SECTION 2.3

DESIGN

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Introduction

The Site 2 East Expansion (Expansion) of the Veolia E.S. Zion Landfill has been designed by experienced landfill engineers, geologists and scientists based on thorough and comprehensive investigations and analyses of regional and site-specific conditions. These engineers, geologists and scientists have designed numerous landfills that are operating safely, and have reviewed many other landfill facilities on behalf of local governments and large corporations. Additionally, the existing landfill design has been thoroughly reviewed and scrutinized by the IEPA and has been deemed protective of the public health, welfare, and safety. The proposed design draws on this collective experience to provide the highest level of environmental safety.

In conjunction with a suitable site location and favorable geologic and hydrogeologic conditions, multiple engineered design features are included to safely contain the waste which is placed in the landfill. These design features, which have been successfully used at the existing landfill and many other modern landfills, have been shown to protect the public health, safety, and welfare, and include the following:

1. *Composite Liner System.* The Expansion has been designed with a composite liner system consisting of a minimum 5-foot thick compacted cohesive soil liner with a maximum permeability 1×10^{-7} cm/sec and a 60-mil high density polyethylene (HDPE) geomembrane (or equivalent). The composite liner system will prevent the release of potential hazards from the landfill and perform at a level which exceeds state, and federal standards. The liner system has been computer modeled, and the computer analysis demonstrates that the proposed landfill will not impact existing or future groundwater quality.

2. *Geotechnical Analysis*. The Expansion has been designed to maintain sufficient factors of safety during static (F.S. $\geq$ 1.5) and seismic (F.S. $\geq$ 1.3) conditions for both long term and short term conditions for global mass stability and maximum interim slopes that may be constructed during waste filling prior to the completion of construction. The geotechnical analyses demonstrate that landfill slopes will not fail and that liner and final cover integrity will be maintained over the life of the landfill and beyond.

3. *Leachate Collection System.* Liquids that come in contact with waste are known as leachate. These liquids are managed such that they will not impact the environment. The proposed Expansion has been designed with a leachate collection system consisting of a one-foot thick permeable granular drainage layer placed above the composite liner on the landfill floor and sideslopes. The leachate collection layer drains to collection points located along the perimeter of the waste boundary. Leachate will be removed from these collection points and managed.

4. *Construction Phasing.* The Expansion will expand the existing landfill footprint approximately 26.5 acres to the east and vertically expand over 53.8 acres of the currently permitted waste disposal footprint. The landfill expansion will provide two new cells (Cells 9 and 10). The construction phasing will begin with the vertical expansion and move forward to Cells 9 and 10. Once active, each phase will generally be filled to final proposed grades. Landfill operations will be conducted to protect the newly constructed and existing liner system and to minimize the active area of the landfill.

5. *Final Cover System*. The final cover system of the landfill consists of a low-permeability layer to prevent precipitation from entering the landfill, and is overlain by a protective soil layer used to prevent erosion and maintain the long-term integrity of the cap.

   The low-permeability layer will include a double-sided 40-mil liner linear low density polyethylene (LLDPE) geomembrane and a two-foot thick compacted cohesive soil layer with a maximum permeability of 1×10^{-6} cm/sec. A double-sided geocomposite drainage net will overlay the geomembrane to drain infiltrated water away from the low-permeability layer.

   Additional soils will be placed over the geocomposite in a two layer fashion, and will include, from the bottom up: a minimum of 2.5 feet of protective cover soil and six inches of vegetative cover soil. The overall slope of the final cover will be a maximum of 3H:1V. In order to minimize the potential for erosion, the final slopes of the landfill will be vegetated.

6. *Landfill Gas*. The proposed Expansion will have an active landfill gas collection and gas-to-energy system that will tie into the existing system.

Landfill History

The Zion Landfill was initially permitted in 1976 by BFI Waste Systems of North America, Inc. BFI owned and operated the site until July 30, 1999 when Allied Waste Industries, Inc. acquired Browning-Ferris Industries, Inc., which was the parent company of BFI Waste Systems of North America, Inc. On March 31, 2000, Allied sold the site to Superior Zion Landfill, Inc. On the same day, Superior Zion Landfill, Inc. changed its name to Onyx Zion Landfill, Inc. On July 1, 2006, Onyx Zion Landfill, Inc. changed its name to Veolia E.S. Zion Landfill, Inc. The Veolia E.S. Zion Landfill, Inc. Facility consists of a number of older units that have ceased acceptance of waste and are closed, as well as the currently active unit.

The portion of the Facility referred to herein as the Veolia E.S. Zion Landfill consists of two areas individually referred to as Old Site 2 and the Site 2 Expansion. Old Site 2 is a non-hazardous solid waste unit that was regulated under 35 IAC, Part 807. Old Site 2 commenced landfilling operations on December 23, 1981, pursuant to IEPA permit No. 1980-24-DE. In 1993, a final cover system was constructed over the site. Siting approval for the Site 2 Expansion (initially identified as Site 3 at that time) was granted by the Zion City Council on April 17, 1995 which approved a new landfill unit east of Old Site 2 including a "piggyback" onto the eastern portion of Old Site 2. Collectively, Old Site 2 and the Site 2 Expansion are referred to as the Veolia E.S. Zion Landfill.

Design Period

The Expansion will provide an additional site life of approximately ten (10) years. The landfill expansion has been designed and will be constructed and operated to perform safely throughout the entire design period, including a minimum of thirty (30) years for the post-closure care period. The estimated operating life of the Facility may vary due to changes in incoming waste volumes and waste compaction rates, but is estimated to continue until approximately 2022. Additional information and calculations on the operating life is provided in Section 1 and Appendix E of this Application.

Landfill Composite Liner System

An engineered composite liner system will be constructed at the bottom and sides of the landfill to contain the waste materials and prevent contaminants from leaving the landfill and impacting groundwater. The composite liner will consist of a compacted cohesive soil liner overlain by a geomembrane (plastic) liner. The soil liner will consist of a minimum 5-foot thick layer of recompacted cohesive soil with a maximum permeability of 1×10^{-7} cm/sec. The geomembrane will be a 60-mil high density polyethylene (HDPE) liner or equivalent. The 1995 Site 2 Landfill Expansion liner system has been permitted and constructed utilizing the same design. It is noted that the recompacted soil liner thickness exceeds the typical three-foot liner thickness used at other landfill facilities within Illinois.

The liner design was evaluated using computer modeling, and was found to protect the groundwater resources at and surrounding the site as discussed in Section 2.7 of this Application.

Effectiveness of Landfill Composite Liner Systems

In 2003, the Illinois Environmental Protection Agency (IEPA) commissioned a report to study the merits and effectiveness of alternate liner systems at Illinois landfills. The report analyzed the current liner design required by the IEPA (single composite liner system) along with a review of the regulatory requirements from other states.

The report concluded that the Illinois regulations specify minimum design standards but also require an evaluation of the design within the specific geologic and hydrogeologic setting. Illinois is one of the few states that requires the evaluation of the landfill design within the geologic and hydrogeologic setting utilizing a groundwater model. The evaluation of the specific landfill design may require additional requirements beyond the minimum design standard including, but not limited to, a double-composite liner system.

Additionally, this report also concluded that due to the complicated construction of double-composite liner systems, there is a much better chance of successfully completing construction of the liner if the design is kept simple.

"The current design requirements for municipal solid waste landfills contained in the Illinois regulations are protective of the human health and the environment. The minimum liner design standard currently in the Illinois regulations requires a single liner."

Dr. Daniel is a published expert on landfill design, specifically liners. Dr. Daniel has stated:

> *"(t)o the best of my knowledge, there has been no documented instance of groundwater contamination anywhere in the U.S. as a result of leakage through single-composite liner systems, such as required in Illinois."* [1]

Hydrogeology Considerations

The design of the Expansion is supplemented by existing geologic features to provide a high level of environmental safety. The clay that is naturally present beneath the site will work in

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1 Munie, J. "A Study of the Merits and Effectiveness of Alternate Liner Systems at Illinois Landfills." A Research Paper submitted in fulfillment of House Resolution 715. January 2003.

conjunction with the engineered features of the landfill expansion to protect groundwater resources in the vicinity of the Site.

