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Tetra Tech EM Inc.

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April 17, 1998

AR Update No. 3

(9)

Mr. Ross DelRosario
Remedial Project Manager
Remedial and Enforcement Branch (SM-6J)
U.S. Environmental Protection Agency
77 West Jackson Boulevard
Chicago, IL 60604

**Subject: Hydrologic Evaluation of Landfill Performance (HELP) Assessment of
Landfill Cap at the Industrial Excess Landfill (IEL) Site
ARCS Contract No. 68-W8-0084, Work Assignment No. 21-5NW2**

Dear Mr. DelRosario:

Per your request, Tetra Tech EM Inc. (Tetra Tech) has conducted landfill cap assessment for the IEL site using the U.S. Environmental Protection Agency (EPA) HELP computer model. The assessment included the following scenarios: (1) pre-construction conditions, (2) Resource Conservation and Recovery Act (RCRA) Subtitle C landfill cap, (3) alternative landfill cap A using 18 inches of soil and a double synthetic liner, and (4) alternative landfill cap B using 18 inches of soil and a single geosynthetic liner.

The enclosed technical memorandum summarizes major components of landfill cap in each of these scenarios and results of the HELP model assessment for the existing conditions and for conditions after installing either of the three landfill caps.

If you have any questions, please call me at (312) 856-8769 or Bhupen Gandhi at (847) 255-4166.

Sincerely,

Majid A. Chaudhry, Ph.D., P.E.
Site Manager

MAC/jmk

cc: Diane Spencer, EPA Project Officer
Peggy Hendrixson, EPA Contracting Officer
Bhupen Gandhi, Tetra Tech

TECHNICAL MEMORANDUM

COMPARISON OF STORM WATER INFILTRATION AND RUNOFF FOR THREE TYPES OF LANDFILL CAPS INDUSTRIAL EXCESS LANDFILL UNIONTOWN, OHIO

INTRODUCTION

Under Alternative Remedial Contracting Strategy (ARCS) Work Assignment No. 21, Tetra Tech EM Inc. (Tetra Tech, formerly PRC Environmental Management, Inc.) prepared a prefinal remedial design (RD) for a Resource Conservation and Recovery Act (RCRA) Subtitle C landfill cap at the Industrial Excess Landfill (IEL) Superfund site in Uniontown, Ohio. As part of the landfill cap RD, Tetra Tech evaluated storm water runoff and infiltration at the IEL site using the U.S. Environmental Protection Agency (EPA) Hydrologic Evaluation of Landfill Performance (HELP) computer model. Since the prefinal design submittal in 1995, EPA recently requested Tetra Tech to evaluate storm water runoff and infiltration at the IEL site for an alternative landfill cap design with a geosynthetic clay liner, as well as one without the geosynthetic clay liner. Tetra Tech conducted this additional evaluation also using the HELP model.

This technical memorandum (1) summarizes major components of the RCRA Subtitle C landfill cap, alternative landfill cap A, and alternative landfill cap B; (2) compares storm water runoff and infiltration quantities simulated by the HELP model for existing (pre-cap) conditions and for conditions after installing either of the three landfill caps; and (3) discusses and evaluates the differences in runoff and infiltration quantities for the three landfill cap designs.

SUMMARY OF LANDFILL CAP COMPONENTS

The major components of the RCRA Subtitle C landfill cap and the alternate landfill caps from the top to the bottom for the IEL site are presented below. Additional information on the individual components is presented in the prefinal RD (PRC 1995).

RCRA Subtitle C Landfill Cap

- 6-inch topsoil layer
- 2-foot soil layer
- 1-foot drainage layer
- 2-foot clay barrier layer with 30-mil high-density polyethylene (HDPE) liner on top
- 1-foot gas collection layer

Alternate Landfill Cap A

- 6-inch topsoil layer
- 1.5-foot soil layer
- Geonet/geotextile drainage layer
- 30-mil HDPE liner
- Geosynthetic clay liner
- 1-foot engineered soil base layer/gas collection layer

Alternate Landfill Cap B

- 6-inch topsoil layer
- 1.5-foot soil layer
- Geonet/geotextile drainage layer
- 30-mil HDPE liner
- 1-foot engineered soil base layer/gas collection layer

COMPARISON OF RUNOFF AND INFILTRATION QUANTITIES

In the prefinal RD, Tetra Tech used the HELP model to simulate storm water runoff and infiltration quantities at the IEL site for (1) pre-cap conditions and (2) conditions after installing a RCRA Subtitle C landfill cap. In April 1998, as requested by EPA, Tetra Tech also evaluated runoff and infiltration quantities at the IEL site for conditions after installing the alternate landfill cap.

As mentioned above, Tetra Tech used the HELP model to simulate storm water infiltration and runoff for four sets of conditions. Tetra Tech used climatic data for Cleveland, Ohio, in the HELP model simulations because Cleveland's climate is very similar to that of Uniontown, Ohio. In addition, Tetra Tech's HELP model simulations used a 5-year climatic cycle. Additional information regarding the simulations and evaluations performed by Tetra Tech are presented in the prefinal RD (PRC 1995).

Table 1 summarizes the runoff and infiltration quantities for the four sets of conditions presented above. The printout of the output from the HELP model simulations is attached to this technical memorandum.

EVALUATION OF CHANGES IN RUNOFF AND INFILTRATION QUANTITIES

The data in Table 1 indicate that the three parameters most affected by the installation of a landfill cap are runoff, accumulation, and infiltration.

Table 1
Simulated Storm Water Infiltration and Runoff Quantities

Parameter (Average Annual Value, inches)	Condition 1		Condition 2		Condition 3		Condition 4	
	Existing Soil Cover	Percent of Total Precipitation	RCRA Subtitle C Cap	Percent of Total Precipitation	Alternative Cap A	Percent of Total Precipitation	Alternative Cap B	Percent of Total Precipitation
Runoff	0.21	0.57	4.71	12.82	4.47	12.16	4.47	12.16
Evapotranspiration	26.62	72.48	27.65	75.28	27.29	74.30	27.29	74.30
Accumulation	NA	NA	4.56	12.41	5.31	14.44	5.31	14.44
Infiltration	10.00	27.23	0.00	0.00	0.00	0.00	0.00	0.00

Note:

NA Not applicable

Under existing conditions, there is no drainage layer at the site and thus there is no storm water accumulation. Construction of a landfill cap would increase the accumulation to 4.56 inches for the RCRA Subtitle C cap, 5.31 inches for alternative cap A, and 5.31 inches for alternative cap B.

