UCRL-CR-124994-I
PO#B3233464
GOLDER DOCUMENT NO. 963-7108

Title I Conceptual Design for Pit 6 Landfill Closure

**Lawrence Livermore National Laboratory
Site 300**

August 1996

Prepared For

**Environmental Restoration Program and Division
University of California
7000 East Avenue
Livermore, CA 94550**

By

**Golder
Associates**

1451 Harbor Bay Parkway, Suite 1000
Alameda, CA 94502

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963-7108

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Drawing 2	Current Site Layout Plan
Drawing 3	Existing Topography
Drawing 4	Top of Cover Grading Plan
Drawing 5	Cross-Sections

Drawing 6 Closure Cover Details
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Drawing 8 Surface Water Control Plan

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Appendix A - Subsidence/Collapse Calculations
Appendix B - Post Closure Truck Loads Calculations
Appendix C - Surface Water Control Calculations
Appendix D - Liner Performance (H.E.L.P.) Calculations
Appendix E - Seismic Design Calculations
Appendix F - Cover Soil Loss Calculations
Appendix G - Subsurface Drainage Calculations
Appendix H- Construction Specification Outline
Appendix I - Construction Quality Assurance Plan Outline

**Title I Conceptual Design
Pit 6 Landfill Closure
Lawrence Livermore National Laboratory**

1. INTRODUCTION

The objective of this design project is to evaluate and prepare design and construction documents for a closure cover cap for the Pit 6 Landfill located at Lawrence Livermore National Laboratory Site 300. This submittal constitutes the Title I Design (Conceptual Design) for the closure cover of the Pit 6 Landfill. A Title I Design is generally 30 percent of the design effort. Title II Design takes the design to 100 percent complete. Comments and edits to this Title I Design will be addressed in the Title II design submittal.

2. CONTENTS

This report contains the following:

- Project Background
- Design Issues and Engineering Approach
- Design Drawings
- Calculation Packages
- Construction Specifications Outline
- Construction Quality Assurance Plan Outline

3. BACKGROUND

Pit 6 Landfill is described as an area approximately 2½ acres in size consisting of 3 trenches and 6 animal burial pits. Waste, which inventories indicate may include mixed, hazardous, and low-level radioactive waste, was placed in Pit 6 between July 1962 and February 1973. The three trenches were approximately 12 to 22 feet wide, may have been up to 240 feet long, and were about 12 feet deep. An estimated 1,762 yd³ of solid waste was buried in the three trenches. Records indicate that this waste primarily consists of shop and laboratory materials (including ventilation ducting and glove boxes), capacitors, empty drums and tanks, compressed gas cylinders, pallets, and mercury-filled lamps and ignition tubes. Some of this waste may be subject to void space collapse. The trenches are reportedly covered with between 1 and 3 feet of native clayey loam soil. The 6 burial pits range in size from 12 X 30 feet to 12 X 75 feet and were probably 13 to 16 feet deep. They are reportedly covered with 12 to 14 feet of native clayey loam soil.

4. DESIGN ISSUES AND ENGINEERING APPROACH

The design objectives set by the Lawrence Livermore National Laboratory (LLNL) include:

- Reduce the likelihood of any future releases from or exposure to hazardous material contained in pit 6; and
- Mitigate potential worker and animal inhalation exposure to volatile organic compounds (VOCs) that may volatilize from subsurface soil at concentrations resulting in excess lifetime cancer risks of 10^{-6} or a Hazard Index greater than 1. The landfill cap and associated drainage diversion system are to be designed to:
- Mitigate potential infiltration of surface water into the buried waste,
- prevent localized collapse into void spaces in the buried waste,
- prevent potential damage from burrowing animals or vegetation, and allow for easy low-cost maintenance, and
- adequately prevent escape of VOC vapors to the surface to mitigate potential inhalation risk to onsite workers.

4.1 Design Issues

The primary design issues identified by Golder Associates Inc. (Golder) which had to be addressed for this project include:

- cover design
- biotic layer
- void spaces
- seismic design
- low cost maintenance
- minimize infiltration
- vapor control
- surface water control
- post closure use

Cover Design: Several cover designs are possible. An analysis was made to determine the cover design option that best meets the design objectives for the project.

Biotic Layer: Small soil burrowing animals could impact the integrity of the closure cover cap. A biotic layer may be required to discourage damage by the animals.

Void Spaces: Tanks and glove boxes were reported to be buried in the trenches. Collapse of the tanks could result in void spaces which would impact the closure cover system and present a hazard to equipment operators during construction or maintenance operations. The cover design must accommodate the void spaces and offer protection to construction and maintenance personnel. The cover must be able to withstand the loads from a 2½ ton maintenance truck.

Seismic Design: The Pit 6 Landfill is located near the eastern tectonic plate boundary between the Pacific and North American plates that is defined by the broad San Andreas fault system. This broad plate boundary region is characterized by numerous surface-active faults with documented high rates of historic and paleo seismicity. Potential earthquake sources within the region are well documented and are generally associated with the right-lateral strike-slip faults of the San Andreas fault system. Also, a Holocene fault has been mapped within approximately 150 feet of the southern limits of Pit 6 Landfill (Carpenter, D.W., and others, 1991, Investigation of Holocene faulting near closure landfill pit 6, Lawrence Livermore National Laboratory Site 300: Lawrence Livermore National Laboratory, California [UCRL-ID-106316]).

The seismic design will consider (1) the potential for strong ground shaking, and (2) the potential for fault rupture through the landfill/cover system.

Low Cost Maintenance: If possible, a low cost maintenance closure cover system should be installed to minimize long term costs and high maintenance requirements.

Minimize Infiltration: Leachate is generated as water infiltrates through the contents of landfills. Infiltration of surface water should be minimized to prevent the creation of leachate.

Vapor Control: The cover design should prevent the escape of possible VOC vapors to the surface to mitigate potential inhalation risk to onsite workers.

Surface Water Control: A storm water runoff and runoff control system must be designed to protect the closure cover system. The surface water control system should also be low maintenance and operate passively, if possible.

Post Closure Use: Presently, LLNL plans to restore the closed Pit 6 Landfill area back to its current use, a rifle range. The design should accommodate the proposed post closure use of the area.

4.2 Engineering Approach

To address each of the above design issues the following engineering approach was chosen for the design of the closure cover system.

Cover Design: The chosen closure cover cap system consist of the following (from top to bottom):

- ◆ 2 feet of vegetative soil layer
- ◆ geocomposite drainage and biotic layer
- ◆ 60 mil HDPE Geomembrane
- ◆ Geosynthetic Clay Liner
- ◆ 2 feet of compacted general fill (soil)
- ◆ geogrid reinforcement (in the bottom 6 inches of the general fill)

Biotic Layer: The geocomposite layer includes an HDPE geogrid which will double as a component to the drainage layer and as a biotic layer.

Void Spaces: A geogrid reinforcement material will be used to accommodate voids created by collapse of buried materials.

Seismic Design: The design Peak Ground Acceleration will be based on the seismic event that has a 10 percent probability of exceedence in 50 years.

Low Cost Maintenance: The vegetative and biotic layers should result in a low cost maintenance system.

Minimize Infiltration: The thickness of the vegetative layer was optimized to maximize evapo/transpiration. The geocomposite drainage layer offers an effective lateral drainage system above the liner barrier system. The HDPE geomembrane and Geosynthetic Clay Liner (GCL) offers an effective barrier system that will significantly minimize infiltration.

Alternatives were evaluated using the H.E.L.P. model, a landfill liner water balance program.

Vapor Control: The HDPE liner presents a highly effective vapor control barrier. The GCL and four feet of soil cover (two feet of general fill and two feet of vegetative cover) offer additional vapor control.

Surface Water Control: The design storm event chosen for the project is the 24 hour, Probable Maximum Precipitation (PMP). Surface water runoff and runon control will consist of lined and unlined surface ditches and channels, down drain pipes, rip rap lined channels, and corrugated metal culverts.

Post Closure Use: The rifle range firing shed will be re-constructed. The additional loads imposed by the structure will be incorporated into the geogrid design for the area of the shed.

5. DESIGN DRAWINGS

The conceptual design is presented in Design Drawings which include the following drawings:

1. Cover Sheet
2. Current Site Layout Plan
3. Existing Topography
4. Top of Cover Grading Plan
5. Cross-Sections
6. Closure Cover Details
7. Closure Cover Details
8. Surface Water Control Plan

The conceptual design drawings are included with this Title I submittal as ½ size drawings (11 inches by 17 inches).

6. CALCULATION PACKAGES

The calculation packages for the conceptual design are presented as Appendix A through G. The calculation packages include the following:

- A. Subsidence/Collapse Calculations
- B. Post Closure Truck Loads Calculations
- C. Surface Water Control Calculations
- D. Liner Performance (H.E.L.P.) Calculations
- E. Seismic Design Calculations
- F. Cover Soil Loss Calculations
- G. Subsurface Drainage Calculations

A summary of the major assumptions made by Golder and the results follows.

6.1 Subsidence/Collapse

Assumptions

- Strain $\leq 5\%$
- void size = 10 ft.
- infinite void length
- soil = 125 pcf
- 4 ft. of soil loading

Results

- HDPE geogrid, Tensar
- 2 layers UX1600HS
- 6 inch spacing
- orient transverse to trench axis

Additional geogrid will probably be required for the rifle range structures. When LLNL completes rifle range structure loads and supplies the information to Golder, the calculations and design drawings will be modified. It is expected that these modifications will be presented in the Title II Design submittal.

6.2 Post Closure Truck Loads

Same as Subsidence/Collapse above.

6.3 Surface Water Control

Assumptions

- PMP - 24 hour, Type I storm = 11.6 inches
- Hydrologic Soil Group C (drainage area above Pit 6), Group D (cover)
- lightly grazed, CN=73 and 80 (respectively)
- SCS TR-55, SEDCAD, and Hydrocalc programs

Results

- East ditch = 2 feet deep, 1:1 side slope, V-ditch, concrete
- South ditch = 2 feet deep, 2:1 side slope, V-ditch, concrete
- West ditch = 2 feet deep, 1:1 side slope, V-ditch, concrete
- West road ditch = 2 feet deep, 1:1 side slope, V-ditch, concrete
- North ditch = 3 feet deep, 2:1 side slope, trapezoidal, rip rap
- South East corner = 18 inch downslope pipe

6.4 Liner Performance (H.E.L.P.)

Assumptions

- use (1962 average rainfall year) and 1983 (average rainfall year + 4 Standard Deviations)
- daily rainfall and temperature from Site 300
- daily radiation index from Sacramento, CA

Results

- 1962 = 13.85 inches rainfall
- 1983 = 32.37 inches rainfall
- with 1.0×10^{-3} cm/s vegetative cover = yields 0.8 gallons/year for entire cover (1983)
- with 1.0×10^{-4} cm/s vegetative cover = yields 0.3 gallons/year for entire cover (1983)

6.5 Seismic Design

Assumptions

- sliding: $C = 0$ (no cohesion), $\phi = 15$ degrees, dry conditions
- PGA = 0.44 (10% in 50 years)
- 5% strain for geosynthetics
- displacements < 6 inches

Results

- sliding displacement between 2 - 4 inches
- vertical displacement strain allows 5.76 inches; predict 1.8 inches with PGA

6.6 Cover Soil Loss

Assumptions

- soil loss < 2.0 tons/ac
- SCS Soil Loss Equation
- $R=25$, $K=0.36$, $LS=1.8$, $C=0.013$, $P=0.9$

Results

- Soil loss = 0.2 tons/ac

6.7 Subsurface Drainage

Assumptions

- no ponding on cover surface
- vegetative cover permeability range from 1.0×10^{-3} cm/s to 1.0×10^{-5} cm/s
- normal loads (soils) 250 to 300 lbs/ft²
- crushing loads = 125 lbs/ft² gravel + 2½ ton truck

Results

- need a transmissivity, T, of 1.38 gpm/ft, Tex-Net has a T of 2.2 gpm/ft
- peak flow = 40 gallons/minute, 4 inch pipe = 67 gallons/minute
- wall crushing F.S. = 22, wall buckling F.S. = 16, ring deflection 1.3 % < 6.5% for SDR 26 pipe

7. CONSTRUCTION SPECIFICATION OUTLINE

The outline for the construction specifications is included as Appendix H.

8. CONSTRUCTION QUALITY ASSURANCE PLAN OUTLINE

The Construction Quality Assurance Plan outline is included as Appendix I.

DESIGN DRAWINGS

TITLE I CONCEPTUAL DESIGN
FOR

PIT 6 LANDFILL CLOSURE

LAWRENCE LIVERMORE NATIONAL LABORATORY
SITE 300

LOCATION MAP

DRAWING NO.	TITLE
1	COVER SHEET
2	CURRENT SITE LAYOUT PLAN
3	EXISTING TOPOGRAPHY
4	TOP OF COVER GRADING PLAN
5	CROSS-SECTIONS
6	CLOSURE COVER DETAILS
7	CLOSURE COVER DETAILS
8	SURFACE WATER CONTROL PLAN

LEGEND:

S-15	INTERMITTENT SPRING	CULVERT
[Rectangle]	BUILDING	ADIT, INACCESSIBLE
[Hatched Rectangle]	TRAILER OR CANOPY	APPROXIMATE LOCATIONS OF SOLID WASTE DISPOSAL TRENCHES
[Double Line]	PAVED ROAD	APPROXIMATE LOCATIONS OF ANIMAL BURIAL PITS
[Single Line]	UNPAVED ROAD	

SITE 300

*PRELIMINARY
CONCEPTUAL*

REV.	DATE	DESCRIPTION	DR BY	RVW BY
SCALE: AS SHOWN				
SEC				
M/O				
H.C.				
DES BY				
		PROJECT NO.: 963-7108 TASK NO.: 310		
		PROJECT: LLNL/PIT 6 LANDFILL COVER/CA		

CHK BY	KGH	SHEET TITLE:		
RVW BY	KSO	CURRENT SITE LAYOUT PLAN		
		SHEET: 2 OF 8		
		DRAWING NO. REV.		

**LAWRENCE LIVERMORE
NATIONAL LABORATORY**

LEGEND:

- PREVIOUSLY EXISTING FENCELINE
- LIMIT OF LANDFILL COVER
- EXISTING DITCH FLOWLINE
- 710 EXISTING GROUND SURFACE ELEVATION CONTOURS (FT., MSL)
- 715 FINAL COVER CONTOURS AND ELEVATION (FT., MSL)
- K6-01 EXISTING MONITORING WELL AND NUMBER
- EXISTING ROAD
- LIMITS OF MAGNETIC ANOMALY
- AREAS WITH EXISTING UNCOMPACTED FILL TO BE REMOVED AND REPLACED

NOTES:

- 1) TOPOGRAPHY SUPPLIED BY LAWRENCE LIVERMORE NATIONAL LABORATORY. DRAWING NO. S96010.
- 2) WELL K6-03 SHALL BE PROTECTED BY PLACEMENT OF A 5 FT. DIA. CONCRETE PIPE SECTION AROUND WELL DURING CONSTRUCTION.
- 3) SEE DRAWING NO. 8 FOR SURFACE WATER CONTROL PLAN.

- DETAIL/SECTION DESIGNATION
- DRAWING WHERE SECTION/DETAIL IS LOCATED
- DRAWING WHERE SECTION/DETAIL IS REFERENCED

PRELIMINARY
CONCEPTUAL

REV.	DATE	DESCRIPTION	DRN BY	RVW BY
SCALE: AS SHOWN				
SEC				
M/O				
H.C.				
DES BY	PER			
PROJECT NO.: 963-7108		TASK NO.: 310		
PROJECT: LLNL/PIT 6 LANDFILL COVER/CA				
TOP OF COVER GRADING PLAN				
LAWRENCE LIVERMORE NATIONAL LABORATORY				
SHEET: 4 OF 0				
DRAWING NO. REV.

DETAIL/SECTION DESIGNATION
DRAWING WHERE SECTION/DETAIL IS LOCATED
DRAWING WHERE SECTION/DETAIL IS REFERENCED

PRELIMINARY
CONCEPTUAL

REV.	DATE	DESCRIPTION	DRN BY	RVW BY
SCALE: AS SHOWN				
SEC				
M/O				
H.C.				
DES BY	BAM/PEB			
DR BY	BAM/PEB		PROJECT NO.: 963-7108 TASK NO.: 310	
CHK BY	KGH		PROJECT: LLNL/PIT 6 LANDFILL COVER/CA	
RVW BY	KSO		REPORT: CROSS-SECTIONS	
SHEET TITLE: CROSS-SECTIONS			SHEET: 5 OF 8	
LAWRENCE LIVERMORE NATIONAL LABORATORY			DRAWING NO.	REV.

1
5 6
TYPICAL

2
5 6
TYPICAL EAST AND WEST
COVER TERMINATION DETAIL

1
5 6
DETAIL/SECTION
DESIGNATION
DRAWING WHERE
SECTION/DETAIL
IS LOCATED
DRAWING WHERE
SECTION/DETAIL
IS REFERENCED

PRELIMINARY

REV.	DATE	DESCRIPTION	DRN BY	KVM DT		
SCALE: AS SHOWN		<p>Golder Associates</p>				
SEC					PROJECT NO.: 963-7108	TASK NO.: 310
M/O					PROJECT: LLNL/PIT 6 LANDFILL COVER/CA	
H.C.					REPORT:	
CHK BY	KGH	SHEET TITLE: CLOSURE COVER DETAILS				
RVW BY	KSO	SHEET: 6 OF 8				
LAWRENCE LIVERMORE NATIONAL LABORATORY SITE 300		DRAWING NO.	REV.			
		6	0

3
TYPICAL NORTH END COVER
TERMINATION DETAIL

4
TYPICAL
END COVER
TERMINATION DETAIL

1
DETAIL/SECTION
DESIGNATION
DRAWING WHERE
SECTION/DETAIL
IS LOCATED
DRAWING WHERE
SECTION/DETAIL
IS REFERENCED

PRELIMINARY
CONCEPTUAL

REV.	DATE	DESCRIPTION	DRN BY	RVW BY
SCALE: AS SHOWN				
SEC				
M/O				
H.C.				
DES BY	BAM			
DR BY	BAM			
CHK BY	KGH			
RVW BY	KSO			
		PROJECT NO.: 963-7108 TASK NO.: 210		
		PROJECT: LLNL/PIT 6 LANDFILL COVER/CA		
		REPORT: CLOSURE COVER DETAILS		
		SHEET: 7 OF 8		
DRAWING NO.		REV.		
7		0		

**LAWRENCE LIVERMORE
NATIONAL LABORATORY
SITE 300**

LEGEND:

- PREVIOUSLY EXISTING FENCELINE
- LIMIT OF LANDFILL COVER
- EXISTING DITCH FLOWLINE
- EXISTING GROUND SURFACE ELEVATION CONTOURS (FT., MSL)
- 710
- 715
- FINAL COVER CONTOURS AND ELEVATION (FT., MSL)
- EXISTING ROAD
- EXISTING MONITORING WELL AND NUMBER
- K6-01
- AREAS WITH EXISTING UNCOMPACTED FILL TO BE REMOVED AND REPLACED
- DRAINAGE FLOW DIRECTION

- NOTES:**
- 1) TOPOGRAPHY SUPPLIED BY LAWRENCE LIVERMORE NATIONAL LABORATORY. DRAWING NO. S96010.
 - 2) DRAINAGE FLOW PATHS OFFSET FOR CLARITY.
 - 3) WELL K6-03 SHALL BE PROTECTED BY PLACEMENT OF A 5 FT. DIA. CONCRETE PIPE SECTION AROUND WELL DURING CONSTRUCTION.

PRELIMINARY
CONCEPTUAL

REV.	DATE	DESCRIPTION	DRN BY	RYW BY
SCALE: AS SHOWN				
PROJECT NO.: 963-7108		TASK NO.: 310		
PROJECT: LLNL/PIT 6 LANDFILL COVER/CA				
REPORT:				
SHEET TITLE: SURFACE WATER CONTROL PLAN				
LAWRENCE LIVERMORE NATIONAL LABORATORY				
SHEET: 8 OF 8		DRAWING NO. REV.		

CALCULATION PACKAGE

SECTION A

Subsidence/Collapse Calculations

SUBJECT <u>LLNL / Pit 6</u>		
Job No. <u>963-7108</u>	Made by <u>KMH</u>	Date <u>7/8/96</u>
Ref.	Checked <u>BAM</u>	Sheet <u>1</u> of <u>4</u>
	Reviewed <u>LGO</u>	

Geogrid Design

Variables:

H = Height of Cover
 γ = Avg unit wt. of cover
 B = Width of Void
 y = Maximum deflection of geogrid
 I = Interior Angle defined by radial deflection (I is in Radians)
 R = Radius of deflection curvature
 LC = Length of deflected curvature

Geometry Equations

$$B = 2R \sin(\frac{1}{2}I) \quad R = \frac{LC}{I} \Rightarrow B = \frac{2LC}{I} \sin(\frac{1}{2}I)$$

$$LC = \frac{BI}{2} \cdot \frac{1}{\sin(\frac{1}{2}I)} = \frac{BI \cdot 2\pi}{2 \cdot 360} \cdot \frac{1}{\sin(\frac{1}{2}I)} = \frac{BI\pi}{360} \cdot \frac{1}{\sin(\frac{1}{2}I)} \quad (\text{EQN 1})$$

$$y = \frac{1}{2} B \cdot \tan(\frac{1}{4}I)$$

$$\text{Strain } (\epsilon) = \frac{LC}{B} - 1 = \frac{\frac{BI}{2 \sin(\frac{1}{2}I)}}{B} - 1 = \frac{I}{2 \sin(\frac{1}{2}I)} - 1 \quad (\text{EQN 2})$$

Tensile Force Equation (Ignore potential Benefit of arching)

$$T = H \gamma \cdot B \cdot \sqrt{r} \quad (\text{From tensioned membrane theory})$$

$$\begin{aligned}
 \text{where } \sqrt{r} &= \frac{1}{4} \cdot \left(\frac{2y}{B} + \frac{B}{2y} \right) = \frac{1}{4} \left(\frac{2 \cdot \frac{1}{2} B \tan(\frac{1}{4}I)}{B} + \frac{B}{2 \cdot \frac{1}{2} B \tan(\frac{1}{4}I)} \right) \\
 &= \frac{1}{4} \left(\tan(\frac{1}{4}I) + \frac{1}{\tan(\frac{1}{4}I)} \right)
 \end{aligned}$$

$$T = H \gamma B \cdot \frac{1}{4} \left(\tan(\frac{1}{4}I) + \frac{1}{\tan(\frac{1}{4}I)} \right) \quad (\text{EQN 3})$$

SUBJECT LLNL Pit 6

Job No. 963-7108

Ref.

Made by KGH

Checked BMM

Reviewed ILSD

Date 7/8/96

Sheet 2 of 4

Calculate Tensile Loads

Assumptions:

- Limit strain to 5%
- Maximum void size = 10 feet
- Assume "infinite" void length in sizing geogrid
Infinite void length assumes that the tensile strength is independent of void length. MJJ
- Soil unit weight avg = 125 pcf
- Max. of 4 FT of soil for loading. (THE CQA FOR THE SOIL COVER WILL ACCOUNT FOR TOLERANCES OF ± 0.1 FT) MJJ

From attached spreadsheet, required Tensile strength = 4,890 lbs/ft

Determine Suitable Geogrid product/configuration

Calculate Long Term Design load as:

$$T_{allow} = \frac{T_{ult}}{FS_{to} * FS_{cr} * FS_{bd} * FS_{jwr}}$$

where:

T_{ult} = Ultimate Tensile strength

FS_{to} = Partial FS due to installation damage

FS_{cr} = Partial FS due to creep

FS_{bd} = Partial FS due to biological degradation/chemical degradation

FS_{jwr} = Partial FS due to joint & seam connection

Calculation of required tensile strength of geogrid reinforcement for cover applications with no soil arching.
Based on tensioned geomembrane theory proposed by Bonaparte and Berg (1987).

