Factor of Safety = 1.204 Side Force Inclination = 21.58
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Kingston 6 Section Y-Y, Multi-Stage Run With UTEXAS3
GYPSUM STACK Option 2, Earthquake = 0.11g
KIF Wet with Pond Surcharge Included

TABLE NO. 18
INFORMATION FOR CURRENT MODE OF SEARCH - All Circles Are Tangent to a Horizontal Line at Y = 730.000

Center Coordinates X	Center Coordinates Y	Radius	1-Stage Factor of Safety	Side Force Inclination (degrees)	Iterations
293.00	691.00	-39.00	Center of circle is below lowest point of slope - CIRCLE REJECTED		
593.00	691.00	-39.00	Center of circle is below lowest point of slope - CIRCLE REJECTED		
893.00	691.00	-39.00	Center of circle is below lowest point of slope - CIRCLE REJECTED		
293.00	991.00	261.00	1.898	2.78	5
893.00	991.00	261.00	2.769	10.49	4
293.00	1291.00	561.00	1.753	3.07	6
593.00	1291.00	561.00	1.376	28.98	8
893.00	1291.00	561.00	2.460	12.95	5
543.00	941.00	211.00	1.154	13.43	8
593.00	941.00	211.00	1.183	19.34	8
643.00	941.00	211.00	1.301	18.14	8
543.00	991.00	261.00	1.231	15.07	7
643.00	991.00	261.00	1.289	19.81	8
543.00	1041.00	311.00	1.284	16.82	8
593.00	1041.00	311.00	1.233	23.39	8
643.00	1041.00	311.00	1.289	21.68	8
493.00	891.00	161.00	1.246	6.04	7
543.00	891.00	161.00	1.091	11.87	9
593.00	891.00	161.00	1.183	16.67	8
493.00	941.00	211.00	1.252	6.75	7
493.00	991.00	261.00	1.284	7.51	7
493.00	841.00	111.00	1.372	4.64	7
543.00	841.00	111.00	1.055	10.44	12
593.00	841.00	111.00	1.257	13.56	7
493.00	791.00	61.00	See Message on Next Line(s)		
Last Trial Values =			114.000	43.16	1001
(Last Trial Values Shown Above Are Not Correct Final Values)					
FATAL ERROR IN CALCULATING FACTOR OF SAFETY					
SOLUTION DID NOT CONVERGE WITHIN1000 ITERATIONS					
543.00	791.00	61.00	1.156	8.66	7
Message on the following line(s) applies to the above circle					
DENOMINATOR IN EQUATIONS FOR F WAS SMALL FOR 2 SLICES					
FIRST AND LAST SLICES WHERE DENOMINATOR WAS LOW - 1 2					
593.00	791.00	61.00	1.662	9.83	6
Message on the following line(s) applies to the above circle					
DENOMINATOR IN EQUATIONS FOR F WAS SMALL FOR 4 SLICES					
FIRST AND LAST SLICES WHERE DENOMINATOR WAS LOW - 1 4					
513.00	811.00	81.00	1.230	5.78	7
543.00	811.00	81.00	1.068	9.65	8
573.00	811.00	81.00	1.226	11.41	7
513.00	841.00	111.00	1.148	6.99	7
573.00	841.00	111.00	1.110	13.76	9
513.00	871.00	141.00	1.135	7.68	7
543.00	871.00	141.00	1.071	11.30	10
573.00	871.00	141.00	1.100	15.31	8
533.00	831.00	101.00	1.063	9.06	8

543.00	831.00	101.00	1.055	10.13	10
553.00	831.00	101.00	1.057	11.42	10
533.00	841.00	111.00	1.066	9.20	8
553.00	841.00	111.00	1.054	11.78	11
533.00	851.00	121.00	1.071	9.42	10
543.00	851.00	121.00	1.058	10.73	12
553.00	851.00	121.00	1.057	12.11	11
563.00	831.00	101.00	1.075	12.60	9
563.00	841.00	111.00	1.067	13.02	9
563.00	851.00	121.00	1.065	13.40	10

At the end of the current mode of search the most critical
circle which was found has the following values -
X-center = 553.00 Y-center = 841.00 Radius = 111.00
Factor of Safety = 1.054 Side Force Inclination = 11.78

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Kingston 6 Section Y-Y, Multi-Stage Run With UTEXAS3
GYPSUM STACK Option 2, Earthquake = 0.11g
KIF Wet with Pond Surcharge Included

TABLE NO. 19
INFORMATION FOR CURRENT MODE OF SEARCH - All Circles Have the
Same Radius - Radius = 111.000

Center Coordinates X	Y	Radius	1-Stage Factor of Safety	Side Force Inclination (degrees)	Iterations
253.00	541.00	111.00	Center of circle is below lowest point of slope - CIRCLE REJECTED		
553.00	541.00	111.00	Center of circle is below lowest point of slope - CIRCLE REJECTED		
853.00	541.00	111.00	Center of circle is below lowest point of slope - CIRCLE REJECTED		
253.00	841.00	111.00	2.244	2.22	5
853.00	841.00	111.00	3.649	16.32	6

Message on the following line(s) applies to the above circle
DENOMINATOR IN EQUATIONS FOR F WAS SMALL FOR 8 SLICES
FIRST AND LAST SLICES WHERE DENOMINATOR WAS LOW - 3 10

253.00 1141.00 111.00 See Message on Next Line(s)
CIRCLE DOES NOT INTERSECT SLOPE
553.00 1141.00 111.00 See Message on Next Line(s)
CIRCLE DOES NOT INTERSECT SLOPE
853.00 1141.00 111.00 See Message on Next Line(s)
CIRCLE DOES NOT INTERSECT SLOPE

503.00	791.00	111.00	Bottom of circle exceeds allowable depth - CIRCLE REJECTED		
553.00	791.00	111.00	Bottom of circle exceeds allowable depth - CIRCLE REJECTED		
603.00	791.00	111.00	Bottom of circle exceeds allowable depth - CIRCLE REJECTED		
503.00	841.00	111.00	1.235	5.74	7
603.00	841.00	111.00	1.307	13.63	7

503.00 891.00 111.00 See Message on Next Line(s)
CIRCLE DOES NOT INTERSECT SLOPE
553.00 891.00 111.00 See Message on Next Line(s)
CIRCLE DOES NOT INTERSECT SLOPE
603.00 891.00 111.00 See Message on Next Line(s)
CIRCLE DOES NOT INTERSECT SLOPE

523.00	811.00	111.00	Bottom of circle exceeds allowable depth - CIRCLE REJECTED		
553.00	811.00	111.00	Bottom of circle exceeds allowable depth - CIRCLE REJECTED		
583.00	811.00	111.00	Bottom of circle exceeds allowable depth - CIRCLE REJECTED		
523.00	841.00	111.00	1.091	8.21	8

583.00	841.00	111.00	1.188	13.69	7
523.00	871.00	111.00	See Message on Next Line(s)		

CIRCLE DOES NOT INTERSECT SLOPE

553.00	871.00	111.00	2.299	21.67	5
583.00	871.00	111.00	2.501	19.69	5
543.00	831.00	111.00	1.413	10.97	7
553.00	831.00	111.00	1.393	11.92	7
563.00	831.00	111.00	1.393	12.89	7
543.00	841.00	111.00	1.055	10.44	12
563.00	841.00	111.00	1.067	13.02	9
543.00	851.00	111.00	1.467	14.92	6
553.00	851.00	111.00	1.525	16.19	6
563.00	851.00	111.00	1.597	16.78	8

At the end of the current mode of search the most critical
circle which was found has the following values -
X-center = 553.00 Y-center = 841.00 Radius = 111.00
Factor of Safety = 1.054 Side Force Inclination = 11.78

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Kingston 6 Section Y-Y, Multi-Stage Run With UTEXAS3
GYPSUM STACK Option 2, Earthquake = 0.11g
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TABLE NO. 21
***** 1-STAGE FINAL CRITICAL CIRCLE INFORMATION *****
X Coordinate of Center - - - - - - - 553.000
Y Coordinate of Center - - - - - - - 841.000
Radius - - - - - - - - - - - - - - - - 111.000
Factor of Safety - - - - - - - - - - 1.054
Side Force Inclination - - - - - - - 11.78

Number of circles tried - - - - - - 159
No. of circles F calc. for - - - - - 120

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GYPSUM STACK Option 2, Earthquake = 0.11g
KIF Wet with Pond Surcharge Included

TABLE NO. 26
****
* Coordinate, Weight, Strength and Pore Water Pressure *
* Information for Individual Slices for Conventional *
* Computations or First Stage of Multi-Stage Computations. *
* (Information is for the Critical Shear Surface in the *
* Case of an Automatic Search.) *
****

Slice No.	X	Y	Slice Weight	Matl. Type	Cohesion	Friction Angle	Pore Pressure
	489.4	750.0					
1	491.9	748.4	799.7	6	.00	32.10	599.1
	494.3	746.8					
2	496.8	745.3	2412.0	6	.00	32.10	790.8
	499.3	743.9					
3	501.9	742.5	3975.9	6	.00	32.10	966.2
	504.5	741.2					
4	506.8	740.1	4858.7	6	.00	32.10	1117.7
	509.2	739.0					
5	511.9	737.9	6697.0	7	100.00	14.50	1252.7
	514.6	736.8					
6	515.8	736.4	3174.0	7	100.00	14.50	1345.3
	516.9	736.0					
7	519.7	735.2	8935.2	7	100.00	14.50	1425.1
	522.4	734.3					
8	525.3	733.6	11049.0	7	100.00	14.50	1524.9
	528.1	732.8					
9	530.9	732.3	13033.2	7	100.00	14.50	1606.3

	533.8	731.7					
10	536.6	731.3	14861.4	7	100.00	14.50	1669.1
	539.5	730.8					
11	540.2	730.7	3828.1	7	100.00	14.50	1700.9
	540.9	730.7					
12	543.8	730.4	16936.0	7	100.00	14.50	1721.0
	546.7	730.2					
13	546.8	730.2	639.3	7	100.00	14.50	1736.4
	546.9	730.2					
14	549.8	730.1	18519.3	7	100.00	14.50	1742.0
	552.7	730.0					
15	552.9	730.0	964.9	7	100.00	14.50	1747.2
	553.0	730.0					
16	555.9	730.1	19900.1	7	100.00	14.50	1742.5
	558.8	730.2					
17	561.7	730.4	20973.6	7	100.00	14.50	1723.5
	564.6	730.6					
18	567.5	731.0	21800.2	7	100.00	14.50	1685.6
	570.4	731.4					
19	573.2	731.9	22372.8	7	100.00	14.50	1628.9
	576.1	732.4					
20	578.9	733.1	22688.4	7	100.00	14.50	1553.5
	581.7	733.8					

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Kingston 6 Section Y-Y, Multi-Stage Run With UTEXAS3
GYPSUM STACK Option 2, Earthquake = 0.11g
KIF Wet with Pond Surcharge Included

TABLE NO. 26

```
***********************************************************
*  Coordinate, Weight, Strength and Pore Water Pressure   *
*  Information for Individual Slices for Conventional     *
*  Computations or First Stage of Multi-Stage Computations. *
*  (Information is for the Critical Shear Surface in the  *
*  Case of an Automatic Search.)                          *
***********************************************************
```

Slice No.	X	Y	Slice Weight	Matl. Type	Cohesion	Friction Angle	Pore Pressure
	581.7	733.8					
21	584.5	734.6	22747.6	7	100.00	14.50	1459.7
	587.3	735.4					
22	590.0	736.4	22554.8	7	100.00	14.50	1347.7
	592.8	737.4					
23	594.8	738.2	16511.2	7	100.00	14.50	1236.4
	596.8	739.0					
24	598.4	739.7	13211.3	6	.00	32.10	1140.6
	600.0	740.4					
25	602.6	741.7	21119.3	6	.00	32.10	1014.6
	605.2	743.0					
26	606.0	743.5	6831.9	6	.00	32.10	904.7
	606.9	744.0					
27	609.4	745.4	19258.3	6	.00	32.10	783.6
	611.9	746.9					
28	614.3	748.5	17098.6	6	.00	32.10	591.3
	616.7	750.1					
29	619.1	751.9	14877.3	6	.00	32.10	383.1
	621.4	753.6					
30	621.7	753.8	1446.5	6	.00	32.10	263.2
	621.9	754.0					
31	623.5	755.2	8997.3	6	.00	32.10	171.9
	625.0	756.5					
32	625.7	757.1	4039.3	6	.00	32.10	53.4
	626.4	757.8					
33	626.6	757.9	719.4	5	180.00	36.00	7.2
	626.7	758.0					
34	627.9	759.1	6292.0	5	180.00	36.00	.0
	629.0	760.1					
35	631.1	762.2	10132.0	4	110.00	36.00	.0
	633.2	764.2					

36	635.1	766.4	8334.7	4	110.00	36.00	.0
	637.1	768.5					
37	638.9	770.8	6537.4	4	110.00	36.00	.0
	640.8	773.0					
38	641.1	773.5	1152.2	4	110.00	36.00	.0
	641.5	774.0					
39	643.2	776.4	4378.9	1	100.00	43.00	.0
	644.9	778.7					
40	646.5	781.2	2649.7	1	100.00	43.00	.0
	648.0	783.6					

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Kingston 6 Section Y-Y, Multi-Stage Run With UTEXAS3
GYPSUM STACK Option 2, Earthquake = 0.11g
KIF Wet with Pond Surcharge Included

TABLE NO. 26

```
***********************************************************
*  Coordinate, Weight, Strength and Pore Water Pressure   *
*  Information for Individual Slices for Conventional     *
*  Computations or First Stage of Multi-Stage Computations. *
*  (Information is for the Critical Shear Surface in the  *
*  Case of an Automatic Search.)                           *
***********************************************************
```

Slice No.	X	Y	Slice Weight	Matl. Type	Cohesion	Friction Angle	Pore Pressure
	648.0	783.6					
41	648.1	783.7	46.3	1	100.00	43.00	.0
	648.1	783.8					

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Kingston 6 Section Y-Y, Multi-Stage Run With UTEXAS3
GYPSUM STACK Option 2, Earthquake = 0.11g
KIF Wet with Pond Surcharge Included

TABLE NO. 27

```
*********************************************************
*  Seismic Forces and Forces Due to Surface Pressures for *
*  Individual Slices for Conventional Computations or the *
*  First Stage of Multi-Stage Computations.              *
*  (Information is for the Critical Shear Surface in the *
*  Case of an Automatic Search.)                         *
*********************************************************
```

				FORCES DUE TO SURFACE PRESSURES			
Slice No.	X	Seismic Force	Y for Seismic Force	Normal Force	Shear Force	X	Y
1	491.9	88.	749.2	2421.	0.	491.9	750.0
2	496.8	265.	747.7	2501.	0.	496.8	750.0
3	501.9	437.	746.3	2575.	0.	501.9	750.0
4	506.8	534.	745.0	2376.	0.	506.8	750.0
5	511.9	737.	744.0	2695.	0.	511.9	750.0
6	515.8	349.	743.3	1141.	0.	515.8	750.0
7	519.7	983.	743.1	2917.	0.	519.7	750.9
8	525.3	1215.	743.2	2961.	0.	525.3	752.8
9	530.9	1434.	743.5	2997.	0.	530.9	754.7
10	536.6	1635.	744.0	3024.	0.	536.6	756.6
11	540.2	421.	744.3	730.	0.	540.2	757.8
12	543.8	1863.	744.8	762.	0.	543.8	759.0
13	546.8	70.	745.3	27.	0.	546.8	760.0
14	549.8	2037.	745.8	0.	0.	549.8	761.0
15	552.9	106.	746.3	0.	0.	552.9	762.0
16	555.9	2189.	746.9	0.	0.	555.9	763.0
17	561.7	2307.	748.1	0.	0.	561.7	764.9
18	567.5	2398.	749.4	0.	0.	567.5	766.9
19	573.2	2461.	750.9	0.	0.	573.2	768.8
20	578.9	2496.	752.5	0.	0.	578.9	770.7

21	584.5	2502.	754.2	0.	0.	584.5	772.5
22	590.0	2481.	756.0	0.	0.	590.0	774.4
23	594.8	1816.	757.7	0.	0.	594.8	776.0
24	598.4	1453.	759.0	0.	0.	598.4	777.2
25	602.6	2323.	760.7	0.	0.	602.6	778.6
26	606.0	752.	762.1	0.	0.	606.0	779.7
27	609.4	2118.	763.2	0.	0.	609.4	780.0
28	614.3	1881.	764.7	0.	0.	614.3	780.0
29	619.1	1637.	766.2	0.	0.	619.1	780.0
30	621.7	159.	767.1	0.	0.	621.7	780.0
31	623.5	990.	768.1	0.	0.	623.5	780.5
32	625.7	444.	769.3	0.	0.	625.7	781.3
33	626.6	79.	769.8	0.	0.	626.6	781.6
34	627.9	692.	770.6	0.	0.	627.9	782.0
35	631.1	1115.	772.7	0.	0.	631.1	783.1
36	635.1	917.	775.5	0.	0.	635.1	784.4
37	638.9	719.	778.3	0.	0.	638.9	785.7
38	641.1	127.	780.0	0.	0.	641.1	786.4
39	643.2	482.	781.7	0.	0.	643.2	787.1

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GYPSUM STACK Option 2, Earthquake = 0.11g
KIF Wet with Pond Surcharge Included

TABLE NO. 27

```
*************************************************************
*  Seismic Forces and Forces Due to Surface Pressures for    *
*  Individual Slices for Conventional  Computations or the   *
*  First Stage of Multi-Stage Computations.                   *
*  (Information is for the Critical Shear Surface in the     *
*  Case of an Automatic Search.)                              *
*************************************************************
```

Slice No.	X	Seismic Force	Y for Seismic Force	FORCES DUE TO SURFACE PRESSURES: Normal Force	Shear Force	X	Y
40	646.5	291.	784.7	0.	0.	646.5	788.2
41	648.1	5.	786.2	0.	0.	648.1	788.7

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Kingston 6 Section Y-Y, Multi-Stage Run With UTEXAS3
GYPSUM STACK Option 2, Earthquake = 0.11g
KIF Wet with Pond Surcharge Included

TABLE NO. 29

```
*******************************************************************
*  Information Generated During Iterative Solution for the Factor  *
*  of Safety and Side Force Inclination by Spencer's Procedure     *
*******************************************************************
```

```
        Trial     Trial
        Factor   Side Force    Force      Moment                 Delta
Iter-    of     Inclination  Imbalance  Imbalance    Delta-F     Theta
ation  Safety    (degrees)     (lbs.)   (ft.-lbs.)              (degrees)

   1   3.00000    15.0000   .8263E+05  -.4671E+08
First-order corrections to F and THETA .........  -.519E+01 -.258E+00
Values factored by  .964E-01 - Deltas too large   -.500E+00 -.248E-01

   2   2.50000    14.9752   .7311E+05  -.4132E+08
First-order corrections to F and THETA .........  -.322E+01 -.293E+00
Values factored by  .155E+00 - Deltas too large   -.500E+00 -.455E-01

   3   2.00000    14.9297   .5897E+05  -.3330E+08
First-order corrections to F and THETA .........  -.168E+01 -.365E+00
Values factored by  .298E+00 - Deltas too large   -.500E+00 -.109E+00

   4   1.50000    14.8209   .3552E+05  -.1999E+08
```

```
First-order corrections to F and THETA .........  -.574E+00 -.587E+00
Values factored by  .871E+00 - Deltas too large   -.500E+00 -.511E+00

   5   1.00000    14.3095  -.1281E+05   .7753E+07
First-order corrections to F and THETA .........   .246E+00  .104E+02
Values factored by  .829E+00 - Deltas too large    .204E+00  .859E+01

   6   1.20441    22.9039  -.1095E+05   .6878E+07
On iteration   6 the following slices produced
low denominators in the equations for the factor
of safety -    1   2
First-order corrections to F and THETA .........  -.780E+00 -.275E+02
Values factored by  .313E+00 - Deltas too large   -.244E+00 -.859E+01

   7    .96043    14.3095  -.1945E+05   .1162E+08
First-order corrections to F and THETA .........   .152E+00  .263E+01
Second-order correction - Iteration   1 ........   .181E+00  .263E+01
Second-order correction - Iteration   2 ........   .184E+00  .263E+01
Second-order correction - Iteration   3 ........   .184E+00  .263E+01

   8   1.14402    16.9407   .1017E+04   .1106E+06
First-order corrections to F and THETA .........  -.870E-01 -.418E+01
Second-order correction - Iteration   1 ........  -.750E-01 -.418E+01
Second-order correction - Iteration   2 ........  -.748E-01 -.418E+01
Second-order correction - Iteration   3 ........  -.748E-01 -.418E+01

   9   1.06919    12.7579   .1882E+03   .1131E+04
First-order corrections to F and THETA .........  -.147E-01 -.939E+00
Second-order correction - Iteration   1 ........  -.143E-01 -.939E+00
Second-order correction - Iteration   2 ........  -.143E-01 -.939E+00

  10   1.05490    11.8193   .1321E+01   .3805E+04
First-order corrections to F and THETA .........  -.545E-03 -.405E-01
Second-order correction - Iteration   1 ........  -.545E-03 -.405E-01

  11   1.05436    11.7788  -.9681E-02   .1469E+02
First-order corrections to F and THETA .........  -.940E-06 -.771E-04

Factor of Safety - - - - - - - -     1.054
Side Force Inclination - - - - -     11.78
Number of Iterations - - - - - -    11
```

1 UTEXAS3 - VER. 1.209 - 2/28/98 - (C) 1985-1998 S. G. WRIGHT
One (1) copy licensed to Parsons I & T, Cincinnati, OH
Date: 12: 4:2004 Time: 1:14:13 Input file: kfgyye3.dat
Kingston 6 Section Y-Y, Multi-Stage Run With UTEXAS3
GYPSUM STACK Option 2, Earthquake = 0.11g
KIF Wet with Pond Surcharge Included

TABLE NO. 38

```
***************************************************************
*  Final Results for Stresses Along the Shear Surface         *
*  (Results for Critical Shear Surface in Case of a Search.)  *
***************************************************************
```

SPENCER'S PROCEDURE USED TO COMPUTE FACTOR OF SAFETY
Factor of Safety = 1.054 Side Force Inclination = 11.78 Degrees

-------- VALUES AT CENTER OF BASE OF SLICE---------

Slice No.	X-center	Y-center	Total Normal Stress	Effective Normal Stress	Shear Stress
1	491.9	748.4	1015.0	415.9	247.5
2	496.8	745.3	1473.1	682.3	405.9
3	501.9	742.5	1817.8	851.6	506.7
4	506.8	740.1	2072.9	955.2	568.3
5	511.9	737.9	2060.4	807.7	293.0
6	515.8	736.4	2189.3	844.0	301.9
7	519.7	735.2	2451.3	1026.1	346.5
8	525.3	733.6	2792.2	1267.3	405.7
9	530.9	732.3	3089.5	1483.2	458.6
10	536.6	731.3	3345.1	1676.0	505.9

11	540.2	730.7	3486.9	1786.0	532.9
12	543.8	730.4	3177.8	1456.9	452.2
13	546.8	730.2	3290.2	1553.8	476.0
14	549.8	730.1	3244.4	1502.5	463.4
15	552.9	730.0	3341.6	1594.4	485.9
16	555.9	730.1	3420.7	1678.2	506.5
17	561.7	730.4	3549.4	1825.9	542.7
18	567.5	731.0	3641.1	1955.5	574.5
19	573.2	731.9	3696.7	2067.8	602.1
20	578.9	733.1	3717.2	2163.7	625.6
21	584.5	734.6	3703.5	2243.8	645.2
22	590.0	736.4	3656.6	2309.0	661.2
23	594.8	738.2	3591.0	2354.7	672.4
24	598.4	739.7	3378.4	2237.8	1331.4
25	602.6	741.7	3245.0	2230.4	1327.0
26	606.0	743.5	3125.0	2220.4	1321.0
27	609.4	745.4	2916.5	2132.9	1269.0
28	614.3	748.5	2562.1	1970.9	1172.6
29	619.1	751.9	2198.4	1815.4	1080.1
30	621.7	753.8	1996.1	1732.9	1031.0
31	623.5	755.2	1887.0	1715.1	1020.4
32	625.7	757.1	1754.1	1700.7	1011.9
33	626.6	757.9	1566.2	1559.0	1245.0
34	627.9	759.1	1490.2	1490.2	1197.6
35	631.1	762.2	1327.0	1327.0	1018.7
36	635.1	766.4	1079.5	1079.5	848.2
37	638.9	770.8	834.4	834.4	679.3
38	641.1	773.5	690.6	690.6	580.2
39	643.2	776.4	491.9	491.9	529.9

1

-------- VALUES AT CENTER OF BASE OF SLICE---------

Slice No.	X-center	Y-center	Total Normal Stress	Effective Normal Stress	Shear Stress
40	646.5	781.2	276.6	276.6	339.5
41	648.1	783.7	173.8	173.8	248.6

CHECK SUMS - (ALL SHOULD BE SMALL)
SUM OF FORCES IN VERTICAL DIRECTION = .01 (= .109E-01)
SHOULD NOT EXCEED .100E+03
SUM OF FORCES IN HORIZONTAL DIRECTION = .02 (= .208E-01)
SHOULD NOT EXCEED .100E+03
SUM OF MOMENTS ABOUT COORDINATE ORIGIN = -12.29 (= -.123E+02)
SHOULD NOT EXCEED .100E+03
SHEAR STRENGTH/SHEAR FORCE CHECK-SUM = .00 (= .484E-02)
SHOULD NOT EXCEED .100E+03

1 UTEXAS3 - VER. 1.209 - 2/28/98 - (C) 1985-1998 S. G. WRIGHT
One (1) copy licensed to Parsons I & T, Cincinnati, OH
Date: 12: 4:2004 Time: 1:14:13 Input file: kfgyye3.dat
Kingston 6 Section Y-Y, Multi-Stage Run With UTEXAS3
GYPSUM STACK Option 2, Earthquake = 0.11g
KIF Wet with Pond Surcharge Included

TABLE NO. 39
****
* Final Results for Side Forces and Stresses Between Slices. *
* (Results for Critical Shear Surface in Case of a Search.) *
****

SPENCER'S PROCEDURE USED TO COMPUTE FACTOR OF SAFETY
Factor of Safety = 1.054 Side Force Inclination = 11.78 Degrees

--------------- VALUES AT RIGHT SIDE OF SLICE ----------------

Slice No.	X-Right	Side Force	Y-Coord. of Side Force Location	Fraction of Height	Sigma at Top	Sigma at Bottom
1	494.3	4456.	748.9	.653	2612.1	112.7

2	499.3	10692.	747.5	.592	2642.0	764.5
3	504.5	17886.	746.3	.576	2885.6	1083.7
4	509.2	24714.	745.3	.573	3157.0	1241.8
5	514.6	30105.	744.9	.609	3699.7	782.1
6	516.9	32274.	744.7	.618	3870.0	654.5
7	522.4	38545.	744.4	.574	3101.1	1196.8
8	528.1	44736.	744.1	.540	2593.6	1599.7
9	533.8	50558.	744.0	.513	2228.7	1905.7
10	539.5	55763.	744.0	.493	1951.8	2135.0
11	540.9	56898.	744.0	.488	1894.9	2179.9
12	546.7	59481.	744.3	.473	1643.5	2270.8
13	546.9	59559.	744.3	.473	1635.1	2273.7
14	552.7	60782.	744.6	.459	1401.1	2325.3
15	553.0	60819.	744.7	.458	1390.1	2327.1
16	558.8	61057.	745.2	.445	1186.2	2348.7
17	564.6	60259.	745.9	.434	1010.2	2332.7
18	570.4	58370.	746.9	.425	861.7	2273.2
19	576.1	55371.	748.0	.418	741.3	2165.1
20	581.7	51281.	749.5	.415	650.9	2003.3
21	587.3	46153.	751.3	.417	593.7	1782.1
22	592.8	40073.	753.5	.426	575.1	1494.0
23	596.8	34998.	755.6	.442	591.0	1230.0
24	600.0	32913.	756.4	.429	498.7	1230.9
25	605.2	28976.	758.0	.412	369.2	1189.6
26	606.9	27549.	758.6	.407	332.1	1164.7
27	611.9	23072.	760.7	.416	338.8	1026.7
28	616.7	18546.	763.1	.435	369.0	846.6
29	621.4	14253.	765.9	.467	424.7	632.0
30	621.9	13823.	766.3	.472	432.4	607.4
31	625.0	11134.	768.5	.488	411.7	477.4
32	626.4	9930.	769.6	.499	406.1	412.6
33	626.7	9812.	769.7	.496	397.4	416.5
34	629.0	8711.	770.6	.472	318.5	448.3
35	633.2	6322.	773.0	.447	215.6	418.2
36	637.1	4028.	775.6	.429	137.4	339.5
37	640.8	2010.	778.9	.443	98.0	198.6
38	641.5	1636.	779.8	.463	99.3	156.1
39	644.9	603.	782.6	.437	41.1	90.8
40	648.0	8.	785.6	.387	.5	2.7

1

--------------- VALUES AT RIGHT SIDE OF SLICE ----------------

Slice No.	X-Right	Side Force	Y-Coord. of Side Force Location	Fraction of Height	Sigma at Top	Sigma at Bottom
41	648.1	0.	1071.3	ABOVE	.6	-.6

```
CHECK SUMS - (ALL SHOULD BE SMALL)
SUM OF FORCES IN VERTICAL DIRECTION     =        .01  (=  .109E-01)
     SHOULD NOT EXCEED       .100E+03
SUM OF FORCES IN HORIZONTAL DIRECTION   =        .02  (=  .208E-01)
     SHOULD NOT EXCEED       .100E+03
SUM OF MOMENTS ABOUT COORDINATE ORIGIN  =     -12.29  (= -.123E+02)
     SHOULD NOT EXCEED       .100E+03
SHEAR STRENGTH/SHEAR FORCE CHECK-SUM    =        .00  (=  .484E-02)
     SHOULD NOT EXCEED       .100E+03
```

ATTACHMENT 5

Peak ground Acceleration Evaluation

PARSONS	CLIENT NAME: TVA PROJECT NAME: Kingston Ash Disposal Facility (KIF)				JOB NO.: 55090501
STANDARD CALCULATION SHEET	SUBJECT: **Peak Ground Acceleration for Liquefaction & Stability Evaluation**				CALC NO.: KIF-0-DC-024-C-001
	REVISION	0	1	2	3
	ORIGINATOR:	Y.S.Shah			
	REVIEWER:	Anundson			
	DATE:	04-24-04			

PURPOSE

To determine Peak Ground Acceleration (PGA) for evaluation of the pseudo-static (global) stability and veneer stability of the proposed final gypsum-ash stack (Elev. @ top ~ 970') and for liquefaction potential of the foundation soils/materials underlying the stack.

REFERENCES

1. RCRA Subtitle D (258), *Seismic Design Guidance for Municipal Waste Landfill Facilities*, EPA/600/R-95/051 dated April 1995. (Subtitle D258)
2. Tennessee Division of Solid Waste, *Technical Guidance document, dated 7/29/93,* (Guidance document)

ASSUMPTIONS

1. Bedrock PGA at site = 0.22g (Ref. 2)
2. Existing soil overburden @ site below stack ("Free-Field Condition"):

   G.S. @ Elev. 763'±

   Elev. 763' – Elev, 758' … Compact Fly Ash (FA) Base

   Elev. 758' – Elev. 739' … FA + Bottom Ash (BA), medium compact (considering future consolidation under stack)

   Elev. 739' – Elev. 729' … FA, loose

   Elev. 729' – Elev. 714' … Natural Clay, stiff

   Elev. 714' – Elev. 703'+ … Residuum (SC-SM), stiff to hard

   Below Elev. 703' + …… Bedrock (Shale)

   Thus, the total thickness of the (primarily stiff) soil overburden = 60' << 100'.
3. Stack height, H = 970' – 763' = 207'.

DETERMINATION OF PGA

In accordance with the procedure stated on Pages 45 and 46 of Subtitle 258,

Step 1: The site can be classified as STIFF, considering consolidation of foundation materials under the weight of the gradually built 207 feet high stack and the soil-overburden depth much less than 100 feet.

Step 2: Free-Field Acceleration for stiff site = Bedrock PGA = 0.22g.

Step 3: Using Figures 4.4 and 4.5 (analytical data median curve) and PGA = 0.22g, the Peak acceleration at the top of the stack ~ 0.31g

Step 4: Using the Makdisi and Seed average curve in Fig. 4.6 with Crest Acceleration value of 0.31g, the values of PGA at various depths below the sliding mass and the average PGA over the entire length of the sliding surface are estimated as follows:

Depth Below Crest	Peak or Max. Acceleration
0	0.32g
0.1H	0.96 x 0.31g = 0.30g
0.2H	0.90 x 0.31g = 0.28g
0.3H	0.80 x 0.31g = 0.25g
0.4H	0.70 x 0.31g = 0.22g
0.5H	0.60 x 0.31g = 0.19g
0.6H	0.56 x 0.31g = 0.17g
0.7H	0.44 x 0.31g = 0.14g
0.8H	0.41 x 0.31g = 0.13g
0.9H	0.38 x 0.31g = 0.12g
1.0H	0.34 x 0.31g = 0.10g
Ave. Max. Accel or PGA	= 2.22/11 = **0.20g**

Subtitle 258 states (P. 46) that this stepped procedure is a "*simplified, decoupled analysis that ignores interaction between the waste mass and the ground. Analyses of the coupled response of landfills and foundation soils indicates that this simplified, decoupled analysis will yield a conservative upper bound estimate of the combined amplification potential of a landfill and its foundation (Bray, et al. 1995; GeoSyntec, 1994).*"

Subtitle 258, also on the same page, recommends using the average Peak Acceleration (0.20g) computed above as PGA for the (global) slope stability and deformation potential evaluations, however, for the cover, it recommends using the crest acceleration (0.31g). On the other hand, the Guidance Document suggests (P.14) using the pseudo-static coefficient for the veneer (or cover) stability evaluation by defining, a_{max} as "*the pseudo-static seismic coefficient*". This is perhaps because it states, "*it is the opinion of the Solid Waste Division that this type of failure mechanism will generally not result in a catastrophic type of failure. Therefore, some flexibility will be given for the design of the stability of landfill cover systems*". Apparently, TDSW is taking a practical approach for their requirement with respect to the veneer/cover stability evaluation; whereas the Subtitle 258 approach, although theoretically reasonable, is apparently conservative.

Further, for the (global) pseudo-static slope stability evaluation, Subtitle 258 recommends use of the earthquake coefficient, k_s, and recommends that the value of this coefficient be equal to 0.5 times the peak acceleration (= 0.20g, as calculated above). Thus, k_s = 0.20g/2 = 0.10g is recommended for the pseudo-static slope stability evaluation. As this is an empirical value, K_s = 0.22g/2 = 0.11g is used for this study conservatively.

For evaluation of foundation soil liquefaction potential, Ref. 1 (on P. 42) recommends using the free-field motion; i.e. PGA (0.22g).

CONCLUSION

1. For evaluation of the pseudo-static global stability, use k_s = 0.11g.
2. For evaluation of the liquefaction potential of foundation soils/materials, use PGA = 0.22g.
3. For evaluation of the seismic deformation potential, if required, use 0.20g.
4. For evaluation of the veneer stability, use $a_{max} = k_s$ = 0.11g per the guidance document and verify stability using a_{max} = 0.20g.

END

PARSONS	CLIENT NAMETVA PROJECT NAME: Kingston Ash Disposal Facility				JOB NO.: 51020101
STANDARD CALCULATION SHEET	SUBJECT: Ave. Maximum (Peak) Ground Acceleration for Stability Evaluation				CALC NO.: KIF-0-DC-024-C-002
	REVISION	~~0~~ 1	~~1~~ 2	~~2~~	~~3~~	Page 1 of ~~6~~ 2
	ORIGINATOR:	Y.S.Shah				
	REVIEWER:					
	DATE:	11-19-04				

• Addendum to calc. dated 04-24-04.

Consider CPT 9, 10 & 12A in the expansion area:

	GS Elev.	Refusal Depth
CPT 9	-- 764.4'	49.4'
CPT 10	-- 762.6'	47.4'
CPT 12A	-- 763.9'	61.5'
Ave.	763.6'	52.8' → ∴ T/Rock @ 710.8'
Use	763'±	-- 60' --→ " " 703'

Thus, consider CPT 12A for this calc.

Per Table 4.1 of "Seismic Analysis & Design Considerations for Municipal Solid Waste Landfills", EPA, March 2-3, 1994 @ Saratoga Springs, NY,

Shear Mod. G_{max} (kg/cm²) $= \begin{cases} 111.8\,(N_{60})^{0.611} & \text{-- Sand} \\ 157.5\,(N_{60})^{0.607} & \text{-- clay} \end{cases}$

$\therefore G_{max}(psf) = \begin{cases} 2.287\times10^5\,(N_{60})^{0.611} \\ 3.222\times10^5\,(N_{60})^{0.607} \end{cases}$ -- 1 kg/cm² = 2046 psf

Shear Wave Velo. V_s (ft/sec) $= \left\{ \dfrac{32.2\ G_{max}(psf)}{\gamma\,(pcf)} \right\}^{1/2}$

PARSONS	CLIENT NAME TVA PROJECT NAME: Kingston Ash Disposal Facility				JOB NO.: 51020101
STANDARD CALCULATION SHEET	SUBJECT: **Ave. Maximum (Peak) Ground Acceleration for Stability Evaluation**				CALC NO.: KIF-0-DC-024-C-002
	REVISION	1	2		Page 2 of 2
	ORIGINATOR:	Y.S.Shah			
	REVIEWER:				
	DATE:	11-19-04			

$$= \begin{cases} 2{,}714\,(N_{60})^{0.3055}/\sqrt{\gamma} & \text{-- clay} \\ 3{,}222\,(N_{60})^{0.3035}/\sqrt{\gamma} & \text{-- sand} \end{cases}$$

From CPT-12A table (Mactec report, dated May 4, 2004)

Ave. N_{60} --- 0-7' --- 225.9/9 = 25 -- sand
7'-13' --- 338.2/19 = 18 -- clay
13'-30' --- 1366.3/52 = 26 -- sand
30'-34' --- 68/13 = 5 -- clay
34'-60' --- 1533.3/79 = 19 -- sand
(Ignored values over 50)

∴ Ave. N_{60} in sand = (25×7' + 26×17' + 19×26')/50' = 22
" " clay = (18×6' + 5×4')/10' = 12.8, say 12

$$\therefore V_s = \begin{cases} 2{,}714\,(22)^{0.3055}/\sqrt{115} = \underline{651}\ \text{ft/sec.} & \text{-- } \gamma = 115 \text{ pcf assumed} \\ 3{,}222\,(12)^{0.3035}/\sqrt{110} = \underline{653}\ \text{ft/sec.} & \text{-- } \gamma = 110 \text{ " "} \end{cases}$$

Thus, the average $V_s \sim 650$ ft/sec. for the 60' soil O.B.
↓
∴ "Medium Stiff" soil per Subtitle 258, P. 45

If the 100' requirement is ignored & soil OB treated Med. Stiff,

Ave. PGA = (0.22g [bedrock] + 0.31g [Fig. 4.5])/2 = 0.265g ---
∴ Crest " = 0.34g --- (Fig. 4.5)
∴ Ave. PGA along sliding surface (pseudo-static) failure
= 0.64 (Fig. 4-7) × 0.34g = 0.22g → ∴ k_s = 0.11g -- o.k.

