PETERSON / PURITAN OU2
SLOPE STABILITY ANALYSIS

CERCLA Docket No. 1-87-1064
CUMBERLAND, RHODE ISLAND

Prepared for:

Shield Environmental Associates, Inc
2456 Fortune Drive, Suite 100
Lexington, Kentucky 40509

Prepared by:

SHIELD ENGINEERING, INC.

4301 Taggart Creek Road
Charlotte, NC 28208
Project Number 1030105

January 29, 2004

1.0 LIMITATIONS

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Our conclusions and recommendations are based upon our site observations, provided survey and provided field data. We have assumed that information provided to us by others is correct and true, unless otherwise noted. If additional information or changes in information is available in the future, we request the chance to review and change our recommendations, if necessary.

The Slope Stability Analysis was prepared under my direct supervision:

By: Thomas M. Vick, P.E.
Principal Engineer

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MAY 06 2004

I assisted with the preparation of this project:

By: John M. Long
Staff Engineer

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1.0 LIMITATIONS

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By: ______________________ JAN 29 2004
Thomas M. Vick, P.E.
Principal Engineer

I assisted with the preparation of this project:

By: ______________________
John M. Long
Staff Engineer

2.0 INTRODUCTION

Shield Engineering, Inc. (Shield) is pleased to provide slope stability analysis of the J. M. Mills Landfill located in the Peterson/Puritan OU2 site in Cumberland, Rhode Island. The slope-stability analysis was preformed on both sides (slopes) of the landfill using GSTABL 7 with STEDwin©. In-situ testing was performed by CONETEC of West Berlin, New Jersey. The results were presented in their "Field Report for the Peterson/Puritan OU2 Superfund Site, Cumberland, Rhode Island" dated September 18, 2003. We understand this report is included elsewhere in the DBSR. Nine (9) cone penetration tests (CPTs) were performed at various locations around the landfill. The primary purpose of this testing was to establish strength and lithologic characteristics of native (including alluvial and/or fill materials in and near the landfill) and waste materials found onsite. Figure 1 illustrates the site layout and general orientation of the landfill and Figure 2 illustrates the location of the CPT test borings.

3.0 FIELD TESTING

CPT testing indicated that native lithology was relatively homogeneous. Native material consists of predominately sand with some silt. There appears to be some minor bedding in the sand and silty sand layers. Layers are thin and the strength of the bulk material relies on the larger grained matrix material, sand. The material is likely alluvial in origin, based on the close proximity of the Blackstone River. This is consistent with the boring logs provided to us by Shield Environmental Associates, Inc., of Lexington Kentucky. The material in the landfill itself appeared to be heterogeneous, as expected. Shear strength values for the landfill materials were very erratic resulting in a range of engineering properties.

Onsite observations provided insight to the stability of the landfill. A few of the observations made onsite were:

- The landfill is standing without any lateral support (it is free standing)
- The landfill had little to no cover soil (varies by location)
- The slopes range from an estimated 2:1 to 3:1
- The landfill seems to contain large voids, consistent with anticipated conditions
- Materials included in the landfill appear to be a combination of construction and demolition (C&D) waste and municipal solid waste (MSW)
- High temperatures at the bottom of the landfill indicated that organic degradation is occurring, this could be confirmed by methane monitoring
- Surface failure was not clearly identified (due to heavy vegetation) however, topographic data indicates that localized failures may have occurred
- No cracks were observed at the top of the landfill

Soil and landfill testing by CONETEC consisted of approximately 355 linear feet of boring data. In each location probes were pushed until refusal was encountered. Pore pressure dissipation tests were performed in each of the applicable locations. The water table was intersected during six of the nine tests. The CONETEC report includes basic principles of cone technology, testing results in graphical form, results in numeric form along with calculations and pore pressure dissipation test data.

The locations of the borings are depicted on Figure 2. Boring locations were chosen based on the geometry of the landfill. Site restrictions did not allow for a CPT sample to be collected along the railroad tracks. Subsurface strata were assumed to be continuous from data collected northwest and southeast of the landfill, CPT-7 and CPT-9, respectively.

4.0 ANALYSIS

In order to perform the stability analysis it was necessary to make assumptions, based on site-specific project information and on-site observations. A sensitivity analysis was preformed on the phi angle (ϕ, also known as the internal friction angle) and the unit weight (γ) of the landfill material. The result of the sensitivity analysis indicated that the unit weight was less of an influential factor than the phi angle in the stability of the landfill. Experience, engineering judgement and comparison to observed field conditions were used whenever possible to establish the most representative analysis.

In this case, two modes of slope failure are likely. The first is global failure of the landfill. Global failure typically occurs along deep circular failure surfaces and is characterized by massive slope failures. The second failure mode is surface failure. Evidence of surface failure is typically seen in the form of slumping and/or subsidence along the surface of the slope. Evidence exists for surface failure based on topographic data and field observations. Saturation of the upper layer of waste materials during a precipitation event may cause the material to become heavier than the underlying material causing surface instability.

The slope stability analysis was performed using the *Simplified Bishop Method* of slices to discretize the soil mass to establish the minimum factor of safety of the slope. The method satisfies vertical force equilibrium for each slice. The moment is then calculated about the center of the trial surface. One of the main assumptions of the Bishop method is zero interslice shear force. The failure surface is also assumed to be circular. The Bishop method is one of the most widely used slope stability methods. Factors of safety (FS) have been calculated to be within 5% of Janbu's formulation (a more rigorous set of assumptions).

In order to assess the stability of the slope, made of unknown materials, data was taken from the results of the CPT testing and compared to hypothetical conditions. Sensitivity of the parameters γ and ϕ was assessed. Data indicated that as unit weight increased the factor of safety increased. It should be noted that dry and wet unit weight affect the stability differently. Typically saturated materials have less strength than like dry materials. The sensitivity analysis also indicated that as the internal friction angle increased the factor of safety increased. This is consistent with previously held notions. Table 3.1 below presents the sensitivity of the dry/wet unit weight and Table 3.2 shows the sensitivity of the internal friction angle.

To access a conservative, likely range for the unit weight and internal friction angle the values of γ_{dry} = 55 pcf, γ_{sat} = 65 psf and 22.5^o were used, respectively as an overall indicator of stability. Using these values, a factor of safety of approximately 1.1 is realized. The FS of 1.1 should not be considered comprehensive as the waste material is heterogeneous and will certainly vary from location to location. A range of FS should be considered in this situation along with a range of the parameters γ and ϕ. Likely ranges of phi vary between 20^o and 45^o, making the FS vary between 1.0 and 2.3.

Figure 3 illustrates the location of the two (2) slope sections that were analyzed for slope stability. The slopes were chosen based on proximity to boring locations and also areas of steep slope to yield worst case scenario conditions. The first section runs from the top of the landfill towards Blackstone River. The second section line runs from the top of the landfill into the wetlands or swampy area. The water table was assumed to somewhat follow the topography in the landfill. Attachment 1 includes the landfill slope sections analyzed. Attachment 2 contains the slope stability data and graphical outputs.

Table 3.1

γ_d/γ_w (psf)	ϕ (degrees)	Factor of Safety
25/35	21	0.48
35/45	21	0.75
45/55	21	0.88
55/65	21	0.96
65/75	21	1.02
75/85	21	1.03
85/95	21	1.03
105/115	21	1.03

Table 3.2

γ_d/γ_w (psf)	ϕ (degrees)	Factor of Safety
45/55	5	0.20
45/55	10	0.40
45/55	15	0.61
45/55	20	0.83
45/55	25	1.07
45/55	30	1.32
45/55	35	1.57
45/55	40	1.80
45/55	45	2.02
45/55	50	2.23
45/55	55	2.45

4.0 CONCLUSIONS AND RECOMMENDATIONS

Slope strength is traditionally gauged by the resulting factor of safety (FS). Due to the inherent nature of landfill-type material, engineering judgement was considered throughout the project. The fact that the landfill appeared to be relatively stable was considered along with the fact that the strength of the slope directly depends on the material contained within. Interlocking steel beams could provide significant increases in the FS, however, organic materials may appear strong until degradation occurs, then lowering the FS. Since this landfill appears to be a combination of materials it is necessary to consider both scenarios.

The results of the analysis, using conservative input values to the model indicate that the overall landfill slopes are stable and may be for some period, however, some localized failures have likely occurred. These rather conservative input values do result in FS(s) lower than typical minimum FS of 1.5 required for water retention by earthen embankments. However, acceptable FS(s) of mounds of solid material such as landfills typically are in the range of 1.2 to 1.3. Since the landfill is free standing, the factor of safety must be equal to at least 1.0. Due to the high variability of the unit weight and the internal friction angle inherent to waste materials, it is likely that localized failure will occur in some location sometime in the future. The high temperatures near the bottom of the landfill indicate that degradation is occurring. Factors of safety will decrease with time as the organic material degrades and weakens. The native sand and silty sand appear strong enough to provide sufficient support for the landfill. Failure surfaces are most likely to occur along the interface between the waste material and the native materials and also along the surface of the slope (depending on the chosen phi angle).

Geographic considerations must be taken into account for this particular site. The close proximity of the Blackstone River could influence the global and surface stability of the landfill. During flood or other high water conditions, the erosion of the bank could scour the toe of the slope compromising the stability of the landfill. The river channel should be stabilized and scour protections should be installed to reduce this potential.

To help maintain the integrity of the landfill slopes, a few remediation techniques should be considered. One technique would be to reduce the overall side slopes of the landfill. To do this, material would have to be removed from the top of the landfill and deposited at another location or along an extended landfill embankment. A capping system should then be designed for the waste material to minimize water infiltration thus controlling the piezometer surface in the landfill material and reducing leachate generation potential (and degradation of the waste materials). Minimum slopes should be maintained to prevent sliding of the cap. If heavy equipment is used during the remediation process thought should be given to the type and weight of the equipment. Dynamic loading as a result of the heavy equipment could reduce the strength of the slope. Stability of the waste materials should be reassessed once a remedial plan is devised to ensure that the design has an adequate FS and that construction proceeds in a safe manner. Further investigation could provide specific construction details and specifications on capping systems, slope gradients and remedial alternatives.

Based on the evidence presented herein the landfill is not likely to experience global failure. However, localized surface failures are likely, as they may have already occurred in some locations. Although the landfill materials may exhibit appreciable strength properties because of reinforcement by interlocking debris, these properties will likely decrease with time. If capping is used as a remedial technique the current steepness of the slope will cause sliding of the cover unless modifications are made.

REFERENCES

Kulhawy, F.H. and P.W. Mayne. (1990), Manual on estimating soil properties for foundation design. Final Report 1493-6, EL-6800, Electric Power Research Institute, Palo Alto, CA.

Robertson, P.K. and R.G. Campanella. (1983), Interpretation of cone penetration tests - Part I: sand. *Can. Geotech. Journ.*, 20:718-733.

