ATTACHMENT 2

Shaw®

POLYCHLORINATED BIPHENYLS (PCBs)

GROUNDWATER MODEL ASSESSMENT

Shaw®

POLYCHLORINATED BIPHENYLS (PCBs) GROUNDWATER MODEL ASSESSMENT

Introduction

After reviewing the hydrogeologic setting and proposed design of the Chemical Waste Unit (CWU) and to simplify the groundwater model, it was determined that contaminant transport would conservatively be modeled vertically through the 3-foot recompacted clay liner (1×10^{-7} cm/sec), excluding the other components of the liner system and the underlying geology. The PCBs concentration (set at 500 parts per million (ppm)) in leachate would be applied directly to the top of the 3-foot recompacted clay liner. A one dimensional POLLUTE model assessing the clay liner as a possible migration pathway was created for the proposed CWU.

Groundwater Model Input

The following information documents the assumptions and values used for the model. The model represents the anticipated site conditions. The assumptions and values are based on the actual design and Construction Quality Assurance Plan proposed for the CWU and the information obtained from numerous site investigations. When site specific information was not available, appropriate and conservative values from literature were used. The input parameters for the groundwater model are identified in Table 1.

All model input must have consistent units. Each of the model input parameters are discussed briefly in the following paragraphs. Documentation for model input parameters is included within this Attachment.

Model Length

As discussed earlier, one (1) layer will be modeled at the site, the 3-foot recompacted clay liner (1.0×10^{-7} cm/sec). The model length is the thickness of the clay liner (3 feet or 0.9144 meters). Although the model has been set up assuming an infinite bottom boundary, the model was evaluated at the base of the recompacted clay liner.

Initial Leachate Concentration

The initial leachate concentration input used was 500 ppm. Clinton Landfill, Inc. has agreed to not accept PCB wastes at concentrations greater than 500 ppm. The actual expected concentration of PCBs in the leachate at the proposed CWU will be much lower (likely more than 100,000 times less) than 500 ppm but to be conservative the maximum concentration was used in the model. The model results represent the PCB concentration in ppm.

Number of Layers

As discussed above, one layer will be modeled at the site, the 3-foot recompacted clay liner. POLLUTE also allows a layer to be subdivided so that the predicted concentration distribution within a layer can be evaluated. The recompacted clay liner was divided into 3 sublayers (a sublayer for every foot of the clay liner (1,2, and 3 feet or 0.3048, 0.6096, and 0.9144 meters).

TABLE 1
POLLUTE MODEL INPUT PARAMETER VALUES

Parameter	**Value**	**Notes**	**Data**
Model Length (L)(m)	0.9144	Total Length of Recompacted Clay Liner	1,2
Initial Concentration (ppm or mg/L)	500	Maximum Concentration of PCB Wastes	2,3
Number of Layers	1	Total Number of Modeled Layers	1,2
Modeling Period (years)	1,000		2
TALBOT PARAMETERS			
TAU	7	Talbot Parameters for the Numerical Inversion of the Laplace Transform	2
Sigma	0		2
RNU	2		2
N	20		2
Recompacted Clay Liner			
Sublayers	3	Model Parameter	2
Thickness (b) (m)	0.9144	Design Specification	1,2
Effective Porosity (n)	0.24	Average Effective Porosity from Laboratory Results for the Clinton Landfill No. 2 Recompacted Clay Liner	1,2
Partitioning Coefficient (K_d) (Kg/m^3)	6.413	Calculated from $k_{oc} \times f_{oc}$	1,2
Degradation (λ)	0.0	No Degradation Modeled	2,3
Density (ρ) (Kg/m^3)	1,970	Average Density from Laboratory Results for the Clinton Landfill No. 2 Recompacted Clay Liner	1,2
Vertical Darcy Velocity (m/yr)	0.042	Assuming 1 foot of Leachate Head on the Recompacted Clay Liner	2,3
Horizontal Darcy Velocity (m/yr)	0.0	Assuming Vertical Flow in Liner (only)	1,2
Effective Diffusion Coefficient (D^*) (m^2/yr)	0.017	Based on Average Free-Solution Diffusion Coefficient for PCBs	2,3
Mechanical Dispersion Coefficient (D_m) (m^2/yr)	0.017	$D_m = D^*$ (Dispersion was set equal to diffusion due to the low seepage rate out of the liner, dispersion will be dominated by diffusion)	2,3
Coeff. of Hydrodynamic Dispersion (D) (m^2/yr)	0.017	$D = D^*$ (Due to the low seepage rate, dispersion will be dominated be diffusion)	2,3

