CHAS. H. SELLS, INC.
Consulting Engineers, Surveyors & Photogrammetrists

PRINCIPALS
STEVEN W. SMITH, P.E.
SUSAN K. FASNACHT, P.E.
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SENIOR ASSOCIATES
DAN E. BREWER, P.E.
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DAVID K. BRUBAKER, P.L.S.

Cameron Johnson
Fac/Part/Co ID# 18-09
Date 1/24/12
Doc ID#
DIN

VOLUME III
OPERATIONAL COVER
& LEACHATE COLLECTION SYSTEM
CQA REPORT

DUKE ENERGY CORP.
MARSHALL STEAM STATION
FLUE GAS DESULFURIZATION (FGD)
GYPSUM LANDFILL, PHASE 1
CATAWBA COUNTY, NC

Received
OCT 2006
Waste Management

OCTOBER 2006

APPROVED
DIVISION OF WASTE MANAGEMENT
SOLID WASTE SECTION
DATE 11-21-06 BY TJ
1809 PTO A2-DOC 13

128 Overhill Drive • Suite 105 • Mooresville, NC 28117 • Tel: 704.662.0100 • Fax: 704.662.0101 • www.chashsells.com
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CHAS. H. SELLS, INC.

Consulting Engineers, Surveyors & Photogrammetrists

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October 25, 2006

Received
OCT 2006
Waste Management

Fac/Perm/Co ID # | Date / / | Doc ID# | DIN

APPROVED
DIVISION OF WASTE MANAGEMENT
SOLID WASTE SECTION
DATE 11-21-09 BY TJ
1809 PTO AZ Doc13

NCDENR
Division of Waste Management
401 Oberlin Road
Suite 150
Raleigh, NC 27605

Attention: Mr. Ed Mussler, P.E.

Reference: **Volume III–Operational Cover & Leachate Collection System CQA Report**
Marshall FGD Gypsum Landfill
Catawba County, NC

Carmen Johnson
Fac/Perm/Co ID# 18-09 | Date 1/24/12 | Doc ID# | DIN

Gentlemen:

Please find enclosed, Volume III – Operational Cover & Leachate Collection System CQA Report for the above referenced project. This report includes the following information:

Operational Cover Information

Manufacturer's Material Data for Leachate Collection Piping

As-Built Drawings for Operational Cover and Leachate Collection System

Based upon our observations and review of the above data, we find the Operational Cover and Leachate collection system has been constructed in accordance with the approved drawings and technical specifications.

If you have any questions or require additional information, please contact us.

Sincerely,

Chas. H. Sells, Inc.

NORTH CAROLINA PROFESSIONAL SEAL 17582 ENGINEER DAN E. BREWER

Dan E. Brewer

Dan E. Brewer, P.E.
Senior Associate

cc: Mr. Pat McCabe, Duke Energy Corp.

INDEX

OPERATIONAL COVER INFORMATION

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1

NCDENR

NORTH CAROLINA DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES

Dexter R. Matthews, Director | Division of Waste Management | Michael F. Easley, Governor
William G. Ross Jr., Secretary

August 18, 2006

Mr. Pat McCabe, P.E.
Environmental Support
Duke Power
526 S. Church Street
EC10A / PO Box 1006
Charlotte, NC 28201-1006

RE: Duke Energy, Marshall Steam Station, FGD Scrubber Residue Landfill - Phase 1. Request to Use Bottom Ash in the Operation Cover/Leachate Collection Layer, Catawba County, NC Permit No. 18-09

Dear Mr. McCabe,

According to the recent written request by you on behalf of Duke Energy, written on August 7, 2006, to the Solid Waste Section (SWS), it states in part; that "based on particle size studies (of on-site stockpiled soils), no suitable soils are available that would not cause significant clogging with the liner system's 8 oz non-woven geotextile. As a result, Duke Energy is proposing to use bottom ash generated at the Marshal Steam Station in lieu of soil" in the operational cover layer of the FGD Scrubber Residue Landfill.

The Solid Waste Section has reviewed the bottom ash information submitted with the above referenced letter and hereby approves the use of bottom ash as a substitution for the previously approved soil in the operational cover layer. Please document the quantity of ash used and verify the depth of the operational cover clearly. Please submit this information along with the CQA documents following completion of the landfill construction. Upon review and approval of the CQA documentation, the SWS will incorporate the bottom ash substitution request into the list of approved documents for the facility permit.