Figures:

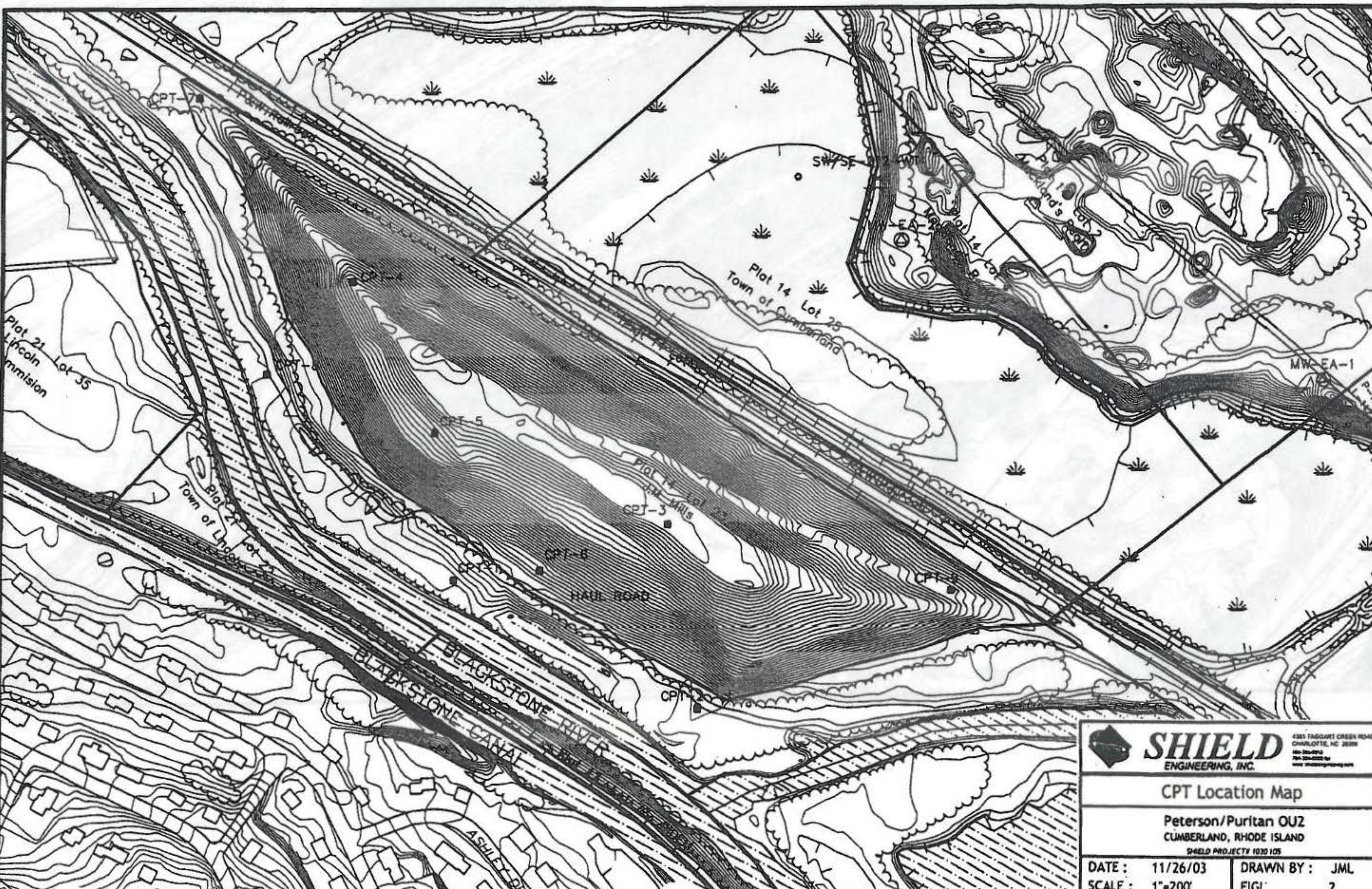
SHIELD ENGINEERING, INC.

Site Map

Peterson/Puritan OU2
CUMBERLAND, RHODE ISLAND

DATE :	11/26/03	DRAWN BY :	JML
SCALE :	1"=200'	FIGURE :	1

H:GEO-ENVIRONMENTAL\2003\1030105-01\DRAWINGS\Figure 1



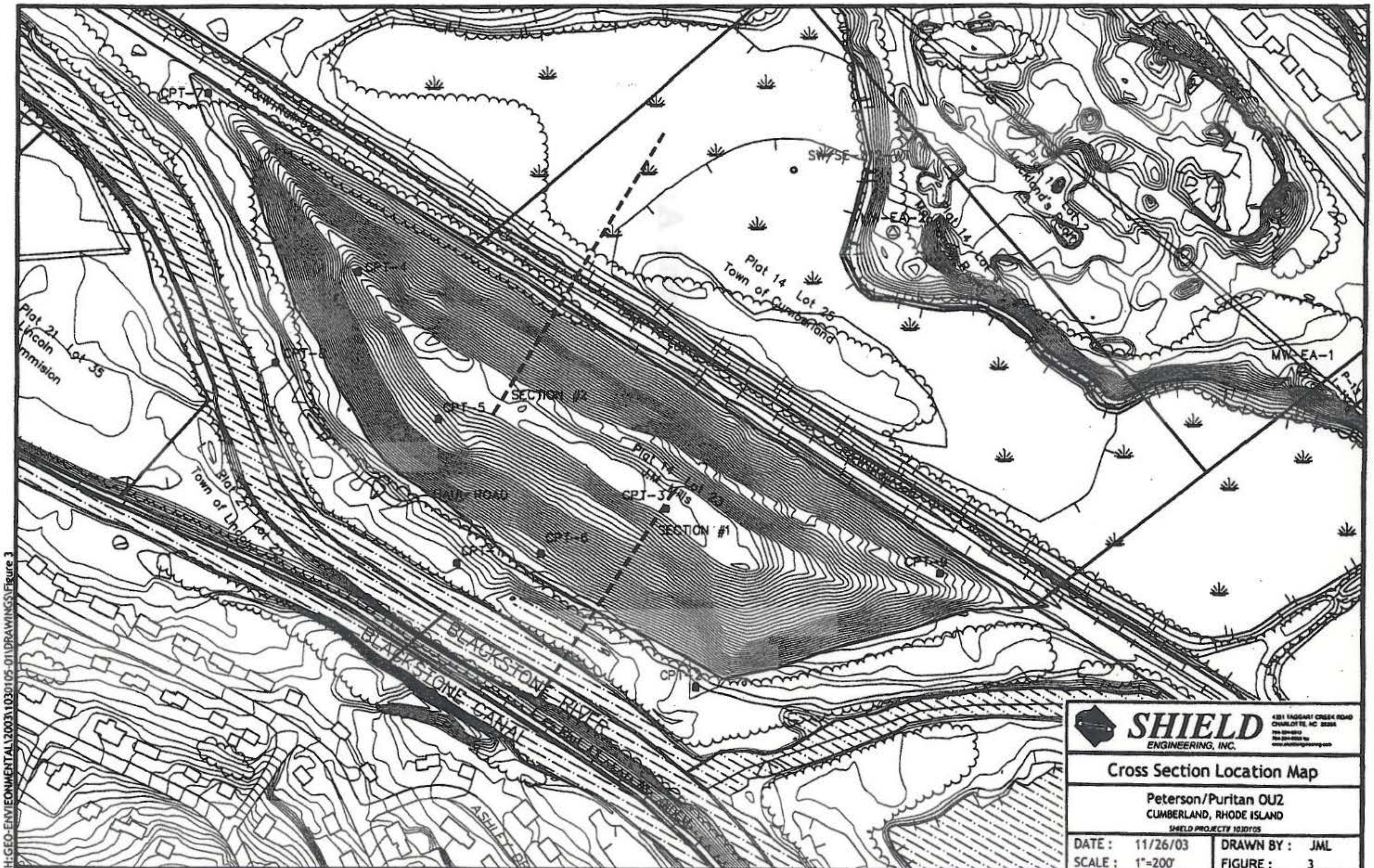
SHIELD ENGINEERING, INC.

CPT Location Map

Peterson/Puritan OU2
CUMBERLAND, RHODE ISLAND
SHIELD PROJECT# 1030 105

DATE :	11/26/03	DRAWN BY :	JML
SCALE :	1"=200'	FIG	2

H:GEO-ENVIEONMENTAL\2003\1030105-01\DRAWINGS\Figure 2



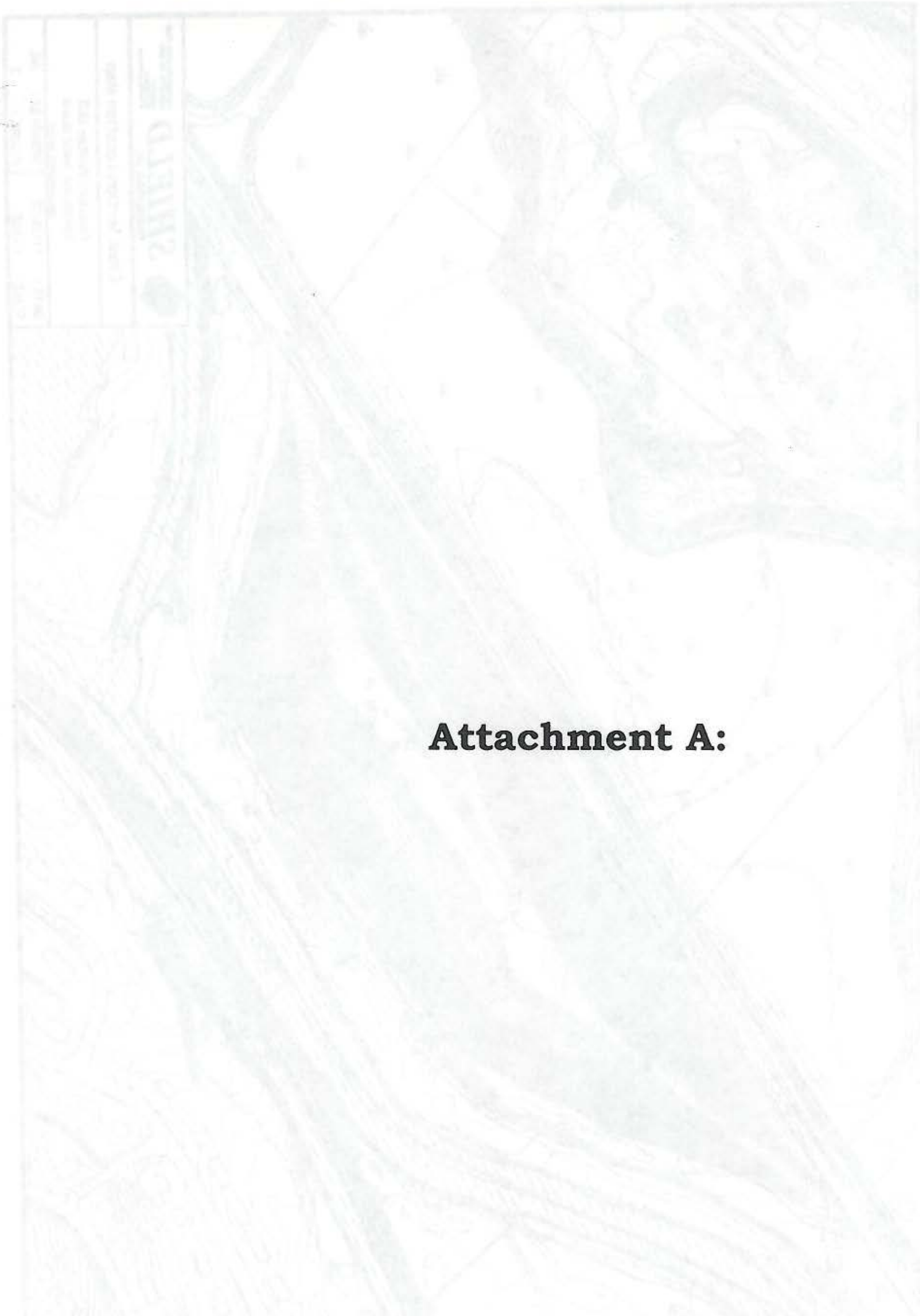
SHIELD ENGINEERING, INC.