Input Parameters

Cover Unit Weight = 125 pcf
Void Geometry Angle 61.5 degrees (used to calc. resulting strain)

Calculated Parameters

Calc. Strain = 1.050

Calculated Tensile Strength (lbs/ft)

Void Diameter	Cover Thickness (ft)				
	3	4	5	6	7
1	367	489	611	733	856
2	733	978	1222	1467	1711
3	1100	1467	1834	2200	2567
4	1467	1956	2445	2934	3423
5	1834	2445	3056	3667	4278
6	2200	2934	3667	4401	5134
7	2567	3423	4278	5134	5990
8	2934	3912	4890	5867	6845
9	3300	4401	5501	6601	7701
10	3667	4890	6112	7334	8557
11	4034	5379	6723	8068	9412
12	4401	5867	7334	8801	10268

$T = 4890 \text{ lbs/ft}$

P. 3/4

SUBJECT LLNL/Pit 6

Job No. 963-7108

Made by Kft

Date 7/8/96

Ref.

Checked BAM

Sheet 4 of 4

Reviewed LSO

For LLNL/Pit 6 cover:

$FS_{ID} = 1.25$ General Fill, silty sand w/ 1" max particle size, compacted in 6 inch lifts

$FS_{CR} = 2.0$ For HDPE Geogrid, Tensar Manufacturer (Per Tensar)

$FS_{BD} = 1.05$ For cover application, HDPE material

$FS_{JNT} = 1.05$ For cover/burial trench application - For this design, Joint/seam connections not critical (Will require end to end joints to be located outside of trenches).

$$T_{allow} = \frac{T_{ult}}{1.25 \times 2 \times 1.05 \times 1.05} = \frac{T_{ult}}{2.76} \checkmark$$

Material	T_{ult}	T_{allow}	No. of layers Req.
UX1500 HS	6,000 lbs/ft	2,175 $\checkmark$	3 $\checkmark$
UX1600 HS	9,000 lbs/ft	3,265 $\checkmark$	2 $\checkmark$
UX1700 HS	12,500 lbs/ft	4,535 $\checkmark$	2 $\checkmark$

Conclusions:

Use 2 layers of UX1600 HS; Min 6-in spacing;
Primary reinforcement direction oriented
transverse to trench axis

SECTION B

Post Closure Truck Loads Calculations

SUBJECT LLNL/Pit 6

Job No. 963-7108

Ref.

Made by K&H

Checked BAW

Reviewed KSO

Date 7/8/96

Sheet 1 of 2

Truck Access Calculation

Objective: Verify access by 2.5 ton truck will not adversely impact cover

Methodology: Check wheel loads & verify pressure on underlying geosynthetics is less than 4 to 5 psi and verify tensile capacity of geogrid to support truck over void.

Assumptions: a. Min. 2 feet of veg. soil cover
b. HDPE geogrid (i.e. Tensar product used)

① Wheel loads

Assume total weight of 2.5 tons distributed $\frac{2}{3}$ to front axle & $\frac{1}{3}$ to rear axle; Tire contact area is $\sim 6" \times 8"$.

At ground surface; Min. Tire pressure =
$$\frac{2.5 \text{ tons} \times \frac{2,000 \text{ lbs}}{\text{ton}} \times \frac{2}{3} \times \frac{1}{2}}{\left(\frac{6}{12}\right) \times \left(\frac{8}{12}\right)} = 5,000 \text{ psf}$$

At geosynthetic layer, assume pressure bulb inclined at 45°. Resulting load distribution area is 2.5 ft x 2.67 ft

Pressure at interface is
$$\frac{(5,000 \text{ lbs}) \times \frac{2}{3} \times \frac{1}{2}}{(2.5 \text{ ft} \times 2.67 \text{ ft})} = 250 \text{ psf (1.73 psi)}$$

Wheel loading of 1.73 psi is less than the 4 to 5 psi loading allowed for equipment during construction for most geosynthetic layers including 60 mil HDPE geomembrane & geocomposite drainage net

SUBJECT LLNC/Pit 6

Job No. 963-7108

Ref.

Made by KMT

Checked BAM

Reviewed LSO

Date 7/8/16

Sheet 2 of 2

② Geogrid Tensile Capacity

The long-term design tensile strength is factored based on a partial Factor of Safety of 2.0 for long-term creep. For short term loading conditions, reduce the partial FS for creep to a value of 1.5.

Assume 2.5 ton truck supported over two rolls of UX1600 HS, each roll 4 feet wide. (This conservatively assumes only one layer of geogrid is used, although multiple layers will be used in final design).

The long-term allowable design load for Tensar UX1600 HS calculated to be 3,250 lbs/ft using a partial FS of 2.0 for creep for this project. (Other partial FS values are used to arrive at this value).

Lowering the partial FS from 2.0 to 1.5 increases the design load to:

$$3,250 \times \frac{2.0}{1.5} = 4,333 \text{ lbs/ft}$$

The increased short-term load carrying capacity is $4,333 - 3,250 \sim 1,000 \text{ lbs/ft}$

Each 4 foot wide roll can support an additional 4,000 lbs of short-term loading. If truck is supported by a min. of 2 rolls (1 roll per axle), total additional short term load support is 8,000 lbs (per layer of geogrid).

8,000 lbs (4 tons) > 2.5 tons; therefore OK for UX1600 HS

Note: Above calculation conservatively assumes all of the long-term design strength is used to support the cover (not available for truck support)

SECTION C

Surface Water Control Calculations

SUBJECT SIZING NORTH DRAINAGE DITCH - PIT 6 LF.		
Job No. 963-7100.210	Made by BAM	Date 6/17/96
Ref.	Checked KSO	Sheet 1 of 8
	Reviewed KSO	

OBJECTIVE : SIZE NORTH DRAINAGE DITCH TO ACCOMMODATE THE PMP.

APPROACH : USE TR55 (SOIL CONSERVATION SERVICE RUNOFF ANALYSIS PROGRAM) TO DETERMINE A TIME OF CONCENTRATION AND A DISCHARGE FOR THE PMP EVENT. USE SEDCAD UTILITY PROGRAM TO SIZE DITCH.

ASSUMPTIONS : ASSUME A PMP FOR SITE 300 OF 11.6 IN. (DWR DEPTH-DURATION FREQUENCY TABLE FOR LIVERMORE).

TYPE I RAINFALL DISTRIBUTION
(SE SIDE OF ALTAMONT PASS)

2YR AND 25YR STORM EVENTS FROM
DWR RAINFALL DEPTH DURATION FREQUENCY
FOR LIVERMORENE

$n = 0.027$ EXCAVATED EARTH CHANNEL WITH
SHORT GRASS (CHOW, 1959)

$n = 0.033$ RIPRAP LINED (CHOW, 1959)

ANALYSIS : SEE ATTACHED

REFERENCES : NATURAL RESOURCES CONSERVATION SERVICE,
"SOIL SURVEY OF SAN JOAQUIN COUNTY,
CALIFORNIA" U.S. DEPARTMENT OF AGRICULTURE,
OCTOBER 1992.

LINDBURG, M.R., "CIVIL ENGINEERING
REFERENCE MANUAL", 6TH. ED., PROFESSIONAL
PUBLICATIONS, INC. 1992.

CALIFORNIA DEPARTMENT OF WATER RESOURCES,
"PRECIPITATION DEPTH-DURATION-FREQUENCY
TABLE".

SUBJECT DETERMINATION OF HYDROLOGIC SOIL GROUP

Job No. 963-7108

Made by BAM

Date 8/1/96

Ref. 323

Checked

Sheet 2 of 8

Reviewed

FROM A REVIEW OF THE NATURAL RESOURCES CONSERVATION SERVICE (FORMERLY SCS) SOIL MAPS, THE DRAINAGE AREA ABOVE THE PIT 6 LANDFILL IS THE WISFLAT-ARBURVA-SAN TIMOTEO COMPLEX (MAPPED UNIT 275).

FROM CONVERSATIONS WITH THE NATURAL RESOURCES CONSERVATION SERVICE (NRCS) AND THE SOIL SURVEY OF SAN JOAQUIN COUNTY, CALIFORNIA, U.S. DEPT OF AGRICULTURE (PAGE 139) THE WISFLAT-ARBURVA-SAN TIMOTEO COMPLEX IS COMPOSED OF:

PERCENT	SOIL	HYDROLOGIC SOIL GROUP (PAGE 469)
35	WISFLAT	D
30	ARBURVA	C
20	SAN TIMOTEO	B
15	OTHER	—

FOR THE DRAINAGE AREA ABOVE THE PIT 6 LANDFILL BASE RUNOFF POTENTIAL ON A WEIGHTED AVERAGE OF THE WISFLAT, ARBURVA, AND SAN TIMOTEO SOILS AND BASED ON PASTURE OR RANGELAND IN GOOD CONDITION:

	$35\% + 30\% + 25\% = 85\%$	
SOIL	HYDROLOGIC SOIL GROUP	WEIGHTED RUNOFF POTENTIAL
WISFLAT	D	$80 \left(\frac{35}{85} \right) = 33$
ARBURVA	C	$74 \left(\frac{30}{85} \right) = 26$
SAN TIMOTEO	B	$61 \left(\frac{20}{85} \right) = 14$

THE AVERAGE RUNOFF POTENTIAL = $33 + 26 + 14 = 73$

FROM THE NRCS SOILS MAPS THE SOILS THAT ARE TO THE EAST, WEST, AND SOUTH OF THE PIT 6 LANDFILL ARE CARBONA CLAY LOAM. THE HYDROLOGIC SOIL GROUP IS D.

ASSUME THE PIT 6 LANDFILL COVER WILL BE HYDROLOGIC SOIL GROUP D. (SOIL WITH HIGHEST RUNOFF POTENTIAL)

NNN 004 NNN

NNN 004 NNN

PRECIPITATION DEPTH-DURATION-FREQUENCY TABLE

STATION NO.	STATION NAME	ELEV	SEC	TWP	RNG	LOT	BWM	LATITUDE	LONGITUDE	COUNTY CODE
BSN ORDER SUB ESO 4997 00	LIVERMORE	86	545	20	03S	02E	M	37.650	121.783	60

MAXIMUM PRECIPITATION FOR INDICATED DURATION D-DAYS H-HOURS

RETURN PERIOD IN YEARS	10	20	30	40	50	60	80	100	150	200	300	600	3650
2	1.50	1.90	2.14	2.34	2.52	2.70	3.03	3.31	3.85	4.27	5.06	7.43	13.84
5	2.11	2.74	3.10	3.35	3.60	3.85	4.27	4.62	5.36	5.94	6.99	10.25	18.05
10	2.52	3.36	3.76	4.04	4.33	4.61	5.07	5.46	6.30	6.97	8.20	11.97	20.48
20	2.81	3.94	4.39	4.70	5.01	5.34	5.81	6.22	7.16	7.91	9.29	13.52	22.61
25	3.03	4.13	4.59	4.90	5.22	5.56	6.04	6.46	7.42	8.20	9.63	14.00	23.25
40	3.27	4.51	5.01	5.33	5.66	6.03	6.15	6.95	7.96	8.80	10.32	14.97	24.55
50	3.43	4.69	5.21	5.54	5.87	6.25	6.73	7.17	8.21	9.07	10.64	15.42	25.14
100	3.76	5.25	5.81	6.15	6.50	6.93	7.41	7.86	8.97	9.90	11.61	16.77	26.91
200	4.11	5.81	6.40	6.76	7.12	7.59	8.06	8.52	9.70	10.71	12.55	18.07	28.59
1000	6.91	7.08	7.76	8.14	8.53	9.08	9.53	10.01	11.32	12.50	14.63	20.95	32.23
10000	6.93	8.87	9.67	10.08	10.49	11.16	11.56	12.05	13.53	14.93	17.46	24.84	37.00
PMP	11.55	15.93	17.79	18.96	20.21	21.48	23.38	24.96	28.80	31.73	37.03	54.18	85.08
MEAN	1.639	2.138	2.388	2.581	2.769	2.961	3.270	3.542	4.096	4.543	5.371	7.841	16.227
CLOCK HR. COR.	1.140	1.070	1.040	1.020	1.010	1.010	1.000	1.000	1.000	1.000	1.000	1.000	1.000
CALCULATED SKEW	1.661	1.595	1.794	1.625	1.481	1.593	1.285	1.064	.965	1.042	1.087	.873	.453
REGIONAL SKEW	1.300	1.600	1.500	1.400	1.300	1.300	1.100	1.000	.900	.900	.900	.800	.500
SKEW USED	1.300	1.600	1.500	1.400	1.300	1.300	1.100	1.000	.900	.900	.900	.800	.500
KURTOSIS	5.672	5.515	6.862	6.729	6.184	7.344	5.714	4.781	4.410	4.535	4.799	4.026	2.470
N	85	85	85	85	85	85	85	85	85	85	85	85	84
RECORD YEAR	1919	1919	1911	1911	1911	1911	1911	1911	1911	1911	1911	1911	1982
RECORD MAXIMUM	3.970	5.450	6.830	7.530	7.680	8.640	8.750	8.750	9.680	11.220	13.190	18.470	24.380
NORMALIZED MAX	2.992	3.210	3.839	4.126	3.987	4.409	3.899	3.564	3.351	3.545	3.618	3.391	2.305
CALC. COEF. VAR	.475	.482	.484	.465	.445	.435	.430	.412	.407	.415	.402	.400	.310
REGN. COEF. VAR	.403	.430	.430	.423	.420	.417	.410	.403	.402	.399	.393	.394	.332
USED COEF. VAR	.403	.430	.430	.423	.420	.417	.410	.403	.402	.399	.393	.394	.332
MEAN/A	.1152	.1503	.1679	.1814	.1946	.2081	.2298	.2490	.2879	.3193	.3775	.5511	1.0000
RP10/A	.1774	.2362	.2641	.2840	.3041	.3244	.3562	.3835	.4429	.4899	.5762	.8413	1.4393
RP25/A	.2131	.2901	.3228	.3447	.3669	.3911	.4245	.4540	.5216	.5765	.6770	.9839	1.6342
RP50/A	.2390	.3299	.3659	.3891	.4126	.4396	.4734	.5041	.5771	.6376	.7482	1.0838	1.7672
RP100/A	.2643	.3693	.4083	.4325	.4571	.4868	.5207	.5523	.6302	.6961	.8163	1.1789	1.8917
RP1000/A	.3453	.4974	.5457	.5725	.5996	.6382	.6702	.7036	.7958	.8783	1.0286	1.4727	2.2652
RP10000/A	.4235	.6233	.6799	.7084	.7373	.7844	.8126	.8467	.9511	1.0492	1.2275	1.7457	2.6007
PMP/A	.8118	1.1197	1.2507	1.3326	1.4206	1.5100	1.6432	1.7541	2.0242	2.2303	2.6030	3.8082	5.9800

PEARSON TYPE III DISTRIBUTION USED
 PROBABLE MAXIMUM PRECIPITATION ESTIMATE BASED ON 15 STANDARD DEVIATIONS
 WHERE N IS SMALL RESULTS ARE NOT DEPENDABLE

REFERENCE: CALIFORNIA DEPARTMENT OF WATER
 RECORDS, "PRECIPITATION DEPTH-DURATION-FREQUENCY TABLE."

3/8

C-3

SCALE 1 IN. = 600 FT
50 FT CONTOURS

$L = 1460 \text{ FT}$
 $A = 0.34, 460 \text{ ft} \approx 14.57 \text{ ACRES}$

TR-55 Tc and Tt THRU SUBAREA COMPUTATION

VERSION 1.11

C-5
5/8

Project : 963-7108.210 User: BAM Date: 06-17-96
 County : SAN JOAQUIN State: CA Checked: _____ Date: _____
 Subtitle: SIZE NORTH DRAINAGE DITCH - RIP-RAP LINED

Flow Type	2 year rain	Length (ft)	Slope (ft/ft)	Surface code	n	Area (sq/ft)	Wp (ft)	Velocity (ft/sec)	Time (hr)
Sheet	1.5	300	0.29	E					0.187
Shallow Concent'd		810	.25	U					0.028
Open Channel		120	.04		.03318		13.9		0.003
Open Channel		260	0.013		.03318		13.9		0.012
Time of Concentration = 0.23*									=====

--- Sheet Flow Surface Codes ---

A Smooth Surface	F Grass, Dense
B Fallow (No Res.)	G Grass, Burmuda
C Cultivated < 20 % Res.	H Woods, Light
D Cultivated > 20 % Res.	I Woods, Dense
E Grass-Range, Short	

--- Shallow Concentrated ---
 --- Surface Codes ---
 P Paved
 U Unpaved

* - Generated for use by GRAPHIC method

TR-55 GRAPHICAL DISCHARGE METHOD

VERSION 1.11

Project : 963-7108.326

County : SAN JOAQUIN

State: CA

User: BAM

Date: 06-17-96

Checked: _____

Date: _____

Subtitle: SIZE NORTH DRAINAGE DITCH

Data: Drainage Area : 14.6 Acres
 Runoff Curve Number : 73
 Time of Concentration: 0.23 * Hours
 Rainfall Type : I
 Pond and Swamp Area : NONE

Storm Number	1	2
Frequency (yrs)	25	PMP
24-Hr Rainfall (in)	3.03	11.6
Ia/P Ratio	0.24	0.06
Used	0.24	0.10
Runoff (in)	0.88	8.10
Unit Peak Discharge (cfs/acre/in)	0.463	0.602
Pond and Swamp Factor 0.0% Ponds Used	1.00	1.00
Peak Discharge (cfs)	6	71

* - Value(s) provided from TR-55 system routines

NORTH CHANNEL WITH A 1.3% SLOPE

INPUT VALUES:

Shape	TRAPEZOIDAL
Discharge	71.00 cfs
Slope	1.30 %
Sideslopes (L and R)	2.00:1 2.00:1
Bottom Width	5.00 feet
Freeboard	1 ft

RESULTS:

Mild Slope Design

Depth	1.71 ft
with Freeboard	2.71 ft
Top Width	11.85 ft
with Freeboard	15.85 ft
Velocity	4.92 fps
Cross Sectional Area	14.42 sq ft
Hydraulic Radius	1.14 ft
Manning's n	0.038
Froude Number	0.79
Dmax	1.500 ft (18.00 in)
D50	0.750 ft (9.00 in)
D10	0.250 ft (3.00 in)

1.3% SLOPE

A 3 FT DEEP RIP-RAP LINED TRAPEZOIDAL DITCH WITH A 5-FOOT BOTTOM WIDTH WILL HOLD THE PMP STORM EVENT WITH 1 FOOT OF FREEBOARD.

SEDCAD+ RIPRAP CHANNEL DESIGN

C-8

8/8

NORTH CHANNEL WITH A 4% SLOPE

INPUT VALUES:

Shape	TRAPEZOIDAL
Discharge	71.00 cfs
Slope	4.00 %
Sideslopes (L and R)	2.00:1 2.00:1
Bottom Width	5.00 feet
Freeboard	1 ft

RESULTS:

Steep Slope Design - PADER Method

Depth	1.39 ft
with Freeboard	2.39 ft
Top Width	10.54 ft
with Freeboard	14.54 ft
Velocity	6.60 fps
Cross Sectional Area	10.76 sq ft
Hydraulic Radius	0.96 ft
Manning's n	0.044
Froude Number	1.15
Dmax	0.625 ft (7.50 in)
D50	0.500 ft (6.00 in)
D10	0.167 ft (2.00 in)

4.0% SLOPE

A 3-FOOT DEEP RIP-RAP LINED TRAPEZOIDAL DITCH WITH A 5-FOOT BOTTOM WIDTH WILL HOLD THE PMP STORM EVENT WITH 1-FOOT OF FREEBOARD.

SUBJECT SURFACE WATER CONTROL

Job No. 963-710B.323

Made by BAM

Date 7/5/96

Ref.

Checked

Sheet 1 of 45

Reviewed RSD

OBJECTIVE: SIZE DRAINAGE DITCHES AND CULVERTS TO ACCOMMODATE THE PROBABLE MAXIMUM PRECIPITATION (PMP).

APPROACH: ① USE TR55 (SOIL CONSERVATION SERVICE RUNOFF ANALYSIS PROGRAM) TO CALCULATE A TIME OF CONCENTRATION AND A DISCHARGE BASED ON THE PMP FOR THE LIVERMORE RAIN STATION.

② USE SEDCAD TO SIZE THE DRAINAGE DITCHES.

③ USE HYDROCALC TO SIZE THE CULVERTS.

ASSUMPTIONS: PMP = 11.6 IN FOR SITE 300 (DWR DEPTH-DURATION FREQUENCY TABLE FOR LIVERMORE). AREA IS SOIL GROUP D AND LIGHTLY GRAZED. $C = 80$ (LINDBURG, 1992 AND NRCS, 1992).

$n = 0.033$ FOR RIP-RAP LINED CHANNEL

$n = 0.025$ FOR EARTH CHANNEL

$n = 0.013$ FOR CONCRETE LINED CHANNEL.

$n = 0.015$ FOR HELICAL PIPE

TYPE I RAINFALL DISTRIBUTION (SE SIDE OF ALTAMONT PASS).

REFERENCES: NATURAL RESOURCES CONSERVATION SERVICE, "SOIL SURVEY OF SAN JOAQUIN COUNTY, CALIFORNIA", U.S. DEPARTMENT OF AGRICULTURE, OCTOBER 1992.

LINDBURG, M.R. "CIVIL ENGINEERING REFERENCE MANUAL", 6TH. ED., PROFESSIONAL PUBLICATIONS, INC., 1992.

CALIFORNIA DEPARTMENT OF WATER RESOURCES, "PRECIPITATION DEPTH-DURATION-FREQUENCY TABLE".

