APPENDIX N

PERMITTED GROUNDWATER IMPACT ASSESSMENT

1. GROUNDWATER IMPACT ASSESSMENT

2. GROUNDWATER IMPACT ASSESSMENT INPUT PARAMETER BACKUP, MODEL RUNS AND ADDITIONAL INFORMATION PROVIDED TO THE IEPA

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APPENDIX N.1

GROUNDWATER IMPACT ASSESSMENT

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SECTION 812.316
GROUNDWATER IMPACT ASSESSMENT

CERTIFICATION BY PROFESSIONAL GEOLOGIST

In accordance with Section 60 of The Professional Geologist Licensing Act, I, John Robert Berry, an Illinois Licensed Professional Geologist, (Illinois License Number 196-000267, expires 3-31-2007) certify that this report was prepared by me or under my direct supervision and that the information contained within is true and accurate to the best of my belief.

SEAL: LICENSED PROFESSIONAL GEOLOGIST
JOHN R. BERRY
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Signature ____________
John R. Berry, P.G.
Senior Hydrogeologist

Date June 9, 2006

SECTION 812.316 –GROUNDWATER IMPACT ASSESSMENT

812.316.1 Introduction

A Groundwater Impact Assessment (GIA) was performed for the proposed Clinton Landfill No. 3 in accordance with the current Illinois Environmental Protection Agency (IEPA) and Illinois Pollution Control Board (IPCB) Regulations under Title 35 Illinois Administrative Code Part 811.317. IEPA guidance documents LPC-PA19 (Instructions for a Significant Modification Demonstrating Compliance with 35 IAC, Subtitle G, Part 814, Subpart C), and LPC-PA2 (Instructions for the Application for a Permit to Develop a Non-Hazardous Landfill) were followed to ensure completeness of the GIA.

The potential for the proposed Clinton Landfill No. 3 to impact the groundwater quality at or near the site was assessed using data generated during the geologic and hydrogeologic investigations, site specific leachate and groundwater quality data, and a computer executed contaminant transport model. The site hydrogeologic conditions were examined during the site geologic and hydrogeologic investigations. The site geology and hydrogeology are discussed in Section 812.314 of this application.

The proposed Clinton Landfill No. 3 has been designed to take advantage of the suitable hydrogeologic conditions. The design of the proposed landfill includes extensive environmental safeguards, including a composite liner system consisting of a 3 foot-thick compacted earth liner and a 60 mil HDPE geomembrane liner, a highly efficient leachate drainage layer and leachate collection system, and a composite final cover over the entire landfill. The designs of the liner and leachate collection system are detailed in Sections 812.306 through 812.308 of this application. The site-specific data obtained from the geologic and hydrogeologic investigation and the site design were incorporated into the baseline contaminant transport model. This GIA is based on minimum landfill design criteria for the proposed Clinton Landfill No. 3 for conservatism. An overview of the site geology, the formulation of a conceptual model, the conversion of the conceptual model into a mathematical framework, and the analysis of the transport processes are presented herein.

812.316.2 Site Geology Summary

A thorough discussion of the site geology may be found in Section 812.314 (Description of the Hydrogeology) of this document. An overview, however, may be helpful in understanding the conceptual models used and to elaborate on some of the model specific data needed.

Clinton Landfill No. 3 will be located within glacial and interglacial deposits of the Pleistocene Stage. The glacial deposits primarily consist of silty clay and clayey silt. Some silt and sand units are also present; however, the majority of these units are relatively thin and are not laterally continuous across the entire facility. Lithologies associated with these deposits include Wisconsinan and Illinoian glacial (and interglacial) deposits which consist primarily of silty clay tills. The deposits contain outwash sands which are water-bearing and have been defined as the upper-most aquifers at the site. Underlying the Wisconsinan and Illinoian glacial deposits are deposits of pre- Illinoian age. These deposits include the Mahomet Sand.

Geologic and hydrogeologic investigations at the facility have identified three distinct units at the facility within the glacial deposits which are considered potential contaminant migration pathways:

- A gray sand unit located in the southeastern portion of the Clinton Landfill No. 3 facility between approximate Elevations 654 and 647 feet AMSL. This unit is referenced as the "Upper Radnor Till Sand". This sand is judged to be an intra-till outwash deposit of the Radnor Till. This unit varies in thickness across the site from approximately 0.25 to 2.8 feet with the average thickness being 1.46 feet below the southeastern portion of the facility based upon soil boring data (Table 812.316-1). The elevation of the top and bottom of this sand and thickness isopleths are shown on Figures 812.314-14 through 812.314-16, respectively in Section 812.314. The extents of this sand are also shown on Figure 812.314-14 through 812.314-16. The flow direction in the Upper Radnor Till Sand at the facility is toward the southwest (Figures 812.314-23 through 821.314-26). The average hydraulic gradient in this unit was determined to be 7.96×10^{-3} across the site. Potentiometric contours based on mean groundwater levels are provided on Figure 812.316-1.

  Because of its limited lateral extent and its proximity to the landfill floor, this unit will be removed from beneath the landfill floor perimeter as shown on Drawing Nos. P-EX1 and P-EX2 (Full size drawings attached separately).

- A gray sand unit is located beneath the liner invert between approximate Elevations 644 and 635 feet AMSL. This unit is referenced as the "Lower Radnor Till Sand" for the groundwater impact assessment. This sand is judged to be an intra-till outwash deposit of the Radnor Till Member. This unit varies in thickness across the site from approximately 0.20 to 5.3 feet with the average thickness being 2.8 feet below the facility based upon soil boring data (see Table 812.316-1). The elevation of the top and bottom of this sand and thickness isopleths are shown on Figures 812.314-17 through 812.314-19, respectively in Section 812.314. The extents of this sand are also shown on Figure 812.314-17 through 812.314-19. The average flow direction in the Lower Radnor Till Sand at the facility is toward the southwest (Figures 812.314-27 through 821.314-30). The average hydraulic gradient in this unit was determined to be 1.24 x 10^{-2} across the site. Potentiometric contours based on two-year mean groundwater levels are provided on Figure 812.316-2.

- An organic soil unit which is located beneath the liner invert between approximate Elevations 644 and 623 feet AMSL. This unit is referenced as the "Organic Soil" for the groundwater impact assessment. This organic unit is judged to be an intra-till organic unit within the Radnor Till. It most likely is represents an inter-glacial episode or substage of the Illinoian glaciation. This unit varies in thickness across the site from approximately 0.60 to 10.0 feet with the average thickness being 3.42 feet below the facility based upon soil boring data (Table 812.316). The elevation of the top and bottom of this organic soil and thickness isopleths are shown on Figures 812.314-20 through 812.314-22, respectively in Section 812.314. The average flow direction in the Organic Soil at the facility is toward the southwest (Figures 812.314-31 through 821.314-34). The average hydraulic gradient in this unit was determined to be 6.06 x 10^{-3} across the site. Potentiometric contours based on mean groundwater levels are provided on Figure 812.316-3.

812.316.3 Conceptual Models

Due to the complex stratigraphy at this site, multiple simplified hydrogeologic models were developed for the groundwater impact assessments. A model was developed for each of the three units which are considered to be potential contaminant migration pathways. In addition, a separate model was developed to demonstrate the Mahomet Sand, which lies well over 100 feet below the bottom invert of the proposed landfill, will not be impacted by the landfill. The three conceptual models, plus a demonstration model for the Mahomet Sand, are illustrated on Figures 812.316-1 through 812.316-4, and are summarized below:

- Upper Radnor Till Sand: This model (see Figure 312.816-1) is based on the hydrogeologic conditions at the southeastern portion of the facility and models potential contamination. Figure 812.316-1 shows the estimated limits of this sand and the interpreted mean potentiometric contours (mean of five quarters, 4th quarter 2003 and the four quarters 2004) in this unit beneath this area of the landfill. These contours indicate a flow direction toward the southwest.

The proposed design for the facility calls for the installation of a minimum, 20-foot wide cutoff trench to be installed at the toe of the landfill invert sidewalls to restrict lateral migration in the unit (see Drawing Nos. P-EX1 and P-EX2, full size drawings attached). This cut-off trench, or keyway, was modeled to determine if lateral migration of contaminants will occur through the keyway. For purposes of this study, it was assumed that complete liner failure has occurred and that full-strength leachate is present in the Upper Radnor Till Sand directly beneath the landfill invert.

The conceptual model assumes that the keyway consists of the minimum thickness, 20 feet. The distance to the nearest compliance boundary (zone of attenuation) was assumed in the modeling as the thickness of the sand. A one-dimensional model was used for this potential pathway. Additional details of the selection of the geologic material properties are provided in Section 812.316.3

<u>Lower Radnor Till Sand:</u> This model (see Figure 812.316-2) is based on the average geologic conditions found under the proposed landfill invert. Figure 812.316-2 shows the interpreted mean potentiometric contours (mean of eight quarters, four quarters of 2003 and four quarters 2004) in this unit. These contours indicate a flow direction toward the southwest.

The landfill liner thickness is based on the requirements of 35 IAC 811 and 812 (3 feet-thick compacted clay liner). The proposed compacted earth liner subgrade is located within the organic silt of the Roxana Silt-Robein Member in most areas of the landfill. To improve the landfill foundation, this organic silt, where encountered at the compacted earth liner subgrade, will be removed to the surface of the Berry Clay. The resulting over-excavation will be backfilled with compacted clay exhibiting a hydraulic conductivity no greater than 1×10^{-7} centimeters per second (cm/sec). The clay thickness above the sand unit is based on the average thickness of this unit underneath the liner of the landfill.

In order to calculate the average thickness of the compacted clay fill layer, surface models of the bottom of the 3-foot compacted earth liner (subgrade), top of the Berry Clay, and top of the Lower

Radnor Till Sand were created using AutoDesk Land Desktop Release 3, which is a digital terrain model (DTM). These surfaces were then used in Land Desktop to calculate the volume of geologic material between the compacted earth liner subgrade and top of the Berry Clay, and the volume between the subgrade and the top of the Lower Radnor Till Sand. Dividing the volume (cubic feet) by the appropriate area (square feet) yields an average thickness (feet) of clay between the subgrade and top of each geologic unit. The average thickness of the compacted clay fill was calculated to be 0.9644 feet (See Appendix 812.316-A for calculations).

In order to calculate the average thickness of the Berry Clay/Radnor Till above the Lower Radnor Till Sand, the surfaces of the compacted earth liner subgrade and top of Lower Radnor Till Sand were also modeled in a digital terrain model (DTM). The DTM software (AutoDesk Land Desktop Release 3) was used. The Civil Design module of the DTM software was used to calculate the volumes between the compacted earth liner subgrade and top of Lower Radnor Till Sand. Dividing these volumes by the appropriate area provides the average thickness from the compacted earth liner subgrade to the top of the Lower Radnor Till Sand. The average thickness of clay from subgrade to the top of the Berry Clay is 0.9644 feet. The average thickness of clay from the subgrade to the top of the Lower Radnor Till Sand is 22.53 feet (see Appendix 812.316-A). In order to find the average thickness of the Berry Clay/Radnor Till above the Lower Radnor Till Sand, subtract 0.9644 feet (average thickness of compacted clay fill) from 22.53 (average thickness of Berry Clay/Radnor Till) to get 21.57 feet. Figure 812.316-5 is provided to show the clay thickness from the subgrade to top of Lower Radnor Till Sand under the proposed landfill.

The average thickness of the Lower Radnor Till Sand is 2.8 feet based on soil boring data (see Table 812.316-1). The hydraulic conductivity of this unit is based upon the geometric mean of the results of in-situ slug testing of monitoring wells screened in this unit (See Table 812.316-2). The potentiometric surface in this unit is above the landfill invert over most of the site except for the southern edge of the facility. Therefore, a two-dimensional model was used for this potential pathway.

- Organic Soil - This model (see Figure 312.816-3) is based on the hydrogeologic conditions across the entire landfill. The landfill liner thickness is based on the requirements of 35 IAC 811 and 812 (3 feet-thick compacted clay liner). As stated above, the proposed compacted earth liner subgrade is located within the organic silt of the Roxana Silt-Robein Member in most areas of the landfill. To improve the landfill foundation, the Roxana Silt-Robein Member, where encountered at the compacted earth liner subgrade, will be removed to the surface of the Berry Clay. The resulting over-excavation will be backfilled with compacted clay exhibiting a hydraulic conductivity no greater than 1×10^{-7} centimeters per second (cm/sec).

The average thickness of the compacted clay fill is 0.9644 feet and was calculated as explained above.

In order to calculate the average thickness of the Berry Clay/Radnor Till above the Organic Soil, the surfaces of the compacted earth liner subgrade and top of Organic Soil were also modeled in a digital terrain model (DTM). The DTM software (AutoDesk Land Development Desktop Release 3) was used. The Civil Design module of the DTM software was used to calculate the volumes between the compacted earth liner subgrade and top of Organic Soil. Dividing these volumes by the appropriate area provides the average thickness from the compacted earth liner subgrade to the top of the Organic Soil. The average thickness of clay from subgrade to the top of the Berry Clay is 0.9644 feet. The average thickness of clay from the subgrade to the top of the Organic Soil is 27.54 feet (see Appendix 812.316-A). In order to find the average thickness of the Berry Clay/Radnor Till above the Organic Soil, subtract 0.9644 feet (average thickness of compacted clay fill) from 27.54 (average thickness of Berry Clay/Radnor Till) to get 26.58 feet. Figure 812.316-6 is provided to show the clay thickness from the subgrade to top of Organic Soil under the proposed landfill. For conservatism, the Organic Soil model assumed that the clay thickness above the organic soil was the same as the clay thickness above the Lower Radnor Till Sand which is 21.57 feet.

The average thickness of the Organic Soil is 3.42 feet based on soil boring data (see Table 812.316-1). The hydraulic conductivity of this unit is based upon the geometric mean of the results of in-situ slug testing of monitoring wells screened in this unit (See Table 812.316-2). The potentiometric surface in this unit is above the landfill invert over most of the site except for the south western edge of the facility. Therefore, a two-dimensional model was used for this potential pathway.

<u>Mahomet Sand</u> - This demonstration model (see Figure 312.816-4) is based on the hydrogeologic conditions across the entire landfill. The landfill liner thickness is based on the requirements of 35 IAC 811 and 812 (3 feet-thick compacted clay liner). As stated above, the proposed compacted earth liner subgrade is located within the organic silt of the Roxana Silt-Robein Member in most areas of the

landfill. To improve the landfill foundation, the Roxana Silt-Robein Member, where encountered at the compacted earth liner subgrade, will be removed to the surface of the Berry Clay. The resulting over-excavation will be backfilled with compacted clay exhibiting a hydraulic conductivity no greater than 1×10^{-7} centimeters per second (cm/sec). The clay thickness of the Berry Clay/Radnor Till above the Lower Radnor Till Sand was set equal to 21.57 feet. The Lower Radnor Till Sand was set equal to its mean thickness (2.8 feet). The clay thickness between the bottom of Lower Radnor Till Sand and the top of the Organic Soil was calculated using AutoDesk Land Desktop Release 3.

In order to calculate the average thickness of the clay layer between the bottom of the Lower Radnor Till Sand and the top of the Organic Soil, surface models of the bottom of the Lower Radnor Till Sand and top of the Organic Soil, were created using AutoDesk Land Desktop Release 3, which is a digital terrain model (DTM). These surfaces were then used in Land Desktop to calculate the volume of geologic material between these two units. Dividing the volume (cubic feet) by the appropriate area (square feet) yields an average thickness (feet) of clay between the units. The average thickness of the compacted clay fill was calculated to be 3.25 feet (See Appendix 812.316-A for calculations).

The Organic Soil was set equal to its average thickness (3.42 feet). Then, for conservatism, it was assumed that only fifty feet of clay is present below the Organic Soil and above the Mahomet Sand. Based upon soil boring data, there is well over 100 feet of clay between the bottom of the Organic Soil and the top of the Mahomet Sand.

The thickness of the Mahomet Sand was conservatively set to equal only 10 feet in thickness to reduce mixing in the unit. This is a highly conservative assumption given that the Mahomet Sand below the site is approximately 90 feet in thickness based upon soil boring data. (See Drawing P-XS7).

812.316.4 Conversion Assumptions

Several assumptions were made in the conversion to the conceptual models. These are:

1) <u>All geologic units and earthen structures are homogeneous and isotropic with respect to all lithologic and hydrologic parameters.</u> Most contaminant transport models are incapable of working with the small scale changes for these parameters, seen within many geologic

materials. Sensitivity analyses performed over the observed range of values provide an adequate examination of this variability.

2) All geologic units are of uniform thickness. These thicknesses are based on the average thicknesses found at the site. Therefore, the average values used here provide a reasonable estimate of the transport progresses at the site. Sensitivity analysis provides a tool to appraise the effects of localized variability in these parameters.

3) Geologic and hydrologic parameters used are mean values for site specific data, or mean values taken from literature research. Ranges for these values are also taken into consideration. Again, the mean values analyzed provide a reasonable analysis of the site conditions. Details of material properties used for the modeling are provided in Section 812.316.7. Transport through a geologic unit with a high variability of hydraulic conductivity, transmissivity, porosity, etc., will actually produce an "average" movement through the geologic unit. Again, sensitivity analysis was performed to evaluate the effect of varying the parameters.

4) The uppermost aquifer is of infinite lateral extent. Generally a required assumption in mathematical models.

5) The geomembrane liner system possesses several "holes" such that it is not a completely impermeable barrier. A conservative assumption that provides for a migration pathway through the liner system. Calculations and HELP modeling were performed using very conservative assumptions to maximize seepage through the liner (see Appendices 812.316-C and 812.307-B)

6) All angles are assumed to be 90°. Providing right angle corners removes extra thickness from the liner and other parts of the landfill, and hence adds additional conservatism to the conceptual model.

812.316.5 Transport Processes

Using the conservative design and geologic simplifications presented on Figures 812.316-2 and 812.316-3, and combining the analysis of groundwater flow information presented in Section 812.314 of the this application, the transport process within each layer may be analyzed with respect to migration of the leachate constituents. Within the systems, migration of contaminants is first controlled by diffusion and vertical advection through the liner system, compacted clay fill, and Berry Clay/Radnor Till existing above the Radnor Till Sand and Organic Soil. Once the leachate constituents move into the upper-most aquifer (Upper Radnor Till Sand and Organic Soil), horizontal advection and dispersion will be dominant, driven by groundwater flow. With the liner/aquitard/aquifer models as shown on Figures 812.316-2 and 812.316-3, a two-dimensional diffusion/advection model is adequate to properly characterize the potential impact of the facility on groundwater.

For the Upper Radnor Till Sand, the keyway/aquifer model as shown on Figure 812.316-1, a one-dimensional diffusion/advection model is adequate to properly characterize the potential impact of the facility on groundwater. In addition, for the demonstration model for the Mahomet Sand as shown on Figure 812.316-4, a one dimensional diffusion/advection model is also adequate to properly characterize the potential impact of the facility on the Mahomet Sand.

812.316.6 Mathematical Model

A. Two-Dimensional Model

An advection/diffusion and dispersion two-dimensional computer model that adequately represents contaminant transport is MIGRATE (version 9.09) by Rowe and Booker (1996). This model provides for:

- advective as well as diffusive transport,
- two-dimensional transport,
- multiple time and distance solutions to the transport equation,
- retardation (sorption-desorption) of non-conservative constituents,
- a transport solution with no space or time discretization errors (Rowe and Booker 1996).

The assumptions inherent in MIGRATE are:

1) Contaminant transport is governed by the two-dimensional advection/dispersion equation within a porous medium.

2) Sorption-desorption of a non-conservative species of contaminant is controlled by the linear sorption term:

$$\rho \times K \times dc/dt$$

where:

ρ	=	dry density of the soil
K	=	distribution coefficient for the soil-solute adsorption
dc/dt	=	derivative of concentration with respect to time.

3) Contaminant migration in a given direction is two-dimensional and for intact material, is governed by:

$$n\frac{\partial c}{\partial t} = nD_z\frac{\partial^2 c}{\partial z^2} - nv_z\frac{\partial c}{\partial z} + nD_x\frac{\partial^2 c}{\partial x^2} - nv_x\frac{\partial c}{\partial x} - \rho K\frac{\partial c}{\partial t}$$

where:

c	= concentration of contaminant at depth/distance x and z at time z (ML^{-3})
D_x and D_z	= coefficient of hydrodynamic dispersion in the x and z directions (L^2T^{-1})
v_x and v_z	= groundwater velocities in the x, z directions (LT^{-2})
ρ	= dry density of the soil (ML^{-3})
K	= partitioning or distribution coefficient (L^3M^{-1})
nv_x and nv_z	= Darcy Velocities in the x, z direction (LT^{-2})
n	= effective porosity of the layer (L^3L^{-3})

4) Multiple layers with different properties may be specified. It is assumed that there is continuity of concentration and flux at the boundary between the layers and that the physical parameters do not

vary with lateral position.

5) It is assumed that the Darcy velocities do not vary with position within any layer of the deposit. Within the modeling scenario, MIGRATE has an advantage that permits the user to model the landfill as a surface boundary condition or as a physical layer within a layered system. For the purposes of this study, the following assumptions have been made:

a) The landfill was modeled as a constant source surface boundary condition. This approach assumes that a contaminant within the landfill (leachate constituent) has a concentration C_o and that the concentration is always homogeneous within the landfill. Presuming a constant source over the entire life and post-closure of the facility is a highly conservative assumption. This implies that full leachate constituent concentrations are present from day one, and no elutriation or removal of the contaminants is occurring.

b) "Bottom" boundary is impermeable. This approach assumes that no contaminant can pass through the boundary.

c) All lateral distances are measured with respect to the center of the landfill.

Using the conservative parameters listed in the conceptual models coupled with the conservative assumptions that MIGRATE offers, the model shall present and produce a conservative representation of leakage from the proposed facility.

B. One-Dimensional Model

An advection/diffusion one-dimensional computer model that adequately represents contaminant transport is POLLUTE (version 6.2) by Rowe and Booker (1994). This model provides for:

- advective as well as diffusive transport,
- one-dimensional transport in either horizontal or vertical direction,
- multiple time and depth solutions to the transport equation,
- retardation (sorption-desorption) of non-conservative constituents,
- a transport solution with no space or time discretization errors (Rowe and Booker 1994).

The assumptions inherent in POLLUTE are:

1) Contaminant transport is governed by the one-dimensional advection/dispersion equation within a porous medium.

2) Sorption-desorption of a non-conservative species of contaminant is linearly controlled, such that:

   S = Kc

   where:

   S = solute sorped per unit weight of soil
   K = distribution/partitioning coefficient
   c = concentration of contaminant in solution.