Cross Section Location Map

Peterson/Puritan OU2
CUMBERLAND, RHODE ISLAND
SHIELD PROJECT# 1030105

DATE :	11/26/03	DRAWN BY :	JML
SCALE :	1"=200'	FIGURE :	3

H:GEO-ENVIEONMENTAL\2003\1030105-01\DRAWINGS\Figure 3

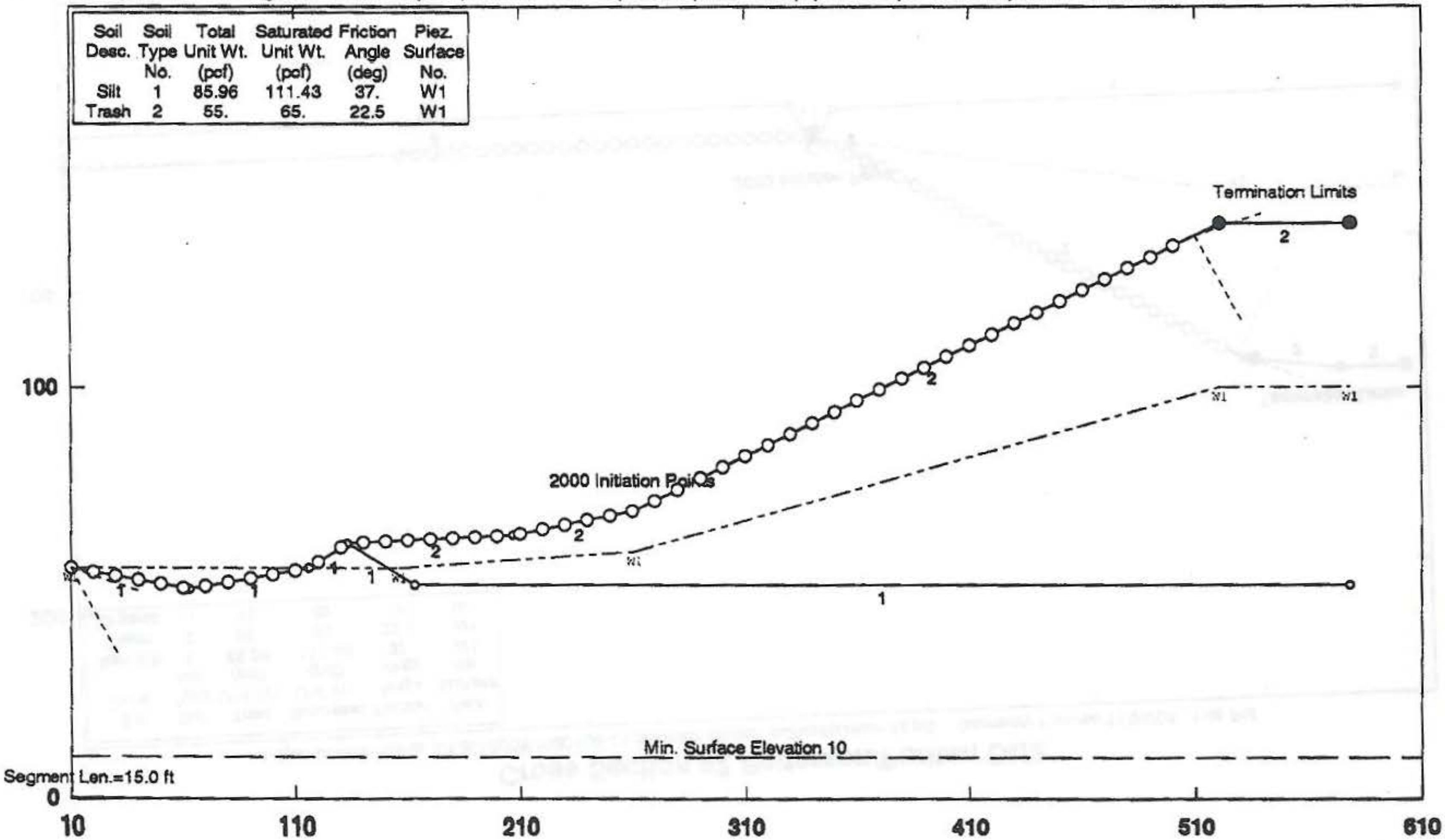


Attachment A:

Cross Section #1 Petterson/Puritan OU2

h:\geo-environmental (0120)\2003\1030105-01 peterson-puritan ou2\cpt\puritan #1.pl0 Geometry Preview 11/24/03 9:20 AM

Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Friction Angle (deg)	Piez. Surface No.
Silt	1	85.96	111.43	37.	W1
Trash	2	55.	65.	22.5	W1

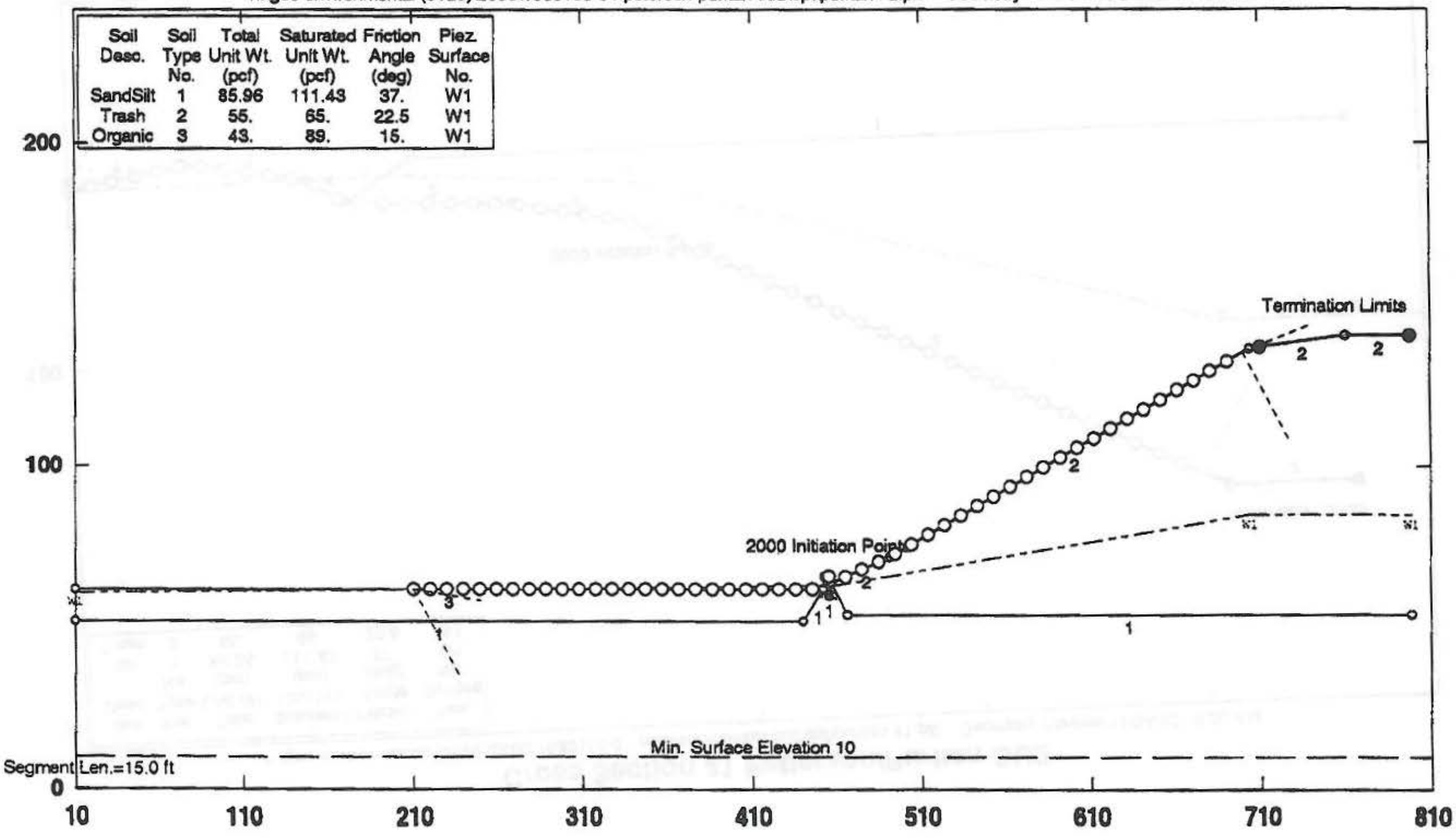


SHIELD ENGINEERING INC.

