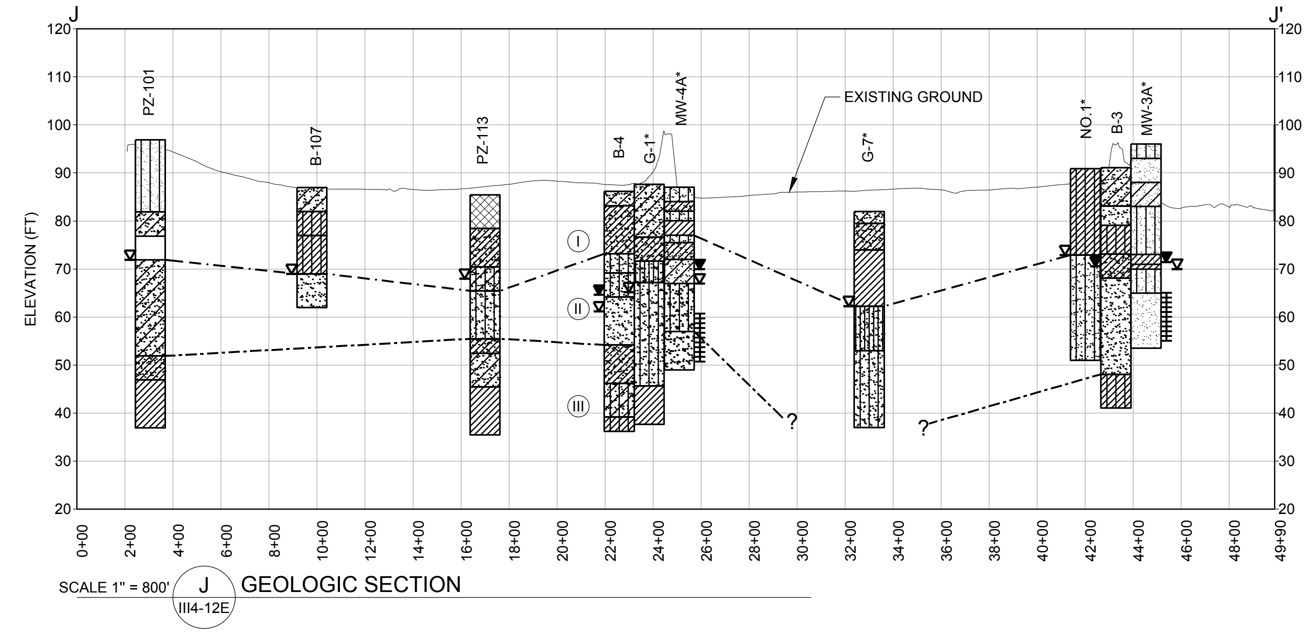
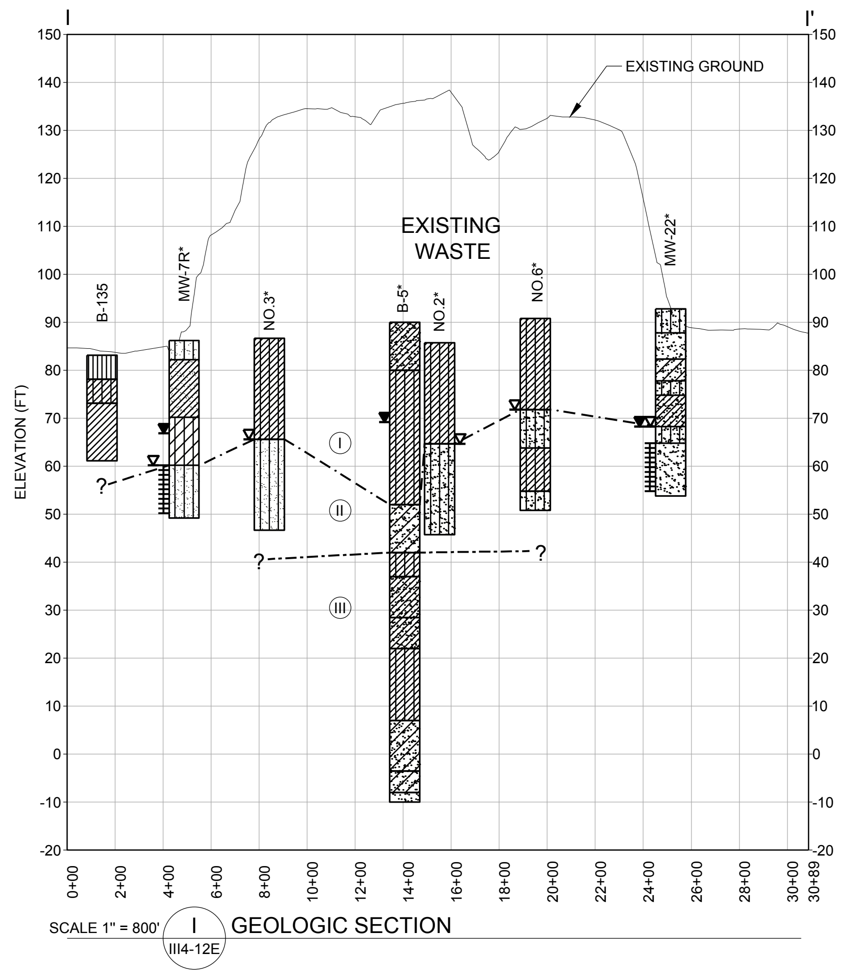
EDINBURG, HIDALGO COUNTY, TEXAS

