## **APPENDIX I**

## EVALUATION OF HYDRAULIC PERFORMANCE FOR SCA DESIGN

## **GEOSYNTEC CONSULTANTS**

### COMPUTATION COVER SHEET

Client: Honeywell Project: On	ondaga Lake SCA Design Project/Proposal #	: <u>GJ4299</u> <b>Task #:</b> 18
TITLE OF COMPUTATIONS	VALUTION OF HYDRAULIC PERFORMAN	NCE FOR SCA DESIGN
COMPUTATIONS BY:	Signature     Description       Printed Name     Joseph Sura       and Title     Senior Staff Engineer	4/19/2011 DATE
ASSUMPTIONS AND PROCEDUR CHECKED BY: (Peer Reviewer)	Printed Name R. Kulasingam	4/19/2011 DATE
COMPUTATIONS CHECKED BY:	Signature Printed Name For and Title Senior Staff Engineer	4/19/2011 DATE
COMPUTATIONS BACKCHECKED BY: (Originator)	Signature Joseph Sura NEW YOR	4/19/2011 DATE
APPROVED BY: (PM or Designate)	Signature     Sector Start Engager       Printed Name     Jay Beech       and Title     Principal	<b>21 A ØL 20 1</b> DATE
APPROVAL NOTES:	Contraction and	
REVISIONS (Number and initial all r	evisions)	
NO. SHEET DA	TE BY CHECKED BY	APPROVAL

		Geosyntec <sup>⊳</sup>
		consultants
		Page 1 of 48
Written by: Joseph Sura	Date: 11/23/2009 Reviewed by:	Fan Zhu / R. Kulasingam Date: <u>12/2/2009</u>
Client: Honeywell Project:	Onondaga Lake SCA Final Design	Project/ Proposal No.: GJ4299 Task No.: 18

#### EVALUATION OF HYDRAULIC PERFORMANCE FOR SCA DESIGN

#### **INTRODUCTION**

This package was prepared in support of the design of the Sediment Consolidation Area (SCA) for the Onondaga Lake Bottom Site, which will be constructed on Wastebed 13 (WB-13). This package presents an analysis of hydraulic performance of the SCA, which will contain geotextile tubes (geo-tubes) filled with dredge material from Onondaga Lake. The analysis presented in this package has three main objectives:

- 1. Evaluate the infiltration rate through the final cover system. The infiltration rate through the cover system is needed to calculate the amount of liquid to be pumped through the base liner liquid management system (LMS) after closure of the SCA.
- 2. Evaluate the liquid head above the liner system. It should be noted that the maximum liquid head acting on the base liner system will be limited to 12 inches per New York State Department of Environmental Conservation (NYSDEC) regulations.
- 3. Determine the liquid head on the cover system of the SCA top and side slopes. The liquid head on the cover system of the SCA side slopes is required to analyze the veneer stability of the final cover system. More details regarding the veneer stability analysis are provided in the calculation package titled "Final Cover Veneer Stability Analyses for SCA Design" (Appendix L of the SCA Final Design).

In addition, calculations were performed to estimate the amount of consolidation water that could potentially be squeezed out of the foundation Solvay waste (SOLW) due to the SCA loading. The estimated amount of consolidation water was compared with the estimated reduction in infiltration of precipitation into WB-13 due to the installation of the SCA liner system. Calculations were also performed to compare the efficiencies of the proposed liner and NYSDEC Part 360 liner systems with regards to protection of groundwater quality.

#### METHODOLOGY

The calculations in this package were performed using the "Hydraulic Evaluation of Landfill Performance" (HELP) software, Version 3.07 developed by the U.S. Environmental Protection Agency. The HELP model is a quasi two-dimensional hydrologic model of water movement across, into, through, and out of landfills. The model accepts weather, soil, and design data and accounts for the effects of surface storage, snowmelt, runoff, infiltration,

				Geo	syn	tec⊳	
				consultants			
				Page	2	of	48
Written by: Joseph Sura	Date:	11/23/2009	Reviewed by:	Fan Zhu / R. Kulasingam	Date	e: <u>12/2/2</u>	2009
Client: Honeywell Pro	ject: Ononda	ga Lake SCA	Final Design	Project/ Proposal No.: G	J4299	Task No.:	18

evapotranspiration, vegetative growth, lateral drainage, and leakage through liners [Schroeder, 1994]. The amount of consolidation water was estimated using methods that are consistent with the calculation package titled "Settlement Analyses for SCA" (Appendix H of the SCA Final Design).

#### **INPUT PARAMETERS**

The HELP software accepts parameters for layer type, hydraulic conductivity K for each layer, drainage path length, slope, moisture storage values, and climate. The SCA was modeled as shown in Figure 1, which provides a typical cross section. Specific properties of the eight different layers of materials are included in Table 1 and are discussed further below. It is noted that the HELP default parameters were used to select the total porosity, field capacity, and wilting point of each layer, however, the hydraulic conductivity was modified to better represent expected or potentially critical conditions.

#### SCA Geometry and Cover

The current design of the side slopes of the SCA is based on a 20-ft offset between geo-tubes. Each geo-tube layer is expected to be approximately 6-ft thick. This results in side slopes of 20 horizontal:6 vertical (i.e., 30% slopes) and a slope angle  $\beta$ =16.7 degrees. The drainage path length along the side slopes is 100 ft. The overall final cover slope on the top of the SCA is approximately 0.5% towards the low points near the sump areas. The longest possible drainage path is shown in Figure 2, which is approximately 1500 ft in length.

The current design of the SCA final cover consists of the following layers, from top to bottom, as shown in Figures 3A and 3B for the top and side slopes, respectively:

- Vegetative soil layer;
- Protective soil layer;
- Geocomposite drainage layer (SCA side slopes only);
- Geomembrane (GM) liner; and
- Leveling layer.

The proposed vegetative soil layer has a thickness of 6 in and was modeled as a sandy silt (ML) with a hydraulic conductivity of  $1.0 \times 10^{-4}$  cm/s. The protective soil layer has a thickness of 24 in and is assumed to be a sandy clay (SC) material with a hydraulic conductivity of  $1.0 \times 10^{-5}$  cm/s.

					Geo	syn	tec⊳	
					consultants			
					Page	3	of	48
Written by: Joseph Sura		Date:	11/23/2009	Reviewed by:	Fan Zhu / R. Kulasingam	Date	e: <u>12/2/</u>	2009
Client: Honeywell	Project:	Onond	laga Lake SCA	Final Design	Project/ Proposal No.: G	J4299	Task No.:	18

The geocomposite drainage layer will only be included in the side slopes of the SCA to reduce the liquid head on the cover and improve the final cover veneer stability. For purposes of this analysis, a 200 mil geocomposite with a minimum measured hydraulic conductivity of 10 cm/s is recommended. After the use of reduction factors to account for creep (1.2), delayed intrusion (1.1), degradation (1.2), particulate clogging (1.2), chemical clogging (1.2), biological clogging (1.3) and a general safety factor of 2.5, the design hydraulic conductivity is considered to be 1.33 cm/s.

The cover GM was modeled using the HELP model parameters for a low density polyethylene (LDPE) liner, which is available in the HELP database. It is noted that changing the type of GM to other materials, such as ethylene-propylene diene monomer (EPDM) or high density polyethylene (HDPE), which are also available in the HELP database, did not affect the calculated values. It was assumed to contain one hole per acre and have good contact with the soil layer below, both of which can typically be achieved during construction. The holes in the GM were assumed to be 0.16 in<sup>2</sup>, following the recommendations of Giroud and Bonaparte [1989].

A leveling layer was assumed to smooth post-settlement contours and maintain positive drainage. The decision on the material to be used in the leveling layer will be determined based on available material sources during operations. Therefore, a sensitivity analysis has been performed to model the impact of using either a SC material of the same type as the protective soil layer (i.e., hydraulic conductivity of 10<sup>-5</sup> cm/s) or a granular material with hydraulic conductivity of 1.0 cm/s that is likely to be available if particle separation is performed on the dredged material. It is noted that the thickness of the leveling layer may vary, based on surface water requirements and the amount of separated material available for disposal. Based on sensitivity analyses, a thickness of 6 inches was selected for modeling.

#### Geo-tubes and Dredge Material

The geo-tubes above the gravel drainage layer were modeled as three separate layers, from bottom to top: (i) a layer for the dredge material; (ii) a small intermediate layer; and (iii) a geotextile layer for the top layer of geo-tubes. The 30-ft thick dredge material was modeled with properties similar to a low plasticity silt (ML). A hydraulic conductivity of  $K_{DREDGE} = 1.0 \times 10^{-5}$  cm/s was used to represent the dredged material. Laboratory test results on the material to be dredged, which consists mostly of Solvay waste (SOLW) from the In-Lake Waste Deposit (ILWD) of Onondaga Lake, indicate that the hydraulic conductivity of the dredge material (K<sub>DREDGE</sub>) may vary from approximately  $K_{DREDGE}=10^{-5}$  cm/s to  $K_{DREDGE}=10^{-6}$  cm/s. As discussed in subsequent sections, sensitivity analyses were performed to evaluate the effect of  $K_{DREDGE}$  on the infiltration rate and the head on the liner.

		Geosy	/ntec <sup>D</sup>
		con	sultants
		Page	4 of 48
Written by: Joseph Sura	Date: 11/23/2009 Reviewed by:	Fan Zhu / R. Kulasingam	Date: 12/2/2009
Client: Honeywell Project:	Onondaga Lake SCA Final Design	Project/ Proposal No.: GJ42	<b>99</b> Task No.: <b>18</b>

The intermediate layer above the dredge material was modeled as a vertical percolation layer of 60-mil thickness of dredge material. This layer is necessary due to modeling restrictions within the HELP program, which does not allow the placement of a barrier soil layer underlying another barrier soil layer.

The geotextile layer represents the interface between the geo-tubes and dredge material. As the liquid flows through the cover system to reach the top geo-tube/dredge material interface, it will experience preferential flow patterns. As shown in Figure 4, the liquid can pass through the geotextile material itself or through the open area filled with dredge material. Therefore, this layer was modeled using a combined equivalent hydraulic conductivity  $K_{EQ}$ , calculated using Equation 1 below, as discussed by Das [2005].

$$K_{\rm EQ} = K_{\rm DREDGE} \times A_{\rm DREDGE} + K_{\rm GT} \times A_{\rm GT}$$
(Eq.1)

where:

K <sub>EQ</sub>	= Equivalent hydraulic conductivity
K <sub>DREDGE</sub>	= Hydraulic conductivity of dredge material
A <sub>DREDGE</sub>	= Cross-sectional area of dredge material, measured as percent open area of the geotextile
K <sub>GT</sub>	= Hydraulic conductivity of woven geotextile
A <sub>GT</sub>	= Cross-sectional area covered by woven geotextile material and calculated as 100% - ADREDGE

The percent open area was assumed to be 4% based on the standard typical minimum value for a woven geotextile [TC Mirafi, 2000]. A sensitivity analysis on the equivalent hydraulic conductivity resulting from different values of  $K_{\rm GT}$  was performed and is shown in Figure 5. As described on Figure 5, a value of  $K_{\rm EQ} = 4.0 \times 10^{-7}$  cm/s was selected based on this analysis.

#### Liner System

The SCA liner system consists of the following layers from top to bottom:

- Gravel drainage layer;
- Nonwoven geotextile cushion;
- Geomembrane (GM) liner; and
- Low permeability soil layer.

					Geo	osyn	tec⊳	
					consultants			
					Page	5	of	48
Written by: Joseph Sura		Date:	11/23/2009	Reviewed by:	Fan Zhu / R. Kulasingan	n Date	e: <u>12/2/</u>	2009
Client: Honeywell	Project:	Onond	laga Lake SCA	A Final Design	Project/ Proposal No.:	GJ4299	Task No.:	18

The proposed gravel drainage layer has an average thickness of 2 ft and a minimum thickness of 1 ft. It was modeled conservatively as a 1-ft thick layer. This drainage layer will be sloped towards the sumps to allow gravity drainage. Based on the predicted grading of the underlying low permeability soil layer 30 years after closure, the gravel drainage layer was modeled with a slope of 1% and a drainage path length of 1500 ft, as shown in Figure 6. A sensitivity analysis using a slope of 0.5% for the gravel drainage layer was also performed. The assumed hydraulic conductivity of the gravel is 10 cm/s based on available material sources. Sensitivity analyses were performed to evaluate the effect of  $K_{\text{GRAVEL}}$  ranging from 5 cm/s to 15 cm/s, based on a range in values for other potentially available gravel types.

A nonwoven (NW) geotextile (GT) cushion will be placed between the gravel drainage layer and GM for protection. This NW GT layer was not included in the HELP model.

The GM was modeled using the HELP model parameters for a low density polyethylene (LDPE) liner, which is available in the HELP database. It is noted that changing the type of GM to other materials, such as ethylene-propylene diene monomer (EPDM) or high density polyethylene (HDPE), which are also available in the HELP database, did not affect the calculated values. It is noted that HDPE was subsequently selected as the GM for the SCA. The GM was assumed to contain one hole per acre and have good contact with the soil layer below, both of which can typically be achieved during construction. The holes in the GM were assumed to be 0.16 in<sup>2</sup>, following the recommendations of Giroud and Bonaparte [1989].

The low permeability soil layer has a proposed minimum thickness of 1 ft. The top 6 inches of this layer is required to have a hydraulic conductivity of  $K=10^{-6}$  cm/s or lower, per agreement with NYSDEC. The bottom part of this layer was modeled with a hydraulic conductivity of  $K=10^{-5}$  cm/s.

#### Climate Data

The data for precipitation, temperature, humidity, and solar radiation were modeled using the HELP software synthetic data generation function for Syracuse, New York for a 100-year modeling period. This generation uses recorded mean monthly data for Syracuse, shown in Table 2, to stochastically generate daily data with approximately the same statistical characteristics as the historic data. The precipitation data was manually adjusted to account for the design storm event of a 25-year, 24-hour rainfall. The rainfall corresponding to the design storm event was selected to be 4.4 inches based on recommendations from the Natural Resources Conservation Service [1986], as shown in Figure 7. The evaporative zone depth, which is the maximum depth from which water may be removed by evapotranspiration, was assumed to be 30

		Geos	yntec <sup>D</sup>		
		consultants			
		Page	6 of 48		
Written by: Joseph Sura	Date: 11/23/2009 Reviewed by:	Fan Zhu / R. Kulasingam	Date: 12/2/2009		
Client: Honeywell Project:	Onondaga Lake SCA Final Design	Project/ Proposal No.: GJ4	<b>299</b> Task No.: 18		

inches, corresponding to the total thickness of the topsoil and the protective soil layer in the final cover system. For this analysis, it is assumed that a good stand of grass will be established on the final cover system; therefore, the leaf area index (i.e., the dimensionless ratio of leaf area of active vegetation to the nominal surface area) of 3.5 was selected. If willows are planted above the GM, less infiltration will result; therefore, that case is not analyzed herein. Values of the climate parameters are shown in Table 3.

#### CASES ANALYZED

Table 4 provides a summary of the cases evaluated, which includes a Base Case (top and side slopes) and a sensitivity analysis on the parameters  $K_{DREDGE}$ ,  $K_{GRAVEL}$ , and  $K_{LEVELING}$ . Case 1, as compared to the Base Case (top), was used to evaluate the effect of uncertainty in the hydraulic conductivity of the dredge material. Cases 2A and 2B, as compared to the Base Case (top), were used to evaluate the effect of the gravel drainage layer hydraulic conductivity on liquid production and the liquid head on the geomembrane liner. Case 3, as compared to the Base Case (top), was used to evaluate the effect of a clayey soil (i.e., SC soil,  $K_{LEVELING}=1.0 \times 10^{-5} \text{ cm/s}$ ) in the leveling layer as compared to granular soil (i.e.,  $K_{LEVELING}=1.0 \text{ cm/s}$ ) in the leveling layer.

For analysis of the SCA side slopes, the Base Case parameters were used with a geocomposite added to the final cover, as discussed previously. This case is referred to as Base (side slopes) in Table 4.

Finally, HELP modeling was also performed to demonstrate the efficiency of the SCA with the proposed composite liner system as compared to the efficiency of the SCA with a prescribed Part 360 liner. The Part 360 prescribed liner system used for comparison is summarized in Table 5.

#### **RESULTS OF ANALYSIS**

The results of the HELP Model analyses are summarized in Table 6. HELP Output files for the Base Case on the SCA top (run I\_1A) and SCA side slopes (run III\_1A) are included in Attachment 1.

The effect of uncertainty in the hydraulic conductivity of the dredge material was studied by comparing the results of Case 1 with the Base Case (top). Increasing the hydraulic conductivity of the dredge material did not significantly affect calculated peak daily or average annual values

					Ge	osyn	tec >	
						consu	ltants	
					Page	7	of	48
Written by: Joseph Sura		Date:	11/23/2009	Reviewed by:	Fan Zhu / R. Kulasing	am Dat	e: <u>12/2</u>	/2009
Client: Honeywell	Project:	Onond	laga Lake SCA	A Final Design	Project/ Proposal No.:	GJ4299	Task No.	: 18

of liquid head on the cover and liner system or liquid production. Therefore, it is recommended that a value of  $K_{DREDGE} = 10^{-5}$  cm/s be used for design purposes.

When compared to the Base Case on the top ( $K_{GRAVEL}=10$  cm/s), changing the gravel hydraulic conductivity (i.e., Cases 2A and 2B) did not significantly affect calculated peak daily or average annual values of liquid head on the cover and liner system or liquid production. Therefore, it is recommended that a value of  $K_{GRAVEL}=10$  cm/s be used for design purposes.

Changing the material used in the leveling layer (i.e., Base Case [top] compared to Case 3) did not affect the calculated peak daily or average annual values of liquid head on the cover and liner system or liquid production. Therefore, based on the results of the HELP analysis, use of either the SC soil or a granular material (or any other soil with K values in between  $1.0 \times 10^{-5}$  cm/s and 1 cm/s) is considered to be acceptable from a hydraulic performance standpoint.

The results of the consolidation water and infiltration reduction calculations are presented in Table 7. These calculations were performed on an annual average basis during the SCA operational period using reasonable assumptions regarding liner construction and geo-tube filling phasing. Key assumptions are presented as footnotes in Table 7. During the four years of operation, total amounts of consolidation water due to filling of the SCA and infiltration reduction due to installation of the liner were calculated to be 189 and 162 million gallons, respectively. Considering the complicated nature of nonlinear field processes such as consolidation and infiltration water and reduction in infiltration are considered to be comparable over a four year operational period. The current capacity of the existing liquid collection system and its ability to handle a potential increase in flow will be further evaluated as part of the closure of WB-9 through WB-15.

The equivalency calculations summarized in Table 8 indicate that the SCA with both the proposed liner and the NYSDEC Part 360 liner have liner efficiencies of greater than 99.99%. Therefore, it can be demonstrated that the proposed system will effectively protect groundwater quality.

#### SUMMARY AND CONCLUSIONS

This package presents the analyses of the hydraulic performance of the proposed SCA using the HELP model. The evaluation presented in this package has three main objectives: (i) evaluate the infiltration rate through the proposed final cover system; (ii) evaluate the liquid head above the liner system; and (iii) evaluate the liquid head above the GM in the cover system on the top and side slopes of the SCA. Analysis of the SCA top and side slopes indicates that the

					Ge	osyn	tec⊳	
						consul	tants	
					Page	8	of	48
Written by: Joseph Sura		Date:	11/23/2009	Reviewed by:	Fan Zhu / R. Kulasinga	am Date	e: <u>12/2/2</u>	009
Client: Honeywell	Project:	Onond	aga Lake SCA	Final Design	Project/ Proposal No.:	GJ4299	Task No.:	18

calculated liquid head on the liner satisfies the NYSDEC requirement of 1 ft or less on the liner system. The calculated annual average liquid rate was approximately 0.4 gallons per minute. The maximum and average calculated liquid heads in the cover system on the SCA side slopes during the peak day were 0.030 inches (0.003 ft) and 0.020 inches (0.002 ft), respectively.

In addition, the calculations performed to estimate the amount of consolidation water indicate that the amount of water squeezed out over the four year operational period is the same order of magnitude as the reduction in infiltration that will occur due to liner system installation. The capacity of the existing liquid collection system is currently being evaluated as part of the WB-9 through WB-15 closure.

The equivalency calculations indicate that the efficiency of the proposed SCA with its composite liner system is comparable to the efficiency of the SCA with a Part 360 liner. Therefore, it can be demonstrated that the proposed SCA liner will effectively protect groundwater quality at the site.

