ENVIRONMENTAL
MANAGEMENT SERVICES, INC.

December 21, 2016

Mr. Brian Hocutt
Cooperative Energy
P.O. Box 15849
Hattiesburg, MS 39402

Re: CCR Units Unstable Areas Certification
R.D. Morrow, Sr. Generating Station
Purvis, Lamar County, Mississippi

Dear Mr. Hocutt:

Cooperative Energy (formerly South Mississippi Electric Power Association) retained Environmental Management Services, Inc. (EMS) to evaluate Cooperative Energy's compliance with the Federal Coal Combustion Residuals Rule (CCR Rule) requirements in accordance with 40 CFR 257.64 which states:

> *(a) An existing or new CCR landfill, existing or new CCR surface impoundment, or any lateral expansion of a CCR unit must not be located in an unstable area unless the owner or operator demonstrates by the dates specified in paragraph (d) of this section that recognized and generally accepted good engineering practices have been incorporated into the design of the CCR unit to ensure that the integrity of the structural components of the CCR unit will not be disrupted. The owner or operator must consider all of the following factors, at a minimum, when determining whether an area is unstable: (1) On-site or local soil conditions that may result in significant differential settling; (2) On-site or local geologic or geomorphologic features; and (3) On-site or local human-made features or events (both surface and subsurface).*

Cooperative Energy has two existing CCR surface impoundments including: 1) the Emergency Scrubber Surge Pond, and 2) the Scrubber Supply Pond. Cooperative Energy has an existing CCR landfill, but does not have a "new CCR landfill", nor does it currently have a lateral expansion of any CCR unit. Therefore, at this time, Cooperative Energy has two existing CCR surface impoundments and an existing CCR landfill that are subject to 40 CFR 257.64.

257.63 Unstable Areas

Unstable area means a location that is susceptible to natural or human-induced events or forces capable of impairing the integrity of some or all of the structural components responsible for preventing releases from a CCR unit. Natural unstable areas include those that have poor soils for foundations, areas susceptible to mass movements, and karst terrains.

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EMS has assessed each of the CCR units to determine whether the areas are unstable using the following criteria:

<u>1. Landfill</u>
(1) On-site or local soil conditions that may result in significant differential settling.
During the design and permitting of the landfill, EMS drilled soil borings and performed geotechnical tests on soil samples and CCR samples to assess the stability of the landfill, its subsoils, and any associated features. The results of these analyses indicate that the soil conditions are stable and should not cause excessive differential settling to the extent that the stability of the landfill or associated features will be compromised.

(2) On-site or local geologic or geomorphologic features.
An EMS Mississippi registered professional geologist has inspected the site, reviewed geological reports, reviewed boring logs, and reviewed topographic maps to evaluate local and geologic and geomorphic features that could cause the CCR unit to be unstable. No features were found that would cause the CCR unit to be unstable when operated as designed. The site is not located in a karst area.

(3) On-site or local human-made features or events (both surface and subsurface).
EMS reviewed the anthropogenic features and activities associated with the CCR unit with respect to cut and fill, drawdown of groundwater, and historic fills. No anthropogenic features were found that would adversely affect the stability of the CCR landfill when operated as designed.

<u>2. CCR Impoundments</u>
(1) On-site or local soil conditions that may result in significant differential settling.
EMS has drilled soil borings and collected soil samples around the CCR impoundments. EMS subsequently reviewed the soil conditions encountered in the boring logs and determined that soil conditions are stable and should not cause excessive differential settling to the extent that the stability of the CCR impoundments or associated features will be compromised.

(2) On-site or local geologic or geomorphologic features.
An EMS Mississippi registered professional geologist has inspected the site, reviewed geological reports, reviewed boring logs, and reviewed topographic maps to evaluate local and geologic and geomorphic features that could cause the CCR units to be unstable. No features were found that would cause the CCR unit to be unstable. The site is not located in a karst area.

(3) On-site or local human-made features or events (both surface and subsurface).
EMS reviewed the anthropogenic features and activities associated with the CCR unit with respect to cut and fill, drawdown of groundwater, and historic fills. No anthropogenic features were found that would adversely affect the stability of the CCR landfill.

Conclusions

Based upon the unstable areas criteria specified in 40 CFR Part 257.63(b), and specific data from investigations of the areas of the CCR units (see attachments), we conclude that the CCR landfill and the CCR impoundments are not located in unstable areas.

Engineer's Certification

I hereby certify, as a Professional Engineer in the State of Mississippi, that the information in this document was assembled under my direct personal charge and that this determination was conducted in accordance with and meets the requirements of 40 CFR Part 257.63(a).

Christopher Taylor Johnson, P.E.
Mississippi Professional Engineer No. 15761

Date: 12/21/2016

CHRISTOPHER T. JOHNSON
LICENSED PROFESSIONAL
ENGINEER
AND
SURVEYOR
12/21/2016
PE-15761
PS-3129
STATE OF MISSISSIPPI

Geologist's Certification

I have reviewed the portions of this report having to do with geology in sufficient depth to accept full responsibility for those contents.

Kenneth D. Ruckstuhl, RPG
MS Professional Geologist No. 0090

Date: 12/21/2016

REGISTERED PROFESSIONAL GEOLOGIST
MS
0090
KENNETH D. RUCKSTUHL

Attachments: Slope Stability Calculations (from Landfill Permit Application)
Waste Ash Characterization (from Landfill Permit Application)

File: Unstable Areas

Attachments

ATTACHMENT C

Slope Stability Calculations

Objective: Determine a factor of safety for the slope stability on the final cover of the landfill at 4H:1V slopes.

(a) Circular arc (similar to bearing capacity)

(b) Block failure at the clay liner/HDPE interface

Methodology: Take a section from a depth of 5 feet and floor slope of one percent, and determine the strength and density properties from all borings. A factor of safety ~ 1.5 will control stack height

Assumptions:
(1) Excavation will be at 3H:1V.
(2) Section of the area to be taken from is shown on page 2.
(3) Levee will be made to Elev. 233.5' at 4H:1V with a width of 15'. Soil properties of levee are the same as the near surface clays.
(4) Final slopes will be made at 4H:1V to 100' above the levee and 10% above the 4H:1V slopes.
(5) Ignore the cover soils and liners and assume the whole area is waste (conservative).
(6) The base liner will be:

Material	γ_t (pcf)	c (psf)	ϕ (deg)
2' LCS (Sand)	120	0	32
*HDPE/GCL	100	85	12
^GCL/Natural Soil	100	500	17

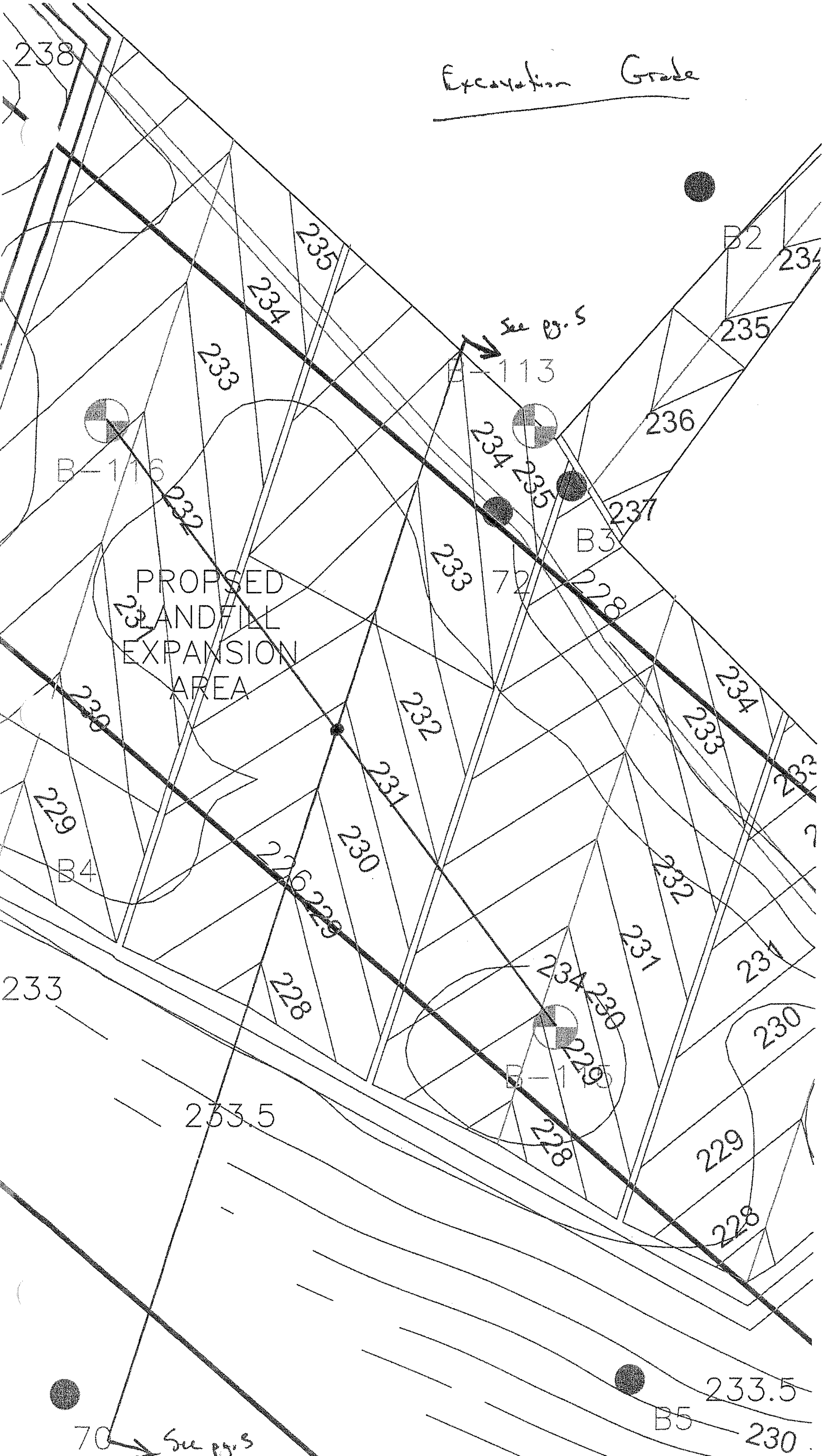
* - for the interface developed from published research (U. of Texas)

^ - for the interface developed from published research (Geosyntec)

(7) Waste Properties - γ_t = 100 pcf, ϕ = 30°. (See Appendix A)
(8) Pages 3 and 4 show densities and soil strengths of the natural soils.
(9) Stratum III sand has an average blow count of 26, give γ = 115 pcf & ϕ = 34°.
(10) The following table presents the properties and materials of the layers.
(11) Page 5 shows the 2-D profile of the analyzed section.

Layer	γ_t (pcf)	c (psf)	ϕ (deg)	Description
1	100	0	30	Waste
2	130	2,000	0	Stratum II Clay and Levee
3	115	0	34	Stratum III Sands
4	130	1,600	0	Stratum IV Clays
5	120	0	32	Leachate Collection Sand (LCS)
6	100	85	12	HDPE/GCL Interface
7	100	500	17	GCL/Natural Soil Interface

Excavation Grade



1" ~ 100'

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TABLE 3
STATISTICAL SOIL STRATA RESULTS
SMEPA

Stratum No.	I	II	III	IV
	Silty Sand/Silt	Silty/Sandy Clay	Silty Sand/Sand	Clay/Silty Clay
Moisture Content (%)				
Number of Tests	2	15	13	22
Average	14.1	18.6	17.4	23.2
Maximum	18.1	25.4	22.5	29.2
Minimum	10.0	13.6	13.6	18.0
Standard Deviation	5.7	3.0	3.1	3.5
Liquid Limit				
Number of Tests	1	14	0	13
Average	23	32	n/a	53
Maximum	23	45	n/a	74
Minimum	23	21	n/a	27
Standard Deviation	n/a	7.1	n/a	13.5
Plastic Limit				
Number of Tests	1	14	0	13
Average	16	16	n/a	20
Maximum	16	21	n/a	25
Minimum	16	13	n/a	15
Standard Deviation	n/a	2.5	n/a	3.1
Plasticity Index				
Number of Tests	1	14	0	13
Average	7	16	n/a	33
Maximum	7	27	n/a	49
Minimum	7	7	n/a	10
Standard Deviation	n/a	5.9	n/a	11.1
Wet Density (pcf)				
Number of Tests	0	5	0	7
Average	n/a	131.4	n/a	128.6
Maximum	n/a	137.5	n/a	138.5
Minimum	n/a	129.2	n/a	123.1
Standard Deviation	n/a	3.5	n/a	5.2
Dry Density (pcf)				
Number of Tests	0	5	0	7
Average	n/a	110.6	n/a	105.3
Maximum	n/a	119.1	n/a	115.4
Minimum	n/a	107.9	n/a	97.4
Standard Deviation	n/a	4.8	n/a	6.6
Shear Strength (ksf)				
Number of Tests	0	5	0	5
Average	n/a	2.01	n/a	1.63
Maximum	n/a	2.79	n/a	3.52
Minimum	n/a	1.34	n/a	0.64
Standard Deviation	n/a	0.63	n/a	1.22

