MAP(S)/ PLAN(S)

SCANNED

SEPARATELY

1325303

PERMIT DOCUMENTS

FOR

TRAIL RIDGE LANDFILL

PLAN A

VOLUME I

SUBMITTED BY

TRAIL RIDGE LANDFILL, INC.
Jacksonville, Florida

England-Thims & Miller, Inc.
Consulting & Design Engineers
3131 St. Johns Bluff Road So. Jacksonville, FL 32216

Date: JULY, 1990 Project No.: E89-113-09

RESPONSES

FDERL Permit File

89-113-9
PLAN "A"

RECEIVED FEB 27 1991 DER-JACKSONVILLE

Florida Department of Environmental Regulation

Northeast District • 3426 Bills Road • Jacksonville, Florida 32207 • 904-798-4200

Bob Martinez, Governor | Dale Twachtmann, Secretary | John Shearer, Assistant Secretary
Ernest Frey, Deputy Assistant Secretary

August 23, 1990

CERTIFIED - RETURN RECEIPT

Mr. Dwayne Igou
Trail Ridge Landfill, Inc.
Post Office Box 6987
Jacksonville, Florida 32236

Dear Mr. Igou:

Duval County - Solid Waste
Trail Ridge Landfill, Class I & III Construction
Permit Application No. 184444
<u>Request for Additional Information</u>

The Department has reviewed the referenced permit application package, received in this office July 27, 1990, in accordance with Florida Administrative Code (FAC) Rule 17-4.055. The following reviews are enclosed:

Attachment 1, Review Memorandum dated August 23, 1990, prepared by Mary C. Nogas, P.E., and Emerson Raulerson

Attachment 2, Review Memorandum dated August 22, 1990, prepared by Michael Eaton and Jeremy Tyler

Attachment 3, Review Memorandum dated August 23, 1990, prepared by Eric Silvers, P.G.

The information requested in these reviews is required in order for the Department to proceed with the processing of your application. Please provide the requested information within thirty (30) days from the date of receipt of this letter. Action on the permit application will be delayed until the requested information has been received by this office.

If you have any questions, please contact me at the letterhead address or telephone number.

Sincerely,

MC Nogas

Mary C. Nogas, P.E.
Supervisor, Solid Waste

MCN:ml
Enclosures
cc: Douglas Miller, P.E.

State of Florida
DEPARTMENT OF ENVIRONMENTAL REGULATION

For Routing To Other Than The Addressee	
To	Location
To	Location
To	Location
From	Date

Interoffice Memorandum

REVIEW MEMORANDUM

FROM: Mary Nogas
Emerson Raulerson

DATE: August 23, 1990

SUBJECT: Trail Ridge Landfill - Plan A

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1. Please confirm that the bottom elevation of the North Borrow Area is 50.

2. Please provide supporting calcualtions for the amount of borrow material that is available at the site; the amount needed, and the amount of dirt needed for final cover.

3. Please justify using a 300-foot zone of influence for gas vents instead of the 300-foot centers that the Department normally requires.

4. The first page of Appendix IX (i.e., HELP Model Summary) lists the soil transmissivity of the geodrain as 2.2×10^{-4} m^2/sec instead of 2.2×10^{-3} as indicated on page 8-2, Section C, Part 1. Please clarify.

5. Please clarify what the leakage fraction is equal to on the second page of Appendix IX for Layer 7.

6. What will be the basis for determining what is an acceptable leak in the liner versus one which requires remediation.

7. Please modify the QAQC Plan to include details for Claymax, as this could not be found in the plan that was submitted.

8. In the original permit application, Appendix IX, paragraph 3, indicates that the thickness of the liner and Claymax that is inputted into the HELP Model has been increased by a factor of 10. In order to compensate for this, the permeability was to also have been increased by a factor of 10, from 10^{-8} to 10^{-7} centimeters per second. This, however, appears not to have been done and the permeability was left at 10^{-8} even though the thickness was increased. Please check.

9. Please provide the Department with the Claymax manufacturer's "technical data," including data analyzing the effect the expanding Claymax will have on the geonet.

10. Please submit information justifying the porosities, field capacities, wilting points, and permeabilities for the Claymax and geonet.

11. Please indicate how the soil characteristics were obtained for Layer 3 of the HELP Model Liner Analysis.

12. It appears that Layers 1 and 2 of the HELP Model Final Cover Analysis utilize identical soil characteristics. However, it is also indicated that one is a vertical percolation layer and the other a lateral drainage layer. Please explain.

13. Please note that the Department has not yet received proof of publication.

14. Please explain what the values of 104.4495, 20.1227, 46.6775, and 54.7967 inches of settlement refer to in the submittal dated July 17, 1990.

15. Please indicate how special wastes will be handled (i.e., a leak-proof container for oil and batteries kept off the ground) and the necessary storage space required based upon the amount of each of the various wastes to be stored at any time.

16. Please indicate whether any portion of the "white goods storage area" will be paved since it is going to be used for storing many other types of special wastes.

17. Please provide documentation which would support your request for a six (6) month installation period for the gas vents.

18. Please indicate that a spotter will be present at the Class III area at all times the landfill is open.

For Routing To Other Than The Addressee	
To	Location
To	Location
To	Location
From	Date

State of Florida
DEPARTMENT OF ENVIRONMENTAL REGULATION

Interoffice Memorandum

NORTHEAST DISTRICT - JACKSONVILLE

TO: Mary Nogas

THROUGH: Jeremy Tyler JT

FROM: Michael Eaton ME

DATE: August 22, 1990

SUBJECT: RAI Questions for Wetland Review of MSSW Application Trail Ridge Landfill - Plan "A"

The following questions should be included in the RAI:

1. Please demonstrate the effect the borrow area will have on the adjacent wetlands. Indicate pre and post conditions in relation to the seasonal high and low groundwater elevation as well as the effect on surface water drainage patterns.

2. Please demonstrate that a 50-foot minimum buff around the borrow area and the wetlands is sufficient to not alter the groundwater or surface water drainage patterns of the adjacent wetlands.

3. Please provide detailed information about the stormwater pump system and its effects on the receiving wetlands. Please include frequency of pumping, volume of discharge, location of discharge pipe, erosion control, and the current environmental condition of the receiving wetland.

ME/eml

State of Florida
DEPARTMENT OF ENVIRONMENTAL REGULATION

For Routing To Other Than The Addressee	
To	Location
To	Location
To	Location
From	Date

Interoffice Memorandum

NORTHEAST DISTRICT

TO: Mary C. Nogas, P.E.
Solid Waste Supervisor

THROUGH: Jay Carver
Waste Cleanup Manager

FROM: Eric R. Silvers, P.G.
Environmental Specialist

DATE: August 23, 1990

SUBJECT: Solid Waste - Duval County
Trailridge Landfill #2
Groundwater Monitoring

The groundwater monitoring plan for the referenced facility has been reviewed and is acceptable as proposed. To avoid any confusion the groundwater monitoring plan for the revised landfill design is essentially identical to the original monitoring plan plus the additional items requested in the July 15, 1990 RAI. It should be noted however that the phased installation of the monitoring wells has been modified to coincide with the revised landfill construction phases.

England-Thims & Miller, Inc.
Consulting & Design Engineers
3131 St Johns Bluff Road So Jacksonville, FL 32216
904-642-8990

PRINCIPALS
James E England, PE President
Robert E Thims, VPres, Sec
Douglas C Miller PE, V Pres
N Hugh Mathews, PE, V Pres
James M Robinson, PE, V Pres

September 11, 1990

Mrs. Mary C. Nogas, P.E.
Supervisor, Solid Waste
Department of Environmental Regulation
Northeast District
7825 Baymeadows Way - Suite 200
Jacksonville, Florida 32256-7577

Reference: Trail Ridge Landfill Plan "A" - Class I and Class III
Request for Additional Information
FDER # 184444
ET&M NO. E89-113-9

Dear Ms. Nogas:

Pursuant to your letter of August 23, 1990, please find attached the responses to your request for additional information on Attachment Nos. 1 and 2. Attachment No. 3 required no response.

Please note a revised Closure and Post-Closure Cost Estimate has been submitted for your approval.

I trust this additional information is satisfactory and completes the Trail Ridge Landfill Plan "A" application file.

If I can be of further service, please do not hesitate to contact me.

Sincerely,

ENGLAND, THIMS & MILLER, INC.

Douglas C. Miller, P.E.
Vice President

Attachments: RAI Response No. 1 and No. 2

Enclosures:
1. Revised Drawings Nos. 17, 18, 19, 20, 25 and 34
2. Borrow Calculations
3. Appendix IX (revised)
4. Claymax Manufactures Data
5. Reference Page 172; "Design, Construction and Monitoring of Sanitary Landfills"
6. Amendment No. 1 to QA/QC Manual
7. Drawing No. 24A - Marked in Red
8. Appendix XIV - Closure and Post Closure Cost Estimate (Revised)
9. Letter from Ellis & Associates (Settlement Calculations)

LEACHATE COLLECTION PERFORMANCE

The performance of the proposed landfill was analyzed by using a widely used computer model, HELP. The HELP Model, Hydrologic Evaluation of Landfill Performance, (Schroeder et al. 1984a; 1986b) performs a sequential daily analysis to determine runoff, evapotranspiration, percolation and lateral drainage from the landfill to obtain daily, monthly, and annual water balances. The model was developed by the U.S. Army Engineers Waterway Experiment Station, Vicksburg, Mississippi for the U. S. Environmental Protection Agency.

Analysis of the Trail Ridge project consisted of two parts. The first involved the evaluation of the liner system to meet current Florida Department of Environmental Regulation (FDER) rules of not allowing the hydraulic head on the liner to be more than 1 inch. This type of constraint necessitated the use of a synthetic geodrain directly above the two 60 mil liners to facilitate rapid lateral drainage of leachate to the collection system. By using this material, which exhibits high flow capacity, the peak daily hydraulic head has been calculated to be 0.0088 inch on the primary liner. This was based on a worst case scenario of 6 feet of municipal waste with 6 inches of cover, with no rainfall being allowed to be diverted outside of the leachate collection system.

As stated above, Analysis No. 1 consisted of modeling the worst case scenario to determine the maximum depth of hydraulic head anticipated on the primary liner system. Eight layers were used in the HELP Model.

<u>LAYER ONE (TOP)</u>	-	6" Daily Cover VERTICAL PERCOLATION LAYER Soil Texture Class No. 5 adjusted for compaction
<u>LAYER TWO</u>	-	6' compacted municipal waste VERTICAL PERCOLATION LAYER Soil Texture Class No. 18
<u>LAYER THREE</u>	-	2' soil blanket over liner VERTICAL PERCOLATION LAYER Soil Texture Class No. 5 adjusted for compaction

LAYER FOUR - Geodrain
LATERAL DRAINAGE LAYER
Transmissivity $1.1X10^{-3}$ m^2/sec
Thickness = 0.22 in.
Porosity 0.700 vol/vol
Field Capacity 0.045 vol/vol - Soil Texture Class No. 1
Wilting Point 0.02 vol/vol - Minimum Value
National Seal Company PN 3000
7000 PSF Loading

LAYER FIVE - 60 mil HDPE liner with Geodrain
FLEXIBLE MEMBRANE LINER WITH BARRIER SOIL LINER

LAYER SIX - Geodrain
LATERAL DRAINAGE LAYER

LAYER SEVEN - 60 mil HDPE with Claymax
FLEXIBLE MEMBRANE LINER WITH BARRIER SOIL LINER
Soil Texture Class No. 17

LAYER EIGHT - 6" compacted base
VERTICAL PERCOLATION LAYER
Soil Texture Class No. 15 adjusted for compaction

RESULTS OF ANALYSIS ONE

By setting the Liner Leakage Eraction for Layer Five (Primary Liner) equal to zero, the head from Layer Four's lateral drainage was computed to be $2.2X10^{-4}$m (0.0088 in). Once this maximum head was established, the leakage rate was determined for one hole (1×10^{-5} M^2) per acre. This rate was 9 GPAD. For conservative measures the leakage rate was also calculated based upon the geodrain being completely saturated. This provided a leakage rate of 46 GPAD.

The second analysis used 11 layers with the bottom 6 layers being the same as the bottom 6 layers of analysis #1 but the top layers have been added to reflect the final cover design incorporated in the proposed construction drawings.

LAYER ONE (TOP) - 6" top soil
VERTICAL PERCOLATION LAYER
Soil Texture Class No. 5

LAYER TWO - 18" compacted soil
LATERAL DRAINAGE LAYER
Soil Texture Class No. 5 adjusted for compaction

LAYER THREE - 12" clay
BARRIER SOIL LINER
Soil Texture Class No. 16

LAYER FOUR - 12" intermediate soil cover
VERTICAL PERCOLATION LAYER
Soil Texture Class No. 5 adjusted for compaction

LAYER FIVE - 100' compacted municipal waste
VERTICAL PERCOLATION LAYER
Soil Texture Class No. 18

LAYER SIX - 2' soil blanket over liner
VERTICAL PERCOLATION LAYER

LAYER SEVEN - Geodrain
LATERAL DRAINAGE LAYER

LAYER EIGHT - 60 mil HDPE flexible membrane liner and Geonet
FLEXIBLE MEMBRANE LINER WITH BARRIER SOIL LINER

LAYER NINE - Geodrain
LATERAL DRAINAGE LAYER

LAYER TEN - 60 MIL HDPE flexible membrane liner with Claymax
FLEXIBLE MEMBRANE LINER WITH BARRIER SOIL LINER

LAYER ELEVEN - 6" Compacted base
VERTICAL PERCOLATION LAYER

RESULTS OF ANALYSIS TWO

By setting the Liner Leakage Fraction for Layer Eight (Primary Liner) equal to zero, no head from Layer Seven's lateral drainage was exhibited. Conclusion: The leachate is absorbed in the upper layers.

NOTE: Rainfall data entered was based on twenty year data as provided by FDER.

LEAKAGE RATE CALCULATIONS FOR LINER ANALYSIS

LATERAL DRAINAGE FROM LAYER 4 (PER H.E.L.P. MODEL)

LARGEST AVERAGE MONTHLY VALUE (SEPT.) = 4.0533 IN/MTH

AVERAGE ANNUAL TOTAL = 16.9584 IN/YEAR

4.0533 IN/MTH > 16.9584 IN/YR

4.0533 IN/MTH = 3.9×10^{-8} M/sec

Q (IMPINGEMENT RATE) = 3.9×10^{-8} M/SEC

$$H = L\left(\sqrt{Q/K + \tan^2\beta} - \tan\beta\right)$$

H = HEAD ON PRIMARY DRAINAGE LAYER

Q = IMPINGEMENT RATE (3.9×10^{-8} M/SEC)

K = HYDRAULIC CONDUCTIVITY OF GEODRAIN (19.6 cm/SEC ≅ 0.2 M/SEC)

$\tan\beta$ = BASE SLOPE (2% = 0.02)

L = DRAINAGE LENGTH (150 FT = 45.72 M ≈ 46 M)

$$H = 46\left(\sqrt{\frac{3.9 \times 10^{-8}}{0.2} + (0.02)^2} - 0.02\right)$$

= 0.00022 M

= 0.0088 IN

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3131 St Johns Bluff Road So Jacksonville, FL 32216
904-642-8990

ASSUMPTION: 1 HOLE/AC

AREA = 0.1 CM^2 = 1×10^{-5} M^2

$$Q = 0.6 A \sqrt{2gH}$$

Q = LEAKAGE RATE THROUGH PRIMARY LINER

A = AREA OF HOLE (1×10^{-5} M^2)

g = 9.8 M/SEC

H = HEAD (2.2×10^{-4} M – SEE PREVIOUS SHEET)

$$Q = 0.6 (1 \times 10^{-5}) \sqrt{2(9.8)(2.2 \times 10^{-4})}$$

$= 3.94 \times 10^{-7}$ M^3/SEC/HOLE

3.94×10^{-7} M^3/SEC/HOLE × 1 HOLE/AC × 1 AC/4047 M^2

Q = 9.74×10^{-11} M/SEC

Q = 9 GAL/AC/DAY

FOR CONSERVATIVE MEASURES, ASSUME THE GEODRAIN IS SATURATED.
HEAD ON PRIMARY LINER = 0.22 IN = 0.0058 M

$$Q = 0.6 (1 \times 10^{-5}) \sqrt{2(9.8)(0.0058)}$$

$= 2.02 \times 10^{-6}$ M^3/SEC ÷ 4047

$= 5.0 \times 10^{-10}$ M/SEC

Q = 46.2 GAL/AC/DAY

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TRAIL RIDGE LANDFILL (PLAN A) - FINAL COVER ANALYSIS (2% SLOPE)
TYPE I SOLID WASTE
E89 - 113 - 9 SEPTEMBER 7, 1990

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FAIR GRASS

LAYER 1

VERTICAL PERCOLATION LAYER

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	=	0.0653 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.0010000000475 CM/SEC

LAYER 2

LATERAL DRAINAGE LAYER

THICKNESS	=	18.00 INCHES
POROSITY	=	0.3573 VOL/VOL
FIELD CAPACITY	=	0.1128 VOL/VOL
WILTING POINT	=	0.0580 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0635 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.0007999999798 CM/SEC
SLOPE	=	2.00 PERCENT
DRAINAGE LENGTH	=	850.0 FEET

LAYER 3

BARRIER SOIL LINER

THICKNESS	=	12.00 INCHES
POROSITY	=	0.4300 VOL/VOL
FIELD CAPACITY	=	0.3660 VOL/VOL
WILTING POINT	=	0.2800 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.2886 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.0000001000000 CM/SEC

LAYER 4

VERTICAL PERCOLATION LAYER

THICKNESS	=	12.00 INCHES
POROSITY	=	0.3573 VOL/VOL
FIELD CAPACITY	=	0.1128 VOL/VOL
WILTING POINT	=	0.0580 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0635 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.0007999999798 CM/SEC

LAYER 5

VERTICAL PERCOLATION LAYER

THICKNESS	=	1200.00 INCHES
POROSITY	=	0.5200 VOL/VOL
FIELD CAPACITY	=	0.2942 VOL/VOL
WILTING POINT	=	0.1400 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.1554 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.0001999999949 CM/SEC

LAYER 6

VERTICAL PERCOLATION LAYER

THICKNESS	=	24.00 INCHES
POROSITY	=	0.3573 VOL/VOL
FIELD CAPACITY	=	0.1128 VOL/VOL
WILTING POINT	=	0.0580 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0635 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.0007999999798 CM/SEC

LAYER 7

LATERAL DRAINAGE LAYER

THICKNESS	=	0.22 INCHES
POROSITY	=	0.7000 VOL/VOL
FIELD CAPACITY	=	0.0450 VOL/VOL
WILTING POINT	=	0.0200 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0225 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	19.6849994659424 CM/SEC
SLOPE	=	2.00 PERCENT
DRAINAGE LENGTH	=	150.0 FEET

LAYER 8

BARRIER SOIL LINER WITH FLEXIBLE MEMBRANE LINER

THICKNESS	=	0.22 INCHES
POROSITY	=	0.7000 VOL/VOL
FIELD CAPACITY	=	0.0450 VOL/VOL
WILTING POINT	=	0.0200 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0225 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	19.6849994659424 CM/SEC
LINER LEAKAGE FRACTION	=	0.00000000

GENERAL SIMULATION DATA

SCS RUNOFF CURVE NUMBER	=	95.00
TOTAL AREA OF COVER	=	43560. SQ FT
EVAPORATIVE ZONE DEPTH	=	30.00 INCHES
UPPER LIMIT VEG. STORAGE	=	9.1734 INCHES
INITIAL VEG. STORAGE	=	1.5348 INCHES

SOIL WATER CONTENT INITIALIZED BY USER.

CLIMATOLOGICAL DATA

USER SPECIFIED RAINFALL WITH SYNTHETIC DAILY TEMPERATURES AND SOLAR RADIATION FOR JACKSONVILLE FLORIDA

MAXIMUM LEAF AREA INDEX	=	3.30
START OF GROWING SEASON (JULIAN DATE)	=	37
END OF GROWING SEASON (JULIAN DATE)	=	4

NORMAL MEAN MONTHLY TEMPERATURES, DEGREES FAHRENHEIT

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
53.20	55.10	61.30	67.70	74.10	79.00
81.30	81.00	78.20	69.50	60.80	54.80

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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	2.60	3.54	2.57	2.82	3.68	4.36
	7.46	9.03	8.11	2.39	2.64	3.05
STD. DEVIATIONS	1.70	2.18	2.39	2.31	2.48	2.07
	3.02	1.53	1.98	1.69	1.98	1.40
RUNOFF						
TOTALS	0.733	0.834	0.802	0.777	1.252	1.053
	2.335	3.419	3.019	0.475	0.607	0.833
STD. DEVIATIONS	1.169	0.890	1.356	0.764	1.360	1.124
	1.260	0.637	1.764	0.790	0.542	0.778
EVAPOTRANSPIRATION						
TOTALS	1.389	1.899	2.219	3.306	2.938	3.204
	4.653	4.513	5.209	3.170	1.537	1.678
STD. DEVIATIONS	0.437	0.506	0.594	2.039	1.619	1.048
	1.469	1.828	0.633	1.103	0.784	0.263
LATERAL DRAINAGE FROM LAYER 2						
TOTALS	0.0022	0.0023	0.0055	0.0036	0.0000	0.0000
	0.0000	0.0000	0.0002	0.0001	0.0000	0.0004
STD. DEVIATIONS	0.0050	0.0044	0.0039	0.0027	0.0000	0.0000
	0.0000	0.0000	0.0004	0.0003	0.0000	0.0010
PERCOLATION FROM LAYER 3						
TOTALS	0.0308	0.0347	0.1001	0.0638	0.0000	0.0000
	0.0000	0.0000	0.0084	0.0074	0.0000	0.0101
STD. DEVIATIONS	0.0689	0.0600	0.0584	0.0405	0.0000	0.0000
	0.0000	0.0000	0.0187	0.0166	0.0000	0.0225
LATERAL DRAINAGE FROM 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

PERCOLATION FROM LAYER 8

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

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

	(INCHES)		(CU. FT.)	PERCENT
PRECIPITATION	52.26	(6.568)	189711.	100.00
RUNOFF	16.139	(3.237)	58586.	30.88
EVAPOTRANSPIRATION	35.716	(4.029)	129650.	68.34
LATERAL DRAINAGE FROM LAYER 2	0.0144	(0.0127)	52.	0.03
PERCOLATION FROM LAYER 3	0.2553	(0.1675)	927.	0.49
LATERAL DRAINAGE FROM LAYER 7	0.0000	(0.0000)	0.	0.00
PERCOLATION FROM LAYER 8	0.0000	(0.0000)	0.	0.00
CHANGE IN WATER STORAGE	0.392	(2.182)	1423.	0.75

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 5

	(INCHES)	(CU. FT.)
PRECIPITATION	4.79	17387.7
RUNOFF	3.647	13239.3
LATERAL DRAINAGE FROM LAYER 2	0.0004	1.3
PERCOLATION FROM LAYER 3	0.0050	18.2
HEAD ON LAYER 3	5.7	
LATERAL DRAINAGE FROM LAYER 7	0.0000	0.0
PERCOLATION FROM LAYER 8	0.0000	0.0
HEAD ON LAYER 8	0.0	
SNOW WATER	0.00	0.0

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.2253

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.0579

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FINAL WATER STORAGE AT END OF YEAR 5

LAYER	(INCHES)	(VOL/VOL)
1	0.74	0.1241
2	1.47	0.0819
3	3.46	0.2886
4	1.70	0.1413
5	186.82	0.1557
6	1.53	0.0636
7	0.00	0.0225
8	0.00	0.0225
SNOW WATER	0.00	

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 TRAIL RIDGE LANDFILL (PLAN A) - LINER ANALYSIS (150 FT. CELL)
 TYPE I SOLID WASTE
 E89 - 113 - 9  SEPTEMBER 7, 1990

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                                BARE GROUND

                                 LAYER  1
                                 --------

                        VERTICAL PERCOLATION LAYER
   THICKNESS                                =      6.00 INCHES
   POROSITY                                 =      0.3573 VOL/VOL
   FIELD CAPACITY                           =      0.1128 VOL/VOL
   WILTING POINT                            =      0.0580 VOL/VOL
   INITIAL SOIL WATER CONTENT               =      0.0635 VOL/VOL
   SATURATED HYDRAULIC CONDUCTIVITY         =      0.0007999999798 CM/SEC


                                 LAYER  2
                                 --------

                        VERTICAL PERCOLATION LAYER
   THICKNESS                                =     72.00 INCHES
   POROSITY                                 =      0.5200 VOL/VOL
   FIELD CAPACITY                           =      0.2942 VOL/VOL
   WILTING POINT                            =      0.1400 VOL/VOL
   INITIAL SOIL WATER CONTENT               =      0.1554 VOL/VOL
   SATURATED HYDRAULIC CONDUCTIVITY         =      0.0001999999949 CM/SEC


                                 LAYER  3
                                 --------

                        VERTICAL PERCOLATION LAYER
   THICKNESS                                =     24.00 INCHES
   POROSITY                                 =      0.3573 VOL/VOL
   FIELD CAPACITY                           =      0.1128 VOL/VOL
   WILTING POINT                            =      0.0580 VOL/VOL
   INITIAL SOIL WATER CONTENT               =      0.0635 VOL/VOL
   SATURATED HYDRAULIC CONDUCTIVITY         =      0.0007999999798 CM/SEC
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LAYER 4

LATERAL DRAINAGE LAYER

THICKNESS	=	0.22 INCHES
POROSITY	=	0.7000 VOL/VOL
FIELD CAPACITY	=	0.0450 VOL/VOL
WILTING POINT	=	0.0200 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0225 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	19.6849994659424 CM/SEC
SLOPE	=	2.00 PERCENT
DRAINAGE LENGTH	=	150.0 FEET

LAYER 5

BARRIER SOIL LINER WITH FLEXIBLE MEMBRANE LINER

THICKNESS	=	0.22 INCHES
POROSITY	=	0.7000 VOL/VOL
FIELD CAPACITY	=	0.0450 VOL/VOL
WILTING POINT	=	0.0200 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0225 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.0000001000000 CM/SEC
LINER LEAKAGE FRACTION	=	0.00000000

GENERAL SIMULATION DATA

SCS RUNOFF CURVE NUMBER	=	83.31
TOTAL AREA OF COVER	=	43560. SQ FT
EVAPORATIVE ZONE DEPTH	=	10.00 INCHES
POTENTIAL RUNOFF FRACTION	=	0.000000
UPPER LIMIT VEG. STORAGE	=	4.2238 INCHES
INITIAL VEG. STORAGE	=	1.0026 INCHES

SOIL WATER CONTENT INITIALIZED BY USER.

