APPENDIX U

LEACHATE COLLECTION AND RECOVERY SYSTEM DESIGN

HELP MODELING AND PIPE STRUCTURAL STABILITY ANALYSIS

MARANA REGIONAL LANDFILL

PIMA COUNTY, ARIZONA

Prepared for
Marana Regional Landfill

May 2011

Prepared by

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Project 090250

HELP Modeling and Pipe Structural Stability Analysis
Marana Regional Landfill
Pima County, Arizona

The material and data in this report were prepared under the supervision and direction of the undersigned. This report was prepared consistent with current and generally accepted geologic and environmental consulting principles and practices that are within the limitations provided herein.

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1 SUMMARY

The design of the base liner, leachate collection system, and final cover system for the Marana Regional Landfill is described in this report. The Hydrologic Evaluation of Landfill Performance (HELP) Model was used to support the base liner and final cover systems designs and evaluate the Leachate Collection and Recovery System (LCRS). The pipe system in the LCRS was evaluated for capacity and strength.

Three scenarios were evaluated using the HELP Model. Scenario 1 modeled a geonet drainage layer, with one 10-foot lift of refuse. The hydraulic conductivity of the geonet drainage layer was 10 cm/sec. Scenario 2 modeled a geonet drainage layer with 130 feet of refuse. Scenario 3 modeled a landfill that had achieved final grade with three feet of cover soil, 231 feet of waste, and a geonet drainage layer.

Since the landfill is located in an arid environment, leachate generation is low and potential infiltration through the lining system is minimal. The model results indicate that in all the simulations, the head on the liner system is less than 12 inches.

A 6-inch diameter pipe on a 3-percent slope will allow adequate flow capacity for each phase. Leachate will be collected through 3/8 inch pipe perforations in four rows, set 90° apart on the pipe circumference and spaced 12-inches center to center. The loading conditions of the pipe require a Schedule 120 PVC pipe to withstand wall buckling, wall crushing, and provide acceptable pipe deflection. Sumps were sized to handle a weekly flow from the maximum average monthly drainage collected from the drainage layer. A sump which is 4-foot deep and 30-feet by 30-feet wide will be adequate to collect the estimated maximum leachate generation over a one-week period.

2 CALCULATIONS

2.1 HELP Modeling

In order to approximate leachate generation, the HELP Modeling was conducted for the landfill under operating and final conditions. The HELP Model, developed by the U.S. Army Corps of Engineers Waterways Experiment Station in Vicksburg, Mississippi, performs a water balance analysis of rainfall, runoff, evapotranspiration, soil moisture storage, lateral drainage, and percolation on a quasi-two-dimensional simulation approach. The HELP Model is useful for predicting amounts of runoff, leachate generation, and hydraulic head above the bottom layer of a disposal facility. Input parameters were evaluated and changed to achieve a credible result from the HELP program due to complexity of landfill operations and varying hydrological conditions at the site. For Scenario 1, which was modeled as having only received one lift of waste, a 5-year weather simulation was applied. For Scenarios 2 & 3, which were being modeled at an interim waste capacity and full waste capacity, respectively, a 30-year weather simulation was applied.

2.2 LCRS Header Pipe

Pipe sizing was performed under maximum leachate generation conditions (initial operations) and stability calculations were performed for the LCRS header pipe under closure conditions. Due to the stress caused by the weight of refuse placed over it, the pipe must be sized with sufficient wall thickness to withstand wall crushing, wall buckling, and ring deflection. The capacity of the pipe must be sized to convey the estimated maximum leachate flow.

3 HELP MODELING SCENARIOS

The HELP Model analysis was performed on three simulated landfill configurations (See Table 4). The run for Scenario 1 modeled an initial condition that was exposed for 5 years. Scenarios 2 & 3 modeled interim and final conditions, respectively, that were exposed for 30 years.

The layer profiles for Scenario 1 included:

- 6 inches of cover soil
- 10 feet of refuse
- 2 foot operations soil layer
- Geonet, which serves as the lateral drainage layer
- Geomembrane
- Geosynthetic Clay Layer (GCL), which serves as the soil barrier layer

The layer profiles for Scenario 2 included:

- 6 inches of cover soil,
- 130 feet of refuse
- 2 foot operations soil layer
- Geonet
- Geomembrane
- Geosynthetic Clay Layer (GCL)

The layer profiles for Scenario 3 included:

- 1 foot of intermediate cover soil
- 231 feet of refuse
- 2 foot operations soil layer
- Geonet
- Geosynthetic Clay Layer (GCL)

All three scenarios were modeled with a geonet drainage layer and a 2-foot operational soil layer above it. The leachate production determined for each scenario was for a typical landfill operational area of 20-acres. The proposed final cover, depicted in Scenario 3, modeled three feet of soil cover, which had a saturated hydraulic conductivity of 1×10^{-5} cm/sec.

4 PARAMETERS

4.1 HELP Model

The HELP Model requires climatological data, ground cover and soil characteristics, runoff curve number, and landfill cross-section with associated geotechnical properties to perform the water balance analysis. The HELP Model incorporates a synthetic weather generator, which generates daily rainfall, mean daily temperatures, and daily solar radiation values for a specific station. Default options for vegetative types and default characteristics for soil types are available for use when site-specific estimates are not available. Parameters used in the water balance analysis are discussed below.

4.1.1 Climate

The HELP Model contains historical climatological "default" data in its database, which allow the user to select a station close to the site under consideration. Data from a weather station can be used to simulate precipitation at another location if that other location is within "a few miles" of the selected station and land use and topography do not vary between the two locations. The program generates a routine designed to preserve the dependence in time, the correlation between variables, and the seasonal characteristics in actual weather data at the specified location.

In order to simulate a landfill cross-section for each of the scenarios, the climatological data (i.e., solar radiation, temperature, precipitation and evapotranspiration) for Marana Regional Landfill was generated synthetically for both 5-year and 30-year periods. The synthetically generated precipitation data from Phoenix, Arizona (monthly totals adjusted to increase annual totals to match conditions in Tucson Arizona (annual average precipitation = 12.0 inches)) was used during the HELP simulations and the normal mean precipitation is presented in Table 3. Synthetically generated temperature and solar radiation data was used for Tucson, Arizona.

4.1.2 Evaporative Zone and Evapotranspiration Data

The HELP Model allows the user to specify a USDA Soil Conservation Service (SCS) runoff curve number, the fraction of area allowing runoff, evaporative zone depth, initial

snow water, maximum leaf area index, average wind speed, growing season start/stop days, and average quarter humidity. The following parameters were selected in order to model a conservative simulation:

- The surface slope was modeled at 3.0 percent for Scenarios 1 and 2 and at 5.0 percent for Scenario 3. A slope length of 100' was used for each scenario. The value of the SCS curve number, which was calculated by HELP, was 82.4 for Scenarios 1 & 2 and 87.8 for Scenario 3.
- The default evaporative zone depths for the Tucson area are 18 inches (Bare), 40 inches (Fair), and 60 inches (Excellent). A conservative evaporative zone depth of 29-inches was used.
- The fraction of area allowing runoff was conservatively assumed to be 0.0-percent for Scenarios 1 & 2, even though it's likely that a portion of this area will runoff. For Scenario 3, the fraction of area allowing runoff was assumed to be 100 percent to model the volume of percolation through the final covers. For all three scenarios the total initial snow water was assumed to be 0.00 inches, and the maximum leaf index was assumed to be 1.0, simulating poor vegetative cover.
- The initial moisture content of the layers and snow water were computed as nearly steady-state values by the model for models containing 10 feet or less of waste. For large lifts of waste experienced after final grade, water contents were assigned manually. The water content in waste for Scenario 1 was assumed to be 0.2542 (vol/vol), 0.2534 (vol/vol) in Scenario 2 and 0.2526 in Scenario 3.
- The default values for Tucson were used for: growing season start and end days (36, 345), average wind speed (8.2 mph), and quarter relative humidity.

4.1.3 Soil Characteristics

The HELP Model allows the user to specify the properties of five different layers: vertical percolation layers, lateral drainage layers, barrier soil liners, geonet/geotextile layers, and geomembrane liners. The permeability of the compacted soil cover material was assumed to be about 1.0×10^{-5} cm/sec (clay/sand default layer was modeled) and was modeled as a vertical percolation soil layer rather than a barrier soil layer. Prior to installation of final cover, soil testing of borrow sources proposed to be used for final cover should be collected to confirm these soil parameters. The following sections provide a description of each layer used in the HELP Model analysis. The parameters of each layer utilized to run the model are contained in Appendix A - HELP Modeling Summaries.

4.1.4 Layer Profiles

The vertical percolation layers considered in the model included a native soil layer (final cover and operation layer), the refuse layer, and the daily cover layer. Parameters for these layers were default parameters from the HELP model (listed in Table 5). The lateral percolation layers considered in the model consisted of either a geonet or gravel drainage layer and HELP default parameters were used for both. A high-density polyethylene (HDPE) geomembrane was modeled as the geomembrane layer. A GCL, with a saturated hydraulic conductivity of 3.0×10^{-9}, was modeled as the barrier soil layer. The refuse layers were modeled using HELP default soil texture No. 18 with a saturated hydraulic conductivity of 1.0×10^{-3} cm/sec. Table 4 summarizes the default model parameters of the HELP program.

4.2 LCRS Header Pipe

The LCRS header pipes are sized to carry peak flows of leachate generated in the landfill. The LCRS system was designed with 6-inch diameter Schedule 120 PVC pipes on a 3-percent slope. 3/8 inch pipe perforations in four rows, with a 90° separation along the pipe circumference, and spaced 12-inches center to center are designed to allow leachate to flow into pipes, while keeping gravel out. The estimated peak daily leachate generation was 24.1 ft^3/day (180 gal/day), which occurred during Scenario 1.

For the analysis a six-inch diameter, Schedule 120 PVC pipe was used. This pipe has a compressive yield strength of 9,600 pounds per square inch (psi) and has an elastic modulus of 420,000 pounds per square inch (psi). A coarse-grained soil with little or no fines and a modulus of soil reaction, E', of 3000 psi was utilized to analyze pipe wall buckling and pipe ring deflection.

5 RESULTS

5.1 HELP Model

A summary of the HELP modeling data input for each scenario is detailed in Table 3. Results of each modeling scenario are provided in the following tables:

TABLE U-1

Summary of HELP Model Data Output for Scenarios 1, 2 & 3
Marana Regional Landfill
Pima County, Arizona

Scenario	Peak Daily Drainage Collected From Drainage Layer (ft^3/day)	Peak Average Monthly Drainage Collected From Drainage Layer (in/month)	Average Annual Drainage Collected From Drainage Layer (ft^3/year)	Peak Daily Maximum Head (inches)
1	23.2	0.0075	55.135	0.011
2	0.00061	0.00	0.00	0.072
3	0.00061	0.00	0.00	0.072

5.2 LCRS Header Pipe

The flow capacity of a 6-inch pipe on a 3-percent slope was calculated to be 628 gallons per minute (gpm). Anticipated maximum flows are on the order of 0.121 gpm (See Appendix B, LCRS Pipe Flow Capacity), well below capacity.

The design stress for 3.0 feet of cover soil and 231 feet of waste was estimated to be 106.1 psi (See Appendix B, LCRS Structural Integrity). The following factors of safety for pipe structural stability were greater than one as presented in Appendix B:

- Pipe wall crushing, FS = 6.06;
- Pipe wall buckling, FS = 5.96;
- Maximum pipe ring deflection, (%) = 6.60

5.3 Final Cover Scenario

In Scenario 3, which models a closed landfill, there was no precipitation transport from the final cover soils layer to the underlying refuse layer. This was determined by comparing the initial and final soil moisture values of the refuse waste layer from Scenario 3. The soil moisture value remained unchanged during the duration of the model run which indicates that no precipitation is transported from the final cover soils layer into the refuse layer.

6 CONCLUSIONS

Due to the arid environment and high rate of evapotranspiration, most of the precipitation that contacts the cover soil will not percolate through the cover. The results of the model indicate that the proposed cover layer performs as well as ADEQ's standard cover layer with both systems allowing negligible infiltration into the landfill. HELP typically over-estimates infiltration and leachate generation, particularly in an arid environment, so actual infiltration and leachate generation may approach zero.

A subgrade with a 3-percent slope and a geocomposite drainage layer will provide sufficient drainage to maintain the leachate head on the liner below 12-inches. Maximum flow length to an LCRS pipe will be 1500 feet. For all the scenarios evaluated, there will be no infiltration predicted through the subgrade liner system.

The leachate sumps will be sized to store a minimum of a week's worth of flow from the highest average monthly drainage flow collected from the drainage layer. The highest average monthly flow collected for the three scenarios was 545 ft^3/month, therefore, the weekly design flow would be 136 ft^3/week. A sump which is 4-foot deep and 30-feet by 30-feet wide will be adequate to collect the volume of leachate over a one week period.

