REPORT OF GEOTECHNICAL LABORATORY TESTING OF GEOTEXTILE COMPOSITE MATERIAL

ASH DISPOSAL AREA
KINGSTON FOSSIL PLANT
KINGSTON, TENNESSEE

Prepared For:

TENNESSEE VALLEY AUTHORITY

Chattanooga, Tennessee

Prepared By:

MACTEC ENGINEERING AND CONSULTING, INC.

Knoxville, Tennessee

MACTEC Project 3043051030.01

January 25, 2006

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January 25, 2006

Mr. Ron Purkey
Tennessee Valley Authority
1101 Market Street, LP-2G
Chattanooga, TN 37402

Subject: **Report of Geotextile Laboratory Testing of Geotextile Composite Material**
Ash Disposal Area
TVA Kingston Fossil Plant
Kingston, Tennessee
MACTEC Project 3043051030.01

Dear Mr. Purkey:

We at MACTEC Engineering and Consulting, Inc., (MACTEC) are pleased to submit this Report of Geotechnical Laboratory Testing for your project. Our services, as authorized through TAO No. MAC-0724-00082, were provided in general accordance with our proposal number Prop05Knox/182, dated June 9, 2005.

This letter report reviews the scope of geotechnical laboratory testing and provides the laboratory test results performed on the geotextile composite material.

Scope of Laboratory Testing

The geotechnical laboratory testing scope of work was provided by Parsons E&C and included the following:

- 2 Three-Point Interface Shear Tests – ASTM D 5321
- 1 Gradient Ratio Test – ASTM D 5101
- 1 Hydraulic Conductivity Ratio Test – ASTM D 5567
- 2 Standard Proctor Compaction Tests – ASTM D 698

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Laboratory Testing Methodology

3-Point Interface Shear Testing

Two 3-point interface shear tests were performed in order to determine the shear resistance of the geotextile composite material against the on-site ash and soil materials. The first test was conducted on the geotextile composite material and a representative sample of the on-site ash material; while the second test was performed on the geotextile composite material and a representative sample of the on-site clayey fill soils. During the testing, the ash material was remolded to 95 percent of its standard Proctor maximum dry density at optimum moisture content, while the clay soils were remolded to 90 percent of its standard Proctor maximum dry density at optimum moisture content. The laboratory test results are provided in the Appendix.

Gradient Ratio Test

One gradient ratio test was performed in order to evaluate the ash / geotextile system permeability and the clogging behavior of the ash material under unidirectional flow conditions. During the test the ash material was remolded to 95 percent of its standard Proctor maximum dry density at optimum moisture content. The test results and associated plots are provided in the Appendix.

Hydraulic Conductivity Ratio (HCR) Test

One hydraulic conductivity ratio test was conducted in order to evaluate the clayey fill soil / geotextile system permeability and the filtration behavior of the clayey fill soils. During the test the clay soils were remolded to 90 percent of its standard Proctor maximum dry density at optimum moisture content. The test results and associated plots are provided in the Appendix.

Standard Proctor Compaction Test

One standard Proctor test was performed on the representative on-site ash sample and the representative on-site clayey fill soil sample. The test results were used in order to specify the remolding requirements for the two materials during the Gradient Ratio and Hydraulic Conductivity Ratio testing. The test results are provided in the Appendix.

We will be happy to provide any additional information or interpretation of the data presented here in which may be necessary.

Sincerely,

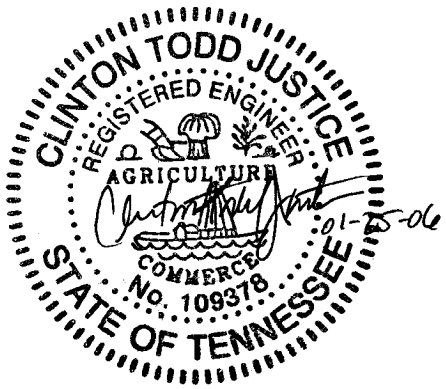
MACTEC ENGINEERING AND CONSULTING, INC.

C. Todd Justice, P.E.
Project Engineer

Carl D. Tockstein, P.E.
Chief Engineer - Tennessee Operations

CTJ/CDT:sjm

Attachments: Laboratory Testing Procedures
Interface Shear Test Results
Gradient Ratio Test Results
Hydraulic Conductivity Ratio Test Results
Standard Proctor Compaction Test Results



LABORATORY TEST PROCEDURES AND RESULTS

LABORATORY TEST PROCEDURES

Interface Shear Test

This test method determines the shear resistance between a geosynthetic (geotextile) and a soil, or other material, by placing the geosynthetic and one or more contact surfaces, such as soil, within a direct shear box. A constant normal force representative of design stresses is applied to the specimen, and a tangential (shear) force is applied to the apparatus so that one section of the box moves in relation to the other section. The shear force is recorded as a function of the horizontal displacement of the moving section of the shear box.

The test is performed at a minimum of three different normal stresses, selected by the user, to model appropriate field conditions. The limiting values of shear stresses are plotted against the applied normal compressive stresses used for testing. The test data are generally represented by a best fit straight line whose slope is the coefficient of friction between the two materials where the shearing occurred. The y-intercept of the straight line is the adhesion. This test is conducted in accordance with ASTM D-5321.

Gradient Ratio Test

This test method requires setting up a cylindrical, clear plastic permeameter with a geotextile and soil material, and passing water through this system by applying various differential heads. Measurements of differential heads and flow rates are taken at different time intervals to determine hydraulic gradients.