The average annual percolation under existing conditions is 10.00 inches. Construction of a landfill cap would essentially provide a barrier against all infiltration of water into the landfill. Thus, the infiltration would be 0 inch for the RCRA Subtitle C cap, alternative cap A, and alternative cap B.

In summary, construction of the landfill cap would essentially eliminate the water infiltration into the waste by evapotranspiration, and channel it through the drainage layer (accumulation) and through surface runoff.

Although the percolation for alternative caps A and B are the same, the removal of the geosynthetic clay liner for alternative cap B will eliminate the added safety and in the long run will result in leakage. Therefore, Tetra Tech strongly recommends using alternative cap A, which uses a geosynthetic clay liner. However, the geosynthetic clay liner may be subjected to cracking due to frost zone in the area.

REFERENCE

PRC Environmental Management, Inc. (PRC). 1995. Prefinal Design Documents for Phase I Landfill Cap and Gas Collection and Treatment System, Industrial Excess Landfill Site. February 16.



IEL, UNIONTOWN, OHIO
EXISTING CONDITION

POOR GRASS

LAYER 1

VERTICAL PERCOLATION LAYER

THICKNESS	=	18.00 INCHES
POROSITY	=	0.3980 VOL/VOL
FIELD CAPACITY	=	0.2443 VOL/VOL
WILTING POINT	=	0.1361 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.2443 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000215999986 CM/SEC

GENERAL SIMULATION DATA

SCS RUNOFF CURVE NUMBER	=	70.00
TOTAL AREA OF COVER	=	43560. SQ FT
EVAPORATIVE ZONE DEPTH	=	12.00 INCHES
UPPER LIMIT VEG. STORAGE	=	4.7760 INCHES
INITIAL VEG. STORAGE	=	3.2732 INCHES
INITIAL SNOW WATER CONTENT	=	0.0000 INCHES
INITIAL TOTAL WATER STORAGE IN SOIL AND WASTE LAYERS	=	4.3974 INCHES

SOIL WATER CONTENT INITIALIZED BY PROGRAM.

CLIMATOLOGICAL DATA

DEFAULT RAINFALL WITH SYNTHETIC DAILY TEMPERATURES AND

SOLAR RADIATION FOR CLEVELAND OHIO

MAXIMUM LEAF AREA INDEX = 1.00
 START OF GROWING SEASON (JULIAN DATE) = 129
 END OF GROWING SEASON (JULIAN DATE) = 285

NORMAL MEAN MONTHLY TEMPERATURES, DEGREES FAHRENHEIT

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
25.50	27.40	36.60	48.10	58.20	67.60
71.60	70.40	64.10	53.20	41.80	31.10

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 74 THROUGH 78

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	2.79 3.20	2.29 4.68	3.40 3.04	2.76 2.35	2.95 2.37	3.57 3.33
STD. DEVIATIONS	0.94 1.50	1.40 2.41	0.92 0.51	1.00 1.22	1.42 1.57	0.34 1.34
RUNOFF						
TOTALS	0.003 0.022	0.021 0.093	0.000 0.000	0.000 0.000	0.000 0.000	0.000 0.070
STD. DEVIATIONS	0.007 0.031	0.047 0.205	0.000 0.000	0.000 0.000	0.000 0.000	0.000 0.151
EVAPOTRANSPIRATION						
TOTALS	0.563 3.363	0.969 3.798	2.067 2.895	3.017 2.033	2.744 1.228	3.352 0.594
STD. DEVIATIONS	0.040 0.840	0.225 0.979	0.155 0.892	0.715 0.378	0.887 0.225	0.933 0.137
PERCOLATION FROM LAYER 1						
TOTALS	2.1789 0.2174	1.8708 0.2216	1.5892 0.4087	0.7339 0.2849	0.0984 0.4887	0.0548 1.8549
STD. DEVIATIONS	1.4030 0.3316	1.2587 0.3789	1.0472 0.7783	0.7095 0.3429	0.0511 0.6988	0.0197 1.7857

AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 74 THROUGH 78

	(INCHES)	(CU. FT.)	PERCENT
PRECIPITATION	36.73 (3.622)	133330.	100.00
RUNOFF	0.209 (0.186)	759.	0.57
EVAPOTRANSPIRATION	26.623 (0.661)	96642.	72.48
PERCOLATION FROM LAYER 1	10.0025 (2.6043)	36309.	27.23
CHANGE IN WATER STORAGE	-0.105 (1.351)	-381.	-0.29

PEAK DAILY VALUES FOR YEARS 74 THROUGH 78

	(INCHES)	(CU. FT.)
PRECIPITATION	2.13	7731.9
RUNOFF	0.329	1194.9
PERCOLATION FROM LAYER 1	1.4371	5216.7
SNOW WATER	1.44	5230.0
MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.3644	
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.1322	