A 6-inch diameter pipe on a 3-percent slope will provide adequate flow capacity for leachate collection from each phase of the landfill. The LCRS header pipes will be spaced to provide a maximum flow length to a header pipe of 1500 feet. The analysis indicates that a 6-inch Schedule 120 PVC pipe would be adequate to withstand the maximum stress of a closure condition (i.e, 106.7 psi). The pipe will withstand wall crushing and wall buckling and will provide adequate resistance to pipe ring deflection.

LIMITATIONS

The services described in this report were performed consistent with generally accepted professional consulting principles and practices. No other warranty, express or implied, is made. These services were performed consistent with our agreement with our client. This report is solely for the use and information of our client unless otherwise noted. Any reliance on this report by a third party is at such party's sole risk.

Opinions and recommendations contained in this report apply to conditions existing when services were performed and are intended only for the client, purposes, locations, time frames, and project parameters indicated. We are not responsible for the impacts of any changes in environmental standards, practices, or regulations subsequent to performance of services. We do not warrant the accuracy of information supplied by others, or the use of segregated portions of this report.

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United States Environmental Protection Agency (USEPA). *The Hydrologic Evaluation of Landfill Performance (HELP) Model – User's Guide for Version 3*. 1994. Print.

TABLES

TABLE U-2
Normal Mean Monthly Precipitation Values
Marana Regional Landfill: Marana, Arizona

Month	Precipitation (in)
January	0.87
February	0.70
March	0.72
April	0.30
May	0.18
June	0.20
July	2.37
August	2.19
September	1.67
October	1.06
November	0.67
December	1.07

TABLE U-3
Summary of HELP Model Data Input
Marana Regional Landfill: Marana, Arizona

Scenario	Layer No.	Layer Type	Thickness (feet)
1. Determine the amount of leachate collected during an initial period of operation. Use one ten-foot lift of waste, 2 feet of on-site soil for the liner cover along with a geonet	1	Vertical Percolation Layer (daily cover)	0.5
	2	Vertical Percolation Layer (waste)	10
	3	Vertical Percolation Layer (operations layer)	2
	4	Lateral Drainage Layer (Geonet)	0.002
	5	Flexible Membrane Liner (HDPE geomembrane)	0.003
	6	Barrier Liner (GCL)	0.02
2. Determine the amount of leachate collected during an interim period of operation. Use one 130-foot lift of waste, 2-feet of on-site soil along with a geonet	1	Vertical Percolation Layer (daily cover)	0.5
	2	Vertical Percolation Layer (waste)	130
	3	Vertical Percolation Layer (operations layer)	2
	4	Lateral Drainage Layer (Geonet)	0.002
	5	Flexible Membrane Liner (HDPE geomembrane)	0.003
	6	Barrier Liner (GCL)	0.02
3. Determine the amount of leachate collected after final closure of operation. Use one 231-foot lift of waste, 2-feet of on-site soil along with a geonet	1	Vertical Percolation Layer (final cover)	3.0
	2	Vertical Percolation Layer (waste)	231
	3	Vertical Percolation Layer (operations layer)	2
	4	Vertical Percolation Layer (Geonet)	0.002
	5	Flexible Membrane Liner (HDPE geomembrane)	0.003
	6	Barrier Liner (GCL)	0.02

TABLE U-4
HELP Default Parameters
Marana Regional Landfill: Marana, Arizona

Classification			Total Porosity	Field Capacity	Wilting Point	Saturated Hydraulic Conductivity
HELP	USDA	USCS	vol/vol	vol/vol	vol/vol	cm/sec
1	CoS	SP	0.417	0.045	0.018	1.0E-02
2	S	SW	0.437	0.062	0.024	5.8E-03
3	FS	SW	0.457	0.083	0.033	3.1E-03
4	LS	SM	0.437	0.105	0.047	1.7E-03
5	LFS	SM	0.457	0.131	0.058	1.0E-03
6	SL	SM	0.453	0.190	0.085	7.2E-04
7	FSL	SM	0.473	0.222	0.104	5.2E-04
8	L	ML	0.463	0.232	0.116	3.7E-04
9	SiL	ML	0.501	0.284	0.135	1.9E-04
10	SCL	SC	0.398	0.244	0.136	1.2E-04
11	CL	CL	0.464	0.310	0.187	6.4E-05
12	SiCL	CL	0.471	0.342	0.210	4.2E-05
13	SC	SC	0.430	0.321	0.221	3.3E-05
14	SiC	CH	0.479	0.371	0.251	2.5E-05
15	C	CH	0.475	0.378	0.265	1.7E-05
16	Barrier Soil		0.427	0.418	0.367	1.0E-07
17	Bentonite Mat (0.6 cm)		0.750	0.747	0.400	3.0E-09
18	Municipal Waste (900 lb/yd^3 or 312 kg/m^3)		0.671	0.292	0.077	1.0E-03
19	Municipal Waste (channeling and dead zones)		0.168	0.073	0.019	1.0E-03
20	Drainage Net (0.5cm)		0.850	0.100	0.005	1.0E+01
21	Gravel		0.397	0.032	0.013	3.0E-01
22	L*	ML	0.419	0.307	0.180	1.9E-05
23	SiL*	ML	0.461	0.360	0.203	9.0E-06
24	SCL*	SC	0.365	0.305	0.202	2.7E-06
25	CL*	CL	0.437	0.373	0.266	3.6E-06
26	SiCL*	CL	0.445	0.393	0.277	1.9E-06
27	SC*	SC	0.400	0.366	0.288	7.8E-07
28	SiC*	CH	0.452	0.411	0.311	1.2E-06
29	C*	CH	0.451	0.419	0.332	6.8E-07
30	Coal-burning Electric Plant Fly Ash*		0.541	0.187	0.047	5.0E-05
31	Coal-burning Electric Plant Fly Ash*		0.578	0.076	0.025	4.1E-03
32	Municipal Incinerator Fly Ash*		0.450	0.116	0.049	1.0E-02
33	Fine Copper Slag		0.375	0.055	0.200	4.1E-02
34	Drainage Net (0.6cm)		0.850	0.010	0.005	3.3E+01

*Moderately compacted

TABLE U-4
HELP Default Parameters (Cont)
Marana Regional Landfill: Marana, Arizona

Classification			Total Porosity	Field Capacity	Wilting Point	Saturated Hydraulic Conductivity
HELP	USDA	USCS	vol/vol	vol/vol	vol/vol	cm/sec
35	High Density Polyethylene (HDPE)					2.0E-13
36	Low Density Polyethylene (LDPE)					4.0E-13
37	Polyvinyl Chloride (PVC)					2.0E-11
38	Butyl Rubber					1.0E-12
39	Chlorinated Polyethylene (CPE)					4.0E-12
40	Hypalon or Chlorosulfonated Polyethylene (CSPE)					3.0E-12
41	Ethylene-Propylene Diene Monomer (EPDM)					2.0E-12
42	Neoprene					3.0E-12

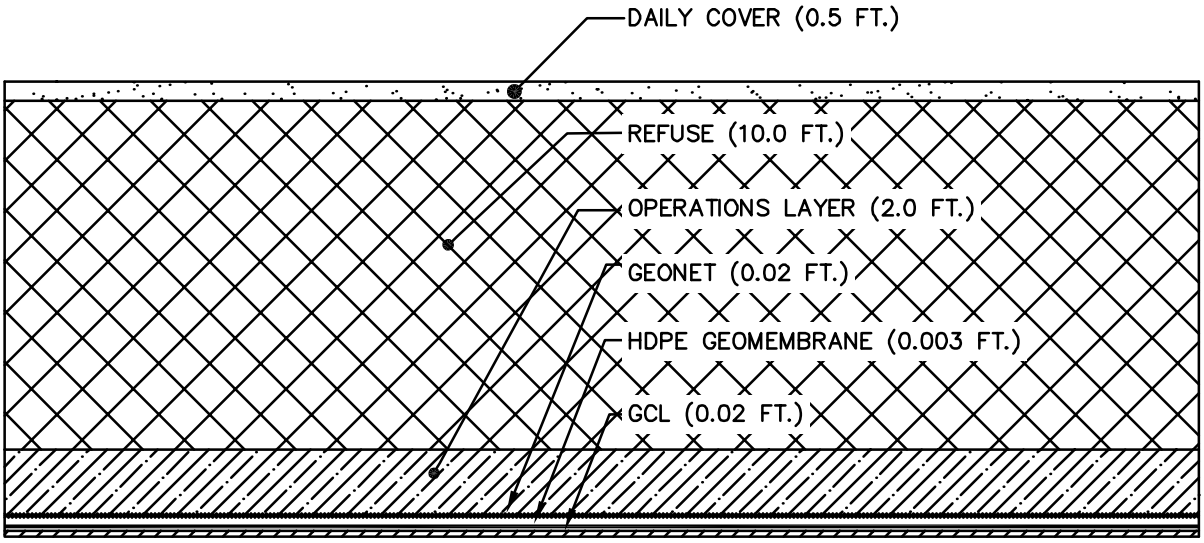
Reference: U.S.E.P.A. 1994. "The Hydrologic Evaluation of Landfill Performance (HELP) Model – User's Guide for Version 3".

TABLE U-5
Typical Cell Properties
Marana Regional Landfill: Marana, Arizona

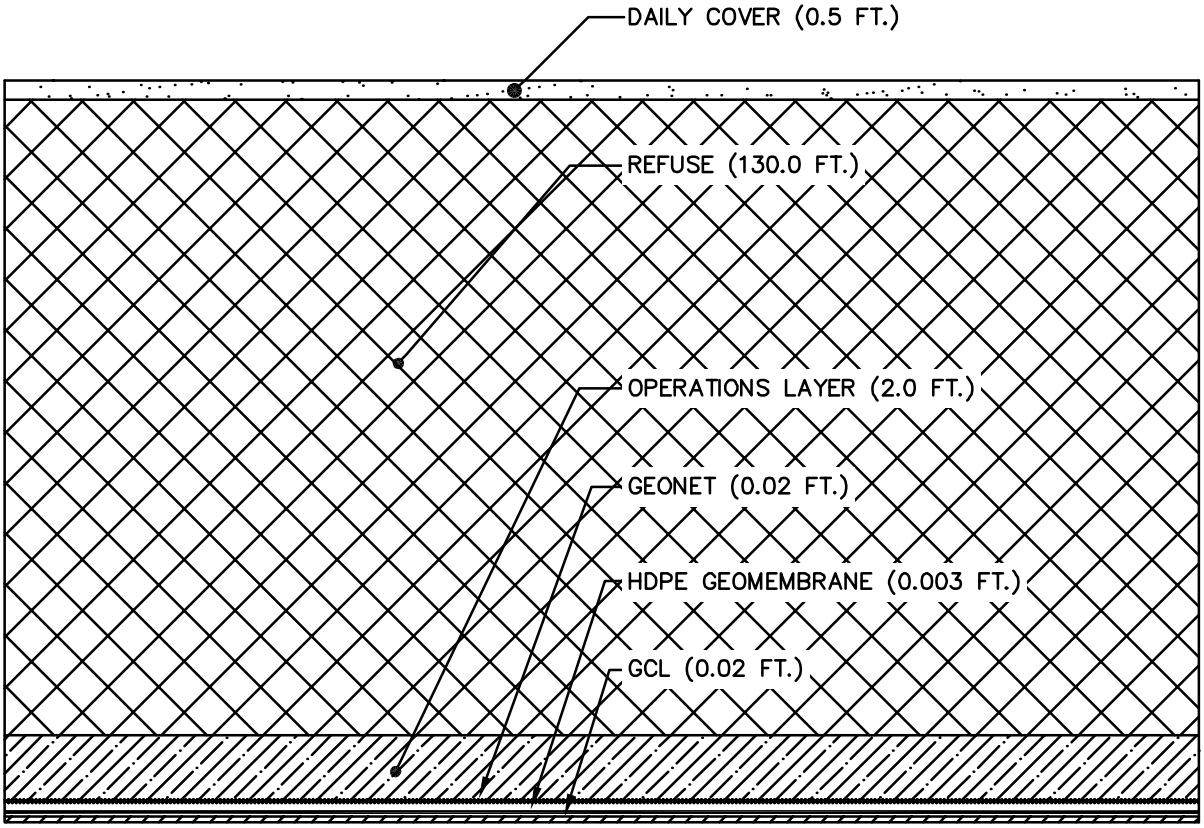
	Initial Scenario	Interim Scenario	Final Cover Scenario
Area (Ac)	20.0	20.0	20.0
Bottom Drainage Length (ft)	1500	1500	1500
Bottom Slope (%)	3	3	3
Top Drainage Length (ft)	100	100	100
Top Slope (%)	3	3	5
Waste Depth (ft)	10	130	231

FIGURES

HELP MODEL SIMULATION CROSS-SECTIONS



SCENARIO 1 (INITIAL)



SCENARIO 2 (INTERIM)

NOTE: NOT TO SCALE

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DKL HOLDINGS
MARANA REGIONAL LANDFILL