If you have any questions or comments, please contact myself or Tim Jewett at (919)-508-8495 or (336)-771-5094, respectively.

Sincerely,

Edward F. Mussler III
CN = Edward F. Mussler III, C = US, O = Division of Waste Management, OU = Solid Waste Section
I have reviewed this document and I am approving this document
2006.08.18 11:20:37 -04'00'

Ed Mussler, Permitting Branch Supervisor
Solid Waste Section
Division of Waste Management

cc: Brian Wootton Solid Waste Section | Geoff Little Solid Waste Section
Tim Jewett Solid Waste Section | Central File

2

S&ME

July 11, 2006

Chas. H. Sells, Inc.
128 Overhill Drive
Mooresville, North Carolina 28117

Attention: Mr. William "Bill" Miller, P.E.

Reference: **"BOTTOM ASH" STOCKPILE SAMPLING AND TESTING**
Duke Power – Marshall Steam Station – FGD Landfill
Terrell, North Carolina
S&ME Project 1356-06-403

Dear Mr. Miller:

As requested, S&ME, Inc. (S&ME), collected bulk samples from three "bottom ash" stockpile areas identified as block aggregate, fines, and raw at the Marshall Steam Station. This letter discusses the sampling activities performed on-site and corresponding soil laboratory results.

SAMPLING ACTIVITIES

On June 30, 2006, S&ME collected three bulk samples from the "bottom ash" stockpile areas. One sample was collected from the stockpile identified as block aggregate, one was collected from the stockpile identified as fines, and one was collected from the stockpile identified as raw. Bulk samples were collected at the surface of the stockpile using a small hand trowel.

All samples were collected at the locations determined by Chas H. Sells, Inc. under the direction of Aaron Kitzmiller with Duke Energy while on-site.

LABORATORY RESULTS

S&ME's soil laboratory performed grain size analyses with hydrometers on the three "bottom ash" samples collected. The results of the laboratory testing are included on the attached laboratory test data sheets for the samples.

S&ME appreciates this and every opportunity we have to be of service to you. We trust this information is responsive to your needs at this time. If you have any questions, please contact us at your convenience. Thank you for choosing S&ME.

Sincerely,

S&ME, Inc.