Explanation of Data:
1. Value is based on actual anticipated site conditions
2. Value is required model input parameter
3. Value is conservative value which will result in higher predicted concentrations than the actual anticipated site conditions

Advective (Darcy) Velocity

POLLUTE requires the input of a Darcy velocity, which was calculated across the 3-foot recompacted clay liner. The Darcy velocity (0.042 m/yr) was determined by multiplying the gradient (1.33)(4 feet (l foot of leachate head + 3 feet of clay liner)/3 feet (thickness fo the clay liner) = 1.33) across the clay liner by the hydraulic conductivity of the clay liner (1.0 x 10^{-7} cm/sec).

Modeling Period

The modeling period was set at 1,000 years.

Talbot Parameters

POLLUTE uses a Laplace transform to find the solution to the advection-dispersion equation. The numerical inversion of the Laplace transform depends on the Talbot parameters. The model provides default values for the Talbot parameters or they can be selected by the user. The default Talbot parameters were used in this groundwater model.

Boundary Conditions

POLLUTE requires the specification of an upper and lower boundary condition. The top boundary condition typically represents the landfill as a potential source. When modeling the landfill as a surface boundary, the concentration of each constituent in leachate can be assumed to be constant or a specific mass can be assumed to be present. Assuming a specific mass results in a decreasing source concentration over time, which would most accurately represent the fact that leachate concentrations in landfills with leachate collection and removal systems will gradually decrease over time. However, a constant concentration was assumed as it results in conservative model results.

The lower boundary condition was specified as an infinite bottom layer. This boundary condition assumes that horizontal flow can continue to any distance, which allows for realistic analysis of conditions at the base of the recompacted clay liner.

Hydrodynamic Dispersion Coefficient

POLLUTE requires the input of a hydrodynamic dispersion coefficient for each layer. Table 1 lists the model input dispersion coefficient value for the recompacted clay liner. Dispersion will be dominanted by diffusion due to the low outward Darcy velocity (0.042 m/yr). An input of 0.017 m^2/y (Lesage and Jackson, 1992) was used to represent the effective diffusion coefficient in the 3-foot recompacted clay liner. This value is the average free-solution diffusion coefficient for PCBs. Documentation of the average free-solution diffusion coefficient is provided in this Attachment.

Effective Porosity and Dry Density Input

Table 1 lists the effective porosity and dry density values for the recompacted clay liner. The effective porosity value for the recompacted clay liner (0.24) was obtained from laboratory data for the Clinton No.2 Landfill recompacted clay liner, which has been provided in this Attachment. The density value was also obtained from laboratory data for the Clinton No.2 Landfill recompacted clay liner.

Partitioning Coefficient

The partitioning coefficient (K_d)($K_d = K_{oc} x f_{oc}$) was used to simulate retardation of constituents in the recompacted clay liner. The partitioning coefficient (K_d) is specific to each particular compound and its respective partition coefficient between organic carbon and water (K_{oc}) and the recompacted clay liner organic carbon content (f_{oc}). The partitioning coefficient (K_d) was calculated to be 6,413 mg/L or 6.413 Kg/m^3 (K_d = 5.3 x 10^5 mg/L x 1.21% or 0.0121 = 6,413 mg/L). The clay from the Tiskilwa Formation will be used for construction of the recompacted clay liner. The average organic carbon content (f_{oc}) for the Tiskilwa Formation was 1.21% or 0.0121. The partition coefficient of PCBs between organic carbon and water (K_{oc}) was 5.3 x 10^5 mg/L. The documentation for the organic carbon content (f_{oc}) and partition coefficient of PCBs between organic carbon and water (K_{oc}) is provided in this Attachment.

Degradation

Degradation is used to simulate degradation of constituents in the subsurface. Degradation is specific to each particular compound.

Although degradation can play a significant role in reducing the migration of numerous constituents in groundwater, it is conservatively assumed that degradation is not present.

Model Evaluation Distance

The model evaluation distance is not a model input parameter. However, this distance is needed in order to evaluate the results of the groundwater model since the model only provides results for specified distances. The model was evaluated at the three points (1,2, and 3 feet or 0.3048, 0.6096, and 0.9144 meters) in the recompacted clay liner.

