SKYLINE LANDFILL
CITY OF FERRIS
DALLAS AND ELLIS COUNTIES, TEXAS
TCEQ PERMIT APPLICATION NO. MSW 42D

PERMIT AMENDMENT APPLICATION

PART III – FACILITY INVESTIGATION AND DESIGN
ATTACHMENT D4
SITE LIFE

Prepared for

Waste Management of Texas, Inc.

April 2012

Revised August 2012

STATE OF TEXAS
DAVID L. CLARK
81905
LICENSED
PROFESSIONAL ENGINEER
8-21-12

Prepared by

BIGGS & MATHEWS ENVIRONMENTAL
1700 Robert Road, Suite 100 • Mansfield, Texas 76063 • 817-563-1144

TEXAS BOARD OF PROFESSIONAL ENGINEERS
FIRM REGISTRATION NO. F-256

TEXAS BOARD OF PROFESSIONAL GEOSCIENTISTS
FIRM REGISTRATION NO. 50222

CONTENTS

30 TAC §330.63(d)(4)(D)

STATE OF TEXAS
DAVID L. CLARK
81905
LICENSED
PROFESSIONAL ENGINEER
8-21-12

1 SITE LIFE

1.1 Solid Waste Generation

The Skyline Landfill accepts waste generated in Dallas and Ellis Counties, Texas, and surrounding areas. The Skyline Landfill has been designed to continue to provide disposal capacity for waste generated from the areas identified as well as other neighboring counties. The Skyline Landfill receives approximately 1,040,000 tons of waste annually (about 3,333 tons per day). The facility accepts waste the equivalent of six days per week (approximately 312 days per year). The landfill projects that the waste acceptance rate will increase at an annual rate of 1.4 percent for the life of the facility based on North Central Texas Council of Governments' population projections for the combined population of Dallas and Ellis counties.

1.2 Airspace Utilization

An airspace utilization factor (ratio of tons disposed to in place cubic yard volume) of 0.77 will be used to calculate the projected site life based on the approximate volume available for deposition of solid waste. The airspace utilization factor is based on previous performance at the facility.

1.3 Landfill Capacity

The total landfill capacity is defined as the volume between the liner and the final cover, and was 80,600,000 cubic yards (cy) estimated using previous permit documentation and TerraModel computer software. A summary of the quantity of existing and remaining airspace in each of the waste fill areas is included in Attachment H. The total remaining landfill disposal capacity is approximately 53,505,000 ~~cubic yards~~ (cy) of waste and daily cover, based on the March 4, 2012 aerial topography. All of the remaining capacity is located in Phases 1 through 3 areas of the site.

1.4 Site Life Calculations

The capacity for solid waste in tons was calculated by multiplying the airspace utilization factor of 0.77 by the remaining solid waste capacity (cubic yards). The remaining solid waste capacity for the site is approximately 41,198,850 tons.

The proposed site will reach its approximate waste capacity of 41,198,850 tons in approximately 32 years based on the increasing waste acceptance rate.

SKYLINE LANDFILL
CITY OF FERRIS
DALLAS AND ELLIS COUNTIES, TEXAS
TCEQ PERMIT APPLICATION NO. MSW 42D

PERMIT AMENDMENT APPLICATION

PART III – FACILITY INVESTIGATION AND DESIGN
ATTACHMENT D5
GEOTECHNICAL DESIGN

Prepared for

Waste Management of Texas, Inc.

April 2012

Revised August 2012

STATE OF TEXAS
DAVID L. CLARK
81905
LICENSED
PROFESSIONAL ENGINEER
8-21-12

Prepared by

BIGGS & MATHEWS ENVIRONMENTAL
1700 Robert Road, Suite 100 • Mansfield, Texas 76063 • 817-563-1144

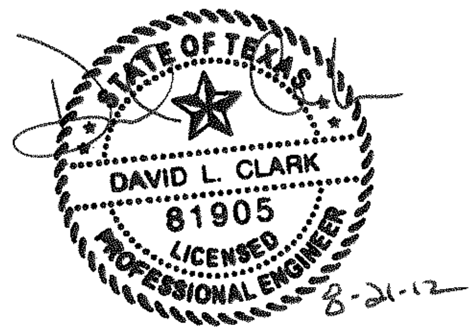
TEXAS BOARD OF PROFESSIONAL ENGINEERS
FIRM REGISTRATION NO. F-256

TEXAS BOARD OF PROFESSIONAL GEOSCIENTISTS
FIRM REGISTRATION NO. 50222

DAVID L. CLARK
81905
LICENSED PROFESSIONAL ENGINEER
STATE OF TEXAS
8-21-12

CONTENTS

CONTENTS (Continued)