The Wadsworth Formation, a low-permeability cohesive soil that has existed for over 10,000 years, is present across the proposed Site and will separate the footprint of the proposed landfill expansion from the uppermost aquifer. Field and laboratory test results and field observations indicate that this soil will effectively restrict vertical and horizontal movement of groundwater and will serve as an additional environmental safeguard at the proposed Expansion. The Wadsworth Formation contains a weathered portion directly below the Peoria Silt that has the potential to exhibit fractures within the upper 20 feet, although no fractures were identified at the site during the most recent investigation. The proposed excavation for the expansion (approximately 60 feet) will remove this weathered zone. Additionally, loading stress caused by landfill will close any fractures within this zone. Thus, Wadsworth formation will provide a geologic barrier between the landfill and the uppermost aquifer that will provide very long-term protection of the environment. Please refer to Section 2.2 for a complete description of the geologic setting of the Site. Please also refer to Sections 2.7 “Groundwater Impact Assessment” for groundwater monitoring and 2.8 “Environmental Monitoring Program” contained within this report.

Recompacted Soil Liner

The recompacted soil liner for the Expansion will meet regulatory requirements by providing a minimum 5-foot layer of compacted cohesive soil with a maximum hydraulic conductivity of 1×10^{-7} cm/sec. The recompacted soil liner thickness exceeds typical three-foot liners as an additional environmental safeguard.

It is anticipated that the recompacted soil liner will be constructed of Wadsworth formation soils due to the favorable physical properties for construction and low hydraulic conductivity. As discussed in Section 2.2 of this Application, the native soils have permeabilities that are less than the 1×10^{-7} cm/sec requirement.

To assure that the soil liner meets design specifications, the Construction Quality Assurance Plan (CQA Plan) outlined in Section 2.5 of this Application will be implemented. Veolia will retain an independent licensed Professional Engineer to ensure that the CQA Plan is implemented and that the landfill is constructed in conformance with the design and permit requirements. Soil material for the liner will be tested to determine suitability prior to placement. The in-place soil liner will have a hydraulic conductivity of no more than 1×10^{-7} cm/sec.

Roots, boulders, debris, and other deleterious material will be removed from the soil prior to compaction. Frozen soil will not be used for construction and liner material will not be placed on frozen ground. Each soil layer will be worked sufficiently to break down oversized clods, and obtain acceptable moisture and density requirements, as defined by the CQA Plan.

Geomembrane

The geomembrane liner will be installed above the compacted soil liner by personnel experienced in liner installation. The geomembrane liner will consist of panels of 60-mil textured HDPE (or equivalent) which will be field welded and tested as outlined in the CQA Plan (see Section 2.5).

Seams will be made in the field according to project specifications and industry standards. Sections will be arranged to minimize the number of field seams, and seams will be oriented close to parallel to the slope to minimize the stress acting on the seams. It is assumed that the geomembrane panels will be 22.5 feet by 400 feet (panel lengths and widths may vary per manufacturer's specifications at the time of construction). Drawing No. D6 is a conceptual geomembrane panel layout drawing. The actual constructed layout of the geomembrane panels will be provided with each cell construction certification report, which is required to be approved by the IEPA prior to waste acceptance.

Based on current technology, a dual fusion wedge weld is generally the preferred seaming method to join panels and will generally be used for areas except at sumps, corners or other irregular areas where an extrusion weld is necessary. Extrusion welds are also highly effective welds and are anticipated to be used to repair destructive sample locations, and any repair areas.

CQA Documentation

Liner construction, documentation, and certification will be performed in accordance with the CQA Plan contained in Section 2.5 of this Application. A Construction Quality Assurance (CQA) Officer will supervise and be responsible for inspections and testing. The CQA Officer will be an independent licensed Professional Engineer. A construction acceptance report will be prepared under the direct supervision of the CQA Officer and submitted to the IEPA after completion of each major phase of construction. Construction documents and as-built drawings will be kept on file and will be available for inspection.

Geotechnical Analyses

The following section describes the geotechnical analyses conducted on the proposed design in order to verify that the liner and final cover will be stable during construction and operation of the landfill and after closure of the Facility. The analyses demonstrate that landfill slopes will not fail and that the structural integrity of the bottom liner and final cover will be maintained over the life of the landfill and beyond. Specifically, this section addresses:

1. *Slope Stability*. This subsection analyzes the slopes of the active face of the waste during interim waste filling operations, as well as the final build-out landform, in order to meet the necessary safety factors. In addition, stability of the bottom and sideslope liner, leachate collection system and final cover are analyzed to determine factors of safety against failure.

2. *Foundation and Mass Stability*. This subsection examines the foundation materials below the landfill, ensuring that the foundation will not be compromised by bearing capacity failure.

3. *Landfill Settlement*. This subsection details the anticipated settlement of the foundation and waste within the landfill, and estimates the potential differential settlement at the landfill. The landfill has been designed to withstand this settlement while maintaining functional design performance of the engineered systems.

4. *Anchor Trench/Runout Design*. This subsection evaluates whether the anchor trench provides holding capacity against the self weight of the geomembrane while allowing pull-out of the geomembrane at loads approaching the ultimate material strength of the geomembrane.

5. *Additional Geosynthetic Strength and Protection Considerations.* This subsection includes several calculations such as geomembrane strain, wheel loading, wind uplift, and puncture resistance. These evaluations consider additional geosynthetic material considerations as to whether the proposed materials will function as required over the life of the landfill.

Supporting documentation and calculations are provided in Appendix J. Geotechnical analyses have been performed under the direct supervision of a licensed professional engineer experienced in geotechnical engineering.

Slope Stability

The Proposed Waste Expansion Area is designed with 4 Horizontal to 1 Vertical (4H:1V) sideslopes, with the exception of the area near the loadout station, which has 3H:1V sideslopes (northeast portion of Expansion). The "plateau" area at the top area of the landfill and benches are sloped at 10H:1V. The peak of the landfill is approximately 930 feet above mean sea level (MSL). The existing areas north and south of the vertical expansion have 3H:1V sideslopes with benches, as shown on Drawing No. D12.

Seismic Analysis

A seismic analysis was performed based on a horizontal acceleration of 0.0629g to demonstrate that the slopes will be stable during seismic events. The design horizontal acceleration corresponds to an earthquake event that has a 10% probability of occurring every 250 years (see Figure 2.2-15).

In general, modern municipal solid waste landfills have performed extremely well during earthquake events.[2] A detailed study of southern California landfills demonstrated that all landfills designed in accordance with a Subtitle D liner standards that were subject to the strongest shaking of the January 17, 1994 Northridge California earthquake (Magnitude 6.7), performed well with no major slope failures.

Failure Scenarios

The following slopes and potential failure scenarios were modeled for the Expansion:

1. Final landform conditions with a block failure through the liner system (long and short terms).

2. Final landform conditions with circular failure through the waste (long and short terms).

3. Final landform conditions with circular failure through the foundation soil (long and short terms).

4. Excavation face with circular failure.

5. Active landfill face conditions with circular failure.

[2] Richardson, G.N. and Kavazanjian, E. J., "RCRA Subtitle D (258) Seismic Design Guidance for Municipal Solid Waste Landfill Facilities," U.S. EPA - EPA/600/R-95/05, April 2005

6. Active landfill face conditions with a block failure through the liner system.

7. Active landfill face conditions with circular failure through the internal berm separating Cell 10 from Cells 3, 6, and 7.

Three cross-sections were analyzed for final landform scenarios (A-A', B-B', C-C'; refer to Appendix J). One cross section was analyzed for interim construction conditions (D-D'). Cross Sections A-A', B-B', C-C' and D-D' were determined to be the most critical cross sections for the global mass stability for the Expansion. The liner design calls for textured 60-mil HDPE geomembrane. The cross section was modeled assuming an excavation slope of 3H:1V. Cross section A-A' utilized a peak final landform elevation of 930 feet MSL with a final cover slope that includes benches and ranges between 3H:1V and 10H:1V. Cross section B-B' utilized a peak final landform elevation of 926 feet MSL with a final cover slope ranging between 4H:1V and 10H:1V. Cross section C-C' utilized a peak final landform elevation of 926 feet MSL with a final cover slope ranging between 3H:1V and 10H:1V. The water table elevation for each cross section was selected from recent groundwater data available at the time of the analysis. Two dozer loadings were applied to all failure scenarios. Please refer to Appendix J for a detailed description of the slope stability analyses.

Cross Section D-D' evaluates the internal soil berm between the existing Cells 3 and 6 and the proposed Cell 10. The location fo Cross Section D-D' is shown on Design Drawing No. D4. It has a peak waste elevation of 838 feet MSL with an intermediate waste slope that includes benches and ranges from 3H:1V to 10H:1V. The internal soil berm was evaluated under short term conditions to evaluate stability during interim construction activities.