Julie R. Petersen, P.G.
Hydrogeologist

Christopher J.L. Stahl, P.E.
Senior Project Manager

Attachments: Soil Laboratory Test Data Sheets

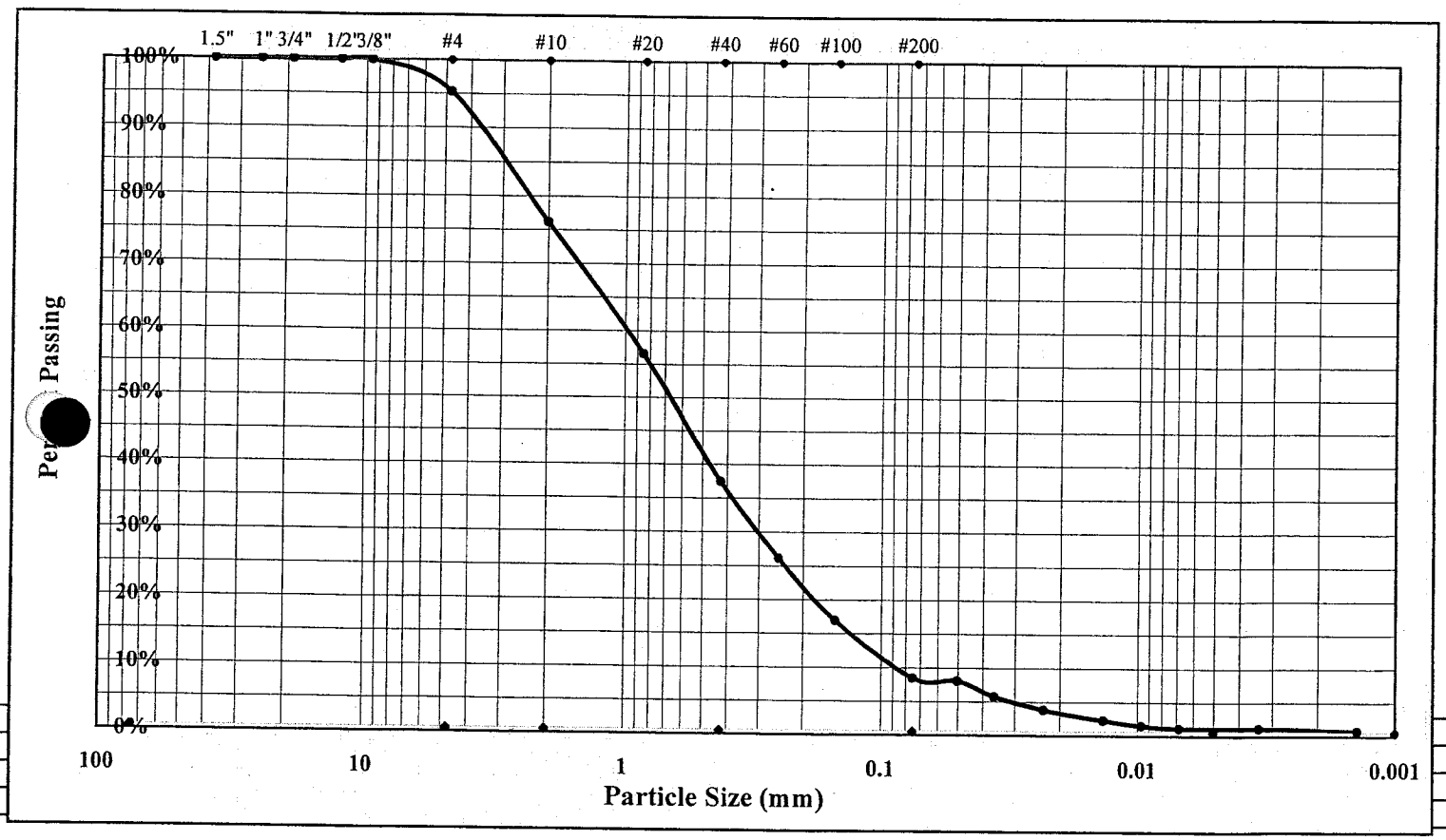
Particle Size Analysis of Soils

ASTM D 422

S&ME

S&ME Project #:	**1356-06-403**	Report Date:	7/10/06
Project Name:	**Marshall Steam Station - Ash Samples**	Test Date(s):	7/3-10/06
Client Name:	Duke Energy		
Client Address:			

Boring #:	Bottom Ash-Block Agg.	Sample #:	S-1	Sample Date:	6/30/06
Location:	Marshall Steam Station	Offset:		Depth:	
Sample Description:	Bottom Ash				



Maximum Particle Size	0	Gravel	4.7%	Silt	4.1%
Silt & Clay (% Passing #200)	8.4%	Sand	86.9%	Clay	4.3%
Apparent Relative Density (Assumed)	2.650	Moisture Content		Colloids	
Liquid Limit		Plastic Limit		Plastic Index	

Description of Sand & Gravel Particles Rounded ☐ Angular ☐ Hard & Durable ☐ Soft ☐ Weathered & Friable ☐

Mechanical Stirring Apparatus (A) Length of Dispersion Period: 1 min. Dispersing Agent: Sodium Hexametaphosphate: 40 g./ Liter

References: ASTM D 422: Particle Size Analysis of Soils
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils
ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)
Direct entry in this cell is allowed

ASTM D 421: Dry Preparation of Soil Samples
ASTM D 854: Specific Gravity of Soils
Direct entry in this cell is allowed
Direct entry in this cell is allowed

Technical Responsibility: Julie Petersen

Signature *Position*

Particle Size Analysis of Soils

A[illegible]D 422

S&ME

Project #: 1356-06-403
Project Name: Marshall Steam Station - Ash Samples
Client Name: Duke Energy
Client Address:

Test Date(s): 7/3-10/06
Report Date: 7/10/06

Boring #: Bottom Ash-Block Agg. Sample #: S-1 Sample Date: 6/30/06
Location: Marshall Steam Station Offset: Depth:
Sample Description: Bottom Ash