3) Contaminant migration in a given direction is one-dimensional and, for intact materials, is governed by:

$$n\frac{\partial c}{\partial t} = nD\frac{\partial^2 c}{\partial z^2} - nv\frac{\partial c}{\partial z} \bullet \rho K_d \frac{\partial c}{\partial t} \bullet \lambda c$$

   where:

   c = concentration of contaminant at depth z at time t,
   D = coefficient of hydrodynamic dispersion at depth z,
   v = groundwater (seepage) velocity at depth z,
   n = porosity of the soil at depth z,
   ρ = dry density of the soil at depth z,
   K_d = distribution/partitioning (sorption) coefficient at depth z,
   v_a = nv = Darcy velocity,
   λ = decay constant of the contaminant species (i.e., the reciprocal of the species mean half life times 1n 2).

4) Multiple layers with different properties may be specified. It is assumed that there is continuity of concentration and flux at the boundary between two layers.

5) It is assumed that Darcy velocities do not vary with position within any layer of the deposit.

Within the modeling scenario, POLLUTE has an advantage that permits a variety of top and bottom conditions. For the purposes of this study, the following assumptions have been made:

a) "Top" boundary set to equal a constant source boundary. Presuming a constant source over the entire life and post-closure of the facility is a highly conservative assumption. This again implies that full leachate constituent concentrations are present from day one, and no elutriation or removal of the contaminants is occurring.

b) "Bottom" boundary (Cutoff Keyway model) is an infinite layer for the Upper Radnor Till an Mahomet Sand.

Using the conservative parameters listed in the conceptual models coupled with the conservative assumptions that POLLUTE offers, the model shall produce a conservative representation of leakage from the facility.

812.316.7 Model Input

Input parameters have for the most part have been determined from site specific data. These parameters include hydraulic conductivity, thickness of the units, leachate constituent concentrations, and porosity. Parameters that are not site specific are taken from literature values for comparable materials. Table 812.316-4 through 812.316-8 contain a list of the input parameters for the models used in the GIA.

The following section will describe in more detail how each parameter was selected. Given are the input parameters that are assumed to stay constant and a justification for each.

<u>A. Source Concentration</u>

A surrogate leachate constituent concentration of 1 milligram per liter (mg/l) is assumed in the models.

B. Layer Thickness

The modeled stratigraphy and layer thickness are based upon the average site geologic conditions and are detailed in Section 812.316.3. The average clay thickness above the Organic Soil was conservatively assumed to be the thickness of the clay above the Lower Radnor Till Sand. In addition, for conservatism the clay thickness below the organic soil and above the Mahomet Sand was assumed to be 50 feet in thickness. Geologic data reveals that well over 100 feet of clay overlies the Mahomet Sand. The Mahomet Sand was conservatively set to equal 10 feet in thickness to reduce mixing and dilution.

C. Distribution Coefficient

Adsorption is not simulated and adsorption coefficients are set equal to 0 for all layers. This is highly conservative given most leachate constituents will be subject to some measure of attenuation within the liner and the underlying clay units.

D. Bulk Density

MIGRATE only uses bulk density when there is retardation. A review of the governing equation for the model shows that if K = 0.0, then that section of the equation equals zero. Because adsorption is not simulated, density values have no bearing on the predicted concentrations for this study. The MIGRATE model default value of 1.9 grams per cubic centimeter (g/cm^3) was used for each layer .

E. Effective Porosity

An important aquifer characteristic of geologic environments used in time and travel calculations, is effective porosity. Fetter (1980) defines effective porosity as "the amount of interconnected pore space through which fluids can pass, expressed as a percent of bulk volume." The relative value of effective porosity (n_e) is very important since it is used to calculate seepage velocity of a given geologic unit. Effective porosity is very difficult to measure; however, total porosity is commonly determined using laboratory test data. In all cases effective porosity is less than total porosity. Therefore, although literature values for effective porosity are available, total porosity values based on site-specific laboratory test data were used where available. Site specific porosity data are summarized on Table 812.314-2 (Section 812.314).

The compacted earth liner porosity is based on many tests conducted on the Clinton Landfill No. 2 Initial Fill Area compacted clay liner. Clays of the Tiskilwa Formation and Berry Clay Member were used for the compacted earth liner at Clinton Landfill No. 2 Initial Fill Area. The test results reveal a mean porosity of 0.288 (See Appendix 812.316-B). The proposed facility will use the clay of these units to construct the Clinton Landfill No. 3 compacted clay liner. The mean porosity of 0.288 is used for the model input for the compacted earth liner and the compacted clay fill in the models. This value was also used for the compacted clay cut-off keyway for the Upper Radnor Till Sand model.

The value for the mean for total porosity for sample mean for the Berry/Radnor Till below the compacted clay fill is 0.286 beneath the Clinton Landfill No. 3 liner invert elevation (see Table 812.314-2 in Section 812.314). The mean porosity of 0.286 is used for the model input for the Berry/Radnor Till.

Values for effective porosity for the sand units were taken from Freeze and Cherry (1979). They reported typical total porosity values for sand ranged from 0.25 to 0.50. A conservative value of 0.30 was used for the baseline models for the Upper and Lower Radnor Till Sand and Mahomet Sand models. Using a value below the mean of the range of is a highly conservative assumption given that using a lower porosity results in higher concentrations, as demonstrated by model sensitivity analysis.

Values for effective porosity for the silt unit (Organic Soil model) were taken from US EPA (1990). They reported typical effective porosity values for silt ranged from 0.34 to 0.61. A value of 0.40 was used for the baseline model for the Organic Soil model. Again, using a value below the mean of the range of is a highly conservative assumption given that using a lower porosity results in higher concentrations as demonstrated in the sensitivity analysis.

F. Hydraulic Conductivity

The hydraulic conductivity values for each of the layers at the Clinton Landfill No. 3 have been measured by both laboratory testing and in-situ testing (slug testing) as detailed in Section 812.314. A summary of all hydraulic conductivity test data for in-situ geologic materials at this site is provided in Table 812.316-2 and Table 812.314-2 (Section 812.314)

The hydraulic conductivity of the 3-foot compacted earth liner in the Clinton Landfill No. 3 is assumed to have a value of 1 x 10^{-7} cm/sec since this is the minimum regulatory value for acceptance. A review of the construction quality assurance laboratory data obtained during several phases of liner construction at the Clinton Landfill No. 2 shows values in the 10^{-8} and 10^{-9} cm/sec range. Therefore, using a value of 1 x 10^{-7} cm/sec is considered to be a conservative value.

The hydraulic conductivity of the insitu clay (Berry Clay and Radnor Till) below the liner is assumed to be 1 x 10^{-7} cm/sec although laboratory data from this unit shows values in the 10^{-8} and 10^{-9} cm/sec range.

The hydraulic conductivities for the Upper and Lower Radnor Till Sands and the Organic Soil migration pathways were determined by insitu slug testing. The geometric mean of the slug testing data was used for each unit. The geometric mean of the hydraulic conductivities values was used because it is commonly accepted that multiple conductivity measurements in the same formation tend to show a log-normal distribution and that the geometric mean is appropriate to use this type of data distribution. For the Upper Radnor Till Sand, a geometric mean value of 5.57 x 10^{-5} cm/sec was calculated. For the Lower Radnor Till Sand, a geometric mean value of 5.37 x 10^{-4} cm/sec was used. For the Organic Soil, a geometric mean value of 5.35 x 10^{-5} cm/sec was used (see Table 812.316-2).

G. Gradient

Site gradient calculations were based on a statistical evaluation of the groundwater elevations at the site. For the Lower Radnor Till Sand and Organic Soil, the elevation of the top of piezometric surface for each well was calculated from each water level measurement made during of the four quarters of 2003 and 2004 resulting in eight quarters of data (see Table 812.316-3).

For the Lower Radnor Till Sand, the mean values of the eight rounds of water level measurements were utilized. The gradient in this unit was calculated by taking the difference in the mean groundwater elevation from well EX-15 to well EX-7 and dividing it by the distance between these wells (3,753.69 feet). This resulted in a gradient of 1.24 x 10^{-2}.

For the Organic Soil, the mean values of the eight rounds of water level measurements were utilized. The gradient in this unit was calculated by taking the difference in the mean groundwater elevation from well EX-24 to well EX-20 and dividing it by the distance between these wells (2765.50 feet).

This resulted in a gradient of 6.06 x 10^{-3}.

For the Upper Radnor Till Sand, the mean values of the five rounds of water level measurements were utilized. The gradient in this unit was calculated by taking the difference in the mean groundwater elevation from well EX-23S to well EX-21S and dividing it by the distance between these wells (1535.92 feet). This resulted in a gradient of 7.96 x 10^{-3}.

H. Darcy Flux and Darcy Velocity

A vertical leachate Darcy Velocity (or Darcy Flux) through the composite liner was taken from the HELP Model (provided in Appendix 812.307-B). HELP model simulations were performed to estimate the build-up of leachate head following the end of the Post-Closure Period, (i.e. after the cessation of the leachate extraction). These simulations, provided in Appendix 812.307-B of this application, indicate an average annual leachate head and Darcy Flux (percolation/leakage through layer 10) throughout the 145-year modeling of 128.8 inches and 0.1384 inches, respectively. This resulted in a vertical Darcy Flux of 3.515 x 10^{-3} meters per year (m/A) through the composite liner. The HELP Model simulations and results are included in Section 812.307 (Appendix 812.307-B).

The horizontal Darcy Velocity in the sand units were based on the statistical potentiometric surface gradient calculations as explained above and the hydraulic conductivity of the layers.

The Upper Radnor Till Sand beneath Clinton Landfill No. 3 with a mean hydraulic conductivity of 5.57 x 10^{-5} cm/sec and a horizontal gradient of 7.96 x 10^{-3}, gives a Darcy Velocity of 0.1397 m/A. This value was used in the model for this unit.

The Lower Radnor Till Sand beneath Clinton Landfill No. 3 with a mean hydraulic conductivity of 5.37 x 10^{-4} cm/sec (169.348 m/A) and a horizontal gradient of 1.24 x 10^{-2}, gives a Darcy Velocity of 2.099 m/A. This value was used in the model for this unit.

The Organic Soil beneath the Clinton Landfill No. 3 with a mean hydraulic conductivity of 5.35 x 10^{-5} cm/sec (16.8 m/A) and a horizontal gradient of 6.06 x 10^{-3}, gives a Darcy Velocity of 0.1018 m/A. This value was used in the model for this unit.

I. Diffusion Coefficient

Several studies have been published to determine the coefficient of hydrodynamic dispersion. The diffusion of chemical constituents within the upper-most aquifer materials (i.e., silt and sand) at the site required a study that was performed in porous media. Freeze and Cherry (1979) explains that diffusion coefficients of a non-reactive species for coarse-grained unconsolidated materials can be somewhat higher than 1×10^{-10} square meters per second (m^2/s) but are less than the coefficients for chemical species in water (2×10^{-9} m^2/s). Therefore, for conservatism, a value of $1 \times 10^{-9} m^2/s$ or 0.0315 square meters per year (m^2/A) was chosen. Using a value lower than the diffusion coefficient for water provides conservatism to the model, as demonstrated by sensitivity analysis.

The diffusion of chemical constituents within the clay liner and clay strata at the site required a study that evaluated low-permeability materials. Freeze and Cherry (1979) looked at one-dimensional diffusion of a non-reactive species in clayey geologic materials. This study indicated diffusion coefficients ranging from 1×10^{-10} to 1×10^{-11} m^2/s. An approximate average of 5×10^{-10} m^2/s or 0.0158 m/A was chosen for the model. This value was also suggested by the IEPA's Groundwater Assistance Unit.

J. Dispersivity

A value for dispersivity (needed for the calculation of mechanical dispersion) was calculated based upon a study conducted by Xu and Eckstein (1995). This method is approved by the Agency. The Xu and Eckstein equation is:

$$\alpha_x = 0.83[\log_{10}(L_p)]^{2.414}$$

where:

α_x = Longitudinal dispersivity
L_p = Length (meters).

The value for transverse dispersivity was calculated by multiplying the longitudinal value by 20 percent. The result is:

Transverse dispersivity = Longitudinal dispersivity x 20 percent.

In the Lower Radnor Till Sand, the flow length (measured from the center of the landfill to the edge of the zone of attenuation) is 1656.23 feet (504.82 meters) as shown on Figure 812.316-2. Using the above formulas, the longitudinal dispersivity and transverse dispersivity are estimated to be:

$\alpha_L = 0.83[\log_{10}(504.82)]^{2.414} = 9.154$ meters

$\alpha_T = 0.20 \times 9.154$ meters $= 1.831$ meters

In the Organic Soil, the flow length (measured from the center of the landfill to the edge of the zone of attenuation) is 1935.87 feet (590.05 meters) as shown on Figure 812.316-3. Using the above formulas, the longitudinal dispersivity and transverse dispersivity are estimated to be:

$\alpha_L = 0.83[\log_{10}(590.05)]^{2.414} = 9.718$ meters

$\alpha_T = 0.20 \times 9.718$ meters $= 1.944$ meters

In the Upper Radnor Till Sand, the flow length (measured from the landfill invert to the edge of the zone of attenuation) is 200 feet (60.96 meters) as shown on Figure 812.316-4. Using the above formulas, the longitudinal dispersivity and transverse dispersivity are estimated to be:

$\alpha_L = 0.83[\log_{10}(60.96)]^{2.414} = 3.362$ meters

$\alpha_T = 0.20 \times 3.36$ meters $= 0.672$ meters

K. Dispersion Coefficients

Hydrodynamic dispersion (D_H) occurs as a result of mechanical mixing and molecular diffusion. The coefficient of hydrodynamic dispersion can be expressed in terms of two components:

$$D_H = \alpha \overline{V} + D^*$$

where:

α = dispersivity (α_L for longitudinal and α_T for transverse)

$\overline{V}$ = average linear velocity

D^*= coefficient of molecular diffusion

Freeze and Cherry (1979) state that at low velocities, diffusion is the important contributor to the dispersion and therefore the coefficient of hydrodynamic dispersion equals the diffusion coefficient ($D_H = D^*$). The clay and liner materials both exhibit very low velocities and therefore were assigned a dispersion coefficient equal to the diffusion coefficient used for the clay materials (0.0158 m^2/A).

Within the Lower Radnor Till Sand, advection is the dominant transport process and is controlled by the hydrodynamic coefficient D_H. The vertical and horizontal dispersion coefficients are estimated as:

Horizontal Dispersion Coefficient

$$D_H = \alpha_L \overline{V} + D^*$$

$$D_H = 9.154 \text{ meters} \times (2.099 \frac{m}{A} / 0.30) + 0.0315 \frac{m^2}{A} = 64.08 \frac{m^2}{A}$$

Vertical Dispersion Coefficient

$$D_H = \alpha_L \overline{V} + D^*$$

$$D_H = 1.831 \text{ meters} \times (2.099 \frac{m}{A} / 0.30) + 0.0315 \frac{m^2}{A} = 12.84 \frac{m^2}{A}$$

Within the Organic Soil, advection is the dominant transport process and is controlled by the hydrodynamic coefficient D_H. The vertical and horizontal dispersion coefficients are estimated as:

Horizontal Dispersion Coefficient

$$D_H = \alpha_L \overline{V} + D^*$$

$$D_H = 9.718 \text{ meters} \times (0.1018 \frac{m}{A} / 0.40) + 0.0315 \frac{m^2}{A} = 2.505 \frac{m^2}{A}$$

Vertical Dispersion Coefficient

$$D_H = \alpha_L \overline{V} + D^*$$

$$D_H = 1.944 \text{ meters} \times (0.1018 \frac{m}{A} / 0.40) + 0.0315 \frac{m^2}{A} = 0.526 \frac{m^2}{A}$$

Within the Upper Radnor Till Sand, advection was assumed as the transport process and advection is controlled by the hydrodynamic coefficient D_H. Only the horizontal dispersion coefficient was calculated since the model for this unit is a one-dimensional model (see Figure 812.316-4). The horizontal dispersion coefficient is estimated as:

Horizontal Dispersion Coefficient

$$D_H = \alpha_L \bar{V} + D^*$$

$$D_H = 3.362 \text{ meters x } (0.1018 \frac{m}{A} / 0.30) + 0.0315 \frac{m^2}{A} = 1.598 \frac{m^2}{A}$$

For the Mahomet sand model, the dispersion coefficient was conservatively set equal to 0.0315 m^2/A, a coefficient lower than diffusion in water. Using a diffusion coefficient lower than diffusion in water provides conservatism to the model, as demonstrated by sensitivity analysis. Model sensitivity analysis used extreme values higher than the diffusion coefficient in water which produced lower prediction factors.

L. Lateral Distances

Five lateral distances were specified in the Lower Radnor Till Sand and Organic Soil models. The distances selected are: 1) at the waste boundary, 2) 25 feet from the waste boundary, 3) 50 feet from the waste boundary, 4) 75 feet from the waste boundary, and 5) at the edge of the zone of attenuation (100 feet from the waste boundary).

M. Integration

MIGRATE uses a LaPlace transform to find the solution to the advective-dispersion equation. The numerical inversion of the LaPlace transform depends on the Talbot parameters. The model provides default values for the three parameters or they can be selected by the user. The numerical inversion in MIGRATE depends on Talbot Integration Parameters and Gauss Integration Parameters. The default values of these parameters will generally produce satisfactory results. Occasionally a solution will need more than the default integration parameters if negative values are given or if concentrations appear at the surface outside the landfill. According to the authors (Booker and Rowe), these negative values may be merely a poor numerical approximation of zero concentrations or flux and can be eliminated by increasing the integration parameters.

However, using very high integration parameters usually increase the computational time without significantly improving the solution. For the models used in the GIA, the default parameters were used.

POLLUTE uses a LaPlace transform to find the solution. In this inversion the accuracy depends upon four parameters. The user may adopt the default values or specify other values. According to the authors (Booker and Rowe), these negative values may be merely a poor numerical approximation of zero concentrations or flux and can be eliminated by increasing the integration parameters. However, using very high integration parameters usually increase the computational time without significantly improving the solution (Booker and Rowe). For the Upper Radnor Till Sand Model (Cut-off Keyway) and Mahomet Sand demonstration model used in the GIAs, the default parameters were used.

812.316.8 Contaminant Transport Results

The maximum surrogate concentration at the downgradient edge of the zone of attenuation at the end of the 145-year assessment period predicted by the Upper Radnor Till Sand baseline model is 2.654×10^{-8} . The maximum surrogate concentration at the downgradient edge of the zone of attenuation at the end of the 145-year assessment period predicted by the Lower Radnor Till Sand baseline model is 1.026×10^{-3} at a depth of 8.636 meters. The maximum surrogate concentration at the downgradient edge of the zone of attenuation at the end of the 145-year assessment period predicted by the Organic Soil baseline model is 4.790×10^{-6} at a depth of 8.13 meters. These concentrations were used as prediction factors (PF) to calculate the predicted leachate constituent concentration (LCC) in groundwater at the zone of attenuation at the end of the 145 year assessment period for all expected leachate constituents. The baseline input and output files are provided in Appendix 812.316-C.

The maximum surrogate concentration in the Mahomet Sand at the end of the 145-year assessment period predicted by the one-dimensional conservative demonstration baseline model is 5.711×10^{-15}. No background for the Mahomet Sand was calculated for the proposed CLI No. 3 facility. Therefore, the PF was compared to the Class I Groundwater Quality Standards. The lowest Class I Groundwater Standard is 0.05 micrograms per liter (ethylene dibromide). Even assuming pure material (i.e. one billion parts per billion) was present in the leachate from the landfill, the predicted LCC in groundwater would not exceed the minimum Class I Standard as demonstrated below:

$$LCC = (5.711 \times 10^{-15}) \times (1.0 \times 10^{9}\ \mu g/l) = 5.711 \times 10^{-6}\ \mu g/l$$

Therefore, the highly conservative demonstration model for the Mahomet Sand clearly shows that the landfill will not impact the Mahomet Sand Aquifer.

The predicted LCC in groundwater for all baseline models, except the Mahomet Sand demonstration model, was calculated by multiplying the PF by the corresponding constituent concentration in leachate. The constituent concentrations in leachate are based on 10 years of analytical results from the existing Clinton Landfill No. 2 landfill leachate. The constituent concentrations, corresponding to the upper 95% confidence limit calculated from the leachate analytical data, were used. The leachate data used is provided in Appendix 812.316- D.
The baseline models predict that the concentration of all leachate constituents in the Upper Radnor Till Sand, Lower Radnor Till Sand, and the Organic Soil will be less than their respective applicable groundwater quality standards (AGQS) at the downgradient edge of the zone of attenuation 100 years after closure of Clinton Landfill No. 3. Tables 812.316-8 through 812.316-10 list source concentrations, AGQS values, and predicted concentrations for all leachate constituents for the Upper Radnor Till Sand, Lower Radnor Till Sand, and the Organic Soil, respectively.

Plots of the baseline results for concentration versus time and concentration versus distance are provided in Appendix 812.316-E. The plots show an overall reasonable distribution at depths in the Upper Radnor Till Sand, Lower Radnor Till Sand, Organic Soil, and Mahomet Sand. However, negative concentrations were found at various lateral distances within the liner and till in these models which are caused by the integration inherent in the program. The error due to integration decreases with depth and time, and the MIGRATE output shows a reasonable concentration distribution in the uppermost aquifers (migration pathways) at all lateral distances. The migration pathways were the only layers shown on the plots.

812.316.9 Model Sensitivity Analysis

Model sensitivity analyses were performed on the model input parameters. The input parameters from the hydrogeologic investigation were increased and decreased using values which usually exceed the maximum reasonably expected variation of geologic properties at the site. The sensitivity analyses model output was obtained for 100 years after closure at the zone of attenuation. The model sensitivity analyses are summarized in Tables 812.316-9 (Upper Radnor Till Sand), 812.316-10 (Lower Radnor Till Sand), and Table 812.316-11 (Organic Soil). The input and output files for each sensitivity analysis run are provided on a compact disk which is provided in Appendix 812.316-F.

812.316.10 Maximum Allowable Predicted Concentrations

Maximum allowable predicted concentrations (MAPCs) are projected concentrations of leachate constituents in the uppermost aquifer that, when exceeded within the zone of attenuation, indicate potential for exceedance of a groundwater quality standard at the limit of the zone of attenuation. To be conservative, it is proposed that the site AGQS values be used as MAPC values for all new monitoring wells. AGQS values for the site are listed in Section 812.317 of this application.