Cross Section #2 Petterson/Puritan OU2

h:\geo-environmental (0120)\2003\1030105-01 peterson-puritan ou2\cpt\puritan #2.pl0 Geometry Preview 11/26/03 1:45 PM

Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Friction Angle (deg)	Piez. Surface No.
SandSilt	1	85.96	111.43	37.	W1
Trash	2	55.	65.	22.5	W1
Organic	3	43.	89.	15.	W1

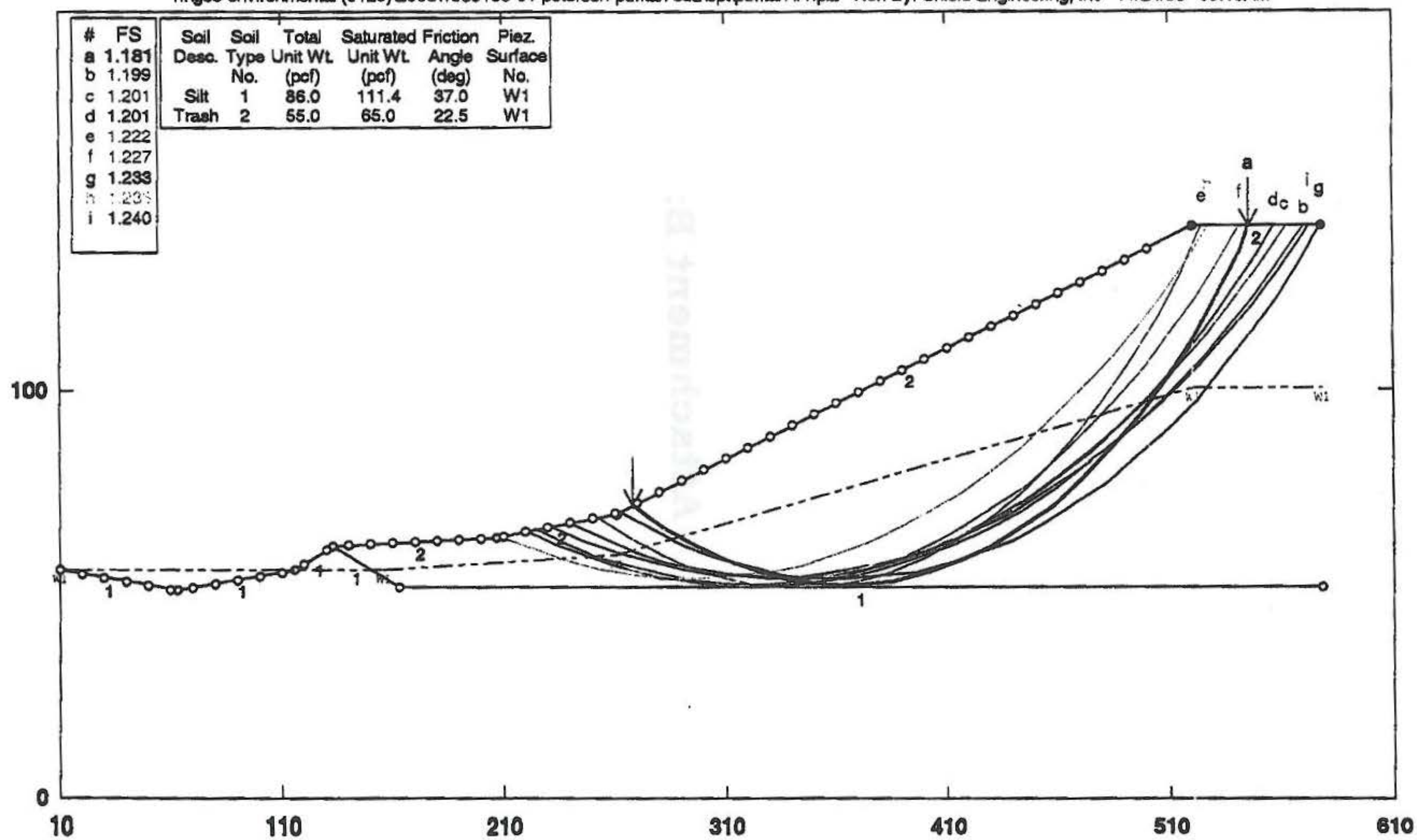


SHIELD ENGINEERING, INC.

Attachment B:

Cross Section #1 Petterson/Puritan OU2

h:\geo-environmental (0120)\2003\1030105-01 peterson-puritan ou2\cpt\puritan #1.pl2 Run By: Shield Engineering, Inc 11/24/03 09:18AM



GSTABL7 v.2 FSmin=1.181

Safety Factors Are Calculated By The Modified Bishop Method

SHIELD ENGINEERING, INC.

```
                          *** GSTABL7 ***
                ** GSTABL7 by Garry H. Gregory, P.E. **
   ** Original Version 1.0, January 1996; Current Version 2.004, June 2003 **
            (All Rights Reserved-Unauthorized Use Prohibited)
*********************************************************************************
                    SLOPE STABILITY ANALYSIS SYSTEM
      Modified Bishop, Simplified Janbu, or GLE Method of Slices.
      (Includes Spencer & Morgenstern-Price Type Analysis)
      Including Pier/Pile, Reinforcement, Soil Nail, Tieback,
      Nonlinear Undrained Shear Strength, Curved Phi Envelope,
      Anisotropic Soil, Fiber-Reinforced Soil, Boundary Loads, Water
      Surfaces, Pseudo-Static & Newmark Earthquake, and Applied Forces.
*********************************************************************************
  Analysis Run Date:          11/24/03
  Time of Run:                09:37AM
  Run By:                     Shield Engineering, Inc
  Input Data Filename:        H:\Geo-Environmental (0120)\2003\1030105-01 Peterson-Puritan
OU2\CPT\Puritan #1.in
  Output Filename:            H:\Geo-Environmental (0120)\2003\1030105-01 Peterson-Puritan
OU2\CPT\Puritan #1.OUT
  Unit System:                English
  Plotted Output Filename:    H:\Geo-Environmental (0120)\2003\1030105-01 Peterson-Puritan
OU2\CPT\Puritan #1.PLT
  PROBLEM DESCRIPTION:    Cross Section #1
                          Petterson/Puritan OU2
  BOUNDARY COORDINATES
       Note: User origin value specified.
       Add 10.00 to X-values and 0.00 to Y-values listed.

     7 Top    Boundaries
     9 Total Boundaries
  Boundary     X-Left     Y-Left    X-Right     Y-Right    Soil Type
     No.        (ft)       (ft)       (ft)        (ft)     Below Bnd
      1         10.00      56.00      63.00       51.00        1
      2         63.00      51.00     116.00       56.00        1
      3        116.00      56.00     133.00       62.00        1
      4        133.00      62.00     207.00       64.00        2
      5        207.00      64.00     261.00       70.00        2
      6        261.00      70.00     521.00      140.00        2
      7        521.00     140.00     579.00      140.00        2
      8        133.00      62.00     163.00       52.00        1
      9        163.00      52.00     579.00       52.00        1
  Default Y-Origin = 0.00(ft)
  Default X-Plus Value = 0.00(ft)
  Default Y-Plus Value = 0.00(ft)
 ISOTROPIC SOIL PARAMETERS
   2 Type(s) of Soil
  Soil  Total  Saturated  Cohesion Friction   Pore   Pressure   Piez.
  Type Unit Wt. Unit Wt. Intercept   Angle  Pressure Constant Surface
   No.   (pcf)    (pcf)     (psf)    (deg)    Param.    (psf)     No.
    1    86.0    111.4       0.0     37.0     0.00       0.0       1
    2    55.0     65.0       0.0     22.5     0.00       0.0       1
  1 PIEZOMETRIC SURFACE(S) SPECIFIED
  Unit Weight of Water =  62.46 (pcf)
  Piezometric Surface No.  1 Specified by  5 Coordinate Points
  Pore Pressure Inclination Factor =  0.50
    Point      X-Water    Y-Water
     No.         (ft)       (ft)
      1          10.00      56.00
      2         156.00      56.00
      3         261.00      60.00
      4         521.00     100.00
      5         579.00     100.00
  A Critical Failure Surface Searching Method, Using A Random
  Technique For Generating Circular Surfaces, Has Been Specified.
  2000 Trial Surfaces Have Been Generated.
     1 Surface(s) Initiate(s) From Each Of  2000 Points Equally Spaced
```

Along The Ground Surface Between X = 10.00(ft)
and X = 510.00(ft)
Each Surface Terminates Between X = 521.00(ft)
and X = 579.00(ft)
Unless Further Limitations Were Imposed, The Minimum Elevation
At Which A Surface Extends Is Y = 10.00(ft)
15.00(ft) Line Segments Define Each Trial Failure Surface.
Following Are Displayed The Ten Most Critical Of The Trial
Failure Surfaces Evaluated. They Are
Ordered - Most Critical First.
* * Safety Factors Are Calculated By The Modified Bishop Method * *
Total Number of Trial Surfaces Attempted = 2000
Number of Trial Surfaces With Valid FS = 2000
Statistical Data On All Valid FS Values:
FS Max = 34.260 FS Min = 1.181 FS Ave = 2.543
Standard Deviation = 2.008 Coefficient of Variation = 78.97 %
Failure Surface Specified By 22 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	268.377	71.986
2	282.306	66.420
3	296.561	61.750
4	311.083	57.994
5	325.814	55.167
6	340.695	53.281
7	355.666	52.343
8	370.666	52.358
9	385.634	53.324
10	400.512	55.238
11	415.238	58.093
12	429.752	61.877
13	443.998	66.574
14	457.917	72.166
15	471.452	78.631
16	484.550	85.941
17	497.158	94.068
18	509.224	102.979
19	520.701	112.637
20	531.541	123.005
21	541.702	134.040
22	546.528	140.000

Circle Center At X = 362.913 ; Y = 288.143 ; and Radius = 235.925
Factor of Safety
*** 1.181 ***
Individual data on the 24 slices

Slice No.	Width (ft)	Weight (lbs)	Water Force Top (lbs)	Water Force Bot (lbs)	Tie Force Norm (lbs)	Tie Force Tan (lbs)	Earthquake Force Hor (lbs)	Earthquake Force Ver (lbs)	Surcharge Load (lbs)
1	13.9	3568.5	0.0	0.0	0.	0.	0.0	0.0	0.0
2	6.5	4043.4	0.0	0.0	0.	0.	0.0	0.0	0.0
3	7.7	6737.3	0.0	934.0	0.	0.	0.0	0.0	0.0
4	14.5	18261.6	0.0	6219.3	0.	0.	0.0	0.0	0.0
5	14.7	25189.0	0.0	11351.4	0.	0.	0.0	0.0	0.0
6	14.9	31317.9	0.0	15643.1	0.	0.	0.0	0.0	0.0
7	15.0	36526.7	0.0	19077.2	0.	0.	0.0	0.0	0.0
8	15.0	40718.1	0.0	21639.8	0.	0.	0.0	0.0	0.0
9	15.0	43819.8	0.0	23320.7	0.	0.	0.0	0.0	0.0
10	14.9	45786.6	0.0	24112.9	0.	0.	0.0	0.0	0.0
11	14.7	46600.9	0.0	24013.4	0.	0.	0.0	0.0	0.0
12	14.5	46272.5	0.0	23022.4	0.	0.	0.0	0.0	0.0
13	14.2	44838.9	0.0	21144.2	0.	0.	0.0	0.0	0.0
14	13.9	42364.2	0.0	18386.1	0.	0.	0.0	0.0	0.0
15	13.5	38938.1	0.0	14759.3	0.	0.	0.0	0.0	0.0
16	13.1	34674.2	0.0	10278.4	0.	0.	0.0	0.0	0.0
17	12.6	29707.7	0.0	4961.6	0.	0.	0.0	0.0	0.0
18	3.9	8265.9	0.0	336.5	0.	0.	0.0	0.0	0.0

19	8.2	16121.5	0.0	0.0	0.	0.	0.0	0.0	0.0
20	11.5	19293.8	0.0	0.0	0.	0.	0.0	0.0	0.0
21	0.3	447.3	0.0	0.0	0.	0.	0.0	0.0	0.0
22	10.5	12775.5	0.0	0.0	0.	0.	0.0	0.0	0.0
23	10.2	6413.9	0.0	0.0	0.	0.	0.0	0.0	0.0
24	4.8	791.1	0.0	0.0	0.	0.	0.0	0.0	0.0