Table 2.3-1 demonstrates that the Expansion meets the requirements of 35 Ill. Admin. Code, Section 811.205, which states that all final slopes must achieve a minimum static slope safety factor of 1.5 and a minimum seismic safety factor of 1.3. The supporting model printouts are provided in Appendix J.

TABLE 2.3-1
FACTORS OF SAFETY FOR VEOLIA ES ZION LANDFILL SITE 2 EAST EXPANSION

Scenario	Short Term						Long Term					
	Static			Seismic			Static			Seismic		
	A-A"	B-B"	C-C"	A-A"	B-B"	C-C"	A-A"	B-B"	C-C"	A-A"	B-B"	C-C"
Liner Block Failure	3.39	3.06	3.44	2.59	2.31	2.71	3.40	3.41	3.33	2.61	2.64	2.63
Waste Circular Failure	2.83	2.75	2.18	2.22	2.17	1.82	2.67	2.60	1.83	2.10	2.05	1.56
Foundation Circular Failure	2.64	2.91	2.49	1.95	2.20	2.00	3.04	3.01	2.43	2.35	2.35	1.95
Excavation Circular Failure	1.85	1.75	1.63	1.52	1.43	1.35	-	-	-	-	-	-
Active Face Circular Failure:	1.77			1.43			-	-	-	-	-	-

TABLE 2.3-1 FACTORS OF SAFETY FOR VEOLIA ES ZION LANDFILL SITE 2 EAST EXPANSION												
Scenario	**Short Term**						**Long Term**					
	Static			**Seismic**			**Static**			**Seismic**		
	A-A"	B-B"	C-C"	A-A"	B-B"	C-C"	A-A"	B-B"	C-C"	A-A"	B-B"	C-C"
Active Face Liner Failure:	2.42			2.02			-	-	-	-	-	-
Internal Soil Wedge (D-D'):	1.91			1.53			-	-	-	-	-	-

Additionally, an infinite slope stability analysis, which conservatively assumes that slope stability is independent of slope length, was conducted to evaluate the stability of the final cover system for the Expansion. The slope of the proposed final cover system for the Expansion was assumed to be 3 horizontal to 1 vertical (3H:1V), which is the steepest design slope of the Expansion. A horizontal acceleration of 0.0629g was used for the analysis of seismic conditions. A double-sided textured geomembrane will be used over the entire final cover. The slopes will have a static factor of safety equal to 1.7, and a seismic factor of safety equal to 1.4 which meets or exceeds factors of safety required by 35 Ill. Admin. Section 811.304 (d) (1.5 for static and 1.3 for seismic). The supporting calculations are provided in Appendix J.

Final cover slope stability analyses assume that the geocomposite above the geomembrane is free-draining from surface water that percolates through the final cover soils. This assumption was validated in Appendix J.4, where the capacity for the geocomposite to remain free-draining was evaluated. Additionally, the toe-drains that drain the geocomposite were also analyzed in Appendix J.6 to ensure that the drains are able to discharge the maximum flow rate anticipated through the geocomposite without water backing up within the geocomposite. The toe-drains have been determined to be appropriately sized to pass this flow rate. The supporting calculations are provided in Appendix J.

A stability analysis of the leachate collection system for the Expansion was also performed. The factor of safety against slope failure of the leachate collection system was determined assuming buttressing effects at the bottom of the sideslope. Assuming a granular drainage material, and 3 horizontal to 1 vertical (3H:1V) sideslopes, the factors of safety were calculated to be greater than 1.7 for static conditions and greater than 1.4 for seismic conditions, in accordance with the requirements of 35 Ill. Admin. Code Section 811.306 (b) (1.3 static conditions and 1.0 for seismic). The supporting calculations are provided in Appendix J.

Bearing Capacity Analysis (Foundation and Mass Stability)

A bearing capacity analysis was performed to demonstrate that the earthen materials beneath the landfill exhibit sufficient strength to support anticipated loads. The worst case scenario is the vertical expansion over the existing landfill. Since the existing landfill is keyed into the Wadsworth Formation, a bearing capacity analysis was performed for this soil. Terzaghi's bearing capacity equation was used to calculate the ultimate bearing capacity using engineering properties of these materials. The factor of safety is the ratio of the ultimate bearing capacity to the overburden pressures expected to act on the foundation. Using conservative assumptions, factors of safety greater than 2.0 under static conditions and 1.5 under seismic conditions (as required by 35 Ill. Admin. Code Section 811.304) were achieved for the Expansion. The supporting calculations are provided in Appendix J. The calculations contained in Appendix J also demonstrate that the bedding materials of the leachate collection system possess the structural strength to support the maximum loads imposed by the overlying materials and landfill equipment.

Landfill Settlement

Settlement at a landfill is generally caused by the weight of the landfill compressing the foundation soils and by decomposition of the waste. Settlement analyses were conducted for the landfill foundation of the Expansion based on the proposed design and using conservative assumptions. The maximum differential settlement of the foundation soils was calculated between the locations of maximum and minimum load on the base of landfill over the shortest distance. The maximum waste settlement due to compression was estimated between the point of maximum waste height and the edge of the landfill, over the shortest distance.

<u>Foundation Settlement</u>. As the landfill is constructed, the weight of the landfill will cause the geological units and low permeability soil liner to consolidate slightly. Consolidation is the settlement due to the reduction of void space. The reduction in void space will have the additional benefit of reducing the hydraulic conductivity of both the liner and underlying soils.

Differential settlement calculations were performed to verify that the leachate collection system will still drain after the landfill foundation settles (refer to Appendix J). Although the slope of the proposed leachate collection system may change over time due to settlement, the resulting slopes will still allow for drainage and meet performance requirements.

The site hydrogeologic conditions and history were also reviewed relative to the potential for sinkholes or subsidence to occur in the landfill foundation. No indications of these conditions were observed at the Facility, which is consistent with regional geologic formation information.

<u>Waste Compression</u>. The proposed recirculation of leachate during the operating phase of the landfill will accelerate waste decomposition, leading to a significant increase in the magnitude of initial and secondary compression and corresponding settlement. While compression will continue for a similar time period as a conventional landfill, most compression will be completed before final cover systems are placed. For the Expansion, the maximum differential settlement was calculated to be 3.7% (refer to Appendix J). The final cover system is designed to accommodate the remaining settlement after cover materials are constructed. The cover system also contains a low linear density polyethylene (LLDPE) geomembrane which was selected for its high flexibility characteristics. As a result, differential settlement will have little effect on the performance of the final cover system as demonstrated in calculations provided in Appendix J.

As an additional safeguard, the landfill final cover will be periodically monitored, and maintenance will be performed as necessary. Final cover inspection and maintenance will be performed in accordance with the facility's post-closure care plan contained in Section 2.9 of this Application.

Anchor Trench/Runout Design

It is anticipated that an anchor trench will be used to anchor the geosynthetics. The anchor trench design was evaluated using a veneer analysis, which is provided in Appendix J. The anchor trench was determined to provide holding capacity against the self-weight of the geomembrane, while allowing pull-out of the geomembrane at loads approaching the ultimate material strength of the geomembrane, which minimizes the potential for tearing.

Leachate Management

Liquid that comes in contact with waste is known as leachate and will be managed. The Expansion is designed with a leachate collection system to collect and remove leachate for treatment at an off-site facility or re-entrained in the waste via leachate recirculation. At this time, on-site treatment or pretreatment of leachate is not planned. However, should on-site treatment or pre-treatment be proposed in the future, a permit application will be submitted to the IEPA for approval.

The leachate collection system will consist of perforated HDPE pipe situated within a coarse aggregate envelope and surrounded by a minimum one-foot thick granular drainage system, located above the geomembrane liner as shown on Drawing Nos. D7, D8, and D9. The leachate collection system will convey the maximum estimated leachate flow volumes expected for the landfill. The proposed design exceeds the IEPA performance requirements by maintaining less than the maximum allowable one foot of leachate head across the liner floor.

Origin of Leachate

Leachate can come from several sources, including the biological breakdown of waste or the movement of infiltrated moisture, such as rainwater, through the waste. Leachate generation will vary depending on the composition and moisture content of the incoming waste (i.e., dry waste will absorb more water then wet waste). The rate of leachate generation and the composition of the leachate are influenced principally by the following factors.

1. The availability and potential for infiltration or seepage of water into the landfill.

2. The physical and chemical characteristics of the waste (i.e. the moisture content, absorptive capacity, and solubility of the waste).

3. The environment in which the biological decomposition process takes place (i.e. pH, availability of oxygen and temperature).

