ATTACHMENT D

HELP MODEL OUTPUT FILES

(NOT INCLUDED WITH THIS REPORT - NOT APPLICABLE TO THE SEPARATION LINER)

APPENDIX F

CLASS I WASTE SETTLEMENT

Golder Associates	Kettleman Hills Facility Landfill B-19 Closure Plan Update	
	Proj. No.: 053-1910	Made By: RH
	Date: 04-11-2006	Checked By: SS
	Sheet: 1 of 1	Reviewed By: SS

Objective:

To estimate the Class I waste settlement due to the overlying Class II/III waste in order to evaluate the resulting separation liner elongation and to confirm that positive drainage will be maintained after the settlement has occurred.

Method:

The waste settlement calculations were performed using the method presented in Rust E&I (1997), as described in Attachment A.

Two cross-sections (Sections A and C), which are shown on Sheet Number 1, were analyzed. Section A was located in the same location as the Rust E&I (1997) Section A and Section C was relocated to the north with respect to the Rust E&I (1997) Section C.

Assumptions:

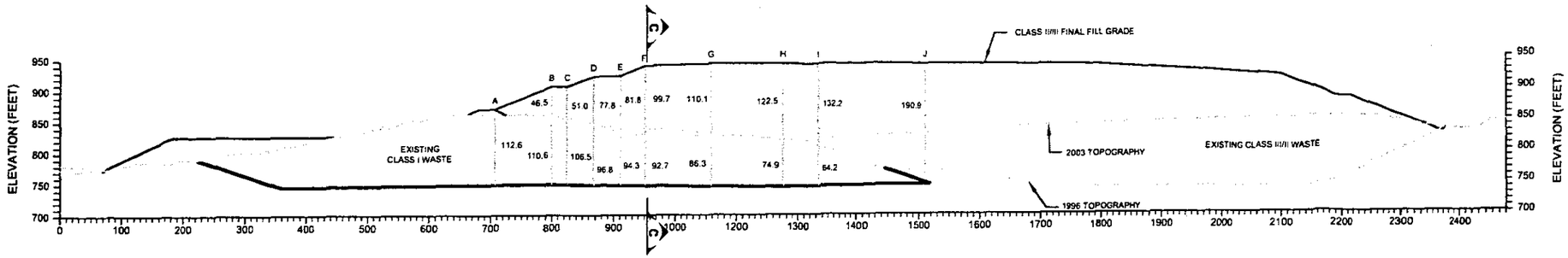
Assumptions made in the evaluation of waste settlement, liner elongation, and post-settlement drainage grades are described in detail in Attachment A. The numerical values assigned to the input parameters of the waste settlement model are shown on Attachment B. Golder was conservative in choosing material properties for the waste since this will render higher waste settlements and, therefore, a worst-case scenario with respect to separation liner elongation and the potential for drainage grades to reverse.

Calculations:

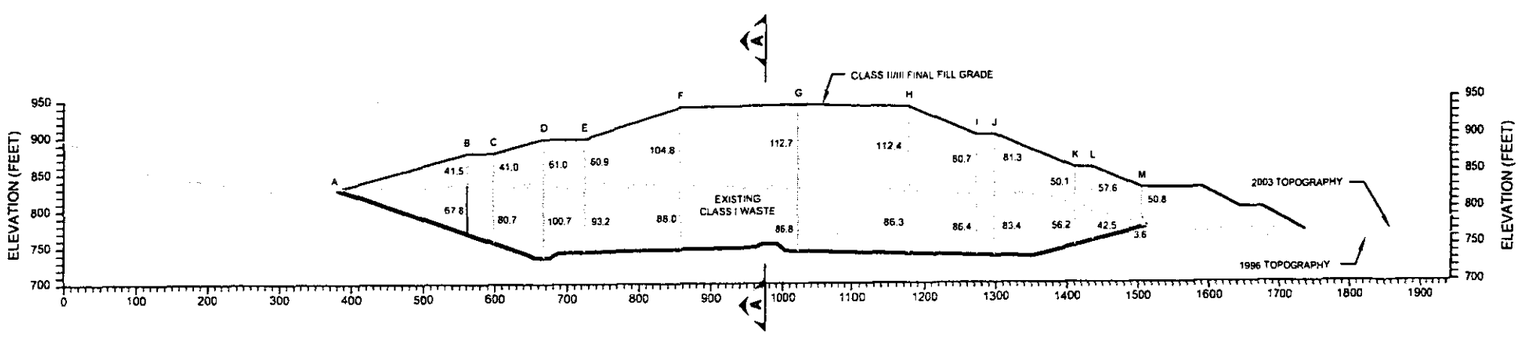
The calculations were performed using a Microsoft Excel® spreadsheet that was programmed with the equations presented in Attachment A. The results of the calculations are presented on the spreadsheet printouts in Attachments B and C.

Summary of Results:

As can be seen in Attachment C, maximum liner elongations of 1.0% and 0.34% are estimated for Sections A and C, respectively. Negative values of liner elongation indicate that tensile stresses will probably not be developed in the liner.
The results shown in Attachment C also indicate that the drainage grades will not be reversed.



A SECTION A
SCALE: 1" = 200'



B SECTION B
SCALE: 1"=200'

SEE SHEET C-4 IN APPENDIX A FOR LOCATIONS.

REV	DATE	DESCRIPTION	DESIGN	DRAWN	REVIEW
A	06-03	ISSUED FOR CLIENT REVIEW	BFM	BFM	SCS

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CHEMICAL WASTE MANAGEMENT
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MODIFIED CLOSURE PLAN FOR B-19 CLASS I LANDFILL

SETTLEMENT CALCULATIONS SECTIONS

SHEET NUMBER
1

Attachment A
page 1/3
(from Rust E&I, 1997)

SETTLEMENT CALCULATIONS

Rust Environment and Infrastructure (Rust E&I) performed an evaluation of potential settlement at the Kettleman Hills Facility B-19 Class I Landfill for 30 years following final placement of the proposed overlying Class II/III refuse. Once settlement was determined, an analysis of the resulting drainage and potential elongation of the Class I geomembrane cover was performed to determine whether the geomembrane could withstand the differential settlement of the landfill. The following information is a summary of the methodologies utilized, findings and conclusions.

GENERAL

For purposes of this analysis, the refuse settlements were anticipated to be caused mainly by the secondary compression of the refuse along with the overburden pressures placed on the refuse from the proposed soil cover. The Class I refuse was assumed to undergo an additional primary settlement during placement of the Class II/III refuse and soil cover, as well as secondary compression beginning at the start of Class II/III refuse placement and continuing for 30 years following final Class II/III refuse placement. A conservative approach to the Class I refuse settlement was used by neglecting the primary and secondary settlement that has already occurred. It was assumed that the bedrock foundation was relatively incompressible, and that any foundation settlement would be fairly uniform, thus not applying any additional differential settlement that may affect the geomembrane separation liner or final cover (see Golder Associates geotechnical report dated 1991).

The methodologies and compression characteristics utilized were generally per *Settlement of Waste Disposal Fills*, George F. Sowers, Proceedings, 8th International Conference on Soil Mechanics and Foundation Engineering, Moscow, U.S.S.R., 1973, pp. 207-210. Additional references were utilized as necessary to determine additional material characteristics.

REFUSE SETTLEMENT

Potential settlement of the Class I refuse consisted of three separate analyses. The initial analysis estimated the primary settlement of the Class I refuse due to the overburden pressures from the Class II/III refuse and the final cover. The second analysis estimated the secondary compression of Class I refuse during the Class II/III filling period, assumed to be 25 years. The final analysis was the estimated secondary compression of the Class I refuse that would occur during the 30 years following final placement of Class II/III refuse. Below is a summary of the methodologies and compression characteristics utilized during analysis.

Primary Settlement. Primary settlements would occur during placement of the Class II/III refuse and the final cover. Settlement was estimated using the one-dimensional consolidation theory:

$$\Delta H = H \times 1/(1+e_o) \times C_c \times \log_{10}(\sigma_f/\sigma_i)$$

where

ΔH = settlement of Class I waste following placement of Class II/III refuse and final cover
H = thickness of Class I refuse along at station (see Figure 1)

e_o = initial void ratio, Class I waste - typically 2 for well compacted fill, 15 for uncompacted fill - use average of 8
C_c = primary compression ratio = 3.5 - for e = 8, (see Figure 2)
$\sigma_f = \sigma_i + \Delta\sigma$ = final overburden pressure placed on Class I waste
$\Delta\sigma$= overburden, Class II/III waste and final cover = h x $\gamma_{II/III}$ + 3.5 x γ_{soil} where 3.5 ft is the anticipated thickness of final cover
σ_i = effective overburden of Class I waste at mid-height of sublayer = H/2 x γ_I
h = height of Class II/III waste above corresponding Class I station
$\gamma_{II/III}$ = density of Class II/III waste = 50 pcf (from 1,350 lb/cy)
γ_{soil} = density of cover soil = 120 pcf (conservative for anticipated cover material)
γ_I = density of Class I waste = 90 pcf (primarily contaminated sandy materials)

Secondary Compression - Class II/III Fill Period. Secondary compression would occur within the Class I material (assumed sandy soil) during placement of the Class II/III refuse and the final cover. Secondary compression is a combination of several factors, including height of waste, length of filling period and suitability of waste for decomposition. Settlement was estimated using the Sowers Method stated above:

$$\Delta H = H \times 1/(1+e_o) \times C_\alpha \times \log_{10}(t_2/t_1)$$

where

ΔH = settlement of Class I waste following placement of Class II/III refuse and final cover
H = thickness of Class I refuse at station (see Figure 1)
e_o = initial void ratio, Class I waste - typically 2 for well compacted fill, 15 for uncompacted fill - use average of 8
C_α = Coefficient of secondary compression = .2 (average between .1 and .3 for relatively new waste, i.e. within the last 20 years)
t_2 = time at end of 25 year Class II/III filling period = 25*12 = 300 mos
t_1 = time beginning Class II/III filling period, after "primary" compression of Class I waste = 1 mo

Secondary Compression - 30 Year Period Following Class II/III Final Placement. Secondary compression would occur within the Class I material (assumed sandy soil) following placement of the Class II/III refuse and the final cover. For this analysis, the settlement of the material during this 30 year period was determined. The same methodology was applied as stated above with the following changes:

t_2 = time throughout and at end of 30 year period - with respect to secondary settlement at start of Class II/III fill, i.e., 30 + 25 years = 55, 55*12 = 660 mos
t_1 = time beginning post closure maintenance period - beginning 1 month after final cover placed, assumed the end of primary settlement within waste pile = 25*12 + 1 = 301 mos

DRAINAGE

Once settlement of the Class I waste fill was determined, the resulting surface slopes were generated

between two consecutive stations. The maximum elevation over the entire surface was identified, and any negative slope (sloping toward the high point) was further analyzed. Slopes were determined by taking the difference between two consecutive station final elevations and dividing by the distance between the stations:

$$\%S = (H_2 - H_1)/L \times 100\%$$

where

$\%S$ = surface slope at end of post closure maintenance period
H_2 = elevation of consecutive point nearest maximum elevation
H_1 = elevation of consecutive point away from maximum elevation
L = distance between H_1 and H_2

GEOMEMBRANE ANALYSIS

The geomembrane was analyzed utilizing differential settlement between two consecutive stations. Once final elevations were known, an analysis of the elongation was performed. The following equation was utilized to determine whether or not there was any anticipated elongation:

$$\%E = (((h_2 - h_1)^2 + L^2)^{1/2} - ((H_2 - H_1)^2 + L^2)^{1/2})/((H_2 - H_1)^2 + L^2)^{1/2} \times 100\%$$

where

$\%E$ = anticipated percent elongation of geomembrane
h_2 = elevation of surface at section, following post closure maintenance period
h_1 = elevation of surface at consecutive section, following post closure maintenance period
L = distance between consecutive points
H_2 = initial elevation of surface at section, beginning post closure maintenance period
H_1 = initial elevation of surface at consecutive section, beginning post closure maintenance period

Negative results for elongation indicate the material may not undergo tensile stresses and thus may not be impacted by the settlement.

RESULTS

The methodologies and compression characteristics stated above were applied to a spreadsheet which provided analysis for all stations and settlement conditions. Sections A and C were utilized for analysis and are included on Figure 1. The settlement results for each settlement type are included, with a summary of results following each Section. These results were determined with the assumptions that the refuse has or will have uniform properties and compression characteristics throughout the entire landfill.

Kettleman Hills Facility Landfill B-19 Closure Plan Update
Class I Waste Settlement - Section A

Material Consolidation Properties

Modified Compression Index, C_{CE}	0.39
Compression Index, C_C	3.5
Secondary Compression Index, C_a	0.2
Modified Secondary Compression Index, C'_a	0.022
Initial Void Ratio, e_0	8
Initial Effective Stress, σ_i	0 psf

Secondary Consolidation Parameters

Time to end of Primary Settlement	0.08 yrs
	1 month
Design Life	25 yrs
Aftercare (period after landfill stops receiving waste	30 yrs

Material Unit Weights

Class III/II Waste	50 pcf
Class I Waste	90 pcf
Final Cover, Foundation and Operations Soils	120 pcf

Section	Depth (ft)					Overburden (psf)	Primary Settlement (ft)	Secondary Settlement (ft)		Total Settlement
	Class I Waste	Foundation	Operations Layer	Class III/II Waste	Final Cover			Pre-Closure	Post-Closure	
A	112.6	2.0	5.0	0.0	3.5	1,260.0	7.38	6.20	0.85	14.43
B	110.6	2.0	2.0	46.5	3.5	3,225.5	13.70	6.09	0.84	20.63
C	106.5	2.0	2.0	51.0	3.5	3,450.5	14.08	5.86	0.81	20.75
D	96.8	2.0	2.0	77.8	3.5	4,790.5	16.42	5.33	0.73	22.49
E	94.3	2.0	2.0	81.8	3.5	4,990.5	16.61	5.19	0.71	22.51
F	92.7	2.0	2.0	99.7	3.5	5,885.5	18.05	5.10	0.70	23.85
G	86.3	2.0	2.0	110.1	3.5	6,403.5	18.25	4.75	0.65	23.65
H	74.9	2.0	2.0	122.5	3.5	7,023.5	17.84	4.12	0.57	22.54
I	64.2	2.0	2.0	132.2	3.5	7,508.5	17.01	3.54	0.49	21.04
J	0.0	2.0	2.0	190.9	3.5	10,446.5	0.00	0.00	0.00	0.00

Attachment B page 1/2

Made By: BM Checked By: [illegible] Reviewed By: [illegible]

Kettleman Hills Facility Landfill B-19 Closure Plan Update
Class I Waste Settlement - Section C

Material Consolidation Properties

Modified Compression Index, C_{CE}	0.39
Compression Index, C_C	3.5
Secondary Compression Index, C_a	0.2
Modified Secondary Compression Index, C'_a	0.022
Initial Void Ratio, e_0	8
Initial Effective Stress, σ_i	0 psf

Secondary Consolidation Parameters

Time to end of Primary Settlement	0.08 yrs
	1 month
Design Life	25 yrs
Aftercare (period after landfill stops receiving wast	30 yrs

Material Unit Weights

Class III/II Waste	50 pcf
Class I Waste	90 pcf
Final Cover Soil	120 pcf

Section	Depth (ft)					Overburden (psf)	Primary Settlement (ft)	Secondary Settlement (ft)		Total Settlement
	Class I Waste	Foundation	Operations Layer	Class III/II Waste	Final Cover			Pre-Closure	Post-Closure	
A	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	0.00	0.00
B	67.8	2.0	2.0	41.5	3.5	2,977.0	10.72	3.73	0.51	14.97
C	80.7	2.0	2.0	41.0	3.5	2,948.5	11.46	4.44	0.61	16.52
D	100.7	2.0	2.0	61.0	3.5	3,949.0	14.93	5.54	0.76	21.24
E	93.2	2.0	2.0	60.9	3.5	3,943.0	14.44	5.13	0.71	20.28
F	88.0	2.0	2.0	104.8	3.5	6,140.8	18.02	4.84	0.67	23.53
G	86.8	2.0	2.0	112.7	3.5	6,532.5	18.49	4.78	0.66	23.93
H	86.1	2.0	2.0	112.4	3.5	6,519.3	18.40	4.74	0.65	23.79
I	83.4	2.0	2.0	80.7	3.5	4,934.3	15.62	4.59	0.63	20.85
J	83.5	2.0	0.0	81.3	0.0	4,303.8	14.48	4.59	0.63	19.71
K	56.2	2.0	0.0	50.1	0.0	2,745.8	9.44	3.09	0.43	12.96
L	42.5	2.0	0.0	57.5	0.0	3,117.3	8.90	2.34	0.32	11.56
M	3.6	2.0	0.0	50.8	0.0	2,781.3	1.91	0.20	0.03	2.14