CLIMATOLOGICAL DATA

SYNTHETIC RAINFALL WITH SYNTHETIC DAILY TEMPERATURES AND
SOLAR RADIATION FOR JACKSONVILLE FLORIDA

MAXIMUM LEAF AREA INDEX	=	0.00
START OF GROWING SEASON (JULIAN DATE)	=	37
END OF GROWING SEASON (JULIAN DATE)	=	4

NORMAL MEAN MONTHLY TEMPERATURES, DEGREES FAHRENHEIT

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
53.20	55.10	61.30	67.70	74.10	79.00
81.30	81.00	78.20	69.50	60.80	54.80

****

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 5

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	2.60	3.54	2.57	2.82	3.68	4.36
	7.46	9.03	8.11	2.39	2.64	3.05
STD. DEVIATIONS	1.70	2.18	2.39	2.31	2.48	2.07
	3.02	1.53	1.98	1.69	1.98	1.40
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	1.510	2.233	2.206	1.557	2.808	2.917
	4.337	4.350	4.179	2.431	1.692	2.085
STD. DEVIATIONS	0.597	0.743	0.952	1.139	1.419	0.621
	1.219	1.467	0.446	0.918	0.761	0.517
LATERAL DRAINAGE FROM LAYER 4						
TOTALS	0.5972	0.8141	1.1759	0.9616	1.0768	1.0802
	1.2483	2.1088	4.0533	1.9930	0.9967	0.8527
STD. DEVIATIONS	0.5245	0.5620	0.8422	0.8089	0.7078	0.6306
	0.7550	1.9844	2.4607	1.1736	0.5880	0.5524
PERCOLATION 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

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

	(INCHES)		(CU. FT.)	PERCENT
PRECIPITATION	52.26	(6.568)	189711.	100.00
RUNOFF	0.000	(0.000)	0.	0.00
EVAPOTRANSPIRATION	32.305	(2.790)	117267.	61.81
LATERAL DRAINAGE FROM LAYER 4	16.9584	(9.7427)	61559.	32.45
PERCOLATION FROM LAYER 5	0.0000	(0.0000)	0.	0.00
CHANGE IN WATER STORAGE	2.998	(7.158)	10884.	5.74

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 5

	(INCHES)	(CU. FT.)
PRECIPITATION	4.79	17387.7
RUNOFF	0.000	0.0
LATERAL DRAINAGE FROM LAYER 4	0.3773	1369.6
PERCOLATION FROM LAYER 5	0.0000	0.0
HEAD ON LAYER 5	0.1	
SNOW WATER	0.00	0.0

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.3749

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.0881

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FINAL WATER STORAGE AT END OF YEAR 5

LAYER	(INCHES)	(VOL/VOL)
1	0.38	0.0635
2	23.05	0.3201
3	4.65	0.1936
4	0.01	0.0586
5	0.00	0.0225
SNOW WATER	0.00	

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ATTACHMENT NO. 1

RESPONSE TO

REVIEW MEMORANDUM

DATED AUGUST 23, 1990

FROM: Mary Nogas
Emerson Raulerson

REFERENCE: TRAIL RIDGE LANDFILL - PLAN "A"

QUESTION 1: **Please confirm that the bottom elevation of the North Borrow Area is 50.**

RESPONSE 1: The bottom elevation of the North Borrow Area is 50.0.

QUESTION 2: **Please provide supporting calculations for the amount of borrow material that is available at the site; the amount needed, and the amount of dirt needed for final cover.**

RESPONSE 2: The calculations for the borrow material available and the borrow material required for landfill construction are attached.

QUESTION 3: **Please justify using a 300-foot zone of influence for gas vents instead of the 300-foot centers that the Department normally requires.**

RESPONSE 3: A 300-foot hexagonal array provides a 100% overlap versus a 60% overlap for 300-foot centers. (see attachment)

QUESTION 4: **The first page of Appendix IX (i.e., HELP Model Summary) lists the soil transmissivity of the geodrain as $2.2X10^{-4}m^2$/sec instead of $2.2X10^{-3}$ as indicated on page 8-2, Section C, Part 1. Please clarify.**

RESPONSE 4: Due to the change in D.E.R. regulations regarding liner designs, a revised arrangement for the components of the liner is proposed. This has necessitated remodelling the H.E.L.P. computer program. This is attached. The correct transmissivity of the geodrain is $1.1X10^{-3}m^2$ /sec @ 7000 psf. Enclosed are results of transmissivity tests performed to verify data of the PN-3000 Geonet. Please note Appendix IX has been replaced in its entirety.

QUESTION 5: **Please clarify what the leakage fraction is equal to on the second page of Appendix IX for Layer 7.**

RESPONSE 5: Liner leakage fractions vary due the underlaying material. A high leakage fraction would be expected with a coarse sand or gravel material. A low leakage fraction would be used for a clay or claymax underlying material.

A different methodology is proposed supplementing the H.E.L.P. program to establish the liner leakage rate. We have set the Liner Leakage Fraction equal to 0.0000 for the Primary Liner so that the maximum head from the Lateral Drainage Layer immediately above could be established. For Analysis One (worst case) the head was calculated to be 0.0088 IN. For Analysis Two (final cover) no head was exhibited on the Primary Liner. These calculations are documented in the USEPA, "Background Document: Proposed Liner and Leak Detection Rule", Prepared by Geoservices, Inc.

QUESTION 6: **What will be the basis for determining what is an acceptable leak in the liner versus one which requires remediation.**

RESPONSE 6: A leachate volume in excess of 100 gallons per acre per day in the secondary leachate collection/leak detection system would require remediation.

QUESTION 7: **Please modify the QAQC Plan to include details for Claymax, as this could not be found in the plan that was submitted.**

RESPONSE 7: See attached Amendment No. 1 to "Quality Assurance Manual for the Installation of Geosynthetic Lining Systems". Please note the liner cross-section has been modified to include claymax below the secondary 60 mil HDPE only. (See Response To Question No. 9.)

QUESTION 8: **In the original permit application, Appendix IX, paragraph 3, indicates that the thickness of the liner and Claymax that is inputted into the HELP Model has been increased by a factor of 10. In order to compensate for this, the permeability was to also have been increased by a factor of 10, from 10^{-8} to 10^{-7} centimeters per second. This, however, appears not to have been done and the permeability was left at 10^{-8} even though the thickness was increased. Please check.**

RESPONSE 8: As shown in the revised Leachate Collection Performance narrative attached, we would propose to use a thickness of 0.25 IN and Soil Texture Class No. 17 default characteristics for the Flexible Membrane Liner with Claymax. However, by setting the Liner Leakage Fraction to 0.000 for the primary liner renders this a moot point since the H.E.L.P. model shows no drainage taking place below the primary liner.

QUESTION 9: Please provide the Department with the Claymax manufacturer's "technical data," including data analyzing the effect the expanding Claymax will have on the geonet.

RESPONSE 9: The technical data from the Claymax manufacturer is attached. The liner cross-section has been modified to include claymax only below the secondary 60 mil HDPE liner. Therefore no claymax is located above the geonet. Revised drawings are attached.

QUESTION 10: Please submit information justifying the porosites, field capacities, wilting points, and permeabilities for the Claymax and geonet.

RESPONSE 10: Enclosed are manufacturers data concerning the Claymax and Geonet. By utilizing the supplemental methodology with the H.E.L.P. no data was entered for the Flexible Membrane Liner with Claymax. By setting the Liner Leakage Fraction equal to zero for the Primary Liner, no drainage is allowed, therefore the underlying layers is not considered. The data inputted for the Geonet, excluding the porosity and the saturated hydraulic conductivity value was obtained from default Soil Texture Class 1 since this demonstrated the highest conductivity value. The 19.6 cm/sec value used in the H.E.L.P. model for the Geonet was obtained as illustrated below:

Hydraulic Transmissivity = $1.1X10^{-3}\ m^2/sec$
Thickness = 0.22 in = 0.5588 cm

$$.0011\ m^2/sec\ X\ \frac{(100\ cm)^2}{m^2} = 11\ cm^2/sec$$

$$11\ cm^2/sec + 0.5588\ cm = \underline{19.6\ cm/sec}$$

QUESTION 11: **Please indicate how the soil characteristics were obtained for Layer 3 of the HELP Model Liner Analysis.**

RESPONSE 11: These characteristics have been revised to be consistant with the 24" soil blanket in the Final Cover Analysis. This is default Soil Texture Class No. 5 adjusted for compaction.

QUESTION 12: **It appears that Layers 1 and 2 of the HELP Model Final cover Analysis utilize identical soil characteristics. However, it is also indicated that one is a vertical percolation layer and the other a lateral drainage layer. Please explain.**

RESPONSE 12: Layer 1 and Layer 2 are the same soils. However Layer 2 has been adjusted for compaction therefore its classification as a lateral drainage layer.

QUESTION 13: **Please note that the Department has not yet received proof of publication.**

RESPONSE 13: A publication request has been transmitted to the Florida Times Union. Proof of Publication will be submitted to the Department upon receipt.

QUESTION 14: **Please explain what the values of 104.4495, 20.1227, 46.6775, and 54.7967 inches of settlement refer to in the submittal dated July 17, 1990.**

RESPONSE 14: The computer program used to calculate settlements requires soil information be input to a depth equal two times the width of the foundation below the ground surface. For the particular site, the only compressible soils which will be subject to settlement are located to depths of approximately 85 to 130 feet below the ground surface which corresponds to approximately three to five percent of the width of the landfills. Therefore, in order to permit the computer program to generate settlements for various soil layers, a dummy layer of soil was input in order to provide data corresponding to a depth of two times the width of the landfill. The indicated settlements from the computer program included the settlement associated with the dummy layer. The settlements reported in our calculations subtracted the settlement associated with the dummy layer from the total settlement calculated from the computer program. The resulting settlement is representative of the settlement which can be expected from the compressible soil deposits located above the Hawthorne formation at the site.

QUESTION 15: **Please indicate how special wastes will be handled (i.e., a leak-proof container for oil and batteries kept off the ground) and the necessary storage space required based upon the amount of each of the various wastes to be stored at any time.**

RESPONSE 15: One City of Jacksonville Standardized leak-proof receptacle for waste oil will be provided. Additional containers may be provided based on demand. Batteries will be temporarily stored above grade on a concrete pad. A 0.5 +/- acre area northwest of the scale house has been designated for temporary storage of white goods. This area can store approximately 500 +/- appliances. Adequate room is available for expansion to the east if demand dictates.

A 0.5 +/- acre area southwest of the scale house has been designated for waste oil receptacles (1), battery storage area (375 s.f.) and non-contract hauler receptacles (6). Adequate area for expansion exists to the south and west if demand dictates.

See revised drawing No. 34 for site plan.

QUESTION 16: **Please indicate whether any portion of the "white goods storage area" will be paved since it is going to be used for storing many other types of special wastes.**

RESPONSE 16: The white goods area and non-contract hauler area will not be paved but will consist of a 6" thick crushed aggregate base. The waste oil receptacle and battery storage area will consist of a 15' X 30' concrete pad 4" thick with a 12" concrete curbing.

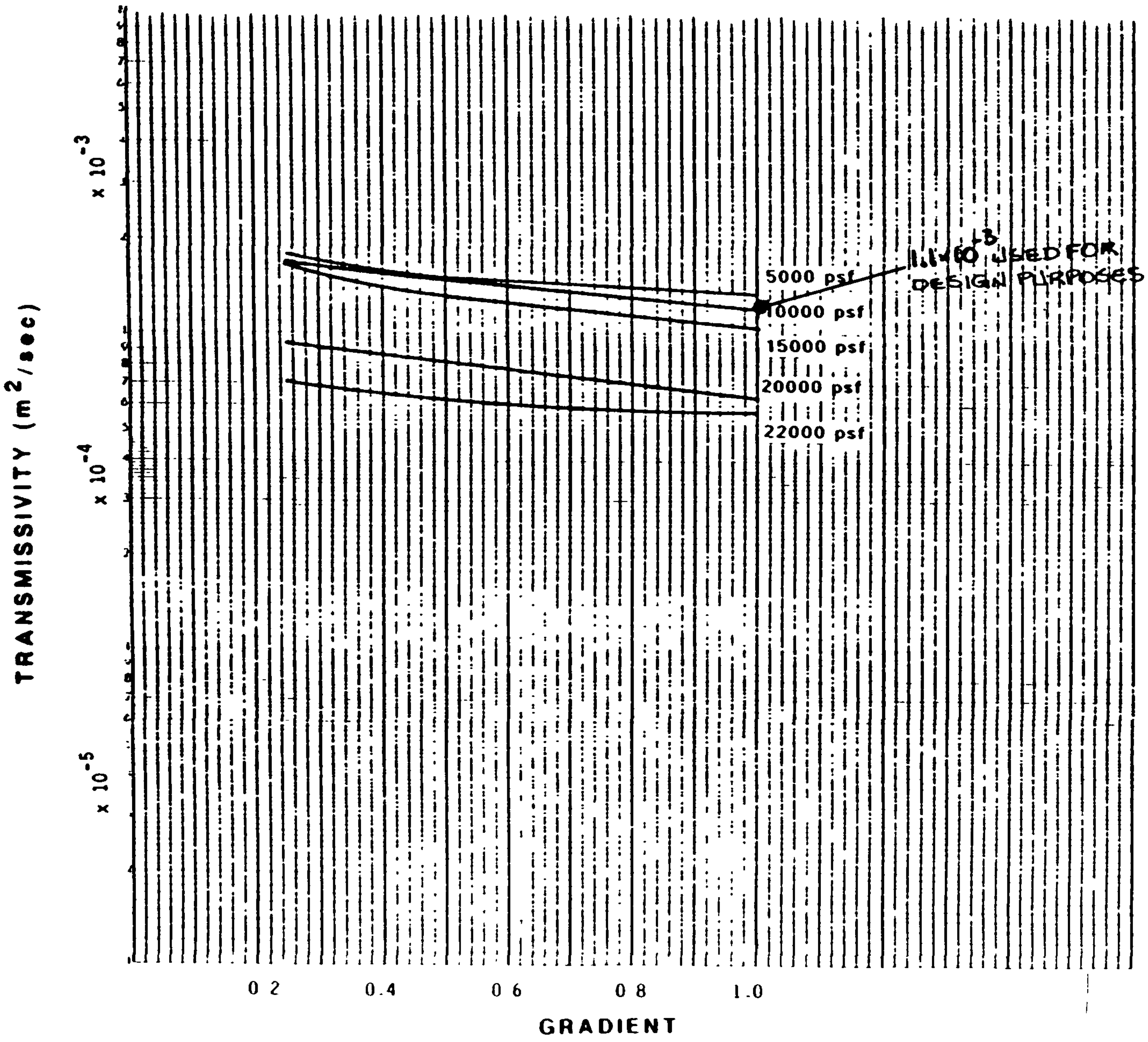
QUESTION 17: **Please provide documentation which would support your request for a six (6) month installation period for the gas vents.**

RESPONSE 17: Based on previous gas well installation experience it is anticipated that the Trail Ridge gas wells up to 140' deep can be installed at the rate of 3 per week. Phase VI of the landfill required 36 wells be installed. This would require 3 months of actual well construction. The drilling and construction of gas wells 36" in diameter by 140 feet deep is highly specialized with limited contractors available. Therefore 90 days has been allowed to schedule and mobilize the gas well contractor. Therefore it is reasonable to request gas well installation be completed within 6 months of final cover. However, every effort will be made to install wells as soon and as quickly as possible.

QUESTION 18: Please indicate that a spotter will be present at the Class III area at all times the landfill is open.

RESPONSE 18: A spotter will be present at the Class III area at all times during landfilling operations.

G 1 0 (6-88)



J & L TESTING COMPANY, INC

Geotechnical Geomembrane and Geotextile Testing

MATERIALS:

NSC 60 mil HDPE

PN-3000 Geonet

FLUID: Water

UNIT NO.: 1 TEMPERATURE: 60° F

SECTION:

UPPER LOAD PLATE

HDPE

GEONET

HDPE

LOWER LOAD PLATE

TRANSMISSIVITY TEST RESULTS

WASTE MANAGEMENT OF NORTH AMERICA

PROJECT NO: 89R454-01

DATE: March 11, 1989

FIGURE 1 A

ATTACHMENT NO. 2

RESPONSE TO

REVIEW MEMORANDUM

DATED AUGUST 22, 1990

FROM: Michael Eaton

SUBJECT: RAI Questions for Wetland Review of MSSW Application

REFERENCE: Trail Ridge Landfill - Plan "A"

QUESTION 1: **Please demonstrate the effect the borrow area will have on the adjacent wetlands. Indicate pre and post conditions in relation to the seasonal high and low groundwater elevation as well as the effect on surface water drainage patterns.**

RESPONSE 1: The North Borrow Area is proposed to be constructed totally in an upland area with a 50′ minimum setback between the excavation and wetland boundary. The borrow area will be excavated in the "wet". No dewatering or lowering of the groundwater is proposed.

The surficial groundwater elevations vary from 1± foot to 4± feet below ground surface depending on the location season and climatic conditions. A berm surrounding the borrow area is designed to elevation 125.0 or 1 foot above natural ground which ever is higher. This berm serves two purposes. First to prevent the lowering of groundwater elevation due to excavation on the east side of the borrow area. Second to prevent surface runoff from entering the borrow area.

The surface water drainage patterns in the North Borrow Area are controlled primarily by two ditch systems. (See attached Drawing No. 24A marked in red). The existing ditch systems intercept surface and groundwater drainage west of the North Borrow Area and discharge east of the Borrow Area. These ditches, which are located in the adjacent jurisdictional wetlands, are the primary control mechanism for surface and groundwater flow in the wetlands. No changes are occurring in these ditch systems.

QUESTION 2: **Please pleas demonstrate that a 50-foot minimum buffer around the borrow area and the wetlands is sufficient to not alter the groundwater or surface water drainage patterns of the adjacent wetlands.**

RESPONSE 2: See response to Question No. 1.

QUESTION 3: **Please provide detailed information about the stormwater pump system and its effects on the receiving wetlands. Please include frequency of pumping, volume of discharge, location of discharge pipe, erosion control, and the current environmental condition of the receiving wetland.**

RESPONSE 3: The stormwater pump stations are designed to pump the volume from the first 1" of stormwater runoff from the upland drainage area in 72 hours or less after a rainfall event. The total volume of discharge after a design rainfall event is 7.28 AC-FT - Class I and 3.97 AC-FT - Class III.

The frequency of pumping is designed to be within 72 hours after a rainfall event. However, the pump station can be operated manually or programmed to run on any schedule.

The wetland irrigation piping is located at the upland edge of the wetland boundary as shown on Drawing No. 25. Erosion is controlled by adjusting the individual 2" value to each irrigation area such that water slowly trickles from the perforated pipe at a non-eroding velocity. Excess water is discharged at the control structure. If no wetland irrigation is desired, then all water is discharged at the outlet control structure.

At the time of initial operation and As-Built Certification of the Water Management System, a on-site inspection will be made with the applicant and Florida Department of Environmental Regulation. At that time a review of site conditions will be made including the desirability of irrigating the wetlands or discharging directly to the surficial outfall. Subsequent to the initial operation decision, an independent environmental consultant shall perform an inspection each quarter for two years and recommend the continuance or modification to the operating procedure. Upon approval from Florida Department of Environmental Regulation, those operating procedures will be implemented.

The existing wetland may be characterized as a series of shallow, depressional wetland pockets within planted pine plantation. These pockets are separated from each other and from DER wetlands to the east by areas of nonlisted, upland vegetation, primarily gallberry (Ilex glabra). The vegetation of these pockets consists of scattered slash pine (Pinus elliottii), St. John's wort (Hypericum fasciculatum), bog button, and red root (Lachnanthes caroliniana). These wetland pockets are rarely inundated and have a seasonally high water table. The entire wetland area provides only marginal wildlife habitat and is rather marginal or transitional in nature.

BORROW MATERIAL

REQUIRED FOR LANDFILL CONSTRUCTION
TRAIL RIDGE LANDFILL - PLAN "A"

CLASS I LANDFILL

* Final Cover (24")	254,750 CY/FT X 2 FT	=	509,500 CY
Daily and intermediate cover (10)%	21,829,350 CY X 10%	=	1,182,935 CY
			2,692,435 CY

CLASS III LANDFILL

* Final Cover (24")	45,750 CY/FT X 2	=	91,500 CY
Weekly Cover (5%)	2,200,350 CY X 5%	=	110,017 CY
			201,517 CY

	TOTAL BORROW REQUIRED	2,893,952 CY
**	**TOTAL BORROW PROVIDED**	3,110,300 CY

* Clay portion of cap shall be imported from off-site.

** See Trail Ridge Landfill - Excavation Volumes Calculations

[illegible] RIDGE [illegible] [illegible] VOLUMES

CLASS I STORMWATER POND

EXISTING ELEVATION - WEST SIDE OF POND: [illegible]
AREA AT ELEVATION [illegible] (SQUARE FEET): [illegible]

EXISTING ELEVATION - EAST SIDE OF POND: [illegible]
AREA AT ELEVATION 107.0 (SQUARE FEET): [illegible]

PROPOSED ELEVATION AT BOTTOM: [illegible]
AREA AT ELEVATION 80.0 (SQUARE FEET): [illegible]

VOLUME OF EXCAVATION (CUBIC YARDS): [illegible]

CLASS III STORMWATER POND

EXISTING ELEVATION - WEST SIDE OF POND: [illegible]
AREA AT ELEVATION 115.0 (SQUARE FEET): [illegible]

EXISTING ELEVATION - EAST SIDE OF POND: [illegible]
AREA AT ELEVATION 101.0 (SQUARE FEET): [illegible]

PROPOSED ELEVATION AT BOTTOM: 80.0
AREA AT ELEVATION 80.0 (SQUARE FEET): [illegible]

VOLUME OF EXCAVATION (CUBIC YARDS): [illegible]

ON SITE BORROW AREA

EXISTING ELEVATION - WEST SIDE OF BORROW AREA: [illegible]
AREA AT ELEVATION 125.0 (SQUARE FEET): [illegible]

EXISTING ELEVATION - EAST SIDE OF BORROW AREA: [illegible]
AREA AT ELEVATION 105.0 (SQUARE FEET): [illegible]

PROPOSED ELEVATION AT BOTTOM: 50.0
AREA AT ELEVATION 50.0 (SQUARE FEET): [illegible]

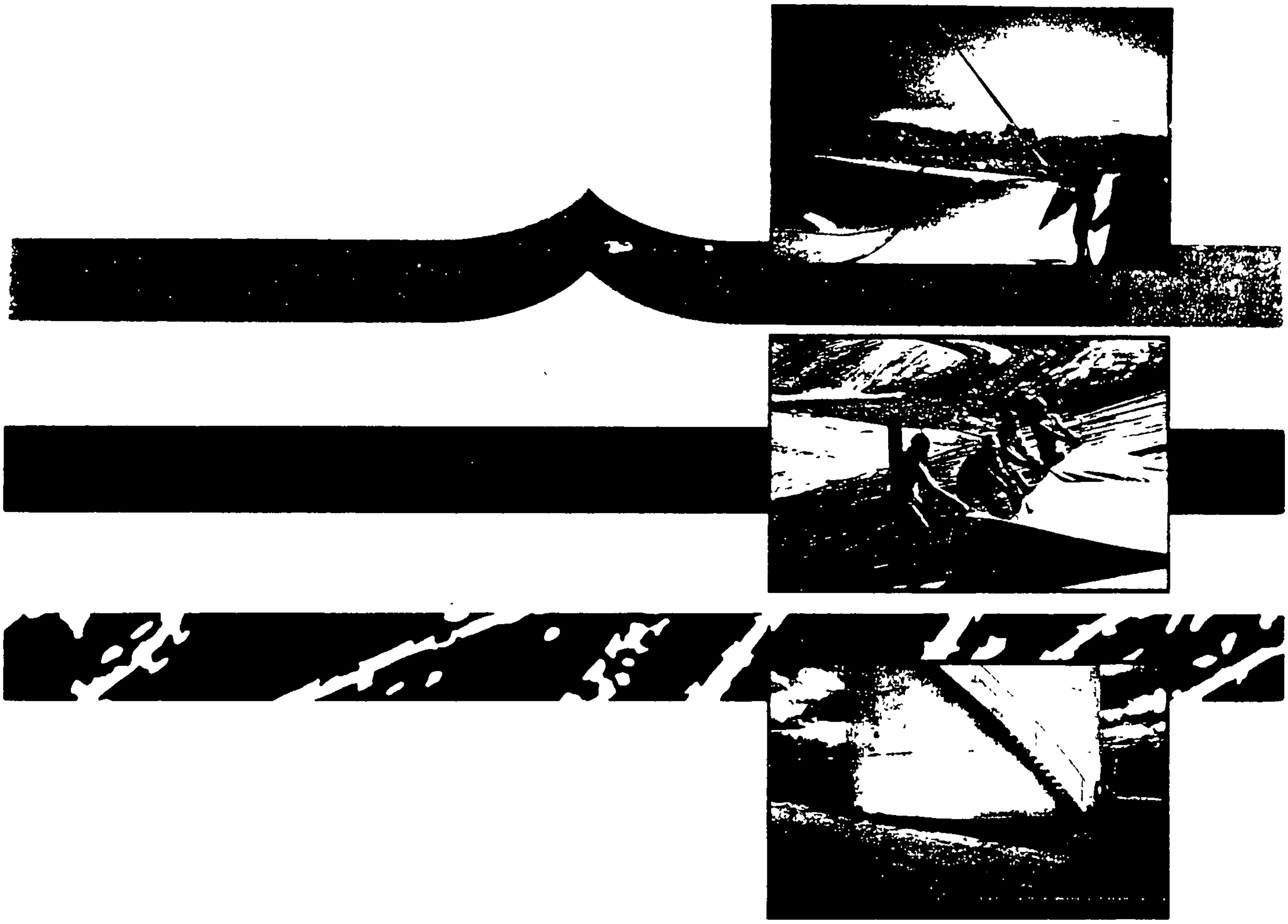
VOLUME OF EXCAVATION (CUBIC YARDS): [illegible]

TOTAL VOLUME OF EXCAVATION (CUBIC YARDS): [illegible]

APPENDIX IX

HELP MODEL, SUMMARY
(REVISED 9-11-90)

CLAYMAX®



CLAYMAX® IS THE STATE-OF-THE-ART GEOCOMPOSITE LINER FOR THE WATER AND WASTE CONTAINMENT INDUSTRY. CLAYMAX® . . . THE IMPERMEABLE BARRIER OF BENTONITE CLAY IN CARPET FORM.