812.316.11 Conclusions

A discussion of the model input data should be made to address the impact of the unit on the surrounding groundwater. For the most part, input parameters such as Darcy Flux, coefficient of chemical diffusion, dispersivity, coefficient of hydrodynamic dispersion, liner leakage, and layer thickness have been selected in such a way as to maximize the computed solute transport over time. Values for hydraulic conductivity were based on a relatively large sampling of site specific data. Therefore, these assessments are a conservative representation of the expected impact of the unit on the groundwater at the site.

A final analysis has been made to review the model assumptions, and determine if any conflict with the conceptual model and the model assumptions exists. The first assumption states that contaminate transport is governed by the two-dimensional and one-dimensional advection/dispersion equation within a porous medium. The general solute transportation equation is not violated by any of the simplifying assumptions made in the conceptual model. The second assumption states that sorption-desorption of a non-conservative species of contaminant is linearly controlled. Since no retardation was applied, there was no sorption of contaminant species. Therefore, one may say that this assumption is true.

The third assumption states that transport through multiple layers with variable properties may be used. One of the requirements of the conceptual model states that multiple "environments" will be encountered; therefore a primary requirement of the model is this multi-layer ability. Finally, it is assumed that the Darcy Flux/Darcy

Velocity does not vary with position within any layer of the deposit. The conceptual model uses average Darcy Flux/Darcy Velocity within each unit. Contaminant transport through a geologic material with a high variability of hydrogeologic parameters will actually produce an "average" movement through the layer. Therefore, this assumption was not violated in the conceptual models.

Groundwater impact assessments were performed for the proposed Clinton Landfill No. 3 facility. The impact assessments reviewed the site geology and hydrogeology to produce conservative conceptual models for the site. These conceptual models were then analyzed to determine what type of contaminant transport model would best represent the site. The models selected for the facility were the two-dimensional contaminant transport model, MIGRATE, and the one-dimensional contaminant transport model, POLLUTE, both produced by Rowe and Booker. These models provided the best solution to the multi-layered diffusion and advection dominated environments at the facility.

On the basis of the modeling, CLI concludes that leachate constituent concentrations of all expected leachate constituents will be less than the final AGQSs throughout the operating life and 100-years past landfill closure, pursuant to 35 IAC 811.317 and 811.320.

TABLES

TABLE 812.316-1

Thickness of Geological Units
Clinton Landfill No. 3

Boring/ Well	Geologic Unit	Top Elevation	Bottom Elevation	Thickness (feet)
EX-3	Upper Radnor Till Sand	652.2	651.3	0.9
EX-5	Upper Radnor Till Sand	652.67	652.42	0.25
EX-6	Upper Radnor Till Sand	653.24	651.24	2
EX-21	Upper Radnor Till Sand	650	647.4	2.6
EX-22	Upper Radnor Till Sand	653.9	651.1	2.8
EX-23	Upper Radnor Till Sand	651.4	649.8	1.6
EX-25	Upper Radnor Till Sand	653.25	652.2	1.05
EX-28	Upper Radnor Till Sand	650.7	650.2	0.5
	Mean:	**652.17**	**650.71**	**1.46**

Boring/ Well	Geologic Unit	Top Elevation	Bottom Elevation	Thickness (feet)
EX-2	Lower Radnor Till Sand	640.02	639.77	0.25
EX-3	Lower Radnor Till Sand	643.00	642.50	0.50
EX-4	Lower Radnor Till Sand	638.28	635.53	2.75
EX-5	Lower Radnor Till Sand	640.97	637.47	3.50
EX-6	Lower Radnor Till Sand	640.59	636.64	3.95
EX-7	Lower Radnor Till Sand	641.10	635.80	5.30
EX-8	Lower Radnor Till Sand	640.00	634.80	5.20
EX-12	Lower Radnor Till Sand	644.30	643.20	1.10
EX-15	Lower Radnor Till Sand	642.30	638.80	3.50
EX-16	Lower Radnor Till Sand	639.90	639.70	0.20
EX-19	Lower Radnor Till Sand	640.90	637.40	3.50
EX-21	Lower Radnor Till Sand	640.40	637.00	3.40
G51D	Lower Radnor Till Sand	641.90	638.65	3.25
	Mean:	**641.05**	**638.25**	**2.80**

Boring/ Well	Geologic Unit	Top Elevation	Bottom Elevation	Thickness (feet)
EX-1	Organic Soil	635.77	629.27	6.50
EX-2	Organic Soil	634.30	630.30	4.00
EX-3	Organic Soil	634.30	633.00	1.30
EX-8	Organic Soil	631.00	629.60	1.40
EX-11	Organic Soil	633.40	631.70	1.70
EX-12	Organic Soil	637.40	633.65	3.75
EX-13	Organic Soil	634.80	631.05	3.75
EX-14	Organic Soil	643.70	641.20	2.50
EX-16	Organic Soil	634.75	632.70	2.05
EX-17	Organic Soil	635.85	632.50	3.35
EX-18	Organic Soil	633.50	630.00	3.50
EX-20	Organic Soil	634.00	632.00	2.00
EX-22	Organic Soil	631.80	627.30	4.50
EX-23	Organic Soil	632.80	622.80	10.00
EX-24	Organic Soil	637.40	632.30	5.10
P-11	Organic Soil	635.40	631.80	3.60
G39D	Organic Soil	634.40	631.60	2.80
G22D	Organic Soil	636.30	630.30	6.00
B-20	Organic Soil	636.50	634.20	2.30
B-22	Organic Soil	631.10	629.50	1.60
G40D	Organic Soil	636.50	635.90	0.60
G23D	Organic Soil	635.40	628.40	7.00
G46D	Organic Soil	634.00	632.50	1.50
G51D	Organic Soil	631.90	630.65	1.25
	Mean:	**634.84**	**631.43**	**3.42**

Notes:
1) Elevations are in feet Above Mean Sea Level (ft. AMSL)

TABLE 812.316-2

SUMMARY OF SLUG TEST RESULTS

Clinton Landfill No. 3

Well No.	Geologic Unit	Hvorslev Method		
		Hydraulic Conductivity (K), cm/sec.		Geometric Mean K (cm/sec.)
		Falling Head (K_f)	Rising Head (K_r)	
EX-22S	Upper Radnor Till Sand	9.39E-05	1.36E-04	1.13E-04
EX-23S	Upper Radnor Till Sand	1.13E-05	7.94E-06	9.47E-06
EX-21S	Upper Radnor Till Sand	1.50E-04	1.73E-04	1.61E-04
			Geometric Mean, all wells:	**5.57E-05**

Well No.	Geologic Unit	Hvorslev Method		
		Hydraulic Conductivity (K), cm/sec.		Geometric Mean K (cm/sec.)
		Falling Head (K_f)	Rising Head (K_r)	
EX-12S	Lower Radnor Till Sand	3.22E-04	2.70E-04	2.95E-04
EX-4	Lower Radnor Till Sand	3.12E-05	3.22E-05	3.17E-05
EX-5	Lower Radnor Till Sand	1.49E-03	1.10E-03	1.28E-03
EX-6	Lower Radnor Till Sand	4.66E-03	4.00E-03	4.32E-03
EX-8S	Lower Radnor Till Sand	9.93E-04	8.63E-04	9.26E-04
EX-21	Lower Radnor Till Sand	5.23E-04	4.76E-04	4.99E-04
			Geometric Mean, all wells:	**5.37E-04**

Well No.	Geologic Unit	Hvorslev Method		
		Hydraulic Conductivity (K), cm/sec.		Geometric Mean K (cm/sec.)
		Falling Head (K_f)	Rising Head (K_r)	
EX-12D	Organic Soil	5.97E-05	7.75E-05	6.80E-05
EX-13	Organic Soil	6.77E-06	4.23E-06	5.35E-06
EX-14	Organic Soil	1.14E-05	6.88E-06	8.86E-06
EX-17	Organic Soil	2.76E-05	1.81E-05	2.24E-05
EX-20	Organic Soil	8.68E-05	8.59E-05	8.63E-05
EX-22D	Organic Soil	1.07E-04	8.09E-05	9.30E-05
EX-23D	Organic Soil	2.64E-03	2.69E-03	2.66E-03
EX-24	Organic Soil	3.79E-05	4.94E-05	4.33E-05
			Geometric Mean, all wells:	**5.35E-05**

Note: cm/sec. = centimeters per second

TABLE 812.316-3
2-Year Mean Groundwater Elevations
CLINTON LANDFILL NO. 3

Vell	3/21/2003	6/17/2003	8/25/2003	10/15/2003	1/15/2004	4/28/2004	8/31/2004	11/18/2004	Mean
-4	691.44	691.17	691.50	691.08	691.08	691.60	691.59	691.43	**691.36**
-5	672.60	672.69	671.76	671.77	673.00	673.33	672.94	672.81	**672.61**
-6	672.05	672.11	671.14	671.11	672.03	672.80	672.37	672.26	**671.98**
-7	644.52	643.81	643.03	643.00	645.00	645.48	648.09	645.90	**644.85**
-8S	646.49	646.19	643.99	643.66	646.27	646.84	645.92	646.13	**645.69**
-12S	665.39	665.46	664.55	664.33	664.47	665.44	665.61	665.23	**665.06**
-12D	664.41	664.89	662.76	662.53	663.52	663.52	665.01	663.94	**663.82**
-13	670.54	670.76	669.90	669.86	669.85	670.44	670.92	669.50	**670.22**
-14	678.72	678.06	678.23	678.35	678.36	678.85	680.05	678.65	**678.66**
-15	691.66	691.48	691.17	691.28	691.32	691.82	691.79	691.64	**691.52**
-17	665.26	665.43	665.10	664.97	665.01	665.72	666.16	665.50	**665.39**
-19	639.95	639.89	640.10	640.34	640.98	641.68	644.79	642.00	**641.22**
-20	658.23	658.93	657.48	657.19	659.18	660.67	659.81	659.25	**658.84**
-21S	NA	NA	NA	660.32	661.61	664.00	662.74	662.48	**662.23**
-21D	658.15	658.23	656.35	656.12	657.98	659.10	658.24	658.29	**657.81**
-22S	664.02	663.65	660.06	659.53	663.67	664.16	664.08	664.40	**663.17**
-2[illegible]	665.61	665.29	663.94	663.40	665.54	666.45	665.57	665.70	**665.19**
[illegible]	673.91	673.82	673.10	673.05	673.67	677.42	674.09	674.01	**674.45**
[illegible]D	673.61	673.65	672.73	672.76	673.60	674.28	673.91	673.81	**673.54**
-24	675.56	675.73	675.06	675.08	675.49	676.21	675.98	675.77	**675.61**

es:
/alues are in feet Above Mean Sea Level (ft. AMSL)
IA = Not Applicable. Well EX-21S was not installed
Mean for wells EX-21S, EX-22S, and EX-23S calculated using 4th quarter 2003 through 4th quarter 2004 data

TABLE 812.316-4
INPUT VALUES FOR MODEL - UPPER RADNOR TILL SAND
Clinton Landfill No. 3

	POLLUTE V6.2 Input	Values	Units
File Information	Baseline Model Input File:	LKWB.IN	
	Baseline Output File:	LKWB.OU	
	Initial Source Concentration	1	mg/l
	Number of Layers	2	
	Lower Boundary Condition	Infinite	
	Top Boundary	Constant Source	
LAYER 1 Compacted Clay Input Parameters	Hydrodynamic Dispersion Coefficient	1.58E-02	m^2/a
	Effective Porosity	0.3	
	Density	1.9	g/cm^3
	Thickness	6.096	m
	Number of Sublayers	4	
	Vertical Darcy Velocity (Flux)	3.515E-03	m/a
LAYER 2 Aquifer Input Parameters	Hydrodynamic Dispersion Coefficient	1.598	m^2/a
	Effective Porosity	0.35	
	Density	1.9	g/cm^3
	Thickness	60.96	m
	Number of Sublayers	13	
	Vertical Darcy Velocity (Flux)	3.515E-03	m/a
Times & Distances	Times for Simulation	5, 10, 15, ..., 145	a
	Vertical Distance (total)	67.056	m
Integration Parameters	Laplace Transform	7, 20, 0, 2	

Notes:

1) m = meters
2) mg/l = milligrams per liter
3) m^2/a = meters squared per year
4) m/a = meters per year
5) cm^3/g = centimeters cubed per gram
6) cm/g^3 = centimeters per cubic gram
7) a = year

TABLE 812.316-5
INPUT VALUES FOR MODEL - LOWER RADNOR TILL SAND
Clinton Landfill No. 3

	MIGRATE V.9 Input	Values	Units
File Information	Baseline Input File:	LRB.IN	
	Baseline Output File:	LRB.OU	
Landfill Parameters	Width of Landfill Base	929.15	m
	Base Width	787.54	m
	Landfill is treated as a	Surface Boundary Condition	
	Initial Source Concentration	1	mg/l
	Number of Layers	5	
	Lower Boundary Condition	Impermeable	
	Change in Source Concentration	Constant Source	
LAYER 1 (Synthetic Liner) Input Parameters	Vertical Dispersion Coefficient	0.00003	m^2/a
	Effective Porosity	1.0	
	Adsorption Coefficient	0	cm^3/g
	Density	1.9	g/cm^3
	Thickness	0.001524 (or 60 mil)	m
	Number of Sublayers	1	
	Horizontal Dispersion Coefficient	0.00003	m^2/a
	Horizontal Darcy Velocity	0	m/a
	Vertical Darcy Velocity	3.515E-03	m/a
LAYER 2 Clay Liner Input Parameters	Vertical Dispersion Coefficient	0.0158	m^2/a
	Effective Porosity	0.288	
	Adsorption Coefficient	0	cm^3/g
	Density	1.9	g/cm^3
	Thickness	0.9144	m
	Number of Sublayers	3	
	Horizontal Dispersion Coefficient	0.0158	m^2/a
	Horizontal Darcy Velocity	0	m/a
	Vertical Darcy Velocity	3.515E-03	m/a
LAYER 3 Clay Fill Input Parameters	Vertical Dispersion Coefficient	0.0158	m^2/a
	Effective Porosity	0.288	
	Adsorption Coefficient	0	cm^3/g
	Density	1.9	g/cm^3
	Thickness	0.2939	m
	Number of Sublayers	3	
	Horizontal Dispersion Coefficient	0.0158	m^2/a
	Horizontal Darcy Velocity	0	m/a
	Vertical Darcy Velocity	3.515E-03	m/a
LAYER 4 Silty Clay Input Parameters	Vertical Dispersion Coefficient	0.0158	m^2/a
	Effective Porosity	0.286	
	Adsorption Coefficient	0	cm^3/g
	Density	1.9	g/cm^3
	Thickness	6.537	m
	Number of Sublayers	3	
	Horizontal Dispersion Coefficient	0.0158	m^2/a
	Horizontal Darcy Velocity	0	m/a
	Vertical Darcy Velocity	3.515E-03	m/a

TABLE 812.316-5
INPUT VALUES FOR MODEL - LOWER RADNOR TILL SAND
Clinton Landfill No. 3

	MIGRATE V.9 Input	Values	Units
LAYER 5 Aquifer Input Parameters	Vertical Dispersion Coefficient	12.84	m^2/a
	Effective Porosity	0.3	
	Adsorption Coefficient	0	cm^3/g
	Density	1.9	g/cm^3
	Thickness	0.8543	m
	Number of Sublayers	3	
	Horizontal Dispersion Coefficient	64.08	m^2/a
	Horizontal Darcy Velocity	2.099	m/a
	Vertical Darcy Velocity	0	m/a
Times	Times for Simulation 1	5, 10, 15, ..., 145	a
Distances	Lateral Distances	474.34, 481.96, 489.58, 497.2, 504.82	m
Integration Parameters	Talbot	7, 11, 0, 1	
	Gauss	Normal	

Notes:

1) m = meters
2) mg/l = milligrams per liter
3) m^2/a = meters squared per year
4) m/a = meters per year
5) cm^3/g = centimeters cubed per gram
6) cm/g^3 = centimeters per cubic gram
7) a = year

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TABLE 812.316-6
INPUT VALUES FOR MODEL - ORGANIC SOIL
Clinton Landfill No. 3

	MIGRATE V.9 Input	Values	Units
File Information	Baseline Input File:	OSB.IN	
	Baseline Output File:	OSB.OU	
Landfill Parameters	Surface Width	1119.15	m
	Base Width	1041.71	m
	Landfill is treated as a	Surface Boundary Condition	
	Initial Source Concentration	1	mg/l
	Number of Layers	5	
	Lower Boundary Condition	Impermeable	
	Change in Source Concentration	Constant Source	
LAYER 1 (Synthetic Liner) Input Parameters	Vertical Dispersion Coefficient	0.00003	m^2/a
	Effective Porosity	1.0	
	Adsorption Coefficient	0	cm^3/g
	Density	1.9	g/cm^3
	Thickness	0.001524 (or 60 mil)	m
	Number of Sublayers	1	
	Horizontal Dispersion Coefficient	0.00003	m^2/a
	Horizontal Darcy Velocity	0	m/a
	Vertical Darcy Velocity	3.515E-03	m/a
LAYER 2 Clay Liner Input Parameters	Vertical Dispersion Coefficient	0.0158	m^2/a
	Effective Porosity	0.288	
	Adsorption Coefficient	0	cm^3/g
	Density	1.9	g/cm^3
	Thickness	0.9144	m
	Number of Sublayers	3	
	Horizontal Dispersion Coefficient	0.0158	m^2/a
	Horizontal Darcy Velocity	0	m/a
	Vertical Darcy Velocity	3.515E-03	m/a
LAYER 3 Clay Fill Input Parameters	Vertical Dispersion Coefficient	0.0158	m^2/a
	Effective Porosity	0.288	
	Adsorption Coefficient	0	cm^3/g
	Density	1.9	g/cm^3
	Thickness	0.2939	m
	Number of Sublayers	3	
	Horizontal Dispersion Coefficient	0.0158	m^2/a
	Horizontal Darcy Velocity	0	m/a
	Vertical Darcy Velocity	3.515E-03	m/a
LAYER 4 Silty Clay Input Parameters	Vertical Dispersion Coefficient	0.0158	m^2/a
	Effective Porosity	0.286	
	Adsorption Coefficient	0	cm^3/g
	Density	1.9	g/cm^3
	Thickness	6.573	m
	Number of Sublayers	3	
	Horizontal Dispersion Coefficient	0.0158	m^2/a
	Horizontal Darcy Velocity	0	m/a
	Vertical Darcy Velocity	3.515E-03	m/a

TABLE 812.316-6
INPUT VALUES FOR MODEL - ORGANIC SOIL
Clinton Landfill No. 3

	MIGRATE V.9 Input	Values	Units
LAYER 5 Aquifer Input Parameters	Vertical Dispersion Coefficient	0.526	m^2/a
	Effective Porosity	0.4	
	Adsorption Coefficient	0	cm^3/g
	Density	1.9	g/cm^3
	Thickness	1.042	m
	Number of Sublayers	3	
	Horizontal Dispersion Coefficient	2.505	m^2/a
	Horizontal Darcy Velocity	0.1018	m/a
	Vertical Darcy Velocity	0	m/a
TimesDistances	Times for Simulation 1	5, 10, 15, ..., 145	a
Distances	Lateral Distances	559.57, 567.19, 574.81, 582.43, 590.05	m
Integration Parameters	Talbot	7, 11, 0, 1	
	Gauss	Normal	

Notes:

1) m = meters
2) mg/l = milligrams per liter
3) m^2/a = meters squared per year
4) m/a = meters per year
5) cm^3/g = centimeters cubed per gram
6) cm/g^3 = centimeters per cubic gram
7) a = year

TABLE 812.316-7
INPUT VALUES FOR MODEL - MAHOMET SAND
Clinton Landfill No. 3

	Pollute V.6.2 Input	Values	Units
File Information	Baseline Input File:	MB.IN	
	Baseline Output File:	MB.OU	
	Initial Source Concentration	1	mg/l
	Number of Layers	9	
	Lower Boundary Condition	Infinite	
	Top Boundary	Constant Source	
	Vertical Darcy Velocity (Flux)	3.515E-03	m/a
LAYER 1 (Synthetic Liner) Input Parameters	Hydrodynamic Dispersion Coefficient	0.00003	m^2/a
	Effective Porosity	1.0	
	Density	1.9	g/cm^3
	Thickness	0.001524 (or 60 mil)	m
	Number of Sublayers	1	
LAYER 2 Clay Liner Input Parameters	Hydrodynamic Dispersion Coefficient	0.0158	m^2/a
	Effective Porosity	0.288	
	Density	1.9	g/cm^3
	Thickness	0.9144	m
	Number of Sublayers	1	
LAYER 3 Clay Fill Input Parameters	Hydrodynamic Dispersion Coefficient	0.0158	m^2/a
	Effective Porosity	0.288	
	Density	1.9	g/cm^3
	Thickness	0.2939	m
	Number of Sublayers	1	
LAYER 4 Silty Clay Input Parameters	Hydrodynamic Dispersion Coefficient	0.0158	m^2/a
	Effective Porosity	0.286	
	Density	1.9	g/cm^3
	Thickness	6.573	m
	Number of Sublayers	2	
LAYER 5 Lower Radnor Till Sand Input Parameters	Hydrodynamic Dispersion Coefficient	12.84	m^2/a
	Effective Porosity	0.3	
	Density	1.9	g/cm^3
	Thickness	0.8543	m
	Number of Sublayers	2	
LAYER 6 Radnor Till Input Parameters	Hydrodynamic Dispersion Coefficient	0.0158	m^2/a
	Effective Porosity	0.286	
	Density	1.9	g/cm^3
	Thickness	0.9906	m
	Number of Sublayers	2	
LAYER 7 Organic Soil Input Parameters	Hydrodynamic Dispersion Coefficient	0.526	m^2/a
	Effective Porosity	0.4	
	Density	1.9	g/cm^3
	Thickness	1.042	m
	Number of Sublayers	2	

TABLE 812.316-7
INPUT VALUES FOR MODEL - MAHOMET SAND
Clinton Landfill No. 3

LAYER 8 Vandalia Till Input Parameters	Hydrodynamic Dispersion Coefficient	0.0158	m^2/a
	Effective Porosity	0.286	
	Density	1.9	g/cm^3
	Thickness	15.24	m
	Number of Sublayers	3	
	Vertical Darcy Velocity (Flux)	3.515E-03	m^2/a
LAYER 9 Mahomet Sand Aquifer Input Parameters	Hydrodynamic Dispersion Coefficient	0.0315	m^2/a
	Effective Porosity	0.3	
	Density	1.9	g/cm^3
	Thickness	30.48	m
	Number of Sublayers	3	
Times	Times for Simulation	5, 10, 15, ..., 145	a
Distances	Vertical Distance (total)	56.393	m
Integration Parameters	Laplace Transform	7, 20, 0, 2	