ATTACHMENT 6

VENEER SLOPE STABILITY ANALYSIS

PARSONS	CLIENT NAME: TVA PROJECT NAME: Kingston Fossil Plant -				JOB NO.: 55090501	
STANDARD CALCULATION SHEET	SUBJECT: **Veneer Slope Stability Analysis & Recommendations**				CALC NO.: DC-55090501-002	
	REVISION	0	1	2	3	
	ORIGINATOR:	G.McNulty	G. McNulty			Page 1 Of 7
	REVIEWER:	Y. Shah	Y. Shah			
	DATE:	11-17-04	12-6-04			

PURPOSE

To evaluate the veneer stability of several sections under the various cap configurations for both stability against seepage and seismic forces:

1. Case 1 –10 percent (5.7 degrees) slope for Dredge Cell lateral expansion

2. Case 2 – Seep Slope Area at 15.9 percent (9 degrees) (~6H:1V) and 33.3 percent (3H:1V) (18.44 degrees) slopes

3. Case 3 – All other Dredge Cell lateral expansion areas with 33.3 percent (3H:1V) slopes.

REFERENCES

1. TVA Drawing Package 10W425, 2004. Kingston Fossil Plant Dredged Cell Expansion, Prepared by Parsons, Inc, Initial Issue, November 11.

2. Soong, T-Y. and R. M. Koerner, 1997. "The Design of Drainage Systems Over Geosynthetically Lined Slopes". Geosynthetic Research Institute, Drexel University, West Wing – Rush Building, Philadelphia, PA, 19104.

3. Richardson, G. N., 2002. "Drainage Geocomposite Design Methodologies and Design Calculators," Technology Transfer Seminar, Sponsored by LandfillDesign.Com, Advanced Geotech Systems, and Tenax, September 17th, Frankfort, Kentucky.

4. Schreiner, L.C. and J. T. Riedel, 1978. "Probable Maximum Precipitation Estimates, United States East of the 105th Meridian," Hydrometeorological Report No. 51, U.S. Department of Commerce and U.S Department of the Army-Corps of the Engineers, National Oceanic and Atmospheric Administration, Hydrometeorological Branch, Office of Hydrology, National Weather Service, Washington, D.C., June.

5. Tennessee Division of Solid Waste Management, 1993. "Technical Guidance Document: Earthquake Evaluation Guidance Policy," 41 pages.

6. Koerner, R. M., 1998. Designing With Geosynthetics, 4th Edition, Prentice Hall, Inc., New Jersey.

7. Mactec, 2004. "Laboratory Testing results – Samples from gypsum Pond at Cumberland Fossil Plant", prepared for Parsons E&C on behalf of TVA, May 13.

EVALUATION STEPS

1. Define Geometry.

Two soil-covers are analyzed:

- One with 24 inches of soil cover (including six inches of vegetative cover), without a geocomposite drainage layer, over ash (Detail F74, Drawing 10W425-74).
- Another with total 18 inches soil cover (including six inches of vegetative cover) over a geocomposite drainage layer (Detail E75, Drawing 10W425-75). In the seep Blow Out area along Swan Road, there will be total 24 inches of soil cover above the geocomposite drainage layer (Detail G74, Drawing 10W425-74).

The lengths along the slopes used in this evaluation for the three cases listed above are obtained from Drawings 10425W-68, 69, 74 and 75.

1. Define Soil, Drainage Layer Properties, and Infiltration Rates

The specifications require that the lower 12 inches of the cover soil have a maximum hydraulic conductivity of 1.0E-06 cm/sec. However, additional analyses are performed to confirm that the design would still perform adequately if the cover soils had up to 1.0E-05 cm/sec. The 6-inches of topsoil is assumed to have a maximum hydraulic conductivity of 1.0E-04 cm/sec. The geocomposite drainage layer is assumed to have a hydraulic conductivity of 1.986 cm/sec. The hydraulic conductivities for the fly ash and bottom ash are assumed to be 5.85E-05 and 1.0E-03 cm/sec, respectively.

The shear strength effective angle of internal friction for the cover soil is assumed to be 29.6 degrees and the effective cohesion 1200 psf. These values are based on triaxial tests of Natural Clay in the area.. Koerner (1996, Table 2.5) suggests that 80 percent of the shear strength of a cohesionless soil may be used for the interface friction.. Therefore, the effective stress seepage analyses herein take no credit for cohesion with the interface. The static efficiencies will be confirmed with site-specific geotextiles and soils. If it proves necessary during testing to increase strength properties, mixing of the gypsum with the clay to increase not only the cohesion but also the friction angle will be considered along with other treatments or materials maintain veneer slope stability.

By contrast, the interface friction and cohesion (for the undrained case) are assumed to be 80 percent of the shear strength during the seismic condition. In addition, the minimum requirement for the clay cover is that it has a phi angle of 26 degrees and cohesion of 250 psf, based on Standard Proctor 2% wet of optimum content (WOMC) or combination of phi and cohesion that will yield a factor of safety for the seismic analysis above one. One run is included with a 1400 psf undrained shear strength (typical of the Alluvial Clayey Soil from CPT data) and is included to demonstrate the factor of safety derived when a seismic force is included.

Schreiner and Riedel (1978) define the PMP near the site as approximately 29.5 inches per hour period over a 10 square mile area (all season). The hourly rate becomes 4.92 inches or 125 mm per hour.

2. Define Seismic Force

The veneer stability is evaluated along the sloped surface of the final stack using the *landfilldesign.com* calculators (Attachment B). In accordance with the recommendation in the Tennessee Guidance (1993, Ref. 20) Document, the seismic coefficient equal to 0.11g or the same value as used for the global stability evaluation is used for the veneer stability evaluation.

2. Evaluate Veneer Stability

Veneer stability analyses that have been performed with the maximum PMP event with the model developed by Soong and Koerner (1997, Ref. 2). Specifically, the HELP model should never be used to account for seepage forces due to precipitation infiltration on slope stability. This is due to a major flaw in the HELP model that has been documented since the early 1990's with U.S. EPA research at its test facilities in Cincinnati, Ohio. Several research studies have shown that the HELP Model, by incorporating daily average weather data, grossly underestimates the actual impingement rate into the drainage systems and, hence, underestimates the head on the liner and results in undersized drainage system, (Soong and Koerner, 1997, Ref. 2). Under-designed drainage systems cause a saturated condition in the overlying soil layer. The detrimental effect of underestimated seepage force can be catastrophic especially on side slopes in landfill capping systems.

Table 1 below gives the results of the veneer slope stability evaluation. The table summarizes the factors of safety against sliding and for drainage layer capacity (DLC). The DLC factors of safety only apply to the static analyses as these consider seepage forces. Natural drainage and drainage by a geocomposite drainage layer were considered. Natural drainage was assumed limited to the top 12 inches of the base material (specifically, ash or gypsum) beneath the clay cover. The seismic stability evaluation considers no seepage force.

The LandfillDesign.com static analysis runs assume a maximum vertical hydraulic conductivity of 1.0E-05 cm/sec. Higher conductivities than 1.0E-05 result in drastic lowering of the slope stability factor of safety and the Drainage Layer Capacity (DLC) factors of safety. The DLCs calculated for both the assumed top 12 inches of the base material (cast gypsum or compacted bottom and fly ash), indicate low water carrying capacity underneath the cover. Over the course of several years, many similar facilities have been built and operated successfully so far without special provisions for cover drainage. However, both types of runs herein indicate that there exists a potential for not only possible localized expressions of springs or boils near the lower portions of slopes but also even veneer failures after intense rainfall events because the DLC falls well below 1. Note that current engineering practice has revised the acceptable DLC for passing specifications from 1.0 to equal to or greater than 6 to avoid potential veneer slope instability (Richardson, 2002). However, the Tennessee Guidance (1993, Ref. 5) allows some flexibility in veneer stability design because it states, "Presently, it is the opinion of the Solid Waste Division that this type of failure mechanism will generally not result in a catastrophic type of failure. Therefore, some flexibility will be given for the design of the stability of landfill cover systems."

TABLE 1

VENEER SLOPE STABILITY AND "DRAINAGE LAYER" FACTORS OF SAFETY

	Seismic	Effective Stress^^		"Total Stress"/Undrained			
Condition/	Coefficient	Φ', degs	c', psf	Φ_R, degs	c_R, psf	F.S.	DLC
Static / 1A1 BA	-	29.6	0.0	-	-	3.327	0.297**
Static / 1A2 Geoc	-	29.6	0. 0	-	-	4.594	9.825^*
Static / 1B1 Geoc	-	29.6	0. 0	-	-	4.577	1.362^
Seismic /1C1 Geoc	0.11g	-	-	26.0	250	5.916	-
Seismic /1C2 Geoc	0.11g	-	-	26.0	250	7.067	-
Static / 2A1 FA	-	29.6	0. 0	-	-	1.611	0.001**
Static / 2A2 FA	-	29.6	0. 0	-	-	1.61	0.008**
Static / 2B1 Geoc	-	29.6	0. 0	-	-	2.929	4.662^
Static / 2B2 Geoc	-	29.6	0. 0	-	-	2.932	46.19^*
Static / 2C1 Geoc	-	29.6	0. 0	-	-	1.374	110.6^*
Seismic /2D1 Geoc	0. 11g	-	-	26.0	250	4.636	-
Seismic /2D2 Geoc	0. 11g	-	-	26.0	250	2.753	-
Static / 3A1 Geoc	-	29.6	0.0	-	-	1.362	77.936^*
Static / 3A2 BA	-	29.6	0.0	-	-	1.649	1.78^* & ***
Static / 3A3 BA	-	29.6	0.0	-	-	0.971	0.887****
Seismic / 3B1 Geoc	0.11g	-	-	26.0	250	3.325	-
Seismic / 3B2 BA	0.11g	-	-	26.0	250	2.996	-
Seismic / 3B3 Geoc	0.11g	-	-	0	1400^^^	3.747	-
Seismic / 3B4 Geoc	0.33g	-	-	26.0	250	2.152	-

BA or FA – Compacted Bottom Ash and Fly Ash below cover soil (Compacted to Standard Proctor at 2% wet of OMC).

Geoc – Geocomposite Drainage Layer with hydraulic conductivity of 1.986 cm/sec, 5.08 mm thick.

* Assumed the top 12 inches of base material (that is, cast gypsum or compacted fly ash and bottom ash) or the actual geocomposite drainage layer.

** Assumed the top 12 inches of sub base cast gypsum, bottom ash or compacted fly ash assumed as drainage layer.

*** Does not include the pipes indicated in Detail B68 on 30 to 50 foot spacing.

**** Demonstrates effect on slope stability FS and DLC with 50-percent drop in hydraulic conductivity in drainage layer composed of BA/FA (that is, in place of a geocomposite drainage layer).

^ Geocomposite drainage layer with 5.08 mm height and 1.986 cm/sec hydraulic conductivity.

^* Cover Soil is in range of 1.0E-06 cm/sec as opposed to 1.0E-05.

^^ Φ' = 29.6 degrees assumed.

^^^ s_U = 1400 psf based on the CPT testing in-place for the on-site soft to stiff alluvial clay.

Attachment 1 gives the printouts for the veneer slope stability runs.

CONCLUSION

It can be concluded that the proposed cover is likely to be stable during both the static and design seismic conditions.

END

ATTACHMENT 1

VENEER STABILITY PRINTOUTS

Via: 1.1 DALCACHE03 (NetCache NetApp/5.5R2)

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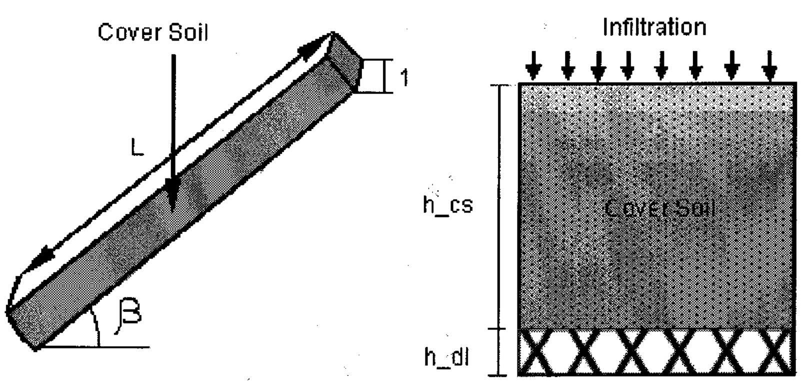
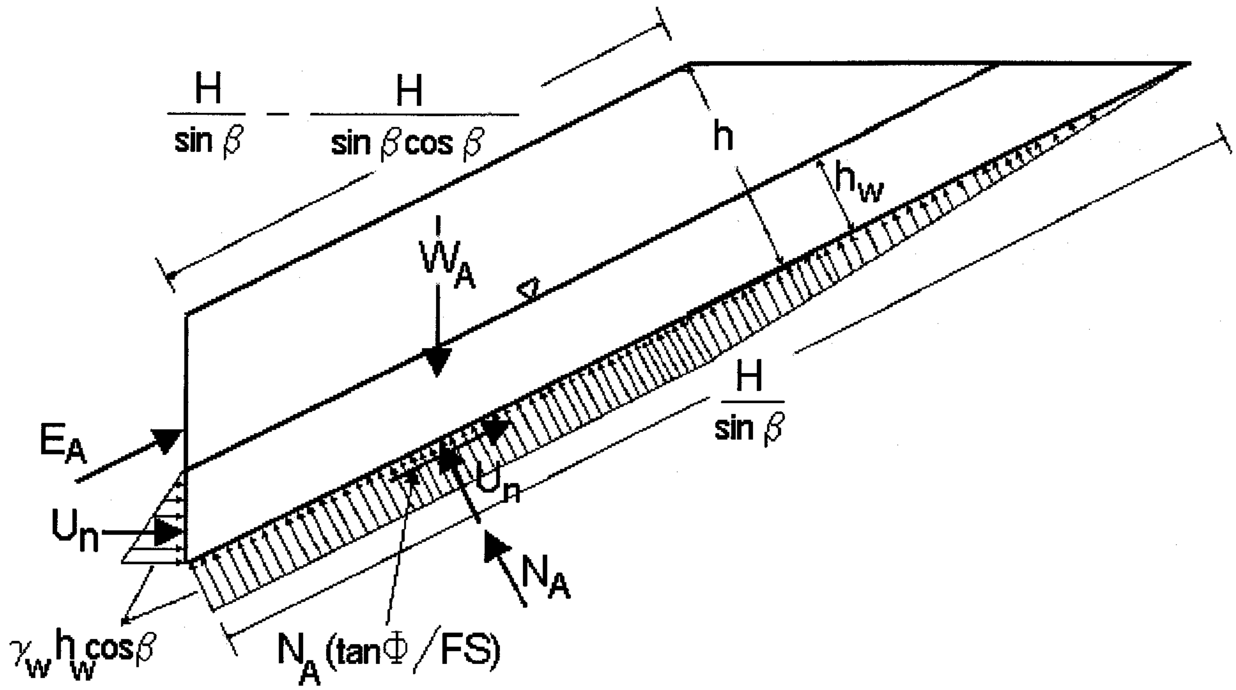
Cover Slope Stability - Design Calculator

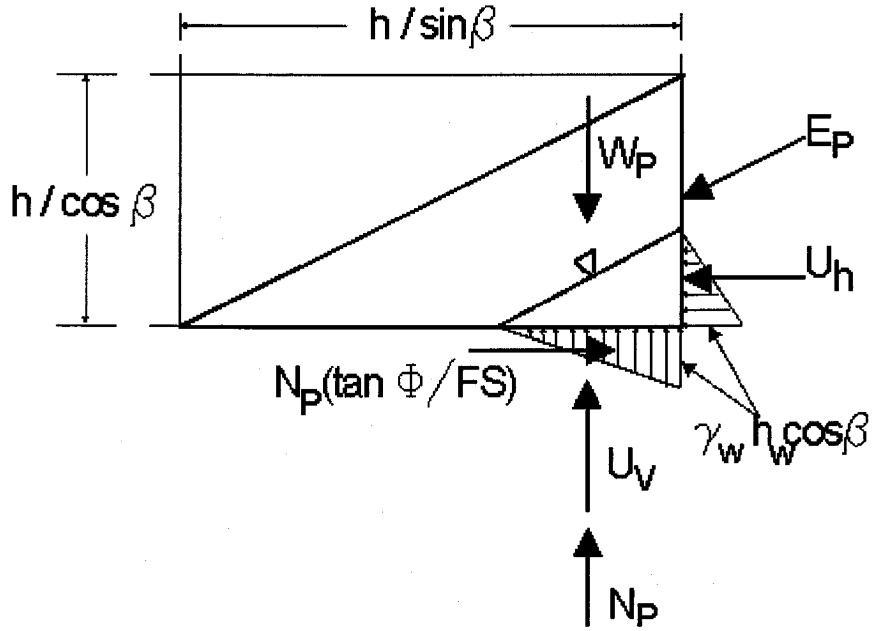
Problem Statement Case 1 Run A1 - Sheet 69 10 percent Slopes for Dredge Cell Lateral Expansion F74 24 Inch Soil Cover Detail Over Bottom Ash With Assumed Drainage Hydraulic Conductivity of 1E-03 cm/sec. PMP of 29.5 inches/ 6hrs was used for infiltration rate as required for this analysis.

FS for slope stability equals 3.327 and Drainage Layer Capacity (DLC) of Bottom Ash /Fly Ash Falls below Minimum required Safety Limit of 1.0, that is actual **DLC equals 0.297**. The low DLC means that the bottom ash drainage layer may liquefy from time to time under various rainfall events and produce erosional boils through the cover soils or even cause localized or larger veneer failures. Other analyses with rainfall events of one inch per hour will yield a DLC below 1.





Active Wedge



Passive Wedge

Input Values

Design Input

Slope characteristics

Length of the slope (L)	51.85883	m
Slope angle (ß)	5.7106	degrees

Height of soil layers

Height of cover soil (h_cs)	609.6	mm
Height of drainage layer (h_dl)	304.8	mm

Permeability of the soil layers

Permeability of cover soil	1.9802E-06	cm/s
Design permeability of drainage layer	.001	cm/s

Rain intensity parameters

Precipitation	124.88	mm/hr

Run-off coefficient	0.4	
Soil characteristics		
Dry unit weight of cover soil	18.85	kN/m^3
Saturated unit weight of the cover soil	21	kN/m^3
Friction angles		
Friction angle of the cover soil	29.6	degrees
Friction angle of the cover soil / underlying interface	29.6	degrees

Stability Calculation

Solution

I. Normalized Input data

Gradient	0.100	
Horizontal length	51.601	m
Height cover soil and drainage layer	0.9144	m
Permeability of cover soil in m/s	1.98E-008	m/s
Design permeability of the drainage layer in m/s	1e-005	m/s

II. Calculation of the Drainage Capacity

Precipitation from input	124.88	mm/hr
Actual runoff	124.8087128	mm/hr
Actual percolation	0.0712872	mm/hr
Actual flux	0.004	m^3/hr
Allowable flux	0.001	m^3/hr
Drainage Layer Capacity (DLC) (needs to be >1.0 to avoid saturation)	**0.297**	

III. Parallel Submergence Ratio (PSR)

Average height water table	3.65E+002	m
Parallel Submergence Ratio (PSR)	**1.000**	

Stability Factor of Safety (FS) **3.327**

Via: 1.1 DALCACHE03 (NetCache NetApp/5.5R2)

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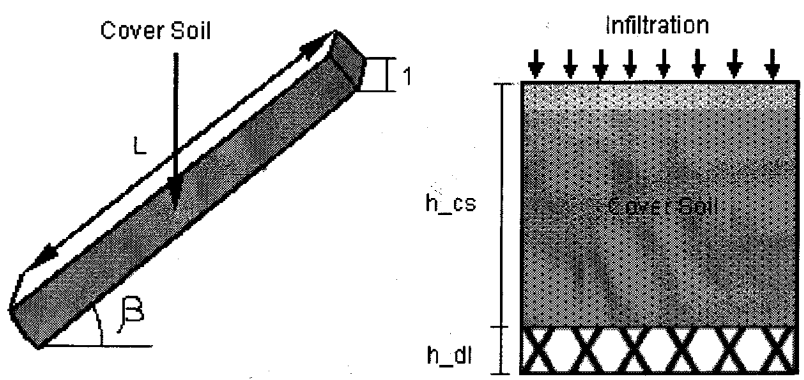
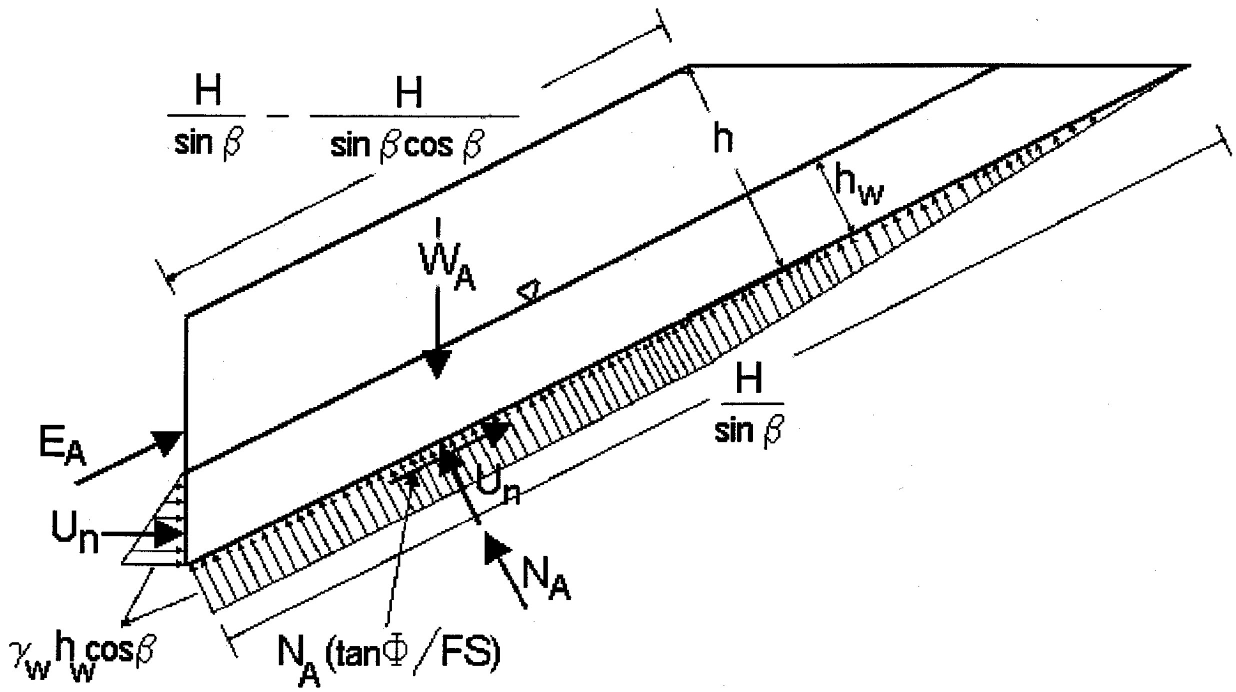
Cover Slope Stability - Design Calculator

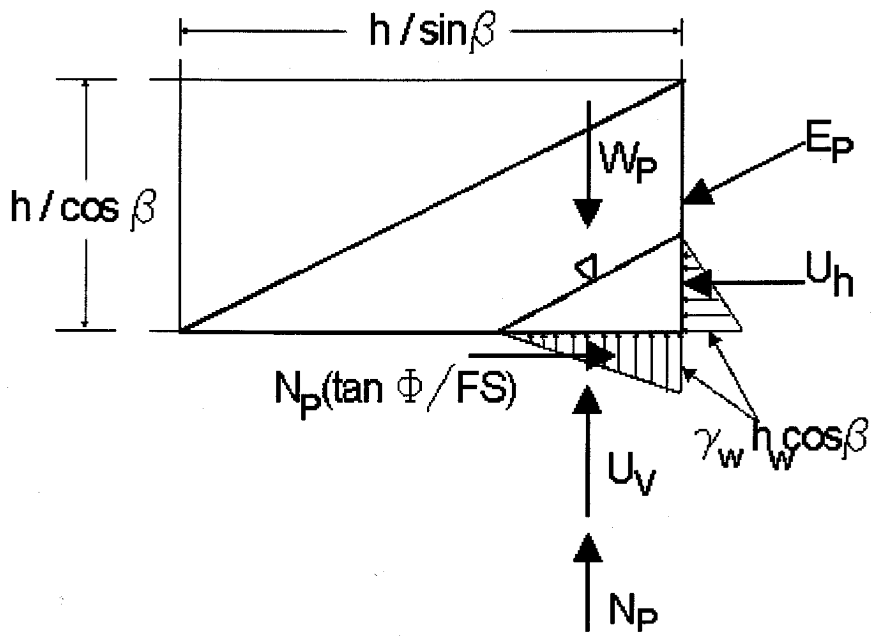
Problem Statement Case 1 Run A2 - Sheet 69 10 percent Slopes for Dredge Cell Lateral Expansion E75 18 Inch Soil Cover With Geocomposite Drainage Layer Over on Ash or Gypsum. PMP of 29.5 inches/ 6hrs was used for infiltration rate as required for this analysis. Effective 18 inches of Cover Soil has hydraulic conductivity of 1.49E-06.

FS for slope stability equals **4.594 and** Drainage Layer Capacity of Bottom Ash Falls exceeds the Minimum required Safety Limit of 1.0, that is, **DLC equals 9.825**.





Active Wedge



Passive Wedge

Input Values

Design Input

Slope characteristics

Length of the slope (L)	51.85883	m
Slope angle (ß)	5.7106	degrees

Height of soil layers

Height of cover soil (h_cs)	457.2	mm
Height of drainage layer (h_dl)	5.08	mm

Permeability of the soil layers

Permeability of cover soil	1.9802E-06	cm/s
Design permeability of drainage layer	1.986	cm/s

Rain intensity parameters

Precipitation	124.88	mm/hr

Run-off coefficient	0.4	
Soil characteristics		
Dry unit weight of cover soil	18.85	kN/m^3
Saturated unit weight of the cover soil	21	kN/m^3
Friction angles		
Friction angle of the cover soil	29.6	degrees
Friction angle of the cover soil / underlying interface	23.68	degrees

Stability Calculation

Solution

I. Normalized Input data

Gradient	0.100	
Horizontal length	51.601	m
Height cover soil and drainage layer	0.46228	m
Permeability of cover soil in m/s	1.98E-008	m/s
Design permeability of the drainage layer in m/s	0.01986	m/s

II. Calculation of the Drainage Capacity

Precipitation from input	124.88	mm/hr
Actual runoff	124.8087128	mm/hr
Actual percolation	0.0712872	mm/hr
Actual flux	0.004	m^3/hr
Allowable flux	0.036	m^3/hr
Drainage Layer Capacity (DLC) (needs to be >1.0 to avoid saturation)	**9.825**	

III. Parallel Submergence Ratio (PSR)

Average height water table	5.17E-004	m
Parallel Submergence Ratio (PSR)	**0.001**	

Stability Factor of Safety (FS)	**4.594**

Via: 1.1 DALCACHE03 (NetCache NetApp/5.5R2)

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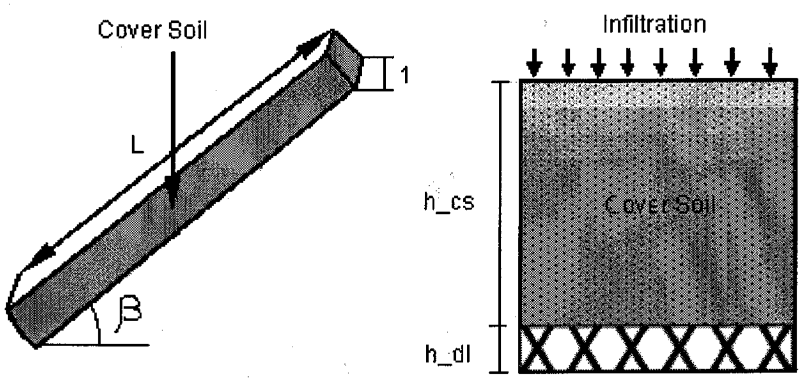
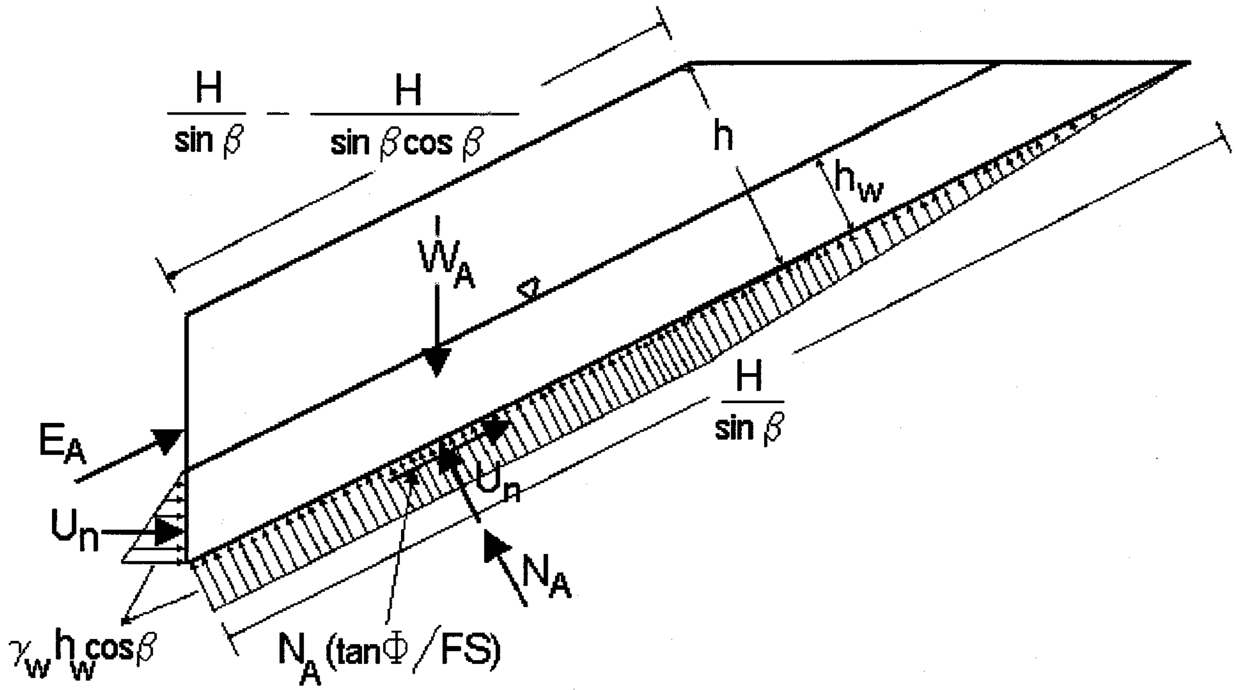
Cover Slope Stability - Design Calculator

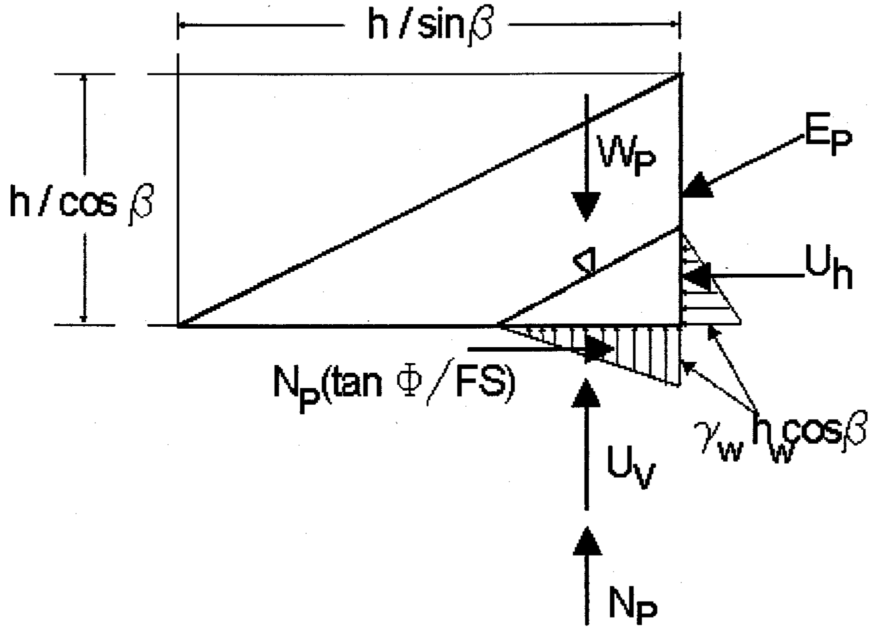
Problem Statement Case 1 Run B1 - Sheet 69 10 percent Slopes for Dredge Cell Lateral Expansion E75 18 Inch Soil Cover E-05 With Geocomposite Drainage Layer Over on Ash or Gypsum. PMP of 29.5 inches/ 6hrs was used for infiltration rate as required for this analysis. Effective 18 inches of Cover Soil has hydraulic conductivity of 1.4285E-05 cm/sec (assume 12 inch compacted soil layer at 1.0E-05 cm/sec, vegetative layer at 1.0e-04 cm/sec).

FS for slope stability equals **4.577 and** Drainage Layer Capacity of Bottom Ash Falls exceeds the Minimum required Safety Limit of 1.0, that is, **DLC equals 1.362**.





Active Wedge



Passive Wedge

Input Values

Design Input

Slope characteristics

Length of the slope (L)	51.85883	m
Slope angle (ß)	5.7106	degrees

Height of soil layers

Height of cover soil (h_cs)	457.2	mm
Height of drainage layer (h_dl)	5.08	mm

Permeability of the soil layers

Permeability of cover soil	1.4285E-05	cm/s
Design permeability of drainage layer	1.986	cm/s

Rain intensity parameters

Precipitation	124.88	mm/hr

Run-off coefficient	0.4	

Soil characteristics

Dry unit weight of cover soil	18.85	kN/m^3
Saturated unit weight of the cover soil	21	kN/m^3

Friction angles

Friction angle of the cover soil	29.6	degrees
Friction angle of the cover soil / underlying interface	23.68	degrees

Stability Calculation

Solution

I. Normalized Input data

Gradient	0.100	
Horizontal length	51.601	m
Height cover soil and drainage layer	0.46228	m
Permeability of cover soil in m/s	1.43E-007	m/s
Design permeability of the drainage layer in m/s	0.01986	m/s

II. Calculation of the Drainage Capacity

Precipitation from input	124.88	mm/hr
Actual runoff	124.36574	mm/hr
Actual percolation	0.51426	mm/hr
Actual flux	0.027	m^3/hr
Allowable flux	0.036	m^3/hr
Drainage Layer Capacity (DLC) (needs to be >1.0 to avoid saturation)	**1.362**	

III. Parallel Submergence Ratio (PSR)

Average height water table	3.73E-003	m
Parallel Submergence Ratio (PSR)	**0.008**	

Stability Factor of Safety (FS)	**4.577**

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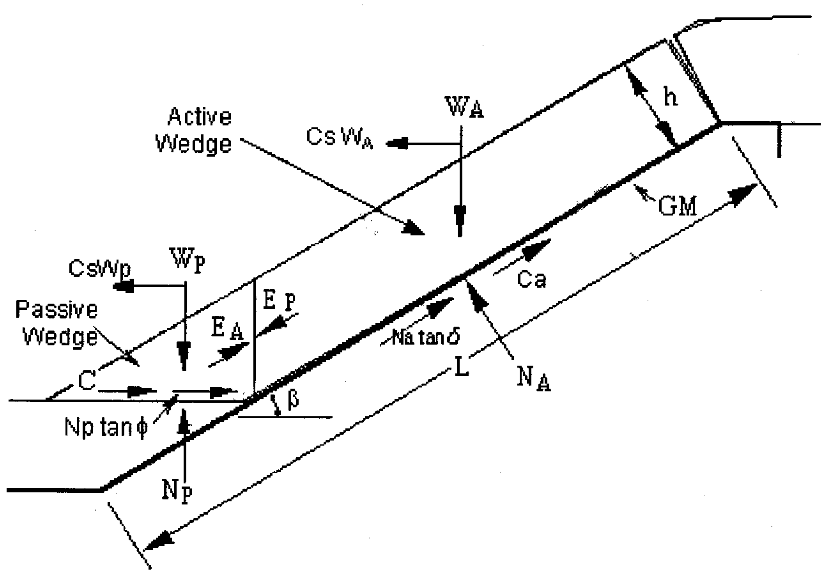
Slope Stability:Seismic Force - Design Calculator

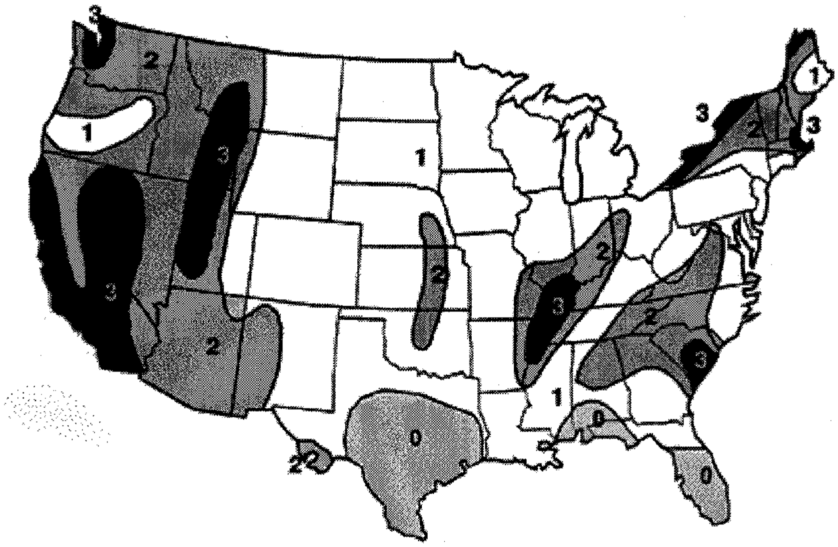
Problem Statement **Case 1 Run C1** - Pseudo-Static Anal Sheet 69 10 percent (5.7 degrees) Slopes for Dredge Cell Lateral Expansion F74 24 Inch Soil Cover Detail Over Bottom Ash.

Factor of Safety with seismic activity (FS) 5.916

This slope stability calculator utilizes a pseudo-static analysis to determine the factor of safety (FS) of a geosynthetic lined slope. This calculator assumes that no seepage forces are present. The unit gradient calculator can be used to calculate the required transmissivity of the drainage geocomposite to assure adequate drainage.

Subtitle "D" of the U.S. EPA regulations requires a seismic analysis if the site has experienced a 0.1 g horizontal acceleration, or more, in the past 250 years. For the continental USA, this does not only include the western states, but major sections of the midwest and northeast as well. The map below shows the seismic coefficients for various zones in the USA.