The test method is recommended for evaluating the performance of various soil-geotextile systems under controlled test conditions. Gradient ratio values obtained may be plotted and used as an indication of the soil-geotextile system clogging potential and permeability. This test is conducted in accordance with ASTM D 5101.

Hydraulic Conductivity Ratio Test

This test method presents a procedure for performing permeability tests of soil/geotextile systems. The technique requires placement of the soil and geotextile in a flexible-wall permeameter. The hydraulic conductivity of the soil/geotextile specimen is measured and plotted as a function of elapsed time and volume of water passing through the sample. The hydraulic conductivity may increase or decrease during the test, depending on the behavior of the geotextile filter. The test is terminated when a stabilized hydraulic conductivity is obtained, or when the hydraulic conductivity decreases below the minimum value allowed by the drainage design. This test is conducted in accordance with ASTM D 5567.

Proctor Compaction Tests (Moisture-Density Relationship)

Compaction tests are performed on representative soil samples to determine the maximum dry density and optimum moisture content. The results of the tests are used in conjunction with other tests to determine engineering properties relating to settlement, bearing capacity, shear strength, and permeability. The results may also be used as a standard to determine the percent compaction of any soil embankment.

The two most commonly used compaction tests are the standard Proctor test and the modified Proctor test. They are performed in accordance with ASTM D 698 and D 1557, respectively. Generally, the standard Proctor compaction test is run on samples from building areas and areas where moderate

loads are anticipated. The modified Proctor compaction test is generally used for analyses of highways and other areas where large building loads are expected. Both tests have three procedures, depending upon soil particle size:

Test	Procedure	Hammer Weight (Pounds)	Hammer Fall (Inches)	Mold Diameter (Inches)	Screen Size (Material Finer Than)	Number of Layers	Number of Blows per Layer
Standard (D 698)	A	5.5	12	4	No. 4 sieve	3	25
	B	5.5	12	4	No. 3/8" sieve	3	25
	C	5.5	12	6	3/4" sieve	3	56
Modified (D 1557)	A	10	18	4	No. 4 sieve	5	25
	B	10	18	4	No. 3/8" sieve	5	25
	C	10	18	6	3/4" sieve	5	56

Test results are presented as a curve depicting dry unit weight versus moisture content. The compaction method used and any deviations from the recommended procedures are noted in the report.

INTERFACE SHEAR TEST RESULTS

GeoTesting express

Client:			
Project Name:	TVA Kingston Proposed Gypsym Stack Borrow Area		
Project Location:	---		
GTX #:	G0958		
Start Date:	12/12/05	Tested By:	rmt
End Date:	12/13/05	Checked By:	jdt
Soil ID:	SOIL (CLAY)		
Soil Description:	Moist, dark reddish brown silty clay with sand		
Geosynthetic ID:	Geocomposite		
Geosynthetic Description:	Black, double non-woven geocomposite		

Interface Shear Test Series by ASTM D 5321

Test Series #:	2	
Test Profile - Top to Bottom:	Textured Gripping Surface / SOIL / GEOCOMPOSITE / Textured Gripping Surface	
Soil Preparation:	Compacted to 90% of Maximum Dry Density at the Optimum Moisture Content	
Compaction Characteristics:	Maximum Dry Density	103.5 pcf
	Optimum Moisture Content	20.0 %
	Compaction Test Method	ASTM D 698
Geosynthetic Preparation:	Saturated for 24 hours under normal load prior to shear.	
Test Equipment:	Top box = 12 in x 12 in; Bottom box = 16 in x 12 in; Load cells and LVDTs connected to data acquisition system for shear force, normal load and horizontal displacement readings; Flat plate clamping device; surface area = 144 in^2	
Horizontal Displacement, in/min:	0.04	Test Condition: inundated

Parameter	Point 1	Point 2	Point 3	Point 4	Point 5	Point 6
Initial Moisture Content, %	20	20	20	---	---	---
Initial Dry Density, pcf	93	93	93	---	---	---
Percent Compaction, %	90	90	90	---	---	---
Normal Compressive Stress, psf	500	1000	2000	---	---	---
Peak Shear Stress, psf	427	812	1557	---	---	---
Post Peak Shear Stress, psf	411	783	1538	---	---	---
Final Moisture Content, %	27	27	26	---	---	---

NOTES:

Peak Friction Angle:	**37**	**degrees**
Peak Cohesion:	**54**	**psf**
Post Peak Friction Angle:	**37**	**degrees**
Post Peak Cohesion:	**34**	**psf**

Figure a. Shear Force vs. Horizontal Displacement

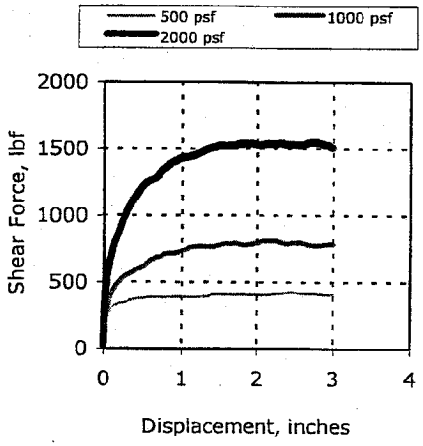
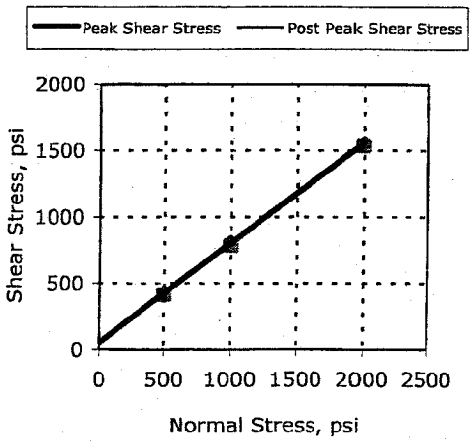