Failure Surface Specified By 26 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	221.104	65.567
2	235.657	61.932
3	250.338	58.856
4	265.126	56.343
5	279.999	54.398
6	294.936	53.022
7	309.915	52.219
8	324.913	51.990
9	339.909	52.333
10	354.881	53.250
11	369.807	54.739
12	384.665	56.798
13	399.433	59.423
14	414.091	62.610
15	428.615	66.356
16	442.986	70.655
17	457.182	75.500
18	471.183	80.884
19	484.967	86.800
20	498.515	93.238
21	511.807	100.189
22	524.823	107.644
23	537.545	115.591
24	549.954	124.019
25	562.031	132.915
26	570.918	140.000

Circle Center At X = 323.413 ; Y = 443.975 ; and Radius = 391.994

Factor of Safety

*** 1.199 ***

Failure Surface Specified By 26 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	223.855	65.873
2	238.410	62.247
3	253.098	59.204
4	267.896	56.748
5	282.780	54.885
6	297.726	53.616
7	312.711	52.943
8	327.711	52.868
9	342.702	53.391
10	357.660	54.511
11	372.561	56.226
12	387.383	58.533
13	402.101	61.429
14	416.691	64.909
15	431.132	68.968
16	445.399	73.599
17	459.470	78.795
18	473.323	84.548
19	486.936	90.848
20	500.287	97.686
21	513.355	105.050
22	526.119	112.928
23	538.559	121.310
24	550.655	130.180
25	562.389	139.525
26	562.938	140.000

Circle Center At X = 322.089 ; Y = 429.120 ; and Radius = 376.296
Factor of Safety
*** 1.201 ***
Failure Surface Specified By 24 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	239.863	67.651
2	254.337	63.714
3	268.974	60.434
4	283.744	57.816
5	298.616	55.866
6	313.562	54.588
7	328.550	53.985
8	343.550	54.058
9	358.531	54.807
10	373.463	56.230
11	388.316	58.324
12	403.060	61.085
13	417.664	64.508
14	432.099	68.586
15	446.336	73.310
16	460.346	78.670
17	474.099	84.656
18	487.569	91.256
19	500.728	98.456
20	513.550	106.242
21	526.007	114.597
22	538.075	123.505
23	549.730	132.948
24	557.673	140.000

Circle Center At X = 334.421 ; Y = 386.484 ; and Radius = 332.559
Factor of Safety
*** 1.201 ***
Failure Surface Specified By 22 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	252.369	69.041
2	266.436	63.834
3	280.807	59.533
4	295.421	56.155
5	310.221	53.714
6	325.147	52.219
7	340.137	51.677
8	355.131	52.090
9	370.069	53.455
10	384.889	55.769
11	399.533	59.021
12	413.939	63.198
13	428.051	68.283
14	441.811	74.255
15	455.163	81.091
16	468.052	88.763
17	480.428	97.239
18	492.239	106.485
19	503.438	116.464
20	513.979	127.136
21	523.820	138.456
22	524.999	140.000

Circle Center At X = 341.144 ; Y = 287.171 ; and Radius = 235.503
Factor of Safety
*** 1.222 ***
Failure Surface Specified By 24 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	225.856	66.095
2	240.282	61.985
3	254.885	58.555

4	269.632	55.812
5	284.491	53.761
6	299.430	52.408
7	314.416	51.756
8	329.415	51.806
9	344.397	52.557
10	359.326	54.008
11	374.172	56.157
12	388.900	58.997
13	403.480	62.524
14	417.878	66.729
15	432.064	71.603
16	446.007	77.135
17	459.675	83.314
18	473.039	90.125
19	486.070	97.555
20	498.739	105.586
21	511.019	114.201
22	522.882	123.381
23	534.302	133.105
24	541.670	140.000

Circle Center At X = 320.846 ; Y = 371.909 ; and Radius = 320.227

Factor of Safety

*** 1.227 ***

Failure Surface Specified By 24 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	262.124	70.303
2	276.452	65.865
3	290.976	62.115
4	305.662	59.061
5	320.477	56.711
6	335.387	55.070
7	350.358	54.142
8	365.356	53.928
9	380.348	54.429
10	395.299	55.645
11	410.174	57.572
12	424.941	60.205
13	439.566	63.540
14	454.015	67.568
15	468.256	72.280
16	482.256	77.665
17	495.983	83.712
18	509.406	90.406
19	522.495	97.733
20	535.220	105.675
21	547.552	114.215
22	559.463	123.332
23	570.926	133.007
24	578.451	140.000

Circle Center At X = 362.322 ; Y = 368.232 ; and Radius = 314.327

Factor of Safety

*** 1.233 ***

Failure Surface Specified By 24 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	209.598	64.289
2	224.237	61.016
3	238.999	58.358
4	253.860	56.319
5	268.793	54.904
6	283.773	54.115
7	298.772	53.953
8	313.764	54.418
9	328.725	55.510
10	343.626	57.226

11	358.443	59.564
12	373.149	62.520
13	387.718	66.088
14	402.126	70.263
15	416.346	75.036
16	430.354	80.400
17	444.126	86.345
18	457.637	92.860
19	470.863	99.935
20	483.783	107.557
21	496.372	115.713
22	508.609	124.387
23	520.472	133.566
24	528.105	140.000

Circle Center At X = 295.145 ; Y = 412.217 ; and Radius = 358.291

Factor of Safety

*** 1.235 ***

Failure Surface Specified By 26 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	230.859	66.651
2	245.457	63.205
3	260.177	60.318
4	274.996	57.995
5	289.893	56.238
6	304.846	55.051
7	319.833	54.435
8	334.833	54.391
9	349.824	54.918
10	364.783	56.017
11	379.690	57.686
12	394.523	59.922
13	409.259	62.722
14	423.878	66.082
15	438.358	69.997
16	452.678	74.461
17	466.818	79.468
18	480.757	85.010
19	494.474	91.080
20	507.949	97.669
21	521.164	104.766
22	534.098	112.363
23	546.733	120.447
24	559.051	129.007
25	571.033	138.031
26	573.450	140.000

Circle Center At X = 328.487 ; Y = 447.402 ; and Radius = 393.069

Factor of Safety

*** 1.240 ***

Failure Surface Specified By 27 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	214.851	64.872
2	229.506	61.677
3	244.263	58.983
4	259.102	56.794
5	274.007	55.112
6	288.961	53.939
7	303.947	53.277
8	318.946	53.127
9	333.942	53.488
10	348.916	54.360
11	363.853	55.742
12	378.733	57.633
13	393.540	60.030
14	408.257	62.930
15	422.866	66.331

16	437.351	70.228
17	451.695	74.617
18	465.881	79.492
19	479.892	84.848
20	493.712	90.679
21	507.326	96.978
22	520.716	103.737
23	533.869	110.949
24	546.768	118.605
25	559.398	126.697
26	571.745	135.214
27	578.200	140.000