Legend

Zone 0:	No damage
Zone 1:	Minor damage; corresponds to intensities V and VI on the modified Mercalli intensity scale
Zone 2:	Moderate damage; corresponds to intensity VII on the modified Mercalli intensity scale
Zone 3:	Major damage; corresponds to intensity VIII and higher on the modified Mercalli intensity scale

Seismic coefficients corresponding to each zone

Zone	Remark	Modified Mercalli Scale	Average Seismic Coefficient (Cs)
0	No damage	-	0
1	Minor damage	V and VI	0.03 to 0.07
2	Moderate damage	VII	0.13
3	Major damage	VIII and higher	0.27

Input Values

Design Inputs

Slope characteristics

Thickness of cover soil (h)	0.6096	m
Slope angle (ß)	5.7106	degrees
Lenght of slope measured along geomembrane (L)	51.85883	m

Soil characteristics

Unit weight of the cover soil (g)	21	kN/m^3
Friction angle of the cover soil (f)	26	degrees
Cohesion of the cover soil (c)	11.97	kN/m^2
Interface friction(d)	20.8	degrees
Interface adhesion (Ca)	9.57854	kN/m^2

Seismic characteristic

Seismic coefficient (Cs)	0.11	g

Seismic Stability Calculation

Solution

Factor of Safety with seismic activity (FS) 5.916

Factor of Safety no seismic activity (FS) 12.927

Via: 1.1 DALCACHE03 (NetCache NetApp/5.5R2)

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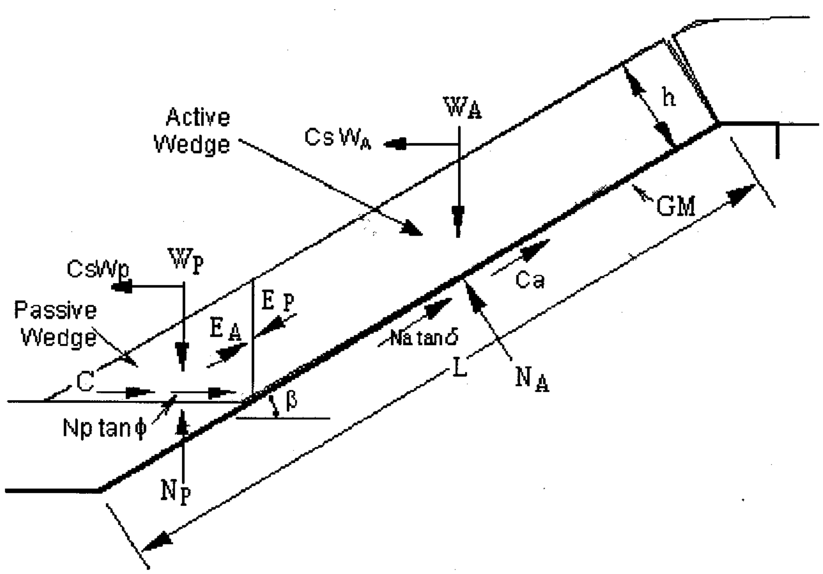
Slope Stability:Seismic Force - Design Calculator

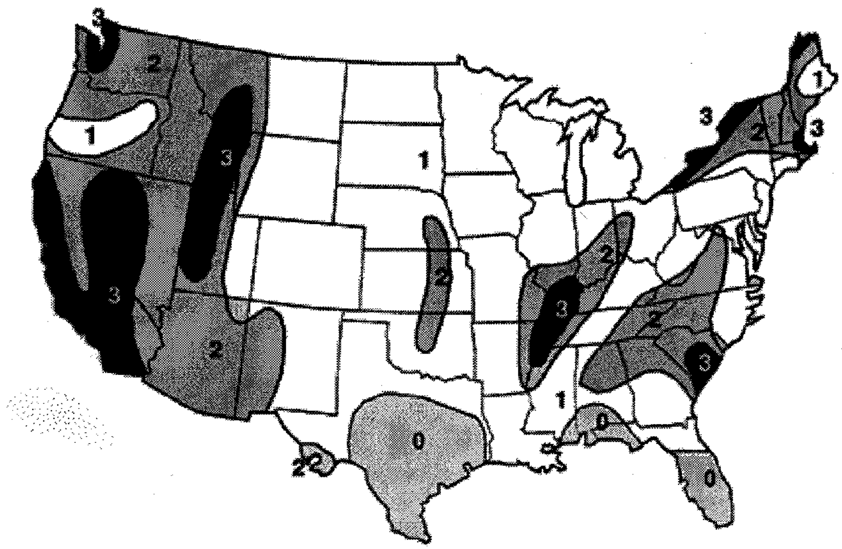
Problem Statement **Case 1 Run C2** - Pseudo-Static Anal Sheet 69 10 percent Slopes for Dredge Cell Lateral Expansion E75 18 Inch Soil Cover over Geocomposite Drainage Layer Detail.

Factor of Safety with seismic activity (FS) 7.067

This slope stability calculator utilizes a pseudo-static analysis to determine the factor of safety (FS) of a geosynthetic lined slope. This calculator assumes that no seepage forces are present. The unit gradient calculator can be used to calculate the required transmissivity of the drainage geocomposite to assure adequate drainage.

Subtitle "D" of the U.S. EPA regulations requires a seismic analysis if the site has experienced a 0.1 g horizontal acceleration, or more, in the past 250 years. For the continental USA, this does not only include the western states, but major sections of the midwest and northeast as well. The map below shows the seismic coefficients for various zones in the USA.





Legend

Zone 0:	No damage
Zone 1:	Minor damage; corresponds to intensities V and VI on the modified Mercalli intensity scale
Zone 2:	Moderate damage; corresponds to intensity VII on the modified Mercalli intensity scale
Zone 3:	Major damage; corresponds to intensity VIII and higher on the modified Mercalli intensity scale

Seismic coefficients corresponding to each zone

Zone	Remark	Modified Mercalli Scale	Average Seismic Coefficient (Cs)
0	No damage	-	0
1	Minor damage	V and VI	0.03 to 0.07
2	Moderate damage	VII	0.13
3	Major damage	VIII and higher	0.27

Input Values

Design Inputs

Slope characteristics

Thickness of cover soil (h)	0.4572	m
Slope angle (ß)	5.7106	degrees
Lenght of slope measured along geomembrane (L)	51.85883	m

Soil characteristics

Unit weight of the cover soil (g)	21	kN/m^3
Friction angle of the cover soil (f)	26	degrees
Cohesion of the cover soil (c)	11.97	kN/m^2
Interface friction(d)	20.8	degrees
Interface adhesion (Ca)	9.57854	kN/m^2
Seismic characteristic		
Seismic coefficient (Cs)	0.11	g

Seismic Stability Calculation

Solution

Factor of Safety with seismic activity (FS) **7.067**

Factor of Safety no seismic activity (FS) **15.300**

Via: 1.1 DALCACHE03 (NetCache NetApp/5.5R2)

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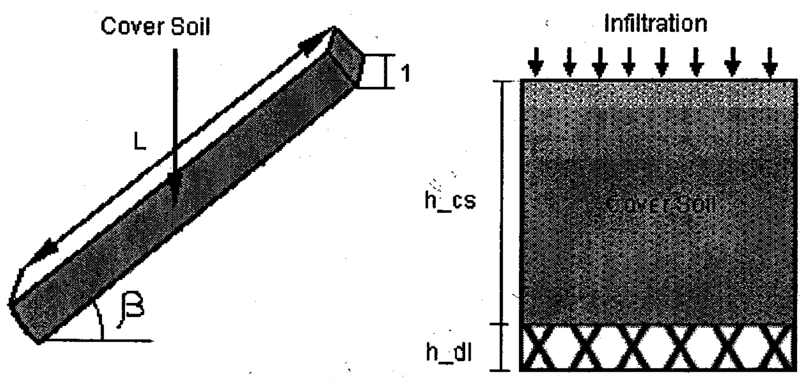
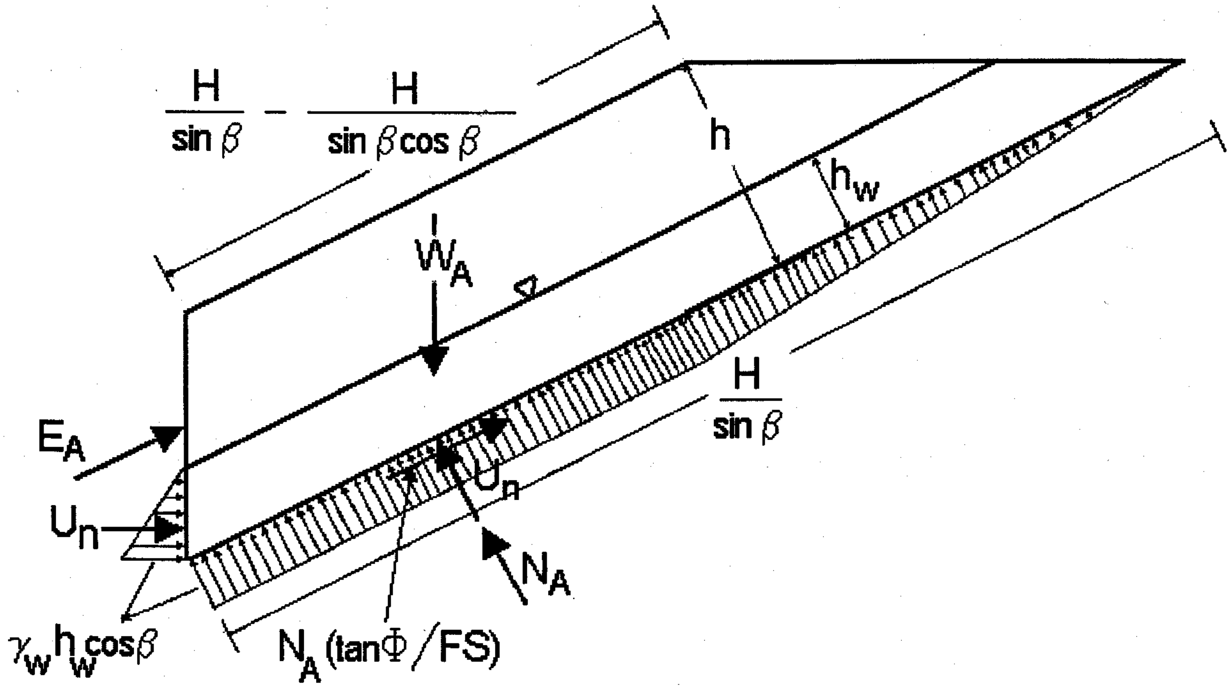
Cover Slope Stability - Design Calculator

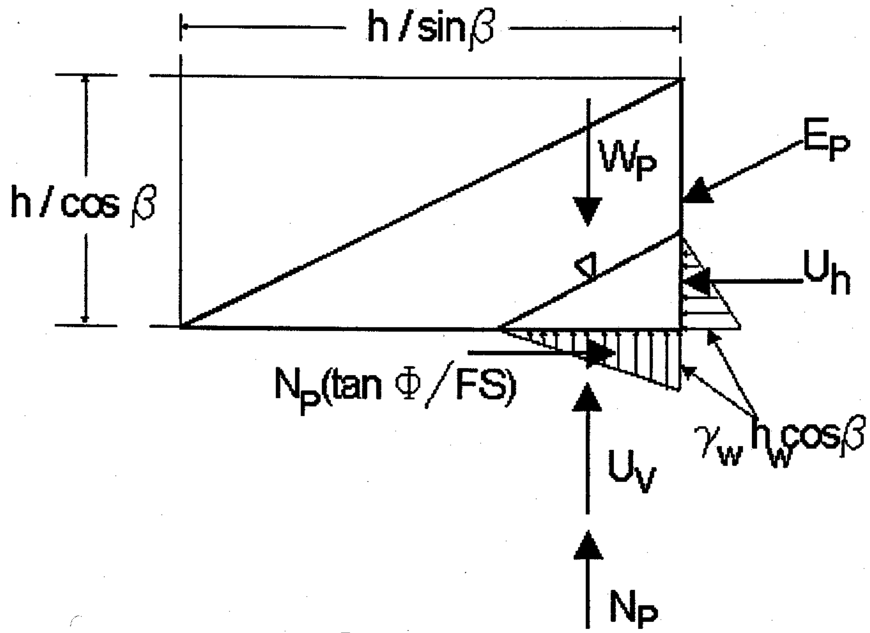
Problem Statement Statement Case 2 Run A1-Sheet 73 SEEP Slope Area at 9 percent with F74 – Fly Ash 5.9E-05 cm/sec as Drainage Layer and Compacted Clay Cover **WITH PMP RAINFALL 29.5 inches/6 hours** (Assumed for this Run with Maximum K of 0.00001 cm/sec for cover soil).

Results: FS for slope stability = **1.611 With PMP in SWAN Road Area is** acceptable. By contrast, DLC = .001 (<1.0 or 6, therefore fails). Compacted Clay Cover with Ash as Drainage layer will likely suffer localized or perhaps larger veneer failures due to liquefaction of the fly ash drainage during rainfall events.





Active Wedge



Passive Wedge

Input Values

Design Input

Slope characteristics

Length of the slope (L)	34.45777	m
Slope angle (ß)	9.0468	degrees

Height of soil layers

Height of cover soil (h_cs)	609.6	mm
Height of drainage layer (h_dl)	304.8	mm

Permeability of the soil layers

Permeability of cover soil	0.00001	cm/s
Design permeability of drainage layer	5.85E-05	cm/s

Rain intensity parameters

Precipitation	124.883	mm/hr

Run-off coefficient	0.4	

Soil characteristics

Dry unit weight of cover soil	18.85	kN/m^3
Saturated unit weight of the cover soil	21.	kN/m^3

Friction angles

Friction angle of the cover soil	29.6	degrees
Friction angle of the cover soil / underlying interface	23.68	degrees

Stability Calculation

Solution

I. Normalized Input data

Gradient	0.157	
Horizontal length	34.029	m
Height cover soil and drainage layer	0.9144	m
Permeability of cover soil in m/s	1.00E-007	m/s
Design permeability of the drainage layer in m/s	5.85e-007	m/s

II. Calculation of the Drainage Capacity

Precipitation from input	124.883	mm/hr
Actual runoff	124.523	mm/hr
Actual percolation	0.36	mm/hr
Actual flux	0.012	m^3/hr
Allowable flux	0.000	m^3/hr
Drainage Layer Capacity (DLC) (needs to be >1.0 to avoid saturation)	**0.008**	

III. Parallel Submergence Ratio (PSR)

Average height water table	2.15E+002	m
Parallel Submergence Ratio (PSR)	**1.000**	

Stability Factor of Safety (FS)	**1.611**

Stability Factor of Safety (FS) **1.611**

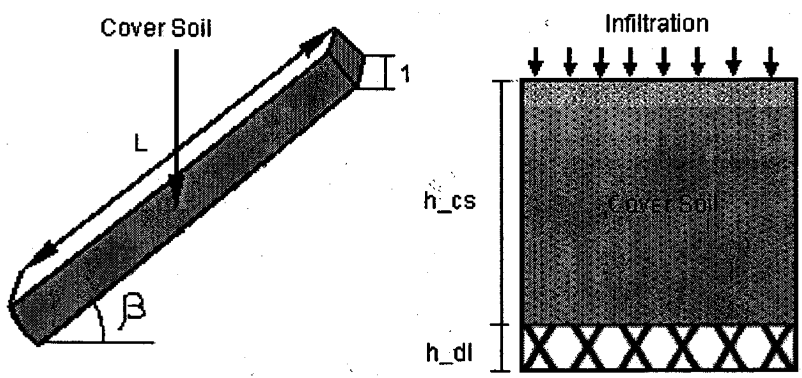
Via: 1.1 DALCACHE03 (NetCache NetApp/5.5R2)

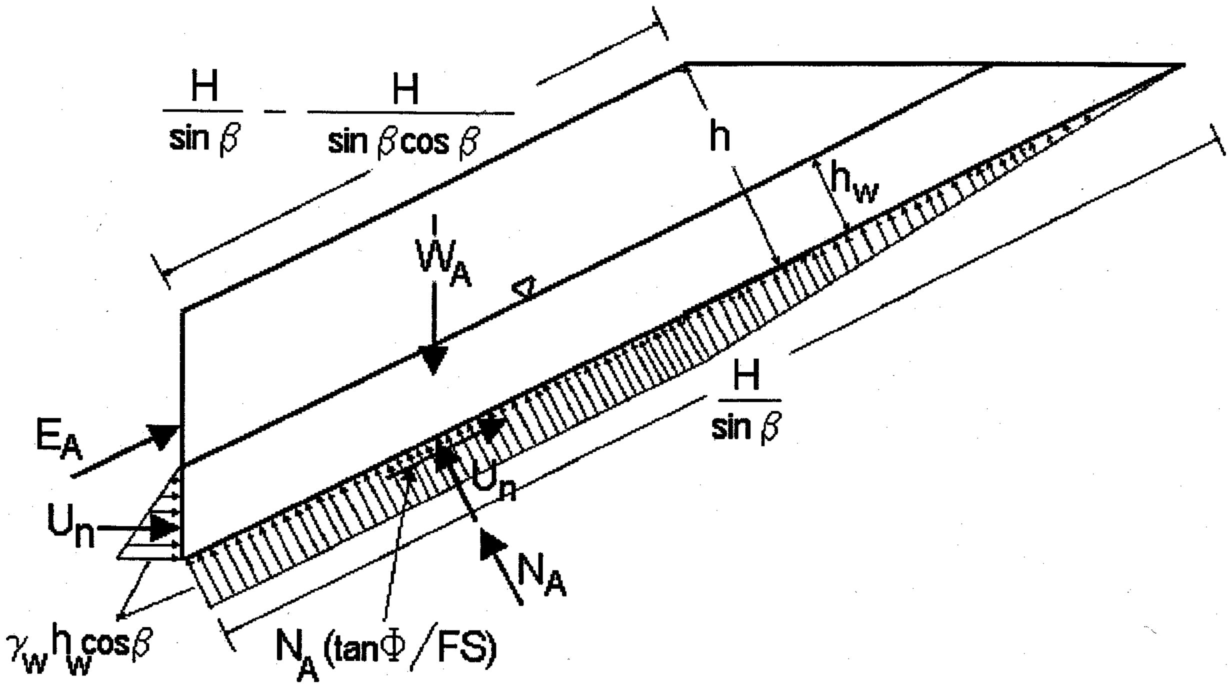
landfilldesign.com

Cover Slope Stability - Design Calculator

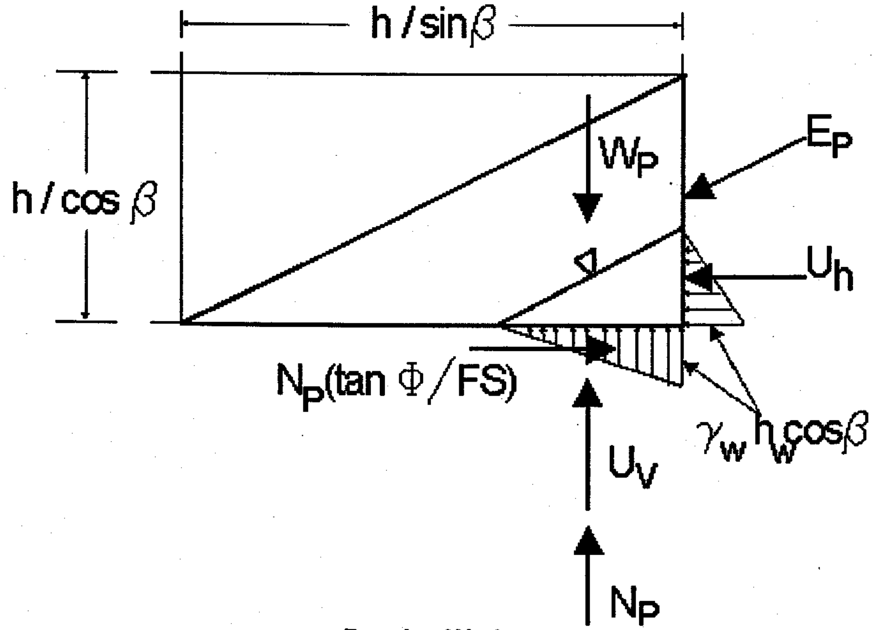
Problem Statement Case 2 Run A2-Sheet 73 SEEP Slope Area at 9 percent with F74 – **WITH 0.25 INCH PER HOUR RAINFALL** Fly Ash 5.9E-05 cm/sec as Drainage Layer and Compacted Clay Cover (Assumed for this Run with Maximum K of 0.00001 cm/sec for cover soil).

Results: FS slope =**1.61** acceptable, DLC = **.008** (<1.0 or 6, therefore fails). Compacted Clay Cover with Ash as Drainage layer CAN suffer localized or perhaps larger veneer failures due to liquefaction of the fly ash drainage during small rainfall events if they remain constant for long enough period.





Active Wedge



Passive Wedge

Input Values

Design Input

Slope characteristics

Length of the slope (L)	34.45777	m
Slope angle (ß)	9.0468	degrees

Height of soil layers

Height of cover soil (h_cs)	609.6	mm
Height of drainage layer (h_dl)	304.8	mm

Permeability of the soil layers

Permeability of cover soil	0.00001	cm/s
Design permeability of drainage layer	5.85E-05	cm/s

Rain intensity parameters

Precipitation	6.35	mm/hr

Run-off coefficient	0.4	

Soil characteristics

Dry unit weight of cover soil	18.85	kN/m^3
Saturated unit weight of the cover soil	21.	kN/m^3

Friction angles

Friction angle of the cover soil	29.6	degrees
Friction angle of the cover soil / underlying interface	23.68	degrees

Stability Calculation

Solution

I. Normalized Input data

Gradient	0.157
Horizontal length	34.029 m
Height cover soil and drainage layer	0.9144 m
Permeability of cover soil in m/s	1.00E-007 m/s
Design permeability of the drainage layer in m/s	5.85e-007 m/s

II. Calculation of the Drainage Capacity

Precipitation from input	6.35 mm/hr
Actual runoff	5.99 mm/hr
Actual percolation	0.36 mm/hr
Actual flux	0.012 m^3/hr
Allowable flux	0.000 m^3/hr
Drainage Layer Capacity (DLC) (needs to be >1.0 to avoid saturation)	**0.008**

III. Parallel Submergence Ratio (PSR)

Average height water table	2.15E+002 m
Parallel Submergence Ratio (PSR)	**1.000**

Stability Factor of Safety (FS) **1.611**

Via: 1.1 DALCACHE03 (NetCache NetApp/5.5R2)

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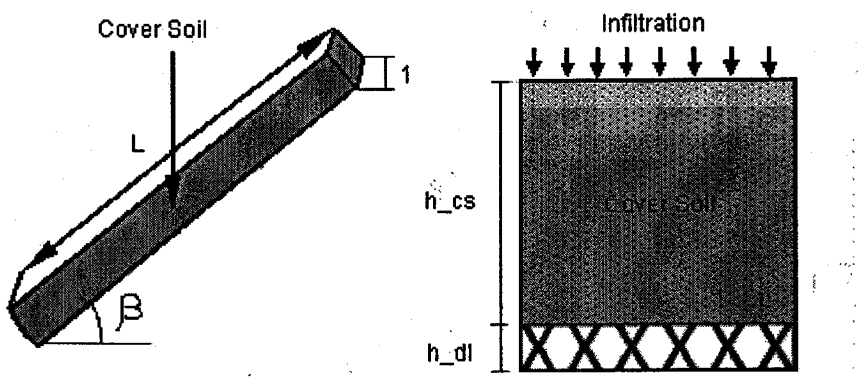
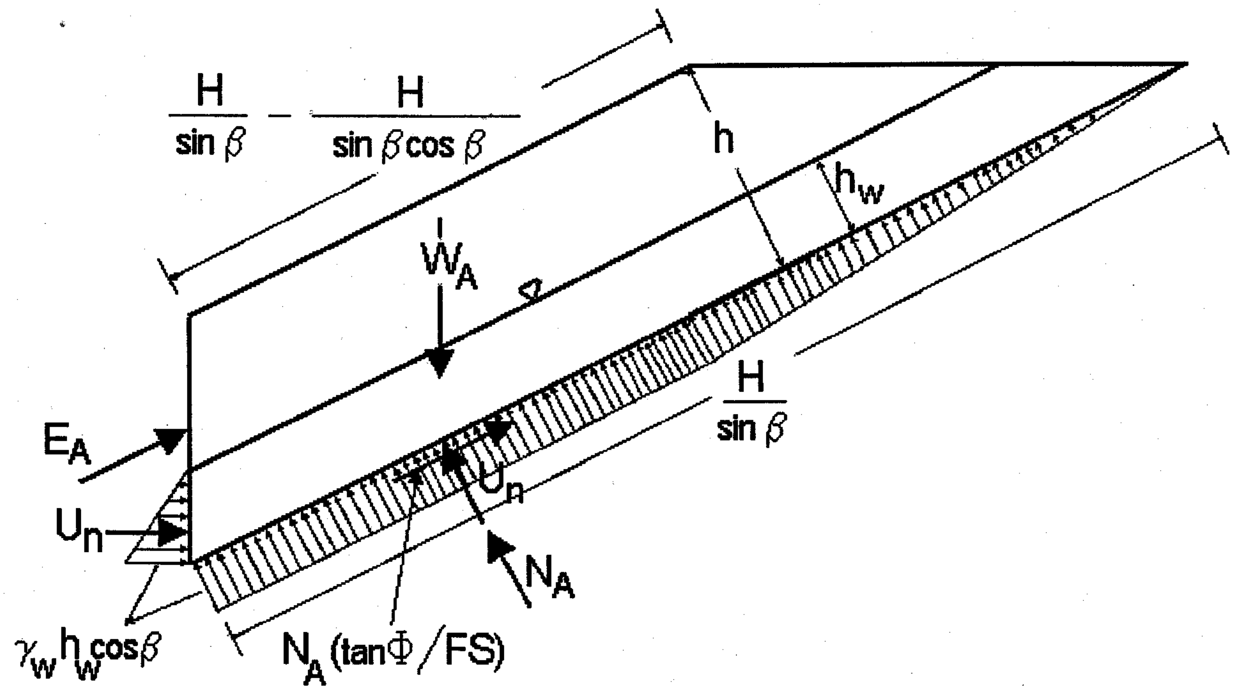
Cover Slope Stability - Design Calculator

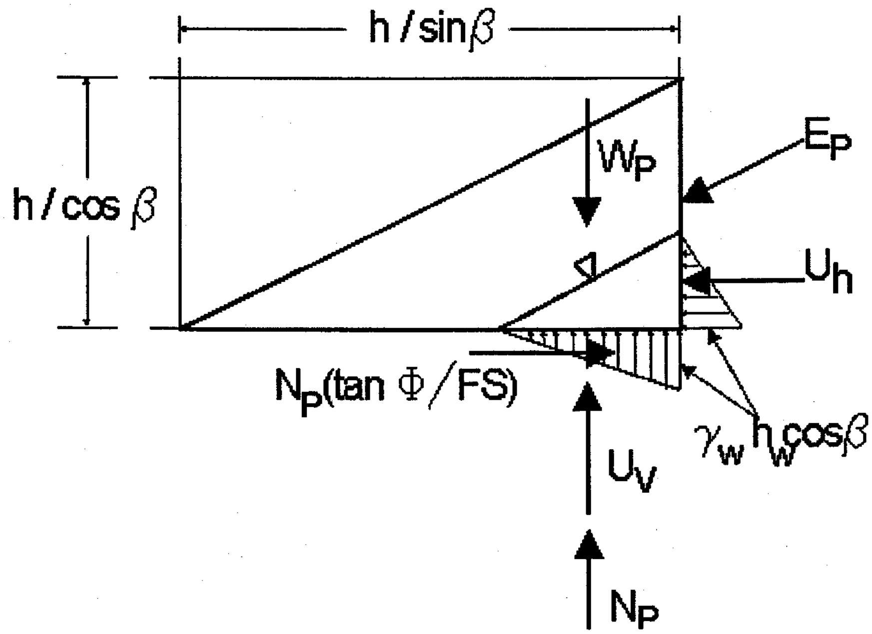
Problem Statement Case 2 Run A2-Sheet 73 SEEP Slope Area at 9 percent with F74 – **WITH 0.25 INCH PER HOUR RAINFALL** Fly Ash 5.9E-05 cm/sec as Drainage Layer and Compacted Clay Cover (Assumed for this Run with Maximum K of 0.00001 cm/sec for cover soil).

Results: FS slope =**1.61** acceptable, DLC = **.008** (<1.0 or 6, therefore fails). Compacted Clay Cover with Ash as Drainage layer CAN suffer localized or perhaps larger veneer failures due to liquefaction of the fly ash drainage during small rainfall events if they remain constant for long enough period.





Active Wedge



Passive Wedge

Input Values

Design Input

Slope characteristics

Length of the slope (L)	34.45777	m
Slope angle (ß)	9.0468	degrees

Height of soil layers

Height of cover soil (h_cs)	609.6	mm
Height of drainage layer (h_dl)	304.8	mm

Permeability of the soil layers

Permeability of cover soil	0.00001	cm/s
Design permeability of drainage layer	5.85E-05	cm/s

Rain intensity parameters

Precipitation	6.35	mm/hr

Run-off coefficient	0.4	

Soil characteristics

Dry unit weight of cover soil	18.85	kN/m^3
Saturated unit weight of the cover soil	21.	kN/m^3

Friction angles

Friction angle of the cover soil	29.6	degrees
Friction angle of the cover soil / underlying interface	23.68	degrees

Stability Calculation

Solution

I. Normalized Input data

Gradient	0.157	
Horizontal length	34.029	m
Height cover soil and drainage layer	0.9144	m
Permeability of cover soil in m/s	1.00E-007	m/s
Design permeability of the drainage layer in m/s	5.85e-007	m/s

II. Calculation of the Drainage Capacity

Precipitation from input	6.35	mm/hr
Actual runoff	5.99	mm/hr
Actual percolation	0.36	mm/hr
Actual flux	0.012	m^3/hr
Allowable flux	0.000	m^3/hr
Drainage Layer Capacity (DLC) (needs to be >1.0 to avoid saturation)	**0.008**	

III. Parallel Submergence Ratio (PSR)

Average height water table	2.15E+002	m
Parallel Submergence Ratio (PSR)	**1.000**	

Stability Factor of Safety (FS)	**1.611**

Via: 1.1 DALCACHE03 (NetCache NetApp/5.5R2)

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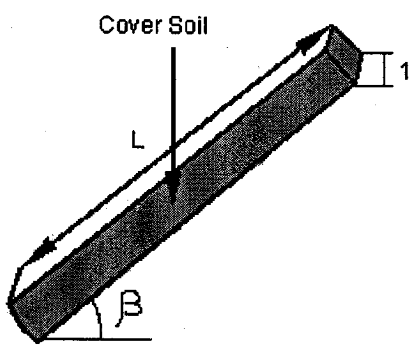
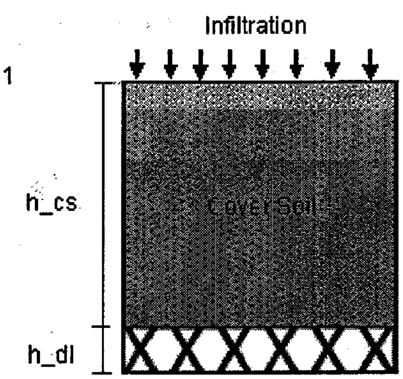
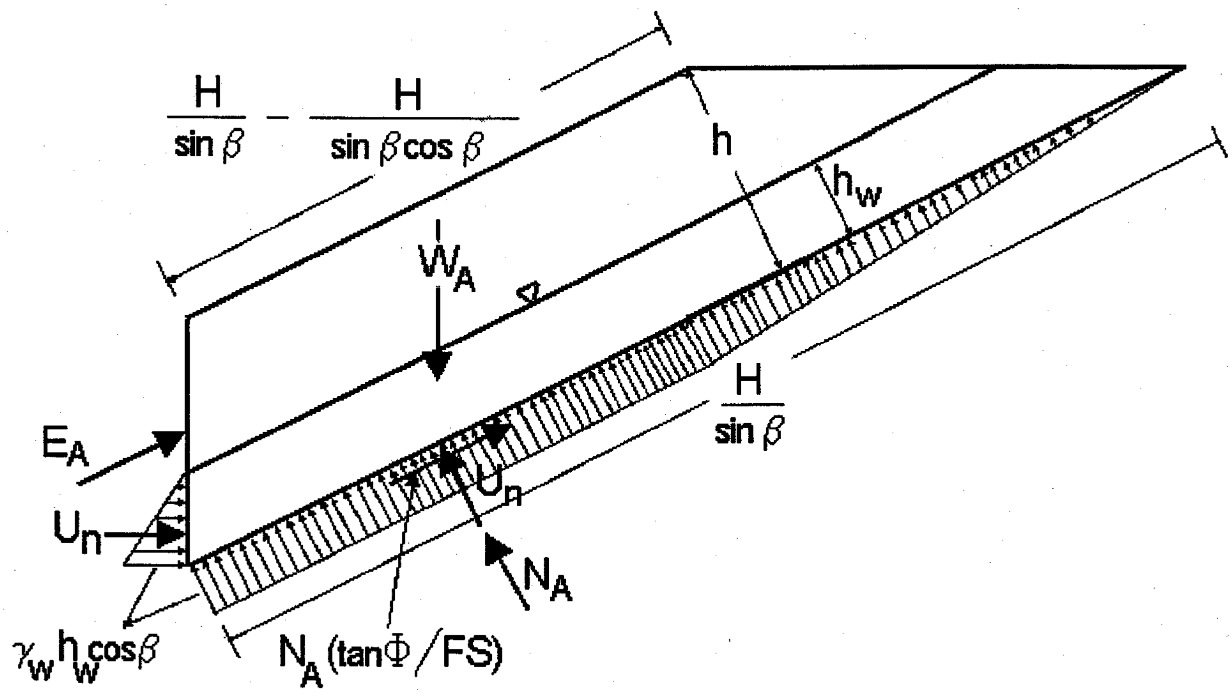
Cover Slope Stability - Design Calculator

Problem Statement Case 2 Run B1- SHEET 73 SEEP (Swan Pond Blow Out) Area Detail G74 slope geocomposite drainage layer cover soil K 1E-05 Between Elevations 765 and 783 feet —slope 9 degrees, L = 113 feet, PMP = 29.5 inches/6hr (124.883 mm/hr),.

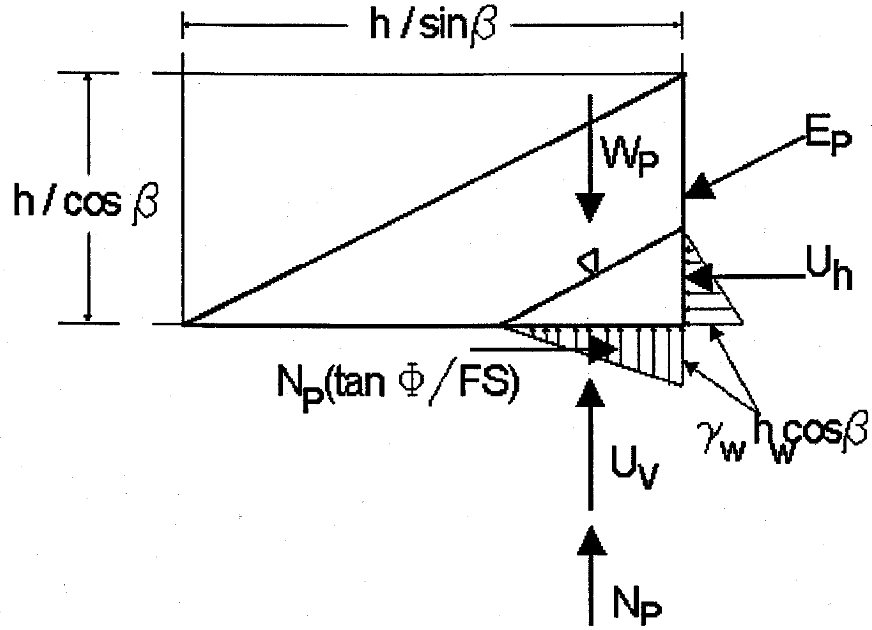
Results: FS slope =2.929 Therefore Acceptable, DLC = 4.662 (>1.0 but less than 6, which includes uncertainty factors. Could consider looking at large capacity drainage layer.)







Active Wedge



Passive Wedge

Input Values

Design Input

Slope characteristics

Length of the slope (L)	34.45777	m
Slope angle (ß)	9.0468	degrees

Height of soil layers

Height of cover soil (h_cs)	609.6	mm
Height of drainage layer (h_dl)	5.08	mm

Permeability of the soil layers

Permeability of cover soil	0.00001	cm/s
Design permeability of drainage layer	1.986	cm/s

Rain intensity parameters

Precipitation	124.883	mm/hr

Run-off coefficient	0.4	

Soil characteristics

Dry unit weight of cover soil	18.85	kN/m^3
Saturated unit weight of the cover soil	21.	kN/m^3

Friction angles

Friction angle of the cover soil	29.6	degrees
Friction angle of the cover soil / underlying interface	23.68	degrees

Stability Calculation

Solution

I. Normalized Input data

Gradient	0.157	
Horizontal length	34.029	m
Height cover soil and drainage layer	0.61468	m
Permeability of cover soil in m/s	1.00E-007	m/s
Design permeability of the drainage layer in m/s	0.01986	m/s

II. Calculation of the Drainage Capacity

Precipitation from input	124.883	mm/hr
Actual runoff	124.523	mm/hr
Actual percolation	0.36	mm/hr
Actual flux	0.012	m^3/hr
Allowable flux	0.057	m^3/hr
Drainage Layer Capacity (DLC) (needs to be >1.0 to avoid saturation)	**4.662**	

III. Parallel Submergence Ratio (PSR)

Average height water table	1.09E-003	m
Parallel Submergence Ratio (PSR)	**0.002**	

Stability Factor of Safety (FS)	**2.929**

Via: 1.1 DALCACHE03 (NetCache NetApp/5.5R2)

go to problem statement input values solution material selection contact help references

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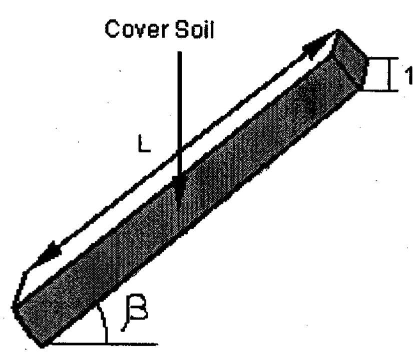
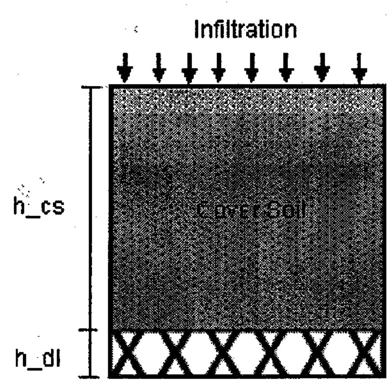
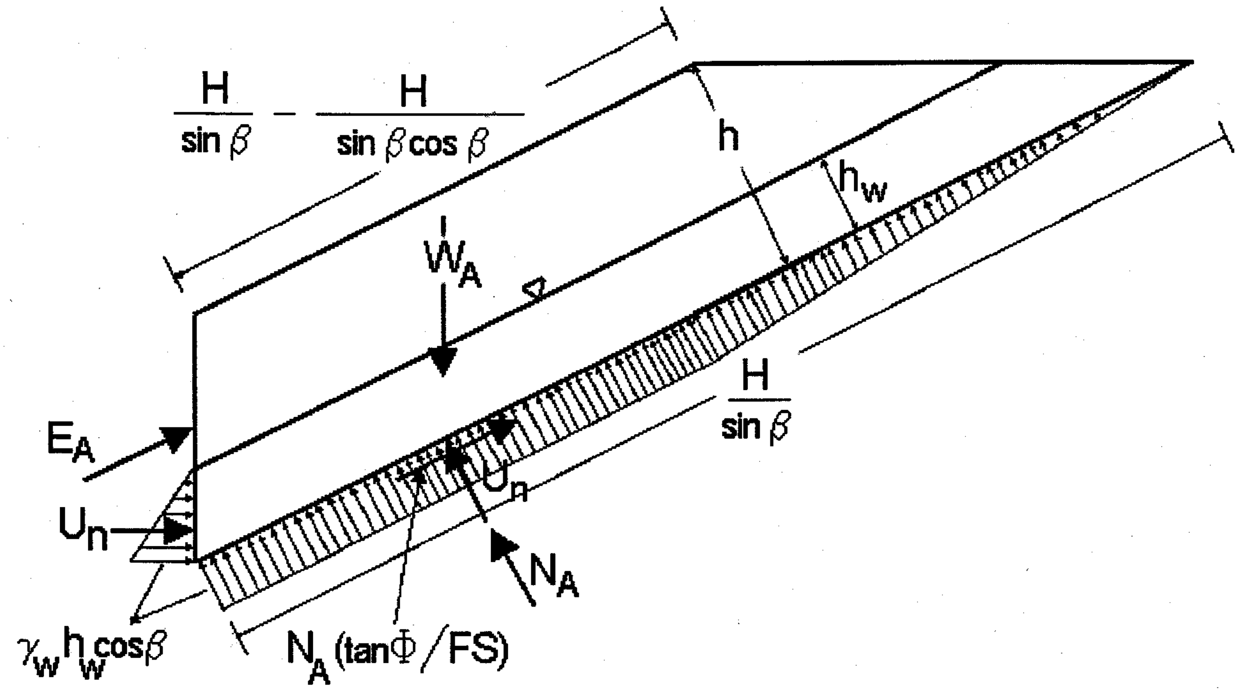
Cover Slope Stability - Design Calculator

Problem Statement Case 2 Run B2 - SHEET 73 SEEP (Swan Pond Blow Out) Area Detail G74 slope geocomposite drainage layer cover soil K 1E-06 Between Elevations 765 and 783 feet —slope 9 degrees, L = 113 feet, PMP = 29.5 inches/6hr (124.883 mm/hr),.