Notes:

1) m = meters
2) mg/l = milligrams per liter
3) m^2/a = meters squared per year
4) m/a = meters per year
5) cm^3/g = centimeters cubed per gram
6) cm/g^3 = centimeters per cubic gram
7) a = year

TABLE 812.316-8
SOURCE CONCENTRATIONS, AGQS VALUES, AND PREDICTED LEACHATE CONCENTRATIONS - UPPER RADNOR TILL SAND
Clinton Landfill No. 3

Parameter	Units	Concentration in Leachate[1]	Predicted LCC in Groundwater[2]	AGQS[3] Upper Radnor Till Sand	AGQS > Predicted LCC?
Alkalinity, Bicarb Total	mg/l	3984.6	1.06E-04	NA	NA
Ammonia, Total	mg/l	559.5	1.49E-05	22.0	Yes
Biological Oxygen Demand (BOD)	mg/l	773.5	2.05E-05	67.0	Yes
Chloride, Total	mg/l	1347.6	3.58E-05	7.8	Yes
Chemical Oxygen Demand (COD)	mg/l	1973.4	5.24E-05	7.0	Yes
Cyanide, Total	mg/l	0.03	7.99E-10	0.005	Yes
Cyanide, Reactive	mg/l	0.009	2.39E-10	NA	NA
Nitrate/Nitrite as N, Total	mg/l	0.19	5.12E-09	0.02	Yes
Oil and Grease, Total	mg/l	389.3	1.03E-05	5.0	Yes
Phenols, Total	mg/l	0.42	1.12E-08	0.005	Yes
Sulfate, Total	mg/l	281.9	7.48E-06	6.2	Yes
Sulfide, Reactive	mg/l	8.79	2.33E-07	NA	NA
Total Organic Carbon (TOC)	mg/l	395.2	1.05E-05	11.0	Yes
Total Dissolved Solids (TDS)	mg/l	5096.2	1.35E-04	692.7	Yes
Total Suspended Solids	mg/l	420.6	1.12E-05	NA	NA
Aluminum, Total	ug/l	2321.2	6.16E-05	454,413.0	Yes
Antimony, Total	ug/l	16.1	4.27E-07	3.0	Yes
Arsenic, Total	ug/l	38.4	1.02E-06	598.4	Yes
Barium, Total	ug/l	632.2	1.68E-05	2,203.2	Yes
Beryllium, Total	ug/l	3.93	1.04E-07	27.6	Yes
Boron, Total	ug/l	26767.5	7.10E-04	1,198.7	Yes
Cadmium, Total	ug/l	15.4	4.08E-07	1.0	Yes
Calcium, Total	mg/l	189.1	5.02E-06	1,516.3	Yes
Chromium, Total	ug/l	97.5	2.59E-06	810.2	Yes
Chromium, Hexavalent	ug/l	114.7	3.04E-06	NA	NA
Cobalt, Total	ug/l	24.2	6.41E-07	330.6	Yes
Copper, Total	ug/l	43.9	1.16E-06	850.9	Yes
Fluoride, Total	mg/l	4.91	1.30E-07	0.80	Yes
Iron, Total	ug/l	310983.9	8.25E-03	825,948.0	Yes
Lead, Total	ug/l	57.2	1.52E-06	836.0	Yes
Magnesium, Total	mg/l	186722.0	4.96E-03	706.6	Yes
Manganese, Total	ug/l	1710.6	4.54E-05	13,939.0	Yes
Mercury, Total	ug/l	1.10	2.93E-08	0.2	Yes
Nickel, Total	ug/l	194.8	5.17E-06	885.6	Yes
Phosphorous, Total	ug/l	3179.3	8.44E-05	NA	NA
Potassium, Total	mg/l	337.6	8.96E-06	141.7	Yes
Selenium, Total	ug/l	28.4	7.54E-07	16.6	Yes
Silver, Total	ug/l	248.0	6.58E-06	5.0	Yes
Sodium, Total	mg/l	1175.1	3.12E-05	25.0	Yes
Thallium, Total	ug/l	3.5	9.42E-08	1.7	Yes
Tin Total, GFAA	ug/l	60.0	1.59E-06	NA	NA
Zinc, Total	ug/l	1293.2	3.43E-05	1,808.2	Yes
1,1,1,2-Tetrachloroethane	ug/l	1.0	2.65E-08	1.0	Yes
1,1,1-Trichloroethane	ug/l	19.0	5.03E-07	1.0	Yes
1,1,2,2-Tetrachloroethane	ug/l	5.0	1.33E-07	1.0	Yes
1,1,2-Trichloroethane	ug/l	5.0	1.33E-07	1.0	Yes
1,1-Dichloroethane	ug/l	6.6	1.75E-07	1.0	Yes
1,1-Dichloroethene	ug/l	5.0	1.33E-07	1.0	Yes
1,1-Dichloropropene	ug/l	5.0	1.33E-07	1.0	Yes
1,2,3-Trichlorobenzene	ug/l	5.0	1.33E-07	1.0	Yes
1,2,3-Trichloropropane	ug/l	5.0	1.33E-07	1.0	Yes
1,2,4-Trichlorobenzene	ug/l	5.0	1.33E-07	1.0	Yes
1,2,4-Trimethylbenzene	ug/l	60.0	1.59E-06	1.0	Yes
1,2-Dibromo-3-chloropropane	ug/l	5.0	1.33E-07	0.05	Yes
1,2-Dichlorobenzene	ug/l	1.0	2.65E-08	1.0	Yes

TABLE 812.316-8
SOURCE CONCENTRATIONS, AGQS VALUES, AND PREDICTED LEACHATE CONCENTRATIONS - UPPER RADNOR TILL SAND
Clinton Landfill No. 3

Parameter	Units	Concentration in Leachate[1]	Predicted LCC in Groundwater[2]	AGQS[3] Upper Radnor Till Sand	AGQS > Predicted LCC?
1,2-Dichloroethane	ug/l	5.0	1.33E-07	1.0	Yes
1,2-Dichloropropane	ug/l	5.0	1.33E-07	1.0	Yes
1,3 Dichloropropane	ug/l	5.0	1.33E-07	1.0	Yes
1,3,5-Trimethylbenzene	ug/l	43.2	1.15E-06	1.0	Yes
1,3-Dichlorobenzene	ug/l	5.0	1.33E-07	1.0	Yes
1,3-Dichloropropene	ug/l	5.0	1.33E-07	NA	NA
1,4-Dichlorobenzene	ug/l	9.6	2.55E-07	1.0	Yes
1-Propanol	ug/l	1000.0	2.65E-05	NA	NA
2,2-Dichloropropane	ug/l	5.0	1.33E-07	1.0	Yes
2,4 Dinitrotoluene	ug/l	10.0	2.65E-07	NA	NA
2,4,5-Trichlorophenol	ug/l	10.0	2.65E-07	NA	NA
2,4,6-Trichlorophenol	ug/l	10.0	2.65E-07	NA	NA
2,4-D	ug/l	1.76	4.67E-08	0.10	Yes
2,4-Dichlorophenol	ug/l	10.0	2.65E-07	NA	NA
2,4-Dimethylphenol	ug/l	235.1	6.24E-06	NA	NA
2,4-Dinitrophenol	ug/l	50.0	1.33E-06	NA	NA
2,4-Dinitrotoluene	ug/l	10.0	2.65E-07	NA	NA
2,6-Dinitrotoluene	ug/l	10.0	2.65E-07	NA	NA
2-Butanone (MEK)	ug/l	1204.6	3.20E-05	5.0	Yes
2-Chloroethylvinyl ether	ug/l	10.0	2.65E-07	NA	NA
2-Chloronaphthalene	ug/l	10.0	2.65E-07	NA	NA
2-Chlorophenol	ug/l	10.0	2.65E-07	NA	NA
2-Chlorotoluene	ug/l	1.0	2.65E-08	1.0	Yes
2-Hexanone (MBK)	ug/l	33.0	8.76E-07	5.0	Yes
2-Methylphenol(o-cresol)	ug/l	37.9	1.01E-06	NA	NA
2-Nitrophenol	ug/l	10.0	2.65E-07	NA	NA
2-Propanol	ug/l	7488.4	1.99E-04	NA	NA
3,3-Dichlorobenzidine	ug/l	10.0	2.65E-07	NA	NA
3,4-Methylphenol(m,p-Cresol)	ug/l	640.8	1.70E-05	10.0	Yes
4,4'-DDD	ug/l	0.1	2.65E-09	NA	NA
4,4'-DDE	ug/l	0.1	2.65E-09	NA	NA
4,4'-DDT	ug/l	0.20	5.31E-09	0.1	Yes
4,6-Dinitro-2-methylphenol	ug/l	50.0	1.33E-06	NA	NA
4-Bromophenyl-phenylether	ug/l	10.0	2.65E-07	NA	NA
4-Chlorophenyl-phenylether	ug/l	10.0	2.65E-07	NA	NA
4-Chlorotoluene	ug/l	5.0	1.33E-07	1.0	Yes
4-Methyl-2-Pentanone(MIBK)	ug/l	122.4	3.25E-06	5.0	Yes
4-Nitrophenol	ug/l	50.0	1.33E-06	NA	NA
Acenaphthene	ug/l	10.0	2.65E-07	NA	NA
Acetone	ug/l	1098.9	2.92E-05	10.0	Yes
Alachlor	ug/l	1.3	3.45E-08	0.4	Yes
Aldicarb	ug/l	0.80	2.12E-08	0.4	Yes
Aldrin	ug/l	0.05	1.33E-09	0.05	Yes
alpha-BHC	ug/l	0.05	1.33E-09	NA	NA
Anthracene	ug/l	10.0	2.65E-07	NA	NA
Aroclor 1016	ug/l	200.0	5.31E-06	0.5	Yes
Aroclor 1221	ug/l	0.5	1.33E-08	0.5	Yes
Aroclor 1232	ug/l	0.5	1.33E-08	0.5	Yes
Aroclor 1242	ug/l	0.5	1.33E-08	0.5	Yes
Aroclor 1248	ug/l	0.5	1.33E-08	0.5	Yes
Aroclor 1254	ug/l	0.5	1.33E-08	0.5	Yes
Aroclor 1260	ug/l	0.5	1.33E-08	0.5	Yes
Atrazine	ug/l	1.80	4.77E-08	0.2	Yes
Benzene	ug/l	10.3	2.73E-07	1.0	Yes
Benzo(a)anthracene	ug/l	10.0	2.65E-07	NA	NA

TABLE 812.316-8
SOURCE CONCENTRATIONS, AGQS VALUES, AND PREDICTED LEACHATE CONCENTRATIONS - UPPER RADNOR TILL SAND
Clinton Landfill No. 3

Parameter	Units	Concentration in Leachate[1]	Predicted LCC in Groundwater[2]	AGQS[3] Upper Radnor Till Sand	AGQS > Predicted LCC?
Benzo(a)pyrene	ug/l	0.51	1.35E-08	0.2	Yes
Benzo(b)fluoranthene	ug/l	10.0	2.65E-07	NA	NA
Benzo(g,h,i)perylene	ug/l	10.0	2.65E-07	NA	NA
Benzo(k)fluoranthene	ug/l	10.0	2.65E-07	NA	NA
beta-BHC	ug/l	0.05	1.33E-09	NA	NA
Bis(2-chloroethoxy)methane	ug/l	10.0	2.65E-07	NA	NA
Bis(2-chloroethyl)ether	ug/l	10.0	2.65E-07	NA	NA
Bis(2-ethylhexyl)phthalate	ug/l	44.7	1.19E-06	22.0	Yes
Bis(chloromethyl)ether	ug/l	10000.0	2.65E-04	NA	NA
Bromobenzene	ug/l	5.0	1.33E-07	1.0	Yes
Bromochloromethane	ug/l	5.0	1.33E-07	1.0	Yes
Bromodichloromethane	ug/l	5.0	1.33E-07	1.0	Yes
Bromoform	ug/l	5.0	1.33E-07	1.0	Yes
Bromomethane	ug/l	10.0	2.65E-07	2.0	Yes
Butyl benzyl phthalate	ug/l	10.0	2.65E-07	NA	NA
Carbofuran	ug/l	8.9	2.37E-07	1.5	Yes
Carbon Disulfide	ug/l	7.7	2.04E-07	4.0	Yes
Carbon Tetrachloride	ug/l	5.0	1.33E-07	1.0	Yes
Chlordane (Tech)	ug/l	0.5	1.33E-08	0.5	Yes
Chlorobenzene	ug/l	10.4	2.76E-07	1.0	Yes
Chloroethane	ug/l	14.4	3.83E-07	2.0	Yes
Chloroform	ug/l	5.0	1.33E-07	1.0	Yes
Chloromethane	ug/l	10.0	2.65E-07	2.0	Yes
Chrysene	ug/l	10.0	2.65E-07	NA	NA
cis-1,2-Dichloroethene	ug/l	13.9	3.69E-07	1.0	Yes
cis-1,3-Dichloropropene	ug/l	1.0	2.65E-08	1.0	Yes
delta-BHC	ug/l	0.05	1.33E-09	NA	NA
Dibenzo(a,h)anthracene	ug/l	10.0	2.65E-07	NA	NA
Dibromochloromethane	ug/l	5.0	1.33E-07	1.0	Yes
Dibromomethane	ug/l	5.0	1.33E-07	1.0	Yes
Dichlorodifluoromethane	ug/l	4.7	1.24E-07	2.0	Yes
Diethyl phthalate	ug/l	60.8	1.61E-06	10.0	Yes
Di-n-butyl phthalate	ug/l	10.0	2.65E-07	10.0	Yes
di-n-octyl phthalate	ug/l	10.0	2.65E-07	NA	NA
Dioxin Screen	ug/l	10.0	2.65E-07	NA	NA
Endosulfan I	ug/l	0.05	1.33E-09	NA	NA
Endosulfan II	ug/l	0.1	2.65E-09	NA	NA
Endosulfan Sulfate	ug/l	0.1	2.65E-09	NA	NA
Endrin	ug/l	0.1	2.65E-09	0.1	Yes
Endrin Aldehyde	ug/l	0.1	2.65E-09	NA	NA
Ethyl Acetate	ug/l	10.0	2.65E-07	NA	NA
Ethylbenzene	ug/l	26.2	6.96E-07	1.0	Yes
Ethylene dibromide	ug/l	0.05	1.33E-09	0.05	Yes
Fluoranthene	ug/l	10.0	2.65E-07	NA	NA
Fluorene	ug/l	10.0	2.65E-07	NA	NA
gamma-BHC (Lindane)	ug/l	0.05	1.33E-09	0.05	Yes
Heptachlor	ug/l	0.05	1.33E-09	0.05	Yes
Heptachlor epoxide	ug/l	0.05	1.33E-09	0.05	Yes
Hexachlorobenzene	ug/l	10.0	2.65E-07	NA	NA
Hexachlorobutadiene	ug/l	10.0	2.65E-07	10.0	Yes
Hexachlorocyclopentadiene	ug/l	10.0	2.65E-07	10.0	Yes
Hexachloroethane	ug/l	10.0	2.65E-07	NA	NA
Indeno(1,2,3-cd)pyrene	ug/l	10.0	2.65E-07	NA	NA
Iodomethane	ug/l	5.0	1.33E-07	1.0	Yes
Isopropylbenzene	ug/l	9.6	2.54E-07	1.0	Yes

TABLE 812.316-8
SOURCE CONCENTRATIONS, AGQS VALUES, AND PREDICTED LEACHATE CONCENTRATIONS - UPPER RADNOR TILL SAND
Clinton Landfill No. 3

Parameter	Units	Concentration in Leachate[1]	Predicted LCC in Groundwater[2]	AGQS[3] Upper Radnor Till Sand	AGQS > Predicted LCC?
m/p-Xylene	ug/l	46.5	1.24E-06	1.0	Yes
Methoxychlor	ug/l	1.0	2.65E-08	0.5	Yes
Methylene Chloride	ug/l	43.8	1.16E-06	7.0	Yes
Naphthalene	ug/l	23.9	6.35E-07	10.0	Yes
n-Butanol	ug/l	1000.0	2.65E-05	NA	NA
n-Butylbenzene	ug/l	5.0	1.33E-07	1.0	Yes
Nitrobenzene	ug/l	10.0	2.65E-07	NA	NA
n-Nitrosodimethylamine	ug/l	10.0	2.65E-07	NA	NA
N-nitrosodi-n-propylamine	ug/l	10.0	2.65E-07	NA	NA
N-nitrosodiphenylamine	ug/l	10.0	2.65E-07	NA	NA
n-Propylbenzene	ug/l	38.2	1.01E-06	1.0	Yes
o-Xylene	ug/l	19.7	5.23E-07	1.0	Yes
Parathion	ug/l	2.0	5.31E-08	0.2	Yes
Pentachlorophenol	ug/l	0.42	1.11E-08	0.05	Yes
Phenanthrene	ug/l	10.0	2.65E-07	NA	NA
p-Isopropyltoluene	ug/l	87.7	2.33E-06	1.0	Yes
Pyrene	ug/l	10.0	2.65E-07	NA	NA
Pyridine	ug/l	10.0	2.65E-07	NA	NA
sec-Butylbenzene	ug/l	5.0	1.33E-07	1.0	Yes
Silvex	ug/l	2.7	7.13E-08	0.05	Yes
Styrene	ug/l	8.5	2.25E-07	1.0	Yes
tert-Butylbenzene	ug/l	5.0	1.33E-07	1.0	Yes
Tetrachloroethene	ug/l	6.3	1.68E-07	1.0	Yes
Tetrahydrofuran	ug/l	605.7	1.61E-05	20.0	Yes
Toluene	ug/l	163.8	4.35E-06	1.0	Yes
Toxaphene	ug/l	1.8	4.78E-08	1.5	Yes
trans-1,2-Dichloroethene	ug/l	5.0	1.33E-07	1.0	Yes
trans-1,3-Dichloropropene	ug/l	5.0	1.33E-07	1.0	Yes
trans-1,4-Dichloro-2-Butene	ug/l	5.0	1.33E-07	1.0	Yes
Trichloroethene	ug/l	8.2	2.17E-07	1.0	Yes
Trichlorofluoromethane	ug/l	10.0	2.65E-07	1.0	Yes
Vinyl Acetate	ug/l	10.0	2.65E-07	5.0	Yes
Vinyl Chloride	ug/l	6.9	1.82E-07	2.0	Yes
Xylenes - Total	ug/l	64.0	1.70E-06	3.0	Yes

Notes:
1. Concentration in leachate is the Upper 95% Confidence Limit derived from the background leachate monitoring data from Clinton Landfill No. 2.
2. Predicted Concentration in Groundwater is the normalized concentration based on the baseline model results as detailed in Section 812.316. Normalized concentration for the Lower Radnor Till Sand = 2.654×10^{-8}.
3. Applicable Groundwater Quality Standard (AGQS) is established as the Upper 95% Tolerance Limit.
4. mg/l = Milligrams per liter = parts per million (ppm); μg/l = Micrograms per liter = parts per billion (ppb)
5. NA = Not Applicable

TABLE 812.316-9
SOURCE CONCENTRATIONS, AGQS VALUES, AND PREDICTED LEACHATE CONCENTRATIONS - LOWER RADNOR TILL SAND
Clinton Landfill No. 3

Parameter	Units	Concentration in Leachate[1]	Predicted LCC in Groundwater[2]	AGQS[3] Lower Radnor Till Sand	AGQS > Predicted LCC?
Alkalinity, Bicarb Total	mg/l	3984.6	4.09	NA	NA
Ammonia, Total	mg/l	559.5	5.74E-01	17.0	Yes
Biological Oxygen Demand (BOD)	mg/l	773.5	7.94E-01	42.6	Yes
Chloride, Total	mg/l	1347.6	1.38	5.7	Yes
Chemical Oxygen Demand (COD)	mg/l	1973.4	2.02	36.3	Yes
Cyanide, Total	mg/l	0.03	3.09E-05	0.005	Yes
Cyanide, Reactive	mg/l	0.009	9.23E-06	NA	NA
Nitrate/Nitrite as N, Total	mg/l	0.19	1.98E-04	0.022	Yes
Oil and Grease, Total	mg/l	389.3	3.99E-01	25.0	Yes
Phenols, Total	mg/l	0.42	4.32E-04	0.005	Yes
Sulfate, Total	mg/l	281.9	2.89E-01	6.8	Yes
Sulfide, Reactive	mg/l	8.79	9.02E-03	NA	NA
Total Organic Carbon (TOC)	mg/l	395.2	4.05E-01	14.2	Yes
Total Dissolved Solids (TDS)	mg/l	5096.2	5.23	643.3	Yes
Total Suspended Solids	mg/l	420.6	4.32E-01	NA	NA
Aluminum, Total	ug/l	2321.2	2.38	323,093.8	Yes
Antimony, Total	ug/l	16.1	1.65E-02	3.0	Yes
Arsenic, Total	ug/l	38.4	3.94E-02	128.7	Yes
Barium, Total	ug/l	632.2	6.49E-01	1,000.0	Yes
Beryllium, Total	ug/l	3.93	4.03E-03	16.1	Yes
Boron, Total	ug/l	26767.5	27.46	736.2	Yes
Cadmium, Total	ug/l	15.4	1.58E-02	1.3	Yes
Calcium, Total	mg/l	189.1	1.94E-01	774.1	Yes
Chromium, Total	ug/l	97.5	1.00E-01	591.1	Yes
Chromium, Hexavalent	ug/l	114.7	1.18E-01	NA	NA
Cobalt, Total	ug/l	24.2	2.48E-02	204.6	Yes
Copper, Total	ug/l	43.9	4.50E-02	438.0	Yes
Fluoride, Total	mg/l	4.91	5.04E-03	0.60	Yes
Iron, Total	ug/l	310983.9	319.07	552,900.1	Yes
Lead, Total	ug/l	57.2	5.87E-02	432.8	Yes
Magnesium, Total	mg/l	186722.0	191.58	1,300.0	Yes
Manganese, Total	ug/l	1710.6	1.76	9,952.2	Yes
Mercury, Total	ug/l	1.10	1.13E-03	0.2	Yes
Nickel, Total	ug/l	194.8	2.00E-01	1,400.0	Yes
Phosphorous, Total	ug/l	3179.3	3.26	NA	NA
Potassium, Total	mg/l	337.6	3.46E-01	2,300.0	Yes
Selenium, Total	ug/l	28.4	2.92E-02	9.8	Yes
Silver, Total	ug/l	248.0	2.54E-01	5.0	Yes
Sodium, Total	mg/l	1175.1	1.21	7,700.0	Yes
Thallium, Total	ug/l	3.5	3.64E-03	2.5	Yes
Tin Total, GFAA	ug/l	60.0	6.16E-02	NA	NA
Zinc, Total	ug/l	1293.2	1.33	1,299.4	Yes
1,1,1,2-Tetrachloroethane	ug/l	1.0	1.03E-03	1.0	Yes
1,1,1-Trichloroethane	ug/l	19.0	1.95E-02	1.0	Yes
1,1,2,2-Tetrachloroethane	ug/l	5.0	5.13E-03	1.0	Yes
1,1,2-Trichloroethane	ug/l	5.0	5.13E-03	1.0	Yes
1,1-Dichloroethane	ug/l	6.6	6.75E-03	1.0	Yes
1,1-Dichloroethene	ug/l	5.0	5.13E-03	1.0	Yes
1,1-Dichloropropene	ug/l	5.0	5.13E-03	1.0	Yes
1,2,3-Trichlorobenzene	ug/l	5.0	5.13E-03	1.0	Yes
1,2,3-Trichloropropane	ug/l	5.0	5.13E-03	1.0	Yes
1,2,4-Trichlorobenzene	ug/l	5.0	5.13E-03	1.0	Yes
1,2,4-Trimethylbenzene	ug/l	60.0	6.16E-02	1.0	Yes

