2.8 ENVIRONMENTAL MONITORING

Introduction

The proposed Veolia E. S. Zion Landfill Site 2 East Expansion has been designed to protect the public, health, safety and welfare. To assure that the Facility functions as designed, this Environmental Monitoring Program has been developed in accordance with applicable regulations. The Environmental Monitoring Program includes groundwater, leachate, subsurface landfill gas, ambient air, and other surface monitoring at the Facility which are described in greater detail within the following sections and within other sections of this Application.

Groundwater Monitoring

Groundwater Monitoring Overview

The groundwater monitoring program has been developed in accordance with 35 Ill. Admin. Code, Sections 811.318 and 811.319. It consists of a network of groundwater quality monitoring wells both upgradient and downgradient of the landfill which will be used to monitor the landfill in order to provide assurance that the Facility is functioning as designed.

The Groundwater Impact Evaluation (GIE) has determined that groundwater quality will not be impacted at or beyond the edge of the zone of attenuation (ZOA) within 100 years after closure of the landfill, as discussed in Section 2.7 of the Application. The groundwater monitoring network will serve as an additional safeguard to verify that the landfill is not having any adverse impact on the groundwater quality and to provide an early warning system in the unlikely event of an impact.

The proposed groundwater monitoring network has been designed based on: 1) the hydrogeological site investigation, 2) the proposed landfill design, and 3) the results of a well spacing model. Monitoring wells will be constructed in accordance with applicable local, state, and federal requirements (35 IAC 811.318, Permit No. 1995-343-LFM, and 77 IAC 920.170). The groundwater monitoring results will be statistically analyzed to check that the background groundwater quality is not exceeded as defined in 35 Ill. Admin. Code Section 811.320.

Proposed Groundwater Monitoring Network

Title 35 Ill. Admin. Code Sections 811.318(b)(3) requires that monitoring wells be located as close to the potential source without interfering with operations and within one-half the distance from the edge of the potential source to the edge of the ZOA. The ZOA is located 100 feet from the waste boundary. As such, new detection monitoring wells for the Uppermost Aquifer have been proposed to be located within 50 feet of the waste boundary. Two existing monitoring wells are located within the Uppermost Aquifer at the edge of the ZOA in accordance with 35 Ill. Admin. Code Section 811.318(b)(5) which requires a minimum of one. These two wells are proposed to remain in operation during the life of the landfill and throughout the post-closure period.

Title 35 Ill. Admin. Code Section 811.318(b)(2) requires that monitoring wells be located in hydrostratigraphic horizons that could serve as contaminant migration pathways. Therefore, the proposed groundwater monitoring program includes the Shallow Drift Aquifer. The selection of this zone for monitoring is based on this unit meeting the definition of the Uppermost Aquifer as stated in the Hydrogeologic Investigation Section (Section 2.2).

The proposed monitoring program will include downgradient and upgradient routine monitoring detection wells and two wells located at the edge of the ZOA. This application proposes the

addition of 13 monitoring wells within the uppermost aquifer (G201, G202, G203, G204, G205, G206, G207, G208, G209, G210, G211, G212, and G213) and the removal or non-installation of 13 monitoring wells which currently exist or which are planned for installation under the currently permitted final monitoring network (G171, G172, G173, G174, G175, G176, G177, G178, G192, GF2S, GF4S, GF7S, and GH2S). The monitoring wells will be installed and abandoned as cell development progresses. Wells to be removed will be properly abandoned in accordance with applicable Illinois Environmental Protection Agency (IEPA) and Illinois Department of Public Health (IDPH) regulations prior to the start of development in those areas. Two existing monitoring wells which are located at the edge of the ZOA will remain and will continue to be monitored (G191 and R193) throughout the operating and post-closure period.

This application proposes a final monitoring network consisting of 48 groundwater monitoring wells at 40 locations. During installation of the 13 new monitoring wells proposed within this application, a nested well may also be installed within saturated intra-till sediments that may be encountered above the Uppermost Aquifer. Should nested wells be installed, the final monitoring network will consist of more than the 48 wells indicated above.

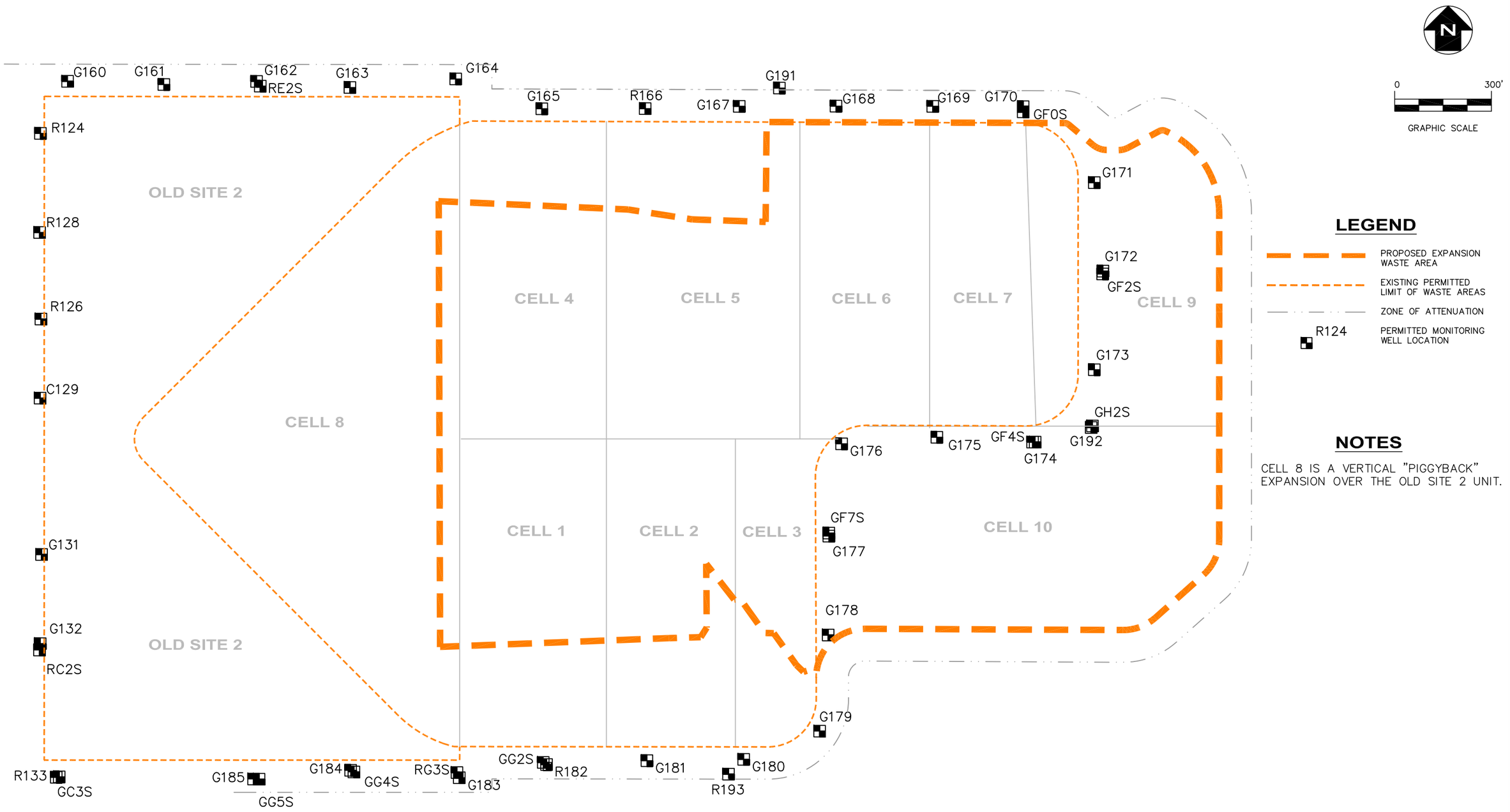
Table 2.8-1 summarizes the proposed monitoring network phasing schedule. The layouts of the existing permitted and proposed final monitoring well networks are depicted on Figures 2.8-1 and 2.8-2, respectively.