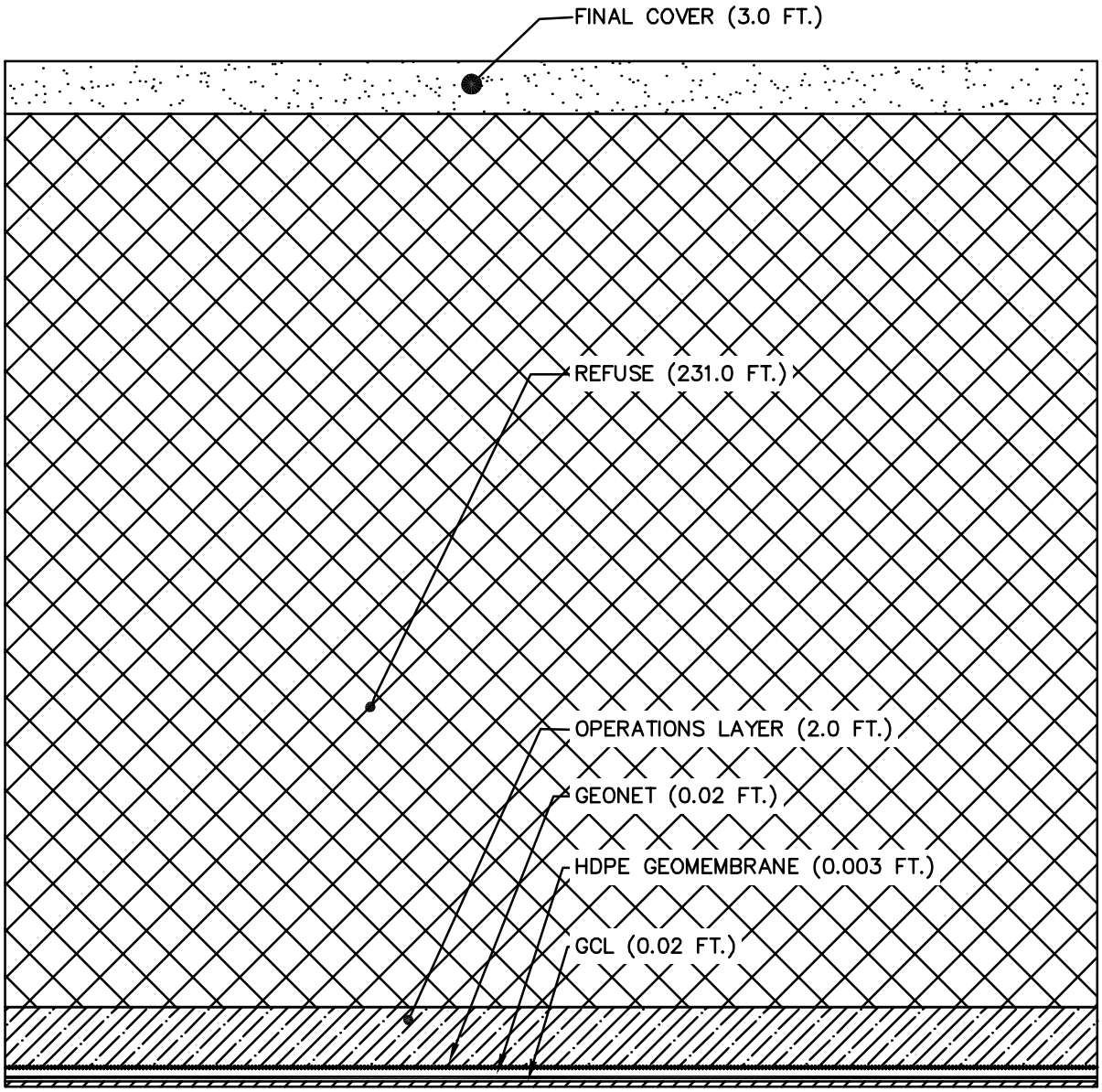
HELP MODEL CROSS SECTIONS

FIGURE NO.
U1

PROJECT NO.
090250

File: X:\PROJECTS\MARANA - SWFP - 090250\PROJECT DRAWINGS\MIMSWFPS-FIG1-HELP CROSS SEC.dwg Layout: FIGURE 1 User: Mark.Case May 05, 2011 - 2:16pm

HELP MODEL SIMULATION CROSS-SECTIONS (CONT.)



SCENARIO 3 (FINAL)

NOTE: NOT TO SCALE

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MARANA REGIONAL LANDFILL

HELP MODEL CROSS SECTIONS

FIGURE NO.
U2

PROJECT NO.
090250

File: X:\PROJECTS\MARANA - SWFP - 090250\PROJECT DRAWINGS\MIMSWFPS-FIG1-HELP CROSS SEC.dwg Layout: FIGURE 2 User: Mark.Case May 05, 2011 - 2:17pm

APPENDIX A

HELP MODELING SUMMARIES

```
******************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
**              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:\HELP\MARPRECP.D4
TEMPERATURE DATA FILE:      C:\HELP\MARTEMPE.D7
SOLAR RADIATION DATA FILE:  C:\HELP\MARSOLAR.D13
EVAPOTRANSPIRATION DATA:    C:\HELP\MAREVAPO.D11
SOIL AND DESIGN DATA FILE:  C:\HELP\MARSOIL4.D10
OUTPUT DATA FILE:           C:\HELP\MARSOIL4.OUT



TIME:  13:25     DATE:   4/13/2011



******************************************************************************

     TITLE:  SCENARIO 1 - INITIAL- geocomposite

******************************************************************************



     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   4
           THICKNESS                   =      6.00   INCHES
           POROSITY                    =      0.4370 VOL/VOL
           FIELD CAPACITY              =      0.1050 VOL/VOL
           WILTING POINT               =      0.0470 VOL/VOL
           INITIAL SOIL WATER CONTENT  =      0.1176 VOL/VOL
           EFFECTIVE SAT. HYD. COND.   =  0.170000002000E-02 CM/SEC
         NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  1.80
                  FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.
```

```
                        LAYER  2
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  18
THICKNESS                   =    120.00   INCHES
POROSITY                    =      0.6710 VOL/VOL
FIELD CAPACITY              =      0.2920 VOL/VOL
WILTING POINT               =      0.0770 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.2542 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC


                        LAYER  3
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  10
THICKNESS                   =     24.00   INCHES
POROSITY                    =      0.3980 VOL/VOL
FIELD CAPACITY              =      0.2440 VOL/VOL
WILTING POINT               =      0.1360 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.2440 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.119999997000E-03 CM/SEC


                        LAYER  4
                        --------

            TYPE 2 - LATERAL DRAINAGE LAYER
              MATERIAL TEXTURE NUMBER  20
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.   =   10.0000000000     CM/SEC
SLOPE                       =      3.00   PERCENT
DRAINAGE LENGTH             =   1500.0    FEET


                        LAYER  5
                        --------

            TYPE 4 - FLEXIBLE MEMBRANE LINER
              MATERIAL TEXTURE NUMBER  35
THICKNESS                   =      0.04   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.   =  0.199999996000E-12 CM/SEC
FML PINHOLE DENSITY         =      0.50   HOLES/ACRE
FML INSTALLATION DEFECTS    =      2.50   HOLES/ACRE
FML PLACEMENT QUALITY       =  3 - GOOD
```

LAYER 6

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 17

```
THICKNESS                   =      0.24   INCHES
POROSITY                    =      0.7500 VOL/VOL
FIELD CAPACITY              =      0.7470 VOL/VOL
WILTING POINT               =      0.4000 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.7500 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.300000003000E-08 CM/SEC
```

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE # 4 WITH BARE GROUND CONDITIONS, A SURFACE SLOPE OF 3.% AND A SLOPE LENGTH OF 100. FEET.

```
SCS RUNOFF CURVE NUMBER             =     82.40
FRACTION OF AREA ALLOWING RUNOFF    =      0.0    PERCENT
AREA PROJECTED ON HORIZONTAL PLANE  =      1.000  ACRES
EVAPORATIVE ZONE DEPTH              =     29.0    INCHES
INITIAL WATER IN EVAPORATIVE ZONE   =      2.881  INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE  =     18.055  INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE  =      2.053  INCHES
INITIAL SNOW WATER                  =      0.000  INCHES
INITIAL WATER IN LAYER MATERIALS    =     37.243  INCHES
TOTAL INITIAL WATER                 =     37.243  INCHES
TOTAL SUBSURFACE INFLOW             =      0.00   INCHES/YEAR
```

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM TUCSON ARIZONA

```
STATION LATITUDE                        =  32.12 DEGREES
```

```
MAXIMUM LEAF AREA INDEX                =   1.00
START OF GROWING SEASON (JULIAN DATE)  =     36
END OF GROWING SEASON (JULIAN DATE)    =    345
EVAPORATIVE ZONE DEPTH                 =  29.0  INCHES
AVERAGE ANNUAL WIND SPEED              =   8.20 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY  =  43.00 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY  =  24.00 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY  =  42.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY  =  42.00 %
```

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR PHOENIX ARIZONA

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
0.87	0.70	0.72	0.30	0.18	0.20
2.37	2.19	1.67	1.06	0.67	1.07

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR TUCSON ARIZONA

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
51.10	53.80	57.80	65.00	73.20	82.90
86.20	84.00	80.40	70.40	58.70	52.00

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR TUCSON ARIZONA
AND STATION LATITUDE = 32.12 DEGREES

****

ANNUAL TOTALS FOR YEAR 1

	INCHES	CU. FEET	PERCENT
PRECIPITATION	7.40	26862.002	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	7.244	26294.100	97.89
DRAINAGE COLLECTED FROM LAYER 4	0.0060	21.610	0.08

PERC./LEAKAGE THROUGH LAYER 6	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 5	0.0000		
CHANGE IN WATER STORAGE	0.150	546.292	2.03
SOIL WATER AT START OF YEAR	37.243	135192.875	
SOIL WATER AT END OF YEAR	37.394	135739.172	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.000	0.00

****

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ANNUAL TOTALS FOR YEAR 2

	INCHES	CU. FEET	PERCENT
PRECIPITATION	18.70	67881.008	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	18.962	68832.734	101.40
DRAINAGE COLLECTED FROM LAYER 4	0.0036	13.182	0.02
PERC./LEAKAGE THROUGH LAYER 6	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 5	0.0000		
CHANGE IN WATER STORAGE	-0.266	-964.897	-1.42
SOIL WATER AT START OF YEAR	37.394	135739.172	
SOIL WATER AT END OF YEAR	37.128	134774.281	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.014	0.00

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ANNUAL TOTALS FOR YEAR 3

	INCHES	CU. FEET	PERCENT
PRECIPITATION	16.68	60548.402	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	13.877	50372.996	83.19
DRAINAGE COLLECTED FROM LAYER 4	0.0448	162.612	0.27
PERC./LEAKAGE THROUGH LAYER 6	0.000000	0.001	0.00
AVG. HEAD ON TOP OF LAYER 5	0.0001		
CHANGE IN WATER STORAGE	2.758	10012.784	16.54
SOIL WATER AT START OF YEAR	37.128	134774.281	
SOIL WATER AT END OF YEAR	39.886	144787.062	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.006	0.00

ANNUAL TOTALS FOR YEAR 4

	INCHES	CU. FEET	PERCENT
PRECIPITATION	8.15	29584.502	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	11.591	42075.406	142.22
DRAINAGE COLLECTED FROM LAYER 4	0.0215	78.218	0.26
PERC./LEAKAGE THROUGH LAYER 6	0.000000	0.001	0.00
AVG. HEAD ON TOP OF LAYER 5	0.0001		
CHANGE IN WATER STORAGE	-3.463	-12569.116	-42.49
SOIL WATER AT START OF YEAR	39.886	144787.062	
SOIL WATER AT END OF YEAR	36.424	132217.937	

SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.005	0.00

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ANNUAL TOTALS FOR YEAR 5

	INCHES	CU. FEET	PERCENT
PRECIPITATION	10.02	36372.605	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	9.629	34954.898	96.10
DRAINAGE COLLECTED FROM LAYER 4	0.0000	0.052	0.00
PERC./LEAKAGE THROUGH LAYER 6	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 5	0.0000		
CHANGE IN WATER STORAGE	0.391	1417.636	3.90
SOIL WATER AT START OF YEAR	36.424	132217.937	
SOIL WATER AT END OF YEAR	36.814	133635.578	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.017	0.00