					Page	9	of	48
Written by: Joseph Sura		Date:	11/23/2009	Reviewed by:	Fan Zhu / R. Kulasingan	n Date	: 12/2/2	2009
Client: Honeywell F	Project:	Onond	aga Lake SCA	Final Design	Project/ Proposal No.:	J4299	Task No.:	18

#### REFERENCES

Das, B.M., "Fundamentals of Geotechnical Engineering", Second Edition, Thomson, 2005.

- Giroud, J.P. and Bonaparte, R. "Leakage Through Liners Constructed with Geomembranes, Part I: Geomembrane Liners", Geotextiles and Geomembranes, Vol.8, No.1, 1989.
- Natural Resources Conservation Service (NRCS), "Urban Hydrology for Small Watersheds", 210-VI-TR-55, Second Edition, June 1986.
- Schroeder, P.R., et al. "The Hydrologic Evaluation of Landfill Performance (HELP) Model: Engineering Documentation for Version 3", EPA/600/9-94/xxx, U.S. EPA Risk Reduction Engineering Laboratory, Cincinnati, OH, 1994.

TC Mirafi, "Filtration and Drainage", Pendergrass, GA, 2000.

			Page	10	of 4	18	
Written by: Joseph Sura		Date: <u>11/23/2009</u> Reviewed by:	Fan Zhu / R. Kulasingam	Date:	12/2/20	)09	
Client: Honeywell	Project:	Onondaga Lake SCA Final Design	Project/ Proposal No.: GJ	[4299	Task No.:	18	

## Tables

				Geosyntec <sup>D</sup>				
				consultants				
				Page	11	of	48	
Written by: Joseph Sura Date: <u>11/23/2009</u> Reviewed by:		Fan Zhu / R. Kulasinga	m Date	: 12/2/2	2009			
Client: Honeywell	Project:	Onondaga Lake SCA	Final Design	Project/ Proposal No.:	GJ4299	Task No.:	18	

Table 1: Material Properties of Layers within SCA System

Layer	Description <sup>[1]</sup>	Layer Type <sup>[2]</sup>	HELP Default <sup>[3]</sup>	HELP USCS Name	Thickness (in)	K (cm/s)
1	Topsoil	1	8	ML	6	1.0E-04
2	Protective Layer	2	13	SC	24	1.0E-05
3	Geomembrane	4	36	LDPE	0.06	4.0E-13 <sup>[4]</sup>
4	Leveling Layer	1	21/13	Gravel / SC	6 <sup>[5]</sup>	1.0 / 1.0E-05
5	Geo-tube with Dredge Filter Cake	3	20	Drainage Net	0.06	4.0E-07 <sup>[6]</sup>
6	Dredge material <sup>[7]</sup>	1	22	ML	0.06	1.0E-05 <sup>[8]</sup>
7	Dredge material	3	22	ML	360	1.0E-05 <sup>[8]</sup>
8	Gravel Drainage	2	21	Gravel	12	10 <sup>[9]</sup>
9	Geomembrane	4	36	LDPE	0.06	4.0E-13 <sup>[4]</sup>
10	Low Permeability Soil (Top 6")	3	24	SC	6	1.0E-06
11	Low Permeability Soil (Bottom 6")	1	13	SC	6	1.0E-05

Notes:

- 2. The following layer types are available in the HELP model: 1=Vertical Percolation, 2=Lateral Drainage, 3=Barrier Soil Liner, 4=Geomembrane Liner (GM).
- 3. This is the HELP default soil texture number. It is noted that the hydraulic conductivity of each layer may be changed from the HELP default to better represent expected or potentially critical conditions. All input parameters can be found in the HELP output files provided in Attachment 1.
- 4. This layer is modeled as LDPE GM, using typical values from the HELP database. Selection of a different GM type will not affect the results significantly.
- 5. The leveling layer thickness may vary based on surface water requirements and the amount of separated material available for disposal. Based on sensitivity analyses discussed in the package, a thickness of 6 inches was selected for modeling.
- 6. This was calculated using the percent Open Area, as discussed in the package.
- 7. This layer is identical to the 360 inch (30 ft) layer of dredge material, but is modeled as a vertical percolation layer. This is necessary due to modeling restrictions within the HELP program.
- 8. The value shown here is the base parameter, used in cases labeled "A". This value was changed to  $K=1.0x10^{-6}$  cm/s in cases labeled "B" to evaluate sensitivity.
- 9. The assumed hydraulic conductivity of the gravel is 10 cm/s, based on potentially available material.
- 10. It is noted that layers 8 through 11 compose the proposed liner system.

<sup>1.</sup> This is a general description of each layer.

				Geosyntec <sup>⊳</sup>				
				consultants				
				Page	12	of	48	
Written by: Joseph Sura		Date: 11/23/2	009 Reviewed by:	Fan Zhu / R. Kulasingam	<u> </u>	: 12/2/2	.009	
Client: Honeywell Pr	roject:	Onondaga Lake	e SCA Final Design	Project/ Proposal No.: G	J4299	Task No.:	18	

11. It is noted that for the side slope case (S\_III\_1A), a 200 mil geocomposite drainage layer was added between layers 2 and 3. This layer was modeled as the HELP default soil texture 20 (i.e., drainage net) and a design hydraulic conductivity of 1.33 cm/s, which corresponds to a measured laboratory hydraulic conductivity of 10 cm/s.

					Geosyntec <sup>⊳</sup>				
					consultants				
					Page	13	of	48	
Written by: Joseph Sura		Date: <u>11/</u>	/23/2009	Reviewed by:	Fan Zhu / R. Kulasinga	m Date	: 12/2/2	2009	
Client: Honeywell	Project:	Onondaga l	Lake SCA	Final Design	Project/ Proposal No.:	GJ4299	Task No.:	18	

Table 2: Normal Mean Precipitation and Temperature Data for Syracuse, NY

Month	Precipitation (in)	Temperature (°F)
January	2.61	22.80
February	2.65	24.00
March	3.11	33.30
April	3.34	46.10
May	3.16	57.00
June	3.63	66.30
July	3.76	70.90
August	3.77	69.30
September	3.29	62.10
October	3.14	51.30
November	3.45	40.60
December	3.20	28.30

Note:

These are the default normal mean monthly values of precipitation and temperature for Syracuse, NY, available in the HELP software.

					Geosyntec <sup>⊳</sup>				
					consultants				
					Page	14	of	48	
Written by: Joseph Sura		Date:	11/23/2009	Reviewed by:	Fan Zhu / R. Kulasinga	<u>m</u> Date	e: <u>12/2/</u> 2	2009	
Client: Honeywell P	Project:	Onond	aga Lake SCA	Final Design	Project/ Proposal No .:	GJ4299	Task No.:	18	

 Table 3: Climate Parameters for Syracuse, NY and Other Parameters for the SCA Final Cover

 (HELP Default Values Unless Stated Otherwise)

Parameter	Value	Units
Fraction of Area allowing Runoff	100%	percent of total area
Evaporative Zone Depth	30	Inches
Latitude	43.07	Degrees
Maximum Leaf Area Index	3.5 <sup>[3]</sup>	
Start of Growing Season (date)	124 <sup>[4]</sup>	
End of Growing Season (date)	284 <sup>[4]</sup>	
Planar Area <sup>[1]</sup>	1	Acre
Average Annual Wind Speed	9.7	miles/hr
Average 1st Quarter Relative Humidity	72%	
Average 2nd Quarter Relative Humidity	68%	
Average 3rd Quarter Relative Humidity	75%	
Average 4th Quarter Relative Humidity	76%	
Peak Daily Rainfall, 25-year, 24-hour storm event <sup>[2]</sup>	4.40	Inches

Notes:

- 1. The area was modeled as one acre to produce values on a per-acre basis. This was multiplied by the total number of acres to calculate total flow rates over the entire area of the SCA. The total area of the SCA was assumed to be approximately 70 acres.
- 2. Value from National Resources Conservation Service data shown in Figure 7.
- 3. This value corresponds to a good stand of grass on top of the final cover.
- 4. These dates correspond to May 4 through October 11.

			Geosyntec <sup>o</sup>				
			consultants				
			Page	15	of	48	
Written by: Joseph Sura Date: 11/23/2009 Reviewed by:			Fan Zhu / R. Kulasingam	Date:	12/2/2	009	
Client: Honeywell	Project:	Onondaga Lake SCA Final Design	Project/ Proposal No.: GJ	4299	Task No.:	18	

Case	Run ID <sup>[1]</sup>	Variable	Description of Variable	K <sub>DREDGE</sub> (cm/s)	K <sub>GRAVEL</sub> (cm/s)	K <sub>LEVELING</sub> (cm/s)
Base Top <sup>[2]</sup>	I_1A	N/A	Base case using parameters from Table 1	1.0E-05	10	1
1	I_1B	K <sub>DREDGE</sub>	Hydraulic conductivity of dredge material	1.0E-06	10	1
2A	I_2A	K <sub>GRAVEL</sub>	Hydraulic conductivity of gravel drainage layer	1.0E-05	5	1
2B	I_2B	K <sub>GRAVEL</sub>	Hydraulic conductivity of gravel drainage layer	1.0E-05	15	1
3	II_1A	K <sub>LEVELING</sub>	Material to be used for leveling layer (SC or granular)	1.0E-05	10	1.0E-05
Base Side Slopes <sup>[3]</sup>	S_III_1A	N/A	Base case using parameters from Table 1	1.0E-05	10	1

 Table 4: Cases Evaluated

Note:

- 1. The Run ID corresponds to the case listed in Table 6.
- 2. This is the base case for comparison. The parameters used are the base parameters shown in Table 1, and the leveling layer is considered to be granular material.
- 3. This is the base case for the side slopes. The parameters used are the base parameters shown in Table 1, with the modifications described in Note 11 of Table 1.

				Page	16	of	48	
Written by: Joseph Sura Date: <u>11/23/2009</u> Reviewed by:				Fan Zhu / R. Kulasinga	m Date	: 12/2/2	009	
Client: Honeywell Pro	oject: <b>Onon</b>	daga Lake SCA	Final Design	Project/ Proposal No.:	GJ4299	Task No.:	18	

Table 5: Part 360 Prescribed Liner System

Layer	Description <sup>[1]</sup>	Layer Type <sup>[2]</sup>	HELP Default <sup>[3]</sup>	HELP USCS Name	Thickness (in)	K (cm/s)
8 <sup>[4]</sup>	Granular Drainage	2	1	SP	24	0.01 <sup>[5]</sup>
9	Geomembrane	4	36	LDPE	0.06	4.0E-13 <sup>[6]</sup>
10	Compacted Clay	3	29	СН	6	1.0E-07 <sup>[5]</sup>
11	Structural Fill	1	10	SC	12	1.0E-04 <sup>[7]</sup>
12	Granular Drainage	2	1	SP	12	0.01 <sup>[5]</sup>
13	Geomembrane	4	36	LDPE	0.06	4.0E-13 <sup>[6]</sup>
14	Compacted Clay	3	29	СН	24	1.0E-07 <sup>[5]</sup>

Notes:

- 1. This is a general description of each layer.
- 2. The following layer types are available in the HELP model: 1=Vertical Percolation, 2=Lateral Drainage, 3=Barrier Soil Liner, 4=Geomembrane Liner (GM).
- 3. This is the HELP default soil texture number. It is noted that the hydraulic conductivity of each layer may be changed from the HELP default to better represent expected or potentially critical conditions.
- 4. Layers 1 through 7 represent the final cover system and geo-tubes. Therefore, they are modeled identically as in the base case. Details of these layers are shown on Table 1. Layers 8 through 14 compose the Part 360 prescribed liner system, as compared to Layers 8 through 11 in Table 1 that represent the proposed liner system.
- 5. Required values per NYSDEC Part 360 regulations.
- 6. This layer is modeled as LDPE GM, using typical values from the HELP database. It is noted that the regulations do not specify a GM material. Selection of a different GM type will not affect the results significantly.
- 7. This hydraulic conductivity value is assumed based on the type of material.

# Geosyntec<sup>▷</sup>

С	onsulta	nts			Page	17	of	48
Written by: Joseph Sura		Date:	11/23/2009	Reviewed by:	Fan Zhu / R. Kulasinga	<u>m</u> Date	e: <u>12/2/2</u>	009
Client: Honeywell	Project:	Onond	laga Lake SCA	Final Design	Project/ Proposal No.:	GJ4299	Task No.:	18

Table 6: Results of HELP Modeling for the SCA

						Peak Daily Values					Average Annual Values				
Case	Run ID	Curve Number	K <sub>DREDGE</sub> (cm/s)	K <sub>GRAVEL</sub> (cm/s)	K <sub>LEVELING</sub> (cm/s)	H <sub>AVG</sub> (in) cover	H <sub>MAX</sub> (in) liner	H <sub>AVG</sub> (in) liner	Liquid (ft <sup>3</sup> /ad)	Liquid (gal/min)	H <sub>AVG</sub> (in) liner	Liquid (ft <sup>3</sup> /ac- yr)	Liquid (gal/ac- day)	Liquid (gal/day)	Liquid (gal/min)
Base Top	I_1A	68.2	1.0E-05	10	1	30.0	0.0	0.0	2.6	0.9	0.0	366.0	7.5	525.0	0.4
1	I_1B	68.2	1.0E-06	10	1	30.0	0.0	0.0	2.6	0.9	0.0	366.0	7.5	525.0	0.4
2A	I_2A	68.2	1.0E-05	5	1	30.0	0.0	0.0	2.6	0.9	0.0	366.0	7.5	525.0	0.4
2B	I_2B	68.2	1.0E-05	15	1	30.0	0.0	0.0	2.6	0.9	0.0	366.0	7.5	525.0	0.4
3	II_1A	68.2	1.0E-05	10	1.0E-05	30.0	0.0	0.0	2.6	0.9	0.0	366.0	7.5	525.0	0.4
Base Side Slopes	S_III_1A	76.1	1.0E-05	10	1	0.02	0.0	0.0	13.1	4.8	0.0	403.5	8.3	578.8	0.4

Notes:

1. The curve number is calculated by HELP based on model inputs.

1. Selected maximum precipitation for a single day is 4.4 inches, based on the National Resources Conservation Service [1986] recommendations for a 25 year, 24 hour storm event.

2. SCA is assumed to have a total acreage of 70 acres.

3. This table uses a drainage path length of 1500 ft and slope of approximately 0.5% for the final cover top area and a drainage path length of 1500 ft and slope of 1% for the gravel drainage layer.

4. The HELP Output file for the base case, I 1A, is included in Attachment 1.

5. Case S\_III\_1A represents the SCA side slopes and is modeled with a final cover drainage path length of 100 ft and slope of 30%. It is noted that the gravel drainage layer is modeled with a drainage path length of 1500 ft and slope of 1%. The HELP Output file for this case is included in Attachment 1.

# Geosyntec<sup>▷</sup>

	С	onsulta	Page	18	of	48			
Written by: Joseph Sura		Date:	11/23/2009	Reviewed by:	Fan Zhu / R. Kulasinga	m Date	: 12/2/2	2009	
Client:	Honeywell	Project:	Onond	laga Lake SCA	Final Design	Project/ Proposal No.:	GJ4299	Task No.:	18

Table 7: Results of Consolidation Water and Reduction in Infiltration Rate Calculations

					Infiltration Cut-of	f (million gallons)		Consolidatio	on Squeezed Water (m	illion gallons)	
Year	SCA Footprint at End of Each Phase (ac) <sup>[1]</sup>	New SCA Footprint in Each Year (ac)	Total Lined SCA Area at End of Each Phase (ac) <sup>[2]</sup>	Additional Lined Area (ac) <sup>[3]</sup>	Assuming 40" Infiltration Each Year <sup>[4]</sup>	Assuming 0.5 x 40" Infiltration Each Year <sup>[5]</sup>	Estimated Average Geo-tube Height (ft) <sup>[6]</sup>	Estimated Average Total Thickness of Gravel Drainage Layer and Liner (ft) <sup>[7]</sup>	Estimated Total Equivalent Soil Thickness (ft) <sup>[8]</sup>	Estimated Average Settlement (ft) <sup>[9]</sup>	Estimated Consolidation Squeezed Water in Each Year (million gallons) <sup>[10]</sup>
0			15	10	14	7					
1	30	30	40	10	54	27	18	5	18.1	5.4	53
2	50	20	61	10	77	39	22	5	20.7	6.2	48
3	72	22	72	10	89	45	23	5	21.3	6.4	49
4	72	0	72	10	89	45	30	5	26.8	8.0	38
Tot	al Estimated In	filtration Cut-or	ff in 4+ years (n	nillion gallons)	323	162	Total Es	timated Consolidation	Squeezed Water in 4	years (million gallons)	189

#### Notes:

- The SCA footprint is measured from the outside toe of the perimeter berm. 1.
- 2. Assuming half of the new SCA footprint will be lined in advance during the previous year.
- Additional lined area for basins, and water treatment and pre-processing facilities. 3.
- The infiltration cut-off volume equals 40 inches of annual average rainfall multiplied by the total lined area at the end of each year. In year 0, only half a year for the infiltration cut-off was assumed. 4.
- Assuming 50% for evapotranspiration based on the analysis presented in the HELP calculations. 5.
- To estimate the average geo-tube height for calculating loads for settlements, a 25% decrease of the available footprint was considered to account for the SCA perimeter berm, the 10-ft gap between geo-tubes and the 6. berm, and the 20-ft offset distance for geo-tube stacking. This assumption is considered reasonable based on the calculation of an average geo-tube height of 30 ft for year 4.
- These thicknesses are based on the calculations presented in the package titled "Volume Calculations for SCA Design". 7.
- Assuming a unit weight of 120 pcf for liner and gravel and 86 pcf for dredge material. The total thickness was converted to an equivalent thickness of soil with a unit weight of 120 pcf. 8.
- 9. Using a rule of thumb: 10 ft soil causes approximately 3 ft of settlement in SOLW (based on test plot results). The total calculated average settlement of 8 feet in the 4<sup>th</sup> year is consistent with the results of detailed settlement calculations presented in the calculation package titled "Settlement Analyses for SCA" in the Final SCA Design.
- 10. The Solvay waste above the groundwater table was conservatively assumed to be fully saturated in the calculation. Primary consolidation time was assumed to be less than one year, thus resulting in all calculated consolidation water for a given year being squeezed out within that year.

				Ge	osyn consul <sup>,</sup>	tec <sup>D</sup>		
					Page	19	of	48
Written by: Joseph Sura		Date:	11/23/2009	Reviewed by:	Fan Zhu / R. Kulasing	am Date	e: <u>12/2/</u> 2	2009
Client: Honeywell	Project:	Onond	laga Lake SCA	Final Design	Project/ Proposal No.:	GJ4299	Task No.:	18

Table 8: Results of Liner Equivalency Calculations

Run ID		Pea	k Daily Val	ues	Average Annual Values			
	Liner Type	Precipitation (in/ac-day)	Leakage (in/ac-day)	Efficiency (%)	Precipitation (in/ac)	Leakage (in/ac)	Efficiency (%)	
I_1A	Proposed	4.40	0.000314	99.9929%	39.20	0.00340	99.9913%	
360_Soil	Part 360 - Double-liner with soils	4.40	0.000000	100.0000%	39.20	0.00001	100.0000%	

Notes:

- 1. The analyses presented in the table use a drainage path length of 1500 ft and slope of 0.5% for the final cover and a drainage path length of 1500 ft and slope of 1% for the drainage layer in the liner.
- 2. The proposed liner system (Base Case [top], run I\_1A) is described in Table 1. The prescribed NYSDEC Part 360 liner is described in Table 5.
- 3. The efficiency of the liner is calculated using the formula:

 $Efficiency = 100\% - \frac{Leakage}{Pr\ ecipitation}$ .