CLAYMAX® liner is the optimum impermeable liner for the water and waste containment industry.

Fresh water ponds, waste lagoons, municipal landfills/caps, tank form containments, irrigation canals and earthen dams

CLAYMAX® liner is a flexible polypropylene bentonite sandwich providing a uniform layer of clay in carpet form creating a cost-effective solution for any liquid containment sealing problem.

CLAYMAX® PRODUCT SPECIFICATION

Sodium Bentonite Content	1 0 lbs per square foot
Thickness	¼ inch
Liner Dimensions	13 5 feet x 82 feet
Effective Area Covered	1059 5 square feet (assume 6' overlap along one side and one end)
Roll Weight/Unit	1130 lbs (minimum)
Permeability Coefficient	2×10^{10} cm per second @ 35' head pressure

LABORATORY TEST DATA

Procedure — Six inches of silica sand covering CLAYMAX liner in a triaxial cell under thirty-five feet of water head pressure

GROUP	PERMEANT	PERMEABILITY
Water	De-Aired Water	2×10^{10} cm/sec
Alkali	20% Hydrated Lime (pH 14)	6×10^{10} cm/sec
Acid	1% Acetic Acid (pH 1)	2×10^{10} cm/sec
Calcium	Calcium Chloride (10%)	2×10^{9} cm/sec
Calcium	Calcium Lignosulfonate	2×10^{9} cm/sec
Alcohol	Ethyl Alcohol (10%)	2×10^{9} cm/sec
Petrols	Unleaded Gasoline	4×10^{10} cm/sec
Petrols	No 6 Fuel Oil	3×10^{9} cm/sec
Petrols	10% Ethanol Gasoline	3×10^{9} cm/sec
Petrols	9 5% Butyl Gasohol	3×10^{9} cm/sec
Landfill Leachate	BOD-200 Sewage Leachate	8×10^{10} cm/sec

The above test performance data were produced under laboratory conditions The actual performance characteristics may vary No performance warranty is express or implied

PACKAGING AND SHIPPING

Roll Content	1107 0 square feet
Roll Weight	1135 lbs (approx) wrapped
Roll Size	14 5 feet long (PVC wrapped) x 18" diameter (approx)

E.P.A. regulations for waste containment specify that lagoon/landfill liners be composed of a heavy plastic membrane layer (HDPE) on top of a thick layer of **compacted clay (3 feet minimum).** Because a single sheet of **CLAYMAX liner exceeds this requirement,** it has been specified and installed as "the clay layer" in several landfills in the United States and Europe

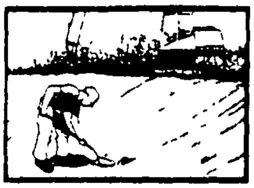
CLAYMAX® liner is the state-of-the-art geocomposite liner that ingeniously combines the durability of woven polypropylene fabric with the impermeability of a pound-per-square-foot of an inert mineral, sodium bentonite (montmorillonite).

Sodium bentonite, the mineral component in CLAYMAX liner, is a high-swelling clay that swells to form a monolithic seal when hydrated with fresh water. The CLAYMAX liner has **self-sealing seams** and an overall **self-healing** ability if ripped or punctured In its hydrated (swollen) state, the clay will swell up to 15 times its dry volume providing tremendous impermeability and a great resistance to all chemicals. In a typical installation, the ¼-inch CLAYMAX liner sheet will swell ½-to-1 inch resulting in the **equivalent permeability of 30 feet of compacted clay.**

EQUIPMENT REQUIRED: The CLAYMAX liner must be installed with the **stenciled polypropylene side up (facing the operator).** The polypropylene protects and supports the system on installation. The liner can either be pulled from a roll suspended at the top of a slope, or the free end may first be secured in a locking trench and the suspended roll can be backed down the slope and across the excavation by the supporting vehicle.

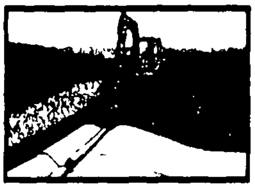
Suspending and unrolling CLAYMAX liner is facilitated by inserting a heavy-duty 3-inch diameter steel pipe through the 3½-inch roll core on which CLAYMAX liner is shipped. This pipe should be 16-18 feet long to accommodate the hoisting chains from the lifting vehicle (any type of vehicle with a fork or front-end bucket) A spreader bar is required to ensure roll clearance and to prevent damage to roll edges

Quality control of CLAYMAX liner seams requires an on-site inspection of a uniform 6-inch overlap and supervision of backfilling to prevent aggregate from opening seams.



The pond, lagoon, tank farm enclosure or canal excavation depth should be determined to allow for a final addition of a minimum 6-8 inches of soil or aggregate cover material. The excavation should be well contoured with slopes that are at a maximum of three-to-one. Protrusions and rocks larger than 2 inches in diameter should be removed and the entire excavation should be compacted sufficiently to prevent ruts from installation vehicles. Compaction can be accomplished using either conventional rolling equipment or wheeled vehicles. Use of sheepsfoot rolling equipment is not recommended. A liner **locking trench (min. 18 inches deep)** must be provided at the top of all slopes.

When installing CLAYMAX liner, **all seams on slopes must be perpendicular to the excavation bottom.** This method prevents seam displacement during the backfill procedure. It is also important that the first CLAYMAX liner roll and all succeeding rolls be pulled tight to smooth out creases.



ANCHORING: All CLAYMAX liner sheets should be anchored to pressure-treated wooden 2 x 4's (or equivalent) and locked into trenches at the top of all slopes, covered with fill and compacted to prevent slippage during installation. This trench should be at least 12 inches above the final contained liquid level and should be approximately **18 inches deep** and **18 inches back from the finished waterline.**

[illegible] CLAYMAX liner seams are non-critical and self-seaming. CLAYMAX liner seams require a **simple 6-inch overlap** with long pins or nails every yard to allow for movement of CLAYMAX liner during ground subsidence. No adhesive or thermal welding is required. The hydrated bentonite will push through the woven polypropylene forming a monolithic seal with a permeability of no greater than 1×10^{-9} cm/sec.

[illegible] Irregular shapes, cuts or tears are **easily repaired** by covering the area with CLAYMAX liner to provide a 6-inch overlap on all sides. These repair pieces should be stapled or nailed in position until cover material has been placed.

[illegible] Cover material (minimum 6-8 inches of aggregate or backfill) should be applied as CLAYMAX liner sheets are placed to afford maximum protection. **Correctly installed, CLAYMAX liner is capable of supporting installation personnel and equipment.** Because it is not recommended for vehicles to operate directly on CLAYMAX liner without the support of a backfill, **cover material should always be pushed forward.** Cover material (other than aggregate) should be compacted after placement.

CLAYMAX® liner, the state-of-the-art geocomposite, can be used as a primary or secondary liner.

MATERIAL SPECIFICATIONS

Primary Backing (Typical Properties) — Polypropylene is nonbiodegradable and inert to most chemicals, acids and alkalis.

Color	Natural white
Filler Fiber	Nylon
Substrate	24 x 10 Delustered woven polypropylene, non-toxic water permeable
Weight	4 oz. per square yard
Tensile Strength	78 lbs. per inch (minimum)
Grab Strength (ASTM D-1682)	Warp 95 lbs., Fill 70 lbs.
Mullen Burst Strength (ASTM D774)	250.25 lbs. per square inch
Puncture Strength (5/16 mandril ASTM D3787 MOD.)	249 lbs.
Melting Point	329°F
Elongation (ASTM D-1682)	Warp 15%, Fill 18%
Shrinkage—Hot Water	Nil
Shrinkage—Dry (20 min. @ 270°F)	2%

Cover Fabric	100% spunlace polyester, open weave allows for expansion of bentonite
Weight	1 oz. per square yard
Grab Strength	Warp 30 lbs., Fill 13.6 lbs.
Burst Strength	35 lbs. per square inch

Bentonite Sizing (Sodium Montmorillonite)	Specially graded, 6 mesh and 30 mesh granules
Mineralogical Composition	90% Montmorillonite (min.)

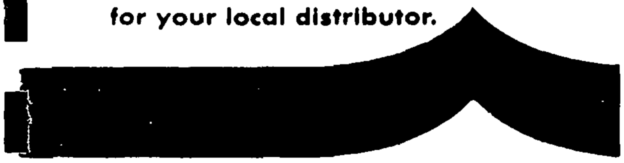
Adhesive	Water soluble, non toxic
Storage	On dry ground, under roof or other protective covering

The manufacturer reserves the right to change product specifications and instructions/limitations without notice. Information contained herein supersedes previously printed material prior to 5/88

Salomon Inc.
A Süd-Chemie AG Company
150 River Road
Suite L-3B
Montville, NJ 07045
Telephone: 201-335-8300
Telex: 96-1470

contact
James Clem Corporation
444 North Michigan Avenue, Suite 1610
Chicago, IL 60611 USA

Phone: 312-321-6255
FAX: 312-321-6258
Telex: 543408
for your local distributor.



CLAYMAX Liner Inventory

Decorative Pond

Leachate Collection Pond
(Secondary Liner)

CLAYMAX · LIQUID CONTAINMENT LINER

ADVANTAGES

Economical and easy to install
Minimal labor required
All seams are simple overlap seams
Liner can be cut and trimmed with a utility knife

GENERAL CHARACTERISTICS

Self-healing/Self-sealing
Natural sealant actuated by water
Porous protection layers allowing quicker hydration
Water-soluble adhesive
Factory-uniform continuous bentonite layer
Minimum 1 lb bentonite per sq ft
Totally flexible
Compatible for use with plastic liners and other multiple liner systems
Rolled goods for convenient storage
Standard sheet sizes 13½ x 82' and custom lengths available
Relatively resistant to environmental and biological attack

INSTALLATION ADVANTAGES

Uncomplicated installation requiring
- **No seam welding or sewing**
- **No special equipment or cutting tools**
- **No geotextile or other special protection**

May be staked or nailed
Simple overlap seams
Accommodates complex configurations
No bentonite loss when cut or trimmed
Virtually no waste material

CAUTIONARY INSTRUCTIONS: CLAYMAX liner may be damaged by exposure to water turbulence or hazardous or toxic substances hazardous or solid wastes, salt or other contaminants in water and should not be used for containment of these constituents without prior evaluation CLAYMAX liner must be inspected for damage if exposed to any of those substances or conditions and, if damaged, must be repaired or replaced immediately CLAYMAX liner must be installed in accordance with plan and specification requirements, prepared by a professional engineer

All drawings are intended solely as a guide and for general information only

All test performance data were produced under laboratory conditions and are not intended as a substitute for tests of the specific liquid or leachate that may come in contact with CLAYMAX liner All test performance data are subject to James Clem Corporation's limitation of warranties James Clem Corporation recommends that the purchaser perform site-specific tests of CLAYMAX liner

LIMITATION OF WARRANTIES: James Clem Corporation warrants that CLAYMAX liner meets James Clem Corporation's specifications James Clem Corporation disclaims any other warranties, express or implied, as to CLAYMAX liner, including all warranties of merchantibility and fitness for any particular purpose James Clem Corporation is not liable for any incidental or consequential damages of any kind James Clem Corporation assumes no liability for CLAYMAX liner's performance or for injuries resulting from the use of CLAYMAX liner, including any liability resulting from the purchaser's engineering, design, construction and installation

GENERAL INSTALLATION INFORMATION: CLAYMAX liner should never be installed in standing water

Exposure to turbulent water may also cause damage.

If exposed to any of these substances or conditions, CLAYMAX liner must be inspected and, where necessary, immediately repaired or replaced

If rainfall commences during installation or while under construction, cover with plastic sheeting to provide interim protection

To insure its integrity, CLAYMAX liner must be protected by and remain buried under a minimum of 6" to 8" of backfill or aggregate Backfill must be compacted with rubber-tired or conventional rolling equipment to an 85% Modified Proctor

All illustrations are intended solely as a guide and are for general information only Contact James Clem Corporation for
- ▲ Containment installation instructions on slopes greater than 3 to 1
- ▲ Installations where CLAYMAX liner must resist extreme hydrostatic pressure that may require a double layer of CLAYMAX liner
- ▲ Temporary containment applications
- ▲ Suitability for secondary containment applications

Any unusual CLAYMAX liner application procedures not covered in this brochure must be approved in writing by James Clem Corporation prior to the installation

See James Clem Corporation's below-grade bentonite waterproofing catalog in Sweet's section 07100/CLE BuyLine 3527.

The information contained in this brochure supercedes all information printed prior to 5/88.

Printed in the USA 8 88

1. PRODUCT NAME

CLAYMAX LC™, CLAYMAX CR™ Liner System for Liquid Containment

(Formerly ENVIROMAT)

2. MANUFACTURER

Clem Environmental Corporation (CEC)
P.O. Box 88, Gordon Road
Fairmount, Georgia 30139
Phone: (404) 337-5316/17
(312) 321-6255/56 (in IL)
Telex: 543408
Fax. (404) 337-2215
(312) 321-6258 (in IL)

3. PRODUCT DESCRIPTION

Basic Use: CLAYMAX LC™ is a specially constructed, flexible, impermeable liner system which utilizes the mineral sodium bentonite clay and the geotextile polypropylene. Sodium bentonite is a high swelling smectite which gives CLAYMAX LC™ the ability to heal itself if ripped or punctured. In a hydrated (swollen) state, the clay has tremendous impermeability and a great resistance to all chemicals: acids, bases and hydrocarbons. The bentonite swells to form an impermeable barrier upon contact with fresh water.

CLAYMAX LC™ liner system can be used in construction applications for the containment or exclusion of liquid. These applications include fresh water ponds, waste lagoons, municipal landfills (including caps), tank farm containments, earthen irrigation canals, industrial containments and earthen dams. Seaming is accomplished by a simple overlap with adjoining material since the hydrated bentonite swells to form an impermeable bond. Minor damage is self-healing and major cuts or tears are easily and effectively repaired using patches of CLAYMAX LC™ material.

CLAYMAX LC™ is manufactured 13.5 feet wide and 82 feet long, rolled onto cores. This allows for easy handling at the job site. Longer material can be furnished upon request. No special installation tools or fasteners are required and CLAYMAX LC™'s flexibility speeds installation. The material can be cut with a utility knife to fit around protrusions (pipes, tanks, etc.).

CLAYMAX LC™ is designed for fast installation with a minimum of manpower, equipment and site preparation on both large and

Product Specification (Typical)—CLAYMAX LC™

Bentonite Content	1.0 lbs. per square foot Liner
Thickness	¼ inch
Liner Dimensions	13.5 feet x 82 feet
Effective Area Covered	1059.5 square feet (assume 6" overlap along one side and one end)
Roll Weight/Unit	1130 lbs. (minimum)
Permeability Coefficient	1×10^{-9} cm per second @ 35' head pressure

*Longer rolls available on special order.

Laboratory Test Data

Procedure—Six inches of sand covering CLAYMAX LC™ in a triaxial cell under thirty-five feet of water head pressure.

Group	Permeant	Permeability
Water	De-Aired Water	2×10^{-10} cm/sec.
Alkali	20% Hydrated Lime (pH 14)	6×10^{-10} cm/sec.
Acid	1% Acetic Acid (pH 1)	2×10^{-10} cm/sec.
Calcium	Calcium Chloride (10%)	2×10^{-9} cm/sec.
Alcohol	Ethyl Alcohol (10%)	2×10^{-9} cm/sec.
Petrols	Unleaded Gasoline	4×10^{-10} cm/sec.
Petrols	No. 6 Fuel Oil	3×10^{-9} cm/sec.
Petrols	10% Ethanol Gasohol	3×10^{-9} cm/sec.
Petrols	9.5% Butyl Gasohol	3×10^{-9} cm/sec.
Petrols	100% Benzine	4×10^{-10} cm/sec.

The above test performance data were produced under laboratory conditions. The actual performance characteristics may vary. No performance warranty is express or implied.

Packaging and Shipping

Roll Content	1107.0 square feet
Roll Weight	1135 lbs. (approx.) wrapped
Roll Size	14.5 feet long (PVC wrapped) x 18" diameter (approx.)

Material Specifications

Primary Backing (Typical Properties)—Polypropylene is nonbiodegradable and inert to most chemicals, acids and alkalis.

Color	Natural white
Filler Fiber	Nylon
Substrate	24 x 10 Delustered woven polypropylene, non-toxic, water permeable
Weight	4 oz. per square yard
Tensile Strength	78 lbs. per inch (minimum)
Grab Strength (ASTM D-1682)	Warp 95 lbs., Fill 70 lbs.
Mullen Burst Strength (ASTM D774)	250.25 lbs. per square inch
Puncture Strength (5/16" mandril ASTM D3787 MOD.)	249 lbs.
Melting Point	329° F
Elongation (ASTM D-1682)	Warp 15%, Fill 18%
Shrinkage	
Hot Water	Nil
Dry (20 min @ 270°F)	2%
Cover Fabric	100% spunlace polyester; open weave allows for expansion of bentonite
Weight	1 oz. per square yard
Grab Strength	Warp 30 lbs., Fill 13.6 lbs.
Burst Strength	35 lbs. per square inch
Bentonite (Sodium Montmorillonite)	
Sizing	Specially graded, 6 mesh and 30 mesh granules
Mineralogical Composition	90% Montmorillonite (min.)
Adhesive	Water soluable, non-toxic
Storage	On dry ground under roof or other protective covering

The manufacturer reserves the right to change product specifications and instructions/limitations without notice. Information contained herein supersedes previously printed material (11/87).

PONDS AND RESERVOIRS
Impermeable Liner System
2
May 1988
(Supersedes November 1987)

small job sites. It affords a maximum of containment protection with none of the problems usually associated with other liner products. CLAYMAX™ is flexible, requires no special seam sealing, is self-healing and self-sealing while being extremely resilient and damage resistant.

Composition of Materials: CLAYMAX LC™ is a multi-layered liner system consisting of a layer of tough, durable and flexible heavy woven polypropylene, (on one side) coated with sodium bentonite clay. The bentonite is covered with a layer of thin polyester scrim which protects the bentonite layer during transportation and installation.

Sizes: CLAYMAX LC™ is supplied in rolled sheets. The material is 13.5 feet wide and 82 feet long. The material is rolled on 3½ inch roll cores. Special lengths may be ordered.

4. TECHNICAL DATA

Refer to Specification Table on page 1

CLAYMAX LC™'s active ingredient, natural sodium bentonite, has the ability to swell in the presence of water to a volumetric expansion of 15 times resulting in a 6 fold increase in weight. Actual installation swelling is minimized by weight of aggregate cover material to only 2 to 3 times the original volume. Further expansion is possible into any voids in the material.

Limitations: CLAYMAX LC™ liner material MUST be protected with 6-12 inches (max. 12 inches on slopes) of backfill or aggregate cover material. If backfill is used, it should be compacted with wheeled, rolling equipment.

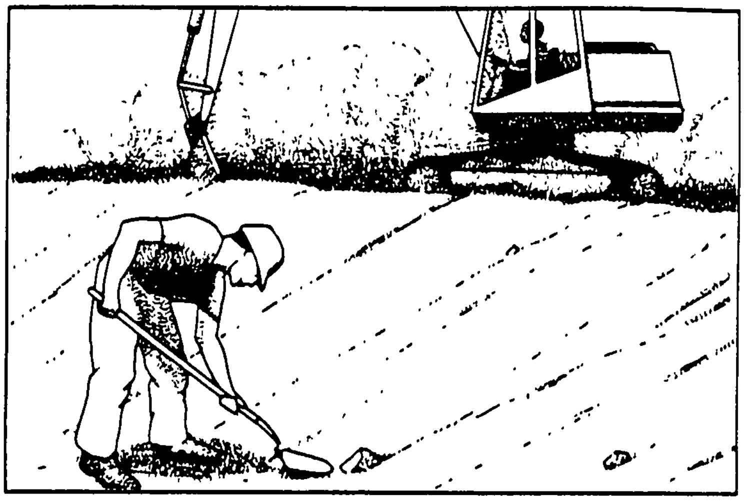
Containment installations, with slopes greater than two to one should be discussed with CEC.

CLAYMAX LC™ must be stored in a dry place.

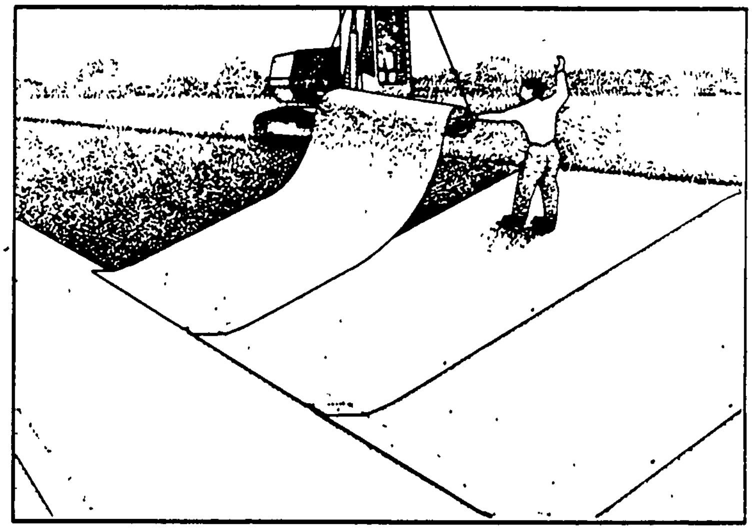
In soils of high alkalinity, acidity or brine condition (or other ground water contamination), samples should be submitted to CEC for analysis and CEC will issue any necessary special installation instructions.

Where installation of CLAYMAX LC™ sheets must resist extreme hydrostatic pressure, a double layer may be required. Please

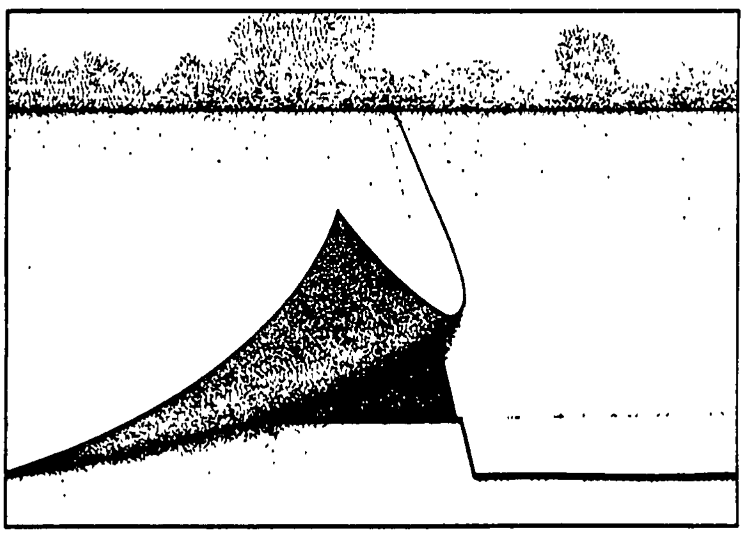
Advantages. • Flexibility allows rapid and easy installation • A small crew can easily perform the installation • All seams are simple overlap seals • CLAYMAX provides for complete inspectibility of liner seal integrity prior to covering • Liner is sufficiently resilient to support installation personnel and light-weight equipment • Liner can be cut and trimmed with a utility knife



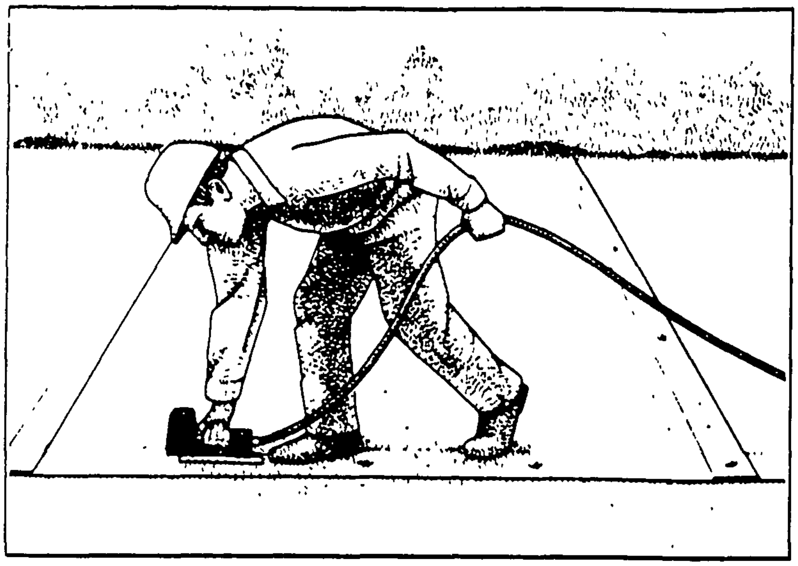
Site Preparation: Excavation should be well contoured; all rocks, vegetation and protrusions larger than 2 inches in diameter should be removed.