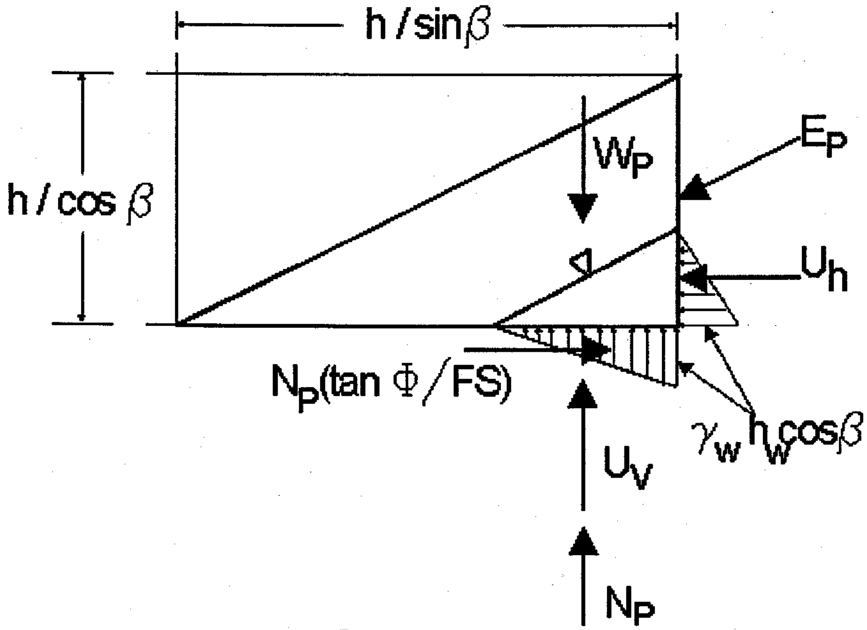
Results: FS slope =2.932 Therefore Acceptable, DLC = 46.19 (>1.0 and 6 (includes uncertainty factors), therefore passes both tests for drainage layer capacity / factor of safety.)







Active Wedge



Passive Wedge

Input Values

Design Input

Slope characteristics

Length of the slope (L)	34.45777	m
Slope angle (ß)	9.0468	degrees

Height of soil layers

Height of cover soil (h_cs)	609.6	mm
Height of drainage layer (h_dl)	5.08	mm

Permeability of the soil layers

Permeability of cover soil	0.000001	cm/s
Design permeability of drainage layer	1.986	cm/s

Rain intensity parameters

Precipitation	124.883	mm/hr

Run-off coefficient	0.4	
Soil characteristics		
Dry unit weight of cover soil	18.85	kN/m^3
Saturated unit weight of the cover soil	21.	kN/m^3
Friction angles		
Friction angle of the cover soil	29.6	degrees
Friction angle of the cover soil / underlying interface	23.68	degrees

Stability Calculation

Solution

I. Normalized Input data

Gradient	0.157
Horizontal length	34.029 m
Height cover soil and drainage layer	0.61468 m
Permeability of cover soil in m/s	1.00E-008 m/s
Design permeability of the drainage layer in m/s	0.01986 m/s

II. Calculation of the Drainage Capacity

Precipitation from input	124.883 mm/hr
Actual runoff	124.847 mm/hr
Actual percolation	0.036 mm/hr
Actual flux	0.001 m^3/hr
Allowable flux	0.057 m^3/hr
Drainage Layer Capacity (DLC) (needs to be >1.0 to avoid saturation)	**46.619**

III. Parallel Submergence Ratio (PSR)

Average height water table	1.09E-004 m
Parallel Submergence Ratio (PSR)	**0.000**

Stability Factor of Safety (FS)	**2.932**

Via: 1.1 DALCACHE03 (NetCache NetApp/5.5R2)

go to problem statement input values solution material selection contact help references

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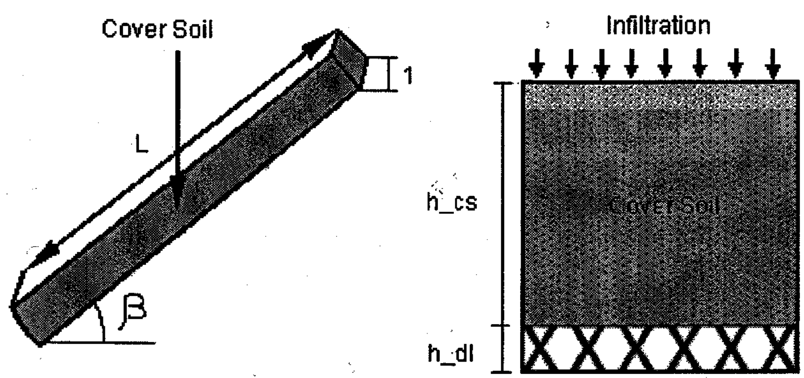
Cover Slope Stability - Design Calculator

Problem Statement Case 2 Run C1 – Slope 3H to 1V SHEET 73 SEEP (Swan Pond Blow Out) Area Detail G74 slope geocomposite drainage layer cover soil K 1E-06 — slope 18.43 degrees, L = 99.5 feet, PMP = 29.5 inches/6hr (124.883 mm/hr),.

Results: FS slope =**1.374 > 1.0, Therefore** Acceptable, DLC = **110.6** (>1.0 and > 6 (includes uncertainty factors), therefore passes both tests extremely well as for the Drainage Layer Capacity Factor of Safety for geocomposite drainage layer).



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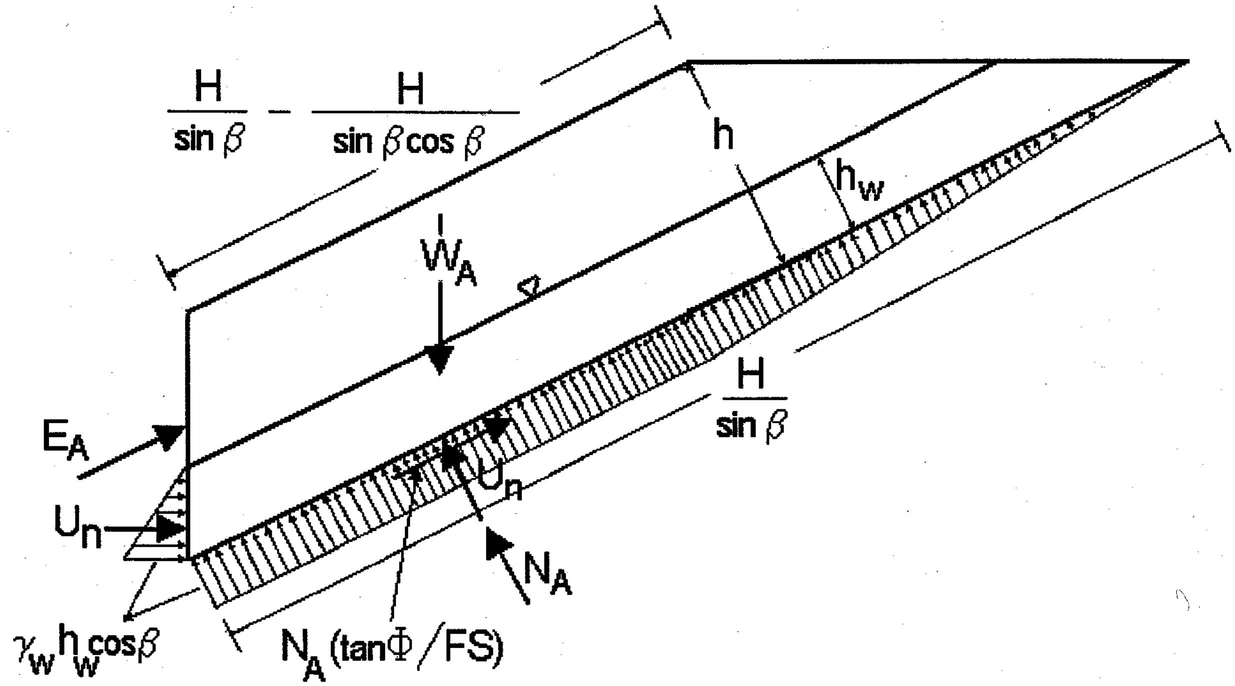
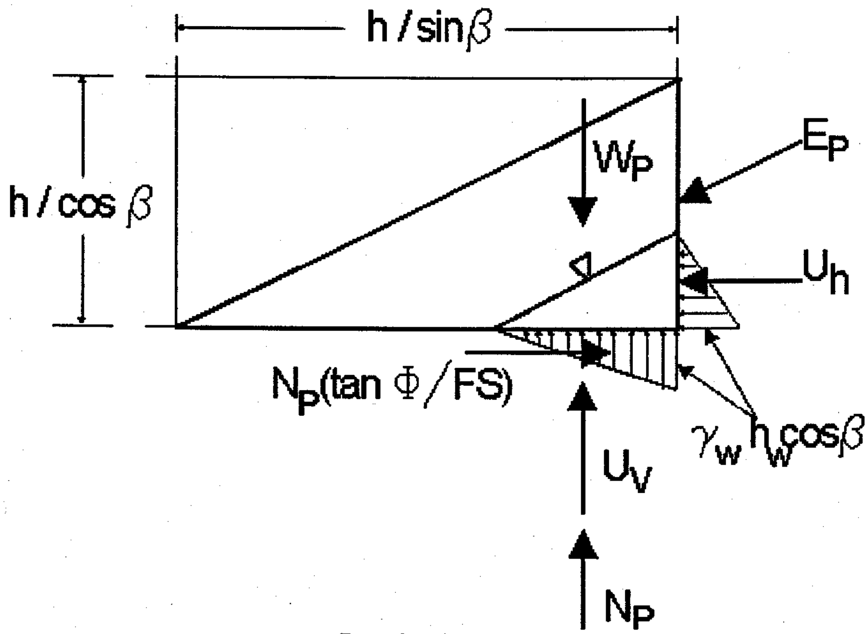


Active Wedge



Passive Wedge

Input Values

Design Input

Slope characteristics

Length of the slope (L)	30.32759	m
Slope angle (ß)	18.43945	degrees

Height of soil layers

Height of cover soil (h_cs)	609.6	mm
Height of drainage layer (h_dl)	5.08	mm

Permeability of the soil layers

Permeability of cover soil	0.000001	cm/s
Design permeability of drainage layer	1.986	cm/s

Rain intensity parameters

Precipitation	124.883	mm/hr

Run-off coefficient	0.4	

Soil characteristics

Dry unit weight of cover soil	18.85	kN/m^3
Saturated unit weight of the cover soil	21	kN/m^3

Friction angles

Friction angle of the cover soil	29.6	degrees
Friction angle of the cover soil / underlying interface	23.68	degrees

Stability Calculation

Solution

I. Normalized Input data

Gradient	0.316	
Horizontal length	28.771	m
Height cover soil and drainage layer	0.61468	m
Permeability of cover soil in m/s	1.00E-008	m/s
Design permeability of the drainage layer in m/s	0.01986	m/s

II. Calculation of the Drainage Capacity

Precipitation from input	124.883	mm/hr
Actual runoff	124.847	mm/hr
Actual percolation	0.036	mm/hr
Actual flux	0.001	m^3/hr
Allowable flux	0.115	m^3/hr
Drainage Layer Capacity (DLC) (needs to be >1.0 to avoid saturation)	**110.917**	

III. Parallel Submergence Ratio (PSR)

Average height water table	4.58E-005	m
Parallel Submergence Ratio (PSR)	**0.000**	

Stability Factor of Safety (FS)	**1.374**

Via: 1.1 DALCACHE03 (NetCache NetApp/5.5R2)

go to problem statement input values solution material selection contact help references

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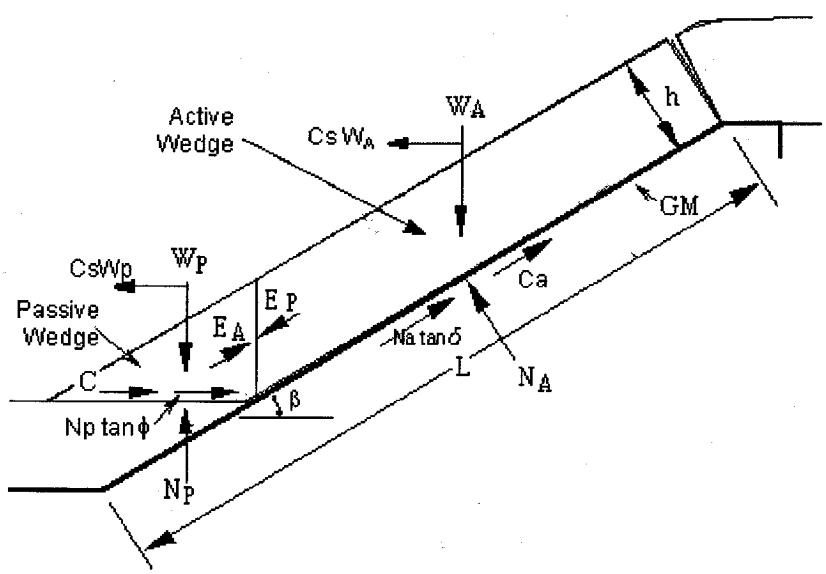
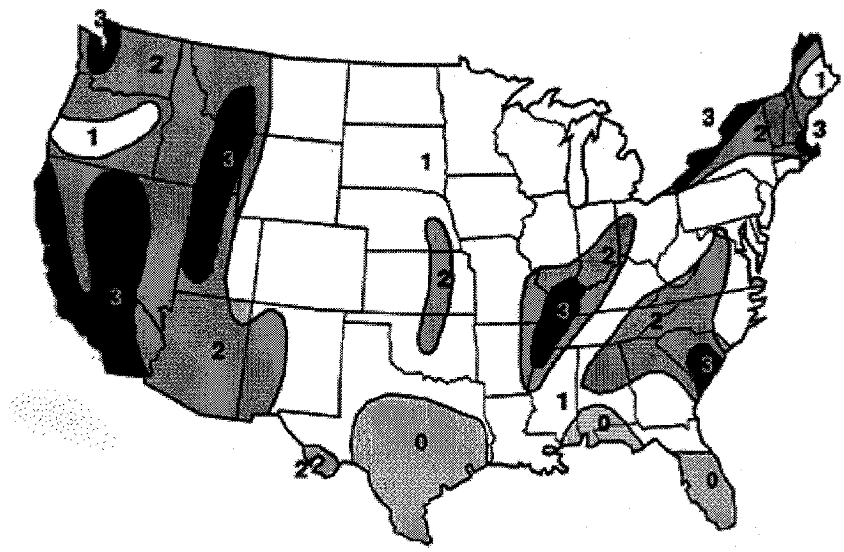
Slope Stability:Seismic Force - Design Calculator

Problem Statement Case 2 Run D1 – **PSEUDO STATIC (SEISMIC) VENEER** SHEET 73 SEEP (Swan Pond Blow Out) Area 9 Degree Slope Detail G74 geocomposite drainage layer. FS Seismic Force = **4.636.**

This slope stability calculator utilizes a pseudo-static analysis to determine the factor of safety (FS) of a geosynthetic lined slope. This calculator assumes that no seepage forces are present. The unit gradient calculator can be used to calculate the required transmissivity of the drainage geocomposite to assure adequate drainage.

Subtitle "D" of the U.S. EPA regulations requires a seismic analysis if the site has experienced a 0.1 g horizontal acceleration, or more, in the past 250 years. For the continental USA, this does not only include the western states, but major sections of the midwest and northeast as well. The map below shows the seismic coefficients for various zones in the USA.





Legend

Zone 0:	No damage
Zone 1:	Minor damage; corresponds to intensities V and VI on the modified Mercalli intensity scale
Zone 2:	Moderate damage; corresponds to intensity VII on the modified Mercalli intensity scale
Zone 3:	Major damage; corresponds to intensity VIII and higher on the modified Mercalli intensity scale

Seismic coefficients corresponding to each zone

Zone	Remark	Modified Mercalli Scale	Average Seismic Coefficient (Cs)
0	No damage	-	0
1	Minor damage	V and VI	0.03 to 0.07
2	Moderate damage	VII	0.13
3	Major damage	VIII and higher	0.27

Input Values

Design Inputs

Slope characteristics

Thickness of cover soil (h) 0.6096 m

Slope angle (ß) 9.0468 degrees

Lenght of slope measured along geomembrane (L) 34.457777 m

Soil characteristics

Unit weight of the cover soil (g)	21	kN/m^3
Friction angle of the cover soil (f)	26	degrees
Cohesion of the cover soil (c)	11.97	kN/m^2
Interface friction(d)	20.8	degrees
Interface adhesion (Ca)	9.57854	kN/m^2

Seismic characteristic

Seismic coefficient (Cs)	0.11	g

Seismic Stability Calculation

Solution

Factor of Safety with seismic activity (FS) 4.636

Factor of Safety no seismic activity (FS) 8.128

Via: 1.1 DALCACHE03 (NetCache NetApp/5.5R2)

go to problem statement input values solution material selection contact help references

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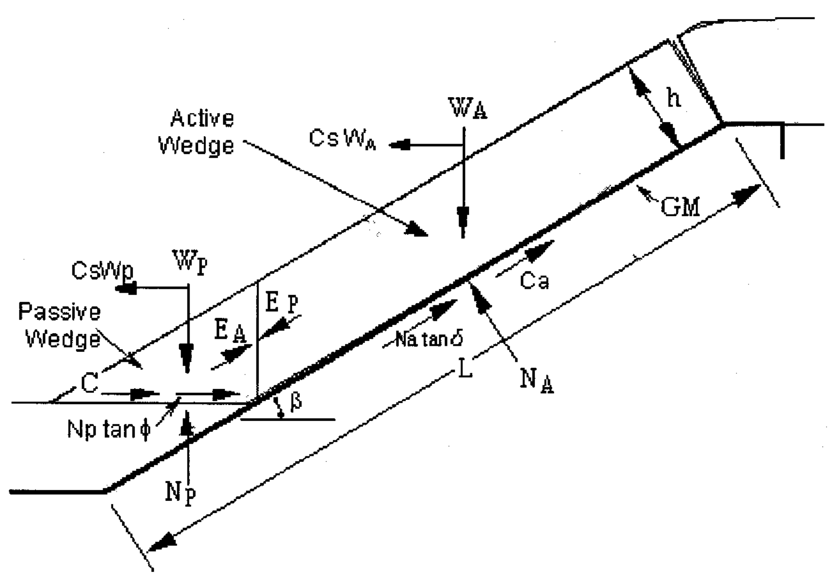
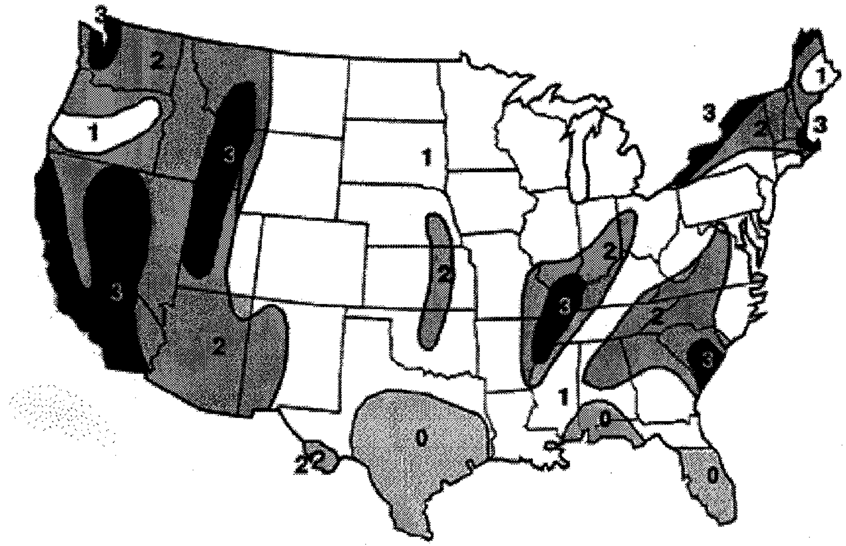
Slope Stability:Seismic Force - Design Calculator

Problem Statement Case 2 Run D2 – **PSEUDO STATIC (SEISMIC) VENEER** SHEET 73 at Swan Pond Seep and Blow Out Area for 3H to 1V or 18.44 Degree Slope, See Detail G74 for case of 24 inches of soil on geocomposite drainage layer. With Seismic Force, Factor of Safety = **2.753.**

This slope stability calculator utilizes a pseudo-static analysis to determine the factor of safety (FS) of a geosynthetic lined slope. This calculator assumes that no seepage forces are present. The unit gradient calculator can be used to calculate the required transmissivity of the drainage geocomposite to assure adequate drainage.

Subtitle "D" of the U.S. EPA regulations requires a seismic analysis if the site has experienced a 0.1 g horizontal acceleration, or more, in the past 250 years. For the continental USA, this does not only include the western states, but major sections of the midwest and northeast as well. The map below shows the seismic coefficients for various zones in the USA.





Legend

Zone 0:	No damage
Zone 1:	Minor damage; corresponds to intensities V and VI on the modified Mercalli intensity scale
Zone 2:	Moderate damage; corresponds to intensity VII on the modified Mercalli intensity scale
Zone 3:	Major damage; corresponds to intensity VIII and higher on the modified Mercalli intensity scale

Seismic coefficients corresponding to each zone

Zone	Remark	Modified Mercalli Scale	Average Seismic Coefficient (Cs)
0	No damage	-	0
1	Minor damage	V and VI	0.03 to 0.07
2	Moderate damage	VII	0.13
3	Major damage	VIII and higher	0.27

Input Values

Design Inputs

Slope characteristics

Thickness of cover soil (h)	0.6096	m
Slope angle (ß)	18.44	degrees
Lenght of slope measured along geomembrane (L)	30.32759	m

Soil characteristics

Unit weight of the cover soil (g)	21	kN/m^3
Friction angle of the cover soil (f)	26	degrees
Cohesion of the cover soil (c)	11.97	kN/m^2
Interface friction(d)	20.8	degrees
Interface adhesion (Ca)	9.57854	kN/m^2

Seismic characteristic

Seismic coefficient (Cs)	0.11	g

Seismic Stability Calculation

Solution

Factor of Safety with seismic activity (FS) 2.753

Factor of Safety no seismic activity (FS) 3.796

Via: 1.1 DALCACHE03 (NetCache NetApp/5.5R2)

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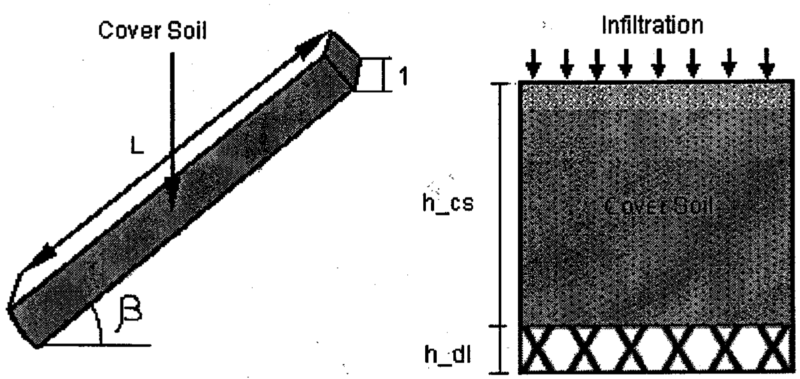
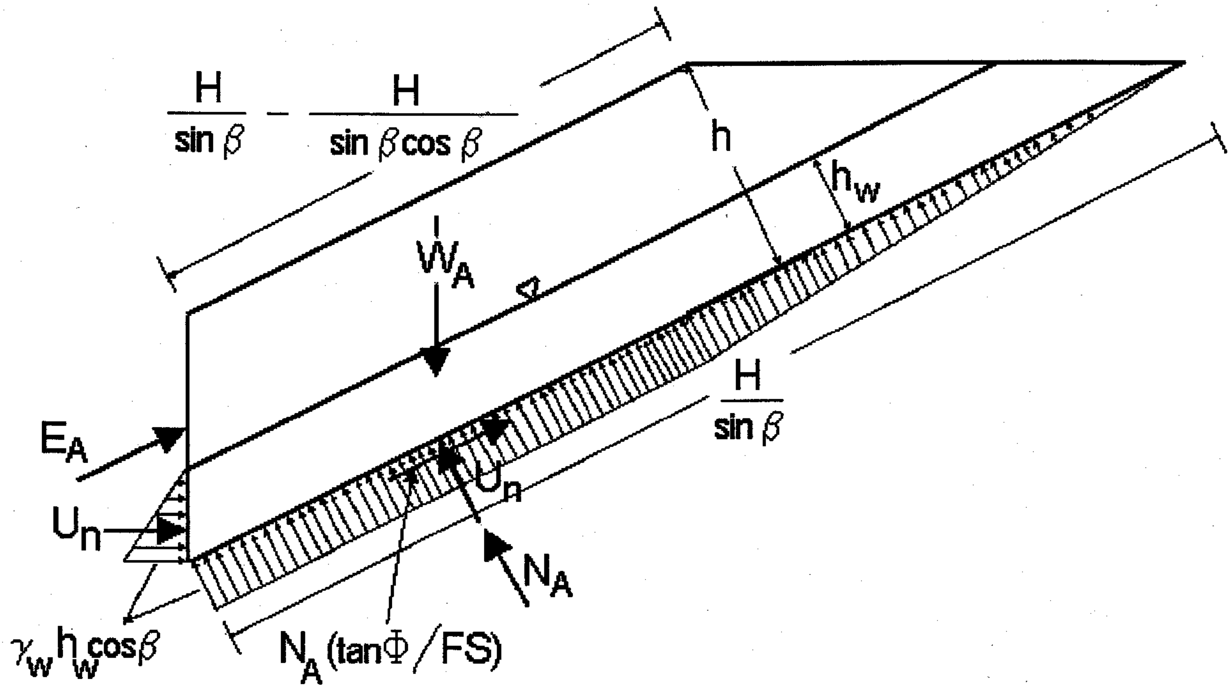
Cover Slope Stability - Design Calculator

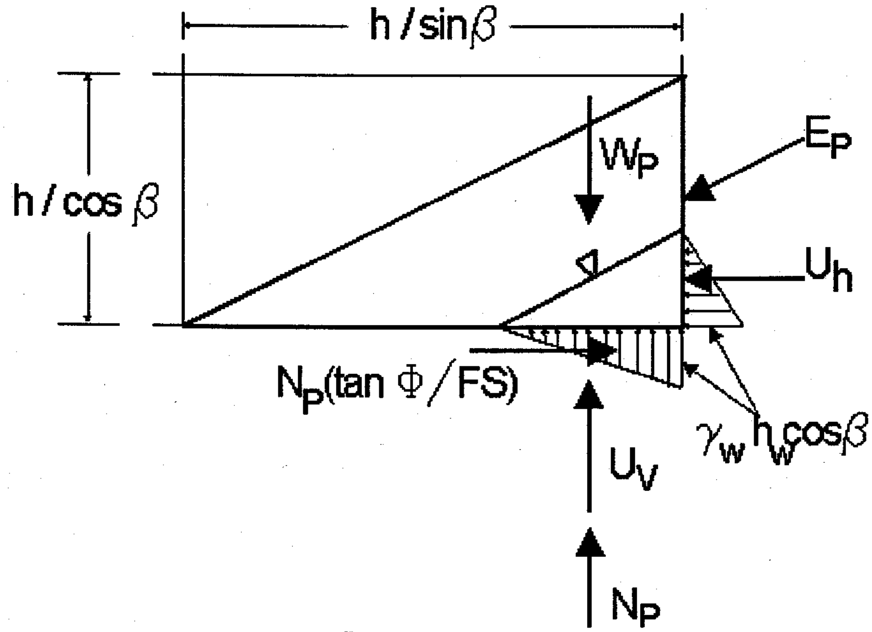
Problem Statement Case 3 Run A1 – 3H to 1V Dredge Cell Lateral Expansion Sheet 75 E75 Detail cover soil 18 inch thick K 1E-06 geocomposite drainage net —slope 18.43 degrees, L = 94.88 feet, PMP = 29.5 inches/6hr (124.883 mm/hr).

Results: FS slope =**1.362> 1.0, Therefore** Acceptable, DLC = **77.936** (>1.0 and > 6 (includes uncertainty factors), therefore passes both tests extremely well as for the Drainage Layer Capacity Factor of Safety for geocomposite drainage layer).





Active Wedge



Passive Wedge

Input Values

Design Input

Slope characteristics

Length of the slope (L)	28.92	m
Slope angle (ß)	18.44	degrees

Height of soil layers

Height of cover soil (h_cs)	457.2	mm
Height of drainage layer (h_dl)	5.08	mm

Permeability of the soil layers

Permeability of cover soil	1.4925e-06	cm/s
Design permeability of drainage layer	1.986	cm/s

Rain intensity parameters

Precipitation	124.883	mm/hr

Run-off coefficient	0.4	
Soil characteristics		
Dry unit weight of cover soil	18.85	kN/m^3
Saturated unit weight of the cover soil	21.	kN/m^3
Friction angles		
Friction angle of the cover soil	29.6	degrees
Friction angle of the cover soil / underlying interface	23.68	degrees

Stability Calculation

Solution

I. Normalized Input data

Gradient	0.316	
Horizontal length	27.435	m
Height cover soil and drainage layer	0.46228	m
Permeability of cover soil in m/s	1.49E-008	m/s
Design permeability of the drainage layer in m/s	0.01986	m/s

II. Calculation of the Drainage Capacity

Precipitation from input	124.883	mm/hr
Actual runoff	124.82927	mm/hr
Actual percolation	0.05373	mm/hr
Actual flux	0.001	m^3/hr
Allowable flux	0.115	m^3/hr
Drainage Layer Capacity (DLC) (needs to be >1.0 to avoid saturation)	**77.936**	

III. Parallel Submergence Ratio (PSR)

Average height water table	6.52E-005	m
Parallel Submergence Ratio (PSR)	**0.000**	

Stability Factor of Safety (FS) **1.362**

Stability Factor of Safety (FS)	**1.362**

Via: 1.1 DALCACHE03 (NetCache NetApp/5.5R2)

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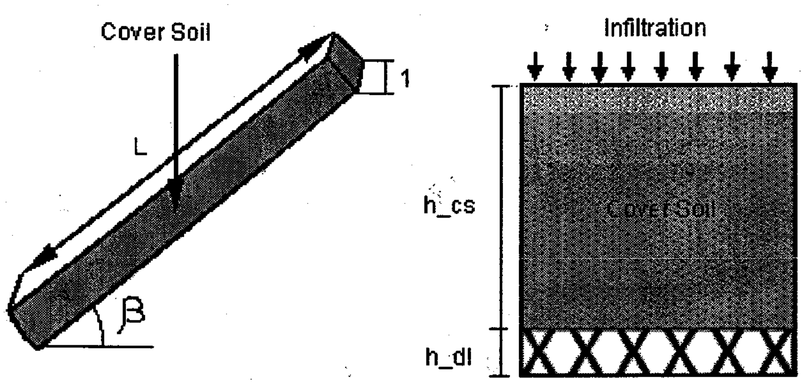
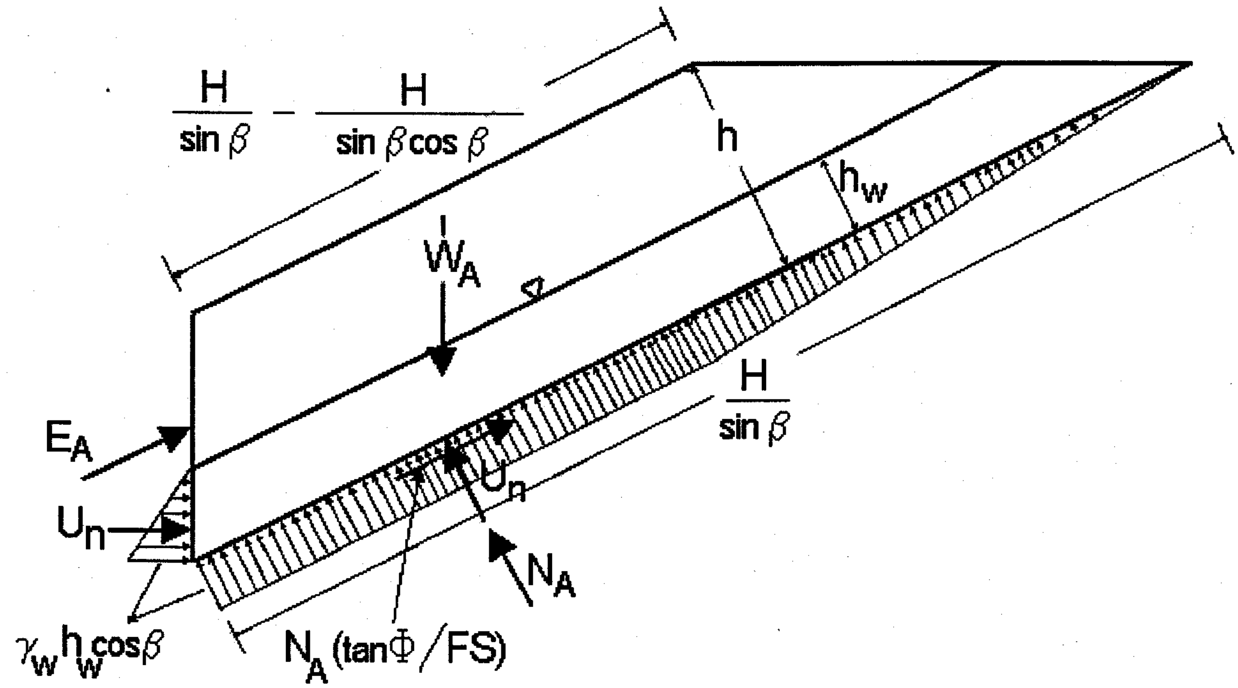
Cover Slope Stability - Design Calculator

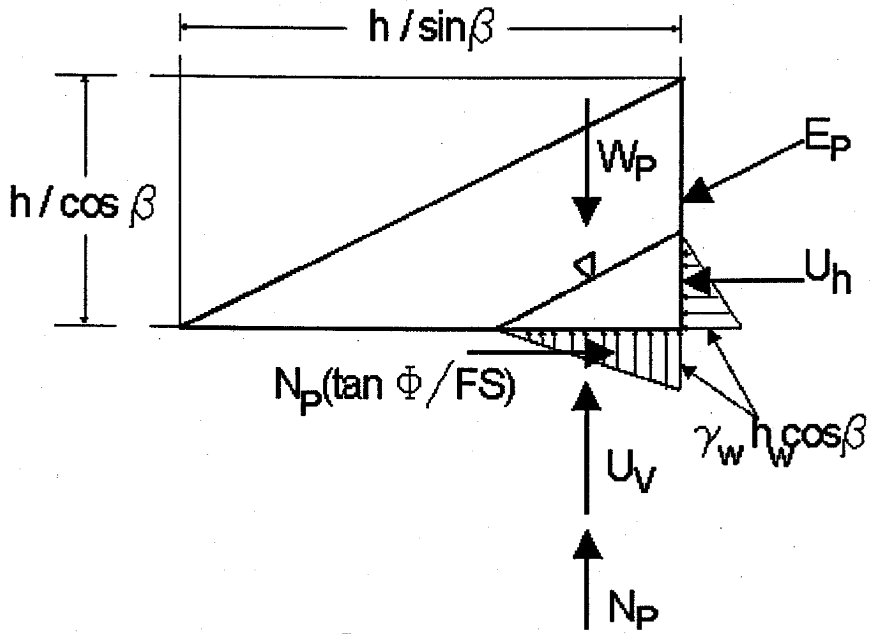
Problem Statement Case 3 Run A2 – Sheet 74 Detail 74 cover soil 24 inch thick K 1E-06 BA Drainage 1e-3 cm per sec 3H to 1V Dredge Cell Lateral Expansion —slope 18.43 degrees, L = 94.88 feet, PMP = 29.5 inches/6hr (124.883 mm/hr).

Results: FS slope =**1.649> 1.0**, therefore acceptable. DLC = **1.775, barely acceptable. Slight decrease in K will likely compromise system.** (>1.0 but << 6 (includes uncertainty factors). Should consider use of pipes with BA ash layers every 30 to 50 feet laterally and a maximum of 30 feet vertically.





Active Wedge



Passive Wedge

Input Values

Design Input

Slope characteristics

Length of the slope (L)	28.92	m
Slope angle (ß)	18.44	degrees
Height of soil layers		
Height of cover soil (h_cs)	609.6	mm
Height of drainage layer (h_dl)	304.8	mm
Permeability of the soil layers		
Permeability of cover soil	1.9802e-06	cm/s
Design permeability of drainage layer	.001	cm/s
Rain intensity parameters		
Precipitation	124.88	mm/hr

Run-off coefficient	0.4	

Soil characteristics

Dry unit weight of cover soil	18.85	kN/m^3
Saturated unit weight of the cover soil	21.	kN/m^3

Friction angles

Friction angle of the cover soil	29.6	degrees
Friction angle of the cover soil / underlying interface	29.6	degrees

Stability Calculation

Solution

I. Normalized Input data

Gradient	0.316	
Horizontal length	27.435	m
Height cover soil and drainage layer	0.9144	m
Permeability of cover soil in m/s	1.98E-008	m/s
Design permeability of the drainage layer in m/s	1e-005	m/s

II. Calculation of the Drainage Capacity

Precipitation from input	124.88	mm/hr
Actual runoff	124.8087128	mm/hr
Actual percolation	0.0712872	mm/hr
Actual flux	0.002	m^3/hr
Allowable flux	0.003	m^3/hr
Drainage Layer Capacity (DLC) (needs to be >1.0 to avoid saturation)	**1.775**	

III. Parallel Submergence Ratio (PSR)

Average height water table	1.72E-001	m
Parallel Submergence Ratio (PSR)	**0.188**	

Stability Factor of Safety (FS)	**1.649**

Stability Factor of Safety (FS) **1.649**

Via: 1.1 DALCACHE03 (NetCache NetApp/5.5R2)

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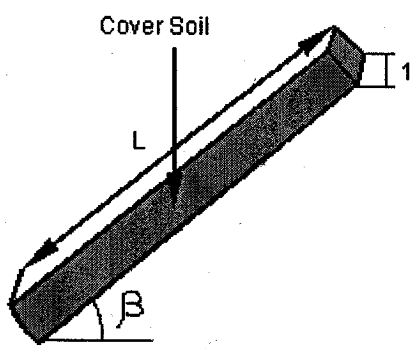
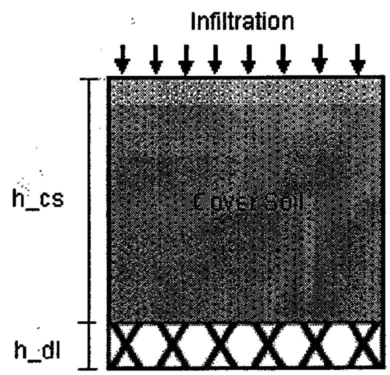
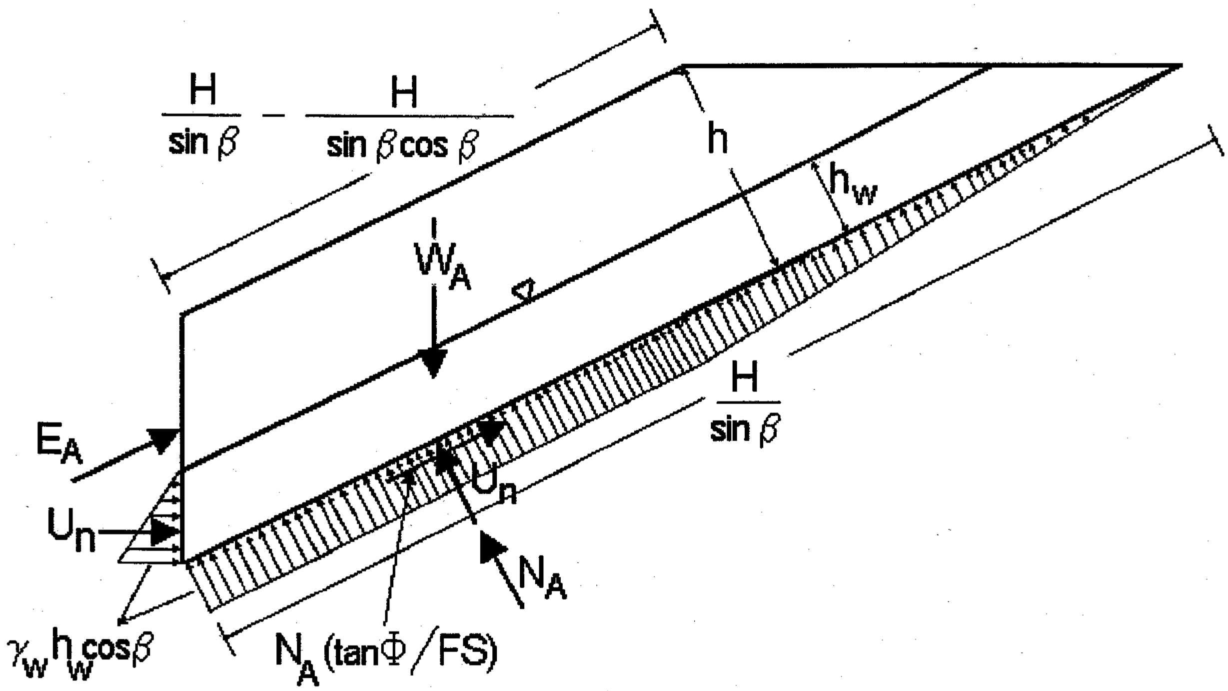
Cover Slope Stability - Design Calculator

Problem Statement Case 3 Run A3 – Sheet 74 Detail 74 cover soil 24 inch thick K 1E-06 BA Drainage 0.5e-3 cm per sec 3H to 1V Dredge Cell Lateral Expansion —slope 18.43 degrees, L = 94.88 feet, PMP = 29.5 inches/6hr (124.883 mm/hr).