TABLE 812.316-9
SOURCE CONCENTRATIONS, AGQS VALUES, AND PREDICTED LEACHATE CONCENTRATIONS - LOWER RADNOR TILL SAND
Clinton Landfill No. 3

Parameter	Units	Concentration in Leachate[1]	Predicted LCC in Groundwater[2]	AGQS[3] Lower Radnor Till Sand	AGQS > Predicted LCC?
1,2-Dibromo-3-chloropropane	ug/l	5.0	5.13E-03	0.050	Yes
1,2-Dichlorobenzene	ug/l	1.0	1.03E-03	1.0	Yes
1,2-Dichloroethane	ug/l	5.0	5.13E-03	1.0	Yes
1,2-Dichloropropane	ug/l	5.0	5.13E-03	1.0	Yes
1,3 Dichloropropane	ug/l	5.0	5.13E-03	1.0	Yes
1,3,5-Trimethylbenzene	ug/l	43.2	4.43E-02	1.0	Yes
1,3-Dichlorobenzene	ug/l	5.0	5.13E-03	1.0	Yes
1,3-Dichloropropene	ug/l	5.0	5.13E-03	NA	NA
1,4-Dichlorobenzene	ug/l	9.6	9.85E-03	1.0	Yes
1-Propanol	ug/l	1000.0	1.03	NA	NA
2,2-Dichloropropane	ug/l	5.0	5.13E-03	1.0	Yes
2,4 Dinitrotoluene	ug/l	10.0	1.03E-02	NA	NA
2,4,5-Trichlorophenol	ug/l	10.0	1.03E-02	NA	NA
2,4,6-Trichlorophenol	ug/l	10.0	1.03E-02	NA	NA
2,4-D	ug/l	1.76	1.81E-03	0.10	Yes
2,4-Dichlorophenol	ug/l	10.0	1.03E-02	NA	NA
2,4-Dimethylphenol	ug/l	235.1	2.41E-01	NA	NA
2,4-Dinitrophenol	ug/l	50.0	5.13E-02	NA	NA
2,4-Dinitrotoluene	ug/l	10.0	1.03E-02	NA	NA
2,6-Dinitrotoluene	ug/l	10.0	1.03E-02	NA	NA
2-Butanone (MEK)	ug/l	1204.6	1.24	5.0	Yes
2-Chloroethylvinyl ether	ug/l	10.0	1.03E-02	NA	NA
2-Chloronaphthalene	ug/l	10.0	1.03E-02	NA	NA
2-Chlorophenol	ug/l	10.0	1.03E-02	NA	NA
2-Chlorotoluene	ug/l	1.0	1.03E-03	1.0	Yes
2-Hexanone (MBK)	ug/l	33.0	3.39E-02	5.0	Yes
2-Methylphenol(o-cresol)	ug/l	37.9	3.89E-02	NA	NA
2-Nitrophenol	ug/l	10.0	1.03E-02	NA	NA
2-Propanol	ug/l	7488.4	7.68	NA	NA
3,3-Dichlorobenzidine	ug/l	10.0	1.03E-02	NA	NA
3,4-Methylphenol(m,p-Cresol)	ug/l	640.8	6.57E-01	10.0	Yes
4,4'-DDD	ug/l	0.1	1.03E-04	NA	NA
4,4'-DDE	ug/l	0.1	1.03E-04	NA	NA
4,4'-DDT	ug/l	0.20	2.05E-04	0.10	Yes
4,6-Dinitro-2-methylphenol	ug/l	50.0	5.13E-02	NA	NA
4-Bromophenyl-phenylether	ug/l	10.0	1.03E-02	NA	NA
4-Chlorophenyl-phenylether	ug/l	10.0	1.03E-02	NA	NA
4-Chlorotoluene	ug/l	5.0	5.13E-03	1.0	Yes
4-Methyl-2-Pentanone (MIBK)	ug/l	122.4	1.26E-01	5.0	Yes
4-Nitrophenol	ug/l	50.0	5.13E-02	NA	NA
Acenaphthene	ug/l	10.0	1.03E-02	NA	NA
Acetone	ug/l	1098.9	1.13	10.0	Yes
Alachlor	ug/l	1.3	1.33E-03	0.40	Yes
Aldicarb	ug/l	0.80	8.21E-04	0.40	Yes
Aldrin	ug/l	0.05	5.13E-05	0.050	Yes
alpha-BHC	ug/l	0.05	5.13E-05	NA	NA
Anthracene	ug/l	10.0	1.03E-02	NA	NA
Aroclor 1016	ug/l	200.0	2.05E-01	0.50	Yes
Aroclor 1221	ug/l	0.5	5.13E-04	0.50	Yes
Aroclor 1232	ug/l	0.5	5.13E-04	0.50	Yes
Aroclor 1242	ug/l	0.5	5.13E-04	0.50	Yes
Aroclor 1248	ug/l	0.5	5.13E-04	0.50	Yes

TABLE 812.316-9
SOURCE CONCENTRATIONS, AGQS VALUES, AND PREDICTED LEACHATE CONCENTRATIONS - LOWER RADNOR TILL SAND
Clinton Landfill No. 3

Parameter	Units	Concentration in Leachate[1]	Predicted LCC in Groundwater[2]	AGQS[3] Lower Radnor Till Sand	AGQS > Predicted LCC?
Aroclor 1254	ug/l	0.5	5.13E-04	0.50	Yes
Aroclor 1260	ug/l	0.5	5.13E-04	0.50	Yes
Atrazine	ug/l	1.80	1.84E-03	0.20	Yes
Benzene	ug/l	10.3	1.06E-02	1.0	Yes
Benzo(a)anthracene	ug/l	10.0	1.03E-02	NA	NA
Benzo(a)pyrene	ug/l	0.51	5.23E-04	0.20	Yes
Benzo(b)fluoranthene	ug/l	10.0	1.03E-02	NA	NA
Benzo(g,h,i)perylene	ug/l	10.0	1.03E-02	NA	NA
Benzo(k)fluoranthene	ug/l	10.0	1.03E-02	NA	NA
beta-BHC	ug/l	0.05	5.13E-05	NA	NA
Bis(2-chloroethoxy)methane	ug/l	10.0	1.03E-02	NA	NA
Bis(2-chloroethyl)ether	ug/l	10.0	1.03E-02	NA	NA
Bis(2-ethylhexyl)phthalate	ug/l	44.7	4.59E-02	7.6	Yes
Bis(chloromethyl)ether	ug/l	10000.0	10.26	NA	NA
Bromobenzene	ug/l	5.0	5.13E-03	1.0	Yes
Bromochloromethane	ug/l	5.0	5.13E-03	1.0	Yes
Bromodichloromethane	ug/l	5.0	5.13E-03	1.0	Yes
Bromoform	ug/l	5.0	5.13E-03	1.0	Yes
Bromomethane	ug/l	10.0	1.03E-02	2.0	Yes
Butyl benzyl phthalate	ug/l	10.0	1.03E-02	NA	NA
Carbofuran	ug/l	8.9	9.15E-03	1.5	Yes
Carbon Disulfide	ug/l	7.7	7.87E-03	8.0	Yes
Carbon Tetrachloride	ug/l	5.0	5.13E-03	1.0	Yes
Chlordane (Tech)	ug/l	0.5	5.13E-04	0.50	Yes
Chlorobenzene	ug/l	10.4	1.07E-02	1.0	Yes
Chloroethane	ug/l	14.4	1.48E-02	2.0	Yes
Chloroform	ug/l	5.0	5.13E-03	1.0	Yes
Chloromethane	ug/l	10.0	1.03E-02	2.0	Yes
Chrysene	ug/l	10.0	1.03E-02	NA	NA
cis-1,2-Dichloroethene	ug/l	13.9	1.43E-02	1.0	Yes
cis-1,3-Dichloropropene	ug/l	1.0	1.03E-03	1.0	Yes
delta-BHC	ug/l	0.05	5.13E-05	NA	NA
Dibenzo(a,h)anthracene	ug/l	10.0	1.03E-02	NA	NA
Dibromochloromethane	ug/l	5.0	5.13E-03	1.0	Yes
Dibromomethane	ug/l	5.0	5.13E-03	1.0	Yes
Dichlorodifluoromethane	ug/l	4.7	4.78E-03	2.0	Yes
Diethyl phthalate	ug/l	60.8	6.24E-02	10.0	Yes
Di-n-butyl phthalate	ug/l	10.0	1.03E-02	10.0	Yes
di-n-octyl phthalate	ug/l	10.0	1.03E-02	NA	NA
Dioxin Screen	ug/l	10.0	1.03E-02	NA	NA
Endosulfan I	ug/l	0.05	5.13E-05	NA	NA
Endosulfan II	ug/l	0.1	1.03E-04	NA	NA
Endosulfan Sulfate	ug/l	0.1	1.03E-04	NA	NA
Endrin	ug/l	0.1	1.03E-04	0.10	Yes
Endrin Aldehyde	ug/l	0.1	1.03E-04	NA	NA
Ethyl Acetate	ug/l	10.0	1.03E-02	NA	NA
Ethylbenzene	ug/l	26.2	2.69E-02	1.0	Yes
Ethylene dibromide	ug/l	0.05	5.13E-05	0.050	Yes
Fluoranthene	ug/l	10.0	1.03E-02	NA	NA
Fluorene	ug/l	10.0	1.03E-02	NA	NA
gamma-BHC (Lindane)	ug/l	0.05	5.13E-05	0.050	Yes
Heptachlor	ug/l	0.05	5.13E-05	0.050	Yes

TABLE 812.316-9
SOURCE CONCENTRATIONS, AGQS VALUES, AND PREDICTED LEACHATE CONCENTRATIONS - LOWER RADNOR TILL SAND
Clinton Landfill No. 3

Parameter	Units	Concentration in Leachate[1]	Predicted LCC in Groundwater[2]	AGQS[3] Lower Radnor Till Sand	AGQS > Predicted LCC?
Heptachlor epoxide	ug/l	0.05	5.13E-05	0.050	Yes
Hexachlorobenzene	ug/l	10.0	1.03E-02	NA	NA
Hexachlorobutadiene	ug/l	10.0	1.03E-02	10.0	Yes
Hexachlorocyclopentadiene	ug/l	10.0	1.03E-02	10.0	Yes
Hexachloroethane	ug/l	10.0	1.03E-02	NA	NA
Indeno(1,2,3-cd)pyrene	ug/l	10.0	1.03E-02	NA	NA
Iodomethane	ug/l	5.0	5.13E-03	1.0	Yes
Isopropylbenzene	ug/l	9.6	9.81E-03	1.0	Yes
m/p-Xylene	ug/l	46.5	4.77E-02	1.0	Yes
Methoxychlor	ug/l	1.0	1.03E-03	0.50	Yes
Methylene Chloride	ug/l	43.8	4.50E-02	7.0	Yes
Naphthalene	ug/l	23.9	2.45E-02	10.0	Yes
n-Butanol	ug/l	1000.0	1.03	NA	NA
n-Butylbenzene	ug/l	5.0	5.13E-03	1.0	Yes
Nitrobenzene	ug/l	10.0	1.03E-02	NA	NA
n-Nitrosodimethylamine	ug/l	10.0	1.03E-02	NA	NA
N-nitrosodi-n-propylamine	ug/l	10.0	1.03E-02	NA	NA
N-nitrosodiphenylamine	ug/l	10.0	1.03E-02	NA	NA
n-Propylbenzene	ug/l	38.2	3.92E-02	1.0	Yes
o-Xylene	ug/l	19.7	2.02E-02	1.0	Yes
Parathion	ug/l	2.0	2.05E-03	0.20	Yes
Pentachlorophenol	ug/l	0.42	4.28E-04	0.050	Yes
Phenanthrene	ug/l	10.0	1.03E-02	NA	NA
p-Isopropyltoluene	ug/l	87.7	9.00E-02	1.0	Yes
Pyrene	ug/l	10.0	1.03E-02	NA	NA
Pyridine	ug/l	10.0	1.03E-02	NA	NA
sec-Butylbenzene	ug/l	5.0	5.13E-03	1.0	Yes
Silvex	ug/l	2.7	2.76E-03	0.050	Yes
Styrene	ug/l	8.5	8.69E-03	1.0	Yes
tert-Butylbenzene	ug/l	5.0	5.13E-03	1.0	Yes
Tetrachloroethene	ug/l	6.3	6.51E-03	1.0	Yes
Tetrahydrofuran	ug/l	605.7	6.21E-01	20.0	Yes
Toluene	ug/l	163.8	1.68E-01	1.0	Yes
Toxaphene	ug/l	1.8	1.85E-03	1.5	Yes
trans-1,2-Dichloroethene	ug/l	5.0	5.13E-03	1.0	Yes
trans-1,3-Dichloropropene	ug/l	5.0	5.13E-03	1.0	Yes
trans-1,4-Dichloro-2-Butene	ug/l	5.0	5.13E-03	1.0	Yes
Trichloroethene	ug/l	8.2	8.40E-03	1.0	Yes
Trichlorofluoromethane	ug/l	10.0	1.03E-02	1.0	Yes
Vinyl Acetate	ug/l	10.0	1.03E-02	5.0	Yes
Vinyl Chloride	ug/l	6.9	7.03E-03	2.0	Yes
Xylenes - Total	ug/l	64.0	6.56E-02	3.0	Yes

Notes:
1. Concentration in leachate is the Upper 95% Confidence Limit derived from the background leachate monitoring data from Clinton Landfill No. 2.
2. Predicted Concentration in Groundwater is the normalized concentration based on the baseline model results as detailed in Section 812.316. Normalized concentration for the Lower Radnor Till Sand = 1.026×10^{-3}.
3. Applicable Groundwater Quality Standard (AGQS) is established as the Upper 95% Tolerance Limit.
4. mg/l = Milligrams per liter = parts per million (ppm); µg/l = Micrograms per liter = parts per billion (ppb)
5. NA = Not Applicable

TABLE 812.316-10
SOURCE CONCENTRATIONS, AGQS VALUES, AND PREDICTED LEACHATE CONCENTRATIONS - ORGANIC SOIL
Clinton Landfill No. 3

Parameter	Units	Concentration in Leachate[1]	Predicted LCC in Groundwater[2]	AGQS[3] Organic Soil	AGQS > Predicted LCC?
Alkalinity, Bicarb Total	mg/l	3984.6	1.91E-02	NA	NA
Ammonia, Total	mg/l	559.5	2.68E-03	18.0	Yes
Biological Oxygen Demand (BOD)	mg/l	773.5	3.71E-03	45.4	Yes
Chloride, Total	mg/l	1347.6	6.45E-03	13.0	Yes
Chemical Oxygen Demand (COD)	mg/l	1973.4	9.45E-03	122.3	Yes
Cyanide, Total	mg/l	0.03	1.44E-07	0.0050	Yes
Cyanide, Reactive	mg/l	0.009	4.31E-08	NA	NA
Nitrate/Nitrite as N, Total	mg/l	0.19	9.25E-07	0.40	Yes
Oil and Grease, Total	mg/l	389.3	1.86E-03	0.1	Yes
Phenols, Total	mg/l	0.42	2.02E-06	0.005	Yes
Sulfate, Total	mg/l	281.9	1.35E-03	56.7	Yes
Sulfide, Reactive	mg/l	8.79	4.21E-05	NA	NA
Total Organic Carbon (TOC)	mg/l	395.2	1.89E-03	46.0	Yes
Total Dissolved Solids (TDS)	mg/l	5096.2	2.44E-02	500.0	Yes
Total Suspended Solids	mg/l	420.6	2.01E-03	NA	NA
Aluminum, Total	ug/l	2321.2	1.11E-02	60,412.0	Yes
Antimony, Total	ug/l	16.1	7.70E-05	3.0	Yes
Arsenic, Total	ug/l	38.4	1.84E-04	50.0	Yes
Barium, Total	ug/l	632.2	3.03E-03	541.0	Yes
Beryllium, Total	ug/l	3.93	1.88E-05	2.6	Yes
Boron, Total	ug/l	26767.5	1.28E-01	544.8	Yes
Cadmium, Total	ug/l	15.4	7.37E-05	1.0	Yes
Calcium, Total	mg/l	189.1	9.06E-04	224.0	Yes
Chromium, Total	ug/l	97.5	4.67E-04	50.0	Yes
Chromium, Hexavalent	ug/l	114.7	5.49E-04	NA	NA
Cobalt, Total	ug/l	24.2	1.16E-04	26.0	Yes
Copper, Total	ug/l	43.9	2.10E-04	143.4	Yes
Fluoride, Total	mg/l	4.91	2.35E-05	0.58	Yes
Iron, Total	ug/l	310983.9	1.49	5,000.0	Yes
Lead, Total	ug/l	57.2	2.74E-04	7.5	Yes
Magnesium, Total	mg/l	186722.0	8.94E-01	111.0	Yes
Manganese, Total	ug/l	1710.6	8.19E-03	150.0	Yes
Mercury, Total	ug/l	1.10	5.29E-06	0.2	Yes
Nickel, Total	ug/l	194.8	9.33E-04	100.0	Yes
Phosphorous, Total	ug/l	3179.3	1.52E-02	NA	NA
Potassium, Total	mg/l	337.6	1.62E-03	19.8	Yes
Selenium, Total	ug/l	28.4	1.36E-04	2.2	Yes
Silver, Total	ug/l	248.0	1.19E-03	5.0	Yes
Sodium, Total	mg/l	1175.1	5.63E-03	61.7	Yes
Thallium, Total	ug/l	3.5	1.70E-05	1.0	Yes
Tin Total, GFAA	ug/l	60.0	2.87E-04	NA	NA
Zinc, Total	ug/l	1293.2	6.19E-03	185.4	Yes
1,1,1,2-Tetrachloroethane	ug/l	1.0	4.79E-06	1.0	Yes
1,1,1-Trichloroethane	ug/l	19.0	9.09E-05	1.0	Yes
1,1,2,2-Tetrachloroethane	ug/l	5.0	2.40E-05	1.0	Yes
1,1,2-Trichloroethane	ug/l	5.0	2.40E-05	1.0	Yes
1,1-Dichloroethane	ug/l	6.6	3.15E-05	1.0	Yes
1,1-Dichloroethene	ug/l	5.0	2.40E-05	1.0	Yes
1,1-Dichloropropene	ug/l	5.0	2.40E-05	1.0	Yes
1,2,3-Trichlorobenzene	ug/l	5.0	2.40E-05	1.0	Yes
1,2,3-Trichloropropane	ug/l	5.0	2.40E-05	1.0	Yes
1,2,4-Trichlorobenzene	ug/l	5.0	2.40E-05	1.0	Yes
1,2,4-Trimethylbenzene	ug/l	60.0	2.87E-04	1.0	Yes
1,2-Dibromo-3-chloropropane	ug/l	5.0	2.40E-05	0.05	Yes

TABLE 812.316-10
SOURCE CONCENTRATIONS, AGQS VALUES, AND PREDICTED LEACHATE CONCENTRATIONS - ORGANIC SOIL
Clinton Landfill No. 3