			Geos	Syntec <sup>D</sup> onsultants
			Page	20 of 48
Written by: Joseph Sura		Date: 11/23/2009 Reviewed by:	Fan Zhu / R. Kulasingam	Date: 12/2/2009
Client: Honeywell	Project:	Onondaga Lake SCA Final Design	Project/ Proposal No.: GJ	4299 Task No.: 18

## Figures



Geomembrane Liner (overlain by geotextile cushion)



Figure 2: Design Top of Final Cover



Figure 3B: Section View of Final Cover (SCA side slopes)

		Geosyntec <sup>▷</sup>				
	C					
		Page 24 of 48				
Written by: Joseph Sura	Date: <u>11/23/2009</u> Reviewed by:	Fan Zhu / R. Kulasingam Date: 12/2/2009				
Client: Honeywell Projec	Onondaga Lake SCA Final Design	Project/ Proposal No.: GJ4299 Task No.: 18				



Figure 4: Conceptual View of Geo-tube/Dredge Material Layer Equivalent Hydraulic Conductivity

Notes:

- 1. This figure illustrates the modeling of the geo-tube/dredge material layer equivalent hydraulic conductivity.
- 2. The open area of the geo-tubes (assumed to be 4% of total area) is covered with dredge filter cake material, as shown. Therefore, the hydraulic conductivity of the geo-tubes/dredge material interface layer was modeled as a liner with equivalent hydraulic conductivity.



Figure 5: Sensitivity of Dredge Material/Geo-tube Equivalent Hydraulic Conductivity to the Hydraulic Conductivity of the Geo-tube Material

Notes:

- 1. This figure shows the equivalent hydraulic conductivity of Layer 5, the top of geo-tubes with open areas plugged with dredge material.
- 2. The actual fabric of a woven geotextile was assumed to have a hydraulic conductivity of  $10^{-8}$  cm/s or less.
- 3. The calculations were performed using a hydraulic conductivity of  $1.0 \times 10^{-5}$  cm/s for the dredge material.
- 4. Based on the assumed  $K_{GT} = 10^{-8}$  cm/s, a K<sub>EQ</sub> value of  $4 \times 10^{-7}$  cm/s has been assumed for the analyses.



Figure 6: Top of Low Permeability Soil Liner Grades - 30 Years after Closure

					Geosyntec <sup>⊳</sup>					
					consultants					
					Page	27	of	48		
Written by: Joseph Sura		Date:	11/23/2009	Reviewed by:	Fan Zhu / R. Kulasingar	<u>m</u> Date	e: <u>12/2/2</u>	2009		
Client: Honeywell	Project:	Onond	aga Lake SCA	Final Design	Project/ Proposal No.:	GJ4299	Task No.:	18		



Figure 7: NRCS Map for Calculation of 25-year, 24-hour Storm Event [NRCS, 1986]

Note:

The value selected for the model is 4.40 inches, based on the approximate location of Onondaga Lake.

		Geosyntec <sup>D</sup>
		Page 28 of 48
Written by: Joseph Sura	Date: <u>11/23/2009</u> Reviewed by:	Fan Zhu / R. Kulasingam Date: 12/2/2009
Client: Honeywell Project:	Onondaga Lake SCA Final Design	Project/ Proposal No.: GJ4299 Task No.: 18

## **Attachment 1: HELP Output Files**

Geosyntec<sup>▷</sup> consultants Page 29 of 48 Written by: Joseph Sura Date: 11/23/2009 Reviewed by: Fan Zhu / R. Kulasingam Date: 12/2/2009 Client: Honeywell Project: Onondaga Lake SCA Final Design Project/ Proposal No.: GJ4299 Task No.: 18 \*\*\*\*\*\* \* \* \* \* \* \* \* \* \* \* HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE \* \* \* \* \* \* HELP MODEL VERSION 3.07 (1 NOVEMBER 1997) \* \* DEVELOPED BY ENVIRONMENTAL LABORATORY \* \* \* \* \* \* USAE WATERWAYS EXPERIMENT STATION \* \* \* \* FOR USEPA RISK REDUCTION ENGINEERING LABORATORY \* \* \* \* \* \* \* \* \* PRECIPITATION DATA FILE: C:\PROGRA~1\HELP\OLPRECIP.D4 TEMPERATURE DATA FILE: C:\PROGRA~1\HELP\OLTEMP.D7 SOLAR RADIATION DATA FILE: C:\PROGRA~1\HELP\OLSOLAR.D13 EVAPOTRANSPIRATION DATA:C:\PROGRA~1\HELP\OL\_LAI35.D11SOIL AND DESIGN DATA FILE:C:\PROGRA~1\HELP\I\_1A.D10OUTPUT DATA FILE:C:\PROGRA~1\HELP\I\_1A.OUT TIME: 13:38 DATE: 12/ 9/2009 TITLE: Onondaga Lake SCA - Final Design NOTE: INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM. LAYER 1 \_\_\_\_\_ TYPE 1 - VERTICAL PERCOLATION LAYER MATERIAL TEXTURE NUMBER 108 = 6.00 INCHES = 0.4630 VOL/VOL THICKNESS POROSITY = FIELD CAPACITY 0.2320 VOL/VOL FIELD CAPACITY=0.2320 VOL/VOLWILTING POINT=0.1160 VOL/VOLINITIAL SOIL WATER CONTENT=0.4586 VOL/VOLEFFECTIVE SAT. HYD. COND.=0.999999975000E-04 CM/SEC LAYER 2

TYPE 2 - LATERAL DRAINAGE LAYER

## Geosyntec<sup>▷</sup>

					Geosymee							
						consu	ltants					
					Page	30	of	48				
Written by:	Joseph Sura	Date: 1	1/23/2009	Reviewed by:	Fan Zhu / R. Kulasi	<b>ngam</b> Dat	te: <u>12/2/</u>	2009				
Client: Ho	oneywell Project:	Onondag	a Lake SCA	Final Design	Project/ Proposal No.:	GJ4299	Task No.:	18				
		MATERIAL '	TEXTURE NU	MBER 113								
	THICKNESS		=	24.00 INCH	ES							
	POROSITY FIFLD CARACITY		=	0.4300 VOL/	VOL							
	WILTING POINT		=	0.2210 VOL/	VOL							
	INITIAL SOIL W	ATER CONT	ENT =	0.4310 VOL/	VOL							
	EFFECTIVE SAT.	HYD. CON	D. = 0.	999999975000E	-05 CM/SEC							
	SLOPE		=	0.51 PERC	ENT							
	DRAINAGE LENGT	Ή	= 1	.500.0 FEET								
			LAYER 3									
	ТҮ	PE 4 - FLI MATERIAL	EXIBLE MEM TEXTURE NU	IBRANE LINER IMBER 36								
	THICKNESS		=	0.06 INCH	ES							
	POROSITY		=	0.0000 VOL/	VOL							
	FIELD CAPACITY		=	0.0000 VOL/	VOL							
	WILTING POINT INITIAL SOIL W		= ENT -	0.0000 VOL/	VOL							
	EFFECTIVE SAT.	HYD. CON	$D_{1} = 0$	399999993000E	-12 CM/SEC							
	FML PINHOLE DE	NSITY	=	0.00 HOLE	S/ACRE							
	FML INSTALLATI	ON DEFECT	S =	1.00 HOLE	S/ACRE							
	FML PLACEMENT	QUALITY	= 3	- GOOD								
			LAYER 4									
	TYPE	1 - VERT	ICAL PERCO	LATION LAYER								
		MATERIAL '	TEXTURE NU	MBER 221								
	THICKNESS		=	6.00 INCH	ES							
	FURUSITY FIELD CAPACITY		=	0.39/0 VOL/	VOL							
	WILTING POINT		=	0.0130 VOL/	VOL							
	INITIAL SOIL W	ATER CONT	ENT =	0.0320 VOL/	VOL							
	EFFECTIVE SAT.	HYD. CON	D. = 1	.00000000000	CM/SEC							
			LAYER 5									
		TYPE 3 - 1 MATERIAL 1	BARRIER SC	DIL LINER IMBER 120								

MATERIAL TE	KTURE	NUMBER 120		
THICKNESS	=	0.06	INCHES	
POROSITY	=	0.8500	VOL/VOL	
FIELD CAPACITY	=	0.0100	VOL/VOL	
WILTING POINT	=	0.0050	VOL/VOL	
INITIAL SOIL WATER CONTENT	Г =	0.8500	VOL/VOL	
EFFECTIVE SAT. HYD. COND.	=	0.40000005	5000E-06	CM/SEC

LAYER 6

							Geosyntec <sup>⊳</sup>							
				CO	nsultar	nts								
			Pag	ge	31 0	of 4	48							
Written by: Joseph Sura Date: 11/23	/2009	Reviewed by:	Fan Zhu / R.	Kulasingam	Date:	12/2/2	009							
Client: Honeywell Project: Onondaga La	ke SCA	Final Design	Project/ Propo	sal No.: GJ4	<b>299</b> Ta	ask No.:	18							
TYPE 1 - VERTICAL	J PERCO	LATION LAYER												
THICKNESS	=	0.06 INCHE	S											
POROSITY	=	0.4190 VOL/V	OL											
FIELD CAPACITY WILTING POINT	=	0.3070 VOL/V	OL OL											
INITIAL SOIL WATER CONTENT	=	0.3070 VOL/V	OL											
EFFECTIVE SAT. HYD. COND.	= 0.	999999975000E-	05 CM/SEC											
LAY 	ER 7													
TYPE 3 - BARR	RIER SO	IL LINER												
MATERIAL TEXT	URE NU	MBER 122 360 00 INCHE	· C											
POROSITY	=	0.4190 VOL/V	OL											
FIELD CAPACITY	=	0.3070 VOL/V	OL											
WILTING POINT	=	0.1800 VOL/V	OL											
INITIAL SOIL WATER CONTENT	=	0.4190 VOL/V	OL OF CM/SEC											
EFFECTIVE SAL. HID. COND.	= 0.	9999999975000E-	US CM/SEC											
LAY	YER 8													
TYPE 2 - LATERA	AL DRAI	NAGE LAYER												
MATERIAL TEXT	URE NU	MBER 121												
THICKNESS	=	12.00 INCHE	S											
POROSITY EIELD CADACITY	=	0.3970 VOL/V	OL OL											
WILTING POINT	=	0.0130 VOL/V	OL											
INITIAL SOIL WATER CONTENT	=	0.0320 VOL/V	OL											
EFFECTIVE SAT. HYD. COND.	= 1	0.0000000000	CM/SEC											
SLOPE	= 1	1.00 PERCE	NT											
DRAINAGE LENGIH	= 1	.500.0 FEEI												
LAY	YER 9													
TYPE 4 - FLEXIE	BLE MEM	BRANE LINER												
MATERIAL TEXT	URE NU	MBER 36 0.06 тысче	s											
POROSITY	=	0.0000 VOL/V	OL											
FIELD CAPACITY	=	0.0000 VOL/V	OL											
WILTING POINT	=	0.0000 VOL/V	OL											
INITIAL SOIL WATER CONTENT	=	0.0000 VOL/V	OL											
EFFECTIVE SAT. HYD. COND. FMI. DINUCLE DENSITY	= 0.	3999999993000E- 0 00 凹へて下の	IZ CM/SEC											
FML FINIOLE DENSITI	=	1.00 HOLES	ACRE											
FML PLACEMENT QUALITY	= 3	- GOOD												

		Geosyntec <sup>⊳</sup>				
		consultants				
		Page 32 of 48				
Written by: Joseph Sura	Date: <u>11/23/2009</u> Reviewed by:	Fan Zhu / R. Kulasingam Date: 12/2/2009				
Client: Honeywell Projec	: Onondaga Lake SCA Final Design	Project/ Proposal No.: GJ4299 Task No.: 18				

#### LAYER 10 \_\_\_\_\_

YPE 3 -	BARRIER	SOIL LINER		
TERIAL	TEXTURE	NUMBER 124		
	=	6.00	INCHES	
	=	0.3650	VOL/VOL	
	=	0.3050	VOL/VOL	
	=	0.2020	VOL/VOL	
CER CONT	CENT =	0.3650	VOL/VOL	
HYD. CON	ND. =	0.99999999	7000E-06	CM/SEC
	TPE 3 - ATERIAL CER CONT IYD. CON	PE 3 - BARRIER TERIAL TEXTURE = = = ER CONTENT = IYD. COND. =	<pre>'PE 3 - BARRIER SOIL LINER TERIAL TEXTURE NUMBER 124 = 6.00 = 0.3650 = 0.3050 = 0.2020 'ER CONTENT = 0.3650 iYD. COND. = 0.99999999'</pre>	<pre>'PE 3 - BARRIER SOIL LINER TERIAL TEXTURE NUMBER 124 = 6.00 INCHES = 0.3650 VOL/VOL = 0.3050 VOL/VOL = 0.2020 VOL/VOL CER CONTENT = 0.3650 VOL/VOL IYD. COND. = 0.999999997000E-06</pre>

LAYER 11

\_\_\_\_\_

#### TYPE 1 - VERTICAL PERCOLATION LAYER MATERIAL TEXTURE NUMBER 113

THICKNESS	=	6.00 INCHES
POROSITY	=	0.4300 VOL/VOL
FIELD CAPACITY	=	0.3210 VOL/VOL
WILTING POINT	=	0.2210 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.3049 VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.999999975000E-05 CM/SEC

#### GENERAL DESIGN AND EVAPORATIVE ZONE DATA -----

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE # 8 WITH A GOOD STAND OF GRASS, A SURFACE SLOPE OF 1.8 AND A SLOPE LENGTH OF 1500. FEET.

SCS RUNOFF CURVE NUMBER	=	68.20	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.000	ACRES
EVAPORATIVE ZONE DEPTH	=	30.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	13.096	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	13.098	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	6.000	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	168.601	INCHES
TOTAL INITIAL WATER	=	168.601	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA -----

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM NEW YORK SYRACUSE

# Geosyntec<sup>▷</sup>

consultants

ge	33	of	

						Ра	ige	33	of	48	
Written by: Joseph Sura		Date: 11/	23/2009	Reviewed	by: 1	Fan Zhu / R	. Kulasing	am Date	: 12/2/2009		
Client: Honeywell	Project:	<b>Onondaga</b>	Lake SCA l	Final Desig	gn P	roject/ Propo	osal No.:	GJ4299	Task No.:	18	
	STATION LATI MAXIMUM LEAF START OF GROU END OF GROWI EVAPORATIVE : AVERAGE ANNU AVERAGE 1ST ( AVERAGE 3RD ( AVERAGE 4TH (	TUDE AREA INDEX VING SEASON ( ZONE DEPTH AL WIND SPE QUARTER REL QUARTER REL QUARTER REL QUARTER REL	G (JULIAN JULIAN DA ED ATIVE HUM ATIVE HUM ATIVE HUM	= DATE) = NTE) = IIDITY = MIDITY = MIDITY = MIDITY =	43.07 3.50 124 284 30.0 9.70 72.00 68.00 75.00 76.00	DEGREES INCHES MPH % % %					
NOT	E: PRECIPITA COEFFIC	FION DATA W LENTS FOR	AS SYNTHE SYRACUS	TICALLY SE	GENERAT NE	ED USING W YORK					
	NORMAL I	MEAN MONTHL	Y PRECIPI	TATION (	INCHES)						
JAN/JUL	FEB/AUG	MAR/SEP	APR/	OCT	MAY/NOV	JUN/1	DEC				
2.61 3.76	2.65 3.77	3.11 3.29	3. 3.	.34 .14	3.16 3.45	3.	 63 20				
NOT	E: TEMPERATUI COEFFIC	RE DATA WAS IENTS FOR MONTHLY TEM	SYNTHETI SYRACUS	CALLY GE SE (DEGREES	NERATED NE 5 FAHREN	USING W YORK HEIT)					
JAN/JUL	FEB/AUG	MAR/SEP	APR/	OCT	MAY/NOV	JUN/I	DEC				
22.80 70.90	24.00 69.30	33.30 62.10	46. 51.	10 30	57.00 40.60	66. 28.	30 30				
NOT	E: SOLAR RAD COEFFIC AND S	LATION DATA LENTS FOR FATION LATI	WAS SYNT SYRACUS TUDE =	THETICALI SE 43.07 DE	Y GENER NE GREES	ATED USING W YORK	G				
*********** AVE	RAGE MONTHLY	************** /ALUES IN I	********** NCHES FOR	********* R YEARS	1 THR	********* OUGH 100	* * * * * * * * *	*			
		JAN/JUL FE	B/AUG MA	AR/SEP A	APR/OCT	MAY/NOV	JUN/DEC	-			
PRECIPITAT	ION										
TOTALS		2.59 3.87	2.72 3.95	3.16 3.27	3.27 2.95	3.09 3.40	3.71 3.22				
STD. DEV	VIATIONS	0.70 1.67	0.96 1.76	1.19 1.60	1.19 1.16	1.31 1.19	1.57 0.76				

RUNOFF

# Geosyntec<sup>D</sup> consultants

48

Page	34	of

tten	by: Joseph Sura	1	Date: 1	1/23/2009	Reviewed	by:	Fan Zhu / R.	Kulasing	am Dat	e: <u>12/2/2</u>	009
ent:	Honeywell	Project:	Onondaga	a Lake SCA	Final Desig	gn	Project/ Propos	al No.:	GJ4299	Task No.:	18
	TOTALS		0.840	1.708	5.121	2.038	0.493	0.312			
			0.056	0.019	0.027	0.158	0.770	1.251			
	STD. DEVIATI	IONS	0.941 0.419	1.678 0.152	2.481 0.165	1.397 0.473	0.690 1.120	0.666 1.084			
	EVAPOTRANSPIR	ATION									
	TOTALS		0.491 6.166	0.407 4.126	0.480 2.211	1.806 1.045	2.889 0.710	5.480 0.497			
	STD. DEVIATI	IONS	0.080 0.755	0.077 1.297	0.169 0.674	0.691 0.154	0.799	0.644 0.109			
	LATERAL DRAINA	AGE COLLECT	TED FROM I	LAYER 2							
	TOTALS		0.0000 0.0001	0.0000	0.0000 0.0000	0.000	2 0.0003 1 0.0002	0.0002 0.0002			
	STD. DEVIATI	IONS	0.0000	0.0000 0.0000	0.0000 0.0001	0.000 0.000	1 0.0000 1 0.0002	0.0000 0.0002			
	PERCOLATION/LE	EAKAGE THRO	DUGH LAYEF	<b>૨</b> 3							
	TOTALS		0.0052 0.0069	0.0043	0.0052 0.0021	0.012 0.004	9 0.0194 6 0.0100	0.0150 0.0128			
	STD. DEVIATI	IONS	0.0019 0.0034	0.0011 0.0037	0.0018 0.0044	0.004 0.007	6 0.0006 1 0.0084	0.0014 0.0065			
	PERCOLATION/LE	EAKAGE THRO	DUGH LAYEF	R 5							
	TOTALS		0.0052	0.0043	0.0052 0.0021	0.012 0.004	9 0.0194 6 0.0100	0.0150 0.0128			
	STD. DEVIATI	IONS	0.0019 0.0034	0.0011 0.0037	0.0018 0.0044	0.004 0.007	6 0.0006 1 0.0084	0.0014 0.0065			
	PERCOLATION/LE	EAKAGE THRO	DUGH LAYEF	R 7							
	TOTALS		0.0052 0.0069	0.0043	0.0052 0.0021	0.012 0.004	9 0.0194 6 0.0100	0.0150 0.0128			
	STD. DEVIATI	IONS	0.0019 0.0034	0.0011 0.0037	0.0018 0.0044	0.004 0.007	6 0.0006 1 0.0084	0.0014 0.0065			
	LATERAL DRAINA	AGE COLLECT	TED FROM I	LAYER 8							
	TOTALS		0.0052	0.0043 0.0024	0.0051 0.0020	0.012 0.004	5 0.0194 5 0.0097	0.0153 0.0131			
	STD. DEVIATI	IONS	0.0020 0.0034	0.0011 0.0037	0.0017 0.0044	0.004 0.007	7 0.0006 0 0.0084	0.0014 0.0066			
	PERCOLATION/LE	EAKAGE THRO	DUGH LAYEF	R 10							
	TOTALS		0.0000	0.0000	0.0000	0.000 0.000	0.0000	0.0000 0.0000			
	STD. DEVIATI	IONS	0.0000 0.0000	0.0000 0.0000	0.0000	0.000	0.0000	0.0000 0.0000			
consultants