TABLE 2.8-1 PROPOSED GROUNDWATER MONITORING WELL NETWORK PHASING				
Well Number	**Northing**	**Easting**	**Screened Aquifer**	**Installation \ Phasing**
R124	12,427.2	9,375.0	Shallow Drift	Existing well installed adjacent to the waste boundary on the western edge of Old Site 2.
R126	11,851.6	9,376.6	Shallow Drift	Existing well installed adjacent to the waste boundary on the western edge of Old Site 2.
R128	12,119.8	9,372.5	Shallow Drift	Existing well installed adjacent to the waste boundary on the western edge of Old Site 2.
C129	11,606.4	9,374.0	Shallow Drift	Existing well installed adjacent to the waste boundary on the western edge of Old Site 2.
G131	11,121.6	9,378.6	Shallow Drift	Existing well installed adjacent to the waste boundary on the western edge of Old Site 2.
G132	10,844.6	9,373.9	Shallow Drift	Existing well installed adjacent to the waste boundary on the western edge of Old Site 2.
R133	10,430.6	9,424.3	Shallow Drift	Existing well installed adjacent to the waste boundary on the southern edge of Old Site 2.
G160	12,588.7	9,459.2	Shallow Drift	Existing well installed adjacent to the waste boundary on the northern edge of Old Site 2.
G161	12,578.9	9,757.6	Shallow Drift	Existing well installed adjacent to the waste boundary on the northern edge of Old Site 2.
G162	12,588.4	10,045.2	Shallow Drift	Existing well installed adjacent to the waste boundary on the northern edge of Old Site 2.
G163	12,569.5	10,334.7	Shallow Drift	Existing well installed adjacent to the waste boundary on the northern edge of Old Site 2.
G164	12,596.0	10,622.5	Shallow Drift	Existing well installed adjacent to the waste boundary on the northern edge of Cell 8.
G165	12,503.5	10,929.6	Shallow Drift	Existing well installed adjacent to the waste boundary next to Cell 4.
R166	12,504.0	11,250.1	Shallow Drift	Existing well installed adjacent to the waste boundary next to Cell 5.

TABLE 2.8-1 (Continued) PROPOSED GROUNDWATER MONITORING WELL NETWORK PHASING				
Well Number	**Northing**	**Easting**	**Screened Aquifer**	**Installation \ Phasing**
G167	12,511.1	11,541.7	Shallow Drift	Existing well installed adjacent to the waste boundary next to Cell 5.
G168	12,511.7	11,841.7	Shallow Drift	Existing well installed adjacent to the waste boundary next to Cell 6.
G169	12,511.1	12,141.7	Shallow Drift	Existing well installed adjacent to the waste boundary next to Cell 7.
G170	12,494.2	12,422.1	Shallow Drift	Existing well installed adjacent to the waste boundary next to Cell 7 during this hydrogeologic investigation but is not yet included in the active monitoring network.
GF0S	12,510.0	12,422.0	Intratill Sediments	Well to be installed adjacent to the waste boundary prior to waste placement in Cell 7.
G179	10,574.0	11,791.0	Shallow Drift	Existing well installed adjacent to the waste boundary next to Cell 3.
G180	10,486.4	11,555.5	Shallow Drift	Existing well installed adjacent to the waste boundary next to Cell 3.
G181	10,482.3	11,255.6	Shallow Drift	Existing well installed adjacent to the waste boundary next to Cell 2.
R182	10,470.5	10,944.3	Shallow Drift	Existing well installed adjacent to the waste boundary next to Cell 1.
G183	10,429.4	10,673.7	Shallow Drift	Existing well installed adjacent to the waste boundary on the southern edge of Cell 8.
G184	10,452.5	10,336.9	Shallow Drift	Existing well installed adjacent to the waste boundary on the southern edge of Old Site 2.
G185	10,425.5	10,035.9	Shallow Drift	Existing well installed adjacent to the waste boundary on the southern edge of Old Site 2.
G191	12,567.8	11,666.3	Shallow Drift	Existing ZOA well installed approximately 100 feet from the waste boundary next to Cells 5 and 6.
R193	10,440.5	11,508.6	Shallow Drift	Existing ZOA well installed approximately 100 feet from the waste boundary next to Cells 2 and 3.

TABLE 2.8-1 (Continued) PROPOSED GROUNDWATER MONITORING WELL NETWORK PHASING				
Well Number	**Northing**	**Easting**	**Screened Aquifer**	**Installation \ Phasing**
GG2S	10,476.9	10,934.3	Intratill Sediments	Existing well installed adjacent to the waste boundary next to Cell 1.
RC2S	10,824.9	9,371.5	Intratill Sediments	Existing well installed adjacent to the waste boundary on the western edge of Old Site 2.
RE2S	12,573.8	10,056.7	Intratill Sediments	Existing well installed adjacent to the waste boundary on the northern edge of Old Site 2.
GC3S	10,432.2	9,433.2	Intratill Sediments	Existing well installed adjacent to the waste boundary on the southern edge of Old Site 2.
RG3S	10,445.4	10,666.6	Intratill Sediments	Existing well installed adjacent to the waste boundary on the southern edge of Cell 8.
GG4S	10,447.5	10,347.0	Intratill Sediments	Existing well installed adjacent to the waste boundary on the southern edge of Old Site 2.
GG5S	10,424.9	10,052.8	Intratill Sediments	Existing well installed adjacent to the waste boundary on the southern edge of Old Site 2.
G201	12442.2	12648.0	Shallow Drift	Well to be installed adjacent to the waste boundary with Cell 9 development.
G202	12478.2	12875.9	Shallow Drift	Well to be installed adjacent to the waste boundary with Cell 9 development.
G203	12304.1	13050.2	Shallow Drift	Well to be installed adjacent to the waste boundary with Cell 9 development.
G204	12056.0	13075.1	Shallow Drift	Well to be installed adjacent to the waste boundary with Cell 9 development.
G205	11806.0	13075.1	Shallow Drift	Well to be installed adjacent to the waste boundary with Cell 9 development.
G206	11556.0	13075.1	Shallow Drift	Well to be installed adjacent to the waste boundary with Cell 9 development.
G207	11306.0	13075.1	Shallow Drift	Well to be installed adjacent to the waste boundary with Cell 10 development.