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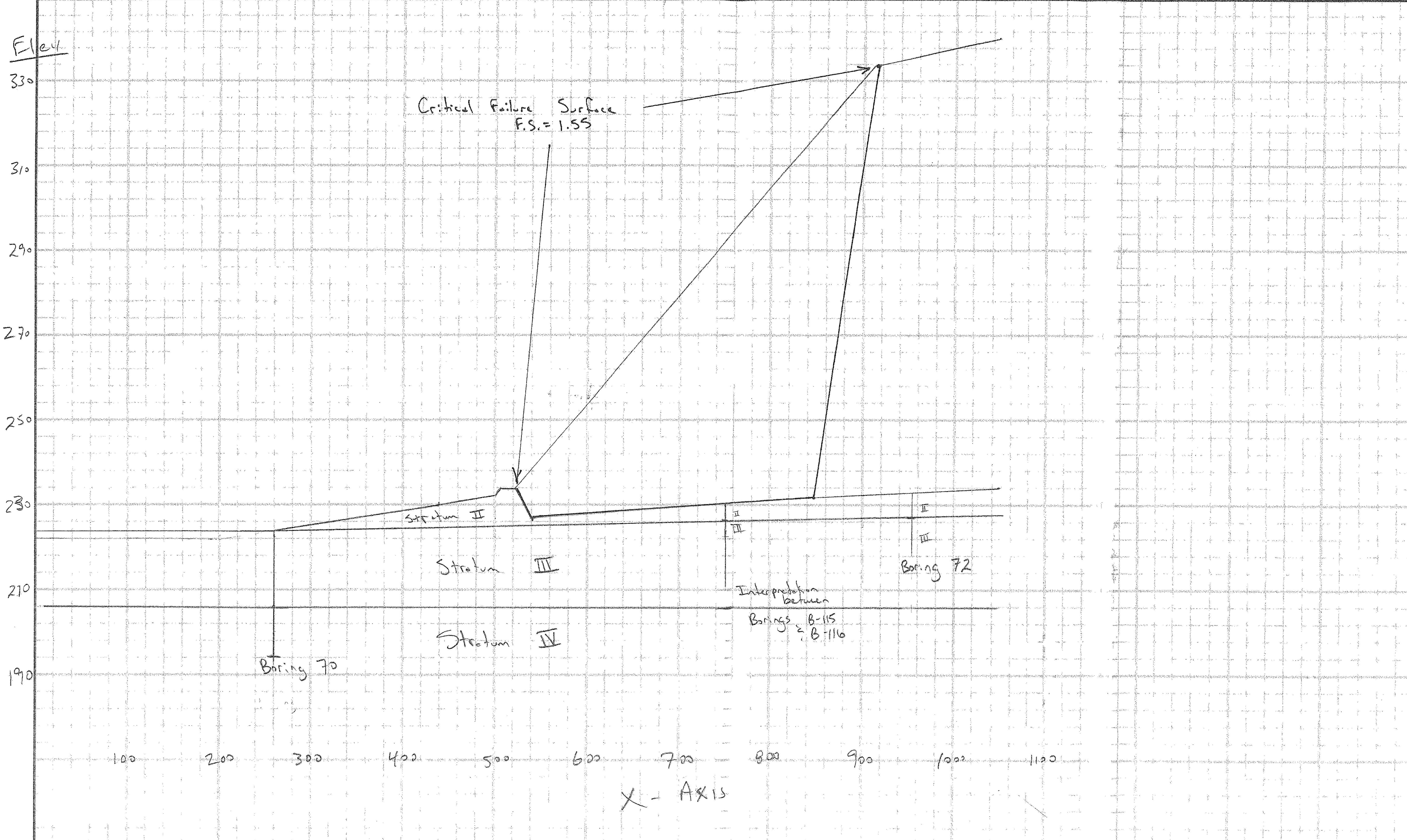
Calculations For: SMEPA Landfill	Made By: KL	Date: 1/28/03	Sheet No.: 5 of 23
Subject: Slope Stability	Checked By:	Date:	Job No.: SMEPA



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MANAGEMENT SERVICES, INC.

TABLE 3
STATISTICAL SOIL STRATA RESULTS
SMEPA

Stratum No.	I	II	III	IV
	Silty Sand/Silt	Silty/Sandy Clay	Silty Sand/Sand	Clay/Silty Clay
Percent Sand (%)				
Number of Tests	1	5	13	3
Average	62.8	28.3	81.9	22.1
Maximum	62.8	53.3	99.8	48.7
Minimum	62.8	5.5	66.3	5.9
Standard Deviation	n/a	17.6	10.4	23.2
SPT (blows per foot)				
Number of Tests	4	11	14	4
Average	10	20	26	17
Maximum	18	34	50	30
Minimum	4	6	4	9
Std. Deviation	6.0	11.0	13.9	9.7
Permeability, (cm/s)				
Number of Tests	2	5	1	1
Average	2.2E-06	1.2E-06	2.0E-04	2.9E-08
Lognormal Average	2.0E-06	4.5E-07	2.0E-04	2.9E-08
Maximum	3.2E-06	3.4E-06	2.0E-04	2.9E-08
Minimum	1.2E-06	2.4E-08	2.0E-04	2.9E-08
Standard Deviation	1.4E-06	1.4E-06	n/a	n/a

Notes:
n/a - not applicable
Permeability results are a combination of laboratory and field permeability testing.
The information provided on this table is general and specific conditons can be found on the soil boring logs in Appendix D and the Geotechnical Laboratory Results in Appendix E.

Calculations For: SMEPA Landfill	Made By: KL	Date: 1/28/03	Sheet No.: 6 of 23
Subject: Slope Stability	Checked By:	Date:	Job No.: SMEPA

Analysis:

CIRCULAR ARC ANALYSES

Circular arc will bottom out at the top of the Stratum III sand

Input		Output		FS	Output Pages
$X_{initiation}$	$X_{termination}$	$X_{initiation}$	$X_{termination}$		
500 - 550	850 - 900	538.39	895.45	2.23	
550 - 600	**850 - 900**	**577.78**	**876.94**	**2.23**	**7 - 15**
550 - 600	900 - 950	600	911.11	2.24	

Analysis:

BLOCK ANALYSES

Block Failure will be analyzed along the HDPE/clay liner interface - the weakest block plane

Typically Blocks 1, 2 and 3 are fixed and block 4 is varied until a minimum FS is reached

Block	Input		Output		FS	Output Pages
	X	Y	X	Y		
1	521.7	233.5	521.7	233.5		
2	239.7	227.7	539.7	227.7		
3	833.5	232.1	833.5	232.1		
4	900 - 930	232.765 - 233.065	904.68	232.8	1.70	
4	**840 - 870**	**232.265 - 232.765**	**846.36**	**232.2**	**1.56**	**16 - 23**
3	800 - 833.5	231.59 - 232.1	832.38	232.05	1.56	

Recommendations: The failure along the HDPE/GCL is the most critical failure surface (Block analysis). This analyses shows that a factor of safety greater then 1.5 will be achieved; therefore, a stack height of 100' on a 4H:1V slope will be safe.

** PCSTABL5M **

by
Purdue University

1

--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer`s Method of Slices

Run Date: 1/28/03
Time of Run: 13:05
Run By: KL
Input Data Filename: smepa1.in
Output Filename: smepa1y.out

PROBLEM DESCRIPTION SMEPA Closed Case Subsurface Soil Failur
e (Cicular Arc)

BOUNDARY COORDINATES

6 Top Boundaries
23 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	.00	224.00	260.00	224.00	3
2	260.00	224.00	500.00	232.00	2
3	500.00	232.00	506.50	233.50	2
4	506.50	233.50	521.50	233.50	2
5	521.50	233.50	906.50	333.50	1
6	906.50	333.50	1043.50	340.50	1
7	521.70	233.50	528.50	233.50	5
8	528.50	233.50	540.50	229.70	5
9	540.50	229.70	833.50	234.10	5
10	833.50	234.10	1043.50	236.20	5
11	521.70	233.50	539.70	227.70	6
12	539.70	227.70	833.50	232.10	6
13	833.50	232.10	1043.50	234.20	6
14	521.60	233.50	539.60	227.60	7
15	539.60	227.60	833.50	232.00	7
16	833.50	232.00	1043.50	234.10	7
17	521.50	233.50	539.50	227.50	2
18	539.50	227.50	833.50	231.90	2
19	833.50	231.90	1043.50	234.00	2
20	260.00	224.00	749.50	226.65	3
21	749.50	226.65	953.50	227.10	3
22	953.50	227.10	1043.50	227.30	3
23	.00	206.00	1043.50	206.00	4

ISOTROPIC SOIL PARAMETERS

7 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	100.0	100.0	.0	30.0	.00	.0	1
2	130.0	130.0	2000.0	.0	.00	.0	1
3	115.0	115.0	.0	34.0	.00	.0	1
4	130.0	130.0	1600.0	.0	.00	.0	1
5	120.0	120.0	.0	32.0	.00	.0	1
6	100.0	100.0	85.0	12.0	.00	.0	1
7	100.0	100.0	500.0	17.0	.00	.0	1

1

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

Unit Weight of Water = 62.40

Piezometric Surface No. 1 Specified by 5 Coordinate Points

Point No.	X-Water (ft)	Y-Water (ft)
1	.00	223.00
2	215.00	224.00
3	630.00	226.00
4	960.00	228.00
5	1043.50	228.50

1

A Critical Failure Surface Searching Method, Using A Random Technique For Generating Circular Surfaces, Has Been Specified.

200 Trial Surfaces Have Been Generated.

20 Surfaces Initiate From Each Of 10 Points Equally Spaced Along The Ground Surface Between X = 550.00 ft.
and X = 600.00 ft.

Each Surface Terminates Between X = 850.00 ft.
and X = 900.00 ft.

Unless Further Limitations Were Imposed, The Minimum Elevation At Which A Surface Extends Is Y =226.00 ft.

15.00 ft. Line Segments Define Each Trial Failure Surface.

Restrictions Have Been Imposed Upon The Angle Of Initiation. The Angle Has Been Restricted Between The Angles Of -35.0 And 10.0 deg.

Following Are Displayed The Ten Most Critical Of The Trial Failure Surfaces Examined. They Are Ordered - Most Critical First.

* * Safety Factors Are Calculated By The Modified Bishop Method * *

Failure Surface Specified By 22 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	577.78	248.12
2	592.56	250.68
3	607.32	253.36
4	622.05	256.16
5	636.76	259.10
6	651.45	262.15
7	666.11	265.33
8	680.74	268.63
9	695.34	272.05
10	709.92	275.60
11	724.46	279.27
12	738.97	283.07
13	753.45	286.98
14	767.90	291.02
15	782.31	295.18
16	796.69	299.46
17	811.03	303.86
18	825.33	308.38
19	839.60	313.02
20	853.82	317.78
21	868.00	322.66
22	876.94	325.82

Circle Center At X = 282.0 ; Y = 2001.7 and Radius, 1778.4

*** 2.230 ***

Individual data on the 21 slices

Slice No.	Width Ft(m)	Weight Lbs(kg)	Water Force Top Lbs(kg)	Water Force Bot Lbs(kg)	Tie Force Norm Lbs(kg)	Tie Force Tan Lbs(kg)	Earthquake Force Hor Lbs(kg)	Earthquake Force Ver Lbs(kg)	Surcharge Load Lbs(kg)
1	14.8	946.7	.0	.0	.0	.0	.0	.0	.0
2	14.8	2739.8	.0	.0	.0	.0	.0	.0	.0
3	14.7	4335.3	.0	.0	.0	.0	.0	.0	.0
4	14.7	5733.6	.0	.0	.0	.0	.0	.0	.0
5	14.7	6935.4	.0	.0	.0	.0	.0	.0	.0
6	14.7	7941.4	.0	.0	.0	.0	.0	.0	.0
7	14.6	8752.0	.0	.0	.0	.0	.0	.0	.0
8	14.6	9368.5	.0	.0	.0	.0	.0	.0	.0
9	14.6	9791.3	.0	.0	.0	.0	.0	.0	.0
10	14.5	10021.9	.0	.0	.0	.0	.0	.0	.0
11	14.5	10061.1	.0	.0	.0	.0	.0	.0	.0
12	14.5	9910.4	.0	.0	.0	.0	.0	.0	.0
13	14.4	9570.7	.0	.0	.0	.0	.0	.0	.0
14	14.4	9043.9	.0	.0	.0	.0	.0	.0	.0
15	14.4	8331.1	.0	.0	.0	.0	.0	.0	.0
16	14.3	7434.1	.0	.0	.0	.0	.0	.0	.0
17	14.3	6354.5	.0	.0	.0	.0	.0	.0	.0
18	14.3	5094.1	.0	.0	.0	.0	.0	.0	.0
19	14.2	3654.8	.0	.0	.0	.0	.0	.0	.0
20	14.2	2038.5	.0	.0	.0	.0	.0	.0	.0
21	8.9	374.6	.0	.0	.0	.0	.0	.0	.0