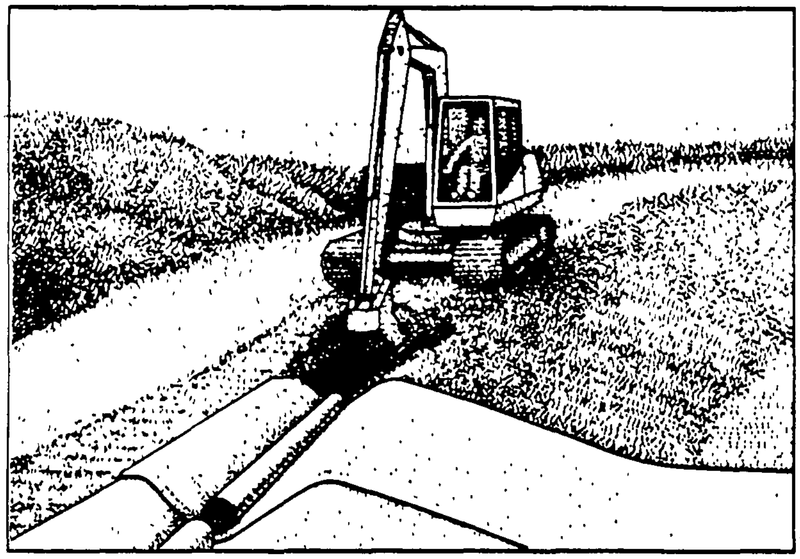
Installing adjoining rolls of CLAYMAX requires a 6-inch overlap. All seaming on slopes must be vertical and perpendicular to the base.



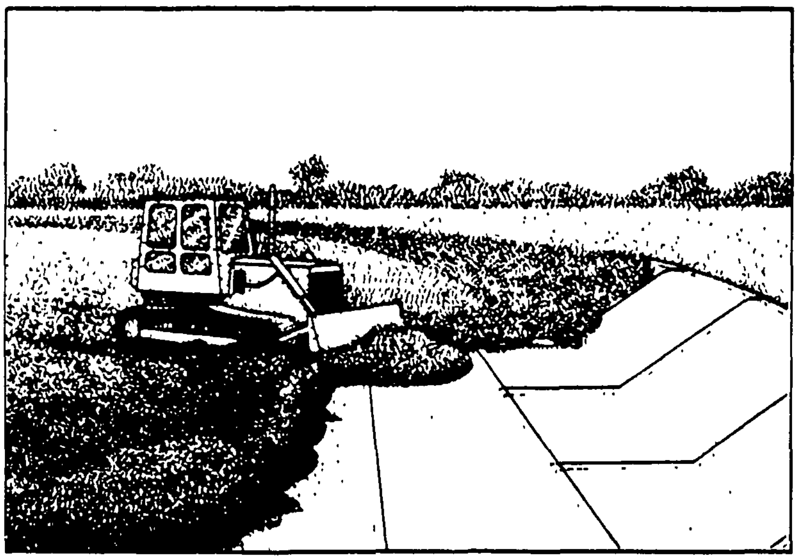
Detail of the 6-inch overlap; all soil must be removed from the overlap area of the liner to ensure a monolithic seal.



The 6-inch seams may be stapled or pinned to base soil to prevent seam opening during the backfill process.



Anchoring. Each CLAYMAX roll must be locked into trenches at the top of the slope, covered with fill and compacted to prevent slippage.



Covering: Backfill should always be pushed forward with equipment operating on the backfill. Cover material (other than aggregate) should be compacted after placement.

consult CEC or your local distributor when this condition exists.

Special installation application procedures for CLAYMAX™ must be approved in writing by the manufacturer prior to installation.

CLAYMAX LC™ which has been damaged by precipitation prior to backfill protection MUST BE REPLACED if seal integrity is to be maintained.

5. INSTALLATION

Site Preparation: The pond, lagoon, tank farm enclosure or canal excavation dimensions should be determined allowing for final addition of not more than the required 6-12 inches of soil or aggregate cover material. Ideally, the excavation should be well contoured with slopes that are a maximum of three to one. All vegetation, protrusions and rocks larger than 2 inches in diameter should be removed and the entire excavation should be compacted to 90% optimum density. Minor surface irregularities, however can be accommodated. Compaction can be accomplished using either conventional rolling equipment or wheeled vehicles. Use of sheetsfoot rolling equipment is not recommended. A liner locking trench must be provided at the top of all slopes.

Orientation: It is essential to install CLAYMAX LC™ so that all seams of the material laid on slopes are perpendicular to the pond bottom. This will prevent seam displacement during cover material placement.

Anchoring: All CLAYMAX LC™ "runs" must be locked into trenches at the top of the slopes, covered with fill and compacted to prevent slippage. The locking trench should be 24 inches back horizontally from the top of the slope. The trench should have a minimum depth of 18 inches and a width of at least 12 inches for slopes up to three to one. Greater slopes would require a revised locking trench design.

Seaming: It is essential that the first and succeeding rolls of CLAYMAX LC™ be pulled tight to smooth out creases or irregularities in the "runs". CLAYMAX LC™ should always be installed with the polypropylene side up, showing the stenciled trademark CLAYMAX™ Once the first "run" has been laid adjoining "runs" need only be laid with a 6-inch overlap on each side. Be certain that all dirt is removed from the overlap area of the mat. The 6-inch seams may be stapled (with uncrimped staples) or pinned to the base soil to prevent seam openings during the installation process.

Repairing: Irregular shapes, cuts or tears in installed CLAYMAX LC™ are easily accommodated by covering such areas with sufficient CLAYMAX™ to provide a 6-inch overlap on all adjoining CLAYMAX™. These repair pieces should be pinned in place to hold the material until cover material has been placed.

Covering: Cover material (no more than 6-12 inches of aggregate or backfill) should be applied as roll "runs" are completed to afford maximum protection against damage from personnel or equipment. Correctly installed, CLAYMAX™ is sufficiently resilient to support installation personnel. Care should be exercised to prevent seam damage or "run" slippage, and backfill should always be pushed forward with equipment operating on the backfill. Cover material (other than aggregate) should be compacted after placement.

Handling Suggestions: CLAYMAX LC™ MUST be pulled from the top of the roll and installed polypropylene side UP (stencilled CLAYMAX™ this side). The liner can be either pulled from a roll suspended at the top of a slope or the free end may first be secured and the suspended roll can be backed down the slope and across the excavation by the supporting vehicle. Suspending and unrolling CLAYMAX LC™ is facilitated by inserting a heavy-duty 3-inch diameter steel pipe through the 3½ inch roll core on which CLAYMAX™ is shipped. This pipe should be 16 or 17 feet long to accommodate the hoisting chains from the lifting vehicle which may be wheeled power equipment with either forks or front-end bucket. A spreader bar may be required to ensure roll clearance and to prevent damage to roll edges.

Installation Precautions: CAUTION—•CLAYMAX LC™ should not be installed in standing water or while heavy rain is falling.

6. AVAILABILITY AND COST

Availability: CLAYMAX LC™ liquid containment system is available through a worldwide network of distributors and approved installers. Contact the manufacturer, or your local CLAYMAX LC™ representative, to order.

Cost: Material cost will vary depending on such factors as "point-of-use location." For current cost information, contact your local CLAYMAX™ representative. For the name, address and telephone number of the representative in your area, contact the manufacturer.

7. WARRANTY

CLAYMAX LC™ waterproofing system is normally warranted by the installing contractor who can make specific details available upon request.

8. MAINTENANCE

No maintenance is required when CLAYMAX LC™ is installed in accordance with the manufacturer's instructions; however, the protective cover layer (backfill) must be maintained and repaired as necessary.

9. TECHNICAL SERVICES

Clem Environmental Corporation (CEC), will provide, on request, necessary technical assistance in the evaluation of installation applicability. On-site installation assistance is also available from the manufacturer.

10. FILING SYSTEMS

SPEC-DATA® II —

Sweet's 02770/AIM, Buyline 3526

Additional information is available from the manufacturer upon request.

The information and recommendations contained herein are based on data which is believed to be reliable but all such information and recommendations are given without guarantee or warranty.

2.0 PLAN FOR INSTALLING LINER SYSTEM

2.1 Limits for Placement of Liner

The liner will be installed as shown on the excavation drawings and to the limits defined in the anchor trench detail (see Detail 7, Figure 30). The distance from the edge of waste for areas to receive future liner extensions is 25 feet as shown in the interim berm detail (see Detail 6, Figure 30). The edge of the liner is protected utilizing plywood, a protective HDPE layer, and protective soil cover as shown in the detail.

For the perimeter berm (outer edge of liner), a minimum distance of 15 feet is maintained between the waste and end of the liner (see Detail 7, Figure 30). The edge of the liner will be marked using surveying stakes.

2.2 Subbase

Following the preparation of the subgrade, a minimum 6 inch-thick layer of subbase materials will be placed. All areas will be excavated a minimum of 12-inches for topsoil removal. Once all unsuitable materials have been removed, each area will be proof-rolled, and following approval of the surface by the engineer, the subgrade will be filled to a depth of 6-inches below the grades shown on the excavation drawings.

The subbase layer will then be constructed using sandy soils obtained form the Turkey Hill Borrow Area and approved by the engineer. The Borrow soil will be placed and spread in 6- to 9- inch thick loose lifts. The subbase lift will then be compacted to at least 95 percent of its Standard Proctor maximum dry density. The compaction operations will be controlled by performing periodic field density determinations and comparing the results with appropriate Standard Proctor moisture-density relationships that will also be obtained during construction. The subbase layers will be placed and compacted until the surface reaches the bottom grade shown on the excavation drawings.

The material used for the subbase will be the granular with no particles larger than 1/2 inch. Compaction will be performed by vibratory roller, or equal equipment. The resulting subbase will be smooth and free of debris, rock, plant materials, and other foreign material. Density tests and gradation tests will be done during construction at the frequency given in Form 23 in Section 1.0 of this Application.

The sump locations are the lowest elevation point in each of the cells. The bottom of the subbase at each cell's sump location has been positioned to be at least 8-feet above the seasonal high groundwater elevation and at least 8-feet above the regional groundwater elevation. The groundwater elevations used to set this low point were determined from wells and piezometers (see Figure 3-12).

From the sump point, the subbase is graded to maintain a minimum 2 percent slope. The maximum slope occurs at the interim berms at 50 percent (2 horizontal to 1 vertical), see Form 38, Request for Equivalency in Section 11.0.

2.3 Liners

The HDPE double liner system will be constructed at the locations shown on the excavation drawings. Construction will conform with the guidelines set forth in Waste Management of North America, Inc.'s (WMNA) "Specification Guidelines for the Procurement and Installation of Geosynthetic Lining Systems," dated June 1986, and all other applicable manufacturer's recommendations. A brief summary of the proposed construction guidelines is presented below:

- The liner installation contractor will be approved and/or licensed by the geomembrane manufacturer, and have the necessary personnel and equipment to perform the work.

- All personnel performing field liner seaming will be qualified by experience or by passing field seaming tests. A master seamer, having at least 1,000,000 square feet of seaming experience, must be present during all seaming operations.

- Geomembrane placement will not proceed when the ambient air temperature is below 40°F (unless other authorized), or in the presence of excessive moisture (e.g., precipitation, fog, dew, ponded water, etc.), or in the presence of excessive winds.

- The liner installation contractor will take precautions to avoid damage to the geomembrane during placement. The geomembranes will be placed to minimize wrinkles, and will be sufficiently loaded and/or anchored (e.g., sandbags, tires, etc.) to prevent uplift by wind. Any geomembrane panels damaged during placement or subsequent activities will be repaired or replaced.

- Field seams will be orientated parallel to (down) slopes, and will not be located in areas of potential stress concentrations to the extent possible. Adjacent geomembrane panels will be overlapped a sufficient distance to permit peel tests to be performed on all field seams. Typical minimum overlap limits are 3-inches for extrusion-welded seams and 5-inches for fusion-welded seams.

- Field seams will be joined by extrusion or fusion welds, using only equipment and materials specifically approved. Prior to seaming the entire seam area will be free of moisture, dirt, dust, foreign material, and debris of any kind.

QA/QC observations and testing during all HDPE liner installations will be performed in accordance with the

"Quality Assurance Manual for the Installation of Geosynthetic Lining Systems" prepared by WMNA and dated June 1986. All manufacturer's recommendations and installation procedures, in addition to the details presented in the drawings will be followed. Also, refer to Part III of this section for details of the QA/QC Plan.

The HDPE liners required for the landfill expansion will be installed by a contractor experienced in HDPE liner installation and licensed to perform installations by the liner manufacturer. An independent QA/QC inspector will be retained to oversee the HDPE liner installations to assure conformance with WMNA guidelines. In addition, a representative from the liner manufacturer will supervise the installation to assure conformance to manufacturer's specifications. A brief summary of the proposed QA/QC inspection procedures is presented below:

- Individual HDPE liner rolls will be inspected as they are unrolled for sheet thickness and the presence of blemishes or irregularities.

- All field seams will be non-destructively tested throughout their entire length to demonstrate water-tightness. In addition, test specimens (coupons) will be removed from the field seams at specified intervals for destructive testing. Each specimen will be tested to determine the bonded seam strength.

- All areas requiring repair and/or cap strip placement will be rewelded under the observation of the QA/QC inspector and be non-destructively tested to assure water-tightness.

- An independent QA consultant will be retained to observe and document the geomembrane installation to assure that the geosynthetic liner system is properly constructed. Final acceptance of the geosynthetic liner system will be based on certification by the QA consultant that the geosynthetic materials have been properly installed.

Following approval of a lined area by the QA/QC inspector, overlying layers of geosynthetic or soil materials will be placed.

2.4 Leachate Detection and Collection Zones

The leachate detection zone will be constructed above the secondary liner. This drainage system will consist of a geonet over the floor and side slopes of the cell.

Installation of a geonet will follow Waste Management's "Specific Guidelines for the Procurement and Installation of Geosynthetic Lining Systems," and is summarized below:

- o Generally, geonets shall be installed in such a manner to minimize wrinkles. To achieve this, anchor trenches, sand bags, and hand positioning shall be utilized.
- o Dirt, excessive dust or stones shall be prevented from becoming entrapped in the geonet. Dirt or excessive dust shall be swept and hosed clean prior to placement of the next component.
- o Geonets shall not be welded to geomembranes unless otherwise specified.
- o Geonets shall only be cut with scissors.

When joining adjacent geonets according to construction drawings and specifications. As a minimum the following minimum requirements shall be met:

- o Adjacent rolls shall be overlapped by at least 4-inches.
- o These overlaps shall be secured by spot welding or tying.
- o Tying can be achieved by strings, plastic fasteners, or polymer braid. Tying devices shall be white or yellow for easy inspection. Metallic devices are not allowed.

- Spot welding or tying shall be every 5-feet along the slope, every 2-feet across the slope, and every 6-inches in the anchor trench.
- In the corners of the side slopes or rectangular landfill, where overlaps between perpendicular geonet strips are required, an extra layer of geonet shall be unrolled along the slope, on top of the previously installed geonets, from top to bottom of the slope.
- When more than one layer of geonet is installed, joints shall be staggered.

Any holes or tears in the geonet shall be patched. The patch shall extend 2-feet beyond the edges of the hole or tear and be secured to the original geonet by spot welding or tying every 6-inches. If the tear or hole width across the roll is more than 50 percent the width of the rolls, the damaged area shall be cut out and the two remaining portions joined as specified above.

An inclined up-slope HDPE riser will extend from the sump to the top of the perimeter berm. The riser will be perforated in its end to permit entry of liquids. If steady-state flow occurs in quantities sufficient to make removal with a vacuum truck unfeasible, a submersible well pump with automatic on/off sensors will be installed. Details are shown on Figure 26.

2.5 Protective Cover

The protective cover/primary leachate collection system will consist of a minimum 18-inch thick layer of fine gravel and 6-inch thick layer of select free draining material with an incised coarse gravel and perforated pipe drain network (Figure 27). The side slopes will consist of geonet drainage system constructed in the same manner as outlined in Part D of this Narrative.

During construction, the granular material used in the primary leachate collection system will be tested per the schedule in the Form 23 (located in Section 1.0 of the Phase I Application).

The pipe drains will consist of 6-inch-diameter laterals and Schedule 80 PVC laterals spaced on 100-foot centers which will connect into an 8-inch-diameter Schedule 80 PVC central collector pipe (see Figure 28). The minimum slope on the pipes will be two percent. The pipes will connect to an up-slope riser which is contained within the lined area. Pipe spacing has been selected so that the hydraulic head required for the anticipated leachate flow will remain well below 12-inches for average conditions. The proposed drainage system layout is shown in the excavation drawings. The up-slope riser detail and drainage material gradation requirements are shown on Figures 25 and 26.

The up-slope risers will be equipped with submersible pumps which will automatically turn on and shut off to minimize head buildup on the liner. The liquids will be conveyed from the risers to a forcemain perimeter header line. The disposition of the collected leachate is discussed in Section 5.0 of the Phase II Application.

2.6 Final Cover and Grading

2.6.1 Clay Cap

In the 3 hor.:1 ver. portions of the final cover the final cover will consist of a 12-inch-thick compacted clay layer, a 6-inch drainage layer, and a 24-inch-thick vegetative cover layer (see Detail 18, Figure 32). Both the compacted soil layer and the vegetative cover layer will be constructed from fill obtained onsite or from the Turkey Hill Borrow Area. The 12-inch intermediate cover layer may be constructed prior to final cover construction.

The 12-inch thick compacted clay cover will be constructed from clay soils obtained at the Turkey Hill Borrow Area or other sources. The layer will be constructed in a series of compacted lifts, each with a maximum thickness of 8-inches prior to compaction. Soil moisture will be modified as necessary to bring the moisture content to about -1 percent and +3 percent of optimum moisture. Each clay lift will be compacted utilizing a sheepsfoot (or similar acting) roller to at least 95 percent of its Standard Proctor maximum dry density. The compaction operations will be monitored by performing periodic field density determinations and comparing the results with appropriate Standard Proctor moisture-density relationships also obtained during construction. Refer to the QA/QC Plan Part II in this section. The clay cover fill will provide a continuous smooth compacted surface with placement of the final lift.

Following completion of the clay cover layer, a 6-inch drainage layer will be installed above the 1-foot clay cover. The vegetative cover soils (24-inch) will be placed above the drainage layer. The vegetative cover soils will be spread in up to 12-inch loose lifts and lightly compacted to the grades shown on the drawings. The surface of the vegetative cover soils will be furrowed parallel to the final cover slopes to minimize erosion potential and maximize moisture retention. The vegetative cover soils will be properly prepared and vegetated in as short a time as practical following placement. Fertilizer and/or limestone will be applied and incorporated into the soil as necessary. The surface will then be seeded and mulched as outlined in Section 4.0, Form 16.

2.6.2 Synthetic Cap

The top, low-slope portion of the landfill will be capped with a synthetic liner and a geonet will serve as the drainage layer. See Section 2.3 and 2.4 for the procedures to be used.

Final cover will be placed as soon as practical after the working areas reach final grades. The final cover will be placed in any case, within one year of attaining final refuse elevation. Sequencing of the final cover will correspond to the staging of the landfill as discussed in Section 1.0.

The benches will be constructed in the final cover as shown in Figure 4 and 5. The bench will be constructed to maintain the minimum cover with Mirimat lined or grass-lined ditches to prevent erosion into the cover.

3.0 QUALITY ASSURANCE PLAN FOR CONSTRUCTION AND INSTALLATION OF LINERS

3.1 Qualifications of Independent QA Personnel (describe experience and training)

The Geosynthetic Quality Assurance Consultant will be a well-established engineering firm incorporated (or otherwise registered) in the United States. The Geosynthetic Quality Assurance Consultant will hold: an "umbrella" coverage as required by statute and/or contractural agreement. The Geosynthetic Quality Assurance Consultant will be experienced with geosynthetics, including geomembranes, geonets, geogrids, and geotextiles. The Geosynthetic Quality Assurance Consultant will be experienced in the preparation of quality assurance documentation, including quality assurance forms, reports, certifications, and manuals.

The Geosynthetic Quality Assurance Consultant will provide the following, in writing to the Owner:

- Corporate background and information.
- Proof of "umbrella" insurance coverage as required by statute and/or proposed contractual agreement.
- Quality assurance capabilities:
  - a summary of the firm's experience with geosynthetics, including geomembranes, geonets, geogrids, and geotextiles
  - a summary of the firm's experience in quality assurance, including installation quality assurance of geomembranes, geogrids, geonets, and geotextiles
  - a summary of quality assurance documentations and methods used for the firm, including sample quality assurance forms, reports, certifications, and manuals prepared by the firm.

The Geosynthetic Quality Assurance Engineer will hold at least a B.S. engineering degree and be registered as a Professional Engineer in the state in question. He shall also comply with the experience requirements listed for the Geosynthetic Quality Assurance Consultant. The Geosynthetic Quality Assurance Engineer will also be specifically experienced in the installation of geosynthetics and will be trained and certified by the Geosynthetic Quality Assurance Consultant in the duties and responsibilities associates with geosynthetic quality assurance. Some of the duties of the Geosynthetic Quality Assurance Engineer may, in some cases, be assigned to another individual who is assigned as the full-time onsite resident manager in charge of the Quality Assurance Monitors. In such cases, this onsite manager will meet the installation-related experience requirements listed for the Geosynthetic Quality Assurance Engineer. Geosynthetic Quality Assurance Monitors will be quality assurance personnel who have been specifically trained in quality assurance of geosynthetics.

The Geosynthetic Quality Assurance Consultant will provide the following, in writing, to the Owner:

- Resumes of personnel to be involved in the project including the Geosynthetic Quality Assurance Engineer, the onsite manager (if different than the Geosynthetic Quality Assurance Monitors.

- Proof of professional registration (or ability to be registered) in the project state of the engineer to be designated the Geosynthetic Quality Assurance Engineer, as well as proof of B.S., M.S., or Ph. D. engineering degree.

- Proof of quality assurance experience of quality assurance personnel with emphasis on geomembranes, geonets, geotextiles, and geogrids.

3.2 Quality Assurance for Subbase

The following procedures will be used during construction:

a. Laboratory and field testing will be done in accordance with the schedule shown in Form 23 in Section 1.0 of the Phase II Application.

b. The Construction Quality Assurance (CQA) Monitor will inspect the subbase construction.

c. Compaction will be performed by a vibratory roller, or equal equipment, to a dry density equal to or greater than 95 percent of the maximum dry density obtained in a Standard Proctor compaction test. The resulting subbase will be smooth and free of debris, rock, plant materials, and other foreign material.

d. The CQA Monitor will survey representative lifts to ensure that facility dimensions, side slopes, and bottom slopes are as specified in the design. The final subbase configuration will be surveyed by a registered land surveyor.

e. Upon completion of the subbase layer, the Geosynthetic liner installer will provide a certification of acceptance of the surface preparation to the Geosynthetic Quality Assurance Monitor prior to the liner system installation. This certification will accompany the monitor's daily field notes from the subbase construction phase.