TABLE 2.8-1 (Continued) PROPOSED GROUNDWATER MONITORING WELL NETWORK PHASING				
Well Number	**Northing**	**Easting**	**Screened Aquifer**	**Installation \ Phasing**
G208	11061.5	13042.6	Shallow Drift	Well to be installed adjacent to the waste boundary with Cell 10 development.
G209	10890.2	12859.9	Shallow Drift	Well to be installed adjacent to the waste boundary with Cell 10 development.
G210	10842.9	12624.0	Shallow Drift	Well to be installed adjacent to the waste boundary with Cell 10 development.
G211	10844.1	12374.0	Shallow Drift	Well to be installed adjacent to the waste boundary with Cell 10 development.
G212	10845.3	12124.0	Shallow Drift	Well to be installed adjacent to the waste boundary with Cell 10 development.
G213	10831.5	11876.7	Shallow Drift	Well to be installed adjacent to the waste boundary with Cell 10 development.



REV. NO.	DATE	DESCRIPTION

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VEOLIA E.S. ZION LANDFILL SITE 2 EAST EXPANSION
LAKE COUNTY, ILLINOIS

FIGURE 2.8-1
EXISTING MONITORING WELL NETWORK

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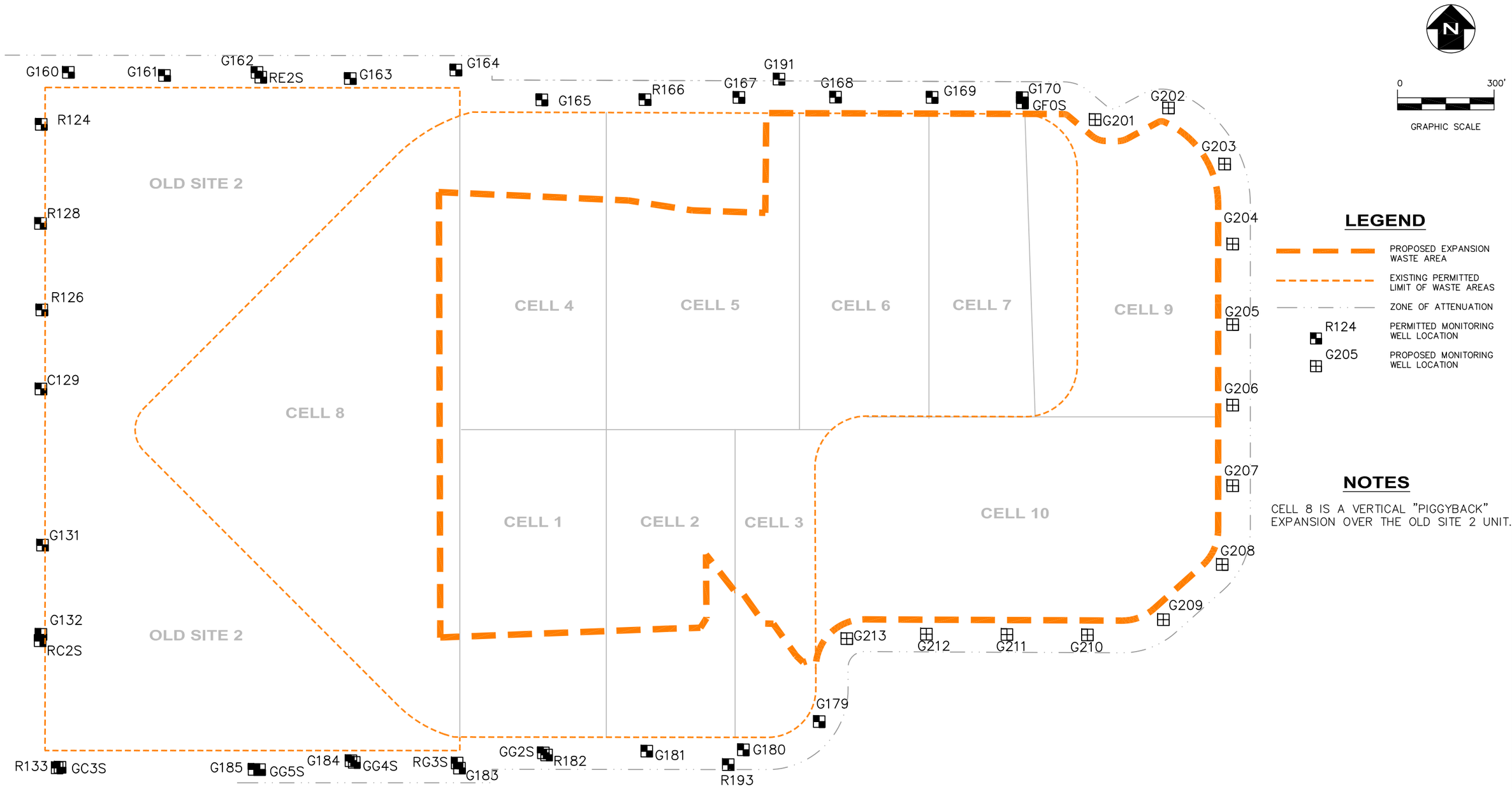

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LAKE COUNTY, ILLINOIS

FIGURE 2.8-2
PROPOSED MONITORING WELL NETWORK

DRAWN BY:	APD	APPROVED BY:	MNF	PROJ. NO.:	122150	DATE:	AUG 2009

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Monitoring Well Spacing Determination

The Monitoring Analysis Package (MAP) was utilized to determine optimum monitoring well spacing for the proposed landfill expansion. The Monitoring Efficiency Model (MEMO), one of three modeling packages contained within the MAP application, was utilized to determine the efficiency of the proposed monitoring well network. The design of the groundwater monitoring network was optimized using MEMO, taking into account site geometry and hydrogeological characteristics.

MEMO utilizes a fundamental two-dimensional analytical transport model responsible for configuring plumes. The governing equation for the transport model, originally presented in Domenico and Robbins (1985) and later modified by Domenico (1987), is:

$$C(x,y,t) = \left(\frac{C_O}{4}\right) \exp\left\{\left(\frac{xv}{2\alpha_x}\right)\left[1-\left(1+\frac{4\lambda\alpha_X}{v^2}\right)^{1/2}\right]\right\}$$

$$efrc\left\{\frac{\left[x-vt\left(1+\frac{4\lambda\alpha_X}{v^2}\right)^{1/2}\right]}{2(\alpha_X t)^{1/2}}\right\}$$

$$\left\{erf\left[\frac{\left(y+\frac{S_W}{2}\right)}{2\left(\frac{\alpha_Y x}{v}\right)^{1/2}}\right]-erf\left[\frac{\left(y-\frac{S_W}{2}\right)}{2\left(\frac{\alpha_Y x}{v}\right)^{1/2}}\right]\right\}$$

where,

C (x,y,t) =	The concentration of the contaminant at location x, y from the source at time t,
C_O =	Source concentration - the highest concentration of the contaminant in the groundwater at the source,
x =	Distance from planar source to the location of concern along the center line of the plume,
y =	Distance from planar source to the location of concern perpendicular to the centerline of the plume,
λ =	1st order decay constant,
S_W =	Width of source area,
v =	Average Contaminant Velocity (ki/n_e),
α_x =	Dispersivity in the x direction,
α_y =	Dispersivity in the y direction, and
t =	Time.