Failure Surface Specified By 23 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	555.56	242.35
2	570.35	244.84
3	585.12	247.46
4	599.86	250.21
5	614.58	253.09
6	629.28	256.09
7	643.95	259.22
8	658.59	262.48
9	673.21	265.86
10	687.79	269.36
11	702.34	273.00
12	716.87	276.75
13	731.36	280.63
14	745.81	284.64
15	760.23	288.77
16	774.62	293.02
17	788.96	297.40
18	803.27	301.90
19	817.54	306.52
20	831.77	311.26
21	845.96	316.13
22	860.11	321.12
23	863.31	322.28

Circle Center At X = 272.6 ; Y = 1964.6 and Radius, 1745.3

*** 2.230 ***

Failure Surface Specified By 22 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	600.00	253.89
2	614.81	256.27
3	629.60	258.79
4	644.36	261.46
5	659.09	264.27
6	673.80	267.23
7	688.47	270.33
8	703.12	273.57
9	717.73	276.96
10	732.31	280.49
11	746.85	284.17
12	761.36	287.99
13	775.83	291.95
14	790.25	296.05
15	804.64	300.29
16	818.99	304.67
17	833.29	309.20
18	847.54	313.86
19	861.75	318.67
20	875.92	323.61
21	890.03	328.69
22	894.76	330.45

Circle Center At X = 365.5 ; Y = 1762.4 and Radius, 1526.6

*** 2.232 ***

Failure Surface Specified By 22 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	588.89	251.00
2	603.71	253.33
3	618.50	255.80
4	633.27	258.42
5	648.01	261.20
6	662.72	264.13
7	677.41	267.20
8	692.05	270.43
9	706.67	273.81
10	721.25	277.34
11	735.79	281.02
12	750.29	284.84
13	764.76	288.82
14	779.18	292.94
15	793.56	297.21
16	807.89	301.63
17	822.18	306.19
18	836.42	310.91
19	850.61	315.76

20	864.76	320.77
21	878.84	325.91
22	882.30	327.21

Circle Center At X = 370.2 ; Y = 1695.7 and Radius, 1461.2

*** 2.233 ***

Failure Surface Specified By 26 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	550.00	240.90
2	564.82	243.20
3	579.63	245.62
4	594.41	248.17
5	609.17	250.85
6	623.90	253.66
7	638.61	256.60
8	653.29	259.67
9	667.95	262.87
10	682.58	266.19
11	697.17	269.64
12	711.74	273.22
13	726.27	276.93
14	740.78	280.76
15	755.24	284.72
16	769.68	288.81
17	784.07	293.02
18	798.43	297.36
19	812.75	301.83
20	827.03	306.42
21	841.27	311.13
22	855.47	315.97
23	869.63	320.93
24	883.74	326.02
25	897.80	331.23
26	897.89	331.26

Circle Center At X = 295.3 ; Y = 1936.4 and Radius, 1714.5

*** 2.233 ***

Failure Surface Specified By 24 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	566.67	245.23
2	581.50	247.46
3	596.31	249.83

4	611.10	252.34
5	625.86	255.00
6	640.60	257.80
7	655.31	260.75
8	669.99	263.83
9	684.63	267.06
10	699.25	270.44
11	713.83	273.95
12	728.38	277.61
13	742.89	281.40
14	757.37	285.34
15	771.80	289.42
16	786.19	293.64
17	800.55	298.00
18	814.86	302.50
19	829.12	307.14
20	843.34	311.91
21	857.51	316.83
22	871.64	321.88
23	885.71	327.07
24	894.32	330.34

Circle Center At X = 345.5 ; Y = 1770.0 and Radius, 1540.7

*** 2.234 ***

Failure Surface Specified By 22 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	588.89	251.00
2	603.72	253.24
3	618.53	255.62
4	633.31	258.17
5	648.07	260.87
6	662.79	263.72
7	677.49	266.73
8	692.15	269.90
9	706.78	273.21
10	721.37	276.69
11	735.93	280.31
12	750.44	284.09
13	764.92	288.03
14	779.35	292.11
15	793.74	296.35
16	808.09	300.74
17	822.38	305.28
18	836.63	309.96
19	850.83	314.80
20	864.97	319.79
21	879.07	324.93
22	891.42	329.58

Circle Center At X = 384.7 ; Y = 1658.8 and Radius, 1422.5

*** 2.234 ***

Failure Surface Specified By 22 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	555.56	242.35
2	570.40	244.47
3	585.23	246.77
4	600.02	249.24
5	614.79	251.87
6	629.52	254.68
7	644.23	257.66
8	658.89	260.81
9	673.52	264.12
10	688.11	267.61
11	702.66	271.26
12	717.16	275.08
13	731.63	279.07
14	746.04	283.22
15	760.40	287.54
16	774.72	292.02
17	788.98	296.67
18	803.18	301.49
19	817.33	306.46
20	831.43	311.60
21	845.46	316.91
22	851.07	319.10

Circle Center At X = 379.0 ; Y = 1529.5 and Radius, 1299.2

*** 2.236 ***

Failure Surface Specified By 21 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	577.78	248.12
2	592.63	250.24
3	607.45	252.54
4	622.24	255.02
5	637.00	257.69
6	651.73	260.54
7	666.42	263.56
8	681.08	266.77

9	695.69	270.16
10	710.26	273.72
11	724.78	277.47
12	739.26	281.39
13	753.69	285.49
14	768.07	289.77
15	782.39	294.22
16	796.66	298.85
17	810.87	303.65
18	825.02	308.63
19	839.11	313.78
20	853.13	319.11
21	857.11	320.67

Circle Center At X = 412.5 ; Y = 1458.6 and Radius, 1221.7

*** 2.236 ***

Failure Surface Specified By 23 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	561.11	243.79
2	575.97	245.82
3	590.81	248.02
4	605.62	250.40
5	620.40	252.95
6	635.16	255.66
7	649.87	258.55
8	664.56	261.61
9	679.21	264.84
10	693.82	268.24
11	708.39	271.81
12	722.91	275.55
13	737.39	279.46
14	751.83	283.53
15	766.22	287.77
16	780.56	292.18
17	794.84	296.76
18	809.07	301.50
19	823.25	306.40
20	837.37	311.47
21	851.42	316.70
22	865.42	322.10
23	870.69	324.20

Circle Center At X = 393.5 ; Y = 1525.4 and Radius, 1292.5

*** 2.237 ***

** PCSTABL5M **

by
Purdue University

1

--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer`s Method of Slices

Run Date: 1/28/03
Time of Run: 12:27
Run By: KL
Input Data Filename: smepa2.in
Output Filename: smepa2z.out

PROBLEM DESCRIPTION SMEPA Closed Case Subsurface Soil Failur
e (Failure along HDPE/GCL)

BOUNDARY COORDINATES

6 Top Boundaries
23 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	.00	224.00	260.00	224.00	3
2	260.00	224.00	500.00	232.00	2
3	500.00	232.00	506.50	233.50	2
4	506.50	233.50	521.50	233.50	2
5	521.50	233.50	906.50	333.50	1
6	906.50	333.50	1043.50	340.50	1
7	521.70	233.50	528.00	233.50	5
8	528.00	233.50	539.40	229.70	5
9	539.40	229.70	833.50	234.10	5
10	833.50	234.10	1043.50	236.20	5
11	521.70	233.50	539.10	227.70	6
12	539.10	227.70	833.50	232.10	6
13	833.50	232.10	1043.50	234.20	6
14	521.60	233.50	539.30	227.60	7
15	539.30	227.60	833.50	232.00	7
16	833.50	232.00	1043.50	234.10	7
17	521.50	233.50	539.50	227.50	2
18	539.50	227.50	833.50	231.90	2
19	833.50	231.90	1043.50	234.00	2
20	260.00	224.00	749.50	226.65	3
21	749.50	226.65	953.50	227.10	3
22	953.50	227.10	1043.50	227.30	3
23	.00	206.00	1043.50	206.00	4

1

ISOTROPIC SOIL PARAMETERS

7 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	100.0	100.0	.0	30.0	.00	.0	1
2	130.0	130.0	2000.0	.0	.00	.0	1
3	115.0	115.0	.0	34.0	.00	.0	1
4	130.0	130.0	1600.0	.0	.00	.0	1
5	120.0	120.0	.0	32.0	.00	.0	1
6	100.0	100.0	85.0	12.0	.00	.0	1
7	100.0	100.0	500.0	17.0	.00	.0	1

1

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

Unit Weight of Water = 62.40

Piezometric Surface No. 1 Specified by 5 Coordinate Points

Point No.	X-Water (ft)	Y-Water (ft)
1	.00	223.00
2	215.00	224.00
3	630.00	226.00
4	960.00	228.00
5	1043.50	228.50

1

A Critical Failure Surface Searching Method, Using A Random Technique For Generating Sliding Block Surfaces, Has Been Specified.

100 Trial Surfaces Have Been Generated.

4 Boxes Specified For Generation Of Central Block Base

Length Of Line Segments For Active And Passive Portions Of Sliding Block Is 10.0

Box No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Height (ft)
1	521.70	233.50	521.70	233.50	.00
2	539.10	227.70	539.10	227.70	.00
3	833.50	232.10	833.50	232.10	.10
4	840.00	232.17	870.00	232.46	.05

1

Following Are Displayed The Ten Most Critical Of The Trial Failure Surfaces Examined. They Are Ordered - Most Critical First.

* * Safety Factors Are Calculated By The Modified Janbu Method * *

Failure Surface Specified By 18 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	521.64	233.54
2	521.70	233.50
3	539.10	227.70
4	833.50	232.09
5	846.36	232.20
6	850.40	241.35
7	855.91	249.70
8	862.94	256.81
9	869.53	264.33
10	873.62	273.45
11	880.68	280.53
12	884.63	289.72
13	889.49	298.46
14	896.51	305.58
15	901.70	314.13
16	906.48	322.92
17	913.17	330.34
18	914.75	333.92

*** 1.558 ***

Individual data on the 22 slices

Slice No.	Width Ft(m)	Weight Lbs(kg)	Water Force Top Lbs(kg)	Water Force Bot Lbs(kg)	Tie Force Norm Lbs(kg)	Tie Force Tan Lbs(kg)	Earthquake Force Hor Lbs(kg)	Earthquake Force Ver Lbs(kg)	Surcharge Load Lbs(kg)
1	.1	.2	.0	.0	.0	.0	.0	.0	.0
2	6.3	1342.0	.0	.0	.0	.0	.0	.0	.0
3	11.1	8324.8	.0	.0	.0	.0	.0	.0	.0
4	.3	324.6	.0	.0	.0	.0	.0	.0	.0
5	294.1	********	.0	.0	.0	.0	.0	.0	.0
6	12.9	108582.4	.0	.0	.0	.0	.0	.0	.0
7	.0	92.5	.0	.0	.0	.0	.0	.0	.0
8	.9	7553.0	.0	.0	.0	.0	.0	.0	.0
9	3.1	25404.1	.0	.0	.0	.0	.0	.0	.0
10	5.5	40800.2	.0	.0	.0	.0	.0	.0	.0
11	7.0	47835.1	.0	.0	.0	.0	.0	.0	.0
12	6.6	41152.4	.0	.0	.0	.0	.0	.0	.0
13	4.1	22739.0	.0	.0	.0	.0	.0	.0	.0
14	7.1	34526.6	.0	.0	.0	.0	.0	.0	.0
15	3.9	16638.3	.0	.0	.0	.0	.0	.0	.0
16	4.9	16717.4	.0	.0	.0	.0	.0	.0	.0
17	7.0	19632.5	.0	.0	.0	.0	.0	.0	.0
18	5.2	11270.8	.0	.0	.0	.0	.0	.0	.0
19	4.8	6857.8	.0	.0	.0	.0	.0	.0	.0
20	.0	21.5	.0	.0	.0	.0	.0	.0	.0
21	6.7	4691.1	.0	.0	.0	.0	.0	.0	.0
22	1.6	275.9	.0	.0	.0	.0	.0	.0	.0

Failure Surface Specified By 18 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	521.66	233.54
2	521.70	233.50
3	539.10	227.70
4	833.50	232.10
5	867.49	232.42
6	872.09	241.29
7	878.42	249.03
8	883.28	257.77
9	889.45	265.64
10	896.52	272.72
11	902.90	280.42
12	906.00	289.92
13	912.88	297.18
14	918.91	305.16
15	923.49	314.05
16	930.00	321.64
17	936.95	328.83
18	940.92	335.26