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 5

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						

```
-------------
  TOTALS                 0.77     0.86     0.97     0.43     0.01     0.32
                         2.25     1.46     1.40     1.48     1.24     0.99

  STD. DEVIATIONS        0.61     0.94     0.92     0.33     0.03     0.65
                         2.65     1.21     1.62     2.62     1.12     0.40

RUNOFF
------
  TOTALS                 0.000    0.000    0.000    0.000    0.000    0.000
                         0.000    0.000    0.000    0.000    0.000    0.000

  STD. DEVIATIONS        0.000    0.000    0.000    0.000    0.000    0.000
                         0.000    0.000    0.000    0.000    0.000    0.000

EVAPOTRANSPIRATION
------------------
  TOTALS                 0.738    0.515    1.261    0.843    0.655    0.547
                         1.812    1.832    0.981    0.643    1.377    1.056

  STD. DEVIATIONS        0.369    0.431    1.106    0.086    0.898    0.698
                         2.295    1.183    0.696    0.753    0.810    0.270

LATERAL DRAINAGE COLLECTED FROM LAYER  4
----------------------------------------
  TOTALS                 0.0000   0.0000   0.0028   0.0015   0.0018   0.0000
                         0.0000   0.0017   0.0000   0.0000   0.0075   0.0000

  STD. DEVIATIONS        0.0000   0.0000   0.0064   0.0033   0.0026   0.0000
                         0.0000   0.0033   0.0000   0.0000   0.0167   0.0000

PERCOLATION/LEAKAGE THROUGH LAYER  6
-------------------------------------
  TOTALS                 0.0000   0.0000   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   0.0000


-------------------------------------------------------------------------------
               AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)
-------------------------------------------------------------------------------


DAILY AVERAGE HEAD ON TOP OF LAYER  5
-------------------------------------
  AVERAGES               0.0000   0.0000   0.0001   0.0000   0.0000   0.0000
                         0.0000   0.0000   0.0000   0.0000   0.0002   0.0000

  STD. DEVIATIONS        0.0000   0.0000   0.0002   0.0001   0.0001   0.0000
                         0.0000   0.0001   0.0000   0.0000   0.0005   0.0000

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 5

	INCHES		CU. FEET	PERCENT
PRECIPITATION	12.19	(5.160)	44249.7	100.00
RUNOFF	0.000	(0.0000)	0.00	0.000
EVAPOTRANSPIRATION	12.261	(4.4740)	44506.03	100.579
LATERAL DRAINAGE COLLECTED FROM LAYER 4	0.01519	(0.01848)	55.135	0.12460
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.00000	(0.00000)	0.001	0.00000
AVERAGE HEAD ON TOP OF LAYER 5	0.000	(0.000)		
CHANGE IN WATER STORAGE	-0.086	(2.2252)	-311.46	-0.704

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                PEAK DAILY VALUES FOR YEARS    1 THROUGH    5
   ---------------------------------------------------------------------------
                                                (INCHES)      (CU. FT.)
                                               ----------   -------------
      PRECIPITATION                              2.79         10127.700

      RUNOFF                                     0.000            0.0000

      DRAINAGE COLLECTED FROM LAYER  4           0.00639         23.20868

      PERCOLATION/LEAKAGE THROUGH LAYER  6       0.000000         0.00003

      AVERAGE HEAD ON TOP OF LAYER  5            0.006

      MAXIMUM HEAD ON TOP OF LAYER  5            0.011

      LOCATION OF MAXIMUM HEAD IN LAYER  4
            (DISTANCE FROM DRAIN)                0.0 FEET

      SNOW WATER                                 0.00             0.0000


      MAXIMUM VEG. SOIL WATER (VOL/VOL)                  0.2571

      MINIMUM VEG. SOIL WATER (VOL/VOL)                  0.0708


       ***  Maximum heads are computed using McEnroe's equations.  ***

            Reference:  Maximum Saturated Depth over Landfill Liner
                        by Bruce M. McEnroe, University of Kansas
                        ASCE Journal of Environmental Engineering
                        Vol. 119, No. 2, March 1993, pp. 262-270.

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FINAL WATER STORAGE AT END OF YEAR 5

LAYER	(INCHES)	(VOL/VOL)
1	0.3687	0.0615
2	30.4075	0.2534
3	5.8560	0.2440
4	0.0020	0.0100
5	0.0000	0.0000
6	0.1800	0.7500
SNOW WATER	0.000	

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******************************************************************************
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**                                                                          **
**                                                                          **
**              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:\HELP\MARPREC1.D4
TEMPERATURE DATA FILE:      C:\HELP\MARTEMP1.D7
SOLAR RADIATION DATA FILE:  C:\HELP\MARSOLA1.D13
EVAPOTRANSPIRATION DATA:    C:\HELP\MAREVAP1.D11
SOIL AND DESIGN DATA FILE:  C:\HELP\MARINTEM.D10
OUTPUT DATA FILE:           C:\HELP\MAINTER3.OUT


TIME:  13:30     DATE:   4/13/2011



******************************************************************************

     TITLE:  SCENARIO 2 - INTERIM W/GEOCOMPOSITE

******************************************************************************



     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER
              WERE SPECIFIED BY THE USER.


                                   LAYER  1
                                   --------

                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER   4
            THICKNESS                  =      6.00   INCHES
            POROSITY                   =      0.4370 VOL/VOL
            FIELD CAPACITY             =      0.1050 VOL/VOL
            WILTING POINT              =      0.0470 VOL/VOL
            INITIAL SOIL WATER CONTENT =      0.0650 VOL/VOL
            EFFECTIVE SAT. HYD. COND.  =  0.170000002000E-02 CM/SEC
          NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  1.80
                   FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.
```

```
                        LAYER  2
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  18
THICKNESS                   =   1560.00   INCHES
POROSITY                    =      0.6710 VOL/VOL
FIELD CAPACITY              =      0.2920 VOL/VOL
WILTING POINT               =      0.0770 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.2534 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC


                        LAYER  3
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  10
THICKNESS                   =     24.00   INCHES
POROSITY                    =      0.3980 VOL/VOL
FIELD CAPACITY              =      0.2440 VOL/VOL
WILTING POINT               =      0.1360 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.2440 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.119999997000E-03 CM/SEC


                        LAYER  4
                        --------

            TYPE 2 - LATERAL DRAINAGE LAYER
              MATERIAL TEXTURE NUMBER  20
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.   =   10.0000000000     CM/SEC
SLOPE                       =      3.00   PERCENT
DRAINAGE LENGTH             =   1500.0    FEET


                        LAYER  5
                        --------

            TYPE 4 - FLEXIBLE MEMBRANE LINER
              MATERIAL TEXTURE NUMBER  35
THICKNESS                   =      0.04   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.   =  0.199999996000E-12 CM/SEC
FML PINHOLE DENSITY         =      0.50   HOLES/ACRE
FML INSTALLATION DEFECTS    =      2.50   HOLES/ACRE
FML PLACEMENT QUALITY       =  3 - GOOD
```

LAYER 6

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 17

```
THICKNESS                   =      0.24   INCHES
POROSITY                    =      0.7500 VOL/VOL
FIELD CAPACITY              =      0.7470 VOL/VOL
WILTING POINT               =      0.4000 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.7500 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.300000003000E-08 CM/SEC
```

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE # 4 WITH BARE GROUND CONDITIONS, A SURFACE SLOPE OF 3.% AND A SLOPE LENGTH OF 100. FEET.

```
SCS RUNOFF CURVE NUMBER             =     82.40
FRACTION OF AREA ALLOWING RUNOFF    =      0.0    PERCENT
AREA PROJECTED ON HORIZONTAL PLANE  =      1.000  ACRES
EVAPORATIVE ZONE DEPTH              =     29.0    INCHES
INITIAL WATER IN EVAPORATIVE ZONE   =      6.218  INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE  =     18.055  INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE  =      2.053  INCHES
INITIAL SNOW WATER                  =      0.000  INCHES
INITIAL WATER IN LAYER MATERIALS    =    401.732  INCHES
TOTAL INITIAL WATER                 =    401.732  INCHES
TOTAL SUBSURFACE INFLOW             =      0.00   INCHES/YEAR
```

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM TUCSON ARIZONA

```
STATION LATITUDE                        =  32.12 DEGREES
```

```
MAXIMUM LEAF AREA INDEX                =   1.00
START OF GROWING SEASON (JULIAN DATE)  =     36
END OF GROWING SEASON (JULIAN DATE)    =    345
EVAPORATIVE ZONE DEPTH                 =  29.0  INCHES
AVERAGE ANNUAL WIND SPEED              =   8.20 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY  =  43.00 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY  =  24.00 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY  =  42.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY  =  42.00 %
```

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR PHOENIX ARIZONA

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
0.87	0.70	0.72	0.30	0.18	0.20
2.37	2.19	1.67	1.06	0.67	1.07

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR TUCSON ARIZONA

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
51.10	53.80	57.80	65.00	73.20	82.90
86.20	84.00	80.40	70.40	58.70	52.00

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR TUCSON ARIZONA
AND STATION LATITUDE = 32.12 DEGREES

****

ANNUAL TOTALS FOR YEAR 1

	INCHES	CU. FEET	PERCENT
PRECIPITATION	7.40	26862.002	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	10.043	36456.965	135.72
DRAINAGE COLLECTED FROM LAYER 4	0.0000	0.001	0.00

PERC./LEAKAGE THROUGH LAYER 6	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 5	0.0000		
CHANGE IN WATER STORAGE	-2.643	-9594.996	-35.72
SOIL WATER AT START OF YEAR	401.732	1458287.000	
SOIL WATER AT END OF YEAR	399.089	1448692.000	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.034	0.00

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ANNUAL TOTALS FOR YEAR 2

	INCHES	CU. FEET	PERCENT
PRECIPITATION	18.70	67881.008	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	18.900	68606.711	101.07
DRAINAGE COLLECTED FROM LAYER 4	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 6	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 5	0.0000		
CHANGE IN WATER STORAGE	-0.200	-725.712	-1.07
SOIL WATER AT START OF YEAR	399.089	1448692.000	
SOIL WATER AT END OF YEAR	398.889	1447966.370	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.007	0.00

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ANNUAL TOTALS FOR YEAR 3

	INCHES	CU. FEET	PERCENT
PRECIPITATION	16.68	60548.402	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	13.957	50665.098	83.68
DRAINAGE COLLECTED FROM LAYER 4	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 6	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 5	0.0000		
CHANGE IN WATER STORAGE	2.723	9883.353	16.32
SOIL WATER AT START OF YEAR	398.889	1447966.370	
SOIL WATER AT END OF YEAR	401.611	1457849.620	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.048	0.00

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ANNUAL TOTALS FOR YEAR 4

	INCHES	CU. FEET	PERCENT
PRECIPITATION	8.15	29584.502	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	11.169	40541.805	137.04
DRAINAGE COLLECTED FROM LAYER 4	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 6	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 5	0.0000		
CHANGE IN WATER STORAGE	-3.019	-10957.354	-37.04
SOIL WATER AT START OF YEAR	401.611	1457849.620	
SOIL WATER AT END OF YEAR	398.593	1446892.370	

SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.052	0.00

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ANNUAL TOTALS FOR YEAR 5

	INCHES	CU. FEET	PERCENT
PRECIPITATION	10.02	36372.605	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	9.660	35065.781	96.41
DRAINAGE COLLECTED FROM LAYER 4	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 6	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 5	0.0000		
CHANGE IN WATER STORAGE	0.360	1306.858	3.59
SOIL WATER AT START OF YEAR	398.593	1446892.370	
SOIL WATER AT END OF YEAR	398.953	1448199.120	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.035	0.00

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ANNUAL TOTALS FOR YEAR 6

	INCHES	CU. FEET	PERCENT
PRECIPITATION	16.19	58769.703	100.00
RUNOFF	0.000	0.000	0.00

EVAPOTRANSPIRATION	15.834	57477.879	97.80
DRAINAGE COLLECTED FROM LAYER 4	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 6	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 5	0.0000		
CHANGE IN WATER STORAGE	0.356	1291.792	2.20
SOIL WATER AT START OF YEAR	398.953	1448199.120	
SOIL WATER AT END OF YEAR	399.309	1449491.000	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.031	0.00

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ANNUAL TOTALS FOR YEAR 7

	INCHES	CU. FEET	PERCENT
PRECIPITATION	10.53	38223.898	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	10.936	39696.453	103.85
DRAINAGE COLLECTED FROM LAYER 4	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 6	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 5	0.0000		
CHANGE IN WATER STORAGE	-0.406	-1472.472	-3.85
SOIL WATER AT START OF YEAR	399.309	1449491.000	
SOIL WATER AT END OF YEAR	398.903	1448018.500	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.083	0.00

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ANNUAL TOTALS FOR YEAR 8

	INCHES	CU. FEET	PERCENT
PRECIPITATION	11.48	41672.402	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	10.629	38581.926	92.58
DRAINAGE COLLECTED FROM LAYER 4	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 6	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 5	0.0000		
CHANGE IN WATER STORAGE	0.851	3090.396	7.42
SOIL WATER AT START OF YEAR	398.903	1448018.500	
SOIL WATER AT END OF YEAR	399.755	1451108.870	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.080	0.00

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ANNUAL TOTALS FOR YEAR 9

	INCHES	CU. FEET	PERCENT
PRECIPITATION	13.13	47661.902	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	12.898	46819.555	98.23
DRAINAGE COLLECTED FROM LAYER 4	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 6	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 5	0.0000		
CHANGE IN WATER STORAGE	0.232	842.362	1.77