NNN 004 NNN

PRECIPITATION DEPTH-DURATION-FREQUENCY TABLE

STATION NO. STATION NAME ELEV SEC TWP RNG LOT BWM LATITUDE LONGITUDE COUNTY CODE
 BSN ORDER SUB LIVERMORE 86 545 20 03S 02E M 37.650 121.783 60
 ESO 4997 00

MAXIMUM PRECIPITATION FOR INDICATED DURATION D-DAYS H-HOURS

RETURN PERIOD IN YEARS	10	20	30	40	50	60	80	100	150	200	300	600	3650
2	1.50	1.90	2.14	2.34	2.52	2.70	3.03	3.31	3.85	4.27	5.06	7.43	13.84
5	2.11	2.76	3.10	3.35	3.60	3.85	4.27	4.62	5.36	5.94	6.99	10.25	18.05
10	2.52	3.36	3.76	4.04	4.33	4.61	5.07	5.46	6.30	6.97	8.20	11.97	20.48
20	2.91	3.94	4.39	4.70	5.01	5.34	5.81	6.22	7.16	7.91	9.29	13.52	22.61
25	3.03	4.13	4.59	4.90	5.22	5.56	6.04	6.46	7.42	8.20	9.63	14.00	23.25
40	3.24	4.51	5.01	5.33	5.66	6.03	6.51	6.95	7.96	8.80	10.32	14.97	24.55
50	3.40	4.69	5.21	5.54	5.87	6.25	6.73	7.17	8.21	9.07	10.64	15.42	25.14
100	3.76	5.25	5.81	6.15	6.50	6.93	7.41	7.86	8.97	9.90	11.61	16.77	26.91
200	4.11	5.81	6.40	6.76	7.12	7.59	8.06	8.52	9.70	10.71	12.55	18.07	28.59
1000	4.91	7.08	7.76	8.14	8.53	9.08	9.53	10.01	11.32	12.50	14.63	20.95	32.23
10000	6.03	8.87	9.67	10.08	10.49	11.16	11.56	12.05	13.53	14.93	17.46	24.84	37.00
PMP	11.55	15.93	17.79	18.96	20.21	21.48	23.38	24.96	28.80	31.73	37.03	54.18	85.08
MEAN	1.639	2.138	2.388	2.581	2.769	2.961	3.270	3.542	4.096	4.543	5.371	7.841	14.227
CLOCK HR. COR.	1.140	1.070	1.040	1.020	1.010	1.010	1.000	1.000	1.000	1.000	1.000	1.000	1.000
CALCULATED SKEW	1.661	1.595	1.794	1.625	1.481	1.593	1.285	1.064	.965	1.042	1.087	.873	.453
REGIONAL SKEW	1.300	1.600	1.500	1.400	1.300	1.300	1.100	1.000	.900	.900	.900	.800	.500
SKEW USED	1.300	1.600	1.500	1.400	1.300	1.300	1.100	1.000	.900	.900	.900	.800	.500
KURTOSIS	5.672	5.515	6.862	6.729	6.184	7.344	5.714	4.781	4.410	4.535	4.799	4.026	2.470
N	85	85	85	85	85	85	85	85	85	85	85	85	84
RECORD YEAR	1919	1919	1911	1911	1911	1911	1911	1911	1911	1911	1911	1911	1982
RECORD MAXIMUM	3.970	5.450	6.830	7.530	7.680	8.640	8.750	8.750	9.680	11.220	13.190	18.470	24.380
NORMALIZED MAX	2.992	3.210	3.839	4.126	3.987	4.609	3.899	3.564	3.351	3.545	3.618	3.391	2.305
CALC. COEF. VAR	.475	.482	.484	.465	.445	.435	.430	.412	.407	.415	.402	.400	.310
REGN. COEF. VAR	.403	.430	.430	.423	.420	.417	.410	.403	.402	.399	.393	.394	.332
USED COEF. VAR	.403	.430	.430	.423	.420	.417	.410	.403	.402	.399	.393	.394	.332
MEAN/A	.1152	.1503	.1679	.1814	.1946	.2081	.2298	.2490	.2879	.3193	.3775	.5511	1.0000
RP10/A	.1774	.2362	.2641	.2840	.3041	.3244	.3562	.3835	.4429	.4899	.5762	.8413	1.4393
RP25/A	.2131	.2901	.3228	.3447	.3669	.3911	.4245	.4540	.5216	.5765	.6770	.9839	1.6342
RP50/A	.2390	.3299	.3659	.3891	.4126	.4396	.4734	.5041	.5771	.6376	.7482	1.0838	1.7672
RP100/A	.2643	.3693	.4083	.4325	.4571	.4868	.5207	.5523	.6302	.6961	.8163	1.1789	1.8917
RP1000/A	.3453	.4974	.5457	.5725	.5996	.6382	.6702	.7036	.7958	.8783	1.0286	1.4727	2.2652
RP10000/A	.4235	.6233	.6799	.7084	.7373	.7844	.8126	.8467	.9511	1.0492	1.2275	1.7457	2.6007
PMP/A	.8118	1.1197	1.2507	1.3326	1.4206	1.5100	1.6432	1.7541	2.0242	2.2303	2.6030	3.8082	5.9800

PEARSON TYPE III DISTRIBUTION USED
 PROBABLE MAXIMUM PRECIPITATION ESTIMATE BASED ON 15 STANDARD DEVIATIONS
 WHERE N IS SMALL RESULTS ARE NOT DEPENDABLE

REFERENCE: CALIFORNIA DEPARTMENT OF WATER
 RESOURCES, "PRECIPITATION DEPTH-
 DURATION-FREQUENCY TABLE"

2/45

TR-55 Tc and Tt THRU SUBAREA COMPUTATION

VERSION 1.11

C-11
3/45

Project : 963-7108.326 User: BAM Date: 07-03-96
County : SAN JOAQUIN State: CA Checked: _____ Date: _____
Subtitle: SIZE SOUTHERN DRAINAGE DITCH

Flow Type	2 year rain	Length (ft)	Slope (ft/ft)	Surface code	n	Area (sq/ft)	Wp (ft)	Velocity (ft/sec)	Time (hr)
Sheet	1.5	88	0.12	E					0.100
Sheet		171	.07	E					0.210
Time of Concentration = 0.31									=====

Subarea #2									
Flow Type	2 year rain	Length (ft)	Slope (ft/ft)	Surface code	n	Area (sq/ft)	Wp (ft)	Velocity (ft/sec)	Time (hr)
Sheet	1.5	65	.05	E					0.111
Shallow Concent'd		12	.34	U					0.000
Shallow Concent'd		9	.02	U					0.001
Open Channel		221	.018		.0138		8.94		0.004
Open Channel		53	.094		.0138		8.94		0.000
Time of Concentration = 0.12*									=====
									0.43

--- Sheet Flow Surface Codes ---
 A Smooth Surface
 B Fallow (No Res.)
 C Cultivated < 20 % Res.
 D Cultivated > 20 % Res.
 E Grass-Range, Short

F Grass, Dense
 G Grass, Burmuda
 H Woods, Light
 I Woods, Dense

--- Shallow Concentrated ---
 --- Surface Codes ---
 P Paved
 U Unpaved

TR-55 GRAPHICAL DISCHARGE METHOD

C-12
4/45
VERSION 1.11

Project : 963-7108.326
County : SAN JOAQUIN State: CA
Subtitle: SIZE SOUTHERN DRAINAGE DITCH

User: BAM
Checked: _____

Date: 07-03-96
Date: _____

Data: Drainage Area : 2.41 Acres
Runoff Curve Number : 80
Time of Concentration: 0.43 Hours
Rainfall Type : I
Pond and Swamp Area : NONE

Storm Number	1	2
Frequency (yrs)	25	1
24-Hr Rainfall (in)	3.03	11.6
Ia/P Ratio	0.17	0.04
Used	0.17	0.10
Runoff (in)	1.27	9.06
Unit Peak Discharge (cfs/acre/in)	0.424	0.470
Pond and Swamp Factor 0.0% Ponds Used	1.00	1.00
Peak Discharge (cfs)	1	10

SOUTHERN V-DITCH

INPUT VALUES:

Shape	TRIANGULAR	
Discharge	10.00 cfs	
Slope	1.80 %	
Sideslopes	2.00:1 (L)	2.00:1 (R)
Manning's n	0.015	
Material	CONCRETE	
Freeboard	1 ft	

RESULTS:

Depth	0.85 ft
with Freeboard	1.85 ft
Top Width	3.39 ft
with Freeboard	7.39 ft
Velocity	6.97 fps
Cross Sectional Area	1.43 sq ft
Hydraulic Radius	0.38 ft
Froude Number	1.89

A 2-FOOT DEEP V-DITCH WILL HOLD THE PMP
WITH 1-FOOT OF FREEBOARD

C-14
6/45

PIPE CULVERT ANALYSIS
COMPUTATION OF CULVERT PERFORMANCE CURVE

August 6, 1996
EXTENSION TO EXISTING CULVERT
FROM SOUTHERN DRAINAGE
2-FOOT DIAMETER HELICAL PIPE

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Culvert Diameter (feet).....	2.00
FHWA Chart Number (1,2 or 3).....	2
Scale Number on Chart (Type of Culvert Entrance).....	3
Manning's Roughness Coefficient (n-value).....	0.0150
Entrance Loss Coefficient of Culvert Opening.....	0.50
Culvert Length (feet).....	20.0
Culvert Slope (feet per foot).....	0.0180

PROGRAM RESULTS:

Flow Rate (cfs)	Tailwater Depth (ft)	Headwater (ft) Inlet Control	Headwater (ft) Outlet Control	Normal Depth (ft)	Critical Depth (ft)	Depth at Outlet (ft)	Outlet Velocity (fps)
6.0	0.00	1.30	1.18	0.65	0.87	0.65	6.78
8.0	0.00	1.57	1.33	0.76	1.01	0.76	7.35
OK 10.0	0.00	1.82	1.49	0.85	1.13	0.85	7.82
12.0	0.00	2.08	1.68	0.95	1.24	0.95	8.18
14.0	0.00	2.33	1.88	1.04	1.35	1.04	8.51

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A 2-FOOT DIAMETER HELICAL PIPE WILL CONVEY
THE PMP. DEEPEN V-DITCH TO 3.0 FEET AT THE
ENTRANCE TO THE CULVERT.

><±±±f.**< |±"\$>**8|6>"6~±â':*.&\$6|8

PIPE CULVERT ANALYSIS
COMPUTATION OF CULVERT PERFORMANCE CURVE

August 4, 1996
SOUTHERN DRAINAGE TO EXISTING CULVERT
2-FOOT DIAMETER HELICAL PIPE

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Culvert Diameter (feet).....	<u>2.00</u>
FHWA Chart Number (1,2 or 3).....	2
Scale Number on Chart (Type of Culvert Entrance).....	3
Manning's Roughness Coefficient (n-value).....	0.0150
Entrance Loss Coefficient of Culvert Opening.....	0.50
Culvert Length (feet).....	40.0
Culvert Slope (feet per foot).....	0.0750

PROGRAM RESULTS:

Flow Rate (cfs)	Tailwater Depth (ft)	Headwater (ft) Inlet Control	Headwater (ft) Outlet Control	Normal Depth (ft)	Critical Depth (ft)	Depth at Outlet (ft)	Outlet Velocity (fps)
6.0	0.00	1.30	-1.44	0.45	0.87	0.45	11.29
8.0	0.00	1.56	-1.28	0.52	1.01	0.52	12.24
10.0	0.00	1.82	-1.09	0.58	1.13	0.58	13.08
12.0	0.00	2.07	-0.89	0.64	1.24	0.64	13.74
14.0	0.00	2.32	-0.66	0.70	1.35	0.70	14.37

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A 2-FOOT DIAMETER HELICAL PIPE WILL CONVEY THE
PMP. REMOVE EXISTING 18-INCH CMP AND REPLACE
WITH 2-FOOT DIAMETER HELICAL PIPE. DEEPEN U-DITCH
TO 3.0 FEET AT ENTRANCE TO CULVERT.

88² (2) 2%

17 $\frac{0}{\text{ce}}$ 7%

-
- LIMIT OF LANDFILL COVER
 EXISTING DITCH FLOWLINE
 DRAINAGE FLOW DIRECTION
 LIMITS OF MAGNETIC ANOMALY
 AREAS WITH EXISTING UNCOMPACTED FILL TO BE REMOVED AND REPLACED
- DETAIL/SECTION DESIGNATION
 DRAWING WHERE SECTION/DETAIL IS LOCATED
 DRAWING WHERE SECTION/DETAIL IS REFERENCED

- NOTES:
- 1) TOPOGRAPHY SUPPLIED BY LAWRENCE LIVERMORE NATIONAL LABORATORY. DATE OF PHOTOGRAPHY _____
 - 2) SUBGRADE QUANTITIES:
VOLUME CALCULATIONS
PRISMATOIDAL METHOD-EAGLE POINT PROGRAM
ORIGINAL SURFACE TOPO
FINAL SURFACE SUBG
RAW CUT VOLUME 2,888 CY
RAW FILL VOLUME 8,888 CY
- COVER LIMITS AREA 102,093 SF = 2.34 ACRE
DISTURBED AREA 158,973 SF = 3.19 ACRE
- WELLS K6-03 AND B06-11 SHALL BE PROTECTED BY PLACEMENT OF A 5 FT. DIA. CONCRETE PIPE SECTION AROUND WELL DURING CONSTRUCTION.

$$\text{AREA} = 2.41 \text{ AC.}$$

53^e @ 9.4%

REV.	DATE	DESCRIPTION	DRAWN BY	REV. BY
		Golden Associates		
SCALE: AS SHOWN		PROJECT NO.: 883-7108	TASK NO.: 310	
DES BY: PLS		LULU/PIT 8 LANDFILL COVER/CA		
DWN BY: PLS		REPORT:		
CHK BY: KGH		SHEET TITLE:		
RWN BY: KSD		PIT 8 LANDFILL TOP OF COVER GRADING PLAIN		
LAWRENCE LIVERMORE NATIONAL LABORATORY SITE 300			SHEET: 2 OF 3	
			DRAWING NO.	REV.
			2	0

Project : 963-7108.326

User: BAM

Date: 07-03-96

County : SAN JOAQUIN

State: CA

Checked: _____

Date: _____

-Subtitle: SIZE SOUTHERN DRAINAGE DITCH EXTENSION

Flow Type	2 year rain	Length (ft)	Slope (ft/ft)	Surface code	n	Area (sq/ft)	Wp (ft)	Velocity (ft/sec)	Time (hr)
Sheet	1.5	88	0.12	E					0.100
Sheet		171	.07	E					0.210
Time of Concentration = 0.31									=====

Subarea #2									
Flow Type	2 year rain	Length (ft)	Slope (ft/ft)	Surface code	n	Area (sq/ft)	Wp (ft)	Velocity (ft/sec)	Time (hr)
Sheet	1.5	65	.05	E					0.111
Shallow Concent'd		12	.34	U					0.000
Shallow Concent'd		9	.02	U					0.001
Open Channel		221	.018		.0138		8.94		0.004
Open Channel		53	.094		.0138		8.94		0.000
Time of Concentration = 0.12*									=====

--- Sheet Flow Surface Codes ---

A Smooth Surface	F Grass, Dense
B Fallow (No Res.)	G Grass, Burmuda
C Cultivated < 20 % Res.	H Woods, Light
D Cultivated > 20 % Res.	I Woods, Dense
E Grass-Range, Short	

USE 0.44

--- Shallow Concentrated ---
 --- Surface Codes ---
 P Paved
 U Unpaved

TR-55 GRAPHICAL DISCHARGE METHOD

VERSION 1.11

C-18
10/45

Project : 963-7108.326

User: BAM

Date: 07-03-96

County : SAN JOAQUIN

State: CA

Checked: _____

Date: _____

Subtitle: SIZE SOUTHERN DRAINAGE DITCH EXTENSION

Data: Drainage Area : 4.12 Acres
Runoff Curve Number : 80
Time of Concentration: 0.44 Hours
Rainfall Type : I
Pond and Swamp Area : NONE

Storm Number	1	2
Frequency (yrs)	25	1
24-Hr Rainfall (in)	3.03	11.6
Ia/P Ratio	0.17	0.04
Used	0.17	0.10
Runoff (in)	1.27	9.06
Unit Peak Discharge (cfs/acre/in)	0.420	0.465
Pond and Swamp Factor 0.0% Ponds Used	1.00	1.00
Peak Discharge (cfs)	2	17

C-19
11/45

SEDCAD+ NONERODIBLE CHANNEL DESIGN

SOUTHERN V-DITCH EXTENSION

INPUT VALUES:

Shape	TRIANGULAR
Discharge	17.00 cfs
Slope	2.00 %
Sideslopes	2.00:1 (L) 2.00:1 (R)
Manning's n	0.015
Material	CONCRETE
Freeboard	1 ft

RESULTS:

Depth	1.01 ft
with Freeboard	2.01 ft
Top Width	4.05 ft
with Freeboard	8.05 ft
Velocity	8.29 fps
Cross Sectional Area	2.05 sq ft
Hydraulic Radius	0.45 ft
Froude Number	2.05

A 2-FOOT V-DITCH WITH 2:1 SIDESLOPES
WILL CONTAIN THE PMP WITH 1-FOOT OF
FREE BOARD.

C-20
12/45

PIPE CULVERT ANALYSIS
COMPUTATION OF CULVERT PERFORMANCE CURVE

August 4, 1996
CULVERT AT TOE OF TERRACE
2-FOOT DIAMETER CULVERT

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Culvert Diameter (feet).....	2.00
FHWA Chart Number (1,2 or 3).....	2
Scale Number on Chart (Type of Culvert Entrance).....	1
Manning's Roughness Coefficient (n-value).....	0.0150
Entrance Loss Coefficient of Culvert Opening.....	0.50
Culvert Length (feet).....	12.0
Culvert Slope (feet per foot).....	0.0200

PROGRAM RESULTS:

Flow Rate (cfs)	Tailwater Depth (ft)	Headwater Inlet Control (ft)	Headwater Outlet Control (ft)	Normal Depth (ft)	Critical Depth (ft)	Depth at Outlet (ft)	Outlet Velocity (fps)
15.0	0.00	2.21	2.06	1.05	1.40	1.05	9.00
16.0	0.00	2.37	2.16	1.09	1.44	1.09	9.12
N.G. 17.0	0.00	2.52	2.27	1.13	1.49	1.13	9.28
18.0	0.00	2.62	2.39	1.17	1.53	1.17	9.40
19.0	0.00	2.77	2.51	1.22	1.57	1.22	9.51
20.0	0.00	2.92	2.63	1.26	1.61	1.26	9.58

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FOR A 2-FOOT DIAMETER HELICAL PIPE WILL NEED
A 3.5 FT DEEP V-DITCH ENTRANCE. NG.

PIPE CULVERT ANALYSIS
COMPUTATION OF CULVERT PERFORMANCE CURVE

August 4, 1996
CULVERT AT TOE OF TERRACE
2.5-FOOT DIAMETER HELICAL PIPE

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Culvert Diameter (feet).....	2.50
FHWA Chart Number (1,2 or 3).....	2
Scale Number on Chart (Type of Culvert Entrance).....	1
Manning's Roughness Coefficient (n-value).....	0.0150
Entrance Loss Coefficient of Culvert Opening.....	0.50
Culvert Length (feet).....	12.0
Culvert Slope (feet per foot).....	0.0200

PROGRAM RESULTS:

Flow Rate (cfs)	Tailwater Depth (ft)	Headwater Inlet Control (ft)	Headwater Outlet Control (ft)	Normal Depth (ft)	Critical Depth (ft)	Depth at Outlet (ft)	Outlet Velocity (fps)
15.0	0.00	1.90	1.90	0.94	1.31	1.31	5.78
16.0	0.00	1.98	1.96	0.97	1.35	0.97	9.08
OK 17.0	0.00	2.05	2.01	1.00	1.39	1.00	9.25
18.0	0.00	2.13	2.07	1.03	1.44	1.03	9.40
19.0	0.00	2.21	2.13	1.07	1.48	1.07	9.53

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USE A 2.5-FOOT HELICAL PIPE WITH A 3-FOOT DEEP
V-DITCH AT THE ENTRANCE.

88° @ 12% 171° @ 7%

- NOTES:
- 1) TOPOGRAPHY SUPPLIED BY LAWRENCE LIVERMORE NATIONAL LABORATORY. DATE OF PHOTOGRAPHY
 - 2) SUBGRADE QUANTITIES:
 PRISMOIDAL METHOD-EAGLE POINT PROGRAM
 ORIGINAL SURFACE TOPO
 FINAL SURFACE SUB3
 RAW CUT VOLUME 2,888 CY
 RAW FILL VOLUME 8,888 CY
 COVER LIMITS AREA 102,093 SF = 2.34 ACRE
 DISTURBED AREA 138,973 SF = 3.19 ACRE
 - 3) WELLS KB-03 AND BC6-11 SHALL BE PROTECTED BY PLACEMENT OF A 5 FT. DIA. CONCRETE PIPE SECTION AROUND WELL DURING CONSTRUCTION.

AREA = 4.12 AC

DATE		DESCRIPTION		DRN BY	REV BY
SCALE: AS SHOWN		PROJECT NO.: 883-7108		TASK NO.: 276	
DES BY: PLS		PROJECT: LNL/PIT & LANDFILL COVER/CA			
DRN BY: PLS		REPORT:			
CHK BY: KGH		SHEET TITLE: PIT & LANDFILL TOP OF COVER GRADING PLAN			
CHK BY: KSD		SHEET: 2 OF 2			
DRAWING NO.		REV.			
2		0			

LAWRENCE LIVERMORE NATIONAL LABORATORY SITE 300

TR-55 Tc and Tt THRU SUBAREA COMPUTATION

VERSION 1.11

C-23
15/45

Project : 963-7108.323

User: BAM

Date: 07-06-96

County : SAN JOAQUIN

State: CA

Checked: _____

Date: _____

Subtitle: DRAINAGE TO NORTHEAST CULVERT

Flow Type	2 year rain	Length (ft)	Slope (ft/ft)	Surface code	n	Area (sq/ft)	Wp (ft)	Velocity (ft/sec)	Time (hr)
Sheet	1.5	74	.1	A					0.012
Shallow Concent'd		13	.143	U					0.001

Time of Concentration = 0.01*
=====

--- Sheet Flow Surface Codes ---

A Smooth Surface	F Grass, Dense
B Fallow (No Res.)	G Grass, Burmuda
C Cultivated < 20 % Res.	H Woods, Light
D Cultivated > 20 % Res.	I Woods, Dense
E Grass-Range, Short	

--- Shallow Concentrated ---
--- Surface Codes ---
P Paved
U Unpaved

* - Generated for use by GRAPHIC method

C-24
16/45

TR-55 GRAPHICAL DISCHARGE METHOD

VERSION 1.11

Project : 963-7108.323
County : SAN JOAQUIN State: CA
Subtitle: DRAINAGE TO NORTHEAST CULVERT

User: BAM
Checked: _____

Date: 07-06-96
Date: _____

Data: Drainage Area : .09 Acres
Runoff Curve Number : 80
Time of Concentration: 0.01 * Hours
Rainfall Type : I
Pond and Swamp Area : NONE

Storm Number	1	2
Frequency (yrs)	25	1
24-Hr Rainfall (in)	3.03	11.6
Ia/P Ratio	0.17	0.04
Used	0.17	0.10
Runoff (in)	1.27	9.06
Unit Peak Discharge (cfs/acre/in)	1.181	1.143
Pond and Swamp Factor 0.0% Ponds Used	1.00	1.00
Peak Discharge (cfs)	0	1

* - Value(s) provided from TR-55 system routines

C-25
17/45

PIPE CULVERT ANALYSIS
COMPUTATION OF CULVERT PERFORMANCE CURVE

July 6, 1996
NORTHEAST CULVERT
18 IN. DIAMETER

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Culvert Diameter (feet).....	1.50
FHWA Chart Number (1,2 or 3).....	2
Scale Number on Chart (Type of Culvert Entrance).....	3
Manning's Roughness Coefficient (n-value).....	0.0240
Entrance Loss Coefficient of Culvert Opening.....	0.50
Culvert Length (feet).....	20.0
Culvert Slope (feet per foot).....	0.0750

PROGRAM RESULTS:

	Flow Rate (cfs)	Tailwater Depth (ft)	Headwater Inlet Control	Headwater Outlet Control	Normal Depth (ft)	Critical Depth (ft)	Depth at Outlet (ft)	Outlet Velocity (fps)
	0.5	0.00	0.35	-0.62	0.18	0.26	0.18	4.03
OK	1.0	0.00	0.52	-0.55	0.26	0.37	0.26	4.95
	1.5	0.00	0.65	-0.49	0.31	0.46	0.31	5.58
	2.0	0.00	0.77	-0.43	0.36	0.53	0.36	6.07

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AREA = 0.09 AC.

- 74° @ 10%

REV.	DATE	DESCRIPTION	DRAWN BY	REV. BY
SCALE: AS SHOWN		PROJECT NO.: 883-7108	TASK NO.: 218	
DES. BY: PER		PROJECT: LHL/PIT & LANDFILL COVER/CA		
DRA. BY: PER		REPORT:		
CHK. BY: KGH		SHEET TITLE: PIT & LANDFILL TOP OF COVER GRADING PLAN		
REV. BY: KSD		SHEET: 2 OF 3		
DRAWING NO.		REV.		
2		0		

10/4/87
C-26

C-27
19/45

TR-55 Tc and Tt THRU SUBAREA COMPUTATION

VERSION 1.11

Project : 963-7108.323

User: BAM

Date: 07-05-96

County : SAN JOAQUIN

State: CA

Checked: _____

Date: _____

Subtitle: SIZE EAST DRAINAGE DITCH

Flow Type	2 year rain	Length (ft)	Slope (ft/ft)	Surface code	n	Area (sq/ft)	Wp (ft)	Velocity (ft/sec)	Time (hr)
Sheet	1.5	74	.10	a					0.012
Shallow Concent'd		13	.143	u					0.001
Open Channel		20	.075			.0241.77	4.71		0.001
Open Channel		60	.109			.0194	5.65		0.001
Time of Concentration = 0.01									=====
Open Channel		41	.098			.0241.77	4.71		0.001
Open Channel		262	.065			.0194	5.65		0.005
Travel Time = 0.01*									

0.02

--- Sheet Flow Surface Codes ---

A Smooth Surface	F Grass, Dense	--- Shallow Concentrated ---
B Fallow (No Res.)	G Grass, Burmuda	--- Surface Codes ---
C Cultivated < 20 % Res.	H Woods, Light	P Paved
D Cultivated > 20 % Res.	I Woods, Dense	U Unpaved
E Grass-Range, Short		

SEDCAD+ NONERODIBLE CHANNEL DESIGN

EAST DRAINAGE DITCH

INPUT VALUES:

Shape	TRIANGULAR	
Discharge	4.00 cfs	
Slope	6.50 %	
Sideslopes	1.00:1 (L)	1.00:1 (R)
Manning's n	0.015	
Material	CONCRETE	
Freeboard	1 ft	

RESULTS:

Depth	0.65 ft	
with Freeboard	1.65 ft	OK
Top Width	1.30 ft	
with Freeboard	3.30 ft	
Velocity	9.49 fps	
Cross Sectional Area	0.42 sq ft	
Hydraulic Radius	0.23 ft	
Froude Number	2.94	

A 2-FOOT DEEP V-DITCH WITH 1:1 SIDESLOPES
WILL CONTAIN THE PMP WITH 1-FOOT OF
FREEBOARD.