Pan #:	538	Beaker #:	RR
Hydrometer Jar #:			6
Pan Tare Weight (grams):			
Total Sample Air Dried Wt. + tare wt. (grams):			239.50
Weight of Total Sample Air Dried:			239.50
Weight of Air Dried Hydrometer Sample (g):			100.00
Total Sample Oven Dried:			239.33
Hydrometer Sample Oven Dried (W):			99.91
% Passing #10:			76.1%
Correction Factor a (Table 1):			1.00

Apparent Relative Density (Assumed) 2.650

	Moisture Content	Hygroscopic	Natural
	Tare #	4	
A	Tare Wt.	14.00	
B	Wet Wt. + A	24.81	
C	Dry Wt. + A	24.80	
D	Water Wt. (B-C)	0.01	
E	Dry Wt. (C-A)	10.80	
	% Moisture (100 x D/E)	0.09%	

Sieve	Retained Wt.	Percent Passing	
3.0"		Pan # (washed)	100.0%
1.5"			100.0%
1.0"			100.0%
3/4"			100.0%
1/2"			100.0%
3/8"	0.0		100.0%
#4	11.3	Soil Mortar	95.3%
#10	57.1	**100.0%**	76.1%
#20	25.7	74.2%	56.5%
#40	50.8	49.2%	37.4%
#60	65.6	34.3%	26.2%
#100	77.7	22.3%	16.9%
#200	88.9	11.0%	8.4%

Notes: Description of Sand & Gravel Particles Rounded ☐ Angular ☐ Hard & Durable ☐ Soft ☐ Weathered & Friable ☐

Maximum Particle Size:			Total Sand:	86.9%	< 4.74 mm and > 0.075 mm	Type:	Mechanical Stirring Apparatus (A)
% Gravel:	4.7%	< 75 mm and > 4.75 mm	Silt & Clay:	8.4%	< 0.075	Dispersion Time:	1 min.
Coarse Sand:	19.1%	< 4.75 mm and > 2.00 mm	Silt:	4.1%	< 0.075 and > 0.005 mm	Sodium Hexametaphosphate:	40 g./ Liter
Medium Sand:	38.7%	< 2.00 mm and > 0.425 mm	Clay:	4.3%	< 0.005 mm		
Fine Sand:	29.0%	< 0.425 mm and > 0.075 mm	Colloids:		< 0.001 mm	**Control Cylinder** ☒	**Composite Correction** ☐

Liquid Limit Plastic Limit Plastic Index Hydrometer: 151H ☐ 152H ☒

Time		Temp.	Hydrometer	Corrections		Hydrometer	Percent Passing		Effective Depth	Table 3	Diameter
Clock	T (Min.)	(0.5 °C)	Reading	Control Cylinder	Composite Correction	R	P(-#10) = (R x a / W) x 100	P (total) = P x % Passing #10	L	K	D = K x ((L/T)^1/2
	1	23.0	17.5	7.0		10.50	10.5%	8.0%	14.6	0.01317	0.05028
	2	23.0	14.5	7.0		7.50	7.5%	5.7%	15.1	0.01317	0.03615
	5	23.0	12.0	7.0		5.00	5.0%	3.8%	15.5	0.01317	0.02317
	15	23.0	10.0	7.0		3.00	3.0%	2.3%	15.8	0.01317	0.01352
	30	23.0	9.0	7.0		2.00	2.0%	1.5%	16.0	0.01317	0.00961
	60	23.0	8.5	7.0		1.50	1.5%	1.1%	16.0	0.01317	0.00681
	250	22.5	8.5	7.0		1.50	1.5%	1.1%	16.0	0.01325	0.00336
	1440	22.5	8.0	7.0		1.00	1.0%	0.8%	16.1	0.01325	0.00140

References: ASTM D 422: Particle Size Analysis of Soils ASTM D 421: Dry Preparation of Soil Samples ASTM D 854: Specific Gravity of Soils
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Effective Depth (cm)
L=L1+0.5(L2-(VB/A))
(152H) .164cm per increment,
V_B=67.0cm^3, L_2=14cm, A=27.8cm^2