Attachment B page 2/2

Made By: BM Checked By: [illegible] Reviewed By: [illegible]

Kettleman Hills Facility Landfill B-19 Closure Plan Update
Class I Waste Summary - Section A

Section	Initial Elevation (ft. msl)	Primary Settlement (feet)	Pre-Post Closure Settlement (feet)	Post-Closure Settlement (feet)	Final Elevation (ft. msl)	Distance Between Sections (feet)	Final Slope (%)	Elongation (%)
A	861.49	7.38	6.20	0.85	847.06			
B	860.27	13.70	6.09	0.84	839.64	92.34	8.0%	0.314%
C	855.71	14.08	5.86	0.81	834.96	25.65	18.3%	0.084%
D	845.50	16.42	5.33	0.73	823.01	42.81	27.9%	0.989%
E	842.40	16.61	5.19	0.71	819.89	43.15	7.2%	0.004%
F	840.30	18.05	5.10	0.70	816.45	40.76	8.4%	0.222%
G	832.62	18.25	4.75	0.65	808.97	106.52	7.0%	-0.013%
H	819.67	17.84	4.12	0.57	797.13	116.67	10.1%	-0.101%
I	810.02	17.01	3.54	0.49	788.98	59.12	13.8%	-0.373%
J	750.32	0.00	0.00	0.00	750.32	177.38	21.8%	-2.999%

Attachment C
page 1/2

Made By: BM Checked By:_____ Reviewed By:_____

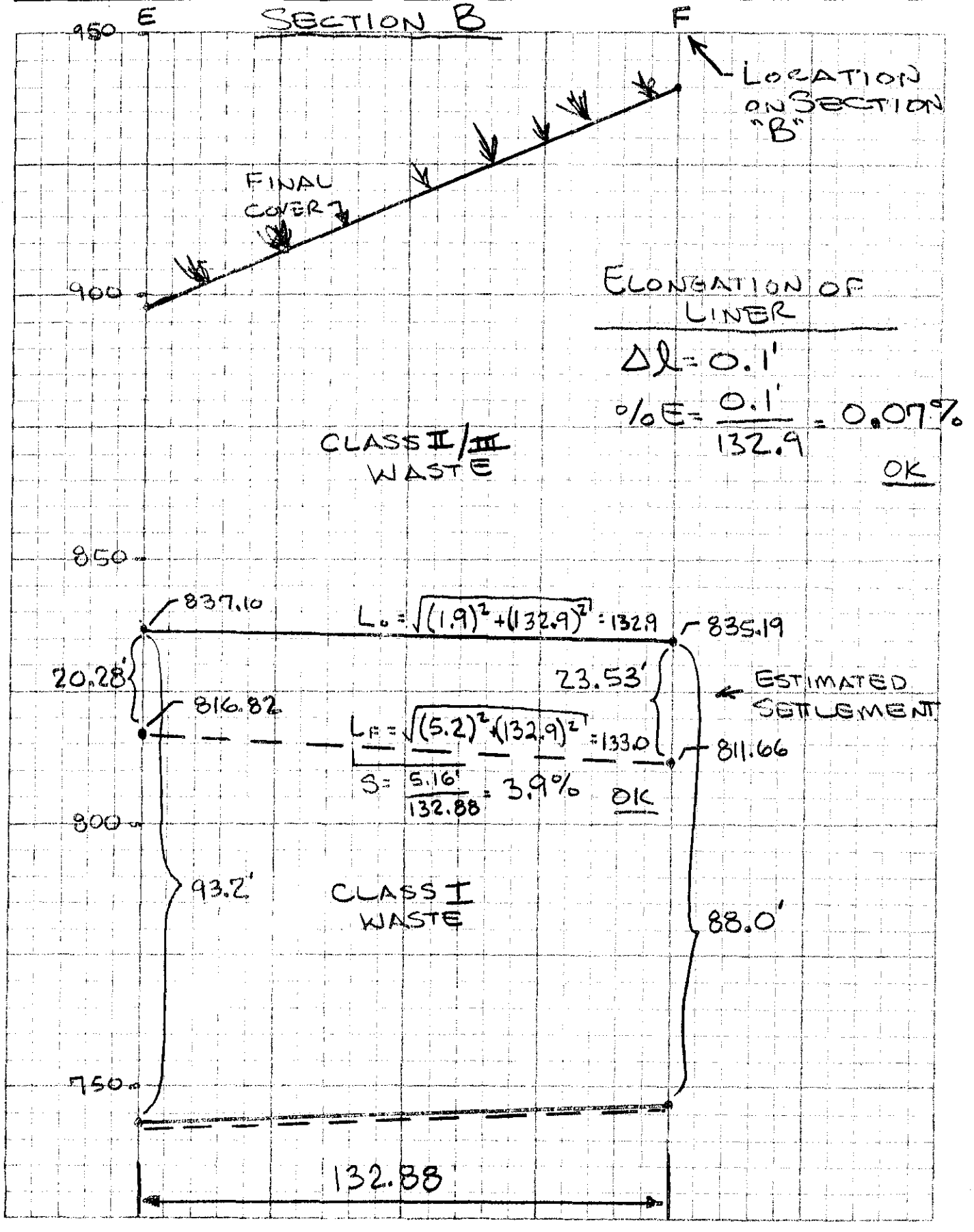
Kettleman Hills Facility Landfill B-19 Closure Plan Update
Class I Waste Summary - Section C

Section	Initial Elevation (ft. msl)	Primary Settlement (feet)	Pre-Post Closure Settlement (feet)	Post-Closure Settlement (feet)	Final Elevation (ft. msl)	Distance Between Sections (feet)	Final Slope (%)	Elongation (%)
A	829.19	1.10	0.10	0.00	827.99			
B	836.60	4.90	1.60	0.20	829.90	45.00	4.2%	-1.240%
C	837.41	6.40	2.60	0.30	828.11	47.00	3.8%	0.058%
D	837.07	7.10	3.50	0.40	826.07	31.00	6.6%	0.210%
E	837.10	14.44	5.13	0.71	816.82	112.00	8.3%	0.340%
F	835.19	18.02	4.84	0.67	811.66	132.88	3.9%	0.065%
G	830.69	18.49	4.78	0.66	806.76	164.99	3.0%	0.007%
H	826.24	18.40	4.74	0.65	802.45	155.15	2.8%	-0.002%
I	820.99	15.62	4.59	0.63	800.14	95.84	2.4%	-0.121%
J	820.39	14.48	4.59	0.63	800.68	25.01	2.2%	-0.006%
K	806.52	9.44	3.09	0.43	793.56	112.88	6.3%	-0.549%
L	799.07	8.90	2.34	0.32	787.51	25.04	24.2%	-1.392%
M	777.78	1.91	0.20	0.03	775.64	70.03	16.9%	-2.961%

Attachment C
Page 2/2

Made By: BM Checked By:_____ Reviewed By:_____

Golder Associates	SUBJECT EXAMPLE SETTLEMENT & STRAIN		
	Job No. 053-1910	Made by	Date 6.18.06
	Ref. KHF B19	Checked	Sheet 1 of 1
		Reviewed	



APPENDIX G

STORMWATER DRAINAGE

KETTLEMAN HILLS FACILITY

SURFACE DRAINAGE ANALYSIS

This drainage analysis was performed in conjunction with the proposed grading and drainage plan for Module B-19 (B-19) at the Kettleman Hills Facility (KHF) in Kings County, California. Module B-19 is a permitted Class I landfill, of which the remaining portion of the landfill is currently operated as a Class III solid waste management unit. The analysis for the B-19 landfill drainage system is designed to meet the Class I criteria under Title ~~27~~, 23 California Code of Regulations (CCR), Section 2546, which meets or exceeds the Class III criteria for precipitation and drainage controls.

Proposed drainage facilities for the entire landfill area are shown on Figure 1, Drainage Map.

Existing Conditions

The B-19 landfill is in the central portion of the KHF. The landfill is divided into three sections, a Class I area at the south, a Control Unit at the middle, and a Bioreactor Unit at the northern portion of the landfill.

Portions of the Class I area have reached final grades. Existing drainage control for the Class I area consist primarily of a drainage bench for conveyance of storm runoff to perimeter ditches and pipe culverts along the southern and eastern perimeter of the landfill.

The remaining portion of the landfill, the Control and Bioreactor units, is active and operated as a ~~Class III~~ CLASS II/III disposal unit. Temporary top deck surfaces of the active area are constructed at minimum two percent (2%) slope to promote drainage. Storm runoff are conveyed through diversion berms and pipe downdrains to drainage ditches along the perimeter of the landfill.

Existing access road and perimeter channels provide protection against inundation and drainage control along the perimeter of the landfill. Collected storm runoff from the B-19 landfill are conveyed through perimeter channels and pipe culverts into the existing East Retention Basin (ERB).

Proposed Final Landfill Grading

The B-19 landfill when fully developed will predominantly have grass-covered slopes and occasional gravel surface on benches and access road. The final landfill sideslopes will be constructed no steeper than 2.5:1 (horizontal to vertical) slope ratio. The top deck will be developed with a final grade of no less than 3 percent to provide sufficient slope for surface runoff. Diversion berms on deck areas and drainage benches on side slopes will be provided to convey runoff to overside drains and drainage ditches along the perimeter of the landfill.

Runoff from B-19 landfill will continue to be routed through the existing ERB located near the southeastern boundary of the landfill.

Design Criteria

The design criteria for the surface drainage analyses are as follows.

Design Storm	
Frequency:	Probable Maximum Precipitation (PMP)
Duration:	24 hours

The following references were used for the drainage analysis.

1. Technical Release 55 (TR-55), *Urban Hydrology for Small Watershed,* developed by the U.S. Soil Conservation Service (SCS).

2. *Flow Master* computer program, developed by Haestad Methods, Inc., Waterbury, Connecticut.

Hydrologic Analysis

The hydrologic analysis used for the B-19 landfill is based on the SCS method. The TR-55 computer program, based on the SCS procedures for estimating runoff and peak discharges in small watershed, was used in this analysis.

Precipitation

Rainfall data from Kettleman Station , the nearest precipitation station to the site, was used for the analysis. The estimated 24-hour, PMP is approximately 7.4 inches, [State of California, Department of Water Resources (DWR), Kettleman Station].

Rainfall Distribution

TR-55 includes four synthetic 24-hour rainfall distributions developed by the NRCS representing various regions of the United States. Based on the geographical location of the site, Type I rainfall distribution was selected for the analysis.

Time of Concentration

The time of concentration (Tc) is the time for runoff to travel from the most hydraulically distant point in a drainage subarea to reach the collection point. Calculation of T_c consists of overland flow or sheet flow, shallow concentrated flow, and open channel flow, or some combination, to the collection point.

Overland flow times were calculated based on the kinematic equation for sheet flow condition. Travel times for shallow concentrated and open channel flows were calculated based on flow velocities obtained from Manning's equation. Data input for the TR-55 computer program are presented in the hydrology calculations.

Hydrologic Soil Group

Selection of runoff CURVE NUMBERS (CNs) are based on the hydrologic soil classification, cover type, hydrologic conditions, and antecedent moisture condition. Based on available soil information, land use, and Type II antecedent moisture condition, the CN values used for the analysis are:

Area Description	Type of Cover	CN
Landfill Top Deck	Fair, grass	84
Landfill Side Slope	Fair, grass	86
Perimeter/Access Road	Gravel	91

Drainage Areas

Tributary areas to drainage diversion berms, downdrains, perimeter ditches, and pipe culverts are divided into subareas as shown on the drainage map. Subareas to drainage facilities are as follows:

Subarea Designation	Drainage Facilities
A1 – A5	Top Deck Drainage Swale, LF Benches, Downdrains, North and East Perimeter Ditches, and Pipe Culvert
B1 – B3	Top Deck Drainage Swale, LF Benches, Downdrains, East Perimeter Ditch, and Pipe Culvert
C1 – C4	West and South Perimeter Ditches, LF Benches, Downdrains, and Pipe Culvert
D1 – D4	LF Benches, Downdrains, South and East Perimeter Ditches, and Pipe Culvert

Hydraulic Analysis

Estimated peak flows obtained from the hydrologic evaluation of drainage subareas were used for designing the proposed stormwater drainage system for the B-19 landfill. Drainage control facilities for the landfill consist of diversion berm with drainage swale on top deck area, V-ditch on landfill benches, trapezoidal ditch on access and perimeter roads, pipe downdrains on sideslopes, and pipe culverts across perimeter road.

The *Flow Master* computer program, based on Manning's equation for open channel hydraulics, was used for sizing drainage facilities. The summary of landfill drainage structures is presented in Table 1.

Conclusions

The drainage facilities proposed for the final B-19 landfill configuration are designed to handle the PMP, 24-hour storm event. Periodic maintenance and best management practices should be implemented throughout the active phase of the landfill to maintain hydraulic capacities of proposed drainage facilities.

FEET PER SECOND

Drainage ditches with flow velocities less than 5 (fps) should be lined with grass or erosion control mat. Drainage ditches with 5 fps or greater flow velocities should be lined with concrete or equivalent protective material for protection against erosion. Pipe downdrains on landfill sideslopes are designed to convey flow to perimeter drainage facilities and should be provided with energy dissipator or transition section at pipe outlet for protection against erosion. Crossdrains or culverts across access road may be metal or concrete pipe with 2-foot minimum cover over the pipe for vehicular traffic.

Attachments:

Figure 1 - Drainage Map

Design Calculations

TABLE 1

KETTLEMAN HILLS FACILITY
Kings County, California

Module B-19
Summary of Drainage Facilities

Drainage Area	Description	Qs (cfs)	FLOW DEPTH (FT)	FREE-BOARD (FT)	Qt (cfs)	Remarks
A1	Top Deck	6	.64	.86		Drainage Swale, ECM/Grass-lined
		6	–	–		18" CSP Downdrain
A2	Side Slope/Access Road	20	.75	.75	26	Type 2 Ditch, Access Road
A3	Side Slope/LF Bench	7	.88	.62		Type 1 Ditch, LF Bench
		8	–	–		18" CSP Downdrain
A4	Side Slope/LF Bench	8	.93	.57		Type 1 Ditch, LF Bench
		14	–	–	22	24" CSP Downdrain
A5	Side Slope/Perimeter Road	5	1.34	.66	53	Type 3 Ditch, Perimeter Road
			.73	.77	3	Type 1 Ditch, Bench
			–	–	56	36" CSP Culvert/Crossdrain
B1	Top Deck	4	–	–		Drainage Swale, ECM/Grass-lined
		4	–	–		18" CSP Downdrain
	Side Slope/LF Bench	6	.55	.95		Type 1 Ditch, LF Bench
			–	–	11	18" CSP Downdrain
B2	Side Slope/LF Bench	15	1.17	.33		Type 1 Ditch, LF Bench
			–	–	26	24" CSP Downdrain
B3	Side Slope/Perimeter Road	13	.82	.68		Type 2 Ditch, Perimeter Road
			–	–	51	36" CSP Culvert/Crossdrain
C1	Side Slope/LF Bench	3	.64	.86		Type 1 Ditch, LF Bench
		3				18" CSP Downdrain
	Side Slope/Perimeter Road		.52	.98	5	Type 2 Ditch, Perimeter Road
C2	Side Slope/Perimeter Road	8	1.05	.45		Type 1 Ditch, LF Bench
			.91	.59	16	Type 2 Ditch, Perimeter Road
C3	Side Slope/Perimeter Road	6	1.20	0.3	30	Type 2 Ditch, Perimeter Road
C4	Side Slope/Perimeter Road		–	–	10	18" CSP Downdrain
			–	–	40	30" CSP Culvert/Crossdrain

TABLE 1 (CONTINUED)