*** 1.571 ***

Failure Surface Specified By 18 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	521.65	233.54
2	521.70	233.50
3	539.10	227.70
4	833.50	232.06
5	864.62	232.40
6	871.62	239.54
7	878.63	246.68
8	885.70	253.75
9	892.51	261.07
10	899.37	268.35
11	904.88	276.69
12	909.33	285.65
13	914.36	294.29
14	921.40	301.39
15	924.62	310.86
16	925.39	320.83
17	932.30	328.05
18	937.01	335.06

*** 1.575 ***

Failure Surface Specified By 18 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	521.62	233.53
2	521.70	233.50
3	539.10	227.70
4	833.50	232.07
5	853.85	232.29
6	860.92	239.36
7	867.15	247.18
8	873.98	254.49
9	880.94	261.66
10	887.86	268.88
11	893.62	277.05
12	894.27	287.03
13	899.15	295.76
14	905.09	303.80
15	910.79	312.03
16	917.65	319.30
17	919.88	329.05
18	923.00	334.34

*** 1.598 ***

Failure Surface Specified By 17 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	521.59	233.52
2	521.70	233.50
3	539.10	227.70
4	833.50	232.06
5	843.92	232.21
6	850.08	240.08
7	856.80	247.49
8	860.68	256.71
9	865.67	265.37
10	872.15	272.99
11	875.02	282.57
12	877.29	292.31
13	882.01	301.13
14	886.75	309.93
15	892.26	318.27
16	896.00	327.55
17	897.57	331.18

*** 1.606 ***

Failure Surface Specified By 18 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	521.63	233.53
2	521.70	233.50
3	539.10	227.70
4	833.50	232.09
5	868.14	232.45
6	870.64	242.13
7	877.65	249.26
8	881.99	258.27
9	888.14	266.15
10	894.77	273.65
11	901.02	281.45
12	905.26	290.51
13	909.83	299.40
14	915.16	307.86
15	920.68	316.20
16	927.05	323.91
17	934.07	331.03
18	937.47	335.08

*** 1.607 ***

Failure Surface Specified By 18 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	521.66	233.54
2	521.70	233.50
3	539.10	227.70
4	833.50	232.07
5	868.72	232.45
6	872.87	241.54
7	879.93	248.63
8	885.66	256.82
9	892.00	264.55
10	894.03	274.35
11	900.88	281.63
12	904.96	290.76
13	910.15	299.31
14	915.49	307.76
15	922.46	314.94
16	925.81	324.36
17	931.82	332.35
18	933.70	334.89

*** 1.610 ***

Failure Surface Specified By 17 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	521.66	233.54
2	521.70	233.50
3	539.10	227.70
4	833.50	232.09
5	840.43	232.17
6	846.46	240.15
7	849.54	249.67
8	854.74	258.21
9	861.81	265.28
10	868.36	272.84
11	875.19	280.14
12	878.35	289.63
13	883.43	298.24
14	886.30	307.82
15	893.35	314.92
16	893.80	324.91
17	898.84	331.51

*** 1.622 ***

Failure Surface Specified By 18 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	521.64	233.54
2	521.70	233.50
3	539.10	227.70
4	833.50	232.08
5	850.46	232.26
6	857.46	239.40
7	864.28	246.72
8	867.10	256.31
9	873.85	263.69
10	875.60	273.53
11	881.87	281.32
12	885.67	290.58
13	892.70	297.68
14	898.93	305.51
15	903.94	314.16
16	907.49	323.51
17	909.82	333.23
18	910.19	333.69

*** 1.622 ***

Failure Surface Specified By 18 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	521.65	233.54
2	521.70	233.50
3	539.10	227.70
4	833.50	232.05
5	865.36	232.43
6	870.72	240.87
7	876.84	248.78
8	881.99	257.35
9	889.03	264.46
10	893.46	273.42
11	899.67	281.26
12	905.87	289.10
13	912.93	296.18
14	919.92	303.34
15	925.25	311.80
16	926.07	321.77
17	933.12	328.86
18	935.67	334.99

*** 1.623 ***

APPENDIX A

Waste Ash Characterization

ENVIRONMENTAL MANAGEMENT SERVICES, INC.

Calculations For:	SMEPA Landfill	Made By:	KL	Date:	1/23/03	Sheet No.:	1 of 15
Subject:	Waste Ash Characterization	Checked By:		Date:		Job No.:	SMEPA

Objective : Determine the characteristics of the waste ash for design.

Approach: Geotechnical laboratory testing of both waste streams, "Fly Ash" and "Bottom Ash", were performed. Testing included unconsolidated, undrained (UU) triaxial testing at confining pressures of 5 and 15 psi, consolidated, undrained (CU) triaxial testing, consolidated, drained (CD) triaxial testing and hydraulic conductivity (flexible wall) of both ash materials (see pp. 12-14).

Lab Results:

Ash Type	Waste Ash Properties	Laboratory Test					
		UU @ 5 psi	UU @ 15 psi	CU* Total	CU* Effective	CD	Perm
Fly Ash	moisture (%)	37.9	40.2	42.4	42.4	39.9	42.1
	dry density (pcf)	67.8	67.1	66.3	66.3	67.4	66.3
	wet density (pcf)	93.5	94.1	94.4	94.4	94.3	94.2
	cohesion (ksf)	1.14	2.19	0.53	0.68	0	n/a
	angle of internal friction (deg)	0	0	26.2	32.5	29.8	n/a
	hydraulic conductivity (cm/s)	n/a	n/a	n/a	n/a	n/a	7.15E-05
Bottom Ash	moisture (%)	44.9	45.5	47.2	47.2	44.3	46.4
	dry density (pcf)	75.7	75.0	74.4	74.4	75.7	75.5
	wet density (pcf)	109.7	109.1	109.5	109.5	109.2	110.5
	cohesion (ksf)	1.88	3.05	0.32	0.66	0	n/a
	angle of internal friction (deg)	0	0	40.9	41.0	38.3	n/a
	hydraulic conductivity (cm/s)	n/a	n/a	n/a	n/a	n/a	5.05E-05

* The moisture content, dry density and wet density are the average of three tested samples. Total and Effective are the total stresses measured and the effective stresses measured, respectively. Effective stress is equal to the total stress minus the pore pressure as measured during the test.

Recommendations:

(1) The material appears to behave fairly frictional. To be conservative, use the lowest CD result on the flyash for strength (slope stability modelling), cohesion of 0 psf and angle of internal friction of 30 degrees.

(2) Also for slope stability purposes and settlement analyses, use an average unit weight (wet density) of 100 pcf.

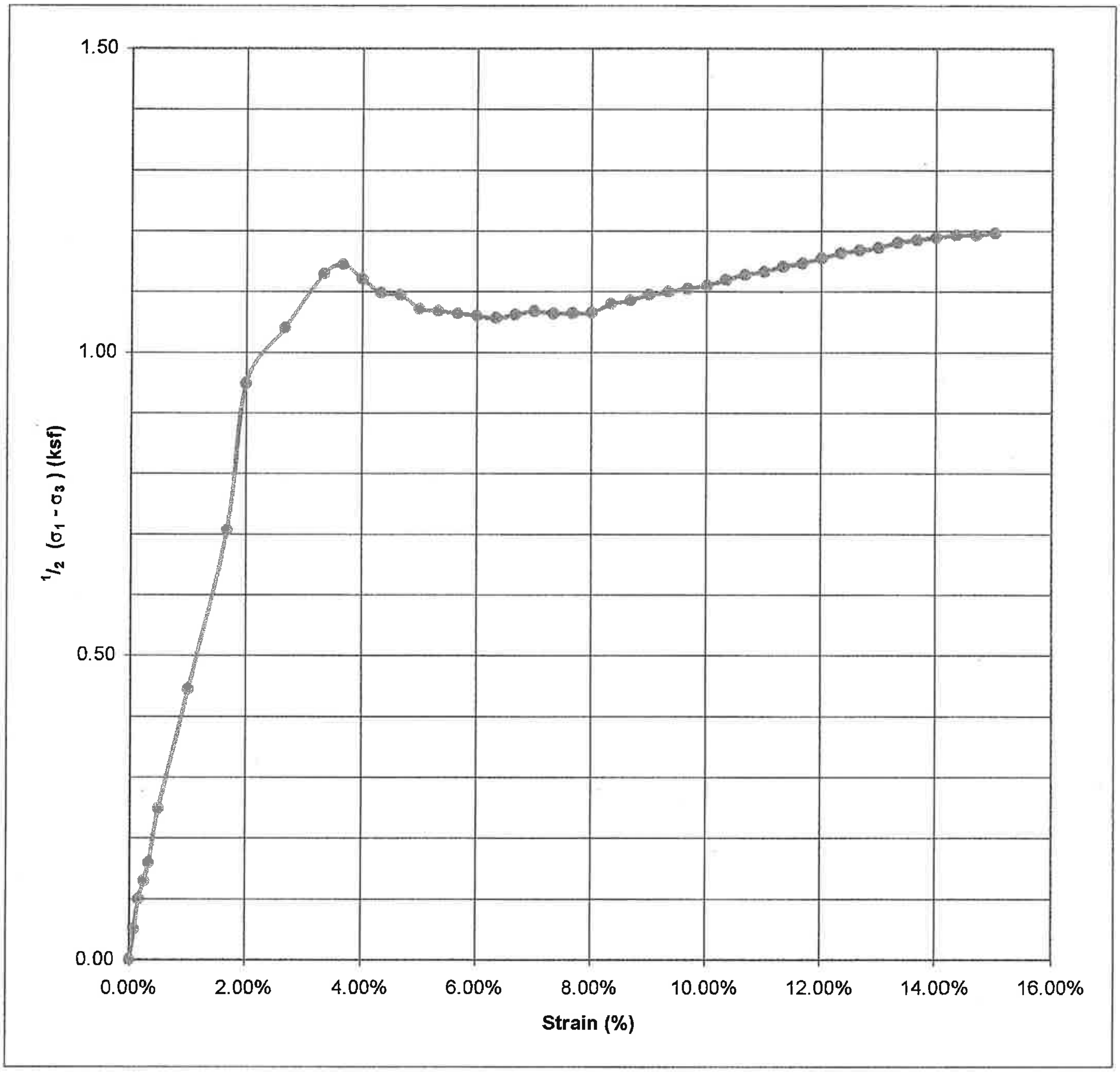
(3) For the help model to determine the necessary permeability of the leachate collection system sand, use an ash permeability of 6.0×10^{-5} cm/s.

ENVIRONMENTAL MANAGEMENT SERVICES, INC.

Unconsolidated, Undrained Triaxial Compression
Waste Ash Characterization
SMEPA
Purvis, MS

Boring No:	Fly Ash	Dry Density:	67.8	pcf
Depth:	N/A	Natural Moisture Content:	37.9%	
Confining Pressure:	5.0 psi	Strain at Failure:	3.7%	
Type of Failure:	50 deg sheer	Cohesion:	1.14	ksf