Circle Center At X = 315.862 ; Y = 492.934 ; and Radius = 439.818

Factor of Safety

*** 1.241 ***

**** END OF GSTABL7 OUTPUT ****

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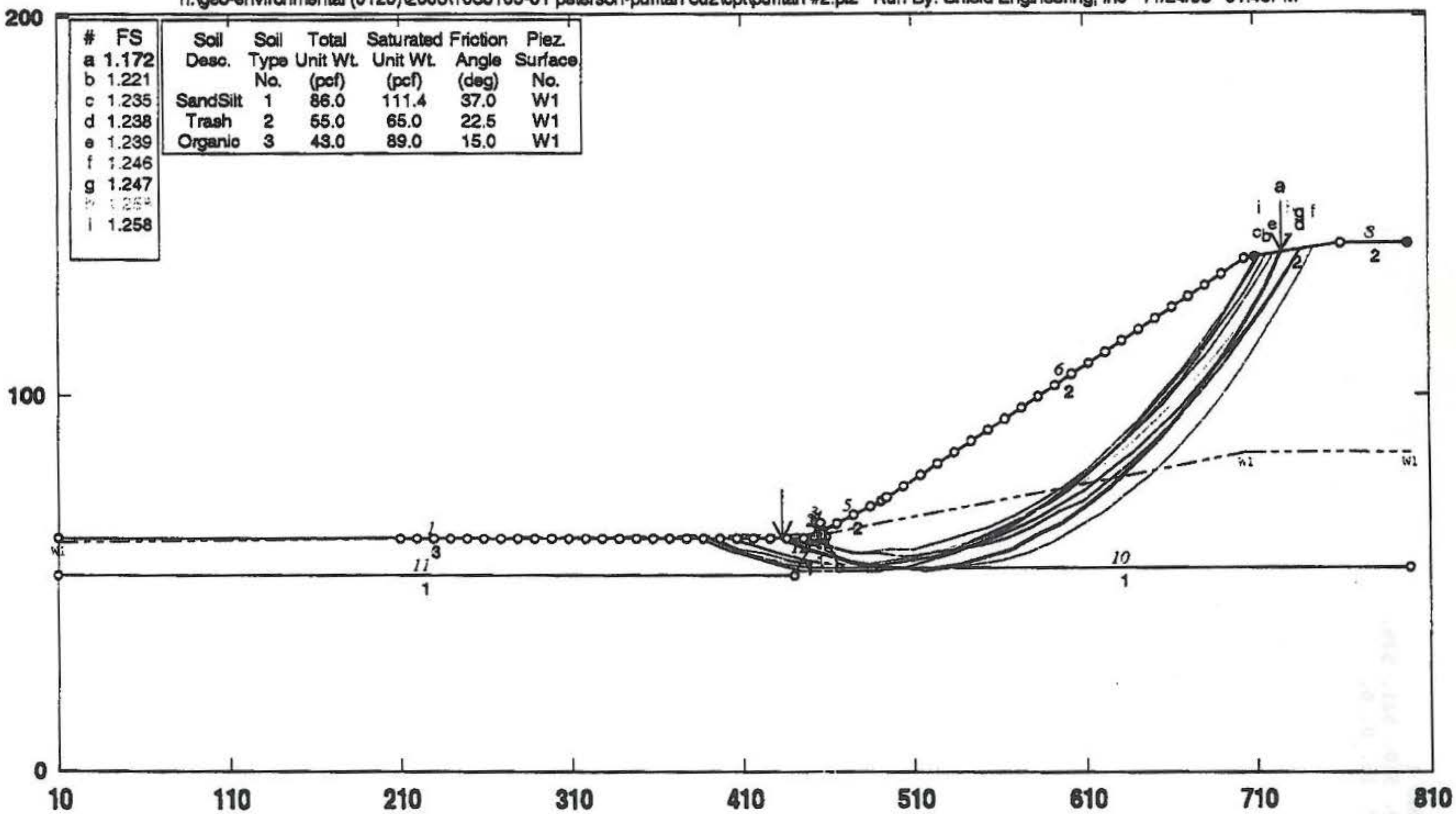
PROFIL  H:\Geo-Environmental (0120)\2003\1030105-01 Peterson-Puritan OU2\CPT\Puritan #1.in Versi
Cross Section #1                                Petterson/Puritan OU2
9 7
10. 56. 63. 51. 1
63. 51. 116. 56. 1
116. 56. 133. 62. 1
133. 62. 207. 64. 2
207. 64. 261. 70. 2
261. 70. 521. 140. 2
521. 140. 579. 140. 2
133. 62. 163. 52. 1
163. 52. 579. 52. 1
0. 0. 0.
SOIL  Silt    Trash
2
85.96 111.43 0. 37. 0. 0. 1
55. 65. 0. 22.5 0. 0. 1
WATER
1 62.46
5 0.5
10. 56.
156. 56.
261. 60.
521. 100.
579. 100.
CIRCL2
```

2000 1
10. 510. 521. 579.
10. 15. 0. 0.

Cross Section #2 Petterson/Puritan OU2

h:\geo-environmental (0120)\2003\1030105-01 peterson-puritan ou2\cpt\puritan #2.pl2 Run By: Shield Engineering, Inc 11/24/03 01:48PM



#	FS
a	1.172
b	1.221
c	1.235
d	1.238
e	1.239
f	1.246
g	1.247
h	[illegible]
i	1.258

Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Friction Angle (deg)	Piez. Surface No.
SandSilt	1	86.0	111.4	37.0	W1
Trash	2	55.0	65.0	22.5	W1
Organic	3	43.0	89.0	15.0	W1

GSTABL7 v.2 FSmin=1.172

Safety Factors Are Calculated By The Modified Bishop Method

SHIELD ENGINEERING, INC.

*** GSTABL7 ***
** GSTABL7 by Garry H. Gregory, P.E. **
** Original Version 1.0, January 1996; Current Version 2.004, June 2003 **

****

SLOPE STABILITY ANALYSIS SYSTEM
Modified Bishop, Simplified Janbu, or GLE Method of Slices.
(Includes Spencer & Morgenstern-Price Type Analysis)
Including Pier/Pile, Reinforcement, Soil Nail, Tieback,
Nonlinear Undrained Shear Strength, Curved Phi Envelope,
Anisotropic Soil, Fiber-Reinforced Soil, Boundary Loads, Water
Surfaces, Pseudo-Static & Newmark Earthquake, and Applied Forces.
****

Analysis Run Date: 11/24/03
Time of Run: 01:48PM
Run By: Shield Engineering, Inc
Input Data Filename: h:\Geo-Environmental (0120)\2003\1030105-01 Peterson-Puritan OU2\CPT\puritan #2.in
Output Filename: h:\Geo-Environmental (0120)\2003\1030105-01 Peterson-Puritan OU2\CPT\puritan #2.OUT
Unit System: English
Plotted Output Filename: h:\Geo-Environmental (0120)\2003\1030105-01 Peterson-Puritan OU2\CPT\puritan #2.PLT
PROBLEM DESCRIPTION: Cross Section #2
Petterson/Puritan OU2

BOUNDARY COORDINATES
Note: User origin value specified.
Add 10.00 to X-values and 0.00 to Y-values listed.

8 Top Boundaries
12 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	10.00	62.00	451.50	62.00	3
2	451.50	62.00	452.50	66.00	3
3	452.50	66.00	455.50	66.00	3
4	455.50	66.00	456.50	64.00	1
5	456.50	64.00	491.00	72.00	2
6	491.00	72.00	703.60	136.00	2
7	703.60	136.00	760.60	140.00	2
8	760.60	140.00	798.60	140.00	2
9	456.60	64.00	466.00	54.00	1
10	466.00	54.00	798.60	54.00	1
11	10.00	52.00	440.00	52.00	1
12	440.00	52.00	451.50	62.00	1

Default Y-Origin = 0.00(ft)
Default X-Plus Value = 0.00(ft)
Default Y-Plus Value = 0.00(ft)

ISOTROPIC SOIL PARAMETERS
3 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	86.0	111.4	0.0	37.0	0.00	0.0	1
2	55.0	65.0	0.0	22.5	0.00	0.0	1
3	43.0	89.0	0.0	15.0	0.00	0.0	1

1 PIEZOMETRIC SURFACE(S) SPECIFIED
Unit Weight of Water = 62.46 (pcf)
Piezometric Surface No. 1 Specified by 4 Coordinate Points
Pore Pressure Inclination Factor = 0.50

Point No.	X-Water (ft)	Y-Water (ft)
1	10.00	61.00
2	456.50	63.00
3	703.60	85.00
4	798.60	85.00

A Critical Failure Surface Searching Method, Using A Random
Technique For Generating Circular Surfaces, Has Been Specified.
2000 Trial Surfaces Have Been Generated.
1 Surface(s) Initiate(s) From Each Of 2000 Points Equally Spaced
Along The Ground Surface Between X = 210.00(ft)
and X = 700.00(ft)
Each Surface Terminates Between X = 710.00(ft)
and X = 798.00(ft)
Unless Further Limitations Were Imposed, The Minimum Elevation
At Which A Surface Extends Is Y = 10.00(ft)
15.00(ft) Line Segments Define Each Trial Failure Surface.
**** ERROR - RC11 ****
>>200 attempts to generate failure surface have failed. Revise limitations
The Factor Of Safety For The Trial Failure Surface Defined
By The Coordinates Listed Below Is Misleading.
Failure Surface Defined By 25 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	454.63	66.00
2	456.37	55.39
3	476.54	45.82
4	488.90	37.32
5	501.97	29.97
6	515.66	23.83
7	529.85	18.96
8	544.42	15.40
9	559.25	13.17
10	574.23	12.29
11	589.22	12.77
12	604.11	14.61
13	618.77	17.78
14	633.08	22.28
15	646.92	28.04
16	660.19	35.04
17	672.77	43.22
18	684.56	52.49
19	695.45	62.80
20	705.38	74.05
21	714.24	86.15
22	721.96	99.01
23	728.50	112.51
24	733.78	126.55
25	737.03	138.35

Factor Of Safety For The Preceding Specified Surface = 2.766
Following Are Displayed The Ten Most Critical Of The Trial
Failure Surfaces Evaluated. They Are
Ordered - Most Critical First.
* * Safety Factors Are Calculated By The Modified Bishop Method * *
Total Number of Trial Surfaces Attempted = 2000
Number of Trial Surfaces with Misleading FS = 1
Number of Failed Attempts to Generate Trial Surface = 1001
Number of Trial Surfaces With Valid FS = 998
Percentage of Trial Surfaces With Non-Valid FS Solutions
of the Total Attempted = 50.1 %
Statistical Data On All Valid FS Values:
FS Max = 3.894 FS Min = 1.172 FS Ave = 2.265
Standard Deviation = 0.373 Coefficient of Variation = 16.46 %
Failure Surface Specified By 22 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	433.302	62.000
2	448.003	59.020
3	462.824	56.711
4	477.735	55.078
5	492.705	54.125
6	507.702	53.853

7	522.696	54.262
8	537.657	55.353
9	552.552	57.122
10	567.352	59.567
11	582.025	62.681
12	596.541	66.459
13	610.871	70.893
14	624.984	75.974
15	638.852	81.691
16	652.446	88.032
17	665.737	94.984
18	678.699	102.534
19	691.304	110.664
20	703.527	119.359
21	715.342	128.600
22	725.778	137.556

Circle Center At X = 506.191 ; Y = 383.709 ; and Radius = 329.863

Factor of Safety

*** 1.172 ***

Individual data on the 34 slices

Slice No.	Width (ft)	Weight (lbs)	Water Force Top (lbs)	Water Force Bot (lbs)	Tie Force Norm (lbs)	Tie Force Tan (lbs)	Earthquake Force Hor (lbs)	Earthquake Force Ver (lbs)	Surcharge Load (lbs)
1	14.7	1949.5	853.0	2266.4	0.	0.	0.0	0.0	0.0
2	0.1	15.8	3.6	14.9	0.	0.	0.0	0.0	0.0
3	3.4	1132.4	208.2	918.5	0.	0.	0.0	0.0	0.0
4	1.0	451.7	0.0	289.7	0.	0.	0.0	0.0	0.0
5	3.0	1697.5	0.0	929.8	0.	0.	0.0	0.0	0.0
6	1.0	754.2	0.0	330.2	0.	0.	0.0	0.0	0.0
7	0.1	40.1	0.0	33.5	0.	0.	0.0	0.0	0.0
8	0.9	584.1	0.0	294.1	0.	0.	0.0	0.0	0.0
9	5.4	3380.3	0.0	2092.5	0.	0.	0.0	0.0	0.0
10	0.7	400.5	0.0	303.0	0.	0.	0.0	0.0	0.0
11	14.2	10115.4	0.0	7472.6	0.	0.	0.0	0.0	0.0
12	13.3	12962.2	0.0	8952.0	0.	0.	0.0	0.0	0.0
13	1.7	1898.0	0.0	1271.8	0.	0.	0.0	0.0	0.0
14	6.9	8222.8	0.0	5334.0	0.	0.	0.0	0.0	0.0
15	8.1	10874.6	0.0	6706.7	0.	0.	0.0	0.0	0.0
16	5.4	7861.8	0.0	4659.2	0.	0.	0.0	0.0	0.0
17	9.6	15077.7	0.0	8563.3	0.	0.	0.0	0.0	0.0
18	15.0	26048.5	0.0	13766.9	0.	0.	0.0	0.0	0.0
19	14.9	28430.2	0.0	13672.7	0.	0.	0.0	0.0	0.0
20	14.8	30054.8	0.0	12940.1	0.	0.	0.0	0.0	0.0
21	14.7	30920.5	0.0	11570.6	0.	0.	0.0	0.0	0.0
22	14.5	31036.0	0.0	9567.0	0.	0.	0.0	0.0	0.0
23	14.3	30419.8	0.0	6933.5	0.	0.	0.0	0.0	0.0
24	14.1	29100.3	0.0	3675.5	0.	0.	0.0	0.0	0.0
25	6.3	12482.0	0.0	427.5	0.	0.	0.0	0.0	0.0
26	7.6	14726.1	0.0	0.0	0.	0.	0.0	0.0	0.0
27	13.6	25191.0	0.0	0.0	0.	0.	0.0	0.0	0.0
28	13.3	22730.1	0.0	0.0	0.	0.	0.0	0.0	0.0
29	13.0	19814.4	0.0	0.0	0.	0.	0.0	0.0	0.0
30	12.6	16502.1	0.0	0.0	0.	0.	0.0	0.0	0.0
31	12.2	12858.1	0.0	0.0	0.	0.	0.0	0.0	0.0
32	0.1	66.4	0.0	0.0	0.	0.	0.0	0.0	0.0
33	11.7	8010.7	0.0	0.0	0.	0.	0.0	0.0	0.0
34	10.4	2360.0	0.0	0.0	0.	0.	0.0	0.0	0.0

Failure Surface Specified By 25 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	389.181	62.000
2	403.943	59.340
3	418.792	57.221
4	433.709	55.645
5	448.674	54.614

6	463.666	54.130
7	478.666	54.194
8	493.654	54.805
9	508.609	55.962
10	523.512	57.664
11	538.343	59.909
12	553.082	62.694
13	567.710	66.015
14	582.207	69.867
15	596.554	74.246
16	610.731	79.145
17	624.720	84.559
18	638.502	90.479
19	652.059	96.898
20	665.373	103.808
21	678.426	111.199
22	691.200	119.061
23	703.679	127.384
24	715.846	136.157
25	716.838	136.929

Circle Center At X = 469.426 ; Y = 465.082 ; and Radius = 410.992

Factor of Safety

*** 1.221 ***

Failure Surface Specified By 21 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	434.772	62.000
2	449.672	60.264
3	464.629	59.134
4	479.620	58.613
5	494.620	58.701
6	509.603	59.399
7	524.547	60.704
8	539.424	62.616
9	554.212	65.131
10	568.885	68.244
11	583.420	71.951
12	597.792	76.246
13	611.978	81.120
14	625.954	86.567
15	639.697	92.577
16	653.185	99.141
17	666.395	106.247
18	679.305	113.884
19	691.895	122.040
20	704.142	130.699
21	711.772	136.574

Circle Center At X = 484.947 ; Y = 427.715 ; and Radius = 369.141

Factor of Safety

*** 1.235 ***

Failure Surface Specified By 22 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	444.577	62.000
2	459.441	59.982
3	474.373	58.557
4	489.350	57.725
5	504.348	57.489
6	519.344	57.850
7	534.313	58.805
8	549.233	60.354
9	564.080	62.495
10	578.829	65.223
11	593.459	68.535
12	607.946	72.426
13	622.266	76.889

14	636.398	81.918
15	650.320	87.503
16	664.008	93.637
17	677.442	100.311
18	690.600	107.512
19	703.462	115.230
20	716.007	123.453
21	728.216	132.168
22	736.096	138.280

Circle Center At X = 502.803 ; Y = 434.667 ; and Radius = 377.188

Factor of Safety

*** 1.238 ***

Failure Surface Specified By 25 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	392.122	62.000
2	406.928	59.596
3	421.809	57.709
4	436.747	56.343
5	451.723	55.498
6	466.719	55.176
7	481.718	55.377
8	496.701	56.101
9	511.649	57.347
10	526.544	59.113
11	541.369	61.398
12	556.106	64.198
13	570.735	67.511
14	585.241	71.331
15	599.604	75.655
16	613.808	80.477
17	627.835	85.792
18	641.668	91.592
19	655.291	97.871
20	668.686	104.621
21	681.838	111.835
22	694.730	119.502
23	707.347	127.615
24	719.673	136.162
25	721.102	137.228

Circle Center At X = 468.454 ; Y = 485.295 ; and Radius = 430.122

Factor of Safety

*** 1.239 ***

Failure Surface Specified By 23 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	442.126	62.000
2	456.825	59.011
3	471.641	56.666
4	486.545	54.970
5	501.508	53.926
6	516.503	53.536
7	531.501	53.800
8	546.473	54.719
9	561.390	56.290
10	576.225	58.511
11	590.948	61.377
12	605.533	64.883
13	619.951	69.022
14	634.174	73.786
15	648.176	79.166
16	661.930	85.152
17	675.409	91.733
18	688.589	98.896
19	701.443	106.627
20	713.948	114.911

21	726.079	123.733
22	737.813	133.077
23	744.469	138.868

Circle Center At X = 517.941 ; Y = 397.185 ; and Radius = 343.652

Factor of Safety

*** 1.246 ***

Failure Surface Specified By 25 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	401.682	62.000
2	416.497	59.653
3	431.383	57.809
4	446.323	56.469
5	461.300	55.635
6	476.296	55.308
7	491.295	55.488
8	506.279	56.176
9	521.232	57.370
10	536.135	59.069
11	550.973	61.271
12	565.727	63.973
13	580.382	67.173
14	594.920	70.866
15	609.325	75.050
16	623.580	79.717
17	637.670	84.865
18	651.577	90.486
19	665.286	96.574
20	678.781	103.122
21	692.047	110.122
22	705.069	117.568
23	717.831	125.449
24	730.320	133.758
25	736.703	138.323

Circle Center At X = 478.463 ; Y = 498.785 ; and Radius = 443.482

Factor of Safety

*** 1.247 ***

Failure Surface Specified By 26 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	385.749	62.000
2	400.554	59.591
3	415.430	57.665
4	430.361	56.225
5	445.331	55.272
6	460.323	54.806
7	475.323	54.829
8	490.315	55.340
9	505.281	56.339
10	520.208	57.824
11	535.078	59.795
12	549.875	62.249
13	564.586	65.183
14	579.193	68.595
15	593.681	72.480
16	608.034	76.836
17	622.239	81.656
18	636.279	86.936
19	650.140	92.670
20	663.806	98.852
21	677.264	105.476
22	690.500	112.535
23	703.498	120.021
24	716.246	127.926
25	728.730	136.242
26	731.092	137.929

Circle Center At X = 467.129 ; Y = 515.178 ; and Radius = 460.427
Factor of Safety
*** 1.258 ***
Failure Surface Specified By 25 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	384.278	62.000
2	398.993	59.089
3	413.807	56.736
4	428.700	54.944
5	443.650	53.715
6	458.635	53.052
7	473.635	52.956
8	488.627	53.425
9	503.591	54.461
10	518.506	56.061
11	533.349	58.223
12	548.100	60.944
13	562.738	64.221
14	577.242	68.047
15	591.591	72.419
16	605.764	77.329
17	619.742	82.771
18	633.505	88.738
19	647.032	95.219
20	660.305	102.207
21	673.304	109.691
22	686.012	117.661
23	698.410	126.104
24	710.480	135.010
25	712.503	136.625

Circle Center At X = 468.693 ; Y = 450.064 ; and Radius = 397.139
Factor of Safety
*** 1.258 ***
Failure Surface Specified By 24 Coordinate Points

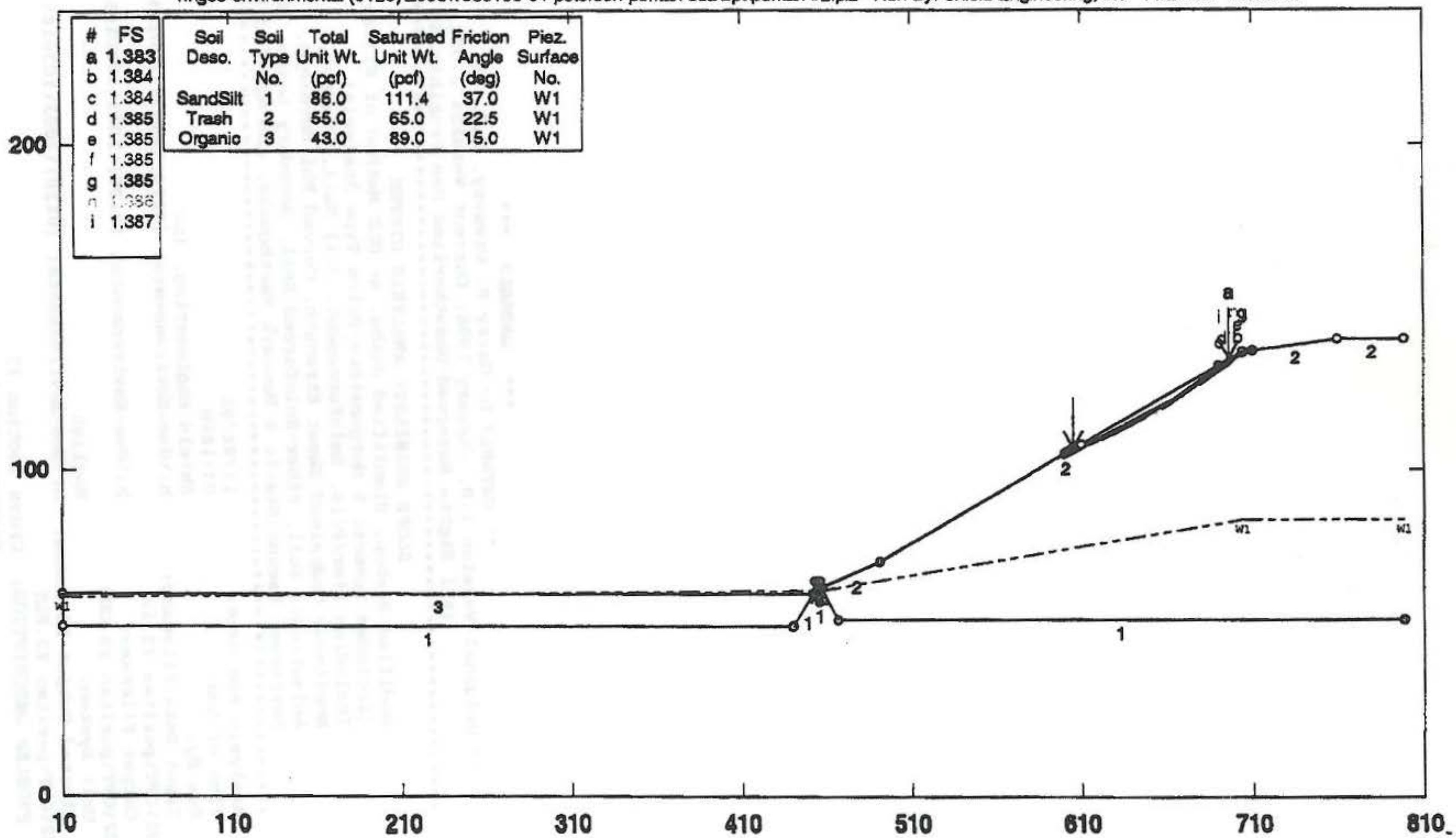
Point No.	X-Surf (ft)	Y-Surf (ft)
1	406.094	62.000
2	420.949	59.919
3	435.865	58.341
4	450.827	57.268
5	465.816	56.701
6	480.816	56.641
7	495.810	57.088
8	510.779	58.041
9	525.708	59.499
10	540.579	61.461
11	555.376	63.924
12	570.080	66.886
13	584.677	70.343
14	599.148	74.291
15	613.477	78.725
16	627.649	83.642
17	641.646	89.034
18	655.453	94.896
19	669.054	101.222
20	682.434	108.003
21	695.576	115.233
22	708.467	122.902
23	721.092	131.003
24	731.127	137.932

Circle Center At X = 475.104 ; Y = 500.232 ; and Radius = 443.632
Factor of Safety
*** 1.259 ***
**** END OF GSTABL7 OUTPUT ****