KETTLEMAN HILLS FACILITY
Kings County, California

Module B-19
Summary of Drainage Facilities

Drainage Area	Description	Qs (cfs)	FLOW DEPTH (FT)	FREE BOARD (FT)	Qt (cfs)	Remarks
D1	Side Slope/Perimeter Road	19	.89	.61		Type 2 Ditch, Perimeter Road
D2	Side Slope/Perimeter Road	8	1.14	.36	27	Type 2 Ditch, Perimeter Road
			—	—	27	30" CSP Downdrain
D3	Side Slope/LF Bench	9	.97	.53		Type 1 Ditch, LF Bench
			—	—	9	18" CSP Downdrain
D4	Side Slope/Bench	9	1.25	.25	18	Type 1 Ditch, Bench
			—	—	39	30" CSP Culvert/Crossdrain

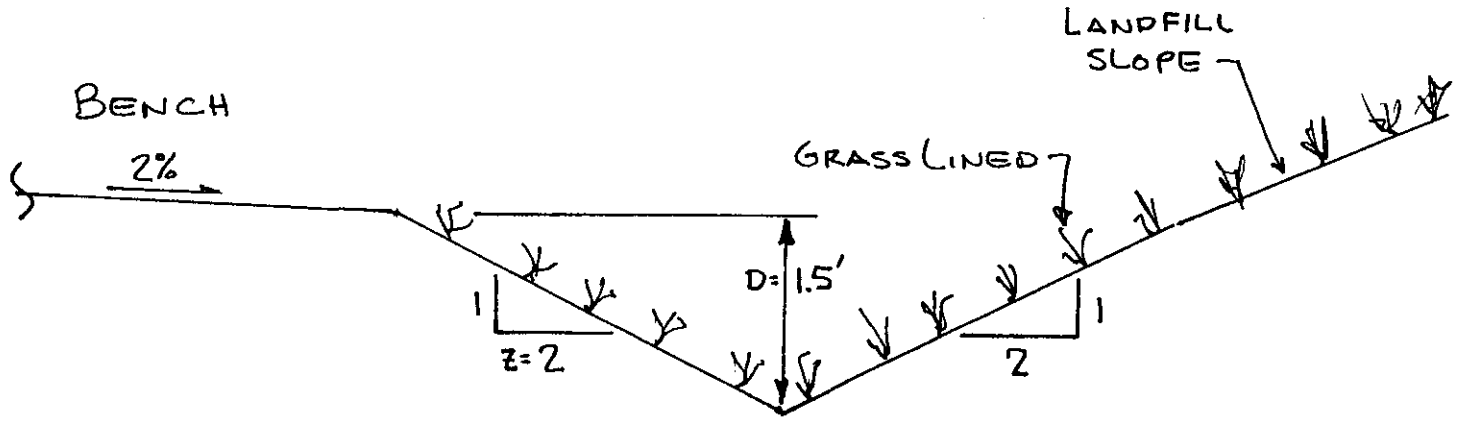
Notes:

1. Location of drainage facilities are shown on the drainage map.

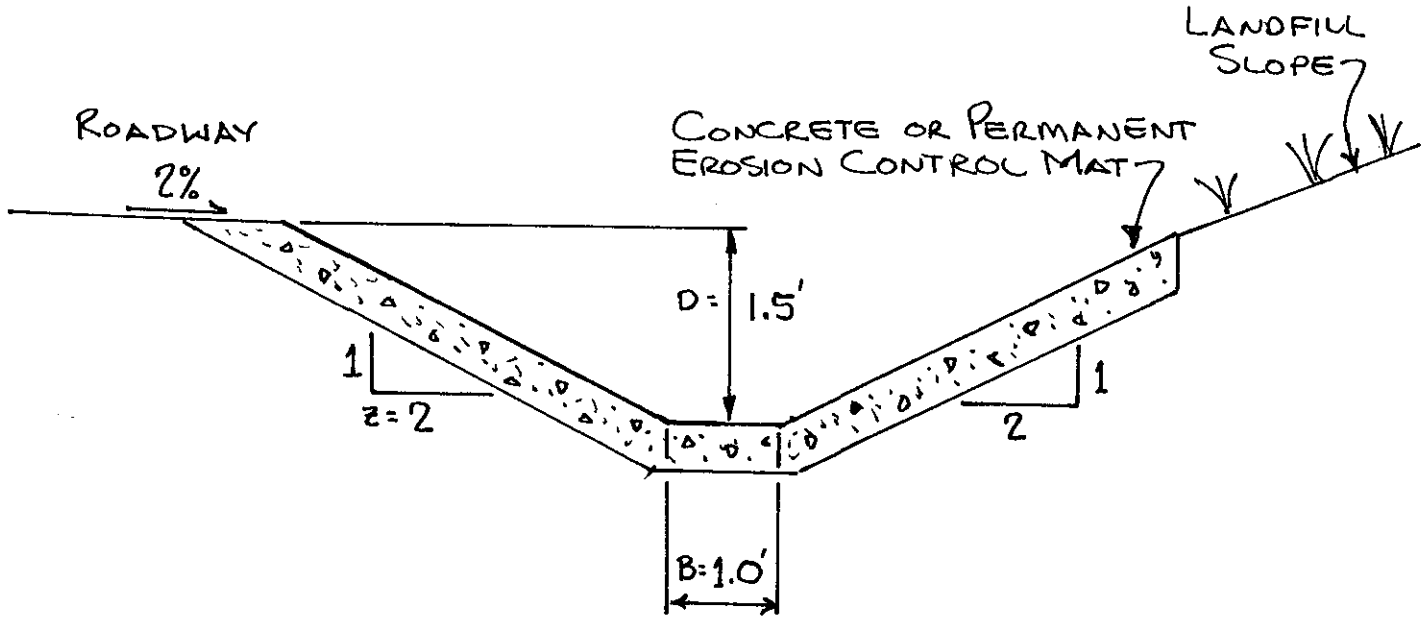
Abbreviations:

Type 1: V-Ditch; ECM/Grass-lined; D=1.5', Z=2
Type 2: Trapezoidal Ditch; Concrete-lined; B=1', D=1.5', Z=2
Type 3: Trapezoidal Ditch; Concrete-lined, B=2', D=2', Z=2

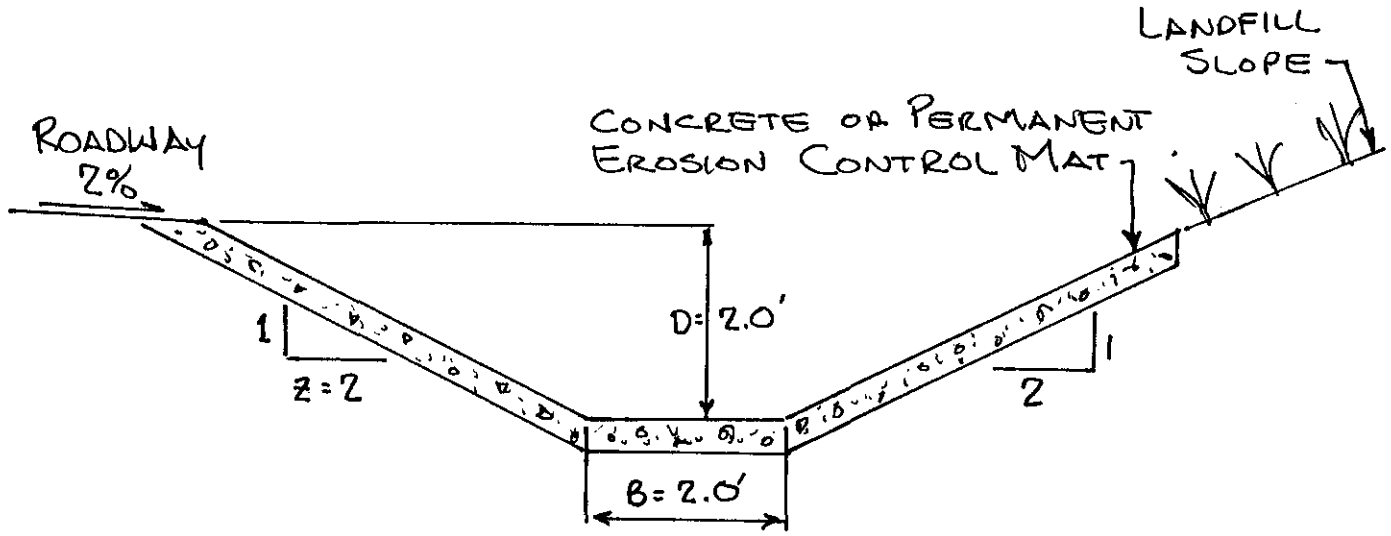
cfs = cubic feet per second
CSP = Corrugated Steel Pipe
ECM = Erosion Control Mat
Qs = subarea peak flow
Qt = combined peak flow



TYPE 1 DITCH - BENCH



TYPE 2 DITCH - ACCESS ROAD



TYPE 3 DITCH - PERIMETER ROAD

DESIGN CALCULATIONS

HYDROLOGY ANALYSIS

TR-55 DATA INPUT

KETTLEMAN HILLS FACILITY
Kings County, California

Module B-19
Drainage Analysis - TR-55 Data Input

Subarea Designation	Description	Type of Cover	Area	Weighted CN	Distance	S	To	V	Tt	Tc
			ac		ft	ft/ft	hr	fps	hr	hr
A1	Top Deck & Sideslope/ Access Road	Fair grass/gravel	1.34	84	27	0.050	0.051			
					610	0.010		2.3	0.074	0.124
A2	Sideslope/Access Road	Fair grass/gravel	4.19	88	72	0.050	0.111			
					1557	0.060		13.9	0.031	0.142
A3	Sideslope/LF Bench	Fair grass/gravel	1.62	88	27	0.400	0.022			
					870	0.020		4.5	0.054	0.076
A4	Sideslope/LF Bench	Fair grass/gravel	3.16	87	122	0.400	0.074			
					626	0.020		4.7	0.037	0.111
A5	Sideslope/Perimeter Road	Fair grass/gravel	1.61	88	62	0.400	0.043			
					368	0.010		8.4	0.012	0.055
B1	Top Deck & Sideslope/LF Bench	Fair grass/gravel	3.38	86	125	0.050	0.172			
					672	0.010		2.1	0.089	0.261
B2	Sideslope/LF Bench	Fair grass/gravel	4.04	87	114	0.400	0.070			
					1077	0.020		5.5	0.054	0.124
B3	Sideslope/Perimeter Road	Fair grass/gravel	5.45	87	94	0.400	0.060			
					475	0.010		5.9	0.022	0.082
C1	Sideslope/LF Bench, Perimeter Road	Fair grass/gravel	1.79	88	72	0.400	0.048			
					477	0.020		4.7	0.028	0.076
C2	Sideslope/LF Bench, Perimeter Road	Fair grass/gravel	3.37	87	173	0.400	0.097			
					600	0.010		6.3	0.026	0.124
C3	Sideslope/Perimeter Road	Fair grass/gravel	1.68	88	156	0.150	0.133			
					580	0.010		7.4	0.022	0.154
C4	Sideslope/LF Bench, Perimeter Road	Fair grass/gravel	2.23	87	83	0.250	0.065			
					356	0.060		9.8	0.010	0.075

KETTLEMAN HILLS FACILITY
Kings County, California

Module B-19
Drainage Analysis - TR-55 Data Input

Subarea Designation	Description	Type of Cover	Area	Weighted CN	Distance	S	To	V	Tt	Tc
			ac		ft	ft/ft	hr	fps	hr	hr
D1	Flat Area, Sideslope/Perimeter Road	Fair grass/gravel	6.38	85	378	0.150	0.269			
					747	0.015		7.6	0.027	0.297
D2	Flat Area, Sideslope/Perimeter Road	Fair grass/gravel	2.49	85	350	0.140	0.260			
					566	0.010		7.2	0.022	0.282
D3	Sideslope/LF Bench	Fair grass/gravel	1.85	87	172	0.400	0.097			
					680	0.020		4.8	0.039	0.136
D4	Sideslope/Bench, Perimeter Road	Fair grass/gravel	1.96	88	67	0.500	0.042			
					511	0.020		5.7	0.025	0.067

Notes:
1. See drainage map, for subarea delineation and drainage path locations.
2. Subarea time of concentration includes overland and shallow concentrated/ditch flow times.
3. Subareas with less than 0.1 hr time of concentration were rounded to the nearest 0.1 hr for computer data input.

Abbreviations:
CN = Curve Number
V = flow velocity
L = length of ditch or pipe
S = slope of ditch or pipe
To = overland travel time
Tt = travel time for shallow concentrated/ditch flow to point of concentration
Tc = time of concentration
ac = acres
cfs = cubic feet per second
ft = feet
ft/sec = feet per second
hr = hour

DRAINAGE AREA &
WEIGHTED CN CALCULATIONS

KETTLEMAN HILLS FACILITY
Kings County, California

Module B-19
Drainage Analysis - Drainage Area and Weighted CN Calculations

Subarea	Description	Type of Cover	Top Deck (ac)	Side Slope (ac)	Access Road, Bench, or Perimeter Road (ac)	Total Area (ac)	Weighted CN
		CN	84	86	91		
A1	Top Deck	Fair Grass	1.34			1.34	84
A2	Side Slope/Acces Road	Fair Grass / Gravel		2.76	1.43	4.19	88
A3	Side Slope/LF Bench	Fair Grass / Gravel		0.99	0.63	1.62	88
A4	Side Slope/LF Bench	Fair Grass / Gravel		2.80	0.36	3.16	87
A5	Side Slope/Perimeter Road	Fair Grass / Gravel		0.86	0.75	1.61	88
B1	Top Deck	Fair Grass	1.05				
	Side Slope/LF Bench	Fair Grass / Gravel		1.66	0.67	3.38	86
B2	Side Slope/LF Bench	Fair Grass / Gravel		3.26	0.78	4.04	87
B3	Side Slope/Perimeter Road	Fair Grass / Gravel		4.20	1.25	5.45	87
C1	Side Slope/Perimeter Road	Fair Grass / Gravel		1.02	0.77	1.79	88
C2	Side Slope/Perimeter Road	Fair Grass / Gravel		2.70	0.67	3.37	87
C3	Side Slope/Perimeter Road	Fair Grass / Gravel		1.15	0.53	1.68	88
C4	Side Slope/Perimeter Road	Fair Grass / Gravel		1.58	0.65	2.23	87
D1	Flat Area, Side Slope/LF Bench	Fair Grass / Gravel	3.58	2.28	0.51	6.38	85
D2	Flat Area, Side Slope/Per. Road	Fair Grass / Gravel	1.86	0.24	0.39	2.49	85
D3	Side Slope/Perimeter Road	Fair Grass / Gravel		1.38	0.47	1.85	87
D4	Side Slope/Perimeter Road	Fair Grass / Gravel		1.20	0.76	1.96	88

TR-55 PEAK FLOW CALCULATIONS

SUBAREAS
A1 - A5

TABULAR HYDROGRAPH METHOD Version 2.10

Project : Kettleman Hills Facility User: EMCN Date: 06-02-20..