Description: Fly Ash

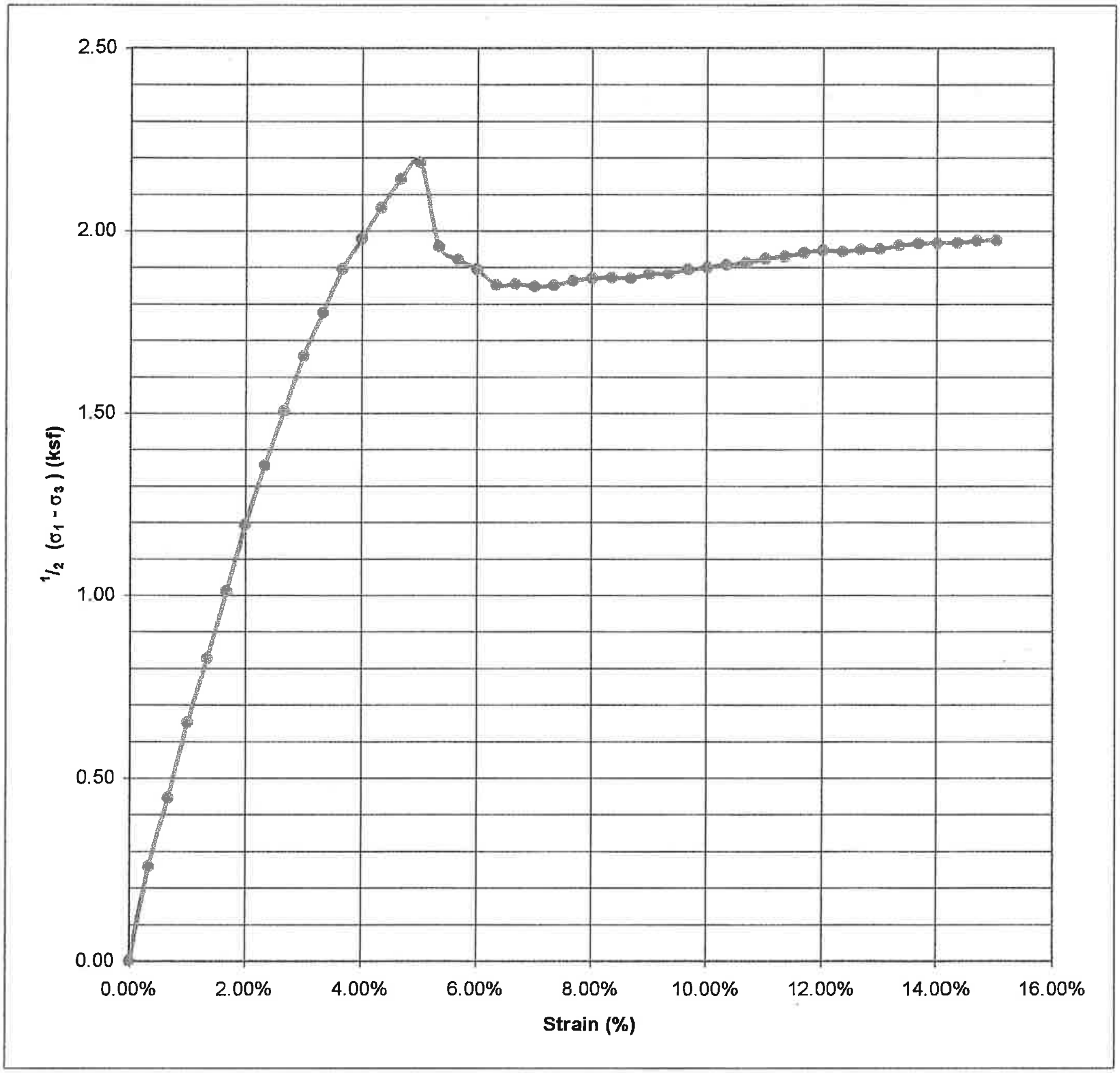


ENVIRONMENTAL MANAGEMENT SERVICES, INC.

Unconsolidated, Undrained Triaxial Compression
Waste Ash Characterization
SMEPA
Purvis, MS

Boring No:	Fly Ash	Dry Density:	67.1	pcf
Depth:	N/A	Natural Moisture Content:	40.2%	
Confining Pressure:	15.0 psi	Strain at Failure:	5.0%	
Type of Failure:	65 deg sheer	Cohesion:	2.19	ksf

Description: Fly Ash



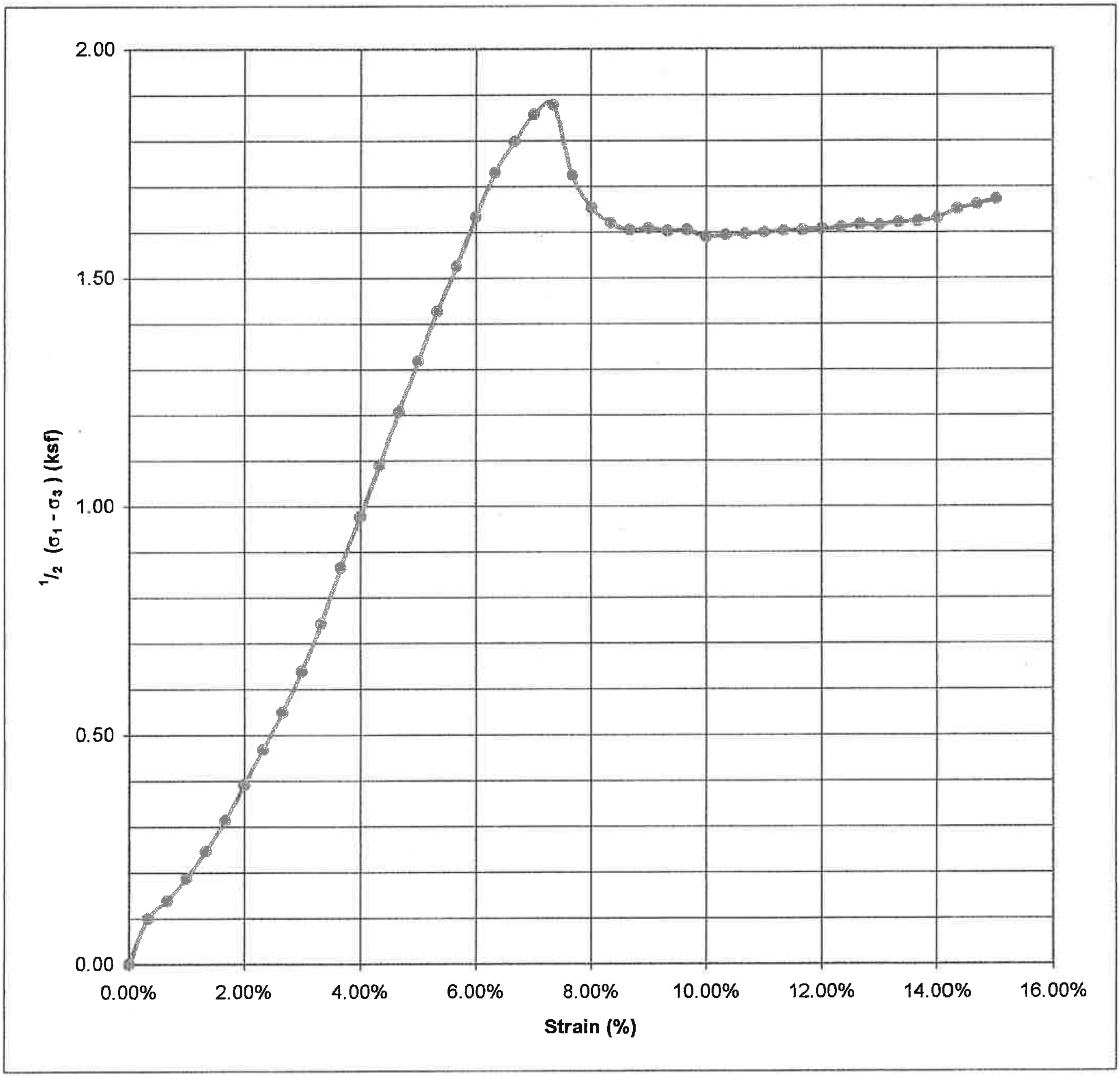
ENVIRONMENTAL MANAGEMENT SERVICES, INC.

Unconsolidated, Undrained Triaxial Compression
Waste Ash Characterization
SMEPA
Purvis, MS

Boring No: Bottom Ash
Depth: N/A
Confining Pressure: 5.0 psi
Type of Failure: 60 deg sheer

Dry Density: 75.7 pcf
Natural Moisture Content: 44.9%
Strain at Failure: 7.3%
Cohesion: 1.88 ksf

Description: Bottom Ash



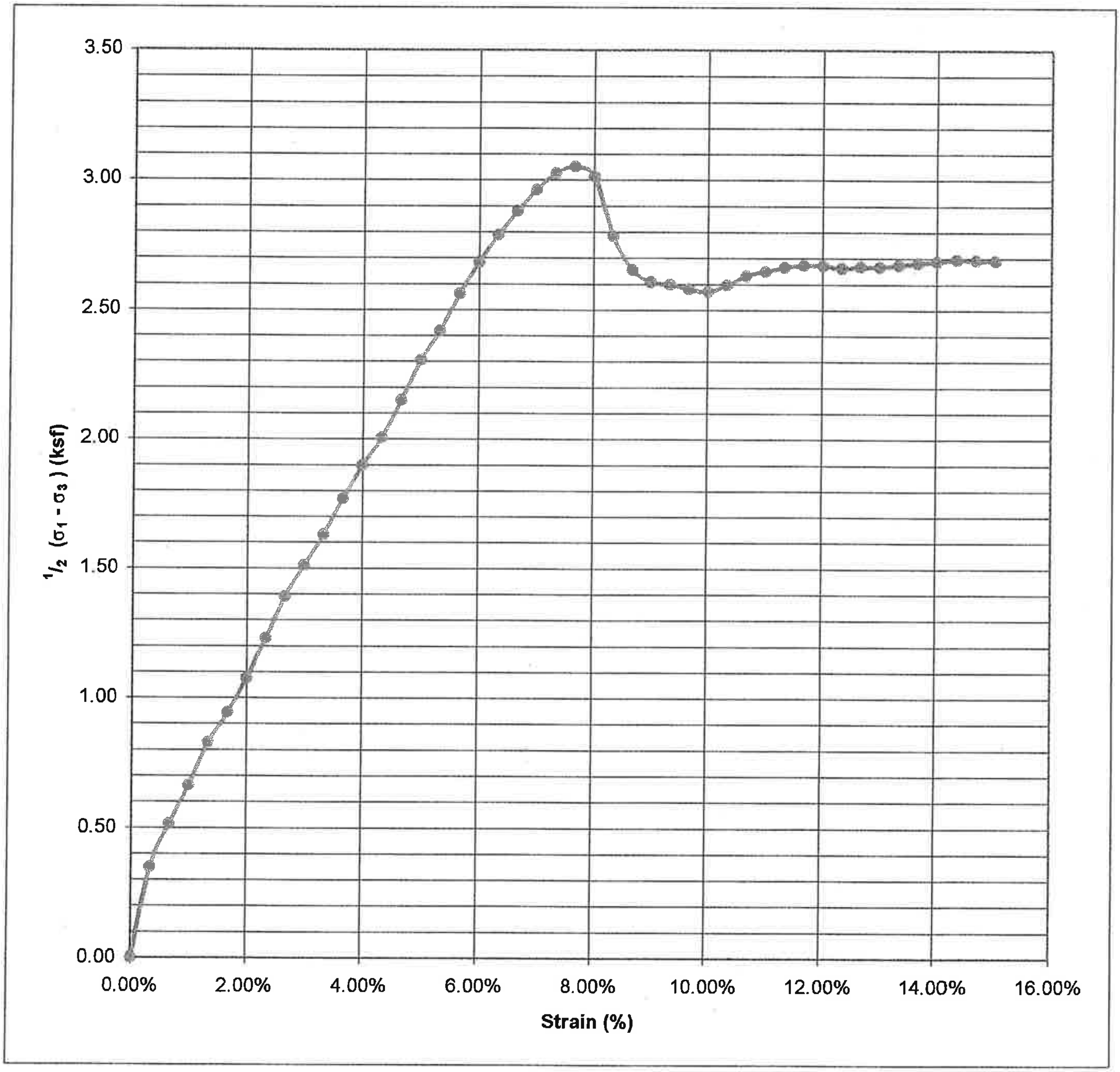
ENVIRONMENTAL MANAGEMENT SERVICES, INC.

Unconsolidated, Undrained Triaxial Compression
Waste Ash Characterization
SMEPA
Purvis, MS

Boring No: Bottom Ash
Depth: N/A
Confining Pressure: 15.0 psi
Type of Failure: 60 deg sheer

Dry Density: 75.0 pcf
Natural Moisture Content: 45.5%
Strain at Failure: 7.7%
Cohesion: 3.05 ksf