SOIL WATER AT START OF YEAR	399.755	1451108.870	
SOIL WATER AT END OF YEAR	399.987	1451951.250	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.017	0.00

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ANNUAL TOTALS FOR YEAR 10

	INCHES	CU. FEET	PERCENT
PRECIPITATION	17.59	63851.699	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	16.057	58287.379	91.29
DRAINAGE COLLECTED FROM LAYER 4	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 6	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 5	0.0000		
CHANGE IN WATER STORAGE	1.533	5564.309	8.71
SOIL WATER AT START OF YEAR	399.987	1451951.250	
SOIL WATER AT END OF YEAR	401.519	1457515.620	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.014	0.00

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ANNUAL TOTALS FOR YEAR 11

	INCHES	CU. FEET	PERCENT

PRECIPITATION	7.85	28495.500	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	10.421	37829.785	132.76
DRAINAGE COLLECTED FROM LAYER 4	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 6	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 5	0.0000		
CHANGE IN WATER STORAGE	-2.571	-9334.223	-32.76
SOIL WATER AT START OF YEAR	401.519	1457515.620	
SOIL WATER AT END OF YEAR	398.948	1448181.370	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.064	0.00

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ANNUAL TOTALS FOR YEAR 12

	INCHES	CU. FEET	PERCENT
PRECIPITATION	10.75	39022.496	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	11.068	40176.809	102.96
DRAINAGE COLLECTED FROM LAYER 4	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 6	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 5	0.0000		
CHANGE IN WATER STORAGE	-0.318	-1154.315	-2.96
SOIL WATER AT START OF YEAR	398.948	1448181.370	
SOIL WATER AT END OF YEAR	398.630	1447027.000	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00

ANNUAL WATER BUDGET BALANCE	0.0000	0.003	0.00

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ANNUAL TOTALS FOR YEAR 13

	INCHES	CU. FEET	PERCENT
PRECIPITATION	11.23	40764.895	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	9.972	36198.230	88.80
DRAINAGE COLLECTED FROM LAYER 4	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 6	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 5	0.0000		
CHANGE IN WATER STORAGE	1.258	4566.635	11.20
SOIL WATER AT START OF YEAR	398.630	1447027.000	
SOIL WATER AT END OF YEAR	399.888	1451593.620	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.028	0.00

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ANNUAL TOTALS FOR YEAR 14

	INCHES	CU. FEET	PERCENT
PRECIPITATION	12.52	45447.605	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	13.787	50048.543	110.12
DRAINAGE COLLECTED FROM LAYER 4	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 6	0.000000	0.000	0.00

AVG. HEAD ON TOP OF LAYER 5	0.0000		
CHANGE IN WATER STORAGE	-1.267	-4600.976	-10.12
SOIL WATER AT START OF YEAR	399.888	1451593.620	
SOIL WATER AT END OF YEAR	398.621	1446992.620	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.038	0.00

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ANNUAL TOTALS FOR YEAR 15

	INCHES	CU. FEET	PERCENT
PRECIPITATION	13.06	47407.797	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	12.412	45054.004	95.04
DRAINAGE COLLECTED FROM LAYER 4	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 6	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 5	0.0000		
CHANGE IN WATER STORAGE	0.648	2353.828	4.97
SOIL WATER AT START OF YEAR	398.621	1446992.620	
SOIL WATER AT END OF YEAR	399.269	1449346.500	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.035	0.00

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ANNUAL TOTALS FOR YEAR 16

	INCHES	CU. FEET	PERCENT
PRECIPITATION	7.30	26499.000	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	7.919	28746.066	108.48
DRAINAGE COLLECTED FROM LAYER 4	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 6	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 5	0.0000		
CHANGE IN WATER STORAGE	-0.619	-2247.037	-8.48
SOIL WATER AT START OF YEAR	399.269	1449346.500	
SOIL WATER AT END OF YEAR	398.650	1447099.500	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.028	0.00

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ANNUAL TOTALS FOR YEAR 17

	INCHES	CU. FEET	PERCENT
PRECIPITATION	13.12	47625.598	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	10.617	38540.520	80.92
DRAINAGE COLLECTED FROM LAYER 4	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 6	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 5	0.0000		
CHANGE IN WATER STORAGE	2.503	9085.081	19.08
SOIL WATER AT START OF YEAR	398.650	1447099.500	
SOIL WATER AT END OF YEAR	401.153	1456184.500	

SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.003	0.00

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ANNUAL TOTALS FOR YEAR 18

	INCHES	CU. FEET	PERCENT
PRECIPITATION	8.98	32597.398	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	11.480	41674.160	127.85
DRAINAGE COLLECTED FROM LAYER 4	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 6	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 5	0.0000		
CHANGE IN WATER STORAGE	-2.500	-9076.772	-27.85
SOIL WATER AT START OF YEAR	401.153	1456184.500	
SOIL WATER AT END OF YEAR	398.652	1447107.750	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.010	0.00

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ANNUAL TOTALS FOR YEAR 19

	INCHES	CU. FEET	PERCENT
PRECIPITATION	12.02	43632.605	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	11.587	42062.289	96.40

DRAINAGE COLLECTED FROM LAYER 4	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 6	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 5	0.0000		
CHANGE IN WATER STORAGE	0.433	1570.290	3.60
SOIL WATER AT START OF YEAR	398.652	1447107.750	
SOIL WATER AT END OF YEAR	399.085	1448678.120	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.028	0.00

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ANNUAL TOTALS FOR YEAR 20

	INCHES	CU. FEET	PERCENT
PRECIPITATION	5.84	21199.201	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	5.298	19231.437	90.72
DRAINAGE COLLECTED FROM LAYER 4	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 6	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 5	0.0000		
CHANGE IN WATER STORAGE	0.542	1967.764	9.28
SOIL WATER AT START OF YEAR	399.085	1448678.120	
SOIL WATER AT END OF YEAR	399.627	1450645.870	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.002	0.00

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                         ANNUAL TOTALS FOR YEAR   21
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                                          INCHES          CU. FEET     PERCENT
                                         --------        ----------    -------
  PRECIPITATION                            13.57          49259.105    100.00

  RUNOFF                                    0.000             0.000      0.00

  EVAPOTRANSPIRATION                       14.478         52553.809    106.69

  DRAINAGE COLLECTED FROM LAYER  4          0.0000            0.000      0.00

  PERC./LEAKAGE THROUGH LAYER  6            0.000000          0.000      0.00

  AVG. HEAD ON TOP OF LAYER  5              0.0000

  CHANGE IN WATER STORAGE                  -0.908         -3294.673     -6.69

  SOIL WATER AT START OF YEAR             399.627       1450645.870

  SOIL WATER AT END OF YEAR               398.719       1447351.120

  SNOW WATER AT START OF YEAR               0.000             0.000      0.00

  SNOW WATER AT END OF YEAR                 0.000             0.000      0.00

  ANNUAL WATER BUDGET BALANCE               0.0000           -0.031      0.00
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                         ANNUAL TOTALS FOR YEAR   22
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                                          INCHES          CU. FEET     PERCENT
                                         --------        ----------    -------
  PRECIPITATION                            11.55          41926.508    100.00

  RUNOFF                                    0.000             0.000      0.00

  EVAPOTRANSPIRATION                       10.274         37296.172     88.96

  DRAINAGE COLLECTED FROM LAYER  4          0.0000            0.000      0.00

  PERC./LEAKAGE THROUGH LAYER  6            0.000000          0.000      0.00

  AVG. HEAD ON TOP OF LAYER  5              0.0000

  CHANGE IN WATER STORAGE                   1.276          4630.333     11.04
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  SOIL WATER AT START OF YEAR            398.719       1447351.120
  SOIL WATER AT END OF YEAR              399.995       1451981.500
  SNOW WATER AT START OF YEAR              0.000             0.000      0.00
  SNOW WATER AT END OF YEAR                0.000             0.000      0.00
  ANNUAL WATER BUDGET BALANCE              0.0000            0.003      0.00
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                         ANNUAL TOTALS FOR YEAR   23
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                                        INCHES          CU. FEET     PERCENT
                                       --------        ----------    -------
  PRECIPITATION                          9.12          33105.598    100.00
  RUNOFF                                 0.000             0.000      0.00
  EVAPOTRANSPIRATION                     9.242         33548.914    101.34
  DRAINAGE COLLECTED FROM LAYER  4       0.0000            0.000      0.00
  PERC./LEAKAGE THROUGH LAYER  6         0.000000          0.000      0.00
  AVG. HEAD ON TOP OF LAYER  5           0.0000
  CHANGE IN WATER STORAGE               -0.122          -443.337     -1.34
  SOIL WATER AT START OF YEAR            399.995       1451981.500
  SOIL WATER AT END OF YEAR              399.873       1451538.120
  SNOW WATER AT START OF YEAR              0.000             0.000      0.00
  SNOW WATER AT END OF YEAR                0.000             0.000      0.00
  ANNUAL WATER BUDGET BALANCE              0.0000            0.017      0.00
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                         ANNUAL TOTALS FOR YEAR   24
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                                        INCHES          CU. FEET     PERCENT
                                       --------        ----------    -------
  PRECIPITATION                         13.21          47952.297    100.00
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RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	12.814	46514.125	97.00
DRAINAGE COLLECTED FROM LAYER 4	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 6	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 5	0.0000		
CHANGE IN WATER STORAGE	0.396	1438.241	3.00
SOIL WATER AT START OF YEAR	399.873	1451538.120	
SOIL WATER AT END OF YEAR	400.269	1452976.370	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.069	0.00

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ANNUAL TOTALS FOR YEAR 25

	INCHES	CU. FEET	PERCENT
PRECIPITATION	6.12	22215.605	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	7.740	28095.531	126.47
DRAINAGE COLLECTED FROM LAYER 4	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 6	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 5	0.0000		
CHANGE IN WATER STORAGE	-1.620	-5880.028	-26.47
SOIL WATER AT START OF YEAR	400.269	1452976.370	
SOIL WATER AT END OF YEAR	398.649	1447096.370	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.102	0.00

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ANNUAL TOTALS FOR YEAR 26

	INCHES	CU. FEET	PERCENT
PRECIPITATION	7.46	27079.805	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	4.953	17979.434	66.39
DRAINAGE COLLECTED FROM LAYER 4	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 6	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 5	0.0000		
CHANGE IN WATER STORAGE	2.507	9100.368	33.61
SOIL WATER AT START OF YEAR	398.649	1447096.370	
SOIL WATER AT END OF YEAR	401.156	1456196.750	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.003	0.00

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ANNUAL TOTALS FOR YEAR 27

	INCHES	CU. FEET	PERCENT
PRECIPITATION	15.08	54740.395	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	13.230	48025.809	87.73
DRAINAGE COLLECTED FROM LAYER 4	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 6	0.000000	0.000	0.00

AVG. HEAD ON TOP OF LAYER 5	0.0000		
CHANGE IN WATER STORAGE	1.850	6714.636	12.27
SOIL WATER AT START OF YEAR	401.156	1456196.750	
SOIL WATER AT END OF YEAR	403.006	1462911.370	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.048	0.00

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ANNUAL TOTALS FOR YEAR 28

	INCHES	CU. FEET	PERCENT
PRECIPITATION	14.37	52163.098	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	16.307	59194.039	113.48
DRAINAGE COLLECTED FROM LAYER 4	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 6	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 5	0.0000		
CHANGE IN WATER STORAGE	-1.937	-7031.020	-13.48
SOIL WATER AT START OF YEAR	403.006	1462911.370	
SOIL WATER AT END OF YEAR	401.069	1455880.370	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.080	0.00

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ANNUAL TOTALS FOR YEAR 29

	INCHES	CU. FEET	PERCENT
PRECIPITATION	14.80	53724.004	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	14.772	53621.508	99.81
DRAINAGE COLLECTED FROM LAYER 4	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 6	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 5	0.0000		
CHANGE IN WATER STORAGE	0.028	102.470	0.19
SOIL WATER AT START OF YEAR	401.069	1455880.370	
SOIL WATER AT END OF YEAR	401.097	1455982.870	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.028	0.00

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ANNUAL TOTALS FOR YEAR 30

	INCHES	CU. FEET	PERCENT
PRECIPITATION	14.11	51219.297	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	14.072	51082.715	99.73
DRAINAGE COLLECTED FROM LAYER 4	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 6	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 5	0.0000		
CHANGE IN WATER STORAGE	0.038	136.590	0.27
SOIL WATER AT START OF YEAR	401.097	1455982.870	
SOIL WATER AT END OF YEAR	401.135	1456119.370	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00

SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.010	0.00

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 30

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	0.88	0.63	0.62	0.24	0.21	0.17
	2.42	1.90	1.46	1.21	0.95	1.06
STD. DEVIATIONS	0.65	0.63	0.57	0.27	0.32	0.36
	1.81	1.33	1.50	1.40	0.94	1.02
RUNOFF						
TOTALS	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATIONS	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION						
TOTALS	0.934	0.749	0.766	0.567	0.551	0.256
	1.681	2.347	1.298	1.022	0.776	0.803
STD. DEVIATIONS	0.484	0.488	0.598	0.328	0.737	0.397
	1.367	1.340	1.024	0.768	0.612	0.493
LATERAL DRAINAGE COLLECTED FROM LAYER 4						
TOTALS	0.0000	0.0000	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	0.0000
PERCOLATION/LEAKAGE THROUGH LAYER 6						
TOTALS	0.0000	0.0000	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	0.0000

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 5

AVERAGES	0.0000	0.0000	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	0.0000

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 30

	INCHES		CU. FEET	PERCENT
PRECIPITATION	11.73	(3.440)	42583.5	100.00
RUNOFF	0.000	(0.0000)	0.00	0.000
EVAPOTRANSPIRATION	11.751	(3.1434)	42655.78	100.170
LATERAL DRAINAGE COLLECTED FROM LAYER 4	0.00000	(0.00000)	0.000	0.00000
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.00000	(0.00000)	0.000	0.00000
AVERAGE HEAD ON TOP OF LAYER 5	0.000	(0.000)		
CHANGE IN WATER STORAGE	-0.020	(1.5481)	-72.25	-0.170

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                PEAK DAILY VALUES FOR YEARS    1 THROUGH   30
   ---------------------------------------------------------------------------
                                                (INCHES)      (CU. FT.)
                                               ----------   -------------
      PRECIPITATION                              3.30         11979.000

      RUNOFF                                     0.000            0.0000

      DRAINAGE COLLECTED FROM LAYER  4           0.00000          0.00061

      PERCOLATION/LEAKAGE THROUGH LAYER  6       0.000000         0.00002

      AVERAGE HEAD ON TOP OF LAYER  5            0.000

      MAXIMUM HEAD ON TOP OF LAYER  5            0.072

      LOCATION OF MAXIMUM HEAD IN LAYER  4
            (DISTANCE FROM DRAIN)                0.0 FEET

      SNOW WATER                                 0.03           110.0433


      MAXIMUM VEG. SOIL WATER (VOL/VOL)                  0.2860

      MINIMUM VEG. SOIL WATER (VOL/VOL)                  0.0708


       ***  Maximum heads are computed using McEnroe's equations.  ***

            Reference:  Maximum Saturated Depth over Landfill Liner
                        by Bruce M. McEnroe, University of Kansas
                        ASCE Journal of Environmental Engineering
                        Vol. 119, No. 2, March 1993, pp. 262-270.

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FINAL WATER STORAGE AT END OF YEAR 30

LAYER	(INCHES)	(VOL/VOL)
1	0.3769	0.0628
2	394.7199	0.2530
3	5.8560	0.2440
4	0.0020	0.0100
5	0.0000	0.0000
6	0.1800	0.7500
SNOW WATER	0.000	

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****

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******************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
**              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:\HELP\MARPREC1.D4
TEMPERATURE DATA FILE:      C:\HELP\MARTEMP1.D7
SOLAR RADIATION DATA FILE:  C:\HELP\MARSOLA1.D13
EVAPOTRANSPIRATION DATA:    C:\HELP\MAREVAP1.D11
SOIL AND DESIGN DATA FILE:  C:\HELP\SCENAR33.D10
OUTPUT DATA FILE:           C:\HELP\MASCEN33.OUT



TIME:  17:16     DATE:   4/19/2011



******************************************************************************

     TITLE:  SCENARIO 3 - FINAL WITH INTERIM 30 YR MOISTURE W/ GEOCOMP.

******************************************************************************



     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER
              WERE SPECIFIED BY THE USER.



                                   LAYER  1
                                   --------

                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER  23
           THICKNESS                  =     29.00   INCHES
           POROSITY                   =      0.4610 VOL/VOL
           FIELD CAPACITY             =      0.3600 VOL/VOL
           WILTING POINT              =      0.2030 VOL/VOL
           INITIAL SOIL WATER CONTENT =      0.2815 VOL/VOL
           EFFECTIVE SAT. HYD. COND.  =  0.900000032000E-05 CM/SEC
         NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  1.80
                  FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.
```

```
                        LAYER  2
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  23
THICKNESS                   =      7.00   INCHES
POROSITY                    =      0.4610 VOL/VOL
FIELD CAPACITY              =      0.3600 VOL/VOL
WILTING POINT               =      0.2030 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.2815 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.900000032000E-05 CM/SEC


                        LAYER  3
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  18
THICKNESS                   =   2772.00   INCHES
POROSITY                    =      0.6710 VOL/VOL
FIELD CAPACITY              =      0.2920 VOL/VOL
WILTING POINT               =      0.0770 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.2526 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC


                        LAYER  4
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  10
THICKNESS                   =     24.00   INCHES
POROSITY                    =      0.3980 VOL/VOL
FIELD CAPACITY              =      0.2440 VOL/VOL
WILTING POINT               =      0.1360 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.2440 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.119999997000E-03 CM/SEC


                        LAYER  5
                        --------

            TYPE 2 - LATERAL DRAINAGE LAYER
              MATERIAL TEXTURE NUMBER  20
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.   =   10.0000000000     CM/SEC
SLOPE                       =      3.00   PERCENT
DRAINAGE LENGTH             =   1500.0    FEET
```

LAYER 6

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 35

```
THICKNESS                   =      0.04   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.   =  0.199999996000E-12 CM/SEC
FML PINHOLE DENSITY         =      0.50   HOLES/ACRE
FML INSTALLATION DEFECTS    =      2.50   HOLES/ACRE
FML PLACEMENT QUALITY       =  3 - GOOD
```

LAYER 7

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 17

```
THICKNESS                   =      0.24   INCHES
POROSITY                    =      0.7500 VOL/VOL
FIELD CAPACITY              =      0.7470 VOL/VOL
WILTING POINT               =      0.4000 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.7500 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.300000003000E-08 CM/SEC
```

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE #23 WITH A GOOD STAND OF GRASS, A SURFACE SLOPE OF 5.% AND A SLOPE LENGTH OF 100. FEET.

```
SCS RUNOFF CURVE NUMBER             =     87.80
FRACTION OF AREA ALLOWING RUNOFF    =    100.0    PERCENT
AREA PROJECTED ON HORIZONTAL PLANE  =      1.000  ACRES
EVAPORATIVE ZONE DEPTH              =     29.0    INCHES
INITIAL WATER IN EVAPORATIVE ZONE   =      8.163  INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE  =     13.369  INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE  =      5.887  INCHES
```

```
INITIAL SNOW WATER                  =      0.000  INCHES
INITIAL WATER IN LAYER MATERIALS    =    716.379  INCHES
TOTAL INITIAL WATER                 =    716.379  INCHES
TOTAL SUBSURFACE INFLOW             =      0.00   INCHES/YEAR
```

EVAPOTRANSPIRATION AND WEATHER DATA

```
NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
         TUCSON                ARIZONA

     STATION LATITUDE                      =  32.12 DEGREES
     MAXIMUM LEAF AREA INDEX               =   1.00
     START OF GROWING SEASON (JULIAN DATE) =     36
     END OF GROWING SEASON (JULIAN DATE)   =    345
     EVAPORATIVE ZONE DEPTH                =  29.0  INCHES
     AVERAGE ANNUAL WIND SPEED             =   8.20 MPH
     AVERAGE 1ST QUARTER RELATIVE HUMIDITY =  43.00 %
     AVERAGE 2ND QUARTER RELATIVE HUMIDITY =  24.00 %
     AVERAGE 3RD QUARTER RELATIVE HUMIDITY =  42.00 %
     AVERAGE 4TH QUARTER RELATIVE HUMIDITY =  42.00 %
```

```
NOTE:  PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
         COEFFICIENTS FOR    PHOENIX             ARIZONA
```

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
0.87	0.70	0.72	0.30	0.18	0.20
2.37	2.19	1.67	1.06	0.67	1.07

```
NOTE:  TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
         COEFFICIENTS FOR    TUCSON              ARIZONA
```

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
51.10	53.80	57.80	65.00	73.20	82.90
86.20	84.00	80.40	70.40	58.70	52.00

```
NOTE:  SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
         COEFFICIENTS FOR    TUCSON              ARIZONA
           AND STATION LATITUDE  =  32.12 DEGREES
```

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                         ANNUAL TOTALS FOR YEAR    1
-------------------------------------------------------------------------------
                                         INCHES          CU. FEET     PERCENT
                                        --------        ----------    -------
  PRECIPITATION                           7.40          26862.002    100.00

  RUNOFF                                  0.296          1075.337      4.00

  EVAPOTRANSPIRATION                      8.578         31137.240    115.92

  DRAINAGE COLLECTED FROM LAYER  5        0.0000            0.001      0.00

  PERC./LEAKAGE THROUGH LAYER  7          0.000000          0.000      0.00

  AVG. HEAD ON TOP OF LAYER  6            0.0000

  CHANGE IN WATER STORAGE                -1.474         -5350.616    -19.92

  SOIL WATER AT START OF YEAR           716.379       2600456.250

  SOIL WATER AT END OF YEAR             714.905       2595105.750

  SNOW WATER AT START OF YEAR             0.000            0.000      0.00

  SNOW WATER AT END OF YEAR               0.000            0.000      0.00

  ANNUAL WATER BUDGET BALANCE             0.0000           0.040      0.00
*******************************************************************************


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                         ANNUAL TOTALS FOR YEAR    2
-------------------------------------------------------------------------------
                                         INCHES          CU. FEET     PERCENT
                                        --------        ----------    -------
  PRECIPITATION                          18.70          67881.008    100.00

  RUNOFF                                  4.903         17797.486     26.22

  EVAPOTRANSPIRATION                     13.877         50374.008     74.21

  DRAINAGE COLLECTED FROM LAYER  5        0.0000            0.000      0.00

  PERC./LEAKAGE THROUGH LAYER  7          0.000000          0.000      0.00

  AVG. HEAD ON TOP OF LAYER  6            0.0000

  CHANGE IN WATER STORAGE                -0.080          -290.462     -0.43

  SOIL WATER AT START OF YEAR           714.905       2595105.750
```

SOIL WATER AT END OF YEAR	714.825	2594815.250	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.023	0.00

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ANNUAL TOTALS FOR YEAR 3

	INCHES	CU. FEET	PERCENT
PRECIPITATION	16.68	60548.402	100.00
RUNOFF	4.876	17699.041	29.23
EVAPOTRANSPIRATION	11.678	42392.578	70.01
DRAINAGE COLLECTED FROM LAYER 5	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 7	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 6	0.0000		
CHANGE IN WATER STORAGE	0.126	456.630	0.75
SOIL WATER AT START OF YEAR	714.825	2594815.250	
SOIL WATER AT END OF YEAR	714.951	2595271.750	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.151	0.00

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ANNUAL TOTALS FOR YEAR 4

	INCHES	CU. FEET	PERCENT
PRECIPITATION	8.15	29584.502	100.00

RUNOFF	0.209	759.381	2.57
EVAPOTRANSPIRATION	7.609	27622.445	93.37
DRAINAGE COLLECTED FROM LAYER 5	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 7	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 6	0.0000		
CHANGE IN WATER STORAGE	0.331	1202.836	4.07
SOIL WATER AT START OF YEAR	714.951	2595271.750	
SOIL WATER AT END OF YEAR	715.282	2596474.750	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.160	0.00

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ANNUAL TOTALS FOR YEAR 5

	INCHES	CU. FEET	PERCENT
PRECIPITATION	10.02	36372.605	100.00
RUNOFF	0.884	3210.723	8.83
EVAPOTRANSPIRATION	8.420	30563.746	84.03
DRAINAGE COLLECTED FROM LAYER 5	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 7	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 6	0.0000		
CHANGE IN WATER STORAGE	0.716	2597.985	7.14
SOIL WATER AT START OF YEAR	715.282	2596474.750	
SOIL WATER AT END OF YEAR	715.998	2599072.750	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.152	0.00

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ANNUAL TOTALS FOR YEAR 6

	INCHES	CU. FEET	PERCENT
PRECIPITATION	16.19	58769.703	100.00
RUNOFF	3.441	12490.383	21.25
EVAPOTRANSPIRATION	12.912	46869.543	79.75
DRAINAGE COLLECTED FROM LAYER 5	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 7	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 6	0.0000		
CHANGE IN WATER STORAGE	-0.163	-590.229	-1.00
SOIL WATER AT START OF YEAR	715.998	2599072.750	
SOIL WATER AT END OF YEAR	715.835	2598482.500	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.004	0.00

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ANNUAL TOTALS FOR YEAR 7

	INCHES	CU. FEET	PERCENT
PRECIPITATION	10.53	38223.898	100.00
RUNOFF	2.117	7683.177	20.10
EVAPOTRANSPIRATION	8.452	30679.814	80.26
DRAINAGE COLLECTED FROM LAYER 5	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 7	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 6	0.0000		