Technician Name: Karen Warner / Jennifer Olsen

Technical Responsibility: Julie Petersen

Certification #

Signature

Position

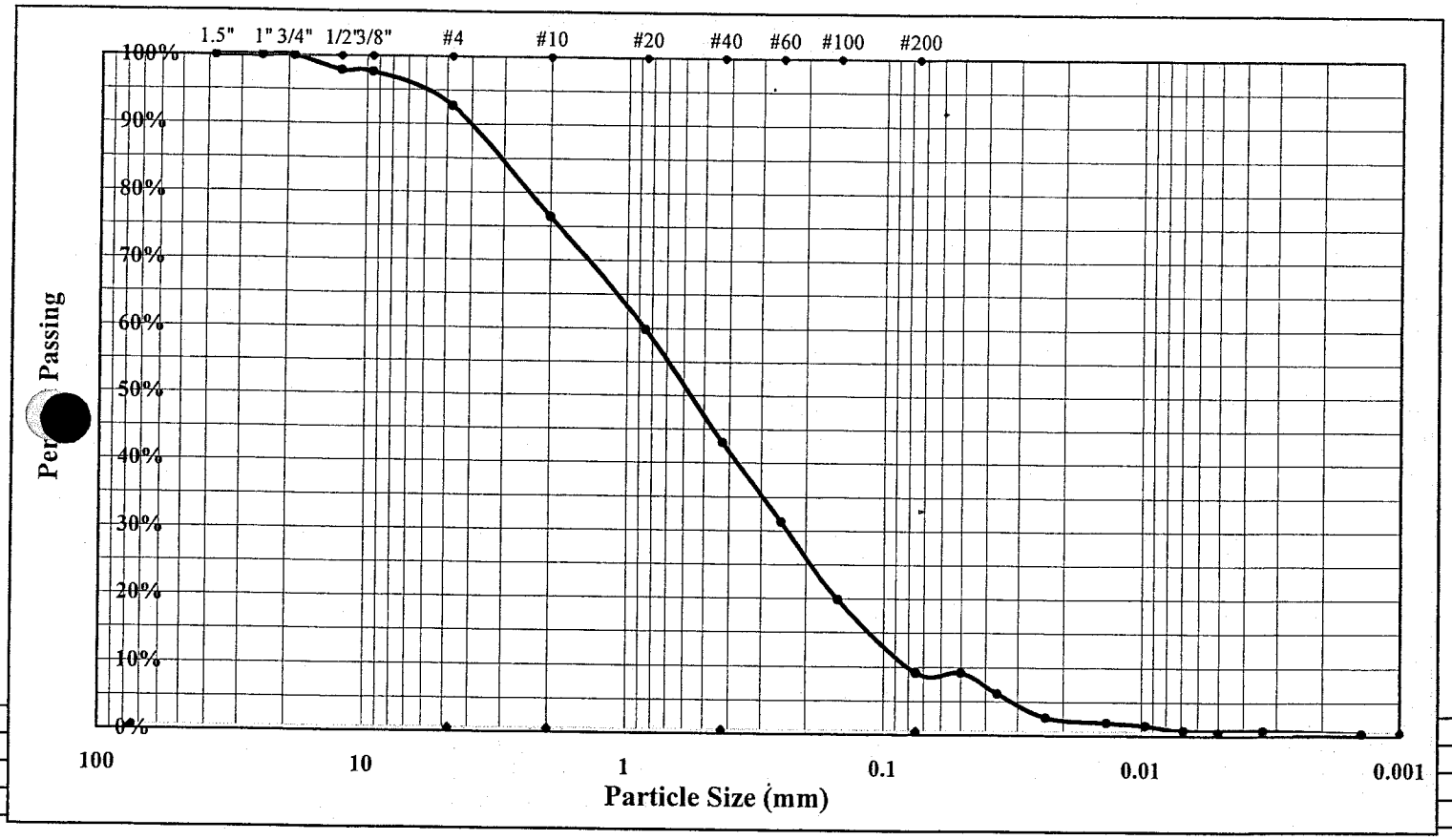
Particle Size Analysis of Soils

ASTM D 422

S&ME

S&ME Project #:	**1356-06-403**	Report Date:	7/10/06
Project Name:	**Marshall Steam Station - Ash Samples**	Test Date(s):	7/3-10/06
Client Name:	Duke Energy		
Client Address:			

Boring #:	Bottom Ash - Raw	Sample #:	S-2	Sample Date:	6/30/06
Location:	Marshall Steam Station	Offset:		Depth:	
Sample Description:	Bottom Ash				



