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The proposed modifications to the monitoring well system are designed in accordance with the above stated regulations. Furthermore, spacing between all downgradient wells adheres to the provisions in 30 TAC §330.403(a)(2) that monitoring well spacing does not exceed 600 feet as measured along the Point of Compliance (POC). Each of the monitoring wells is also spaced along the POC (less than 500 feet from the proposed Solid Waste Management Unit [SWMU] pursuant to 30 TAC §330.3(106)) and are located respective of the previously discussed operation concerns and potential downgradient critical receptors. The groundwater monitoring system is designed to monitor downgradient of each sump. In summary, to design a monitoring well system to comply with 30 TAC §330.403, the following criteria listed in Table III-5-3 were followed:

Table III-5-3: Groundwater Monitoring System Design Criteria

Criterion	Location of information in the Report
Identify and Characterize the Uppermost Aquifer	Section 2.0 – Site Hydrogeology
Establish Groundwater Flow Direction and Rate	Section 2.1 – Hydraulic Characteristics
Evaluate Potential Impacts of Operation Attributes of the Facility on Groundwater Flow	Section 3.2.1 – Relationship of Excavation Bottom to Uppermost Aquifer
	Section 3.2.2 – Leachate Sump Design
Determine Impacts of Critical Receptors	Section 3.2.3 – Critical Receptors
Determine the Appropriate Locations and Screened Intervals of Groundwater Monitoring Wells	Section 3.3.3 – Monitoring Well Locations
	Section 3.3.4 – Monitoring Well Construction

Furthermore, it is understood that the Stratum II/III interface exerts some structural controls over the direction of groundwater flow. To this end, the Stratum II/III interface topography has also been taken into account in the monitoring well network design. Fortunately, the comprehensiveness of the above mentioned regulations ensure the monitoring well network will take into account different controls exerted on the groundwater flow regime.

3.3.2 Contaminant Pathway Analysis

In the unlikely event of a leachate release (i.e., failure of multiple engineered containment systems), contaminants would likely move along the constructed liner/natural soil interface or downward into the unsaturated portion of the Taylor Marl. However, due to the low permeability of the material (determined in Attachment 4 Section 5.3 Soil Properties) and penetration into the unweathered unit being limited, contaminants are likely to move horizontally. If the contaminants were to reach the groundwater, the miscible contaminants would be diluted by the groundwater and would move laterally towards the perimeter monitoring system. Movement in the unweathered claystone (Stratum III) is unlikely due to the low subsurface investigations show that the site is underlain by three distinct strata, which is consistent with previous studies and permitting at the site, namely (in order from ground surface down):

- Stratum I – Residual clay in the lower Taylor Marl - Ozan Formation: Stiff to hard, dark brown to tan, low plasticity clay, with high plasticity clay with organic content comprising the top of the stratum in some areas.
- Stratum II – Weathered claystone in the Ozan Formation: Weathered, extremely weak to weak, tan and light gray, with orange mottling, claystone.
- Stratum III – Unweathered claystone in the Taylor Group: Slightly weathered to fresh (unweathered), massive, weak to strong, light gray claystone.

All three stratums belong to the Cretaceous Gulf Series of the Navarro-Taylor Groups. Stratum I, a low-plasticity clay with pockets of high plasticity clay and organic content, is the product of Stratum II clay weathering. The interface between Stratum I and II was not always easily defined because of the gradual transition from residual soil to rock. Also, multiple criteria were considered in determining the top of Stratum III, which included the change of rock type, change in color, SPT N-values, and change from completely/highly weathered, fissile claystone to slightly weathered/unweathered, massive claystone.

5.3 Soil Properties

In accordance with 30 TAC §330.63(e)(5), the geotechnical properties of the predominant strata at the site are summarized in the following sections.

5.3.1 Stratum I

This stratum is described as hard, dark brown, tan or gray (with frequent orange mottling), high plasticity clay. The thickness of Stratum I ranges from 0 to 28 ft. Table III-4-5 summarizes the properties of Stratum I. This Stratum roughly corresponds to the uppermost soil type or topsoil described in Permit MSW-692A.

BORING NO	LOCATION		GROUND ELEVATION (FT-MSL)	BORING DEPTH (FT)	BOTTOM ELEVATION (FT-MSL)
	NORTHING	EASTING			
MW-16	524003.95	2948989.50	587.4	36.00	552.4
MW-17	525901.88	2949877.27	571.2	37.00	534.1
MW-18	526377.79	2949582.43	570.2	29.00	542.0
MW-19	523042.05	2947199.15	573.5	32.00	541.3
MW-20	525818.50	2947750.00	622.1	39.00	581.3
MW-21	525971.25	2947213.46	616.6	38.00	578.2
MW-22	524040.29	2946044.59	593.0	39.50	552.3

* Shallow auger borings to verify soil cover thickness.

NA – Not Available

** MW-5 - Converted piezometer RST-105; no boring log provided and not displayed on Figure III-4-11.

MW-7 - Converted piezometer RST-109; no boring log provided and not displayed on Figure III-4-11.

MW-8 - Converted piezometer RST-111; no boring log provided and not displayed on Figure III-4-11.

*** Boring log is included, but coordinates unknown and not placed on Figure III-4-11.

(1) Borehole location coordinates and surface elevations were retrieved from the table found on Figure 4-7 of the Geology Report in the Rust E&I (1999) previous Permit Amendment Application No. MSW-692A.

(2) Borehole location coordinates and surface elevations were surveyed by SAM, Inc.

(3) Boring logs were not provided; possibly shallow twin of adjacent deeper borings in which no boring log was prepared and therefore not displayed on Figure III-4-11.

(4) Gas monitoring probe locations are displayed on Figure III-6-2.