Model Results

The POLLUTE output for the PCBs groundwater model assessment is included in this Attachment. The model predicted PCB concentrations, for the entire 1,000 year simulation period, at the base of the recompacted clay liner (3 feet or 0.9144 meters) is 0.0 ppm. Predicted concentrations at 1 and 2 feet were 4.48 x 10^{-15} ppm and 1.10 x 10^{-33} ppm, respectively.

The PCBs groundwater model assessment indicates that PCBs will not migrate out of the 3 foot recompacted clay liner even after 1,000 years and therefore will not impact the local or regional groundwater resources (including the Mahomet Aquifer).

It should be noted that the model discussed above is extremely conservative (resulting in higher predicted concentrations) and did not include the additional 150 feet of in-situ clay or incorporate the three layers of 60-mil thick HDPE geomembrane or the geocomposite clay liner. Additionally, the initial leachate concentration was conservatively set at 500 ppm, the actual expected concentration of PCBs in the leachate at the proposed CWU will be much lower (likely more than 100,000 times less) than 500 ppm.

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PCBs GROUNDWATER MODEL DOCUMENTATION

Shaw®

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Clinton Landfill #3 (Compacted Clay Liner)

POLLUTE VERSION 6.3
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     THE DARCY VELOCITY (Flux) THROUGH THE LAYERS  Va =   0.4200E-01      m/a
       (Positive for down or into the layer)



                              PROPERTIES OF THE MATRIX

Layer  No. Of  Coefficient    Matrix   Distribution/     Dry       Layer
  No. Sublayer Hydrodynamic  Porosity  Partitioning    Density   Thickness
               Dispersion              Coefficient
                   m2/a                    m3/kg         kg/m3        m
------------------------------------------------------------------------------
   1      3    0.17000E-01   0.24000   0.6413E+01   1970.0000   0.9144E+00



The TOP and BOTTOM BOUNDARY CONDITIONS
are  defined by CODES  Top = 2  Bottom = 4
See below for details

CODE        TOP                         BOTTOM
   =       Zero Flux                    Zero Flux
 2 =       C = Const.                  C = Const2.
 3 =       Finite Mass            Fixed Outflow Velocity
 4 =                              Infinite Bottom Layer
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 Initial Source Concentration      C0 =    0.5000E+03     mg/L

There is no Radioactive or Biological Decay being Considered


The Parameters used to Invert the Laplace Transform are
TAU = 0.700E+01 N =     20 SIG = 0.000E+00 RNU = 0.200E+01



CALCULATED CONCENTRATIONS AT SELECTED DEPTHS AND TIMES


   TIME        DEPTH    CONCENTRATION
    yr           m          mg/L
=================================================================================


0.2500E+03 0.0000E+00  0.5000E+03
           0.3048E+00  0.0000E+00
           0.6096E+00  0.0000E+00
           0.9144E+00  0.0000E+00

0.5000E+03 0.0000E+00  0.5000E+03
           0.3048E+00  0.2403E-22
           0.6096E+00  0.6019E-49
           0.9144E+00  0.0000E+00

0.7500E+03 0.0000E+00  0.5000E+03
           0.3048E+00  0.9697E-17
           0.6096E+00  0.5309E-39
           0.9144E+00  0.0000E+00

0.1000E+04 0.0000E+00  0.5000E+03
           0.3048E+00  0.4481E-14
           0.6096E+00  0.1102E-32
           0.9144E+00  0.0000E+00 ← BASE OF 3 FOOT RECOMPACTED CLAY LINER
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NOTICE