Figure b. Shear Stress vs. Normal Stress



GeoTesting express

Client:			
Project Name:	TVA Kingston Proposed Gypsym Stack Borrow Area		
Project Location:	---		
GTX #:	G0958		
Start Date:	12/12/05	Tested By:	rmt
End Date:	12/12/05	Checked By:	jdt
Soil ID:	ASH		
Soil Description:	Moist, grayish brown sandy silt		
Geosynthetic ID:	Geocomposite		
Geosynthetic Description:	Black, double non-woven geocomposite		

Interface Shear Test Series by ASTM D 5321

Test Series #:	1
Test Profile - Top to Bottom:	Textured Gripping Surface / SOIL / GEOCOMPOSITE / Textured Gripping Surface
Soil Preparation:	Compacted to 95% of Maximum Dry Density at the Optimum Moisture Content
Compaction Characteristics:	Maximum Dry Density 90.0 pcf Optimum Moisture Content 20.5 % Compaction Test Method ASTM D 698
Geosynthetic Preparation:	Saturated for 1 hour under normal load prior to shear.
Test Equipment:	Top box = 12 in x 12 in; Bottom box = 16 in x 12 in; Load cells and LVDTs connected to data acquisition system for shear force, normal load and horizontal displacement readings; Flat plate clamping device; surface area = 144 in^2
Horizontal Displacement, in/min:	0.04 Test Condition: inundated

Parameter	Point 1	Point 2	Point 3	Point 4	Point 5	Point 6
Initial Moisture Content, %	20	20	20	---	---	---
Initial Dry Density, pcf	85	85	85	---	---	---
Percent Compaction, %	95	95	95	---	---	---
Normal Compressive Stress, psf	500	1000	2000	---	---	---
Peak Shear Stress, psf	451	749	1520	---	---	---
Post Peak Shear Stress, psf	437	665	1464	---	---	---
Final Moisture Content, %	27	27	27	---	---	---

NOTES:

Peak Friction Angle:	**36**	**degrees**
Peak Cohesion:	**66**	**psf**
Post Peak Friction Angle:	**35**	**degrees**
Post Peak Cohesion:	**38**	**psf**

Figure a. Shear Force vs. Horizontal Displacement

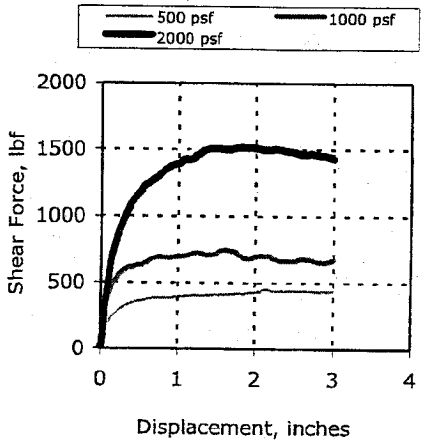
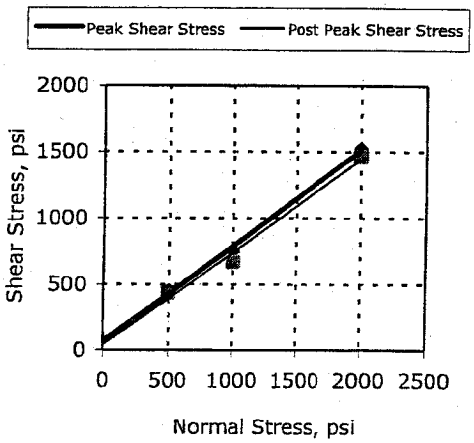


Figure b. Shear Stress vs. Normal Stress



GRADIENT RATIO TEST RESULTS

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Client:	MACTEC
Project Name:	TVA Kingston Proposed Gypsym Stack Borrow Area
Project Location:	---
GTX #:	G0958
Test Date:	12/28/05-01/10/06
Soil Sample ID:	ASH
Description:	Moist, grayish brown sandy silt
Sample Preparation:	Target Compaction: 95% of maximum dry density (90.0 pcf) at air-dried moisture content.
Geosynthetic Sample ID:	Geocomposite (textile portion only)
Description:	Black, double non-woven geocomposite

Measuring the Soil-Geotextile System Clogging Potential by the Gradient Ratio by ASTM D 5101