An analysis of the monitoring well efficiency was performed for the uppermost aquifer. The monitoring well efficiency is defined as the ratio of the area from which a release would be detected to the total potential source area. The calculated efficiency of the proposed monitoring network was 99.7%. As the calculated monitoring efficiency is above 95%, the proposed monitoring network exceeds IEPA requirements. The output file from the MEMO model is included in Appendix Q. Well locations were evaluated using site specific input parameters presented in the Hydrogeologic Investigation (Section 2.2).

MEMO Input Data

Coordinate Data

MEMO requires a coordinate system to represent the monitoring network and various other aspects of the analysis. The coordinate system was derived from surveyed coordinates of the waste boundary of the proposed Site 2 East Expansion. The potential source area is defined as an area that potential contamination may originate. The source area for the proposed unit as defined in the MEMO model includes the entire expansion area and a portion of the permitted waste disposal area. The majority of the permitted waste area was not modeled due to restrictions on the amount of monitoring wells which can be input into the MEMO model. However, as the existing monitoring network has been approved by the IEPA and since groundwater flow is to the east, the model which has been constructed is conservative to evaluate the monitoring network for the proposed expansion.

Within the MEMO program, the compliance boundary is defined as the line where active monitoring takes place. In accordance with Title 35 Ill. Admin. Code, Sections 811.318(b)(3), the compliance boundary is defined as a line which is a maximum of 50 feet from and circumscribing the waste boundary. Forty-six of the proposed downgradient or upgradient routine monitoring detection wells are located on, or within, the compliance boundary.

Within the MEMO model, the buffer zone boundary is designated as the edge of the ZOA, located 100 feet from the waste boundary, in accordance with Title 35 Ill. Admin Code, Section 811.318(b)(5). MEMO utilizes the buffer zone to represent the relationship between the monitoring well locations and the GIE compliance boundary. Two monitoring detection wells (G191 and R193) are located at the edge of the ZOA.

The potentiometric surface of the uppermost aquifer determined by the Hydrogeological Investigation (Section 2.2) is represented in this model by the development of gradient zones. Due to the consistent flow direction in the Shallow Drift Aquifer (uppermost aquifer), two gradient zones with azimuth bearing flow directions of 11.5 and 326.0 degrees were utilized to represent the potentiometric surface across the site for this model.

Hydrogeological Data

Following are discussions of the various hydrogeologic parameters utilized by MEMO:

- *Dilution Contour.* The dilution contour is utilized by MEMO as a criterion by which to detect the migration of the hypothetical plume. Within the model solution process, if the concentration in any monitoring well portrayed in the evaluation exceeds the dilution contour value, the model concludes that the monitoring system is designed properly. The MAP User's Manual defines the dilution contour as the ratio of the concentration of the contaminant at the detected point in the plume to the concentration of the source. MAP documentation suggests that the concentration of

the contaminant at the detection point is equal to the laboratory's detection limit. The concentration at the source is the concentration of the constituent as it occurs in leachate. Chloride is chosen to represent the constituent released in a hypothetical plume from the landfill, because it is transported conservatively due to its resistence to degradation and non-sorbing properties. The laboratory detection limit of chloride is 0.01 mg/L. The site-specific average chloride value has been calculated to be 858 mg/L which was calculated from six sampling events at the existing landfill between February 2007 and May 2008. The resultant dilution factor is 1.2×10^{-5}.

- *Longitudinal Dispersivity.* Longitudinal dispersivity is derived from the following empirical equation developed by Xu and Eckstein (1995):

$$\alpha_L = 0.83(\log L)^{2.414}$$

where,

α_L = longitudinal dispersivity, and
L = flow path length.

It is conservatively assumed that a failure occurs at the downward gradient edge of the proposed landfill at the leachate sump (refer to Figure 2.8-3). Therefore, the flowpath is determined as follows:

$$\begin{aligned} L &= D1 + D2 \\ &= 190\,ft + 50\,ft \\ &= 240\,ft = 73.15m \end{aligned}$$

where,

L = Flow Path Length,
D1 = Average Distance from Leachate Sump to Waste Boundary at Cells 9 and 10
D2 = Average Distance from Waste Boundary to Compliance Point

$$\alpha_L = 0.83(\log 73.15)^{2.414} = 3.73m = 12.24\,ft.$$

- *Transverse Dispersivity.* In accordance with IEPA LPC-PA2, the transverse dispersivity is determined as 20% of the longitudinal dispersivity.

- *Diffusion Coefficient.* The diffusion coefficient of the uppermost aquifer was assumed to be 0.064 m^2/y (0.689 ft^2/y) which is the "free solution" diffusion coefficient for chloride at infinite dilution in water at 25 ^{0} C. This value is conservative when evaluating the movement of a contaminant through a porous media.

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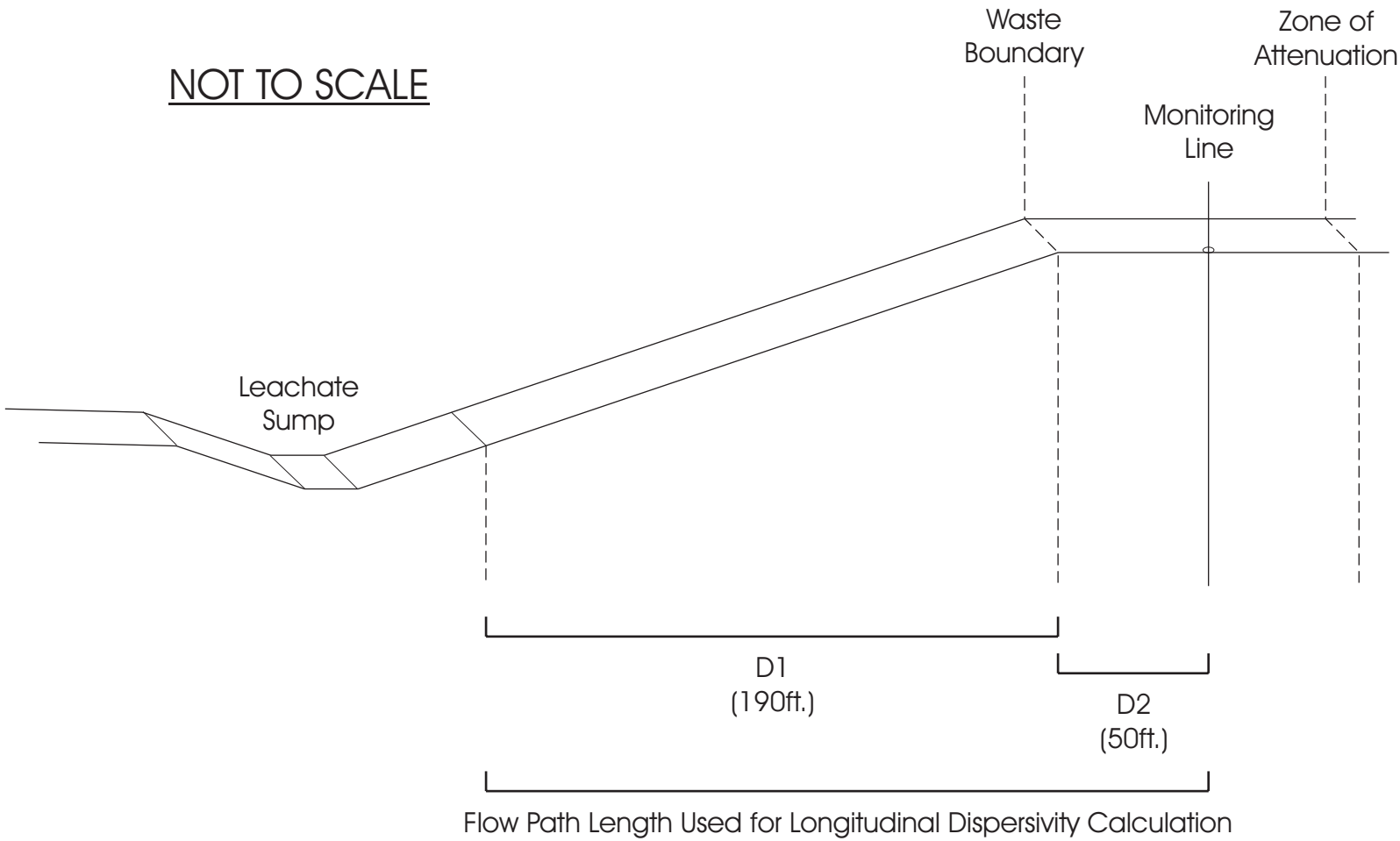