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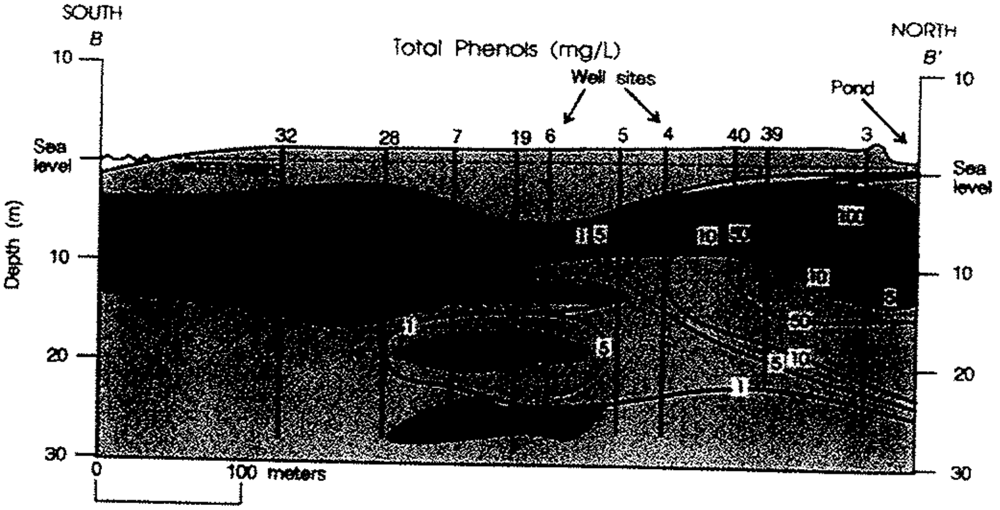
Groundwater Contamination and Analysis at Hazardous Waste Sites



edited by

Suzanne Lesage **Richard E. Jackson**

e groundwater has
r chlorine isomers.
or PCB sorbed on
elative concentra-
solution processes

not been reported
d aquatic systems
degrading PCBs.
present in shallow
nditions, nutrient
it cannot be deter-
However, aerobic
certainly proceed
es, owing to lower
rganic substrates.
the environment
patterns in PCB-
.. These GC
chlorine isomers
somers compared
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environmental conditions for degradation can occur in groundwater systems. If anaerobic biodegradation reactions do occur in groundwater, the loss of the higher chlorine isomers and associated formation of the lower chlorine isomers would be similar to that expected due to attenuation of dissolved PCB concentrations by sorption. This may make identification of anaerobic biodegradation in the subsurface difficult.

C. Matrix Diffusion

In fractured rock environments there is a greater potential for extensive migration of dissolved PCBs in groundwater because groundwater velocities are frequently much higher than in porous media, and the potential for sorption of PCBs on the materials composing the fracture surfaces is generally lower than in porous media. Nevertheless, fractured sedimentary rocks such as sandstones, shales, and carbonates frequently do have a substantial matrix porosity (5–20%), and the diffusion of PCBs into the matrix will reduce concentrations in the groundwater flowing through the fractures [19–21]. The attenuation of PCBs by matrix diffusion will be substantially enhanced as a result of sorption on the matrix solids.

The degree of attenuation of PCB migration through fractured media will depend on the diffusivity of the PCB compounds and the degree of sorption. Lower chlorine PCB isomers will have slightly higher diffusivities than higher chlorine isomers because of their lower molecular weights. Aqueous diffusion coefficients for PCB isomers were estimated from the measured diffusion coefficient of benzene and the relative molecular weight of benzene and the PCB isomers [22,23]. The estimated aqueous diffusion coefficient for Cl_1 isomers is approximately 50% greater than that for Cl_8 isomers (see Table 2). The higher the diffusion coefficient, the higher the potential

Table 2 Estimated Free-Solution Diffusion Coefficients for PCB Isomers

PCB isomer	Free-solution diffusion coefficient at 20°C (m²/sec)
Cl_1	6.4×10^{-10}
Cl_2	6.2×10^{-10}
Cl_3	5.8×10^{-10}
Cl_4	5.5×10^{-10}
Cl_5	5.3×10^{-10}
Cl_6	5.1×10^{-10}
Cl_7	4.8×10^{-10}
Cl_8	4.7×10^{-10}
Chloride	2.0×10^{-9}