```
PROFIL  h:\Geo-Environmental (0120)\2003\1030105-01 Peterson-Puritan OU2\CPT\puritan #2.in V
Cross Section #2                                    Petterson/Puritan OU2
12 8
10. 62. 451.5 62. 3
451.5 62. 452.5 66. 3
452.5 66. 455.5 66. 3
455.5 66. 456.5 64. 1
456.5 64. 491. 72. 2
491. 72. 703.6 136. 2
703.6 136. 760.6 140. 2
760.6 140. 798.6 140. 2
456.6 64. 466. 54. 1
466. 54. 798.6 54. 1
10. 52. 440. 52. 1
440. 52. 451.5 62. 1
0. 0. 0.
SOIL  SandSiltTrash   Organic
3
85.96 111.43 0. 37. 0. 0. 1
55. 65. 0. 22.5 0. 0. 1
43. 89. 0. 15. 0. 0. 1
WATER
1 62.46
4 0.5
10. 61.
456.5 63.
703.6 85.
798.6 85.
CIRCL2
2000 1
210. 700. 710. 798.
10. 15. 0. 0.
```

Cross Section #2 Petterson/Puritan OU2

h:\geo-environmental (0120)\2003\1030105-01 peterson-puritan ou2\cpt\puritan #2.pl2 Run By: Shield Engineering, Inc 11/24/03 03:16PM



GSTABL7 v.2 FSmin=1.383

Safety Factors Are Calculated By The Modified Bishop Method

SHIELD ENGINEERING, INC