TR-55 GRAPHICAL DISCHARGE METHOD

VERSION 1.11

C-29
21/45

Project : 963-7108.323

County : SAN JOAQUIN

State: CA

User: BAM

Checked: _____

Date: 07-05-96

Date: _____

Subtitle: SIZE EAST DRAINAGE DITCH

Data: Drainage Area : .55 Acres
 Runoff Curve Number : 80
 Time of Concentration: 0.10 Hours
 Rainfall Type : I
 Pond and Swamp Area : NONE

Storm Number	1	2
Frequency (yrs)	25	1
24-Hr Rainfall (in)	3.03	11.6
Ia/P Ratio	0.17	0.04
Used	0.17	0.10
Runoff (in)	1.27	9.06
Unit Peak Discharge (cfs/acre/in)	0.729	0.787
Pond and Swamp Factor 0.0% Ponds Used	1.00	1.00
Peak Discharge (cfs)	1	4

PIPE CULVERT ANALYSIS
COMPUTATION OF CULVERT PERFORMANCE CURVEAugust 4, 1996
EAST CULVERT - UNDER COVER ACCESS ROAD
1.5-FOOT HELICAL PIPE

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Culvert Diameter (feet).....	1.50
FHWA Chart Number (1,2 or 3).....	2
Scale Number on Chart (Type of Culvert Entrance).....	3
Manning's Roughness Coefficient (n-value).....	0.0150
Entrance Loss Coefficient of Culvert Opening.....	0.50
Culvert Length (feet).....	41.0
Culvert Slope (feet per foot).....	0.0980

PROGRAM RESULTS:

Flow Rate (cfs)	Tailwater Depth (ft)	Headwater (ft) Inlet Control	Headwater (ft) Outlet Control	Normal Depth (ft)	Critical Depth (ft)	Depth at Outlet (ft)	Outlet Velocity (fps)
1.0	0.00	0.51	-3.07	0.19	0.37	0.19	7.55
2.0	0.00	0.76	-2.95	0.27	0.53	0.27	9.30
3.0	0.00	0.98	-2.83	0.33	0.66	0.33	10.47
OK 4.0	0.00	1.19	-2.69	0.38	0.77	0.38	11.38
5.0	0.00	1.39	-2.53	0.43	0.86	0.43	12.13
6.0	0.00	1.58	-2.35	0.47	0.95	0.47	12.80

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A 1.5-FOOT DIAMETER HELICAL PIPE WILL CONVEY
THE PMP. THE ENTRANCE TO THE PIPE WILL BE
A 2.5-FOOT V-DITCH.

PIPE CULVERT ANALYSIS
COMPUTATION OF CULVERT PERFORMANCE CURVE

August 4, 1996
SOUTH EASTERN CULVERT - NEAR MW K6-19
1.5-FOOT HELICAL PIPE

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Culvert Diameter (feet).....	1.50
FHWA Chart Number (1,2 or 3).....	2
Scale Number on Chart (Type of Culvert Entrance).....	3
Manning's Roughness Coefficient (n-value).....	0.0150
Entrance Loss Coefficient of Culvert Opening.....	0.50
Culvert Length (feet).....	30.0
Culvert Slope (feet per foot).....	0.1670

PROGRAM RESULTS:

	Flow Rate (cfs)	Tailwater Depth (ft)	Headwater Inlet Control (ft)	Headwater Outlet Control (ft)	Normal Depth (ft)	Critical Depth (ft)	Depth at Outlet (ft)	Outlet Velocity (fps)
	1.0	0.00	0.50	-4.06	0.17	0.37	0.17	9.09
	2.0	0.00	0.75	-3.95	0.24	0.53	0.24	11.20
	3.0	0.00	0.97	-3.83	0.29	0.66	0.29	12.63
OK	4.0	0.00	1.17	-3.70	0.33	0.77	0.33	13.76
	5.0	0.00	1.37	-3.55	0.37	0.86	0.37	14.65
	6.0	0.00	1.57	-3.39	0.41	0.95	0.41	15.39

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A 1.5-FOOT DIAMETER HELICAL PIPE WILL CONVEY
THE PMP. THE ENTRANCE TO THE PIPE WILL BE A
2.5-FOOT DEEP V-DITCH.

SUBJECT SIZE CULVERT NEAR EP6-08

Job No. 963-7108

Made by BAM

Date 8/6/96

Ref. 1323

Checked

Sheet 24 of 45

Reviewed

BASED ON THE RESULTS OF THE PIPE CULVERT ANALYSIS FOR THE CULVERTS UNDER THE COVER ACCESS ROAD AND TO THE SOUTHEAST NEAR K6-19 AN 18 IN. DIA HELICAL PIPE CULVERT WILL CONVEY THE PMP. THE ENTRANCE TO THE CULVERT WILL BE A 25-FOOT V-DITCH. THE LENGTH OF THE CULVERT WILL BE 20 FEET.

LEGEND:	17 - 10.07
PREVIOUSLY EXISTING FENCELINE		DETAIL/SECTION DESIGNATION
LIMIT OF LANDFILL COVER		DRAWING WHERE SECTION/DETAIL IS LOCATED
EXISTING DITCH FLOWLINE		DRAWING WHERE SECTION/DETAIL IS REFERENCED
DRAINAGE FLOW DIRECTION
LIMITS OF MAGNETIC ANOMALY
AREAS WITH EXISTING UNCOMPACTED FILL TO BE REMOVED AND REPLACED		

NOTES:

- 1) TOPOGRAPHY SUPPLIED BY LAWRENCE LIVERMORE NATIONAL LABORATORY. DATE OF PHOTOGRAPHY _____
- 2) SUBGRADE QUANTITIES:
 PRISMOSOL METHOD—EAGLE POINT PROGRAM
 ORIGINAL SURFACE TOPO
 FINAL SURFACE SURF
 RAW CUT VOLUME 2,888 CY
 RAW FILL VOLUME 8,588 CY
 COVER LIMITS AREA 102,093 SF = 2.34 ACRE
 DISTURBED AREA 138,973 SF = 3.19 ACRE
- 3) WELLS KB-03 AND KB-11 SHALL BE PROTECTED BY PLACEMENT OF A 3 FT. DIA. CONCRETE PIPE SECTION AROUND WELL DURING CONSTRUCTION.

AREA = 0.55 AC.

742 @ 10.0%

20 @ 7.5%

602 @ 10.9%

412 @ 9.8%

262 @ 6.5%

302 @ 16.7%

REV.	DATE	DESCRIPTION	DWN BY	REV BY
SCALE: AS SHOWN		PROJECT NO.: 883-7108	TASK NO.: 230	
DES BY: PER		PROJECT: LNL/PIT 6 LANDFILL COVER/CA		
DWN BY: PER		REPORT:		
CHK BY: KGH		SHEET TITLE: PIT 6 LANDFILL TOP OF COVER GRADING PLAN		
REV BY: XSO		SHEET: 2 OF 2		
LAWRENCE LIVERMORE NATIONAL LABORATORY SITE 300		DRAWING NO.: 2		
		REV: 0		

TR-55 Tc and Tt THRU SUBAREA COMPUTATION

VERSION 1.11

C-34
26/45

Project : 963-7108.326 User: BAM Date: 07-03-96
County : SAN JOAQUIN State: CA Checked: _____ Date: _____
Subtitle: SIZE WEST DRAINAGE DITCH

Flow Type	2 year rain	Length (ft)	Slope (ft/ft)	Surface code	n	Area (sq/ft)	Wp (ft)	Velocity (ft/sec)	Time (hr)
Sheet	1.5	17	.33	E					0.018
Sheet		7	.33	E					0.009
Open Channel		167	.078		.0254		5.65		0.004
Open Channel		108	.046		.0254		5.65		0.003
Time of Concentration =									0.03*

--- Sheet Flow Surface Codes ---

A Smooth Surface	F Grass, Dense	--- Shallow Concentrated ---
B Fallow (No Res.)	G Grass, Burmuda	--- Surface Codes ---
C Cultivated < 20 % Res.	H Woods, Light	P Paved
D Cultivated > 20 % Res.	I Woods, Dense	U Unpaved
E Grass-Range, Short		

* - Generated for use by GRAPHIC method

Project : 963-7108.326
County : SAN JOAQUIN State: CA
Subtitle: SIZE WEST DRAINAGE DITCH

User: BAM
Checked: _____

Date: 07-03-96
Date: _____

Data: Drainage Area : .21 Acres
Runoff Curve Number : 80
Time of Concentration: 0.03 * Hours
Rainfall Type : I
Pond and Swamp Area : NONE

Storm Number	1	2
Frequency (yrs)	25	1
24-Hr Rainfall (in)	3.03	11.6
Ia/P Ratio	0.17	0.04
Used	0.17	0.10
Runoff (in)	1.27	9.06
Unit Peak Discharge (cfs/acre/in)	0.993	1.023
Pond and Swamp Factor 0.0% Ponds Used	1.00	1.00
Peak Discharge (cfs)	0	2

* - Value(s) provided from TR-55 system routines

SEDCAD+ NONERODIBLE CHANNEL DESIGN

WEST DRAINAGE DITCH

INPUT VALUES:

Shape	TRIANGULAR	
Discharge	2.00 cfs	
Slope	7.80 %	
Sideslopes	1.00:1 (L)	1.00:1 (R)
Manning's n	0.015	
Material	CONCRETE	
Freeboard	1 ft	

RESULTS:

Depth	0.48 ft
with Freeboard	1.48 ft
Top Width	0.97 ft
with Freeboard	2.97 ft
Velocity	8.54 fps
Cross Sectional Area	0.23 sq ft
Hydraulic Radius	0.17 ft
Froude Number	3.06

A 2-FOOT U-DITCH WITH 1:1 SIDESLOPES
WILL CONTAIN THE PMP STORM EVENT.

PIPE CULVERT ANALYSIS
COMPUTATION OF CULVERT PERFORMANCE CURVE

August 6, 1996
CULVERT FOR ROAD CROSSING NEAR K6-15
1.0-FOOT HELICAL PIPE

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Culvert Diameter (feet).....	1.00
FHWA Chart Number (1,2 or 3).....	2
Scale Number on Chart (Type of Culvert Entrance).....	3
Manning's Roughness Coefficient (n-value).....	0.0150
Entrance Loss Coefficient of Culvert Opening.....	0.50
Culvert Length (feet).....	20.0
Culvert Slope (feet per foot).....	0.0460

PROGRAM RESULTS:

	Flow Rate (cfs)	Tailwater Depth (ft)	Headwater Inlet Control	Headwater Outlet Control	Normal Depth (ft)	Critical Depth (ft)	Depth at Outlet (ft)	Outlet Velocity (fps)
	1.0	0.00	0.63	-0.15	0.26	0.42	0.26	6.09
OK	2.0	0.00	0.99	0.12	0.38	0.60	0.38	7.41
	3.0	0.00	1.39	0.48	0.47	0.74	0.47	8.23

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A 1-FOOT DIAMETER HELICAL PIPE WILL
CONVEY THE PMP.

TR-55 Tc and Tt THRU SUBAREA COMPUTATION

VERSION 1.11

C-39
31/45

Project : 963-7108.323

County : SAN JOAQUIN

State: CA

User: BAM

Date: 07-05-96

Checked: _____

Date: _____

Subtitle: WEST ACCESS ROAD DRAINAGE V-DITCH

Flow Type	2 year rain	Length (ft)	Slope (ft/ft)	Surface code	n	Area (sq/ft)	Wp (ft)	Velocity (ft/sec)	Time (hr)
Sheet	1.5	14	.5	E					0.013
Open Channel		225	.087		.0254		5.65		0.004
Open Channel		243	.144		.0254		5.65		0.004
Time of Concentration =									0.02*

--- Sheet Flow Surface Codes ---

A Smooth Surface

F Grass, Dense

--- Shallow Concentrated ---

B Fallow (No Res.)

G Grass, Burmuda

--- Surface Codes ---

C Cultivated < 20 % Res.

H Woods, Light

P Paved

D Cultivated > 20 % Res.

I Woods, Dense

U Unpaved

E Grass-Range, Short

* - Generated for use by GRAPHIC method

TR-55 GRAPHICAL DISCHARGE METHOD

VERSION 1.11

C-40
32/45

Project : 963-7108.323
County : SAN JOAQUIN State: CA
Subtitle: WEST ACCESS ROAD DRAINAGE V-DITCH

User: BAM
Checked: _____

Date: 07-05-96
Date: _____

Data: Drainage Area : .58 Acres
Runoff Curve Number : 80
Time of Concentration: 0.02 * Hours
Rainfall Type : I
Pond and Swamp Area : NONE

Storm Number	1	2
Frequency (yrs)	25	1
24-Hr Rainfall (in)	3.03	11.6
Ia/P Ratio	0.17	0.04
Used	0.17	0.10
Runoff (in)	1.27	9.06
Unit Peak Discharge (cfs/acre/in)	1.071	1.081
Pond and Swamp Factor 0.0% Ponds Used	1.00	1.00
Peak Discharge (cfs)	1	6

* - Value(s) provided from TR-55 system routines

C-41
33/45

SEDCAD+ RIPRAP CHANNEL DESIGN

WEST V-DITCH EXTENSION

INPUT VALUES:

Shape	TRIANGULAR	
Discharge	6.00 cfs	
Slope	8.67 %	
Sideslopes (L and R)	1.00:1	1.00:1
Freeboard	1 ft	

RESULTS:

Steep Slope Design - PADER Method

Depth	1.01 ft	
with Freeboard	2.01 ft	OK
Top Width	2.03 ft	
with Freeboard	4.03 ft	
Velocity	5.83 fps	
Cross Sectional Area	1.03 sq ft	
Hydraulic Radius	0.36 ft	
Manning's n	0.038	
Froude Number	1.44	
Dmax	0.313 ft (3.75 in)	
D50	0.250 ft (3.00 in)	
D10	0.083 ft (1.00 in)	

SEDCAD+ RIPRAP CHANNEL DESIGN

WEST V-DITCH EXTENSION

INPUT VALUES:

Shape	TRIANGULAR	
Discharge	6.00 cfs	
Slope	14.40 %	
Sideslopes (L and R)	1.00:1	1.00:1
Freeboard	1 ft	

RESULTS:

Steep Slope Design - PADER Method

Depth	0.96 ft	
with Freeboard	1.96 ft	OK
Top Width	1.92 ft	
with Freeboard	3.92 ft	
Velocity	6.54 fps	
Cross Sectional Area	0.92 sq ft	
Hydraulic Radius	0.34 ft	
Manning's n	0.042	
Froude Number	1.67	
Dmax	0.625 ft (7.50 in)	
D50	0.500 ft (6.00 in)	
D10	0.167 ft (2.00 in)	

A 2-FOOT RIP-RAP LINED V-DITCH WILL
CONTAIN THE PMP WITH 1-FOOT OF FREEBOARD.

WEST V-DITCH EXTENSION

INPUT VALUES:

Shape	TRIANGULAR	
Discharge	6.00 cfs	
Slope	14.40 %	
Sideslopes	1.00:1 (L)	1.00:1 (R)
Manning's n	0.015	
Material	CONCRETE	
Freeboard	1 ft	

RESULTS:

Depth	0.65 ft
with Freeboard	1.65 ft
Top Width	1.30 ft
with Freeboard	3.30 ft
Velocity	14.17 fps
Cross Sectional Area	0.42 sq ft
Hydraulic Radius	0.23 ft
Froude Number	4.37

SEDCAD+ NONERODIBLE CHANNEL DESIGN

WEST V-DITCH EXTENSION

INPUT VALUES:

Shape	TRIANGULAR	
Discharge	6.00 cfs	
Slope	8.67 %	
Sideslopes	1.00:1 (L)	1.00:1 (R)
Manning's n	0.015	
Material	CONCRETE	
Freeboard	1 ft	

RESULTS:

Depth	0.72 ft
with Freeboard	1.72 ft
Top Width	1.43 ft
with Freeboard	3.43 ft
Velocity	11.70 fps
Cross Sectional Area	0.51 sq ft
Hydraulic Radius	0.25 ft
Froude Number	3.45

A 2-FOOT LINED V-DITCH WILL CONVEY THE
PMP WITH 1-FOOT OF FREEBOARD.

C-46
30/45

TR-55 Tc and Tt THRU SUBAREA COMPUTATION

VERSION 1.11

Project : 963-7108.323 User: BAM Date: 07-05-96
County : SAN JOAQUIN State: CA Checked: _____ Date: _____
Subtitle: CULVERT FROM WEST ACCESS ROAD DRAINAGE V-DITCH

SOUTHWEST CORNER OF SITE.

Flow Type	2 year rain	Length (ft)	Slope (ft/ft)	Surface code	n	Area (sq/ft)	Wp (ft)	Velocity (ft/sec)	Time (hr)
Sheet	1.5	14	.5	E					0.013
Open Channel		225	.087		.0254		5.65		0.004
Open Channel		243	.144		.0254		5.65		0.004
Time of Concentration = 0.02*									
=====									

--- Sheet Flow Surface Codes ---

A Smooth Surface	F Grass, Dense	--- Shallow Concentrated ---
B Fallow (No Res.)	G Grass, Burmuda	--- Surface Codes ---
C Cultivated < 20 % Res.	H Woods, Light	P Paved
D Cultivated > 20 % Res.	I Woods, Dense	U Unpaved
E Grass-Range, Short		

* - Generated for use by GRAPHIC method

C-4-
39/45

TR-55 GRAPHICAL DISCHARGE METHOD

VERSION 1.11

Project : 963-7108.323

User: BAM

Date: 07-05-96

County : SAN JOAQUIN

State: CA

Checked: _____

Date: _____

Subtitle: CULVERT FROM WEST ACCESS ROAD DRAINAGE V-DITCH

Data: Drainage Area : 1.17 Acres
Runoff Curve Number : 80
Time of Concentration: 0.02 * Hours
Rainfall Type : I
Pond and Swamp Area : NONE

Storm Number	1	2
Frequency (yrs)	25	1
24-Hr Rainfall (in)	3.03	11.6
Ia/P Ratio	0.17	0.04
Used	0.17	0.10
Runoff (in)	1.27	9.06
Unit Peak Discharge (cfs/acre/in)	1.071	1.081
Pond and Swamp Factor 0.0% Ponds Used	1.00	1.00
Peak Discharge (cfs)	2	11

* - Value(s) provided from TR-55 system routines

PIPE CULVERT ANALYSIS
COMPUTATION OF CULVERT PERFORMANCE CURVEAugust 6, 1996
CULVERT CROSSING ROAD AT SOUTHWEST CORNER OF THE SITE
2.0-FOOT HELICAL PIPE

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Culvert Diameter (feet).....	2.00
FHWA Chart Number (1,2 or 3).....	2
Scale Number on Chart (Type of Culvert Entrance).....	3
Manning's Roughness Coefficient (n-value).....	0.0150
Entrance Loss Coefficient of Culvert Opening.....	0.50
Culvert Length (feet).....	20.0
Culvert Slope (feet per foot).....	0.0200

PROGRAM RESULTS:

	Flow Rate (cfs)	Tailwater Depth (ft)	Headwater (ft) Inlet Control	Headwater (ft) Outlet Control	Normal Depth (ft)	Critical Depth (ft)	Depth at Outlet (ft)	Outlet Velocity (fps)
	6.0	0.00	1.30	1.14	0.63	0.87	0.63	7.04
	8.0	0.00	1.57	1.29	0.74	1.01	0.74	7.63
	10.0	0.00	1.82	1.45	0.83	1.13	0.83	8.10
OK	11.0	0.00	1.95	1.54	0.88	1.19	0.88	8.32
	12.0	0.00	2.08	1.64	0.92	1.24	0.92	8.52
	14.0	0.00	2.33	1.84	1.00	1.35	1.00	8.86

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A 2-FOOT DIAMETER HELICAL PIPE WILL CONVEY
THE PMP STORM EVENT. DEEPEN THE V-DITCH
ENTRANCE TO 3 FEET.

- NOTES:
1) TOPOGRAPHY SUPPLIED BY LAWRENCE LIVERMORE NATIONAL LABORATORY, DRAWING NO. 596010.
2) DRAINAGE FLOW PATHS OFFSET FOR CLARITY.

REV.	DATE	DESCRIPTION	DRAWN BY	REV. BY
SCALE: AS SHOWN		PROJECT NO.: 883-7108	TASK NO.: 10	
DES BY: PEB		PROJECT: LLNL/PIT & LANDFILL COVER/CA		
DWN BY: PEB		REPORT:		
CHK BY: KGH		SHEET TITLE:		
REV BY: KSO		SURFACE WATER CONTROL PLAN		
LAWRENCE LIVERMORE NATIONAL LABORATORY SITE 300		SHEET: 8 OF 8 DRAWING NO.: REV. 0		

CONCEPTUA

SUBJECT CULVERT IN 1:1 V-DITCH DESIGN

Job No. 963-7108

Made by BAM

Date 7/5/96

Ref. TASK 323

Checked

Sheet 42 of 45

Reviewed

SCALE 1" = 1 FT

SUBJECT <u>CULVERT IN A 1:1 V-DITCH DESIGN</u>		
Job No. <u>963-7108</u>	Made by <u>BAM</u>	Date <u>8/1/96</u>
Ref. <u>TASK 323</u>	Checked	Sheet <u>43 of 45</u>
	Reviewed

SUBJECT CULVER IN 2:1 V-DITCH DESIGN

Job No. 963-7108

Made by BAM

Date 8/1/96

Ref. TASK 323

Checked

Sheet 44 of 45

Reviewed

SCALE 1 IN = 2 FT

3.0 FT DEEP TRAPEZOIDAL DITCH WITH A 5 FT.
BOTTOM @ 2:1 SIDESLOPES, RIP-RAP LINED

AC

CONTROL

MARY

- NOTES:
- 1) TOPOGRAPHY SUPPLIED BY LAWRENCE LIVERMORE NATIONAL LABORATORY, DRAWING NO. 596010.
 - 2) DRAINAGE FLOW PATHS OFFSET FOR CLARITY.
 - 3) WELL K8-03 SHALL BE PROTECTED BY PLACEMENT OF A 5 FT. DIA. CONCRETE PIPE SECTION AROUND WELL DURING CONSTRUCTION.

2.0 FT DEEP V-DITCH @ 1:1
SIDESLOPES, CONCRETE LINED

2 FT DEEP
V-DITCH @ 2:1
SIDESLOPES, CONCRETE
LINED

2.5 FT DEEP
V-DITCH @ 2:1
SIDESLOPES, CONCRETE
LINED

PRELIMINARY
CONCEPTUAL

REV.	DATE	DESCRIPTION	DRAWN BY	BY

Golder Associates

SCALE: AS SHOWN PROJECT NO.: 883-7108 TASK NO.: 110
 DCS BY: FEB PROJECT: LLNL/MT 8 LANDFILL COVER/CA

SURFACE WATER CONTROL PLAN

SHEET: 8 OF 8
 DRAWING NO. REV.

LAWRENCE LIVERMORE NATIONAL LABORATORY
 SITE 200

SECTION D

Liner Performance (H.E.L.P.) Calculations

Golder Associates	SUBJECT HELP ANALYSIS FOR PIT 6 LANDFILL COVER		
	Job No. 953-7108	Made by MJJ	Date 8-5-96
	Ref. LLNL/Pit 6 Landfill	Checked	Sheet 1 of 9
	Cover/CA	Reviewed	

OBJECTIVE: To simulate the infiltration through the low permeability layer in the landfill cover at the Pit 6 Landfill and to determine the sensitivity of the vegetative cover permeability on the rate of infiltration.

METHODOLOGY:

The Hydrologic Evaluation of Landfill Performance (HELP) program (version 3) will be used to simulate the infiltration through the Geosynthetic Clay Liner (GCL) in the landfill cover system. The HELP model is a quasi-two-dimensional, deterministic, water-routing model for determining water balances.

REFERENCES:

Schroeder, Paul R, et. al "The Hydrologic Evaluation of Landfill Performance (HELP) Model, Version 3" U.S. Army Corps of Engineers, Waterways Experiment Station (WES), September 1994.