Municipal solid waste landfill leachate typically contains the following chemicals in order of decreasing concentrations: 1) dissolved and suspended solids including salts (i.e. sodium chloride), sulfates, and sodium bicarbonate; 2) metals (principally iron and zinc); and, 3) organic compounds. The waste decomposition process will also yield methane, carbon dioxide, and traces of other gases. Some heat will be generated as the waste decomposes. Inert materials (i.e., particles of sand, grit, metal, plastics, and construction/demolition debris) which do not readily degrade will essentially remain unchanged by the decomposition process.

The rate of decomposition in a landfill depends on the type of waste and the landfill environment in which the waste is present, with moisture content being the primary factor. Food wastes typically decompose first, followed by paper, wood, textiles, and discarded un-stabilized plastics. Microbes that are initially present in the waste or introduced with the materials used as daily cover will initiate the aerobic portion of the decomposition process. The recirculation of leachate changes the concentrations of certain compounds. Chloride and ammonia nitrogen can accumulate in landfills that recirculate leachate, resulting in elevated concentrations when compared to conventional landfills.

Most of the leachate in a conventional landfill stems from precipitation that falls on the active area of the landfill, or from precipitation that percolates through daily/intermediate cover. The low permeability final cover employed at the Expansion will essentially eliminate long-term leachate generation on sections of the landfill that have been capped.

The leachate collection system design includes a minimum 1-foot thick granular drainage layer above the floor liner and sidewalls to facilitate the collection of leachate. The quantity of leachate generated will depend primarily on the quantity of percolation through the landfill cover and the moisture content of the waste.

The final cover system will consist of a low permeability layer, which includes a textured 40-mil linear low density polyethylene (LLDPE) geomembrane, or equivalent, and a two foot compacted cohesive soil layer with a maximum permeability of 1×10^{-6} cm/sec. Overlaying the 40-mil LLDPE is a geocomposite, which will effectively prevent any hydraulic head from building up on the final cover liner system. A minimum of three (3) feet of protective soils will overlay the geocomposite layer. The upper six (6) inches of the protective fill layer will consist of vegetative soils in order to promote a healthy growth of vegetation.

The slope of the final cover will be a maximum of 3:1V and minimum of 10H:1V. The covered landfill will be contoured and sloped as shown on Drawing No. D12 to direct runoff into the stormwater management system. The LLDPE geomembrane, geocomposite, low permeability soil layer, protective soil layer, and vegetation will effectively prevent the infiltration of surface water. These devices will cause rainfall or snow melt to be diverted by runoff, drainage, and evapotranspiration.

Leachate Collection System

The leachate collection system consists of a highly permeable leachate drainage layer overlaying the entire base of the landfill and a system of leachate collection pipes, collection sumps, collection risers and cleanout risers. The location and details of the components of the leachate collection system are shown on Drawing Nos. D7, D8 and D9.

The leachate collection system is designed to efficiently collect leachate throughout the operating life and post-closure care period and beyond for the Expansion. The system is designed to handle leachate quantities determined based on existing leachate generation rates and rates at similar facilities. Design calculations, with supporting assumptions and information, are provided in Appendix K.

The calculations were performed using conservative assumptions, resulting in a collection system that is capable of handling projected leachate quantities. Material and construction specifications for the components of the leachate management system are provided in the CQA Program in Section 2.5 of this Application.

The leachate collection system for the landfill expansion will have the following benefits:

1. The highly permeable granular drainage layer will have a minimum hydraulic conductivity of 1.0×10^{-3} cm/sec and 12-inches in thickness. This drainage

layer will minimize the leachate head above the HDPE composite liner system by promoting flow to the collection pipes.

2. The collection pipes are capable of handling volumes far exceeding the maximum estimated leachate flow volumes.

3. The leachate collection cleanout risers will allow access to all points along the collection lines for cleaning out the pipes and backflushing, if necessary.

4. The granular pipe envelope will serve as a conduit to other collection points in the unlikely event that a temporary clog or localized pipe failure occurs.

5. All of the components of the leachate collection system will be constructed of materials that are chemically resistant to the anticipated composition of leachate.

The drainage material will have a minimum hydraulic conductivity of 1.0×10^{-3} cm/sec, which will facilitate the flow of leachate across the base of the landfill and into the trenches containing the collection pipes. A minimum nonwoven 6 oz/yd^2 geotextile will be placed above the entire drainage layer to minimize clogging. The geotextile seams will be overlapped and field sewn as required by the CQA Plan. The drainage material will also act as protection for the geomembrane against sharp objects which may be contained within the waste material. The drainage layer has been designed to maintain laminar flow and will be constructed of materials that are chemically resistant to leachate.

The bottom liner for the Expansion is designed to slope at a minimum of 2.23 percent toward the leachate collection pipe in the permitted design where the vertical expansion will take place, and 2.5 percent toward the leachate pipe where the horizontal expansion will take place. The maximum horizontal spacing between leachate collection pipes is approximately 400 feet, resulting in a maximum horizontal distance from the leachate divide to the collection point of approximately 200 feet. The leachate collection pipes will be sloped at a minimum of 0.5 percent to promote drainage within the pipes to the leachate header pipes and leachate collection sumps.

The pipe component of the leachate collection system will consist of a 6-inch diameter SDR 17 HDPE pipe. The HDPE collection pipe has the necessary flexibility to conform to localized variations in the bottom slope. The pipe also has the necessary strength to withstand the weight of the overlaying waste, operating equipment, and daily and final soil covers. The collection pipes will slope towards a leachate collection structure as shown on Drawing Nos. D7 and D9. Calculations demonstrating the structural capacity of the perforated pipe are presented in Appendix K.

Leachate will be extracted from the landfill using riser pipes. The riser pipes will extend from the collection sumps to the edge of the waste footprint, where the point of extraction is accessible. Pumps will be placed within the risers to remove leachate from the landfill, and will be equipped with a leachate level detection system for monitoring leachate levels.

To facilitate cleanout, each collection pipe will be connected to a cleanout riser at one or both ends. The proposed cleanout riser locations are shown on Drawing No. D7. The leachate collection pipes at the Expansion will most likely be cleaned by hydraulic jetting or flushing, which requires access from only one end of the pipe.

Hydraulic flushing or jetting typically uses a 1" hose connected to a 3" diameter nozzle to deliver high-pressure water to remove obstructions. The hose and nozzle will fit through the 6" diameter leachate collection pipe. The 3" diameter nozzle can produce approximately 3,000 psi of hydraulic pressure, allowing it to break up obstructions.

Liquid or debris from the cleaning of the leachate collection line will be handled and disposed. It is anticipated that liquid will be treated as leachate and any solid debris will be returned to the active face of the landfill or hauled by a properly licensed truck to another permitted disposal facility.

Components of the leachate collection system will be constructed of materials that are chemically resistant to the anticipated composition of leachate. The leachate collection pipes will be cleaned and maintained as necessary utilizing an approved cleaning method. The cleanout system has been designed so that work can be performed at the ground surface. The leachate collection and management system will be routinely inspected for evidence of clogging or general system repair. Areas specifically targeted for maintenance inspections and monitoring include: collection pipes (leachate levels), extraction points, leachate storage tanks, and leachate containment structures. Observed damage or deficiencies will be quickly repaired following detection.

Leachate Collection System Efficiency (Ability to Remove Leachate from the Landfill)

The leachate collection system was determined to be highly efficient even under conservative assumptions that overestimate the amount of leachate likely to be generated. The maximum leachate head in the granular drainage blanket was calculated based on the estimated leachate generation rates, the hydraulic conductivity of the drainage layer and the leachate collection system design. The analysis indicates that the maximum leachate head in the granular drainage blanket will not exceed 12 inches, as required by regulations. The calculations used to determine the leachate head are presented in Appendix K.

The efficiency of the leachate collection pipes to collect and transport the maximum estimated leachate volume was assessed using Manning's equation for open channel flow. The analysis indicates that the proposed 6-inch diameter pipes are more than capable of collecting and transporting the peak percolation rate calculated by the HELP model. The pipes will not restrict leachate flow from the granular drainage blanket, and have more than enough capacity to collect and transport the predicted leachate volume. The 6-inch diameter pipe size will also accommodate conventional sewer cleaning equipment for pipe cleaning and inspection purposes. Calculations which demonstrate the capacity of the leachate collection system are contained in Appendix K.