						Pa	age	33	01	4
en	by: Joseph Sura	Date:	11/23/2009	Reviewe	d by: <u>1</u>	Fan Zhu / R	. Kulasinga	m Date	e: <u>12/2/2</u>	2
ıt:	Honeywell Proje	ect: Onondag	ga Lake SCA	Final Des	<b>ign</b> P	roject/ Prop	osal No.:	GJ4299	Task No.:	
	PERCOLATION/LEAKAGE	THROUGH LAYE	R 11							
	TOTALS	0.0004 0.0003	0.0004	0.0004 0.0001	0.0004 0.0001	0.0004 0.0002	0.0003 0.0003			
	STD. DEVIATIONS	0.0011 0.0006	0.0009 0.0003	0.0009 0.0003	0.0008 0.0003	0.0008 0.0006	0.0007 0.0006			
	AVERAGE	S OF MONTHLY	AVERAGED	DAILY HE	ADS (INC	HES)		_		
	DAILY AVERAGE HEAD O	N TOP OF LAY	YER 3							
	AVERAGES	5.1671 8.4427	4.5585 2.6768	5.1793 2.6671	17.5567 6.0991	26.9031 13.9574	21.4400 16.9021			
	STD. DEVIATIONS	2.5364 5.0019	1.2677 4.8488	2.2985 6.1433	7.1492 9.8299	0.7459 12.0795	2.1231 9.2454			
	DAILY AVERAGE HEAD O	N TOP OF LAY	TER 5							
	AVERAGES	0.0001 0.0001	0.0001 0.0000	0.0001 0.0000	0.0001 0.0001	0.0002 0.0001	0.0002 0.0001			
	STD. DEVIATIONS	0.0000 0.0000	0.0000 0.0000	0.0000 0.0001	0.0001 0.0001	0.0000 0.0001	0.0000 0.0001			
	DAILY AVERAGE HEAD O	N TOP OF LAY	YER 7							
	AVERAGES	0.0002 0.0002	0.0002	0.0002 0.0001	0.0005 0.0002	0.0007 0.0004	0.0006 0.0005			
	STD. DEVIATIONS	0.0001 0.0001	0.0000 0.0001	0.0001 0.0002	0.0002 0.0003	0.0000 0.0003	0.0001 0.0002			
	DAILY AVERAGE HEAD O	N TOP OF LAY	YER 9							
	AVERAGES	0.0004 0.0006	0.0004	0.0004 0.0002	0.0011 0.0004	0.0017 0.0009	0.0013 0.0011			
	STD. DEVIATIONS	0.0002 0.0003	0.0001 0.0003	0.0001 0.0004	0.0004 0.0006	0.0000 0.0007	0.0001 0.0006			
*	**************************************	**************************************		********** **********	******** ******** EARS	********* ********** 1 THROIIC4	********* ********** 100	*		
_						 FFT		_		
1	PRECIPITATION	 39	.20 (	4.823)		 79.7	100.00			
J	RUNOFF	12	2.794 (	3.3907)	464	41.28	32.641			

consultants

							Page		36	of	4	8
Writter	Written by: Joseph Sura Date: 11/23/200		09	Reviewed by:	Fan Zhu /	R. Kulasinga	am Dat	te: <u>1</u>	2/2/20	09		
Client:	Honeywell	Project:	Onon	daga Lake S	SCA	A Final Design	Project/ Pro	posal No.:	GJ4299	Task 1	No.:	18
	LATERAL DRAINAG	GE COLLECTE 2	D	0.00145	(	0.00054)	5.246	0.00369				
	PERCOLATION/LEA LAYER 3	AKAGE THROU	JGH	0.10082	(	0.02666)	365.966	0.25722				
	AVERAGE HEAD ON OF LAYER 3	N TOP		10.962 (		3.116)						
	PERCOLATION/LEA	AKAGE THROU	JGH	0.10082	(	0.02666)	365.966	0.25722				
	AVERAGE HEAD ON OF LAYER 5	N TOP		0.000 (		0.000)						
	PERCOLATION/LEA LAYER 7	AKAGE THROU	JGH	0.10082	(	0.02666)	365.966	0.25722				
	AVERAGE HEAD ON OF LAYER 7	N TOP		0.000 (		0.000)						
	LATERAL DRAINAG	GE COLLECTE 8	:D	0.10081	(	0.02665)	365.952	0.25721				
	PERCOLATION/LEA LAYER 10	AKAGE THROU	JGH	0.00001	(	0.00000)	0.020	0.00001				
	AVERAGE HEAD ON OF LAYER 9	N TOP		0.001 (		0.000)						
	PERCOLATION/LEA LAYER 11	AKAGE THROU	JGH	0.00340	(	0.00747)	12.332	0.00867				
	CHANGE IN WATER	R STORAGE		-0.013	(	1.5171)	-46.59	-0.033				
	* * * * * * * * * * * * * * * * *	* * * * * * * * * * *	*****	* * * * * * * * * *	* * *	* * * * * * * * * * * * * * * *	********	******	*			
	* * * * * * * * * * * * * * * * * *	**************************************	******	********** Es for ye/	*** ARS	1 THROUGH	100	*****				
						( INCHES )						
	PRECIPITA	TTON				4 40						
	PINOFF	1101				4 242	15750	7656				
	DRAINACE			AVED 2		4.342	13739.	06091				
	DEPCOLATI	OULLECIED F		CH LAVED	3	0.00002	0.	55133				
	AVEDACE U	END ON TOD	OFIN	VED 2	J	20,000	2.	55155				
	AVERAGE H	EAD ON TOP	OF LA	VED 2		27 207						
	LOCATION (	DF MAXIMUM	HEAD	IN LAYER	2	506 A mmm						
		ONI/IEAVACE		אי) רעד דאעיהים	Б	0 000703	0	55122				
	PERCULATIO	UN/ LEAKAGE	IRKUU	JA LAIEK	Э	0.000/03	2.	22722				
	AVERAGE HI	LAD ON TOP	OF LAY	14K 5		0.000						

# Geosyntec<sup>D</sup> consultants

			37	of	48	
Written by: Joseph Sura Date: 11/23/2009	Reviewed by:	Fan Zhu / R. Kulasing	am Dat	e: <u>12/2/2</u>	2009	
Client: Honeywell Project: Onondaga Lake SCA	Final Design	Project/ Proposal No.:	GJ4299	Task No.:	18	
PERCOLATION/LEAKAGE THROUGH LAYER 7	0.000703	2.55133				
AVERAGE HEAD ON TOP OF LAYER 7	0.001					
DRAINAGE COLLECTED FROM LAYER 8	0.00070	2.55124				
PERCOLATION/LEAKAGE THROUGH LAYER 10	0.000000	0.00009				
AVERAGE HEAD ON TOP OF LAYER 9	0.002					
MAXIMUM HEAD ON TOP OF LAYER 9	0.004					
LOCATION OF MAXIMUM HEAD IN LAYER 8 (DISTANCE FROM DRAIN)	0.0 FEET					
PERCOLATION/LEAKAGE THROUGH LAYER 11	0.000314	1.14110				
SNOW WATER	9.62	34911.7891				
MAXIMUM VEG. SOIL WATER (VOL/VOL)	0	.4366				
MINIMUM VEG. SOIL WATER (VOL/VOL)	0	0.2000				
*** Maximum heads are computed using	McEnroe's equa	ations. ***				
Reference: Maximum Saturated Dep by Bruce M. McEnroe, ASCE Journal of Envir Vol. 119, No. 2, Marc	pth over Landf. University of ronmental Engin ch 1993, pp. 2	ill Liner Kansas neering 62-270.				
*****	* * * * * * * * * * * * * * *	* * * * * * * * * * * * * * * * * * * *				

				Ge	Geosyntec				
					consu	tants			
				Page	38	of	48		
ritten by: Joseph Sura		Date: 11/23/2009	Reviewed by:	Fan Zhu / R. Kulasing	<b>gam</b> Dat	e: <u>12/2/</u>	2009		
ient: Honeywell	Project:	Onondaga Lake SCA	A Final Design	Project/ Proposal No.:	GJ4299	Task No.:	18		
****	****	* * * * * * * * * * * * * * * * * *	* * * * * * * * * * * * * * * *	****	*				
	FINAL W	ATER STORAGE AT E	ND OF YEAR 100						
	LAYER	(INCHES)	(VOL/VOL)						
	1	2.7516	0.4586						
	2	9.3544	0.3898						
	3	0.0000	0.0000						
	4	0.1920	0.0320						
	5	0.0510	0.8500						
	б	0.0184	0.3070						
	7	150.8400	0.4190						
	8	0.3840	0.0320						
	9	0.0000	0.0000						
	10	2.1900	0.3650						
	11	1.4902	0.2484						
	SNOW WAT	ER 0.046							

~

#### Geosyntec<sup>▷</sup> consultants Page 39 of 48 Written by: Joseph Sura Date: 11/23/2009 Reviewed by: Fan Zhu / R. Kulasingam Date: 12/2/2009 Client: Honeywell Project: Onondaga Lake SCA Final Design Project/ Proposal No.: GJ4299 Task No.: 18 \* \* \* \* \* \* \* \* \* \* \* \* \* \* HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE \* \* \* \* \* \* HELP MODEL VERSION 3.07 (1 NOVEMBER 1997) \* \* DEVELOPED BY ENVIRONMENTAL LABORATORY \* \* \* \* \* \* USAE WATERWAYS EXPERIMENT STATION \* \* \* \* FOR USEPA RISK REDUCTION ENGINEERING LABORATORY \* \* \* \* \* \* \* \* \* PRECIPITATION DATA FILE: C:\PROGRA~1\HELP\OLPRECIP.D4 TEMPERATURE DATA FILE: C:\PROGRA~1\HELP\OLTEMP.D7 SOLAR RADIATION DATA FILE: C:\PROGRA~1\HELP\OLSOLAR.D13 EVAPOTRANSPIRATION DATA: C:\PROGRA~1\HELP\OL\_LAI35.D11 SOIL AND DESIGN DATA FILE: C:\PROGRA~1\HELP\S\_III1A.D10 OUTPUT DATA FILE: C:\PROGRA~1\HELP\S\_III1A.OUT TIME: 13:47 DATE: 12/ 9/2009 \*\*\*\*\* TITLE: Onondaga Lake SCA - Final Design NOTE: INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM. LAYER 1 \_\_\_\_\_ TYPE 1 - VERTICAL PERCOLATION LAYER MATERIAL TEXTURE NUMBER 108 = 6.00 INCHES = 0.4630 VOL/VOL THICKNESS POROSITY = FIELD CAPACITY 0.2320 VOL/VOL FIELD CAPACITY=0.2320 VOL/VOLWILTING POINT=0.1160 VOL/VOLINITIAL SOIL WATER CONTENT=0.4567 VOL/VOLEFFECTIVE SAT. HYD. COND.=0.999999975000E-04 CM/SEC LAYER 2

TYPE 2 - LATERAL DRAINAGE LAYER

consultants

				Page	40	of	48
	Date:	11/23/2009	Reviewed by:	Fan Zhu / R. Kulasinga	<u>m</u> Date	: 12/2/2	009
Project:	Onond	aga Lake SCA	Final Design	Project/ Proposal No.:	GJ4299	Task No.:	18

MATERIAL TEXTURE NUMBER 113THICKNESS=24.00INCHESPOROSITY=0.4300VOL/VOLFIELD CAPACITY=0.3210VOL/VOLWILTING POINT=0.2210VOL/VOLINITIAL SOIL WATER CONTENT=0.4057VOL/VOLEFFECTIVE SAT. HYD. COND.=0.999999975000E-05CM/SEC

LAYER 3

TYPE 2 - LATERA	L DF	AINAGE LAYE	ER.	
MATERIAL TEXT	URE	NUMBER 220		
THICKNESS	=	0.20	INCHES	
POROSITY	=	0.8500	VOL/VOL	
FIELD CAPACITY	=	0.0100	VOL/VOL	
WILTING POINT	=	0.0050	VOL/VOL	
INITIAL SOIL WATER CONTENT	=	0.0100	VOL/VOL	
EFFECTIVE SAT. HYD. COND.	=	1.33000004	1000	CM/SEC
SLOPE	=	30.00	PERCENT	
DRAINAGE LENGTH	=	100.0	FEET	

#### LAYER 4

# TYPE 4 - FLEXIBLE MEMBRANE LINER<br/>MATERIAL TEXTURE NUMBER 36THICKNESS=0.06INCHESPOROSITY=0.0000VOL/VOLFIELD CAPACITY=0.0000VOL/VOLWILTING POINT=0.0000VOL/VOLINITIAL SOIL WATER CONTENT=0.0000VOL/VOLEFFECTIVE SAT. HYD. COND.=0.39999993000E-12CM/SECFML PINHOLE DENSITY=0.00HOLES/ACREFML INSTALLATION DEFECTS=1.00HOLES/ACREFML PLACEMENT QUALITY=3 - GOOD

#### LAYER 5

TYPE 1 - VERTICAL	PER	COLATION LAYER	
MATERIAL TEXT	URE	NUMBER 221	
THICKNESS	=	6.00 INCHES	
POROSITY	=	0.3970 VOL/VOL	
FIELD CAPACITY	=	0.0320 VOL/VOL	
WILTING POINT	=	0.0130 VOL/VOL	
INITIAL SOIL WATER CONTENT	=	0.0320 VOL/VOL	
EFFECTIVE SAT. HYD. COND.	=	1.0000000000	CM/SEC

LAYER 6

Written by: Joseph Sura

Client: Honeywell

Geosyntec<sup>></sup> consultants 41 of 48 Page Written by: Joseph Sura Date: 11/23/2009 Reviewed by: Fan Zhu / R. Kulasingam Date: 12/2/2009 Client: Honeywell **Onondaga Lake SCA Final Design** Project/ Proposal No.: GJ4299 Task No.: 18 Project: \_\_\_\_\_ TYPE 3 - BARRIER SOIL LINER MATERIAL TEXTURE NUMBER 120 THICKNESS = 0.06 INCHES 0.8500 VOL/VOL POROSITY = FIELD CAPACITY = 0.0100 VOL/VOL = 0.0050 VOL/VOL WILTING POINT INITIAL SOIL WATER CONTENT = 0.8500 VOL/VOL EFFECTIVE SAT. HYD. COND. = 0.40000005000E-06 CM/SEC LAYER 7 \_\_\_\_\_ TYPE 1 - VERTICAL PERCOLATION LAYER MATERIAL TEXTURE NUMBER 122 0.06 INCHES THICKNESS = 0.4190 VOL/VOL 0.3070 VOL/VOL POROSITY = FIELD CAPACITY = 0.3070 VOL/VOL WILTING POINT = 0.1800 VOL/VOL INITIAL SOIL WATER CONTENT = 0.3070 VOL/VOL EFFECTIVE SAT. HYD. COND. = 0.999999975000E-05 CM/SEC LAYER 8 \_\_\_\_\_ TYPE 3 - BARRIER SOIL LINER MATERIAL TEXTURE NUMBER 122 THICKNESS = 360.00 INCHES 0.4190 VOL/VOL 0.3070 VOL/VOL POROSITY = FIELD CAPACITY = WILTING POINT = 0.1800 VOL/VOL INITIAL SOIL WATER CONTENT = 0.4190 VOL/VOL EFFECTIVE SAT. HYD. COND. = 0.999999975000E-05 CM/SEC LAYER 9 \_\_\_\_\_ TYPE 2 - LATERAL DRAINAGE LAYER MATERIAL TEXTURE NUMBER 121

THICKNESS	=	12.00	INCHES	
POROSITY	=	0.3970	VOL/VOL	
FIELD CAPACITY	=	0.0320	VOL/VOL	
WILTING POINT	=	0.0130	VOL/VOL	
INITIAL SOIL WATER CONTENT	=	0.0320	VOL/VOL	
EFFECTIVE SAT. HYD. COND.	=	10.000000	0000	CM/SEC
SLOPE	=	1.00	PERCENT	
DRAINAGE LENGTH	=	1500.0	FEET	

LAYER 10

### Ceosyntec ▷ consultants Page 42 of 48

Written	by: Joseph Sura		Date:	11/23/2009	Reviewed by:	iewed by: Fan Zhu / R. Kulasinga		Date:	12/2/2009	
Client:	Honeywell	Project:	Onond	aga Lake SCA	Final Design	Project/ Proposal No .:	GJ429	9 T	ask No.:	18

-----

#### TYPE 4 - FLEXIBLE MEMBRANE LINER MATERIAL TEXTURE NUMBER 36

	0102	Horibblic 50
THICKNESS	=	0.06 INCHES
POROSITY	=	0.0000 VOL/VOL
FIELD CAPACITY	=	0.0000 VOL/VOL
WILTING POINT	=	0.0000 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0000 VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.399999993000E-12 CM/SEC
FML PINHOLE DENSITY	=	0.00 HOLES/ACRE
FML INSTALLATION DEFECTS	=	1.00 HOLES/ACRE
FML PLACEMENT QUALITY	=	3 - GOOD

LAYER 11

\_\_\_\_\_

	TYPE 3 -	BARRIER	SOIL LINER		
	MATERIAL	TEXTURE	NUMBER 124		
THICKNESS		=	6.00	INCHES	
POROSITY		=	0.3650	VOL/VOL	
FIELD CAPACITY	ζ	=	0.3050	VOL/VOL	
WILTING POINT		=	0.2020	VOL/VOL	
INITIAL SOIL V	VATER CONT	FENT =	0.3650	VOL/VOL	
EFFECTIVE SAT.	. HYD. CON	ND. =	0.99999999	7000E-06	CM/SEC

#### LAYER 12

TYPE 1 - VERTICAL PERCOLATION LAYER<br/>MATERIAL TEXTURE NUMBER 113THICKNESS=6.00INCHESPOROSITY=0.4300VOL/VOLFIELD CAPACITY=0.3210VOL/VOLWILTING POINT=0.2210VOL/VOLINITIAL SOIL WATER CONTENT=0.3038VOL/VOLEFFECTIVE SAT. HYD. COND.=0.999999975000E-05CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE # 8 WITH A GOOD STAND OF GRASS, A SURFACE SLOPE OF 30.% AND A SLOPE LENGTH OF 100. FEET.