FINAL WATER STORAGE AT END OF YEAR 78

LAYER	(INCHES)	(VOL/VOL)
1	4.56	0.2535
SNOW WATER	0.00	





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**                **
**  HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE  **
**  HELP MODEL VERSION 3.03 (31 DECEMBER 1994)      **
**  DEVELOPED BY ENVIRONMENTAL LABORATORY           **
**  USAE WATERWAYS EXPERIMENT STATION              **
**  FOR USEPA RISK REDUCTION ENGINEERING LABORATORY **
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PRECIPITATION DATA FILE: C:\HELP3\IEL1.D4
TEMPERATURE DATA FILE:  C:\HELP3\IEL1.D7
SOLAR RADIATION DATA FILE: C:\HELP3\IEL1.D13
EVAPOTRANSPIRATION DATA: C:\HELP3\IEL1.D11
SOIL AND DESIGN DATA FILE: C:\HELP3\IEL_RCRA.D10
OUTPUT DATA FILE:      C:\HELP3\IEL_RCRA.OUT
```

TIME: 14:58 DATE: 4/16/1998

TITLE: IEL RCRA Cap

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 5

THICKNESS = 6.00 INCHES
POROSITY = 0.4570 VOL/VOL
FIELD CAPACITY = 0.1310 VOL/VOL
WILTING POINT = 0.0580 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.3013 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.100000005000E-02 CM/SEC
NOTE: SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY 3.00
FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.

LAYER 2

TYPE 1 - VERTICAL PERCOLATION LAYER

MATERIAL TEXTURE NUMBER 9

THICKNESS = 24.00 INCHES
POROSITY = 0.5010 VOL/VOL
FIELD CAPACITY = 0.2840 VOL/VOL
WILTING POINT = 0.1350 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.3043 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.190000006000E-03 CM/SEC

LAYER 3

TYPE 2 - LATERAL DRAINAGE LAYER

MATERIAL TEXTURE NUMBER 2

THICKNESS = 12.00 INCHES
POROSITY = 0.4370 VOL/VOL
FIELD CAPACITY = 0.0620 VOL/VOL
WILTING POINT = 0.0240 VOL/VOL

INITIAL SOIL WATER CONTENT = 0.0620 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.579999993000E-02 CM/SEC
SLOPE = 0.00 PERCENT
DRAINAGE LENGTH = 0.0 FEET

LAYER 4

TYPE 4 - FLEXIBLE MEMBRANE LINER

MATERIAL TEXTURE NUMBER 35

THICKNESS = 0.03 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 = 5.00 HOLES/ACRE
FML INSTALLATION DEFECTS = 5.00 HOLES/ACRE
FML PLACEMENT QUALITY = 3 - GOOD

LAYER 5

TYPE 3 - BARRIER SOIL LINER

MATERIAL TEXTURE NUMBER 16

THICKNESS = 24.00 INCHES
POROSITY = 0.4270 VOL/VOL
FIELD CAPACITY = 0.4180 VOL/VOL
WILTING POINT = 0.3670 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.4270 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.100000001000E-06 CM/SEC

LAYER 6

TYPE 1 - VERTICAL PERCOLATION LAYER

MATERIAL TEXTURE NUMBER 4

THICKNESS = 12.00 INCHES
POROSITY = 0.4370 VOL/VOL
FIELD CAPACITY = 0.1050 VOL/VOL
WILTING POINT = 0.0470 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.1033 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.170000002000E-02 CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
SOIL DATA BASE USING SOIL TEXTURE # 5 WITH A
FAIR STAND OF GRASS, A SURFACE SLOPE OF 12.0%
AND A SLOPE LENGTH OF 100. FEET.

SCS RUNOFF CURVE NUMBER = 68.60
FRACTION OF AREA ALLOWING RUNOFF = 100.0 PERCENT
AREA PROJECTED ON HORIZONTAL PLANE = 1.000 ACRES
EVAPORATIVE ZONE DEPTH = 20.0 INCHES
INITIAL WATER IN EVAPORATIVE ZONE = 6.228 INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE = 9.756 INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE = 2.238 INCHES
INITIAL SNOW WATER = 0.000 INCHES
INITIAL WATER IN LAYER MATERIALS = 21.341 INCHES
TOTAL INITIAL WATER = 21.341 INCHES
TOTAL SUBSURFACE INFLOW = 0.00 INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
CLEVELAND OHIO

MAXIMUM LEAF AREA INDEX = 2.00
START OF GROWING SEASON (JULIAN DATE) = 120
END OF GROWING SEASON (JULIAN DATE) = 290
AVERAGE ANNUAL WIND SPEED = 10.80 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY = 72.00 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY = 68.00 %

AVERAGE 3RD QUARTER RELATIVE HUMIDITY = 72.00 %
 AVERAGE 4TH QUARTER RELATIVE HUMIDITY = 72.00 %

NOTE: PRECIPITATION DATA FOR CLEVELAND OHIO
 WAS ENTERED FROM THE DEFAULT DATA FILE.

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
 COEFFICIENTS FOR CLEVELAND OHIO

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
25.50	27.40	36.60	48.10	58.20	67.60
71.60	70.40	64.10	53.20	41.80	31.10

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
 COEFFICIENTS FOR CLEVELAND OHIO

STATION LATITUDE = 41.24 DEGREES

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ANNUAL TOTALS FOR YEAR 1974

	INCHES	CU. FEET	PERCENT	
PRECIPITATION	39.88	144764.406	100.00	
RUNOFF	3.872	14055.138	9.71	
EVAPOTRANSPIRATION		27.729	100656.766	69.53
DRAINAGE COLLECTED FROM LAYER 3		8.2727	30029.895	20.74

PERC./LEAKAGE THROUGH LAYER 5	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 5	0.0067		
PERC./LEAKAGE THROUGH LAYER 6	0.017169	62.324	0.04
CHANGE IN WATER STORAGE	-0.011	-39.700	-0.03
SOIL WATER AT START OF YEAR	21.341	77469.203	
SOIL WATER AT END OF YEAR	21.330	77429.500	
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	-0.014	0.00

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ANNUAL TOTALS FOR YEAR 1975

	INCHES	CU. FEET	PERCENT	
PRECIPITATION	40.81	148140.297	100.00	
RUNOFF	6.590	23922.566	16.15	
EVAPOTRANSPIRATION		29.085	105576.930	71.27