Leachate Collection and Disposal

Leachate will be pumped from the collection structures to the leachate recirculation system or to an existing above-ground storage tank and leachate not recirculated will be hauled to a licensed pre-treatment or treatment facility. Leachate is currently permitted to be hauled to Kenosha Water Utility. The type of pump used will depend on the actual quantity and quality of leachate generated for each cell and is anticipated to vary over the life of the landfill. The actual type and size of the pump will be selected to maintain no more than one-foot of leachate head above the liner system. Pumps will be installed with an automated leachate-level activated switch to pump leachate from the collection system, as needed. The leachate drainage and collection system will not be used for the purpose of storing leachate.

Leachate Storage Tanks and Secondary Containment System

The existing leachate storage tanks (one 165,000 gallon and two 32,000 gallon tanks) will be used to temporarily store leachate extracted from the landfill until it is transported to a disposal/treatment facility. The leachate storage tanks are compatible with leachate and resistant to temperature extremes. Manufacturer's product information for the existing leachate storage tanks is provided in Appendix K. Leachate transfer lines located outside the waste disposal area will be dual contained.

Storage of 5 days worth of leachate is required unless demonstration is provided to the IEPA that multiple treatment, storage and disposal options in the Facility's approved leachate management system will achieve an equivalent performance. The existing total of 229,000 gallons of storage, including one (1) 165,000 gallon storage tank and two (2) 32,000 gallon storage tanks, significantly exceeds IEPA storage capacity requirements, as calculated in Appendix K.

Leachate storage tanks are located within a secondary containment system. All on-site storage structures and secondary containment facilities are in accordance with the conditions and specifications required by 35 Ill. Admin. Code Section 811.309.

Leachate Treatment

Leachate is currently being treated at the Kenosha Water Utility. The proposed off-site treatment facility meets the requirements of 35 Ill. Admin. Code Section 811.309(e). All required permits and approvals are in place and will be maintained in accordance with local, state, and federal regulations.

Automatic Extraction and Recirculation System Operations

Leachate recirculation is the process of removing the leachate from the leachate collection system and reintroducing the leachate back into the landfill. Leachate is re-circulated back into the landfill to create an environment favorable to the rapid microbial decomposition of the biodegradable solid waste.

Some of the advantages to leachate re-circulation are listed below:

- ❏ Increased rate of waste settlement;
- ❏ Increased rate of landfill gas production;
- ❏ Increased rate of biological stabilization of the organic fraction of the solid waste.

The existing Site 2 is permitted to recirculate leachate. Leachate is recirculated into perforated pipes that are placed horizontally in trenches cut into the previously placed waste. Leachate will be directly pumped into the leachate recirculation pipes from the leachate extraction sumps. The leachate extraction pumping systems are designed to operate automatically. These systems will rely upon mechanical and electrical components that will require routine system checks and maintenance to ensure satisfactory performance. Maintenance will depend upon the specific components that are selected, but generally will be performed in accordance with the manufacturers' recommendations.

Leachate will be recirculated by pumping leachate from the force main to a series of distribution trenches. The leachate will flow in a solid header pipe and discharge into a perforated pipe (lateral distribution piping) located in trenches that have been backfilled with a pervious material such as stone. The trenches will be located between lifts of solid waste. The horizontal pipes will contain perforations appropriately spaced to provide reasonably uniform distribution along the length of the pipe.

Pumps, meters, valves, and monitoring stations that control and monitor the flow of leachate are part of the Facility and will be accessible to the Operator.

Leachate Monitoring

Leachate will be sampled in accordance with 811.309(g), which requires semi-annual monitoring with each leachate monitoring point being sampled at least once every two years. Sampling will be conducted as long as the leachate collection system is in operation (30 years after closure of the facility), unless a reduced post closure sampling period is found to sufficiently protect the public health and the environment. Test results will be submitted to the IEPA. The schedule for leachate sampling is discussed in further detail in Sections 2.6 and 2.8 of this Application.

Construction Phasing

The Landfill will be developed in phases. The phasing will begin with the vertical expansion and move forward to Cells 9 and 10. Once active, each phase of the landfill will generally be filled to final proposed grades. Table 2.3-2 provides the approximate phasing schedule of the Expansion. Figure 2.3-1 shows the approximate phasing locations for the Expansion. It is noted that the phasing of the expansion is subject to change.

TABLE 2.3-2
APPROXIMATE PHASING OF CELL DEVELOPMENT

Phase	Phase Description	Approx. Year of Construction	Approx. Year of Filling	Approx. Year of Closure
I	Vertical Expansion over Existing Areas	NA	2012-2014	2013-2015
II	Cell 9	2014	2014-2017	2012-2018
III	Cell 10	2017	2017-2022	2019-2023

Notes:
1. Years of Construction, Filling, and Closure are approximate.
2. Phasing Plan may differ than shown on Figure 2.3-1.

The site development provides for sequential construction, filling, and closure of parts of the unit throughout the operating life. The final cover will be placed contemporaneously with landfill development when possible. This will be accomplished by constructing the final cover in phases as portions of the landfill achieve final grade. Construction of the stormwater features will be developed concurrently with development, as appropriate, to ensure adequate stormwater controls are provided.

Initial Filling Sequence

After receipt of the operating authorization, waste filling will initiate, and select waste will be placed over the leachate collection drainage layer. The initial waste lift will be placed approximately 5 to 10 feet thick to cover the entire floor. Select fill will be placed against the sidewalls as equipment access allows. The initial waste and select fill layers will serve as a protective and insulating layer over the leachate collection system and synthetic liner. Daily (or intermediate) cover will be placed over the initial lift of waste to serve as a working surface. Subsequent lifts of waste will be covered at the end of each day with daily cover.

Material Balance

The estimated soil excavation quantities are sufficient to meet the needs for construction of the bottom liner, final cover and other engineered features as documented in Appendix N. If any additional material is required (i.e. leachate collection system material), suitable material from off-site may be used as approved by the CQA Officer and the IEPA.

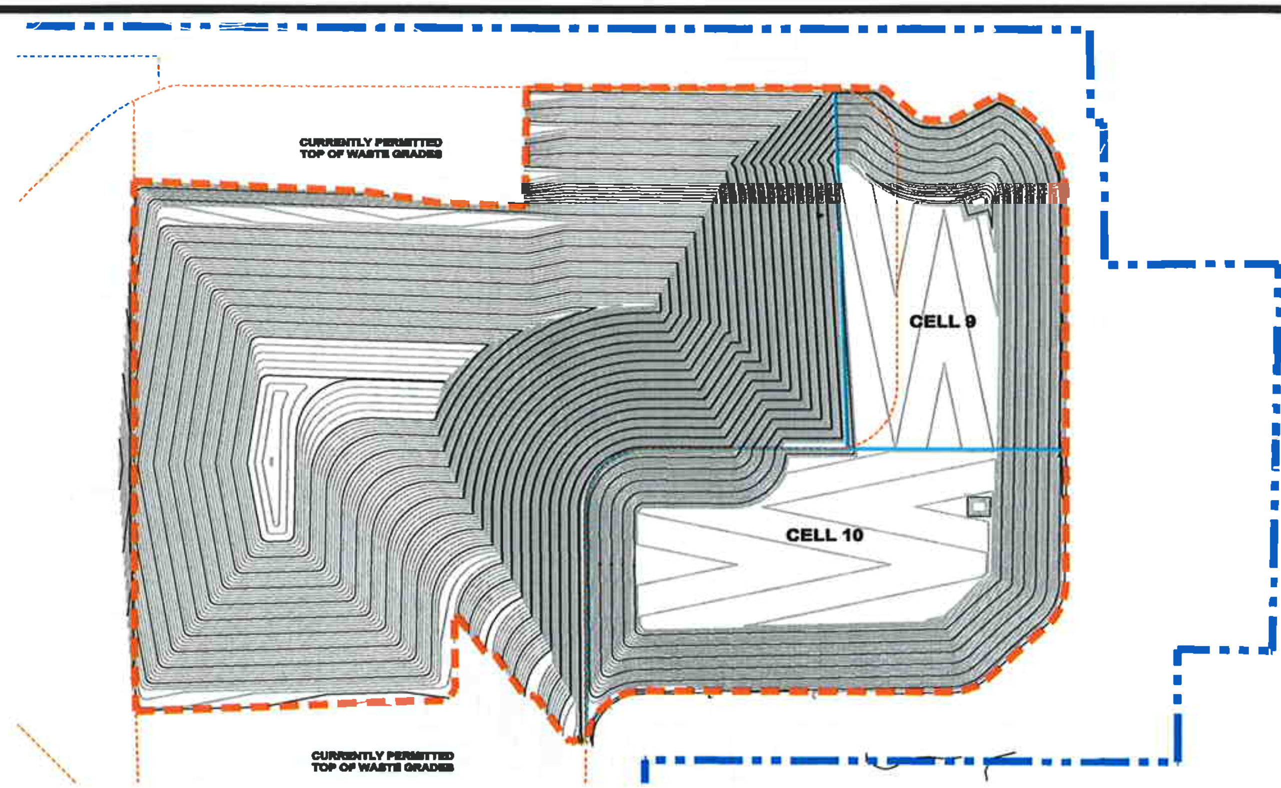
Based on estimated soil quantities calculations provided in Appendix N. The net soil balance is approximately 957,000 yd^3 surplus soil (excess cut). It is anticipated that the majority of this material will be stockpiled onsite or removed from site for miscellaneous development projects.