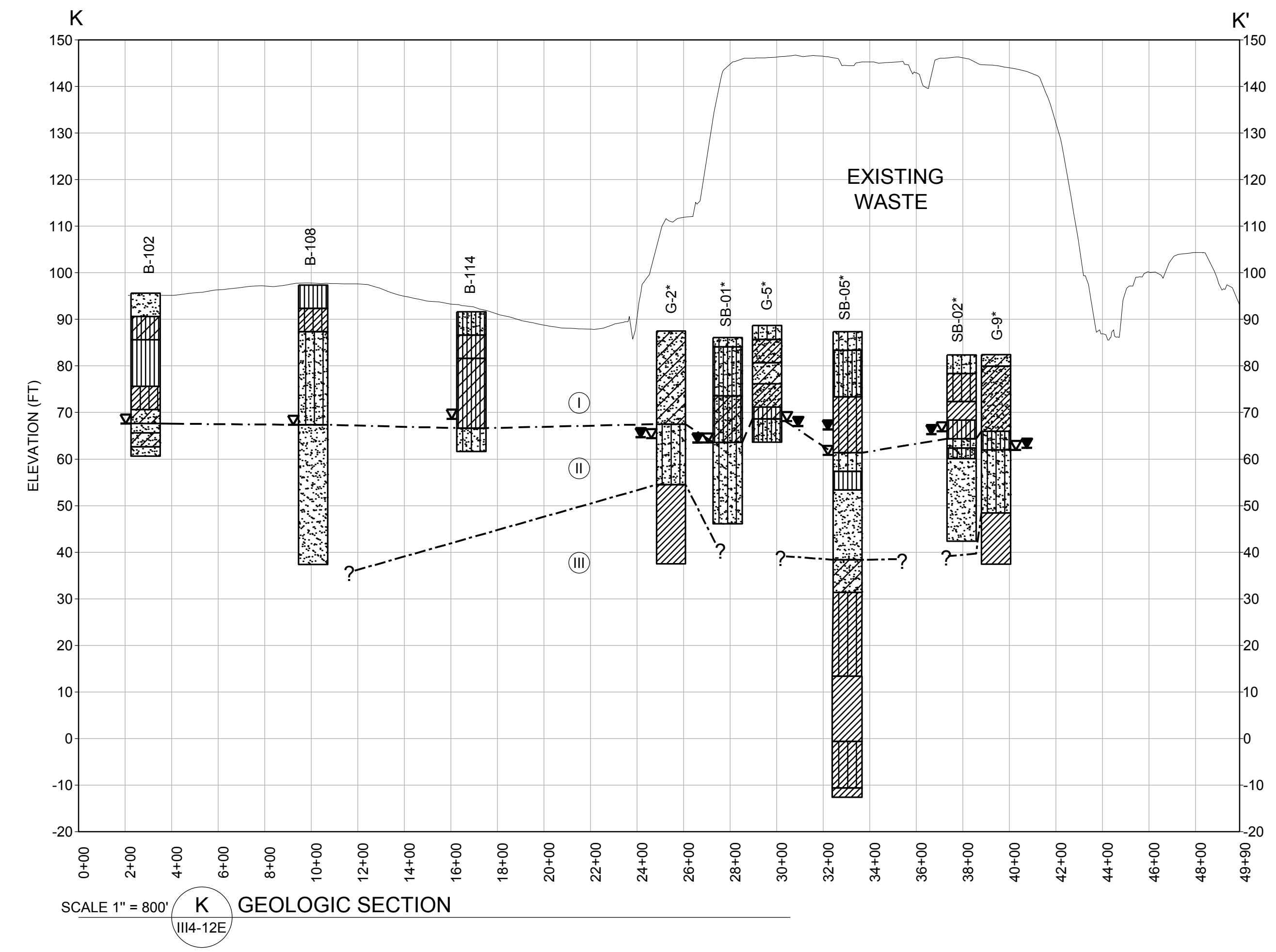
TITLE
INTERPRETIVE GEOLOGIC CROSS-SECTION III

PROJECT NO.	APPLICATION SECTION	REV.		FIGURE
1401491	III4	1	15 of 33	III4-12D

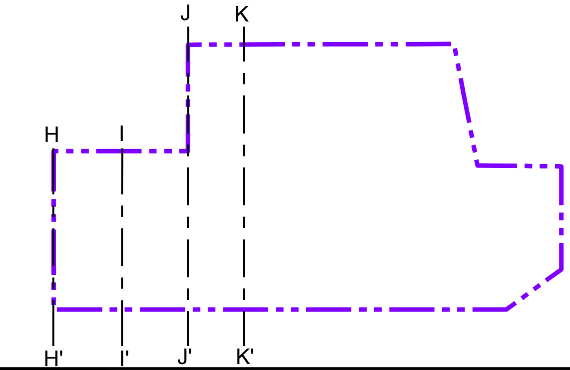








KEY MAP



LEGEND

- EXISTING GROUND
- END OF DATA FOR TOP OF STRATUM II
- END OF DATA FOR TOP OF STRATUM III
- No. 2 — LANGLEY-PITMAN 1976 BORINGS
- B-3 — PSI 1993 BORINGS
- SB-01 — RUST 1996 BORINGS
- PZ-101/B-103 — GOLDER 2015 BORINGS
- STATIC WATER LEVEL
- INITIAL WATER LEVEL
- SCREENED INTERVAL
- I II III STRATUM IDs

SOIL CLASSIFICATION

TOP SOIL, SILTY SAND, CLAYEY SAND, NO RECOVERY, SILT, SILTY CLAY, CLAYEY SILT, SAND, SANDY SILT, SANDY SILTY CLAY, CLAY, SANDY CLAY, SILTY CLAYEY SAND

*** BORINGS EXTRAPOLATED TO THE LINE OF CROSS-SECTION**

BORING	EXTRAPOLATED DISTANCE (ft) AND OFFSET DIRECTION
No. 1	171.1 W
No. 2	479.2 E
No. 3	310.6 E
No. 6	102.1 E
B-1	70.7 E
B-5	100.7 E
G-1	320.8 E
G-2	216.9 E
G-5	227.1 E

BORING	EXTRAPOLATED DISTANCE (ft) AND OFFSET DIRECTION
G-7	264.2 E
G-9	220.0 E
MW-3A	281.6 W
MW-4A	236.1 W
MW-7R	197.6 E
MW-22	158.9 E
SB-01	342.5 W
SB-02	342.0 W
SB-05	224.2 E

ISSUED FOR PERMITTING PURPOSES ONLY

0 400 800
1" = 800' FEET

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
1	2017-11-07	RESPONSE TO TCEQ FIRST NOTICE OF DEFICIENCY	CEI	TNB	CGD	CEI
0	2017-07-21	ISSUED FOR CLIENT REVIEW	CEI	AA	JAW	CEI

SEAL
STATE OF TEXAS
CHAD E. IRELAND
99293
LICENSED
PROFESSIONAL ENGINEER
GOLDER ASSOCIATES INC.
TEXAS REGISTRATION F-2578

CLIENT
CITY OF EDINBURG SOLID WASTE MANAGEMENT

CONSULTANT
Golder Associates

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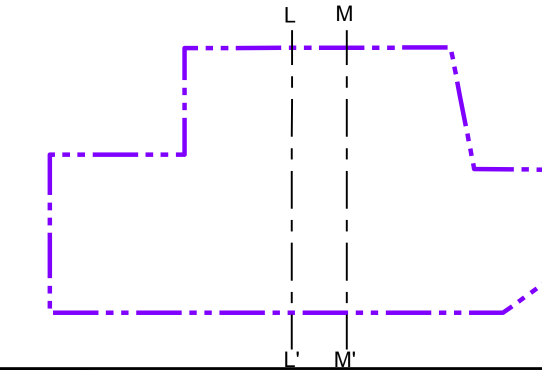
HOUSTON, TEXAS
USA
[+1] (281) 821-6868
www.golder.com

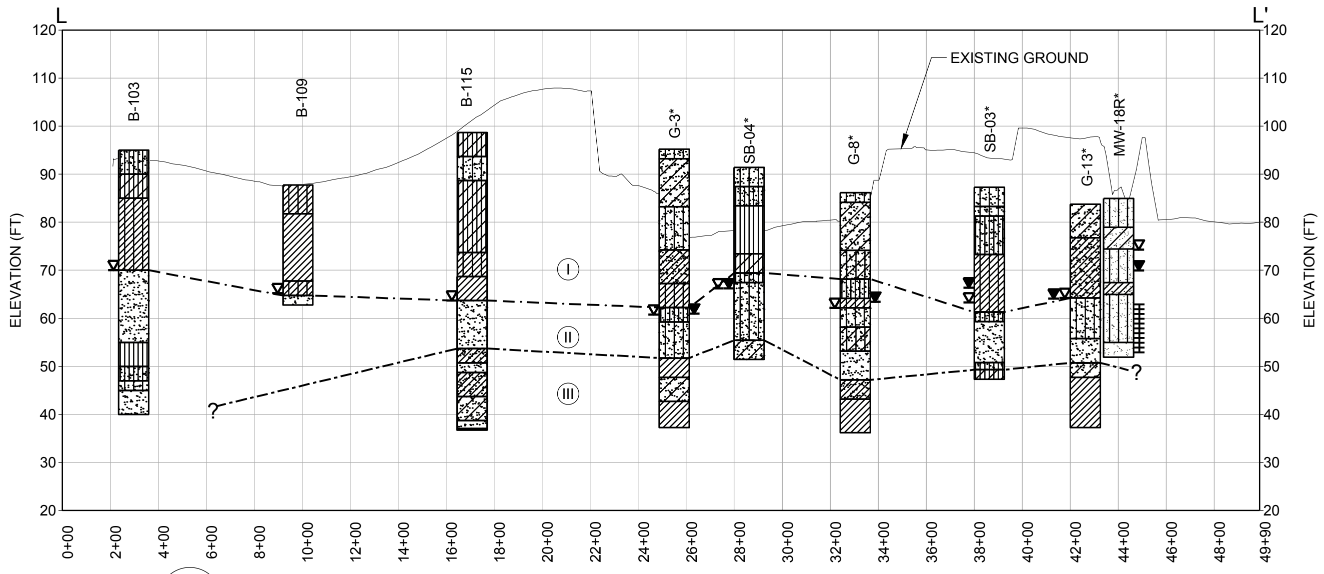
PROJECT
EDINBURG REGIONAL DISPOSAL FACILITY
PERMIT AMENDMENT APPLICATION TCEQ PERMIT MSW-956C
EDINBURG, HIDALGO COUNTY, TEXAS