County : Kings State: CA Checked: ____ Date: _____

Subtitle: Drainage Analysis - Module B-19

Total watershed area: 0.019 sq mi Rainfall type: I Frequency: PMP

	Subareas				
	A1	A2	A3	A4	A5
Area(sq mi)	0.00	0.01	0.00	0.00	0.00
Rainfall(in)	7.4	7.4	7.4	7.4	7.4
Curve number	84	88	88	87	88
Runoff(in)	5.52	5.98	5.98	5.87	5.98
Tc (hrs)	0.12	0.14	0.08	0.11	0.05
(Used)	0.10	0.10	0.10	0.10	0.10
TimeToOutlet	0.01	0.00	0.01	0.00	0.00
(Used)	0.00	0.00	0.00	0.00	0.00
Ia/P	0.05	0.04	0.04	0.04	0.04
(Used)	0.10	0.10	0.10	0.10	0.10

Time (hr)	Total Flow	Subarea Contribution to Total Flow (cfs) A1	A2	A3	A4	A5
9.0	2	0	1	0	1	0
9.3	5	0	2	1	1	1
9.6	7	1	2	1	2	1
9.9	20	2	7	3	5	3
10.0	37	4	13	5	10	5
10.1	56P	6P	20P	8P	14P	8P
10.2	36	4	13	5	9	5
10.3	16	2	6	2	4	2
10.4	14	1	5	2	4	2
10.5	12	1	4	2	3	2
10.6	10	1	4	1	3	1
10.7	8	1	3	1	2	1
10.8	8	1	3	1	2	1
11.0	8	1	3	1	2	1
11.2	7	1	2	1	2	1
11.4	7	1	2	1	2	1
11.6	7	1	2	1	2	1
11.8	6	1	2	1	1	1
12.0	6	1	2	1	1	1
12.3	6	1	2	1	1	1
12.6	6	1	2	1	1	1
13.0	5	0	2	1	1	1
13.5	4	0	1	1	1	1
14.0	2	0	1	0	1	0
14.5	2	0	1	0	1	0
15.0	2	0	1	0	1	0
15.5	2	0	1	0	1	0
16.0	2	0	1	0	1	0
17.0	2	0	1	0	1	0
18.0	2	0	1	0	1	0
20.0	2	0	1	0	1	0
24.0	1	0	1	0	0	0

SUBAREAS
B1 – B3

TABULAR HYDROGRAPH METHOD Version 2.1(

Project : Kettleman Hills Facility User: EMCN Date: 06-02-2004

County : Kings State: CA Checked: ____ Date: _____

Subtitle: Drainage Analysis - Module B-19

Total watershed area: 0.020 sq mi Rainfall type: I Frequency: PMP

	Subareas		
	B1	B2	B3
Area(sq mi)	0.01	0.01	0.01
Rainfall(in)	7.4	7.4	7.4
Curve number	86	87	87
Runoff(in)	5.75	5.87	5.87
Tc (hrs)	0.26	0.12	0.08
(Used)	0.30	0.10	0.10
TimeToOutlet	0.00	0.00	0.00
(Used)	0.00	0.00	0.00
Ia/P	0.04	0.04	0.04
(Used)	0.10	0.10	0.10

Time (hr)	Total Flow	Subarea Contribution to Total Flow (cfs) B1	B2	B3
9.0	3	1	1	1
9.3	4	1	1	2
9.6	6	1	2	3
9.9	19	3	7	9
10.0	33	4	12	17
10.1	51P	7	19P	25P
10.2	39	11P	12	16
10.3	25	11	6	8
10.4	19	8	5	6
10.5	15	6	4	5
10.6	12	4	3	5
10.7	11	4	3	4
10.8	10	3	3	4
11.0	7	2	2	3
11.2	7	2	2	3
11.4	7	2	2	3
11.6	7	2	2	3
11.8	7	2	2	3
12.0	6	2	2	2
12.3	5	1	2	2
12.6	5	1	2	2
13.0	4	1	1	2
13.5	4	1	1	2
14.0	4	1	1	2
14.5	3	1	1	1
15.0	3	1	1	1
15.5	3	1	1	1
16.0	3	1	1	1
17.0	3	1	1	1
18.0	3	1	1	1
20.0	3	1	1	1
24.0	1	0	0	1

SUBAREAS
C1 – C4

TABULAR HYDROGRAPH METHOD Version 2.10

Project : Kettleman Hills Facility User: EMCN Date: 06-02-2004
County : Kings State: CA Checked: ____ Date: _____
Subtitle: Drainage Analysis - Module B-19

Total watershed area: 0.014 sq mi Rainfall type: I Frequency: PMP

	Subareas			
	C1	C2	C3	C4
Area(sq mi)	0.00	0.01	0.00	0.00
Rainfall(in)	7.4	7.4	7.4	7.4
Curve number	88	87	88	87
Runoff(in)	5.98	5.87	5.98	5.87
Tc (hrs)	0.08	0.12	0.15	0.08
(Used)	0.10	0.10	0.20	0.10
TimeToOutlet	0.02	0.00	0.00	0.00
(Used)	0.00	0.00	0.00	0.00
Ia/P	0.04	0.04	0.04	0.04
(Used)	0.10	0.10	0.10	0.10

Time (hr)	Total Flow	Subarea Contribution to Total Flow (cfs) C1	C2	C3	C4
9.0	3	1	1	0	1
9.3	4	1	1	1	1
9.6	5	1	2	1	1
9.9	15	3	6	2	4
10.0	26	6	10	3	7
10.1	40P	8P	16P	6P	10P
10.2	28	5	10	6	7
10.3	15	3	5	4	3
10.4	12	2	4	3	3
10.5	9	2	3	2	2
10.6	9	2	3	2	2
10.7	7	1	3	1	2
10.8	5	1	2	1	1
11.0	5	1	2	1	1
11.2	5	1	2	1	1
11.4	5	1	2	1	1
11.6	5	1	2	1	1
11.8	5	1	2	1	1
12.0	5	1	2	1	1
12.3	4	1	1	1	1
12.6	4	1	1	1	1
13.0	4	1	1	1	1
13.5	4	1	1	1	1
14.0	4	1	1	1	1
14.5	3	1	1	0	1
15.0	2	0	1	0	1
15.5	2	0	1	0	1
16.0	2	0	1	0	1
17.0	2	0	1	0	1
18.0	1	0	1	0	0
20.0	1	0	1	0	0
24.0	0	0	0	0	0

SUBAREAS
D1 – D4

TABULAR HYDROGRAPH METHOD Version 2.10

Project : Kettleman Hills Facility User: EMCN Date: 06-02-2004

County : Kings State: CA Checked: ____ Date: _____

Subtitle: Drainage Analysis - Module B-19

Total watershed area: 0.020 sq mi Rainfall type: I Frequency: PMP

	Subareas			
	D1	D2	D3	D4
Area(sq mi)	0.01	0.00	0.00	0.00
Rainfall(in)	7.4	7.4	7.4	7.4
Curve number	85	85	87	88
Runoff(in)	5.64	5.64	5.87	5.98
Tc (hrs)	0.30	0.28	0.14	0.07
(Used)	0.30	0.30	0.10	0.10
TimeToOutlet	0.01	0.01	0.00	0.00
(Used)	0.00	0.00	0.00	0.00
Ia/P	0.05	0.05	0.04	0.04
(Used)	0.10	0.10	0.10	0.10

Time (hr)	Total Flow	Subarea Contribution to Total Flow (cfs) D1	D2	D3	D4
9.0	4	1	1	1	1
9.3	5	2	1	1	1
9.6	6	3	1	1	1
9.9	13	5	2	3	3
10.0	23	8	3	6	6
10.1	37	14	5	9P	9P
10.2	39P	19P	8P	6	6
10.3	33	19	8	3	3
10.4	24	14	6	2	2
10.5	18	10	4	2	2
10.6	15	8	3	2	2
10.7	12	6	3	1	2
10.8	9	5	2	1	1
11.0	8	4	2	1	1
11.2	7	4	1	1	1
11.4	6	3	1	1	1
11.6	6	3	1	1	1
11.8	6	3	1	1	1
12.0	6	3	1	1	1
12.3	6	3	1	1	1
12.6	6	3	1	1	1
13.0	5	2	1	1	1
13.5	5	2	1	1	1
14.0	5	2	1	1	1
14.5	5	2	1	1	1
15.0	4	2	1	0	1
15.5	4	2	1	0	1
16.0	4	2	1	0	1
17.0	2	1	1	0	0
18.0	2	1	1	0	0
20.0	1	1	0	0	0
24.0	1	1	0	0	0

HYDRAULIC ANALYSIS

DIVERSION BERM & LF BENCH DRAINAGE DITCH

Trapezoidal Channel Analysis & Design
Open Channel - Uniform flow

Worksheet Name: KHF Module B-19

Comment: Drainage Diversion Berm - Subarea A1

Solve For Depth

Given Input Data:

Bottom Width.....	0.00 ft
Left Side Slope..	10.00:1 (H:V)
Right Side Slope.	3.00:1 (H:V)
Manning's n.....	0.030
Channel Slope....	0.0100 ft/ft
Discharge.....	6.00 cfs

Computed Results:

Depth.....	0.64 ft
Velocity.....	2.28 fps
Flow Area.....	2.63 sf
Flow Top Width...	8.27 ft
Wetted Perimeter.	8.40 ft
Critical Depth...	0.56 ft
Critical Slope...	0.0206 ft/ft
Froude Number....	0.71 (flow is Subcritical)

Trapezoidal Channel Analysis & Design
Open Channel - Uniform flow

Worksheet Name: KHF Module B-19

Comment: LF Bench Drainage Ditch - Subarea A3

Solve For Depth

Given Input Data:

Bottom Width.....	0.00 ft
Left Side Slope..	2.00:1 (H:V)
Right Side Slope.	2.00:1 (H:V)
Manning's n.....	0.025
Channel Slope....	0.0200 ft/ft
Discharge.....	7.00 cfs

Computed Results:

Depth.....	0.88 ft
Velocity.....	4.52 fps
Flow Area.....	1.55 sf
Flow Top Width...	3.52 ft
Wetted Perimeter.	3.94 ft
Critical Depth...	0.95 ft
Critical Slope...	0.0136 ft/ft
Froude Number....	1.20 (flow is Supercritical)

Trapezoidal Channel Analysis & Design
Open Channel - Uniform flow

Worksheet Name: KHF Module B-19

Comment: LF Bench Drainage Ditch - Subarea A4

Solve For Depth

Given Input Data:

Bottom Width.....	0.00 ft
Left Side Slope..	2.00:1 (H:V)
Right Side Slope.	2.00:1 (H:V)
Manning's n.....	0.025
Channel Slope....	0.0200 ft/ft
Discharge.....	8.00 cfs

Computed Results:

Depth.....	0.93 ft
Velocity.....	4.67 fps
Flow Area.....	1.71 sf
Flow Top Width...	3.70 ft
Wetted Perimeter.	4.14 ft
Critical Depth...	1.00 ft
Critical Slope...	0.0133 ft/ft
Froude Number....	1.21 (flow is Supercritical)

Open Channel Flow Module, Version 3.21 (c) 1990
Haestad Methods, Inc. * 37 Brookside Rd * Waterbury, Ct 06708

Trapezoidal Channel Analysis & Design
Open Channel - Uniform flow

Worksheet Name: KHF Module B-19

Comment: LF Bench Drainage Ditch - Subarea A5

Solve For Depth

Given Input Data:

Bottom Width.....	0.00 ft
Left Side Slope..	2.00:1 (H:V)
Right Side Slope.	2.00:1 (H:V)
Manning's n.....	0.025
Channel Slope....	0.0100 ft/ft
Discharge.....	3.00 cfs

Computed Results:

Depth.....	0.73 ft
Velocity.....	2.82 fps
Flow Area.....	1.06 sf
Flow Top Width...	2.92 ft
Wetted Perimeter.	3.26 ft
Critical Depth...	0.67 ft
Critical Slope...	0.0152 ft/ft
Froude Number....	0.82 (flow is Subcritical)

Trapezoidal Channel Analysis & Design
Open Channel - Uniform flow

Worksheet Name: KHF Module B-19

Comment: Drainage Diversion Berm - Subarea B1

Solve For Depth

Given Input Data:

Bottom Width.....	0.00 ft
Left Side Slope..	10.00:1 (H:V)
Right Side Slope.	3.00:1 (H:V)
Manning's n.....	0.030
Channel Slope....	0.0100 ft/ft
Discharge.....	4.00 cfs

Computed Results:

Depth.....	0.55 ft
Velocity.....	2.06 fps
Flow Area.....	1.94 sf
Flow Top Width...	7.10 ft
Wetted Perimeter.	7.22 ft
Critical Depth...	0.47 ft
Critical Slope...	0.0217 ft/ft
Froude Number....	0.70 (flow is Subcritical)

Trapezoidal Channel Analysis & Design
Open Channel - Uniform flow

Worksheet Name: KHF Module B-19

Comment: LF Bench Drainage Ditch - Subarea B2

Solve For Depth

Given Input Data:

Bottom Width.....	0.00 ft
Left Side Slope..	2.00:1 (H:V)
Right Side Slope.	2.00:1 (H:V)
Manning's n.....	0.025
Channel Slope....	0.0200 ft/ft
Discharge.....	15.00 cfs

Computed Results:

Depth.....	1.17 ft
Velocity.....	5.46 fps
Flow Area.....	2.75 sf
Flow Top Width...	4.69 ft
Wetted Perimeter.	5.24 ft
Critical Depth...	1.28 ft
Critical Slope...	0.0123 ft/ft
Froude Number....	1.26 (flow is Supercritical)

Trapezoidal Channel Analysis & Design
Open Channel - Uniform flow

Worksheet Name: KHF Module B-19

Comment: LF Bench Drainage Ditch - Subarea C1

Solve For Depth

Given Input Data:

Bottom Width.....	0.00 ft
Left Side Slope..	2.00:1 (H:V)
Right Side Slope.	2.00:1 (H:V)
Manning's n.....	0.025
Channel Slope....	0.0200 ft/ft
Discharge.....	3.00 cfs

Computed Results:

Depth.....	0.64 ft
Velocity.....	3.65 fps
Flow Area.....	0.82 sf
Flow Top Width...	2.56 ft
Wetted Perimeter.	2.87 ft
Critical Depth...	0.67 ft
Critical Slope...	0.0152 ft/ft
Froude Number....	1.14 (flow is Supercritical)

Trapezoidal Channel Analysis & Design
Open Channel - Uniform flow

Worksheet Name: KHF Module B-19

Comment: LF Bench Drainage Ditch - Subarea C2

Solve For Depth

Given Input Data:

Bottom Width.....	0.00 ft
Left Side Slope..	2.00:1 (H:V)
Right Side Slope.	2.00:1 (H:V)
Manning's n.....	0.025
Channel Slope....	0.0100 ft/ft
Discharge.....	8.00 cfs

Computed Results:

Depth.....	1.05 ft
Velocity.....	3.60 fps
Flow Area.....	2.22 sf
Flow Top Width...	4.22 ft
Wetted Perimeter.	4.71 ft
Critical Depth...	1.00 ft
Critical Slope...	0.0133 ft/ft
Froude Number....	0.87 (flow is Subcritical)

Trapezoidal Channel Analysis & Design
Open Channel - Uniform flow

Worksheet Name: KHF Module B-19

Comment: LF Bench Drainage Ditch - Subarea D3

Solve For Depth

Given Input Data:

Bottom Width.....	0.00 ft
Left Side Slope..	2.00:1 (H:V)
Right Side Slope.	2.00:1 (H:V)
Manning's n.....	0.025
Channel Slope....	0.0200 ft/ft
Discharge.....	9.00 cfs

Computed Results:

Depth.....	0.97 ft
Velocity.....	4.81 fps
Flow Area.....	1.87 sf
Flow Top Width...	3.87 ft
Wetted Perimeter.	4.33 ft
Critical Depth...	1.05 ft
Critical Slope...	0.0131 ft/ft
Froude Number....	1.22 (flow is Supercritical)

Open Channel Flow Module, Version 3.21 (c) 1990
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Trapezoidal Channel Analysis & Design
Open Channel - Uniform flow

Worksheet Name: KHF Module B-19

Comment: Bench Drainage Ditch - Subarea D4

Solve For Depth

Given Input Data:

Bottom Width.....	0.00 ft
Left Side Slope..	2.00:1 (H:V)
Right Side Slope.	2.00:1 (H:V)
Manning's n.....	0.025
Channel Slope....	0.0200 ft/ft
Discharge.....	18.00 cfs

Computed Results:

Depth.....	1.25 ft
Velocity.....	5.72 fps
Flow Area.....	3.15 sf
Flow Top Width...	5.02 ft
Wetted Perimeter.	5.61 ft
Critical Depth...	1.38 ft
Critical Slope...	0.0120 ft/ft
Froude Number....	1.27 (flow is Supercritical)

Trapezoidal Channel Analysis & Design
Open Channel - Uniform flow

Worksheet Name: KHF Module B-19

Description: LF Bench Drainage Ditch

Solve For Depth

Given Constant Data;

Bottom Width..... 0.00
Z-Left..... 2.00
Z-Right..... 2.00

Variable Input Data	Minimum	Maximum	Increment By
Mannings 'n'	0.020	0.025	0.005
Channel Slope	0.0100	0.0250	0.0050
Channel Discharge	1.00	20.00	1.00