SCS RUNOFF CURVE NUMBER	=	76.10	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.000	ACRES
EVAPORATIVE ZONE DEPTH	=	30.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	12.477	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	13.098	INCHES

							СС	onsul	tants	
						Page		43	of	48
Written l	by: Joseph Sura	1	Date: 11/23/2	009 Review	ved by:	Fan Zhu / R. K	ulasingam	_ Date	e: <u>12/2/</u>	2009
Client:	Honeywell	Project:	Onondaga Lake	e SCA Final D	esign	Project/ Proposal	No.: GJ	4299	Task No.:	18
	LOWER LI INITIAL INITIAL TOTAL IN TOTAL SU	IMIT OF EVA SNOW WATER WATER IN I NITIAL WATH JBSURFACE :	APORATIVE STOR AYER MATERIAL R NFLOW	AGE = = S = 16 = 16	6.000 0.000 57.977 57.977 0.00	INCHES INCHES INCHES INCHES INCHES/YEAR				
		EVAPO:	TRANSPIRATION	AND WEATHER	DATA					
	NOTE:	EVAPOTRANS SYRACUSI	PIRATION DATA	WAS OBTAINN NEW YORK	ED FROM					
	STA MA2 STA ENI EVA AVF AVF AVF AVF	ATION LATI (IMUM LEAF ART OF GROWI O OF GROWI APORATIVE 2 ERAGE ANNUZ ERAGE 1ST ( ERAGE 2ND ( ERAGE 3RD ( ERAGE 4TH (	UDE AREA INDEX JING SEASON (JUL G SEASON (JUL CONE DEPTH L WIND SPEED JUARTER RELATI JUARTER RELATI JUARTER RELATI	ULIAN DATE) IAN DATE) VE HUMIDITY VE HUMIDITY VE HUMIDITY VE HUMIDITY	$\begin{array}{rrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrr$	07 DEGREES 50 24 84 0 INCHES 70 MPH 00 % 00 % 00 %				
	NOTE :	PRECIPITAT COEFFIC	TION DATA WAS TENTS FOR S	SYNTHETICALI YRACUSE	LY GENER	ATED USING NEW YORK				
		NORMAL N	IEAN MONTHLY P	RECIPITATION	N (INCHE	S)				
	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/N	OV JUN/DEC	-			
	2.61 3.76	2.65 3.77	3.11 3.29	3.34 3.14	 3.1 3.4	 6 3.63 5 3.20				

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR SYRACUSE NEW YORK

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
22.80	24.00	33.30	46.10	57.00	66.30
70.90	69.30	62.10	51.30	40.60	28.30

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR SYRACUSE NEW YORK AND STATION LATITUDE = 43.07 DEGREES

consultants

				Page	44	of 4	48
Written b	by: Joseph Sura		Date: 11/23/2009 Reviewed	by: Fan Zhu / R. Kulasingam	Date:	12/2/20	)09
Client:	Honeywell	Project:	Onondaga Lake SCA Final Desig	n Project/ Proposal No.: G	J4299	Fask No.:	18

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 100

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	2.59 3.87	2.72 3.95	3.16 3.27	3.27 2.95	3.09 3.40	3.71 3.22
STD. DEVIATIONS	0.70 1.67	0.96 1.76	1.19 1.60	1.19 1.16	1.31 1.19	1.57 0.76
RUNOFF						
TOTALS	0.497 0.038	1.349 0.037	4.738 0.071	1.504 0.048	0.063 0.080	0.094 0.259
STD. DEVIATIONS	0.697 0.224	1.446 0.147	2.349 0.214	1.452 0.155	0.208 0.213	0.310 0.487
EVAPOTRANSPIRATION						
TOTALS	0.491 4.723	0.407 3.571	0.479 2.156	1.824 1.070	2.916 0.725	5.443 0.498
STD. DEVIATIONS	0.080 1.357	0.077 1.206	0.168 0.670	0.702 0.183	0.812 0.141	0.668 0.111
LATERAL DRAINAGE COLL	ECTED FROM	LAYER 3				
TOTALS	0.0459	0.0000 0.0232	0.1598 0.0449	1.8128 0.3348	0.8908 1.0917	0.3306 1.1946
STD. DEVIATIONS	0.1518 0.1773	0.0000 0.1174	0.4555 0.1629	0.7230 0.6606	0.6554 1.0613	0.3481 0.9642
PERCOLATION/LEAKAGE T	HROUGH LAY	er 4				
TOTALS	0.0008	0.0000	0.0017 0.0013	0.0247 0.0063	0.0222 0.0183	0.0121 0.0205
STD. DEVIATIONS	0.0029 0.0041	0.0000 0.0028	0.0051 0.0043	0.0103 0.0115	0.0076 0.0156	0.0059 0.0136
PERCOLATION/LEAKAGE T	HROUGH LAY	ER 6				
TOTALS	0.0008	0.0000 0.0006	0.0017 0.0013	0.0247 0.0063	0.0222 0.0183	0.0121 0.0205
STD. DEVIATIONS	0.0029 0.0041	0.0000 0.0028	0.0051 0.0043	0.0103 0.0115	0.0076 0.0156	0.0059 0.0136
PERCOLATION/LEAKAGE T	HROUGH LAY	er 8				
TOTALS	0.0008	0.0000	0.0017 0.0013	0.0247 0.0063	0.0222 0.0183	0.0121 0.0205
STD. DEVIATIONS	0.0029 0.0041	0.0000	0.0051 0.0043	0.0103 0.0115	0.0076 0.0156	0.0059 0.0136

consultants

							Pag	ge	45	of	48
Written	by: Joseph Sura		Date:	11/23/2009	Reviewed	l by:	Fan Zhu / R.	Kulasinga	<u>m</u> Date	e: <u>12/2//</u>	2009
Client:	Honeywell P	roject:	Onondag	ga Lake SCA	Final Desi	<b>gn</b> I	Project/ Propo	sal No.:	GJ4299	Task No.:	18
	LATERAL DRAINAGE C	COLLECT	TED FROM	LAYER 9							
	TOTALS		0.0010 0.0027	0.0000 0.0006	0.0015 0.0013	0.0238 0.0061	0.0228 0.0177	0.0123 0.0213			
	STD. DEVIATIONS		0.0033 0.0042	0.0000 0.0028	0.0046 0.0043	0.0108 0.0112	0.0078 0.0155	0.0059 0.0137			
	PERCOLATION/LEAKAG	GE THRO	DUGH LAYE	R 11							
	TOTALS		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000			
	STD. DEVIATIONS		0.0000	0.0000 0.0000	0.0000	0.0000	0.0000	0.0000 0.0000			
	PERCOLATION/LEAKAG	SE THRO	DUGH LAYE	R 12							
	TOTALS		0.0000 0.0004	0.0000	0.0000	0.0003	0.0005 0.0003	0.0005 0.0004			
	STD. DEVIATIONS		0.0001 0.0006	0.0000 0.0007	0.0000	0.0006 0.0005	5 0.0010 5 0.0006	0.0009 0.0006			
-	AVERA	AGES OF	MONTHLY	AVERAGED	DAILY HEA	ADS (INC	CHES)		-		
	DAILY AVERAGE HEAL			ER 4							
	AVERAGES		0.0001 0.0002	0.0000 0.0000	0.0003	0.0036	5 0.0018 5 0.0022	0.0007 0.0023			
	STD. DEVIATIONS		0.0003 0.0003	0.0000 0.0002	0.0009 0.0003	0.0015 0.0013	5 0.0013 8 0.0021	0.0007 0.0019			
	DAILY AVERAGE HEAD	ON TO	OP OF LAY	TER 6							
	AVERAGES		0.0000 0.0000	0.0000 0.0000	0.0000	0.0003	8 0.0002 L 0.0002	0.0001 0.0002			
	STD. DEVIATIONS		0.0000 0.0000	0.0000 0.0000	0.0001 0.0000	0.0001 0.0001	L 0.0001 L 0.0002	0.0001 0.0002			
	DAILY AVERAGE HEAD	ON TO	OP OF LAY	ER 8							
	AVERAGES		0.0000 0.0001	0.0000	0.0001 0.0000	0.0009 0.0002	0.0008 0.0007	0.0004 0.0007			
	STD. DEVIATIONS		0.0001 0.0001	0.0000 0.0001	0.0002	0.0004 0.0004	4 0.0003 4 0.0006	0.0002 0.0005			
	DAILY AVERAGE HEAD	ON TO	OP OF LAY	ER 10							
	AVERAGES		0.0001 0.0002	0.0000	0.0001 0.0001	0.0021	0.0019 0.0016	0.0011 0.0018			
	STD. DEVIATIONS		0.0003 0.0004	0.0000 0.0002	0.0004 0.0004	0.0010 0.0010	0.0007 0.0014	0.0005 0.0012			

11/23/20 aga Lake ******** • DEVIA  9.20 8.779 4.302 6.00731	009 SCA **** TIO  HES  ( ( ( ( (	Reviewed A Final Desig ************************************	by: <u>Fan Zhu /</u> n Project/ Pro ARS 1 THROUG CU. FEET 142279.7 31868.48 88217 59	Page / R. Kulasingar oposal No.: 0 ************************************	consult 46 <u>m</u> Date GJ4299	tants of 2: <u>12/2/</u> Task No.:	<u>48</u> 2009 1
11/23/20 nga Lake ******** . DEVIA . DEVIA . DEVIA . OEVIA . OUTA . OUTA	009 SC4 **** TIO  ( ( ( ( (	Reviewed A Final Desig ************************************	by: <u>Fan Zhu</u> , n Project/ Pro	Y R. Kulasingar         oposal No.:         oposal No.: <t< th=""><th>40 <u>m</u> Date GJ4299</th><th>e: <u>12/2/</u> Task No.:</th><th><u>40</u> 2009</th></t<>	40 <u>m</u> Date GJ4299	e: <u>12/2/</u> Task No.:	<u>40</u> 2009
11/23/20 nga Lake ******** . DEVIA . DEVIA . DEVIA 9.20 8.779 4.302 6.00731	SC4 **** **** TIO  ( ( ( ( (	A Final Desig	n Project/ Pro	A. Kutasingar           oposal No.:         0           ************************************	<u>n</u> Date	Task No.:	1
ega Lake	SCA **** TIO  ( ( ( (	A Final Desig ************************************	n Project/ Pro	>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>	GJ4299	Task No.:	1
******** . DEVIA 	**** TIO  HES ( ( ( (	**************************************	ARS 1 THROUG CU. FEET 142279.7 31868.48 88217 59	**************************************			
. DEVIA INC 9.20 8.779 4.302 6.00731	TIO  HES  ( ( (	NS) FOR YEA 	ARS 1 THROUG CU. FEET 142279.7 31868.48 88217 59	GH 100 PERCENT 100.00 22.398			
INC 9.20 8.779 4.302 6.00731	 HES  ( ( (	4.823) 2.3674) 2.5984)	CU. FEET 142279.7 31868.48 88217 59	PERCENT 100.00 22.398			
9.20 8.779 4.302 6.00731	( ( (	4.823) 2.3674) 2.5984)	142279.7 31868.48 88217 59	100.00 22.398			
8.779 4.302 6.00731	( (	2.3674) 2.5984)	31868.48 88217 59	22.398			
4.302 6.00731	(	2.5984)	88217 59				
6.00731	(		0021/.32	62.003			
	,	2.22963)	21806.545	15.32654			
0.11115	(	0.03784)	403.480	0.28358			
0.001 (		0.000)					
0.11115	(	0.03784)	403.480	0.28358			
0.000 (		0.000)					
0.11115	(	0.03784)	403.480	0.28358			
0.000 (		0.000)					
0.11115	(	0.03780)	403.465	0.28357			
0.00000	(	0.00000)	0.015	0.00001			
0.001 (		0.000)					
0.00307	(	0.00595)	11.137	0.00783			
0.008	(	1.3026)	-27.54	-0.019			
	0.11115 0.000 ( 0.11115 0.000 ( 0.11115 0.00000 0.001 ( 0.00307 0.008 *******	0.11115 ( 0.000 ( 0.11115 ( 0.000 ( 0.11115 ( 0.00000 ( 0.001 ( 0.00307 ( 0.008 (	0.111115 (       0.03784)         0.000 (       0.000)         0.111115 (       0.03784)         0.000 (       0.000)         0.111115 (       0.03780)         0.111115 (       0.03780)         0.111115 (       0.03780)         0.00000 (       0.00000)         0.111115 (       0.00000)         0.00000 (       0.00000)         0.001 (       0.0000)         0.00307 (       0.00595)         0.008 (       1.3026)	0.111115 (       0.03784)       403.480         0.000 (       0.000)         0.11115 (       0.03784)       403.480         0.000 (       0.000)         0.11115 (       0.03780)       403.465         0.000 (       0.000)       0.015         0.11115 (       0.03780)       0.015         0.0000 (       0.0000)       0.115         0.001 (       0.000)       11.137         0.008 (       1.3026)       -27.54	0.111115 (       0.03784)       403.480       0.28358         0.000 (       0.000)       0.011115 (       0.03784)       403.480       0.28358         0.000 (       0.000)       0.000)       0.11115 (       0.03780)       403.465       0.28357         0.00000 (       0.03780)       403.465       0.28357         0.00000 (       0.00000)       0.015       0.00001         0.001 (       0.000)       0.015       0.00783         0.00307 (       0.00595)       11.137       0.00783         0.008 (       1.3026)       -27.54       -0.019	0.11115 ( $0.03784$ ) $403.480$ $0.28358$ $0.000$ ( $0.000$ ) $0.11115$ ( $0.03784$ ) $403.480$ $0.28358$ $0.000$ ( $0.000$ ) $0.000$ $0.11115$ ( $0.03780$ ) $403.465$ $0.28357$ $0.00000$ ( $0.0000$ ) $0.015$ $0.0001$ $0.001$ ( $0.0000$ ) $0.015$ $0.0001$ $0.00307$ ( $0.00595$ ) $11.137$ $0.00783$ $0.008$ ( $1.3026$ ) $-27.54$ $-0.019$	0.11115 (       0.03784)       403.480       0.28358         0.000 (       0.000)       0.011115 (       0.03784)       403.480       0.28358         0.000 (       0.000)       0.000 (       0.000)       0.28357         0.0000 (       0.0000)       0.015       0.00001         0.001 (       0.000)       0.015       0.00001         0.00307 (       0.00595)       11.137       0.00783         0.008 (       1.3026)       -27.54       -0.019

# Geosyntec consultants 47 of

			Page	47	of	48
Written by: Joseph Sura	Date: 11/23/2009	Reviewed by:	Fan Zhu / R. Kulasing	am Date	e: <u>12/2/2</u>	2009
Client: Honeywell Project:	Onondaga Lake SCA I	Final Design	Project/ Proposal No.:	GJ4299	Task No.:	18
DRAINAGE COLLECTED F	FROM LAYER 3	0.34412	1249.16895			
PERCOLATION/LEAKAGE	THROUGH LAYER 4	0.004427	16.06958			
AVERAGE HEAD ON TOP	OF LAYER 4	0.020				
MAXIMUM HEAD ON TOP	OF LAYER 4	0.030				
LOCATION OF MAXIMUM (DISTANCE FROM	HEAD IN LAYER 3 1 DRAIN)	0.0 FEET				
PERCOLATION/LEAKAGE	THROUGH LAYER 6	0.004427	16.06958			
AVERAGE HEAD ON TOP	OF LAYER 6	0.002				
PERCOLATION/LEAKAGE	THROUGH LAYER 8	0.004427	16.06958			
AVERAGE HEAD ON TOP	OF LAYER 8	0.005				
DRAINAGE COLLECTED F	FROM LAYER 9	0.00361	13.08806			
PERCOLATION/LEAKAGE	THROUGH LAYER 11	0.000000	0.00022			
AVERAGE HEAD ON TOP	OF LAYER 10	0.010				
MAXIMUM HEAD ON TOP	OF LAYER 10	0.019				
LOCATION OF MAXIMUM (DISTANCE FROM	HEAD IN LAYER 9 1 DRAIN)	0.0 FEET				
PERCOLATION/LEAKAGE	THROUGH LAYER 12	0.000289	1.04834			
SNOW WATER		9.62	34911.7891			
MAXIMUM VEG. SOIL WA	ATER (VOL/VOL)	0	.4355			
MINIMUM VEG. SOIL WA	ATER (VOL/VOL)	0	.2000			
*** Maximum heads	are computed using	McEnroe's equ	ations. ***			
Reference: Ma by As Vo	aximum Saturated Dep 7 Bruce M. McEnroe, 3CE Journal of Envir 51. 119, No. 2, Marc	oth over Landf University of conmental Engi: th 1993, pp. 2	ill Liner Kansas neering 62-270.			
*******	******	* * * * * * * * * * * * * *	* * * * * * * * * * * * * * * * * * * *	*		
*****	* * * * * * * * * * * * * * * * * * * *	* * * * * * * * * * * * * *	* * * * * * * * * * * * * * * * * * * *	*		
FINAL V	NATER STORAGE AT END	OF YEAR 100				
LAYER	( INCHES )	(VOL/VOL)				
1	2.7516	0.4586				
2	9.2275	0.3845				
3	0.0020	0.0100				

consultants

				Page	48	of	48
Written by: Joseph Sura		Date: 11/23/2009	Reviewed by:	Fan Zhu / R. Kulasing	g <b>am</b> Dat	e: <u>12/2/</u>	2009
Client: Honeywell	Project:	Onondaga Lake SCA	Final Design	Project/ Proposal No.:	GJ4299	Task No.:	18
	4	0.0000	0.0000				
	5	0.1920	0.0320				
	6	0.0510	0.8500				
	7	0.0184	0.3070				
	8	150.8400	0.4190				
	9	0.3840	0.0320				
	10	0.0000	0.0000				
	11	2.1900	0.3650				
	12	1.5163	0.2527				
	SNOW WATE	ER 0.046					
***********	* * * * * * * * * * *	* * * * * * * * * * * * * * * * * * *	* * * * * * * * * * * * * * *	* * * * * * * * * * * * * * * * * * * *	*		

PARSONS

Addendum to Appendix I

#### **GEOSYNTEC CONSULTANTS**

#### COMPUTATION COVER SHEET

Client: <u>Honeywell</u> Project: _	Onondaga Lake SCA Design Project/Propos	sal #: Task #:18
TITLE OF COMPUTATIONS	ADDENDUM TO APPENDIX I: EVALU PERFORMANCE FOR SC	<b>JTION OF HYDRAULIC</b> A DESIGN
COMPUTATIONS BY:	SignatureDescriptionPrinted NameJoseph Suraand TitleSenior Staff Engineer	4/19/2011 DATE
ASSUMPTIONS AND PROCEDU CHECKED BY: (Peer Reviewer)	JRES Signature R. Kulangam Printed Name R. Kulasingam and Title Senior Engineer	4/19/2011 DATE
COMPUTATIONS CHECKED BY:	Signature Mgth For Printed Name Fan Zhu and Title Senior Staff Engineer	4/19/2011 DATE
COMPUTATIONS BACKCHECKED BY: (Originator)	Signature Joseph Suramenter	<b>4/14/2011</b> DATE
APPROVED BY: (PM or Designate)	Signature     Jay Beech       Printed Name     Jay Beech       and Title     Principal	ZIAPA 20 (1 DATE
APPROVAL NOTES:	The reaction of the second sec	
REVISIONS (Number and initial a NO. SHEET I	ll revisions) DATE BY CHECKED B	Y APPROVAL

÷1

			Geosyntec							
					consultants					
					Page	1	of	28		
Written by: Joseph Sura		Date:	3/10/2011	Reviewed by:	R. Kulasingam/Jay Bee	ech Date	e: <u>3/11/2</u>	2011		
Client: Honeywell P	Project:	Onond	aga Lake SCA	Final Design	Project/ Proposal No.:	GJ4299	Task No.:	18		

#### ADDENDUM TO APPENDIX I: "EVALUATION OF HYDRAULIC PERFORMANCE FOR SCA DESIGN"

#### **INTRODUCTION**

The purpose of this addendum is to present the results of additional analyses performed using the "Hydraulic Evaluation of Landfill Performance" (HELP) software for the Sediment Consolidation Area (SCA). The initial Appendix I "Evaluation of Hydraulic Performance for SCA Design" (hereafter referred to as the "HELP Package") included analyses for the post-closure period after placement of an assumed final cover system that included a geomembrane (i.e., post-closure conditions). These analyses resulted in a calculated liquid inflow rate for post-closure conditions of 0.4 gal/min. To be conservative in the sump and riser design, a cover system that does not include a geomembrane was evaluated using the same methodology and material parameters as described in the HELP Package. Those results are presented in this addendum.

#### **INPUT PARAMETERS**

The HELP software accepts parameters for layer type, hydraulic conductivity K for each layer, drainage path length, slope, moisture storage values, and climate. The SCA was modeled as shown in Figure 1, which provides a typical cross section. Specific properties of the eight different layers of materials are included in Table 1. It is noted that the input parameters of the geo-tubes, dredge material, liner system and climate data have been discussed in detail in the HELP Package and are not repeated here.

As discussed in the HELP package, the current design of the SCA results in side slopes of 20 horizontal : 6 vertical (i.e., 30% slopes), a slope angle  $\beta$ =16.7 degrees and a drainage path length along the side slopes of 100 ft. On the side slopes of the SCA, a soil cover with a minimum thickness of 21 inches (i.e., a 3-inch leveling layer and 18 inches of cover soil) was assumed in the analysis to represent an alternative condition.

On the top portion of the SCA, a leveling layer with a minimum thickness of 3 inches was assumed to smooth post-settlement contours and maintain positive drainage. In addition, an 18-inch cover soil layer was assumed in the analysis as part of a potential interim or final cover system. The overall cover slope is approximately 0.5% towards the low points near the sump areas. The longest possible drainage path is shown in Figure 2, which is approximately 1500 ft in length.

		Geosyntec <sup>▷</sup>
		consultants
		Page 2 of 28
Written by: Joseph Sura	Date: 3/10/2011 Reviewed by:	R. Kulasingam/Jay Beech Date: 3/11/2011
Client: Honeywell Proj	ect: Onondaga Lake SCA Final Design	Project/ Proposal No.: GJ4299 Task No.: 18

The leveling layer and the cover soil layer, both along the side slopes and on top of the SCA, were combined into a single 21-inch cover layer and modeled as a sandy clay (SC) soil type with a hydraulic conductivity of  $1.0 \times 10^{-5}$  cm/s. It is noted that analyses presented in the HELP Package indicate that the hydraulic conductivity of this layer did not significantly impact the calculation results. In the analyses presented herein, a value of Leaf Area Index of 0 has been used to represent the bare ground and minimal vegetation in the bare ground. Additionally, the evaporative zone depth is 21 inches to represent the total modeled cover system thickness in the analyses presented herein.

#### SUMMARY AND CONCLUSIONS

This addendum presents the analyses of the hydraulic performance of the proposed SCA using the HELP model for a potential condition. The analysis presented in this package is intended to evaluate the infiltration rate through a cover system consisting of a 3-inch leveling layer and 18 inches of cover soil (i.e., 21 inches total). The calculated annual average leachate rate was approximately 15 gallons per minute for the top area case and approximately 12 gallons per minute for the side slope case. Because the majority of the SCA area is underneath the flat top, the leachate rate of 15 gallons per minute has been selected for use in the Sump and Riser Package to calculate the required pump capacity for during closure conditions.