Date	Time of Test, hrs	Grad., i Δ h/L	Δ h, cm (1-6)	Manometer Readings, cm						Δh_s	Δh_{sf}	Gradient Ratio	Q, cc	Flow Time, sec	Temperature, °C	Permeability @ 20°C, m/sec
				1	2	3	4	5	6							
01/05/06	0.00	1.08	10.2	32.6	25.3	32.7	21.7	29.6	22.4	3.4	3.3	1.94	0.53	245	19	2.50E-07
01/05/06	0.50	1.07	10.1	32.7	28.2	32.6	22.7	29.8	22.6	4.2	3.7	1.76	0.25	245	19	1.19E-07
01/05/06	1.00	1.06	10.0	32.6	29.1	32.6	23.3	29.7	22.6	4.4	3.9	1.79	0.69	245	18.5	3.32E-07
01/05/06	2.00	1.07	10.1	32.7	29.8	32.7	24.1	29.8	22.6	4.3	4.4	2.02	0.68	245	18	3.24E-07
01/05/06	4.00	1.07	10.1	32.7	30.0	32.7	24.7	29.8	22.6	4.1	4.7	2.27	0.68	245	18	3.24E-07
01/05/06	6.00	1.07	10.1	32.7	30.1	32.7	25.0	29.7	22.6	4.1	4.8	2.35	0.68	245	17.5	3.24E-07
01/06/06	23.00	1.07	10.1	32.7	30.1	32.6	25.1	29.1	22.6	4.3	4.5	2.12	0.68	245	18	3.24E-07
01/06/06	23.50	2.68	25.4	32.5	28.3	32.5	22.0	29.2	7.1	4.8	18.5	7.71	1.97	245	17.5	3.74E-07
01/06/06	23.75	5.36	50.8	69.0	32.0	68.7	22.5	29.2	18.2	24.5	7.7	0.62	3.43	245	17	3.25E-07
01/06/06	24.25	5.36	50.8	69.0	44.7	69.3	24.3	29.2	18.2	30.3	8.6	0.57	3.88	245	17	3.68E-07
01/06/06	24.75	5.36	50.8	69.0	50.0	69.2	26.2	29.2	18.2	31.9	9.5	0.60	3.66	245	16.5	3.47E-07
01/06/06	25.75	5.39	51.0	69.2	54.6	69.3	29.5	29.2	18.2	32.6	11.2	0.68	3.61	245	16	3.41E-07
01/06/06	27.75	5.39	51.0	69.2	56.6	69.3	31.4	29.3	18.2	32.6	12.2	0.75	3.70	245	15	3.49E-07
01/06/06	29.75	5.60	53.0	71.2	56.9	71.2	32.1	29.2	18.2	33.4	12.5	0.75	3.67	245	15	3.33E-07
01/07/06	51.75	5.37	50.9	69.1	58.3	69.2	32.9	28.5	18.2	33.1	12.5	0.76	3.42	245	16	3.24E-07
01/09/06	95.50	5.27	49.9	68.1	59.1	68.2	33.3	27.9	18.2	33.1	12.4	0.75	3.44	245	16.5	3.32E-07
01/09/06	96.00	7.53	71.3	72.3	43.2	72.6	32.0	27.7	1.0	28.1	28.9	2.06	5.09	245	15	3.44E-07
01/09/06	96.75	10.73	101.6	108.3	65.7	108.3	32.6	28.7	6.7	56.4	24.0	0.85	6.95	245	15	3.29E-07
01/09/06	97.25	10.76	101.9	108.6	79.4	108.7	33.4	28.2	6.7	63.3	24.1	0.76	7.12	245	15	3.37E-07
01/09/06	97.75	10.33	97.8	104.5	82.1	104.5	34.0	28.1	6.7	62.3	24.4	0.78	6.76	245	15	3.33E-07
01/09/06	98.75	10.30	97.5	104.2	84.2	104.2	35.1	28.1	6.7	62.6	24.9	0.80	6.80	245	15	3.36E-07
01/09/06	100.75	10.24	97.0	103.8	84.6	103.8	36.4	28.2	6.8	61.9	25.5	0.82	6.78	245	15	3.37E-07
01/09/06	102.75	10.29	97.4	104.1	84.4	104.1	36.7	28.1	6.7	61.9	25.7	0.83	6.47	245	15	3.20E-07
01/10/06	124.75	10.80	102.3	109.0	89.8	109.0	40.0	27.9	6.7	65.5	27.3	0.83	6.93	245	15	3.26E-07

Notes: Plots can be provided if requested
Points at gradients of 2.68 and 7.53 are transitional points to get to the next gradient increment.