Vol 7.3 of Climatedata, Hydrosphere 1996, Boulder, CO

CALCULATIONS:

Selection of Design Parameters

Cover Characteristics

The cover consists of the following layers (Figure 1):

- 24" Vegetative Soil Layer
- Geosynthetic Drainage Layer (0.28 in.)
- Geosynthetic Clay Liner
 - 60 mil. textured HDPE geomembrane
 - 0.18 in. Bentonite clay layer.
- 24" Compacted General Fill

For the purposes of the HELP model the layers of the landfill cover were classified with a hydraulic function as shown below.

Table 1

Cover Layer	Hydraulic Function
24" Vegetative Soil Layer	Vertical Percolation
Geosynthetic Drainage Layer	Lateral Drainage
60 mil. textured HDPE geomembrane	Vertical Barrier Layer
Bentonite clay layer.	Vertical Barrier Layer

The following physical properties were assigned to the cover layers:

Table 2

Base Case Cover Parameters

Cover Layer	Permeability	Porosity	Field Capacity	Wilting Point
	cm/s	vol/vol	vol/vol	vol/vol
24" Vegetative Soil Layer	1.E-3	0.44	0.105	0.0470
Geosynthetic Drainage Layer	1.1	0.85	0.01	0.005
60 mil. textured HDPE geomembrane	2.7E-13	0	0	0
Bentonite clay layer	1E-13	0.75	0.747	0.400

Note: Default soil characteristics were chosen for the soil layers with the exception of the permeability. (Table 3) Permeability values for the Geosynthetics and Bentonite clay layer were obtained from manufacturer's literature. (GSE and Fluid Systems)

1
5 6
TYPICAL COVER SECTION DETAIL

2
5 6
TYPICAL EAST AND WEST COVER TERMINATION DETAIL

D-2
SHEET 20F9
FIGURE 1

PRELIMINARY
CONCEPTUAL

REV.	DATE	DESCRIPTION	DRN BY	DRN BY	
SCALE: AS SHOWN					
SEC					
M/D					
H.C.					
DES BY	BAW				
DR BY	BAW	PROJECT NO. 963-7188	TASK NO. 310		
CHK BY	GBH	PROJECT: LNL/PIT 6 LANDFILL COVER/CA			
APP BY	KSD	REPORT:			
		SHEET TITLE:			
		CLOSURE COVER DETAILS			
		LAWRENCE LIVERMORE NATIONAL LABORATORY SITE 300			
		SHEET: 6 OF 6			
		DRAWING NO. 6		REV. 0	

TABLE 3. DEFAULT SOIL, WASTE, AND GEOSYNTHETIC CHARACTERISTICS

Classification			Total Porosity	Field Capacity	Wilting Point	Saturated Hydraulic Conductivity
HELP	USDA	USCS	vol/vol	vol/vol	vol/vol	cm/sec
1	CoS	SP	0.417	0.045	0.018	1.0×10^{-3}
2	S	SW	0.437	0.062	0.024	5.8×10^{-3}
3	FS	SW	0.457	0.083	0.033	3.1×10^{-3}
4	LS	SM	0.437	0.105	0.047	1.7×10^{-3}
5	LFS	SM	0.457	0.131	0.058	1.0×10^{-3}
6	SL	SM	0.453	0.190	0.085	7.2×10^{-4}
7	FSL	SM	0.473	0.222	0.104	5.2×10^{-4}
8	L	ML	0.463	0.232	0.116	3.7×10^{-4}
9	SiL	ML	0.501	0.284	0.135	1.9×10^{-4}
10	SCL	SC	0.398	0.244	0.136	1.2×10^{-4}
11	CL	CL	0.464	0.310	0.187	6.4×10^{-5}
12	SiCL	CL	0.471	0.342	0.210	4.2×10^{-5}
13	SC	SC	0.430	0.321	0.221	3.3×10^{-5}
14	SiC	CH	0.479	0.371	0.251	2.5×10^{-5}
15	C	CH	0.475	0.378	0.265	1.7×10^{-5}
16	Barrier Soil		0.427	0.418	0.367	1.0×10^{-7}
17	Bentonite Mat (0.6 cm)		0.750	0.747	0.400	3.0×10^{-9}
18	Municipal Waste (900 lb/yd ³ or 312 kg/m ³)		0.671	0.292	0.077	1.0×10^{-3}
19	Municipal Waste (channeling and dead zones)		0.168	0.073	0.019	1.0×10^{-3}
20	Drainage Net (0.5 cm)		0.850	0.010	0.005	1.0×10^{-1}
21	Gravel		0.397	0.032	0.013	3.0×10^{-1}
22	L*	ML	0.419	0.307	0.180	1.9×10^{-3}
23	SiL*	ML	0.461	0.360	0.203	9.0×10^{-4}
24	SCL*	SC	0.365	0.305	0.202	2.7×10^{-4}
25	CL*	CL	0.437	0.373	0.266	3.6×10^{-4}
26	SiCL*	CL	0.445	0.393	0.277	1.9×10^{-4}
27	SC*	SC	0.400	0.366	0.288	7.8×10^{-7}
28	SiC*	CH	0.452	0.411	0.311	1.2×10^{-4}
29	C*	CH	0.451	0.419	0.332	6.8×10^{-7}
30	Coal-Burning Electric Plant Fly Ash*		0.541	0.187	0.047	5.0×10^{-5}
31	Coal-Burning Electric Plant Bottom Ash*		0.578	0.076	0.025	4.1×10^{-3}
32	Municipal Incinerator Fly Ash*		0.450	0.116	0.049	1.0×10^{-2}
33	Fine Copper Slag*		0.375	0.055	0.020	4.1×10^{-3}
34	Drainage Net (0.6 cm)		0.850	0.010	0.005	3.3×10^{-1}
35	High Density Polyethylene (HDPE)					2.0×10^{-13}
36	Low Density Polyethylene (LDPE)					4.0×10^{-13}
37	Polyvinyl Chloride (PVC)					2.0×10^{-11}
38	Butyl Rubber					1.0×10^{-12}
39	Chlorinated Polyethylene (CPE)					4.0×10^{-12}
40	Hypalon or Chlorosulfonated Polyethylene (CSPE)					3.0×10^{-12}
41	Ethylene-Propylene Diene Monomer (EPDM)					2.0×10^{-12}
42	Neoprene					3.0×10^{-12}

(concluded)

Golder Associates	SUBJECT HELP ANALYSIS FOR PIT 6 LANDFILL COVER		
	Job No. 953-7108	Made by MJJames	Date 8-5-96
	Ref. LLNL/Pit 6 Landfill	Checked	Sheet 4 of 7
	Cover/CA	Reviewed	

Geomembrane Placement Quality

The 60 mil geomembrane placement quality was assumed to be excellent because of perfect contact with the bentonite layer. The pinhole density of the geomembrane was 0 holes/acre and a installation defect density of 1 hole/acre. The GCL product referenced was "Gundseal" manufactured by GSE.

Climatological Data

Daily rainfall and temperature data for the site between the years 1930 through 1995 was obtained from the Hydrosphere 1996, volume 7.3 of Climatedata which is equivalent to the NCDC Summary of the day.

Table 4 summarizes the annual rainfall data. A statistical analysis was performed on this data to determine the average rainfall year. 1962 was then chosen to represent an average rainfall year and 1983 as chosen because it was the year with highest record rainfall (i.e. greater than Mean + 4 standard deviations). The daily temperature data for 1962 and 1983 were used in the analysis for these years. Since solar radiation data was not available for the site, the data was synthetically generated using the coefficients for Sacramento, California.

General Design and Evaporative Zone Data

A SCS runoff curve number of 60.4 was specified based on a fair stand of grass for a default soil texture of 4. (Table 3 and Figure 2)

The evaporative zone depth of 24 inches was specified based on personal communication with David Dwyer from the Soil Conservation Service, Plant Material Center in Fresno, CA.

One acre of landfill surface area was considered for these calculations.

Figure 2. Relation between SCS Curve Number and Default Soil Texture Number for Various Levels of Vegetation

REF: SCHROEDER ET, AL.

Initial Moisture Content

The initial moisture content of the vegetative soil layer was initialized to near steady-state values by the program.

Table 4 Summary of Annual Rainfall and Statistical Analysis							
Year	Total Rainfall (in)	Year	Total Rainfall (in)	Year	Total Rainfall (in)	Year	Total Rainfall (in)
1931	14.88	1947	8.74	1963	17.3	1979	16.15
1932	7.95	1948	11.33	1964	13.39	1980	13.76
1933	12.35	1949	10.33	1965	13.65	1981	16.88
1934	11.33	1950	21.9	1966	9	1982	25.06
1935	13.06	1951	16.94	1967	18.66	1983	32.37
1936	14.99	1952	22.31	1968	13.76	1984	11.28
1937	21.21	1953	8.19	1969	16.84	1985	10.67
1938	16.15	1954	13.67	1970	19.69	1986	15.28
1939	9.18	1955	17.94	1971	9.08	1987	12.42
1940	21.57	1956	11.26	1972	8.29	1988	8.18
1941	19.47	1957	13.11	1973	15.49	1989	9.34
1942	17.04	1958	18.89	1974	7.68	1990	9.02
1943	11.81	1959	9.39	1975	13.22	1991	12.55
1944	16.14	1960	12.85	1976	6.4	1992	14.33
1945	14.25	1961	10.45	1977	7.49	1993	19.67
1946	9.59	1962	13.85	1978	13.67	1994	9.38
						1995	16.27

Statistical Analysis on Rainfall Data

	Calculated Rainfall		Actual Year	Actual Rainfall	
Average	13.97	in.	1962	13.85	in.
Std. Dev.	4.83	in.			
Max	32.37	in.	1983		
Min.	6.40	in.	1976		
Mean + σ	18.81	in.	1958	18.89	in.
Mean - σ	9.14	in.	1939	9.18	in.
Mean + 2σ	23.64	in.	1982	25.06	in.
Mean + 3σ	26.06	in.	1982	25.06	in.
Mean + 4σ	30.89	in.	1983	32.37	in.

→ Note 1983 rainfall > Mean + 4σ

REFERENCE: DATA FROM HYDROSPHERE 1996, VOLUME 7.3 OF CLIMATEDATA.

Golder Associates	SUBJECT HELP ANALYSIS FOR PIT 6 LANDFILL COVER			
	Job No. 953-7108	Made by M James	Date 8-5-96	
	Ref. LLNL/Pit 6 Landfill	Checked	Sheet 6 of 9	
	Cover/CA	Reviewed		

Modeling Criteria

Base Case

The base case for this analyses is the cover with a vegetative cover permeability of 1E-3 cm/s and the average rainfall year (i.e. 1962)

Sensitivity Analyses

In order to determine the sensitivity of the model the rainfall and the vegetative cover permeability was varied.

The HELP program was run for the following conditions for three consecutive years of rainfall data:

	Vegetative Cover Permeability in cm/s	Rainfall Year	HELP Input File	HELP Output File
Base Case	1.00E-03	1962	MRCRA-3	RCRA3-62
	1.00E-03	1983	MRCRA-3	RCRA3-83
	1.00E-04	1962	MRCRA-4	RCRA4-62
	1.00E-04	1983	MRCRA-4	RCRA4-83

These years were chosen to provide average and maximum values of infiltration that could be expected at the site. Table 5 summarizes the results of these runs. The total infiltration is calculated by using a cover area of 2.7 acres.

RESULTS:

For the base case the the model predicts the average annual infiltration through a cover with a permeability of 1E-3 cm/s to be approximately 0.8 gallons. For the maximum rainfall the modeled infiltration rate increases to approximately 1.2 gallons.

For a vegetative cover with a lower permeability of 1E-4 cm/s and average annual rainfall the predicted infiltration rate is approximately 0.3 gallons which is about half the modeled infiltration rate of the base case.

For the case with a vegetative cover permeability of 1E-4 cm/s and maximum annual rainfall the predicted annual infiltration rate is approximately 0.5 gallons, a decrease of approximately 0.7 gallons from the base case rate of infiltration for the maximum rainfall.

CONCLUSIONS:

As expected the model predicts that the permeability of the vegetative cover controls the rate of infiltration. A decrease in the vegetative cover permeability decreases the rate of infiltration through the low permeability liner system.

Table 5		
Summary of Predicted Infiltration through the Landfill Cover		
Base Case		
Cover Soil Permeability	1.00E-03 cm/s	
Rainfall Year	1962	
Rainfall	13.85 (in)	
Year	Infiltration	Total
1962	(in)	(gal)
Run 1	1.00E-05	0.73
Run 2	1.20E-05	0.88
Run 3	1.00E-05	0.73
Sensitivity Analyses		
Cover Soil Permeability	1.00E-03 cm/s	
Rainfall Year	1983	
Rainfall	32.37 (in)	
Year	Infiltration	Total
1983	(in)	(gal)
Run 1	1.60E-05	1.17
Run 2	1.50E-05	1.10
Run 3	1.60E-05	1.17
Cover Soil Permeability	1.00E-04 cm/s	
Rainfall Year	1962	
Rainfall	13.85 (in)	
Year	Infiltration	Total
1962	(in)	(gal)
Run 1	4.00E-06	0.29
Run 2	4.00E-06	0.29
Run 3	4.00E-06	0.29
Cover Soil Permeability	1.00E-04 cm/s	
Rainfall Year	1983	
Rainfall	32.37 (in)	
Year	Infiltration	Total
1983	(in)	(gal)
Run 1	7.00E-06	0.51
Run 2	7.00E-06	0.51
Run 3	6.00E-06	0.44

TEX-NET® SPECIFICATIONS

GEOCOMPOSITE PROPERTIES				
PROPERTY	TEST	UNITS	MINIMUM²	
			TN3002CN/1120	TN3002CN/1126
Transmissivity ¹ (4,000 psf)	ASTM D 4716	m ² /sec	8 x 10 ⁻⁵	6 x 10 ⁻⁵
Ply Adhesion	ASTM D 413 or F 904	lb/in	2.0	2.0
Tensile Strength (MD)	ASTM D 4632	lbs	535	580
COMPONENT PROPERTIES³				
GEONET	TEST	UNITS	PN 3000 CN	
Polymer Density	ASTM D 1505	g/cm ³	0.94	
Polymer Melt Index (Max)	ASTM D 1238	g/10 min	0.5	
Carbon Black Content	ASTM D 4218	%	2.0	
Thickness	ASTM D 5199	inches	0.200	
Mass Per Unit Area	ASTM D 5261	lbs/ft ²	0.150	
Transmissivity ¹	ASTM D 4716	m ² /sec	1x10 ⁻⁵ @ 4,000 psf	
Tensile Strength	ASTM D 5035	lbs/in	40	
GEOTEXTILE	TEST	UNITS	MINIMUM²	
			1120	1126
Fabric Weight	ASTM D 5261	oz/yd ²	5.7	7.1
Thickness	ASTM D 5199	mils	75	95
Grab Strength	ASTM D 4632	lbs	160	210
Water Flow Rate	ASTM D 4491	gpm/ft ²	130	110
AOS	ASTM D 4751	Sieve Size	70	70
		mm	0.210	0.210

1. Measured using water @ 20° C (68°F) with a gradient of one, between two steel plates, after one hour. Value may vary, based on dimensions of the transmissivity specimen and specific Laboratory.
2. These values represent minimum acceptable test values for a roll as tested according to NSC/FSI's Manufacturing Quality Control Manual. Individual test specimen values are not addressed in this specification.
3. Component properties are tested prior to the lamination process. They cannot be tested on the final product.

GSE GundSeal® Geomembrane Supported Geosynthetic Clay Liner (GCL)

GSE GundSeal composite liner is the only geosynthetic clay liner (GCL) that combines the high swelling and sealing characteristics of bentonite clay with the low permeability of a polyethylene geomembrane. No other single geosynthetic clay liner offers these combined product attributes. **GundSeal** consists of 1 lb/ft² (4.9 kg/m²) of high quality sodium bentonite adhered to a geomembrane. This composite liner allows the installer to conveniently roll out a blanket of clay, replacing or supplementing compacted clay that may be required for liner and cap systems. The polyethylene geomembrane backing for the **GundSeal** GCL is available in thicknesses ranging from 12 mil (0.3 mm) up to 80 mil (2.0 mm) and may be textured for improved slope stability.

Properties of GSE GundSeal GCL Composite

Bentonite Coating, minimum, lb/ft ² (kg/m ²)	GSE QC/QA Procedures	1.0 (4.9) *	4.5 mm thickness
Effective Hydraulic Conductivity: Geomembrane, m/s	ASTM E 96	2.7×10^{-15} **	0.177
Hydraulic Conductivity: Bentonite, m/s	ASTM D 5084 @ 5 psi (34.5 kPa)	1×10^{-10} **	
Hydraulic Conductivity: Overlapped Seam, m/s	ASTM D 5084 @ 5 psi (34.5 kPa)	1×10^{-10} **	
Wet/Dry Cycles, 10 cycles	ASTM D 5084 @ 5 psi (34.5 kPa)	No Effect on Permeability	
Freeze/Thaw Cycles, 4 cycles	ASTM D 5084 @ 5 psi (34.5 kPa)	No Effect on Permeability	
Free Swell, in (mm)	GRI GCL-1	0.4 (10)	
Moisture Content, Bentonite Layer, %	ASTM D 4643	20	

*12% adjusted moisture content

** Test procedures may not provide precise results

Properties of Polyethylene Geomembrane Used in the Production of GSE GundSeal GCL

PROPERTY	TEST METHOD	NOMINAL VALUES				
		Smooth Geomembrane **			Textured Geomembrane **	
Thickness, mils (mm)	ASTM D 751/1593/5199	12 (0.3)	20 (0.5)	60 (1.5)	30 (0.75)	60 (1.5)
Density, g/cc	ASTM D 792/1505	0.946	0.946	0.946	0.946	0.946
Melt Flow Index, g/10 minutes	ASTM D 1238, Cond. 190/2.16	≤1.0	≤1.0	≤1.0	≤1.0	≤1.0
Tensile Properties	ASTM D 638, Type IV					
Strength at Break, lb/in-width (N/mm)	Dumbell, 2 ipm	35 (6)	80 (14)	240 (41)	36 (6)	75 (13)
Strength at Yield, lb/in-width (N/mm)	Gauge lengths per	30 (5.3)	50 (8.8)	150 (26)	69 (12)	138 (24)
Elongation at Break, %	NSF Std. 54	700	700	700	150	150
Elongation at Yield, %		13	13	13	13	13
Tear Resistance, lb (N)	ASTM D 1004	6 (27)	15 (67)	45 (200)	22 (98)	45 (200)
Puncture Resistance, lb (N)	FTMS 101, Method 2065	16 (71)	26 (115)	80(356)	39(174)	80(356)

**Available in thicknesses ranging up to 80 mil (2.0 mm). See specific GSE geomembrane product data sheets for additional information.

Properties of Bentonite Used in the Production of GSE GundSeal GCL

PROPERTY	TEST METHOD	NOMINAL VALUES
Montmorillonite Content, %	X-ray Analysis	90
Moisture Content, %	ASTM D 2216	8.2
Fluid Loss, ml	API Spec 13A, Sec 4	18
Free Swell, ml	USP-NF-XVII (dry)	28
Plate Water Absorption, %	ASTM E 946 (dry)	850
Bulk Density, lb/ft ³ (g/cc)	ASTM B 417	70 (1.1)

Initial Moisture = 0.224 vol / vol

```

*****
*****
**
**
**      HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE
**      HELP MODEL VERSION 3.01      (14 OCTOBER 1994)
**      DEVELOPED BY ENVIRONMENTAL LABORATORY
**      USAE WATERWAYS EXPERIMENT STATION
**      FOR USEPA RISK REDUCTION ENGINEERING LABORATORY
**
*****
*****

```

```

PRECIPITATION DATA FILE:  C:\HELP3\1962.D4
TEMPERATURE DATA FILE:   C:\HELP3\1962.D7
SOLAR RADIATION DATA FILE: C:\HELP3\1962.D13
EVAPOTRANSPIRATION DATA:  C:\HELP3\1962.D11
SOIL AND DESIGN DATA FILE: C:\HELP3\MRCRA-3.D10
OUTPUT DATA FILE:        C:\HELP3\RCRA3-62.OUT

```

```

TIME:  16:23      DATE:   7/ 8/1996

```

```

*****
TITLE:  LLNL Pit 6 Modified RCRA Cover Option  Veg Cover K=1*E-3
*****

```

```

NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
        COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.

```

```

LAYER  1
-----

```

```

      TYPE 1 - VERTICAL PERCOLATION LAYER
      MATERIAL TEXTURE NUMBER  0

```

```

THICKNESS           =      24.00  INCHES
POROSITY             =      0.4370 VOL/VOL
FIELD CAPACITY       =      0.1050 VOL/VOL
WILTING POINT        =      0.0470 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.0668 VOL/VOL
EFFECTIVE SAT. HYD. COND. =  0.100000005000E-02 CM/SEC

```

```

LAYER  2
-----

```

```

      TYPE 2 - LATERAL DRAINAGE LAYER
      MATERIAL TEXTURE NUMBER  0

```

```

THICKNESS           =      0.28  INCHES
POROSITY             =      0.8500 VOL/VOL
FIELD CAPACITY       =      0.0100 VOL/VOL
WILTING POINT        =      0.0050 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.0219 VOL/VOL
EFFECTIVE SAT. HYD. COND. =  1.10000002000      CM/SEC
SLOPE                =      8.00  PERCENT
DRAINAGE LENGTH      =     336.0  FEET

```

LAYER 3

TYPE 4 - FLEXIBLE MEMBRANE LINER

MATERIAL TEXTURE NUMBER 0

THICKNESS	=	0.06	INCHES
POROSITY	=	0.0000	VOL/VOL
FIELD CAPACITY	=	0.0000	VOL/VOL
WILTING POINT	=	0.0000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0000	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.270000005000E-12	CM/SEC
FML PINHOLE DENSITY	=	0.00	HOLES/ACRE
FML INSTALLATION DEFECTS	=	1.00	HOLES/ACRE
FML PLACEMENT QUALITY	=	2	- EXCELLENT

LAYER 4

TYPE 3 - BARRIER SOIL LINER

MATERIAL TEXTURE NUMBER 0

THICKNESS	=	0.18	INCHES
POROSITY	=	0.7500	VOL/VOL
FIELD CAPACITY	=	0.7470	VOL/VOL
WILTING POINT	=	0.4000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.7500	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.100000001000E-09	CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS USER-SPECIFIED.

SCS RUNOFF CURVE NUMBER	=	60.40	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.000	ACRES
EVAPORATIVE ZONE DEPTH	=	24.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	1.602	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	10.488	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	1.128	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	1.741	INCHES
TOTAL INITIAL WATER	=	1.741	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
SACRAMENTO CALIFORNIA

MAXIMUM LEAF AREA INDEX	=	3.00
START OF GROWING SEASON (JULIAN DATE)	=	73
END OF GROWING SEASON (JULIAN DATE)	=	319
AVERAGE ANNUAL WIND SPEED	=	8.10 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	77.00 %

AVERAGE 2ND QUARTER RELATIVE HUMIDITY = 60.00 %
 AVERAGE 3RD QUARTER RELATIVE HUMIDITY = 55.00 %
 AVERAGE 4TH QUARTER RELATIVE HUMIDITY = 73.00 %

NOTE: PRECIPITATION DATA FOR LIVERMORE CA
 WAS ENTERED FROM AN ASCII DATA FILE.

NOTE: TEMPERATURE DATA FOR LIVERMORE CA
 WAS ENTERED FROM AN ASCII DATA FILE.