			Ge					
			Page	3	of	28		
Written by: Joseph Sura		Date: <u>3/10/2011</u> Revi	ewed by: <b>R. Kulasingam/Jay B</b>	eech Date	e: <u>3/11/2</u>	011		
Client: Honeywell	Project:	Onondaga Lake SCA Final	Design Project/ Proposal No.:	GJ4299	Task No.:	18		

Tables

					Ge	osyn	tec	>
						consul	tants	
					Page	4	of	28
Written by: Joseph Sura		Date:	3/10/2011	Reviewed by:	R. Kulasingam/Jay Bee	ech Date	e: <u>3/1</u>	1/2011
Client: Honeywell	Project:	Onond	aga Lake SCA	A Final Design	Project/ Proposal No.:	GJ4299	Task No	o.: <b>18</b>

Table 1: Material Properties of Layers within SCA System

Layer	Description <sup>[1]</sup>	Layer Type <sup>[2]</sup>	HELP Default <sup>[3]</sup>	HELP USCS Name	Thickness (in)	K (cm/s)
1	Cover <sup>[4]</sup>	2	13	SC	21	1.0E-05
2	Geo-tube with Dredge Filter Cake	3	20	Drainage Net	0.06	4.0E-07 <sup>[5]</sup>
3	Dredge material <sup>[6]</sup>	1	22	ML	0.06	1.0E-05
4	Dredge material	3	22	ML	360	1.0E-05
5	Gravel Drainage	2	21	Gravel	12	10 <sup>[7]</sup>
6	Geomembrane	4	36	LDPE	0.06	4.0E-13 <sup>[8]</sup>
7	Low Permeability Soil (Top 6")	3	24	SC	6	1.0E-06
8	Low Permeability Soil (Bottom 6")	1	13	SC	6	1.0E-05

Notes:

- 1. This is a general description of each layer.
- 2. The following layer types are available in the HELP model: 1=Vertical Percolation, 2=Lateral Drainage, 3=Barrier Soil Liner, 4=Geomembrane Liner (GM).
- 3. This is the HELP default soil texture number. It is noted that the hydraulic conductivity of each layer may be changed from the HELP default to better represent expected or potentially critical conditions. All input parameters can be found in the HELP output files provided in Attachment 1.
- 4. The 3-inch leveling layer and 18-inch cover soil layer have been combined into a single layer in the HELP program.
- 5. This was calculated using the percent Open Area, as discussed in the HELP package.
- 6. This layer is identical to the 360 inch (30 ft) layer of dredge material, but is modeled as a vertical percolation layer. This is necessary due to modeling restrictions within the HELP program.
- 7. The assumed hydraulic conductivity of the gravel is 10 cm/s, based on potentially available material.
- 8. This layer is modeled as LDPE GM, using typical values from the HELP database. Selection of a different GM type is not expected to affect the results significantly.

consultants

			Page	5	of 2	28
Written by: Joseph Sura		Date: 3/10/2011 Reviewed by:	R. Kulasingam/Jay Beech	Date:	3/11/20	)11
Client: Honeywell	Project:	Onondaga Lake SCA Final Design	Project/ Proposal No.: GJ4	4299	Task No.:	18

Table 2: Results of HELP Modeling for the SCA

					Peak D	Daily Values			Aver	age Annual V	ge Annual Values	
Run ID	Curve Number	K <sub>DREDGE</sub> (cm/s)	K <sub>GRAVEL</sub> (cm/s)	H <sub>MAX</sub> (in) liner	H <sub>AVG</sub> (in) liner	Liquid (ft <sup>3</sup> /ac-day)	Liquid (gal/min)	H <sub>AVG</sub> (in) liner	Leachate (ft <sup>3</sup> /ac-yr)	Liquid (gal/ac-day)	Liquid (gal/day)	
21INCH_A	93.1	10 <sup>-5</sup>	10	1.2	0.6	864	314.3	0.0	15324	314	21982	
S21IN_A	94.6	10 <sup>-5</sup>	10	1.2	0.6	856	311.1	0.0	12065	247	17307	

Notes:

- 1. The first row presents the results for the top area (21INCH\_A) and the second row presents the results for the bottom area (S21IN\_A). The curve number is calculated by HELP based on model inputs.
- 2. Selected maximum precipitation for a single day is 4.4 inches, as presented in the HELP Package.
- 3. SCA is assumed to have a total acreage of 70 acres.
- 4. This table uses a drainage path length of 1500 ft and slope of 0.5% for the cover on the flat top of the SCA and a drainage path length of 100 ft and slope of 30% for the cover on the side slopes of the SCA.
- 5. A drainage path length of 1500 ft and slope of 1% are assumed for the gravel drainage layer, as discussed in the HELP Package.
- 6. The HELP Output files for these cases are included in Attachment 1.

)	Leachate (gal/min)
	15.3
	12.0

					Ge	eosy	ntec <sup>¢</sup>	>
						con	sultants	
					Page	6	of	28
Written by: Joseph Sura		Date:	3/10/2011	Reviewed by:	R. Kulasingam/Jay Beec	h_ Date	e: <u>3/11/2</u>	011
Client: Honeywell	Project:	Onond	aga Lake SCA	A Final Design	Project/ Proposal No.:	G <b>J4299</b>	Task No.:	18

Figures



Figure 1: Schematic Cross-Section

Geomembrane Liner (overlain by geotextile cushion)





Figure 2: Assumed Top of Cover System

Note: The cover system during closure has been assumed to consist of a 3-inch leveling layer and 18 inches of cover soil for the purposes of the HELP modeling.

					Ge	osy	nteo	CD
						con	sultant	S
					Page	9	of	28
Written by: Joseph Sura		Date:	3/10/2011	Reviewed by:	R. Kulasingam/Jay Beech	Date	e: <u>3/1</u>	1/2011
Client: Honeywell	Project:	Onond	aga Lake SCA	A Final Design	Project/ Proposal No.: G	J4299	Task No	o.: <b>18</b>

				Ge	osyntec <a>&gt;</a>	
					consultants	
				Page	10 of 28	
Written by: Joseph Sura		Date: 3/10/2011	Reviewed by:	R. Kulasingam/Jay Beech	Date:3/11/2011	
Client: Honeywell	Project:	Onondaga Lake SCA	Final Design	Project/ Proposal No.: G	J4299 Task No.: 18	

# **Attachment 1: HELP Output Files**

							Geos	yntec	, D
							CO	nsultants	5
						Page	11	of	28
Written	by: Joseph S	bura	Date: <u>3</u> /	10/2011	Reviewed by:	R. Kulasingam/Jay l	Beech D	ate: <u>3/11</u>	/2011
Client:	Honeywell	Project:	Onondaga	Lake SCA	Final Design	Project/ Proposal No.:	GJ4299	Task No.	: 18
	* * * * * * * * * *	* * * * * * * * * * * * * * * *	* * * * * * * * * *	* * * * * * * * *	* * * * * * * * * * * * * *	* * * * * * * * * * * * * * * * * * * *	* * * *		
	* * * * * * * * * *	* * * * * * * * * * * * * *	******	* * * * * * * * *	* * * * * * * * * * * * *	* * * * * * * * * * * * * * * * * * * *	* * * * *		
	* *						* *		
	**						**		
	* *	HYDROLO	GIC EVALU	ATION OF	LANDFILL PERF	ORMANCE	* *		
	**	HELP	MODEL VER	SION 3.0	( L NOVEMBER	1997) ODV	**		
	* *		ELOPED BI	NAVG FYDI	RIMIAL LABORAL	N	* *		
	* *	FOR USER	A RISK REI	DUCTION F	ENGINEERING LA	BORATORY	* *		
	* *	1011 0022				Dorari ora	* *		
	* *						* *		
	*********	: * * * * * * * * * * * * * * * * * * *	********	* * * * * * * * * *	*************	*******************	* * * * *		
	PRECIPITAT TEMPERATUR SOLAR RADI EVAPOTRANS SOIL AND I OUTPUT DAT	TION DATA FILE RE DATA FILE: ATION DATA FI SPIRATION DATA DESIGN DATA FI CA FILE:	: C:/bi C:/bi : C:/bi C:/bi	ROGRA~1\H ROGRA~1\H ROGRA~1\H ROGRA~1\H ROGRA~1\H ROGRA~1\H	HELP\ONONDAGA\ HELP\ONONDAGA\ HELP\ONONDAGA\ HELP\ONONDAGA\ HELP\ONONDAGA\ HELP\ONONDAGA\	OLPRECIP.D4 OLTEMP.D7 OLSOLAR.D13 OLEVAPTR.D11 21INCH_A.D10 21INCH_A.OUT			
	TIME: 10:	21 DATE:	3/11/203	11					
	* * * * * * * * * *	***********	* * * * * * * * * *	* * * * * * * * *	* * * * * * * * * * * * * * * *	* * * * * * * * * * * * * * * * * * * *	* * * * *		
	TITLE	: Onondaga I	ake SCA						
	* * * * * * * * * *	*********	* * * * * * * * *	* * * * * * * * *	* * * * * * * * * * * * * * *	*****	* * * * *		
	NOTE :	INITIAL MOI COMPUTED	STURE CON AS NEARLY	FENT OF T STEADY-S	THE LAYERS AND STATE VALUES B	SNOW WATER WERE Y THE PROGRAM.			
				LAYER	1				
			י - ייערא	ι,ΔΥΈΡΔΙ. Ι	ORATNAGE T.AVED				
			MATERIA	L TEXTUR	E NUMBER 113				
		THICKNESS	DICLA	= =	21.00 I	NCHES			
		POROSITY		=	0.4300 V	OL/VOL			
		FIELD CAPACI	TY	=	0.3210 V	OL/VOL			
		WILTING POIN	Т	=	0.2210 V	OL/VOL			
		INITIAL SOII	WATER CO	NTENT =	0.4011 V	OL/VOL			
		EFFECTIVE SA	T. HYD. CO	OND. =	0.9999999750	UUE-05 CM/SEC			
		SLOPE DRAINAGE LEN	GTH	=	0.51 P 1500.0 F	ekcent Eet			

					Ĺ	Jeos	/ntec '	
						cor	sultants	
					Page	12	of	28
					1 age	12	01	20
Written by: Joseph	Sura Date: 3/10/201	1	Reviewed by:	<b>R. K</b>	ulasingam/Jay Be	ech Dat	te: 3/11/2	011
- <u> </u>								
Client: Honeywell	Project: Onondaga Lake	SCA	Final Design	Projec	ct/ Proposal No.:	GJ4299	Task No.:	18
	7 4 7	עבס	2					
	תנת כ התניה		COTT TIMED					
	MATERIAL TEXT	TURE	NUMBER 120					
	THICKNESS	=	0.06	INCHES				
	POROSITY	=	0.8500	VOL/VOL				
	FIELD CAPACITY	=	0.0100	VOL/VOL				
	INITIAL SOIL WATER CONTENT	=	0.8500	VOL/VOL				
	EFFECTIVE SAT. HYD. COND.	=	0.4000000	5000E-06	CM/SEC			
	LA	YER	3					
	TYPE 1 - VERTICAL	L PE	RCOLATION LA	AYER				
	MATERIAL TEX	FURE	NUMBER 122					
	THICKNESS	=	0.06	INCHES				
	FIELD CAPACITY	=	0.3070	VOL/VOL				
	WILTING POINT	=	0.1800	VOL/VOL				
	INITIAL SOIL WATER CONTENT	=	0.3070	VOL/VOL				
	EFFECTIVE SAT. HYD. COND.	=	0.99999997	5000E-05	CM/SEC			
	LAY	YER	4					
	TYPE 3 - BARI	RIER	SOIL LINER					
	MATERIAL TEX	FURE	NUMBER 122					
	THICKNESS	=	360.00	INCHES				
	FIELD CAPACITY	=	0.3070	VOL/VOL				
	WILTING POINT	=	0.1800	VOL/VOL				
	INITIAL SOIL WATER CONTENT	=	0.4190	VOL/VOL				
	EFFECTIVE SAT. HYD. COND.	=	0.99999997	5000E-05	CM/SEC			
	۲.۵.۲	YER	5					
	ירימיתיגד _ נימיתיאיד		ם אד אז ארמידי די איזי	7D				
	MATERIAL TEXT	ע ער FURE	NUMBER 121	<u>лт</u>				
	THICKNESS	=	12.00	INCHES				
	POROSITY	=	0.3970	VOL/VOL				
	FIELD CAPACITY	=	0.0320	VOL/VOL				
	WILLING POINT INITIAL SOIL WATER CONTENT	=	0.0130					
	EFFECTIVE SAT. HYD. COND.	=	10.0000000	0000	CM/SEC			
	SLOPE	=	1.00	PERCENT				
	DRAINAGE LENGTH	=	1500.0	FEET				

5

.

 $\overline{}$ 

					G	eosy	ntec	D
						cons	sultants	5
					Page	13	of	28
Written by: Joseph Sura		Date:	3/10/2011	Reviewed by:	R. Kulasingam/Jay Beed	: <u>h</u> Date	: <u>3/11</u>	/2011
Client: Honeywell H	Project:	Onond	aga Lake SCA	Final Design	Project/ Proposal No.:	GJ4299	Task No.	: 18

#### LAYER 6

TYPE 4 - FLEXIB	LE	MEMBRANE LINER
MATERIAL TEXT	URE	NUMBER 36
THICKNESS	=	0.06 INCHES
POROSITY	=	0.0000 VOL/VOL
FIELD CAPACITY	=	0.0000 VOL/VOL
WILTING POINT	=	0.0000 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0000 VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.399999993000E-12 CM/SEC
FML PINHOLE DENSITY	=	0.00 HOLES/ACRE
FML INSTALLATION DEFECTS	=	1.00 HOLES/ACRE
FML PLACEMENT QUALITY	=	3 - GOOD

LAYER	7

```
-----
```

	TYPE	3 -	BARRIER	SOIL	LINER		
	MATER	LAIS	TEXTURE	NUMBE	R 124		
THICKNESS			=	6	.00	INCHES	
POROSITY			=	0	.3650	VOL/VOL	
FIELD CAPACITY	Y		=	0	.3050	VOL/VOL	
WILTING POINT			=	0	.2020	VOL/VOL	
INITIAL SOIL N	WATER	CONT	rent =	0	.3650	VOL/VOL	
EFFECTIVE SAT	. HYD.	COI	ND. =	0.999	999997	7000E-06	CM/SEC

#### LAYER 8

#### TYPE 1 - VERTICAL PERCOLATION LAYER MATERIAL TEXTURE NUMBER 113

PATERIAL IEAI	OICE	NONDER IIS		
THICKNESS	=	6.00	INCHES	
POROSITY	=	0.4300	VOL/VOL	
FIELD CAPACITY	=	0.3210	VOL/VOL	
WILTING POINT	=	0.2210	VOL/VOL	
INITIAL SOIL WATER CONTENT	=	0.3055	VOL/VOL	
EFFECTIVE SAT. HYD. COND.	=	0.999999975	5000E-05	CM/SEC

#### GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE #10 WITH BARE GROUND CONDITIONS, A SURFACE SLOPE OF 1.% AND

						Ľ	JEUSY	'illec*	
							con	sultants	
						Page	14	of	28
Written by:	Joseph Sura	Da	te: <u>3/10/2011</u>	Reviewed by:	R. Kula	asingam/Jay Be	eech Dat	e: <u>3/11/2</u>	2011
Client: He	oneywell	Project: On	ondaga Lake SC	A Final Design	Project/	Proposal No.:	GJ4299	Task No.:	18
		A SLOPE	LENGTH OF 1500	. FEET.					
	SCS RU	NOFF CURVE N	UMBER	= 93.7	0				
	FRACTI	ON OF AREA A	LLOWING RUNOFF	= 100.0	) PERC	ENT			
	AREA P EVAPOR	ROJECTED ON ATIVE ZONE D	HORIZONTAL PLA EPTH	ME = 1.0 = 21.0	) OO ACRE; ) INCHI	S ES			
	INITIA	L WATER IN E	VAPORATIVE ZON	E = 8.4	123 INCH	ES			
	LOWER	LIMIT OF EVA	PORATIVE STORA PORATIVE STORA	GE = 9.0 GE = 4.0	541 INCH	ES			
	INITIA TNITTA	L SNOW WATER	AYER MATERIALS	= 0.0	000 INCH: 739 INCH	ES ES			
	TOTAL	INITIAL WATE	R	= 163.7	739 INCH	ES			
	TOTAL	SUBSURFACE I	NFLOW	= 0.0	0 INCH	ES/YEAR			
		EVAPO1		ND WEATHER DA					
	NOTE :	EVAPOTRANS	PIRATION DATA	WAS OBTAINED H	ROM				
		SYRACUSE		NEW YORK					
	S	TATION LATIT	UDE	=	43.07 D	EGREES			
	M	AXIMUM LEAF TART OF GROW	AREA INDEX ING SEASON (JU	= LIAN DATE) =	0.00 124				
	E	ND OF GROWIN	G SEASON (JULI	AN DATE) =	284				
	E: A	VAPORATIVE Z VERAGE ANNUA	ONE DEPTH L WIND SPEED	=	9.70 M	NCHES PH			
	A	VERAGE 1ST Q	UARTER RELATIV	E HUMIDITY =	72.00 %				
	A	VERAGE 2ND Q VERAGE 3RD Q	UARTER RELATIV	E HUMIDITY =	75.00 %				
	A	VERAGE 4TH Q	UARTER RELATIV	E HUMIDITY =	76.00 %				
	NOTE :	PRECIPITAT COEFFICI	ION DATA WAS S ENTS FOR SY	YNTHETICALLY ( RACUSE	ENERATED NEW	USING YORK			
		NORMAL M	EAN MONTHLY PR	ECIPITATION (	INCHES)				
	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT N	IAY/NOV	JUN/DEC			
	2.61	2.65	3.11	3.34	3.16	3.63			
	3.76	3.77	3.29	3.14	3.45	3.20			
	NOTE :	TEMPERATUR COEFFICI	E DATA WAS SYN ENTS FOR SY	THETICALLY GEN RACUSE	NERATED U	SING YORK			
	N	ORMAL MEAN M	ONTHLY TEMPERA	TURE (DEGREES	FAHRENHE	IT)			
	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	IAY/NOV	JUN/DEC			
	22.80	24.00	33.30	46.10	57.00	66.30			
	70.90	69.30	62.IU	51 311	(11) 611	10 10			

		Geo	JSYINEC
			consultants
		Page	15 of 28
Written by: Joseph Sura	Date: <u>3/10/2011</u> Reviewed by:	R. Kulasingam/Jay Beech	Date: <u>3/11/2011</u>
Client: Honeywell Project:	Onondaga Lake SCA Final Design	Project/ Proposal No.: GJ4	<b>1299</b> Task No.: 18

Coormtoop

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR SYRACUSE NEW YORK AND STATION LATITUDE = 43.07 DEGREES

#### 

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 100

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	2.59 3.87	2.72 3.95	3.16 3.27	3.27 2.95	3.09 3.40	3.71 3.22
STD. DEVIATIONS	0.70 1.67	0.96 1.76	1.19 1.60	1.19 1.16	1.31 1.19	1.57 0.76
RUNOFF						
TOTALS	0.733 0.920	1.621 0.980	4.974 0.804	1.821 0.609	0.496 0.729	0.908 0.700
STD. DEVIATIONS	0.866 0.775	1.595 0.770	2.440 0.807	1.390 0.519	0.531 0.577	0.806 0.717
EVAPOTRANSPIRATION						
TOTALS	0.487 2.908	0.399 2.686	0.440 2.162	1.872 1.725	2.692 1.127	2.624 0.560
STD. DEVIATIONS	0.084 0.959	0.081 0.922	0.190 0.704	0.779 0.387	0.844 0.205	0.776 0.167
LATERAL DRAINAGE COL	LECTED FROM	LAYER 1				
TOTALS	0.0000 0.0000	0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000
STD. DEVIATIONS	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000
PERCOLATION/LEAKAGE	THROUGH LAY	er 2				
TOTALS	0.0376 0.0801	0.0001	0.1122	0.9305 0.4396	0.2320 0.9808	0.0693 0.9108
STD. DEVIATIONS	0.1316 0.1188	0.0012 0.1843	0.2816 0.2764	0.2540 0.3798	0.2286 0.5621	0.1284 0.6118