3.3 Quality Assurance of Synthetic Liners

The following procedures will be used during liner placement. Additional details are provided in Attachment G.

a. Prior to installation of any geomembrane material, the manufacturer will provide the project manager and the Geosynthetic Quality Assurance Consultant with the following information:

- The origin (resin supplier's name, resin production plant) identification (brand name, number), and production date of the resin
- A copy of the quality control certificates issued by the resin supplier
- Reports on the tests conducted by the manufacturer and/or the Geosynthetic Quality Assurance Laboratory to verify the quality of the resin used to manufacture the geomembrane rolls assigned to the considered facility (these tests should include specific gravity ASTM D7921 Method A or ASTM D1505) and melt index (ASTM D1238 Condition 190/2.16)
- A statement that no reclaimed polymer is added to the resin (however, the use of polymer recycled during the manufacturing process may be permitted if done with appropriate cleanliness and if recycled polymer does not exceed 2 percent by weight)

In addition, the Geosynthetic Quality Assurance Monitor will inspect the material delivery and "spotting"' unloading and onsite transport and storage; onsite conformance testing to verify thickness of geomembranes and geonets; and all placement operations.

b. The Geosynthetic Quality Assurance Consultant will verify that:

- A qualified land surveyor has verified all lines and grades
- A qualified geotechnical engineer, normally the soils quality assurance consultant has verified that the supporting soil meets the density specification.
- The surface to be lined has been rolled and compacted so as to be free of irregularities, protrusions, loose soil, and abrupt changes in grade
- The surface of the supporting soil does not contain stones that may be damaging to the geomembrane
- There is no area excessively softened by high water content

The installer will certify in writing that the surface on which the geomembrane will be installed is acceptable. The certificate of acceptance will be given by the installer to the project manager prior to commencement of geomembrane installation in the area under consideration. The Geosynthetic Quality Assurance Consultant will be given a copy of this certificate by the project manager.

c. The Geosynthetic Quality Assurance Consultant will observe the following:

- Any equipment used does not damage the geomembrane by handling, trafficing, excessive heat, leakage of hydrocarbons, or other means

- The prepared surface underlying the geomembrane has not deteriorated since previous acceptance, and is still acceptable immediately prior to geomembrane placement

- Any geosynthetic elements immediately underlying the geomembranes are clean and free of debris

- All personnel working on the geomembrane do not smoke, wear damaging shoes, or engage in other activities that could damage the geomembrane

- The method used to unroll the panels does not cause scratches or crimps in the geomembrane and does not damage the supporting soil

- The method used to place the panels minimizes wrinkles (especially differential wrinkles between adjacent panels)

- Adequate temporary loading and/or anchoring (e.g., sand bags, tires), not likely to damage the geomembrane, has been placed to prevent uplift by wind (in case of high winds, continuous loading, e.g., by adjacent sand bags, is recommended along edges of panels to minimize risk of wind flow under the panels

- Direct contact with the geomembrane is minimized (i.e., the geomembrane is protected by geotextiles, extra geomembrane, or other suitable materials in areas where excessive traffic may be expected)

The Geosynthetic Quality Assurance Manager will inform the project manager if the above conditions are not fulfilled.

d. Geomembrane placement will not proceed at an ambient temperature below 40°F (5°C) unless otherwise authorized. Geomembrane placement will not be done during any precipitation,in the presence of excessive moisture (e.g., fog, dew), in an area of ponded water, or in the presence of excessive winds.

The Geosynthetic Quality Assurance Consultant will verify that the above conditions are fulfilled. Additionally, the Geosynthetic Quality Assurance Consultant will check that the supporting soil has not been damaged by weather conditions.

The Geosynthetic Quality Assurance Manager will inform the project manager if the above conditions are not fulfilled.

e. The anchor trench will be excavated by the earthwork contractor (unless otherwise specified) to the lines and widths shown on the design drawings, prior to geomembrane placement. The Geosynthetic Quality Assurance Consultant will verify that the anchor trench has been constructed according to design drawings.

f. The Geosynthetic Quality Assurance Consultant will verify that field panels are installed at the location indicated on the designer's layout plan, as approved or modified.

Field panels may be installed using any one of the following schedules:

- All field panels are placed prior to field seaming (in order to protect the subgrade from erosion by rain)

- Field panels are placed one at a time and each field panel is seamed immediately after its placement (in order to minimize the number of unseamed field panels exposed to wind)

- Any combination of the above

g. The Geosynthetic Quality Assurance Consultant will inspect each panel, after placement and prior to seaming, for damage. The Geosynthetic Quality Assurance Manager will advise the project manager which panels, or portions of panels, should be rejected, repaired, or accepted. Damaged panels or portions of damaged panels that have been rejected will be marked and their removal from the work area recorded by the Geosynthetic Quality Assurance Consultant.

h. Approved processes for field seaming are extrusion welding and fusion welding. The Geosynthetic Quality Assurance Consultant will log apparatus temperatures, ambient temperatures, and geomembrane surface temperatures at appropriate intervals for the extrusion welding apparatus. Also, the Geosynthetic Quality Assurance Consultant will log ambient, seaming apparatus, and geomembrane surface temperatures as well as seaming apparatus pressures for the fusion welding apparatus.

After the entire liner seaming is complete, the Geosynthetic Quality Assurance Consultant will verify that the seaming procedures were done according to the specifications.

i. The Geosynthetic Quality Assurance Consultant will observe all non-destructive seam continuity testing and all destructive seam testing. Destructive samples are collected and tested for seam strength at the Geosynthetic Quality Assurance Laboratory. The results of the tests are then presented to the consultant before covering the liner.

j. Upon completion of the synthetic liner system installation, the geosynthetic monitor will review all of the field notes and test results. Barring discrepancies from the design specifications and no outstanding failed panels, seams, etc. that have yet to be repaired, the Geosynthetic Quality Assurance Monitor will inform the CQA Monitor to proceed with the next phase of construction.

3.4 Quality Assurance of Protective Cover

The following procedures will be used during placement of the protective cover.

a. Samples will be taken and analyzed in accordance with the schedule shown in Form 23 in Section 1.0 of the Phase II Application.

b. Continuous inspection by the Geosynthetic Quality Assurance Monitor will minimize the potential for damage to the synthetic liner.

c. Equipment used for placing a granular material will not be driven directly on the geomembrane. A minimum thickness of eighteen inches of granular material is specified between construction equipment and the geomembrane. In heavily trafficked areas, such as access ramps, granular material should be at least three feet.

d. The CQA Monitor will conduct a survey of the protective liner in order to document that the entire 24 inches of protective cover has been placed over the entire lined area.

e. The CQA Monitor will review the field notes and verify that the cover extends to and beyond the liner limits.

3.5 Quality Assurance of the Leachate Collection Systems

a. Continuous inspection and periodic surveying by the CQA Monitor will ensure that the pipes are placed in the specified locations and at the specified grades, respectively.

b. Testing of pipe joints and testing of solid wall pipes will be made by the contractor under the inspection of the CQA Monitor.

c. The Geosynthetic Quality Assurance Consultant will verify that the geotextiles were installed to the limits indicated in the designer's layout plan. In addition, the Geosynthetic Quality Assurance Consultant and fabricator will verify that adequate seaming and overlapping of the geotextiles were accomplished to satisfy the Geosynthetic Quality Assurance Plan. Finally, the Geosynthetic Quality Assurance Monitor will continuously inspect the installation to assure no damage to the synthetic layers and geotextiles has occurred during construction.

d. THE CQA Monitor will verify that the structures are as designed by taking appropriate measurements and noting the material with which it is constructed.

i. The mechanical and equipment installation will be inspected by the CQA Monitor to ensure that the equipment is installed in accordance with the design specifications and manufacturer's recommendations. The equipment manifests will be checked by the CQA Monitor to ensure that the equipment brought to the site is as the design specified.

3.6 Quality Assurance of the Final Cover System

a. The final cover foundation will be proof-rolled, prior to placement of the final cover, under the inspection of the CQA Monitor.

b. Lab testing will be done in accordance with the procedures outlined in the Form 23 in Section 1.0 of the Phase II Application.

c. The CQA Monitor will continuously monitor the cover system construction to ensure it is constructed to the designer's specifications.

d. The CQA Monitor will continuously inspect the drainage layer and collection system construction in order to verify that the dimensions and slopes are as the design specified.

e. The CQA Monitor will continuously inspect the 2-foot soil cover layer construction. Since this layer will be constructed in one lift, overcompaction will not be a concern. Random elevation checks will be conducted by the CQA Monitor to verify the thickness and slope of the cover is what the designer specified.

f. The CQA Monitor will continuously inspect the 2-foot soil cover seeding process to ensure it is carried out according to the design specifications. The CQA Monitor will document the tilling depth, application rate of additives, and equipment used. The seeding process will occur during adequate growing conditions.

DESIGN, CONSTRUCTION, AND MONITORING OF SANITARY LANDFILL

Amalendu Bagchi
Wisconsin Department of Natural Resources

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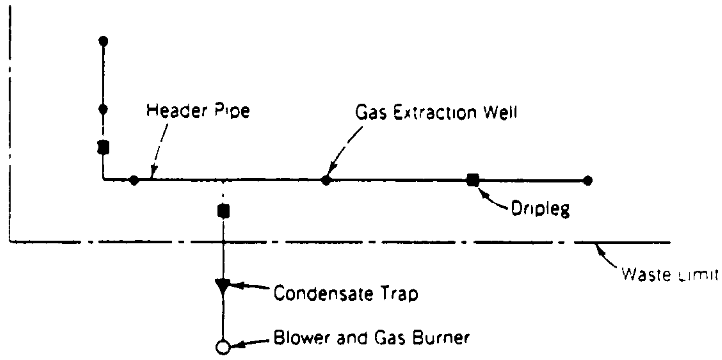

FIG. 8.26. Typical layout of active gas venting system elements

Extraction Well. Spacing of extraction wells is a key issue in extracting landfill gas efficiently. They should be spaced such that their zone of influence overlaps. As shown in Fig. 8.27, a 27% overlap can be obtained by installing the extraction wells on the corners of equilateral triangles of side $1.73R$ and a 100% overlap can be obtained by installing the extraction wells on the corner of a regular hexagon of side R. A square array would provide a 60% overlap. Thus, spacing of extraction wells is given by

$$\text{Spacing} = (2 - O_l/100)R \qquad (8.23)$$

in which R = the radius of influence of gas extraction wells and O_l = the required overlap.

The zone of influence of a gas extraction system should be determined from actual field study. An extraction well should be installed within the landfill with gas probes at regular distances from the well (Fig. 8.28). Short-term and/or long-

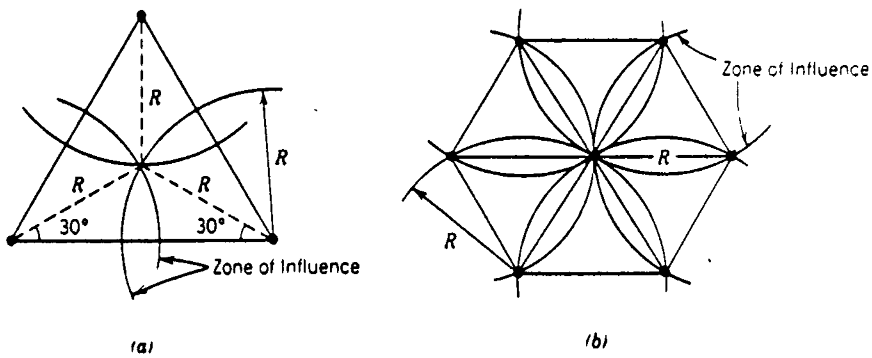

FIG. 8.27. Positioning of gas extraction well for complete overlap (a) triangular array, (b) hexagonal array. Solid circles indicate locations of gas extraction wells.

TRAIL RIDGE LANDFILL - PLAN A

AMENDMENT NO. 1

TO

QUALITY ASSURANCE MANUAL FOR THE INSTALLATION OF GEOSYNTHETIC LINING SYSTEMS.

1.0 **PURPOSE**

The purpose of this amendment is to supplement the Waste Management of North America, Inc., "Quality Assurance Manual For The Installation of Geosynthetic Lining Systems" to include two layers of constructed base on which the primary and secondary Geosynthetic Lining System will be installed.

2.0 **BASE CONSTRUCTION**

2.1 **SUBGRADE**

The contractor shall prepare the subgrade for base construction by grading the subgrade 6" below the base grades shown on the construction drawings.

2.1.1 **FILL**

Fill required to construct the subgrade to final grade shall be a clean sand (A-3 or better) placed loose in 12" lifts and compacted to 95% density @ +/- 2% optimum moisture (ASTM D2922; ASTM D1557).

2.1.2 **FINISHED SUBGRADE**

Finish grade shall be 6" below the base grades shown on the construction drawings. Finish grade shall be rolled and compacted to be free of roots, stones, protrusions or other irregularities.

2.1.3 **TESTING (BY SOILS QUALITY ASSURANCE CONSULTANT)**

The finished subgrade shall be compacted to 95% density at +/- 2% of optimum moisture (ASTM D2922; ASTM D1557). One density test per 10,000 S.F. of finished subgrade shall be required. In addition 1 density test per 10,000 S.F. per 12" lift shall be required in fill areas.

2.2 **COMPACTED SUB BASE (LAYER NO. 1)**

The contractor shall prepare the compacted subbase to meet the base grades shown on the construction drawings.

2.2.1 **MATERIAL**

The material for the 6" compacted sub base shall consist of a clayey fine sand with a saturated hydraulic conductivity of less than or equal to $1X10^{-5}$ cm/sec.

2.2.2 **INSTALLATION**

The compacted sub base shall be installed in one 6" lift on top of the prepared subgrade. The sub base shall be rolled and compacted to the finish base grades shown on the construction drawings. A registered land surveyor shall verify all lines and grades and prepare an as-built base grade survey.

2.2.3 **TESTING (BY SOILS QUALITY ASSURANCE CONSULTANT)**

The material shall be compacted to 90% maximum dry density as defined by the Standard Proctor Test (ASTM D-698). One test shall be conducted for each 10,000 S.F. of subbase. The material shall be sampled and tested to provide a saturated hydraulic conductivity of $1X10^{-5}$ cm/sec or less. (COE.EM 1110-2-1906).

2.2.4 **RE-TESTING**

Any areas that do not pass the minimum specifications outlined above shall be re-tested in the same general location. If the second test results indicate that the material still does not meet the minimum specifications, the area shall be scarified, re-compacted and re-tested. If the third test results indicated substandard material, the material shall be removed and replaced with suitable material.

2.3 **BENTONITE BASE (LAYER NO. 2)**

2.3.1 **MATERIAL**

The bentonite base shall consist of a manufactured bentonite sheet 0.25 in. thick. The bentonite sheet shall include a minimum of 1 lb per sq. ft. sodium montmorillonite (90% montmorillonite, min.) between a primary backing of polypropylene and cover fabric of 100% spunlace polyester.

2.3.2 **INSTALLATION**

The bentonite sheets shall be installed in accordance with the manufactures recommendation.

2.3.2.1 **ORIENTATION**

All seams on side slopes must be perpendicular to the excavation bottom. Seams in the base of the landfill shall be laid parallel to the leachate collection pipe. The first sheet shall be laid at the leachate collection trench, proceeding up the slope with subsequent sheets to form a shingle effect. The stenciled polypropylene side of the bentonite sheets shall be facing up.

2.3.2.2 **ANCHORING**

The bentonite sheets shall be anchored 18" deep in the perimeter anchor trench as detailed on the construction documents. The bentonite sheets shall be pulled tight to eliminate any creases or irregularities. Sand bags shall be used to provide temporary anchoring during installation.

2.3.2.3 **SEAMING**

The bentonite sheets are self seaming and shall be overlapped a minimum of 6".

2.3.2.4 **REPAIRS**

Repairs to any tear or cut in a bentonite sheet shall be accomplished by covering the area with an additional layer of bentonite sheet with a minimum of 6" overlap on all sides.

2.3.2.5 **STORAGE**

The bentonite sheets shall be stored in rolls temporarily on-site, at a dry location. Each roll shall be encased in a plastic covering sealed at each end. Multiple rolls shall be covered with a plastic tarp.

Prior to installation each roll shall be inspected for damage due to moisture or handling. Damaged rolls shall be marked rejected and separated from the remaining stockpile.

2.3.2.6 **COVERING**

The bentonite sheets shall be covered after installation with the secondary 60 mil HDPE liner. If the HDPE liner can not be installed immediately following the installation of the bentonite sheet a temporary plastic tarp shall be installed.

The bentonite sheets shall not be installed in standing water or during rainfall. If the bentonite sheet becomes wet during installation it shall be inspected and replaced if necessary.

APPENDIX XIV

CLOSURE AND POST CLOSURE COST ESTIMATE
(REVISED 9-11-90)

Revised 9-11-90

APPENDIX XIV

TRAIL RIDGE LANDFILL
CLOSURE AND POST CLOSURE ESTIMATE

CLOSURE

$ 645,979	Top Soil 176 acres x 43,560 S.F./ACRE x 0.5 FT divided by 27 C.F/C.Y. x 1.3 x $3.50/C.Y.
2,030,219	Clay Liner 176 acres x 43,560 S.F./ACRE x 1.0 FT divided by 27 C.F/C.Y. x 1.3 x $5.50/C.Y.
1,937,939	Cover Soil 176 acres x 43,560 S.F./ACRE x 1.5 FT divided by 27 C.F/C.Y. x 1.3 x $3.50/C.Y.
100,000	Seed and Mulch (200 acres at $500 per acre)
35,000	Closure Certification
3,000,000	Gas Collection System
$7,749,133	Total Closure

POST CLOSURE

$ 200,000	Security, fencing, etc. ($10,000 per year)
120,000	Erosion Repair (1,500 C.Y. per year at $4.00/C.Y.)
40,000	Surface Water Control ($2,000 per year)
240,000	Leachate Collection System ($12,000 per year)
5,329,000	Leachate Disposal ($266,450 per year) 100 gal/day/acre x $.05/gal
240,000	Gas Collection System ($12,000 per year)
800,000	Water Quality Monitoring ($40,000 per year)
$ 6,969,000	Total Post Closure
$14,718,133	Total Closure and Post Closure

Note: A twenty year period is assumed for post closure.
All cost estimates are 1990 Dollars

England·Thims & Miller, Inc.
Consulting & Design Engineers
3131 St Johns Bluff Road So. Jacksonville, FL 32216
904-642-8990

PRINCIPALS
James E England, P.E., President
Robert E Thims, V Pres., Sec
Douglas C Miller, P.E., V Pres
N Hugh Mathews, P.E., V Pres

October 10, 1990

Mrs. Mary C. Nogas, P.E.
Supervisor, Solid Waste
Department of Environmental Regulation
7825 Baymeadows Way
Suite 200
Jacksonville, Florida 32256-7577

Reference: Trail Ridge Landfill Plan "A" Class I and Class III
FDER No. 184444
ET&M NO. E89-113-09

Dear Mrs. Nogas:

Pursuant to our meeting of October 8, 1990, please find herein the response to the following issues:

1. **H.E.L.P. Model**

   See revised H.E.L.P. Model Calculations.
   (See revised Drawing Nos. 15, 16, 18, and 19 - Cap Modifications)

2. **Gas Wells**

   The applicant agrees to install additional gas wells beyond those shown on the permit documents if odor or gas concentration limits are exceeded.

3. **North Borrow Area**

   A. **Stormwater Calculations**

   See attached stormwater calculations for volume of impoundment, peak discharge, drawdown time and spillway capacity. (See revised drawing No. 24A).

   B. **Staff Gauge**

   A staff gauge has been added in the North Borrow Area (See Drawing No. 24A).

Reference: Trail Ridge Landfill Plan "A" Class I and Class III
FDER No. 184444

C. **Effects on Water Table**

The crest of the spillway is elevation 123.0. This is the approximate water table at the upgradient (west) end of the borrow area. Therefore, no change in water table is anticipated at the west end of the borrow area. The water table elevation adjacent to the north, south and east side of the North Borrow Area could increase with a maximum water elevation of 123.0 in the borrow area. To mitigate this potential increase in groundwater elevation and prevent hydraulic piping through the exterior face of the embankment, a drainage blanket has been designed under the earthen dike.

This drainage blanket will dissipate the upgradient hydraulic pressure. Therefore, no significant increase in water table is anticipated. (See attached calculations from Golder and Associates and revised Drawing No. 24A).

Should you have any questions concerning this information, please do not hesitate to call.

Sincerely,

ENGLAND, THIMS & MILLER, INC.

Douglas C. Miller, P.E.
Vice President

DCM:kl

Enclosures:
1. H.E.L.P. Model Calculations (Revised 10-10-90)
2. North Borrow Area Stormwater Calculations
3. Water Table Calculations - Golder & Associates
4. Drawings Nos. 15, 16, 18, 19, and 24A (Revised)

cc: Harvey Bush
Warren Smith
Don Miller

England·Thims & Miller, Inc.
Consulting & Design Engineers
3131 St Johns Bluff Road So. Jacksonville, FL 32216
904-642-8990

BY JT   SHEET NO 1 OF 3

CHECKED BY ______   DATE 10-11-90

REVISED BY ______   DATE ______

PROJ NAME TRAIL RIDGE "PLAN A"

PROJ NO 89-113-9

LEAKAGE RATE CALCULATIONS FOR LINER ANALYSIS

LATERAL DRAINAGE FROM LAYER FOUR (PER H.E.L.P. MODEL)

LARGEST AVERAGE MONTHLY VALUE (SEPTEMBER) = 4.4307 IN/MTH

AVERAGE ANNUAL TOTAL 19.6741 IN/YR.

$$4.4307 \text{ IN/MTH} > 19.6741 \text{ IN/YR}$$

$$4.4307 \text{ IN/MTH} = 4.3 \times 10^{-8} \text{ M/SEC}$$

Q (IMPINGEMENT RATE) = 4.3×10^{-8} M/SEC

$$H = L\left(\sqrt{Q/K + \tan^2\beta} - \tan\beta\right)$$

H = HEAD ON PRIMARY LINER

Q = IMPINGEMENT RATE (4.3×10^{-8} M/SEC)

K = HYDRAULIC CONDUCTIVITY OF GEODRAIN (15.6 CM/S ≈ 0.2 M/SEC)

$\tan\beta$ = BASE SLOPE (2% - 0.02)

L = DRAINAGE LENGTH (150 FT ≈ 46 M)

$$H = 46\left(\sqrt{\frac{4.3\times10^{-8}}{0.2} + (0.02)^2} - 0.02\right)$$

= 0.00025 M

= 0.0097 IN

[signature] 10-11-90

ASSUME : 1 HOLE/AC

$AREA_{HOLE} = 0.1 CM^2 = 1 \times 10^{-5} M^2$

$Q = 0.6 A \sqrt{2gH}$

Q = LEAKAGE RATE

A = AREA OF HOLE ($1 \times 10^{-5} M^2$)

g = 9.8 M/SEC

H = 0.00025 M. (SEE PREVIOUS SHEET)

$Q = 0.6(1 \times 10^{-5}) \sqrt{2(9.8)(0.00025)}$

$= 4.2 \times 10^{-7} M^3/SEC/HOLE$

$4.2 \times 10^{-7} M^3/SEC/HOLE \times 1 \ HOLE/AC \times 1 \ AC/4047 M^2$

$Q = 1.04 \times 10^{-10} M/SEC$

= 9.6 GAL/AC/DAY

FOR CONSERVATIVE MEASURES, ASSUME THE GEODRAIN (PRIMARY) IS SATURATED.
HEAD = 0.22 IN = 0.0056 M

Q = 46.2 GPAD

∴ ASSUME A LEAKAGE RATE IN EXCESS OF 100 gPAD WOULD REQUIRE REMEDIATION.

DEPTH OF FLOW CALCULATIONS IN LDS (AS SUGGESTED BY GIROUD ET AL [illegible])

ASSUMED LEAKAGE RATE = 100GPD

$$\text{DEPTH OF FLOW} = \frac{Q}{B \, K \, i}$$

Q = LEAKAGE RATE (100 GPD = 1×10^{-9} M³/S)

* B = WIDTH OF LEAKAGE FLOW

K = HYDRAULIC CONDUCTIVITY OF LDS (19.5 cm/s = 0.2 M/S)

i = HYDRAULIC GRADIENT OF LDS SLOPE (0.02)

$$D = \frac{1 \times 10^{-9}\ \text{M/SEC}}{(1\text{M})(0.2\ \text{M/S})(0.02)}$$

$= 0.00000025\text{M}$

$\cong 0.0000098\text{IN}$

0.0000098IN < 0.22 IN (DEPTH OF LDS)

∴ LDS DOES NOT BECOME SATURATED

REFERENCE: EQUATIONS & METHODOLOGY OBTAINED FROM PERMIT DOCUMENTS SUBMITTED TO D.E.R. FOR MEDLEY LANDFILL EXPANSION FROM GEOSERVICES INC

* (GIROUD SUGGESTS A CONSERVATIVE FLOW WIDTH TO BE 1M - 5M)

LINER LEAKAGE FRACTION
=0.[illegible] FOR PRIMARY LINER

****

[illegible] LANDFILL - LINER ANALYSIS
[illegible] DUVAL COUNTY, FLORIDA
[illegible] OCTOBER [illegible]

****

[illegible]

LAYER [illegible]

[illegible] PERCOLATION LAYER

THICKNESS	=	[illegible] INCHES
POROSITY	=	[illegible] VOL/VOL
FIELD CAPACITY	=	[illegible] VOL/VOL
WILTING POINT	=	[illegible] VOL/VOL
INITIAL SOIL WATER CONTENT	=	[illegible] VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	[illegible] CM/SEC

LAYER [illegible]

VERTICAL PERCOLATION LAYER

THICKNESS	=	[illegible] INCHES
POROSITY	=	[illegible] VOL/VOL
FIELD CAPACITY	=	[illegible] VOL/VOL
WILTING POINT	=	[illegible] VOL/VOL
INITIAL SOIL WATER CONTENT	=	[illegible] VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	[illegible] CM/SEC

LAYER 3

VERTICAL PERCOLATION LAYER

THICKNESS	=	24.00 INCHES
POROSITY	=	0.4570 VOL/VOL
FIELD CAPACITY	=	0.1309 VOL/VOL
WILTING POINT	=	0.0580 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.1309 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.0010000[illegible]475 CM/SEC

LAYER 4

LATERAL DRAINAGE LAYER

THICKNESS = [illegible] INCHES
POROSITY = [illegible] VOL/VOL
FIELD CAPACITY = [illegible] VOL/VOL
WILTING POINT = [illegible] VOL/VOL
INITIAL SOIL WATER CONTENT = [illegible] VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY = [illegible] CM/SEC
SLOPE = [illegible] PERCENT
DRAINAGE LENGTH = [illegible] FEET

LAYER 5

BARRIER SOIL LINER WITH FLEXIBLE MEMBRANE LINER

THICKNESS = [illegible] INCHES
POROSITY = [illegible] VOL/VOL
FIELD CAPACITY = [illegible] VOL/VOL
WILTING POINT = [illegible] VOL/VOL
INITIAL SOIL WATER CONTENT = [illegible] VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY = [illegible] CM/SEC
LINER LEAKAGE FRACTION = [illegible]

LAYER 6

LATERAL DRAINAGE LAYER

THICKNESS = [illegible] INCHES
POROSITY = [illegible] VOL/VOL
FIELD CAPACITY = [illegible] VOL/VOL
WILTING POINT = [illegible] VOL/VOL
INITIAL SOIL WATER CONTENT = [illegible] VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY = [illegible] CM/SEC
SLOPE = [illegible] PERCENT
DRAINAGE LENGTH = [illegible] FEET

LAYER 7

BARRIER SOIL LINER WITH FLEXIBLE MEMBRANE LINER

THICKNESS = 0.25 INCHES
POROSITY = 0.4000 VOL/VOL
FIELD CAPACITY = 0.3560 VOL/VOL
WILTING POINT = 0.2899 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.0025 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY = 0.000000010000 CM/SEC
LINER LEAKAGE FRACTION = 0.00000000

LAYER 8

VERTICAL PERCOLATION LAYER

THICKNESS	=	0 INCHES
POROSITY	=	[illegible].4750 VOL/VOL
FIELD CAPACITY	=	0.3777 VOL/VOL
WILTING POINT	=	0.2548 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.3777 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.[illegible] CM/SEC

GENERAL SIMULATION DATA

SCS RUNOFF CURVE NUMBER	=	[illegible]
TOTAL AREA OF COVER	=	[illegible] SQ FT
EVAPORATIVE ZONE DEPTH	=	[illegible] INCHES
[illegible]	=	
UPPER LIMIT VEG. STORAGE	=	[illegible] INCHES
INITIAL VEG. STORAGE	=	[illegible] INCHES

SOIL WATER CONTENT INITIALIZED BY USER

CLIMATOLOGICAL DATA

SYNTHETIC RAINFALL WITH SYNTHETIC DAILY TEMPERATURES AND
SOLAR RADIATION FOR JACKSONVILLE FLORIDA

MAXIMUM LEAF AREA INDEX	=	[illegible]
START OF GROWING SEASON (JULIAN DATE)	=	[illegible]
END OF GROWING SEASON (JULIAN DATE)	=	[illegible]4

NORMAL MEAN MONTHLY TEMPERATURES, DEGREES FAHRENHEIT

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

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 5

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	2.60	3.54	2.57	2.32	3.68	4.36
	7.46	9.03	8.11	2.39	2.64	3.05
STD. DEVIATIONS	1.70	2.18	2.39	2.31	2.48	2.67
	3.02	1.53	1.78	1.69	1.98	1.40
RUNOFF						
TOTALS	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

STD. DEVIATIONS	0.000	0.000	0.000	[illegible]	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000

EVAPOTRANSPIRATION

TOTALS	1.584	2.228	2.159	1.517	2.536	2.984
	4.262	4.240	4.082	2.439	1.655	2.049
STD. DEVIATIONS	0.612	1.580	0.666	[illegible]	[illegible]	[illegible]
	1.246	1.479	0.492	0.907	0.735	0.567

LATERAL DRAINAGE FROM LAYER 4

TOTALS	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
STD. DEVIATIONS	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

PERCOLATION FROM LAYER 5?