Parameter	Units	Concentration in Leachate[1]	Predicted LCC in Groundwater[2]	AGQS[3] Organic Soil	AGQS > Predicted LCC?
1,2-Dichlorobenzene	ug/l	1.0	4.79E-06	1.0	Yes
1,2-Dichloroethane	ug/l	5.0	2.40E-05	1.0	Yes
1,2-Dichloropropane	ug/l	5.0	2.40E-05	1.0	Yes
1,3 Dichloropropane	ug/l	5.0	2.40E-05	1.0	Yes
1,3,5-Trimethylbenzene	ug/l	43.2	2.07E-04	1.0	Yes
1,3-Dichlorobenzene	ug/l	5.0	2.40E-05	1.0	Yes
1,3-Dichloropropene	ug/l	5.0	2.40E-05	NA	NA
1,4-Dichlorobenzene	ug/l	9.6	4.60E-05	1.0	Yes
1-Propanol	ug/l	1000.0	4.79E-03	NA	NA
2,2-Dichloropropane	ug/l	5.0	2.40E-05	1.0	Yes
2,4 Dinitrotoluene	ug/l	10.0	4.79E-05	NA	NA
2,4,5-Trichlorophenol	ug/l	10.0	4.79E-05	NA	NA
2,4,6-Trichlorophenol	ug/l	10.0	4.79E-05	NA	NA
2,4-D	ug/l	1.76	8.43E-06	0.10	Yes
2,4-Dichlorophenol	ug/l	10.0	4.79E-05	NA	NA
2,4-Dimethylphenol	ug/l	235.1	1.13E-03	NA	NA
2,4-Dinitrophenol	ug/l	50.0	2.40E-04	NA	NA
2,4-Dinitrotoluene	ug/l	10.0	4.79E-05	NA	NA
2,6-Dinitrotoluene	ug/l	10.0	4.79E-05	NA	NA
2-Butanone (MEK)	ug/l	1204.6	5.77E-03	5.0	Yes
2-Chloroethylvinyl ether	ug/l	10.0	4.79E-05	NA	NA
2-Chloronaphthalene	ug/l	10.0	4.79E-05	NA	NA
2-Chlorophenol	ug/l	10.0	4.79E-05	NA	NA
2-Chlorotoluene	ug/l	1.0	4.79E-06	1.0	Yes
2-Hexanone (MBK)	ug/l	33.0	1.58E-04	5.0	Yes
2-Methylphenol(o-cresol)	ug/l	37.9	1.82E-04	NA	NA
2-Nitrophenol	ug/l	10.0	4.79E-05	NA	NA
2-Propanol	ug/l	7488.4	3.59E-02	NA	NA
3,3-Dichlorobenzidine	ug/l	10.0	4.79E-05	NA	NA
3,4-Methylphenol(m,p-Cresol)	ug/l	640.8	3.07E-03	10.0	Yes
4,4'-DDD	ug/l	0.1	4.79E-07	NA	NA
4,4'-DDE	ug/l	0.1	4.79E-07	NA	NA
4,4'-DDT	ug/l	0.20	9.58E-07	0.10	Yes
4,6-Dinitro-2-methylphenol	ug/l	50.0	2.40E-04	NA	NA
4-Bromophenyl-phenylether	ug/l	10.0	4.79E-05	NA	NA
4-Chlorophenyl-phenylether	ug/l	10.0	4.79E-05	NA	NA
4-Chlorotoluene	ug/l	5.0	2.40E-05	1.0	Yes
4-Methyl-2-Pentanone(MIBK)	ug/l	122.4	5.86E-04	5.0	Yes
4-Nitrophenol	ug/l	50.0	2.40E-04	NA	NA
Acenaphthene	ug/l	10.0	4.79E-05	NA	NA
Acetone	ug/l	1098.9	5.26E-03	10.0	Yes
Alachlor	ug/l	1.3	6.23E-06	0.40	Yes
Aldicarb	ug/l	0.80	3.83E-06	0.40	Yes
Aldrin	ug/l	0.05	2.40E-07	0.05	Yes
alpha-BHC	ug/l	0.05	2.40E-07	NA	NA
Anthracene	ug/l	10.0	4.79E-05	NA	NA
Aroclor 1016	ug/l	200.0	9.58E-04	0.50	Yes
Aroclor 1221	ug/l	0.5	2.40E-06	0.50	Yes
Aroclor 1232	ug/l	0.5	2.40E-06	0.50	Yes
Aroclor 1242	ug/l	0.5	2.40E-06	0.50	Yes
Aroclor 1248	ug/l	0.5	2.40E-06	0.50	Yes
Aroclor 1254	ug/l	0.5	2.40E-06	0.50	Yes
Aroclor 1260	ug/l	0.5	2.40E-06	0.50	Yes
Atrazine	ug/l	1.80	8.61E-06	0.20	Yes

TABLE 812.316-10
SOURCE CONCENTRATIONS, AGQS VALUES, AND PREDICTED LEACHATE CONCENTRATIONS - ORGANIC SOIL
Clinton Landfill No. 3

Parameter	Units	Concentration in Leachate[1]	Predicted LCC in Groundwater[2]	AGQS[3] Organic Soil	AGQS > Predicted LCC?
Benzene	ug/l	10.3	4.93E-05	1.0	Yes
Benzo(a)anthracene	ug/l	10.0	4.79E-05	NA	NA
Benzo(a)pyrene	ug/l	0.51	2.44E-06	0.20	Yes
Benzo(b)fluoranthene	ug/l	10.0	4.79E-05	NA	NA
Benzo(g,h,i)perylene	ug/l	10.0	4.79E-05	NA	NA
Benzo(k)fluoranthene	ug/l	10.0	4.79E-05	NA	NA
beta-BHC	ug/l	0.05	2.40E-07	NA	NA
Bis(2-chloroethoxy)methane	ug/l	10.0	4.79E-05	NA	NA
Bis(2-chloroethyl)ether	ug/l	10.0	4.79E-05	NA	NA
Bis(2-ethylhexyl)phthalate	ug/l	44.7	2.14E-04	6.0	Yes
Bis(chloromethyl)ether	ug/l	10000.0	4.79E-02	NA	NA
Bromobenzene	ug/l	5.0	2.40E-05	1.0	Yes
Bromochloromethane	ug/l	5.0	2.40E-05	1.0	Yes
Bromodichloromethane	ug/l	5.0	2.40E-05	1.0	Yes
Bromoform	ug/l	5.0	2.40E-05	1.0	Yes
Bromomethane	ug/l	10.0	4.79E-05	2.0	Yes
Butyl benzyl phthalate	ug/l	10.0	4.79E-05	NA	NA
Carbofuran	ug/l	8.9	4.27E-05	1.5	Yes
Carbon Disulfide	ug/l	7.7	3.67E-05	26.0	Yes
Carbon Tetrachloride	ug/l	5.0	2.40E-05	1.0	Yes
Chlordane (Tech)	ug/l	0.5	2.40E-06	0.50	Yes
Chlorobenzene	ug/l	10.4	4.99E-05	1.0	Yes
Chloroethane	ug/l	14.4	6.91E-05	2.0	Yes
Chloroform	ug/l	5.0	2.40E-05	1.0	Yes
Chloromethane	ug/l	10.0	4.79E-05	2.0	Yes
Chrysene	ug/l	10.0	4.79E-05	NA	NA
cis-1,2-Dichloroethene	ug/l	13.9	6.67E-05	1.0	Yes
cis-1,3-Dichloropropene	ug/l	1.0	4.79E-06	1.0	Yes
delta-BHC	ug/l	0.05	2.40E-07	NA	NA
Dibenzo(a,h)anthracene	ug/l	10.0	4.79E-05	NA	NA
Dibromochloromethane	ug/l	5.0	2.40E-05	1.0	Yes
Dibromomethane	ug/l	5.0	2.40E-05	1.0	Yes
Dichlorodifluoromethane	ug/l	4.7	2.23E-05	2.0	Yes
Diethyl phthalate	ug/l	60.8	2.91E-04	10.0	Yes
Di-n-butyl phthalate	ug/l	10.0	4.79E-05	10.0	Yes
di-n-octyl phthalate	ug/l	10.0	4.79E-05	NA	NA
Dioxin Screen	ug/l	10.0	4.79E-05	NA	NA
Endosulfan I	ug/l	0.05	2.40E-07	NA	NA
Endosulfan II	ug/l	0.1	4.79E-07	NA	NA
Endosulfan Sulfate	ug/l	0.1	4.79E-07	NA	NA
Endrin	ug/l	0.1	4.79E-07	0.10	Yes
Endrin Aldehyde	ug/l	0.1	4.79E-07	NA	NA
Ethyl Acetate	ug/l	10.0	4.79E-05	NA	NA
Ethylbenzene	ug/l	26.2	1.26E-04	1.0	Yes
Ethylene dibromide	ug/l	0.05	2.40E-07	0.050	Yes
Fluoranthene	ug/l	10.0	4.79E-05	NA	NA
Fluorene	ug/l	10.0	4.79E-05	NA	NA
gamma-BHC (Lindane)	ug/l	0.05	2.40E-07	0.050	Yes
Heptachlor	ug/l	0.05	2.40E-07	0.050	Yes
Heptachlor epoxide	ug/l	0.05	2.40E-07	0.050	Yes
Hexachlorobenzene	ug/l	10.0	4.79E-05	NA	NA
Hexachlorobutadiene	ug/l	10.0	4.79E-05	10.0	Yes
Hexachlorocyclopentadiene	ug/l	10.0	4.79E-05	10.0	Yes
Hexachloroethane	ug/l	10.0	4.79E-05	NA	NA

TABLE 812.316-10
SOURCE CONCENTRATIONS, AGQS VALUES, AND PREDICTED LEACHATE CONCENTRATIONS - ORGANIC SOIL
Clinton Landfill No. 3

Parameter	Units	Concentration in Leachate[1]	Predicted LCC in Groundwater[2]	AGQS[3] Organic Soil	AGQS > Predicted LCC?
Indeno(1,2,3-cd)pyrene	ug/l	10.0	4.79E-05	NA	NA
Iodomethane	ug/l	5.0	2.40E-05	1.0	Yes
Isopropylbenzene	ug/l	9.6	4.58E-05	1.0	Yes
m/p-Xylene	ug/l	46.5	2.23E-04	1.0	Yes
Methoxychlor	ug/l	1.0	4.79E-06	0.50	Yes
Methylene Chloride	ug/l	43.8	2.10E-04	5.0	Yes
Naphthalene	ug/l	23.9	1.15E-04	10.0	Yes
n-Butanol	ug/l	1000.0	4.79E-03	NA	NA
n-Butylbenzene	ug/l	5.0	2.40E-05	1.0	Yes
Nitrobenzene	ug/l	10.0	4.79E-05	NA	NA
n-Nitrosodimethylamine	ug/l	10.0	4.79E-05	NA	NA
N-nitrosodi-n-propylamine	ug/l	10.0	4.79E-05	NA	NA
N-nitrosodiphenylamine	ug/l	10.0	4.79E-05	NA	NA
n-Propylbenzene	ug/l	38.2	1.83E-04	1.0	Yes
o-Xylene	ug/l	19.7	9.44E-05	1.0	Yes
Parathion	ug/l	2.0	9.58E-06	0.20	Yes
Pentachlorophenol	ug/l	0.42	2.00E-06	0.050	Yes
Phenanthrene	ug/l	10.0	4.79E-05	NA	NA
p-Isopropyltoluene	ug/l	87.7	4.20E-04	1.0	Yes
Pyrene	ug/l	10.0	4.79E-05	NA	NA
Pyridine	ug/l	10.0	4.79E-05	NA	NA
sec-Butylbenzene	ug/l	5.0	2.40E-05	1.0	Yes
Silvex	ug/l	2.7	1.29E-05	0.050	Yes
Styrene	ug/l	8.5	4.06E-05	1.0	Yes
tert-Butylbenzene	ug/l	5.0	2.40E-05	1.0	Yes
Tetrachloroethene	ug/l	6.3	3.04E-05	1.0	Yes
Tetrahydrofuran	ug/l	605.7	2.90E-03	20.0	Yes
Toluene	ug/l	163.8	7.84E-04	2.0	Yes
Toxaphene	ug/l	1.8	8.62E-06	1.5	Yes
trans-1,2-Dichloroethene	ug/l	5.0	2.40E-05	1.0	Yes
trans-1,3-Dichloropropene	ug/l	5.0	2.40E-05	1.0	Yes
trans-1,4-Dichloro-2-Butene	ug/l	5.0	2.40E-05	1.0	Yes
Trichloroethene	ug/l	8.2	3.92E-05	1.0	Yes
Trichlorofluoromethane	ug/l	10.0	4.79E-05	1.0	Yes
Vinyl Acetate	ug/l	10.0	4.79E-05	5.0	Yes
Vinyl Chloride	ug/l	6.9	3.28E-05	2.0	Yes
Xylenes - Total	ug/l	64.0	3.06E-04	3.0	Yes

Notes:
1. Concentration in leachate is the Upper 95% Confidence Limit derived from the background leachate monitoring data from Clinton Landfill No. 2.
2. Predicted Concentration in Groundwater is the normalized concentration based on the baseline model results as detailed in Section 812.316. Normalized concentration for the Organic Soil = 4.790×10^{-6}.
3. Applicable Groundwater Quality Standard (AGQS) is established as the Upper 95% Tolerance Limit.
4. mg/l = Milligrams per liter = parts per million (ppm); µg/l = Micrograms per liter = parts per billion (ppb)
5. NA = Not Applicable

TABLE 16-11

SENSITIVITY ANALYSIS SUMMARY - UPPER RADNOR TILL SAND (LINER KEY WAY MODEL)

POLLUTE Model Results

Clinton Landfill No. 3

Sensitivity Analysis On				Baseline	Model Output		File Name	File Name	Results
Input Parameter	Layer	Low Value	High Value	Model	Low	High	Low	High	
Darcy Velocity (m/a)		3.515E-04	3.515E-02	3.515E-03	3.040E-09	1.372E-03	LKW1.IN	LKW2.IN	Higher Velocity - incr.
Diffusion Coefficient (m^2/a)	1	0.01	0.03	0.0158	7.970E-10	9.075E-07	LKW3.IN	LKW4.IN	Higher Coefficient - incr.
	2	0.598	2.598	1.598	7.008E-13	5.692E-07	LKW5.IN	LKW6.IN	Higher Coefficient - incr.
Effective Porosity	1	0.20	0.5	0.288	4.532E-08	1.854E-08	LKW7.IN	LKW8.IN	Lower Porosity - incr.
	2	0.25	0.5	0.3	1.470E-07	1.472E-10	LKW9.IN	LKW10.IN	Lower Porosity - incr.
Thickness (meters)	1	5.096	7.096	6.096	2.533E-07	2.256E-09	LKW11.IN	LKW12.IN	Thicker - decr.
	2	30.48	91.44	60.96	3.080E-05	3.775E-12	LKW13.IN	LKW14.IN	Thicker - decr.
Vertical Velocity (m/a)	2	0.01397	1.1397	0.1397	5.323E-16	6.819E-05	LKW15.IN	LKW16.IN	Higher Velocity - incr.
Bottom Boundary Condition	NA	Zero Flux (Impermeable)		Infinite Layer	0		LKW17.IN		

Baseline Input File = LKWB.IN; Baseline Output File = LKWB.OU

Baseline Model Results at Zone of Attenuation = 2.435E-08

Baseline Model Values & Results

Initial Concentration = 1 ppm

Thickness Layer 1 (Compacted Clay) = 20 feet

Thickness Layer 2 (Sand) = 200 feet

Notes:

1) m/a. = meters per year
2) m^2/a = squared meters per year
3) incr. = increase
4) decr. = decrease

TABLE 812.316-12
SENSITIVITY ANALYSIS SUMMARY FOR MIGRATE MODEL - LOWER RADNOR TILL SAND
Clinton Landfill No. 3

Layer	Input Parameter	Model Input			Model Output			File Name	File Name	Results
		Base Model	Low	High	Base Model	Low	High	Low	High	
1	Porosity	1	0.5	NA	1.026E-03	8.370E-04		LR1.IN		Lower Porosity- Decr.
1	Vert. Diff. Coefficient, m^2/a	3.00E-05	2.00E-05	4.00E-05	1.026E-03	9.172E-04	1.095E-03	LR2.IN	LR3.IN	Higher Coefficient - Incr.
1	Horiz. Diff. Coefficient, m^2/a	3.00E-05	2.00E-05	4.00E-05	1.026E-03	1.026E-03	1.026E-03	LR4.IN	LR5.IN	No Change
1	Vert. Velocity, m/a	3.515E-03	2.515E-03	4.515E-03	1.026E-03	9.848E-04	1.068E-03	LR6.IN	LR7.IN	Higher Velocity - Incr
2	Porosity	0.288	0.2	0.42	1.026E-03	1.062E-03	9.623E-04	LR8.IN	LR9.IN	Higher Porosity-Decr
2	Vert. Diff. Coefficient, m^2/a	0.0158	0.01	0.02	1.026E-03	7.148E-04	1.203E-03	LR10.IN	LR11.IN	Higher Coefficient - incr.
2	Horiz. Diff. Coefficient, m^2/a	0.0158	0.01	0.02	1.026E-03	1.026E-03	1.026E-03	LR12.IN	LR13.IN	No Change
2	Vert. Velocity, m/a	3.515E-03	2.515E-03	4.515E-03	1.026E-03	9.337E-04	1.123E-03	LR14.IN	LR15.IN	Higher Velocity - Incr
3	Thickness, m	0.2939	0.1939	0.4939	1.026E-03	1.215E-03	7.273E-04	LR16.IN	LR17.IN	Thicker - Decr.
3	Porosity	0.288	0.2	0.42	1.026E-03	1.044E-03	9.715E-04	LR18.IN	LR19.IN	Lower Porosity- Incr.
3	Vert. Diff. Coefficient, m^2/a	0.0158	0.01	0.02	1.026E-03	9.196E-04	1.072E-03	LR20.IN	LR21.IN	Higher Coefficient - Incr.
3	Horiz. Diff. Coefficient, m^2/a	0.0158	0.01	0.02	1.026E-03	1.026E-03	1.026E-03	LR22.IN	LR23.IN	No Change
3	Vert. Velocity, m/a	3.515E-03	2.515E-03	4.515E-03	1.026E-03	9.984E-04	1.053E-03	LR24.IN	LR25.IN	Higher Velocity - Incr
4	Thickness, m	6.573	6	7.6	1.026E-03	2.623E-03	1.612E-04	LR26.IN	LR27.IN	Thicker - Decr.
4	Porosity	0.286	0.2	0.42	1.026E-03	1.568E-03	2.607E-04	LR28.IN	LR29.IN	Lower Porosity- Incr.
4	Vert. Diff. Coefficient, m^2/a	0.0158	0.01	0.02	1.026E-03	4.225E-05	1.738E-03	LR30.IN	LR31.IN	Higher Coefficient - Incr.
4	Horiz. Diff. Coefficient, m^2/a	0.0158	0.01	0.02	1.026E-03	6.174E-04	6.175E-04	LR32.IN	LR33.IN	No Change
4	Vert. Velocity, m/a	3.515E-03	2.515E-03	4.515E-03	1.026E-03	3.209E-04	1.145E-03	LR34.IN	LR35.IN	Higher Velocity - Incr
5	Thickness, m	0.8543	0.7543	0.9543	1.026E-03	6.480E-04	5.879E-03	LR36.IN	LR37.IN	Thicker - Decr.
5	Porosity	0.30	0.25	0.5	1.026E-03	1.280E-03	2.811E-04	LR38.IN	LR39.IN	Lower Porosity - Incr.
5	Vert. Diff. Coefficient, m^2/a	12.84	1.284	32.84	1.026E-03	1.026E-03	1.026E-03	LR40.IN	LR41.IN	No Change
5	Horiz. Diff. Coefficient, m^2/a	64.08	44.08	74.08	1.026E-03	1.028E-03	1.025E-03	LR42.IN	LR43.IN	Higher Coeff.- Incr.
5	Vert. Velocity, m/a	0	2.515E-03	4.515E-03	1.026E-03	1.026E-03	1.027E-03	LR44.IN	LR45.IN	No Change
5	Horiz. Velocity, m/a	2.099	1.099	3.099	1.026E-03	4.917E-04	1.370E-03	LR46.IN	LR47.IN	Higher Velocity - Incr
	Bottom Boundary	Impermeable	Zero Concentration		1.026E-03	0		LR48.IN		
	Top Boundary	Constant Conc.	Impermeable		1.026E-03	0		LR49.IN		

Notes: 1) **Baseline Model Input File** = LRB.IN and **Baseline Model Output File** = LRB.OU

2) The results are for 145 years at 100 feet from the waste boundary in Layer 5 - Lower Radnor Till Sand, Sublayer 14

3) m = meters, a = year, m^2/a = square meters per year, m/a = meters per year

4) Incr. = increase in concentration, Decr. = Decrease in Concentration

TABLE 812.316-13
SENSITIVITY ANALYSIS SUMMARY FOR MIGRATE MODEL - ORGANIC SOIL
Clinton Landfill No. 3

Layer	Input Parameter	Model Input			Model Output			File Name	File Name	Results
		Base Model	Low	High	Base Model	Low	High	Low	High	
1	Porosity	1	0.5	NA	4.790E-06	3.908E-06		OS1.IN		Lower Porosity- Decr.
1	Vert. Diff. Coefficient, m^2/a	3.00E-05	2.00E-05	4.00E-05	4.790E-06	4.282E-03	5.114E-06	OS2.IN	OS3.IN	Higher Coefficient - Incr.
1	Horiz. Diff. Coefficient, m^2/a	3.00E-05	2.00E-05	4.00E-05	4.790E-06	4.790E-06	4.790E-06	OS4.IN	OS5.IN	No Change
1	Vert. Velocity, m/a	3.515E-03	2.515E-03	4.515E-03	4.790E-06	4.599E-06	4.988E-06	OS6.IN	OS7.IN	Higher Velocity - Incr
2	Porosity	0.288	0.2	0.42	4.790E-06	4.963E-06	4.492E-06	OS8.IN	OS9.IN	Higher Porosity - Decr.
2	Vert. Diff. Coefficient, m^2/a	0.0158	0.01	0.02	4.790E-06	3.325E-06	5.634E-06	OS10.IN	OS11.IN	Higher Coefficient - Incr.
2	Horiz. Diff. Coefficient, m^2/a	0.0158	0.01	0.02	4.790E-06	4.795E-06	4.787E-06	OS12.IN	OS13.IN	Lower Coefficient - Incr.
2	Vert. Velocity, m/a	3.515E-03	2.515E-03	4.515E-03	4.790E-06	4.360E-06	5.243E-06	OS14.IN	OS15.IN	Higher Velocity - Incr
3	Thickness, m	0.2939	0.1939	0.3939	4.790E-06	5.690E-03	4.029E-06	OS16.IN	OS17.IN	Thicker - Decr.
3	Porosity	0.288	0.2	0.42	4.790E-06	4.873E-06	4.537E-06	OS18.IN	OS19.IN	Lower Porosity- Incr.
3	Vert. Diff. Coefficient, m^2/a	0.0158	0.01	0.02	4.790E-06	4.282E-06	5.010E-05	OS20.IN	OS21.IN	Higher Coefficient - Incr.
3	Horiz. Diff. Coefficient, m^2/a	0.0158	0.01	0.02	4.790E-06	4.792E-06	4.789E-06	OS22.IN	OS23.IN	Higher Coefficient - Incr.
3	Vert. Velocity, m/a	3.515E-03	2.515E-03	4.515E-03	4.790E-06	4.663E-06	4.918E-06	OS24.IN	OS25.IN	Higher Velocity - Incr
4	Thickness, m	6.573	5.753	7.573	4.790E-06	2.564E-05	8.088E-07	OS26.IN	OS27.IN	Thicker - Decr.
4	Porosity	0.286	0.2	0.42	4.790E-06	1.113E-05	2.315E-06	OS28.IN	OS29.IN	Lower Porosity- Incr.
4	Vert. Diff. Coefficient, m^2/a	0.0158	0.01	0.02	4.790E-06	4.114E-07	1.312E-05	OS30.IN	OS31.IN	Higher Coefficient - Incr.
4	Horiz. Diff. Coefficient, m^2/a	0.0158	0.01	0.02	4.790E-06	4.825E-06	4.766E-06	OS32.IN	OS33.IN	Lower Coefficient - Incr.
4	Vert. Velocity, m/a	3.515E-03	2.515E-03	4.515E-03	4.790E-06	2.596E-06	8.540E-06	OS34.IN	OS35.IN	Higher Velocity - Incr
5	Thickness, m	1.042	0.5	1.5	4.790E-06	6.923E-06	3.836E-06	OS36IN	OS37.IN	Thicker - Decr.
5	Porosity	0.4	0.25	0.61	4.790E-06	1.312E-05	2.729E-06	OS38.IN	OS39.IN	Lower Porosity - Incr.
5	Vert. Diff. Coefficient, m^2/a	0.526	0.0526	1.526	4.790E-06	4.728E-06	4.797E-06	OS40.IN	OS41.IN	Higher Coeff.- Incr.
5	Horiz. Diff. Coefficient, m^2/a	2.505	1.505	4.505	4.790E-06	4.617E-06	8.387E-06	OS42.IN	OS43.IN	Higher Coeff.- Incr.
5	Vert. Velocity, m/a	0	2.515E-03	4.515E-03	4.790E-06	4.793E-06	4.796E-06	OS44.IN	OS45.IN	Higher Velocity - Incr
5	Horiz. Velocity, m/a	0.1018	0.01018	1.018	4.790E-06	4.251E-06	4.438E-04	OS46.IN	OS47.IN	Higher Velocity - Incr
	Bottom Boundary	Impermeable	Zero Concentration			0		LR48.IN		
	Top Boundary	Constant Conc.	Impermeable			0		LR49.IN		