PERCOLATION/LEAKAGE THROUGH LAYER 4

Page

consultants 16 of 28

						Page		6	01	28
Written by:	Joseph Sura	Date:3/10	/ <b>2011</b> F	Reviewed by:	R. Ku	lasingam/Ja	y Beech	Date:	3/11/2	011
Client: H	oneywell Project	t: Onondaga La	ake SCA Fi	nal Design	Project	/ Proposal N	o.: <b>GJ42</b>	<b>99</b> T	ask No.:	18
	TOTALS	0.0389 0.0801	0.0001 0.1705	0.1093 0.2579	0.9260 0.4391	0.2393 0.9773	0.0695 0.9134			
	STD. DEVIATIONS	0.1332 0.1188	0.0012 0.1843	0.2765 0.2763	0.2610 0.3794	0.2367 0.5590	0.1284 0.6110			
	LATERAL DRAINAGE CO	DLLECTED FROM I	LAYER 5							
	TOTALS	0.0478 0.0792	0.0000 0.1680	0.0988 0.2580	0.9101 0.4288	0.2634 0.9472	0.0684 0.9518			
	STD. DEVIATIONS	0.1465 0.1191	0.0004 0.1810	0.2581 0.2750	0.2794 0.3786	0.2604 0.5434	0.1261 0.6075			
	PERCOLATION/LEAKAGE	E THROUGH LAYE	r 7							
	TOTALS	0.0000 0.0000	0.0000	0.0000 0.0000	0.0000 0.0000	0.0000	0.0000 0.0000			
	STD. DEVIATIONS	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000	0.0000 0.0000			
	PERCOLATION/LEAKAGE	E THROUGH LAYE	r 8							
	TOTALS	0.0001 0.0002	0.0000	0.0001 0.0004	0.0003 0.0004	0.0005 0.0004	0.0002 0.0004			
	STD. DEVIATIONS	0.0001 0.0004	0.0000 0.0005	0.0009 0.0008	0.0010 0.0008	0.0009 0.0008	0.0003 0.0007			
-	AVERAC	GES OF MONTHLY	AVERAGED	DAILY HEA	DS (INCHI	 ES)				
	DAILY AVERAGE HEAD	ON TOP OF LAY	er 2							
	AVERAGES	0.0039 0.0045	0.0000	0.0139 0.0198	0.1109 0.0367	0.0149 0.1046	0.0042 0.0963			
	STD. DEVIATIONS	0.0140 0.0092	0.0000 0.0167	0.0365 0.0289	0.0336 0.0407	0.0245 0.0739	0.0104 0.0749			
	DAILY AVERAGE HEAD	ON TOP OF LAY	er 4							
	AVERAGES	0.0008 0.0026	0.0000 0.0049	0.0012 0.0071	0.0134 0.0105	0.0070 0.0179	0.0023 0.0157			
	STD. DEVIATIONS	0.0025 0.0033	0.0000 0.0046	0.0028 0.0059	0.0049 0.0072	0.0049 0.0067	0.0038 0.0075			
	DAILY AVERAGE HEAD	ON TOP OF LAY	ER 6							
	AVERAGES	0.0041 0.0068	0.0000 0.0143	0.0084 0.0228	0.0803 0.0366	0.0225 0.0836	0.0060 0.0812			
	STD. DEVIATIONS	0.0125	0.0000	0.0220	0.0246	0.0222	0.0111 0.0519			

						G	eosy	ntec	D
							con	sultants	
					Pag	ge	17	of	28
Joseph Sura	Date:	3/10/2011	. F	Reviewed by:	R. Kulasinga	m/Jay Beec	c <u>h</u> Date	e: <u>3/11/</u>	201
neywell Project:	Onondag	ga Lake SCA	\ Fi	nal Design	Project/ Propos	sal No.:	GJ4299	Task No.:	
*****	* * * * * * * *	******	* * *	* * * * * * * * * * *	****	* * * * * * * * *	* * *		
****	* * * * * * * *	******	* * *	* * * * * * * * * * *	****	* * * * * * * * *	* * *		
AVERAGE ANNUAL TOT.	ALS & (S	TD. DEVIA	ΓIO	NS) FOR YEA	RS 1 THROU	GH 100			
		INC	HES		CU. FEET	PERCEN	IT		
RECIPITATION		39.20	(	4.823)	142279.7	100.00			
UNOFF		15.292	(	3.0922)	55511.18	39.016			
VAPOTRANSPIRATION		19.682	(	2.2864)	71445.80	50.215			
ATERAL DRAINAGE COLLE FROM LAYER 1	CTED	0.00000	(	0.00000)	0.009	0.0000	1		
ERCOLATION/LEAKAGE THE LAYER 2	ROUGH	4.22148	(	1.02389)	15323.965	10.770	31		
verage head on top of layer 2		0.035 (		0.010)					
ERCOLATION/LEAKAGE THE LAYER 4	ROUGH	4.22148	(	1.02250)	15323.965	10.770	31		
VERAGE HEAD ON TOP OF LAYER 4		0.007 (		0.001)					
ATERAL DRAINAGE COLLE FROM LAYER 5	CTED	4.22143	(	1.02041)	15323.796	10.7701	.9		
ERCOLATION/LEAKAGE TH	ROUGH	0.00005	(	0.00001)	0.172	0.000	12		
VERAGE HEAD ON TOP OF LAYER 6		0.031 (		0.007)					
ERCOLATION/LEAKAGE TH	ROUGH	0.00325	(	0.00646)	11.792	0.008	29		
HANGE IN WATER STORAG	E	-0.004	(	1.2893)	-12.89	-0.009			
	Joseph Sura eywell Project: AVERAGE ANNUAL TOT AVERAGE ANNUAL TOT RECIPITATION JNOFF VAPOTRANSPIRATION ATERAL DRAINAGE COLLE FROM LAYER 1 ERCOLATION/LEAKAGE TH LAYER 2 VERAGE HEAD ON TOP OF LAYER 2 ERCOLATION/LEAKAGE TH LAYER 4 VERAGE HEAD ON TOP OF LAYER 4 ATERAL DRAINAGE COLLE FROM LAYER 5 ERCOLATION/LEAKAGE TH LAYER 7 VERAGE HEAD ON TOP OF LAYER 6 ERCOLATION/LEAKAGE TH LAYER 8	Joseph Sura Date:	Joseph Sura       Date:       3/10/2011         eywell       Project:       Onondaga Lake SCA         AVERAGE ANNUAL TOTALS & (STD. DEVIA)         AVERAGE ANNUAL TOTALS & (STD. DEVIA)         RECIPITATION       39.20         JNOFF       15.292         VAPOTRANSPIRATION       19.682         ATERAL DRAINAGE COLLECTED       0.00000         FROM LAYER 1       0.035 (         ERCOLATION/LEAKAGE THROUGH       4.22148         LAYER 2       0.035 (         VERAGE HEAD ON TOP       0.007 (         OF LAYER 2       0.007 (         ERCOLATION/LEAKAGE THROUGH       4.22148         LAYER 4       0.007 (         OF LAYER 5       0.007 (         OF LAYER 5       0.001 (         ERCOLATION/LEAKAGE THROUGH       0.0005         LAYER 7       0.031 (         VERAGE HEAD ON TOP       0.031 (         OF LAYER 6       0.00325	Joseph Sura       Date:       3/10/2011       F         eeywell       Project:       Onondaga Lake SCA Fi         AVERAGE ANNUAL TOTALS & (STD. DEVIATIO         AVERAGE ANNUAL TOTALS & (STD. DEVIATIO         INCHES         RECIPITATION       39.20 (         JNOFF       15.292 (         VAPOTRANSPIRATION       19.682 (         ATERAL DRAINAGE COLLECTED       0.00000 (         FROM LAYER 1       0.00000 (         ERCOLATION/LEAKAGE THROUGH       4.22148 (         LAYER 2       VERAGE HEAD ON TOP       0.035 (         OF LAYER 2       0.007 (         OF LAYER 4       0.007 (         VERAGE HEAD ON TOP       0.007 (         OF LAYER 4       0.007 (         VERAGE HEAD ON TOP       0.007 (         OF LAYER 4       0.0005 (         LAYER 7       0.031 (         VERAGE HEAD ON TOP       0.031 (         OF LAYER 7       0.031 (         VERAGE HEAD ON TOP       0.031 (         OF LAYER 6       0.00325 (	Joseph Sura       Date:       3/10/2011       Reviewed by:         egwell       Project:       Onondaga Lake SCA Final Design         AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEA         AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEA         INCHES         RECIPITATION       39.20 (       4.823)         JNOFF       15.292 (       3.0922)         JAPOTRANSPIRATION       19.682 (       2.2864)         ATERAL DRAINAGE COLLECTED       0.00000 (       0.00000)         FROM LAYER 1       0.0035 (       0.010)         ERCOLATION/LEAKAGE THROUGH       4.22148 (       1.02250)         LAYER 2       0.007 (       0.001)         OF LAYER 4       0.00005 (       0.00001)         VERAGE HEAD ON TOP       0.007 (       0.001)         OF LAYER 4       0.00005 (       0.00001)         VERAGE HEAD ON TOP       0.0010 (       0.00001)         LAYER 7       0.031 (       0.007)         VERAGE HEAD ON TOP       0.031 (       0.007)         OF LAYER 6       0.0031 (       0.007)         ERCOLATION/LEAKAGE THROUGH       0.00325 (       0.00646)	Joseph Sura       Date:       3/10/2011       Reviewed by:       R. Kulasinga         eywell       Project:       Onondaga Lake SCA Final Design       Project/ Proposition         AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS)       FOR YEARS       1 THROU         AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS)       FOR YEARS       1 THROU         INCHES       CU. FEET         RECIPITATION       39.20       ( 4.823)       142279.7         JNOFF       15.292       3.0922)       55511.18         /APOTRANSPIRATION       19.682       ( 2.2864)       71445.80         YERAL DRAINAGE COLLECTED       0.00000       0.00000       0.009         FROM LAYER       1       15323.965       142479         LAYER       2       0.035       0.010)       0.009         OF LAYER       2       0.007       0.001)       0.172         LAYER       4       2       15323.965       14248         VERAGE HEAD ON TOP       0.007       0.001)       0.172         LAYER       4       0.00005       0.00001)       0.172         LAYER       5       0.031       0.0071       0.172         LAYER       6       0.00325       0.00646       11.792	Joseph Sura         Date:         3/10/2011         Reviewed by:         R. Kulasingam/Jay Beed           eywell         Project:         Onondaga Lake SCA Final Design         Project/ Proposal No.:           AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS)         FOR YEARS         1 THROUGH         100           AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS)         FOR YEARS         1 THROUGH         100           INCHES         CU. FEET         PERCEN           RECIPITATION         39.20         ( 4.823)         142279.7         100.00           JNOFF         15.292         ( 3.0922)         55511.18         39.016           APOTRANSPIRATION         19.682         ( 2.2864)         71445.80         50.215           NTERAL DRAINAGE COLLECTED         0.00000         0.0000         0.0000         0.0000           FROM LAYER         1         15323.965         10.770           AVERAGE HEAD ON TOP         0.035         0.010)         0         15323.965         10.7701           OF LAYER         4         .22148         1.02250)         15323.965         10.7701           FRAGE HEAD ON TOP         0.007         0.001)         0.172         0.000           OF LAYER         4         .22143         1.02041)	Page         17           Joseph Sura         Date:         3/10/2011         Reviewed by:         R. Kulasingam/Jay Beech         Date           eywell         Project:         Onondaga Lake SCA Final Design         Project/ Proposal No.:         GJ4299           Average Annual TOTALS & (STD. DEVIATIONS) FOR YEARS         1 THROUGH         100           INCHES         CU. FEET         PERCENT           RECIPITATION         39.20         ( 4.823)         142279.7           NOFF         15.292         ( 3.0922)         55511.18         39.016           APOTRANSPIRATION         19.682         ( 2.2864)         71445.80         50.215           ATTERAL DRAINAGE COLLECTED         0.00000         0.0000         0.009         0.00001           FROM LAYER         1         15323.965         10.77031         LAYER         2           VERAGE HEAD ON TOP         0.007         0.001)         05         LAYER         10.77031         LAYER           SERCOLATION/LEAKAGE THROUGH         4.22143         1.02041)         15323.796         10.77019           FRAGE HEAD ON TOP         0.0017         0.0001)         0.172         0.00012           JAYER 4         4.22143         1.02041)         15323.796         10.	Page         17         of           Joseph Sura         Date:         3/10/2011         Reviewed by:         R. Kulasingam/Jay Beech         Date:         3/11/           eywell         Project:         Onondaga Lake SCA Final Design         Project/ Proposal No.:         GJ4299         Task No.:           AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS)         FOR YEARS         1 THROUGH         100           INCHES         CU. FEET         PERCENT           INCHES         CU. FEET         PERCENT           RECIPITATION         39.20 (         4.823)         142279.7         100.00           INOFF         15.292 (         3.0922)         55511.18         39.016           APOTRANSPIRATION         19.682 (         2.2864)         71445.80         50.215           ATTERAL DRAINAGE COLLECTED         0.00000 (         0.0000)         0.00001         ERCOLATION/LEAKAGE THROUGH         4.22148 (         1.02250)         15323.965         10.77031         LAYER 4           VERAGE HEAD ON TOP         0.007 (         0.001)         0.77031         LAYER 4         ATERAL DRAINAGE COLLECTED         4.22143 (         1.02041)         15323.796         10.77031           LAYER 4         0.0007 (         0.001)         0.172         0.00012

							(		mtec <sup>(</sup> sultants	
Written by:	Joseph Sura	Date:	3/10/2011	Review	ved by:	R. K	ulasingam/Jay Bo	eech Date	e: 3/11/2	<u>28</u> 011
Client: Ho	oneywell Project:	Onond	aga Lake SC.	A Final D	esign	Projec	ct/ Proposal No.:	GJ4299	Task No.:	18
	PERCOLATION/LEAK	AGE THR	OUGH LAYER	2	0.5451	38	1978.84949			
	AVERAGE HEAD ON 7	TOP OF I	layer 2		2.583					
	MAXIMUM HEAD ON 7	TOP OF I	LAYER 2		4.205					
	LOCATION OF MAXIN (DISTANCE N	IUM HEAD FROM DRA	D IN LAYER AIN)	1	167.7 FE	ET				
	PERCOLATION/LEAKA	AGE THR	OUGH LAYER	4	0.3402	09	1234.95764			
	AVERAGE HEAD ON 7	TOP OF I	LAYER 4		0.060					
	DRAINAGE COLLECTI	ED FROM	LAYER 5		0.2381	3	864.42590			
	PERCOLATION/LEAK	AGE THR	OUGH LAYER	7	0.0000	02	0.00813			
	AVERAGE HEAD ON 7	TOP OF I	LAYER 6		0.630					
	MAXIMUM HEAD ON 7	TOP OF I	LAYER 6		1.225					
	LOCATION OF MAXIN (DISTANCE )	IUM HEAD ROM DRA	D IN LAYER AIN)	5	41.7 FE	ET				
	PERCOLATION/LEAK	AGE THR	OUGH LAYER	8	0.0003	29	1.19497			
	SNOW WATER				9.62		34911.7891			
	MAXIMUM VEG. SOII	. WATER	(VOL/VOL)			0.41	120			
	MINIMUM VEG. SOII	L WATER	(VOL/VOL)			0.29	954			
	*** Maximum hea	ads are	computed u	using Mcl	Enroe's (	equati	ions. ***			
	Reference:	Maxim by Br ASCE Vol.	um Saturate uce M. McEn Journal of 119, No. 2,	ed Depth nroe, Un: Environ March 1	over La iversity mental En 1993, pp	ndfill of Ka nginee . 262-	l Liner ansas ering -270.			
*	*****	* * * * * * *	* * * * * * * * * * *	******	* * * * * * * * *	*****	* * * * * * * * * * * * * * *	* * * *		
*	* * * * * * * * * * * * * * * * * * * *	* * * * * * *	* * * * * * * * * * *	******	* * * * * * * * *	* * * * * *	* * * * * * * * * * * * * * *	* * * *		
	FINA	AL WATE	R STORAGE A	AT END OF	F YEAR	100				
	LAX	/ER	( INCHES	 S)	(VOL/VO	 L)				
		 L	8.342	20	0.397	 2				
	:	2	0.051	.0	0.850	0				
		3	0.018	34	0.307	0				
		ł	150.840	00	0.419	0				

				consultants
			Page	19 of 28
Written by: Joseph Sura	Date: <u>3/</u>	(10/2011 Reviewed by:	R. Kulasingam/Jay Beech	h Date: <u>3/11/2011</u>
Client: Honeywell	Project: Onondaga	Lake SCA Final Design	Project/ Proposal No.: 0	GJ4299 Task No.: 18
	5	0.3840 0.03	20	
	6	0.0000 0.00	00	
	7	2.1900 0.36	50	
	8	1.5129 0.25	21	
	SNOW WATER	0.046		
* * * * * * * * * * * * * * * * * * * *	* * * * * * * * * * * * * * * * * * * *	*********************************	***************************************	* *

						Geosyntec <sup>&gt;</sup>				
							C	onsultant	S	
						Page	2	0 of	28	
Written	by: Joseph S	bura	Date: 3	/10/2011	Reviewed by:	R. Kulasingam/Jay	Beech	Date: <u>3/1</u>	<u>1/2011</u>	
Client:	Honeywell	Project:	Onondaga	Lake SCA	A Final Design	Project/ Proposal No.	: <b>GJ42</b> 9	9 Task No	).: <b>18</b>	
	* * * * * * * * * *	*****	******	* * * * * * * * *	* * * * * * * * * * * * * *	* * * * * * * * * * * * * * * * * * * *	* * * * * *			
	* * * * * * * * * *	* * * * * * * * * * * * *	*******	*******	* * * * * * * * * * * * * *	* * * * * * * * * * * * * * * * * * * *	* * * * * *			
	* *						* *			
	**						**			
	**	HYDROLO	GIC EVALU	ATION OF	LANDFILL PERE	ORMANCE	* *			
	**	HELP	MODEL VER	SION 3.0	/ (I NOVEMBER	(1997)	**			
	* *		ISAF WATTR	MANG EXDI	RENIAL LABORAJ	I OR I	* *			
	* *	FOR USER	PA RISK RE	DUCTION 1	ENGINEERING LA	BORATORY	* *			
	* *	1011 0022		2001101			* *			
	* *						* *			
	* * * * * * * * * *	* * * * * * * * * * * * * *	* * * * * * * * * *	* * * * * * * * *	* * * * * * * * * * * * * * *	* * * * * * * * * * * * * * * * * * * *	* * * * * *			
	********	******	*******	* * * * * * * * *	* * * * * * * * * * * * * * *	******	* * * * * *			
		ידים גיידגים וארידי	·· · · · · · · · · · ·	ו\1		OLDEGID DA				
	PRECIPIIAI	TON DATA FILE		ROGRA~1\I	HELP (ONONDAGA)	OLPRECIP.D4				
	SOLAR RADI	ATION DATA FI	TE: C:\P	ROGRA~1\1	HELP\ONONDAGA\	OLSOLAR D13				
	EVAPOTRANS	PIRATION DATA	.: C:\P	ROGRA~1\I	HELP\ONONDAGA\	OLEVAPTR.D11				
	SOIL AND D	ESIGN DATA FI	LE: C:\P	ROGRA~1\I	HELP\ONONDAGA	S21IN A.D10				
	OUTPUT DAI	A FILE:	C:\P	ROGRA~1\I	HELP\ONONDAGA	S21IN A.OUT				
	TIME: 10:	22 DATE:	3/11/20	11						
	* * * * * * * * * *	* * * * * * * * * * * * * * *	* * * * * * * * * *	* * * * * * * * *	* * * * * * * * * * * * * * *	* * * * * * * * * * * * * * * * * * * *	* * * * * *			
			1							
	TITLE	: Onondaga I	Jake SCA							
	+++++++++	****		++++++++	* * * * * * * * * * * * * * *	* * * * * * * * * * * * * * * * * * * *	* * * * * *			
				~ ~ ~ ~ ~ ~ ~ ~ ~	~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~		~ ~ ~ ~ ~ ~			
	NOTE :	TNTTTAL MOI	STURE CON	TENT OF '	THE LAYERS AND	) SNOW WATER WERE				
	11012	COMPUTED	AS NEARLY	STEADY-	STATE VALUES E	BY THE PROGRAM.				
				LAYER	1					
			TYPE 2 -	LATERAL 1	DRAINAGE LAYEF	ł				
		TUTOWNDOO	MATERIA	L TEXTUR	E NUMBER 113	NOUEO				
		THICKNESS		=	ZT.00 T ₹ 0021 0					
		FURUSIII	ͲV	=	0.4300 \					
		WILTING DOIN	 TT	=	0.3410 \ 0.2210 T					
		TNITTAL COT	. WATER CO	= אידיבאיד –	0.2210 \ 0.4010 \					
		EFFECTIVE Q	T. HYD C	OND. =	0.9999999750	00E-05 CM/SEC				
		SLOPE		=	30.00	PERCENT				
		DRAINAGE LEN	IGTH	=	100.0 F	FET				
					Ĺ	Jeos	/ntec '			
----------------------	---	-----------	-----------------	-------------	-------------------	---------	------------	-----		
						cor	sultante			
					Page	21	of	28		
					1 age	21	01	20		
Written by: Joseph S	Sura Date: 3/10/201	1	Reviewed by	<b>R. K</b>	ulasingam/Jay Be	ech Dat	te: 3/11/2	011		
Client: Honeywell	Project: Onondaga Lake S	SCA	Final Design	Projec	ct/ Proposal No.:	GJ4299	Task No.:	18		
	Τ.Δ.Σ	/	2							
	ייעסד 2 – סמעיי	סידרס	SOTI LINER							
	MATERIAL TEXT	TURE	NUMBER 120							
	THICKNESS	=	0.06	INCHES						
	POROSITY	=	0.8500	VOL/VOL						
	WILTING POINT	=	0.0100	VOL/VOL						
	INITIAL SOIL WATER CONTENT	=	0.8500	VOL/VOL						
	EFFECTIVE SAT. HYD. COND.	=	0.40000009	5000E-06	CM/SEC					
	7 7 7	ZEPD	2							
		(ER								
	TYPE 1 - VERTICAI MATERIAI, TEXT	L PEI	NUMBER 122	AYER						
	THICKNESS	=	0.06	INCHES						
	POROSITY	=	0.4190	VOL/VOL						
	FIELD CAPACITY	=	0.3070	VOL/VOL						
	WILTING POINT INITIAL SOIL WATER CONTENT	=	0.1800	VOL/VOL						
	EFFECTIVE SAT. HYD. COND.	=	0.99999997	5000E-05	CM/SEC					
	LA3	ZER	4							
	TYPE 3 - BARE	RIER	SOIL LINER							
	MAIERIAL IEX. THICKNESS	LURE =	360.00	INCHES						
	POROSITY	=	0.4190	VOL/VOL						
	FIELD CAPACITY	=	0.3070	VOL/VOL						
	WILTING POINT	=	0.1800	VOL/VOL						
	INITIAL SOIL WATER CONTENT	=	0.4190	VOL/VOL	CM/SEC					
	EFFECTIVE SAL. HID. COND.	-	0.999999997	5000E-05	CM/SEC					
	LAY	ZER	5							
	TYPE 2 - LATERA	AL DI	RAINAGE LAYI	ER						
	MATERIAL TEXT	TURE	NUMBER 121	TNOURS						
	THICKNESS	=	12.00 0 3070	LNCHES						
	FIELD CAPACITY	=	0.0320	VOL/VOL						
	WILTING POINT	=	0.0130	VOL/VOL						
	INITIAL SOIL WATER CONTENT	=	0.0320	VOL/VOL						
	EFFECTIVE SAT. HYD. COND.	=	10.000000	0000	CM/SEC					
	SLOPE DRAINAGE LENGTH	=	1500 0	PERCENT						
	PIGITING TRADITI	-	1000.0	1 11 1						