DRAINAGE COLLECTED FROM LAYER 3		5.7385	20830.871	14.06
PERC./LEAKAGE THROUGH LAYER 5		0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 5		0.0053		
PERC./LEAKAGE THROUGH LAYER 6		0.014734	53.485	0.04

CHANGE IN WATER STORAGE	-0.618	-2243.583	-1.51
SOIL WATER AT START OF YEAR	21.330	77429.500	
SOIL WATER AT END OF YEAR	20.712	75185.914	
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	0.024	0.00

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ANNUAL TOTALS FOR YEAR 1976

	INCHES	CU. FEET	PERCENT
PRECIPITATION	34.81	126360.344	100.00
RUNOFF	6.102	22151.959	17.53
EVAPOTRANSPIRATION		27.001	98013.203 77.57
DRAINAGE COLLECTED FROM LAYER 3		2.7045	9817.344 7.77
PERC./LEAKAGE THROUGH LAYER 5		0.000000	0.000 0.00
AVG. HEAD ON TOP OF LAYER 5		0.0024	
PERC./LEAKAGE THROUGH LAYER 6		0.012912	46.869 0.04
CHANGE IN WATER STORAGE	-1.011	-3669.104	-2.90
SOIL WATER AT START OF YEAR	20.712	75185.914	

SOIL WATER AT END OF YEAR	19.598	71138.977		
SNOW WATER AT START OF YEAR	0.000	0.000	0.00	
SNOW WATER AT END OF YEAR	0.104	377.833	0.30	
ANNUAL WATER BUDGET BALANCE	0.0000	0.073	0.00	

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ANNUAL TOTALS FOR YEAR 1977

	INCHES	CU. FEET	PERCENT	
	-----	-----	-----	
PRECIPITATION	36.09	131006.711	100.00	
RUNOFF	3.770	13686.853	10.45	
EVAPOTRANSPIRATION		27.810	100948.648	77.06
DRAINAGE COLLECTED FROM LAYER 3		2.0797	7549.202	5.76
PERC./LEAKAGE THROUGH LAYER 5		0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 5		0.0018		
PERC./LEAKAGE THROUGH LAYER 6		0.011416	41.440	0.03
CHANGE IN WATER STORAGE		2.419	8780.562	6.70
SOIL WATER AT START OF YEAR		19.598	71138.977	
SOIL WATER AT END OF YEAR		22.120	80297.375	
SNOW WATER AT START OF YEAR		0.104	377.833	0.29
SNOW WATER AT END OF YEAR		0.000	0.000	0.00

ANNUAL WATER BUDGET BALANCE 0.0000 0.008 0.00

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ANNUAL TOTALS FOR YEAR 1978

	INCHES	CU. FEET	PERCENT	
	-----	-----	-----	
PRECIPITATION		32.06	116377.820	100.00
RUNOFF	3.209	11649.743	10.01	
EVAPOTRANSPIRATION		26.633	96676.297	83.07
DRAINAGE COLLECTED FROM LAYER 3		4.0020	14527.377	12.48
PERC./LEAKAGE THROUGH LAYER 5		0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 5		0.0034		
PERC./LEAKAGE THROUGH LAYER 6		0.010241	37.175	0.03
CHANGE IN WATER STORAGE		-1.794	-6512.825	-5.60
SOIL WATER AT START OF YEAR		22.120	80297.375	
SOIL WATER AT END OF YEAR		20.326	73784.555	
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	0.049	0.00

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1974 THROUGH 1978

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

PRECIPITATION

TOTALS 2.80 2.28 3.40 2.76 2.95 3.57
 3.20 4.68 3.04 2.35 2.37 3.33

STD. DEVIATIONS 0.94 1.39 0.92 1.00 1.42 0.34
 1.50 2.41 0.51 1.22 1.57 1.34

RUNOFF

TOTALS 0.929 1.192 1.995 0.275 0.000 0.000
 0.000 0.002 0.000 0.000 0.000 0.316

STD. DEVIATIONS 0.908 1.251 1.106 0.333 0.000 0.000
 0.000 0.005 0.000 0.000 0.000 0.406

EVAPOTRANSPIRATION

TOTALS 0.803 0.883 1.715 2.750 3.009 4.124
 3.707 3.376 2.876 2.247 1.328 0.834

STD. DEVIATIONS 0.120 0.218 0.151 0.536 0.711 0.812
 0.942 0.779 0.795 0.364 0.151 0.150

LATERAL DRAINAGE COLLECTED FROM LAYER 3

TOTALS 0.0175 0.0000 0.2334 1.3771 0.8485 0.5046
 0.1303 0.0045 0.4857 0.0520 0.0767 0.8290

STD. DEVIATIONS 0.0240 0.0000 0.5219 1.0742 0.2781 0.3246

0.0991 0.0098 1.0635 0.1002 0.1480 1.3807

PERCOLATION/LEAKAGE THROUGH 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 6

TOTALS 0.0012 0.0011 0.0012 0.0011 0.0011 0.0011
 0.0011 0.0011 0.0011 0.0011 0.0010 0.0011

STD. DEVIATIONS 0.0003 0.0002 0.0003 0.0002 0.0002 0.0002
 0.0002 0.0002 0.0002 0.0002 0.0002 0.0002

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ACROSS LAYER 5

AVERAGES 0.0002 0.0000 0.0011 0.0143 0.0087 0.0054
 0.0014 0.0000 0.0055 0.0005 0.0008 0.0088

STD. DEVIATIONS 0.0003 0.0000 0.0025 0.0110 0.0029 0.0035
 0.0011 0.0001 0.0120 0.0010 0.0016 0.0150

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1974 THROUGH 1978

INCHES CU. FEET PERCENT

PRECIPITATION	36.73	(3.622)	133329.9	100.00
RUNOFF	4.709	(1.5257)	17093.25	12.820
EVAPOTRANSPIRATION	27.651	(0.9415)	100374.37	75.283
LATERAL DRAINAGE COLLECTED FROM LAYER 3	4.55949	(2.50396)	16550.939	12.41352
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.00000	(0.00000)	0.000	0.00000
AVERAGE HEAD ACROSS TOP OF LAYER 5	0.004	(0.002)		
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.01329	(0.00274)	48.259	0.03619
CHANGE IN WATER STORAGE	-0.203	(1.6022)	-736.93	-0.553

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PEAK DAILY VALUES FOR YEARS 1974 THROUGH 1978

	(INCHES)	(CU. FT.)	
PRECIPITATION	2.13	7731.900	
RUNOFF	2.449	8888.6064	
DRAINAGE COLLECTED FROM LAYER 3	1.16388	4224.87549	
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.000000	0.000000	
AVERAGE HEAD ACROSS LAYER 5	0.320		
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.000051	0.18541	
SNOW WATER	3.18	11543.2246	
MAXIMUM VEG. SOIL WATER (VOL/VOL)		0.4058	
MINIMUM VEG. SOIL WATER (VOL/VOL)		0.1016	

FINAL WATER STORAGE AT END OF YEAR 1978

LAYER	(INCHES)	(VOL/VOL)
1	1.0245	0.1708
2	7.1296	0.2971
3	0.7512	0.0626
4	0.0000	0.0000
5	10.2480	0.4270
6	1.1730	0.0978
SNOW WATER		0.000