TOTALS	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
STD. DEVIATIONS	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

LATERAL DRAINAGE FROM LAYER 6?

TOTALS	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
STD. DEVIATIONS	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

PERCOLATION FROM LAYER 7?

TOTALS	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	0.0006	[illegible]	[illegible]
STD. DEVIATIONS	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

PERCOLATION FROM LAYER 8?

TOTALS	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	0.0445	0.0441	[illegible]	[illegible]	[illegible]	[illegible]
STD. DEVIATIONS	0.0254	0.0135	0.0195	0.0476	0.0452	0.0250
	0.0043	0.0037	0.0031	0.0029	0.0025	0.0023

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

	(INCHES)		(CU. FT.)	PERCENT
PRECIPITATION	52.26	(5.568)	1897110.	100.00
RUNOFF	0.000	(0.000)	0.	0.00

LATERAL DRAINAGE FROM LAYER 4	19.5741 (6.5 [illegible]	714171.	37.65
PERCOLATION FROM LAYER 5	0.0000 (0.0000)	[illegible]	0.0[illegible]
LATERAL DRAINAGE FROM LAYER 6	0.0000 (0.0000)	0.	0.00
PERCOLATION FROM LAYER 7	[illegible]	[illegible]	[illegible]
PERCOLATION FROM LAYER 8	[illegible] ([illegible])	25[illegible].	0.1[illegible]
CHANGE IN WATER STORAGE	[illegible]	[illegible]	[illegible]

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 5

	(INCHES)	(CU. FT.)
PRECIPITATION	4.7[illegible]	[illegible]
RUNOFF	[illegible]	[illegible]
LATERAL DRAINAGE FROM LAYER 4	[illegible]	[illegible]
PERCOLATION FROM LAYER 5	[illegible]	[illegible]
HEAD ON LAYER 5	[illegible]	
LATERAL DRAINAGE FROM LAYER 6	[illegible]	[illegible]
PERCOLATION FROM LAYER 7	[illegible]	[illegible]
HEAD ON LAYER 7	[illegible]	
PERCOLATION FROM LAYER 8	[illegible]	[illegible]
SNOW WATER	[illegible]	[illegible]

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.4055

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.0743

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FINAL WATER STORAGE AT END OF YEAR 5

LAYER	(INCHES)	(VOL/VOL)
1	0.39	0.0626

3	5.75	.2230
4	[illegible]	[illegible]
5	[illegible]	0.0225
6	[illegible]	[illegible]
7	[illegible]	[illegible]
8	[illegible]	[illegible]
SNOW WATER	[illegible]	

1	3.12	[illegible]
2	3.48	[illegible]
3	5.16	[illegible]
4	2.39	[illegible]
5	[illegible]	[illegible]
6	4.59	[illegible]
7	[illegible]	[illegible]
8	[illegible]	[illegible]
[illegible]		[illegible]
[illegible]	[illegible]	
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	

1 IER LEAKAGE RATE
=0.00 FOR PRIMARY LINER

TRAILRIDGE LANDFILL - FINAL COVER ANALYSIS
JACKSONVILLE, DUVAL COUNTY, FLORIDA
[illegible] OCTOBER 11, 1990

[illegible]

LAYER 1

VERTICAL PERCOLATION LAYER

THICKNESS	=	[illegible] INCHES
POROSITY	=	[illegible] VOL/VOL
FIELD CAPACITY	=	[illegible] VOL/VOL
WILTING POINT	=	[illegible] VOL/VOL
INITIAL SOIL WATER CONTENT	=	[illegible] VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	[illegible] CM/SEC

LAYER 2

LATERAL DRAINAGE LAYER

THICKNESS	=	12.[illegible] INCHES
POROSITY	=	[illegible] VOL/VOL
FIELD CAPACITY	=	0.1[illegible] VOL/VOL
WILTING POINT	=	[illegible] VOL/VOL
INITIAL SOIL WATER CONTENT	=	[illegible] VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	[illegible] CM/SEC
SLOPE	=	[illegible] PERCENT
DRAINAGE LENGTH	=	[illegible] FEET

LAYER 3

BARRIER SOIL LINER

[illegible]ICKNESS	=	12.00 INCHES
POROSITY	=	0.4300 VOL/VOL
[illegible]LD CAPACITY	=	0.366[illegible] VOL/VOL
[illegible]TING POINT	=	0.2802 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4300 VOL/VOL
S[illegible]URATED HYDRAULIC CONDUCTIVITY	=	0.000000100000 CM/SEC

LAYER 4

VERTICAL PERCOLATION LAYER

THICKNESS	=	12.00 INCHES
POROSITY	=	0.4570 VOL/VOL
FIELD CAPACITY	=	0.1309 VOL/VOL
WILTING POINT	=	0.0580 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.2020 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.001000000475 CM/SEC

LAYER 5

VERTICAL PERCOLATION LAYER

THICKNESS	=	[illegible] INCHES
POROSITY	=	[illegible] VOL/VOL
FIELD CAPACITY	=	[illegible] VOL/VOL
WILTING POINT	=	[illegible] VOL/VOL
INITIAL SOIL WATER CONTENT	=	[illegible] VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	[illegible] CM/SEC

LAYER 6

VERTICAL PERCOLATION LAYER

THICKNESS	=	24.00 INCHES
POROSITY	=	[illegible] VOL/VOL
FIELD CAPACITY	=	[illegible] VOL/VOL
WILTING POINT	=	[illegible] VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.1571 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	[illegible] CM/SEC

LAYER 7

LATERAL DRAINAGE LAYER

THICKNESS	=	[illegible] INCHES
POROSITY	=	0.7000 VOL/VOL
FIELD CAPACITY	=	0.0450 VOL/VOL
WILTING POINT	=	0.0200 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0457 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	19.6849994659424 CM/SEC
SLOPE	=	2.00 PERCENT
DRAINAGE LENGTH	=	150.0 FEET

LAYER 8

BARRIER SOIL LINER WITH FLEXIBLE MEMBRANE LINER

THICKNESS	=	0.06 INCHES
POROSITY	=	[illegible] VOL/VOL

```
WILTING POINT                    =      [illegible] VOL/VOL
INITIAL SOIL WATER CONTENT       =      .000 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY =   19.6849994659424 CM/SEC
LINER LEAKAGE FRACTION           =      0.00000000


                       LAYER 9
                       --------

               LATERAL DRAINAGE LAYER
THICKNESS                        =      0.22 INCHES
POROSITY                         =      [illegible] VOL/VOL
FIELD CAPACITY                   =      [illegible] VOL/VOL
WILTING POINT                    =      [illegible]
INITIAL SOIL WATER CONTENT       =      [illegible]
SATURATED HYDRAULIC CONDUCTIVITY =      [illegible]
SLOPE                            =      [illegible] PERCENT
DRAINAGE LENGTH                  =      [illegible] FEET


                       LAYER 10
                       --------

     BARRIER SOIL LINER WITH FLEXIBLE MEMBRANE LINER
THICKNESS                        =      [illegible] INCHES
POROSITY                         =      [illegible] VOL/VOL
FIELD CAPACITY                   =      [illegible]
WILTING POINT                    =      [illegible]
INITIAL SOIL WATER CONTENT       =      [illegible]
SATURATED HYDRAULIC CONDUCTIVITY =      [illegible]
LINER LEAKAGE FRACTION           =      [illegible]


                       LAYER 11
                       --------

              VERTICAL PERCOLATION LAYER
THICKNESS                        =      6.00 INCHES
POROSITY                         =      0.4750 VOL/VOL
FIELD CAPACITY                   =      0.3777 VOL/VOL
WILTING POINT                    =      0.2648 VOL/VOL
INITIAL SOIL WATER CONTENT       =      0.2648 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY =      0.00001700[illegible] CM/SEC


                GENERAL SIMULATION DATA
                -----------------------

SCS RUNOFF CURVE NUMBER          =      74.26
TOTAL AREA OF COVER              =  435600. SQ FT
EVAPORATIVE ZONE DEPTH           =       8.00 INCHES
UPPER LIMIT VEG. STORAGE         =       3.7840 INCHES
INITIAL VEG. STORAGE             =       2.9575 INCHES
        SOIL WATER CONTENT INITIALIZED BY PROGRAM.
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CLIMATOLOGICAL DATA

SYNTHETIC RAINFALL WITH SYNTHETIC DAILY TEMPERATURES AND SOLAR RADIATION FOR JACKSONVILLE FLORIDA

MAXIMUM LEAF AREA INDEX = 2.00
START OF GROWING SEASON (JULIAN DATE) = 37
END OF GROWING SEASON (JULIAN DATE) = 4

NORMAL MEAN MONTHLY TEMPERATURES, DEGREES FAHRENHEIT

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

****

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH [illegible]

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	2.6[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	7.4[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
STD. DEVIATIONS	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.40
RUNOFF						
TOTALS	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	0.846	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
STD. DEVIATIONS	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	0.474	0.186	1.320
EVAPOTRANSPIRATION						
TOTALS	1.674	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	5.677	5.349	5.574	[illegible]	1.692	1.262
STD. DEVIATIONS	0.445	0.640	1.104	1.715	2.369	1.592
	1.625	2.108	0.310	1.074	0.911	0.238
LATERAL DRAINAGE FROM LAYER 2						
TOTALS	0.0322	0.0317	0.0322	0.0283	0.0300	0.0275
	0.0296	0.0328	0.0346	0.0301	0.0274	0.0324
STD. DEVIATIONS	0.0046	0.0043	0.0037	0.0014	0.0034	0.0024
	0.0011	0.0026	0.0032	0.0030	0.0014	0.0064
PERCOLATION FROM LAYER 3						
TOTALS	0.2718	0.2616	0.2750	0.2471	0.2555	0.2367
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

61.50	.0	.0	.0
63.00	.0	.0	.0
64.50	.0	.0	.0
66.00	.0	.0	.0
67.50	.0	.0	.0
69.00	.0	.0	.0
70.50	.0	.0	.0
72.00	.0	.0	.0

OUTPUT SUMMARY

PEAK FLOW (cfs)	= 179.6
TIME TO PEAK (hrs)	= 10.50
RUNOFF DEPTH (in.)	= [illegible]
RUNOFF VOLUME (ac. ft)	= [illegible]

LICENSED TO: ENGLAND, THIMS & MILLER, INC.

****
* RESERVOIR ROUTING *
****

STAGE: 123.00 123.20 123.40 123.60 123.80 124.00 124.20 124.40
124.60 124.80
STORAGE: .00 6.05 12.11 18.19 24.29 30.42 36.56 42.73
48.91 55.12
FLOW: .0 2.9 8.3 15.2 23.2 32.3 42.3 53.1
64.7 76.0

TIME	INFLOW	STAGE	STORAGE	OUTFLOW
[illegible]	.0	[illegible]	[illegible]	.0
1.50	[illegible]	[illegible]	[illegible]	[illegible]
3.00	[illegible]	[illegible]	[illegible]	[illegible]
4.50	3.1	123.05	[illegible]	[illegible]
6.00	[illegible]	[illegible]	[illegible]	1.[illegible]
7.50	3.4	123.09	[illegible]	1.1
9.00	12.0	123.17	3.85	1.9
10.50	179.6	123.33	7.11	3.3
12.00	14.8	123.50	15.1[illegible]	11.7
13.50	7.6	123.50	15.17	11.8
15.00	6.7	123.49	14.73	11.7
16.50	5.4	123.47	14.17	10.6
18.00	4.8	123.45	13.57	9.9
19.50	4.3	123.43	12.9[illegible]	9.2
21.00	3.6	123.41	12.27	8.5
22.50	.0	123.38	11.15	7.7
24.00	.0	123.35	10.30	6.7
25.50	.0	123.32	9.75	6.1
27.00	.0	123.30	9.22	5.6
28.50	.0	123.28	8.77	5.0
30.00	.0	123.26	7.70	4.5
31.50	.0	123.24	7.26	4.0
33.00	.0	123.23	6.79	3.6
34.50	.0	123.2[illegible]	6.3[illegible]	3.3
36.00	.0	123.20	5.99	2.9
37.50	.0	123.19	5.6[illegible]	2.7
39.00	.0	123.18	5.31	2.6
40.50	.0	123.17	5.00	2.4
42.00	.0	123.16	4.70	2.3
43.50	.0	123.15	4.43	2.2
45.00	.0	123.14	4.17	2.0
46.50	.0	123.13	3.93	1.9
48.00	.0	123.12	3.70	1.8
49.50	.0	123.12	3.48	1.7
51.00	.0	123.11	3.28	1.6
52.50	.0	123.10	3.09	1.5
54.00	.0	123.10	2.91	1.4
55.50	.0	123.09	2.74	1.3
57.00	.0	123.09	2.58	1.3
58.50	.0	123.08	2.43	1.2
60.00	.0	123.08	2.28	1.1
61.50	.0	123.07	2.15	1.0
63.00	.0	123.07	2.02	1.0
64.50	.0	123.06	1.91	.9
66.00	.0	123.06	1.79	.9
67.50	.0	123.06	1.69	.8
69.00	.0	123.05	1.59	.8

```
      72.00              .0     123.05          1.41            .7

                          OUTPUT SUMMARY
                          --------------
        PEAK FLOW (cfs)                       =     11.9
        PEAK STAGE (ft)                       =   123.51
        TIME TO PEAK (hrs)                    =    12.75
        RUNOFF VOLUME STORED (ac-ft)          =      5.3

**** END OF JOB ****
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England-Thims & Miller, Inc.
Consulting & Design Engineers
3131 St Johns Bluff Road So Jacksonville, FL 32216
904-642-8990

BY ______ SHEET NO ___ OF ___
CHECKED BY ______ DATE ______
REVISED BY ______ DATE ______

PROJ. NAME TRAILRIDGE LANDFILL

PROJ NO E89-113-9

VOLUME IMPOUNDED BY BORROW PIT

- NORMAL WATER LEVEL: EL 123.0
  AREA OF 123.0 CONTOUR: 30.16 ACRES
- ELEVATION AT EASTERLY END OF BORROW PIT: 100.0
  AREA OF 100.0 CONTOUR: 24.15 ACRES
- AVERAGE AREA OF 123 AND 100 CONTOURS: $\bar{A} = \frac{30.16 + 24.15}{2}$
  $= 27.155$ ACRES
- DEPTH: $123 - 100 = 23$ FT
- TOTAL VOLUME IMPOUNDED $V = 27.155$ ACRES (23 FT)
  $=$ **624.6 ACRE-FT**

STD. DEVIATIONS	0.0271	[illegible]	[illegible]	0.0112	0.0221	0.0177
	0.0070	0.0162	0	0.0197	0.0134	0.0750

LATERAL DRAINAGE FROM LAYER 7

TOTALS	0.0904	0.0840	0.0939	0.0926	0.0974	0.0953
	0.1005	0.1019	0.0998	0.1044	0.1021	0.1066
STD. DEVIATIONS	[illegible]	[illegible]	[illegible]	0.0245	[illegible]	[illegible]
	[illegible]	[illegible]	0.0174	[illegible]	0.0157	0.0155

PERCOLATION FROM LAYER 9

TOTALS	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
STD. DEVIATIONS	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

LATERAL DRAINAGE FROM LAYER [illegible]

TOTALS	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
STD. DEVIATIONS	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	0.0000	[illegible]	[illegible]	[illegible]	[illegible]

PERCOLATION FROM LAYER 10

TOTALS	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	0.0000	[illegible]	[illegible]	[illegible]
STD. DEVIATIONS	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

PERCOLATION FROM LAYER 11

TOTALS	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	0.0000	[illegible]	[illegible]	[illegible]
STD. DEVIATIONS	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

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

	(INCHES)	(CU. FT.)	PERCENT
PRECIPITATION	52.26 (6.568)	1897110.	100.00
RUNOFF	8.270 (2.855)	300211.	15.82
EVAPOTRANSPIRATION	40.846 (3.440)	1482716.	78.16
LATERAL DRAINAGE FROM LAYER 2	0.3688 (0.0064)	13387.	0.71
PERCOLATION FROM LAYER 3	3.1193 (0.0502)	113195.	5.97
LATERAL DRAINAGE FROM	[illegible]	[illegible]	[illegible]

LAYER [illegible]

PERCOLATION FROM LAYER 8	0.0000 (0.2[illegible]	0.	0.00
LATERAL DRAINAGE FROM LAYER 9	0.0000 (0.0000)	0.	0.00
PERCOLATION FROM LAYER 10	0.0000 (0.0000)	0.	0.00
PERCOLATION FROM LAYER 11	0.0000 (0.0000)	0.	0.00
CHANGE IN WATER STORAGE	1.6[illegible]7 (1.766)	58[illegible].	[illegible].39

****

PEAK DAILY VALUES FOR YEARS 1 THROUGH 5

	(INCHES)	(CU. FT.)
PRECIPITATION	4.7[illegible]	[illegible]
RUNOFF	[illegible]	[illegible]
LATERAL DRAINAGE FROM LAYER 2	[illegible]	51.1
PERCOLATION FROM LAYER 2	[illegible]	[illegible]
HEAD ON LAYER 2	[illegible]	
LATERAL DRAINAGE FROM LAYER 7	[illegible]	145.2
PERCOLATION FROM LAYER 8	[illegible]	[illegible]
HEAD ON LAYER 8	[illegible]	
LATERAL DRAINAGE FROM LAYER 9	[illegible]	[illegible]
PERCOLATION FROM LAYER 10	[illegible]	[illegible]
HEAD ON LAYER 10	[illegible]	
PERCOLATION FROM LAYER 11	[illegible]	[illegible]
SNOW WATER	0.00	0.0

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.47[illegible]

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.1034

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FINAL WATER STORAGE AT END OF YEAR 5

England-Thims & Miller, Inc.
Consulting & Design Engineers
3131 St Johns Bluff Road So Jacksonville, FL 32216
904-642-8990

BY ______ SHEET NO ____ OF ____

CHECKED BY ______ DATE ______

PROJ NAME Trailridge Landfill REVISED BY ______ DATE ______

PROJ NO [illegible]

Volume Impounded By Borrow Pit

- Normal Water Level: El 123.0
  Area of 123.0 Contour: 30.16 Acres

- Elevation of Borrow Pit Bottom: 100.0
  Area of 100.0 Contour: 24.15 Acres

- Average Area of 123 and 100 Contours: $\bar{A} = \frac{30.16 + 24.15}{2}$
  $= 27.155$ Acres

- Depth: 123 - 100 = 23 Ft

Total Volume Impounded $V = 27.155$ Acres (23 Ft)

$= 624.6$ Acre-Ft

```
*********************************
*        SUPRA-1 PROGRAM        *
*   VERSION 1.21, JAN., 1987    *
*       COPYRIGHT (C) BY        *
*  SUPRA ENGINEERING SOFTWARE   *
*********************************


            FUNCTION MENU
            -------------
 1 - RUNOFF HYDROGRAPH COMPUTATION
      A - SCS UNIT HYDROGRAPH
      B - LINEAR RESERVOIR ROUTING
 2 - RESERVOIR ROUTING
 3 - CHANNEL ROUTING
 4 - SAVE HYDROGRAPH
 5 - READ HYDROGRAPH
 6 - HYDROGRAPH ADDITION
 7 - FLOW DIVERSION
      A - CONTROLLED BY MAXIMUM FLOW
      B - SPLIT FLOW
      C - AS A FUNCTION OF TOTAL OUTFLOW
 8 - INFLOW HYDROGRAPH INSERTION
 9 - BASEFLOW ADDITION
10 - POND OUTLET DESIGN
      A - ONE STAGE RECTANGULAR WEIR
      B - TWO-STAGE RECTANGULAR WEIR
      C - CIRCULAR PIPE


TITLE: BORROW PIT DESIGN
       TRAIL RIDGE LANDFILL

SIMULATION TIME (hrs)                 =   72.0
TIME STEP (min.)                      =    3.0
PRINT INTERVAL                        =     10

TOTAL RAINFALL DEPTH (in.)            =    8.6
RAINFALL TIME INTERVAL (min.)         =   30.0
TYPE OF RAINFALL DISTRIBUTION               3
  1 - RAINFALL DIST. IS GIVEN BY THE USER
  2 - SCS TYPE I DIST. (24 HR STORM)
  3 - SCS TYPE IA DIST. (24-HR STORM)
  4 - SCS TYPE II DIST. (24-HR STORM)
  5 - SCS TYPE II (MOD.) DIST. (24-HR STORM)
  6 - SCS TYPE III DIST. (24-HR STORM)
```

10-10-90

LICENSED TO: ENGLAND, THIMS & MILLER, INC.

****
* HYDROGRAPH COMPUTATION *
****

** SCS UNIT HYDROGRAPH METHOD **

INPUT SUMMARY

SUB-BASIN: 1
AREA (acres) = [illegible]
EFFECTIVE IMPERVIOUS AREA (%) = .0
NONEFFECTIVE IMPERVIOUS AREA (%) = .0
[illegible]
[illegible]
[illegible]
[illegible]
[illegible] = [illegible]

TIME	[illegible]	[illegible]	TOTAL FLOW
.00	.0	.0	.0
1.50	.0	1.2	1.2
3.00	.0	4.[illegible]	4.[illegible]
4.50	.0	5.4	5.[illegible]
6.00	.0	6.6	6.6
7.50	.0	[illegible].4	[illegible].4
9.00	.0	[illegible]	[illegible]
10.50	.0	[illegible]	[illegible]
12.00	.0	[illegible].8	[illegible]
13.50	.0	7.[illegible]	[illegible]
15.00	.0	6.[illegible]	[illegible]
16.50	.0	5.4	5.[illegible]
18.00	.0	4.8	4.8
19.50	.0	[illegible]	4.[illegible]
21.00	.0	3.6	3.6
22.50	.0	.0	[illegible]
24.00	.0	.0	[illegible]
25.50	.0	[illegible]	[illegible]
27.00	.0	.0	.0
28.50	.0	.0	.0
30.00	.0	.0	[illegible]
31.50	.0	.0	[illegible]
33.00	.0	.0	.0
34.50	.0	.0	.0
36.00	.0	.0	.0
37.50	.0	.0	.0
39.00	.0	.0	.0
40.50	.0	.0	.0
42.00	.0	.0	.0
43.50	.0	.0	.0
45.00	.0	.0	.0
46.50	.0	.0	.0
48.00	.0	.0	.0
49.50	.0	.0	.0
51.00	.0	.0	.0
52.50	.0	.0	.0
54.00	.0	.0	.0
55.50	.0	.0	.0
57.00	.0	.0	.0
58.50	.0	.0	[illegible]

England·Thims & Miller, Inc.
Consulting & Design Engineers
3131 St Johns Bluff Road So. Jacksonville, FL 32216
904-642-8990

PRINCIPALS
James E England, P.E., President
Robert E Thims, V Pres., Sec
Douglas C Miller, P.E., V Pres
N Hugh Mathews, P.E., V Pres

October 11, 1990

Mrs. Mary C. Nogas, P.E.
Supervisor, Solid Waste
Department of Environmental Regulation
7825 Baymeadows Way
Suite 200
Jacksonville, Florida 32256-7577

Reference: Trail Ridge Landfill Plan "A"
FDER No. 184444
ET&M NO. E89-113-09

Dear Mrs. Nogas:

Pursuant to our meeting of October 10, 1990, please find enclosed herewith additional information concerning the above referenced permit application.