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
 COEFFICIENTS FOR SACRAMENTO CALIFORNIA

STATION LATITUDE = 37.40 DEGREES

MONTHLY TOTALS (IN INCHES) FOR YEAR 1962

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	0.73 0.00	5.61 0.00	1.82 0.00	0.22 3.64	0.00 0.28	0.00 1.55
RUNOFF	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	0.083 0.002	1.009 0.002	0.159 0.000	0.046 0.767	0.002 0.010	0.002 0.080
LATERAL DRAINAGE COLLECTED FROM LAYER 2	0.6109 0.0218	4.5440 0.0149	1.7203 0.0097	0.1483 2.7836	0.1311 0.1337	0.0363 1.5309
PERCOLATION THROUGH LAYER 4	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON LAYER 4	0.013 0.000	0.624 0.000	0.058 0.000	0.003 0.648	0.003 0.003	0.001 0.134
STD. DEVIATION OF DAILY HEAD ON LAYER 4	0.026 0.000	1.151 0.000	0.158 0.000	0.002 1.518	0.002 0.003	0.000 0.454

ANNUAL TOTALS FOR YEAR 1962

	INCHES	CU. FEET	PERCENT
PRECIPITATION	13.85	50275.508	100.00

RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	2.163	7851.153	15.62
DRAINAGE COLLECTED FROM LAYER 2	11.6855	42418.352	84.37
PERC./LEAKAGE THROUGH LAYER 4	0.000010	0.035	0.00
AVG. HEAD ON TOP OF LAYER 4	0.1240		
CHANGE IN WATER STORAGE	0.002	5.972	0.01
SOIL WATER AT START OF YEAR	1.741	6320.499	
SOIL WATER AT END OF YEAR	1.743	6326.470	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.003	0.00

MONTHLY TOTALS (IN INCHES) FOR YEAR 1962

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
	-----	-----	-----	-----	-----	-----
PRECIPITATION	0.73 0.00	5.61 0.00	1.82 0.00	0.22 3.64	0.00 0.28	0.00 1.55
RUNOFF	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	0.034 0.002	0.434 0.002	0.174 0.000	0.049 0.747	0.002 0.016	0.002 0.084
LATERAL DRAINAGE COLLECTED FROM LAYER 2	0.6825 0.0218	5.1030 0.0149	1.7028 0.0096	0.1459 2.7746	0.1293 0.1487	0.0362 1.5349
PERCOLATION THROUGH LAYER 4	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON LAYER 4	0.015 0.000	1.104 0.000	0.053 0.000	0.003 0.649	0.003 0.003	0.001 0.123
STD. DEVIATION OF DAILY HEAD ON LAYER 4	0.035 0.000	1.516 0.000	0.135 0.000	0.002 1.513	0.002 0.003	0.000 0.411

ANNUAL TOTALS FOR YEAR 1962

	INCHES	CU. FEET	PERCENT
PRECIPITATION	13.85	50275.508	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	1.546	5610.905	11.16
DRAINAGE COLLECTED FROM LAYER 2	12.3043	44664.602	88.84
PERC./LEAKAGE THROUGH LAYER 4	0.000012	0.042	0.00
AVG. HEAD ON TOP OF LAYER 4	0.1629		
CHANGE IN WATER STORAGE	0.000	-0.047	0.00
SOIL WATER AT START OF YEAR	1.743	6326.470	
SOIL WATER AT END OF YEAR	1.743	6326.423	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.008	0.00

MONTHLY TOTALS (IN INCHES) FOR YEAR 1962

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	0.73 0.00	5.61 0.00	1.82 0.00	0.22 3.64	0.00 0.28	0.00 1.55
RUNOFF	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	0.034 0.002	0.985 0.002	0.180 0.000	0.045 0.719	0.002 0.016	0.002 0.084
LATERAL DRAINAGE COLLECTED FROM LAYER 2	0.6826 0.0219	4.5473 0.0149	1.6993 0.0098	0.1446 2.7915	0.1355 0.1554	0.0366 1.5411
PERCOLATION THROUGH LAYER 4	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON LAYER 4	0.015 0.000	0.651 0.000	0.046 0.000	0.003 0.667	0.003 0.004	0.003 0.108
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EVAPOTRANSPIRATION

TOTALS	0.050 0.002	0.809 0.002	0.171 0.000	0.047 0.744	0.002 0.014	0.002 0.082
STD. DEVIATIONS	0.029 0.000	0.325 0.000	0.011 0.000	0.002 0.024	0.000 0.004	0.000 0.002

LATERAL DRAINAGE COLLECTED FROM LAYER 2

TOTALS	0.6587 0.0218	4.7314 0.0149	1.7075 0.0097	0.1463 2.7833	0.1320 0.1459	0.0363 1.5357
STD. DEVIATIONS	0.0414 0.0001	0.3218 0.0000	0.0113 0.0001	0.0019 0.0084	0.0032 0.0111	0.0002 0.0051

PERCOLATION/LEAKAGE THROUGH LAYER 4

TOTALS	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000
STD. DEVIATIONS	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ACROSS LAYER 4

AVERAGES	0.0144 0.0005	0.7931 0.0003	0.0523 0.0002	0.0033 0.6545	0.0029 0.0033	0.0008 0.1216
STD. DEVIATIONS	0.0009 0.0000	0.2698 0.0000	0.0056 0.0000	0.0000 0.0106	0.0001 0.0003	0.0000 0.0130

AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1962 THROUGH 1962

	INCHES		CU. FEET	PERCENT
PRECIPITATION	13.85	(0.003)	50275.5	100.00
RUNOFF	0.000	(0.0000)	0.00	0.000
EVAPOTRANSPIRATION	1.926	(0.3326)	6991.41	13.906
LATERAL DRAINAGE COLLECTED FROM LAYER 2	11.92345	(0.33327)	43282.113	86.08985
PERCOLATION/LEAKAGE THROUGH FROM LAYER 4	0.00001	(0.00000)	0.037	0.00007
AVERAGE HEAD ACROSS TOP OF LAYER 4	0.137	(0.022)		

CHANGE IN WATER STORAGE 0.001 (0.0010) 1.95 0.004

PEAK DAILY VALUES FOR YEARS 1962 THROUGH 1962

	(INCHES)	(CU. FT.)
PRECIPITATION	2.17	7877.100
RUNOFF	0.000	0.0000
DRAINAGE COLLECTED FROM LAYER 2	0.41337	1500.52319
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.000001	0.00346
AVERAGE HEAD ACROSS LAYER 4	6.196	
SNOW WATER	0.00	0.0000
MAXIMUM VEG. SOIL WATER (VOL/VOL)		0.1674
MINIMUM VEG. SOIL WATER (VOL/VOL)		0.0595

FINAL WATER STORAGE AT END OF YEAR 1962

LAYER	(INCHES)	(VOL/VOL)
1	1.6040	0.0668
2	0.0060	0.0219
3	0.0000	0.0000
4	0.1328	0.7500
SNOW WATER	0.000	


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**
**      HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE
**      HELP MODEL VERSION 3.01   (14 OCTOBER 1994)
**      DEVELOPED BY ENVIRONMENTAL LABORATORY
**      USAE WATERWAYS EXPERIMENT STATION
**      FOR USEPA RISK REDUCTION ENGINEERING LABORATORY
**
*****
*****

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PRECIPITATION DATA FILE:  C:\HELP3\1983.D4
TEMPERATURE DATA FILE:   C:\HELP3\1983.D7
SOLAR RADIATION DATA FILE: C:\HELP3\1983.D13
EVAPOTRANSPIRATION DATA:  C:\HELP3\1983.D11
SOIL AND DESIGN DATA FILE: C:\HELP3\MRCRA-3.D10
OUTPUT DATA FILE:        C:\HELP3\rcra3-83.OUT

```

TIME: 15:28 DATE: 7/ 8/1996

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*****
TITLE:  LLNL Pit 6 Modified RCRA Cover Option  Veg Cover K=1*E-3
*****

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NOTE: INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.

LAYER 1

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 0

THICKNESS	=	24.00	INCHES
POROSITY	=	0.4370	VOL/VOL
FIELD CAPACITY	=	0.1050	VOL/VOL
WILTING POINT	=	0.0470	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0791	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.100000005000E-02	CM/SEC

LAYER 2

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 0

THICKNESS	=	0.28	INCHES
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POROSITY	=	0.8500	VOL/VOL
FIELD CAPACITY	=	0.0100	VOL/VOL
WILTING POINT	=	0.0050	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.1850	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	1.10000002000	CM/SEC
SLOPE	=	8.00	PERCENT
DRAINAGE LENGTH	=	336.0	FEET

LAYER 3

TYPE 4 - FLEXIBLE MEMBRANE LINER

MATERIAL TEXTURE NUMBER 0

THICKNESS	=	0.06	INCHES
POROSITY	=	0.0000	VOL/VOL
FIELD CAPACITY	=	0.0000	VOL/VOL
WILTING POINT	=	0.0000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0000	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.270000005000E-12	CM/SEC
FML PINHOLE DENSITY	=	0.00	HOLES/ACRE
FML INSTALLATION DEFECTS	=	1.00	HOLES/ACRE
FML PLACEMENT QUALITY	=	2	EXCELLENT

LAYER 4

TYPE 3 - BARRIER SOIL LINER

MATERIAL TEXTURE NUMBER 0

THICKNESS	=	0.18	INCHES
POROSITY	=	0.7500	VOL/VOL
FIELD CAPACITY	=	0.7470	VOL/VOL
WILTING POINT	=	0.4000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.7500	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.100000001000E-09	CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS USER-SPECIFIED.

SCS RUNOFF CURVE NUMBER	=	60.40	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.000	ACRES
EVAPORATIVE ZONE DEPTH	=	24.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	1.899	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	10.488	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	1.128	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	2.082	INCHES
TOTAL INITIAL WATER	=	2.082	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA -----

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
SACRAMENTO CALIFORNIA

MAXIMUM LEAF AREA INDEX = 3.00
 START OF GROWING SEASON (JULIAN DATE) = 73
 END OF GROWING SEASON (JULIAN DATE) = 319
 AVERAGE ANNUAL WIND SPEED = 8.10 MPH
 AVERAGE 1ST QUARTER RELATIVE HUMIDITY = 77.00 %
 AVERAGE 2ND QUARTER RELATIVE HUMIDITY = 60.00 %
 AVERAGE 3RD QUARTER RELATIVE HUMIDITY = 55.00 %
 AVERAGE 4TH QUARTER RELATIVE HUMIDITY = 73.00 %

NOTE: PRECIPITATION DATA FOR LIVERMORE CA
 WAS ENTERED FROM AN ASCII DATA FILE.

NOTE: TEMPERATURE DATA FOR LIVERMORE CA
 WAS ENTERED FROM AN ASCII DATA FILE.

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
 COEFFICIENTS FOR SACRAMENTO CALIFORNIA

STATION LATITUDE = 37.40 DEGREES

MONTHLY TOTALS (IN INCHES) FOR YEAR 1983 -----

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
	-----	-----	-----	-----	-----	-----
PRECIPITATION	6.28 0.00	5.56 0.50	6.14 1.02	3.51 0.27	0.21 5.44	0.00 3.44
RUNOFF	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	0.626 0.023	0.808 0.140	0.788 0.083	0.410 0.098	0.097 1.371	0.022 0.238
LATERAL DRAINAGE COLLECTED FROM LAYER 2	4.8837 0.0309	5.1108 0.1800	5.9618 0.0952	2.3514 0.9295	1.0734 3.9560	0.0500 3.1330
PERCOLATION THROUGH LAYER 4	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES) -----

EVAPOTRANSPIRATION	0.548	0.783	0.764	0.393	0.115	0.019
	0.021	0.108	0.096	0.051	1.453	0.244
LATERAL DRAINAGE COLLECTED FROM LAYER 2	4.8840	5.1734	5.9219	2.3832	1.0512	0.0496
	0.0310	0.2124	0.1545	0.9148	3.7504	3.2481
PERCOLATION THROUGH LAYER 4	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON LAYER 4	0.911	0.573	0.408	0.321	0.057	0.001
	0.001	0.005	0.004	0.053	0.400	0.146
STD. DEVIATION OF DAILY HEAD ON LAYER 4	1.402	0.983	0.673	0.930	0.236	0.000
	0.000	0.007	0.013	0.228	0.995	0.359

ANNUAL TOTALS FOR YEAR 1983

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	32.37	117503.141	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	4.595	16680.973	14.20
DRAINAGE COLLECTED FROM LAYER 2	27.7746	100821.664	85.80
PERC./LEAKAGE THROUGH LAYER 4	0.000015	0.056	0.00
AVG. HEAD ON TOP OF LAYER 4	0.2399		
CHANGE IN WATER STORAGE	0.000	0.381	0.00
SOIL WATER AT START OF YEAR	1.993	7233.484	
SOIL WATER AT END OF YEAR	1.993	7233.865	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.065	0.00

MONTHLY TOTALS (IN INCHES) FOR YEAR 1983

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	6.28 0.00	5.56 0.50	6.14 1.02	3.51 0.27	0.21 5.44	0.00 3.44
RUNOFF	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	0.581 0.018	0.813 0.138	0.555 0.072	0.418 0.055	0.118 1.392	0.016 0.238
LATERAL DRAINAGE COLLECTED FROM LAYER 2	4.8844 0.0292	5.1721 0.1945	6.1031 0.1617	2.3203 0.9310	1.0511 3.9503	0.0488 3.1118
PERCOLATION THROUGH LAYER 4	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON LAYER 4	0.884 0.001	0.687 0.004	0.461 0.006	0.325 0.059	0.057 0.393	0.001 0.121
STD. DEVIATION OF DAILY HEAD ON LAYER 4	1.377 0.000	1.151 0.006	0.721 0.025	0.942 0.261	0.237 0.958	0.000 0.309

ANNUAL TOTALS FOR YEAR 1983

	INCHES	CU. FEET	PERCENT
PRECIPITATION	32.37	117503.141	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	4.412	16015.056	13.63
DRAINAGE COLLECTED FROM LAYER 2	27.9582	101488.211	86.37
PERC./LEAKAGE THROUGH LAYER 4	0.000016	0.058	0.00
AVG. HEAD ON TOP OF LAYER 4	0.2501		
CHANGE IN WATER STORAGE	0.000	-0.212	0.00
SOIL WATER AT START OF YEAR	1.993	7233.865	
SOIL WATER AT END OF YEAR	1.993	7233.653	

SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.024	0.00

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1983 THROUGH 1983

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	6.28 0.00	5.56 0.50	6.14 1.02	3.51 0.27	0.21 5.44	0.00 3.44
STD. DEVIATIONS	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00
RUNOFF						
TOTALS	0.000 0.000	0.000 0.000	0.000 0.000	0.000 0.000	0.000 0.000	0.000 0.000
STD. DEVIATIONS	0.000 0.000	0.000 0.000	0.000 0.000	0.000 0.000	0.000 0.000	0.000 0.000
EVAPOTRANSPIRATION						
TOTALS	0.585 0.021	0.802 0.128	0.702 0.084	0.407 0.068	0.110 1.405	0.019 0.240
STD. DEVIATIONS	0.039 0.003	0.016 0.018	0.128 0.012	0.012 0.026	0.011 0.043	0.003 0.003
LATERAL DRAINAGE COLLECTED FROM LAYER 2						
TOTALS	4.8840 0.0304	5.1521 0.1956	5.9956 0.1371	2.3516 0.9251	1.0586 3.8856	0.0494 3.1643
STD. DEVIATIONS	0.0000 0.0010	0.0358 0.0162	0.0952 0.0365	0.0314 0.0090	0.0129 0.1171	0.0006 0.0734
PERCOLATION/LEAKAGE THROUGH LAYER 4						
TOTALS	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000
STD. DEVIATIONS	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ACROSS LAYER 4

AVERAGES	0.9084	0.6401	0.4327	0.3238	0.0575	0.0011
	0.0007	0.0043	0.0042	0.0482	0.3974	0.1293
STD. DEVIATIONS	0.0229	0.0600	0.0266	0.0022	0.0003	0.0000
	0.0000	0.0004	0.0021	0.0134	0.0039	0.0146

AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1983 THROUGH 1983

	INCHES	CU. FEET	PERCENT
PRECIPITATION	32.37 (0.009)	117503.1	100.00
RUNOFF	0.000 (0.0000)	0.00	0.000
EVAPOTRANSPIRATION	4.570 (0.1476)	16590.32	14.119
LATERAL DRAINAGE COLLECTED FROM LAYER 2	27.82948 (0.11196)	101021.000	85.97302
PERCOLATION/LEAKAGE THROUGH FROM LAYER 4	0.00002 (0.00000)	0.057	0.00005
AVERAGE HEAD ACROSS TOP OF LAYER 4	0.246 (0.005)		
CHANGE IN WATER STORAGE	-0.030 (0.0517)	-108.28	-0.092

PEAK DAILY VALUES FOR YEARS 1983 THROUGH 1983

	(INCHES)	(CU. FT.)
PRECIPITATION	1.62	5880.600
RUNOFF	0.000	0.0000
DRAINAGE COLLECTED FROM LAYER 2	0.41056	1490.32764
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.000001	0.00229
AVERAGE HEAD ACROSS LAYER 4	4.102	
SNOW WATER	0.00	0.0000

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.2008

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.0470

FINAL WATER STORAGE AT END OF YEAR 1983

LAYER	(INCHES)	(VOL/VOL)
1	1.7978	0.0749
2	0.0622	0.2263
3	0.0000	0.0000
4	0.1328	0.7500
SNOW WATER	0.000	


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**
**      HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE
**      HELP MODEL VERSION 3.01   (14 OCTOBER 1994)
**      DEVELOPED BY ENVIRONMENTAL LABORATORY
**      USAE WATERWAYS EXPERIMENT STATION
**      FOR USEPA RISK REDUCTION ENGINEERING LABORATORY
**
*****
*****

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PRECIPITATION DATA FILE:  C:\HELP3\1962.D4
TEMPERATURE DATA FILE:   C:\HELP3\1962.D7
SOLAR RADIATION DATA FILE: C:\HELP3\1962.D13
EVAPOTRANSPIRATION DATA:  C:\HELP3\1962.D11
SOIL AND DESIGN DATA FILE: C:\HELP3\MRCRA-4.D10
OUTPUT DATA FILE:        C:\HELP3\RCRA4-62.OUT

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TIME:  16:13      DATE:   7/ 8/1996

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*****
TITLE:  LLNL Pit 6 Modified RCRA Cover Option  Veg Cover K=1*E-4
*****

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NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
        COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.

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LAYER  1
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          TYPE 1 - VERTICAL PERCOLATION LAYER
          MATERIAL TEXTURE NUMBER  0
THICKNESS           =      24.00  INCHES
POROSITY             =      0.4370 VOL/VOL
FIELD CAPACITY       =      0.1050 VOL/VOL
WILTING POINT       =      0.0470 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.0470 VOL/VOL
EFFECTIVE SAT. HYD. COND. =  0.999999975000E-04 CM/SEC

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LAYER  2
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          TYPE 2 - LATERAL DRAINAGE LAYER
          MATERIAL TEXTURE NUMBER  0
THICKNESS           =      0.28  INCHES
POROSITY             =      0.8500 VOL/VOL
FIELD CAPACITY       =      0.0100 VOL/VOL
WILTING POINT       =      0.0050 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.0100 VOL/VOL
EFFECTIVE SAT. HYD. COND. =  1.10000002000 CM/SEC

```


SLOPE	=	8.00	PERCENT
DRAINAGE LENGTH	=	336.0	FEET

LAYER 3

TYPE 4 - FLEXIBLE MEMBRANE LINER

MATERIAL TEXTURE NUMBER 0

THICKNESS	=	0.06	INCHES
POROSITY	=	0.0000	VOL/VOL
FIELD CAPACITY	=	0.0000	VOL/VOL
WILTING POINT	=	0.0000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0000	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.2700000005000E-12	CM/SEC
FML PINHOLE DENSITY	=	0.00	HOLES/ACRE
FML INSTALLATION DEFECTS	=	1.00	HOLES/ACRE
FML PLACEMENT QUALITY	=	2	EXCELLENT

LAYER 4

TYPE 3 - BARRIER SOIL LINER

MATERIAL TEXTURE NUMBER 0

THICKNESS	=	0.18	INCHES
POROSITY	=	0.7500	VOL/VOL
FIELD CAPACITY	=	0.7470	VOL/VOL
WILTING POINT	=	0.4000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.7500	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.1000000001000E-09	CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS USER-SPECIFIED.

SCS RUNOFF CURVE NUMBER	=	60.40	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.000	ACRES
EVAPORATIVE ZONE DEPTH	=	24.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	1.128	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	10.488	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	1.128	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	1.263	INCHES
TOTAL INITIAL WATER	=	1.263	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
SACRAMENTO CALIFORNIA

MAXIMUM LEAF AREA INDEX	=	3.00
START OF GROWING SEASON (JULIAN DATE)	=	73

END OF GROWING SEASON (JULIAN DATE) = 319
AVERAGE ANNUAL WIND SPEED = 8.10 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY = 77.00 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY = 60.00 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY = 55.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY = 73.00 %

NOTE: PRECIPITATION DATA FOR LIVERMORE CA
WAS ENTERED FROM AN ASCII DATA FILE.

NOTE: TEMPERATURE DATA FOR LIVERMORE CA
WAS ENTERED FROM AN ASCII DATA FILE.

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR SACRAMENTO CALIFORNIA

STATION LATITUDE = 37.40 DEGREES

MONTHLY TOTALS (IN INCHES) FOR YEAR 1962

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	0.73 0.00	5.61 0.00	1.82 0.00	0.22 3.64	0.00 0.28	0.00 1.55
RUNOFF	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	0.209 0.000	1.368 0.000	0.579 0.000	0.102 1.212	0.160 0.118	0.000 0.637
LATERAL DRAINAGE COLLECTED FROM LAYER 2	0.4829 0.0000	4.1142 0.0000	1.3257 0.0000	0.0392 2.3377	0.0008 0.2517	0.0000 0.9130
PERCOLATION THROUGH LAYER 4	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON LAYER 4	0.011 0.000	0.464 0.000	0.029 0.000	0.001 0.188	0.000 0.006	0.000 0.020
STD. DEVIATION OF DAILY HEAD ON LAYER 4	0.031 0.000	1.042 0.000	0.058 0.000	0.003 0.702	0.000 0.015	0.000 0.044

ANNUAL TOTALS FOR YEAR 1962

	INCHES	CU. FEET	PERCENT
PRECIPITATION	13.85	50275.508	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	4.385	15916.777	31.66
DRAINAGE COLLECTED FROM LAYER 2	9.4652	34358.707	68.34
PERC./LEAKAGE THROUGH LAYER 4	0.000004	0.015	0.00
AVG. HEAD ON TOP OF LAYER 4	0.0598		
CHANGE IN WATER STORAGE	0.000	0.000	0.00
SOIL WATER AT START OF YEAR	1.263	4586.498	
SOIL WATER AT END OF YEAR	1.263	4586.498	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.011	0.00

MONTHLY TOTALS (IN INCHES) FOR YEAR 1962

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	0.73 0.00	5.61 0.00	1.82 0.00	0.22 3.64	0.00 0.28	0.00 1.55
RUNOFF	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	0.140 0.000	1.424 0.000	0.579 0.000	0.100 1.264	0.161 0.117	0.000 0.641
LATERAL DRAINAGE COLLECTED FROM LAYER 2	0.5976 0.0000	4.0900 0.0000	1.2487 0.0000	0.0403 2.3383	0.0009 0.1990	0.0000 0.9089
PERCOLATION THROUGH LAYER 4	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	0.013	0.436	0.027	0.001	0.000	0.000
LAYER 4	0.000	0.000	0.000	0.183	0.004	0.020
STD. DEVIATION OF DAILY	0.042	1.000	0.057	0.003	0.000	0.000
HEAD ON LAYER 4	0.000	0.000	0.000	0.695	0.014	0.043

ANNUAL TOTALS FOR YEAR 1962

	INCHES	CU. FEET	PERCENT
PRECIPITATION	13.85	50275.508	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	4.426	16067.097	31.96
DRAINAGE COLLECTED FROM LAYER 2	9.4238	34208.375	68.04
PERC./LEAKAGE THROUGH LAYER 4	0.000004	0.014	0.00
AVG. HEAD ON TOP OF LAYER 4	0.0571		
CHANGE IN WATER STORAGE	0.000	0.000	0.00
SOIL WATER AT START OF YEAR	1.263	4586.498	
SOIL WATER AT END OF YEAR	1.263	4586.498	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.022	0.00

MONTHLY TOTALS (IN INCHES) FOR YEAR 1962

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	0.73 0.00	5.61 0.00	1.82 0.00	0.22 3.64	0.00 0.28	0.00 1.55
RUNOFF	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	0.127 0.000	1.458 0.000	0.569 0.000	0.102 1.206	0.160 0.126	0.000 0.668
LATERAL DRAINAGE COLLECTED	0.6025	4.0765	1.2448	0.0399	0.0009	0.0000

FROM LAYER 2	0.0000	0.0000	0.0000	2.3475	0.2381	0.8820
PERCOLATION THROUGH LAYER 4	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON LAYER 4	0.013	0.477	0.027	0.001	0.000	0.000
	0.000	0.000	0.000	0.203	0.005	0.019
STD. DEVIATION OF DAILY HEAD ON LAYER 4	0.043	1.059	0.056	0.003	0.000	0.000
	0.000	0.000	0.000	0.716	0.014	0.043