```
**                               **
**                               **
**      HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE      **
**      HELP MODEL VERSION 3.03 (31 DECEMBER 1994)          **
**      DEVELOPED BY ENVIRONMENTAL LABORATORY                **
**      USAE WATERWAYS EXPERIMENT STATION                   **
**      FOR USEPA RISK REDUCTION ENGINEERING LABORATORY     **
**                               **
**                               **
```

```
PRECIPITATION DATA FILE: C:\HELP3\IEL1.D4
TEMPERATURE DATA FILE:   C:\HELP3\IEL1.D7
SOLAR RADIATION DATA FILE: C:\HELP3\IEL1.D13
EVAPOTRANSPIRATION DATA: C:\HELP3\IEL1.D11
SOIL AND DESIGN DATA FILE: C:\HELP3\IEL_PROP.D10
OUTPUT DATA FILE:       C:\HELP3\IEL_PROP.OUT
```

TIME: 15: 8 DATE: 4/16/1998

TITLE: IEL Proposed Design ALTERNATE A

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 5

THICKNESS = 6.00 INCHES
POROSITY = 0.4570 VOL/VOL
FIELD CAPACITY = 0.1310 VOL/VOL
WILTING POINT = 0.0580 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.2415 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.100000005000E-02 CM/SEC

NOTE: SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY 3.00 FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.

LAYER 2

TYPE 1 - VERTICAL PERCOLATION LAYER

MATERIAL TEXTURE NUMBER 9

THICKNESS = 18.00 INCHES
POROSITY = 0.5010 VOL/VOL
FIELD CAPACITY = 0.2840 VOL/VOL
WILTING POINT = 0.1350 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.3067 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.190000006000E-03 CM/SEC

LAYER 3

TYPE 2 - LATERAL DRAINAGE LAYER

MATERIAL TEXTURE NUMBER 20

THICKNESS = 0.25 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 = 12.00 PERCENT
DRAINAGE LENGTH = 100.0 FEET

LAYER 4

TYPE 4 - FLEXIBLE MEMBRANE LINER

MATERIAL TEXTURE NUMBER 35

THICKNESS = 0.03 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 = 5.00 HOLES/ACRE
FML INSTALLATION DEFECTS = 5.00 HOLES/ACRE
FML PLACEMENT QUALITY = 3 - GOOD

LAYER 5

TYPE 3 - BARRIER SOIL LINER

MATERIAL TEXTURE NUMBER 17

THICKNESS = 0.30 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

LAYER 6

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 4
THICKNESS = 12.00 INCHES
POROSITY = 0.4370 VOL/VOL
FIELD CAPACITY = 0.1050 VOL/VOL
WILTING POINT = 0.0470 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.1033 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.170000002000E-02 CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
SOIL DATA BASE USING SOIL TEXTURE # 5 WITH A
FAIR STAND OF GRASS, A SURFACE SLOPE OF 12.%
AND A SLOPE LENGTH OF 100. FEET.

SCS RUNOFF CURVE NUMBER = 68.60
FRACTION OF AREA ALLOWING RUNOFF = 100.0 PERCENT
AREA PROJECTED ON HORIZONTAL PLANE = 1.000 ACRES
EVAPORATIVE ZONE DEPTH = 20.0 INCHES
INITIAL WATER IN EVAPORATIVE ZONE = 5.833 INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE = 9.756 INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE = 2.238 INCHES
INITIAL SNOW WATER = 0.000 INCHES
INITIAL WATER IN LAYER MATERIALS = 8.436 INCHES
TOTAL INITIAL WATER = 8.436 INCHES
TOTAL SUBSURFACE INFLOW = 0.00 INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
CLEVELAND OHIO

MAXIMUM LEAF AREA INDEX = 2.00
START OF GROWING SEASON (JULIAN DATE) = 120
END OF GROWING SEASON (JULIAN DATE) = 290

AVERAGE ANNUAL WIND SPEED = 10.80 MPH
 AVERAGE 1ST QUARTER RELATIVE HUMIDITY = 72.00 %
 AVERAGE 2ND QUARTER RELATIVE HUMIDITY = 68.00 %
 AVERAGE 3RD QUARTER RELATIVE HUMIDITY = 72.00 %
 AVERAGE 4TH QUARTER RELATIVE HUMIDITY = 72.00 %

NOTE: PRECIPITATION DATA FOR CLEVELAND OHIO
 WAS ENTERED FROM THE DEFAULT DATA FILE.

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
 COEFFICIENTS FOR CLEVELAND OHIO

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
25.50	27.40	36.60	48.10	58.20	67.60
71.60	70.40	64.10	53.20	41.80	31.10

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
 COEFFICIENTS FOR CLEVELAND OHIO

STATION LATITUDE = 41.24 DEGREES

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ANNUAL TOTALS FOR YEAR 1974

	INCHES	CU. FEET	PERCENT
PRECIPITATION	39.88	144764.406	100.00
RUNOFF	3.528	12805.436	8.85

EVAPOTRANSPIRATION	27.310	99134.094	68.48
DRAINAGE COLLECTED FROM LAYER 3	8.6540	31414.076	21.70
PERC./LEAKAGE THROUGH LAYER 5	0.000001	0.003	0.00
AVG. HEAD ON TOP OF LAYER 5	0.0004		
PERC./LEAKAGE THROUGH LAYER 6	0.017169	62.322	0.04
CHANGE IN WATER STORAGE	0.371	1348.472	0.93
SOIL WATER AT START OF YEAR	8.436	30622.420	
SOIL WATER AT END OF YEAR	8.807	31970.893	
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 1975

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	40.81	148140.297	100.00
RUNOFF	6.526	23689.287	15.99
EVAPOTRANSPIRATION	28.241	102513.570	69.20
DRAINAGE COLLECTED FROM LAYER 3	7.0032	25421.768	17.16

PERC./LEAKAGE THROUGH LAYER 5	0.000001	0.004	0.00
AVG. HEAD ON TOP OF LAYER 5	0.0003		
PERC./LEAKAGE THROUGH LAYER 6	0.014734	53.483	0.04
CHANGE IN WATER STORAGE	-0.975	-3537.860	-2.39