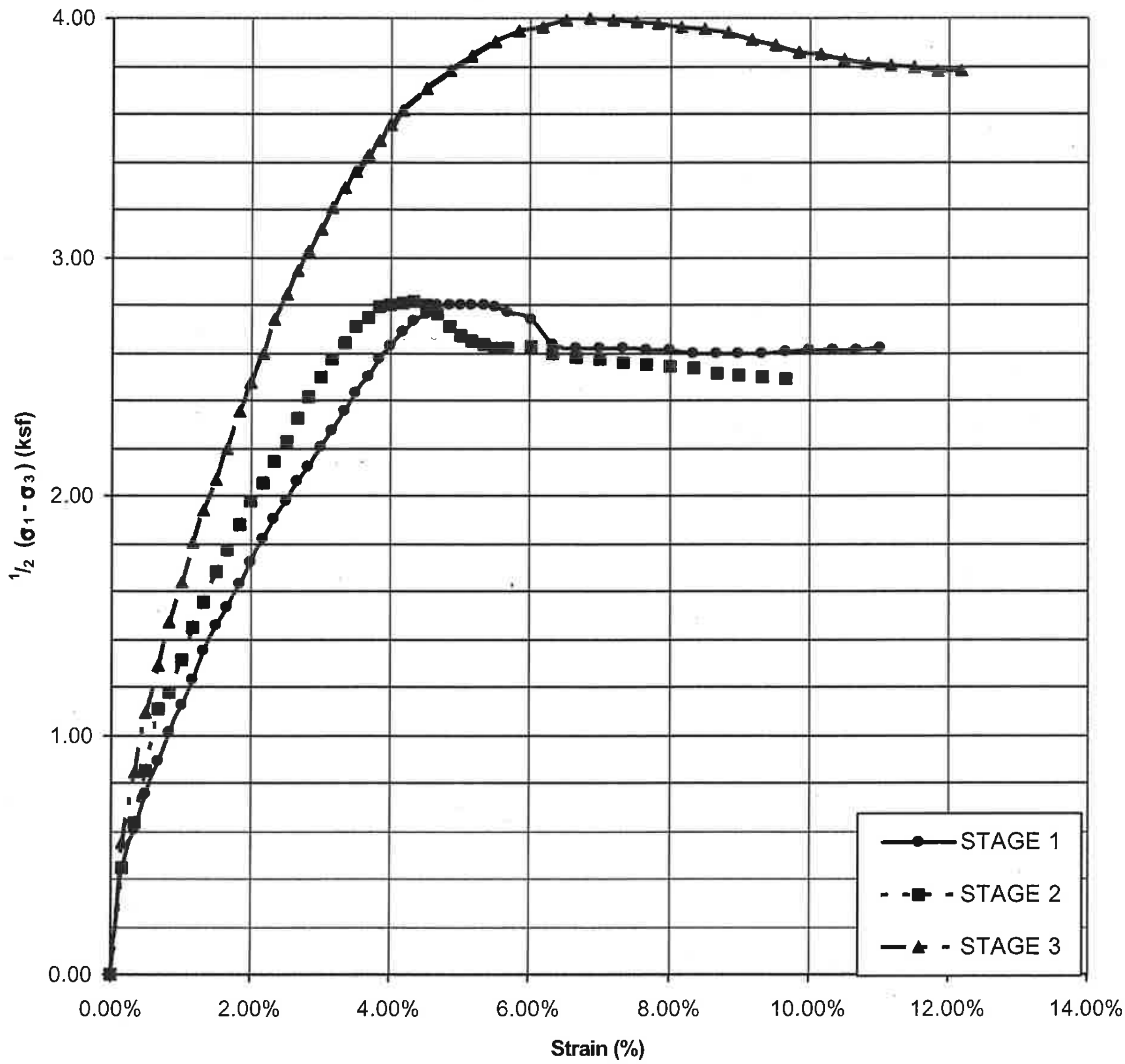
Description: Bottom Ash



ENVIRONMENTAL MANAGEMENT SERVICES, INC.

Consolidated, Undrained Triaxial Compression
Waste Ash Characterization
SMEPA
Purvis, MS

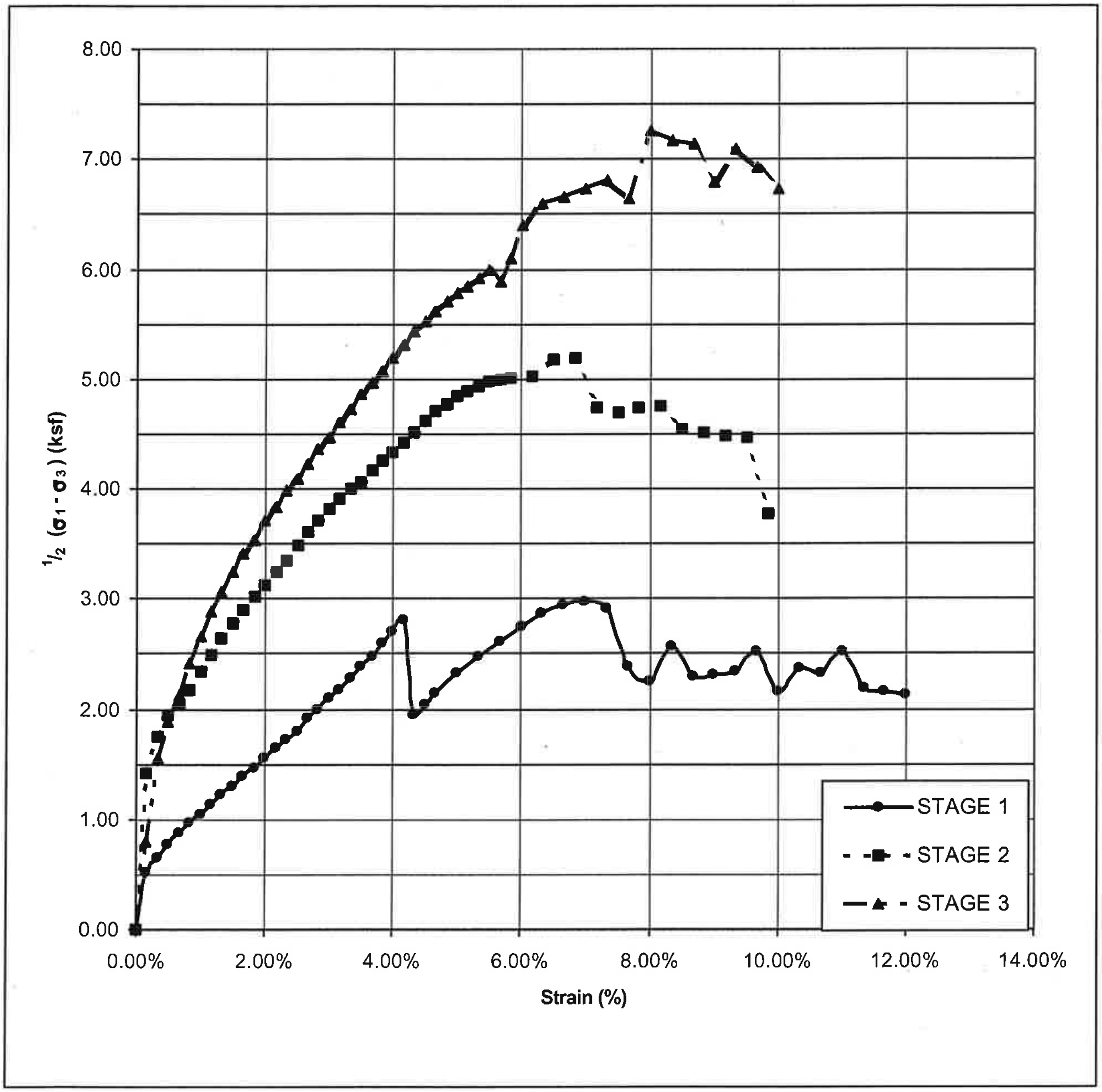
	STAGE 1	STAGE 2	STAGE 3
Boring No:	Fly Ash	Fly Ash	Fly Ash
Depth:	N/A	N/A	N/A
Confining Pressure:	15.0 psi	20.0 psi	25.0 psi
Back Pressure:	10.0 psi	10.0 psi	10.0 psi
Dry Density:	67.3 pcf	64.4 pcf	67.3 pcf
Moisture Content:	40.4%	46.0%	40.7%
$\frac{1}{2}(\sigma_1 - \sigma_3)_{final}$	2.80 ksf	2.81 ksf	4.00 ksf
Description:	Fly Ash	Fly Ash	Fly Ash



ENVIRONMENTAL MANAGEMENT SERVICES, INC.

Consolidated, Undrained Triaxial Compression
Waste Ash Characterization
SMEPA
Purvis, MS

	STAGE 1	STAGE 2	STAGE 3
Boring No:	Bottom Ash	Bottom Ash	Bottom Ash
Depth:	N/A	N/A	N/A
Confining Pressure:	15.0 psi	20.0 psi	25.0 psi
Back Pressure:	10.0 psi	10.0 psi	10.0 psi
Dry Density:	75.3 pcf	72.6 pcf	75.4 pcf
Moisture Content:	45.0%	50.1%	46.6%
$\frac{1}{2}(\sigma_1 - \sigma_3)_{final}$	2.98 ksf	5.19 ksf	7.25 ksf
Description:	Bottom Ash	Bottom Ash	Bottom Ash

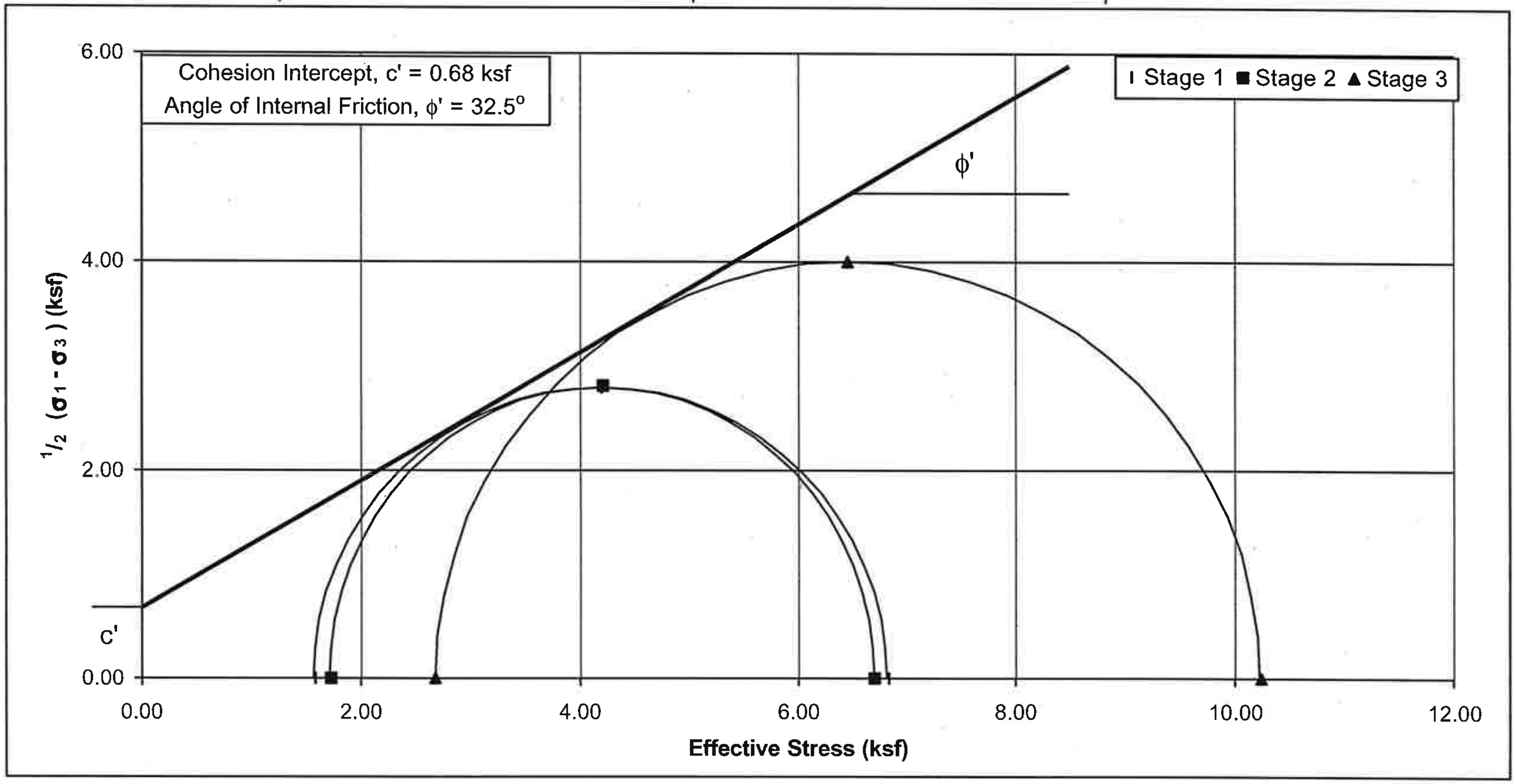


ENVIRONMENTAL MANAGEMENT SERVICES, INC.