Maximum Particle Size	0	Gravel	7.3%	Silt	4.8%
Silt & Clay (% Passing #200)	9.1%	Sand	83.5%	Clay	4.3%
Apparent Relative Density (Assumed)	2.650	Moisture Content		Colloids	
Liquid Limit		Plastic Limit		Plastic Index	

Description of Sand & Gravel Particles Rounded ☐ Angular ☐ Hard & Durable ☐ Soft ☐ Weathered & Friable ☐

Mechanical Stirring Apparatus (A) Length of Dispersion Period: 1 min. Dispersing Agent: Sodium Hexametaphosphate: 40 g./ Liter

References: ASTM D 422: Particle Size Analysis of Soils
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils
ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)
Direct entry in this cell is allowed

ASTM D 421: Dry Preparation of Soil Samples
ASTM D 854: Specific Gravity of Soils
Direct entry in this cell is allowed
Direct entry in this cell is allowed

Technical Responsibility: Julie Petersen

Signature *Position*

Particle Size Analysis of Soils

AS[illegible]D 422

S&ME

Project #: 1356-06-403
Project Name: Marshall Steam Station - Ash Samples
Client Name: Duke Energy
Client Address:

Test Date(s): 7/3-10/06
Report Date: 7/10/06

Boring #: Bottom Ash - Raw Sample #: S-2 Sample Date: 6/30/06
Location: Marshall Steam Station Offset: Depth:
Sample Description: Bottom Ash

Pan #:	DJ	Beaker #:	YY
Hydrometer Jar #:			3
Pan Tare Weight (grams):			
Total Sample Air Dried Wt. + tare wt. (grams):			213.22
Weight of Total Sample Air Dried:			213.22
Weight of Air Dried Hydrometer Sample (g):			100.00
Total Sample Oven Dried:			213.09
Hydrometer Sample Oven Dried (W):			99.92
% Passing #10:			76.4%
Correction Factor a (Table 1):			1.00

Apparent Relative Density (Assumed) 2.650

	Moisture Content	Hygroscopic	Natural
	Tare #	XX	
A	Tare Wt.	16.07	
B	Wet Wt. + A	28.74	
C	Dry Wt. + A	28.73	
D	Water Wt. (B-C)	0.01	
E	Dry Wt. (C-A)	12.66	
	% Moisture (100 x D/E)	0.08%	

Sieve	Retained Wt.	Percent Passing	
3.0"		Pan # (washed)	100.0%
1.5"			100.0%
1.0"			100.0%
3/4"	0.0		100.0%
1/2"	4.4		97.9%
3/8"	4.9		97.7%
#4	15.6	Soil Mortar	92.7%
#10	50.2	100.0%	76.4%
#20	21.7	78.3%	59.8%
#40	43.6	56.3%	43.1%
#60	59.0	41.0%	31.3%
#100	74.0	25.9%	19.8%
#200	88.0	12.0%	9.1%

Notes: Description of Sand & Gravel Particles Rounded ☐ Angular ☐ Hard & Durable ☐ Soft ☐ Weathered & Friable ☐

Maximum Particle Size:			Total Sand:	83.5%	< 4.74 mm and > 0.075 mm	Type: Mechanical Stirring Apparatus (A)
% Gravel:	7.3%	< 75 mm and > 4.75 mm	Silt & Clay:	9.1%	< 0.075	Dispersion Time: 1 min.
Coarse Sand:	16.3%	< 4.75 mm and > 2.00 mm	Silt:	4.8%	< 0.075 and > 0.005 mm	Sodium Hexametaphosphate: 40 g./ Liter
Medium Sand:	33.4%	< 2.00 mm and > 0.425 mm	Clay:	4.3%	< 0.005 mm	
Fine Sand:	33.9%	< 0.425 mm and > 0.075 mm	Colloids:		< 0.001 mm	Control Cylinder ☒ Composite Correction ☐