SOIL WATER AT START OF YEAR	8.807	31970.893	
SOIL WATER AT END OF YEAR	7.833	28433.033	
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	0.039	0.00

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ANNUAL TOTALS FOR YEAR 1976

	INCHES	CU. FEET	PERCENT	
	-----	-----	-----	
PRECIPITATION	34.81	126360.344	100.00	
RUNOFF	5.969	21667.811	17.15	
EVAPOTRANSPIRATION		26.500	96194.180	76.13
DRAINAGE COLLECTED FROM LAYER 3		3.3963	12328.712	9.76
PERC./LEAKAGE THROUGH LAYER 5		0.000001	0.003	0.00
AVG. HEAD ON TOP OF LAYER 5		0.0001		

PERC./LEAKAGE THROUGH LAYER 6	0.012911	46.868	0.04
CHANGE IN WATER STORAGE	-1.068	-3877.202	-3.07
SOIL WATER AT START OF YEAR	7.833	28433.033	
SOIL WATER AT END OF YEAR	6.661	24177.998	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.104	377.833	0.30
ANNUAL WATER BUDGET BALANCE	0.0000	-0.026	0.00

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ANNUAL TOTALS FOR YEAR 1977

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	36.09	131006.711	100.00
RUNOFF	3.344	12140.139	9.27
EVAPOTRANSPIRATION	27.837	101049.398	77.13
DRAINAGE COLLECTED FROM LAYER 3	2.2386	8126.060	6.20
PERC./LEAKAGE THROUGH LAYER 5	0.000001	0.002	0.00
AVG. HEAD ON TOP OF LAYER 5	0.0001		
PERC./LEAKAGE THROUGH LAYER 6	0.011416	41.440	0.03
CHANGE IN WATER STORAGE	2.658	9649.653	7.37

SOIL WATER AT START OF YEAR	6.661	24177.998		
SOIL WATER AT END OF YEAR	9.423	34205.484		
SNOW WATER AT START OF YEAR	0.104	377.833	0.29	
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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ANNUAL TOTALS FOR YEAR 1978

	INCHES	CU. FEET	PERCENT	
	-----	-----	-----	
PRECIPITATION		32.06	116377.820	100.00
RUNOFF	2.970	10780.850	9.26	
EVAPOTRANSPIRATION		26.559	96408.742	82.84
DRAINAGE COLLECTED FROM LAYER 3		5.2308	18987.922	16.32
PERC./LEAKAGE THROUGH LAYER 5		0.000001	0.004	0.00
AVG. HEAD ON TOP OF LAYER 5		0.0002		
PERC./LEAKAGE THROUGH LAYER 6		0.010241	37.174	0.03
CHANGE IN WATER STORAGE		-2.710	-9836.887	-8.45
SOIL WATER AT START OF YEAR		9.423	34205.484	
SOIL WATER AT END OF YEAR		6.713	24368.598	

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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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1974 THROUGH 1978

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

PRECIPITATION

 TOTALS 2.80 2.28 3.40 2.76 2.95 3.57
 3.20 4.68 3.04 2.35 2.37 3.33
 STD. DEVIATIONS 0.94 1.39 0.92 1.00 1.42 0.34
 1.50 2.41 0.51 1.22 1.57 1.34

RUNOFF

 TOTALS 0.843 1.163 1.919 0.258 0.000 0.000
 0.000 0.008 0.000 0.000 0.000 0.276
 STD. DEVIATIONS 0.851 1.261 1.102 0.309 0.000 0.000
 0.000 0.019 0.000 0.000 0.000 0.356

EVAPOTRANSPIRATION

 TOTALS 0.805 0.873 1.697 2.764 3.043 3.926
 3.399 3.527 2.879 2.156 1.372 0.847

STD. DEVIATIONS 0.124 0.230 0.196 0.515 0.810 0.696
1.038 0.771 0.805 0.498 0.211 0.174

LATERAL DRAINAGE COLLECTED FROM LAYER 3

TOTALS 0.0000 0.0000 0.1446 1.5391 1.3212 0.4890
0.0165 0.0323 0.5312 0.2902 0.2668 0.6737

STD. DEVIATIONS 0.0000 0.0000 0.3234 1.2070 0.2708 0.3549
0.0225 0.0269 1.0648 0.3389 0.2919 1.0555

PERCOLATION/LEAKAGE THROUGH 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 6

TOTALS 0.0012 0.0011 0.0012 0.0011 0.0011 0.0011
0.0011 0.0011 0.0011 0.0011 0.0010 0.0011

STD. DEVIATIONS 0.0003 0.0002 0.0003 0.0002 0.0002 0.0002
0.0002 0.0002 0.0002 0.0002 0.0002 0.0002

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ACROSS LAYER 5

AVERAGES 0.0000 0.0000 0.0001 0.0008 0.0006 0.0002
0.0000 0.0000 0.0003 0.0001 0.0001 0.0003

STD. DEVIATIONS 0.0000 0.0000 0.0002 0.0006 0.0001 0.0002
0.0000 0.0000 0.0005 0.0002 0.0001 0.0005

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1974 THROUGH 1978

	INCHES	CU. FEET	PERCENT	
PRECIPITATION	36.73 (3.622)	133329.9	100.00	
RUNOFF	4.467 (1.6492)	16216.70	12.163	
EVAPOTRANSPIRATION	27.289 (0.7686)	99060.00	74.297	
LATERAL DRAINAGE COLLECTED FROM LAYER 3	5.30460 (2.60535)	19255.707	14.44215	
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.00000 (0.00000)	0.003	0.00000	
AVERAGE HEAD ACROSS TOP OF LAYER 5	0.000 (0.000)			
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.01329 (0.00274)	48.257	0.03619	
CHANGE IN WATER STORAGE	-0.345 (2.0028)	-1250.76	-0.938	

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PEAK DAILY VALUES FOR YEARS 1974 THROUGH 1978

	(INCHES)	(CU. FT.)	
PRECIPITATION	2.13	7731.900	
RUNOFF	2.446	8880.1445	
DRAINAGE COLLECTED FROM LAYER 3	0.52038	1888.97815	
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.000000	0.00004	
AVERAGE HEAD ACROSS LAYER 5	0.008		
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.000051	0.18541	
SNOW WATER	3.18	11543.2246	
MAXIMUM VEG. SOIL WATER (VOL/VOL)		0.4027	
MINIMUM VEG. SOIL WATER (VOL/VOL)		0.1024	

FINAL WATER STORAGE AT END OF YEAR 1978

LAYER	(INCHES)	(VOL/VOL)
1	0.4917	0.0820
2	4.8206	0.2678
3	0.0027	0.0110
4	0.0000	0.0000
5	0.2250	0.7500
6	1.1730	0.0978
SNOW WATER		0.000