Notes: 1) **Baseline Model Input File = OSB.IN and Baseline Model Output File = OSB.OU**

2) The results are for 145 years at 100 feet from the waste boundary in Layer 5 - Organic Soil, Sublayer 11

3) m = meters, a = year, m^2/a = square meters per year, m/a = meters per year

4) Incr. = increase in concentration, Decr. = Decrease in Concentration

T:\Projects\91-118 CLI\Permit Applications\CLI #3 Initial BOL Application Log 2005-070\Groundwater\GIA-June 2006\Revised GIA Sensitivity Analysis.xls

TABLE 316-14
SENSITIVITY ANALYSIS SUMMARY - MAHOMET SAND
POLLUTE Model Results
Clinton Landfill No. 3

Sensitivity Analysis On				Baseline	Model Output		File Name	File Name	Results
Input Parameter	**Layer**	**Low Value**	**High Value**	**Model**	**Low**	**High**	**Low**	**High**	
Dispersion Coefficient (m^2/a)	1	0.00001	0.0005	0.00003	4.463E-15	6.123E-15	M1	M2	Higher Coefficient - incr.
	2	0.01	0.03	0.0158	4.574E-15	7.329E-15	M3	M4	Higher Coefficient - incr.
	3	0.01	0.03	0.0158	5.373E-15	6.045E-12	M5	M6	Higher Coefficient - incr.
	4	0.01	0.03	0.0158	1.600E-15	2.312E-14	M7	M8	Higher Coefficient - incr.
	5	1.284	22.84	12.84	5.674E-15	5.713E-15	M9	M10	Higher Coefficient - incr.
	6	0.01	0.03	0.0158	4.332E-15	7.904E-15	M11	M12	Higher Coefficient - incr.
	7	0.0526	5.26	0.526	4.840E-15	5.815E-15	M13	M14	Higher Coefficient - incr.
	8	0.01	0.03	0.0158	2.446E-16	1.160E-13	M15	M16	Lower Coefficient - decr.
	9	0.00315	315	0.0315	3.515E-15	2.126E-16	M17	M18	Lower Coefficient - incr.
Effective Porosity	1	0.1	NA	1	3.273E-15	NA	M19	NA	Lower Porosity - incr.
	2	0.2	0.5	0.288	5.743E-15	5.423E-15	M20	M21	Lower Porosity - incr.
	3	0.2	0.5	0.288	5.800E-15	5.313E-15	M22	M23	Lower Porosity - incr.
	4	0.2	0.5	0.286	1.104E-14	2.507E-15	M24	M25	Lower Porosity - incr.
	5	0.25	0.5	0.3	6.010E-15	4.535E-15	M26	M27	Lower Porosity - incr.
	6	0.2	0.5	0.286	5.429E-15	5.790E-15	M28	M29	Higher Porosity - incr.
	7	0.25	0.61	0.4	7.009E-12	4.525E-15	M30	M31	Lower Porosity - incr.
	8	0.2	0.5	0.286	2.222E-14	7.134E-16	M32	M33	Lower Porosity - incr.
	9	0.25	0.5	0.3	5.195E-15	3.089E-15	M34	M35	Lower Porosity - incr.
Thickness (meters)	3	0.1	1.9644	0.9644	5.561E-15	7.506E-16	M36	M37	Thicker - decr.
	4	6	7.6	6.573	4.120E-15	7.295E-16	M38	M39	Thicker - decr.
	5	0.5	1.1	0.8543	2.672E-15	2.038E-15	M40	M41	Thicker - decr.
	6	0.5	1.5	0.9906	3.947E-15	1.288E-15	M42	M43	Thicker - decr.
	7	0.75	1.25	1.042	2.814E-15	2.062E-15	M44	M45	Thicker - decr.
	8	10.24	20.24	15.24	2.282E-13	4.954E-18	M46	M47	Thicker - decr.
	9	1.048	30.48	3.048	3.990E-15	7.513E-27	M48	M49	Thicker - decr.

Notes:
1) m/a. = meters per year
2) m^2/a = squared meters per year
3) incr. = increase
4) decr. = decrease
5) NA = Not applicable

***Baseline Model Result= 5.7112E-15**

FIGURES

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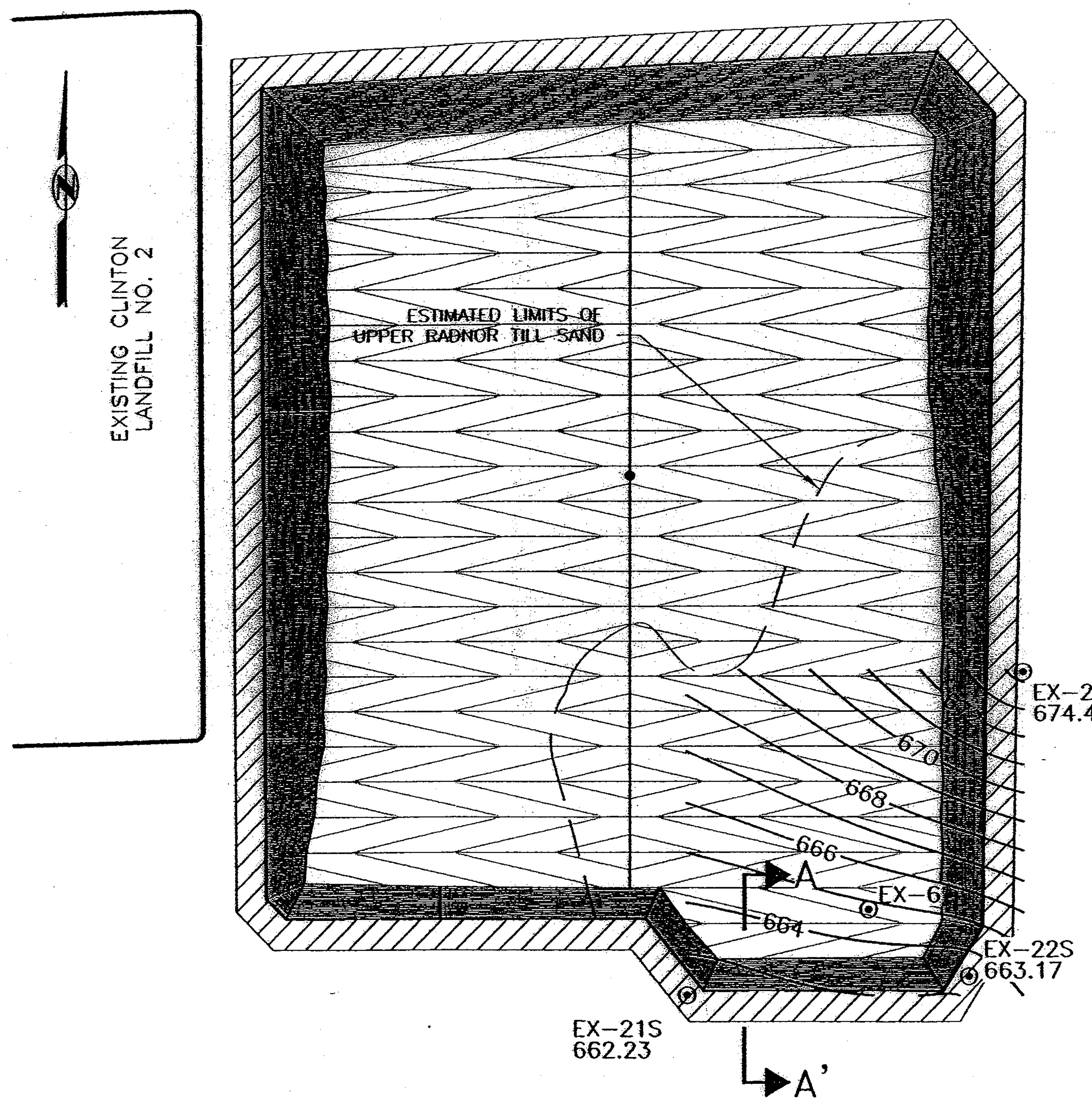
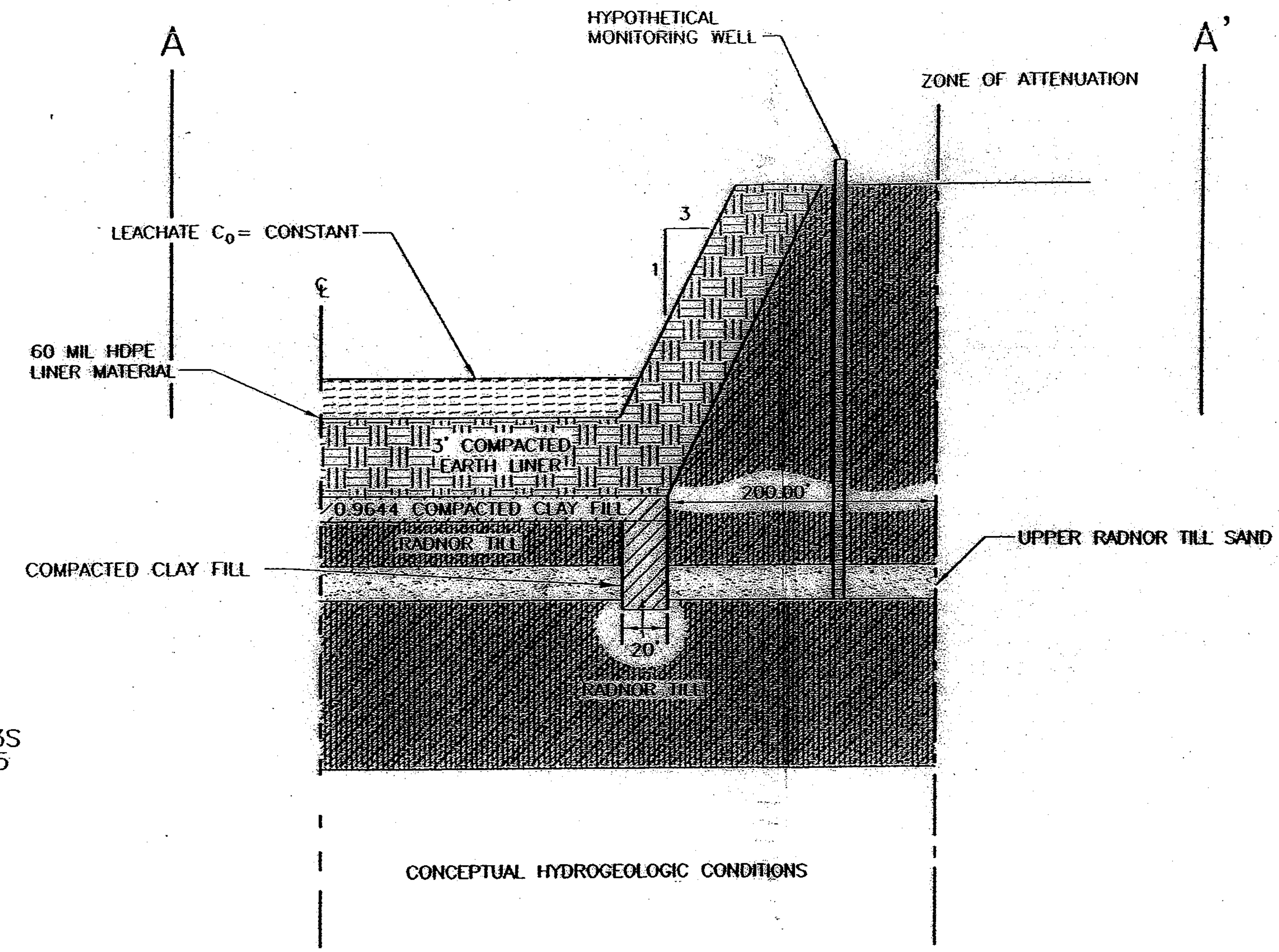


LANDFILL INVERT PLAN

NOT TO SCALE



SECTION A–A'

NOT TO SCALE

LEGEND

⦿	PIEZOMETER SCREENED IN UPPER RADNOR TILL SAND
662.23	MEAN POTENTIOMETRIC ELEVATION (UPPER RADNOR TILL SAND, FEET – MSL)
—664—	MEAN POTENTIOMETRIC ELEVATION CONTOUR LINE (UPPER RADNOR TILL SAND, FEET – MSL)
(hatched box)	ZONE OF ATTENUATION

NOTE: MEAN POTENTIOMETRIC ELEVATIONS BASED ON 2003 AND 2004 MONITORING DATA

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Peoria, Illinois

FIGURE 812.316-1

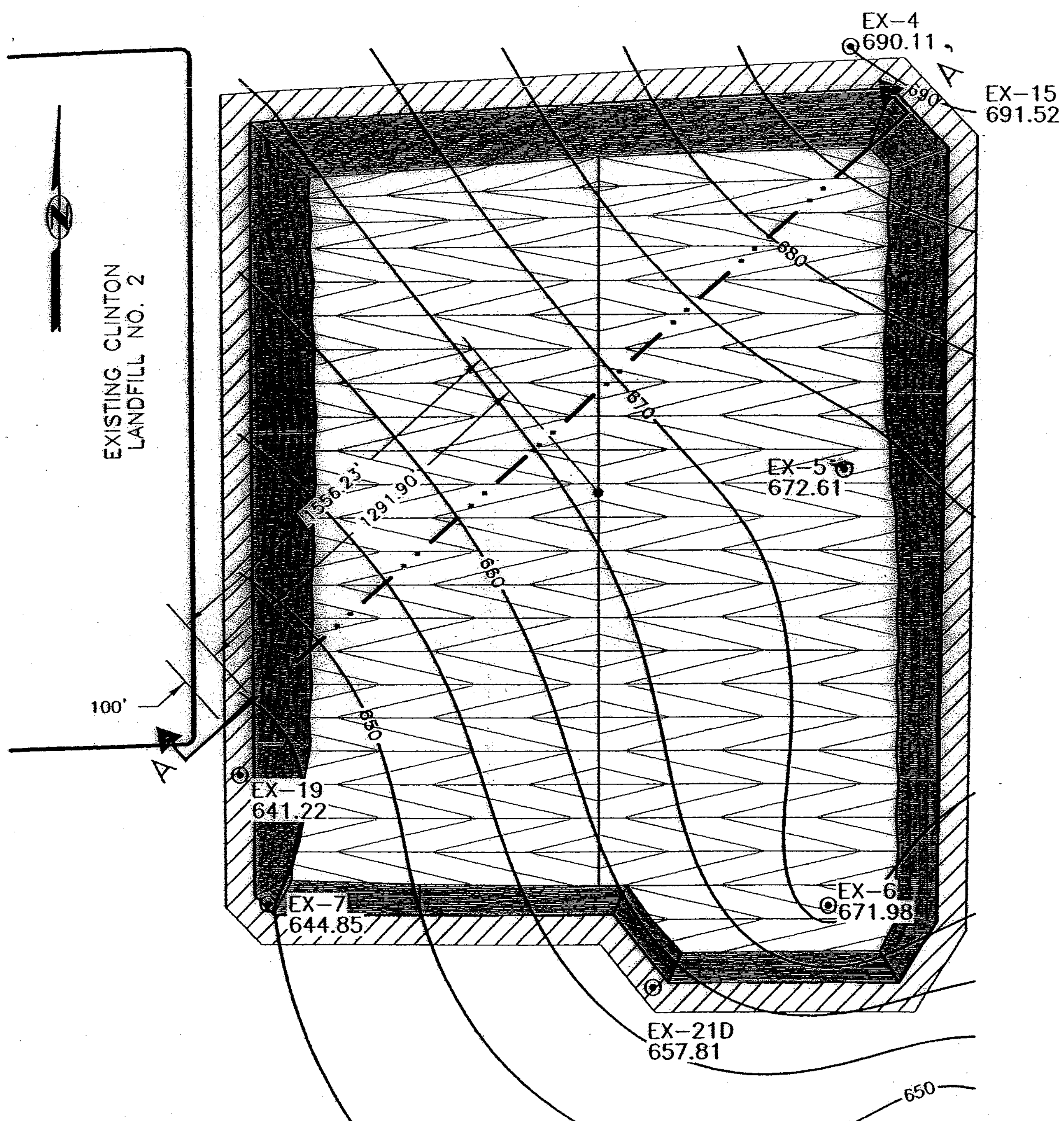
HYDROGEOLOGIC MODEL UPPER RADNOR TILL SAND

CLINTON LANDFILL NO. 3

CLINTON, ILLINOIS

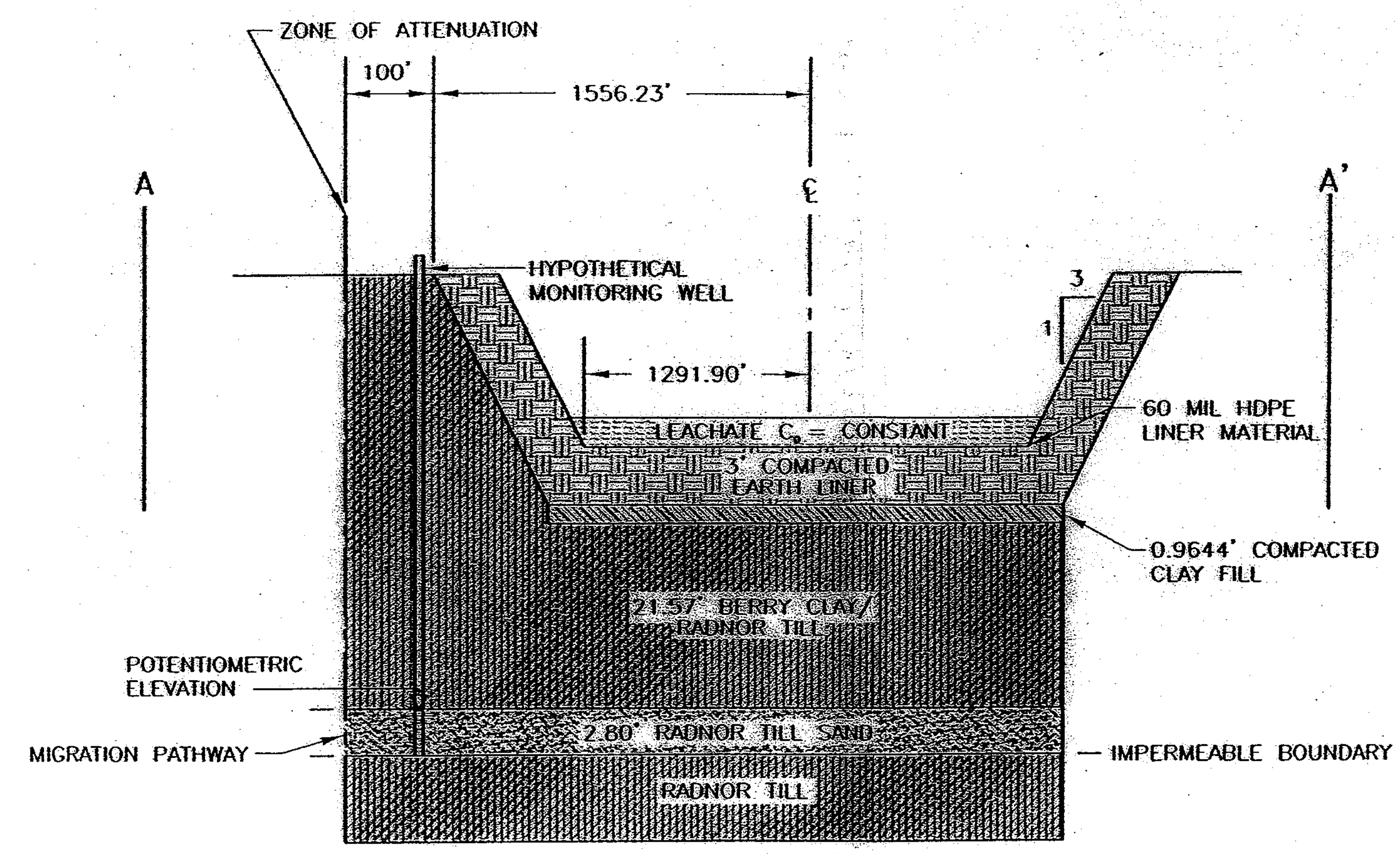
PROJECT NO. 91-118.02

CAD DWG NO:911181008 EMPLOYEE NO: 89736 DATE/TIME: 02/26/05 14:24 ACAD-15.