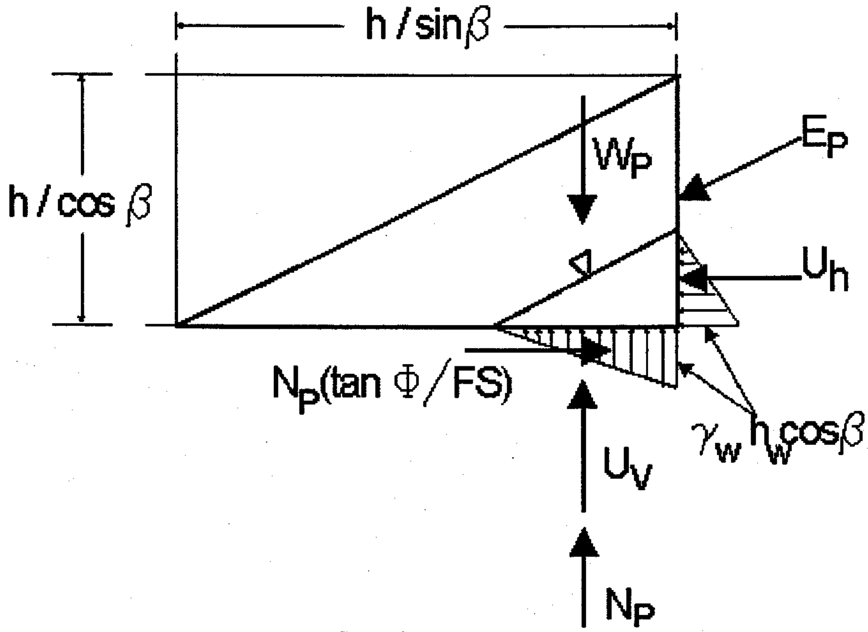
Results: FS slope =**0.971 < 1.0,** therefore **slope failure would occur because of the decrease in drainage layer hydraulic conductivity from Case 3 Run A2.** DLC now equals **0.887, which is below 1 and unacceptable.** Slight decreases in K often compromise system veneer stability and act as the irreversible "tipping point" toward veneer failure.. Should consider use of pipes with BA ash layers every 30 to 50 feet laterally and a maximum of 30 feet vertically or go with the alternate geocomposite drainage layers.







Active Wedge



Passive Wedge

Input Values

Design Input

Slope characteristics

Length of the slope (L)	28.92	m
Slope angle (ß)	18.44	degrees

Height of soil layers

Height of cover soil (h_cs)	609.6	mm
Height of drainage layer (h_dl)	304.8	mm

Permeability of the soil layers

Permeability of cover soil	1.9802e-06	cm/s
Design permeability of drainage layer	.0005	cm/s

Rain intensity parameters

Precipitation	124.88	mm/hr

Run-off coefficient	0.4	

Soil characteristics

Dry unit weight of cover soil	18.85	kN/m^3
Saturated unit weight of the cover soil	21.	kN/m^3

Friction angles

Friction angle of the cover soil	29.6	degrees
Friction angle of the cover soil / underlying interface	29.6	degrees

Stability Calculation

Solution

I. Normalized Input data

Gradient	0.316	
Horizontal length	27.435	m
Height cover soil and drainage layer	0.9144	m
Permeability of cover soil in m/s	1.98E-008	m/s
Design permeability of the drainage layer in m/s	5e-006	m/s

II. Calculation of the Drainage Capacity

Precipitation from input	124.88	mm/hr
Actual runoff	124.8087128	mm/hr
Actual percolation	0.0712872	mm/hr
Actual flux	0.002	m^3/hr
Allowable flux	0.002	m^3/hr
Drainage Layer Capacity (DLC) (needs to be >1.0 to avoid saturation)	**0.887**	

III. Parallel Submergence Ratio (PSR)

Average height water table	1.01E+001	m
Parallel Submergence Ratio (PSR)	**1.000**	

Stability Factor of Safety (FS)	**0.971**

Via: 1.1 DALCACHE03 (NetCache NetApp/5.5R2)

go to problem statement input values solution material selection contact help references

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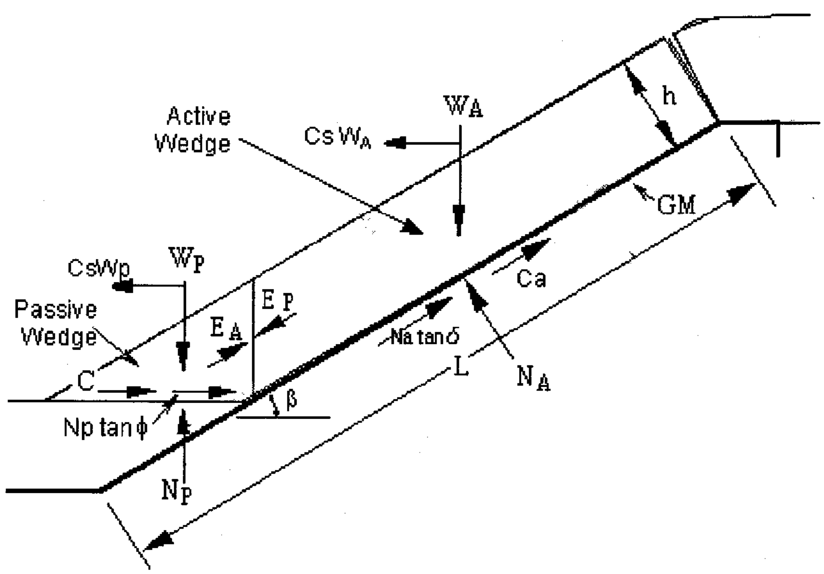
Slope Stability:Seismic Force - Design Calculator

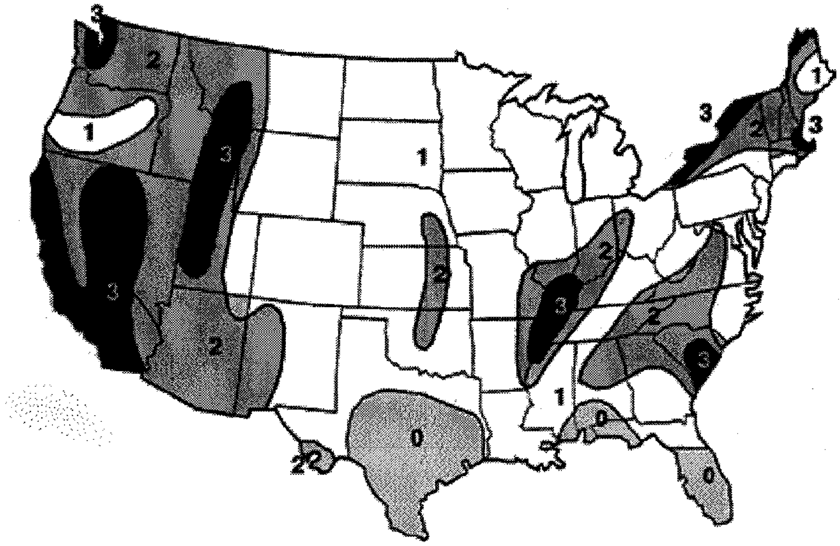
Problem Statement Case 3 Run B1 – Pseudo-Static Analysis of 3H to 1V Dredge Cell Lateral Expansion Sheet 75 E75 Detail cover soil 18 inch thick drainage net —slope 18.43 degrees, L = 94.88 feet.

Results: FS slope =**3.325 > 1.0**, Therefore acceptable.

This slope stability calculator utilizes a pseudo-static analysis to determine the factor of safety (FS) of a geosynthetic lined slope. This calculator assumes that no seepage forces are present. The unit gradient calculator can be used to calculate the required transmissivity of the drainage geocomposite to assure adequate drainage.

Subtitle "D" of the U.S. EPA regulations requires a seismic analysis if the site has experienced a 0.1 g horizontal acceleration, or more, in the past 250 years. For the continental USA, this does not only include the western states, but major sections of the midwest and northeast as well. The map below shows the seismic coefficients for various zones in the USA.





Legend

Zone 0:	No damage
Zone 1:	Minor damage; corresponds to intensities V and VI on the modified Mercalli intensity scale
Zone 2:	Moderate damage; corresponds to intensity VII on the modified Mercalli intensity scale
Zone 3:	Major damage; corresponds to intensity VIII and higher on the modified Mercalli intensity scale

Seismic coefficients corresponding to each zone

Zone	Remark	Modified Mercalli Scale	Average Seismic Coefficient (Cs)
0	No damage	-	0
1	Minor damage	V and VI	0.03 to 0.07
2	Moderate damage	VII	0.13
3	Major damage	VIII and higher	0.27

Input Values

Design Inputs

Slope characteristics

Thickness of cover soil (h)	0.4572	m
Slope angle (ß)	18.44	degrees
Lenght of slope measured along geomembrane (L)	28.92	m

Soil characteristics

Unit weight of the cover soil (g)	21	kN/m^3
Friction angle of the cover soil (f)	26	degrees
Cohesion of the cover soil (c)	11.97	kN/m^2
Interface friction(d)	20.8	degrees
Interface adhesion (Ca)	9.57854	kN/m^2

Seismic characteristic

Seismic coefficient (Cs)	0.11	g

Seismic Stability Calculation

Solution

Factor of Safety with seismic activity (FS) 3.325

Factor of Safety no seismic activity (FS) 4.576

Via: 1.1 DALCACHE03 (NetCache NetApp/5.5R2)

go to problem statement input values solution material selection contact help references

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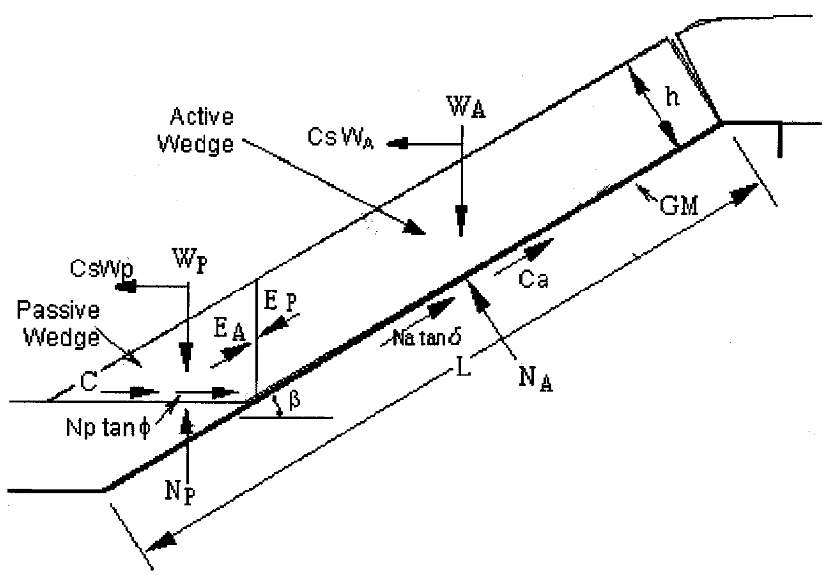
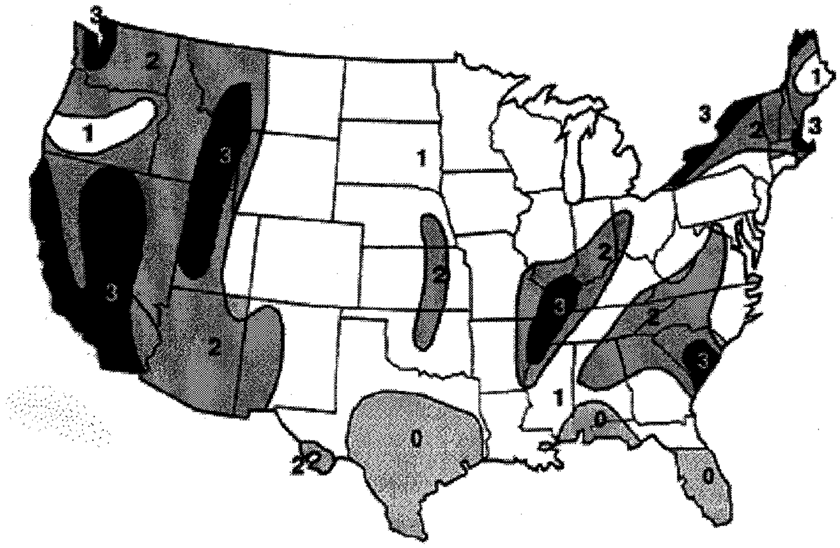
Slope Stability:Seismic Force - Design Calculator

Problem Statement Problem Statement Case 3 Run B2 – Pseudo Static Analysis of Sheet 74 3H-1V Detail F74 Dredge Cell cover soil 24 inch thick K 1E-06 BA Drainage 1e-3 cm per sec Dredge Cell Lateral Expansion Factor of Safety of Cap During Application of Seismic Force = **2.996 > 1, therefore ok.**

This slope stability calculator utilizes a pseudo-static analysis to determine the factor of safety (FS) of a geosynthetic lined slope. This calculator assumes that no seepage forces are present. The unit gradient calculator can be used to calculate the required transmissivity of the drainage geocomposite to assure adequate drainage.

Subtitle "D" of the U.S. EPA regulations requires a seismic analysis if the site has experienced a 0.1 g horizontal acceleration, or more, in the past 250 years. For the continental USA, this does not only include the western states, but major sections of the midwest and northeast as well. The map below shows the seismic coefficients for various zones in the USA.





Legend

Zone 0:	No damage
Zone 1:	Minor damage; corresponds to intensities V and VI on the modified Mercalli intensity scale
Zone 2:	Moderate damage; corresponds to intensity VII on the modified Mercalli intensity scale
Zone 3:	Major damage; corresponds to intensity VIII and higher on the modified Mercalli intensity scale

Seismic coefficients corresponding to each zone

Zone	Remark	Modified Mercalli Scale	Average Seismic Coefficient (Cs)
0	No damage	-	0
1	Minor damage	V and VI	0.03 to 0.07
2	Moderate damage	VII	0.13
3	Major damage	VIII and higher	0.27

Input Values

Design Inputs

Slope characteristics

Thickness of cover soil (h)	0.6096	m
Slope angle (ß)	18.44	degrees
Lenght of slope measured along geomembrane (L)	28.92	m

Soil characteristics

Unit weight of the cover soil (g)	21	kN/m^3
Friction angle of the cover soil (f)	26	degrees
Cohesion of the cover soil (c)	11.97	kN/m^2
Interface friction(d)	26	degrees
Interface adhesion (Ca)	9.57854	kN/m^2

Seismic characteristic

Seismic coefficient (Cs)	0.11	g

Seismic Stability Calculation

Solution

Factor of Safety with seismic activity (FS) 2.996

Factor of Safety no seismic activity (FS) 4.134

Via: 1.1 DALCACHE03 (NetCache NetApp/5.5R2)

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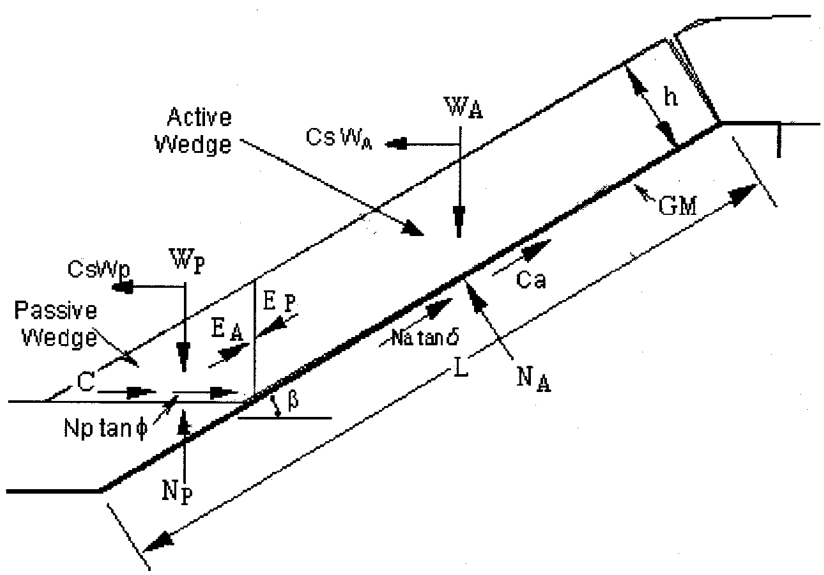
Slope Stability:Seismic Force - Design Calculator

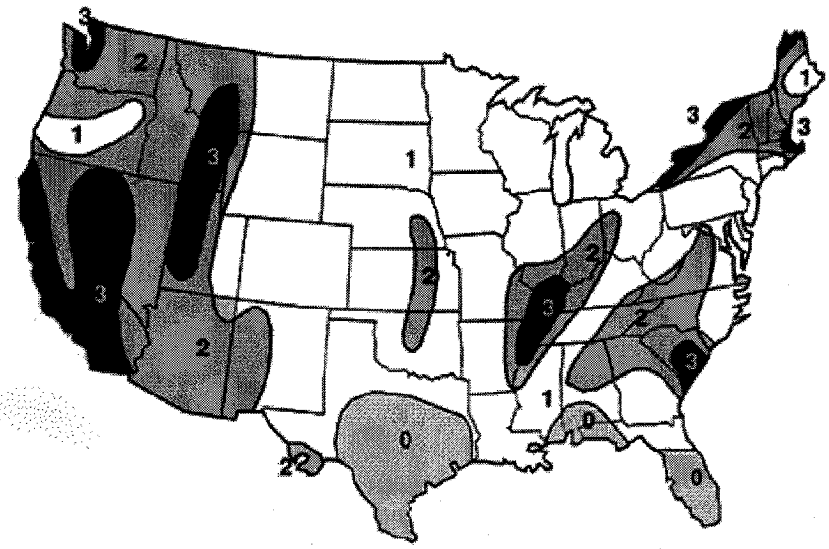
Problem Statement **Case 3 Run B3** – Pseudo-Static phi=0 Analysis of 3H to 1V Dredge Cell Lateral Expansion Sheet 75 E75 Detail cover soil 18 inch thick geocom drainage net —slope 18.43 degrees, L = 94.88 feet. Analysis with Undrained Strengths Phi = 0 Analysis Only.

Results: FS slope =**13.747> 1.0,** Therefore acceptable

This slope stability calculator utilizes a pseudo-static analysis to determine the factor of safety (FS) of a geosynthetic lined slope. This calculator assumes that no seepage forces are present. The unit gradient calculator can be used to calculate the required transmissivity of the drainage geocomposite to assure adequate drainage.

Subtitle "D" of the U.S. EPA regulations requires a seismic analysis if the site has experienced a 0.1 g horizontal acceleration, or more, in the past 250 years. For the continental USA, this does not only include the western states, but major sections of the midwest and northeast as well. The map below shows the seismic coefficients for various zones in the USA.





Legend

Zone 0:	No damage
Zone 1:	Minor damage; corresponds to intensities V and VI on the modified Mercalli intensity scale
Zone 2:	Moderate damage; corresponds to intensity VII on the modified Mercalli intensity scale
Zone 3:	Major damage; corresponds to intensity VIII and higher on the modified Mercalli intensity scale

Seismic coefficients corresponding to each zone

Zone	Remark	Modified Mercalli Scale	Average Seismic Coefficient (Cs)
0	No damage	-	0
1	Minor damage	V and VI	0.03 to 0.07
2	Moderate damage	VII	0.13
3	Major damage	VIII and higher	0.27

Input Values

Design Inputs

Slope characteristics

Thickness of cover soil (h)	0.4572	m
Slope angle (ß)	18.44	degrees
Lenght of slope measured along geomembrane (L)	28.92	m

Soil characteristics

Unit weight of the cover soil (g)	21	kN/m^3
Friction angle of the cover soil (f)	0	degrees
Cohesion of the cover soil (c)	67.05	kN/m^2
Interface friction(d)	0	degrees
Interface adhesion (Ca)	53.6	kN/m^2

Seismic characteristic

Seismic coefficient (Cs)	0.11	g

Seismic Stability Calculation

Solution

Factor of Safety with seismic activity (FS) 13.747

Factor of Safety no seismic activity (FS) 18.926

ATTACHMENT 7

LIQUEFACTION EVALUATION

PURPOSE

To evaluate liquefaction potential for existing foundation soils/materials at the location of the proposed gypsum-ash stack.

REFERENCES

1. Tennessee Division of Solid Waste, *Technical Guidance Document, dated 7/29/93,* (Guidance Document)
2. RCRA Subtitle D (258), *Seismic Design Guidance for Municipal Waste Landfill Facilities,* EPA/600/R-95/051 dated April 1995. (Subtitle D258)

EVALUATION STEPS

1. Peak ground acceleration, $a_{max} = 0.22g$.
2. Existing subsurface condition based on boring B-9 and CPT-9 (being representative of the condition below the stack and worse for this evaluation than B-10 and CPT-10):

   Ground Surface (GS) @ Elev. 764.6'

Stratum	Depth	General Description
A	GS – 7.5'	... Compact Fill
B	7.5' – 24.5'	... Bottom Ash (BA), medium compact to compact
C	24.5' – 35.5'	...Sluiced fly ash (FA), loose to medium
D	35.5' – 49'±	...Natural Clay, stiff

   Refusal @ 49'± per CPT-9.

   GWL @ 6.7' (Elev. 757.7') per CPT-9 (somewhat lower in B-9)

3. For total and effective vertical pressures (Tstress and Estress, resp.) at various depths below GS, see CPT table given in Appendix A. Based on this table, the total and effective vertical pressures and the ratio of these pressures (VPR) at the mid-heights of the four subsurface strata (i.e., at depths 3.75', 16.0', 30.0' and ~ 42', respectively) are as follows:

Stratum	Depth	Total (tsf)	Effective (tsf)	VPR = TStress / EStress
A	3.75'	0.23	0.23	1.000
B	16.0'	0.96	0.67	1.433
C	30.0'	1.77	1.05	1.686
D	~42'	2.47	1.36	1.816

4. For values of corrected N, $N_{1(60)}$, also see table in Appendix A. The average $N_{1(60)}$ values obtained from the table and as shown on the table are >40, 18 and 13 for strata A, B and C, respectively. For the clayey cohesive Stratum D, the average s_u as shown in the table is 942 psf. The natural clay (Stratum D) has an average liquid limit of 28.6% (average of 25.6%, 26.8%, 35.9% and 26%) and average natural moisture content of 22.4% (average of 24.3%, 24.3%, 18.9% and 21.9%) and is slightly over-consolidated based on the laboratory test data given in the latest Mactec report and 1975 TVA report. Also, the clay is generally stiff based on the CPT data. Therefore, liquefaction of this clay is not likely and is not considered in the following evaluation.

5. The values of the stress reduction factor, r_d, for the cohesionless materials in the top three strata at the mid-height depths based on Figure 6 (Guidance Document) are 1.00, 0.97 and 0.93, respectively.

6. The cyclic stress ratio, R_i, values based on the VPR and r_d values determined in Steps 3 and 5 above, for a_{max} value of 0.22g, are calculated as follows:

Stratum	$R_i = 0.65 \times a_{max}/g \times VPR \times r_d$
A	0.65 x 0.22 x 1.00 x 1.000 = 0.143
B	0.65 x 0.22 x 0.97 x 1.433 = 0.199
C	0.65 x 0.22 x 0.93 x 1.686 = 0.224

7. The cyclic strength ratio, R_f, for the three materials based on the $N_{1(60)}$ values determined in Step 4 above and Figure 7 (Guidance Document) are >0.5, 0.25 (M = 6) or 0.20 (M = 7 ½), and 0.18 (M = 6) or 0.14 (M = 7 ½), respectively.

8. Thus, the factor of safety (FS) against the initial liquefaction for the three materials is calculated as follows:

Stratum	$FS = R_f / R_i$

	M = 6	M = 7 1/2
A	>0.5/0.143 = 3.50	>0.5/0.143 = 3.50
B	0.25/0.199 = 1.26	0.20/0.199 = 1.01
C	0.18/0.244 = 0.74	0.14/0.244 = 0.57

The FS values above indicate that:

- Stratum A is not likely to liquefy.
- Stratum B may liquefy if M ≥ 7 ½ for the design seismic event.
- Stratum C will liquefy during the design seismic event.

If the CPT table given in the appendix is reviewed closely, it shows that isolated pockets of material in Stratum B may liquefy during the event, but the stratum is generally more compact than the average $N_{1(60)}$ value indicates. Also, it contains significant proportion of coarser ash than in Stratum C. Further, the ash in stratum may undergo more consolidation as the stack is raised and likelihood of M = 7 ½ corresponding to a 0. 22g event is less likely than M = 6. Therefore, partial liquefaction, if any, of Stratum B is not likely to affect the stack significantly. Thus, only Stratum C should be considered to be of a primary concern with respect to liquefaction.

9. For the liquefying Stratum C,

   - Depth below GS = 24.5 ft = 7.47 m
   - Thickness = 11.0 ft = 3.35 m

   Hence, referring to Fig. 8, it is clearly indicated that no surface manifestation or any surface damage is likely to occur due to liquefaction of this stratum.

10. Using Fig. 5.9 in Ref. 2, it can be estimated that the volumetric strain due to liquefaction of Stratum C is likely to be approximately 2%, i.e., it is likely to undergo a settlement of only 2.6 inches (= 11ft x 0.02 = 0.22 ft). This magnitude of the settlement should not be a significant concern for the proposed stack.

END

APPENDIX A

CPT-9 Table

KIF-0-DC 024-002

Page 5 of 7

ConeTec Inc. - CPT Interpretation

Page: 1a

Interpretation Output - Release 1.00.19M

[illegible] No: 04-0401-1123-5670
[illegible] No: 04-717
[illegible]ient: MACTEC
Project: TVA Kingston
Site: CPT-9
Location: TVA Kingston
Cone: 20 TON AD142
CPT Date: 04/24/03
CPT Time: 13:20
CPT File: 717CP009.COR
Northing (m): 0.000
Easting (m): 0.000
Elevation (m): 0.000

G.S. @ Elev. 764.4'

Water Table (m): 2.05 (ft): 6.7 (Elev. 757.7')
Unit Weight of Water (User Specified): 62.40 pcf
Su Nkt used: 12.50 Su/P' (nc): 0.30
Averaging Increment (m): 0.10
Phi Method : Robertson and Campanella, 1983
Dr Method : Jamiolkowski - All Sands
State Parameter M: 1.20
Used Unit Weights Assigned to Soil Zones
Values of 1.0E9 or UnDef are printed for parameters that are not valid for the material type (SBT)

Depth (ft)	AvgQt (tsf)	AvgFs (tsf)	AvgRf (%)	AvgUd (ft)	SBT	U.Wt. pcf	TStress (tsf)	EStress (tsf)	Ueq (tsf)	Cn	N60 (blows/ft)	(N1)60 (blows/ft)	Su (tsf)	CRR
0.16	90.9	0.34	0.37	0.6	8	120.9	0.01	0.01	0.00	2.00	21.8	43.5	UnDef	0.00
0.49	96.0	1.28	1.33	0.4	8	120.9	0.03	0.03	0.00	2.00	23.0	46.0	UnDef	0.00
0.82	256.0	2.30	0.90	0.3	9	124.1	0.05	0.05	0.00	2.00	49.0	98.1	UnDef	0.00
1.15	293.7	2.75	0.94	-0.3	9	124.1	0.07	0.07	0.00	2.00	56.3	112.5	UnDef	0.00
[illegible]48	384.1	3.89	1.01	-0.6	9	124.1	0.09	0.09	0.00	2.00	73.6	147.1	UnDef	0.00
[illegible]80	398.6	5.71	1.43	2.7	9	124.1	0.11	0.11	0.00	2.00	76.3	152.7	UnDef	0.00
2.13	307.1	4.44	1.45	2.7	8	120.9	0.13	0.13	0.00	2.00	73.5	147.0	UnDef	0.00
2.46	311.4	1.60	0.52	0.1	10	127.3	0.15	0.15	0.00	2.00	49.7	99.4	UnDef	0.00
2.79	273.8	2.14	0.78	6.2	9	124.1	0.17	0.17	0.00	2.00	52.4	104.9	UnDef	0.00
3.12	255.0	2.40	0.94	1.4	9	124.1	0.19	0.19	0.00	2.00	48.8	97.7	UnDef	0.00
3.44	293.4	2.50	0.85	2.5	9	124.1	0.21	0.21	0.00	2.00	56.2	112.4	UnDef	0.00
3.77	343.4	3.40	0.99	0.4	9	124.1	0.23	0.23	0.00	2.00	65.8	131.5	UnDef	0.00
4.10	327.0	3.43	1.05	-2.8	9	124.1	0.25	0.25	0.00	1.99	62.6	124.4	UnDef	0.00
4.43	294.0	2.97	1.01	-6.5	9	124.1	0.27	0.27	0.00	1.91	56.3	107.6	UnDef	0.00
4.76	242.8	2.35	0.97	-10.0	9	124.1	0.29	0.29	0.00	1.84	46.5	85.7	UnDef	0.00
5.09	178.9	1.69	0.95	-8.7	9	124.1	0.31	0.31	0.00	1.78	34.3	61.1	UnDef	0.00
5.41	144.5	1.25	0.87	-8.6	9	124.1	0.33	0.33	0.00	1.73	27.7	47.8	UnDef	0.00
5.74	126.3	0.64	0.50	-11.1	9	124.1	0.36	0.36	0.00	1.68	24.2	40.6	UnDef	0.00
6.07	100.0	0.59	0.59	-5.5	8	120.9	0.38	0.38	0.00	1.63	24.0	39.1	UnDef	0.46
6.40	97.1	0.59	0.60	-3.1	8	120.9	0.40	0.40	0.00	1.59	23.2	37.0	UnDef	0.40
6.73	88.1	0.45	0.51	0.5	8	120.9	0.42	0.42	0.00	1.55	21.1	32.7	UnDef	0.30
7.05	57.0	0.22	0.38	0.3	8	120.9	0.43	0.43	0.01	1.53	13.6	20.9	UnDef	0.14
7.38	34.4	0.20	0.57	2.9	7	117.8	0.45	0.43	0.02	1.52	11.0	16.7	UnDef	0.10
7.79	23.6	0.10	0.40	3.7	7	117.8	0.48	0.45	0.03	1.50	7.5	11.3	UnDef	0.08
8.20	20.9	0.06	0.29	6.5	7	117.8	0.50	0.46	0.05	1.48	6.7	9.9	UnDef	0.08
8.53	27.4	0.06	0.20	0.7	7	117.8	0.52	0.47	0.06	1.46	8.8	12.8	UnDef	0.09
8.86	27.3	0.09	0.31	2.8	7	117.8	0.54	0.48	0.07	1.45	8.7	12.6	UnDef	0.09
9.19	43.0	1.39	3.23	3.6	5	114.6	0.56	0.48	0.08	1.44	20.6	29.6	3.39	0.23
9.51	39.4	1.43	3.63	4.4	5	114.6	0.58	0.49	0.09	1.42	18.9	26.9	3.10	0.25
9.84	13.3	0.38	2.83	7.9	5	114.6	0.60	0.50	0.10	1.41	6.4	9.0	1.02	0.15
10.17	7.5	0.07	0.94	9.7	5	114.6	0.62	0.51	0.11	1.40	3.6	5.0	0.55	0.09
10.50	5.3	0.11	2.10	10.4	4	114.6	0.64	0.52	0.12	1.39	3.4	4.7	0.37	0.08
10.83	12.6	0.07	0.56	4.9	6	114.6	0.65	0.53	0.13	1.38	4.8	6.6	0.95	0.08
11.15	17.2	0.07	0.41	-0.4	6	114.6	0.67	0.54	0.14	1.37	6.6	9.0	1.32	0.00
11.48	20.2	0.10	0.47	7.8	7	117.8	0.69	0.54	0.15	1.36	6.4	8.7	UnDef	0.00
[illegible]81	25.4	0.07	0.28	-0.8	7	117.8	0.71	0.55	0.16	1.34	8.1	10.9	UnDef	0.08
[illegible].14	35.7	0.15	0.41	4.4	7	117.8	0.73	0.56	0.17	1.33	11.4	15.2	UnDef	0.09
12.47	60.4	0.28	0.46	5.2	8	120.9	0.75	0.57	0.18	1.32	14.5	19.1	UnDef	0.12
12.80	60.9	0.46	0.76	6.6	8	120.9	0.77	0.58	0.19	1.31	14.6	19.1	UnDef	0.14

Ave. N1(60) > 40

FILL

BOTTOM ASH

ConeTec Inc. - CPT Interpretation
Run No: 04-0401-1123-5670
CPT File: 717CP009.COR

th (ft)	AvgQt (tsf)	AvgFs (tsf)	AvgRf (%)	AvgUd (ft)	SBT	U.Wt. pcf	TStress (tsf)	EStress (tsf)	Ueq (tsf)	Cn	N60	(N1)60 (blows/ft)	Su (tsf)	CRR
13.12	51.4	0.44	0.85	6.9	7	117.8	0.79	0.59	0.20	1.30	16.4	21.4	UnDef	0.12
13.45	40.3	0.25	0.61	8.6	7	117.8	0.81	0.60	0.21	1.29	12.9	16.6	UnDef	0.10
13.78	30.0	0.12	0.38	11.8	7	117.8	0.83	0.61	0.22	1.28	9.6	12.3	UnDef	0.08
14.11	25.6	0.10	0.37	10.2	7	117.8	0.85	0.62	0.23	1.27	8.2	10.4	UnDef	0.08
14.44	26.0	0.15	0.56	15.6	7	117.8	0.87	0.63	0.24	1.26	8.3	10.5	UnDef	0.09
14.76	27.3	0.18	0.64	19.6	7	117.8	0.89	0.64	0.25	1.25	8.7	10.9	UnDef	0.09
15.09	25.7	0.15	0.59	16.9	7	117.8	0.91	0.65	0.26	1.25	8.2	10.2	UnDef	0.09
15.42	21.2	0.11	0.52	19.9	7	117.8	0.93	0.65	0.27	1.24	6.8	8.4	UnDef	0.09
15.75	20.9	0.16	0.77	18.4	6	114.6	0.94	0.66	0.28	1.23	8.0	9.8	1.59	0.09
16.08	22.3	0.16	0.72	19.9	6	114.6	0.96	0.67	0.29	1.22	8.5	10.4	1.71	0.09
16.40	29.5	0.14	0.46	23.0	7	117.8	0.98	0.68	0.30	1.21	9.4	11.4	UnDef	0.08
16.73	42.1	0.09	0.20	16.5	8	120.9	1.00	0.69	0.31	1.20	10.1	12.1	UnDef	0.09
17.06	45.8	0.20	0.43	19.4	8	120.9	1.02	0.70	0.32	1.20	11.0	13.1	UnDef	0.09
17.39	42.6	0.34	0.80	33.2	7	117.8	1.04	0.71	0.33	1.19	13.6	16.1	UnDef	0.11
17.72	49.9	0.53	1.05	35.5	7	117.8	1.06	0.72	0.34	1.18	15.9	18.8	UnDef	0.12
18.04	53.6	0.61	1.13	29.7	7	117.8	1.08	0.73	0.35	1.17	17.1	20.1	UnDef	0.13
18.37	52.0	0.57	1.10	34.1	7	117.8	1.10	0.74	0.36	1.17	16.6	19.3	UnDef	0.13
18.70	68.4	0.87	1.27	35.3	7	117.8	1.12	0.75	0.37	1.16	21.8	25.3	UnDef	0.17
19.03	125.1	1.23	0.99	29.8	8	120.9	1.14	0.75	0.38	1.15	30.0	34.5	UnDef	0.39
19.36	150.1	2.87	1.91	6.1	7	117.8	1.16	0.76	0.39	1.14	47.9	54.8	UnDef	0.00
19.68	169.6	4.20	2.47	9.9	7	117.8	1.18	0.77	0.40	1.14	54.1	61.6	UnDef	0.00
20.01	205.8	5.68	2.76	15.2	7	117.8	1.20	0.78	0.41	1.13	65.7	74.3	UnDef	0.00
20.34	294.7	6.77	2.30	41.1	7	117.8	1.22	0.79	0.42	1.12	94.1	105.8	UnDef	0.00
20.67	300.7	6.45	2.14	1.7	8	120.9	1.24	0.80	0.43	1.12	72.0	80.5	UnDef	0.00
21.00	210.1	4.76	2.26	-0.9	7	117.8	1.25	0.81	0.44	1.11	67.1	74.5	UnDef	0.00
21.33	168.7	4.00	2.37	4.3	7	117.8	1.27	0.82	0.46	1.11	53.9	59.5	UnDef	0.00
21.65	169.3	3.96	2.34	7.8	7	117.8	1.29	0.83	0.47	1.10	54.0	59.4	UnDef	0.00
98	121.1	3.61	2.98	8.4	6	114.6	1.31	0.84	0.48	1.09	46.4	50.7	9.58	0.00
31	59.8	2.17	3.63	36.7	5	114.6	1.33	0.85	0.49	1.09	28.6	31.2	4.68	0.44
22.64	67.4	1.40	2.08	19.1	7	117.8	1.35	0.85	0.50	1.08	21.5	23.3	UnDef	0.23
22.97	101.1	1.47	1.46	20.7	8	120.9	1.37	0.86	0.51	1.08	24.2	26.0	UnDef	0.30
23.29	112.4	1.98	1.76	19.7	7	117.8	1.39	0.87	0.52	1.07	35.9	38.4	UnDef	0.40
23.62	72.3	1.66	2.30	54.6	7	117.8	1.41	0.88	0.53	1.06	23.1	24.6	UnDef	0.27
23.95	74.0	1.22	1.65	57.3	7	117.8	1.43	0.89	0.54	1.06	23.6	25.0	UnDef	0.21
24.28	49.8	0.90	1.80	41.2	7	117.8	1.45	0.90	0.55	1.05	15.9	16.8	UnDef	0.16
24.61	32.3	0.37	1.13	70.2	7	117.8	1.47	0.91	0.56	1.05	10.3	10.8	UnDef	0.11
24.93	19.1	0.20	1.02	115.7	6	114.6	1.49	0.92	0.57	1.04	7.3	7.6	1.41	0.11
25.26	16.7	0.11	0.66	72.1	6	114.6	1.50	0.93	0.58	1.04	6.4	6.6	1.21	0.09
25.59	9.3	0.18	1.88	100.0	5	114.6	1.52	0.94	0.59	1.03	4.5	4.6	0.62	0.09
25.92	19.5	0.28	1.42	50.1	6	114.6	1.54	0.94	0.60	1.03	7.5	7.7	1.43	0.17
26.25	33.7	0.51	1.50	28.8	6	114.6	1.56	0.95	0.61	1.02	12.9	13.2	2.57	0.13
26.57	30.3	0.52	1.70	27.3	6	114.6	1.58	0.96	0.62	1.02	11.6	11.8	2.30	0.15
26.90	29.1	0.47	1.62	27.3	6	114.6	1.60	0.97	0.63	1.02	11.2	11.3	2.20	0.14
27.23	26.1	0.33	1.27	24.3	6	114.6	1.62	0.98	0.64	1.01	10.0	10.1	1.96	0.12
27.56	28.3	0.25	0.87	23.8	7	117.8	1.64	0.99	0.65	1.01	9.0	9.1	UnDef	0.10
27.89	34.6	0.34	0.99	24.1	7	117.8	1.66	1.00	0.66	1.00	11.0	11.1	UnDef	0.11
28.21	27.9	0.54	1.94	30.9	6	114.6	1.67	1.00	0.67	1.00	10.7	10.7	2.10	0.22
28.54	18.9	0.40	2.12	89.6	6	114.6	1.69	1.01	0.68	0.99	7.3	7.2	1.38	0.15
28.87	24.8	0.57	2.28	87.8	6	114.6	1.71	1.02	0.69	0.99	9.5	9.4	1.85	0.24
29.20	32.6	0.64	1.97	88.9	6	114.6	1.73	1.03	0.70	0.99	12.5	12.3	2.47	0.19
29.53	28.4	0.61	2.16	109.3	6	114.6	1.75	1.04	0.71	0.98	10.9	10.7	2.13	0.31
29.86	25.9	0.50	1.93	117.5	6	114.6	1.77	1.05	0.72	0.98	9.9	9.7	1.93	0.26
30.18	23.2	0.47	2.03	108.3	6	114.6	1.79	1.06	0.73	0.97	8.9	8.7	1.72	0.21
30.59	20.2	0.35	1.75	109.3	6	114.6	1.81	1.07	0.74	0.97	7.7	7.5	1.47	0.16
31.00	18.2	0.35	1.90	103.5	6	114.6	1.83	1.08	0.76	0.96	7.0	6.7	1.31	0.14
31.33	14.5	0.31	2.14	93.5	5	114.6	1.85	1.09	0.77	0.96	6.9	6.7	1.01	0.11
31.66	12.1	0.22	1.83	104.5	5	114.6	1.87	1.09	0.78	0.96	5.8	5.5	0.81	0.10
31.99	14.4	0.31	2.17	83.9	5	114.6	1.89	1.10	0.79	0.95	6.9	6.5	1.00	0.11
32	12.2	0.25	2.01	78.4	5	114.6	1.91	1.11	0.80	0.95	5.8	5.5	0.82	0.10
.64	10.8	0.19	1.72	82.8	5	114.6	1.93	1.12	0.81	0.94	5.2	4.9	0.71	0.09
32.97	9.7	0.10	0.98	90.8	5	114.6	1.95	1.13	0.82	0.94	4.7	4.4	0.62	0.09
33.30	8.8	0.05	0.57	91.3	6	114.6	1.97	1.14	0.83	0.94	3.4	3.1	0.54	0.09