TITLE
INTERPRETIVE GEOLOGIC CROSS-SECTION IV

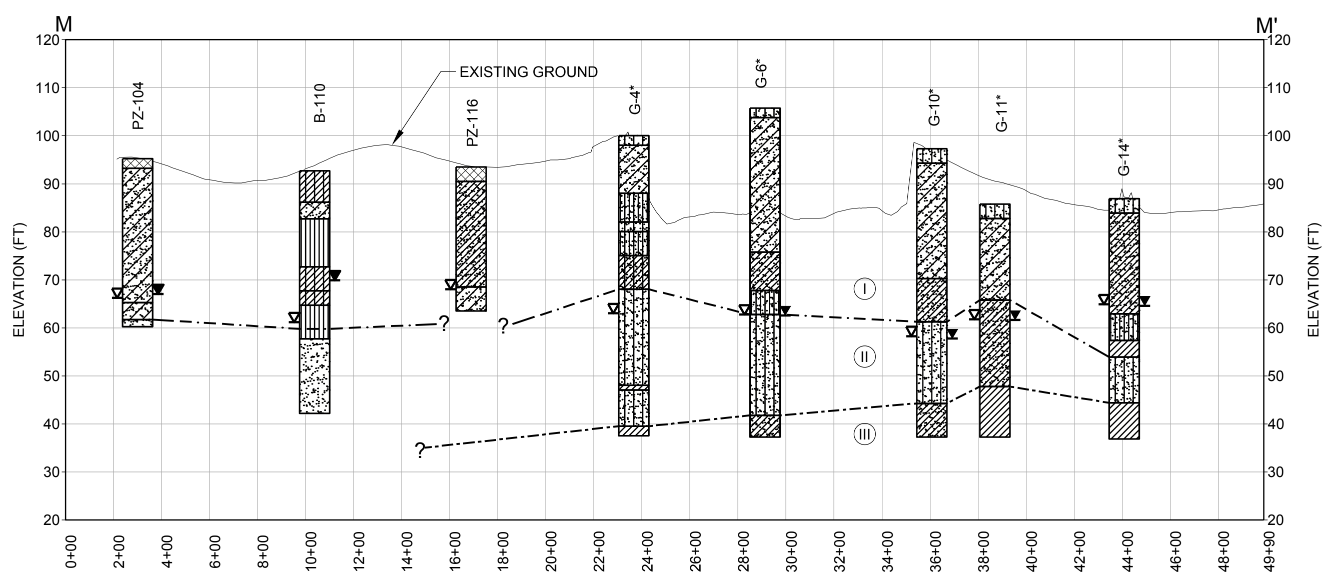
PROJECT NO. 1401491 | APPLICATION SECTION III4 | REV. 1 | 16 of 33 | FIGURE III4-12E

KEY MAP





SCALE 1" = 800' L III4-12F GEOLOGIC SECTION



SCALE 1" = 800' M III4-12F GEOLOGIC SECTION

LEGEND

- EXISTING GROUND
- ? END OF DATA FOR TOP OF STRATUM II
- ? END OF DATA FOR TOP OF STRATUM III
- No. 2 LANGLEY-PITMAN 1976 BORINGS
- B-3 PSI 1993 BORINGS
- SB-01 RUST 1996 BORINGS
- PZ-101/B-103 GOLDER 2015 BORINGS
- STATIC WATER LEVEL
- INITIAL WATER LEVEL
- SCREENED INTERVAL
- I II III STRATUM IDs

SOIL CLASSIFICATION

TOP SOIL	SILTY SAND	CLAYEY SAND	NO RECOVERY
SILT	SILTY CLAY	CLAYEY SILT	
SAND	SANDY SILT	SANDY SILTY CLAY	
CLAY	SANDY CLAY	SILTY CLAYEY SAND	

* BORINGS EXTRAPOLATED TO THE LINE OF CROSS-SECTION

BORING	EXTRAPOLATED DISTANCE (ft) AND OFFSET DIRECTION
G-3	341.7 E
G-4	192.0 E
G-6	104.1 E
G-8	176.3 E
G-10	96.4 E
G-11	295.5 W
G-13	220.4 W
G-14	200.7 E
MW-18R	130.2 W

BORING	EXTRAPOLATED DISTANCE (ft) AND OFFSET DIRECTION
SB-03	47.2 W
SB-04	47.6 W

ISSUED FOR PERMITTING PURPOSES ONLY

0 400 800
1" = 800' FEET

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
1	2017-11-07	RESPONSE TO TCEQ FIRST NOTICE OF DEFICIENCY	CEI	TNB	CGD	CEI
0	2017-07-21	ISSUED FOR CLIENT REVIEW	CEI	AA	JAW	CEI

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CLIENT

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CONSULTANT

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HOUSTON, TEXAS
USA
[+1] (281) 821-6868
www.golder.com

PROJECT

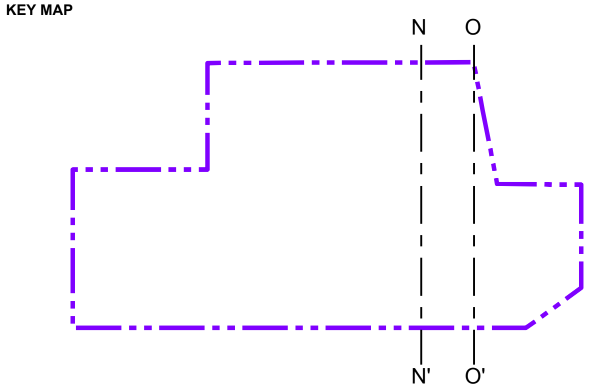
EDINBURG REGIONAL DISPOSAL FACILITY
PERMIT AMENDMENT APPLICATION TCEQ PERMIT MSW-956C
EDINBURG, HIDALGO COUNTY, TEXAS