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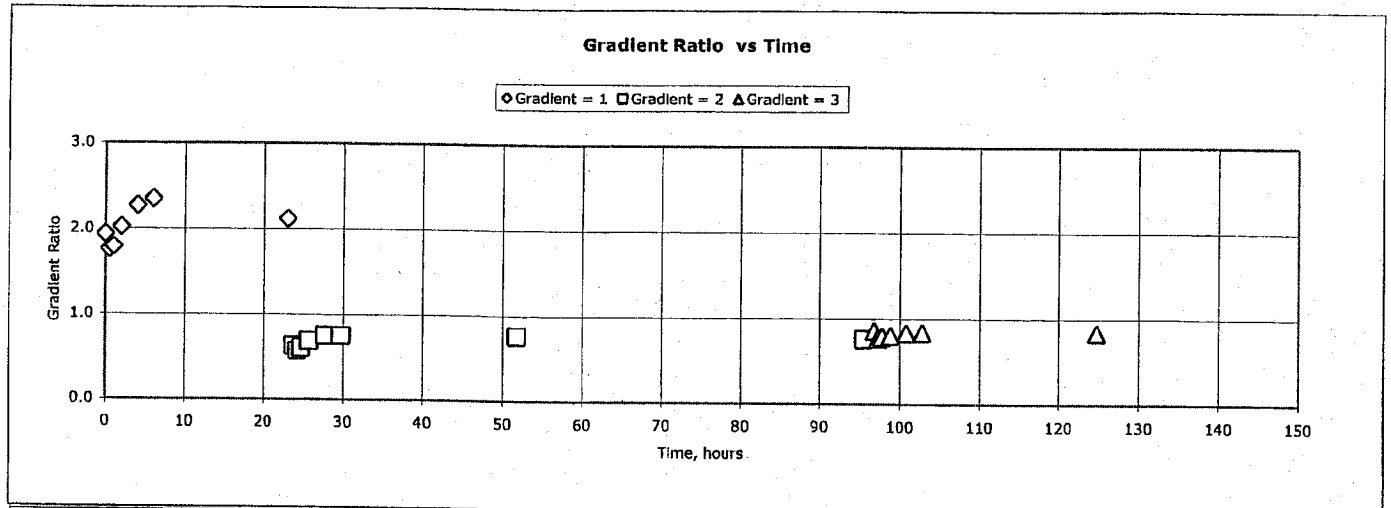
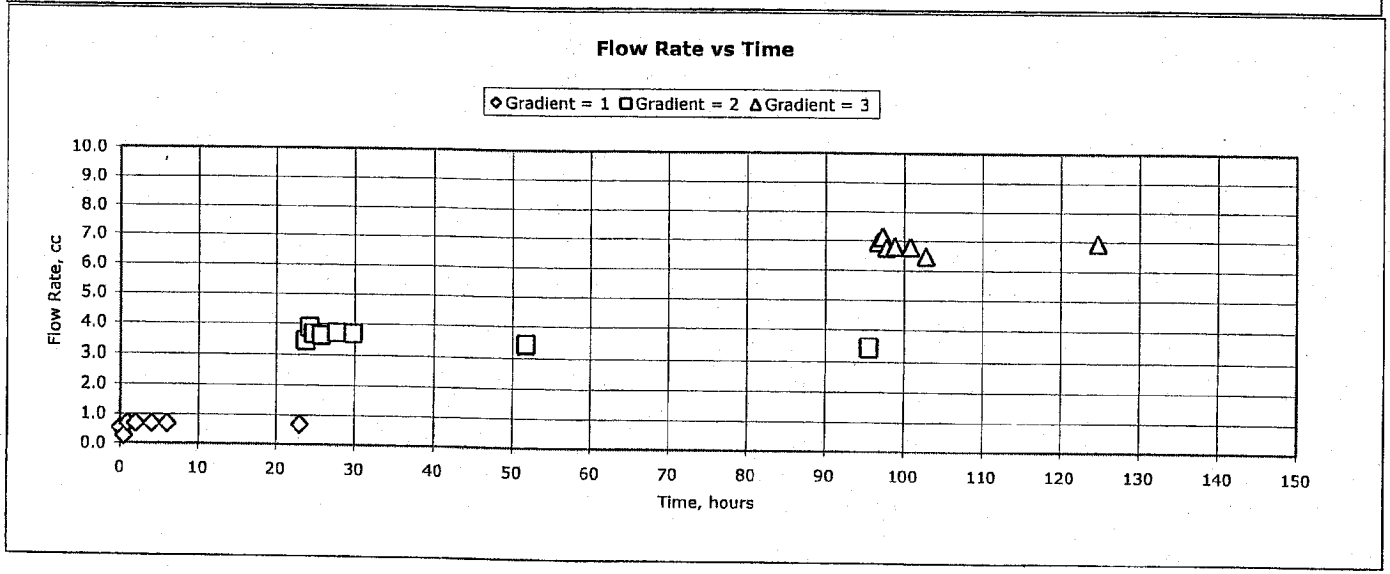
Client:	MACTEC
Project Name:	TVA Kingston Proposed Gypsym Stack Borrow Area
Project Location:	---
GTX #:	G0958
Test Date:	12/28/05-01/10/06
Soil Sample ID:	ASH
Description:	Moist, grayish brown sandy silt
Sample Preparation:	Target Compaction: 95% of maximum dry density (90.0 pcf) at air-dried moisture content.
Geosynthetic Sample ID:	Geocomposite (textile portion only)
Description:	Black, double non-woven geocomposite