Note: To calculate monitoring efficiency, 1 meter long tears were assumed to be present across the liner system on the tightest grid allowable by the model and extending all of the way to the waste boundary.

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ENVIRONMENTAL MONITORING PROGRAM

FIGURE 2.8-3
LONGITUDINAL DISPERSIVITY FLOW PATH DISTANCE

APPROVED BY: MNF	PROJ. NO.: 122150	DATE: AUGUST 2009

- *Average Contaminant Velocity.* The average contaminant velocity is defined as follows[1]:

$$v = \frac{ki}{n_e}$$

where,

v = Average Contaminant Velocity,
k = Hydraulic Conductivity,
i = Gradient,
n_e = Effective Porosity, and

The Average Contaminant Velocity used in the model is the calculated seepage velocity for the Shallow Drift Aquifer 0.07 m/yr (0.23 ft/yr) as reported in the Hydrogeologic Investigation report.

- *Width of Line Source.* As suggested in IEPA guidance document LPC-PA2, the width of line source is 1m (3.28 ft.).

- *Solution Method.* The "Advection Time Only" solution method was utilized for the well spacing assessment. This method projects a grid over the entire source area. A continuous release is allowed to migrate from each grid square with respect to the user-input hydrogeological parameters. A contaminant concentration is then calculated for each well point at the end of the user-input advection time. To be conservative and to allow all contamination enough time to reach the MEMO defined compliance boundary, the default advection time of 36,500 years was used.

Monitoring Well Phasing

The proposed groundwater monitoring network will be developed concurrently with the proposed landfill cell development. Table 2.8-1 provides a summary of the groundwater monitoring wells and the installation and phasing status of the monitoring point.

Establishment of Applicable Groundwater Quality Standards

Applicable Groundwater Quality Standard (AGQS) values have been established for the Uppermost Aquifer (Shallow Drift Aquifer) and the Intratill Sediments at the existing Veolia E.S. Zion Site 2 Landfill. These permitted AGQS values were used in the GIE model. The applicable water quality standards may be revised to incorporate new standards, additional wells, or intra-well evaluations as approved by the IEPA. Applicable pages of the permit which indicate permitted AGQS values for the existing Site 2 Landfill have been provided in Appendix Q. Any new AGQS values will be calculated as detailed in the following sections.

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[1] Walton, William C. (1991). Principals of Groundwater Engineering. Lewis Publishers, Inc., Chelsea, Michigan.

Outlier Testing of Background Groundwater Quality Data

Prior to calculation of the AGQS values, the monitoring data will be evaluated for potential outliers using Sanitas Groundwater Monitoring Software (Sanitas), or equivalent. Any identified outliers will be checked for potential sampling or data entry errors. After review of all potential outliers, a determination will be made as to whether those values, should any exist, be removed from the data set. Statistical analysis will then be performed as discussed below to calculate the AGQS values.

Statistical Evaluation of Background Groundwater Quality Data

To calculate background groundwater quality standards, a statistical evaluation will be performed under the guidance of two USEPA documents. Specifically, these guidance documents are titled "Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities," Interim Final Guidance, USEPA Office of Solid Waste, PB89-151047, April 1989 and "Statistical Analysis of Ground-Water Monitoring at RCRA Facilities," Addendum to Interim Final Guidance, USEPA Office of Solid Waste, July 1992.

Ultimately, the AGQS values will be determined using appropriate statistical procedures specific to each particular constituent due to the characteristics of its data set (ie. number of non-detects, normality, etc...). For those data sets which exhibited 100 percent non-detects, a non-parametric evaluation will be performed where the lowest detection limit will become the AGQS value. For those data sets with 50 to 100 percent non-detects, a non-parametric evaluation will be performed where the highest detect will become the AGQS value, and for all other data sets (<50% non-detects), a parametric evaluation will be performed using Sanitas where the 95% tolerance limit will be calculated.

The Sanitas software allows for the development of AGQS values through the use of a built-in decision logic framework that assures consistency with the USEPA's statistical requirements. The decision logic framework allows the software to move through the series of statistical step flow charts and testing algorithms, ultimately choosing the most appropriate statistical method and making any necessary adjustments or transformations. More specifically, Sanitas utilizes a variety of power transformations in an attempt to normalize the distribution for use in the parametric tests (ladder of powers). The software then chooses the data transformation that normalizes the data with the least powerful transformation. When necessary, the software automatically substitutes a value of one half of the method detection limit for non-detects.

Maximum Allowable Predicted Concentrations (MAPCs)

The GIE in Section 2.7 demonstrates that the landfill will not cause a statistically significant increase in any of the constituent concentrations over background at or beyond the edge of the ZOA for the uppermost aquifer within 100 years of landfill closure. MAPC values were conservatively set equal to the AGQS values.

Design and Construction of Monitoring Wells

Monitoring wells for the Veolia E.S. Zion Landfill Site 2 East Expansion will be designed and constructed in accordance with 35 Ill. Admin. Code, Sections 811.318 and the USEPA Handbook of Suggested Practices for the Design and Installation of Ground-Water Monitoring Wells.

A typical as-built diagram for groundwater monitoring well construction is provided in Appendix Q and on Drawing No. D13. The monitoring wells will be constructed to yield groundwater samples that represent the quality of groundwater at the landfill site.