TITLE

INTERPRETIVE GEOLOGIC CROSS-SECTION V

PROJECT NO.	APPLICATION SECTION	REV.		FIGURE
1401491	III4	1	17 of 33	III4-12F

KEY MAP

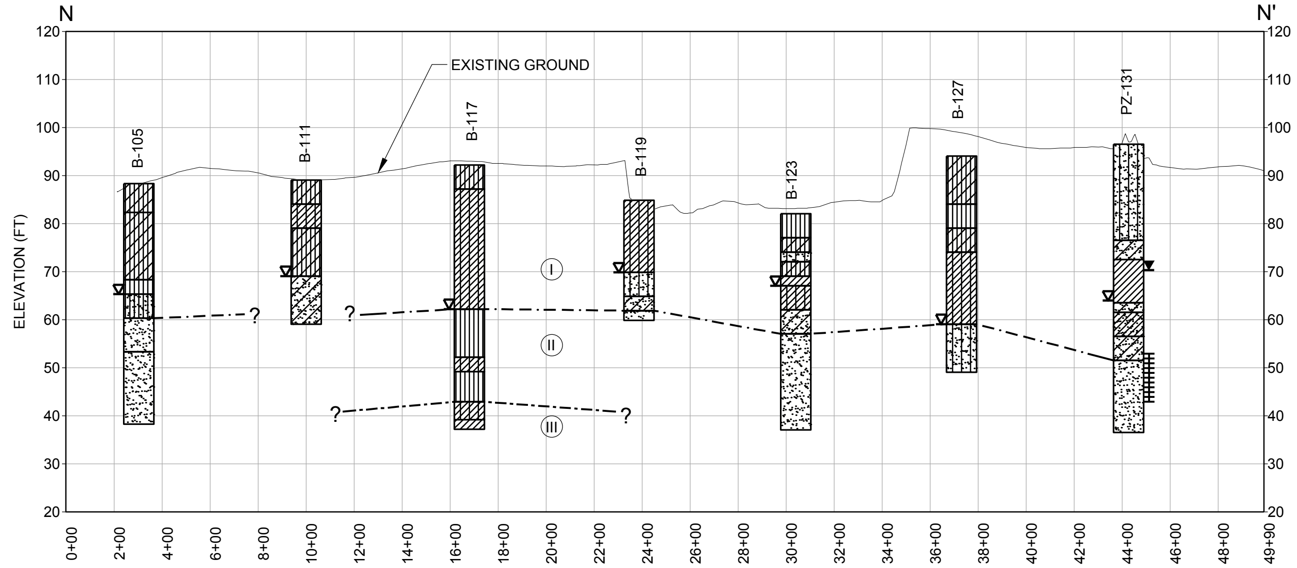


LEGEND

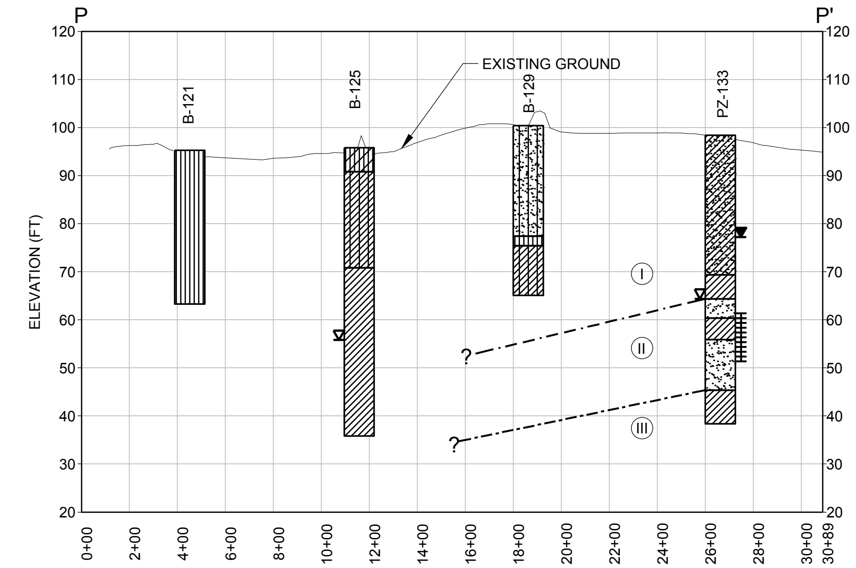
	EXISTING GROUND
—··—··—?	END OF DATA FOR TOP OF STRATUM II
—·—·—?	END OF DATA FOR TOP OF STRATUM III
No. 2	LANGLEY-PITMAN 1976 BORINGS
B-3	PSI 1993 BORINGS
SB-01	RUST 1996 BORINGS
PZ-101/B-103	GOLDER 2015 BORINGS
▼	STATIC WATER LEVEL
▽	INITIAL WATER LEVEL
	SCREENED INTERVAL
(I) (II) (III)	STRATUM IDs

SOIL CLASSIFICATION

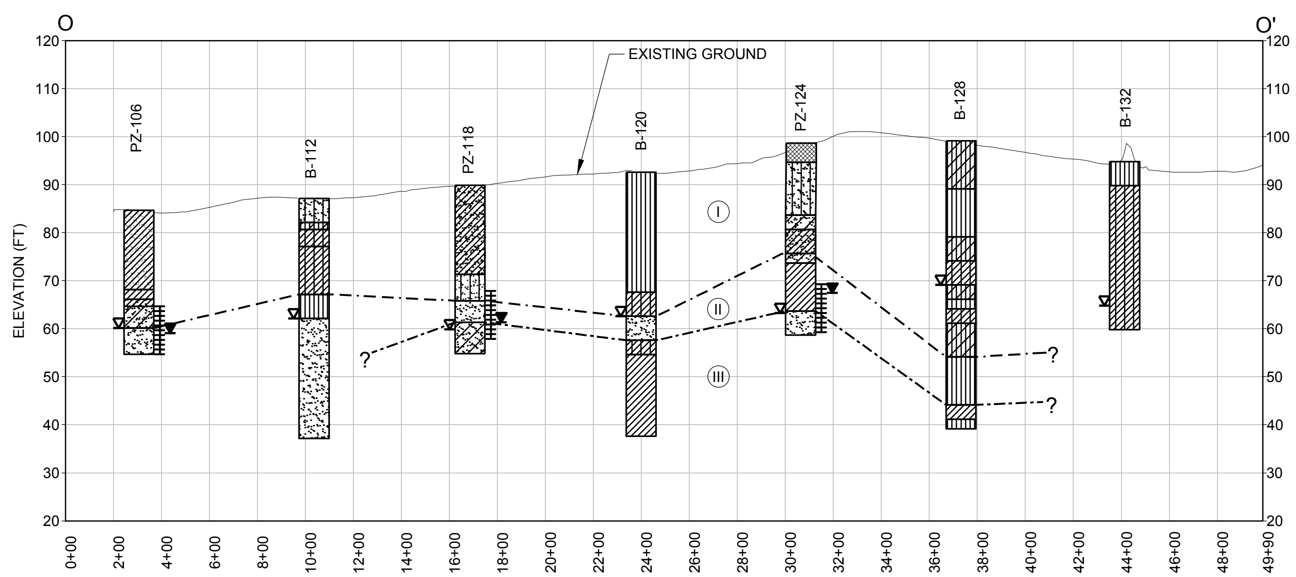
TOP SOIL, SILT, SAND, CLAY, SILTY SAND, SILTY CLAY, SANDY SILT, SANDY CLAY, CLAYEY SAND, CLAYEY SILT, SANDY SILTY CLAY, SILTY CLAYEY SAND, NO RECOVERY



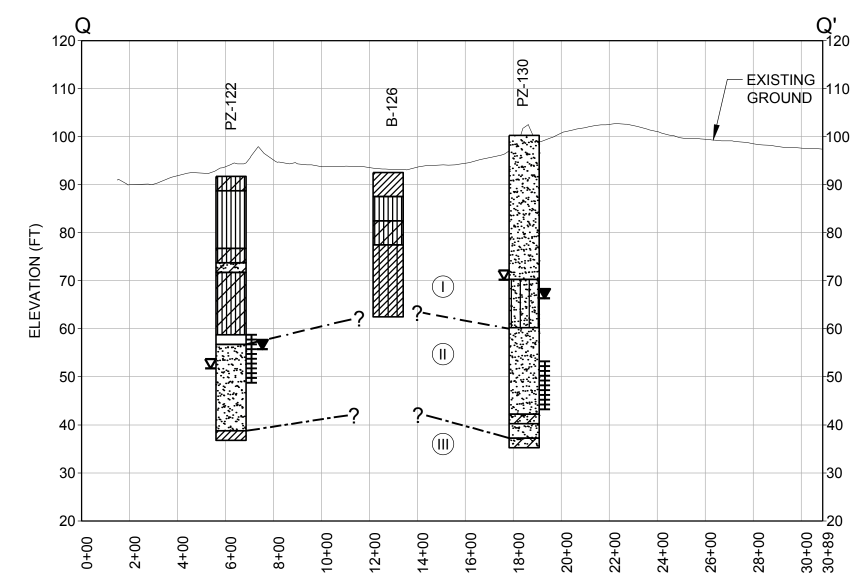
SCALE 1" = 800' N / III4-12G GEOLOGIC SECTION