Bottom Width ft	Z-Left (H:V)	Z-Right (H:V)	VARIABLE Mannings 'n'	VARIABLE Channel Slope ft/ft	COMPUTED Channel Depth ft	VARIABLE Channel Discharge cfs	COMPUTED Velocity fps
0.00	2.00	2.00	0.020	0.0100	0.44	1.00	2.53
0.00	2.00	2.00	0.025	0.0100	0.48	1.00	2.14
0.00	2.00	2.00	0.020	0.0150	0.41	1.00	2.95
0.00	2.00	2.00	0.025	0.0150	0.45	1.00	2.49
0.00	2.00	2.00	0.020	0.0200	0.39	1.00	3.28
0.00	2.00	2.00	0.025	0.0200	0.42	1.00	2.78
0.00	2.00	2.00	0.020	0.0250	0.37	1.00	3.57
0.00	2.00	2.00	0.025	0.0250	0.41	1.00	3.02
0.00	2.00	2.00	0.020	0.0100	0.58	2.00	3.01
0.00	2.00	2.00	0.025	0.0100	0.63	2.00	2.55
0.00	2.00	2.00	0.020	0.0150	0.53	2.00	3.50
0.00	2.00	2.00	0.025	0.0150	0.58	2.00	2.96
0.00	2.00	2.00	0.020	0.0200	0.51	2.00	3.90
0.00	2.00	2.00	0.025	0.0200	0.55	2.00	3.30
0.00	2.00	2.00	0.020	0.0250	0.49	2.00	4.24
0.00	2.00	2.00	0.025	0.0250	0.53	2.00	3.59
0.00	2.00	2.00	0.020	0.0100	0.67	3.00	3.33
0.00	2.00	2.00	0.025	0.0100	0.73	3.00	2.82
0.00	2.00	2.00	0.020	0.0150	0.62	3.00	3.88
0.00	2.00	2.00	0.025	0.0150	0.68	3.00	3.28
0.00	2.00	2.00	0.020	0.0200	0.59	3.00	4.32
0.00	2.00	2.00	0.025	0.0200	0.64	3.00	3.65
0.00	2.00	2.00	0.020	0.0250	0.57	3.00	4.70
0.00	2.00	2.00	0.025	0.0250	0.61	3.00	3.97
0.00	2.00	2.00	0.020	0.0100	0.75	4.00	3.58
0.00	2.00	2.00	0.025	0.0100	0.81	4.00	3.03
0.00	2.00	2.00	0.020	0.0150	0.69	4.00	4.17
0.00	2.00	2.00	0.025	0.0150	0.75	4.00	3.52
0.00	2.00	2.00	0.020	0.0200	0.66	4.00	4.64
0.00	2.00	2.00	0.025	0.0200	0.71	4.00	3.93
0.00	2.00	2.00	0.020	0.0250	0.63	4.00	5.05
0.00	2.00	2.00	0.025	0.0250	0.68	4.00	4.27
0.00	2.00	2.00	0.020	0.0100	0.81	5.00	3.78
0.00	2.00	2.00	0.025	0.0100	0.88	5.00	3.20
0.00	2.00	2.00	0.020	0.0150	0.75	5.00	4.41
0.00	2.00	2.00	0.025	0.0150	0.82	5.00	3.73
0.00	2.00	2.00	0.020	0.0200	0.71	5.00	4.91
0.00	2.00	2.00	0.025	0.0200	0.78	5.00	4.15
0.00	2.00	2.00	0.020	0.0250	0.68	5.00	5.34
0.00	2.00	2.00	0.025	0.0250	0.74	5.00	4.51

Bottom Width ft	Z-Left (H:V)	Z-Right (H:V)	VARIABLE Mannings 'n'	VARIABLE Channel Slope ft/ft	COMPUTED Channel Depth ft	VARIABLE Channel Discharge cfs	COMPUTED Velocity fps
0.00	2.00	2.00	0.020	0.0100	0.87	6.00	3.96
0.00	2.00	2.00	0.025	0.0100	0.95	6.00	3.35
0.00	2.00	2.00	0.020	0.0150	0.81	6.00	4.61
0.00	2.00	2.00	0.025	0.0150	0.88	6.00	3.90
0.00	2.00	2.00	0.020	0.0200	0.76	6.00	5.14
0.00	2.00	2.00	0.025	0.0200	0.83	6.00	4.34
0.00	2.00	2.00	0.020	0.0250	0.73	6.00	5.58
0.00	2.00	2.00	0.025	0.0250	0.80	6.00	4.72
0.00	2.00	2.00	0.020	0.0100	0.92	7.00	4.12
0.00	2.00	2.00	0.025	0.0100	1.00	7.00	3.48
0.00	2.00	2.00	0.020	0.0150	0.85	7.00	4.79
0.00	2.00	2.00	0.025	0.0150	0.93	7.00	4.05
0.00	2.00	2.00	0.020	0.0200	0.81	7.00	5.34
0.00	2.00	2.00	0.025	0.0200	0.88	7.00	4.52
0.00	2.00	2.00	0.020	0.0250	0.78	7.00	5.80
0.00	2.00	2.00	0.025	0.0250	0.84	7.00	4.91
0.00	2.00	2.00	0.020	0.0100	0.97	8.00	4.26
0.00	2.00	2.00	0.025	0.0100	1.05	8.00	3.60
0.00	2.00	2.00	0.020	0.0150	0.90	8.00	4.96
0.00	2.00	2.00	0.025	0.0150	0.98	8.00	4.19
0.00	2.00	2.00	0.020	0.0200	0.85	8.00	5.52
0.00	2.00	2.00	0.025	0.0200	0.93	8.00	4.67
0.00	2.00	2.00	0.020	0.0250	0.82	8.00	6.00
0.00	2.00	2.00	0.025	0.0250	0.89	8.00	5.08
0.00	2.00	2.00	0.020	0.0100	1.01	9.00	4.38
0.00	2.00	2.00	0.025	0.0100	1.10	9.00	3.71
0.00	2.00	2.00	0.020	0.0150	0.94	9.00	5.10
0.00	2.00	2.00	0.025	0.0150	1.02	9.00	4.32
0.00	2.00	2.00	0.020	0.0200	0.89	9.00	5.68
0.00	2.00	2.00	0.025	0.0200	0.97	9.00	4.81
0.00	2.00	2.00	0.020	0.0250	0.85	9.00	6.18
0.00	2.00	2.00	0.025	0.0250	0.93	9.00	5.23
0.00	2.00	2.00	0.020	0.0100	1.05	10.00	4.50
0.00	2.00	2.00	0.025	0.0100	1.15	10.00	3.81
0.00	2.00	2.00	0.020	0.0150	0.98	10.00	5.24
0.00	2.00	2.00	0.025	0.0150	1.06	10.00	4.43
0.00	2.00	2.00	0.020	0.0200	0.93	10.00	5.84
0.00	2.00	2.00	0.025	0.0200	1.01	10.00	4.94
0.00	2.00	2.00	0.020	0.0250	0.89	10.00	6.35
0.00	2.00	2.00	0.025	0.0250	0.97	10.00	5.37

Bottom Width ft	Z-Left (H:V)	Z-Right (H:V)	VARIABLE Mannings 'n'	VARIABLE Channel Slope ft/ft	COMPUTED Channel Depth ft	VARIABLE Channel Discharge cfs	COMPUTED Velocity fps
0.00	2.00	2.00	0.020	0.0100	1.09	11.00	4.61
0.00	2.00	2.00	0.025	0.0100	1.19	11.00	3.90
0.00	2.00	2.00	0.020	0.0150	1.01	11.00	5.37
0.00	2.00	2.00	0.025	0.0150	1.10	11.00	4.54
0.00	2.00	2.00	0.020	0.0200	0.96	11.00	5.98
0.00	2.00	2.00	0.025	0.0200	1.04	11.00	5.06
0.00	2.00	2.00	0.020	0.0250	0.92	11.00	6.50
0.00	2.00	2.00	0.025	0.0250	1.00	11.00	5.50
0.00	2.00	2.00	0.020	0.0100	1.13	12.00	4.71
0.00	2.00	2.00	0.025	0.0100	1.23	12.00	3.98
0.00	2.00	2.00	0.020	0.0150	1.05	12.00	5.48
0.00	2.00	2.00	0.025	0.0150	1.14	12.00	4.64
0.00	2.00	2.00	0.020	0.0200	0.99	12.00	6.11
0.00	2.00	2.00	0.025	0.0200	1.08	12.00	5.17
0.00	2.00	2.00	0.020	0.0250	0.95	12.00	6.64
0.00	2.00	2.00	0.025	0.0250	1.03	12.00	5.62
0.00	2.00	2.00	0.020	0.0100	1.16	13.00	4.81
0.00	2.00	2.00	0.025	0.0100	1.26	13.00	4.06
0.00	2.00	2.00	0.020	0.0150	1.08	13.00	5.59
0.00	2.00	2.00	0.025	0.0150	1.17	13.00	4.73
0.00	2.00	2.00	0.020	0.0200	1.02	13.00	6.23
0.00	2.00	2.00	0.025	0.0200	1.11	13.00	5.27
0.00	2.00	2.00	0.020	0.0250	0.98	13.00	6.78
0.00	2.00	2.00	0.025	0.0250	1.06	13.00	5.73
0.00	2.00	2.00	0.020	0.0100	1.20	14.00	4.90
0.00	2.00	2.00	0.025	0.0100	1.30	14.00	4.14
0.00	2.00	2.00	0.020	0.0150	1.11	14.00	5.70
0.00	2.00	2.00	0.025	0.0150	1.20	14.00	4.82
0.00	2.00	2.00	0.020	0.0200	1.05	14.00	6.35
0.00	2.00	2.00	0.025	0.0200	1.14	14.00	5.37
0.00	2.00	2.00	0.020	0.0250	1.01	14.00	6.90
0.00	2.00	2.00	0.025	0.0250	1.09	14.00	5.84
0.00	2.00	2.00	0.020	0.0100	1.23	15.00	4.98
0.00	2.00	2.00	0.025	0.0100	1.33	15.00	4.21
0.00	2.00	2.00	0.020	0.0150	1.14	15.00	5.80
0.00	2.00	2.00	0.025	0.0150	1.24	15.00	4.90
0.00	2.00	2.00	0.020	0.0200	1.08	15.00	6.46
0.00	2.00	2.00	0.025	0.0200	1.17	15.00	5.46
0.00	2.00	2.00	0.020	0.0250	1.03	15.00	7.02
0.00	2.00	2.00	0.025	0.0250	1.12	15.00	5.94

Bottom Width ft	Z-Left (H:V)	Z-Right (H:V)	VARIABLE Mannings 'n'	VARIABLE Channel Slope ft/ft	COMPUTED Channel Depth ft	VARIABLE Channel Discharge cfs	COMPUTED Velocity fps
0.00	2.00	2.00	0.020	0.0100	1.26	16.00	5.06
0.00	2.00	2.00	0.025	0.0100	1.37	16.00	4.28
0.00	2.00	2.00	0.020	0.0150	1.17	16.00	5.89
0.00	2.00	2.00	0.025	0.0150	1.27	16.00	4.98
0.00	2.00	2.00	0.020	0.0200	1.10	16.00	6.56
0.00	2.00	2.00	0.025	0.0200	1.20	16.00	5.55
0.00	2.00	2.00	0.020	0.0250	1.06	16.00	7.14
0.00	2.00	2.00	0.025	0.0250	1.15	16.00	6.04
0.00	2.00	2.00	0.020	0.0100	1.29	17.00	5.14
0.00	2.00	2.00	0.025	0.0100	1.40	17.00	4.35
0.00	2.00	2.00	0.020	0.0150	1.19	17.00	5.98
0.00	2.00	2.00	0.025	0.0150	1.30	17.00	5.06
0.00	2.00	2.00	0.020	0.0200	1.13	17.00	6.66
0.00	2.00	2.00	0.025	0.0200	1.23	17.00	5.64
0.00	2.00	2.00	0.020	0.0250	1.08	17.00	7.25
0.00	2.00	2.00	0.025	0.0250	1.18	17.00	6.13
0.00	2.00	2.00	0.020	0.0100	1.31	18.00	5.21
0.00	2.00	2.00	0.025	0.0100	1.43	18.00	4.41
0.00	2.00	2.00	0.020	0.0150	1.22	18.00	6.07
0.00	2.00	2.00	0.025	0.0150	1.32	18.00	5.13
0.00	2.00	2.00	0.020	0.0200	1.15	18.00	6.76
0.00	2.00	2.00	0.025	0.0200	1.25	18.00	5.72
0.00	2.00	2.00	0.020	0.0250	1.11	18.00	7.35
0.00	2.00	2.00	0.025	0.0250	1.20	18.00	6.22
0.00	2.00	2.00	0.020	0.0100	1.34	19.00	5.28
0.00	2.00	2.00	0.025	0.0100	1.46	19.00	4.47
0.00	2.00	2.00	0.020	0.0150	1.24	19.00	6.15
0.00	2.00	2.00	0.025	0.0150	1.35	19.00	5.20
0.00	2.00	2.00	0.020	0.0200	1.18	19.00	6.85
0.00	2.00	2.00	0.025	0.0200	1.28	19.00	5.80
0.00	2.00	2.00	0.020	0.0250	1.13	19.00	7.45
0.00	2.00	2.00	0.025	0.0250	1.23	19.00	6.30
0.00	2.00	2.00	0.020	0.0100	1.37	20.00	5.35
0.00	2.00	2.00	0.025	0.0100	1.49	20.00	4.53
0.00	2.00	2.00	0.020	0.0150	1.27	20.00	6.23
0.00	2.00	2.00	0.025	0.0150	1.38	20.00	5.27
0.00	2.00	2.00	0.020	0.0200	1.20	20.00	6.94
0.00	2.00	2.00	0.025	0.0200	1.31	20.00	5.87
0.00	2.00	2.00	0.020	0.0250	1.15	20.00	7.55
0.00	2.00	2.00	0.025	0.0250	1.25	20.00	6.38

LF ACCESS ROAD
DRAINAGE DITCH

Trapezoidal Channel Analysis & Design
Open Channel - Uniform flow

Worksheet Name: KHF Module B-19

Comment: Access Road Drainage Ditch - Subarea A2

Solve For Depth

Given Input Data:

Bottom Width.....	1.00 ft
Left Side Slope..	2.00:1 (H:V)
Right Side Slope.	2.00:1 (H:V)
Manning's n.....	0.015
Channel Slope....	0.0600 ft/ft
Discharge.....	26.00 cfs

Computed Results:

Depth.....	0.75 ft
Velocity.....	13.85 fps
Flow Area.....	1.88 sf
Flow Top Width...	4.00 ft
Wetted Perimeter.	4.36 ft
Critical Depth...	1.37 ft
Critical Slope...	0.0040 ft/ft
Froude Number....	3.56 (flow is Supercritical)

Trapezoidal Channel Analysis & Design
Open Channel - Uniform flow

Worksheet Name: KHF Module B-19

Comment: Access Road Drainage Ditch - Subarea C4

Solve For Depth

Given Input Data:

Bottom Width.....	1.00 ft
Left Side Slope..	2.00:1 (H:V)
Right Side Slope.	2.00:1 (H:V)
Manning's n.....	0.015
Channel Slope....	0.0600 ft/ft
Discharge.....	7.00 cfs

Computed Results:

Depth.....	0.40 ft
Velocity.....	9.81 fps
Flow Area.....	0.71 sf
Flow Top Width...	2.59 ft
Wetted Perimeter.	2.78 ft
Critical Depth...	0.74 ft
Critical Slope...	0.0048 ft/ft
Froude Number....	3.29 (flow is Supercritical)

PERIMETER ROAD
DRAINAGE DITCH

Trapezoidal Channel Analysis & Design
Open Channel - Uniform flow

Worksheet Name: KHF Module B-19

Comment: Perimeter Road Drainage Ditch - Subarea A5

Solve For Depth

Given Input Data:

Bottom Width.....	2.00 ft
Left Side Slope..	2.00:1 (H:V)
Right Side Slope.	2.00:1 (H:V)
Manning's n.....	0.015
Channel Slope....	0.0100 ft/ft
Discharge.....	53.00 cfs

Computed Results:

Depth.....	1.34 ft
Velocity.....	8.43 fps
Flow Area.....	6.28 sf
Flow Top Width...	7.37 ft
Wetted Perimeter.	8.00 ft
Critical Depth...	1.70 ft
Critical Slope...	0.0036 ft/ft
Froude Number....	1.61 (flow is Supercritical)

Trapezoidal Channel Analysis & Design
Open Channel - Uniform flow

Worksheet Name: KHF Module B-19

Comment: Perimeter Road Drainage Ditch - Subarea B3

Solve For Depth

Given Input Data:

Bottom Width.....	1.00 ft
Left Side Slope..	2.00:1 (H:V)
Right Side Slope.	2.00:1 (H:V)
Manning's n.....	0.015
Channel Slope....	0.0100 ft/ft
Discharge.....	13.00 cfs