1. **GAS VENTING LAYOUT**

A gas survey will be conducted prior to the installation of the gas wells and the number and spacing of said wells shall be modified, if required, based upon the results of that survey.

2. **H.E.L.P. ANALYSIS**

The calculations for the Leakage Rate and Depth of Flow in the LDS are enclosed. These calculations indicate the LDS does not become saturated while conveying the leakage rate of 100 GPAD. As suggested, we are providing as supplemental data, revised H.E.L.P. model runs for your analysis.

I trust this additional information is satisfactory and completes the Trail Ridge Landfill Plan "A" application file.

If I can be of further service, please do not hesitate to contact me.

Sincerely,

ENGLAND, THIMS & MILLER, INC.

Douglas C. Miller, P.E.
Vice President

DCM:kl

E89.113.9
TRAILRIDGE

England-Thims & Miller, Inc.
Consulting & Design Engineers
3131 St Johns Bluff Road So Jacksonville FL 32216
904-642-8990

ORIGINALS OF
SUBMITTAL MADE TO
D.E.R. ON 10/10/90

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 TRAILRIDGE LANDFILL - LINER ANALYSIS
 JACKSONVILLE, DUVAL COUNTY, FLORIDA
 E89-113-9  OCTOBER 9, 1990

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                              BARE GROUND

                               LAYER  1
                               --------

                       VERTICAL PERCOLATION LAYER
   THICKNESS                             =      6.00 INCHES
   POROSITY                              =      0.4570 VOL/VOL
   FIELD CAPACITY                        =      0.1309 VOL/VOL
   WILTING POINT                         =      0.0580 VOL/VOL
   INITIAL SOIL WATER CONTENT            =      0.1309 VOL/VOL
   SATURATED HYDRAULIC CONDUCTIVITY      =      0.0010000000475 CM/SEC


                               LAYER  2
                               --------

                       VERTICAL PERCOLATION LAYER
   THICKNESS                             =     72.00 INCHES
   POROSITY                              =      0.5200 VOL/VOL
   FIELD CAPACITY                        =      0.2942 VOL/VOL
   WILTING POINT                         =      0.1400 VOL/VOL
   INITIAL SOIL WATER CONTENT            =      0.2942 VOL/VOL
   SATURATED HYDRAULIC CONDUCTIVITY      =      0.0001999999949 CM/SEC


                               LAYER  3
                               --------

                       VERTICAL PERCOLATION LAYER
   THICKNESS                             =     24.00 INCHES
   POROSITY                              =      0.4570 VOL/VOL
   FIELD CAPACITY                        =      0.1309 VOL/VOL
   WILTING POINT                         =      0.0580 VOL/VOL
   INITIAL SOIL WATER CONTENT            =      0.1309 VOL/VOL
   SATURATED HYDRAULIC CONDUCTIVITY      =      0.0010000000475 CM/SEC
```

LAYER 4

LATERAL DRAINAGE LAYER

```
THICKNESS                          =      0.22 INCHES
POROSITY                           =      0.7000 VOL/VOL
FIELD CAPACITY                     =      0.0450 VOL/VOL
WILTING POINT                      =      0.0200 VOL/VOL
INITIAL SOIL WATER CONTENT         =      0.0225 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY   =     19.6849994659424 CM/SEC
SLOPE                              =      2.00 PERCENT
DRAINAGE LENGTH                    =    150.0 FEET
```

LAYER 5

BARRIER SOIL LINER WITH FLEXIBLE MEMBRANE LINER

```
THICKNESS                          =      0.22 INCHES
POROSITY                           =      0.7000 VOL/VOL
FIELD CAPACITY                     =      0.0450 VOL/VOL
WILTING POINT                      =      0.0200 VOL/VOL
INITIAL SOIL WATER CONTENT         =      0.0225 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY   =     19.6849994659424 CM/SEC
LINER LEAKAGE FRACTION             =      0.00001000
```

LAYER 6

LATERAL DRAINAGE LAYER

```
THICKNESS                          =      0.22 INCHES
POROSITY                           =      0.7000 VOL/VOL
FIELD CAPACITY                     =      0.0450 VOL/VOL
WILTING POINT                      =      0.0200 VOL/VOL
INITIAL SOIL WATER CONTENT         =      0.0450 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY   =     19.6849994659424 CM/SEC
SLOPE                              =      2.00 PERCENT
DRAINAGE LENGTH                    =    150.0 FEET
```

LAYER 7

BARRIER SOIL LINER WITH FLEXIBLE MEMBRANE LINER