LANDFILL INVERT PLAN

NOT TO SCALE



SECTION A-A'

NOT TO SCALE

LEGEND

- ⦿ PIEZOMETER SCREENED IN LOWER RADNOR TILL SAND
- 644.85 MEAN POTENTIOMETRIC ELEVATION (LOWER RADNOR TILL SAND, FEET – MSL)
- —650— MEAN POTENTIOMETRIC ELEVATION CONTOUR LINE (LOWER RADNOR TILL SAND, FEET – MSL)
- ZONE OF ATTENUATION

NOTE: MEAN POTENTIOMETRIC ELEVATIONS BASED ON 2003 AND 2004 MONITORING DATA

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FIGURE 812.316-2

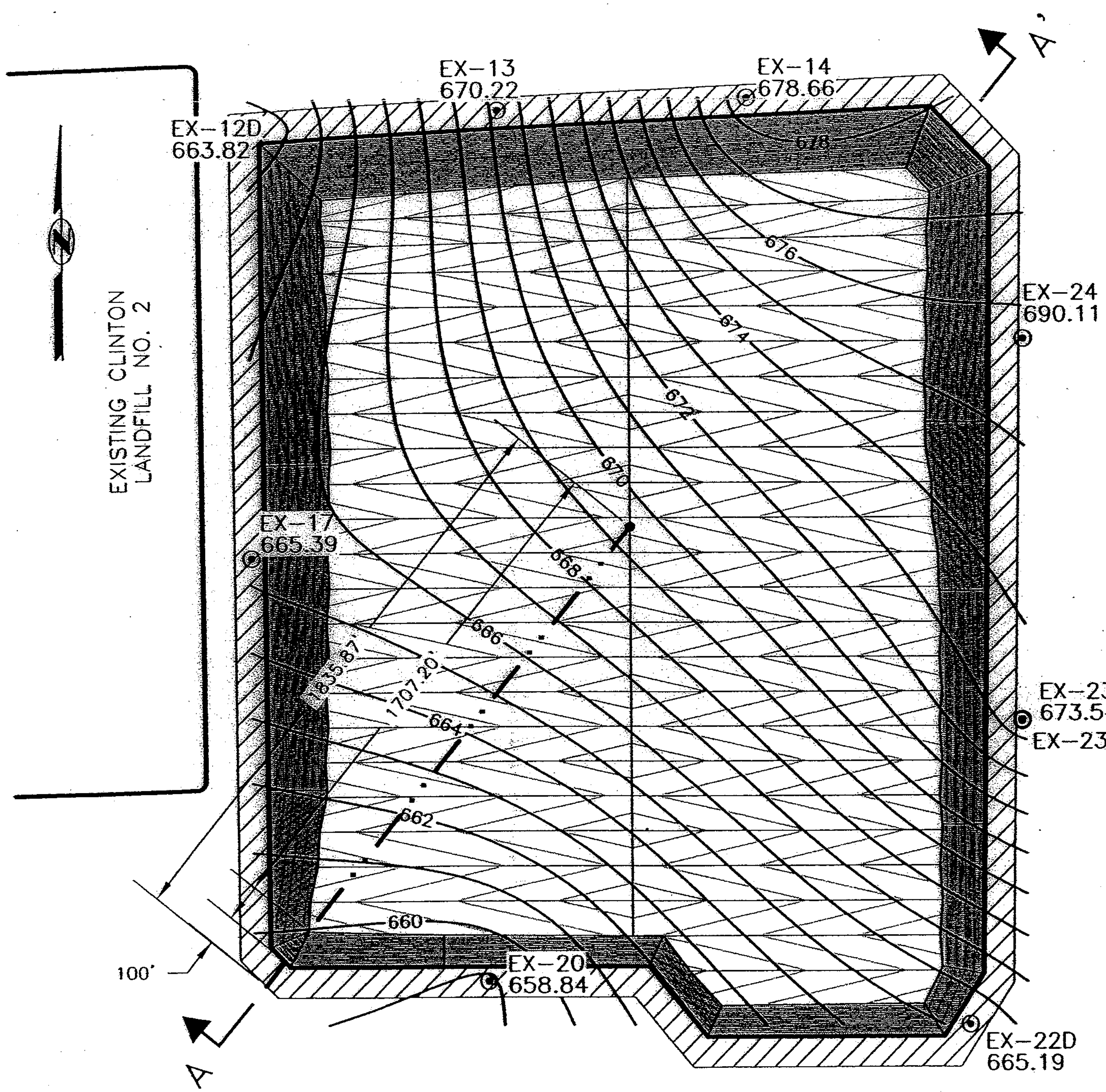
HYDROGEOLOGIC MODEL LOWER RADNOR TILL SAND

CLINTON LANDFILL NO. 3

CLINTON, ILLINOIS

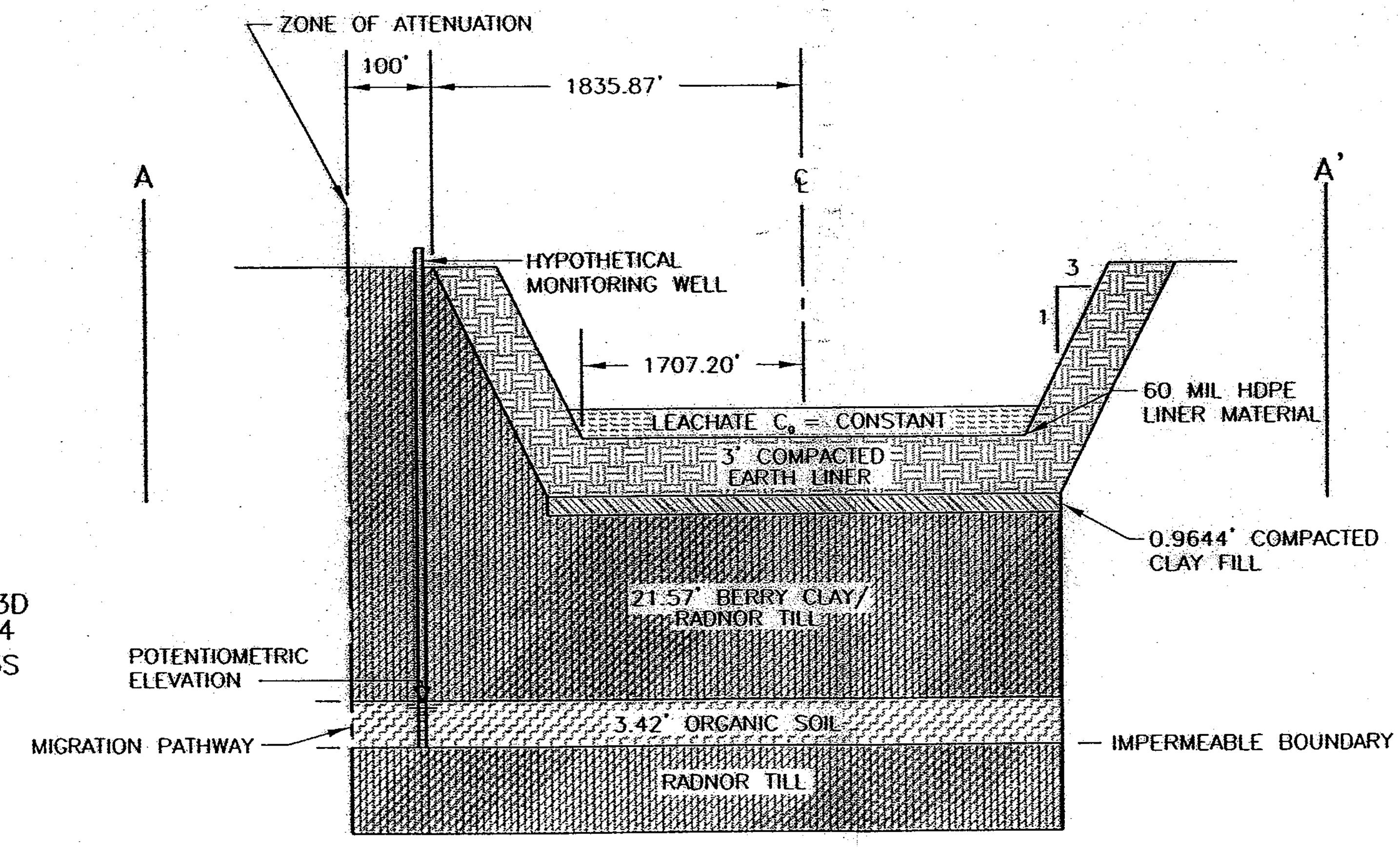
PROJECT NO. 91-118.02

CAD DWG NO:911181009 EMPLOYEE NO: 89736 DATE/TIME: 02/26/05 15:37 ACAD-15.



LANDFILL INVERT PLAN

NOT TO SCALE



SECTION A-A'

NOT TO SCALE

LEGEND

⊙	PIEZOMETER SCREENED IN ORGANIC SOIL
665.19	MEAN POTENTIOMETRIC ELEVATION (ORGANIC SOIL, FEET – MSL)
—660—	MEAN POTENTIOMETRIC ELEVATION CONTOUR LINE (ORGANIC SOIL, FEET – MSL)
(hatched)	ZONE OF ATTENUATION

NOTE: MEAN POTENTIOMETRIC ELEVATIONS BASED ON 2003 AND 2004 MONITORING DATA

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FIGURE 812.316-3

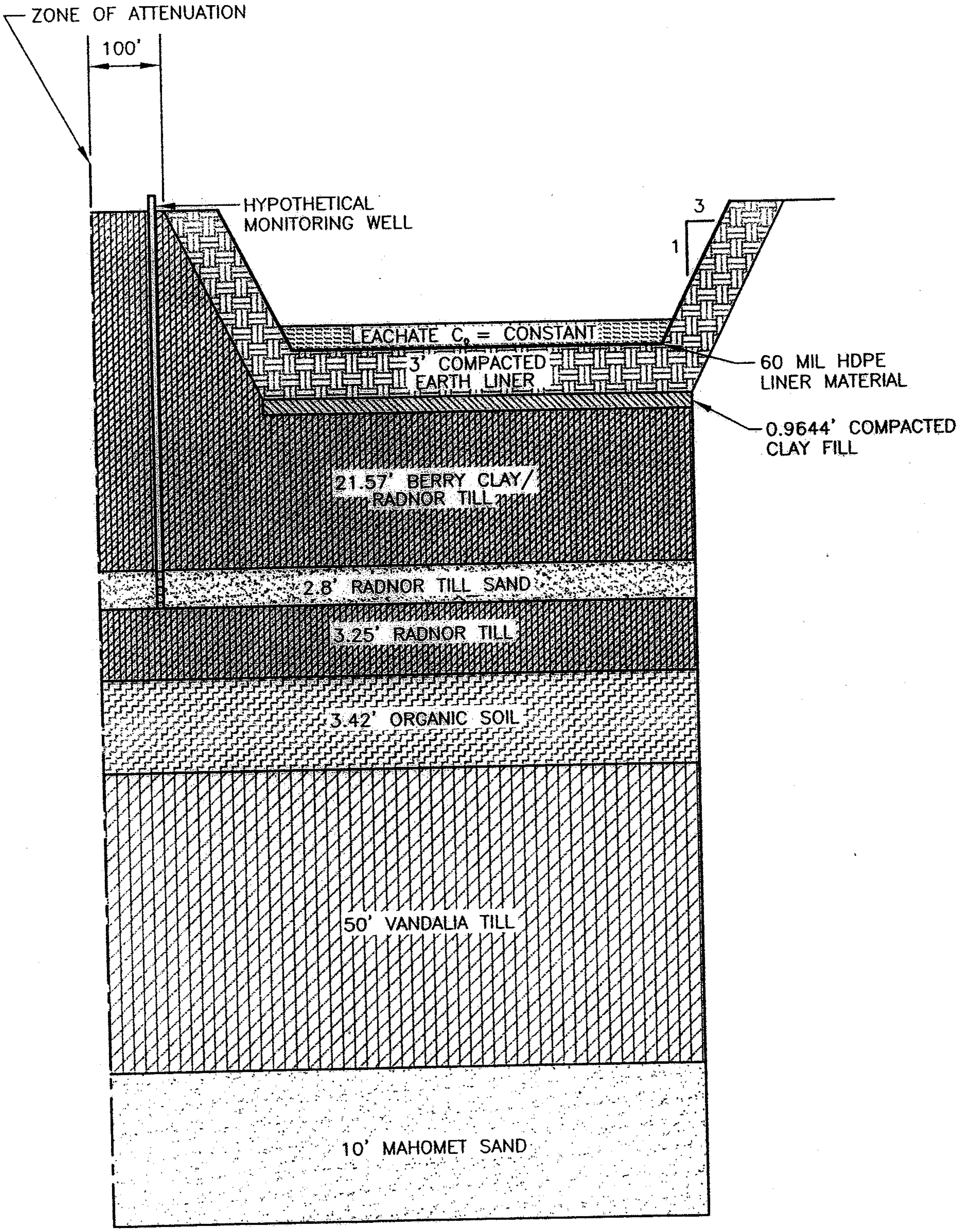
HYDROGEOLOGIC MODEL ORGANIC SOIL

CLINTON LANDFILL NO. 3

CLINTON, ILLINOIS

PROJECT NO. 91-118.02

CAD DWG NO:911181136 EMPLOYEE NO: 9834 DATE/TIME: 06/06/06 10:38 ACAD-15.



NOT TO SCALE

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FIGURE 812.316-4

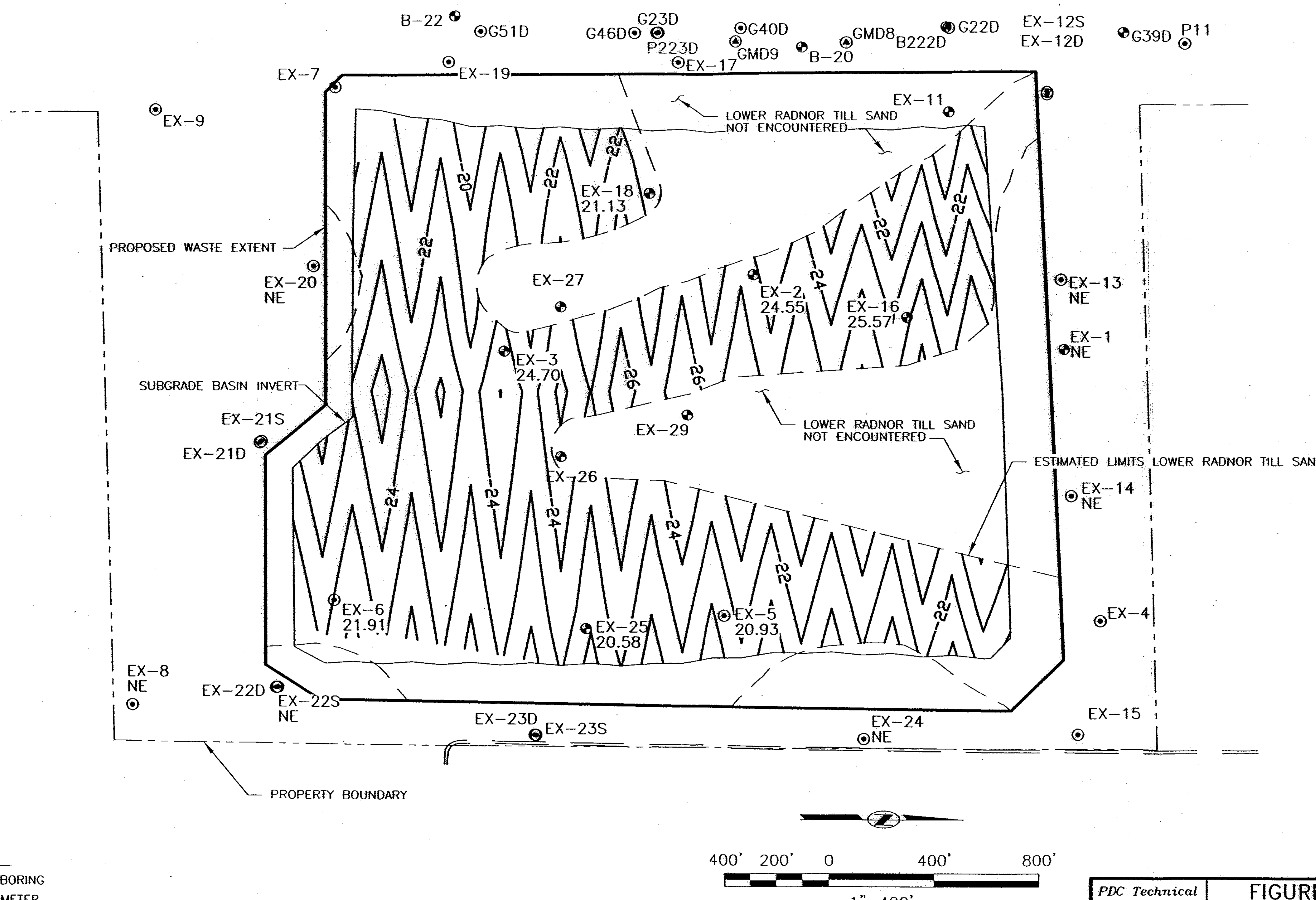
CONCEPTUAL HYDROGEOLOGIC MODEL – MAHOMET SAND

CLINTON LANDFILL NO. 3

CLINTON, ILLINOIS

PROJECT NO. 91-118.02

CAD DWG NO:91118965 EMPLOYEE NO: DATE/TIME: 06/02/06 11:43 ACAD-15.



LEGEND

- SOIL BORING
- PIEZOMETER
- GAS MONITORING DEVICE

21.91 DISTANCE FROM TOP SUBGRADE TO TOP OF LOWER RADNOR TILL SAND (NE = LOWER RADNOR TILL NOT ENCOUNTERED)

—22— DISTANCE FROM SUBGRADE TO LOWER RADNOR TILL SAND (FEET)

NOTE: ONLY THOSE SOIL BORINGS AND PIEZOMETERS THAT EXTEND TO THE EXPECTED ELEVATION OF THE LOWER RADNOR TILL SAND ARE SHOWN

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FIGURE 812.316-5

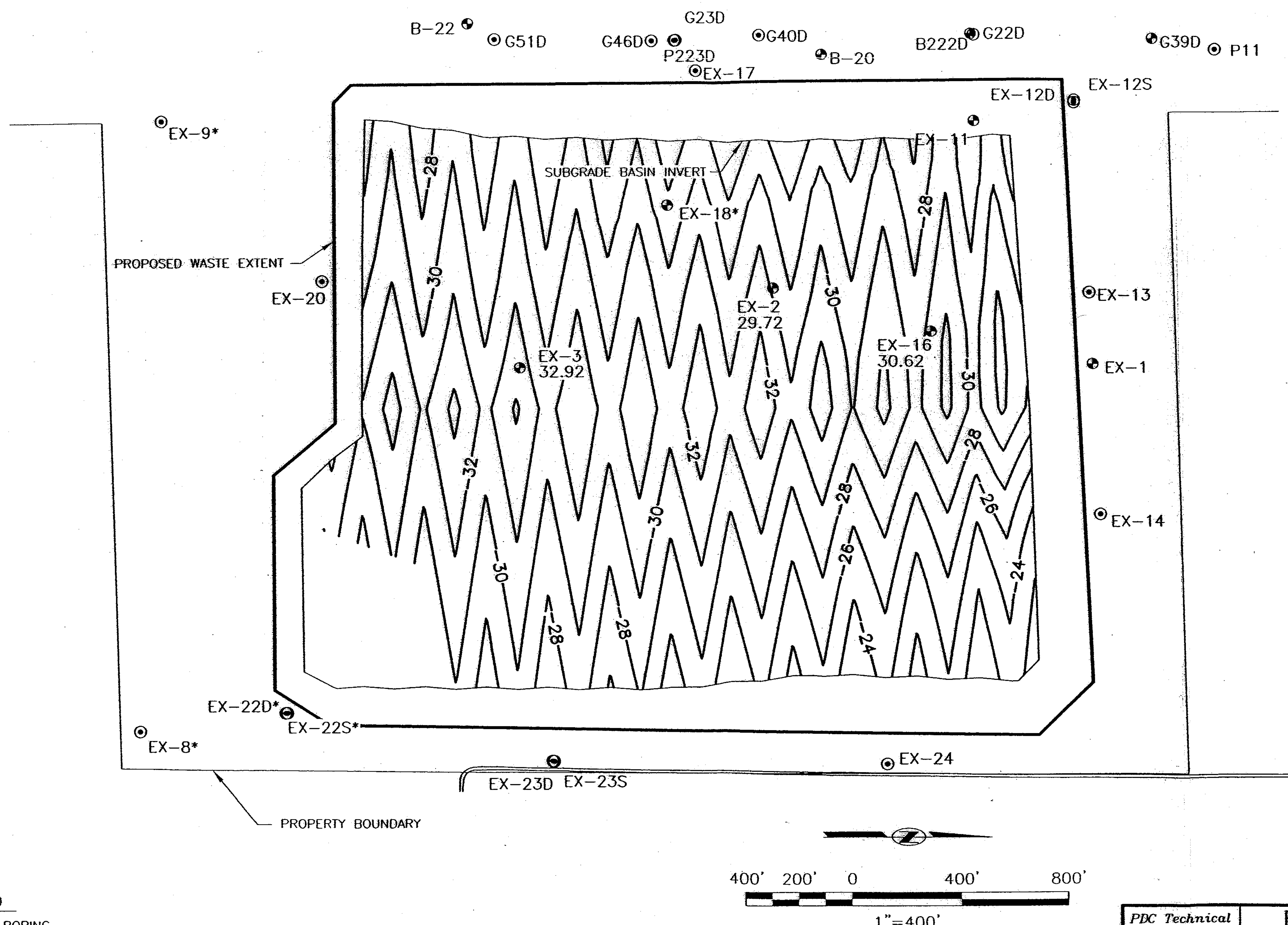
CLAY THICKNESS-SUBGRADE TO TOP OF LOWER RADNOR TILL SAND

CLINTON LANDFILL NO. 3

CLINTON, ILLINOIS

PROJECT NO. 91-118.02

CAD DWG NO:91118971 EMPLOYEE NO: 9834 DATE/TIME: 06/02/06 11:52 ACAD-15.



LEGEND

⊕	SOIL BORING
⊙	PIEZOMETER
32.92	DISTANCE FROM TOP OF SUBGRADE TO TOP OF ORGANIC SOIL (NE = ORGANIC SOIL NOT ENCOUNTERED)
EX-8*	BERRY CLAY NOT ENCOUNTERED BUT ORGANIC SOIL WAS ENCOUNTERED
—30—	DISTANCE FROM TOP OF SUBGRADE TO ORGANIC SOIL (FEET)
NOTE:	ONLY THOSE SOIL BORINGS AND PIEZOMETERS THAT EXTEND TO THE EXPECTED ELEVATION OF THE ORGANIC SOIL ARE SHOWN

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Peoria, Illinois

FIGURE 812.316-6

CLAY THICKNESS-SUBGRADE TO TOP OF ORGANIC SOIL

CLINTON LANDFILL NO. 3

CLINTON, ILLINOIS

PROJECT NO. 91-118.02

APPENDIX N.2

GROUNDWATER IMPACT ASSESSMENT INPUT PARAMETER BACKUP, MODEL RUNS, AND ADDITIONAL INFORMATION PROVIDED TO THE IEPA

Shaw®


area®
GROUNDWATER IMPACT
ASSESSMENT INPUT
PARAMETER BACKUP,
MODEL RUNS, AND
ADDITIONAL INFORMATION
PROVIDED TO THE IEPA