Computed Results:

Depth.....	0.82 ft
Velocity.....	5.95 fps
Flow Area.....	2.18 sf
Flow Top Width...	4.30 ft
Wetted Perimeter.	4.69 ft
Critical Depth...	0.99 ft
Critical Slope...	0.0044 ft/ft
Froude Number....	1.47 (flow is Supercritical)

Trapezoidal Channel Analysis & Design
Open Channel - Uniform flow

Worksheet Name: KHF Module B-19

Comment: Perimeter Road Drainage Ditch - Subarea C1

Solve For Depth

Given Input Data:

Bottom Width.....	1.00 ft
Left Side Slope..	2.00:1 (H:V)
Right Side Slope.	2.00:1 (H:V)
Manning's n.....	0.015
Channel Slope....	0.0100 ft/ft
Discharge.....	5.00 cfs

Computed Results:

Depth.....	0.52 ft
Velocity.....	4.65 fps
Flow Area.....	1.08 sf
Flow Top Width...	3.10 ft
Wetted Perimeter.	3.35 ft
Critical Depth...	0.62 ft
Critical Slope...	0.0050 ft/ft
Froude Number....	1.39 (flow is Supercritical)

Trapezoidal Channel Analysis & Design
Open Channel - Uniform flow

Worksheet Name: KHF Module B-19

Comment: Perimeter Road Drainage Ditch - Subarea C2

Solve For Depth

Given Input Data:

Bottom Width.....	1.00 ft
Left Side Slope..	2.00:1 (H:V)
Right Side Slope.	2.00:1 (H:V)
Manning's n.....	0.015
Channel Slope....	0.0100 ft/ft
Discharge.....	16.00 cfs

Computed Results:

Depth.....	0.91 ft
Velocity.....	6.28 fps
Flow Area.....	2.55 sf
Flow Top Width...	4.62 ft
Wetted Perimeter.	5.05 ft
Critical Depth...	1.10 ft
Critical Slope...	0.0043 ft/ft
Froude Number....	1.49 (flow is Supercritical)

Trapezoidal Channel Analysis & Design
Open Channel - Uniform flow

Worksheet Name: KHF Module B-19

Comment: Perimeter Road Drainage Ditch - Subarea C3

Solve For Depth

Given Input Data:

Bottom Width.....	1.00 ft
Left Side Slope..	2.00:1 (H:V)
Right Side Slope.	2.00:1 (H:V)
Manning's n.....	0.015
Channel Slope....	0.0100 ft/ft
Discharge.....	30.00 cfs

Computed Results:

Depth.....	1.20 ft
Velocity.....	7.36 fps
Flow Area.....	4.08 sf
Flow Top Width...	5.80 ft
Wetted Perimeter.	6.36 ft
Critical Depth...	1.47 ft
Critical Slope...	0.0040 ft/ft
Froude Number....	1.55 (flow is Supercritical)

Trapezoidal Channel Analysis & Design
Open Channel - Uniform flow

Worksheet Name: KHF Module B-19

Comment: Perimeter Road Drainage Ditch - Subarea C4

Solve For Depth

Given Input Data:

Bottom Width.....	1.00 ft
Left Side Slope..	2.00:1 (H:V)
Right Side Slope.	2.00:1 (H:V)
Manning's n.....	0.015
Channel Slope....	0.0600 ft/ft
Discharge.....	10.00 cfs

Computed Results:

Depth.....	0.48 ft
Velocity.....	10.79 fps
Flow Area.....	0.93 sf
Flow Top Width...	2.90 ft
Wetted Perimeter.	3.12 ft
Critical Depth...	0.88 ft
Critical Slope...	0.0045 ft/ft
Froude Number....	3.36 (flow is Supercritical)

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Trapezoidal Channel Analysis & Design
Open Channel - Uniform flow

Worksheet Name: KHF Module B-19

Comment: Perimeter Road Drainage Ditch - Subarea D1

Solve For Depth

Given Input Data:

Bottom Width.....	1.00 ft
Left Side Slope..	2.00:1 (H:V)
Right Side Slope.	2.00:1 (H:V)
Manning's n.....	0.015
Channel Slope....	0.0150 ft/ft
Discharge.....	19.00 cfs

Computed Results:

Depth.....	0.89 ft
Velocity.....	7.63 fps
Flow Area.....	2.49 sf
Flow Top Width...	4.57 ft
Wetted Perimeter.	5.00 ft
Critical Depth...	1.19 ft
Critical Slope...	0.0042 ft/ft
Froude Number....	1.82 (flow is Supercritical)

Trapezoidal Channel Analysis & Design
Open Channel - Uniform flow

Worksheet Name: KHF Module B-19

Comment: Perimeter Road Drainage Ditch - Subarea D2

Solve For Depth

Given Input Data:

Bottom Width.....	1.00 ft
Left Side Slope..	2.00:1 (H:V)
Right Side Slope.	2.00:1 (H:V)
Manning's n.....	0.015
Channel Slope....	0.0100 ft/ft
Discharge.....	27.00 cfs

Computed Results:

Depth.....	1.14 ft
Velocity.....	7.17 fps
Flow Area.....	3.77 sf
Flow Top Width...	5.58 ft
Wetted Perimeter.	6.12 ft
Critical Depth...	1.40 ft
Critical Slope...	0.0040 ft/ft
Froude Number....	1.54 (flow is Supercritical)

PIPE DOWNDRAIN

Circular Channel Analysis & Design
Solved with Manning's Equation

Open Channel - Uniform flow

Worksheet Name: KHF Module B-19

Description: Pipe Downdrain

Solve For Actual Depth

Given Constant Data;

Diameter..... 1.50
Mannings n..... 0.024

Variable Input Data	Minimum	Maximum	Increment By
Slope	0.0500	0.0800	0.0100
Discharge	2.00	20.00	1.00

Diameter ft	VARIABLE Channel Slope ft/ft	Mannings 'n'	VARIABLE Discharge cfs	COMPUTED Depth ft	COMPUTED Velocity fps	COMPUTED Capacity Full cfs
1.50	0.0500	0.024	2.00	0.40	5.25	12.72
1.50	0.0600	0.024	2.00	0.38	5.60	13.94
1.50	0.0700	0.024	2.00	0.37	5.92	15.05
1.50	0.0800	0.024	2.00	0.36	6.20	16.09
1.50	0.0500	0.024	3.00	0.50	5.89	12.72
1.50	0.0600	0.024	3.00	0.47	6.29	13.94
1.50	0.0700	0.024	3.00	0.45	6.64	15.05
1.50	0.0800	0.024	3.00	0.44	6.97	16.09
1.50	0.0500	0.024	4.00	0.58	6.37	12.72
1.50	0.0600	0.024	4.00	0.55	6.81	13.94
1.50	0.0700	0.024	4.00	0.53	7.20	15.05
1.50	0.0800	0.024	4.00	0.51	7.56	16.09
1.50	0.0500	0.024	5.00	0.65	6.77	12.72
1.50	0.0600	0.024	5.00	0.62	7.24	13.94
1.50	0.0700	0.024	5.00	0.60	7.66	15.05
1.50	0.0800	0.024	5.00	0.57	8.04	16.09
1.50	0.0500	0.024	6.00	0.72	7.09	12.72
1.50	0.0600	0.024	6.00	0.69	7.59	13.94
1.50	0.0700	0.024	6.00	0.66	8.04	15.05
1.50	0.0800	0.024	6.00	0.63	8.44	16.09
1.50	0.0500	0.024	7.00	0.79	7.37	12.72
1.50	0.0600	0.024	7.00	0.75	7.90	13.94
1.50	0.0700	0.024	7.00	0.72	8.36	15.05
1.50	0.0800	0.024	7.00	0.69	8.79	16.09
1.50	0.0500	0.024	8.00	0.86	7.61	12.72
1.50	0.0600	0.024	8.00	0.81	8.16	13.94
1.50	0.0700	0.024	8.00	0.78	8.65	15.05
1.50	0.0800	0.024	8.00	0.75	9.09	16.09
1.50	0.0500	0.024	9.00	0.93	7.81	12.72
1.50	0.0600	0.024	9.00	0.88	8.38	13.94
1.50	0.0700	0.024	9.00	0.84	8.90	15.05
1.50	0.0800	0.024	9.00	0.80	9.36	16.09
1.50	0.0500	0.024	10.00	1.00	7.97	12.72
1.50	0.0600	0.024	10.00	0.94	8.58	13.94
1.50	0.0700	0.024	10.00	0.89	9.11	15.05
1.50	0.0800	0.024	10.00	0.86	9.60	16.09
1.50	0.0500	0.024	11.00	1.08	8.10	12.72
1.50	0.0600	0.024	11.00	1.00	8.74	13.94
1.50	0.0700	0.024	11.00	0.95	9.30	15.05
1.50	0.0800	0.024	11.00	0.91	9.80	16.09

Diameter ft	VARIABLE Channel Slope ft/ft	Mannings 'n'	VARIABLE Discharge cfs	COMPUTED Depth ft	COMPUTED Velocity fps	COMPUTED Capacity Full cfs
1.50	0.0500	0.024	12.00	1.16	8.19	12.72
1.50	0.0600	0.024	12.00	1.07	8.87	13.94
1.50	0.0700	0.024	12.00	1.01	9.46	15.05
1.50	0.0800	0.024	12.00	0.97	9.98	16.09
1.50	0.0500	0.024	13.00	1.26	8.20	12.72
1.50	0.0600	0.024	13.00	1.15	8.96	13.94
1.50	0.0700	0.024	13.00	1.08	9.59	15.05
1.50	0.0800	0.024	13.00	1.02	10.14	16.09
Unable to compute this instance.						
1.50	0.0600	0.024	14.00	1.24	8.99	13.94
1.50	0.0700	0.024	14.00	1.14	9.68	15.05
1.50	0.0800	0.024	14.00	1.08	10.26	16.09
Unable to compute this instance.						
Unable to compute this instance.						
1.50	0.0700	0.024	15.00	1.22	9.71	15.05
1.50	0.0800	0.024	15.00	1.15	10.35	16.09
Unable to compute this instance.						
Unable to compute this instance.						
1.50	0.0700	0.024	16.00	1.34	9.60	15.05
1.50	0.0800	0.024	16.00	1.22	10.38	16.09
Unable to compute this instance.						
Unable to compute this instance.						
Unable to compute this instance.						
1.50	0.0800	0.024	17.00	1.32	10.29	16.09
Unable to compute this instance.						
Unable to compute this instance.						
Unable to compute this instance.						
Unable to compute this instance.						
Unable to compute this instance.						
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Unable to compute this instance.						
Unable to compute this instance.						

Circular Channel Analysis & Design
Solved with Manning's Equation

Open Channel - Uniform flow

Worksheet Name: KHF Module B-19

Description: Pipe Downdrain

Solve For Actual Depth

Given Constant Data;

Diameter.....	1.50
Slope.....	0.4000
Mannings n.....	0.024

Variable Input Data	Minimum	Maximum	Increment By
Discharge	2.00	20.00	1.00

Diameter ft	Channel Slope ft/ft	Mannings 'n'	VARIABLE Discharge cfs	COMPUTED Depth ft	COMPUTED Velocity fps	COMPUTED Capacity Full cfs
1.50	0.4000	0.024	2.00	0.24	10.95	35.99
1.50	0.4000	0.024	3.00	0.29	12.35	35.99
1.50	0.4000	0.024	4.00	0.34	13.43	35.99
1.50	0.4000	0.024	5.00	0.38	14.33	35.99
1.50	0.4000	0.024	6.00	0.41	15.10	35.99
1.50	0.4000	0.024	7.00	0.45	15.77	35.99
1.50	0.4000	0.024	8.00	0.48	16.38	35.99
1.50	0.4000	0.024	9.00	0.51	16.93	35.99
1.50	0.4000	0.024	10.00	0.54	17.43	35.99
1.50	0.4000	0.024	11.00	0.57	17.89	35.99
1.50	0.4000	0.024	12.00	0.60	18.32	35.99
1.50	0.4000	0.024	13.00	0.62	18.72	35.99
1.50	0.4000	0.024	14.00	0.65	19.09	35.99
1.50	0.4000	0.024	15.00	0.68	19.44	35.99
1.50	0.4000	0.024	16.00	0.70	19.77	35.99
1.50	0.4000	0.024	17.00	0.73	20.07	35.99
1.50	0.4000	0.024	18.00	0.75	20.37	35.99
1.50	0.4000	0.024	19.00	0.77	20.64	35.99
1.50	0.4000	0.024	20.00	0.80	20.90	35.99

Circular Channel Analysis & Design
Solved with Manning's Equation

Open Channel - Uniform flow

Worksheet Name: KHF Module B-19

Description: Pipe Downdrain

Solve For Actual Depth

Given Constant Data;

Diameter..... 2.00
Mannings n..... 0.024

Variable Input Data	Minimum	Maximum	Increment By
Slope	0.0500	0.0800	0.0100
Discharge	20.00	30.00	1.00

Diameter ft	VARIABLE Channel Slope ft/ft	Mannings 'n'	VARIABLE Discharge cfs	COMPUTED Depth ft	COMPUTED Velocity fps	COMPUTED Capacity Full cfs
2.00	0.0500	0.024	20.00	1.27	9.52	27.40
2.00	0.0600	0.024	20.00	1.19	10.23	30.02
2.00	0.0700	0.024	20.00	1.14	10.86	32.42
2.00	0.0800	0.024	20.00	1.09	11.43	34.66
2.00	0.0500	0.024	21.00	1.31	9.61	27.40
2.00	0.0600	0.024	21.00	1.23	10.34	30.02
2.00	0.0700	0.024	21.00	1.17	10.98	32.42
2.00	0.0800	0.024	21.00	1.12	11.56	34.66
2.00	0.0500	0.024	22.00	1.36	9.70	27.40
2.00	0.0600	0.024	22.00	1.27	10.44	30.02
2.00	0.0700	0.024	22.00	1.21	11.09	32.42
2.00	0.0800	0.024	22.00	1.16	11.68	34.66
2.00	0.0500	0.024	23.00	1.40	9.77	27.40
2.00	0.0600	0.024	23.00	1.31	10.53	30.02
2.00	0.0700	0.024	23.00	1.24	11.20	32.42
2.00	0.0800	0.024	23.00	1.19	11.80	34.66
2.00	0.0500	0.024	24.00	1.45	9.83	27.40
2.00	0.0600	0.024	24.00	1.35	10.61	30.02
2.00	0.0700	0.024	24.00	1.28	11.30	32.42
2.00	0.0800	0.024	24.00	1.22	11.91	34.66
2.00	0.0500	0.024	25.00	1.50	9.89	27.40
2.00	0.0600	0.024	25.00	1.39	10.69	30.02
2.00	0.0700	0.024	25.00	1.32	11.39	32.42
2.00	0.0800	0.024	25.00	1.26	12.01	34.66
2.00	0.0500	0.024	26.00	1.55	9.92	27.40
2.00	0.0600	0.024	26.00	1.44	10.76	30.02
2.00	0.0700	0.024	26.00	1.36	11.47	32.42
2.00	0.0800	0.024	26.00	1.29	12.11	34.66
2.00	0.0500	0.024	27.00	1.61	9.94	27.40
2.00	0.0600	0.024	27.00	1.48	10.81	30.02
2.00	0.0700	0.024	27.00	1.39	11.55	32.42
2.00	0.0800	0.024	27.00	1.33	12.20	34.66
2.00	0.0500	0.024	28.00	1.68	9.93	27.40
2.00	0.0600	0.024	28.00	1.53	10.86	30.02
2.00	0.0700	0.024	28.00	1.43	11.61	32.42
2.00	0.0800	0.024	28.00	1.36	12.28	34.66
2.00	0.0500	0.024	29.00	1.77	9.85	27.40
2.00	0.0600	0.024	29.00	1.58	10.88	30.02
2.00	0.0700	0.024	29.00	1.48	11.67	32.42
2.00	0.0800	0.024	29.00	1.40	12.35	34.66

Diameter ft	VARIABLE Channel Slope ft/ft	Mannings 'n'	VARIABLE Discharge cfs	COMPUTED Depth ft	COMPUTED Velocity fps	COMPUTED Capacity Full cfs
Unable to compute this instance.						
2.00	0.0600	0.024	30.00	1.64	10.89	30.02
2.00	0.0700	0.024	30.00	1.52	11.72	32.42
2.00	0.0800	0.024	30.00	1.44	12.42	34.66