5

.

 $\overline{}$ 

			G	eosy	ntec <sup>c</sup>	>
				cons	ultants	
			Page	22	of	28
Written by: Joseph Sura	Date: 3/10/2011	Reviewed by:	R. Kulasingam/Jay Bee	ech Date:	3/11/2	011
Client: <b>Honeywell</b> Pro	oject: Onondaga Lake S	CA Final Design	Project/ Proposal No .:	GJ4299	Task No.:	18

## LAYER 6

TYPE 4 - FLEXIB	LEI	MEMBRANE LINER
MATERIAL TEXT	URE	NUMBER 36
THICKNESS	=	0.06 INCHES
POROSITY	=	0.0000 VOL/VOL
FIELD CAPACITY	=	0.0000 VOL/VOL
WILTING POINT	=	0.0000 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0000 VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.399999993000E-12 CM/SEC
FML PINHOLE DENSITY	=	0.00 HOLES/ACRE
FML INSTALLATION DEFECTS	=	1.00 HOLES/ACRE
FML PLACEMENT QUALITY	=	3 - GOOD

```
_____
```

	TYPE	3 -	BARRIER	SOIL LIN	ER		
	MATE	RIAL	TEXTURE	NUMBER 1	24		
THICKNESS			=	6.00		INCHES	
POROSITY			=	0.36	50	VOL/VOL	
FIELD CAPACITY	Y		=	0.30	50	VOL/VOL	
WILTING POINT			=	0.20	20	VOL/VOL	
INITIAL SOIL N	WATER	CON	TENT =	0.36	50	VOL/VOL	
EFFECTIVE SAT	. HYD	. COI	ND. =	0.999999	997	000E-06	CM/SEC

### LAYER 8

#### TYPE 1 - VERTICAL PERCOLATION LAYER MATERIAL TEXTURE NUMBER 113

	оны	Nonibelity 115
THICKNESS	=	6.00 INCHES
POROSITY	=	0.4300 VOL/VOL
FIELD CAPACITY	=	0.3210 VOL/VOL
WILTING POINT	=	0.2210 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.3069 VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.999999975000E-05 CM/SEC

### GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE #10 WITH BARE GROUND CONDITIONS, A SURFACE SLOPE OF 30.% AND

						(	Geosy	/ntec <sup>(</sup>	>
							con	sultants	
						Page	23	of	28
Written by:	Joseph Sura	Da	ate: <u>3/10/2011</u>	Reviewed by:	R. Ku	ılasingam/Jay Bo	eech Dat	e: <u>3/11/2</u>	2011
Client: <b>H</b> o	oneywell	Project: Or	nondaga Lake SC.	A Final Design	Projec	t/ Proposal No.:	GJ4299	Task No.:	18
		A SLOPE	LENGTH OF 100	). FEET.					
	SCS RU FRACTI AREA F EVAPOR INITIA UPPER LOWER INITIA	NOFF CURVE N ON OF AREA A ROJECTED ON ATIVE ZONE I L WATER IN F LIMIT OF EVA LIMIT OF EVA L SNOW WATER	NUMBER ALLOWING RUNOFF HORIZONTAL PLA DEPTH EVAPORATIVE ZON APORATIVE STORA APORATIVE STORA	$ \begin{array}{rcrcrc}                                 $	60 0 PER 000 ACR 0 INC 422 INC 030 INC 641 INC 000 INC	CENT ES HES HES HES HES HES			
	INITIA TOTAL TOTAL	L WATER IN I INITIAL WATE SUBSURFACE I	LAYER MATERIALS ER INFLOW	s = 163. = 163. = 0.	747 INC 747 INC 00 INC	HES HES HES/YEAR			
		EVAP07	TRANSPIRATION A	ND WEATHER DA	NTA 				
	NOTE :	EVAPOTRANS SYRACUSE	SPIRATION DATA	WAS OBTAINED NEW YORK	FROM				
	S M S E E A A A A A A A A A A A A	TATION LATIT LAXIMUM LEAF TART OF GROWIN VAPORATIVE 2 VERAGE ANNUA VERAGE 1ST ( VERAGE 2ND ( VERAGE 3RD ( VERAGE 4TH (	TUDE AREA INDEX NING SEASON (JUL IG SEASON (JULI CONE DEPTH AL WIND SPEED QUARTER RELATIV QUARTER RELATIV QUARTER RELATIV QUARTER RELATIV	= JLIAN DATE) = CAN DATE) = P VE HUMIDITY = VE HUMIDITY = VE HUMIDITY = VE HUMIDITY =	43.07 0.00 124 284 21.0 9.70 72.00 68.00 75.00 76.00	DEGREES INCHES MPH % % % %			
	NOTE :	PRECIPITAT COEFFICI	FION DATA WAS S LENTS FOR SY	SYNTHETICALLY RACUSE	GENERATE NEW	D USING YORK			
		NORMAL N	MEAN MONTHLY PR	RECIPITATION (	INCHES)	Page 23 of  Kulasingam/Jay Beech Date: 3/11, ject/ Proposal No.: GJ4299 Task No.:  PERCENT ACRES INCHES INC			
	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC			
	2.61 3.76	2.65 3.77	3.11 3.29	3.34 3.14	3.16 3.45	3.63 3.20			
	NOTE :	TEMPERATUF COEFFICI	RE DATA WAS SYN IENTS FOR SY	THETICALLY GE RACUSE	NERATED NEW	USING YORK			
	Ν	IORMAL MEAN N	NONTHLY TEMPERA	ATURE (DEGREES	5 FAHRENH	EIT)			
	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC			
	22 80	24 00	33 30	46 10					

			Geo	JSyme
				consultants
			Page	24 of 28
Written by: Joseph Sura		Date: <u>3/10/2011</u> Reviewed by:	R. Kulasingam/Jay Beech	Date: <u>3/11/2011</u>
Client: Honeywell	Project:	Onondaga Lake SCA Final Design	Project/ Proposal No.: GJ	<b>4299</b> Task No.: 18

Coormtoop

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR SYRACUSE NEW YORK AND STATION LATITUDE = 43.07 DEGREES

#### 

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 100

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	2.59 3.87	2.72 3.95	3.16 3.27	3.27 2.95	3.09 3.40	3.71 3.22
STD. DEVIATIONS	0.70 1.67	0.96 1.76	1.19 1.60	1.19 1.16	1.31 1.19	1.57 0.76
RUNOFF						
TOTALS	0.733 1.167	1.620 1.232	4.976 0.999	1.919 0.773	0.654 0.901	1.141 0.770
STD. DEVIATIONS	0.865 0.870	1.595 0.881	2.437 0.892	1.370 0.588	0.604 0.650	0.896 0.728
EVAPOTRANSPIRATION						
TOTALS	0.487 2.728	0.399 2.540	0.440 2.096	1.852 1.696	2.565 1.126	2.497 0.560
STD. DEVIATIONS	0.084 0.902	0.081 0.887	0.190 0.692	0.763 0.392	0.828 0.205	0.738 0.167
LATERAL DRAINAGE COLL	ECTED FROM	LAYER 1				
TOTALS	0.0000 0.0000	0.0000	0.0001 0.0000	0.0005 0.0001	0.0000 0.0004	0.0000 0.0004
STD. DEVIATIONS	0.0001 0.0000	0.0000 0.0000	0.0002 0.0001	0.0001 0.0001	0.0001 0.0003	0.0000
PERCOLATION/LEAKAGE T	HROUGH LAY	er 2				
TOTALS	0.0350 0.0191	0.0001	0.1110 0.1242	0.8880 0.2833	0.1837 0.7883	0.0197 0.8231
STD. DEVIATIONS	0.1202 0.0540	0.0011 0.0898	0.2791 0.1731	0.2390 0.2893	0.2010 0.4846	0.0507 0.5429

PERCOLATION/LEAKAGE THROUGH LAYER 4

## Geosyntec<sup>▷</sup>

consultants 25 of 28

							Page		25	of	28
Written by:	Joseph Sura	l	Date: 3/10	/2011	Reviewed by:	R. Ku	lasingam/Ja	ay Beech	Date	3/11/2	011
Client: H	loneywell	Project:	Onondaga La	ake SCA F	inal Design	Project	/ Proposal N	lo.: <b>GJ4</b>	299	Task No.:	18
	TOTALS		0.0353 0.0191	0.0001 0.0482	0.1084 0.1242	0.8837 0.2833	0.1906 0.7860	0.0198 0.8251			
	STD. DEVI	LATIONS	0.1205 0.0540	0.0011 0.0898	0.2746 0.1731	0.2442 0.2893	0.2106 0.4823	0.0507 0.5429			
	LATERAL DRA	AINAGE COLI	LECTED FROM	LAYER 5							
	TOTALS		0.0433 0.0194	0.0000 0.0459	0.0980 0.1233	0.8697 0.2758	0.2138 0.7568	0.0203 0.8573			
	STD. DEVI	LATIONS	0.1324 0.0543	0.0004 0.0869	0.2568 0.1707	0.2580 0.2862	0.2364 0.4651	0.0500 0.5400			
	PERCOLATION	I/LEAKAGE 7	THROUGH LAYE	R 7							
	TOTALS		0.0000 0.0000	0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000			
	STD. DEVI	LATIONS	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000	0.0000 0.0000			
	PERCOLATION	N/LEAKAGE 7	THROUGH LAYE	R 8							
	TOTALS		0.0001 0.0001	0.0000	0.0002	0.0004 0.0004	0.0005	0.0001 0.0005			
	STD. DEVI	IATIONS	0.0001 0.0002	0.0000 0.0004	0.0010 0.0008	0.0011 0.0008	0.0010 0.0009	0.0002 0.0008			
		AVERAGES	5 OF MONTHLY	AVERAGE	D DAILY HEA	DS (INCHI	ES)				
	DAILY AVERA	AGE HEAD OI	N TOP OF LAY	er 2							
	AVERAGES		0.0035 0.0008	0.0000 0.0027	0.0138 0.0079	0.1056 0.0208	0.0110 0.0800	0.0009 0.0843			
	STD. DEVI	LATIONS	0.0124 0.0026	0.0000 0.0064	0.0362 0.0151	0.0331 0.0285	0.0213 0.0618	0.0027 0.0652			
	DAILY AVERA	AGE HEAD OI	N TOP OF LAY	er 4							
	AVERAGES		0.0007 0.0007	0.0000	0.0012 0.0039	0.0129 0.0076	0.0058 0.0158	0.0007 0.0153			
	STD. DEVI	LATIONS	0.0024 0.0019	0.0000 0.0028	0.0028 0.0048	0.0045 0.0064	0.0046 0.0068	0.0018 0.0074			
	DAILY AVERA	AGE HEAD OI	N TOP OF LAY	ER 6							
	AVERAGES		0.0037 0.0017	0.0000	0.0084 0.0109	0.0767 0.0235	0.0182 0.0668	0.0018 0.0732			
	STD. DEVI	LATIONS	0.0113 0.0046	0.0000 0.0074	0.0219 0.0151	0.0228 0.0244	0.0202 0.0410	0.0044 0.0461			

						Ge	eosy	mtec	D
							con	sultants	
					Pag	ge	26	of	28
en by: Joseph Sura	Letter Date	3/10/2011	_ F	Reviewed by:	R. Kulasinga	m/Jay Beecł	n Dat	e: <u>3/11/</u>	201
t: Honeywell	Project: Onor	ndaga Lake SC.	A Fi	inal Design	Project/ Propos	sal No.: O	GJ4299	Task No.:	
* * * * * * * * * * * * *	* * * * * * * * * * * * * * * * * * * *	* * * * * * * * * * * * *	:***	*******	* * * * * * * * * * * * * * *	* * * * * * * * * *	* * *		
* * * * * * * * * * * * *	* * * * * * * * * * * * * * * * * *	* * * * * * * * * * * * *	:***	*****	* * * * * * * * * * * * * *	* * * * * * * * * *	* * *		
AVERAGE	ANNUAL TOTALS &	& (STD. DEVIA	VIIO	NS) FOR YEA	ARS 1 THROU	GH 100			
		INC	HES	3	CU. FEET	PERCENT	C 		
PRECIPITATIO	лс	39.20	(	4.823)	142279.7	100.00			
RUNOFF		16.885	(	3.2589)	61291.30	43.078			
EVAPOTRANSP	IRATION	18.986	(	2.2032)	68919.23	48.439			
LATERAL DRA FROM LAYE	INAGE COLLECTED R 1	0.00155	i (	0.00046)	5.610	0.00394	1		
PERCOLATION LAYER 2	/LEAKAGE THROUGH	H 3.32363	; (	0.81308)	12064.770	8.4796	52		
AVERAGE HEA OF LAYER	O ON TOP 2	0.028 (		0.008)					
PERCOLATION LAYER 4	/LEAKAGE THROUGH	H 3.32363	; (	0.81268)	12064.769	8.4796	52		
AVERAGE HEAI OF LAYER	O ON TOP 4	0.006 (		0.001)					
LATERAL DRA FROM LAYEI	INAGE COLLECTED R 5	3.32359	· (	0.81028)	12064.630	8.47952	2		
PERCOLATION LAYER 7	/LEAKAGE THROUGH	H 0.00004	: (	0.00001)	0.136	0.0001	LO		
AVERAGE HEAD OF LAYER	) ON TOP 6	0.024 (		0.006)					
PERCOLATION LAYER 8	LEAKAGE THROUGH	H 0.00319	• (	0.00634)	11.580	0.0081	4		
	ATER STORAGE	-0.003	(	1.2900)	-12.67	-0.009			

							C	Geosy	ntec <sup>(</sup> sultants	>
							Page	27	of	28
Written by:	Joseph Sura	Date:	3/10/2011	Revi	ewed by:	R. Ku	llasingam/Jay Be	ech Date	e: <u>3/11/2</u>	2011
Client: He	oneywell Project:	Onon	daga Lake SC	A Final	Design	Project	t/ Proposal No.:	GJ4299	Task No.:	18
	PERCOLATION/LEAK	AGE THI	ROUGH LAYER	2	0.5422	13	1968.23474			
	AVERAGE HEAD ON	TOP OF	LAYER 2		2.577					
	MAXIMUM HEAD ON	TOP OF	LAYER 2		4.503					
	LOCATION OF MAXI (DISTANCE	MUM HEA FROM DI	AD IN LAYER RAIN)	1	0.0 FE	ET				
	PERCOLATION/LEAK	AGE THE	ROUGH LAYER	4	0.3402	09	1234.95764			
	AVERAGE HEAD ON	TOP OF	LAYER 4		0.060					
	DRAINAGE COLLECT	ED FROM	M LAYER 5		0.2357	0	855.57355			
	PERCOLATION/LEAK	AGE THI	ROUGH LAYER	7	0.0000	02	0.00805			
	AVERAGE HEAD ON	TOP OF	LAYER 6		0.624					
	MAXIMUM HEAD ON	TOP OF	LAYER 6		1.213					
	LOCATION OF MAXI (DISTANCE	MUM HEA FROM DI	AD IN LAYER RAIN)	5	41.3 FE	ET				
	PERCOLATION/LEAK	AGE THI	ROUGH LAYER	8	0.0003	67	1.33393			
	SNOW WATER				9.62		34911.7891			
	MAXIMUM VEG. SOI	L WATER	R (VOL/VOL)			0.41	20			
	MINIMUM VEG. SOI	L WATEN	R (VOL/VOL)			0.29	50			
	*** Maximum he	ads are	e computed u	using M	lcEnroe's	equati	ons. ***			
	Reference:	Maxin by Br ASCE Vol.	num Saturate ruce M. McEr Journal of 119, No. 2,	ed Dept nroe, U Envirc March	h over La niversity nmental E 1993, pp	ndfill of Ka nginee . 262-	Liner nsas ring 270.			
*	* * * * * * * * * * * * * * * * * * * *	* * * * * * *	* * * * * * * * * * * *	* * * * * * *	* * * * * * * * *	* * * * * *	* * * * * * * * * * * * * *	* * * *		
*	* * * * * * * * * * * * * * * * * * * *	* * * * * * *	* * * * * * * * * * * *	* * * * * * *	* * * * * * * * *	* * * * * *	* * * * * * * * * * * * *	* * * *		
	FIN	AL WATI	ER STORAGE A	AT END	OF YEAR	100				
	LA	YER	( INCHES	 3)	(VOL/VO	 L)				
		 1	8.341	9	0.397	2				
		2	0.051	LO	0.850	0				
		3	0.018	34	0.307	0				
		4	150.840	00	0.419	0				

# Geosyntec<sup>▷</sup>

					cons	sultants	
				Page	28	of	28
Written by: Jo	oseph Sura	Date: 3/10/201	<b>1</b> Reviewed by:	R. Kulasingam/Jay B	eech Date	e: <u>3/11/2</u>	011
Client: Honey	well Project:	Onondaga Lake S	CA Final Design	Project/ Proposal No.:	GJ4299	Task No.:	18
		5 0.3	840 0.03	320			
		6 0.0	000 0.00	000			
		7 2.1	900 0.36	50			
		8 1.5	264 0.25	544			
	SNOW	WATER 0.0	46				
* * * * *	*****************	* * * * * * * * * * * * * * * * * * * *	* * * * * * * * * * * * * * * * * * * *	* * * * * * * * * * * * * * * * * * * *	* * * *		