Borrow Areas

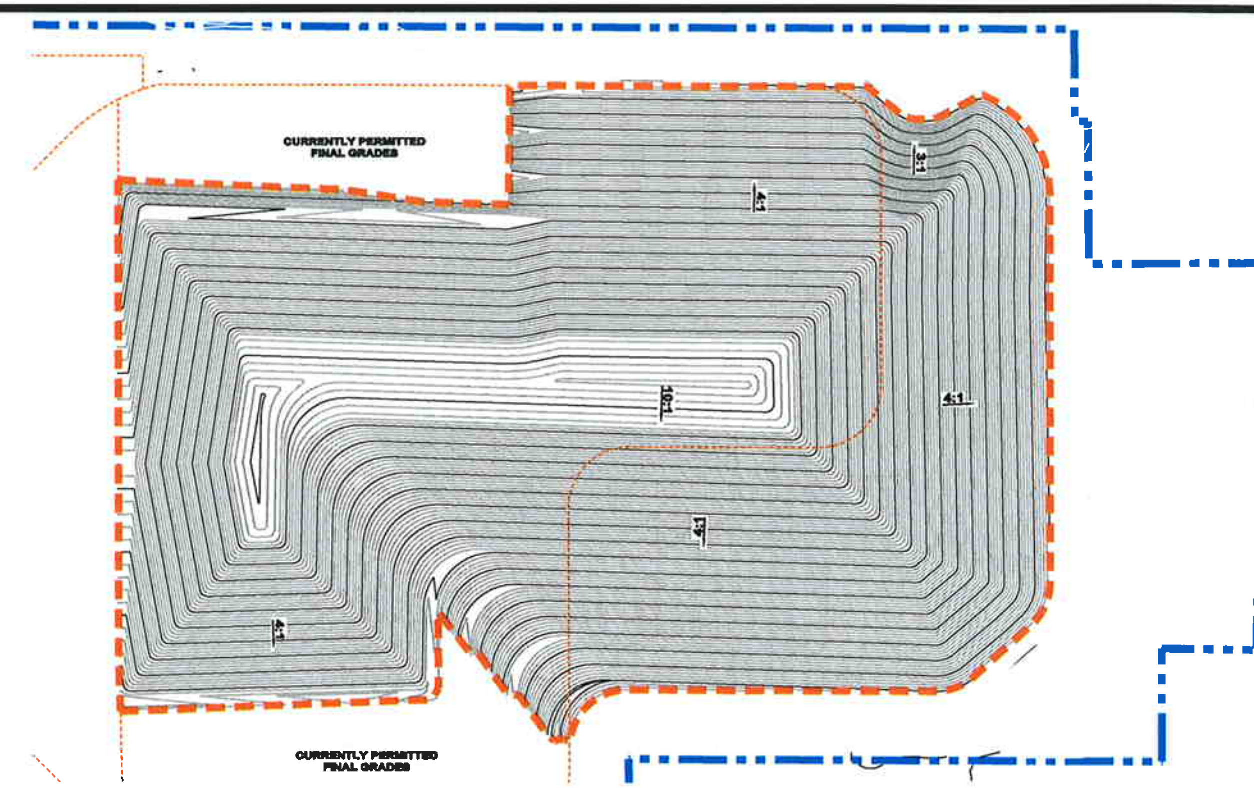
It is anticipated that soil for landfill development will primarily be derived from site excavations that satisfy the CQA requirements. However, it is expected that offsite material for the leachate collection blanket and some parts of the liner/cover systems may come from off-site sources. Any material from offsite sources will comply with the applicable CQA requirements.

Soil Stockpiling

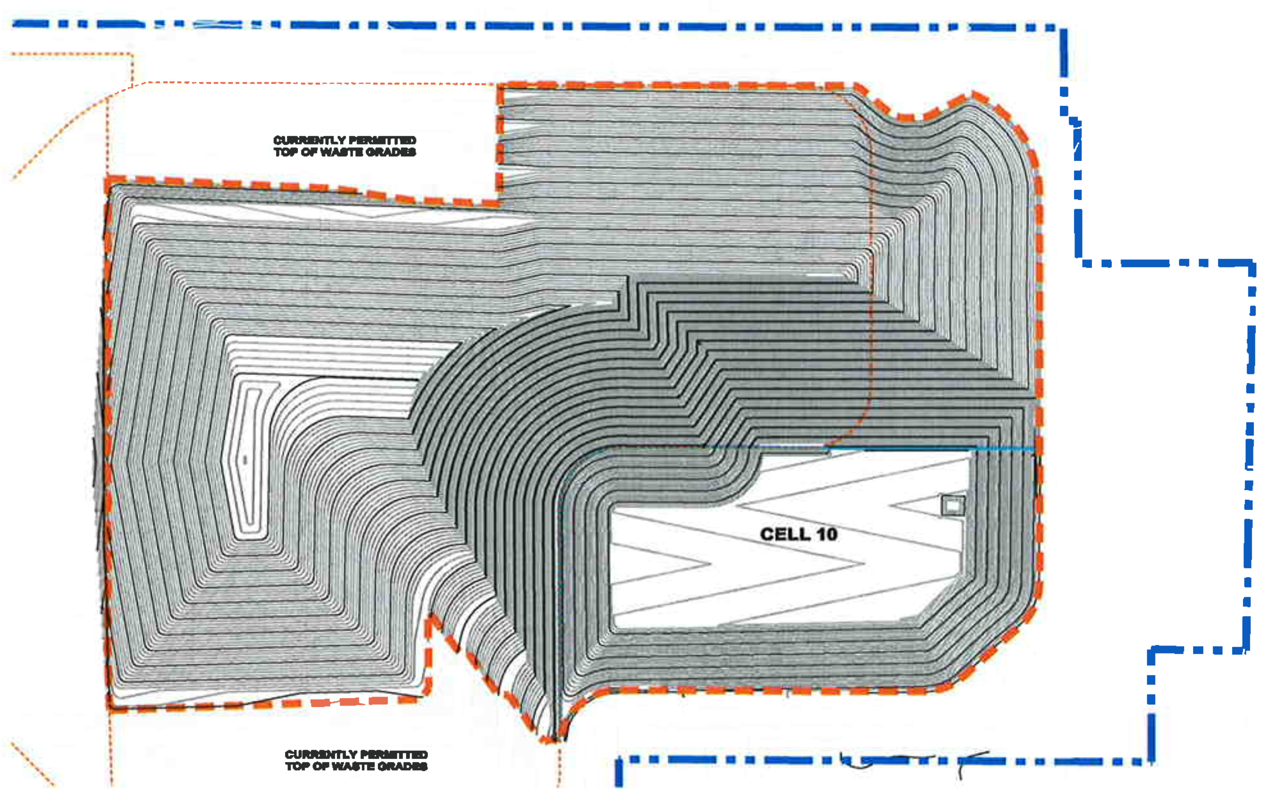
During excavation, material types will be identified and segregated. Excavated materials needed for liner construction will be directly hauled to the fill or stockpiled near the areas intended for utilization. In order to reduce the amount of stockpiling, daily and intermediate cover will be taken as needed from excavation areas.



PHASE I: VERTICAL EXPANSION OVER CURRENTLY CONSTRUCTED CELLS



PHASE III: EXPANSION OF CELL 10 (ACHIEVE FINAL GRADES)



PHASE II: EXPANSION OF CELL 9

NOTES

1. TOP OF INTERMEDIATE COVER AND TOP OF LINER GRADES SHOWN FOR PHASE I AND PHASE II. FINAL COVER GRADES ARE SHOWN FOR PHASE III. IT IS ANTICIPATED THAT FINAL COVER WILL BE PLACED SHORTLY AFTER FINAL WASTE GRADES ARE ACHIEVED.
2. INTERMEDIATE SLOPES ARE SHOWN AT 2.5H:1V. INTERMEDIATE SLOPE TIE–INS ARE APPROXIMATE.
3. PHASING MAY PROCEED DIFFERENTLY THAN SHOWN.