SCALE 1" = 800' P / III4-12G GEOLOGIC SECTION



SCALE 1" = 800' O / III4-12G GEOLOGIC SECTION



SCALE 1" = 800' Q / III4-12G GEOLOGIC SECTION

ISSUED FOR PERMITTING PURPOSES ONLY

0 400 800
1" = 800' FEET

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
1	2017-11-07	RESPONSE TO TCEQ FIRST NOTICE OF DEFICIENCY	CEI	TNB	CGD	CEI
0	2017-07-21	ISSUED FOR CLIENT REVIEW	CEI	AA	JAW	CEI

SEAL

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PROJECT
EDINBURG REGIONAL DISPOSAL FACILITY
PERMIT AMENDMENT APPLICATION TCEQ PERMIT MSW-956C
EDINBURG, HIDALGO COUNTY, TEXAS

TITLE
INTERPRETIVE GEOLOGIC CROSS-SECTION VI

PROJECT NO.	APPLICATION SECTION	REV.		FIGURE
1401491	III4	1	18 of 33	III4-12G

TABLE III4E1
HISTORICAL GROUNDWATER ELEVATIONS (FT MSL)
MONITORING WELLS

Top of Casing Elevations, 10/26/00, (ft msl)	87.58	87.54	89.41	89.36	92.73	94.57	98.38	90.46	91.34	89.99	90.04	87.49	93.49	89.19	89.22	87.73	86.74	88.33	90.10	89.81	91.48	90.99	91.07	92.33	93.20	91.32	88.38	91.35	88.06	95.15	90.72	90.35	
Date	**MW -1**	**MW-1R**	**MW-2**	**MW-2R**	**MW-3**	**MW-3RA**	**MW-3A**	**MW-4**	**MW-4R**	**MW-4A**	**MW-5**	**MW-6**	**MWD-6**	**MW-7**	**MW-7R**	**MWD-7**	**MW-8**	**MW-8R**	**MW-9**	**MW-9R**	**MW-10**	**MW-10R**	**MW-11**	**MW-12**	**MW-15**	**MW-15R**	**MW-16**	**MW-18**	**MW-18R**	**MW-22**	**MW-23**	**MW-24**	**Sampled By**
04/28/93	64.91	--	65.64	--	65.48	--	--	64.51	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	RUST
04/30/93	64.90	--	65.69	--	65.47	--	--	64.49	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	RUST
05/13/93	64.86	--	65.64	--	65.40	--	--	64.59	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	RUST
06/23/93	65.80	--	65.46	--	65.39	--	--	64.41	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	RUST
07/15/93	65.33	--	66.82	--	66.18	--	--	65.06	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	RUST
08/12/93	65.13	--	66.69	--	66.38	--	--	65.04	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	RUST
10/16/97	63.48	--	64.21	--	64.93	--	--	66.56	--	--	65.14	67.99	--	65.39	--	--	66.04	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	ANALABS
02/11/98	63.93	--	64.76	--	65.68	--	--	64.96	--	--	65.46	65.30	--	64.75	--	--	64.09	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	SEM
02/16/98	64.01	--	64.75	--	65.72	--	--	64.84	--	--	65.62	65.49	--	65.03	--	--	64.72	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	SEM
05/07/98	63.18	--	63.91	--	66.23	--	--	65.06	--	--	65.94	65.59	--	64.69	--	--	63.24	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	ANALABS
06/16/98	62.80	--	63.25	--	65.92	--	--	64.66	--	--	65.57	65.25	--	64.22	--	--	62.80	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	SEM
06/25/98	62.77	--	63.13	--	65.82	--	--	64.60	--	--	65.48	65.17	--	64.22	--	--	62.44	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	SEM
12/04/98	63.67	--	63.48	--	66.90	--	--	65.63	--	--	66.55	66.21	--	65.76	--	--	66.71	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	SEM
01/13/99	63.68	--	63.49	--	66.75	--	--	65.54	--	--	66.40	66.09	--	65.50	--	--	65.60	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	SEM
03/22/99	63.91	--	63.55	--	66.33	--	--	65.31	--	--	66.06	65.80	--	65.14	--	--	64.74	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	SEM
07/21/99	63.74	--	63.83	--	66.08	--	--	65.13	--	--	65.76	65.52	--	65.00	--	--	64.34	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	SEM
10/26/99	63.70	--	64.21	--	65.93	--	--	64.76	--	--	65.56	65.24	--	65.10	--	--	64.89	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	SEM
01/27/00	63.66	--	64.49	--	65.52	--	--	64.60	--	--	65.16	64.96	--	65.54	--	--	64.89	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	SEM
05/02/00	63.68	--	64.46	--	65.15	--	--	64.36	--	--	64.77	64.60	--	64.39	--	--	64.79	--	63.67	--	63.99	--	--	--	--	--	--	--	--	--	--	--	SEM
06/30/00	63.88	--	64.49	--	65.32	--	--	64.31	--	--	64.65	64.46	--	64.38	--	--	65.48	--	64.19	--	65.17	--	--	--	--	--	--	--	--	--	--	--	SEM
09/06/00	63.46	--	64.12	--	64.18	--	--	63.88	--	--	63.79	63.69	--	63.93	--	--	64.31	--	63.92	--	66.19	--	--	--	--	--	--	--	--	--	--	--	SEM
10/25/00	63.35	--	63.65	--	63.99	--	--	63.64	--	--	63.68	63.55	--	63.87	--	--	64.12	--	63.56	--	63.87	--	--	--	--	--	--	--	--	--	--	--	SEM
01/15/01	63.17	--	63.31	--	63.88	--	--	63.45	--	--	63.62	63.56	--	63.36	--	--	63.54	--	63.27	--	63.39	--	--	--	--	--	--	--	--	--	--	--	SEM
07/17/01	64.73	--	63.67	--	64.43	--	--	63.42	--	--	64.11	63.84	--	63.82	--	--	67.79	--	64.05	--	66.47	--	--	--	--	--	--	--	--	--	--	--	SEM
08/20/01	64.35	--	63.32	--	--	--	--	63.23	--	--	--	63.50	--	63.63	--	--	66.23	--	63.72	--	65.31	--	--	--	--	--	--	--	--	--	--	--	SEM
10/29/01	64.02	--	63.06	--	63.64	--	--	63.11	--	--	63.40	63.29	--	63.29	--	--	65.38	--	63.40	--	65.15	--	--	--	--	--	--	--	--	--	--	--	SEM