AVERAGE = 5.48×10^{-10} m²/SEC

= 0.017 m²/YEAR

SOILS DATA FOR INITIAL FILL AREA LINER
CLINTON LANDFILL, INC. #2

BORING/LOCATION		SAMPLE ELEV., ft-msl	MATERIAL	DRY DENSITY lb/cu.ft	DRY DENSITY g/c.c.	VOID RATIO	POROSITY	VERT. K cm/s
EAST HALF								
East Berm	N5201/E7590	686.8	CL	129.1	2.068	0.3059	0.234	1.01E-08
South Berm	N5059/E7286	683.3	CL	125.6	2.012	0.3420	0.255	4.43E-09
Floor	N5151/E7306	680.0	CL	130.1	2.084	0.3144	0.239	1.22E-08
Floor	N5261/E7456	675.0	CL	127.4	2.041	0.3325	0.250	4.97E-08
Floor	N5300/E7496	680.0	CL	117.9	1.889	0.4300	0.301	1.12E-08
Floor	N5355/E7276	681.0	CL	122.7	1.965	0.3737	0.272	6.36E-09
Sidewall	N5410/E7476	693.0	CL	106.2	1.701	0.5869	0.370	1.39E-09
Points below 3 foot thick earth liner:								
B-1	N5092/E7212	671.0	CL	123.9	1.985	0.3606	0.265	1.82E-08
B-2	N5100/E7284	670.4	CL	124.1	1.988	0.3580	0.264	1.5E-08
B-4	N5100/E7473	668.6	MH	83.8	1.342	0.9960	0.499	1.65E-06
B-5	N5231/E7210	669.9	CL	128.4	2.057	0.3123	0.238	7E-09
B-6	N5230/E7269	670.0	CL	124.8	1.999	0.3503	0.259	9.52E-09
B-7	N5233/E7368	670.9	CL	128	2.050	0.3172	0.241	1.05E-08
B-9	N5229/E7580	691.0	CL	120.4	1.929	0.3997	0.286	5.28E-08
B-10	N5360/E7224	671.4	CL	125.7	2.014	0.3408	0.254	1.08E-08
B-11	N5360/E7282	670.8	CL	126.2	2.022	0.3359	0.251	9.21E-09
B-12	N5355/E7361	671.0	CL	123.2	1.974	0.3685	0.269	7.53E-09
B-13	N5360/E7476	671.0	CL	123.2	1.974	0.3680	0.269	4.41E-07
B-14	N5421/E7376	690.5	CL	116	1.858	0.4536	0.312	1.35E-08
WEST HALF								
th Berm		697 - 699	CL	128.4	2.057	0.333	0.250	1.5E-08
uth Berm		687 - 689	CL	128.9	2.065	0.326	0.246	1.7E-08
Floor	40' W of E berm, 150' S of N berm	676.8 - 678.8	CL	122.8	1.967	0.468	0.319	8.4E-09
Floor	150' S of N berm, 150' E of W berm	680 - 682	CL	122.8	1.967	0.484	0.326	1.1E-08
West Berm	150' S of N berm	693 - 695	CL	135.0	2.163	0.418	0.295	1.1E-08
North Berm	100 E of W berm	697 - 699	CL	122.8	1.967	0.495	0.331	2.7E-08
West Berm	120' S of N berm	680 - 682	CL	111.2	1.781	NM	–	3.7E-08
West Berm	230' S of N berm	682 - 684	CL	118.2	1.893	NM	–	6E-09
Points below 3 foot thick earth liner:								
Boring T-2	N5319/E7009	675.2	CL	121.4	1.945	NM	NM	1.6E-08
Boring T-3	N5321/E7092	675.6	CL	126.4	2.025	NM	NM	3.1E-08
Boring T-4	N5224/E6926	680.5	CL	111.1	1.780	NM	NM	3.4E-08
Boring T-7	N5090/E6927	677	CL	119.7	1.917	NM	NM	3.7E-08

Notes:

1. NM = not measured; Elev. ft-msl = elevation in feet above mean sea level
2. lb/cu.ft = pounds per cubic feet; g/c.c. = grams per cubic centimeter; cm/s = centimeters per second
3. Vert. K = vertical hydraulic conductivity (permeability)
4. Reference: Liner Certification Reports for Initial Fill Area by SKS.

Vertical Permeability of Clay Liner and In-Situ Soil Below Liner - Initial Fill Area