CHANGE IN WATER STORAGE	-0.038	-139.138	-0.36
SOIL WATER AT START OF YEAR	715.835	2598482.500	
SOIL WATER AT END OF YEAR	715.797	2598343.250	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.047	0.00

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ANNUAL TOTALS FOR YEAR 8

	INCHES	CU. FEET	PERCENT
PRECIPITATION	11.48	41672.402	100.00
RUNOFF	3.396	12327.005	29.58
EVAPOTRANSPIRATION	8.213	29814.393	71.54
DRAINAGE COLLECTED FROM LAYER 5	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 7	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 6	0.0000		
CHANGE IN WATER STORAGE	-0.129	-468.816	-1.13
SOIL WATER AT START OF YEAR	715.797	2598343.250	
SOIL WATER AT END OF YEAR	715.668	2597874.500	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.179	0.00

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ANNUAL TOTALS FOR YEAR 9

	INCHES	CU. FEET	PERCENT
PRECIPITATION	13.13	47661.902	100.00
RUNOFF	2.530	9182.818	19.27
EVAPOTRANSPIRATION	10.172	36925.559	77.47
DRAINAGE COLLECTED FROM LAYER 5	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 7	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 6	0.0000		
CHANGE IN WATER STORAGE	0.428	1553.340	3.26
SOIL WATER AT START OF YEAR	715.668	2597874.500	
SOIL WATER AT END OF YEAR	716.096	2599427.750	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0001	0.184	0.00

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ANNUAL TOTALS FOR YEAR 10

	INCHES	CU. FEET	PERCENT
PRECIPITATION	17.59	63851.699	100.00
RUNOFF	5.654	20525.701	32.15
EVAPOTRANSPIRATION	11.803	42845.289	67.10
DRAINAGE COLLECTED FROM LAYER 5	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 7	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 6	0.0000		
CHANGE IN WATER STORAGE	0.132	480.780	0.75
SOIL WATER AT START OF YEAR	716.096	2599427.750	
SOIL WATER AT END OF YEAR	716.228	2599908.750	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00

SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.071	0.00

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ANNUAL TOTALS FOR YEAR 11

	INCHES	CU. FEET	PERCENT
PRECIPITATION	7.85	28495.500	100.00
RUNOFF	2.161	7846.221	27.53
EVAPOTRANSPIRATION	7.500	27226.197	95.55
DRAINAGE COLLECTED FROM LAYER 5	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 7	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 6	0.0000		
CHANGE IN WATER STORAGE	-1.812	-6576.938	-23.08
SOIL WATER AT START OF YEAR	716.228	2599908.750	
SOIL WATER AT END OF YEAR	714.416	2593331.750	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.019	0.00

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ANNUAL TOTALS FOR YEAR 12

	INCHES	CU. FEET	PERCENT
PRECIPITATION	10.75	39022.496	100.00
RUNOFF	2.407	8736.995	22.39
EVAPOTRANSPIRATION	8.524	30942.672	79.29
DRAINAGE COLLECTED FROM LAYER 5	0.0000	0.000	0.00

PERC./LEAKAGE THROUGH LAYER 7	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 6	0.0000		
CHANGE IN WATER STORAGE	-0.181	-657.140	-1.68
SOIL WATER AT START OF YEAR	714.416	2593331.750	
SOIL WATER AT END OF YEAR	714.235	2592674.500	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.029	0.00

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ANNUAL TOTALS FOR YEAR 13

	INCHES	CU. FEET	PERCENT
PRECIPITATION	11.23	40764.895	100.00
RUNOFF	1.952	7086.231	17.38
EVAPOTRANSPIRATION	8.380	30418.889	74.62
DRAINAGE COLLECTED FROM LAYER 5	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 7	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 6	0.0000		
CHANGE IN WATER STORAGE	0.898	3259.777	8.00
SOIL WATER AT START OF YEAR	714.235	2592674.500	
SOIL WATER AT END OF YEAR	715.133	2595934.250	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.002	0.00

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ANNUAL TOTALS FOR YEAR 14

	INCHES	CU. FEET	PERCENT
PRECIPITATION	12.52	45447.605	100.00
RUNOFF	4.096	14868.220	32.72
EVAPOTRANSPIRATION	9.448	34294.637	75.46
DRAINAGE COLLECTED FROM LAYER 5	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 7	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 6	0.0000		
CHANGE IN WATER STORAGE	-1.023	-3715.300	-8.17
SOIL WATER AT START OF YEAR	715.133	2595934.250	
SOIL WATER AT END OF YEAR	714.110	2592219.000	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.048	0.00

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ANNUAL TOTALS FOR YEAR 15

	INCHES	CU. FEET	PERCENT
PRECIPITATION	13.06	47407.797	100.00
RUNOFF	3.036	11019.489	23.24
EVAPOTRANSPIRATION	9.612	34889.992	73.60
DRAINAGE COLLECTED FROM LAYER 5	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 7	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 6	0.0000		
CHANGE IN WATER STORAGE	0.413	1498.394	3.16
SOIL WATER AT START OF YEAR	714.110	2592219.000	

SOIL WATER AT END OF YEAR	714.523	2593717.500	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.079	0.00

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ANNUAL TOTALS FOR YEAR 16

	INCHES	CU. FEET	PERCENT
PRECIPITATION	7.30	26499.000	100.00
RUNOFF	0.713	2587.884	9.77
EVAPOTRANSPIRATION	6.394	23210.398	87.59
DRAINAGE COLLECTED FROM LAYER 5	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 7	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 6	0.0000		
CHANGE IN WATER STORAGE	0.193	700.787	2.64
SOIL WATER AT START OF YEAR	714.523	2593717.500	
SOIL WATER AT END OF YEAR	714.716	2594418.250	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.068	0.00

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ANNUAL TOTALS FOR YEAR 17

	INCHES	CU. FEET	PERCENT
PRECIPITATION	13.12	47625.598	100.00
RUNOFF	2.935	10653.256	22.37

EVAPOTRANSPIRATION	10.047	36470.141	76.58
DRAINAGE COLLECTED FROM LAYER 5	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 7	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 6	0.0000		
CHANGE IN WATER STORAGE	0.138	502.271	1.05
SOIL WATER AT START OF YEAR	714.716	2594418.250	
SOIL WATER AT END OF YEAR	714.854	2594920.500	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.074	0.00

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ANNUAL TOTALS FOR YEAR 18

	INCHES	CU. FEET	PERCENT
PRECIPITATION	8.98	32597.398	100.00
RUNOFF	2.389	8670.979	26.60
EVAPOTRANSPIRATION	6.414	23281.887	71.42
DRAINAGE COLLECTED FROM LAYER 5	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 7	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 6	0.0000		
CHANGE IN WATER STORAGE	0.178	644.511	1.98
SOIL WATER AT START OF YEAR	714.854	2594920.500	
SOIL WATER AT END OF YEAR	715.032	2595565.000	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.022	0.00

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ANNUAL TOTALS FOR YEAR 19

	INCHES	CU. FEET	PERCENT
PRECIPITATION	12.02	43632.605	100.00
RUNOFF	3.205	11635.554	26.67
EVAPOTRANSPIRATION	8.668	31464.432	72.11
DRAINAGE COLLECTED FROM LAYER 5	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 7	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 6	0.0000		
CHANGE IN WATER STORAGE	0.147	532.625	1.22
SOIL WATER AT START OF YEAR	715.032	2595565.000	
SOIL WATER AT END OF YEAR	715.178	2596097.500	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.005	0.00

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ANNUAL TOTALS FOR YEAR 20

	INCHES	CU. FEET	PERCENT
PRECIPITATION	5.84	21199.201	100.00
RUNOFF	1.105	4012.600	18.93
EVAPOTRANSPIRATION	4.396	15958.032	75.28
DRAINAGE COLLECTED FROM LAYER 5	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 7	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 6	0.0000		

CHANGE IN WATER STORAGE	0.338	1228.537	5.80
SOIL WATER AT START OF YEAR	715.178	2596097.500	
SOIL WATER AT END OF YEAR	715.517	2597326.250	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.032	0.00

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ANNUAL TOTALS FOR YEAR 21

	INCHES	CU. FEET	PERCENT
PRECIPITATION	13.57	49259.105	100.00
RUNOFF	4.638	16834.187	34.17
EVAPOTRANSPIRATION	9.286	33709.449	68.43
DRAINAGE COLLECTED FROM LAYER 5	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 7	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 6	0.0000		
CHANGE IN WATER STORAGE	-0.354	-1284.591	-2.61
SOIL WATER AT START OF YEAR	715.517	2597326.250	
SOIL WATER AT END OF YEAR	715.163	2596041.500	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.061	0.00

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ANNUAL TOTALS FOR YEAR 22

	INCHES	CU. FEET	PERCENT

PRECIPITATION	11.55	41926.508	100.00
RUNOFF	1.425	5174.455	12.34
EVAPOTRANSPIRATION	9.465	34359.680	81.95
DRAINAGE COLLECTED FROM LAYER 5	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 7	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 6	0.0000		
CHANGE IN WATER STORAGE	0.659	2392.379	5.71
SOIL WATER AT START OF YEAR	715.163	2596041.500	
SOIL WATER AT END OF YEAR	715.822	2598434.000	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.005	0.00

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ANNUAL TOTALS FOR YEAR 23

	INCHES	CU. FEET	PERCENT
PRECIPITATION	9.12	33105.598	100.00
RUNOFF	1.038	3768.380	11.38
EVAPOTRANSPIRATION	7.434	26986.213	81.52
DRAINAGE COLLECTED FROM LAYER 5	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 7	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 6	0.0000		
CHANGE IN WATER STORAGE	0.648	2350.948	7.10
SOIL WATER AT START OF YEAR	715.822	2598434.000	
SOIL WATER AT END OF YEAR	716.470	2600785.000	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00

ANNUAL WATER BUDGET BALANCE	0.0000	0.055	0.00

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ANNUAL TOTALS FOR YEAR 24

	INCHES	CU. FEET	PERCENT
PRECIPITATION	13.21	47952.297	100.00
RUNOFF	4.693	17034.117	35.52
EVAPOTRANSPIRATION	10.149	36840.488	76.83
DRAINAGE COLLECTED FROM LAYER 5	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 7	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 6	0.0000		
CHANGE IN WATER STORAGE	-1.631	-5922.235	-12.35
SOIL WATER AT START OF YEAR	716.470	2600785.000	
SOIL WATER AT END OF YEAR	714.838	2594862.750	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.074	0.00

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ANNUAL TOTALS FOR YEAR 25

	INCHES	CU. FEET	PERCENT
PRECIPITATION	6.12	22215.605	100.00
RUNOFF	0.412	1496.430	6.74
EVAPOTRANSPIRATION	6.407	23257.555	104.69
DRAINAGE COLLECTED FROM LAYER 5	0.0000	0.000	0.00

PERC./LEAKAGE THROUGH LAYER 7	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 6	0.0000		
CHANGE IN WATER STORAGE	-0.699	-2538.386	-11.43
SOIL WATER AT START OF YEAR	714.838	2594862.750	
SOIL WATER AT END OF YEAR	714.139	2592324.250	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.005	0.00

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ANNUAL TOTALS FOR YEAR 26

	INCHES	CU. FEET	PERCENT
PRECIPITATION	7.46	27079.805	100.00
RUNOFF	1.473	5347.421	19.75
EVAPOTRANSPIRATION	3.961	14377.279	53.09
DRAINAGE COLLECTED FROM LAYER 5	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 7	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 6	0.0000		
CHANGE IN WATER STORAGE	2.026	7355.048	27.16
SOIL WATER AT START OF YEAR	714.139	2592324.250	
SOIL WATER AT END OF YEAR	716.165	2599679.250	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.058	0.00

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ANNUAL TOTALS FOR YEAR 27

	INCHES	CU. FEET	PERCENT
PRECIPITATION	15.08	54740.395	100.00
RUNOFF	2.771	10057.655	18.37
EVAPOTRANSPIRATION	11.192	40627.430	74.22
DRAINAGE COLLECTED FROM LAYER 5	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 7	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 6	0.0000		
CHANGE IN WATER STORAGE	1.117	4055.391	7.41
SOIL WATER AT START OF YEAR	716.165	2599679.250	
SOIL WATER AT END OF YEAR	717.282	2603734.750	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.079	0.00

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ANNUAL TOTALS FOR YEAR 28

	INCHES	CU. FEET	PERCENT
PRECIPITATION	14.37	52163.098	100.00
RUNOFF	4.210	15281.486	29.30
EVAPOTRANSPIRATION	12.472	45272.262	86.79
DRAINAGE COLLECTED FROM LAYER 5	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 7	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 6	0.0000		
CHANGE IN WATER STORAGE	-2.311	-8390.608	-16.09
SOIL WATER AT START OF YEAR	717.282	2603734.750	
SOIL WATER AT END OF YEAR	714.971	2595344.000	

SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.042	0.00

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ANNUAL TOTALS FOR YEAR 29

	INCHES	CU. FEET	PERCENT
PRECIPITATION	14.80	53724.004	100.00
RUNOFF	3.481	12635.805	23.52
EVAPOTRANSPIRATION	11.059	40144.723	74.72
DRAINAGE COLLECTED FROM LAYER 5	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 7	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 6	0.0000		
CHANGE IN WATER STORAGE	0.260	943.392	1.76
SOIL WATER AT START OF YEAR	714.971	2595344.000	
SOIL WATER AT END OF YEAR	715.231	2596287.500	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.083	0.00

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ANNUAL TOTALS FOR YEAR 30

	INCHES	CU. FEET	PERCENT
PRECIPITATION	14.11	51219.297	100.00
RUNOFF	3.340	12123.565	23.67

EVAPOTRANSPIRATION	11.422	41462.879	80.95
DRAINAGE COLLECTED FROM LAYER 5	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 7	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 6	0.0000		
CHANGE IN WATER STORAGE	-0.652	-2367.122	-4.62
SOIL WATER AT START OF YEAR	715.231	2596287.500	
SOIL WATER AT END OF YEAR	714.579	2593920.250	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.026	0.00

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 30

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	0.88	0.63	0.62	0.24	0.21	0.17
	2.42	1.90	1.46	1.21	0.95	1.06
STD. DEVIATIONS	0.65	0.63	0.57	0.27	0.32	0.36
	1.81	1.33	1.50	1.40	0.94	1.02
RUNOFF						
TOTALS	0.034	0.028	0.008	0.000	0.003	0.021
	0.777	0.455	0.581	0.454	0.138	0.161
STD. DEVIATIONS	0.090	0.084	0.029	0.000	0.015	0.081
	0.802	0.575	0.853	0.796	0.244	0.295
EVAPOTRANSPIRATION						
TOTALS	0.573	0.739	1.114	0.713	0.495	0.174
	1.090	1.785	0.911	0.587	0.497	0.453
STD. DEVIATIONS	0.202	0.256	0.522	0.329	0.528	0.294
	0.923	0.981	0.664	0.438	0.481	0.204

```
  LATERAL DRAINAGE COLLECTED FROM LAYER  5
  ----------------------------------------
    TOTALS                 0.0000   0.0000   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   0.0000

  PERCOLATION/LEAKAGE THROUGH LAYER  7
  -------------------------------------
    TOTALS                 0.0000   0.0000   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   0.0000


-------------------------------------------------------------------------------
               AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)
-------------------------------------------------------------------------------


  DAILY AVERAGE HEAD ON TOP OF LAYER  6
  -------------------------------------
    AVERAGES               0.0000   0.0000   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   0.0000
*******************************************************************************



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     AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS    1 THROUGH   30
-------------------------------------------------------------------------------
                                     INCHES            CU. FEET       PERCENT
                                 -------------------   -------------   ---------
 PRECIPITATION                    11.73    (   3.440)      42583.5     100.00

 RUNOFF                            2.660   (  1.5199)       9654.07     22.671

 EVAPOTRANSPIRATION                9.131   (  2.3548)      33147.33     77.841

 LATERAL DRAINAGE COLLECTED        0.00000 (  0.00000)         0.000    0.00000
   FROM LAYER  5

 PERCOLATION/LEAKAGE THROUGH       0.00000 (  0.00000)         0.000     0.00000
   LAYER  7

 AVERAGE HEAD ON TOP               0.000 (    0.000)
   OF LAYER  6

 CHANGE IN WATER STORAGE          -0.060   (  0.9066)       -217.86     -0.512
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                PEAK DAILY VALUES FOR YEARS    1 THROUGH   30
   ---------------------------------------------------------------------------
                                                (INCHES)      (CU. FT.)
                                               ----------   -------------
      PRECIPITATION                              3.30         11979.000

      RUNOFF                                     2.465         8948.9854

      DRAINAGE COLLECTED FROM LAYER  5           0.00000          0.00061

      PERCOLATION/LEAKAGE THROUGH LAYER  7       0.000000         0.00002

      AVERAGE HEAD ON TOP OF LAYER  6            0.000

      MAXIMUM HEAD ON TOP OF LAYER  6            0.072

      LOCATION OF MAXIMUM HEAD IN LAYER  5
            (DISTANCE FROM DRAIN)                0.0 FEET

      SNOW WATER                                 0.03           110.0433


      MAXIMUM VEG. SOIL WATER (VOL/VOL)                  0.3639

      MINIMUM VEG. SOIL WATER (VOL/VOL)                  0.2030


       ***  Maximum heads are computed using McEnroe's equations.  ***

            Reference:  Maximum Saturated Depth over Landfill Liner
                        by Bruce M. McEnroe, University of Kansas
                        ASCE Journal of Environmental Engineering
                        Vol. 119, No. 2, March 1993, pp. 262-270.

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FINAL WATER STORAGE AT END OF YEAR 30

LAYER	(INCHES)	(VOL/VOL)
1	6.0679	0.2092
2	2.2655	0.3236
3	700.2072	0.2526
4	5.8560	0.2440
5	0.0020	0.0100
6	0.0000	0.0000
7	0.1800	0.7500
SNOW WATER	0.000	

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APPENDIX B

PIPE CAPACITY AND STRUCTURAL STABILITY

MARANA REGIONAL LANDFILL
PIPE LOADING CALCULATION - 6" SCH 120 PERFORATED PVC

Calcs By: Patrick M. Bell, PE 4/19/11
Checked By: Andrew Kaplan, PE 4/19/11 (calcs. only)
Garth R. Bowers, PE 4/19/11

REQUIRED: **Determine if a 6-inch diameter, Schedule 120, PVC pipe is adequate to support the maximum waste loading at Marana Regional Landfill**

METHOD: Use the critical loading to analyze the pipe for the following four design criteria:

1. Ring deflection
2. Pipe buckling
3. Wall crushing
4. Circumferential strain

REFERENCES:

1. Driscopipe, Product and Technical Information, 1991
2. Wilson-Fahmy, R.F. and Koerner, R.M. (1994). Finite Element Analysis of Plastic Pipe *Behavior in Leachate Collection and Removal Systems, GRI Report #12.*
3. Uni-Bell PVC Pipe Association (1997). *Deflection: The Pipe/Soil Mechanism*
4. Caterpillar Tractor Company, *Caterpillar Performance Handbook*, Edition 27, October 1996.

SOLUTION:

A. Pipe Properties

6-inch dia., Schedule 120, Perforated PVC pipe

thickness of pipe wall	t =	**0.562**	in
inside diameter	D_i =	**5.434**	in
outside diameter	D_o =	**6.625**	in
SDR	SDR =	**11.8**	
mean diameter of pipe	D_m =	6.0295	in
mean pipe radius	R =	3.015	in

slots/perforations: Perforated

width or diameter	d =	**0.375**	inch
number of slots/row/foot	n =	**2**	

pipe modulus of elasticity:

Initial	E_P =	**420000**	psi
Long-term (50 year)		**140000**	psi

pipe compressive yield strength:

Initial	P_A =	**9600**	psi
Long-term (50 year)		**3700**	psi

MARANA REGIONAL LANDFILL
PIPE LOADING CALCULATION - 6" SCH 120 PERFORATED PVC

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B. Bedding Material Properties

Gravel bedding

deflection lag factor	L_f =	1.5
bedding constant	K =	0.1
modulus of soil reaction	E_s =	3000

C. Loading on the Pipe

The allowable waste height is determined based on trial and error

2.0	ft. final cover @	115	pcf		230	psf
1.0	ft. intrm cover @	115	pcf		115	psf
231.0	ft. solid waste @	65	pcf		15,015	psf
		Total load		P =	15,360	psf
				=	106.7	psi

Total load with correction for pipe slots/perforations,

$$P_T = \frac{P}{(1 - n.d/12)}$$

Slotted

$$P_T = \frac{P}{(1 - n.(d/12))}$$

Perforated

P_T = 113.8 psi

C. Ring Deflection

Allowable ring deflection $(\Delta Y/D_m)_{allow}$ = 7.50 %

Based on the modified Iowa deflection equation, the ring deflection ratio,

$$\frac{\Delta Y}{D_m} = \frac{L_f K P_T R^3}{E_P I + 0.061 E_s R^3}$$

Where: ΔY = vertical pipe deflection (in)
I = moment of inertia (in^3)

$$I = \frac{t^3}{12}$$

I = 0.01479 in^4/in

Therefore,

	Deflection		Note
	Initial	Long-Term	
	(%)	(%)	
$\Delta Y/D_m$	4.17	6.60	Ring Deflection is Acceptable

MARANA REGIONAL LANDFILL
PIPE LOADING CALCULATION - 6" SCH 120 PERFORATED PVC

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D. Wall Buckling

Acceptable factor of safety = 2

The critical buckling pressure, P_{cr} in psi, is given by,

$$P_{cr} = 0.55\left[E_S \frac{E_P I}{0.149 R^3}\right]^{1/2}$$

Therefore,

	Unit	Initial	Long-Term	Note
P_{cr}	(psi)	1175	678	-
P_T	(psi)	113.8	113.8	-
FS = P_{cr}/P_T	-	10.33	5.96	F.S. is Acceptable

E. Wall Crushing

Acceptable factor of safety = 2

Ignoring bending, the axial stress P_{SA} in psi is given by,

$$P_{SA} = \frac{P_T \; D_m}{2 A_W}$$

A_w = area of pipe wall/unit circumference of pipe, in^2/in = t
= 0.562 in^2/in

Therefore,

	Unit	Initial	Long-Term	Note
P_{SA}	(psi)	610	610	-
P_A	(psi)	9600	3700	-
FS = P_A/P_{SA}	-	15.73	6.06	F.S. is Acceptable

MARANA REGIONAL LANDFILL
PIPE LOADING CALCULATION - 6" SCH 120 PERFORATED PVC

Calcs By: Patrick M. Bell, PE 4/19/11
Checked By: Andrew Kaplan, PE 4/19/11 (calcs. only)
Garth R. Bowers, PE 4/19/11

F. Circumferential Strain

Allowable Long-term Strain = 5 %

The total circumferential strain is a combination of:

(i) strain due to ring deflection or flexure, ε_f
(ii) strain due to hoop stress, ε_h
(iii) strain due to Poisson's effect corresponding to longitudinal strain, ε_p

Ignoring longitudinal strain,

$$\varepsilon = \varepsilon_f + \varepsilon_h$$

Where,

$$\varepsilon_f = 6\left(\frac{t}{D_m}\right)\left(\frac{\Delta Y}{D_m}\right)$$

ε_f = 0.037 = 3.69 %

$$\varepsilon_h = \frac{P_T\ D_m}{2\ t\ E_P}$$

ε_h = 0.0044 = 0.44 %

Therefore,

$\varepsilon = \varepsilon_f + \varepsilon_h$ = 4.13	%	Strain is Acceptable

CONCLUSION:

1. Ring Deflection:	**Ring Deflection is Acceptable**
2. Factor of Safety Against Pipe Buckling:	**F.S. is Acceptable**
3. Factor of Safety Against Wall Crushing:	**F.S. is Acceptable**
4. Long-term circumferential Strain:	**Strain is Acceptable**

HELP Model Pipe Flow Scenarios

Marana Regional Landfill : Marana, Arizona

Prep By : PMB 04/13/11
App By: GRB 04/13/11

Scenario 1

Scenario	Peak Daily Drainage (ft^3/day)	Average Yearly Drainage (ft^3/yr)
1	23.21	55.14

Liner Infiltration

Marana Regional Landfill: Marana, Arizona

Prep By : PMB 04/13/11
App By: GRB 04/13/11

Scenario	Peak Daily Percolation (ft^3/day)	Average Annual Percolation (ft^3/yr)
1	0.00003	0.00000
2	0.00000	0.00000
3	0.00000	0.00000

Maximum Average Annual Percolation

Scenario 1

Q_{perc}= 0.00000 ft^3/yr

Area S1 = 20.0 ac
= 871200 ft^2

(0.000ft^3/yr)/(871200 ft^2)= (0ft/yr)(12in/ft)(25.4mm/in)
= 0 mm/yr

Max Average Annual Percolation
Q_{perc}= 0 mm/yr

Sump Sizing

Marana Regional Landfill: Marana, Arizona

Prep By : PMB 04/13/11
App By: GRB 04/13/11

Flow:

Using peak average monthly flow from HELP 3 model

Scenario 1 Q_p= (0.0075 in/mo)(20.00 ac)(ft/12in)(43560ft^2/ac)
= 545 ft^3/mo

Assume sizing for one week:

Q_{tot}= 545/4= 136 ft^3/week

Sump Size:

A sump of 4x30x30 ft has a volume of:

V_{sump}= 3600 ft^3

Porosity of rock fill = 0.40 vol/vol

$V_{effective}$= 3600*0.4= 1440 ft^3

Because Qtot<Ve, the design is acceptable.

FS = V_s/Q_{tot} =
1440/136 = 10.6
(See note above)

∴ A sump of 3600 ft^3 (4x30x30 or equivalent) is acceptable.