The procedure for constructing the monitoring wells at the landfill will typically consist of the following steps:

1. Prior to well construction, monitoring well locations may be staked in the field by a survey crew under the supervision of a Professional Land Surveyor licensed in the State of Illinois;

2. Borings will be drilled from the ground surface through unconsolidated deposits to the target depth at each monitoring well location. Soil samples will be collected at regular intervals by driving a 2-inch outside diameter split-spoon sampler (ASTM D 1586), pushing a thin-walled 3-inch diameter Shelby tube sampler (ASTM D 1587), or using a similar method. A geologist, geotechnical engineer, or their representative, will direct the field exploration operations, log the soil samples, and document the well construction.

3. Each monitoring well will be constructed using a minimum 2-inch inside diameter, flush joint, machine slotted or wire wrap Schedule 40 or 80 PVC well screen and Schedule 40 or 80 PVC riser pipes. The screen length for the proposed monitoring wells will be between 2 to 10 feet. A threaded PVC end plug will be placed at the bottom of the screen and a vented PVC threaded or expandable cap will be placed on the top. All joints will be sealed using either manufacturer supplied O-rings or Teflon tape;

4. A filter pack will be placed in each well which will be selected based on observation of the geologic materials to be screened and measurement of the slot size of the screen to be used;

5. A minimum 2-foot-thick bentonite chip or pellet seal will be placed above the top of the filter pack;

6. The annular space above the bentonite seal and/or filter pack will be grouted to within 2 to 4 feet of the ground surface with a bentonite Volclay® grout, or equivalent, using the tremie method;

7. Concrete will be used to top off the annular space at the ground surface;

8. A well protector with a locking lid will then be installed in the concrete;

9. The monitoring well will be clearly labeled with the well name so that it can be readily identified in the field;

10. A concrete pad will be constructed around the well protector. The pad will be sloped to divert surface water away from the well;

11. The drill tooling, including augers and split-spoon samplers, will be decontaminated using a steam-generating pressure washer (or equivalent) prior to installing the monitoring wells. The split-spoon sampler and the geologist's or engineer's logging tools will be washed in a solution of Alconox™ (or equivalent) and potable water and then rinsed in potable water between samples; and

12. The monitoring wells will be developed to ensure that the well screens are unobstructed and that representative groundwater is flowing into the wells.

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The construction of each monitoring well will be documented by completing and submitting the IEPA Well Completion Report, the Illinois Department of Public Health (IDPH) Well Construction Report form, and preparing an as-built diagram as provided in Appendix Q.

Monitoring Well and Boring, Plugging, and Abandonment

Test borings, damaged wells or piezometers, and wells or piezometers no longer used for long-term monitoring at the landfill will be abandoned in accordance with 35 Ill. Admin. Code, 811.316 Plugging and Sealing of Drill Holes, and in accordance with 77 Ill. Admin. Code, Section 920.120. Abandonment procedures as described below will be followed in the event a monitoring well becomes unserviceable or must be replaced. Abandonment procedures will typically be used if any unknown wells are encountered during site development. The grout used to abandon the wells will typically be a pure bentonite grout. The specific abandonment procedures are provided in the following sections.

Test Boring Abandonment

Any test borings to be drilled at the landfill for site development will be surveyed and properly sealed prior to abandonment. Abandonment will be documented by a geologist or engineer.

Test borings temporarily left unattended (i.e., to obtain water elevation readings) will be temporarily covered and marked (i.e., using flagged lath). The temporary cover will minimize the flow of stormwater runoff into the boring and prevent accidental entry by animals. If an uncased boring partially or completely collapses, resulting in a potential contaminant migration pathway, the borehole will be redrilled prior to abandonment. Immediately after the required data has been collected or the boring has been redrilled, the boring will be abandoned in accordance with the following procedure.

A tremie pipe will be inserted to the bottom of the boring, possibly through hollow stem augers. The slurry will be pressure grouted through the tremie pipe. As the formation water is displaced, the tremie pipe and augers will be withdrawn. The bottom of the augers and the tremie pipe will remain just below the top of the slurry until the grout reaches the ground surface.

The surveyed ground elevation and the location of the abandoned borehole will be recorded by the supervising engineer or geologist. An abandoned boring certification form will be completed and submitted to the Lake County Health Department (LCHD), IDPH, and IEPA in accordance with permit conditions. A copy of this form is included in Appendix Q.

Monitoring Well or Piezometer Abandonment

Groundwater monitoring wells or piezometers required to be removed from service will be properly abandoned. Abandonment will be documented by a geologist or engineer and will be performed by inserting a tremie pipe through the well casing to the bottom of the well. A bentonite grout slurry will then be pumped through the tremie pipe until all water in the well is displaced. The tremie pipe will then be withdrawn and the well will be topped off with grout. The surface concrete plug will then be removed and the well casing will be cut to at least 30 inches below ground surface prior to backfilling the area.

The ground elevation and the location of the abandoned monitoring well or piezometer will be recorded by the supervising engineer or geologist. An abandoned monitoring well certification form will be completed and will be submitted to the LCHD, IDPH and the IEPA in accordance with permit conditions.

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Groundwater Sampling Procedures

The detailed sampling procedure (including procedures for sample preservation and chain of custody) that will be followed to collect groundwater samples from the monitoring wells is provided in Appendix Q. Depth to water from top of riser and elevation of the groundwater surface in reference to Mean Sea Level (MSL) datum will also be provided. A generalized description of the monitoring well sampling procedure follows below.

Dedicated pumps will be utilized to sample each monitoring well. Care will be taken to decontaminate all external equipment between locations in order to prevent possible cross contamination of wells. Low flow purging techniques may also be used in lieu of traditional purging techniques. After unlocking the monitoring well protector and removing the vented cap, the water level will generally be obtained utilizing an electronic water level indicator. The water level will be recorded and a minimum of 3 well volumes of water will be evacuated from the monitoring well. Field measurements of water level, water temperature, pH, conductivity, and well depth will be recorded periodically throughout the pre-sampling purging process. After the field measurements have stabilized and purging has been completed, the well will be allowed to recover and a water sample will then be collected and preserved in a decontaminated water sample jar. Groundwater will be collected at each monitoring well for laboratory analyses and sample containers will be filled in an order to minimize disturbance of samples (ie. volatile organic compounds first). The groundwater samples will be marked and logged on the water sample chain of custody records. Water samples will be stored on ice and transported or shipped to the laboratory or laboratories in a cooler or other suitable container. The laboratory or laboratories selected for testing will be capable of performing analytical analysis in accordance with standard testing methods as approved by the State. Upon arrival at the laboratory, water samples and the chain of custody records will be surrendered to the laboratory. By following these quality assurance procedures, the potential for false positives or contamination of the samples should be minimized.

Detection Monitoring Parameters, Frequency and Data Analyses

The proposed monitoring program for groundwater with regard to parameters, frequency, and data analysis will be as is already permitted and approved by the IEPA at the site. A copy of the applicable section of the current permit is included in Appendix Q. The proposed expansion monitoring well list will be submitted with the IEPA permit application for review, revisions (if applicable), and approval by the IEPA. Ultimately, sampling and testing will be governed by the applicable State regulations and the approved IEPA permit.