```
                         ***  GSTABL7  ***
                 ** GSTABL7 by Garry H. Gregory, P.E. **
    ** Original Version 1.0, January 1996; Current Version 2.004, June 2003 **
             (All Rights Reserved-Unauthorized Use Prohibited)
*********************************************************************************
                       SLOPE STABILITY ANALYSIS SYSTEM
        Modified Bishop, Simplified Janbu, or GLE Method of Slices.
        (Includes Spencer & Morgenstern-Price Type Analysis)
        Including Pier/Pile, Reinforcement, Soil Nail, Tieback,
        Nonlinear Undrained Shear Strength, Curved Phi Envelope,
        Anisotropic Soil, Fiber-Reinforced Soil, Boundary Loads, Water
        Surfaces, Pseudo-Static & Newmark Earthquake, and Applied Forces.
*********************************************************************************
   Analysis Run Date:        11/24/03
   Time of Run:              03:16PM
   Run By:                   Shield Engineering, Inc
   Input Data Filename:      h:\Geo-Environmental (0120)\2003\1030105-01 Peterson-Puritan
OU2\CPT\puritan #2.in
   Output Filename:          h:\Geo-Environmental (0120)\2003\1030105-01 Peterson-Puritan
OU2\CPT\puritan #2.OUT
   Unit System:              English
   Plotted Output Filename:  h:\Geo-Environmental (0120)\2003\1030105-01 Peterson-Puritan
OU2\CPT\puritan #2.PLT
   PROBLEM DESCRIPTION:    Cross Section #2
                           Petterson/Puritan OU2
   BOUNDARY COORDINATES
```

8 Top Boundaries
12 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	10.00	62.00	451.50	62.00	3
2	451.50	62.00	452.50	66.00	3
3	452.50	66.00	455.50	66.00	3
4	455.50	66.00	456.50	64.00	1
5	456.50	64.00	491.00	72.00	2
6	491.00	72.00	703.60	136.00	2
7	703.60	136.00	760.60	140.00	2
8	760.60	140.00	798.60	140.00	2
9	456.60	64.00	466.00	54.00	1
10	466.00	54.00	798.60	54.00	1
11	10.00	52.00	440.00	52.00	1
12	440.00	52.00	451.50	62.00	1

Default Y-Origin = 0.00(ft)
Default X-Plus Value = 0.00(ft)
Default Y-Plus Value = 0.00(ft)
ISOTROPIC SOIL PARAMETERS
3 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	86.0	111.4	0.0	37.0	0.00	0.0	1
2	55.0	65.0	0.0	22.5	0.00	0.0	1
3	43.0	89.0	0.0	15.0	0.00	0.0	1

1 PIEZOMETRIC SURFACE(S) SPECIFIED
Unit Weight of Water = 62.46 (pcf)
Piezometric Surface No. 1 Specified by 4 Coordinate Points
Pore Pressure Inclination Factor = 0.50

Point No.	X-Water (ft)	Y-Water (ft)
1	10.00	61.00
2	456.50	63.00
3	703.60	85.00
4	798.60	85.00

A Critical Failure Surface Searching Method, Using A Random Technique For Generating Circular Surfaces, Has Been Specified.
2000 Trial Surfaces Have Been Generated.
1 Surface(s) Initiate(s) From Each Of 2000 Points Equally Spaced
Along The Ground Surface Between X = 600.00(ft)
and X = 610.00(ft)
Each Surface Terminates Between X = 690.00(ft)
and X = 710.00(ft)
Unless Further Limitations Were Imposed, The Minimum Elevation
At Which A Surface Extends Is Y = 10.00(ft)
15.00(ft) Line Segments Define Each Trial Failure Surface.
Following Are Displayed The Ten Most Critical Of The Trial
Failure Surfaces Evaluated. They Are
Ordered - Most Critical First.
* * Safety Factors Are Calculated By The Modified Bishop Method * *
Total Number of Trial Surfaces Attempted = 2000
Number of Trial Surfaces With Valid FS = 2000
Statistical Data On All Valid FS Values:
FS Max = 2.774 FS Min = 1.383 FS Ave = 2.039
Standard Deviation = 0.437 Coefficient of Variation = 21.43 %
Failure Surface Specified By 8 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	605.510	106.472
2	620.204	109.490
3	634.787	113.000
4	649.244	116.999
5	663.559	121.482
6	677.714	126.443

7	691.695	131.878
8	695.939	133.694

Circle Center At X = 524.163 ; Y = 540.505 ; and Radius = 441.591

Factor of Safety

*** 1.383 ***

Individual data on the 7 slices

Slice No.	Width (ft)	Weight (lbs)	Water Force Top (lbs)	Water Force Bot (lbs)	Tie Force Norm (lbs)	Tie Force Tan (lbs)	Earthquake Force Hor (lbs)	Earthquake Force Ver (lbs)	Surcharge Load (lbs)
1	14.7	567.7	0.0	0.0	0.	0.	0.0	0.0	0.0
2	14.6	1479.6	0.0	0.0	0.	0.	0.0	0.0	0.0
3	14.5	1956.9	0.0	0.0	0.	0.	0.0	0.0	0.0
4	14.3	2008.4	0.0	0.0	0.	0.	0.0	0.0	0.0
5	14.2	1646.1	0.0	0.0	0.	0.	0.0	0.0	0.0
6	14.0	885.4	0.0	0.0	0.	0.	0.0	0.0	0.0
7	4.2	62.8	0.0	0.0	0.	0.	0.0	0.0	0.0

Failure Surface Specified By 8 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	603.178	105.770
2	617.893	108.681
3	632.502	112.082
4	646.991	115.966
5	661.342	120.331
6	675.539	125.170
7	689.568	130.480
8	700.741	135.139

Circle Center At X = 523.683 ; Y = 546.573 ; and Radius = 447.914

Factor of Safety

*** 1.384 ***

Failure Surface Specified By 8 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	602.517	105.571
2	617.228	108.504
3	631.820	111.980
4	646.273	115.994
5	660.567	120.541
6	674.683	125.614
7	688.601	131.206
8	690.532	132.066

Circle Center At X = 531.295 ; Y = 501.596 ; and Radius = 402.379

Factor of Safety

*** 1.384 ***

Failure Surface Specified By 8 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	605.045	106.331
2	619.775	109.166
3	634.378	112.591
4	648.832	116.603
5	663.112	121.194
6	677.196	126.357
7	691.059	132.084
8	691.942	132.490

Circle Center At X = 542.418 ; Y = 471.781 ; and Radius = 370.776

Factor of Safety

*** 1.385 ***

Failure Surface Specified By 8 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	608.683	107.427
2	623.417	110.240
3	638.035	113.606
4	652.515	117.520

```
   5        666.837      121.978
   6        680.982      126.972
   7        694.928      132.495
   8        701.347      135.322
Circle Center At X =   542.414 ; Y =   495.423 ; and Radius =   393.615
      Factor of Safety
     ***    1.385    ***
Failure Surface Specified By  8 Coordinate Points
  Point      X-Surf       Y-Surf
   No.        (ft)         (ft)
   1        608.258      107.299
   2        622.975      110.197
   3        637.589      113.580
   4        652.082      117.445
   5        666.440      121.788
   6        680.646      126.603
   7        694.685      131.886
   8        704.811      136.085
Circle Center At X =   528.888 ; Y =   549.839 ; and Radius =   449.602
      Factor of Safety
     ***    1.385    ***
Failure Surface Specified By  8 Coordinate Points
  Point      X-Surf       Y-Surf
   No.        (ft)         (ft)
   1        609.489      107.669
   2        624.224      110.475
   3        638.847      113.821
   4        653.336      117.702
   5        667.673      122.112
   6        681.838      127.047
   7        695.812      132.499
   8        703.952      136.025
Circle Center At X =   541.469 ; Y =   505.796 ; and Radius =   403.896
      Factor of Safety
     ***    1.385    ***
Failure Surface Specified By  8 Coordinate Points
  Point      X-Surf       Y-Surf
   No.        (ft)         (ft)
   1        602.472      105.557
   2        617.224      108.278
   3        631.861      111.557
   4        646.363      115.387
   5        660.710      119.765
   6        674.881      124.684
   7        688.855      130.136
   8        699.531      134.775
Circle Center At X =   538.676 ; Y =   493.298 ; and Radius =   392.954
      Factor of Safety
     ***    1.386    ***
Failure Surface Specified By  7 Coordinate Points
  Point      X-Surf       Y-Surf
   No.        (ft)         (ft)
   1        604.304      106.109
   2        619.051      108.851
   3        633.665      112.232
   4        648.118      116.246
   5        662.383      120.885
   6        676.432      126.140
   7        690.044      131.919
Circle Center At X =   548.681 ; Y =   446.255 ; and Radius =   344.665
      Factor of Safety
     ***    1.387    ***
Failure Surface Specified By  8 Coordinate Points
  Point      X-Surf       Y-Surf
   No.        (ft)         (ft)
   1        600.350      104.918
```

2	615.118	107.548
3	629.769	110.766
4	644.279	114.568
5	658.625	118.947
6	672.785	123.897
7	686.736	129.409
8	697.462	134.152

Circle Center At X = 542.569 ; Y = 472.776 ; and Radius = 372.368

Factor of Safety

*** 1.387 ***

**** END OF GSTABL7 OUTPUT ****

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PROFIL  h:\Geo-Environmental (0120)\2003\1030105-01 Peterson-Puritan OU2\CPT\puritan #2.in V
Cross Section #2                                Petterson/Puritan OU2
12 8
10. 62. 451.5 62. 3
451.5 62. 452.5 66. 3
452.5 66. 455.5 66. 3
455.5 66. 456.5 64. 1
456.5 64. 491. 72. 2
491. 72. 703.6 136. 2
703.6 136. 760.6 140. 2
760.6 140. 798.6 140. 2
456.6 64. 466. 54. 1
466. 54. 798.6 54. 1
10. 52. 440. 52. 1
440. 52. 451.5 62. 1
0. 0. 0.
SOIL  SandSiltTrash   Organic
3
85.96 111.43 0. 37..0. 0. 1
55. 65. 0. 22.5 0. 0. 1
43. 89. 0. 15. 0. 0. 1
WATER
1 62.46
4 0.5
10. 61.
456.5 63.
703.6 85.
798.6 85.
CIRCL2
2000 1
600. 610. 690. 710.
10. 15. 0. 0.
```