ANNUAL TOTALS FOR YEAR 1962

	INCHES	CU. FEET	PERCENT
PRECIPITATION	13.85	50275.508	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	4.418	16036.645	31.90
DRAINAGE COLLECTED FROM LAYER 2	9.4322	34238.836	68.10
PERC./LEAKAGE THROUGH LAYER 4	0.000004	0.015	0.00
AVG. HEAD ON TOP OF LAYER 4	0.0621		
CHANGE IN WATER STORAGE	0.000	0.000	0.00
SOIL WATER AT START OF YEAR	1.263	4586.498	
SOIL WATER AT END OF YEAR	1.263	4586.498	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.012	0.00

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1962 THROUGH 1962

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

TOTALS	0.73 0.00	5.61 0.00	1.82 0.00	0.22 3.64	0.00 0.28	0.00 1.55
STD. DEVIATIONS	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00
RUNOFF						
TOTALS	0.000 0.000	0.000 0.000	0.000 0.000	0.000 0.000	0.000 0.000	0.000 0.000
STD. DEVIATIONS	0.000 0.000	0.000 0.000	0.000 0.000	0.000 0.000	0.000 0.000	0.000 0.000
EVAPOTRANSPIRATION						
TOTALS	0.159 0.000	1.417 0.000	0.576 0.000	0.101 1.227	0.160 0.120	0.000 0.649
STD. DEVIATIONS	0.044 0.000	0.045 0.000	0.005 0.000	0.001 0.032	0.000 0.005	0.000 0.017
LATERAL DRAINAGE COLLECTED FROM LAYER 2						
TOTALS	0.5610 0.0000	4.0936 0.0000	1.2730 0.0000	0.0398 2.3412	0.0008 0.2296	0.0000 0.9013
STD. DEVIATIONS	0.0677 0.0000	0.0192 0.0000	0.0456 0.0000	0.0005 0.0055	0.0000 0.0273	0.0000 0.0168
PERCOLATION/LEAKAGE THROUGH LAYER 4						
TOTALS	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000
STD. DEVIATIONS	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000

 AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ACROSS LAYER 4

AVERAGES	0.0123 0.0000	0.4590 0.0000	0.0278 0.0000	0.0009 0.1913	0.0000 0.0052	0.0000 0.0197
STD. DEVIATIONS	0.0015 0.0000	0.0206 0.0000	0.0010 0.0000	0.0000 0.0103	0.0000 0.0006	0.0000 0.0004

 AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1962 THROUGH 1962

INCHES

CU. FEET

PERCENT

PRECIPITATION	13.85	(0.003)	50275.5	100.00
RUNOFF	0.000	(0.0000)	0.00	0.000
EVAPOTRANSPIRATION	4.410	(0.0219)	16006.84	31.838
LATERAL DRAINAGE COLLECTED FROM LAYER 2	9.44040	(0.02158)	34268.637	68.16170
PERCOLATION/LEAKAGE THROUGH FROM LAYER 4	0.00000	(0.00000)	0.015	0.00003
AVERAGE HEAD ACROSS TOP OF LAYER 4	0.060	(0.003)		
CHANGE IN WATER STORAGE	0.000	(0.0000)	0.00	0.000

PEAK DAILY VALUES FOR YEARS 1962 THROUGH 1962

	(INCHES)	(CU. FT.)
PRECIPITATION	2.17	7877.100
RUNOFF	0.000	0.0000
DRAINAGE COLLECTED FROM LAYER 2	0.40592	1473.48987
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.000001	0.00221
AVERAGE HEAD ACROSS LAYER 4	3.964	
SNOW WATER	0.00	0.0000
MAXIMUM VEG. SOIL WATER (VOL/VOL)		0.1604
MINIMUM VEG. SOIL WATER (VOL/VOL)		0.0439

FINAL WATER STORAGE AT END OF YEAR 1962

LAYER	(INCHES)	(VOL/VOL)
1	1.1280	0.0470
2	0.0027	0.0100
3	0.0000	0.0000
4	0.1328	0.7500
SNOW WATER	0.000	

```

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*****
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**
**      HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE
**      HELP MODEL VERSION 3.01   (14 OCTOBER 1994)
**      DEVELOPED BY ENVIRONMENTAL LABORATORY
**      USAE WATERWAYS EXPERIMENT STATION
**      FOR USEPA RISK REDUCTION ENGINEERING LABORATORY
**
*****
*****

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PRECIPITATION DATA FILE:  C:\HELP3\1983.D4
TEMPERATURE DATA FILE:   C:\HELP3\1983.D7
SOLAR RADIATION DATA FILE: C:\HELP3\1983.D13
EVAPOTRANSPIRATION DATA:  C:\HELP3\1983.D11
SOIL AND DESIGN DATA FILE: C:\HELP3\MRCRA-4.D10
OUTPUT DATA FILE:         C:\HELP3\RCRA4-83.OUT