Groundwater monitoring at the landfill can be divided into the following three stages:

1. Monitoring prior to accepting waste;
2. Monitoring during the landfill operations; and
3. Monitoring during post-closure.

The specific monitoring program for each stage is detailed in the following sections.

Monitoring Prior to Accepting Waste

Background groundwater quality has been established at the existing Site 2. Proposed groundwater monitoring wells designated for each cell will be installed in advance of cell development and documentation will be submitted to the IEPA.

Detection Monitoring During Landfill Operation

Groundwater monitoring will be performed quarterly and semi-annually (depending on the well location) in accordance with 35 Ill. Admin. Code, Section 811.319 for the indicator parameters required within 35 Ill. Adm. Code, Section (a)(2). Organic constituents will be monitored within each new well within three months of installation and will be added to the monitoring list at least once every two years in accordance with 35 Ill. Admin. Code, Section 811.319(a)(3). The detection monitoring analytical results for the permitted monitoring wells will be evaluated in accordance with 35 Ill. Admin. Code, Section 811.319(a)(4).

Monitoring During Post-Closure

Monitoring during post-closure will remain unchanged from that performed during landfill operations, unless a change to the monitoring program is approved by the IEPA as provided for in 35 Ill. Admin. Code, Section 811.319.

Statistical Analysis of Groundwater Quality Data

As required by 35 Ill. Admin. Code, Section 811.320, routine groundwater quality monitoring data will be analyzed by comparing the results of the quarterly and semi-annual groundwater sampling to applicable groundwater quality standard (AGQS) values which have been established at the site using the applicable statistical procedure specific to each particular constituent and its background data set.

The routine groundwater quality monitoring data will be compared to the AGQS and MAPC values. The applicable water quality standards may be revised to incorporate new standards, additional wells, or intra-well evaluations as approved by the IEPA. The AGQS values that will be used for groundwater quality evaluation are summarized in the GIE in Section 2.7 of the Application. Additionally, applicable pages of the current permit which indicate permitted AGQS values for the existing Site 2 have been provided in Appendix Q.

Evaluation of Groundwater Quality Data

The groundwater quality data for the routine monitoring parameters will be evaluated in accordance with Title 35 Ill. Admin. Code, Section 811.319(a)(4). The required evaluations include the comparison of the concentration of constituents in wells:

1. Over the last eight consecutive quarters;

2. To the applicable MAPC values (which are set equal to the AGQS values for the Shallow Drift Aquifer);

3. To the preceding measured concentration (for the organic constituents); and

4. To the applicable AGQS values.

As the AGQS values have been established pursuant to statistical procedures, the comparison in item number 4 above satisfies the requirement of Title 35 Ill. Admin. Code, Section 811.320(e) for statistical analysis of groundwater monitoring data. A monitored (observed) increase occurs when:

1. The concentration of any constituent monitored in a particular monitoring well shows a progressive increase over eight consecutive quarters;

2. The concentration of any constituent in a particular monitoring well exceeds the MAPC values at an established monitoring point within the zone of attenuation;

3. The concentration of any organic constituent monitored annually in a particular monitoring well exceeds the preceding measured concentration at any established monitoring point; and

4. The concentration of any constituent monitored in a particular monitoring well at or beyond the zone of attenuation exceeds its AGQS value.

Confirmation of Observed Increase

In the event an observed increase occurs, the increase will be confirmed in accordance with 35 Ill. Admin. Code, Section 811.319(a)(4)(B). The confirmation procedures generally include the following:

1. Take additional samples within 90 days of the initial observation. The samples and sampling protocol used will detect any statistically significant increase in the concentration of the suspect constituent in accordance with 35 Ill. Admin. Code, Section 811.320(e);

2. Determine the source of any confirmed increase, which may include, but not be limited to, natural phenomena, sampling or analytical errors, or an off-site source;

3. The IEPA will be notified in writing no later than 180 days after the original sampling event of any confirmed increase. Within this notification, a demonstration will be made, if possible, that the increase is a result of a source other than the Facility, providing rationale used in such a determination.

4. If an alternate source demonstration cannot be made or is denied by the IEPA, assessment monitoring will be proposed.

In the event that there is a confirmed increase in the concentration of any constituent in any monitoring well, the necessary steps will be implemented immediately. These steps may include the following:

1. Assessment monitoring as outlined in 35 Ill. Admin. Code, Section 811.319(b);

2. Assessment of potential groundwater impact as outlined in 35 Ill. Admin. Code, Section 811.319(c); and

3. Remedial action as outlined in 35 Ill. Admin. Code, Section 811.319(d).

A remedy that will protect human health and the environment will be selected in accordance with 35 Ill. Admin. Code, Section 811.325. The corrective action, if appropriate, will be implemented and completed in accordance with the requirements of 35 Ill. Admin. Code, Section 811.326.

Leachate Monitoring

Leachate Monitoring Overview

Leachate will be sampled in accordance with 811.309g, 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. All test results will be submitted to

the IEPA. At a minimum, leachate will be analyzed for the same list of parameters as the groundwater monitoring wells. The sampling procedure that will be followed to collect leachate samples is provided in Appendix Q.

Leachate Monitoring Points

Table 2.8-2 summarizes the proposed leachate sampling points for the proposed Veolia E.S. Zion Landfill Site 2 East Expansion. Figure 2.8-4 illustrates the locations of the leachate sampling points.