TABLES

Table | Page

3 EARTHWORK

30 TAC §330.337(e)

3.1 Excavation

The cross sections in Attachment D2 show that the excavation will be up to 160 feet below the surrounding ground surface. The excavation may encounter any of the materials identified in Stratums I and II. The excavated materials should be visually classified and may be stockpiled separately according to the construction material properties outlined in Table D5-3. Prior to use the soils will be tested for suitability in accordance with Attachment D7 – Liner Quality Control Plan and Attachment D8 – Final Cover Quality Control Plan. Excavation and construction below the groundwater table is discussed in Section 4 and the stability of excavation slopes is discussed in Section 6.

3.2 Earthfill

General fill will be ~~required to construct roads and perimeter berms~~ used at various locations around the site in applications that are not covered by other performance specifications. General fill should consist of on-site clayey soils, which are free of organic or other objectionable materials. General fill should be spread in maximum 9-inch-thick loose lifts. General fill should be compacted to a minimum of 95 percent of maximum dry density as defined by the standard Proctor test (ASTM D698), within a range of 2 percentage points below to 4 percentage points above optimum moisture content. A minimum of one standard Proctor test should be performed on each representative soil used as general fill material.

4 CONSTRUCTION BELOW THE GROUNDWATER TABLE

30 TAC §330.337

4.1 Groundwater Elevations

Groundwater may be encountered in the landfill excavation within the Stratum I materials. The highest recorded groundwater elevations for the site are included in Attachment D7 – Liner Quality Control Plan, Appendix D7-A – Highest Measured Water Levels.

4.2 Temporary Dewatering System

As shown in Attachment D3 – Construction Design Details, Drawing D3.7 – Temporary Dewatering Plan, the excavation for Phase 1 will extend below the highest recorded groundwater elevations in the Stratum I materials in two areas, including portion~~s~~ of ~~the~~ side slopes in Cells ~~13, 14, and 18~~13 through 15, and portions of the side slope in Cell 18. Consequently, the liners will be constructed below the highest measured groundwater elevations only in the ~~two~~ three locations shown in Drawing D3.7. Areas where the liner is to be constructed below the highest measured groundwater elevations will be dewatered during and after construction by a temporary dewatering system. The temporary dewatering system on the side slopes will consist of geocomposite blanket drains and drainage trenches with either prefabricated composite drains encased in sand~~-filled trenches~~ or drainage pipe encased in aggregate. The side slope dewatering trenches will discharge into open sumps beyond the lined areas or closed sumps beneath the lined areas. The groundwater will be pumped from the sumps into the perimeter drainage system. The temporary dewatering system will be operated until sufficient ballast has been placed to offset the hydrostatic forces.

The anticipated location of the temporary dewatering system based on the information from the boring logs is shown in Attachment D3 – Construction Design Details, Drawing D3.7 – Temporary Dewatering Plan. The actual location of the dewatering system will be adjusted based upon where the Stratum I and II interface is exposed in the subgrade. The design procedures and typical details of the temporary dewatering system are provided in Appendix D7-B – Temporary Dewatering System. Design and installation of the temporary dewatering system will be documented in the Soils and Liner Evaluation Report (SLER) in accordance with Attachment D7 – Liner Quality Control Plan, Section 9.2. The facility will submit a Ballast Evaluation Report (BER) to the TCEQ once it is determined that ballasting or dewatering is no longer necessary. If the TCEQ does not provide a response within 14 days of the date of receipt of the BER, the facility will discontinue dewatering or ballasting operations.

4.3 Hydrostatic Uplift

Liners constructed below the groundwater table may experience hydrostatic pressure. Resistance to uplift from hydrostatic forces will be provided by the weight of the protective cover, waste, daily cover, intermediate cover, and final cover system. The temporary dewatering system will be operated to keep the groundwater lowered until sufficient ballast has been placed to offset hydrostatic forces.

The ballast requirements for each cell must be based on the highest recorded groundwater elevations as shown in Attachment D7 – Liner Quality Control Plan, Appendix D7-A – Highest Measured Water Levels. For example Bballast calculations provided in Attachment D7, Appendix D7-C – Ballast Calculations show the height of solid waste that must be placed ~~that the landfill components overlying the geomembrane liner will provide sufficient ballast~~ to offset the hydrostatic forces with a minimum factor of safety of 1.5.

The highest recorded groundwater elevations must be updated before the construction of each cell and adjusted upward if necessary. The ballast design must be verified to be adequate for the design groundwater elevations prior to the construction of each cell. Ballast calculation, placement, and documentation procedures are provided in Attachment D7 – Liner Quality Control Plan.