Ave. N1(60) = 17.6, say 18 (values over 50 are ignored) — BOTT. ASH (13.12 to 24.28)

Ave N1(60) = 12.8, say 13 — LOOSE FA (24.61 to 33.30)

To 35.5' depth

ConeTec Inc. - CPT Interpretation

Run No: 04-0401-1123-5670
CPT File: 717CP009.COR

Depth (ft)	AvgQt (tsf)	AvgFs (tsf)	AvgRf (%)	AvgUd (ft)	SBT	U.Wt. pcf	TStress (tsf)	EStress (tsf)	Ueq (tsf)	Cn	N60 (blows/ft)	(N1)60 (blows/ft)	Su (tsf)	CRR
33.63	11.5	0.05	0.44	97.1	6	114.6	1.98	1.15	0.84	0.93	4.4	4.1	0.76	0.09
33.96	15.1	0.05	0.33	84.6	6	114.6	2.00	1.15	0.85	0.93	5.8	5.4	1.05	0.00
34.28	13.6	0.08	0.55	98.1	6	114.6	2.02	1.16	0.86	0.93	5.2	4.8	0.93	0.10
34.61	24.8	0.19	0.75	106.3	7	117.8	2.04	1.17	0.87	0.92	7.9	7.3	UnDef	0.10
34.94	28.3	0.35	1.24	101.2	6	114.6	2.06	1.18	0.88	0.92	10.8	10.0	2.10	0.14
35.27	34.4	0.66	1.91	93.0	6	114.6	2.08	1.19	0.89	0.92	13.2	12.1	2.59	0.24
35.60	29.2	0.63	2.16	63.0	6	114.6	2.10	1.20	0.90	0.91	11.2	10.2	2.17	0.29
35.92	21.2	0.37	1.75	76.1	6	114.6	2.12	1.21	0.91	0.91	8.1	7.4	1.53	0.16
36.25	14.6	0.21	1.44	71.4	6	114.6	2.14	1.21	0.92	0.91	5.6	5.1	1.00	0.11
36.58	8.3	0.09	1.08	83.9	5	114.6	2.15	1.22	0.93	0.90	4.0	3.6	0.50	0.08
36.91	7.3	0.03	0.41	88.1	1	111.4	2.17	1.23	0.94	0.90	3.5	3.2	0.41	0.00
37.24	5.2	0.03	0.57	100.7	1	111.4	2.19	1.24	0.95	0.90	2.5	2.3	0.24	0.00
37.57	7.1	0.04	0.56	108.7	1	111.4	2.21	1.25	0.96	0.90	3.4	3.1	0.39	0.00
37.89	9.6	0.10	1.05	111.1	5	114.6	2.23	1.26	0.97	0.89	4.6	4.1	0.59	0.09
38.22	9.5	0.17	1.75	101.1	5	114.6	2.25	1.26	0.98	0.89	4.5	4.0	0.58	0.09
38.55	10.9	0.14	1.29	77.2	5	114.6	2.27	1.27	0.99	0.89	5.2	4.6	0.69	0.09
38.88	10.5	0.08	0.72	35.7	6	114.6	2.28	1.28	1.00	0.88	4.0	3.5	0.66	0.09
39.21	7.5	0.06	0.80	56.7	5	114.6	2.30	1.29	1.01	0.88	3.6	3.2	0.41	0.08
39.53	7.4	0.06	0.74	70.4	5	114.6	2.32	1.30	1.02	0.88	3.6	3.1	0.41	0.08
39.86	7.5	0.04	0.53	79.5	1	111.4	2.34	1.31	1.03	0.87	3.6	3.2	0.42	0.00
40.19	6.7	0.03	0.45	78.5	1	111.4	2.36	1.32	1.04	0.87	3.2	2.8	0.35	0.00
40.52	6.9	0.04	0.51	80.3	1	111.4	2.38	1.32	1.05	0.87	3.3	2.9	0.36	0.00
40.85	5.8	0.04	0.60	82.3	1	111.4	2.40	1.33	1.06	0.87	2.8	2.4	0.27	0.00
41.17	6.5	0.03	0.46	86.9	1	111.4	2.41	1.34	1.07	0.86	3.1	2.7	0.33	0.00
41.50	6.6	0.03	0.45	74.7	1	111.4	2.43	1.35	1.08	0.86	3.2	2.7	0.34	0.00
41.83	6.2	0.03	0.49	82.7	1	111.4	2.45	1.36	1.09	0.86	3.0	2.5	0.30	0.00
42.16	6.7	0.03	0.45	86.1	1	111.4	2.47	1.36	1.11	0.86	3.2	2.8	0.34	0.00
[illegible]49	7.1	0.03	0.42	87.5	1	111.4	2.49	1.37	1.12	0.85	3.4	2.9	0.37	0.00
[illegible]81	8.5	0.03	0.35	78.8	1	111.4	2.51	1.38	1.13	0.85	4.1	3.5	0.48	0.00
43.14	7.5	0.03	0.40	74.5	1	111.4	2.52	1.39	1.14	0.85	3.6	3.1	0.40	0.00
43.47	6.7	0.03	0.45	90.0	1	111.4	2.54	1.40	1.15	0.85	3.2	2.7	0.33	0.00
43.80	7.7	0.04	0.52	90.5	1	111.4	2.56	1.40	1.16	0.84	3.7	3.1	0.41	0.00
44.13	9.2	0.09	0.98	70.4	5	114.6	2.58	1.41	1.17	0.84	4.4	3.7	0.53	0.09
44.45	9.4	0.11	1.12	66.4	5	114.6	2.60	1.42	1.18	0.84	4.5	3.8	0.55	0.09
44.78	11.4	0.18	1.59	70.4	5	114.6	2.62	1.43	1.19	0.84	5.4	4.6	0.70	0.09
45.11	13.2	0.35	2.67	34.7	5	114.6	2.63	1.44	1.20	0.83	6.3	5.3	0.84	0.00
45.44	12.7	0.39	3.08	37.8	4	114.6	2.65	1.45	1.21	0.83	8.1	6.7	0.80	0.00
45.77	10.4	0.27	2.60	49.6	5	114.6	2.67	1.45	1.22	0.83	5.0	4.1	0.62	0.00
46.10	7.9	0.17	2.16	41.4	4	114.6	2.69	1.46	1.23	0.83	5.0	4.2	0.42	0.00
46.42	7.9	0.13	1.66	56.3	5	114.6	2.71	1.47	1.24	0.82	3.8	3.1	0.41	0.08
46.75	9.3	0.14	1.51	57.1	5	114.6	2.73	1.48	1.25	0.82	4.4	3.7	0.52	0.08
47.08	10.0	0.22	2.21	54.5	5	114.6	2.75	1.49	1.26	0.82	4.8	3.9	0.58	0.00
47.41	15.6	0.40	2.54	78.4	5	114.6	2.77	1.50	1.27	0.82	7.5	6.1	1.03	0.10
47.74	17.5	0.40	2.27	27.9	5	114.6	2.79	1.51	1.28	0.81	8.4	6.8	1.18	0.11
48.06	14.8	1.57	10.61	42.0	3	111.4	2.80	1.51	1.29	0.81	14.2	11.5	0.96	0.00
48.39	126.6	2.20	1.73	-0.2	7	117.8	2.82	1.52	1.30	0.81	40.4	32.7	UnDef	0.38
48.72	120.4	2.10	1.74	-21.2	7	117.8	2.84	1.53	1.31	0.81	38.4	31.1	UnDef	0.36
49.05	67.3	1.82	2.71	-20.2	6	114.6	2.86	1.54	1.32	0.81	25.8	20.8	5.16	0.00

NATURAL CL

Ave. Su = 0.471 tsf = 942 psf

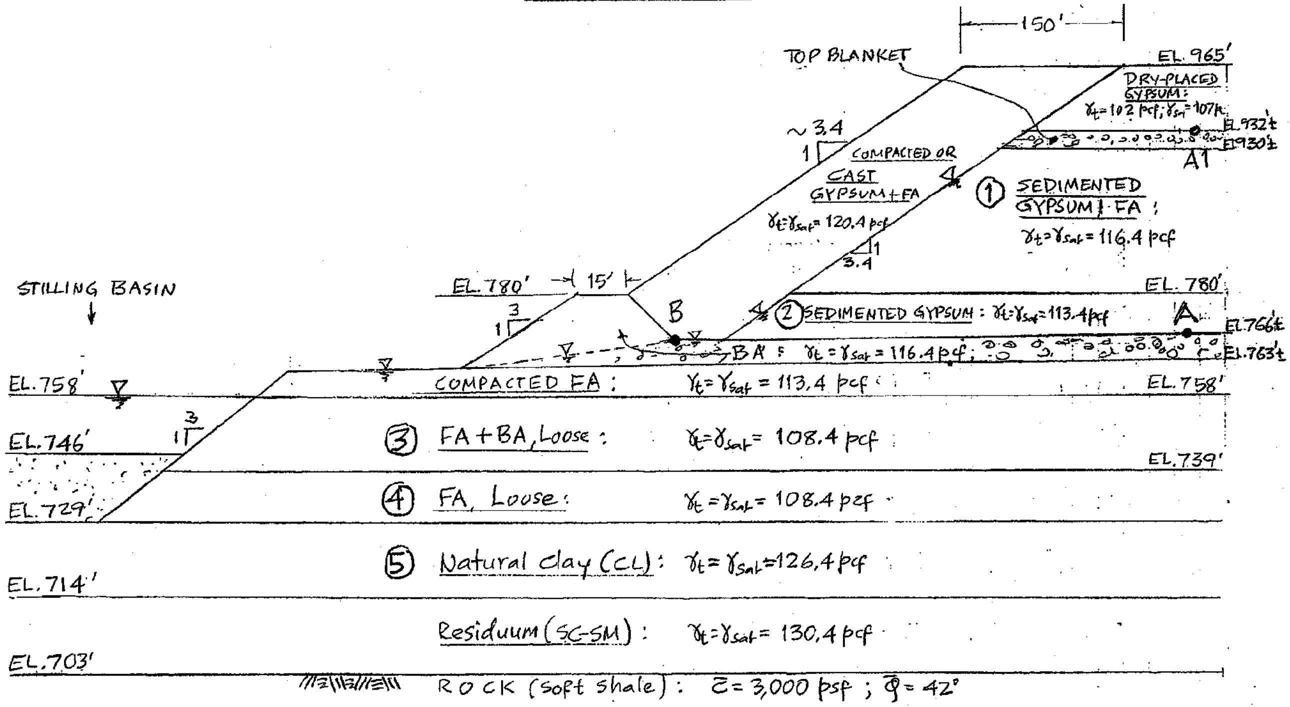
ATTACHMENT 8

EVALUATION OF SETTLEMENT OF DRAINAGE LAYERS

PARSONS	CLIENT NAMETVA PROJECT NAME: Kingston Ash Disposal Facility				JOB NO.: 51020101	
STANDARD CALCULATION SHEET	**SUBJECT: Approximate Evaluation of Settlement of BA Filter Blankets**				**CALC NO.: KIF-0-DC-024-C-001**	
	REVISION	0	1	2	3	Page 1 of 10
	ORIGINATOR:	Y.S.Shah				
	REVIEWER:					
	DATE:	11-18-04				

The following model used for the stability evaluation is used also for this evaluation:

SETTLEMENT EVALUATION MODEL
GYPSUM + ASH – WET PLACEMENT TO EL. 930'
FINAL STACK



(NOT TO SCALE)

Assume negligible to relatively small settlement is caused by strata other than strata 1 thru 5.

COMPRESSIBILITY OF STRATA 1 THRU 5

Strata ① & ② - Sedimented Gypsum:

Based on EPRI's FGD By-Product Disposal Manual, Fourth Edition (TR-104731), p. 3-22 and 3-23, for the wet sludge,

$C_c \doteq \begin{cases} 0.2 \text{ to } 0.3 \\ (0.11+0.24)/2 = 0.175 \end{cases}$ -- p. 3-23 / -- Fig. 3-6

$\therefore$ Use $C_c = 0.2$

$e \doteq (0.98+0.706)/2$ -- "

$\doteq \underline{0.85}$

Stratum ③ - Loose FA+BA:

- SM-ML
- Use data from B-4 & CPT-4 located in the interior area of the ash-site
- Stratum 3 in B-4 @~53'-66' depth, N=4±1
- Ave Q_t for this depth in CPT-4
  $= (749.6 \text{ tsf})/39$
  $= 19.2 \text{ tsf} \rightarrow$ use $\underline{20}$ tsf

$\therefore$ Constrained Modulus M

$= 1/m_v = \alpha . Q_t$ -- (Campanella, 1995)

PARSONS	CLIENT NAMETVA PROJECT NAME: Kingston Ash Disposal Facility				JOB NO.: 51020101
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Where, $\alpha \doteq \frac{(3+6)}{2} = 4\frac{1}{2}$ {Campanell, 1995 {Low plastic silt, ML

$\therefore \quad M = 1/m_v \doteq 4\frac{1}{2} \times 20$ tsf
$= \underline{90}$ tsf

OR $m_v = \underline{0.011}$ ft²/ton.
$= \underline{5.5 \times 10^{-6}}$ ft²/lb.

Stratum ④ – Loose FA :

- ML
- Similarly as for Stratum ③, use data from B-4 & CPT-4.
- Stratum 4 in B-4 @ 73'-83', N = 0
- Ave. Q_t for 73'-83' depth in CPT-4
$= 476.0/31$
$= 15.4$, say $\underline{15}$ tsf

Using $\alpha = 3$, conservatively,

$M = 3 \times 15 = \underline{45}$ tsf

$\therefore m_v = \underline{0.022}$ ft²/ton.

$= \underline{11 \times 10^{-6}}$ ft²/lb.

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Stratum (5) – Natural Clay:

Per Mactec report (May, 2004),

- B-8A, 60'-62', Gr-Br. Sandy lean clay
  LL = 26%, PI = 10%, $G_s = 2.67$, $e_o = 0.68$
  $C_c = 0.19$; $C_v = 0.10$ in²/min. (5 to 10 ksf range)

SETTLEMENT OF BOTTOM FILTER BLANKET

- Elev. @ bottom of blanket = 763'±
- Due to ~3.4H:1V or flat slope of the stack, assume σ_v corresponding to vertical column of fills above, without reduction due to embankmt-type loading (conservative)

A. Settlement of Stratum (3):

$$\bar{\sigma}_{v(o)} = \underset{BA}{(766'-763')54\,pcf} + \underset{FA\ Base}{(763'-758')51\,pcf} + \underset{Loose\ Ash}{\left(\frac{758'-739'}{2}\right)46\,pcf}$$

$$= \underline{854}\ psf$$

$$\bar{\sigma}_{v(f)} = 854\,psf + \underset{Dry\ Ash\ +\ Top\ Blanket}{(965'-930')102\,pcf} + (930'-780')\,54\,pcf + (780'-766')\,51\,pcf$$

$$= \underline{13{,}238}\ psf$$

$$\therefore S_3 \angle m_{v(3)} \cdot H_3 \cdot \Delta\sigma_3$$

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$= (5.5\times10^{-6})(758-739)(13{,}238-854)$ 12,384

$= \underline{1.29'}$

B. <u>Settlement of stratum ④ :</u>

$\bar{\sigma}_{v(0)} = 854\ psf + 437\ psf + \left(\frac{739'-729'}{2}\right)46\ pcf$ (230)
$= \underline{1{,}521}\ psf$

$\bar{\sigma}_{v(f)} = 13{,}238\ psf + (1521\ psf - 854\ psf)$
$= \underline{13{,}905}\ psf$

$\therefore S_4 < (11\times10^{-6})(739-729)(13{,}905-1{,}521)$
$= \underline{1.36'}$

C. <u>Settlement of stratum ⑤ :</u>

$\bar{\sigma}_{v_0} = 1{,}521\ psf + 230\ psf + \left(\frac{729'-714'}{2}\right)64\ pcf$
$= \underline{2{,}711}\ psf$

$\bar{\sigma}_{v(f)} = 13{,}905\ psf + (2{,}711\ psf - 1521\ psf)$
$= \underline{15{,}095}\ psf$

$S_5 = (C_c/(1+e_o))\cdot H_s \log \frac{\sigma_{v(f)}}{\sigma_{v_0}}$
$= (0.19/1.68)(729'-714')\cdot \log(15{,}095/2{,}711)$
$= \underline{1.26'}$

∴ Total (Max.) Settlement of Bottom Filter Blanket

$\doteq 1.29' + 1.36' + 1.26'$

$= \underline{3.91'}$

In reality, considering arching in the gypsum stack aided by development of cohesive bond due to pozzolonic reaction and the embankment-type loading (as opposed to assume σ_{vc}, to correspond to the vertical column load), the actual total settlement of especially the lower strata will be much smaller than the calculated value. Also, note that the compressible stratum thicknesses assumed herein are somewhat conservative. Therefore,

Actual Total Settlement of Bottom Filter Blanket at Point A (P.1) is likely to be

$\leq 3/4\,(3.91')$

$= 2.93'$ or, say, $\leq$ <u>3 feet</u>

The settlement @ Point B is likely to be relatively small.

SETTLEMENT OF TOP FILTER BLANKET

This blanket will be placed at the end of the wet operation and prior to beginning the dry operation, i.e. the blanket will be placed in the year 2029 or thereabout. Thus, the stack will be raised from Elev 770'± to Elev. 930' in 20 years. The EPRI document referenced before states (p3-23), "It is believed that the time required for primary consolidation is very short and may be considerably shorter for sludges which are not completely saturated." The same may be assumed for the existing ash deposits due to the drainage system that will be installed at the bottom of the stack. For the natural clay stratum,

$c_v = 0.10$ in²/min. --- (See P.4)

$H = 15'$ (729'-714') -- two-way drainage due to more pervious layers at top & bottom or interstized pockets of sand.

$$\therefore t_{90} \text{ (days)} = \frac{0.848(H/2)^2}{c_v}$$

$$= \frac{0.848(7.5' \times 12)^2}{0.10 \times 60 \times 24}$$

$$= 47.7 \text{ say } \underline{48 \text{ days}}$$

Thus, 90% of the settlement of the clay is likely to be completed within a period of 48 days after loading. Assume, thus, the settlement of all materials due to stack raising to Elev. 930' is likely to be

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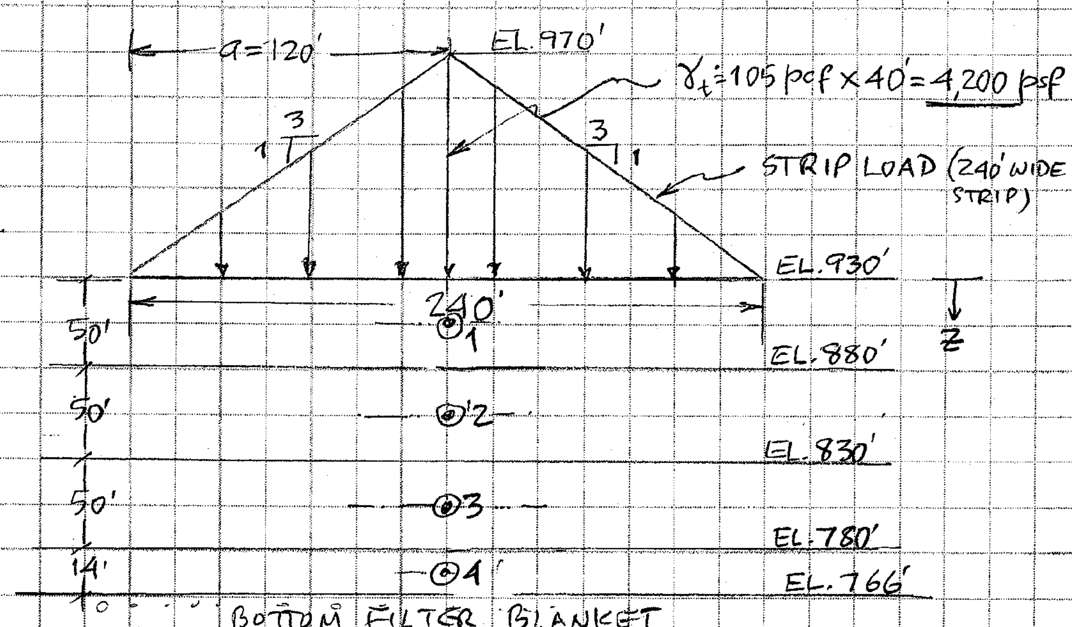
almost completed prior to depositing additional dry ash/gypsum above Elev. 930'.

Also, reviewing Sections A62 on Dwg. 10W425-62 and B63 on Dwg. 10W425-63, it can be seen that the ash or gypsum placed above Elev. 930' is not likely to cause relatively significant settlement, especially the differential settlement of the foundation materials. However, due to the truncated cone shape of the underlying gypsum deposit and stiff dike or outer area of the stack @ Elev. 930', the top filter blanket is likely to sag in the central area than all around the perimeter.

Thus, the maximum sag in the middle of the top blanket is roughly estimated as follows:



Using Osterberg chart with $b/z = 0$,

Point 1 --- $z = 25' \rightarrow a/z = 120'/25' = 4.8$

$\therefore I_1 = 0.43$

Point 2 --- $z = 75' \rightarrow a/z = 120'/75' = 1.6$

$\therefore I_2 = 0.32$

Point 3 --- $z = 125' \rightarrow a/z = 120'/125' = 0.96$

$\therefore I_3 = 0.24$

Point 4 --- $z = 157' \rightarrow a/z = 120'/157' = 0.76$

$\therefore I_4 = 0.20$

Point #	$\sigma_{v(o)}$ (psf)	$\Delta\sigma$ (=4200 I) (psf)	S $\left(= \frac{C_c}{1+e_o} \cdot h_i \cdot \log \frac{\sigma_{v(o)}+\Delta\sigma}{\sigma_{v(o)}}\right)$ (ft)
1	54pcf×25' = 1,350	1,806	1.99
2	54pcf×75' = 4,050	1,344	0.67
3	54pcf×125' = 6,750	1,008	0.33
4	54pcf×150 + 51 pcf×7' = 8,457	840	0.06
			Total = 3.05, say 3'

$\frac{C_c}{1+e_o} = \frac{0.2}{1.85} = 0.108$; $h_1, h_2, h_3, h_4 = 50', 50', 50', 14'$, resp.

As it's assumed that the triangular load is an infinitely long STRIP load as opposed to actually a conical load, the actual settlement is likely to be hardly 2/3rd of 3'. Therefore, assume that the sag will be approximately 2'. Thus, the top filter blanket & similarly the middle one both be sloped outward from the central area towards the perimeter or the blanket edges. The elevation of the central area should be atleast 3' to 4' greater than at the perimeter.

CONCLUSION

1. The maximum settlement of the bottom filter blanket is likely to be approx. 3 feet. Hence, the designed >0.5% slope is adequate.

2. The sag in the top filter blanket (Elev. 930'), is likely to be approx. 2 feet. Therefore, this blanket should be constructed such that the central area is approx. 3' to 4' higher than at the perimeter or its outer edge at the pipe drains.

3. The middle filter blanket (Elev. 870'), if used, should also be constructed similarly as the top blanket as stated in Item 2 above.

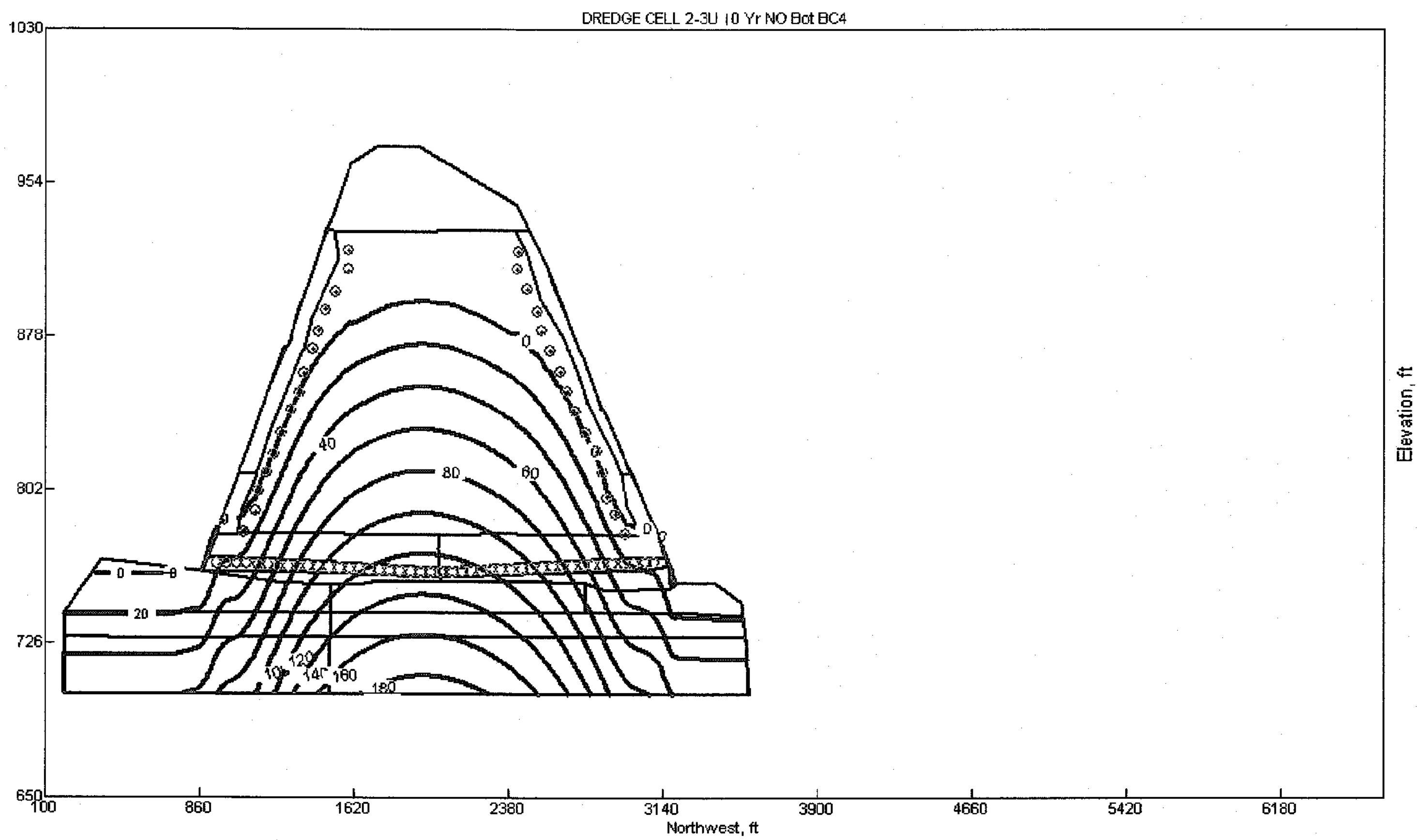
— END —

ATTACHMENT 9

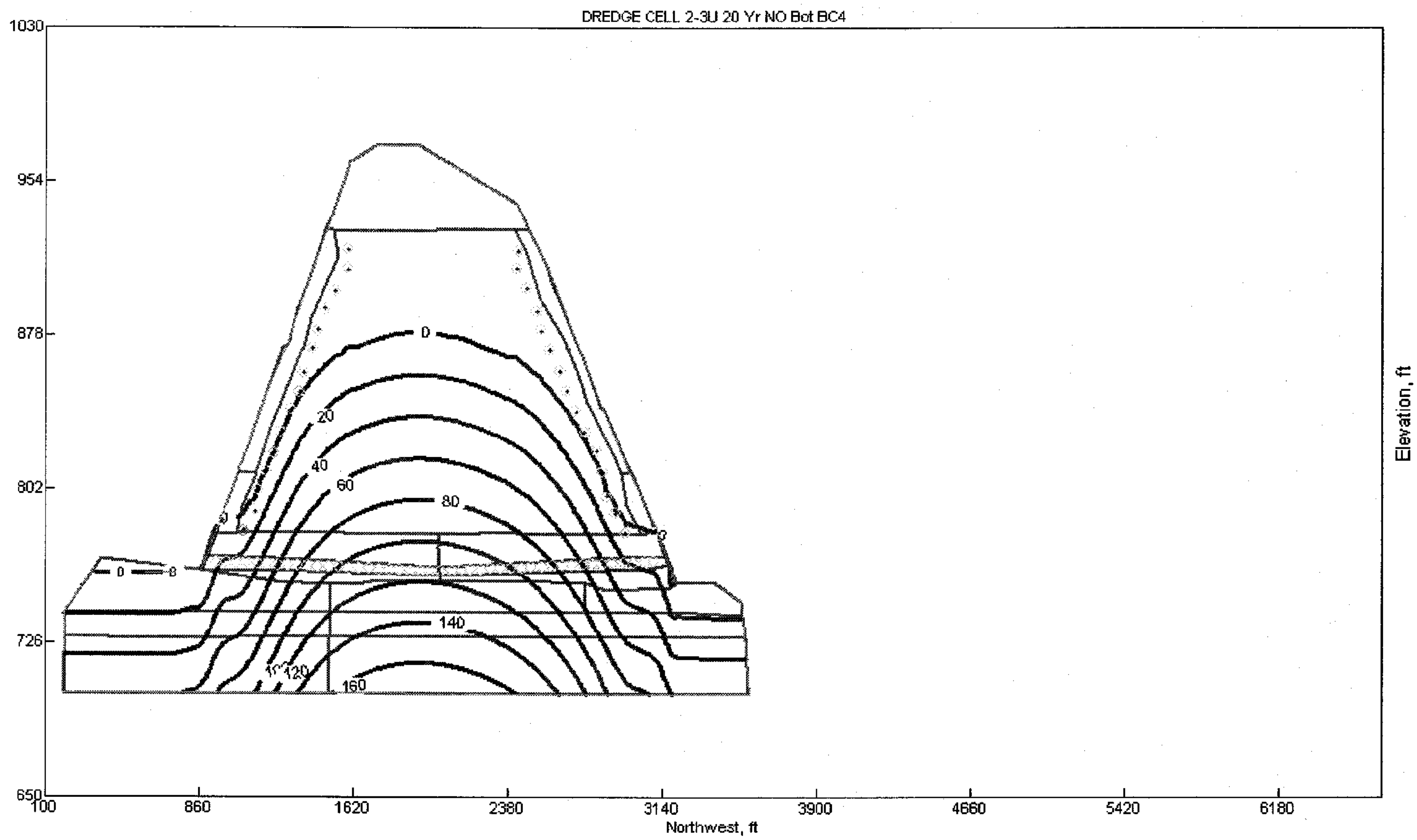
COMPUTER MODEL OUTPUTS FOR MODELING OF
BOTTOM DRAINAGE LAYER –
50 YEARS NO DRAIN VERSUS 5 YEARS WITH DRAIN

ATTACHMENT 9

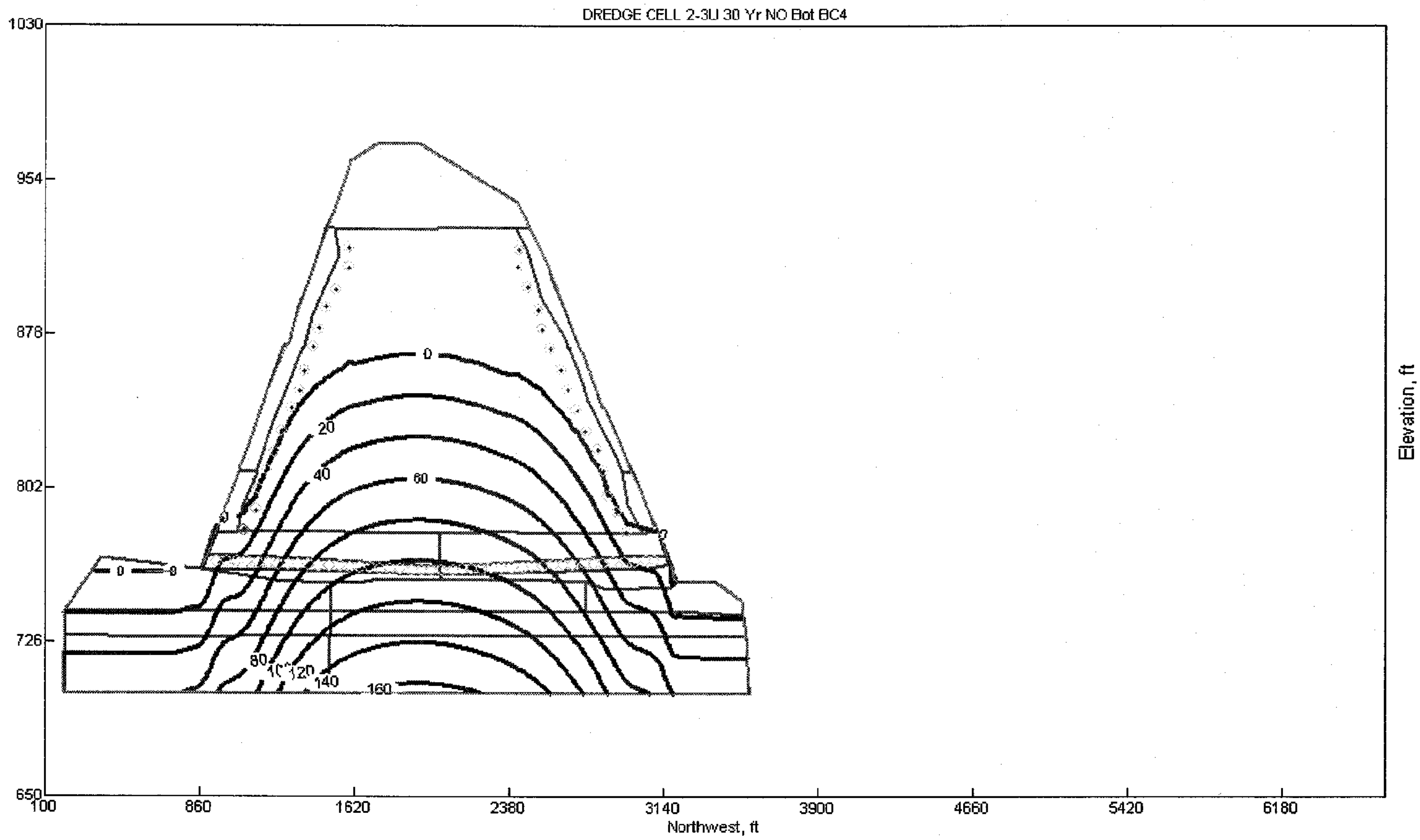
COMPUTER MODEL OUTPUTS FOR MODELING OF
BOTTOM DRAINAGE LAYER –
50 YEARS NO DRAIN VERSUS 5 YEARS WITH DRAIN