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Project Name:	TVA Kingston Proposed Gypsym Stack Borrow Area
Project Location:	---
GTX #:	G0958
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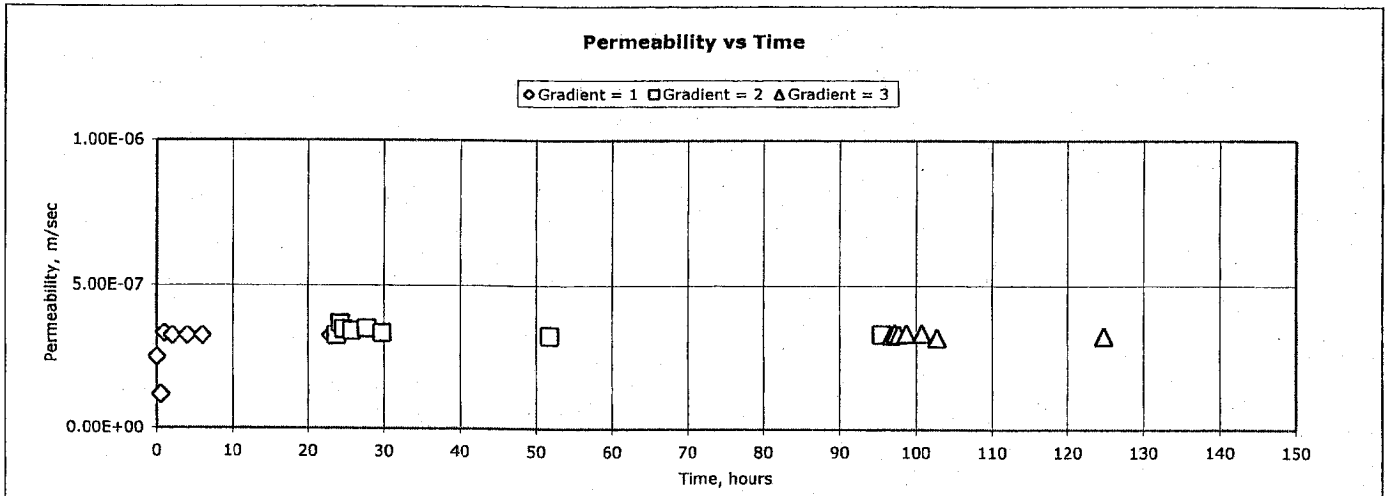
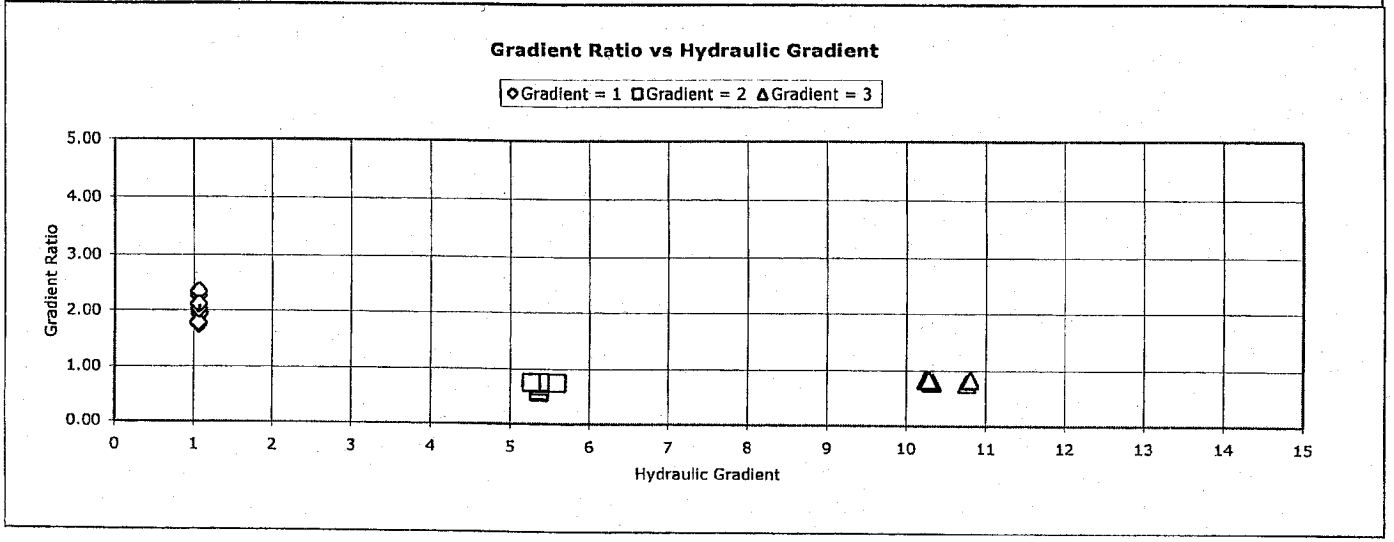