Liquid Limit Plastic Limit Plastic Index Hydrometer: 151H ☐ 152H ☒

Time		Temp.	Hydrometer	Corrections		Hydrometer	Percent Passing		Effective Depth	Table 3	Diameter
Clock	T (Min.)	(0.5 °C)	Reading	Control Cylinder	Composite Correction	R	P(-#10) = (R x a / W) x 100	P (total) = P x % Passing #10	L	K	D = K x ((L/T)^1/2
	1	23.0	19.0	7.0		12.00	12.0%	9.2%	14.3	0.01317	0.04985
	2	23.0	15.0	7.0		8.00	8.0%	6.1%	15.0	0.01317	0.03605
	5	23.0	10.5	7.0		3.50	3.5%	2.7%	15.7	0.01317	0.02335
	15	23.0	9.5	7.0		2.50	2.5%	1.9%	15.9	0.01317	0.01355
	30	23.0	9.0	7.0		2.00	2.0%	1.5%	16.0	0.01317	0.00961
	60	23.0	8.0	7.0		1.00	1.0%	0.8%	16.1	0.01317	0.00683
	250	22.5	8.0	7.0		1.00	1.0%	0.8%	16.1	0.01325	0.00336
	1440	23.0	7.5	7.0		0.50	0.5%	0.4%	16.2	0.01317	0.00140

References: ASTM D 422: Particle Size Analysis of Soils ASTM D 421: Dry Preparation of Soil Samples ASTM D 854: Specific Gravity of Soils
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Effective Depth (cm)
L=L1+0.5(L2-(VB/A))
(152H) .164cm per increment,
V_B=67.0cm^3, L_2=14cm, A=27.8cm^2