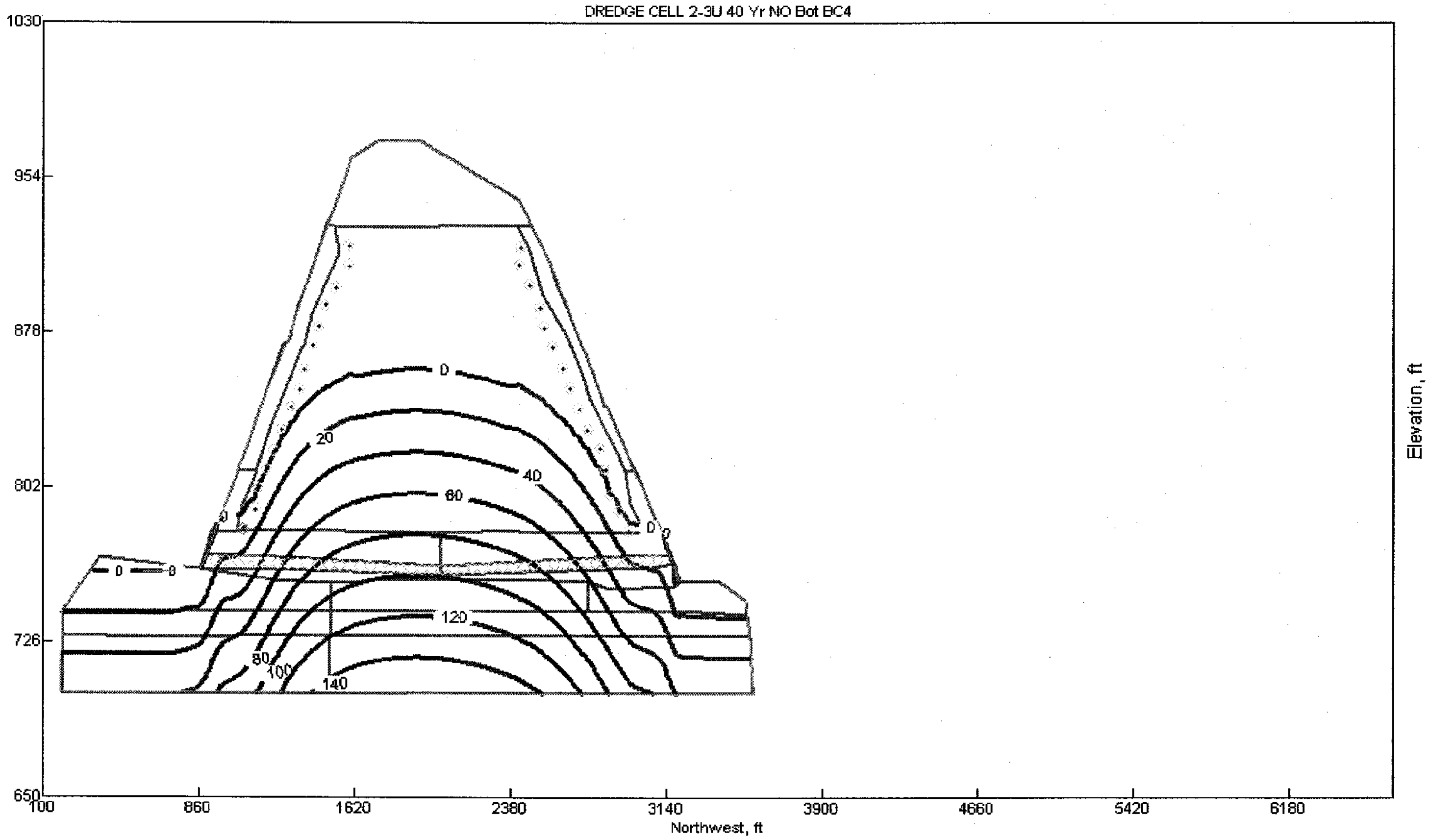
DREDGE CELL 2-3U 10 Yr NO Bot BC4
1030
954
878
802
726
650
100
860
1620
2380
3140
3900
4660
5420
6180
Northwest, ft
Elevation, ft
0
8
20
40
60
80
100
120
140
160
180

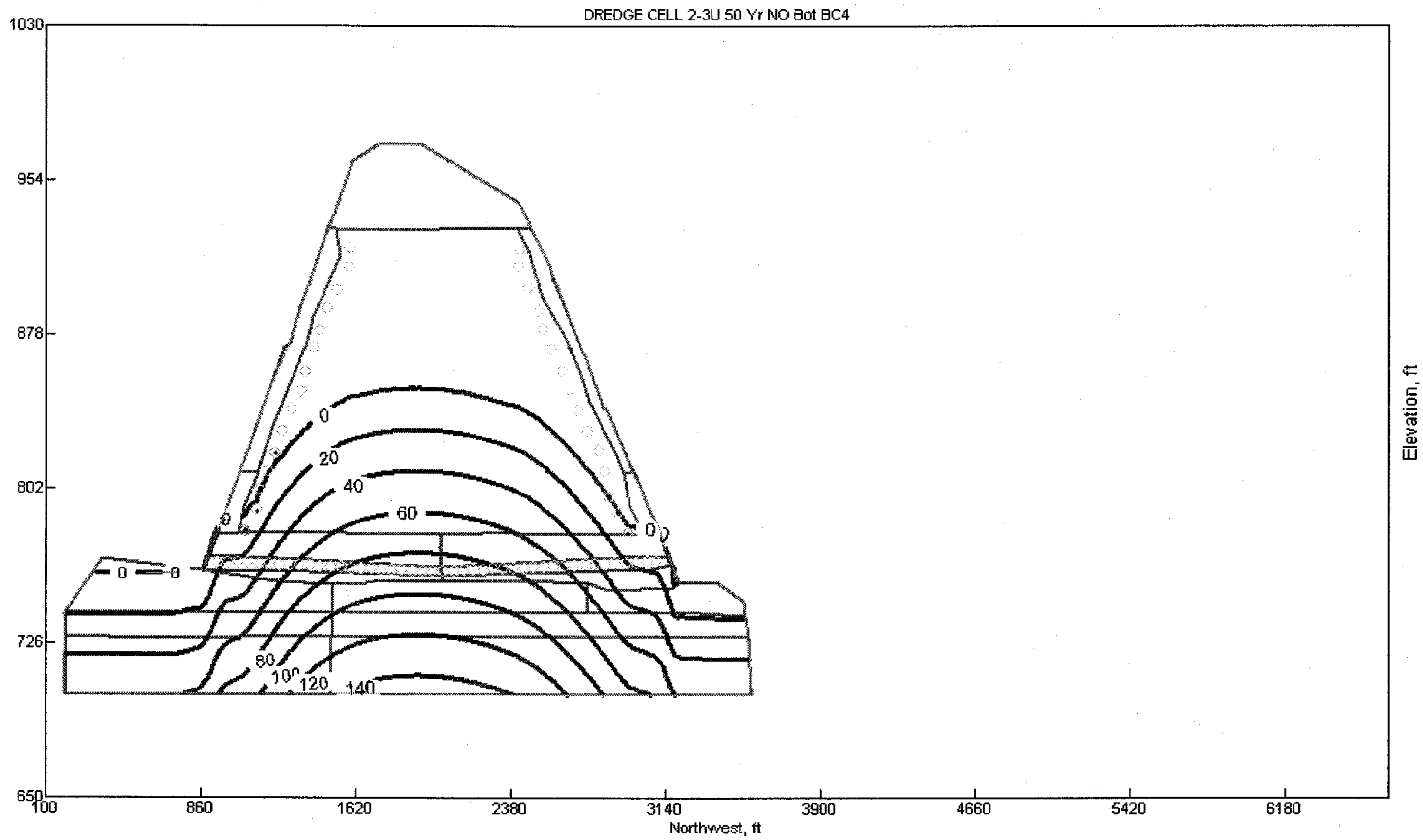


DREDGE CELL 2-3U 20 Yr NO Bot BC4
1030
954
878
802
726
650
100
860
1620
2380
3140
3900
4660
5420
6180
Northwest, ft
Elevation, ft
0
20
40
60
80
140
120
160

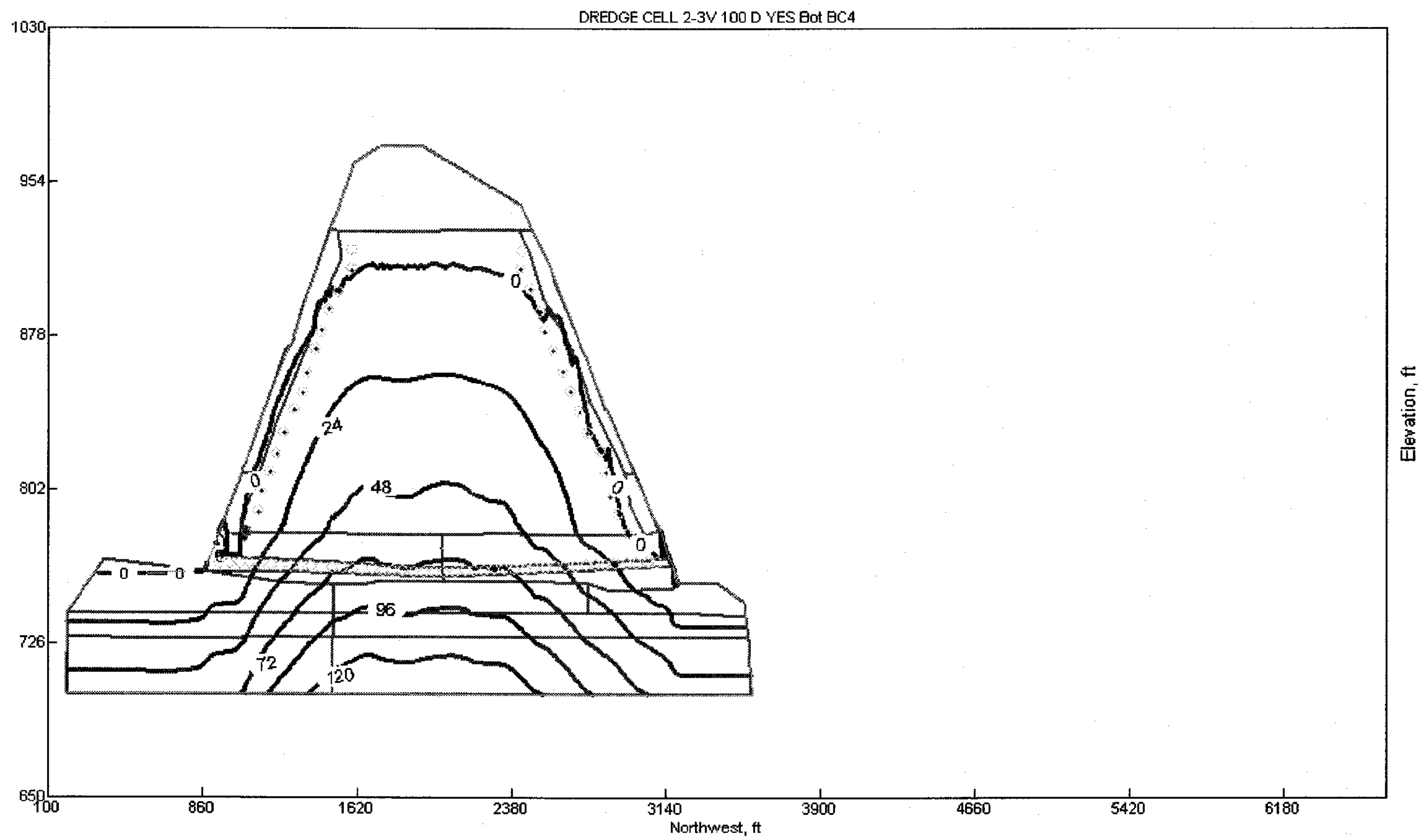

DREDGE CELL 2-3U 30 Yr NO Bot BC4
1030
954
878
802
726
650
100
860
1620
2380
3140
3900
4660
5420
6180
Northwest, ft
Elevation, ft
0
20
40
60
80
120
140
160

DREDGE CELL 2-3U 40 Yr NO Bot BC4

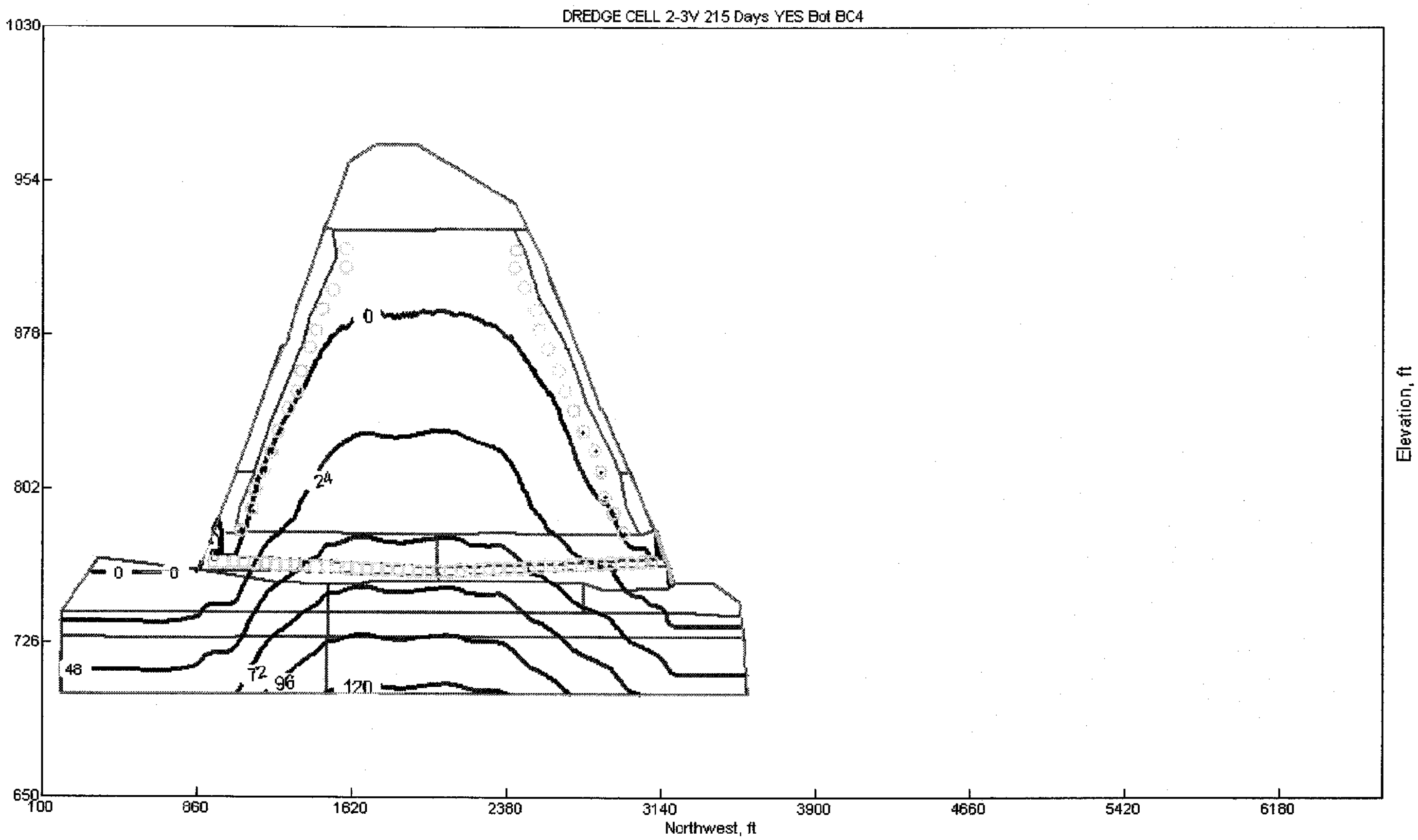




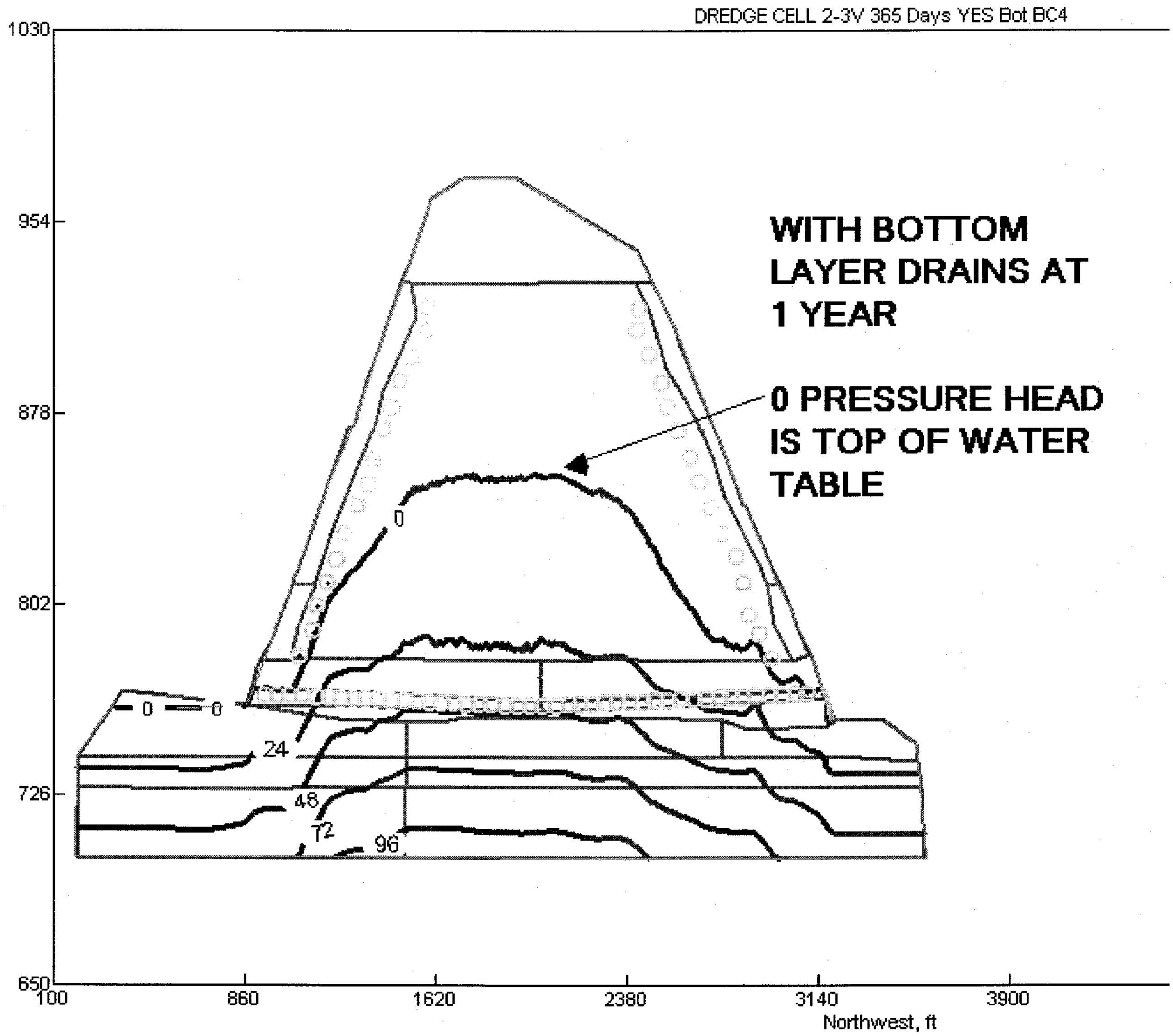
DREDGE CELL 2-3U 50 Yr NO Bot BC4
1030
954
878
802
726
650
100
860
1620
2380
3140
3900
4660
5420
6180
Northwest, ft
Elevation, ft
0
20
40
60
80
100
120
140

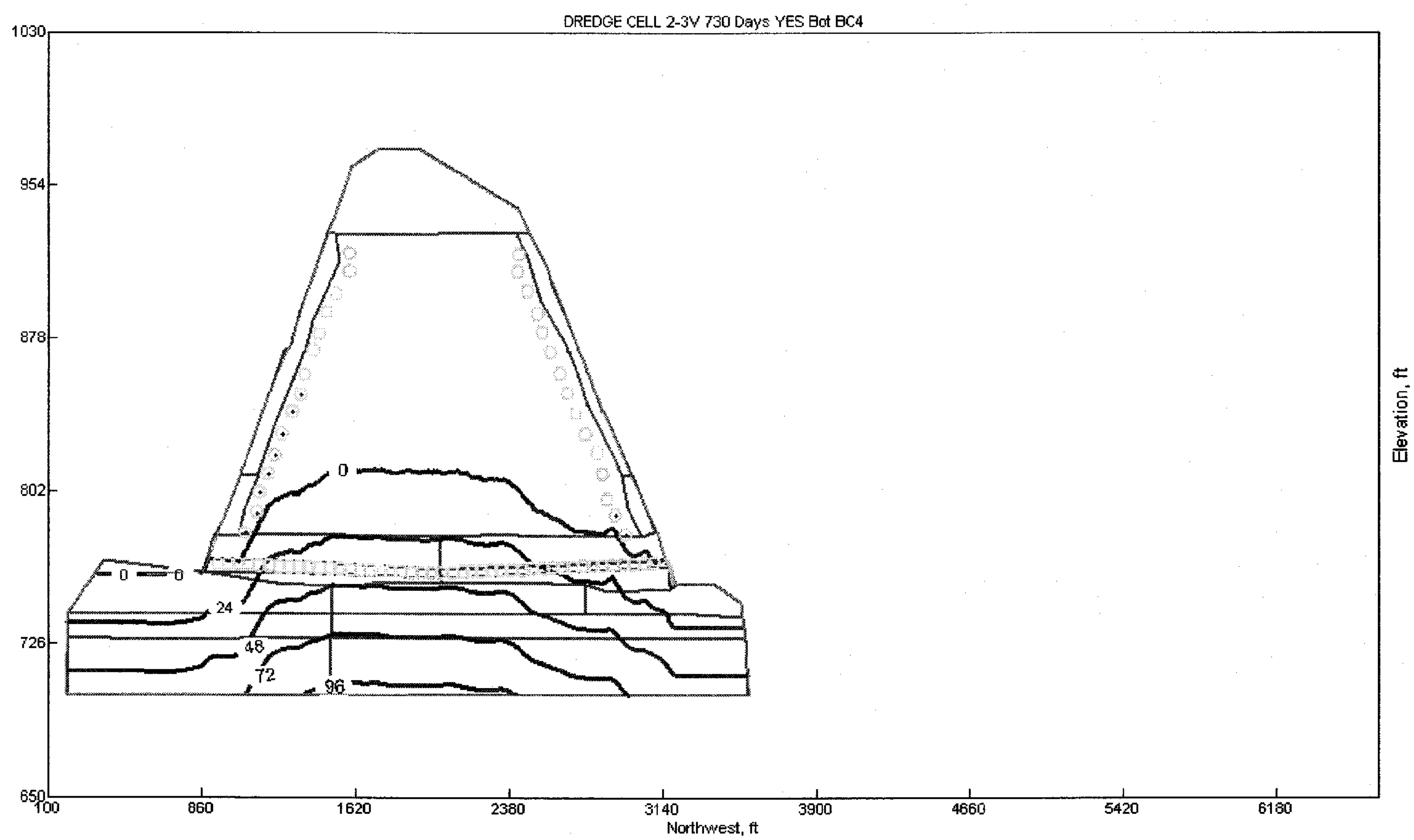


DREDGE CELL 2-3V 100 D YES Bot BC4
1030
954
878
802
726
650
100
860
1620
2380
3140
3900
4660
5420
6180
Northwest, ft
Elevation, ft
0
24
48
72
96
120

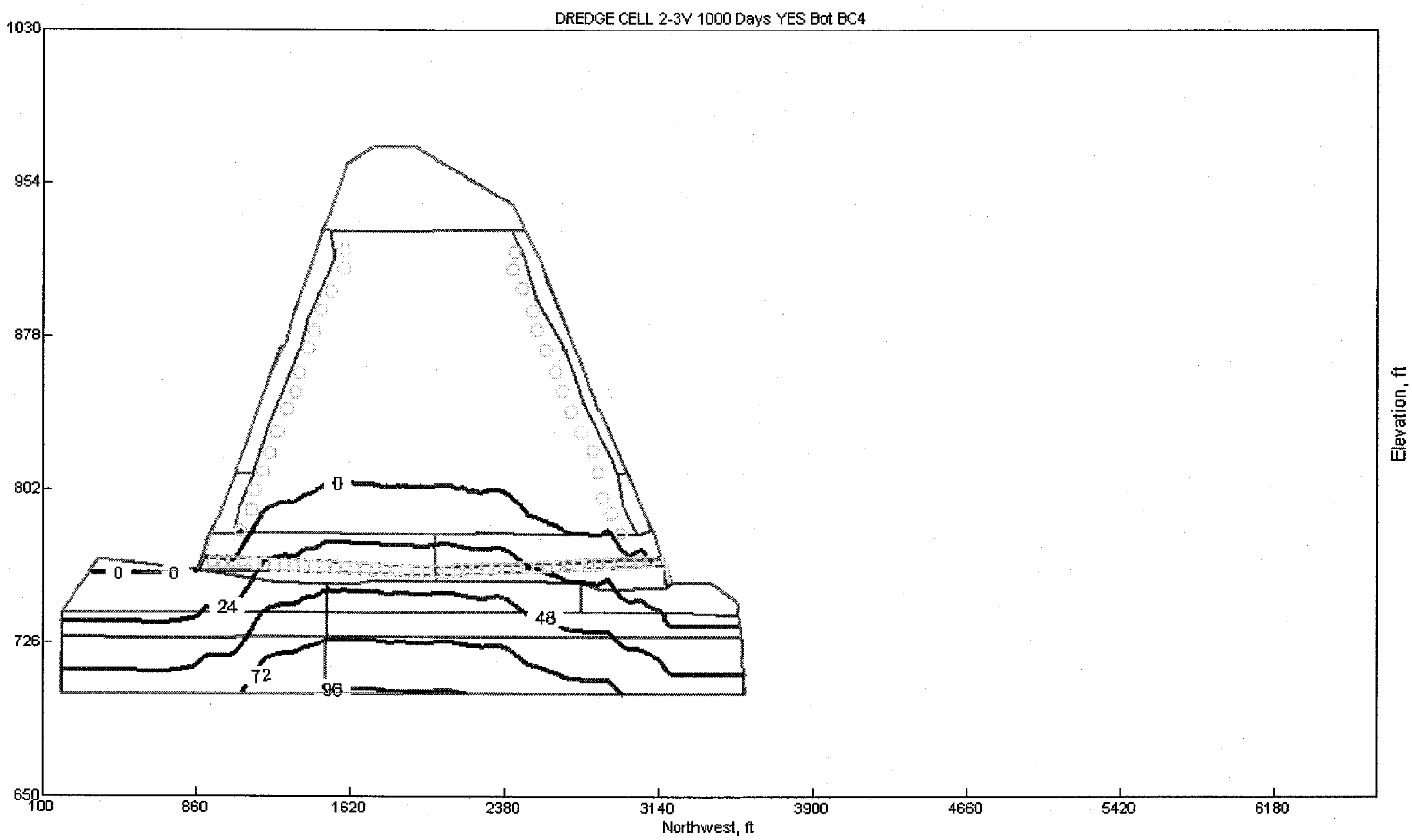


DREDGE CELL 2-3V 215 Days YES Bot BC4
1030
954
878
802
726
650
100
860
1620
2380
3140
3900
4660
5420
6180
Northwest, ft
Elevation, ft
0
0
0
24
48
72
96
120


DREDGE CELL 2-3V 365 Days YES Bot BC4
1030
954
878
802
726
650
100
860
1620
2380
3140
3900
Northwest, ft
WITH BOTTOM LAYER DRAINS AT 1 YEAR
0 PRESSURE HEAD IS TOP OF WATER TABLE
0
0
0
24
48
72
96



DREDGE CELL 2-3V 730 Days YES Bot BC4
1030
954
878
802
726
650
100
860
1620
2380
3140
3900
4660
5420
6180
Northwest, ft
Elevation, ft
0
0
0
24
48
72
96



DREDGE CELL 2-3V 1000 Days YES Bot BC4
1030
954
878
802
726
650
100
860
1620
2380
3140
3900
4660
5420
6180
Northwest, ft
Elevation, ft
0
0
0
24
48
72
96

ATTACHMENT 10

SELECTED FIGURES FROM SEEPAGE STUDY

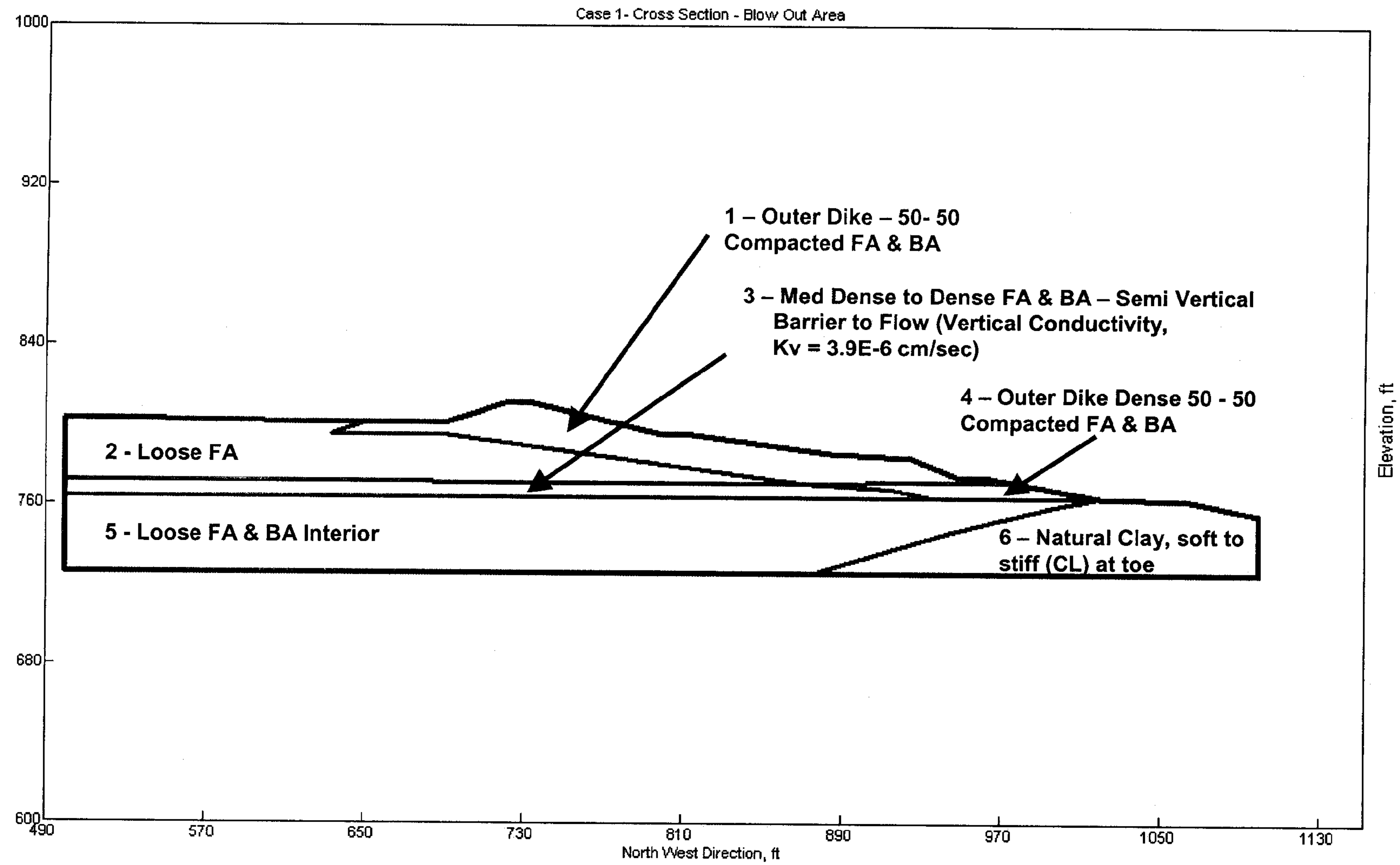


Figure 1. Soil Zones For Case 1 – Stage C at Elevation 810 feet Identified By Number and Brief Description.

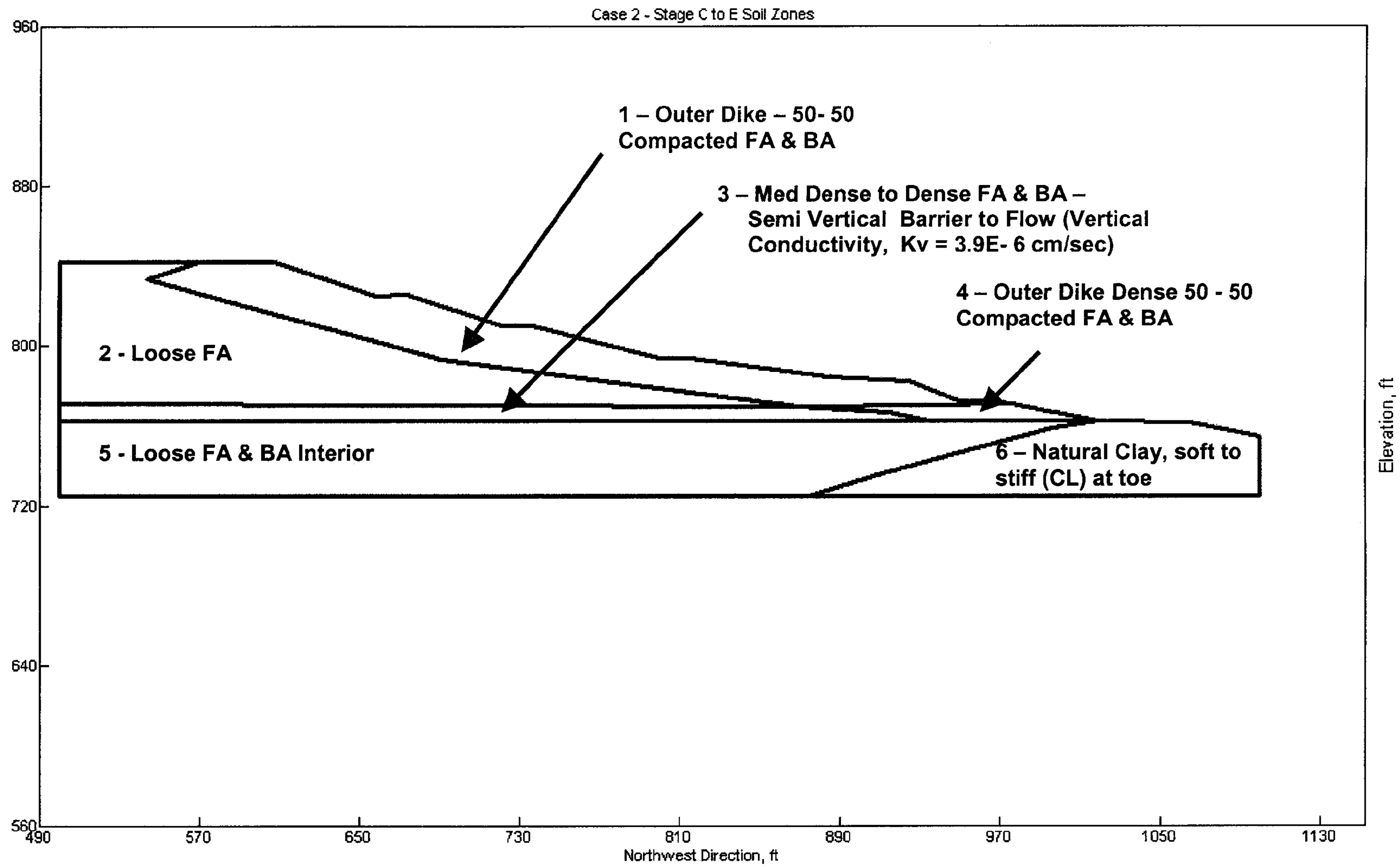


Figure 2. Soil Zones for Case 2 – Stage C to E at Elevation 842 feet Identified By Number and Brief Description.

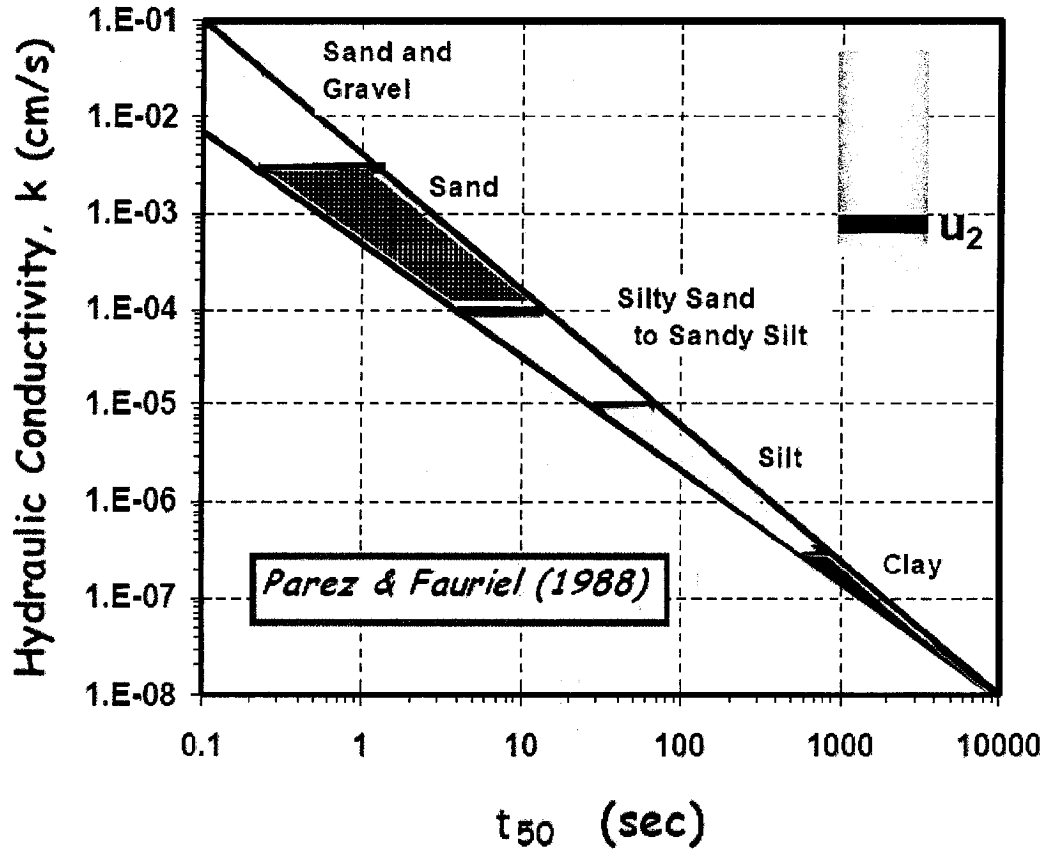


Figure F-2: Coefficient of Permeability (k = Hydraulic Conductivity) from Measured Time to 50% Consolidation (t_{50}) for Monotonic Type 2 Dissipations (from Parez & Fauriel, 1988).

Figure 3. Adapted From Mayne (2002, Ref. 15), Shows That The CPTU Can Measure Hydraulic Conductivity Typically Over Ranges Of 0.1 cm per sec to 1.0E-08 cm per sec Versus t_{50} Dissipation Time.

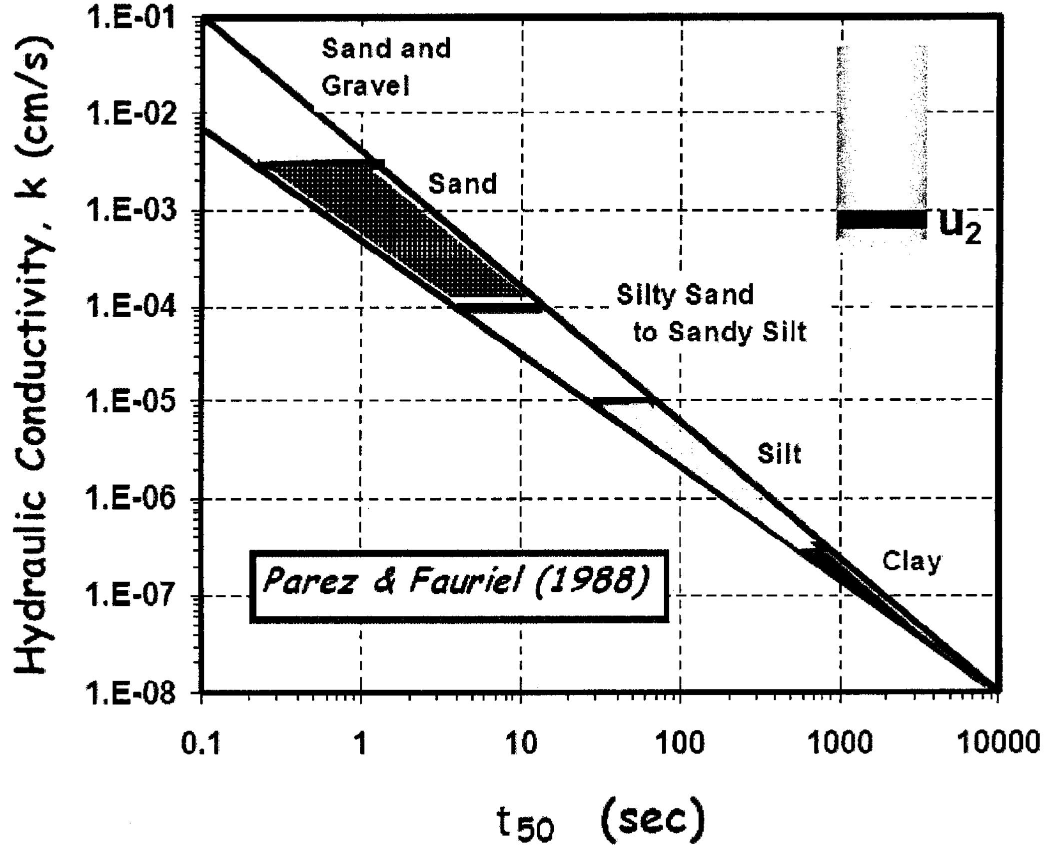


Figure F-2: Coefficient of Permeability (k = Hydraulic Conductivity) from Measured Time to 50% Consolidation (t_{50}) for Monotonic Type 2 Dissipations (from Parez & Fauriel, 1988).