TABLE 2.8-2
EXISTING AND PROPOSED LEACHATE SAMPLING POINTS

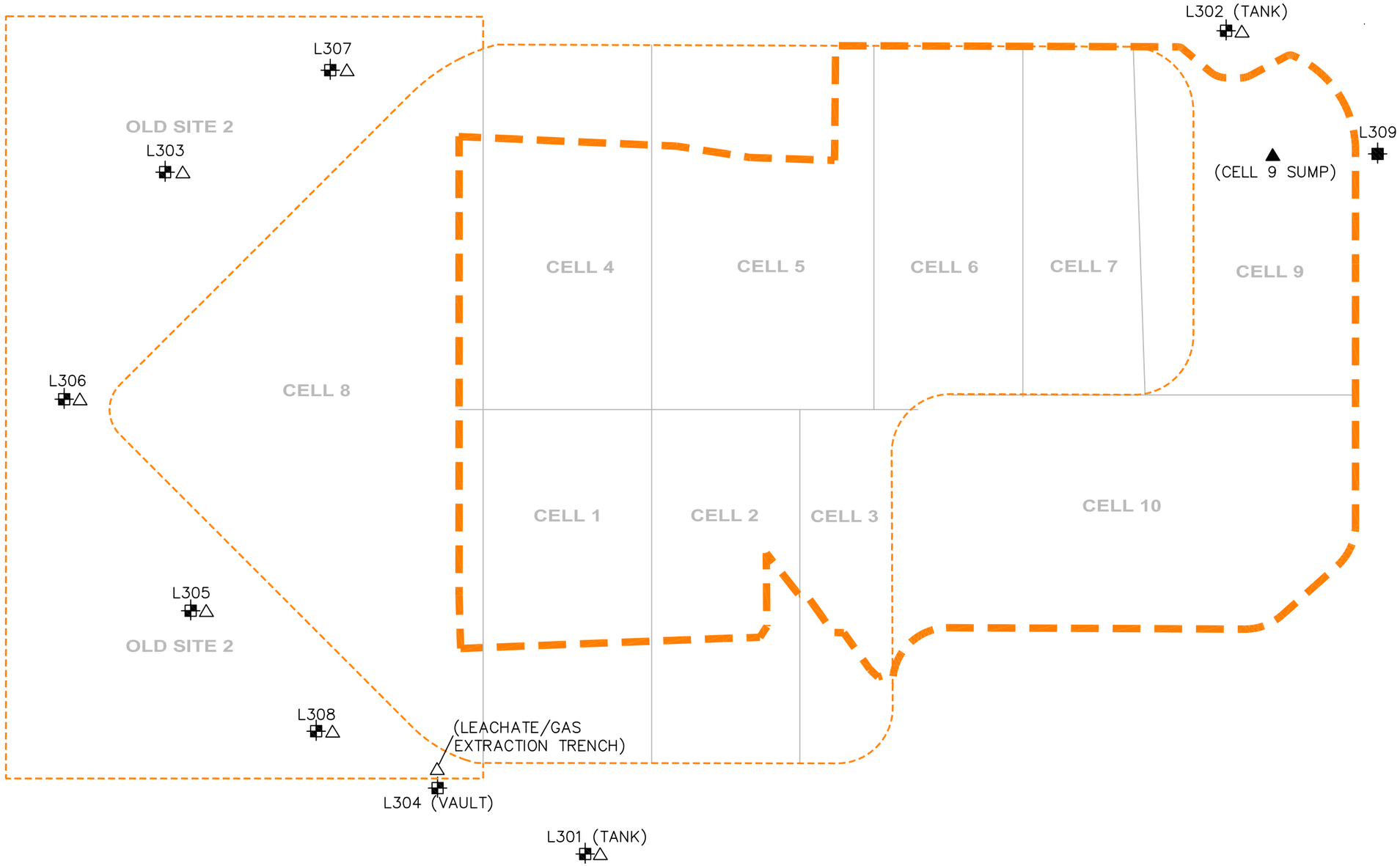
Leachate Sampling Point	Installation Location
Storage Tank #1 (L301)	Leachate Tank South of Cell 1
Storage Tank #2 (L302)	Storage Tank Northeast of Cell 7
EW-43 (L303)	Northwest of Cell 8
South Vault (L304)	South of Cell 8A and Old Site 2
EW-67 (L305)	Southwest of Cell 8
EW-37RR (L306)	West of Cell 8
EW-50 (L307)	Northwest of Cell 8
EW-62 (L308)	Southwest of Cell 8
L309 (Proposed)	Will be Installed East of Cell 9 Sump

Subsurface Landfill Gas Monitoring

Subsurface landfill gas monitoring at the Veolia E.S. Zion Landfill Site 2 East Expansion is proposed to be conducted in accordance with the requirements of 35 Ill. Admin. Code Section 811.310. The proposed landfill gas probe network will be utilized to verify that the landfill gas collection and containment systems are functioning as designed. The proposed landfill gas monitoring network is illustrated on Drawing No. D14 . Landfill gas probes will be inspected at the time of monitoring events for structural integrity and proper operations.

Landfill gas monitoring probes are proposed to be constructed of 1-inch or 2-inch diameter Schedule 40 or 80 PVC pipe, or equivalent material which will not react with or be corroded by 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 air within the probes. The monitoring zone for these probes will be in accordance with 811.310. 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 leakage. 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.

Landfill gas monitoring devices will be sampled on a periodic basis in accordance with 811.310(c). At a minimum, below ground monitoring points will be screened for methane, pressure, nitrogen, oxygen, and carbon dioxide as required by the IEPA. Monitoring will be adjusted as necessary to comply with the federal, state, and local regulations to ensure proper operation procedures.



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GRAPHIC SCALE

LEGEND

- APPROXIMATE EXISTING WASTE AREA
- EXISTING PERMITTED LIMIT OF WASTE AREAS
- L301 — PERMITTED LEACHATE SAMPLING LOCATION
- L309 — PROPOSED LEACHATE SAMPLING LOCATION
- PERMITTED LEACHATE MONITORING LOCATION
- PROPOSED LEACHATE MONITORING LOCATION

NOTES

CELL 8 IS A VERTICAL "PIGGYBACK" EXPANSION OVER THE OLD SITE 2 UNIT.

REV. NO.	DATE	DESCRIPTION

VEOLIA ENVIRONMENTAL SERVICES

Shaw® Shaw Environmental, Inc.

VEOLIA E.S. ZION LANDFILL SITE 2 EAST EXPANSION
LAKE COUNTY, ILLINOIS

FIGURE 2.8-4
PROPOSED LEACHATE MONITORING NETWORK

DRAWN BY:	APD	APPROVED BY:	MNF	PROJ. NO.:	122150	DATE:	AUG 2009

T:\AutoCAD\Projects\122150\dwg\Figures\Leachate Sampling Points.dwg 8/5/2009 10:17:00 AM CDT

Ambient Air Monitoring

As discussed within Section 2.3 of this Application, in addition to subsurface landfill gas monitoring, ambient air monitoring will be conducted around the perimeter of the unit and in on-site buildings to verify that the landfill gas collection and containment systems are functioning as designed. 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 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. Prior to each monitoring event, background will be established as outlined in 40 CFR 60.755.

Surface Water Monitoring

A Stormwater Management Plan for the Veolia E.S. Zion Landfill Site 2 East Expansion has been designed to efficiently collect, route, and detain stormwater runoff from the Facility in an environmentally sound manner as described in greater detail within Section 2.4 of this Application. In accordance with Section 3(C)(1)(f) of the Siting Ordinance, environmental monitoring of surface water will be conducted at the Facility. This monitoring currently occurs, and will continue to occur, in accordance with the existing NPDES permit which will be modified for the proposed landfill expansion as development progresses. The monitoring and analysis procedures, as well as the location of the monitoring points are provided within the Stormwater Pollution Prevention Plan and NPDES Permit which are located in Appendix M.

Conclusions

The potential for the Veolia E.S. Zion Landfill Site 2 East Expansion to impact the environment has been evaluated. In addition to the results of the Groundwater Impact Evaluation which demonstrate that the landfill will not have an adverse impact on the groundwater quality, a comprehensive groundwater monitoring program has been designed for the Site 2 East Expansion. Additionally, Facility operations will include leachate monitoring, subsurface landfill gas monitoring, ambient air monitoring, and surface water monitoring. The Environmental Monitoring Plan at the Facility will serve as an additional safeguard to:

- ❑ Monitor potential sources of environmental impact at the Facility ,
- ❑ Verify that the Facility design and construction are properly functioning to protect the public health, safety and welfare, and
- ❑ Provide an early warning system in the unlikely event of a leachate or landfill gas release.

Monitoring will follow strict quality control, quality assurance, and chain of custody procedures.