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*****
**
**
**      HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE      **
**      HELP MODEL VERSION 3.03 (31 DECEMBER 1994)          **
**      DEVELOPED BY ENVIRONMENTAL LABORATORY                **
**      USAE WATERWAYS EXPERIMENT STATION                   **
**      FOR USEPA RISK REDUCTION ENGINEERING LABORATORY     **
**
**
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PRECIPITATION DATA FILE: C:\HELP3\IEL1.D4
TEMPERATURE DATA FILE:  C:\HELP3\IEL1.D7
SOLAR RADIATION DATA FILE: C:\HELP3\IEL1.D13
EVAPOTRANSPIRATION DATA: C:\HELP3\IEL1.D11
SOIL AND DESIGN DATA FILE: C:\HELP3\IEL_PRP2.D10
OUTPUT DATA FILE:      C:\HELP3\IEL_PRP2.OUT

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TIME: 11: 8 DATE: 4/17/1998

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*****
TITLE: IEL Proposed Design No. 2  ALTERNATE B
*****

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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 5
THICKNESS = 6.00 INCHES

POROSITY = 0.4570 VOL/VOL
FIELD CAPACITY = 0.1310 VOL/VOL
WILTING POINT = 0.0580 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.2415 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.100000005000E-02 CM/SEC
NOTE: SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY 3.00
FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.

LAYER 2

TYPE 1 - VERTICAL PERCOLATION LAYER

MATERIAL TEXTURE NUMBER 9

THICKNESS = 18.00 INCHES
POROSITY = 0.5010 VOL/VOL
FIELD CAPACITY = 0.2840 VOL/VOL
WILTING POINT = 0.1350 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.3067 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.190000006000E-03 CM/SEC

LAYER 3

TYPE 2 - LATERAL DRAINAGE LAYER

MATERIAL TEXTURE NUMBER 20

THICKNESS = 0.25 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 = 12.00 PERCENT
DRAINAGE LENGTH = 100.0 FEET

LAYER 4

TYPE 4 - FLEXIBLE MEMBRANE LINER

MATERIAL TEXTURE NUMBER 35

THICKNESS = 0.03 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 = 5.00 HOLES/ACRE
FML INSTALLATION DEFECTS = 5.00 HOLES/ACRE
FML PLACEMENT QUALITY = 3 - GOOD

LAYER 5

TYPE 1 - VERTICAL PERCOLATION LAYER

MATERIAL TEXTURE NUMBER 4

THICKNESS = 12.00 INCHES
POROSITY = 0.4370 VOL/VOL
FIELD CAPACITY = 0.1050 VOL/VOL
WILTING POINT = 0.0470 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.1035 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.170000002000E-02 CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
SOIL DATA BASE USING SOIL TEXTURE # 5 WITH A
FAIR STAND OF GRASS, A SURFACE SLOPE OF 12.0%
AND A SLOPE LENGTH OF 100. FEET.

SCS RUNOFF CURVE NUMBER = 68.60
FRACTION OF AREA ALLOWING RUNOFF = 100.0 PERCENT
AREA PROJECTED ON HORIZONTAL PLANE = 1.000 ACRES
EVAPORATIVE ZONE DEPTH = 20.0 INCHES
INITIAL WATER IN EVAPORATIVE ZONE = 5.833 INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE = 9.756 INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE = 2.238 INCHES
INITIAL SNOW WATER = 0.000 INCHES
INITIAL WATER IN LAYER MATERIALS = 8.214 INCHES
TOTAL INITIAL WATER = 8.214 INCHES
TOTAL SUBSURFACE INFLOW = 0.00 INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
CLEVELAND OHIO

MAXIMUM LEAF AREA INDEX = 2.00
 START OF GROWING SEASON (JULIAN DATE) = 120
 END OF GROWING SEASON (JULIAN DATE) = 290
 AVERAGE ANNUAL WIND SPEED = 10.80 MPH
 AVERAGE 1ST QUARTER RELATIVE HUMIDITY = 72.00 %
 AVERAGE 2ND QUARTER RELATIVE HUMIDITY = 68.00 %
 AVERAGE 3RD QUARTER RELATIVE HUMIDITY = 72.00 %
 AVERAGE 4TH QUARTER RELATIVE HUMIDITY = 72.00 %

NOTE: PRECIPITATION DATA FOR CLEVELAND OHIO
 WAS ENTERED FROM THE DEFAULT DATA FILE.

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
 COEFFICIENTS FOR CLEVELAND OHIO

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
25.50	27.40	36.60	48.10	58.20	67.60
71.60	70.40	64.10	53.20	41.80	31.10

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
 COEFFICIENTS FOR CLEVELAND OHIO

STATION LATITUDE = 41.24 DEGREES

ANNUAL TOTALS FOR YEAR 1974

	INCHES	CU. FEET	PERCENT
PRECIPITATION	39.88	144764.406	100.00

RUNOFF	3.528	12805.436	8.85	
EVAPOTRANSPIRATION	27.310	99134.094	68.48	
DRAINAGE COLLECTED FROM LAYER 3	8.6523	31407.891	21.70	
PERC./LEAKAGE THROUGH LAYER 4	0.001706	6.192	0.00	
AVG. HEAD ON TOP OF LAYER 4	0.0004			
PERC./LEAKAGE THROUGH LAYER 5	0.016229	58.912	0.04	
CHANGE IN WATER STORAGE	0.374	1358.072	0.94	
SOIL WATER AT START OF YEAR	9.474	34390.602		
SOIL WATER AT END OF YEAR	9.848	35748.676		
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	0.001	0.00	

ANNUAL TOTALS FOR YEAR 1975

	INCHES	CU. FEET	PERCENT	
	-----	-----	-----	
PRECIPITATION	40.81	148140.297	100.00	
RUNOFF	6.526	23689.287	15.99	
EVAPOTRANSPIRATION	28.241	102513.570	69.20	
DRAINAGE COLLECTED FROM LAYER 3	7.0017	25416.150	17.16	
PERC./LEAKAGE THROUGH LAYER 4	0.001551	5.629	0.00	
AVG. HEAD ON TOP OF LAYER 4	0.0003			
PERC./LEAKAGE THROUGH LAYER 5	0.014193	51.522	0.03	
CHANGE IN WATER STORAGE	-0.973	-3530.275	-2.38	