Consolidated, Undrained Triaxial Compression

Waste Ash Characterization
SMEPA
Purvis, MS

	STAGE 1	STAGE 2	STAGE 3
Boring No:	Fly Ash	Fly Ash	Fly Ash
Depth:	N/A	N/A	Fly Ash
Confining Pressure:	15.0 psi	20.0 psi	25.0 psi
Back Pressure:	10.0 psi	10.0 psi	10.0 psi
Dry Density:	67.3 pcf	64.4 pcf	67.3 pcf
Moisture Content:	40.4%	46.0%	40.7%
$\frac{1}{2}(\sigma_1 - \sigma_3)_{final}$	2.80 ksf	2.81 ksf	4.00 ksf
Description:	Fly Ash	Fly Ash	Fly Ash

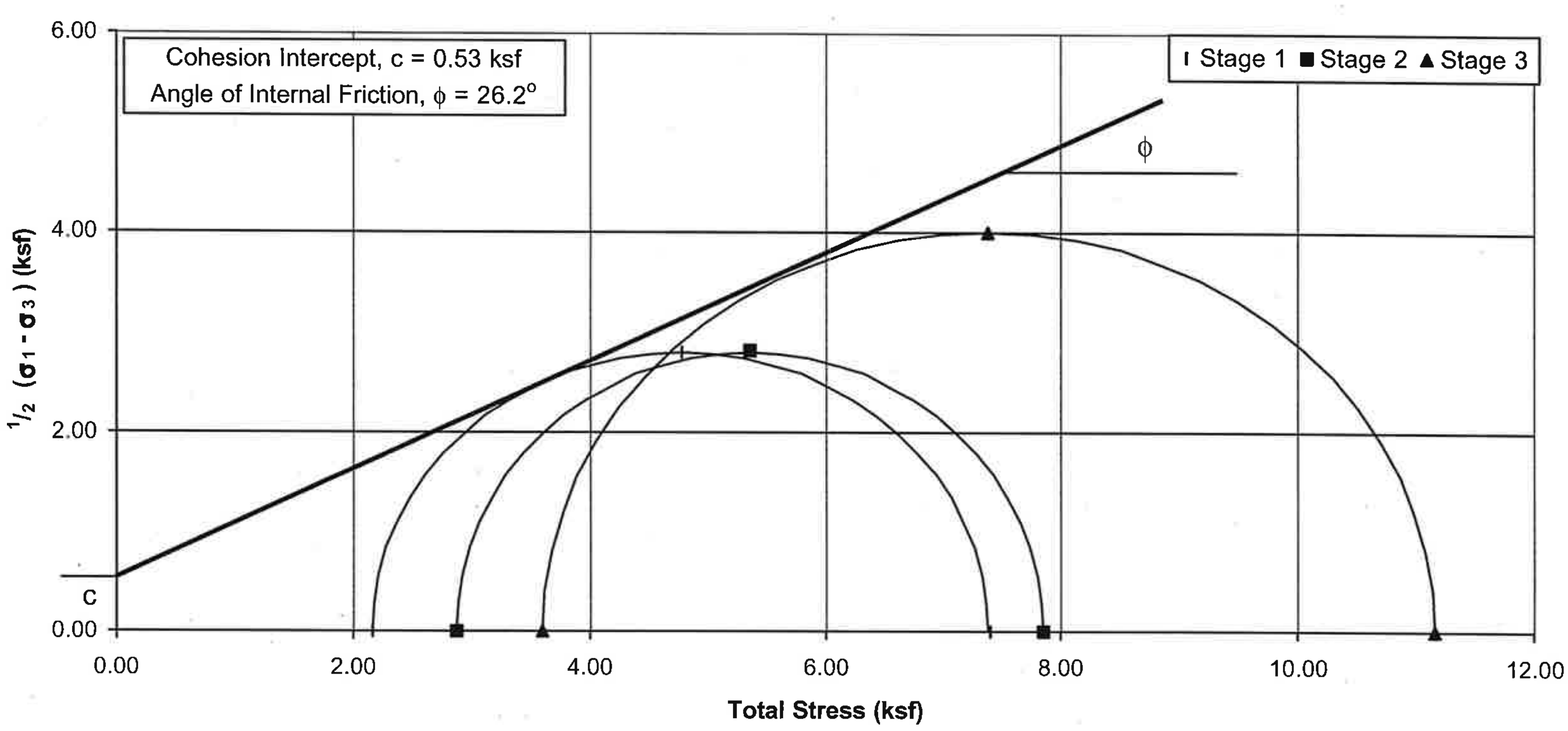


ENVIRONMENTAL MANAGEMENT SERVICES, INC.

Consolidated, Undrained Triaxial Compression

Waste Ash Characterization
SMEPA
Purvis, MS

	STAGE 1	STAGE 2	STAGE 3
Boring No:	Fly Ash	Fly Ash	Fly Ash
Depth:	N/A	N/A	Fly Ash
Confining Pressure:	15.0 psi	20.0 psi	25.0 psi
Back Pressure:	10.0 psi	10.0 psi	10.0 psi
Dry Density:	67.3 pcf	64.4 pcf	67.3 pcf
Moisture Content:	40.4%	46.0%	40.7%
$\frac{1}{2}(\sigma_1 - \sigma_3)_{final}$	2.80 ksf	2.81 ksf	4.00 ksf
Description:	Fly Ash	Fly Ash	Fly Ash

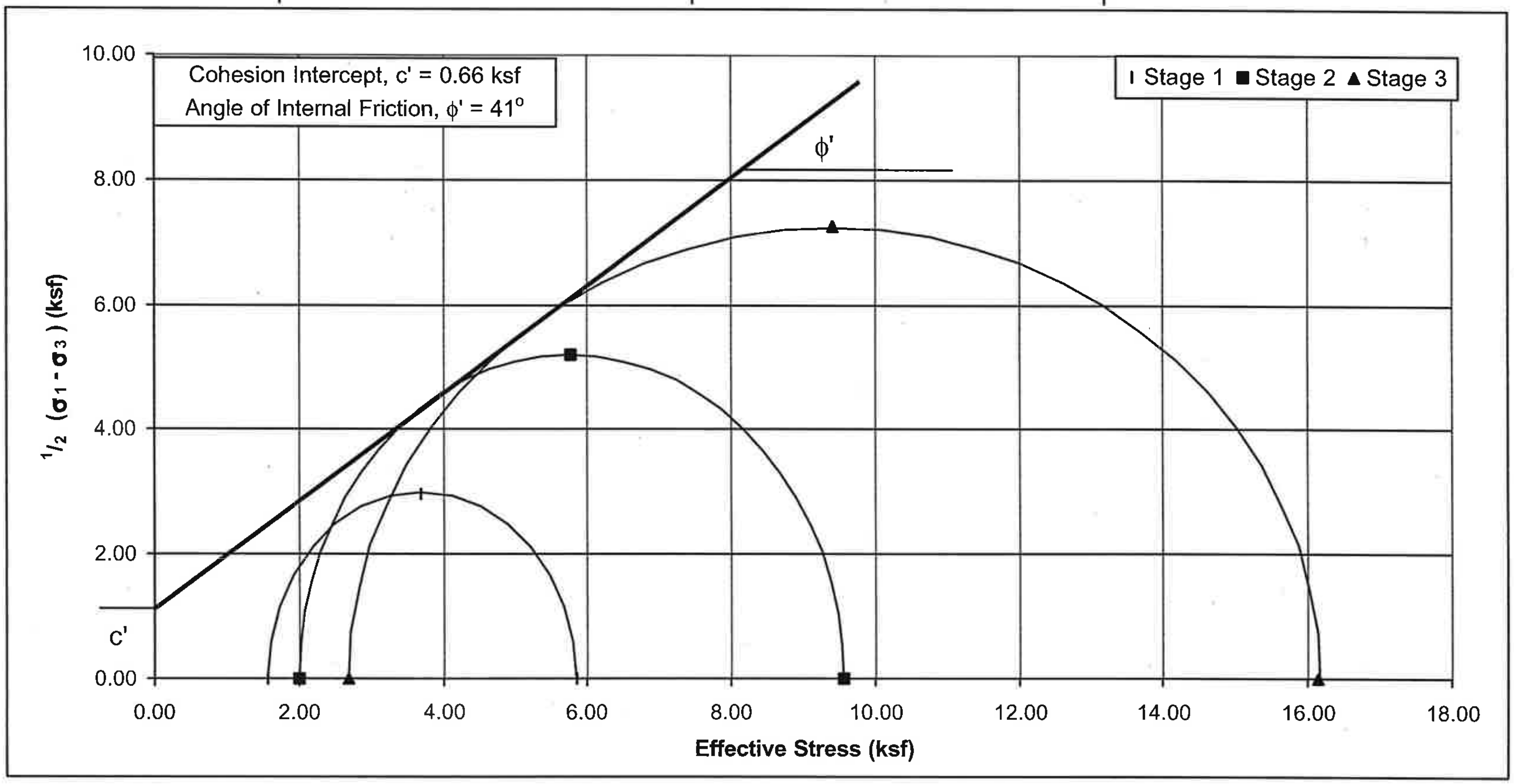


ENVIRONMENTAL MANAGEMENT SERVICES, INC.

Consolidated, Undrained Triaxial Compression

Waste Ash Characterization
SMEPA
Purvis, MS

	STAGE 1	STAGE 2	STAGE 3
Boring No:	Bottom Ash	Bottom Ash	Bottom Ash
Depth:	N/A	N/A	Bottom Ash
Confining Pressure:	15.0 psi	20.0 psi	25.0 psi
Back Pressure:	10.0 psi	10.0 psi	10.0 psi
Dry Density:	75.3 pcf	72.6 pcf	75.4 pcf
Moisture Content:	45.0%	50.1%	46.6%
$^1/_2(\sigma_1 - \sigma_3)_{final}$	2.98 ksf	5.19 ksf	7.25 ksf
Description:	Bottom Ash	Bottom Ash	Bottom Ash

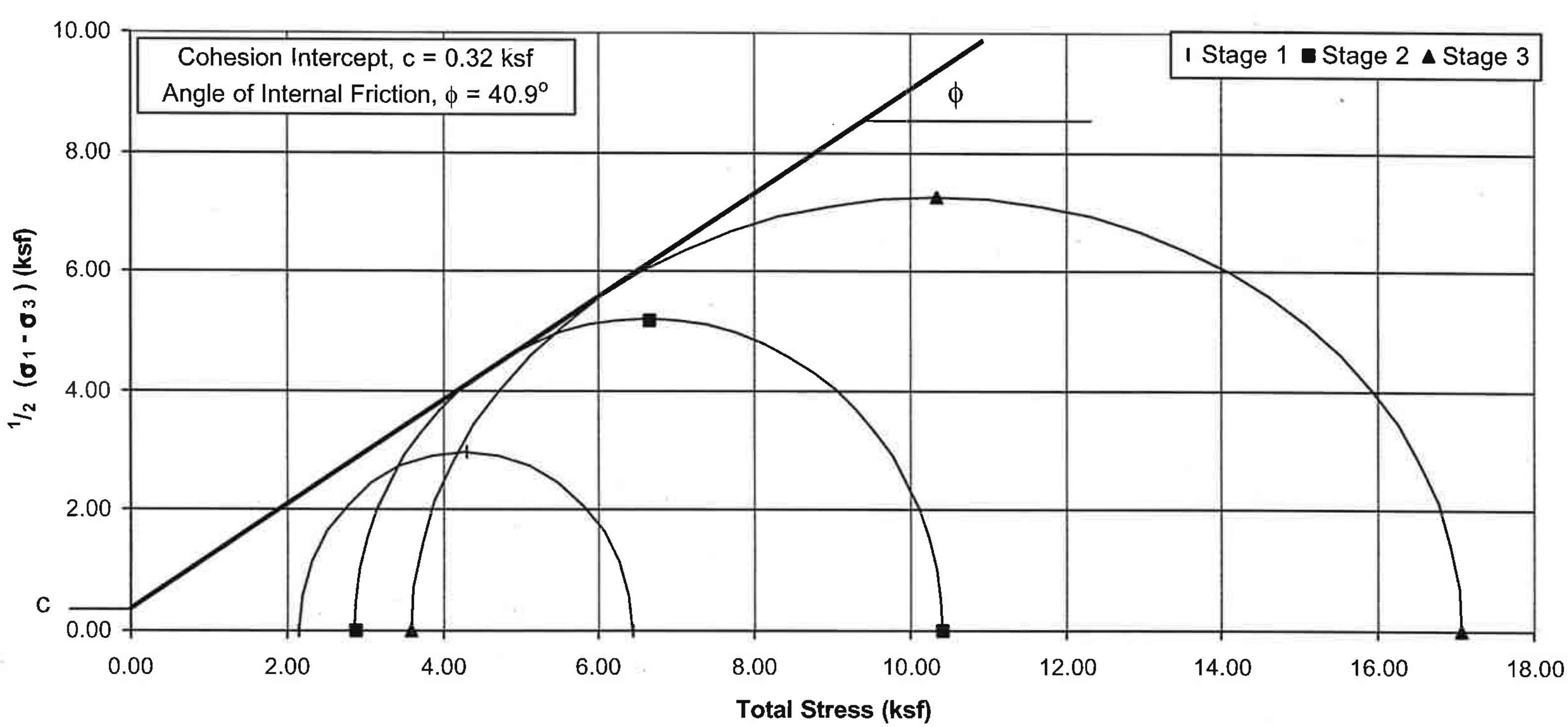


ENVIRONMENTAL MANAGEMENT SERVICES, INC.