```

TIME: 14: 9 DATE: 7/ 8/1996

```

*****
TITLE:  LLNL Pit 6 Modified RCRA Cover Option  Veg Cover K=1*E-4
*****

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NOTE: INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.

LAYER 1

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 0

THICKNESS	=	24.00	INCHES
POROSITY	=	0.4370	VOL/VOL
FIELD CAPACITY	=	0.1050	VOL/VOL
WILTING POINT	=	0.0470	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0546	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.999999975000E-04	CM/SEC

LAYER 2

TYPE 2 - LATERAL DRAINAGE LAYER

MATERIAL TEXTURE NUMBER 0

THICKNESS	=	0.28	INCHES
POROSITY	=	0.8500	VOL/VOL
FIELD CAPACITY	=	0.0100	VOL/VOL
WILTING POINT	=	0.0050	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0614	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	1.10000002000	CM/SEC
SLOPE	=	8.00	PERCENT
DRAINAGE LENGTH	=	336.0	FEET

LAYER 3

TYPE 4 - FLEXIBLE MEMBRANE LINER

MATERIAL TEXTURE NUMBER 0

THICKNESS	=	0.06	INCHES
POROSITY	=	0.0000	VOL/VOL
FIELD CAPACITY	=	0.0000	VOL/VOL
WILTING POINT	=	0.0000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0000	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.270000005000E-12	CM/SEC
FML PINHOLE DENSITY	=	0.00	HOLES/ACRE
FML INSTALLATION DEFECTS	=	1.00	HOLES/ACRE
FML PLACEMENT QUALITY	=	2	EXCELLENT

LAYER 4

TYPE 3 - BARRIER SOIL LINER

MATERIAL TEXTURE NUMBER 0

THICKNESS	=	0.18	INCHES
POROSITY	=	0.7500	VOL/VOL
FIELD CAPACITY	=	0.7470	VOL/VOL
WILTING POINT	=	0.4000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.7500	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.100000001000E-09	CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS USER-SPECIFIED.

SCS RUNOFF CURVE NUMBER	=	60.40	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.000	ACRES
EVAPORATIVE ZONE DEPTH	=	24.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	1.310	INCHES

EVAPOTRANSPIRATION	0.858	2.141	3.327	0.975	0.825	0.000
	0.000	0.018	0.006	0.428	1.567	1.019
LATERAL DRAINAGE COLLECTED	3.6444	3.0152	4.4286	2.3847	0.2986	0.0000
FROM LAYER 2	0.0000	0.4816	0.2268	0.3058	3.7657	2.6559
PERCOLATION THROUGH	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
LAYER 4	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	0.466	0.220	0.163	0.054	0.007	0.000
LAYER 4	0.000	0.011	0.005	0.007	0.200	0.058
STD. DEVIATION OF DAILY	1.043	0.613	0.337	0.060	0.018	0.000
HEAD ON LAYER 4	0.000	0.038	0.028	0.014	0.451	0.073

ANNUAL TOTALS FOR YEAR 1983

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	32.37	117503.141	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	11.163	40521.074	34.49
DRAINAGE COLLECTED FROM LAYER 2	21.2074	76982.828	65.52
PERC./LEAKAGE THROUGH LAYER 4	0.000007	0.024	0.00
AVG. HEAD ON TOP OF LAYER 4	0.0991		
CHANGE IN WATER STORAGE	0.000	-0.837	0.00
SOIL WATER AT START OF YEAR	1.460	5298.591	
SOIL WATER AT END OF YEAR	1.459	5297.754	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.045	0.00

MONTHLY TOTALS (IN INCHES) FOR YEAR 1983

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	6.28 0.00	5.56 0.50	6.14 1.02	3.51 0.27	0.21 5.44	0.00 3.44
RUNOFF	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	0.840 0.000	2.262 0.170	3.237 0.060	0.941 0.291	0.685 1.609	0.000 1.104
LATERAL DRAINAGE COLLECTED FROM LAYER 2	3.5798 0.0000	3.6260 0.2768	3.8786 0.2283	2.3661 0.3546	0.4798 3.8521	0.0000 2.3314
PERCOLATION THROUGH LAYER 4	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON LAYER 4	0.284 0.000	0.283 0.006	0.206 0.005	0.053 0.008	0.010 0.333	0.000 0.051
STD. DEVIATION OF DAILY HEAD ON LAYER 4	0.729 0.000	0.756 0.021	0.571 0.028	0.060 0.013	0.025 0.804	0.000 0.064

ANNUAL TOTALS FOR YEAR 1983

	INCHES	CU. FEET	PERCENT
PRECIPITATION	32.37	117503.141	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	11.199	40653.289	34.60
DRAINAGE COLLECTED FROM LAYER 2	20.9736	76134.164	64.79
PERC./LEAKAGE THROUGH LAYER 4	0.000007	0.024	0.00
AVG. HEAD ON TOP OF LAYER 4	0.1034		

CHANGE IN WATER STORAGE	0.197	715.623	0.61
SOIL WATER AT START OF YEAR	1.459	5297.754	
SOIL WATER AT END OF YEAR	1.657	6013.377	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.039	0.00

MONTHLY TOTALS (IN INCHES) FOR YEAR 1983

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	6.28 0.00	5.56 0.50	6.14 1.02	3.51 0.27	0.21 5.44	0.00 3.44
RUNOFF	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	1.050 0.000	2.337 0.022	3.455 0.006	1.022 0.476	0.791 1.508	0.000 0.818
LATERAL DRAINAGE COLLECTED FROM LAYER 2	3.5752 0.0000	3.6019 0.4726	3.6277 0.2267	2.3527 0.4313	0.2856 3.6808	0.0000 2.8271
PERCOLATION THROUGH LAYER 4	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON LAYER 4	0.277 0.000	0.274 0.010	0.178 0.005	0.053 0.009	0.006 0.195	0.000 0.062
STD. DEVIATION OF DAILY HEAD ON LAYER 4	0.717 0.000	0.740 0.037	0.506 0.028	0.061 0.019	0.020 0.486	0.000 0.076

ANNUAL TOTALS FOR YEAR 1983

	INCHES	CU. FEET	PERCENT
PRECIPITATION	32.37	117503.141	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	11.486	41693.336	35.48
DRAINAGE COLLECTED FROM LAYER 2	21.0818	76526.773	65.13
PERC./LEAKAGE THROUGH LAYER 4	0.000006	0.022	0.00
AVG. HEAD ON TOP OF LAYER 4	0.0892		
CHANGE IN WATER STORAGE	-0.198	-717.030	-0.61
SOIL WATER AT START OF YEAR	1.657	6013.377	
SOIL WATER AT END OF YEAR	1.459	5296.347	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.034	0.00

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1983 THROUGH 1983

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	6.28 0.00	5.56 0.50	6.14 1.02	3.51 0.27	0.21 5.44	0.00 3.44
STD. DEVIATIONS	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00
RUNOFF						
TOTALS	0.000 0.000	0.000 0.000	0.000 0.000	0.000 0.000	0.000 0.000	0.000 0.000
STD. DEVIATIONS	0.000 0.000	0.000 0.000	0.000 0.000	0.000 0.000	0.000 0.000	0.000 0.000
EVAPOTRANSPIRATION						

TOTALS	0.916 0.000	2.247 0.070	3.340 0.024	0.979 0.398	0.767 1.561	0.000 0.980
STD. DEVIATIONS	0.116 0.000	0.099 0.086	0.110 0.031	0.040 0.096	0.073 0.051	0.000 0.147

LATERAL DRAINAGE COLLECTED FROM LAYER 2

TOTALS	3.5998 0.0000	3.4144 0.4103	3.9783 0.2273	2.3679 0.3639	0.3547 3.7662	0.0000 2.6048
STD. DEVIATIONS	0.0387 0.0000	0.3459 0.1157	0.4097 0.0009	0.0161 0.0633	0.1085 0.0857	0.0000 0.2518

PERCOLATION/LEAKAGE THROUGH LAYER 4

TOTALS	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000
STD. DEVIATIONS	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ACROSS LAYER 4

AVERAGES	0.3422 0.0000	0.2592 0.0090	0.1823 0.0051	0.0535 0.0080	0.0078 0.2428	0.0000 0.0570
STD. DEVIATIONS	0.1070 0.0000	0.0345 0.0025	0.0219 0.0000	0.0004 0.0014	0.0024 0.0785	0.0000 0.0055

AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1983 THROUGH 1983

	INCHES		CU. FEET	PERCENT
PRECIPITATION	32.37	(0.009)	117503.1	100.00
RUNOFF	0.000	(0.0000)	0.00	0.000
EVAPOTRANSPIRATION	11.283	(0.1769)	40955.90	34.855
LATERAL DRAINAGE COLLECTED FROM LAYER 2	21.08758	(0.11696)	76547.930	65.14543
PERCOLATION/LEAKAGE THROUGH FROM LAYER 4	0.00001	(0.00000)	0.023	0.00002
AVERAGE HEAD ACROSS TOP OF LAYER 4	0.097	(0.007)		

CHANGE IN WATER STORAGE	0.000	(0.1973)	-0.75	-0.001
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PEAK DAILY VALUES FOR YEARS 1983 THROUGH 1983

	(INCHES)	(CU. FT.)
PRECIPITATION	1.62	5880.600
RUNOFF	0.000	0.0000
DRAINAGE COLLECTED FROM LAYER 2	0.40590	1473.41724
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.000001	0.00213
AVERAGE HEAD ACROSS LAYER 4	3.814	
SNOW WATER	0.00	0.0000
MAXIMUM VEG. SOIL WATER (VOL/VOL)		0.2344
MINIMUM VEG. SOIL WATER (VOL/VOL)		0.0438

FINAL WATER STORAGE AT END OF YEAR 1983

LAYER	(INCHES)	(VOL/VOL)
1	1.3095	0.0546
2	0.0168	0.0612
3	0.0000	0.0000
4	0.1328	0.7500
SNOW WATER	0.000	

SECTION E

Seismic Design Calculations

SUBJECT <u>DETERMINE MAX. DISPLACEMENT OF GEOGRID { HDPE BASED ON A 5% STRAIN (ALLOWABLE) }</u>		
Job No. <u>763-7108.210</u>	Made by <u>LSM</u>	Date <u>6/17/96</u>
Ref.	Checked <u>SV 7/3/96</u>	Sheet <u>1</u> of <u>3</u>
	Reviewed <u>KID</u>	

OBJECTIVE :

CALCULATE THE AMOUNT OF DISPLACEMENT THAT WOULD RESULT BASED ON A 5% ALLOWABLE STRAIN FOR THE GEOGRID AND HDPE COMPONENTS OF THE COVER SYSTEM. CHECK AGAINST THE PROBABILITY VS DISPLACEMENT CURVE FOR A 10% PROBABILITY OF EXCEEDENCE AND A 50 YR RETURN PERIOD.

ASSUMPTIONS:

FIXED SYSTEM WITH NO HDPE SLIPPAGE. HDPE WILL NOT RUPTURE UP TO A 10% STRAIN * ASSUME 5% FOR AN ALLOWABLE FACTOR OF SAFETY. (SAME AS FOR TENSION MEMBRANE ANALYSIS).

* NATIONAL SEAL COMPANY REPORTS A YIELD STRAIN OF 13% FOR 60 MIL HDPE GEOMEMBRANE.

E = STRAIN DUE TO DISPLACEMENT

Δ = AMOUNT OF ALLOWABLE DISPLACEMENT

L = WIDTH OF FAULT RUPTURE ZONE

PAGE E-3) BASED ON CONVERSATIONS WITH D. WEST (6/17/96) FROM PREVIOUS FAULT STUDIES NEAR PIT 6 LANDFILL (REF. 0).
TRENCH TR-P6-01 (0+10 TO 0+30) FAULT RUPTURE ZONE OF:
1.4 FT (NARROWEST)
4.5 FT (3 FT DOWN)
13 FT (SHEAR AREA)
TRENCH TR-P6-03 (0+10 TO 0+20), (FURTHER FROM PIT 6 LANDFILL HAD FAULT RUPTURE ZONES BETWEEN:

< 1 FT TO 2 FT

FOR THIS ANALYSIS A 1.5 FT FAULT RUPTURE ZONE IS ASSUMED.

BASED ON A 5% STRAIN (E) AND A 1.5 FT FAULT RUPTURE ZONE THE AMOUNT OF ALLOWABLE DEFORMATION IS:

$$L + E = 18 \text{ IN} (1.05) = 18.90 \text{ IN.}$$

Deformed Length
(5)

ALLOWABLE DISPLACEMENT (Δ):

$$\Delta = \left((L + E)^2 - L^2 \right)^{1/2} = \left((18.9 \text{ IN.})^2 - (18 \text{ IN.})^2 \right)^{1/2} = \underline{\underline{5.76 \text{ IN.}}}$$

Probability vs Vertical Displacement Lawrence Livermore National Laboratory - Pit 6 Landfill

DETERMINE MAX. DISPLACEMENT OF GEOGRID
SUBJECT ~~EMPE~~ BASED ON 5% ALLOWABLE STRAIN

Job No 963-7108.210
Ref.

Made by BAM
Checked 7/3/96
Reviewed KJD

Date 6/17/96
Sheet 3 of 3

BASED ON A 10% PROBABILITY OF EXCEEDENCE
DESIGN LIFE 50 YR
AND A RETURN PERIOD OF 50 YEARS:

MAX. ALLOWABLE VERTICAL
DISPLACEMENT

5.76 IN

10% PROBABILITY
OF EXCEEDENCE FOR
A 50YR RETURN PERIOD
1.8 IN. LIFE (50)

OK

REFERENCE: CARPENTER, D.W., COPELAND, J.R., LAMARRE, A.L.,
MATEIK, R.S., TAFFET, M.J., AND WASE, W.M.,
1991, INVESTIGATION OF HOLOCENE FAULTING
NEAR CLOSED LANDFILL PITS, LAWRENCE
LIVERMORE NATIONAL LABORATORY SITE 300.
LAWRENCE LIVERMORE NATIONAL LABORATORY,
CALIFORNIA (UCRL-ID-106316).

SUBJECT <u>SLIDING DISPLACEMENT FROM SEISMICITY</u>		
Job No. <u>963-710B</u>	Made by <u>BAM</u>	Date <u>6/17/96</u>
Ref.	Checked <u>SV 7/3/96</u>	Sheet <u>1 of 4</u>
	Reviewed <u>/40</u>	

OBJECTIVE : DEVELOP RELATIONSHIP BETWEEN, HDPE FRICTION ANGLE ϕ & SOIL WEIGHT TO CALCULATE THE AMOUNT OF SLIDING DISPLACEMENT DUE TO SEISMICITY USING THE INFINITE SLOPE MODEL.

ASSUMPTIONS : $C = 0$ NO COHESION, AND DRAINED CONDITIONS
 $\phi_{HDPE} = 15^\circ$ (soil against smooth HDPE)

REFERENCE : J.D. BRAY, A.J. AUGELLO, G.A. LEONARDS, P.C., REPETTO, R.J., BYRNE, "SEISMIC STABILITY PROCEDURE FOR SOLID WASTE LANDFILLS, J. GEOTECHNICAL ENG., VOL. 121, NO. 2, PG 139-151, FEBRUARY 19, 1995."

$$\alpha_{max} = 12\% \quad \tan \alpha = \frac{1}{12} \quad \therefore \alpha = 4.76^\circ$$

WHERE :

K = SEISMIC COEFFICIENT = EQUIVALENT APPLIED HORIZONTAL ACCELERATION REQUIRED TO INDUCE PEAK DYNAMIC SHEAR STRESSES REPRESENTATIVE OF THE DESIGN EARTHQUAKE.

$$\sin \alpha = \frac{W_A}{W} \quad \therefore W_A = W \sin \alpha$$

$$\cos \alpha = \frac{W_N}{W} \quad \therefore W_N = W \cos \alpha$$

$$FS = \frac{\text{RESISTING FORCE}}{\text{DRIVING FORCE}} = 1$$

$$\text{SHEAR STRENGTH} = \tau_A = \sigma_A \tan \phi + c \quad \sigma_A = h(W_N - K \sin \alpha)$$

$$\tau_A = h(W_N - K \sin \alpha) \tan \phi$$

$$\tau_A = h \tan \phi (W \cos \alpha - K \sin \alpha)$$

$$\tau_A = W h \tan \phi (\cos \alpha - K \sin \alpha)$$

SUBJECT SLIDING DISPLACEMENT FROM SEISMICITY

Job No. 963-7106
Ref.Made by BAM
Checked SV 7/3/96
Reviewed KSDate 6/20/96
Sheet 2 of 4

$$\text{RESISTING FORCE} = \tau_A/h = w \tan \phi (\cos \alpha - K \sin \alpha)$$

$$\begin{aligned}\text{DRIVING FORCE} &= W_A + K W \cos \alpha \\ &= W \sin \alpha + K W \cos \alpha\end{aligned}$$

$$FS = \frac{w \tan \phi (\cos \alpha - K \sin \alpha)}{w (\sin \alpha + K \cos \alpha)} = 1$$

$$FS = \frac{\tan \phi \cos \alpha - \tan \phi K \sin \alpha}{\sin \alpha + K \cos \alpha} = 1$$

$$\sin \alpha + K \cos \alpha = \cos \alpha \tan \phi - K \sin \alpha \tan \phi$$

$$K \cos \alpha + K \sin \alpha \tan \phi = \cos \alpha \tan \phi - \sin \alpha$$

$$K = \frac{\cos \alpha \tan \phi - \sin \alpha}{\cos \alpha + \sin \alpha \tan \phi}$$

$$K = \frac{(\cos 4.76) \tan 15 - \sin 4.76}{\cos 4.76 + (\sin 4.76) \tan 15}$$

$$K = 0.181 \quad \checkmark \text{SV}$$

SUBJECT <u>SLIDING DISPLACEMENT FROM SEISMICITY</u>		
Job No. <u>963-7108</u>	Made by <u>BAM</u>	Date <u>6/20/96</u>
Ref.	Checked <u>SV 7/3/96</u>	Sheet <u>3</u> of <u>4</u>
	Reviewed <u>LLS</u>	

DETERMINE RATIO OF $\frac{\text{YIELD ACCELERATION}}{\text{PGA}} = R_{K/PGA}$

WHERE YIELD ACCELERATION = K = EQUIVALENT APPLIED HORIZONTAL ACCELERATION REQUIRED TO INDUCE PEAK DYNAMIC SHEAR STRESSES REPRESENTATIVE OF THE DESIGN EARTHQUAKE.

BASE RATIO ON A PEAK GROUND ACCELERATION (PGA) = 0.44g FOR THE PIT 6 LANDFILL SITE (10% PROBABILITY OF EXCEEDENCE IN 50 YEAR LIFE)

$$R_{K/PGA} = \frac{0.181}{0.44} = 0.41$$

See page 4/4

E.G. FOR A $R_{K/PGA} < 0.25$ CAN EXPECT A $\Delta \geq 1.0\text{ FT}$

$$R_{K/PGA} = 0.33 - 0.25 \quad \Delta = 4\text{ IN} - 8\text{ IN.}$$

$$R_{K/PGA} > 0.5 \quad \Delta < 1\text{ IN.} - 2\text{ IN.}$$

WHERE Δ = SLIDING DISPLACEMENT

CAN EXPECT A SLIDING DISPLACEMENT AT PIT 6 LANDFILL BETWEEN 2 IN - 4 IN, WHICH IS LESS THAN THE 6 INCH MAXIMUM AMOUNT OF SLIDING DISPLACEMENT ACCEPTABLE TO MAINTAIN THE INTEGRITY OF THE HDPE GEOMEMBRANE AND GEOGRID REINFORCEMENT. (SEE PAGE E-1)

SV ✓

Probability of Exceedance vs PGA **Lawrence Livermore National Laboratories-Pit 6 Landfill**

4/4
 1

SECTION F

Cover Soil Loss Calculations

1-1

SUBJECT COVER SOIL LOSS CALCULATION		
Job No. 963-7106.	Made by BAM	Date 7/9/96
Ref. LNL/ATG/CA	Checked MJ JAMES	Sheet 1 of 1
	Reviewed /LS	

OBJECTIVE : CALCULATE SOIL LOSS FOR THE PITG LANDFILL CLOSURE COVER.

APPROACH : USE THE UNIVERSAL SOIL LOSS EQUATION

$$A = R * K * LS * C * P$$

WHERE :

A = SOIL LOSS (TONS/ACRE/YR) < 5
R = RAINFALL EROSION INDEX
K = SOIL ERODABILITY FACTOR
LS = SLOPE LENGTH AND STEEPNESS FACTOR
C = VEGETATIVE COVER MANAGEMENT FACTOR
P = EROSION CONTROL PRACTICE FACTOR

ANALYSIS :

VALUES FOR R, C, & P ARE TAKEN FROM THE ALTAMONT LANDFILL PHASE A DESIGN REPORT

R = 25 ✓ BASED ON ALTAMONT DESIGN

K = 0.36 ✓ VERY FINE SAND (EPA, DESIGN AND (2% ORGANICS) CONSTRUCTION OF COVERS FOR SOLID WASTE LANDFILLS, EPA-600/2-79-165, 8/79

C = 0.013 GRASS THAT PROVIDES 80% GROUND COVER.

P = 0.9 SMOOTH TRACK WALKED SLOPES *

LS = 1.8 ✓ BASED ON AN AVERAGE SLOPE OF 8%.

$$A = 25 * 0.36 * 0.013 * 0.9 * 1.8 = 0.20 \text{ TONS/AC/Y.}$$

SOIL LOSS

0.20 < 2 TONS/AC/YR RECOMMENDED BY USEPA

* Schwab, et al, SOIL AND WATER CONSERVATION ENGINEERING, 1955.

SECTION G

Subsurface Drainage Calculations

SUBJECT LLNL / Pit 6

Job No. 963-7108

Made by KAH

Date 7/17/96

Ref.

Checked BAY

Sheet 1 of 8

Reviewed LSO

Subsurface Drainage

Objective: Calculate subsurface drainage requirements for the cover system. Determine capacity required for geocomposite drainage layer and lateral drain pipes

① Geocomposite Drainage Layer:

Assumptions:

a) No ponding on cover surface

b) Veg. cover permeability in the range of 1×10^{-3} to 1×10^{-5} cm/s

Due to relatively flat slopes, minimizing head build up on geomembrane for slope stability is not a concern. However, head build-up should be minimized to improve performance, while keeping overall cost impacts to reasonable levels. With this in mind, the following design criteria was developed:

Design Criteria:

From HELP Model, select average daily infiltration value (I_d) in which less than 10% of days in the year have higher values for the worst precipitation year of record (1983). Using HELP I_d design value, apply a Factor of Safety of 2.0 to geocomposite transmissivity

SUBJECT LLNL / Pit 6

Job No. 963-7108

Ref.

Made by KGH

Checked BAM

Reviewed LFB

Date 7/17/96

Sheet 2 of 8

FROM HELP RUNS:

1983 (> 30" annual precip.)	I_D	No. of Days I exceeds I_D
Veg. Cover ($K = 1 \times 10^{-3}$ cm/s)	0.25 in.	~ 36
Veg. Cover ($K = 1 \times 10^{-4}$ cm/s)	0.25 in.	~ 21

Based on above results, $I_D = 0.25$ in. meets design criteria for a conservatively high veg. cover $K = 1 \times 10^{-3}$ cm/s. Actual K expected to be closer to 1×10^{-4} cm/s.

As a point of comparison, the No. of days of exceedance was evaluated for precipitation recorded during 1958. The annual precipitation total of 18.89 inches for 1958 statistically represents the mean plus one standard deviation ($+1\sigma$) event.

1958 (18.89 in. precip.)	I_D	No. of Days I exceeds I_D
Veg. Cover ($K = 1 \times 10^{-3}$ cm/s)	0.25 in.	~ 22
Veg. Cover ($K = 1 \times 10^{-4}$ cm/s)	0.25 in.	~ 11

Calculate Required Transmissivity

$$T_{req.} = \frac{Q_p \cdot FS}{i} = \frac{I_D \cdot A \cdot FS}{i} \checkmark$$

Q_p = Avg lateral discharge rate

I_D = Design infiltration rate = 0.25 in/day

A = Infiltration Area = Drainage length $\times$ unit width (Drainage length = 320 ft)

FS = Factor of Safety = 2.0 for this case

i = drainage gradient = 0.05 min. (with no head build-up)

SUBJECT

LLNL / P. 7.6

Job No. 963-7108

Made by VGH

Date 7/17/96

Ref.

Checked BAM

Sheet 3 of 8

Reviewed LSO

$$T_{req} = \frac{(0.25 \text{ in/day} \times \frac{1 \text{ day}}{1440 \text{ min}} \times \frac{\text{ft}}{12 \text{ in}}) \times 320 \text{ ft} \times 2.0}{0.05} = 0.185 \frac{\text{ft}^2}{\text{min}} \checkmark$$

$$T_{req} = 0.185 \text{ ft}^2/\text{min per foot of width} = 1.38 \text{ gpm/ft}$$

SAY $T_{req} = 1.4 \text{ gpm/ft}$ for representative normal load conditions (~ 250 to 300 psf)

FROM NSC TECH CENTER (PAGE 8/0) TEX-NET GEOLCOMPOSITE
TN3002-1120 TESTED AT A NORMAL STRESS OF 350 PSF AND A
GRADIENT $i = 0.10$ HAD A TRANSMISSIVITY $= 0.46 \times 10^{-3} \text{ m}^2/\text{s}$

$$T_{i=0.1} = 0.46 \times 10^{-3} \frac{\text{m}^2}{\text{s}} \left(\frac{1 \text{ FT}}{0.3048 \text{ m}} \right)^2 \left(\frac{7.48 \text{ GAL}}{\text{FT}^3} \right) \left(\frac{60 \text{ S}}{\text{MIN}} \right) = 2.2 \frac{\text{GPM}}{\text{FT}} > T_{REQ} \underline{\underline{OK}}$$

CHECK "WORSE" CASE CONDITIONS FOR HEAD BUILD-UP
Re-run HELP for 1983 precip data with $T_a = 0.7 \text{ gpm/ft}$ ($T_a = \frac{T_{req}}{FS=2}$)

$$T_a = 0.7 \text{ gpm/ft} = 1.45 \text{ cm}^2/\text{s} \checkmark$$

For a thickness of 0.28 in.; $K = 2.04 \text{ cm/s} \checkmark$

Note - HELP runs completed previously assumed $K = 1.1 \text{ cm/s}$ & thickness of 0.28 in for drainage layer. For this lower value of K , the peak head is approx. 3.8 in (or less than 4 in). Thus for the above required Transmissivity, the estimated Head build-up would be less according to the HELP Model.

SUBJECT

LLNL / Pit 6

Job No. 963-7109

Made by KAT

Date 7/17/96

Ref.

Checked BAM

Sheet 4 of 8

Reviewed KSO

② Drain Pipes

Assumptions:

a) Area = 2.6 Acres

b) Use $I_0 = 0.4$ in/day - worse case value for 1983

$$Q_{\text{Total}} = I_0 \times \text{Area} = 0.4 \text{ in/day} \times \frac{1 \text{ ft}}{12 \text{ in}} \times \frac{43,560 \text{ ft}^2}{\text{Acre}} \times 2.6 \text{ Acres} = 3,775.2 \frac{\text{ft}^3}{\text{day}} \checkmark$$

$$Q_{\text{Total}} = 3,775 \frac{\text{ft}^3}{\text{day}} = 19.6 \text{ gpm for entire cover system} \checkmark$$

$$Q_{\text{Design}} = Q_{\text{Total}} \times FS = 19.6 \times 2 \approx 40 \text{ gpm} \checkmark$$

From the attached worksheet, a single 4-inch diameter smooth HDPE pipe has a capacity of 69 gpm. (0.15 cfs) $\checkmark$

Conclusion: A single 4-inch diameter or larger pipe works hydraulically with slope $\geq 0.5\%$

8/5

5-5

6/9
9-6

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Circular Channel Analysis & Design
Solved with Manning's Equation

Open Channel - Uniform flow

Worksheet Name: LLNL Pit 6

Comment: LLNL Pit 6 Landfill subdrain

Solve For Full Flow Capacity

Given Input Data:

Diameter.....	0.33 ft
Slope.....	0.0050 ft/ft
Manning's n.....	0.011
Discharge.....	0.15 cfs ✓ ← = 67 gal/min

Computed Results:

Full Flow Capacity.....	0.15 cfs
Full Flow Depth.....	0.33 ft
Velocity.....	1.81 fps
Flow Area.....	0.09 sf
Critical Depth....	0.22 ft
Critical Slope....	0.0079 ft/ft
Percent Full.....	100.00 %
Full Capacity.....	0.15 cfs
QMAX @.94D.....	0.17 cfs
Froude Number.....	FULL

NSC

July 18, 1996

Barry MacDonnel
Golder Associates
Fax: 510-865-9618

Dear Mr. MacDonnel

A search of our files did not reveal any tests run at very low normal stresses on TN3002CN-1120 or TN3002CN-1125. There were however a few tests run TN3002-1120 and TN3002-1125 at low normal stresses. A sample of TN3002-1125 was tested at 500psf and had a transmissivity of $0.42 \times 10^{-3} \text{ m}^2/\text{sec}$ at a gradient of 1.0 and $0.43 \times 10^{-3} \text{ m}^2/\text{sec}$ at a gradient of 0.33. While a sample of TN3002-1120 tested at a normal stress of 350 psf had a transmissivity of $0.46 \times 10^{-3} \text{ m}^2/\text{sec}$ at a gradient of 0.10. I would expect that the geocomposite made with the cap net would have similar results as at the lower stresses the transmissivity of the cap net and the regular net are about the same. I also have included transmissivity charts for TN3002-1125 and TN3002CN-1125 at normal stress between 2000 psf and 20,000 psf.

Sincerely,

Don Cunningham
Research Technician
National Seal Company

SUBJECT STRUCTURAL STABILITY OF HDPE COLLECTOR PIPE		
Job No. 963-7108	Made by BAM	Date 7/22/96
Ref.	Checked C. J. W.	Sheet 1 of 6
	Reviewed /LSO	

OBJECTIVE :

VERIFY THAT A PERFORATED HDPE PIPE WILL RETAIN ITS STRUCTURAL INTEGRITY UNDER THE CONCEPTUAL DESIGN LOADS FOR THE PIT & LAND FILL.

APPROACH :

USE DRISCO PIPE'S DETAILED BURIAL DESIGN FORMULAS TO DESIGN THE COLLECTOR PIPE TO MAINTAIN STRUCTURAL INTEGRITY BY A FACTOR OF SAFETY OF 2.0. CHECK FOR WALL CRUSHING, WALL BUCKLING, AND RING DEFLECTION.

REFERENCE :

"SYSTEMS DESIGN" DRISCO PIPE 1988.
 "DRISCO PIPE 1000", PHILLIPS DRISCO PIPE, INC, 1989.
 "IMPOUNDMENT FACILITIES", EPA/600/2-88/09/88.

ASSUMPTIONS :

WEIGHT OF SOIL AND DRAIN GRAVEL OVER PIPE 125 LB/FT³
 HEIGHT OF SOIL OVER PIPE = 1.5 FT GRAVEL + 4 FT (RAMP)
 WEIGHT OF TRUCK 2.5 TONS.
 HDPE PIPE PERFORATIONS 3/8 IN DIA. HOLE AT 12 IN SPACING HOLES SET AT 120° INTERVAL
 DRISCO PIPE SDR 26.
 MINIMAL WALL THICKNESS = 0.255 INCHES.
 PIPE IS NOT PRESSURIZED

ANALYSIS:

PRESSURE AT TOP OF PIPE (P_t) :

$$\text{PRESSURE OF SOIL AT TOP OF PIPE} = [1.5 \text{ FT (GRAVEL)} + 4 \text{ FT (RAMP)}] 125 \frac{\text{LB}}{\text{FT}^3} = 688 \frac{\text{LB}}{\text{FT}^2}$$

SUBJECT STRUCTURAL STABILITY OF HDPE COLLECTOR PIPE

Job No. 963-7108

Made by BMM

Date 7/22/96

Ref.

Checked CAH

Sheet 2 of 6

Reviewed /LS

ADDITIONAL PRESSURE OF 2.5 TON TRUCK AT TOP OF PIPE:

USING THE 1H:2V METHOD FOR LOAD DISTRIBUTION AND THE TRUCK LOAD IS DISTRIBUTED $\frac{2}{3}$ TO FRONT AXLE AND $\frac{1}{3}$ TO REAR AXLE WITH A TIRE CONTACT AREA OF 6 IN X 8 IN (ASSUME LOAD FROM ONE TIRE ONLY)

RESULTING LOAD DISTRIBUTION AT A 5.5 FT DEPTH IS:

$$\frac{6 \text{ IN}}{12} + 2 \left(\frac{1}{2} 5.5 \text{ FT} \right) = 6 \text{ FT}$$

$$\frac{8 \text{ IN}}{12} + 2 \left(\frac{1}{2} 5.5 \text{ FT} \right) = 6.17 \text{ FT}$$

PRESSURE AT TOP OF PIPE DUE TO TRUCK =

$$\frac{5000 \text{ lbs} \left(\frac{2}{3} \right) \frac{1}{2}}{(6 \text{ FT}) (6.17 \text{ FT})} = 45 \frac{\text{lbs}}{\text{FT}^2}$$

TOTAL PRESSURE AT TOP OF PIPE (TRUCK AND SOIL)

$$45 \frac{\text{lbs}}{\text{FT}^2} + 688 \frac{\text{lb}}{\text{FT}^2} = 733 \frac{\text{lbs}}{\text{FT}^2} \left(\frac{1 \text{ FT}}{12 \text{ IN}} \right)^2 = \underline{\underline{5.1 \text{ PSI}}}$$

SUBJECT STRUCTURAL STABILITY OF HDPE COLLECTOR PIPE

Job No. 963-710B

Ref.

Made by BAM

Checked CAH

Reviewed KD

Date 7/22/96

Sheet 3 of 6

DESIGN BY WALL CRUSHING:

$$S_A = \frac{SDR - 1}{2} (P_t)$$

S_A = ACTUAL COMPRESSIVE STRESS (PSI)

SDR = STANDARD DIMENSION RATIO

P_t = EXTERNAL PRESSURE (PSI)

ADJUSTMENT TO ACCOUNT FOR PERFORATIONS:

$$P_{t \text{ DESIGN}} = \left(\frac{12}{12 - I_p} \right) P_t \quad \text{FROM EPA/600/2-BB/05.}$$

I_p = CUMULATIVE LENGTH IN INCHES OF PERFORATIONS/F

$$I_p = 2 \left(\frac{3}{8} \text{ IN} \right) = 0.75 \text{ IN.}$$

$$P_{t \text{ DESIGN}} = \left(\frac{12}{12 - 0.75} \right) 5.1 \text{ PSI} = 5.44 \text{ PSI.}$$

$$S_A = \frac{26 - 1}{2} (5.44 \text{ PSI}) = 68 \text{ PSI}$$

$$F.S. = \frac{1500 \text{ PSI}}{S_A} = \frac{1500 \text{ PSI}}{68 \text{ PSI}} = \underline{\underline{22 > 2 \text{ OK}}}$$

DESIGN BY WALL BUCKLING:

$$P_{cb} = 0.8 \sqrt{E' \times P_c}$$

P_{cb} = CRITICAL SOIL BUCKLING PRESSURE, PSI

E' = SOIL MODULUS CALCULATED AS THE RATIO OF VERTICAL SOIL PRESSURE TO VERTICAL SOIL STRAIN, PSI

P_c = HYDROSTATIC, CRITICAL-COLLAPSE DIFFERENTIAL PRESSURE, PSI.

SUBJECT STRUCTURAL STABILITY OF HDPE COLLECTOR PIPE

Job No. 963-7108

Made by BAW

Date 7/22/96

Ref.

Checked CAH

Sheet 4 of 6

Reviewed JSD

FROM WALL CRAWLING DESIGN $S_A = 68 \text{ PSI}$ FOR 50 YR
PERIOD USE $S_A = 100 \text{ PSI}$

$E = 33,500 \text{ PSI}$

Chart 25

Time Dependent Modulus of Elasticity for
Polyethylene Pipe vs. Stress Intensity (73.4°F)

NOTE: The short term modulus of elasticity of Driscopipe per ASTM D 638 is approximately 100,000 psi. Due to the cold flow (creep) characteristic of the pipe material, this modulus is dependent upon the stress intensity and the time duration of the applied stress.

FROM DRISCO PIPE'S DESIGN MANUAL.

SUBJECT <u>STRUCTURAL STABILITY OF HDPE COLLECTOR PIPE</u>		
Job No. <u>963-7108</u>	Made by <u>BAM</u>	Date <u>7/22/96</u>
Ref.	Checked <u>CAH</u>	Sheet <u>5</u> of <u>6</u>
	Reviewed <u>LSO</u>	

$$P_c = \frac{2.32 E}{(SDR)^3} = \frac{2.32 (33,500 \text{ PSI})}{(26)^3} = 4.4 \text{ PSI}$$

Chart 26
Plot of Vertical Stress-Strain Data for
Typical Trench Backfill (Except Clay)
from Actual Tests*

EXAMPLE

Find: E' @ 2000 PSF and 80% Density

Formula: $E' = P_t / \epsilon_s$

Calculations: $E' = 2000 \text{ PSF} / .018 = 111111 \text{ PSF} = 771 \text{ psi}$

Note: The curves shown on this chart are sample curves for a granular soil. If other types of soil are used for backfill, such as clay or clay loam, curves should be developed from laboratory test data for the material used. Soil pressures greater than 4000 psi may be examined by extrapolating the slope of the curve or by generating curves by testing at those higher soil pressures. Probable error of curves is about half the distance between adjacent lines.

$$P_{t \text{ DESIGN}} = 5.44 \text{ PSI}$$

$$= 704 \frac{\text{lbs}}{\text{FT}^2}$$

FROM DRISCOLPINE DESIGN MANUAL.

$$E' = \frac{5.44 \text{ PSI}}{0.002} = 2720 \text{ PSI}$$

$$P_{cb} = 0.8 \sqrt{2720 \text{ PSI} \times 4.4 \text{ PSI}} = 87.5 \text{ PSI}$$

$$S.F. = \frac{P_{cb}}{P_{t \text{ DESIGN}}} = \frac{87.5 \text{ PSI}}{5.44 \text{ PSI}} = 16 > 2 \quad \underline{\underline{\text{OK}}}$$

SUBJECT STRUCTURAL STABILITY OF HDPE COLLECTOR PIPE

Job No. 963-710B
Ref.Made by BAY
Checked CAU
Reviewed LSDDate 7/22/96
Sheet 6 of 6DESIGN BY RING DEFLECTION:ASSUME $\epsilon = \epsilon_s = 0.002$

$$\frac{\Delta Y}{D} = (0.25)(\epsilon) SDR$$

$$\frac{\Delta Y}{D} = \text{PERCENT RING DEFLECTION}$$

$$\frac{\Delta Y}{D} = (0.25)(0.002) 26 = 0.013 = 1.3\%$$

FROM DRISCOLL PIPE DESIGN MANUAL

THE ALLOWABLE RING DEFLECTION IS 6.5%

FOR SDR 26

$$1.3\% < 6.5\% \quad \text{OK}$$

A SDR 26 HDPE PIPE WILL
RESIST THE ESTIMATED LOADING

SECTION H

**Construction
Specifications Outline**

SPECIFICATION OUTLINE
for
SITE 300, PIT 6 CLOSURE COVER
LAWRENCE LIVERMORE NATIONAL LABORATORY

DIVISION 1 - GENERAL REQUIREMENTS

<u>Section</u>	<u>Description</u>
01010	Summary of Work
01019	Contract Considerations
01039	Coordination and Meetings
01090	Reference Standards
01150	Measurement and Payment
01300	Submittals (includes SWPPP for Construction Activity Storm Water Permit)
01400	Quality Control
01410	Testing Laboratory Services
01420	Inspection Services
01500	Construction Facilities and Temporary Controls
01501	Health and Safety Provisions
01502	Environmental Protection
01590	Field Offices and Sheds
01600	Material and Equipment
01700	Contract Closout

DIVISION 2 - SITE WORK

<u>Section</u>	<u>Description</u>
02100	Site Preparaton
02105	Erosion Control
02108	Rifle Range Demolition and Debris Disposal
02110	Site Clearing and Grubbing
02211	Rough Grading
02218	Landscape Grading
02220	Excavation
02221	Backfill
02222	Trenching
02229	Vegetative Soil Cover
02231	Aggregate Base Course
02480	Erosion Control Revegetation
02710	Pipe Culverts
02720	Storm Drainage Facilities
02831	Chain Link Fences and Gates

DIVISION 3 - CONCRETE

<u>Section</u>	<u>Description</u>
03100	Concrete Formwork
03200	Concrete Reinforcement
03300	Cast-in-Place Concrete

DIVISION 13 - SPECIAL CONSTRUCTION

<u>Section</u>	<u>Description</u>
13210	Geomembrane
13220	Geotextile
13230	Geonet
13240	Geogrid
13250	Geotextile/Geonet Composite
13260	Geosynthetic Clay Liner

SECTION I

Construction Quality Assurance Plan Outline

CQA PLAN OUTLINE
for
SITE 300, PIT 6 CLOSURE COVER
LAWRENCE LIVERMORE NATIONAL LABORATORY

TEXT

1. INTRODUCTION

2. DESCRIPTION OF PARTIES INVOLVED WITH CONSTRUCTION QUALITY ASSURANCE

- 2.1 Owner
- 2.2 Operator
- 2.3 Regulatory Agencies
- 2.4 Project Manager
- 2.5 General Manager
- 2.6 Design Engineer
- 2.7 Construction Quality Assurance Engineer
 - 2.7.1 CQA Engineer Qualifications
 - 2.7.2 CQA Engineer Duties
- 2.8 Geosynthetics Manufacturer
- 2.9 Geosynthetic Installer
- 2.10 Earthworks Contractor
- 2.11 CQA Surveyor

3. LINES OF COMMUNICATION

4. MEETINGS

- 4.1 Preconstruction Meeting
- 4.2 Resolution Meeting
- 4.3 Progress Meetings
- 4.4 Problem or Work Deficiency Meetings

5. EARTHWORK CONSTRUCTION QUALITY ASSURANCE

- 5.1 Preconstruction Testing
- 5.2 Construction Testing
- 5.3 Construction Monitoring
 - 5.3.1 Subgrade Preparation
 - 5.3.2 Foundation Layer
 - 5.3.3 Vegetative Cover/Rooting Zone Layer Placement and Seeding
 - 5.3.4 Concrete
 - 5.3.5 Drainage Facilities
 - 5.3.6 Miscellaneous Features
- 5.4 CQA Surveying

6. GEOSYNTHETICS CONSTRUCTION QUALITY ASSURANCE

- 6.1 Review Quality Control Submittals
- 6.2 Conformance Testing
- 6.3 Construction Monitoring and Testing
 - 6.3.1 Geomembrane
 - 6.3.2 Geotextile, Geonet, Geocomposite, Geogrid and GCL
 - 6.3.3 Polyethylene Pipe and Fittings

7. DOCUMENTATION

- 7.1 Daily Record Keeping
- 7.2 Soils Observation and Testing Data Sheets
- 7.3 Geosynthetic Observation and Testing Forms
- 7.4 Construction Problem and Resolution Sheets
- 7.5 Photo Documentation
- 7.6 Design and Specification Changes
- 7.7 Weekly Progress Reports
- 7.8 Certification Report

LIST OF TABLES

Table 1	Soil Material Evaluation Testing Frequency
Table 2	Granular Material Evaluation Testing Frequency
Table 3	Soil Construction Testing Frequency

LIST OF APPENDICES

Appendix A	Typical Forms for Soils and Geosynthetic CQA Activities

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