Clinton Landfill #2

Type of Liner	Location	Boring	Northing ft	Easting ft	Sample Elevation ft	Dry Density lb/cu.ft	Porosity		Vertical Permeability Kv, cm/s	Kv, cm/s Recompa-cted Clay Liner	Kv, cm/s In-Situ S Below Liner
East Half											
In-situ	Floor	B-1	5092	7212	671.0	123.9	0.265		1.82E-08		1.82E-08
In-situ	Floor	B-2	5100	7284	670.4	124.1	0.264		1.5E-08		1.5E-08
In-situ	Floor	B-4	5100	7473	668.6	83.8	0.499		1.65E-06		
In-situ	Floor	B-5	5231	7210	669.9	128.4	0.238		7.0E-09		7.0E-09
In-situ	Floor	B-6	5230	7269	670.0	124.8	0.259		9.52E-09		9.52E-09
In-situ	Floor	B-7	5233	7368	670.9	128.0	0.241		1.05E-08		1.05E-08
In-situ	Sidewall	B-9	5229	7580	691.0	120.4	0.286		5.28E-08		5.28E-08
In-situ	Floor	B-10	5360	7224	671.4	125.7	0.254		1.08E-08		1.08E-08
In-situ	Floor	B-11	5360	7282	670.8	126.2	0.251		9.21E-09		9.21E-09
In-situ	Floor	B-12	5355	7361	671.0	123.2	0.269		7.53E-09		7.53E-09
In-situ	Floor	B-13	5360	7476	671.0	123.2	0.269		4.41E-07		
In-situ	Sidewall	B-14	5421	7376	690.5	116.0	0.312		1.35E-08		1.35E-08
Recompacted	East Berm		5201	7590	686.8	129.1	0.234		1.01E-08		
Recompacted	South Berm		5059	7286	683.3	125.6	0.255		4.43E-09		
Recompacted	Floor		5151	7306	680.0	130.1	0.239		1.22E-08	1.22E-08	
Recompacted	Floor		5261	7456	675.0	127.4	0.250	*	4.97E-08	4.97E-08	
Recompacted	Floor		5300	7496	680.0	117.9	0.301		1.12E-08	1.12E-08	
Recompacted	Floor		5355	7276	681.0	122.7	0.272		6.36E-09	6.36E-09	
Recompacted	Sidewall		5410	7476	693.0	106.2	0.370		1.39E-09		
West Half											
Recompacted	North Berm				698.0	128.4	0.250		1.5E-08		
Recompacted	South Berm				688.0	128.9	0.246		1.7E-08		
compacted	Floor		40' W of E berm, 150' S of N berm		677.8	122.8	0.319		8.4E-09	8.4E-09	
ecompacted	Floor		150' S of N berm, 150' E of W berm		681.0	122.8	0.326	*	1.1E-08	1.1E-08	
Recompacted	West Berm		150' S of N berm		694.0	135.0	0.295		1.1E-08		
Recompacted	North Berm		100 E of W berm		698.0	122.8	0.331		2.7E-08		
Recompacted	West Berm	ST1	120' S of N berm		681.0	111.2	NM		3.7E-08		
Recompacted	West Berm	ST2	230' S of N berm		683.0	118.2	NM		6.0E-09		
In-situ	Floor	T-2	5319	7009	675.2	121.4	NM		1.6E-08		1.6E-08
In-situ	Floor	T-3	5321	7092	675.6	126.4	NM		3.1E-08		3.1E-08
In-situ	Floor	T-4	5224	6926	680.5	111.1	NM		3.4E-08		3.4E-08
In-situ	Floor	T-7	5090	6927	677.0	119.7	NM		3.7E-08		3.7E-08
					Mean Kv =				8.36E-08	1.65E-08	1.94E-08

Results

Mean Kv of Recompacted Soil Liner (Floor Only) = 1.65E-08 cm/s

Mean Kv of In-Situ Soil Below Recompacted Clay Liner = 1.94E-08 cm/s

Mean Porosity of Recompacted Clay Liner = 0.288 * 0.29

Mean Porosity of In-Situ Soil Below Clay Liner = 0.264

Mean Dry Density of Recompacted Clay Liner = 122.9 lb/cu.ft

Mean Dry Density of In-Situ Soil Below Clay Liner = 122.8 lb/cu.ft

* ESTIMATED EFFECTIVE POROSITY =
0.29 - 0.29 x 0.159
= 0.24

Notes:

1. B-1 = Boring #B-1; ST1 = Shelby Tube #ST-1; T-1 = Boring #T-1
2. If in-situ soil Kv values are greater than 1.0E-07, the corresponding Kv and dry density values were not used in calculating mean, because recompacted liner was installed at those locations.
3. NM = Not measured
4. cm/s = centimeters per second; lb/cu.ft = pounds per cubic feet
5. Reference: Liner Certification Reports for Initial Fill Area by SKS.