Figure 3. Adapted From Mayne (2002, Ref. 15), Shows That The CPTU Can Measure Hydraulic Conductivity Typically Over Ranges Of 0.1 cm per sec to 1.0E-08 cm per sec Versus t_{50} Dissipation Time.

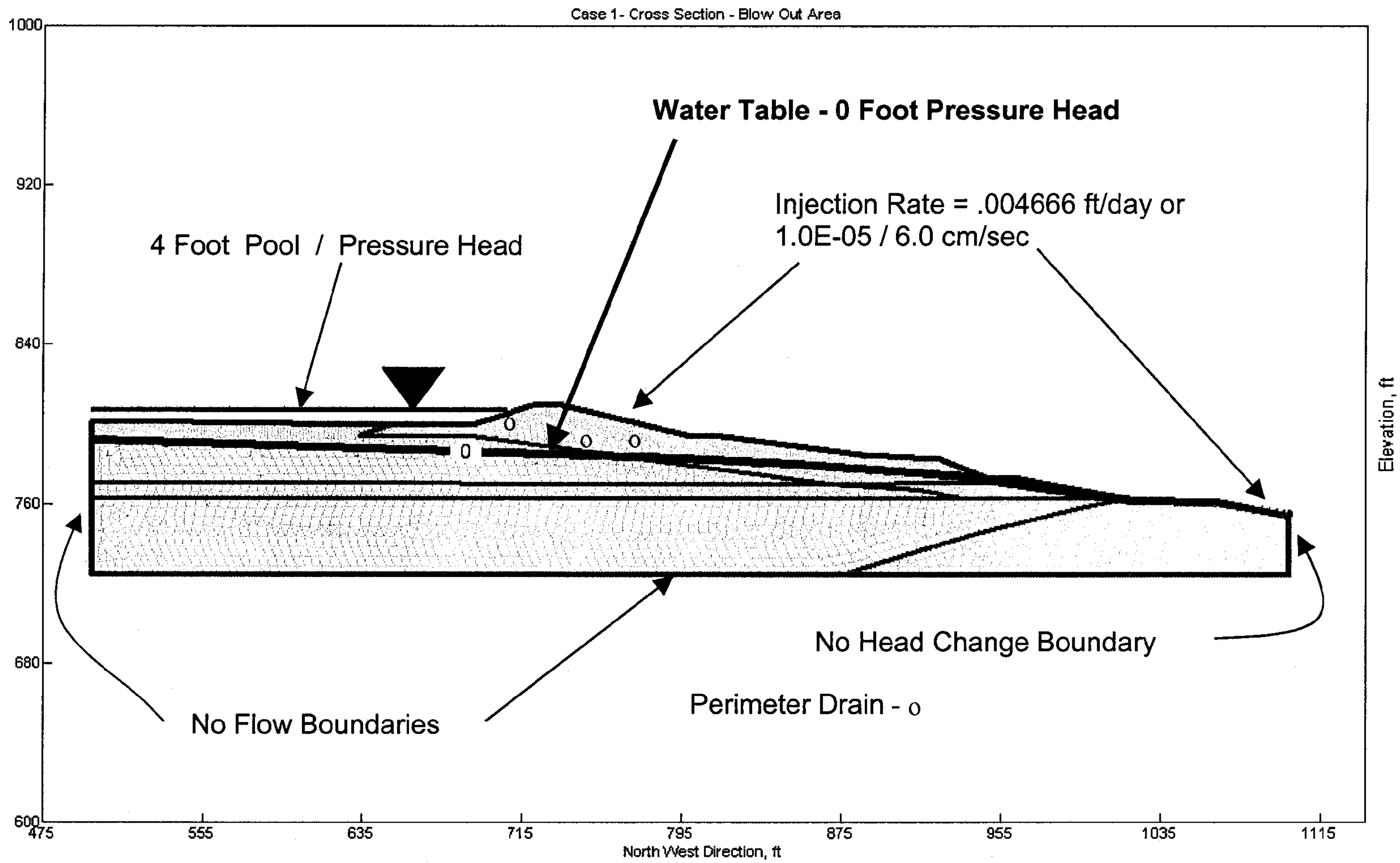


Figure 3A. Case 1 Cross Section for Blow Out Area Showing Finite Element Mesh, Boundary and Initial Conditions.

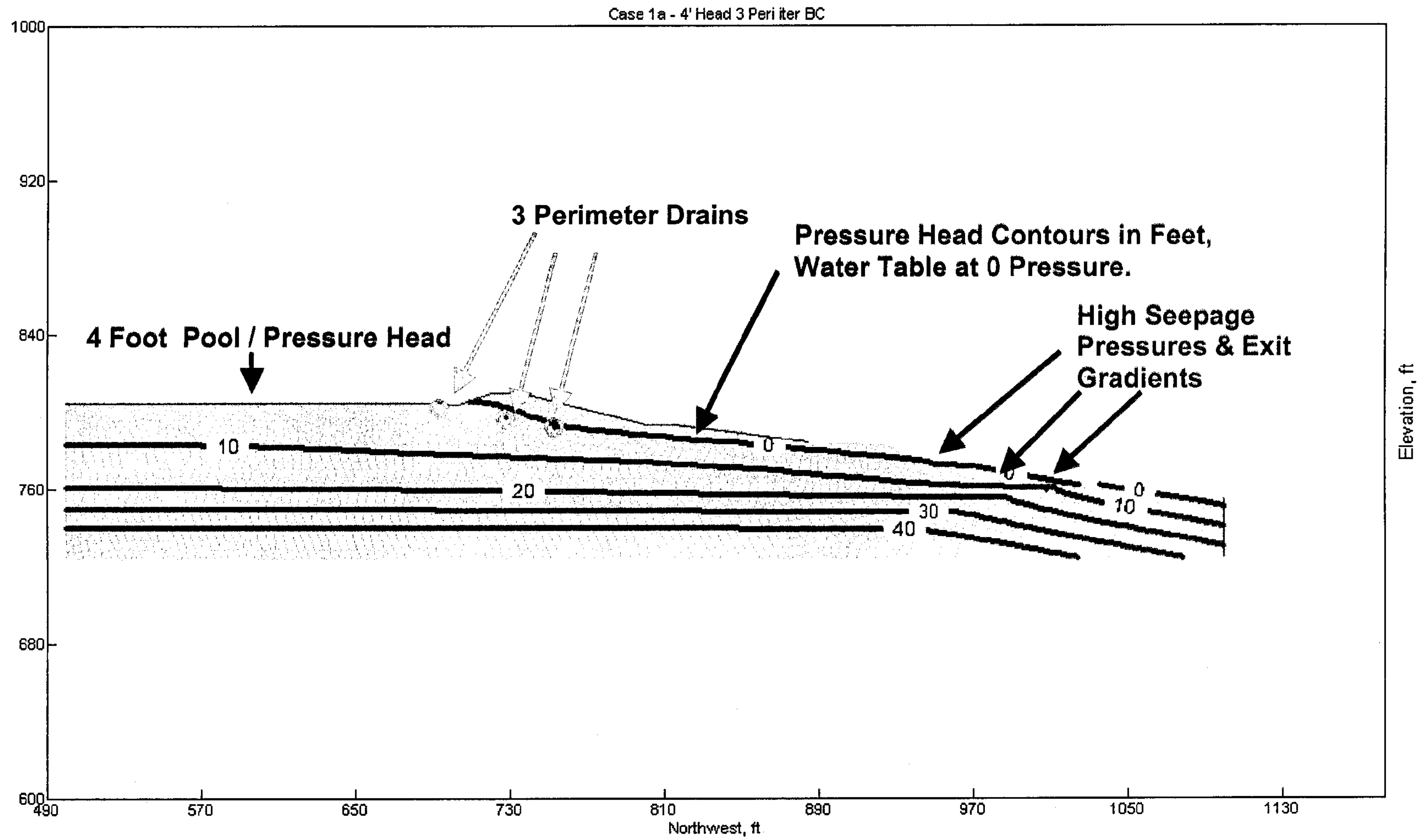


Figure 4. Case 1. Perimeter Drains for Stage C (Stage 1) Still Produce Large Exit Gradients At Steady State.

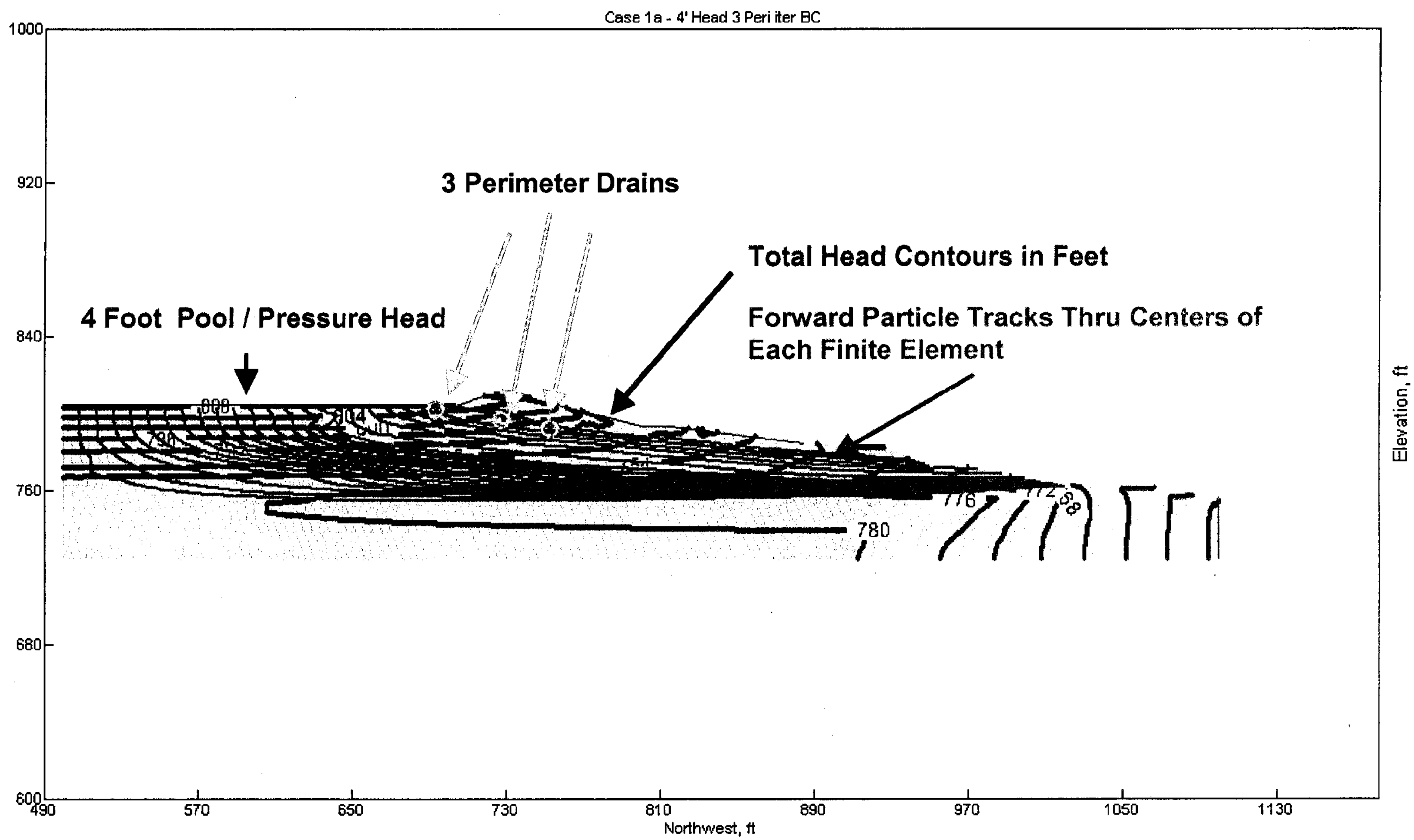


Figure 4A. Case 1. Perimeter Drains for Stage C (Stage 1) Total Heads at Steady State With Particle Track Lines.

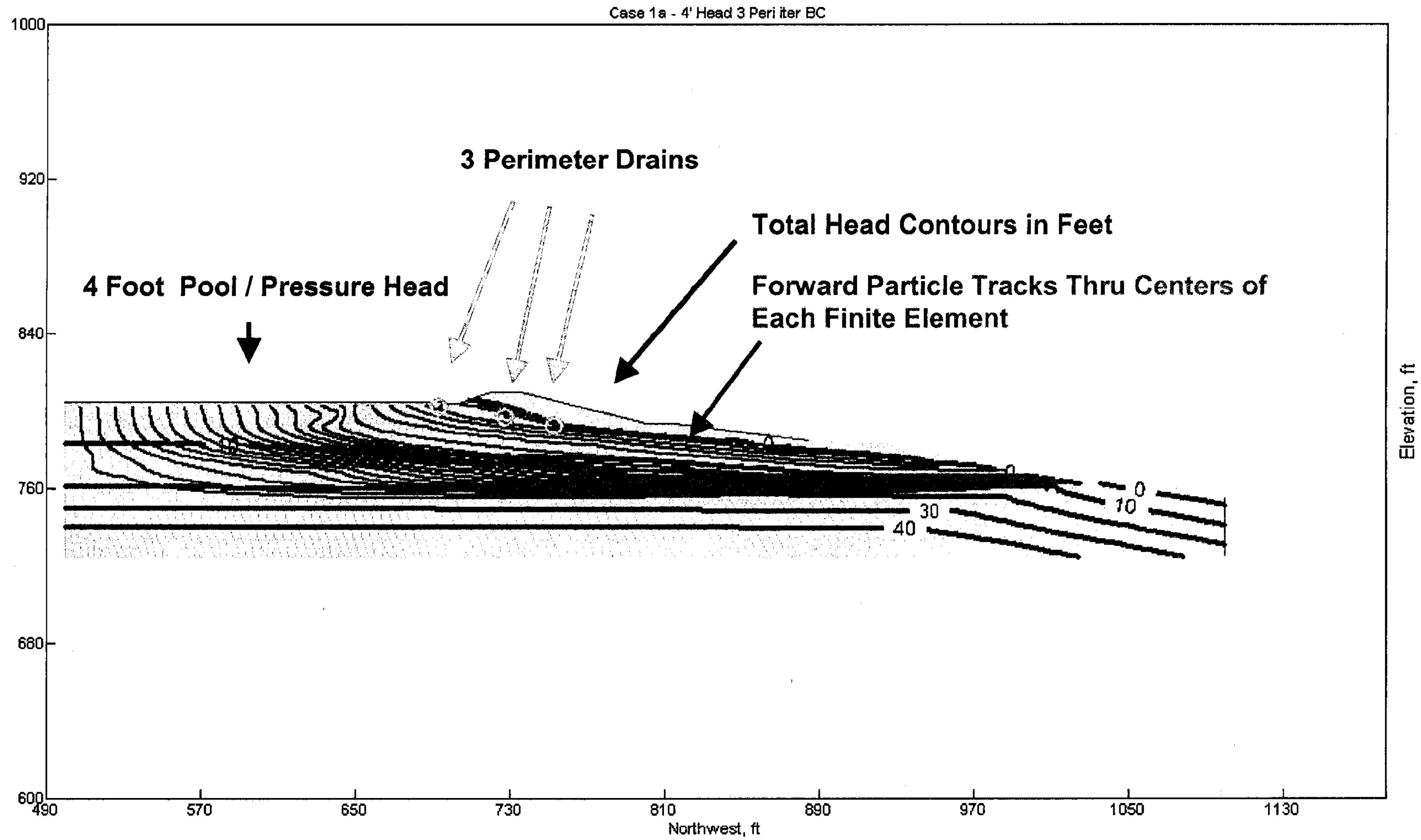


Figure 4B. Case 1. Perimeter Drains for Stage C (Stage 1) Pressure Heads at Steady State With Particle Track Lines.

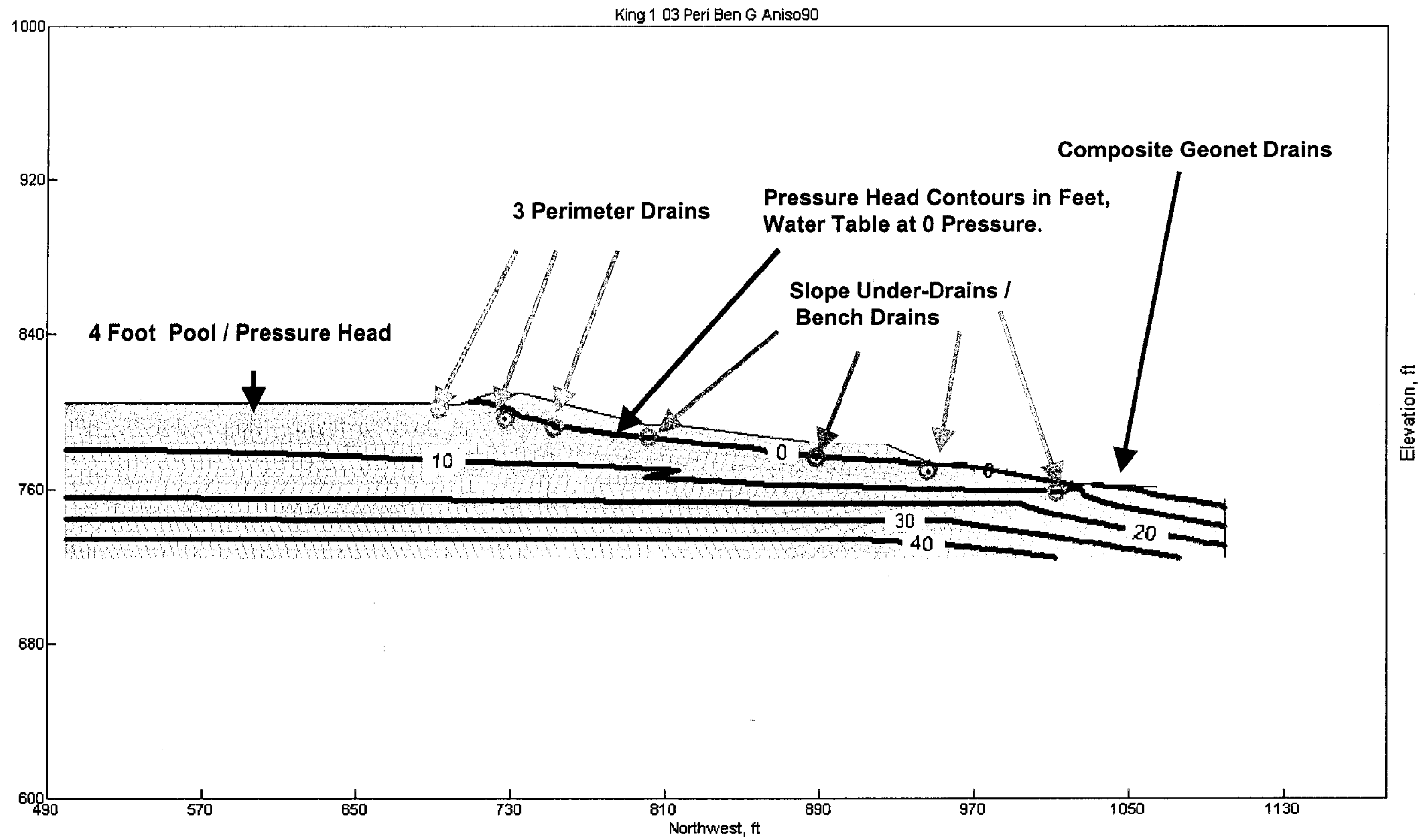


Figure 5. Case 1. Perimeter Drains for Stage C (Stage 1) Control Exit Gradients.

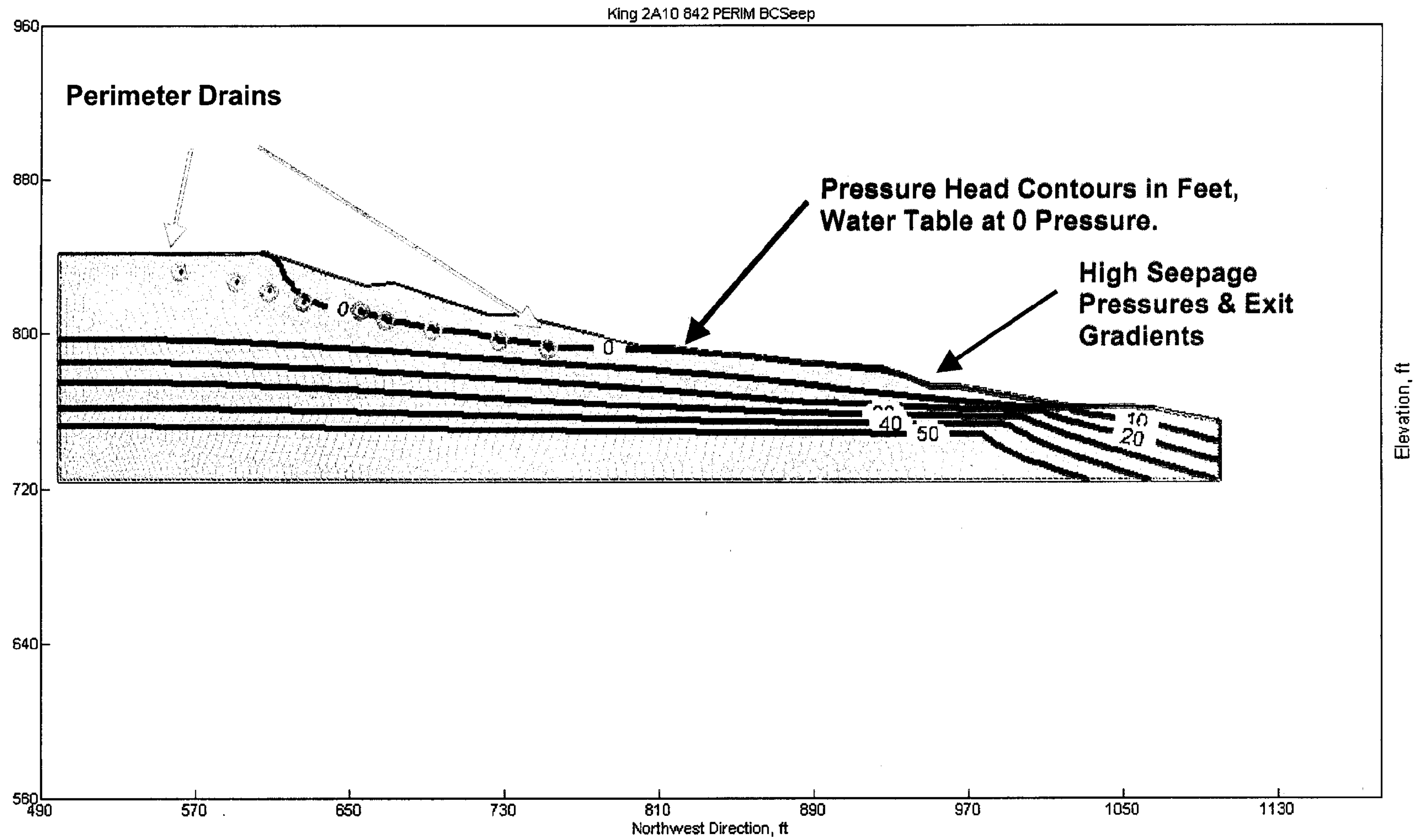


Figure 6. Case 2. Perimeter Drains for Stage E (Stage 3) Still Allow Large Exit Gradients At Steady State.

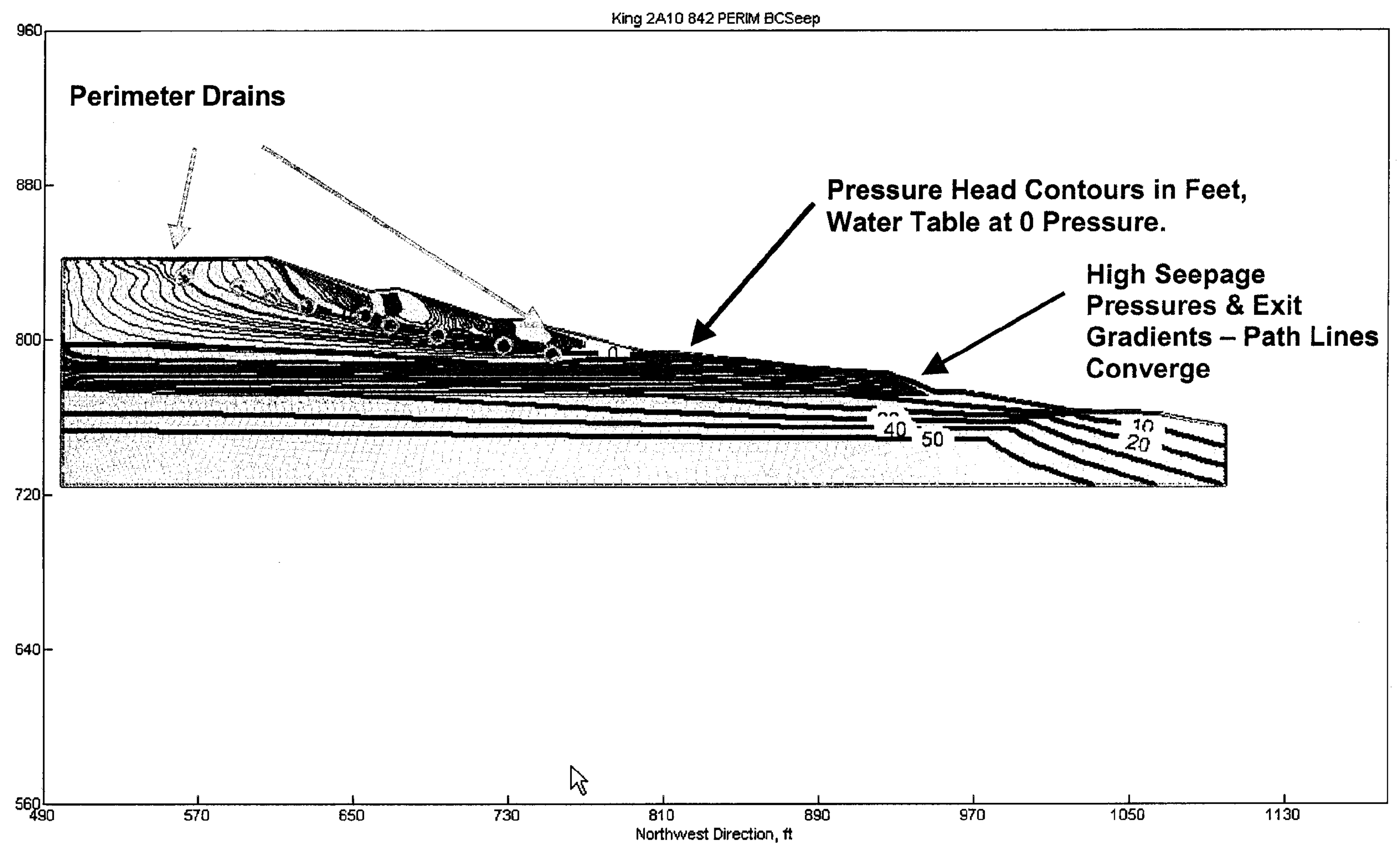


Figure 6A. Case 2. Perimeter Drains for Stage E (Stage 3) With Path Lines That Converge at Location of Large Exit Gradients At Steady State.

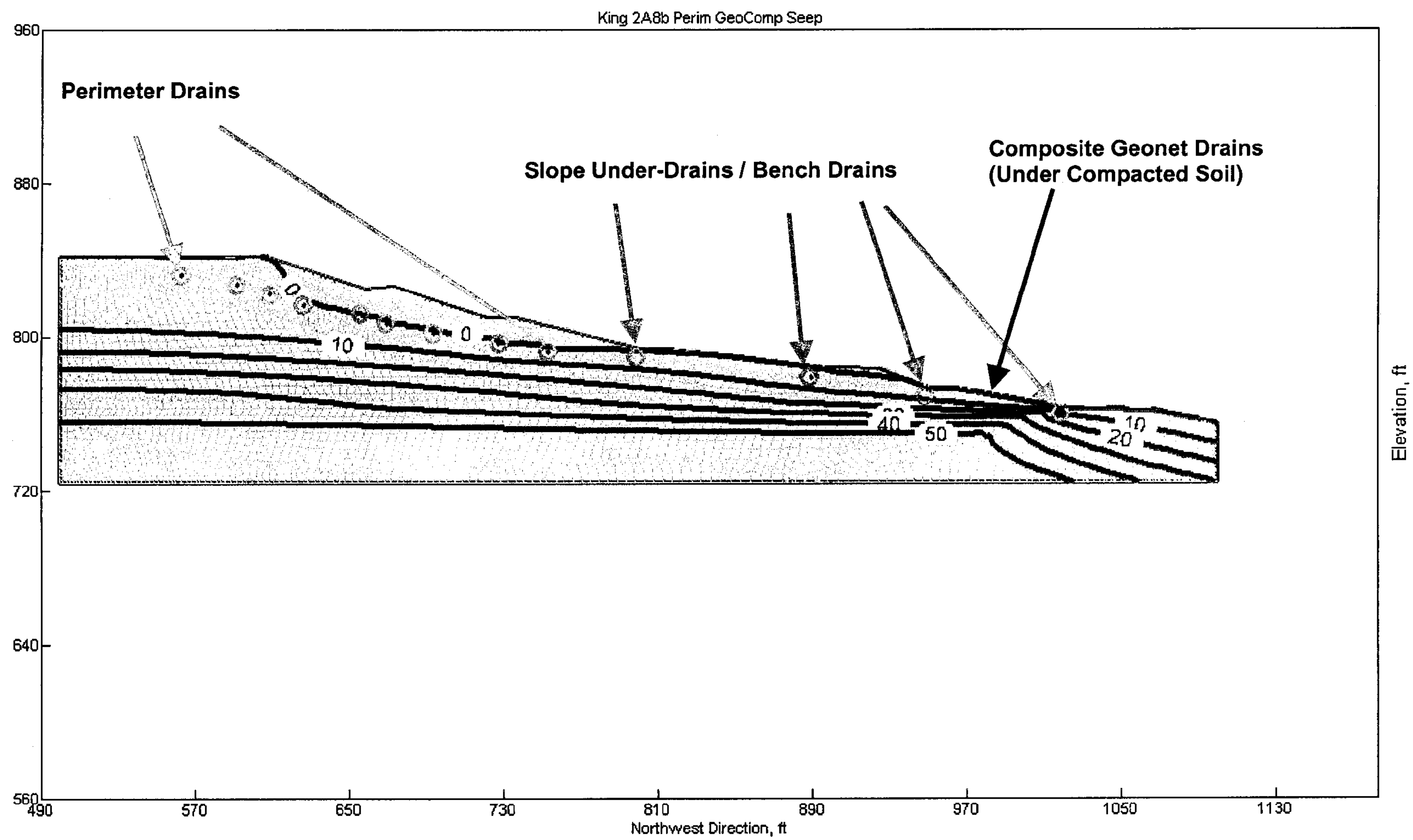


Figure 7. Case 2. Perimeter, Bench, and Composite Geonet Drains for Stage E (Stage E) Control Exit Gradients.

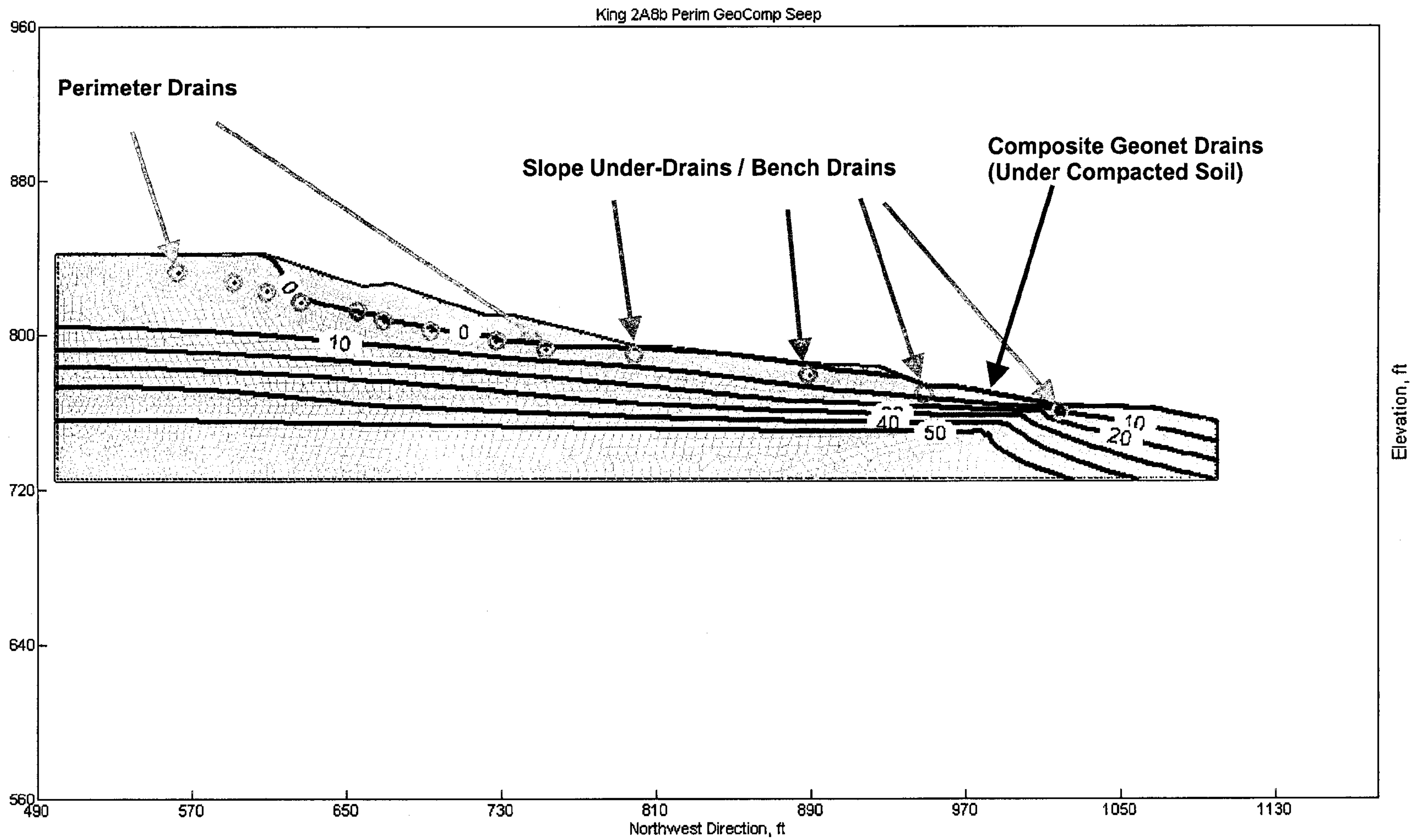


Figure 7. Case 2. Perimeter, Bench, and Composite Geonet Drains for Stage E (Stage E) Control Exit Gradients.

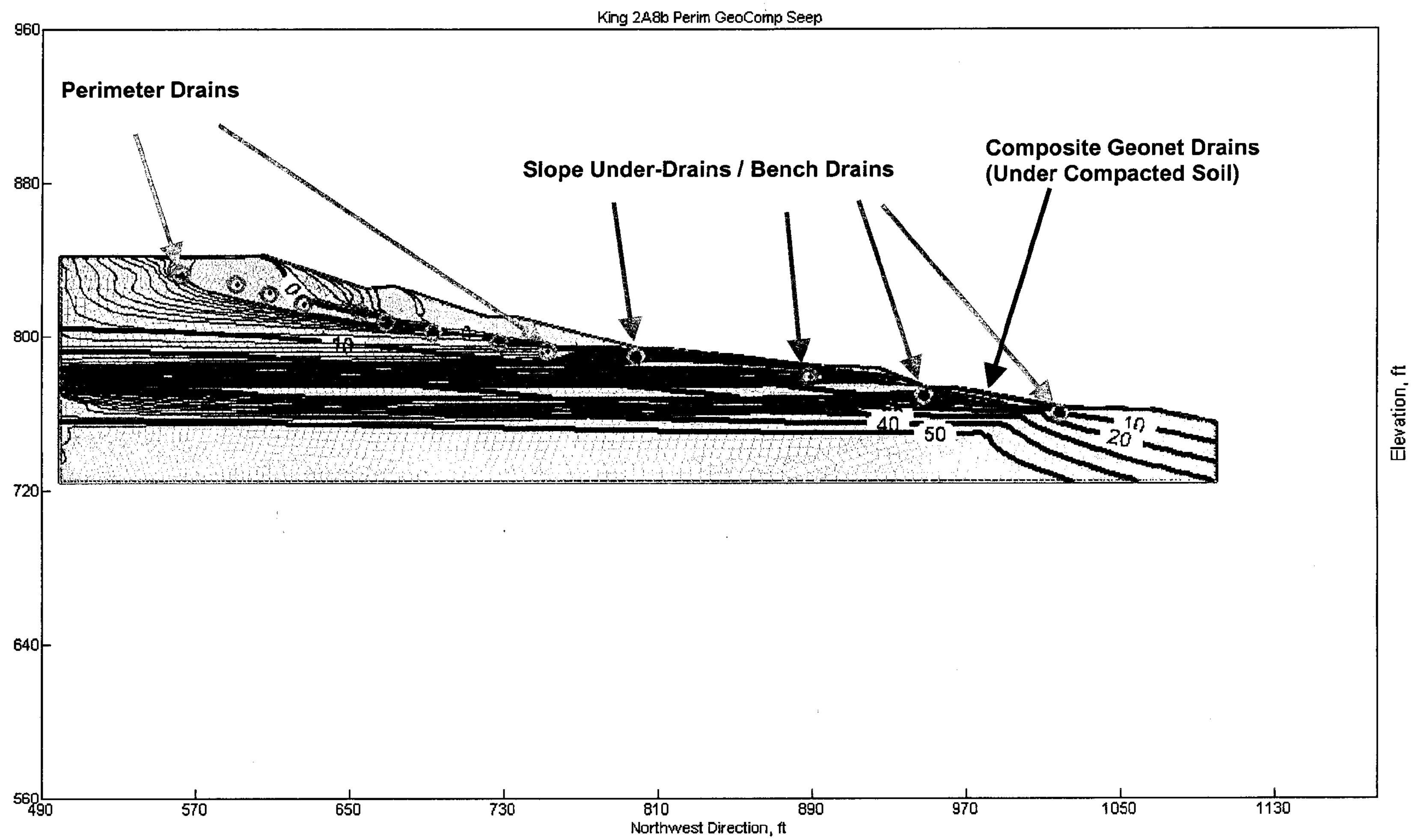


Figure 7A. Case 2. Perimeter, Bench, and Composite Geonet Drains for Stage E (Stage E) With Path Lines That Show Some Improvement In Control of Exit Gradients.