REV. NO.	DATE	DESCRIPTION

Shaw® Shaw Environmental, Inc.

VEOLIA E.S. ZION LANDFILL, INC.
SITE 2 EAST EXPANSION

FIGURE 2.3-1
SITE PHASING PLAN

DRAWN BY:	APPROVED BY:	PROJ. NO.:	DATE:
BWM	RDS	122150	JULY 2009

Final Cover System

The Expansion will be covered with an engineered final cover system which will meet or exceed federal, state, and local requirements. The final cover will be used to: 1) minimize the infiltration of precipitation, 2) prevent the release of landfill gas to the atmosphere, 3) support vegetation, and, 4) eliminate accessibility to the waste by vectors. The proposed final cover system is a multi-layer system consisting of:

1. A 24-inch thick low permeability compacted cohesive soil cover (maximum hydraulic conductivity of 1×10^{-6} cm/sec).

2. A 40-mil LLDPE or equivalent geomembrane liner

3. A geocomposite drainage net.

4. A minimum three-foot thick protective layer overlaying the low permeability layer, with the uppermost six inches consisting of soil suitable for vegetation.

5. Vegetation.

The final cover system will cover the entire landfill unit and connect with the bottom liner system. A typical cross section of the proposed final cover is shown in Drawing No. D13, and the contours of the final landform are shown on Drawing No. D12. As shown on Drawing No. D8, the low permeability layer of the final cover shall connect with the bottom liner system. The slope of the final cover will be a minimum of 10H:1V on the top “plateau” area, with typical sideslopes of 4H:1V, with the exception of the area in the northeast corner of the final landform near the leachate loadout station (refer to Drawing No. D12). The following text provides a more detailed description of each layer within the final cover system.

Low Permeability Layer

The low permeability layer will have a hydraulic conductivity of 1×10^{-6} cm/sec or less. The final cover will be placed in lifts and then compacted with a sheepsfoot roller. Each soil layer will be uniformly placed with all roots, cobbles, debris, organic, and other deleterious material removed prior to compaction. Additionally, the final surface will be inspected prior to geomembrane installation to ensure that no rocks, roots, or other objectionable items are exposed on the cover surface. Construction will be conducted and documented in accordance with the procedures outlined in the CQA Plan located in Section 2.5 of this Application.

Geomembrane Layer

A 40-mil linear low density polyethylene (LLDPE) geomembrane material or equivalent will be included in the composite final cover system for the Facility. The material specifications for the 40-mil geomembrane liner material are included in Section 2.5 of this Application. The geomembrane layer will serve as an impermeable barrier against infiltration of moisture through the final cover into the landfill as well as a barrier preventing landfill gas from migrating out of the landfill.

Geocomposite

Overlaying the geomembrane layer is a geocomposite drainage net. The geocomposite consists of a geonet (drainage net) sandwiched by two non-woven needle-punched geotextiles. The material specifications for the geocomposite material are included in Section 2.5 of this Application. The geocomposite will serve two purposes. The first is to lower the hydraulic head acting on the final cover and therefore enhance the slope stability of the final cover and minimize the ability of water to seep through the 40-mil LLDPE geomembrane. The second purpose is to provide a cushion layer between the 40-mil LLDPE geomembrane and the protective layer. The geocomposite will be installed and tested in accordance with the requirements of the CQA Plan detailed in Section 2.5 of this Application.

Protective Layer

A protective layer consisting of a minimum of 36 inches will be placed over the geocomposite to protect the compacted low permeability layer from frost, desiccation, erosion, and penetration by roots or vectors. The uppermost six inches of the material will consist of soil capable of supporting vegetation. The protective layer will be tested and placed in accordance with the requirements detailed in the CQA Plan, Section 2.5 of this Application.

Vegetation

The vegetative cover planned for the Expansion is intended to protect the final cover from wind and water erosion, as well as to minimize run-off and maximize evapotranspiration. The vegetative cover will be placed after completion of the protective layer at the appropriate time for successful germination and growth.

The vegetative cover will consist of a wide variety of grasses that will: 1) protect the soil surface against erosion; 2) not interfere with the integrity of the low permeable layer; 3) increase evapotranspiration thereby minimizing infiltration into the landfill; 4) provide for sufficient stormwater management and flood control; 5) establish a diverse grassland habitat; and 6) improve the appearance of the final land surface.

Final Cover Construction and Maintenance

The final cover will be constructed in accordance with the construction quality control guidelines outlined in the comprehensive CQA Plan (Section 2.5 of this Application). The low permeability layer of the final cover system will be constructed no later than 60 days after placement of the final lift of solid waste or per IEPA. The final protective layer will be placed as soon as possible after placement of the low permeability layer to prevent desiccation, cracking, freezing or other damage to the low permeability layer. The final protective layer will be 36-inches thick. The maximum depth of frost penetration at the site is approximately 36 inches[3]. However, experience with liner and cap construction in Illinois indicates the frost depth is substantially less. The final protective layer is therefore sufficiently thick to prevent frost penetration into the underlying low permeability layer. Cover maintenance will be performed as necessary to maintain the final cover to meet the design objectives. Any areas identified by the operator or by IEPA inspection as particularly susceptible to erosion will be re-contoured.

Cover Percolation

After placement of final cover, virtually all of the precipitation which falls on the landfill will be diverted into the stormwater management system. Controlled runoff, evaporation, evapotranspiration, and barrier layers will minimize percolation through the final cover system.

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3 See, for instance, the maximum frost penetration map compiled from U.S. Department of Commerce Weather Bureau data and contained in Koerner, R.M. and Daniel, D.E., Final Covers For Solid Waste Landfills and Abandoned Dumps, ASCE Press, 1997, p. 56.

Final Landform

The proposed landscaping at the Expansion will include the construction of the east berm and planting grasses. Suitable grasses will be used for the vegetative cover, which will provide erosion protection. The grass seed mixture that is selected will be amenable to the soil quality/thickness, slopes and moisture/climatological conditions that exist and will not require significant maintenance. The seed mixture will be selected to protect the low permeability liner system from root penetration. Generally a protective layer that is 450 mm (17.7 in.) to 600 mm (23.6 in.) is adequate[4]. Since the protective layer will be 36-inches thick and the grass seed mixture will be carefully selected, the protective layer is deemed more than adequate to prevent root penetration from occurring in the low permeability layer.

Long-term management of grassed areas will require mowing. Fertilizer and/or mulch may be used as necessary to establish proper growth of the seed.

Landfill Gas Management

Landfill gas is a natural byproduct of the decomposition of waste in a landfill. Landfill gas is currently captured at the existing Site and is converted into energy. The proposed expansion will tie into the current landfill gas collection and gas-to-energy facility.

Both below grade and above grade air monitoring will be provided at the Facility. The landfill gas monitoring probes and detection devices will be constructed/installed in accordance withapplicable federal and state requirements. A detail of a typical monitoring probe is included on Drawing No. D13 and the proposed conceptual landfill gas management system is shown on Drawing No. D14.

The low permeability composite bottom liner and final cover systems minimize the potential for landfill gas to migrate from the waste boundary. Landfill gas will typically migrate through the most permeable zones within the landfill waste, and will be less likely to migrate through the low permeable liner and cover systems. The landfill gas will typically migrate through pathways in the waste, flowing toward a landfill gas extraction well.

Landfill Gas Composition

Landfill gas quality is an important determinant of the end use for collected landfill gas. Landfill gas results from the decomposition of the waste, and therefore the quality of the landfill gas produced depends almost exclusively on the decomposition process. Landfill gas quality will be different at each landfill, and will also vary at different stages during the design life of a given landfill. In order to more fully appreciate how landfill gas quality will vary, it is important to understand the waste decomposition process.

The biological and chemical decomposition of solid waste results in the formation of heat, leachate, and landfill gas. Decomposition will begin soon after the waste material is placed in the landfill. The rate of decomposition will be affected by the availability of moisture, the physical and chemical characteristics of the waste, and the availability of oxygen. Waste decomposition passes through three phases, beginning with aerobic decomposition and proceeding to a two-phase anaerobic decomposition.