Once the required height of compacted waste has been achieved for each cell area, temporary groundwater control measures will be decommissioned and the groundwater allowed to rebound. The facility will submit a BER to the TCEQ once it is determined that ballasting or dewatering is no longer necessary. If the TCEQ does not provide a response within 14 days of the date of receipt of the BER, the facility will discontinue dewatering or ballasting operations. Operational procedures for ballast placement are discussed in Part IV – Site Operating Plan. Documentation requirements are discussed in Attachment D7 – Liner Quality Control Plan.

6 SLOPE STABILITY ANALYSES

30 TAC §330.337(e)

Slope stability analyses were performed on representative sections to predict the stability of the excavation slope, liner slope, interim waste slope, final waste slope and final cover slope. Excavation and liner slope sections were developed to represent the critical subsurface conditions that may be encountered.

The geometry of the sections was developed from the proposed excavation and final cover plans and from data on logs of borings drilled in the vicinity of each section. Water surface elevations were assumed at the highest recorded water levels.

Table D5-4 summarizes the unit weights and strength parameters that were used for the stability analyses. The unit weights and strength parameters for the Stratum I – II soils were selected based on a review of the historic and expansion boring logs and laboratory and field test results for the Skyline Landfill. The unit weights and strength parameters for solid waste were selected based on engineering judgment and published values. The strength parameters for the liner and cover geosynthetics were selected based on the most critical interface included in Table D5-5.

Table D5-4
Skyline Landfill
Summary of Material Weight and Strength Properties[1]

Material	Description	Wet Weight (pcf)	Total Stress		Effective Stress	
			Cohesion (psf)	Friction (deg)	Cohesion (psf)	Friction (deg)
Stratum I	Clay and Weathered Shale	119.8	538	20.8	840	22.7
Stratum II	Shale, Clayey	117.6	1,500	25	1,500	25
Liner/Cover	Compacted Clay	119.8	538	20.8	840	22.7
Liner/Cover Floor	Geosynthetics[2]	N/A	309	9.6	309	9.6
Liner/Cover Sidewall	Geosynthetics[2]	N/A	273	13.5	273	13.5
Solid Waste	Solid Waste	50	250	23	250	23

[1] Strength parameters for each material type represent internal strength except for geosynthetics which represent interface strength.

[2] Strength parameters shown are for the interim and final waste slope stability analyses (PCSTABL6) and are selected based on the 5,000 to 15,000 normal stress range and geomembrane/soil liner interface (most critical) from Table D5-5. The geosynthetics interface parameters for the 100 to 500 psf normal stress range in Table D5-5 are used for the veneer slope stability calculations.

Table D5-5 summarizes the strength parameters for the liner and cover geosynthetic materials that were selected based on the direct shear test results included in Appendix D5-C – Direct Shear Test Results. The direct shear test results were conducted by TRI/Environmental, Inc. with on-site soils and geosynthetics used for recent liner construction at the Skyline Landfill. The normal stresses applied to the direct shear box at each interface were 100-500 psf and 5,000-15,000 psf to represent the solid waste overburden stress for the conditions analyzed. The strength parameters for the 100-500 psf normal stress range were used for the veneer slope stability calculations. The strength parameters for the 5,000-15,000 normal stress range were used for the interim waste and final waste slope stability analyses.

Table D5-5
Skyline Landfill
Summary of Direct Shear Tests

Material Interface	100-500 psf Normal Stress		5,000-15,000 psf Normal Stress	
	Cohesion (psf)	Friction (deg)	Cohesion (psf)	Friction (deg)
Sidewall Liner[1]				
Protective Cover/Geocomposite	12	32.6	811	12.8
Geocomposite/Geomembrane/Soil Liner	59	31.8	1409	11.4
Geomembrane/Soil Liner	60	31.8	273	13.5
Floor Liner[2]				
Protective Cover/Geocomposite	30	29.5	773	12.9
Geocomposite/Geomembrane/Soil Liner	28	12.9	601	6.8
Geomembrane/Soil Liner	68	16.5	309	9.6

1) Double-sided geocomposite and textured geomembrane
2) Single-sided geocomposite and smooth geomembrane

The excavation slope was analyzed for short-term conditions using total stress parameters and long-term conditions using effective stress parameters. The interim waste slope was analyzed for short-term conditions using total stress parameters. The final waste slope was analyzed for long-term conditions using effective stress parameters. PCSTABL6, a computer program developed to model the slope stability, was used to analyze the stability of the excavation slopes, interim waste slopes, and final waste slopes. The results of the stability analyses indicate that the proposed slopes are stable under the conditions analyzed. Table D5-6 summarizes the results of the stability analyses and compares the calculated factor of safety to the recommended minimum factor of safety. The recommended minimum factors of safety were selected from the Corps of Engineers "Design and Construction of Levees" manual (EM 1110-2-1913). The slope stability analyses are provided in Appendix D5-B – Slope Stability Analyses.