Circular Channel Analysis & Design
Solved with Manning's Equation

Open Channel - Uniform flow

Worksheet Name: KHF Module B-19

Description: Pipe Downdrain

Solve For Actual Depth

Given Constant Data;

Diameter.....	2.00
Slope.....	0.4000
Mannings n.....	0.024

Variable Input Data	Minimum	Maximum	Increment By
Discharge	20.00	30.00	1.00

Diameter ft	Channel Slope ft/ft	Mannings 'n'	VARIABLE Discharge cfs	COMPUTED Depth ft	COMPUTED Velocity fps	COMPUTED Capacity Full cfs
2.00	0.4000	0.024	20.00	0.69	20.69	77.50
2.00	0.4000	0.024	21.00	0.71	20.97	77.50
2.00	0.4000	0.024	22.00	0.73	21.24	77.50
2.00	0.4000	0.024	23.00	0.75	21.50	77.50
2.00	0.4000	0.024	24.00	0.76	21.75	77.50
2.00	0.4000	0.024	25.00	0.78	21.99	77.50
2.00	0.4000	0.024	26.00	0.80	22.23	77.50
2.00	0.4000	0.024	27.00	0.81	22.46	77.50
2.00	0.4000	0.024	28.00	0.83	22.68	77.50
2.00	0.4000	0.024	29.00	0.85	22.89	77.50
2.00	0.4000	0.024	30.00	0.86	23.09	77.50

PIPE CULVERT

Circular Channel Analysis & Design
Solved with Manning's Equation

Open Channel - Uniform flow

Worksheet Name: KHF Module B-19

Comment: Pipe Culvert/Crossdrain - Subarea A5

Solve For Actual Depth

Given Input Data:

Diameter.....	3.00 ft
Slope.....	0.0250 ft/ft
Manning's n.....	0.024
Discharge.....	56.00 cfs

Computed Results:

Depth.....	2.41 ft
Velocity.....	9.21 fps
Flow Area.....	6.08 sf
Critical Depth....	2.43 ft
Critical Slope....	0.0246 ft/ft
Percent Full.....	80.24 %
Full Capacity.....	57.12 cfs
QMAX @.94D.....	61.45 cfs
Froude Number.....	1.02 (flow is Supercritical)

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Circular Channel Analysis & Design
Solved with Manning's Equation

Open Channel - Uniform flow

Worksheet Name: KHF Module B-19

Comment: Pipe Culvert/Crossdrain - Subarea B3

Solve For Actual Depth

Given Input Data:

Diameter.....	3.00 ft
Slope.....	0.0250 ft/ft
Manning's n.....	0.024
Discharge.....	51.00 cfs

Computed Results:

Depth.....	2.21 ft
Velocity.....	9.14 fps
Flow Area.....	5.58 sf
Critical Depth....	2.32 ft
Critical Slope....	0.0223 ft/ft
Percent Full.....	73.67 %
Full Capacity.....	57.12 cfs
QMAX @.94D.....	61.45 cfs
Froude Number.....	1.11 (flow is Supercritical)

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Circular Channel Analysis & Design
Solved with Manning's Equation

Open Channel - Uniform flow

Worksheet Name: KHF Module B-19

Comment: Pipe Culvert/Crossdrain - Subarea C3

Solve For Actual Depth

Given Input Data:

Diameter.....	2.50 ft
Slope.....	0.0400 ft/ft
Manning's n.....	0.024
Discharge.....	40.00 cfs

Computed Results:

Depth.....	1.85 ft
Velocity.....	10.24 fps
Flow Area.....	3.90 sf
Critical Depth....	2.13 ft
Critical Slope....	0.0304 ft/ft
Percent Full.....	74.18 %
Full Capacity.....	44.44 cfs
QMAX @.94D.....	47.80 cfs
Froude Number.....	1.35 (flow is Supercritical)

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Circular Channel Analysis & Design
Solved with Manning's Equation

Open Channel - Uniform flow

Worksheet Name: KHF Module B-19

Comment: Pipe Culvert/Crossdrain - Subarea D3

Solve For Actual Depth

Given Input Data:

Diameter.....	1.50 ft
Slope.....	0.0500 ft/ft
Manning's n.....	0.024
Discharge.....	9.00 cfs

Computed Results:

Depth.....	0.93 ft
Velocity.....	7.81 fps
Flow Area.....	1.15 sf
Critical Depth....	1.16 ft
Critical Slope....	0.0280 ft/ft
Percent Full.....	62.08 %
Full Capacity.....	12.72 cfs
QMAX @.94D.....	13.69 cfs
Froude Number.....	1.55 (flow is Supercritical)

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Circular Channel Analysis & Design
Solved with Manning's Equation

Open Channel - Uniform flow

Worksheet Name: KHF Module B-19

Comment: Pipe Culvert/Crossdrain - Subarea D2

Solve For Actual Depth

Given Input Data:

Diameter.....	2.50 ft
Slope.....	0.0400 ft/ft
Manning's n.....	0.024
Discharge.....	27.00 cfs

Computed Results:

Depth.....	1.41 ft
Velocity.....	9.49 fps
Flow Area.....	2.85 sf
Critical Depth....	1.77 ft
Critical Slope....	0.0204 ft/ft
Percent Full.....	56.27 %
Full Capacity.....	44.44 cfs
QMAX @.94D.....	47.80 cfs
Froude Number.....	1.56 (flow is Supercritical)

Circular Channel Analysis & Design
Solved with Manning's Equation

Open Channel - Uniform flow

Worksheet Name: KHF Module B-19

Comment: Pipe Culvert/Crossdrain - Subarea D4

Solve For Actual Depth

Given Input Data:

Diameter.....	2.50 ft
Slope.....	0.0400 ft/ft
Manning's n.....	0.024
Discharge.....	39.00 cfs

Computed Results:

Depth.....	1.82 ft
Velocity.....	10.21 fps
Flow Area.....	3.82 sf
Critical Depth....	2.11 ft
Critical Slope....	0.0294 ft/ft
Percent Full.....	72.65 %
Full Capacity.....	44.44 cfs
QMAX @.94D.....	47.80 cfs
Froude Number.....	1.37 (flow is Supercritical)

APPENDIX H

EROSION ANALYSIS

Golder Associates	Kettleman Hills Facility Landfill B-19 Closure Plan Update	
	Proj. No.: 053-1910	Made By: SGS
	Date: 10-20-2006	Checked By: RH
	Sheet: 1 of 9	Reviewed By: SS

Objective:

To estimate the soil loss from final closure slopes of Landfill B-19. The worst case slopes, as shown on the attached figure, are:

Class I Closure – 4(H):1(V) slope, 160 feet horizontal, 40 feet vertical
Class II/III Closure – 2.5(H):1(V) slope, 125 feet horizontal, 50 feet vertical
Buttress Fill – 2.0(H):1(V) slope, 140 feet horizontal, 70 feet vertical

Based on guidance from the US Environmental Protections Agency the soil loss should be less than 2 tons/acre/year (t/ac/yr) (USEPA 1989).

Method:

The Revised Universal Soil Loss Equation, Version 2 (RUSLE2) computer model developed by the National Resources Conservation Services (NRCS) was used to evaluate soil loss from the above slopes. The program is available for download at:

http://fargo.nserl.purdue.edu/rusle2_dataweb/RUSLE2_Index.htm.

Assumptions:

Climate: The default climate "CA_Kings R6" was selected from the Kings County climate zones as being most similar to the Kettleman Hills Facility. CA_Kings R6 has an annual precipitation of 6.9 inches compared to 6.56 inches for the site. The data for the site was obtained from the Western Region Climate Center data base for Kettleman City Climatological Station for data obtained from 1948 to 2001.

Soils: The U.S. Soil Conservation Service has identified three types of soils at the Kettleman Hills Facility. The soils include: Kettleman Loam (5-15% slopes), Kettleman Hills Loam (15-30% slopes) and Kettleman Cantuna (30-50% slopes). A review of the soil properties as listed in the RUSLE2 program files is as follows:

Property/Soil Type	Kettleman Loam (5-15% slopes)	Kettleman Loam (15-30% slopes)	Kettleman Cantuna (30-50% slopes)
Sand Content	40%	40%	67%
Silt Content	38%	38%	22%
Clay Content	23%	23%	10%
Erodibility Factor (k)	0.37	0.37	0.43
RUSLE2 Soil Number	#127	#128	#129

Based on experience at the site, clay content is typically greater than 22%, therefore, select Kettleman Loam 15-30% slopes (soil #128). Additional analysis indicate the soil type has only a small influence on the soil loss. The primary factor affecting soil loss is the amount of vegetation.

Calculations:

The calculations were performed using the RUSLE2 program. The calculations were performed for bare ground and vegetated conditions. The vegetated condition assumed permanent cover of warm season grass which is not harvested. The grass canopy was also reduced by 50% over the default (base) values. The reduced canopy increases the amount of erosion.

Results:

The results of the RUSLE2 evaluations are provided on the attached RUSLE2 Profile Erosion Calculation Record sheets. In summary the results are:

4:1 Class I Landfill Closure Slope (25% grade)
- Bare Ground – 7.5 t/ac/yr
- Warm Season Grass Cover – 0.42 t/a/yr

2.5:1 Class II/III Landfill Closure Slope (40% grade)
- Bare Ground – 11.0 t/ac/yr
- Warm Season Grass Cover – 0.64 t/a/yr

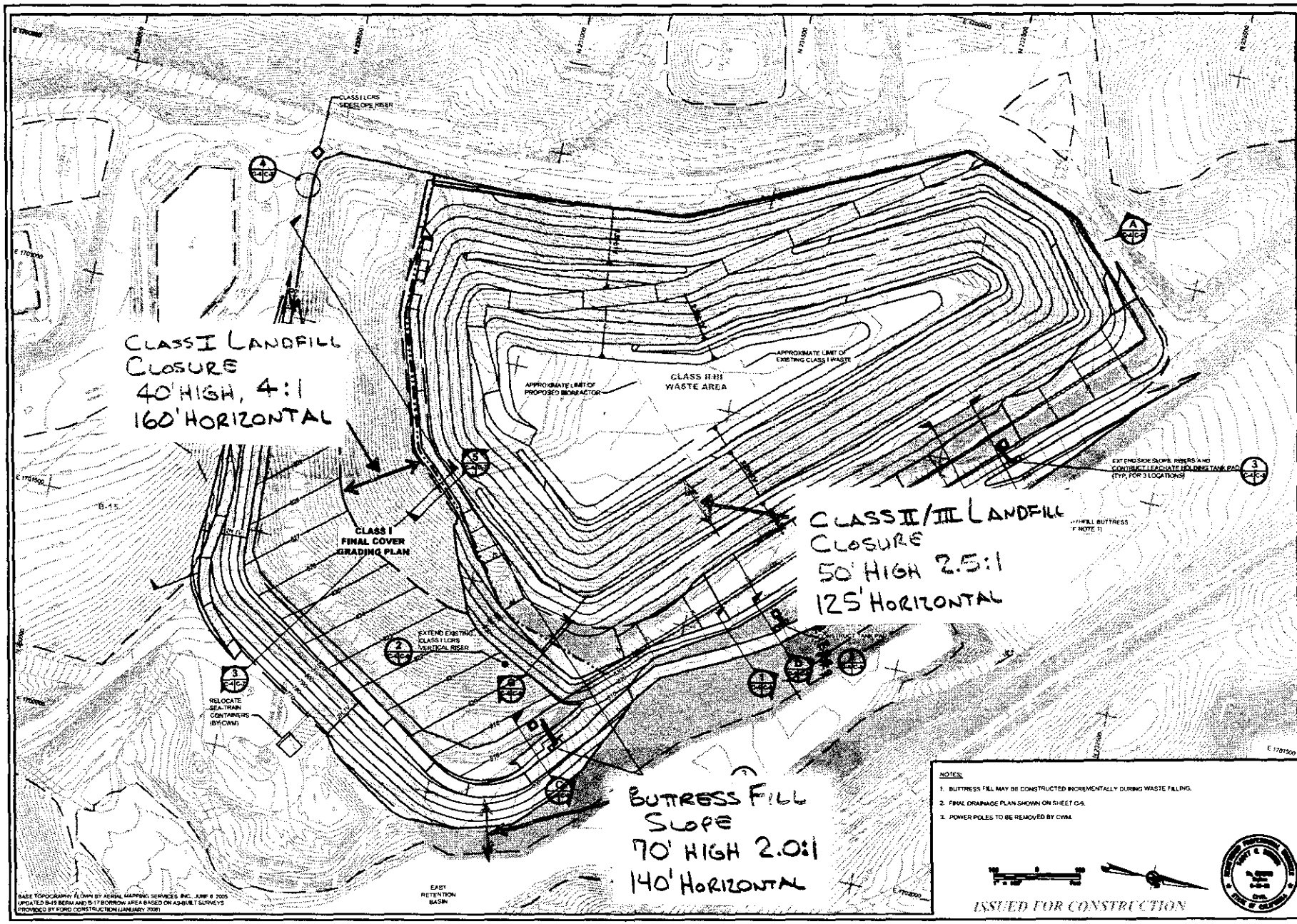
2.0:1 Stability Buttress Slope (50% grade)
- Bare Ground – 14.0 t/ac/yr
- Warm Season Grass Cover – 0.83 t/a/yr

Conclusions:

Once vegetation is established on the Landfill B-19 slopes the amount of soil loss is estimated to be less than 1.0 t/ac/yr. This is well below the U.S. EPA recommended maximum of 2 t/ac/yr. As discussed in the RUSLE2 documentation, RUSLE2 is to be used as a guide – as shown in this case maintaining vegetative cover is essential to keeping soil loss to a minimum.

Commentary:
Golder has been providing engineering services at the Kettleman Hills Facility for over 20 years, including over 10 years of post-closure inspections. During this period several landfill units have been closed. B-13, B-15 and Combined Closures (totaling over 100 acres) were closed in the early- to mid- 1990's. Based on observations of similar slopes, erosion does not appear to be a problem when vegetation is present.

Reference:
United States Environmental Protection Agency. Technical Guidance Document: Final Covers on Hazardous Waste Landfills and Surface Impoundments. EPA/530-SW-89-047. July 1989.



REV	DATE	DESCRIPTION	DRWN	REVIEW	PROJ MGR
4	10/30/06	ISSUED FOR CLIENT REVIEW	BRW	KJK	TCS
3	11/7/06	ISSUED FOR REGULATORY APPROVAL	BRW	KJK	TCS
2	5/1/08	ISSUED FOR CONSTRUCTION	JB	KJK	TCS

Golder Associates
230 Commerce, Suite 200
Irvine, California 92602
(714) 508-4400

CHEMICAL WASTE MANAGEMENT
KETTLEMAN HILLS FACILITY
35251 OLD SKYLINE ROAD
KETTLEMAN CITY, CALIFORNIA 93239
(559) 386-8151

MODIFIED CLOSURE - 2006 CONSTRUCTION FOR B-19 CLASS I LANDFILL

FINAL GRADING PLAN

SHEET NUMBER

C-4

5 OF 11 SHEETS

SOIL LOSS 3/9

USDA NRCS

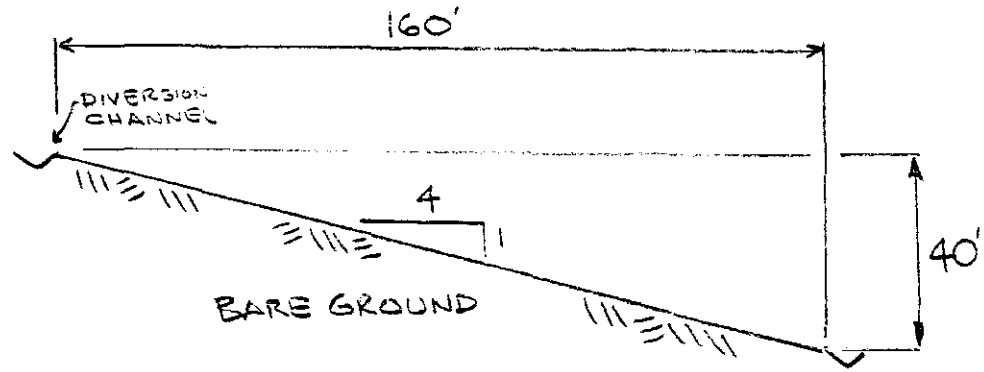
RUSLE2 Profile Erosion Calculation Record

Info: Class I Landfill with 4:1 slope, vertical height 40 feet.