12/18/01	64.71	--	63.24	--	64.01	--	--	--	--	--	--	--	--	--	--	--	66.35	--	63.49	--	65.82	--	--	--	--	--	--	--	--	--	--	--	SEM
01/24/02	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	63.56	--	65.03	--	--	--	--	--	--	--	--	--	--	--	SEM
03/15/02	64.18	--	63.44	--	63.96	--	--	63.22	--	--	63.77	63.49	--	63.51	--	--	65.68	--	63.53	--	64.59	--	--	--	--	--	--	--	--	--	--	--	SEM
04/23/02	63.89	--	63.36	--	63.74	--	--	63.16	--	--	63.51	63.39	--	63.34	--	--	65.34	--	63.32	--	64.36	--	--	--	--	--	--	--	--	--	--	--	SEM
10/14-15/02	64.49	--	62.92	--	64.27	--	--	63.43	--	--	64.12	63.71	--	63.59	--	--	69.69	--	63.40	--	64.13	--	--	--	--	--	--	--	--	--	--	--	SEM
04/16-17/03	65.51	--	64.38	--	65.92	--	--	--	64.01	--	65.50	65.31	--	65.37	--	--	68.77	--	64.22	--	64.08	--	--	--	--	--	--	--	--	--	--	--	SEM
10/29-30/03	--	71.13	--	66.41	--	66.96	--	--	64.23	--	66.99	66.30	--	66.71	--	--	78.83	--	66.65	--	66.61	--	65.29	66.88	--	--	--	--	--	--	--	--	GAI
01/14/04	--	69.23	--	68.16	--	68.20	--	--	65.91	--	--	--	--	67.65	--	--	74.55	--	66.79	--	67.25	--	66.20	68.13	--	--	--	--	--	--	--	--	GAI
01/21/04	--	68.97	--	68.03	--	68.13	--	--	65.81	--	--	--	--	67.44	--	--	73.98	--	66.75	--	67.20	--	66.26	68.16	--	--	--	--	--	--	--	--	GAI
5/19-20/04	--	69.16	--	69.46	--	69.02	--	--	66.25	--	--	--	--	68.30	--	--	72.33	--	68.14	--	67.44	--	66.75	68.99	--	--	--	--	--	--	--	--	GAI
7/14-15/2004	--	70.56	--	70.30	--	69.59	--	--	68.12	--	--	--	--	68.83	--	--	73.10	--	69.30	--	67.86	--	67.18	69.58	--	--	--	--	--	--	--	--	GAI
11/11-12/2004	--	69.79	--	71.44	--	70.59	--	--	69.64	--	--	--	--	70.54	--	--	74.10	--	70.15	--	68.92	--	69.05	70.18	--	--	--	--	--	--	--	--	GAI
2/15-16/2005	--	69.92	--	70.49		70.40	--		69.19	--			--	62.62	--	--	72.56	--	69.85	--	69.46	--	68.77	70.11	--	--	--	--	--	--	--	--	GAI
5/17-18/2005	--	69.92	--	70.46	--	70.21	--	--	68.87	--	--	--	--	69.42	--	--	72.84	--	69.96	--	69.72	--	68.73	69.99	--	--	--	--	--	--	--	--	GAI
9/13-15/2005	--	67.93	--	68.58	--	69.49	--	--	67.44	--	--	--	--	--	--	--	--	--	--	--	--	--	68.15	70.53	--	--	--	--	--	--	--	--	GAI
11/30/05	--	67.69	--	67.46	--	68.16	--	--	67.97	--	--	--	--	68.00	--	--	70.11	--	67.51	--	67.87	--	67.53	68.21	--	--	--	--	--	--	--	--	GAI
5/30-31/2006	--	67.21	--	66.68	--	66.78	--	--	66.48	--	--	--	--	66.72	--	--	68.95	--	66.90	--	66.82	--	66.37	66.82	67.57	--	--	67.71	--	--	--	--	GAI
09/29/06	--	75.28	--	70.18	--	70.43	--	--	70.35	--	--	--	--	71.04	--	--	78.09	--	70.12	--	70.03	--	71.55	70.39	71.13	--	--	69.90	--	--	--	--	GAI
10/30-31/2006	--	75.94	--	73.34	--	71.92	--	--	72.98	--	--	--	--	73.35	--	--	79.02	--	73.31	--	71.31	--	73.09	72.14	73.15	--	--	72.56	--	--	--	--	GAI
12/18-19/2006	--	73.32	--	72.41	--	72.27	--	--	72.59	--	--	--	--	72.87	--	--	75.30	--	71.87	--	71.93	--	72.40	72.33	72.45	--	--	72.71	--	--	--	--	GAI
3/21-22/2007	--	73.92	--	72.68	--	72.36	--	--	71.56	--	--	--	--	72.89	--	--	75.79	--	71.06	--	71.15	--	71.42	72.31	72.42	--	--	73.20	--	--	--	--	GAI
5/22-23/2007	--	72.61	--	72.56	--	71.94	--	--	72.53	--	--	--	--	71.91	--	--	73.18	--	72.53	--	72.79	--	71.02	71.74	72.03	--	--	72.04	--	--	--	--	GAI
08/02/07	--	--	--	73.68	--	72.38	--	--	72.72	--	--	--	--	72.53	--	--	77.33	--	--	--	--	--	73.42	72.64	--	--	--	--	--	--	--	--	GAI
09/05/07	--	74.14	--	75.87	--	74.96	--	--	74.88	--	--	--	--	75.03	--	--	76.17	--	75.16	--	75.23	--	74.17	74.83	--	--	--	--	--	--	--	--	GAI
12/18-19/2007	--	74.45	--	73.54	--	72.67	--	--	72.36	--	--	--	--	72.85	--	--	75.63	--	73.62	--	73.84	--	71.87	71.87	--	--	--	--	--	--	--	--	GAI
2/6-7/2008	--	73.72	--	72.91	--	72.08	--	--	71.95	--	--	--	--	72.28	--	--	74.63	--	73.05	--	73.32	--	71.49	71.98	--	--	--	--	--	--	--	--	GAI
6/18-19/2008	--	71.29	--	71.01	--	70.84	--	--	70.78	--	--	--	--	70.82	--	--	72.41	--	71.19	--	71.51	--	70.40	70.60	--	--	--	--	--	--	--	--	GAI
08/15/08	--	--	--	77.56	--	74.35	--	--	74.42	--	--	--	--	--	--	--	78.96	--	--	--	--	--	74.59	74.08	--	--	--	--	--	--	--	--	GAI
5/12-13/2009	--	74.23	--	74.79	--	74.09	--	--	73.35	--	--	--	--	74.37	--	--	--	--	74.95	--	75.27	--	73.98	73.66	75.18	--	--	74.52	--	--	--	--	GAI
06/4-06/5/2009	--	75.52	--	74.49	--	--	74.02	--	--	74.05	--	--	72.99	--	74.44	--	--	75.61	--	74.66	--	75.12	73.82	73.53	--	74.04	74.07	--	73.20	74.12	74.35	75.42	GAI
09/14-09/15/2009	--	74.69	--	74.03	--	--	72.91	--	--	73.28	--	--	72.16	--	74.02	--	--	75.08	--	73.84	--	74.11	72.90	72.62	--	73.07	73.10	--	72.27	73.02	73.31	74.75	GAI
09/30/09	--	--	--	73.82	--	72.87	--	--	--	--	--	--	--	73.59	--	--	75.23	--	74.16	--	--	--	73.04	72.75	--	--	--	--	--	--	--	--	GAI
12/14/09-12/15/09	--	74.60	--	73.76	--	--	73.20	--	--	73.42	--	--	73.19	--	73.65	--	--	75.62	--	74.04	--	74.43	73.09	73.03	--	73.83	74.20	--	73.31	73.15	73.37	74.87	GAI