Table D5-6
Skyline Landfill
Summary of Slope Stability Analyses

Condition	Slope (H:V)	Slope Angle (°)	Minimum Calculated Factor of Safety	Recommended Factor of Safety	Acceptable Factor of Safety
Excavated Slope					
Short Term	5H:1V	11.3°	4.2	1.3	Yes
Long Term	5H:1V	11.3°	4.3	1.5	Yes
Excavation with Waste Surcharge 1	5H:1V	11.3°	2.9	1.3	Yes
Excavation with Waste Surcharge 2	5H:1V	11.3°	2.8	1.3	Yes
Interim Waste Slope					
Circular Arc Failure	3H:1V	18.4°	1.5	1.3	Yes
Sliding Block Failure	3H:1V	18.4°	1.3	1.3	Yes
Final Waste Slope					
Circular Arc Failure	4H:1V	14.0°	2.0	1.5	Yes
Sliding Block Failure	4H:1V	14.0°	1.6	1.5	Yes
Liner Veneer					
Protective Cover/Geocomposite	5H:1V	11.3°	3.5	1.3	Yes
Geocomposite/Geomembrane	5H:1V	11.3°	4.4	1.3	Yes
Geomembrane/Soil Liner	5H:1V	11.3°	4.4	1.3	Yes
Final Cover Veneer (Side Slope)					
Alternate Final Cover					
Erosion Layer/Geocomposite	4H:1V	14.0°	2.8	1.5	Yes
Geocomposite/Infiltration Layer	4H:1V	14.0°	2.8	1.5	Yes
Subtitle D Final Cover					
Erosion Layer/Geocomposite	4H:1V	14.0°	2.8	1.5	Yes
Geocomposite/Geomembrane	4H:1V	14.0°	3.9	1.5	Yes
Geomembrane/Infiltration Layer	4H:1V	14.0°	3.9	1.5	Yes

The interim and final waste slope stability was analyzed for two failure modes. The circular arc failure analysis was performed using properties of the solid waste, clay liner and supporting soils. The sliding block analysis was performed using properties of the solid waste and the geomembrane to soil liner interface at the floor of the cell.

The slope stability analyses are only valid for the conditions that were analyzed. Any changes to the excavation plan, dewatering system, ballast system, liner system, final cover system or landfill completion plan will necessitate that the slope stability analyses be revised to reflect the actual conditions. Interim 3H:1V waste slopes shall not exceed 210 feet in height. Waste must be placed and properly compacted in horizontal lifts less than 15 feet thick. Temporary construction slopes should not be steeper than the interim slopes and concentrated loadings such as heavy equipment and soil stockpiles

7 LINER CONSTRUCTION

30 TAC §330.331

The composite liner system will consist of a 2-foot-thick compacted soil liner overlain by a 60-mil HDPE geomembrane, a geocomposite drainage layer, and a 2-foot-thick layer of protective soil cover. The liner details are provided in Attachment D3 – Construction Design Details.

7.1 Subgrade Preparation

The liner subgrade must be firm and stable. Prior to beginning liner construction, the subgrade should be proof-rolled with heavy, rubber-tired construction equipment to detect soft areas. Isolated soft areas should be undercut then backfilled with compacted earthfill in accordance with the requirements for general fill. Low areas should be brought to the design grades with general fill that is placed and compacted in accordance with the requirements in Section 4.

7.2 Compacted Soil Liner

The soil liner material must consist of relatively homogeneous cohesive materials, which are free of debris, rocks greater than 1-inch in diameter, plant materials, frozen materials, foreign objects, and organic material. Clay will be available from proposed landfill excavations or on-site borrow sources to provide material for the compacted soil liners. Laboratory tests indicate that the remolded cohesive soils will meet the compacted soil liner requirements listed in 30 TAC §330.339(c)(5). The soil liner properties summarized in Table D5-7 are specified in Attachment D7 – Liner Quality Control Plan.