File: profiles\KHF4to1 bare

Inputs:
Location: California\Kings County\CA_Kings_ R6
Soil: 128 KETTLEMAN LOAM, 15 TO 30 PERCENT SLOPES\KETTLEMAN loam 85%
Slope length (horiz): 160 ft
Avg. slope steepness: 25 %

Management	*Vegetation*	*Yield units*	*Yield (# of units)*
BARE GROUND			



Contouring: a. rows up-and-down hill
Strips/barriers: (none)
Diversion/terrace, sediment basin: (none)
Subsurface drainage: (none)
Adjust res. burial level: Normal res. burial

Outputs:
T value: 3.0 t/ac/yr
Soil loss erod. portion: 7.5 t/ac/yr
Detachment on slope: 7.5 t/ac/yr
Soil loss for cons. plan: 7.5 t/ac/yr
Sediment delivery: 7.5 t/ac/yr

Crit. slope length: -- ft
Surf. cover after planting: -- %

Date	*Operation*	*Vegetation*	*Surf. res. cov. after op, %*
4/15/0	No operation		0

053-1910
KHF-B19
Soil Loss
4/9

US NRCS

RUSLE2 Profile Erosion Calculation Record

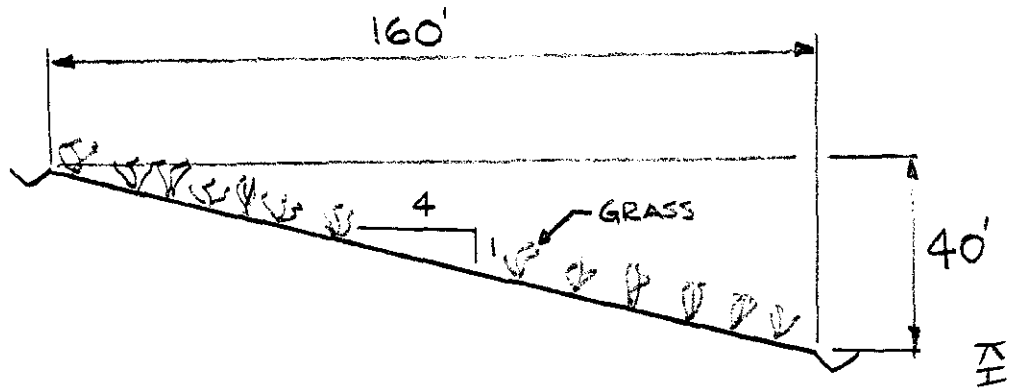
Info: Class I Landfill Final Closure 4:1 slope, vertical height 40 feet.

File: profiles\KHF4to1 ~~bare~~ GRASS

Inputs:
Location: California\Kings County\CA_Kings_ R6
Soil: 128 KETTLEMAN LOAM, 15 TO 30 PERCENT SLOPES\KETTLEMAN loam 85%
Slope length (horiz): 160 ft
Avg. slope steepness: 25 %

Management	*Vegetation*	*Yield units*	*Yield (# of units)*
Strip/Barrier Managements\Warm season grass; not harvested	Permanent cover not harvested\Grass, warm season permanent, not harvested (canopy reduced to 50% of base)	tons	1.5

Contouring: a. rows up-and-down hill
Strips/barriers: (none)
Diversion/terrace, sediment basin: (none)
Subsurface drainage: (none)
Adjust res. burial level: Normal res. burial



Outputs:
T value: 3.0 t/ac/yr
Soil loss erod. portion: 0.42 t/ac/yr
Detachment on slope: 0.42 t/ac/yr
Soil loss for cons. plan: 0.42 t/ac/yr
Sediment delivery: 0.42 t/ac/yr

Crit. slope length: -- ft
Surf. cover after planting: 0 %

Date	*Operation*	*Vegetation*	*Surf. res. cov. after op, %*
1/1/0	begin growth	Permanent cover not harvested\Grass, warm season permanent, not harvested	0

Soil Loss
053-1910
KHF 819
5/9

USDA NRCS Natural Resources Conservation Service

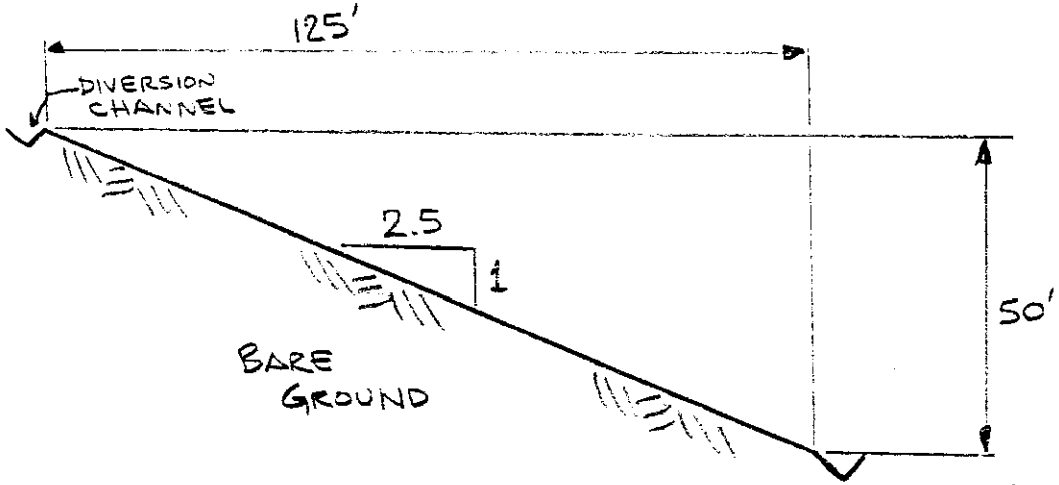
RUSLE2 Profile Erosion Calculation Record

Info: CLASS II/III FINAL CLOSURE

File: profiles\KHF2.5to1 bare

Inputs:
Location: California\Kings County\CA_Kings_ R6
Soil: 128 KETTLEMAN LOAM, 15 TO 30 PERCENT SLOPES\KETTLEMAN loam 85%
Slope length (horiz): 130 ft
Avg. slope steepness: 40 %

Management	*Vegetation*	*Yield units*	*Yield (# of units)*
BARE GROUND			



Contouring: a. rows up-and-down hill
Strips/barriers: (none)
Diversion/terrace, sediment basin: (none)
Subsurface drainage: (none)
Adjust res. burial level: Normal res. burial

Outputs:
T value: 3.0 t/ac/yr
Soil loss erod. portion: 11 t/ac/yr
Detachment on slope: 11 t/ac/yr
Soil loss for cons. plan: 11 t/ac/yr
Sediment delivery: 11 t/ac/yr

Crit. slope length: -- ft
Surf. cover after planting: -- %

Date	*Operation*	*Vegetation*	*Surf. res. cov. after op, %*
4/15/0	No operation		0

053-1910
KHF B19
6/9
Soil Loss

USDA NRCS Natural Resources Conservation Service

RUSLE2 Profile Erosion Calculation Record

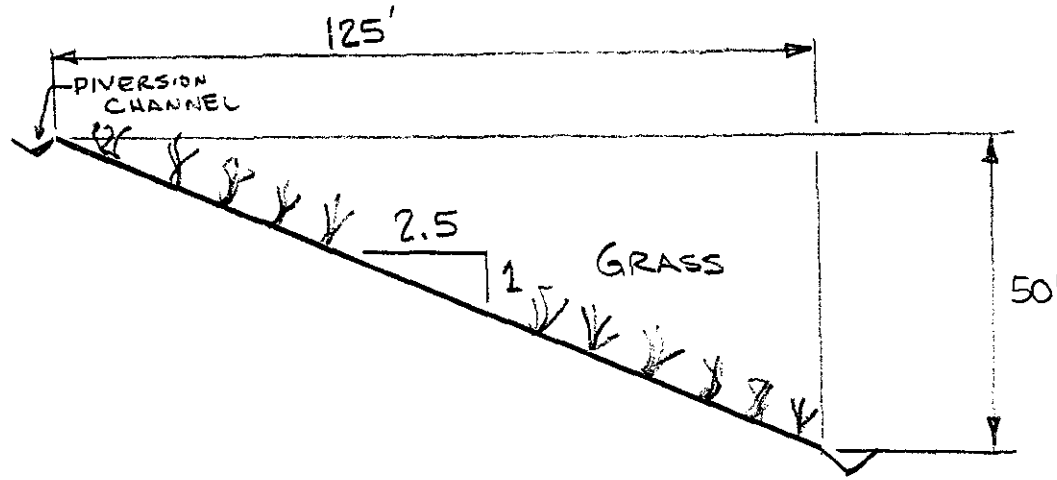
Info: Class I Landfill Final Cover 2.5:1 slope, vertical height 50 feet.

File: profiles\KHF2.5to1 grass

Inputs:
Location: California\Kings County\CA_Kings_ R6
Soil: 128 KETTLEMAN LOAM, 15 TO 30 PERCENT SLOPES\KETTLEMAN loam 85%
Slope length (horiz): 130 ft
Avg. slope steepness: 40 %

Management	*Vegetation*	*Yield units*	*Yield (# of units)*
Strip/Barrier Managements\Warm season grass; not harvested	Permanent cover not harvested\Grass, warm season permanent, not harvested (canopy reduced to 50% of base)	tons	1.5

Contouring: a. rows up-and-down hill
Strips/barriers: (none)
Diversion/terrace, sediment basin: (none)
Subsurface drainage: (none)
Adjust res. burial level: Normal res. burial



Outputs:
T value: 3.0 t/ac/yr
Soil loss erod. portion: 0.64 t/ac/yr
Detachment on slope: 0.64 t/ac/yr
Soil loss for cons. plan: 0.64 t/ac/yr
Sediment delivery: 0.64 t/ac/yr

Crit. slope length: -- ft
Surf. cover after planting: 0 %

Date	*Operation*	*Vegetation*	*Surf. res. cov. after op, %*
1/1/0	begin growth	Permanent cover not harvested\Grass, warm season permanent, not harvested	0

Soil Loss
053-910
KHF B-19
7/9

USDA NRCS Natural Resources Conservation Service

RUSLE2 Profile Erosion Calculation Record

Info: BUTRESS SLOPE

File: profiles\KHF2to1 bare

Inputs:
Location: California\Kings County\CA_Kings_ R6
Soil: 128 KETTLEMAN LOAM, 15 TO 30 PERCENT SLOPES\KETTLEMAN loam 85%
Slope length (horiz): 140 ft
Avg. slope steepness: 50 %

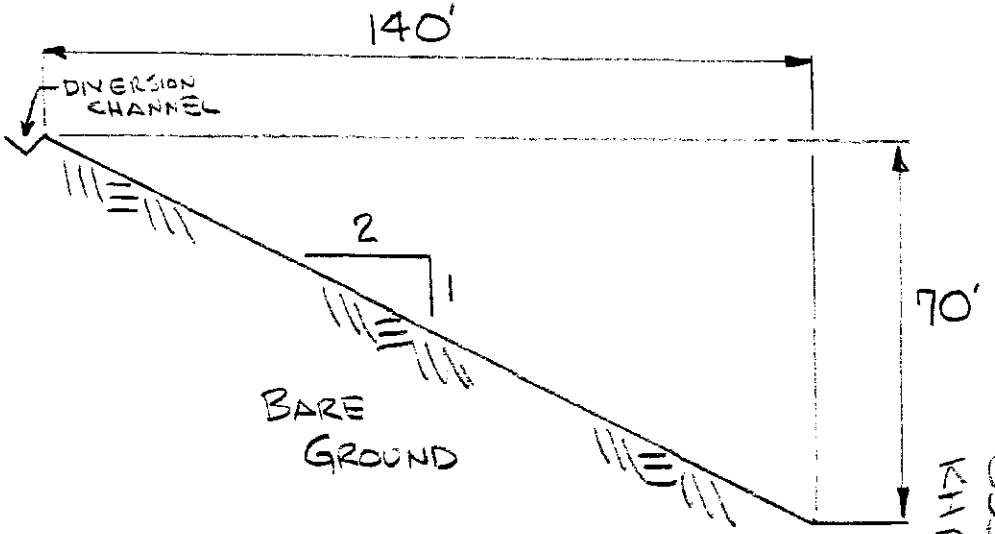
Management	Vegetation	Yield units	Yield (# of units)
BARE	GROUND		

Contouring: a. rows up-and-down hill
Strips/barriers: (none)
Diversion/terrace, sediment basin: (none)
Subsurface drainage: (none)
Adjust res. burial level: Normal res. burial

Outputs:
T value: 3.0 t/ac/yr
Soil loss erod. portion: 14 t/ac/yr
Detachment on slope: 14 t/ac/yr
Soil loss for cons. plan: 14 t/ac/yr
Sediment delivery: 14 t/ac/yr

Crit. slope length: -- ft
Surf. cover after planting: -- %

Date	Operation	Vegetation	Surf. res. cov. after op, %
4/15/0	No operation		0



SOIL LOSS
053-1910
KHF B19
8/9

USDA NRCS Natural Resources Conservation Service

RUSLE2 Profile Erosion Calculation Record

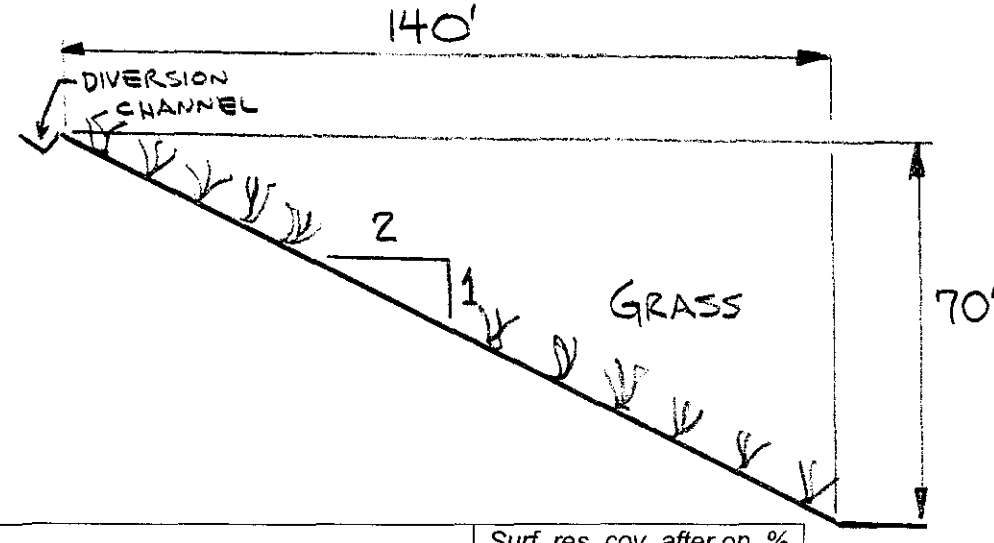
Info: Class I Landfill Stability Buttress 2:1 slope, vertical height 70 feet.

File: profiles\KHF2 to1 grass

Inputs:
Location: California\Kings County\CA_Kings_ R6
Soil: 128 KETTLEMAN LOAM, 15 TO 30 PERCENT SLOPES\KETTLEMAN loam 85%
Slope length (horiz): 140 ft
Avg. slope steepness: 50 %

Management	*Vegetation*	*Yield units*	*Yield (# of units)*
Strip/Barrier Managements\Warm season grass; not harvested	Permanent cover not harvested\Grass, warm season permanent, not harvested (canopy reduced to 50% of base)	tons	1.5

Contouring: a. rows up-and-down hill
Strips/barriers: (none)
Diversion/terrace, sediment basin: (none)
Subsurface drainage: (none)
Adjust res. burial level: Normal res. burial



Outputs:
T value: 3.0 t/ac/yr
Soil loss erod. portion: 0.83 t/ac/yr
Detachment on slope: 0.83 t/ac/yr
Soil loss for cons. plan: 0.83 t/ac/yr
Sediment delivery: 0.83 t/ac/yr

Crit. slope length: -- ft
Surf. cover after planting: 0 %

Date	*Operation*	*Vegetation*	*Surf. res. cov. after op, %*
1/1/0	begin growth	Permanent cover not harvested\Grass, warm season permanent, not harvested	0

Soil Loss
053-1910
KHF B19
9/9