Submitted: July 2017
Revised: November 2017

TABLE III4E1
HISTORICAL GROUNDWATER ELEVATIONS (FT MSL)
MONITORING WELLS

Top of Casing Elevations, 10/26/00, (ft msl)	87.58	87.54	89.41	89.36	92.73	94.57	98.38	90.46	91.34	89.99	90.04	87.49	93.49	89.19
Date	**MW -1**	**MW-1R**	**MW-2**	**MW-2R**	**MW-3**	**MW-3RA**	**MW-3A**	**MW-4**	**MW-4R**	**MW-4A**	**MW-5**	**MW-6**	**MWD-6**	**MW-7**
02/23/10-02/24/10	--	76.89	--	75.61	--	74.37	--	--	74.57	--	--	--	--	75.08
4/6-4/7/2010	--	76.19	--	75.41	--	74.52	74.76	--	74.64	74.87	--	--	74.49	--
7/20-7/21/2010	--	79.79	--	77.91	--	--	75.88	--	--	76.37	--	--	75.54	--
11/9-11/11/2010	--	79.19	--	78.33	--	76.90	77.18	--	77.74	77.89	--	--	75.44	77.99
12/13/10	--	--	--	78.11	--	76.52	--	--	77.19	--	--	--	--	77.45
2/22-2/24/2011	--	77.58	--	76.74	--	--	76.33	--	--	76.93	--	--	75.46	--
6/21-6/22/2011	--	73.51	--	73.38	--	--	74.86	--	--	74.68	--	--	73.32	--
12/12-12/13/2011	--	71.34	--	69.88	--	--	72.06	--	--	72.80	--	--	71.79	--
01/19/12	--	--	--	69.62	--	--	--	--	72.78	72.38	--	--	71.71	--
6/27-6/28/2012	--	69.86	--	68.57	--	--	70.41	--	--	70.48	--	--	69.69	--
07/25/12	--	69.08	--	--	--	--	--	--	69.93	69.15	--	--	--	--
12/10-12/11/2012	--	67.78	--	66.43	--	--	68.23	--	--	68.59	--	--	68.94	--
01/07/13	--	67.42	--	66.28	--	--	68.30	--	68.50	71.71	--	--	68.65	--
03/27/13	--	--	--	--	--	--	--	--	--	--	--	--	--	--
06/12 - 06/13/13	--	66.68	--	65.49	--	--	72.70	--	--	66.88	--	--	67.40	--
07/19/13	--	--	--	66.46	--	--	67.33	--	--	66.90	--	--	71.71	--
09/25/13	--	--	--	--	--	--	--	--	--	--	--	--	--	--
12/13 - 12/14/13	--	71.07	--	67.79	--	--	69.25	--	--	69.64	--	--	70.33	--
02/04/14	--	71.63	--	68.40	--	--	69.43	--	--	70.12	--	--	70.53	--
03/21/14	--	71.82	--	68.77	--	--	69.49	--	--	70.43	--	--	70.49	--
6/21 - 6/22/14	--	69.65	--	67.97	--	--	69.39	--	--	69.34	--	--	69.98	--
07/25/14	--	68.95	--	65.68	--	--	--	--	--	66.82	--	--	69.78	--
09/05/14	--	--	--	--	--	--	--	--	--	--	--	--	--	--
12/10 - 12/11/14	--	71.80	--	69.17	--	--	70.43	--	--	70.20	--	--	71.16	--
01/13/15	--	73.22	--	69.96	--	--	--	--	--	--	--	--	71.63	--
2/24 - 2/25/15	--	72.95	--	70.26	--	--	71.10	--	--	71.77	--	--	71.86	--
03/25/15	--	73.14	--	70.41	--	--	71.38	--	--	72.09	--	--	75.99	--
04/20 - 4/21/15	--	79.24	--	72.69	--	--	72.00	--	--	73.82	--	--	72.28	--
05/28/15	--	81.73	--	74.63	--	--	73.84	--	--	76.34	--	--	73.34	--
06/22 - 06/26/15	--	82.62	--	76.01	--	--	74.91	--	--	76.66	--	--	74.26	--
7/27- 7/30/2015	--	78.97	--	75.06	--	--	76.03	--	--	77.21	--	--	75.54	--
8/20-21/2015	--	77.49	--	74.66	--	--	75.75	--	--	76.51	--	--	75.63	--
9/28-29/2015	--	76.65	--	74.51	--	--	75.64	--	--	76.02	--	--	75.95	--
10/19/15	--	76.43	--	74.41	--	--	75.51	--	--	75.85	--	--	75.99	--
11/16/15	--	77.64	--	75.63	--	--	76.34	--	--	76.84	--	--	76.39	--
12/7-10/2015	--	77.17	--	75.40	--	--	76.11	--	--	76.69	--	--	76.02	--
1/25-26/2016	--	76.73	--	75.12	--	--	75.93	--	--	76.47	--	--	75.78	--
02/15/16	--	76.55	--	74.96	--	--	75.87	--	--	76.31	--	--	75.70	--
03/28/16	--	76.08	--	74.61	--	--	75.47	--	--	75.86	--	--	75.29	--
6/27-29/2016	--	74.86	--	73.32	--	--	75.49	--	--	75.61	--	--	75.54	--
9/7-8/2016	--	--	--	--	--	--	--	--	--	--	--	--	--	--
11/30 - 12/1 2016	--	73.10	--	70.23	--	--	73.31	--	--	74.11	--	--	73.34	--
HISTORIC HIGH	65.80	82.62	66.82	78.33	66.90	76.90	77.18	66.56	77.74	77.89	66.99	67.99	76.39	77.99
HISTORIC LOW	62.77	66.68	62.92	65.49	63.64	66.78	67.33	63.11	64.01	66.82	63.40	63.29	67.40	62.62