Table D5-7
Skyline Landfill
Soil Liner Properties

Test	Specifications
In-Place Density	95% of Standard Proctor (ASTM D 698)
In-Place Moisture Content	Standard Proctor Optimum Moisture Content (OMC) to 4 percentage points above OMC
Hydraulic Conductivity	1.0×10^{-7} cm/sec or less
Plasticity Index	15 minimum
Liquid Limit	30 minimum
Percent Passing No. 200 Mesh Sieve	30 minimum
Percent Passing 1-inch Sieve	100

Preconstruction sampling should be performed on soils to be used as liner material. At a minimum, one liquid limit, plastic limit, percent passing the No. 200 sieve, standard Proctor (ASTM D 698), and hydraulic conductivity test should be performed for each borrow material type prior to use as liner material.

The soil liner material should be placed in maximum 8-inch loose lifts to produce compacted lift thickness of approximately 6 inches. The material should be compacted to a minimum of 95 percent of the maximum dry density determined by standard Proctor (ASTM D 698) at a moisture content between optimum moisture and 4 percentage points above optimum moisture. Rocks within the liner should be less than 1 inch in diameter and should not total more than 10 percent by weight. The material should be processed to a maximum particle size of 1 inch or less before water is added to adjust the moisture content. Soil processing may be achieved using a disc or soil pulverizer. Water should be applied as necessary to the material and worked into the material with the compaction equipment. Water used for the soil liner compaction must not be contaminated by waste or any objectionable material.

The soil liner must be compacted with a pad/tamping-foot or prong-foot roller. A footed roller is necessary to achieve bonding between lifts, to reduce the clod size, and to achieve a blending of the soil matrix through kneading action. The compactor should weigh at least 40,000 pounds and make at least four passes across the area being compacted. A pass is defined as one pass of the compactor, front and rear drums. The Caterpillar 815 and 825 are examples of equipment typically used to achieve satisfactory results. The lift thickness shall be controlled to achieve total penetration into the top of the previously compacted lift; therefore, the lift thickness must not be greater than the pad or prong length. Cleaning devices on the compaction roller must be in place and maintained to prevent the prongs or pad feet from becoming clogged to the point that they cannot achieve full penetration. Soil liner shall not be compacted with a bulldozer, rubber-tired (pneumatic) roller, flat-wheel roller, scraper, truck, or any tracked equipment unless it is used to pull a footed roller.

Tie-ins with previously constructed soil liners shall be constructed using a sloped or stair-step transition as described in Attachment D7 – Liner Quality Control Plan.

7.3 Protective Cover

The protective cover should be constructed of soils that are free of debris, large rock, plant materials, frozen materials, foreign objects, and organic material. Soil will be available from proposed landfill excavations or on-site borrow sources to provide material for the protective cover.

7.4 Liner Testing and Documentation

CQA testing of the soil liner must be performed as the liner is being constructed. Liner system testing is addressed in Attachment D7 – Liner Quality Control Plan. The construction methods and test procedures documented in the SLER must be consistent with the requirements of Attachment D7 – Liner Quality Control Plan.

8 COVER CONSTRUCTION

30 TAC §§330.165, 330.457

8.1 Daily/Intermediate Cover

The daily and intermediate cover should be constructed of soils that are free of waste and debris. Suitable cover soils should be available from on-site sources such as the proposed landfill excavations or on-site borrows. Requirements for the placement of daily and intermediate cover are provided in Part IV – Site Operating Plan.

8.2 Final Cover

The approved alternate final cover system will consist of an 18-inch-thick compacted soil infiltration layer overlain by a geocomposite and a 36-inch-thick erosion layer and will be constructed over the waste fill footprint that has not changed. The Subtitle D final cover system will consist of an 18-inch-thick compacted soil infiltration layer overlain by a geocomposite on the sideslopes and a cushion geotextile on the top slope and a 36-inch-thick erosion layer and will be constructed over the expansion waste fill footprint. The final cover system requirements are provided in Attachment D8 – Final Cover Quality Control Plan and the final cover system details are provided in Attachment D3 – Construction Design Details.

The infiltration layer material must consist of relatively homogeneous cohesive materials that are free of debris, rocks greater than 1 inch in diameter, plant materials, frozen materials, foreign objects, and organic material. The infiltration layer should be constructed directly over the intermediate cover once the waste has reached final grades. The infiltration layer construction procedure should be the same as those outlined in Section 7 for liner construction.

The erosion layer should consist of: (1) topsoil stockpiled during the excavation process, (2) on-site clay which has been modified to be capable of sustaining vegetation, or (3) an imported material suitable to sustain vegetation growth. This layer may be spread and placed in one lift over the drainage layer. After spreading, the layer should be rolled lightly to reduce future erosion, although not to the extent that compaction would inhibit plant growth.

8.3 Final Cover Testing and Documentation

CQA testing of the final cover system must be performed during construction. Final cover system requirements are outlined in Attachment D8 – Final Cover Quality Control Plan.