* MAXIMUM EFFECTIVE POROSITY =
0.33 - 0.33 X 0.159
= 0.28

* MINIMUM EFFECTIVE POROSITY
0.24 - 0.24 X 0.159
= 0.20

TABLE 812.314-3
TOTAL ORGANIC CONTENT
FROM SELECTED BORINGS
Clinton Landfill No. 3

Boring ID Number	Geologic Unit	Sample Elev. (ft-MSL)	Date Collected	Total Organic Content (%)	
EX-14	Berry Clay	659	12/16/2002	8.8	
	Radnor Till	642	12/16/2002	1.4	
EX-13	Roxanna Silt	671	12/20/2002	10.0	
	Radnor Till	655.5	12/20/2002	1.8	
	Berry Clay	661.5	12/20/2002	1.8	
	Organic Soil	633	12/23/2002	3.0	
EX-12	Berry Clay	660	12/27/2002	2.0	
EX-17	Berry Clay	657	1/3/2003	2.0	
EX-15	Tiskilwa Formation	673	1/7/2003	0.94	←
	Berry Clay	662	1/7/2003	1.8	
	Radnor Till	657	1/7/2003	0.93	
	Radnor Till	646	1/7/2003	0.53	
EX-24	Radnor Till	643	1/9/2003	0.54	
	Sangamon Soil	636	1/9/2003	3.7	
EX-16	Tiskilwa Formation	672.5	1/15/2003	1.00	←
	Tiskilwa Formation	669.5	1/15/2003	1.1	←
	Roxanna Silt	668	1/15/2003	7.9	
	Organic Soil	634	1/15/2003	7.3	
EX-18	Radnor Till	649	1/20/2003	1.2	
	Radnor Till	641	1/20/2003	0.56	
	Radnor Till	638	1/20/2003	0.49	
	Organic Soil	632	1/20/2003	1.9	
EX-19	Roxanna Silt	663	1/22/2003	2.5	
	Radnor Till	646	1/22/2003	0.57	
EX-20	Roxanna Silt	665	1/31/2003	2.20	
	Radnor Till	645	2/3/2003	1.1	
EX-21	Tiskilwa Formation	690	1/29/2003	1.4	←
	Tiskilwa Formation	675	1/29/2003	1.6	←
	Roxanna Silt	670	1/30/2003	5.7	
	Radnor Till	652	1/30/2003	1.0	
	Radnor Till	643	1/30/2003	0.93	
EX-22	Berry Clay	660	1/28/2003	1.4	
	Radnor Till	655	1/28/2003	2.5	
	Radnor Till	648	1/28/2003	1.3	
	Radnor Till	644	1/28/2003	1.4	

TISKILWA
FORMATION
AVERAGE
TOTAL ORGANIC
CONTENT
1.21%

Notes:

1. Samples collected from 5-foot split-spoon sampler.
2. ft-MSL = feet above Mean Sea Level datum; value was estimated by PDC Technical Services, Inc. field personnel based on ground surface elevation data provided by SKS Engineers, Inc. at the time of sample collection.
3. Total Organic Content = by American Society for Testing and Materials (ASTM) Standard D2974-00 *"Standard Test Methods for Moisture, Ash, and Organic Matter of Peat and Other Organic Soils".*
4. % = Percent

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APPENDIX A (*continued*)