The previously completed investigations were supplemented by additional borings in the area of the proposed expansion area. The number and depth of additional borings were determined to meet the requirements of 30 TAC §330.63(e)(4)(A) and (B) as described in the soil boring plan that was approved by the Texas Commission on Environmental Quality (TCEQ). The soil boring plan and the TCEQ approval letter are presented in Appendix III-4A.

As proposed in the approved boring plan, a total of 26 additional borings (labeled GA-01 through GA-26) were advanced in the area of the proposed expansion area. Additionally, a secondary set of 16 borings (labeled GA-27 through GA-42) were advanced to further characterize the interface of the weathered and unweathered zones within the Taylor Marl beneath the site. This investigation was performed to better delineate the upper water bearing unit. Table III-4-4 provides the coordinates and elevations of the borings. As listed, 42 total additional borings were advanced, of which 15 reached a depth 30 ft below the elevation of the deepest excavation (approximately 503 ft-msl). The other borings were advanced to at least 5 ft below the deepest excavation. The locations of all the site borings are shown on Figure III-4-11 and the surface of the weathered-unweathered interface in the expansion area as determined from the Golder 2015 geotechnical investigation is shown on Figure III-4-12.

The borings were advanced through the clay materials with either hollow-stem augers or rotary drilling with HQ coring equipment in rock that yielded 2.25-inch diameter core samples. All borings were plugged in accordance with 16 TAC §76.702 and §76.1004 and seven were completed as piezometers to provide groundwater elevation data (GA-4, GA-14, GA-22, GA-23, GA-24, GA-25, and GA-26).

The boring logs from the site investigations are attached as Appendix III-4B. Laboratory data on soil samples obtained during the recent investigation are summarized in Appendix III-4C. Data from the above-referenced previous studies by EarthTech, J & N, Rust, Tetra Tech, and Trinity are attached as Appendix III-4D.

Table III-4-4: Coordinates and Elevations of Borings Advanced at the Proposed Expansion

Boring	Northing	Easting	Ground Elevation (ft-msl)	Depth (ft)	Bottom Elevation (ft-msl)
GA-~~0~~1	526015.8	2947432	614.9	145.0	469.9
GA-~~0~~2	523899.9	2950212	601.0	130.0	471.0
GA-~~0~~3	526292.8	2947891	614.0	120.0	494.0
GA-~~0~~4	526612	2947503	596.9	105.0	491.9
GA-~~0~~5	525983.9	2950251	555.7	85.0	470.7
GA-~~0~~6	525163.7	2951860	550.5	80.0	470.5
GA-~~0~~7	525063.7	2950834	593.1	125.0	468.1
GA-~~0~~8	524671.4	2950828	594.4	125.0	469.4
GA-~~0~~9	524430.8	2949593	585.2	115.0	470.2
GA-10	523539.9	2949986	593.3	125.0	468.3
GA-11	523370.2	2951392	580.0	110.0	470.0
GA-12	522816.5	2950289	570.1	100.0	470.1
GA-13	523569	2949270	575.2	105.0	470.2
GA-14	521850.4	2950642	553.5	60.0	493.5
GA-15	522256.5	2951080	562.4	93.0	469.4
GA-16	522662.5	2948776	560.3	90.0	470.3

Table III-4-5: Properties of Stratum I

	Minimum Value	Maximum Value	Average	Number of Tests	Test Method
Water Content (%)	12.8	30.2	19.4	12	ASTM D2216
Liquid Limit	49	73	58	13	ASTM D4318
Plastic Limit	15	22	18	13	ASTM D4318
Plasticity Index	34	51	40	13	ASTM D4318
Liquidity Index	-0.117	0.185	0.029	13	ASTM D4318
Undrained Triaxial Compression Test (tsf)	0.9	3.9	2.4	2	ASTM D2850
Vertical Permeability (cm/s)	4.80E-08	1.63E-07	1.1E-07	3	ASTM D5084
Horizontal Permeability (cm/s)	3.91E-08	—	—	1	ASTM D5084

5.3.2 Stratum II

Stratum II consists of completely weathered to moderately weathered, fissile and friable, gray to light gray, extremely weak to weak claystone. Fossilized shells and pyrite nodules were identified in some samples. The Rock Quality Designation (RQD) was generally greater than 50%, as shown on the borehole logs in Appendix III-4B. The top of Stratum II was found between approximately elevation 517 and 601 ft-msl, with a thickness up to 49 ft. The average top of the layer is approximately at elevation 563 ft-msl and corresponds to the weathered claystone described in Permit MSW-692A. Table III-4-6 summarizes the properties of Stratum II.

Table III-4-6: Properties of Stratum II

	Minimum Value	Maximum Value	Average	Number of Tests	Test Method
Water Content (%)	9.7	16.8	13.8	4	ASTM D2216
Liquid Limit	44	76	58	4	ASTM D4318
Plastic Limit	16	27	19	4	ASTM D4318
Plasticity Index	28	49	39	4	ASTM D4318
Liquidity Index	-0.208	-0.043	-0.128	4	ASTM D4318
Vertical Permeability (cm/s)	1.57 E-8	—	—	1	ASTM D5084
Horizontal Permeability (cm/s)	8.30 E-8	6.40 E-6	9.08 E-7	12	ASTM D4044

5.3.3 Stratum III

Stratum III is slightly weathered to fresh, massive, light gray, weak to strong claystone. Rock cores were generally free of joints and discontinuities, excepting few locations. The RQD was generally greater than 80% and often 100%, as shown on the borehole logs in Appendix III-4B. The top of Stratum III was found between approximately elevation 506 and 565 ft-msl. The average top of the stratum is approximately 533 ft-msl. The bottom of this stratum was not identified. Stratum III corresponds to the unweathered