Top of Casing Elevations, 10/26/00, (ft msl)	89.22	87.73	86.74	88.33	90.10	89.81	91.48	90.99	91.07	92.33	93.20	91.32	88.38	91.35	88.06	95.15	90.72	90.35	
Date	**MW-7R**	**MWD-7**	**MW-8**	**MW-8R**	**MW-9**	**MW-9R**	**MW-10**	**MW-10R**	**MW-11**	**MW-12**	**MW-15**	**MW-15R**	**MW-16**	**MW-18**	**MW-18R**	**MW-22**	**MW-23**	**MW-24**	**Sampled By**
02/23/10-02/24/10	--	--	77.62	--	75.26	--	75.26	--	74.40	74.30	75.86	--	--	76.17	--	--	--	--	GAI
4/6-4/7/2010	75.57	--	--	77.02	--	75.50	--	76.12	74.02	74.69	--	74.27	74.17	76.25	75.47	74.75	75.05	76.39	GAI
7/20-7/21/2010	78.32	--	--	80.11	--	78.26	--	76.84	--	75.93	--	76.52	76.73	--	77.16	75.85	76.52	77.70	GAI
11/9-11/11/2010	78.52	--	79.05	79.18	77.83	78.36	77.58	78.64	77.12	77.18	77.85	76.87	76.58	78.40	77.81	77.20	77.72	79.16	GAI
12/13/10	--	--	--	--	--	--	--	--	--	76.50	--	--	--	--	--	--	--	--	GAI
2/22-2/24/2011	77.30	--	--	77.99	--	76.94	--	77.38	76.54	76.01	--	76.07	75.46	--	76.38	76.26	76.40	77.71	GAI
6/21-6/22/2011	74.64	--	--	74.20	--	73.73	--	73.97	75.49	74.24	--	74.53	73.78	--	72.76	74.63	74.00	74.01	GAI
12/12-12/13/2011	72.78	--	--	72.54	--	70.73	--	71.00	73.05	72.29	--	73.07	72.53	--	71.20	71.67	70.94	71.33	GAI
01/19/12	--	--	--	--	--	70.22	--	--	--	--	--	--	--	--	70.65	71.51	70.51		GAI
6/27-6/28/2012	70.15	--	--	71.03	--	68.05	--	69.44	71.40	70.69	--	71.98	72.18	--	70.55	69.83	69.09	69.87	GAI
07/25/12	--	--	--	--	--	68.55	--	--	--	--	--	--	--	--	--	--	--	69.19	GAI
12/10-12/11/2012	68.45	--	--	68.74	--	66.90	--	67.46	68.87	68.59	--	69.73	70.06	--	69.65	67.69	67.01	67.70	GAI
01/07/13	--	--	--	--	--	--	--	--	--	--	--	--	69.11	--	--	--	--	67.53	GAI
03/27/13	--	68.22	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	GAI
06/12 - 06/13/13	67.13	67.82	--	67.33	--	65.86	--	66.35	67.27	67.26	--	67.32	67.60	--	67.55	66.21	65.70	66.60	GAI
07/19/13	--	--	--	--	--	66.29	--	--	--	--	--	--	70.65	--	68.42	--	--	67.24	GAI
09/25/13	--	70.60	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	GAI
12/13 - 12/14/13	71.68	70.73	--	72.13	--	68.09	--	68.99	69.72	69.92	--	69.88	70.14	--	70.86	68.49	67.97	70.97	GAI
02/04/14	--	--	--	--	--	68.60	--	--	--	70.02	--	--	70.43	--	--	--	--	71.21	GAI
03/21/14	72.18	70.95	--	73.24	--	69.10	--	69.93	70.26	69.94	--	70.52	70.84	--	70.82	69.04	68.69	71.61	GAI
6/21 - 6/22/14	69.59	69.72	--	70.70	--	68.48	--	69.28	69.95	69.78	--	70.34	70.31	--	70.09	68.87	68.35	69.94	GAI
07/25/14	--	--	--	69.23	--	68.02	--	67.31	--	68.21	--	--	71.04	--	--	--	--	67.92	GAI
09/05/14	--	69.10	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	GAI
12/10 - 12/11/14	72.15	71.96	--	72.95	--	69.31	--	69.77	70.63	70.72	--	74.19	72.51	--	71.64	69.91	69.15	71.29	GAI
01/13/15	73.39	--	--	--	--	69.79	--	70.50	--	--	--	--	74.45	--	72.33	--	--	72.84	GAI
2/24 - 2/25/15	73.12	72.02	--	75.23	--	70.52	--	71.31	71.88	71.61	--	72.98	73.42	--	72.21	70.71	70.33	72.67	GAI
03/25/15	73.72	72.03	--	75.23	--	70.71	--	71.59	72.37	71.68	--	73.42	73.88	--	72.21	71.05	70.52	72.90	GAI
04/20 - 4/21/15	75.59	73.41	--	79.07	--	72.74	--	72.57	73.33	72.21	--	74.01	73.89	--	73.73	71.81	71.97	75.58	GAI
05/28/15	78.27	75.27	--	81.65	--	75.89	--	79.16	75.25	73.55	--	74.97	75.27	--	73.60	74.27	74.07	79.36	GAI
06/22 - 06/26/15	79.47	76.90	--	82.51	--	76.19	--	76.02	77.19	75.46	--	77.62	76.81	--	74.57	74.91	75.04	83.89	GAI
7/27- 7/30/2015	78.02	76.09	--	79.63	--	75.26	--	76.13	77.39	75.99	--	77.20	77.17	--	75.66	75.71	75.10	77.45	GAI
8/20-21/2015	76.78	75.31	--	77.94	--	74.96	--	75.72	76.88	75.76	--	76.75	77.07	--	75.61	75.36	74.62	77.32	GAI
9/28-29/2015	76.15	75.24	--	77.00	--	74.77	--	75.50	76.45	75.86	--	76.74	77.05	--	75.95	75.18	74.56	77.32	GAI
10/19/15	76.02	75.13	--	76.80	--	74.66	--	75.40	76.30	75.77	--	76.59	77.03	--	76.07	75.06	74.46	76.36	GAI
11/16/15	77.30	75.97	--	78.41	--	75.77	--	76.55	77.05	76.50	--	77.30	76.81	--	76.54	75.72	75.22	77.64	GAI
12/7-10/2015	76.95	75.70	--	77.81	--	75.65	--	76.41	76.82	76.19	--	77.10	77.08	--	76.17	75.70	75.29	77.19	GAI
1/25-26/2016	76.70	75.25	--	77.28	--	75.30	--	75.96	77.73	76.02	--	76.97	77.05	--	75.79	75.58	75.11	75.68	GAI
02/15/16	76.49	75.13	--	77.02	--	75.31	--	75.92	76.59	75.89	--	76.91	76.98	--	75.73	75.51	74.09	76.57	GAI
03/28/16	76.01	74.50	--	76.46	--	74.92	--	75.51	76.16	75.40	--	76.48	76.51	--	75.28	75.16	74.69	76.08	GAI
6/27-29/2016	76.12	74.50	--	77.47	--	73.70	--	73.90	75.99	74.78	--	76.29	76.64	--	75.54	74.93	73.97	74.91	GAI
9/7-8/2016	--	73.14	--	--	--	72.48	--	72.67	75.07	--	--	75.20	75.46	--	73.82	--	--	74.44	GAI
11/30 - 12/1 2016	74.16	71.45	--	74.56	--	71.73	--	72.25	74.47	73.40	--	74.79	74.94	--	72.56	72.80	71.73	72.94	GAI
HISTORIC HIGH	79.47	76.90	79.05	82.51	77.83	78.36	77.58	79.16	77.73	77.18	77.85	77.62	77.17	78.40	77.81	77.20	77.72	83.89	
HISTORIC LOW	67.13	67.82	62.44	67.33	63.27	65.86	63.39	66.35	65.29	66.82	67.57	67.32	67.60	67.71	67.55	66.21	65.70	66.60	

Top of casing elevations were surveyed by J.E. Saenz & Associates, Inc. 12-22-97.
Locations were surveyed and top of casing verified by Govind Engineers & Consultants 10/26/00.
Some groundwater elevation data has been corrected based on surveyed and verified top of casing elevations.
-- Water level not measured

All water level data are in feet relative to mean sea level (msl).

TABLE III4E2
HISTORICAL GROUNDWATER ELEVATIONS (FT-MSL)
PIEZOMETERS

		Date																	
		Dec-14	Jan-15	Feb-15	Mar-15	Apr-15	May-15	Jun-15	Jul-15	Aug-15	Sep-15	Oct-15	Nov-15	Dec-15	Jan-16	Feb-16	Mar-16	Jun-16	Dec-16
Piezometer	**Top of Casing Elevation (ft-msl)**	**Groundwater Elevation (ft-msl)**																	
PZ-101	101.73	68.61	69.79	70.58	71.23	71.77	-	74.13	74.65	74.39	74.24	74.07	74.49	74.63	74.74	74.75	74.63	73.78	72.52
PZ-104	99.02	66.98	67.36	67.95	68.42	69.63	-	74.18	75.41	75.13	74.56	74.14	74.34	74.27	74.08	73.97	73.75	73.20	71.97
PZ-106	88.17	58.98	59.24	59.55	59.77	60.30	-	68.00	65.75	64.25	63.39	63.05	64.17	63.90	63.79	63.75	63.40	62.97	61.47
PZ-113	89.79	70.37	71.03	72.15	72.49	75.49	78.4	80.79	78.07	76.71	75.96	75.75	76.75	76.74	76.70	76.61	76.25	75.49	74.22
PZ-116	96.56	69.7	70.22	70.80	71.21	72.45	-	76.20	76.98	76.84	76.36	76.03	76.27	76.28	76.07	75.94	75.57	75.06	73.65
PZ-118	93.22	62.03	62.24	62.59	62.82	63.51	76.54	66.59	66.68	66.52	68.34	66.04	66.40	66.47	66.71	66.71	66.54	66.17	64.89
PZ-122	96.14	-	56.26	56.55	56.44	57.01	-	-	57.34	-	56.68	56.64	57.19	57.50	57.87	57.96	58.10	58.04	57.14
PZ-124	101.67	67.41	67.68	67.72	67.77	68.11	-	70.60	71.54	71.28	71.45	71.16	71.88	71.73	71.76	71.63	71.36	71.44	70.13
PZ-130	104.39	-	66.36	66.74	67.09	67.29	-	68.44	68.74	68.65	69.16	69.11	69.84	69.84	70.30	70.39	70.14	70.03	69.26
PZ-131	100.09	70.4	68.2	71.44	71.49	72.34	86.47	75.59	76.48	75.77	75.36	75.10	75.70	75.51	75.41	75.31	74.81	74.49	72.92
PZ-133	101.96	78.34	68.8	68.91	69.06	69.44	-	71.54	72.36	72.54	72.74	72.71	73.10	73.10	73.28	73.28	73.18	73.08	72.31
PZ-134	86.11	71.98	72.49	73.02	73.11	80.68	82.66	83.04	78.96	77.31	76.66	76.45	77.39	76.91	76.58	76.40	75.98	74.36	73.06