```
THICKNESS                          =      0.25 INCHES
POROSITY                           =      0.4000 VOL/VOL
FIELD CAPACITY                     =      0.3560 VOL/VOL
WILTING POINT                      =      0.2899 VOL/VOL
INITIAL SOIL WATER CONTENT         =      0.0225 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY   =      0.0000000100000 CM/SEC
LINER LEAKAGE FRACTION             =      0.00001000
```

LAYER 8

VERTICAL PERCOLATION LAYER

THICKNESS	=	6.00 INCHES
POROSITY	=	0.4750 VOL/VOL
FIELD CAPACITY	=	0.3777 VOL/VOL
WILTING POINT	=	0.2648 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.3777 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.0000170000003 CM/SEC

GENERAL SIMULATION DATA

SCS RUNOFF CURVE NUMBER	=	83.31
TOTAL AREA OF COVER	=	43560. SQ FT
EVAPORATIVE ZONE DEPTH	=	8.00 INCHES
POTENTIAL RUNOFF FRACTION	=	1.000000
UPPER LIMIT VEG. STORAGE	=	3.7820 INCHES
INITIAL VEG. STORAGE	=	1.3738 INCHES

SOIL WATER CONTENT INITIALIZED BY USER.

CLIMATOLOGICAL DATA

SYNTHETIC RAINFALL WITH SYNTHETIC DAILY TEMPERATURES AND SOLAR RADIATION FOR JACKSONVILLE FLORIDA

MAXIMUM LEAF AREA INDEX	=	0.00
START OF GROWING SEASON (JULIAN DATE)	=	37
END OF GROWING SEASON (JULIAN DATE)	=	4

NORMAL MEAN MONTHLY TEMPERATURES, DEGREES FAHRENHEIT

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
53.20	55.10	61.30	67.70	74.10	79.00
81.30	81.00	78.20	69.50	60.80	54.80

****

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 5

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	2.60	3.54	2.57	2.82	3.68	4.36
	7.46	9.03	8.11	2.39	2.64	3.05
STD. DEVIATIONS	1.70	2.18	2.39	2.31	2.48	2.07
	3.02	1.53	1.98	1.69	1.98	1.40
RUNOFF						
TOTALS	0.224	0.062	0.100	0.103	0.199	0.152
	0.606	0.707	0.609	0.018	0.058	0.103
STD. DEVIATIONS	0.498	0.112	0.224	0.105	0.351	0.304
	0.629	0.220	0.759	0.041	0.086	0.132
EVAPOTRANSPIRATION						
TOTALS	1.583	2.228	2.159	1.517	2.631	2.985
	4.268	4.203	4.082	2.439	1.654	2.049
STD. DEVIATIONS	0.617	0.683	0.886	1.101	1.370	0.582
	1.235	1.479	0.498	0.907	0.741	0.563
LATERAL DRAINAGE FROM LAYER 4						
TOTALS	0.0182	0.0119	0.0200	0.0170	0.0171	0.0170
	0.0199	0.0497	0.1687	0.0701	0.0224	0.0223
STD. DEVIATIONS	0.0212	0.0090	0.0173	0.0199	0.0131	0.0104
	0.0140	0.0562	0.0986	0.0255	0.0070	0.0162
PERCOLATION FROM LAYER 5						
TOTALS	0.9500	0.7689	1.0399	0.9091	0.9660	0.9751
	1.0772	1.6419	3.2656	2.2324	1.2533	1.2119
STD. DEVIATIONS	0.7390	0.4629	0.6865	0.7005	0.6066	0.5458
	0.6150	1.0785	1.2887	0.4250	0.1831	0.4378
LATERAL DRAINAGE FROM LAYER 6						
TOTALS	0.9515	0.7679	1.0399	0.9099	0.9650	0.9753
	1.0760	1.6380	3.2632	2.2374	1.2553	1.2113
STD. DEVIATIONS	0.7407	0.4620	0.6870	0.7009	0.6062	0.5463
	0.6147	1.0756	1.2887	0.4266	0.1834	0.4353

PERCOLATION FROM 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

PERCOLATION FROM LAYER 8

TOTALS	0.0148	0.0090	0.0077	0.0062	0.0056	0.0048
	0.0045	0.0041	0.0037	0.0036	0.0032	0.0032
STD. DEVIATIONS	0.0254	0.0135	0.0105	0.0076	0.0062	0.0050
	0.0043	0.0037	0.0031	0.0029	0.0025	0.0023

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

	(INCHES)		(CU. FT.)	PERCENT
PRECIPITATION	52.26	(6.568)	189711.	100.00
RUNOFF	2.941	(1.057)	10677.	5.63
EVAPOTRANSPIRATION	31.798	(2.931)	115427.	60.84
LATERAL DRAINAGE FROM LAYER 4	0.4543	(0.1931)	1649.	0.87
PERCOLATION FROM LAYER 5	16.2914	(5.6000)	59138.	31.17
LATERAL DRAINAGE FROM LAYER 6	16.2908	(5.6051)	59136.	31.17
PERCOLATION FROM LAYER 7	0.0000	(5.6051)	0.	0.00
PERCOLATION FROM LAYER 8	0.0702	(0.0867)	255.	0.13
CHANGE IN WATER STORAGE	0.707	(3.837)	2568.	1.35

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 5

	(INCHES)	(CU. FT.)
PRECIPITATION	4.79	17387.7
RUNOFF	1.590	5771.7
LATERAL DRAINAGE FROM LAYER 4	0.0172	62.4
PERCOLATION FROM LAYER 5	0.2114	767.5
HEAD ON LAYER 5	0.0	
LATERAL DRAINAGE FROM LAYER 6	0.2106	764.4
PERCOLATION FROM LAYER 7	0.0000	0.0
HEAD ON LAYER 7	0.0	
PERCOLATION FROM LAYER 8	0.0027	9.8
SNOW WATER	0.00	0.0

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.3733

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.0743

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FINAL WATER STORAGE AT END OF YEAR 5

LAYER	(INCHES)	(VOL/VOL)
1	0.38	0.0637
2	23.27	0.3232
3	5.33	0.2222
4	0.01	0.0592
5	0.00	0.0225
6	0.01	0.0590
7	0.01	0.0225
8	1.92	0.3192
SNOW WATER	0.00	

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TRAILRIDGE LANDFILL - FINAL COVER ANALYSIS
JACKSONVILLE, DUVAL COUNTY, FLORIDA
E89-113-9   OCTOBER 9, 1990

****
****

FAIR GRASS

LAYER 1

VERTICAL PERCOLATION LAYER

THICKNESS	=	12.00 INCHES
POROSITY	=	0.4730 VOL/VOL
FIELD CAPACITY	=	0.2217 VOL/VOL
WILTING POINT	=	0.1043 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.2217 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.0015600000042 CM/SEC

LAYER 2

LATERAL DRAINAGE LAYER

THICKNESS	=	12.00 INCHES
POROSITY	=	0.4570 VOL/VOL
FIELD CAPACITY	=	0.1309 VOL/VOL
WILTING POINT	=	0.0580 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.1309 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.0010000000475 CM/SEC
SLOPE	=	2.00 PERCENT
DRAINAGE LENGTH	=	850.0 FEET

LAYER 3

BARRIER SOIL LINER

THICKNESS	=	12.00 INCHES
POROSITY	=	0.4300 VOL/VOL
FIELD CAPACITY	=	0.3663 VOL/VOL
WILTING POINT	=	0.2802 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4300 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.0000001000000 CM/SEC

LAYER 4

VERTICAL PERCOLATION LAYER

THICKNESS	=	12.00 INCHES
POROSITY	=	0.4570 VOL/VOL
FIELD CAPACITY	=	0.1309 VOL/VOL
WILTING POINT	=	0.0580 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.1309 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.0010000000475 CM/SEC

LAYER 5

VERTICAL PERCOLATION LAYER

THICKNESS	=	1200.00 INCHES
POROSITY	=	0.5200 VOL/VOL
FIELD CAPACITY	=	0.2942 VOL/VOL
WILTING POINT	=	0.1400 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.2942 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.0001999999949 CM/SEC

LAYER 6

VERTICAL PERCOLATION LAYER

THICKNESS	=	24.00 INCHES
POROSITY	=	0.4570 VOL/VOL
FIELD CAPACITY	=	0.1309 VOL/VOL
WILTING POINT	=	0.0580 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.1309 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.0010000000475 CM/SEC

LAYER 7

LATERAL DRAINAGE LAYER

THICKNESS	=	0.22 INCHES
POROSITY	=	0.7000 VOL/VOL
FIELD CAPACITY	=	0.0450 VOL/VOL
WILTING POINT	=	0.0200 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0225 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	19.6849994659424 CM/SEC
SLOPE	=	2.00 PERCENT
DRAINAGE LENGTH	=	150.0 FEET

LAYER 8

BARRIER SOIL LINER WITH FLEXIBLE MEMBRANE LINER

THICKNESS	=	0.22 INCHES
POROSITY	=	0.7000 VOL/VOL
FIELD CAPACITY	=	0.0450 VOL/VOL
WILTING POINT	=	0.0200 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0225 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	19.6849994659424 CM/SEC
LINER LEAKAGE FRACTION	=	0.00001000

LAYER 9

LATERAL DRAINAGE LAYER

THICKNESS	=	0.22 INCHES
POROSITY	=	0.7000 VOL/VOL
FIELD CAPACITY	=	0.0450 VOL/VOL
WILTING POINT	=	0.0200 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0225 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	19.6849994659424 CM/SEC
SLOPE	=	2.00 PERCENT
DRAINAGE LENGTH	=	150.0 FEET

LAYER 10

BARRIER SOIL LINER WITH FLEXIBLE MEMBRANE LINER

THICKNESS	=	0.25 INCHES
POROSITY	=	0.4000 VOL/VOL
FIELD CAPACITY	=	0.3560 VOL/VOL
WILTING POINT	=	0.2899 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4000 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.0000000100000 CM/SEC
LINER LEAKAGE FRACTION	=	0.00001000

LAYER 11

VERTICAL PERCOLATION LAYER

THICKNESS	=	6.00 INCHES
POROSITY	=	0.4750 VOL/VOL
FIELD CAPACITY	=	0.3777 VOL/VOL
WILTING POINT	=	0.2648 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.3778 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.0000170000003 CM/SEC

GENERAL SIMULATION DATA

SCS RUNOFF CURVE NUMBER	=	95.00
TOTAL AREA OF COVER	=	43560. SQ FT
EVAPORATIVE ZONE DEPTH	=	8.00 INCHES
UPPER LIMIT VEG. STORAGE	=	3.7840 INCHES
INITIAL VEG. STORAGE	=	1.7736 INCHES

SOIL WATER CONTENT INITIALIZED BY USER.

CLIMATOLOGICAL DATA

SYNTHETIC RAINFALL WITH SYNTHETIC DAILY TEMPERATURES AND SOLAR RADIATION FOR JACKSONVILLE FLORIDA

MAXIMUM LEAF AREA INDEX	=	2.00
START OF GROWING SEASON (JULIAN DATE)	=	37
END OF GROWING SEASON (JULIAN DATE)	=	4

NORMAL MEAN MONTHLY TEMPERATURES, DEGREES FAHRENHEIT

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
53.20	55.10	61.30	67.70	74.10	79.00
81.30	81.00	78.20	69.50	60.80	54.80

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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	2.60	3.54	2.57	2.82	3.68	4.36
	7.46	9.03	8.11	2.39	2.64	3.05
STD. DEVIATIONS	1.70	2.18	2.39	2.31	2.48	2.07
	3.02	1.53	1.98	1.69	1.98	1.40
RUNOFF						
TOTALS	0.735	0.756	0.698	0.785	1.183	1.086
	2.365	3.311	2.760	0.423	0.613	0.785
STD. DEVIATIONS	1.202	0.829	1.181	0.779	1.275	1.202
	1.296	0.630	1.625	0.652	0.546	0.707

EVAPOTRANSPIRATION

TOTALS	1.576	2.204	2.266	1.918	2.744	3.249
	4.465	4.685	4.671	2.426	1.362	1.849
STD. DEVIATIONS	0.506	0.681	1.226	1.282	1.453	0.833
	1.289	1.702	0.949	0.981	0.784	0.446

LATERAL DRAINAGE FROM LAYER 2

TOTALS	0.0208	0.0201	0.0220	0.0202	0.0202	0.0192
	0.0202	0.0212	0.0230	0.0242	0.0229	0.0251
STD. DEVIATIONS	0.0118	0.0116	0.0127	0.0116	0.0116	0.0111
	0.0098	0.0089	0.0094	0.0076	0.0069	0.0038

PERCOLATION FROM LAYER 3

TOTALS	0.1908	0.1792	0.1979	0.1807	0.1797	0.1705
	0.1869	0.1985	0.2133	0.2199	0.2065	0.2208
STD. DEVIATIONS	0.0774	0.0876	0.1024	0.0949	0.0955	0.0915
	0.0606	0.0516	0.0553	0.0465	0.0408	0.0265

LATERAL DRAINAGE FROM LAYER 7

TOTALS	0.0004	0.0003	0.0004	0.0004	0.0004	0.0004
	0.0004	0.0004	0.0004	0.0004	0.0004	0.0005
STD. DEVIATIONS	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002
	0.0002	0.0002	0.0001	0.0001	0.0001	0.0001

PERCOLATION FROM LAYER 8

TOTALS	0.1462	0.1353	0.1508	0.1483	0.1561	0.1546
	0.1640	0.1686	0.1675	0.1772	0.1748	0.1833
STD. DEVIATIONS	0.0824	0.0739	0.0784	0.0728	0.0704	0.0617
	0.0554	0.0459	0.0354	0.0282	0.0207	0.0161

LATERAL DRAINAGE FROM LAYER 9

TOTALS	0.1462	0.1345	0.1506	0.1483	0.1561	0.1546
	0.1639	0.1686	0.1675	0.1771	0.1747	0.1833
STD. DEVIATIONS	0.0824	0.0757	0.0788	0.0729	0.0704	0.0617
	0.0554	0.0460	0.0355	0.0283	0.0207	0.0162

PERCOLATION FROM LAYER 10

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 FROM LAYER 11

TOTALS	0.0148	0.0090	0.0077	0.0062	0.0056	0.0048
	0.0045	0.0041	0.0037	0.0036	0.0032	0.0032
STD. DEVIATIONS	0.0256	0.0136	0.0105	0.0076	0.0062	0.0050
	0.0043	0.0037	0.0031	0.0029	0.0025	0.0023

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

	(INCHES)		(CU. FT.)	PERCENT
PRECIPITATION	52.26	(6.568)	189711.	100.00
RUNOFF	15.502	(3.329)	56271.	29.66
EVAPOTRANSPIRATION	33.414	(3.680)	121293.	63.94
LATERAL DRAINAGE FROM LAYER 2	0.2592	(0.1157)	941.	0.50
PERCOLATION FROM LAYER 3	2.3447	(0.8189)	8511.	4.49
LATERAL DRAINAGE FROM LAYER 7	0.0048	(0.0020)	17.	0.01
PERCOLATION FROM LAYER 8	1.9266	(0.0020)	6993.	3.69
LATERAL DRAINAGE FROM LAYER 9	1.9254	(0.6433)	6989.	3.68
PERCOLATION FROM LAYER 10	0.0000	(0.0000)	0.	0.00
PERCOLATION FROM LAYER 11	0.0703	(0.0869)	255.	0.13
CHANGE IN WATER STORAGE	1.087	(1.361)	3944.	2.08

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 5

	(INCHES)	(CU. FT.)
PRECIPITATION	4.79	17387.7
RUNOFF	3.505	12722.5
LATERAL DRAINAGE FROM LAYER 2	0.0013	4.6
PERCOLATION FROM LAYER 3	0.0098	35.5
HEAD ON LAYER 3	22.6	
LATERAL DRAINAGE FROM LAYER 7	0.0000	0.1
PERCOLATION FROM LAYER 8	0.0063	22.9
HEAD ON LAYER 8	0.0	
LATERAL DRAINAGE FROM LAYER 9	0.0063	22.9
PERCOLATION FROM LAYER 10	0.0000	0.0
HEAD ON LAYER 10	0.0	
PERCOLATION FROM LAYER 11	0.0027	9.8
SNOW WATER	0.00	0.0

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.4252

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.1035

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FINAL WATER STORAGE AT END OF YEAR 5

LAYER	(INCHES)	(VOL/VOL)
1	2.46	0.2050
2	5.48	0.4570
3	5.16	0.4300
4	2.38	0.1981
5	352.75	0.2940
6	4.69	0.1953
7	0.01	0.0486
8	0.00	0.0225
9	0.01	0.0486
10	0.10	0.4000
11	1.92	0.3192
SNOW WATER	0.00	

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Golder Associates Inc.

CONSULTING ENGINEERS

October 10, 1990 903-3010

Mr. Doug Miller
England - Thims & Miller, Inc.
3131 St. Johns Bluff Road, South
Jacksonville, Florida 32216

RE: BORROW PIT INFLUENCE ON GROUNDWATER SYSTEM

Dear Doug:

Attached are the calculations for determining the hydraulic influence of the borrow pit on the natural groundwater system. Based on the water level in the borrow pit being at an elevation of 123 feet (MSL), the pit should have no dewatering impact of the wetlands to the west of the borrow pit. However, along the east side of the pit, the calculations predict that a seepage face would develop which would impair structural stability of the berm. A down-gradient drain should be included in the berm design.

We trust that these calculations satisfactorily address the issues relative to the borrow pit. Please call if you have any questions.

Very truly yours,

GOLDER ASSOCIATES INC.

Donald J. Miller, P.Eng.
Senior Engineer

DJM:kab

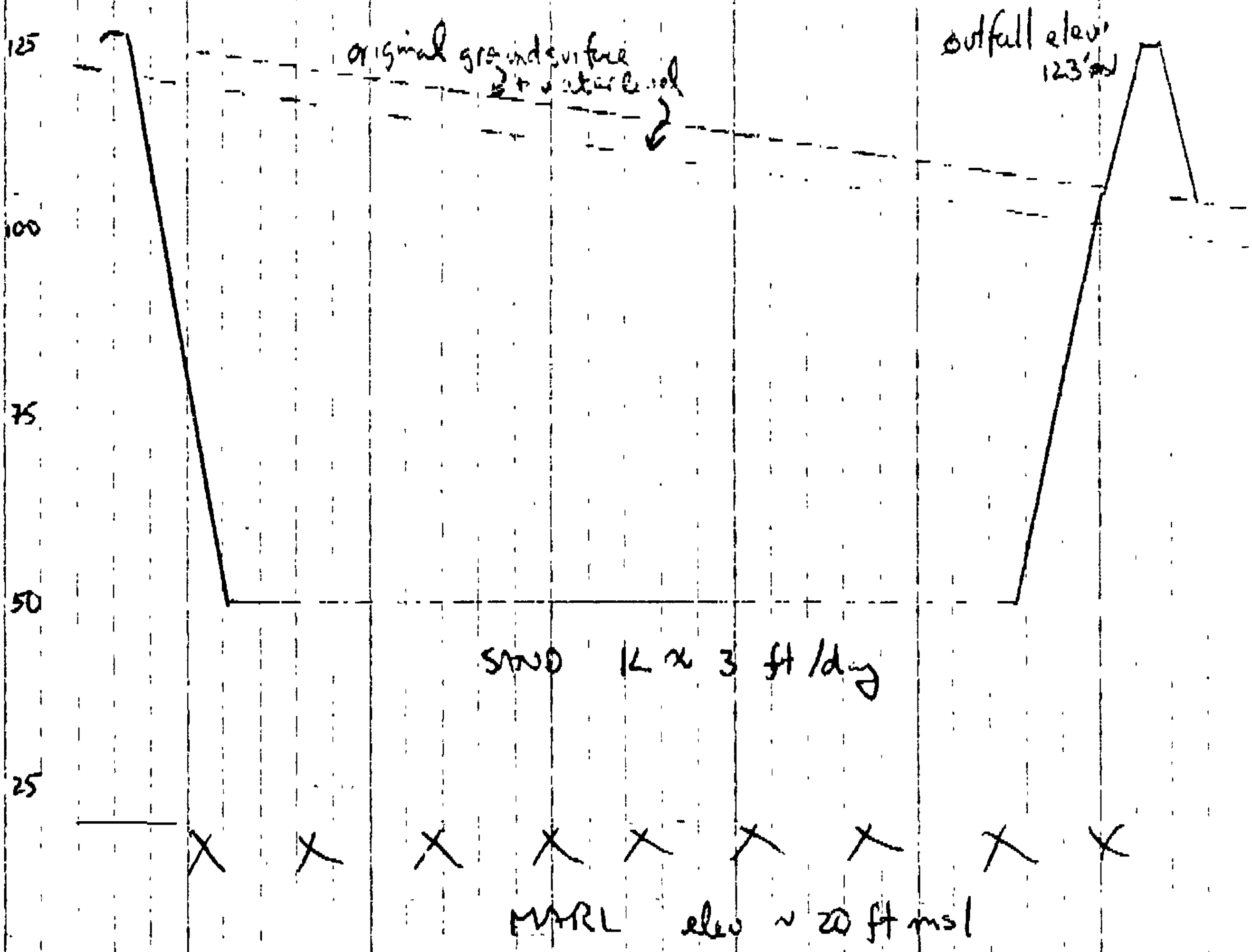
Attachments

cc: Scott McCallister

Golder Associates

SUBJECT TRAIL RIDGE LANDFILL - BORROW AREA		
Job No 903-3010	Made by DJM	Date Oct 10, 1990
Ref.	Checked	Sheet 1 of 7
	Reviewed	

OBJECTIVE - To determine the hydraulic influence of the borrow pit on the natural groundwater system.



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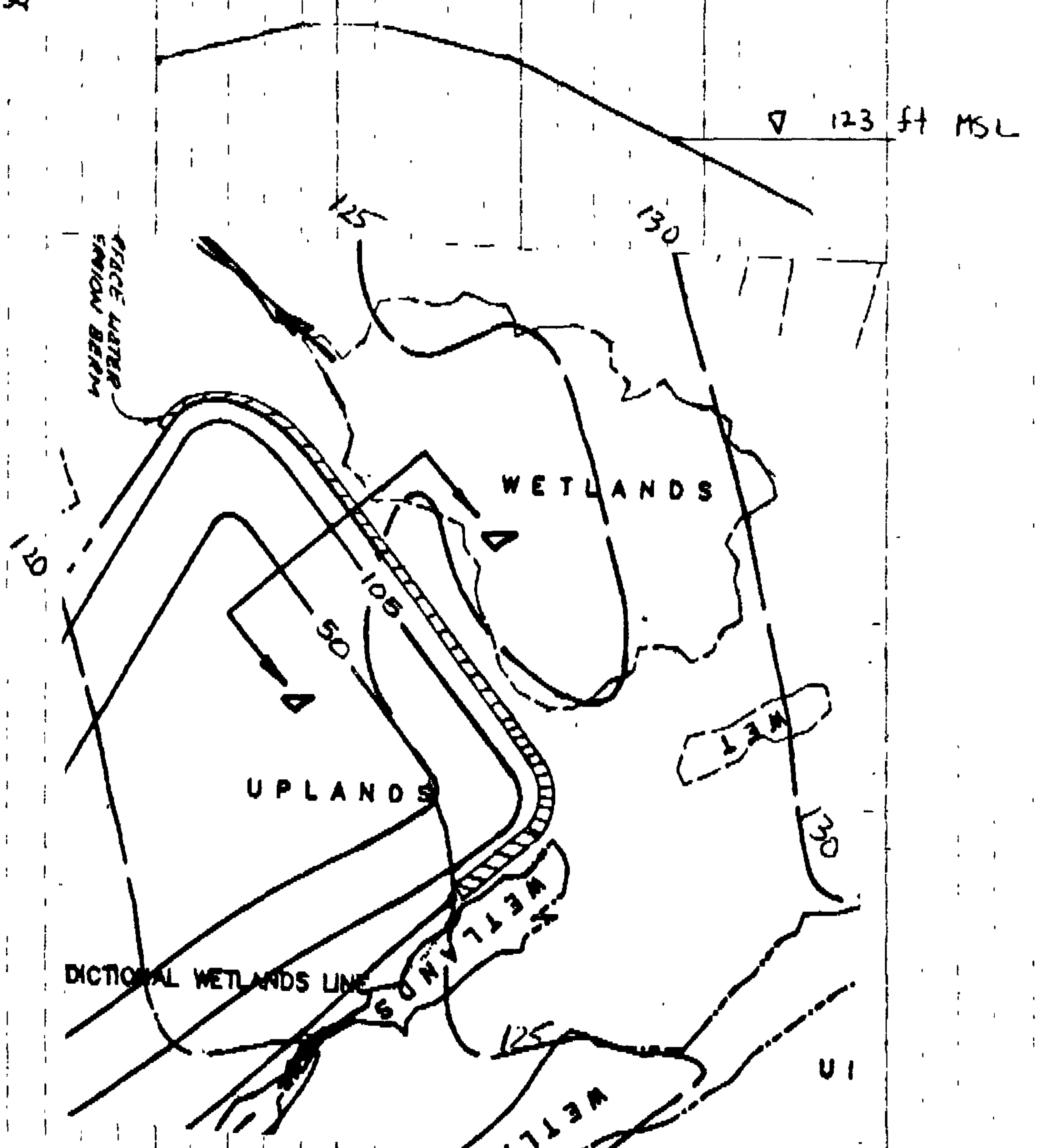
SUBJECT TRAIL RIDGE LANDFILL - BORROW AREA		
Job No 903-3010 Ref	Made by DJM Checked Reviewed	Date October 10, 1990 Sheet 2 of 7

1) At up-gradient Edge

Wetland <
50' buffer



- Water level in pit controlled at an elevation of 123 ft msl
- Wet land at an elevation of 125 ft msl
- Ditch drains wet land (approx 2 ft deep)

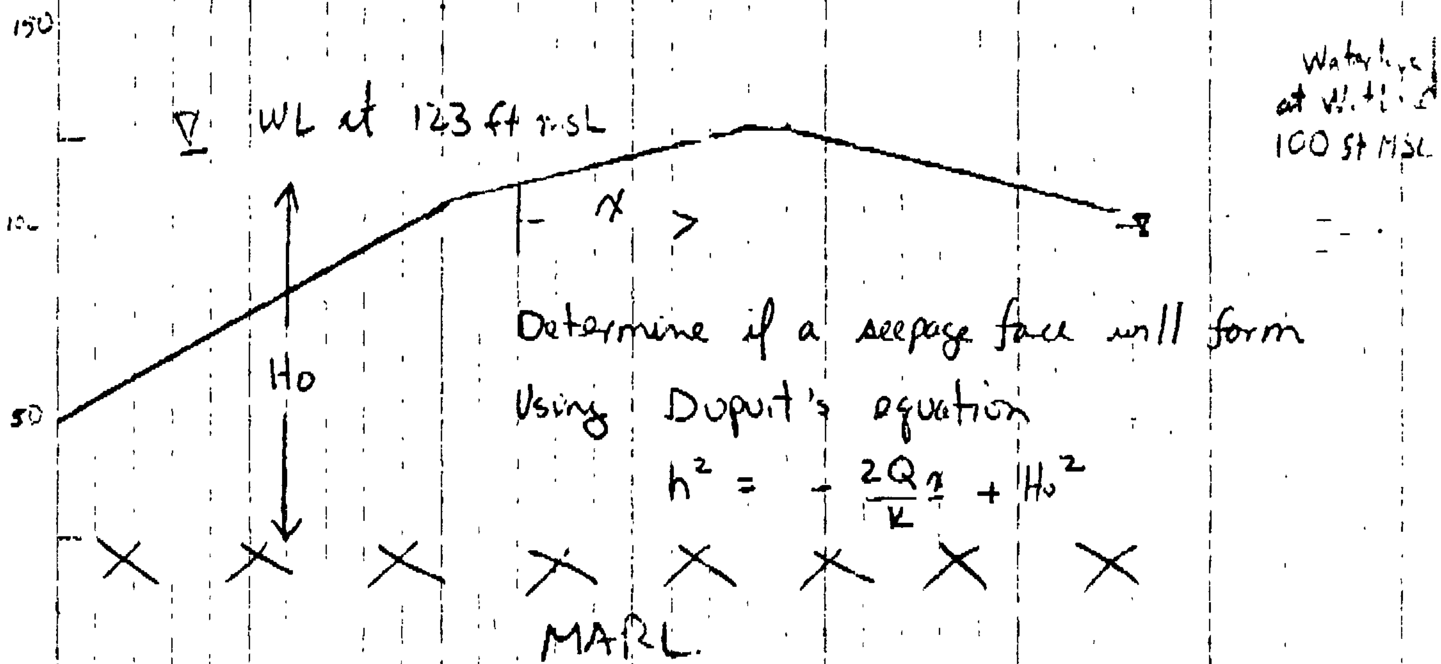
Groundwater in wetland ≤ 123 ft msl

If water level in wetland = 123 ft msl
Borrow Pit will have no influence on wet land

If water level in wet land < 123 ft msl
Borrow Pit will recharge the wet lands

Step 2 - Predict affect at down-gradient boundary

Scale 1" = 50' H
1" = 50' V



Determine if a seepage face will form

Using Dupuit's equation

$$h^2 = -\frac{2Q}{K}x + H_o^2$$

where h is head at distance x

Q is flow per unit length of berm

K is hydraulic conductivity

Q = natural flux out of pit = flux into pit

Flux in = Groundwater Recharge

Golder Associates

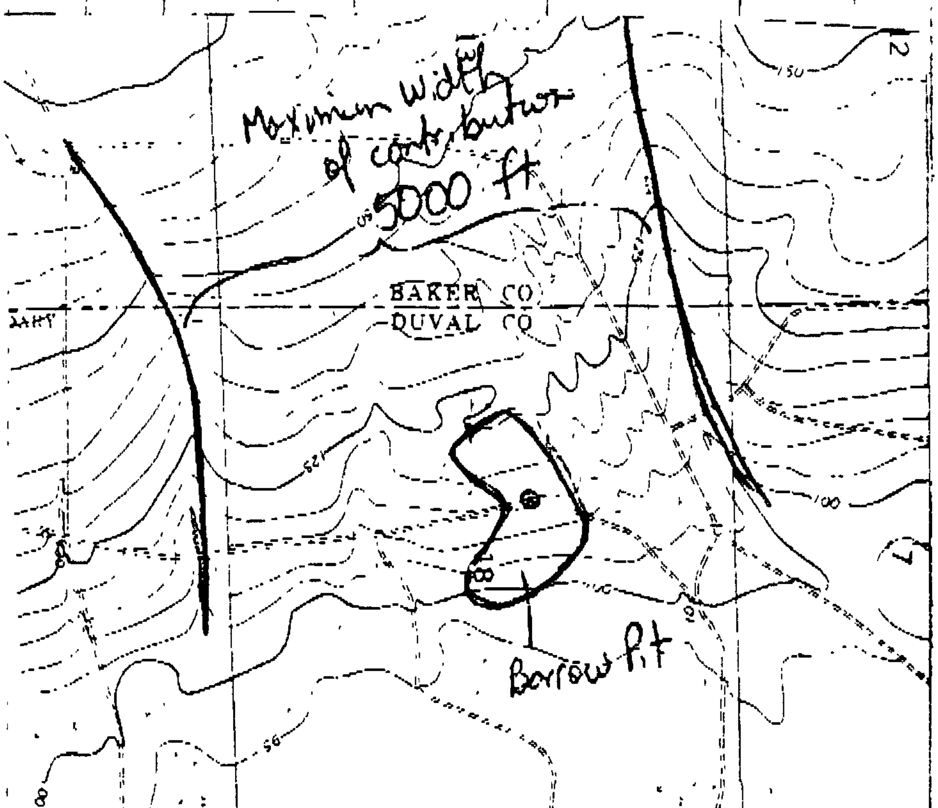
SUBJECT TRAIL RIDGE LANDFILL - BORROW AREA		
Job No 903-3010 Ref	Made by DJM Checked Reviewed	Date Oct 10, 1990 Sheet 5 of 7

Groundwater Recharge = k i A

where A = area of flow

= sat depth × flow width

(assume 100 ft) × (5000 ft)



$Q = 3 \text{ ft/day} \times 0.01 \text{ ft/ft} \times 100 \text{ ft} \times 5000 \text{ ft} / 3000 \text{ ft}$

$= 5 \text{ ft}^3/\text{day}/\text{ft}$

↑ length of down-gradient berm

Golder Associates

SUBJECT TRAIL RIDGE LANDFILL - BORROW AREA		
Job No. 903-3010	Made by DJM	Date Oct 10, 1990
Ref.	Checked	Sheet 6 of 7
	Reviewed	

$$h^2 = -\frac{2Qx}{K} + H_0^2 \qquad H_0 = 102 \text{ ft}$$

at $x = 170$ feet (distance across berm)

$h = 100$ ft water level = 120 ft msL

∴ a seepage face will develop across dam.

Possible solutions (Ref Earth and Earth-Rock Dams
Sherard, Woodward, Gizienski, and
Clevenger; John Wiley + Sons, NY, 1963)

Design Considerations 23

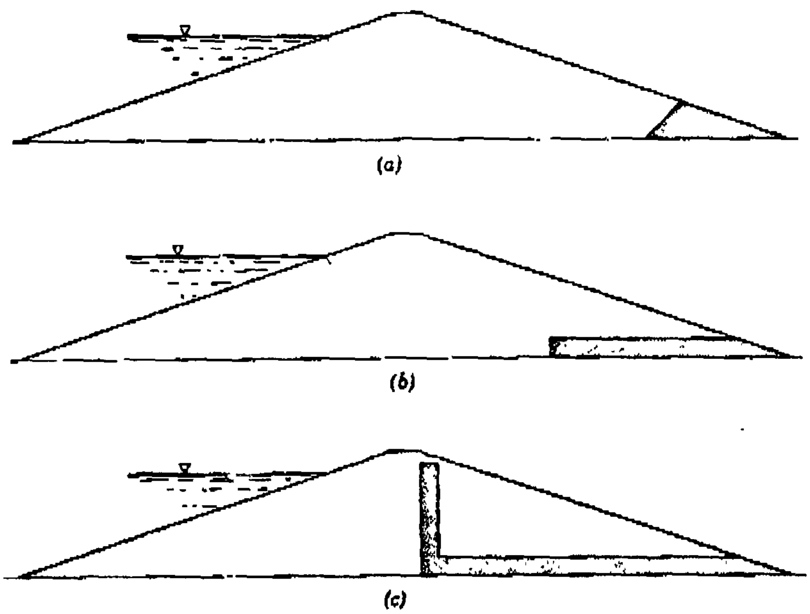


Fig. 1.2 1 Drains used in homogeneous dams (a) Toe drains (b) Horizontal blanket drains. (c) "Chimney" drain.

Golder Associates

SUBJECT TRAIL RIDGE LANDFILL - BORROW AREA		
Job No. 903-3010	Made by DJM	Date Oct 10, 1990
Ref.	Checked	Sheet 7 of 7
	Reviewed	

A blanket drain would likely be a preferred solution based on ease of construction and effectiveness.

Blanket drain would consist of a gravel drainage layer (gravel size depending on the grain size distribution of the berm. Additional filtering could also be achieved with a geotextile filter fabric or nature sand filters.

ANALYSIS TWO
FAIR GRASS

LAYER ONE (TOP) - 12" top soil
VERTICAL PERCOLATION LAYER
Soil Texture Class No. 7

LAYER TWO - 12" compacted soil
LATERAL DRAINAGE LAYER
Soil Texture Class No. 5

LAYER THREE - 12" clay
BARRIER SOIL LINER
Soil Texture Class No. 16

LAYER FOUR - 12" intermediate soil cover
VERTICAL PERCOLATION LAYER
Soil Texture Class No. 5

LAYER FIVE - 100′ compacted municipal waste
VERTICAL PERCOLATION LAYER
Soil Texture Class No. 18

LAYER SIX - 2′ soil blanket over liner
VERTICAL PERCOLATION LAYER
Soil Texture Class No. 5

LAYER SEVEN - Geodrain
LATERAL DRAINAGE LAYER

LAYER EIGHT - 60 mil HDPE flexible membrane liner and Geodrain
FLEXIBLE MEMBRANE LINER WITH BARRIER SOIL LINER

LAYER NINE - Geodrain
LATERAL DRAINAGE LAYER

LAYER TEN - 60 MIL HDPE flexible membrane liner with Claymax
FLEXIBLE MEMBRANE LINER WITH BARRIER SOIL LINER

LAYER ELEVEN - 6" Compacted base
VERTICAL PERCOLATION LAYER

Notes concerning revised H.E.L.P. Analyses

A. The twelve inches of topsoil ($K=5.2 \times 10^{-4}$ cm/sec) shall come from either blending the existing material on-site with organics obtained on-site or hauling in off-site borrow meeting the specified hydraulic transmissivity.

B. The evaporative zone depth has been revised to eight inches.

HELP MODEL CALCULATIONS (Revised 10-10-90)

ANALYSIS ONE
BARE GROUND

LAYER ONE (TOP)	-	6" Daily Cover VERTICAL PERCOLATION LAYER Soil Texture Class No. 5
LAYER TWO	-	6′ compacted municipal waste VERTICAL PERCOLATION LAYER Soil Texture Class No. 18
LAYER THREE	-	2′ soil blanket over liner VERTICAL PERCOLATION LAYER Soil Texture Class No. 5
LAYER FOUR	-	Geodrain LATERAL DRAINAGE LAYER Transmissivity $1.1X10^{-3}$ m^2/sec Thickness = 0.22 in. Porosity 0.700 vol/vol Field Capacity 0.045 vol/vol - Soil Texture Class No. 1 Wilting Point 0.02 vol/vol - Minimum Value National Seal Company PN 3000 7000 PSF Loading
LAYER FIVE	-	60 mil HDPE liner with Geodrain FLEXIBLE MEMBRANE LINER WITH BARRIER SOIL LINER
LAYER SIX	-	Geodrain LATERAL DRAINAGE LAYER
LAYER SEVEN	-	60 mil HDPE with Claymax FLEXIBLE MEMBRANE LINER WITH BARRIER SOIL LINER Soil Texture Class No. 17
LAYER EIGHT	-	6" compacted base VERTICAL PERCOLATION LAYER Soil Texture Class No. 15

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

          FUNCTION MENU
          - - - -
 1    RUNOFF HYDROGRAPH COMPUTATION
      A    SCS UNIT HYDROGRAPH
      B    LINEAR RESERVOIR ROUTING
 2    RESERVOIR ROUTING
 3    CHANNEL ROUTING
 4 -  SAVE HYDROGRAPH
 5    MOVE HYDROGRAPH
 6 -  HYDROGRAPH ADDITION
 7    FLOW DIVERSIONS
      A    CONTROLLED BY A MAXIMUM FLOW
      B    SPLIT FLOW
      C    AS A FUNCTION OF TOTAL OUTFLOW
 8    INFLOW HYDROGRAPH INSERTION
 9 -  BASEFLOW ADDITION
10    POND OUTLET DESIGN
      A -  ONE STAGE RECTANGULAR WEIR
      B    TWO-STAGE RECTANGULAR WEIR
      C    CIRCULAR PIPE

TITLE: BORROW PIT DESIGN
       TRAILRIDGE LANDFILL

SIMULATION TIME (hrs)                -    72.0
TIME STEP (min.)                           9.0
PRINT INTERVAL                       -      10

TOTAL RAINFALL DEPTH (in.)           =     8.6
RAINFALL TIME INTERVAL (min.)        =    30.0
TYPE OF RAINFALL DISTRIBUTION                5
  1 - RAINFALL DIST. IS GIVEN BY THE USER
  2 - SCS TYPE I DIST. (24-HR STORM)
  3 - SCS TYPE IA DIST. (24-HR STORM)
  4 - SCS TYPE II DIST. (24-HR STORM)
  5 - SCS TYPE II (MOD.) DIST. (24-HR STORM)
  6 - SCS TYPE III DIST. (24-HR STORM)
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LICENSED TO: ENGLAND, THIMS & MILLER, INC.

****
* HYDROGRAPH COMPUTATION *
****

** SCS UNIT HYDROGRAPH METHOD **

INPUT SUMMARY

SUB BASIN: 1	
AREA (acres)	[illegible]
EFFECTIVE IMPERVIOUS AREA (%)	[illegible]
NONEFFECTIVE IMPERVIOUS AREA (%)	[illegible]
PERVIOUS AREA (%)	[illegible]
POND OR LAKE AREA (%)	[illegible]
CURVE NUMBER	[illegible]
TIME OF CONCENTRATION (min.)	[illegible]
PEAK RATE FACTOR	484.0

TIME	[illegible]	[illegible]	TOTAL FLOW
.00	.0	.0	.0
1.50	.0	[illegible]	[illegible]
3.00	.0	4.2	[illegible]
4.50	.0	5.4	[illegible]
6.00	.0	6.6	6.6
7.50	.0	8.4	8.4
9.00	.0	12.0	12.0
10.50	.0	179.6	179.6
12.00	.0	16.8	16.8
13.50	.0	9.6	9.6
15.00	.0	6.6	[illegible]
16.50	.0	5.4	[illegible]
18.00	.0	4.8	4.8
19.50	.0	4.2	4.2
21.00	.0	3.6	3.6
22.50	.0	.0	[illegible]
24.00	.0	.0	.0
25.50	.0	.0	.0
27.00	.0	.0	.0
28.50	.0	.0	.0
30.00	.0	.0	.0
31.50	.0	.0	.0
33.00	.0	.0	.0
34.50	.0	.0	.0
36.00	.0	.0	.0
37.50	.0	.0	.0
39.00	.0	.0	.0
40.50	.0	.0	.0
42.00	.0	.0	.0
43.50	.0	.0	.0
45.00	.0	.0	.0
46.50	.0	.0	.0
48.00	.0	.0	.0
49.50	.0	.0	.0
51.00	.0	.0	.0
52.50	.0	.0	.0
54.00	.0	.0	.0
55.50	.0	.0	.0
57.00	.0	.0	.0
58.50	.0	.0	.0

61.50	.0	.0	.0
63.00	.0	.0	.0
64.50	.0	.0	.0
66.00	.0	.0	.0
67.50	.0	.0	.0
69.00	.0	.0	.0
70.50	.0	.0	.0
72.00	.0	.0	.0

OUTPUT SUMMARY

P.K. FLOW (cfs)	[illegible]
TIME TO PEAK (hrs)	[illegible]
RUNOFF DEPTH (in.)	[illegible]
RUNOFF VOLUME (ac-ft)	[illegible]

* RESERVOIR ROUTING *

STAGE. 123.00 123.50 [illegible]
124.30 124.80
STORAGE. .00 6.05 [illegible]
[illegible]
FLOW [illegible]

TIME	INFLOW	STAGE	STORAGE	OUTFLOW
.00	.0	123.[illegible]	[illegible]	[illegible]
1.50	4.[illegible]	[illegible]	.1[illegible]	[illegible]
3.00	4.[illegible]	[illegible]	.[illegible]	[illegible]
4.50	5.[illegible]	123.0[illegible]	1.[illegible]	[illegible]
6.00	[illegible]	123.[illegible]7	2.[illegible]	1.0
7.50	[illegible]	123.0[illegible]	2.[illegible]	1.1
9.00	12.[illegible]	123.[illegible]	[illegible].6[illegible]	1.[illegible]
10.50	[illegible]	123.[illegible]	7.[illegible]	[illegible]
12.00	16.8	123.5[illegible]	15.1[illegible]	11.7
13.50	[illegible]	123.5[illegible]	15.[illegible]	11.8
15.00	[illegible]	123.49	14.73	11.[illegible]
16.50	5.4	123.47	14.1[illegible]	1[illegible]
18.00	4.6	123.45	13.53	9.9
19.50	4.[illegible]	123.43	12.9[illegible]	[illegible]
21.00	3.6	123.41	12.27	8.[illegible]
22.50	.0	123.38	11.16	7.7
24.00	.0	123.35	10.36	6.9
25.50	.0	123.[illegible]	9.75	6.[illegible]
27.00	.0	123.30	9.02	5.6
28.50	.0	123.28	8.37	5.0
30.00	.0	123.26	7.78	4.5
31.50	.0	123.24	7.26	4.0
33.00	.0	123.22	6.79	3.6
34.50	.0	123.21	6.36	3.2
36.00	.0	123.20	5.99	2.9
37.50	.0	123.19	5.64	2.7
39.00	.0	123.18	5.31	2.6
40.50	.0	123.17	5.00	2.[illegible]
42.00	.0	123.16	4.70	2.[illegible]
43.50	.0	123.15	4.43	2.[illegible]
45.00	.0	123.14	4.17	2.0
46.50	.0	123.13	3.93	1.9
48.00	.0	123.12	3.70	1.8
49.50	.0	123.12	3.48	1.7
51.00	.0	123.11	3.28	1.6
52.50	.0	123.10	3.09	1.5
54.00	.0	123.10	2.91	1.4
55.50	.0	123.09	2.74	1.3
57.00	.0	123.09	2.58	1.3
58.50	.0	123.08	2.43	1.2
60.00	.0	123.08	2.28	1.1
61.50	.0	123.07	2.15	1.0
63.00	.0	123.07	2.02	1.0
64.50	.0	123.06	1.91	.9
66.00	.0	123.06	1.79	.9
67.50	.0	123.06	1.69	.8
69.00	.0	123.05	1.59	.8

[illegible]	[illegible]	[illegible]	[illegible]	.7
72.00	[illegible]	[illegible]	[illegible]	[illegible]

OUTPUT SUMMARY

```
PEAK FLOW (cfs)                        =     11.[illegible]
PEAK STAGE (ft)                        =    123.51
TIME TO PEAK (hrs)                           12.75
RUNOFF VOLUME STORED (ac-ft)           =      5.[illegible]
```

**** END OF JOB ****