Initially, aerobic decomposition will take place with the principal by-product being carbon

4 Koerner, R.M., and D.E. Daniel. Final Covers For Solid Waste Landfills and Abandoned Dumps. ASCE Press, 1997.

dioxide. Aerobic decomposition requires oxygen to continue. Modern landfills are designed to keep oxygen out as a method of fire control. Therefore, as the finite amount of oxygen within the waste is depleted, anaerobic decomposition will begin to take place. During the first phase of anaerobic decomposition, carbon dioxide is again the principal gas generated. Once the first phase of anaerobic decomposition is completed, the second phase of anaerobic decomposition begins. This decomposition results in the generation of methane (CH_4) and carbon dioxide (CO_2), as well as trace amounts of nitrogen, hydrogen sulfide, and other non-methanogenic organic compounds (NMOCs). The typical composition of landfill gas generated at a conventional sanitary landfill during this second phase is summarized in Table 2.3-3.

TABLE 2.3-3
TYPICAL COMPOSITION OF LANDFILL GAS

Landfill Gas	Component Percentage* (Dry Volume Basis)
Methane (CH_4)	45% to 65%
Carbon Dioxide (CO_2)	35% to 55%
Oxygen (O_2)	1%
Nitrogen (N_2)	1% to 4%
Other Constituents	1%

* Reference the Solid Waste Handbook, 1986

Quantity of Landfill Gas

The rate of landfill gas generation is dependent upon the waste decomposition process, which is controlled by many factors including moisture availability, waste composition and availability of oxygen. Diversion of paper, aluminum, plastics, and landscape waste may also have an effect on the generation of methane. The total quantity of landfill gas that will be generated can be estimated based on measurements of gas quantities at existing conventional landfills. Actual monitoring of the landfill gas at the Expansion will verify the quantity and quality of the landfill gas.

The quantity of landfill gas that is generated depends on the quantity of waste being decomposed. Data from several sources indicate that on the order of 0.1 cubic feet of landfill gas will be generated for each pound of refuse per year[5]. It is assumed, therefore, that the landfill gas will be actively collected and processed for many years.

The rate of waste decomposition and landfill gas production is primarily controlled by the moisture content of the waste. The final cover of the landfill has been designed to minimize the infiltration of moisture into the waste after closure. Typically, generation of significant quantities of landfill gas occurs for a period of thirty to forty years after placement. The existing active landfill gas collection system will be expanded to manage the additional landfill gas. The current facility generates approximately 6.7 megawatts of electricity from landfill

5 Michels, M., J. Morley, and S. Kitts. "Beneficial Use of Landfill Gas at the Burnsville Sanitary Landfill." Proceedings of the Seventeenth International Madison Waste Conference. September 21-22, 1994.

gas, which can power approximately 6,000 homes.

Landfill Gas Monitoring

Landfill gas monitoring at the Expansion is proposed to be conducted in accordance with the requirements of 35 Ill. Admin. Code Section 811.310. Additional monitoring specified by the New Source Performance Standards (NSPS), such as surface emission monitoring, will be incorporated into the landfill gas monitoring program as required.

Landfill gas monitoring will consist of four types of landfill gas monitoring devices: 1) devices within the waste disposal unit; 2) below ground devices around the perimeter of the disposal unit; 3) ambient air monitoring devices; and, 4) continuous air monitoring devices within on-site buildings. Extraction wells placed in the waste disposal unit will be used to obtain a representative sample of gas concentration. Landfill gas monitoring will also occur around the perimeter of the unit and in the on-site buildings to verify that the landfill gas collection and containment systems are functioning as designed. Landfill gas collection and monitoring locations will be routinely inspected for structural integrity and proper operations.

Landfill gas monitoring devices and ambient air monitoring locations at the site will be sampled in conformance with the requirements of the prevailing regulations. Current regulations require sampling on a monthly basis for the entire operating period once the landfill gas extraction system is online and for a minimum of five years after closure. The sampling frequency may be reduced to a quarterly frequency after five years of closure upon approval by the IEPA. Monitoring will be adjusted as necessary to comply with federal, state and local regulations. Thirty years after closure, current regulations state that monitoring can be discontinued if both of the following conditions have been met for at least one year:

- ❏ The concentration of methane is less than five percent of the lower explosive limit in air for four consecutive quarters at all monitoring points located outside the waste disposal unit.

- ❏ Monitoring points within the waste disposal unit indicate that methane is no longer being produced in quantities that would result in migration from the unit and exceed the standards of 35 Ill. Admin. Code Section 811.311 (a)(1).

Placement of the probes is dependent upon the type of probe and the medium in which collection will occur. Each of the four types of monitoring devices are described in more detail below.

Waste Unit Monitoring

Landfill gas monitoring within the waste unit will be conducted using the active landfill gas collection system wellheads. The landfill gas collection wells will be equipped with sampling ports from which the pressure can be measured and a sample can be collected. The wells will be equipped with air-tight seals to prevent oxygen from being drawn into the landfill and to prevent gas from migrating out of the landfill. The monitoring zone typically will extend through the upper two-thirds of waste thickness depth. The extent of the monitoring zone will allow representative sampling of the composition and buildup of landfill gas, while protecting the liner and leachate collection system from penetration by maintaining a minimum separation. A detail of a typical wellhead is shown on Drawing No. D15.

Below Ground Perimeter Monitoring

Landfill gas monitoring will also be conducted at locations outside the waste boundary using below ground landfill gas probes. These probes will be located around the perimeter of the Facility boundary. The proposed locations of the below ground perimeter landfill gas probes for the Expansion are shown on Design Drawing No. D14 However, the locations will vary as dictated by field conditions and will be phased in adjacent to operational areas prior to waste placement. The design and construction of the landfill gas monitoring system will not interfere with the operations of the liner or leachate collection system, or delay the construction of the final cover system.

The monitoring zone for these probes will extend from just below the ground surface to the top elevation of the most permeable geologic zone corresponding to the landfill invert elevation. At a minimum, the following parameters will be monitored at below ground monitoring points as required by the Illinois Environmental Protection Agency:

- ❏ Methane
- ❏ Pressure
- ❏ Nitrogen (Balance Gas)
- ❏ Oxygen
- ❏ Carbon Dioxide

Landfill gas monitoring probes are proposed to be constructed of 2-inch diameter Schedule 40 PVC pipes, or equivalent materials which will not react with or be corroded by the landfill gas. The probes will be equipped with valve/hose pressure fitting(s), etc., as necessary to measure pressure and allow collection of a representative sample of landfill gas. Pipe joints and fittings will be maintained in air-tight condition, and the probe will be installed with a bentonite seal at the surface to minimize landfill gas leakage. The proposed probe design is shown on Drawing No. D13.

Ambient Air Monitoring

Ambient air will be monitored for methane at a minimum of three downwind locations. The locations will be selected the day of the sampling event. Samples will be taken approximately 1-inch above the ground and approximately 100 feet downwind from the edge of the waste boundary (or closer). Samples will only be taken when the average wind velocity is less than five miles per hour in order to obtain a representative sample.

Continuous Air Monitoring Within Buildings

On-site buildings are equipped with continuous methane detection devices. These devices sound an audible signal if methane is detected at a concentration greater than 25 percent of the lower explosive limit. Upon a signal, the building will be evacuated and emergency procedures will be implemented.

Landfill Gas Collection

Landfill gas emissions from the proposed Expansion will be controlled in accordance with applicable regulations, including the Clean Air Act New Source Performance Standards (NSPS) and 35 Ill. Admin. Code requirements. One method utilized to control the emissions is through the development of an active gas collection system. Drawing Nos. D14 and D15 show the conceptual details and extraction well locations for such a system.

A vertical collection well spacing with a radius of influence of 125-150 feet within the center landfill area and 125' along the perimeter, consistent with the currently utilized landfill gas collection system, is currently anticipated unless a larger well spacing can be demonstrated in accordance with state and federal guidelines.

Extraction wells will be interconnected through a wellhead piping system. This landfill gas extraction network will transport the landfill gas to a central location for processing at a landfill gas flare, gas-to-energy facility or other approved method of processing depending on the landfill gas quality. A minimum 6" solid HDPE pipe will be used. However, header pipes will be properly sized to accommodate the landfill gas quantity.

The landfill gas collection piping system will be composed of HDPE or other material capable of resisting corrosion due to the landfill material and gas composition. HDPE and other materials also offer strength and flexibility which will withstand the effects of settlement to the system. The well head assembly will be equipped to allow the monitoring and adjustment of landfill gas flow and the collection of landfill gas samples. A detailed landfill gas system design meeting the requirements of 35 Admin. Code Section 811.311 and 811.312 will be submitted to the IEPA for approval prior to development.