Consolidated, Undrained Triaxial Compression

Waste Ash Characterization
SMEPA
Purvis, MS

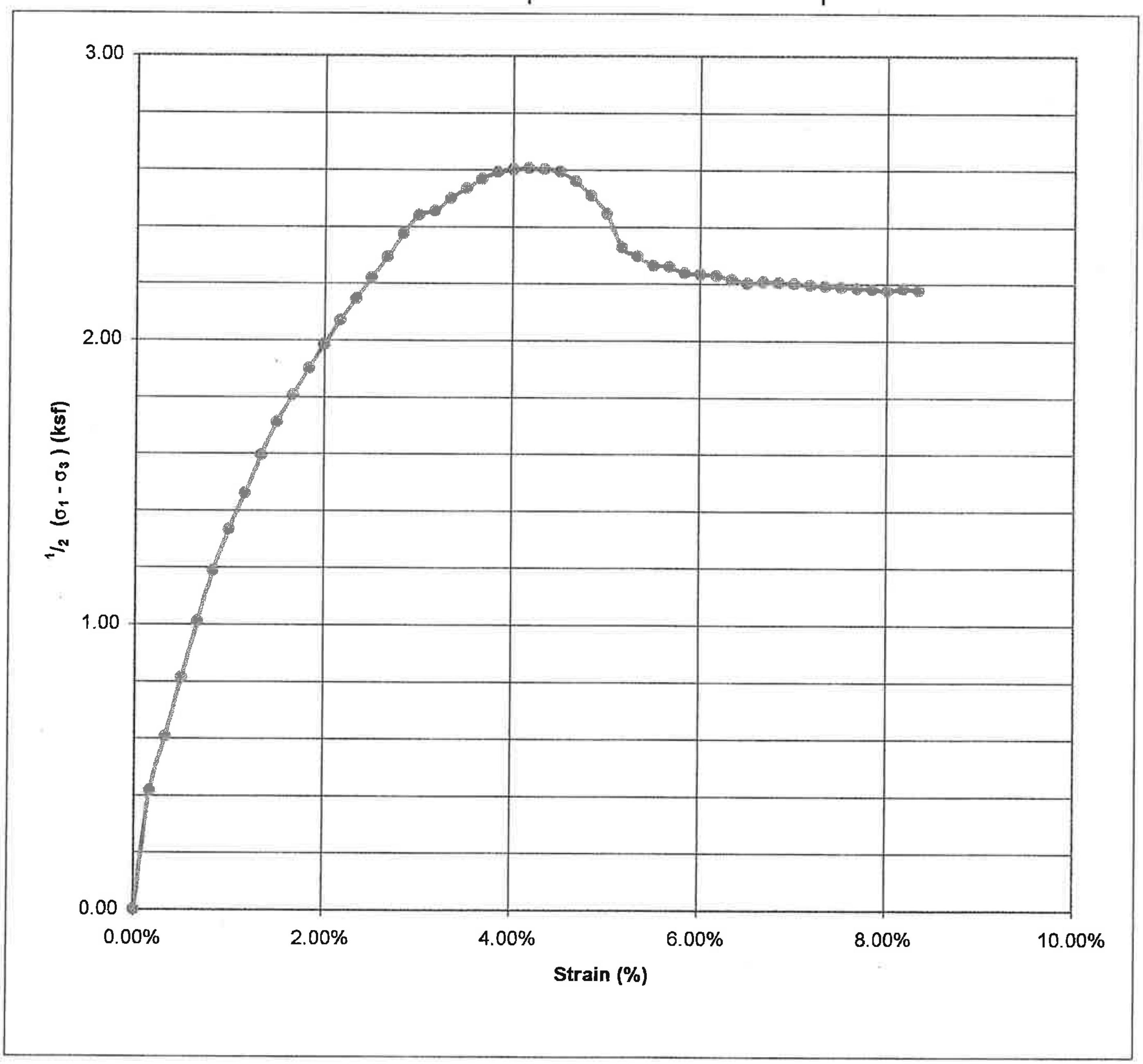
	STAGE 1	STAGE 2	STAGE 3
Boring No:	Bottom Ash	Bottom Ash	Bottom Ash
Depth:	N/A	N/A	Bottom Ash
Confining Pressure:	15.0 psi	20.0 psi	25.0 psi
Back Pressure:	10.0 psi	10.0 psi	10.0 psi
Dry Density:	75.3 pcf	72.6 pcf	75.4 pcf
Moisture Content:	45.0%	50.1%	46.6%
$^1/_2(\sigma_1 - \sigma_3)_{final}$	2.98 ksf	5.19 ksf	7.25 ksf
Description:	Bottom Ash	Bottom Ash	Bottom Ash



ENVIRONMENTAL MANAGEMENT SERVICES, INC.

Consolidated, Drained Triaxial Compression
Waste Ash Characterization
SMEPA
Purvis, MS

Boring No:	Fly Ash
Depth:	N/A
Confining Pressure:	20.0 psi
Back Pressure:	10.0 psi
Dry Density:	67.4 pcf
Moisture Content:	39.9%
$^1/_2(\sigma_1 - \sigma_3)_{final}$:	2.61 ksf
Description:	Fly Ash

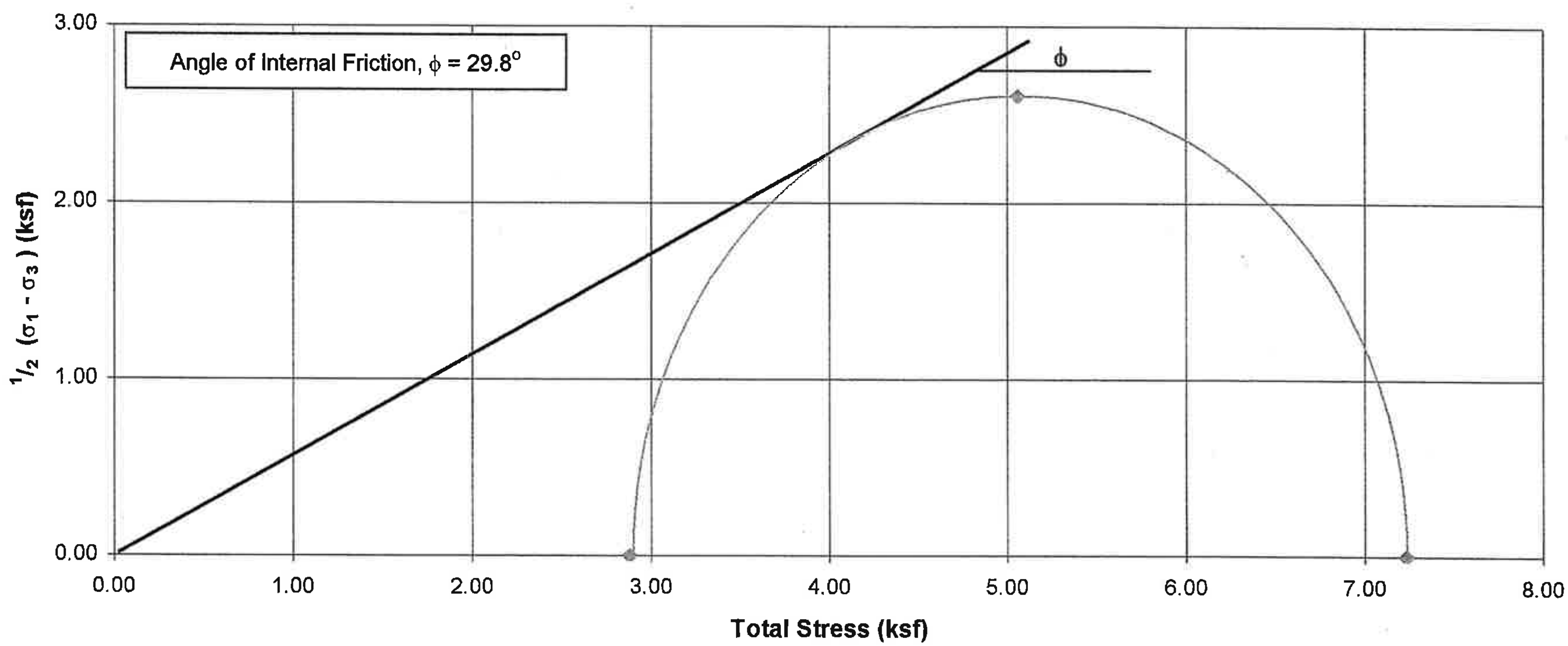


ENVIRONMENTAL MANAGEMENT SERVICES, INC.

Consolidated, Drained Triaxial Compression

Waste Ash Characterization
SMEPA
Purvis, MS

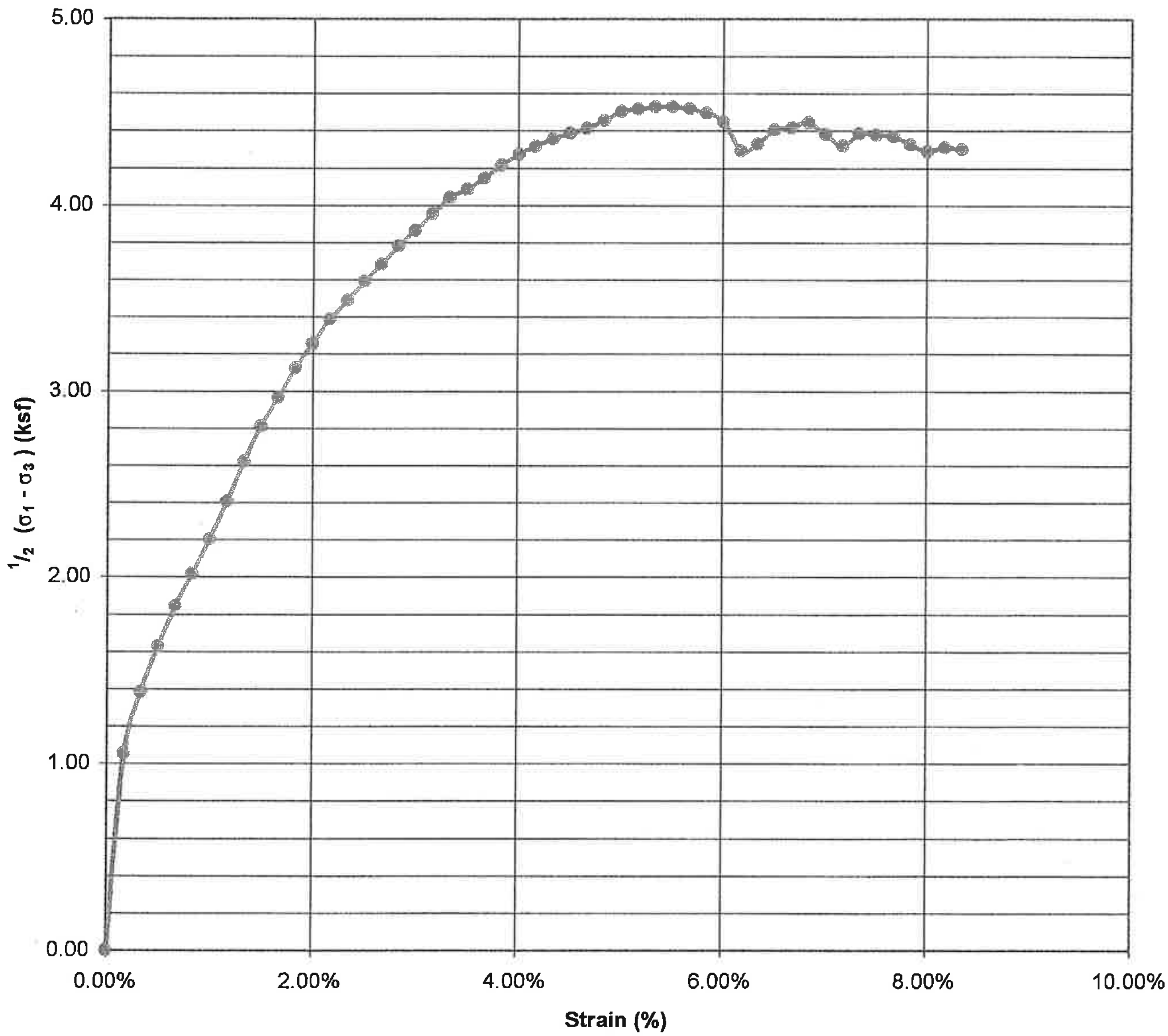
Boring No:	Fly Ash
Depth:	N/A
Confining Pressure:	20.0 psi
Back Pressure:	10.0 psi
Dry Density:	67.4 pcf
Moisture Content:	39.9%
$^1/_2(\sigma_1 - \sigma_3)_{final}$:	2.61 ksf
Description:	Fly Ash



ENVIRONMENTAL MANAGEMENT SERVICES, INC.

Consolidated, Drained Triaxial Compression
Waste Ash Characterization
SMEPA
Purvis, MS

Boring No:	Bottom Ash
Depth:	N/A
Confining Pressure:	20.0 psi
Back Pressure:	10.0 psi
Dry Density:	75.7 pcf
Moisture Content:	44.3%
$^1/_2(\sigma_1 - \sigma_3)_{final}$:	4.53 ksf
Description:	Bottom Ash



ENVIRONMENTAL MANAGEMENT SERVICES, INC.

Consolidated, Drained Triaxial Compression

Waste Ash Characterization
SMEPA
Purvis, MS

Boring No:	Bottom Ash
Depth:	N/A
Confining Pressure:	20.0 psi
Back Pressure:	10.0 psi
Dry Density:	75.7 pcf
Moisture Content:	44.3%
$^1/_2(\sigma_1 - \sigma_3)_{final}$:	4.53 ksf
Description:	Bottom Ash