Chemical name	CAS No.	Water solubility (mg l^{-1})	Reference	Vapor pressure (mm Hg)	Reference	Henry's law constant (atm. m^3 mol^{-1})	Reference	K_{oc} (ml g^{-1})	Reference	K_{ow}	Reference
PCB's:											
Aroclor *1016*®	*12674-11-2*	$4.20 \cdot 10^{-1}$	H	$4.00 \cdot 10^{-4}$	I			$5.01 \cdot 10^{4}$	DD	$2.40 \cdot 10^{4}$	H
Aroclor *1221*®	*11104-28-2*	$1.50 \cdot 10$	I	$6.70 \cdot 10^{-3}$	I	$3.24 \cdot 10^{-4}$	DD	$2.75 \cdot 10^{2}$	DD	$1.23 \cdot 10^{4}$	H
Aroclor *1232*®	*11141-16-5*	1.45	I	$4.06 \cdot 10^{-3}$	I	$8.64 \cdot 10^{-4}$	DD	$6.76 \cdot 10^{2}$	DD	$1.58 \cdot 10^{3}$	I
Aroclor *1242*®	*53469-21-9*	$2.40 \cdot 10^{-1}$	G	$4.10 \cdot 10^{-4}$	G	$5.60 \cdot 10^{-4}$	G	$5.13 \cdot 10^{3}$	DD	$1.29 \cdot 10^{4}$	I
Aroclor *1248*®	*12672-29-6*	$5.40 \cdot 10^{-2}$	G	$4.90 \cdot 10^{-4}$	G	$3.50 \cdot 10^{-3}$	G	$4.37 \cdot 10^{4}$	DD	$5.62 \cdot 10^{5}$	I
Aroclor *1254*®	*11097-69-1*	$1.20 \cdot 10^{-2}$	G	$7.70 \cdot 10^{-5}$	G	$2.70 \cdot 10^{-3}$	G	$4.25 \cdot 10^{4}$	E	$1.07 \cdot 10^{6}$	I
Aroclor *1260*®	*11096-82-5*	$2.70 \cdot 10^{-3}$	G	$4.10 \cdot 10^{-5}$	G	$7.10 \cdot 10^{-3}$	G	$2.63 \cdot 10^{6}$	DD	$1.38 \cdot 10^{7}$	I
Polychlorinated biphenyls (PCB's)	*1336-36-3*	$3.10 \cdot 10^{-2}$	A	$7.70 \cdot 10^{-5}$	A	$1.07 \cdot 10^{-3}$	A	$5.30 \cdot 10^{5}$	A	$1.10 \cdot 10^{6}$	A
Ethers:											
Bis(*2*-chloroethyl)ether	*111-44-4*	$1.02 \cdot 10^{4}$	A	$7.10 \cdot 10^{-1}$	A	$1.31 \cdot 10^{-5}$	A	$1.39 \cdot 10$	A	$3.16 \cdot 10$	A
Bis(*2*-chloroisopropyl)ether	*108-60-1*	$1.70 \cdot 10^{3}$	A	$8.50 \cdot 10^{-1}$	A	$1.13 \cdot 10^{-4}$	A	$6.10 \cdot 10$	A	$1.26 \cdot 10^{2}$	A
Bis(*2*-chloroethoxy)methane	*111-91-1*	$8.10 \cdot 10^{4}$	I	$< 1.0 \cdot 10^{-1}$	I	$3.78 \cdot 10^{-7}$	DD	$1.15 \cdot 10^{2}$	DD	$1.82 \cdot 10$	DD
2-Chloroethyl vinyl ether	*110-75-8*	$1.50 \cdot 10^{4}$	H	$2.67 \cdot 10$	H	$2.50 \cdot 10^{-4}$	Q	6.61	DD	$1.90 \cdot 10$	I
4-Chlorophenyl phenyl ether	*7005-72-3*	3.30	H	$2.70 \cdot 10^{-3}$	I	$2.19 \cdot 10^{-4}$	X	$3.98 \cdot 10^{3}$	DD	$1.20 \cdot 10^{4}$	H

CAS = Chemical Abstract Service; solubility and vapor pressure values are given for a temperature range of 20–30°C. K_{oc} refers to the organic carbon partition coefficient. K_{ow} refers to the octanol–water partition coefficient.

References: A = U.S.E.P.A. (1986b) measured values; B = U.S.E.P.A. (1986b) calculated values; C = Shifrin (1986) measured values; D = Shifrin (1986) calculated values; E = Kenaga and Goring (1978); F = Alford-Stevens (1986); G = Lyman et al. (1982); H = Callahan et al. (1979) measured values; I = Callahan et al. (1979) estimated values; J = Windholz et al. (1983); K = Dean (1979); L = U.S.C.G. (1978); M = Leo et al. (1971); N = Hunt et al. (1988a); O = Mackay et al. (1982); P = Jury et al. (1984); Q = Schwille (1988); R = NIOSH (1987); S = Riddick and Burger (1970); T = J.L. Wilson and Conrad (1984); U = A.S.T.M. (1985); V = Chou and Griffin (1983); W = *Cole-Parmel® Catalog* (1989/1990); X = calculated values; Y = *Ashland® Product Catalog* (1986); Z = M.R. Anderson (1988); AA = A.P.I. (1989); BB = NIPER (National Institute for Petroleum and Energy Research), Bartlesville, Oklahoma (pers. commun., 1989); CC = Chevron®, San Francisco, California (pers. commun., 1989); DD = Montgomery and Welkom (1990).

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