SOIL WATER AT START OF YEAR	9.848	35748.676		
SOIL WATER AT END OF YEAR	8.876	32218.400		
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	0.033	0.00	

ANNUAL TOTALS FOR YEAR 1976

	INCHES	CU. FEET	PERCENT	
	-----	-----	-----	
PRECIPITATION	34.81	126360.344	100.00	
RUNOFF	5.969	21667.811	17.15	
EVAPOTRANSPIRATION		26.500	96194.180	76.13
DRAINAGE COLLECTED FROM LAYER 3		3.3955	12325.608	9.75
PERC./LEAKAGE THROUGH LAYER 4		0.000856	3.106	0.00
AVG. HEAD ON TOP OF LAYER 4		0.0001		
PERC./LEAKAGE THROUGH LAYER 5		0.013135	47.681	0.04
CHANGE IN WATER STORAGE		-1.067	-3874.910	-3.07
SOIL WATER AT START OF YEAR		8.876	32218.400	
SOIL WATER AT END OF YEAR		7.704	27965.656	
SNOW WATER AT START OF YEAR		0.000	0.000	0.00
SNOW WATER AT END OF YEAR		0.104	377.833	0.30
ANNUAL WATER BUDGET BALANCE		0.0000	-0.026	0.00

ANNUAL TOTALS FOR YEAR 1977

	INCHES	CU. FEET	PERCENT		
PRECIPITATION	36.09	131006.711	100.00		
RUNOFF	3.344	12140.139	9.27		
EVAPOTRANSPIRATION		27.837	101049.398	77.13	
DRAINAGE COLLECTED FROM LAYER 3			2.2380	8123.942	6.20
PERC./LEAKAGE THROUGH LAYER 4			0.000584	2.121	0.00
AVG. HEAD ON TOP OF LAYER 4		0.0001			
PERC./LEAKAGE THROUGH LAYER 5			0.011837	42.970	0.03
CHANGE IN WATER STORAGE		2.658	9650.238	7.37	
SOIL WATER AT START OF YEAR		7.704	27965.656		
SOIL WATER AT END OF YEAR		10.467	37993.727		
SNOW WATER AT START OF YEAR		0.104	377.833	0.29	
SNOW WATER AT END OF YEAR		0.000	0.000	0.00	
ANNUAL WATER BUDGET BALANCE		0.0000	0.029	0.00	

ANNUAL TOTALS FOR YEAR 1978

	INCHES	CU. FEET	PERCENT		
PRECIPITATION	32.06	116377.820	100.00		
RUNOFF	2.970	10780.850	9.26		
EVAPOTRANSPIRATION		26.559	96408.742	82.84	

DRAINAGE COLLECTED FROM LAYER 3	5.2296	18983.322	16.31
PERC./LEAKAGE THROUGH LAYER 4	0.001266	4.597	0.00
AVG. HEAD ON TOP OF LAYER 4	0.0002		
PERC./LEAKAGE THROUGH LAYER 5	0.010021	36.377	0.03
CHANGE IN WATER STORAGE	-2.708	-9831.495	-8.45
SOIL WATER AT START OF YEAR	10.467	37993.727	
SOIL WATER AT END OF YEAR	7.758	28162.234	
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

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1974 THROUGH 1978

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

PRECIPITATION

TOTALS	2.80	2.28	3.40	2.76	2.95	3.57
	3.20	4.68	3.04	2.35	2.37	3.33

STD. DEVIATIONS	0.94	1.39	0.92	1.00	1.42	0.34
	1.50	2.41	0.51	1.22	1.57	1.34

RUNOFF

TOTALS	0.843	1.163	1.919	0.258	0.000	0.000
	0.000	0.008	0.000	0.000	0.000	0.276

STD. DEVIATIONS	0.851	1.261	1.102	0.309	0.000	0.000
	0.000	0.019	0.000	0.000	0.000	0.356

EVAPOTRANSPIRATION

TOTALS 0.805 0.873 1.697 2.764 3.043 3.926
3.399 3.527 2.879 2.156 1.372 0.847

STD. DEVIATIONS 0.124 0.230 0.196 0.515 0.810 0.696
1.038 0.771 0.805 0.498 0.211 0.174

LATERAL DRAINAGE COLLECTED FROM LAYER 3

TOTALS 0.0000 0.0000 0.1446 1.5388 1.3209 0.4888
0.0165 0.0323 0.5311 0.2902 0.2667 0.6735

STD. DEVIATIONS 0.0000 0.0000 0.3233 1.2068 0.2708 0.3549
0.0225 0.0269 1.0646 0.3389 0.2918 1.0553

PERCOLATION/LEAKAGE THROUGH LAYER 4

TOTALS 0.0000 0.0000 0.0000 0.0003 0.0003 0.0001
0.0000 0.0000 0.0001 0.0001 0.0001 0.0001

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

PERCOLATION/LEAKAGE THROUGH LAYER 5

TOTALS 0.0013 0.0011 0.0012 0.0009 0.0009 0.0010
0.0012 0.0012 0.0010 0.0011 0.0010 0.0010

STD. DEVIATIONS 0.0002 0.0002 0.0002 0.0002 0.0002 0.0002
0.0002 0.0002 0.0002 0.0002 0.0002 0.0002

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ACROSS LAYER 4

AVERAGES 0.0000 0.0000 0.0001 0.0008 0.0006 0.0002
0.0000 0.0000 0.0003 0.0001 0.0001 0.0003

STD. DEVIATIONS 0.0000 0.0000 0.0002 0.0006 0.0001 0.0002
0.0000 0.0000 0.0005 0.0002 0.0001 0.0005

AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1974 THROUGH 1978

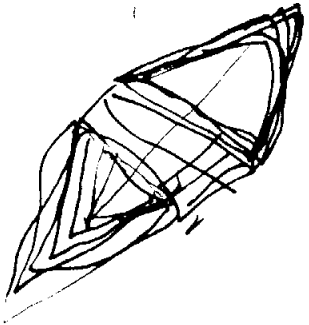
	INCHES	CU. FEET	PERCENT	
PRECIPITATION	36.73 (3.622)	133329.9	100.00	
RUNOFF	4.467 (1.6492)	16216.70	12.163	
EVAPOTRANSPIRATION	27.289 (0.7686)	99060.00	74.297	
LATERAL DRAINAGE COLLECTED FROM LAYER 3		5.30341 (2.60488)	19251.383	14.43891
PERCOLATION/LEAKAGE THROUGH LAYER 4		0.00119 (0.00047)	4.329	0.00325
AVERAGE HEAD ACROSS TOP OF LAYER 4		0.000 (0.000)		
PERCOLATION/LEAKAGE THROUGH LAYER 5		0.01308 (0.00235)	47.492	0.03562
CHANGE IN WATER STORAGE	-0.343 (2.0025)	-1245.67	-0.934	

PEAK DAILY VALUES FOR YEARS 1974 THROUGH 1978

	(INCHES)	(CU. FT.)		
PRECIPITATION	2.13	7731.900		
RUNOFF	2.446	8880.1445		
DRAINAGE COLLECTED FROM LAYER 3	0.52031	1888.71313		
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.000073	0.26329		
AVERAGE HEAD ACROSS LAYER 4	0.008			
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.000053	0.19085		
SNOW WATER	3.18	11543.2246		
MAXIMUM VEG. SOIL WATER (VOL/VOL)		0.4027		
MINIMUM VEG. SOIL WATER (VOL/VOL)		0.1024		

FINAL WATER STORAGE AT END OF YEAR 1978

LAYER	(INCHES)	(VOL/VOL)
1	0.4917	0.0820
2	4.8206	0.2678
3	0.0027	0.0110
4	0.0000	0.0000
5	1.1831	0.0986
SNOW WATER		0.000



Mark Whitmore Newby (2/19)

(330) ~~||~~ || 730-1703

← 1. Sail (boat) 

2. ~~General~~  Account

9:30 -