HYDRAULIC CONDUCTIVITY RATIO TEST RESULTS

GeoTesting express

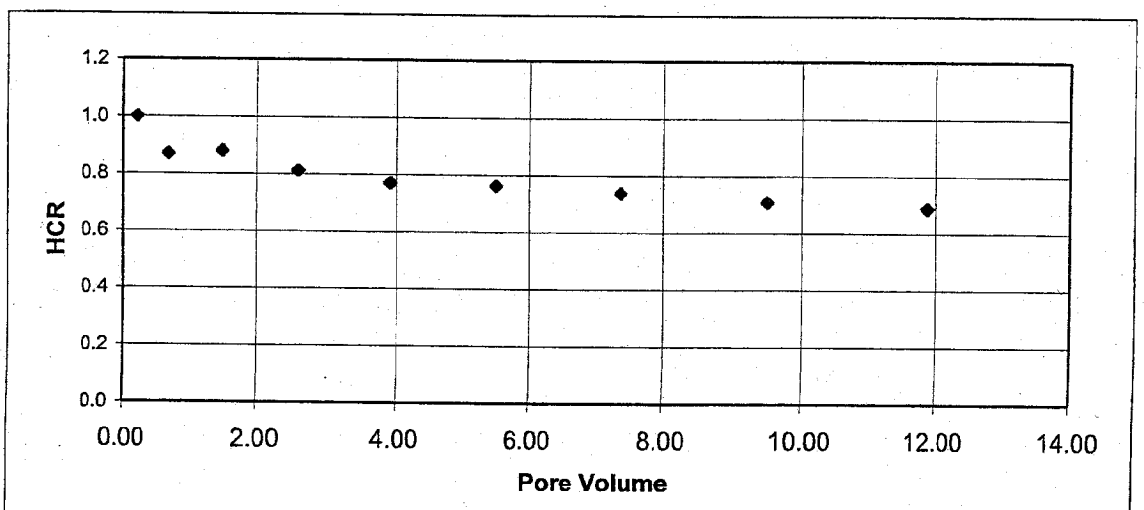
HYDRAULIC CONDUCTIVITY RATIO

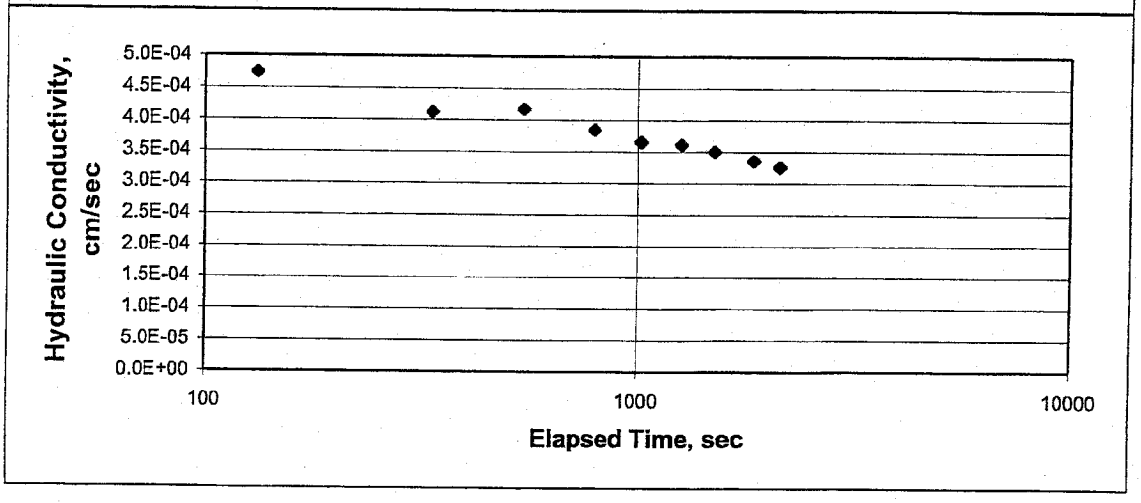
(ASTM D5567)

Project No.	*GTX G0958*	Tested By	*HJ*
Project Name	*TVA Kingston Gypsym Stack*	Test Date	*12/14/2005-12/22/2005*
Boring No.	*Geotextile*	Reviewed By	*JW*
Roll No.	*Effluent appears to be clear*	Review Date	*12/22/2005*
Geotextile		Lab No.	*13731*

Sample Description ***Remolded to 90% of Standard Proctor max. dry density***

Initial Hydraulic Conductivity, cm/sec	4.7E-04
Final Hydraulic Conductivity, cm/sec	3.3E-04
Final HCR	0.69
Hydraulic Gradient Range	12.7 - 10.9





STANDARD PROCTOR COMPACTION TEST RESULTS

COMPACTION TEST REPORT

Project No.: GTX G0958 **Date:** 12/20/05

Project: TVA Kingston Proposed Gypsum Stack Barrow Area

Location: Ash

Elev./Depth: **Sample No.** Bag

Remarks: Tested by: PCS Reviewed by: JDT

MATERIAL DESCRIPTION

Description:

Classifications - **USCS:** **AASHTO:**

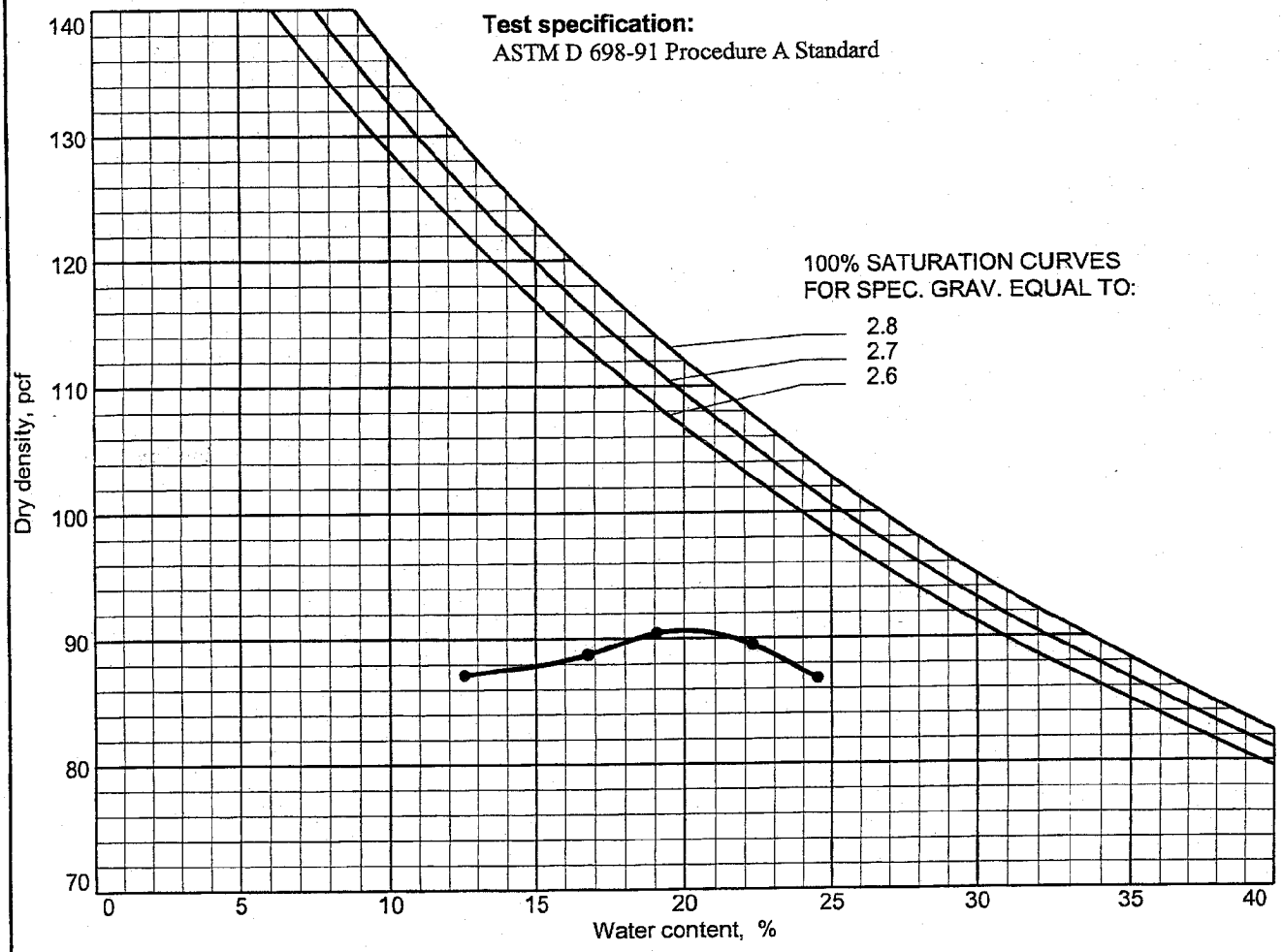
Nat. Moist. = **Sp.G. =** 2.7

Liquid Limit = **Plasticity Index =**

% > No.4 = % **% < No.200 =**

TEST RESULTS
Maximum dry density = 90.6 pcf
Optimum moisture = 20.0 %

Test specification:
ASTM D 698-91 Procedure A Standard



Figure

GeoTesting Express Inc.

COMPACTION TEST REPORT

Project No.: GTX G0958 **Date:** 12/20/06
Project: TVA Kingston Proposed Gypsum Stack Barrow Area

Location: Clay
Elev./Depth: **Sample No.** Bag
Remarks: Tested by: PCS Reviewed by: JDT

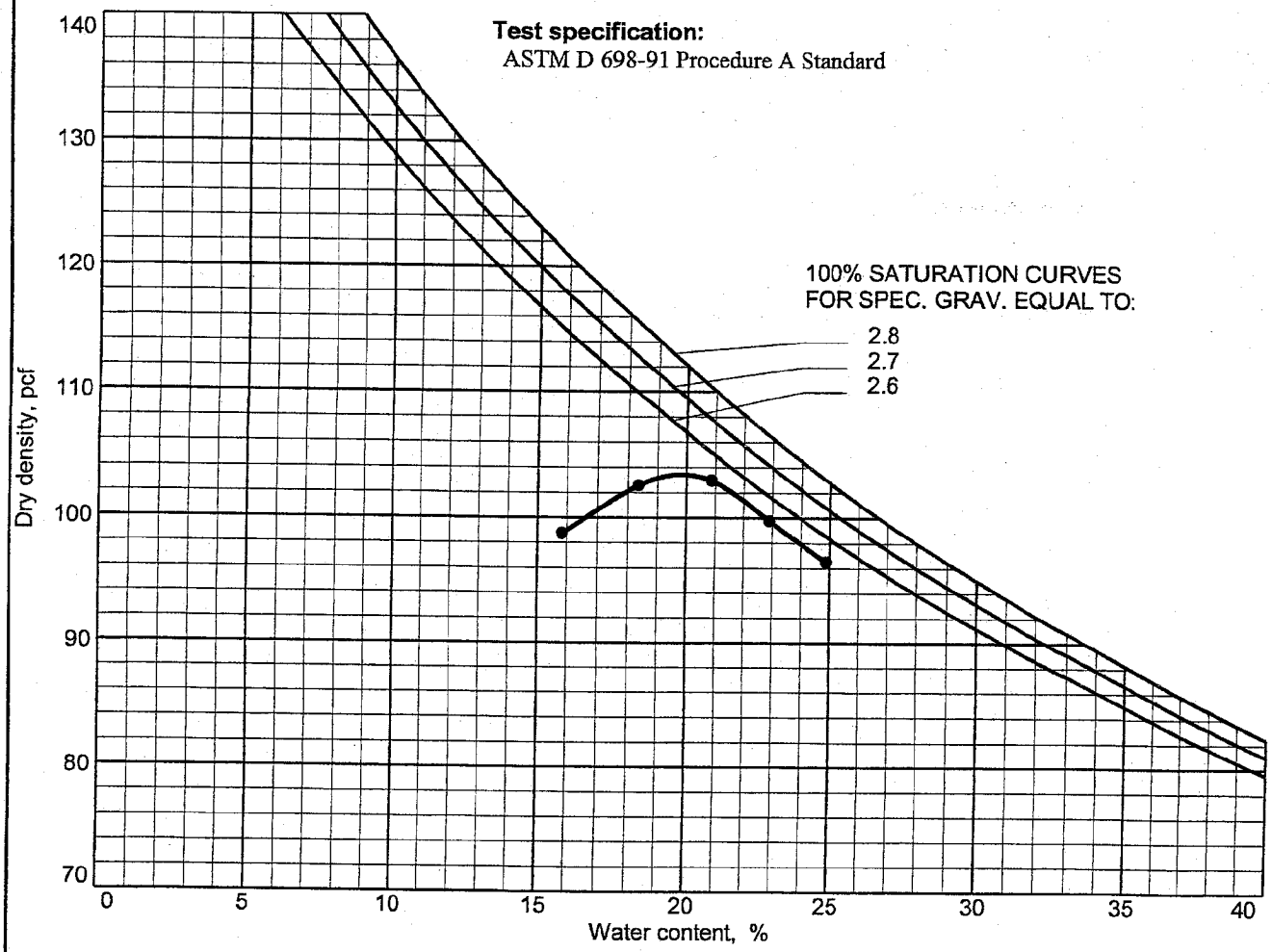
MATERIAL DESCRIPTION

Description:

Classifications - **USCS:** **AASHTO:**
Nat. Moist. = **Sp.G. =** 2.7
Liquid Limit = **Plasticity Index =**
% > No.4 = % **% < No.200 =**

TEST RESULTS
Maximum dry density = 103.5 pcf
Optimum moisture = 19.9 %

Test specification:
ASTM D 698-91 Procedure A Standard



Figure

GeoTesting Express Inc.