Technician Name: Karen Warner / Jennifer Olsen *Certification #*

Technical Responsibility: Julie Petersen *Signature* *Position*

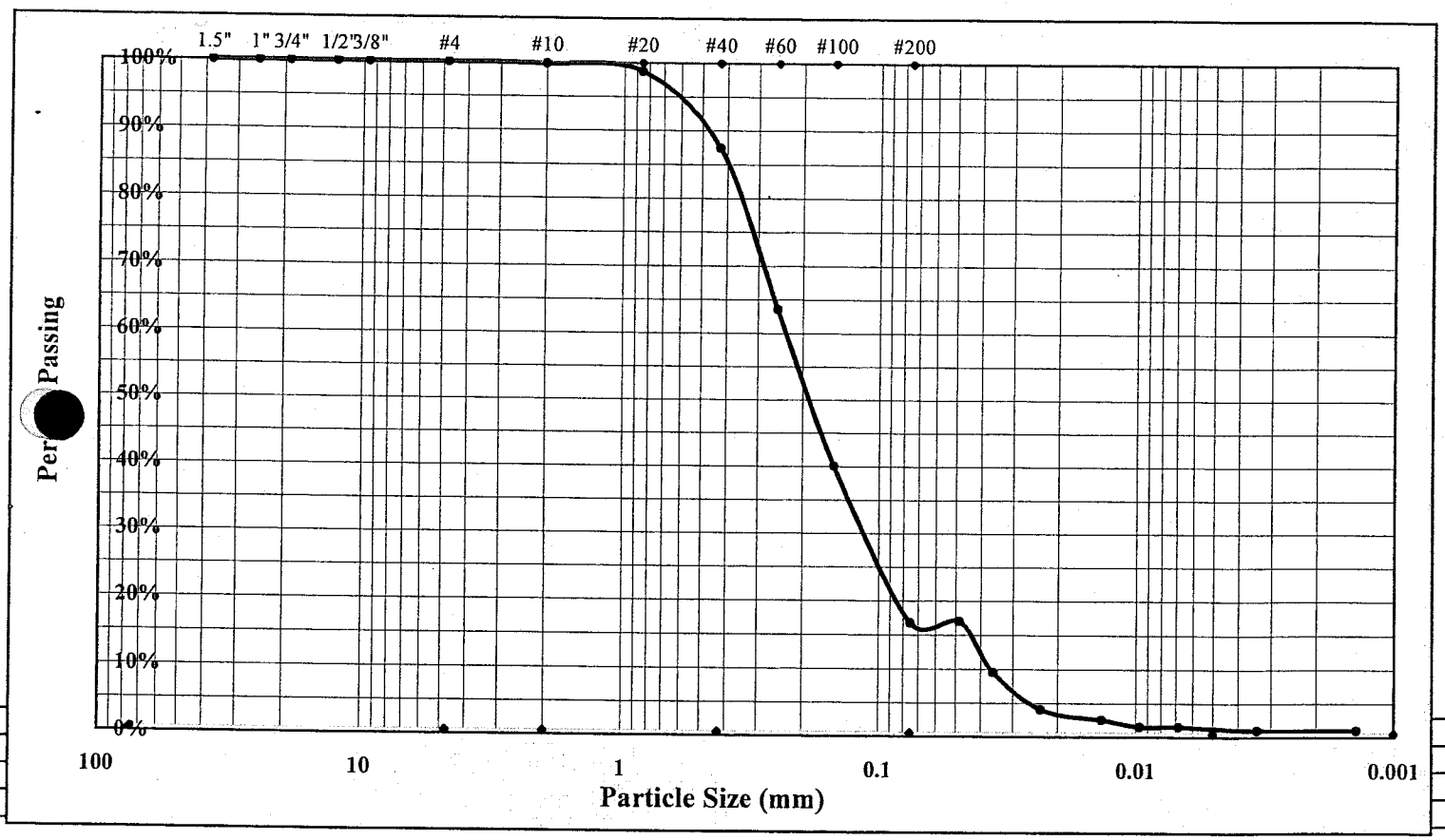
Particle Size Analysis of Soils

ASTM D 422

S&ME

S&ME Project #:	**1356-06-403**	Report Date:	7/10/06
Project Name:	**Marshall Steam Station - Ash Samples**	Test Date(s):	7/3-10/06
Client Name:	Duke Energy		
Client Address:			

Boring #:	Bottom Ash - Fines	Sample #:	S-3	Sample Date:	6/30/06
Location:	Marshall Steam Station	Offset:		Depth:	
Sample Description:	Bottom Ash				



Maximum Particle Size	0	Gravel	0.0%	Silt	12.5%
Silt & Clay (% Passing #200)	16.8%	Sand	83.2%	Clay	4.3%
Apparent Relative Density (Assumed)	2.650	Moisture Content		Colloids	
Liquid Limit		Plastic Limit		Plastic Index	

Description of Sand & Gravel Particles Rounded ☐ Angular ☐ Hard & Durable ☐ Soft ☐ Weathered & Friable ☐

Mechanical Stirring Apparatus (A) Length of Dispersion Period: 1 min. Dispersing Agent: Sodium Hexametaphosphate: 40 g./ Liter

References: ASTM D 422: Particle Size Analysis of Soils

ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils

ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Direct entry in this cell is allowed

ASTM D 421: Dry Preparation of Soil Samples

ASTM D 854: Specific Gravity of Soils

Direct entry in this cell is allowed

Direct entry in this cell is allowed

Technical Responsibility: Julie Petersen

Signature *Position*

Particle Size Analysis of Soils

AS[illegible]D 422

S&ME

Project #: 1356-06-403
Project Name: Marshall Steam Station - Ash Samples
Client Name: Duke Energy
Client Address:

Test Date(s): 7/3-10/06
Report Date: 7/10/06

Boring #: Bottom Ash - Fines Sample #: S-3 Sample Date: 6/30/06
Location: Marshall Steam Station Offset: Depth:
Sample Description: Bottom Ash

Pan #:	534	Beaker #:	ZZ
Hydrometer Jar #:			1
Pan Tare Weight (grams):			
Total Sample Air Dried Wt. + tare wt. (grams):			194.77
Weight of Total Sample Air Dried:			194.77
Weight of Air Dried Hydrometer Sample (g):			100.00
Total Sample Oven Dried:			193.85
Hydrometer Sample Oven Dried (W):			99.53
% Passing #10:			99.8%
Correction Factor a (Table 1):			1.00

Apparent Relative Density (Assumed) 2.650

	Moisture Content	Hygroscopic	Natural
	Tare #	32	
A	Tare Wt.	13.94	
B	Wet Wt. + A	24.48	
C	Dry Wt. + A	24.43	
D	Water Wt. (B-C)	0.05	
E	Dry Wt. (C-A)	10.49	
	% Moisture (100 x D/E)	0.48%	

Sieve	Retained Wt.	Percent Passing	
3.0"		Pan # (washed)	100.0%
1.5"			100.0%
1.0"			100.0%
3/4"			100.0%
1/2"			100.0%
3/8"			100.0%
#4	0.0	Soil Mortar	100.0%
#10	0.4	100.0%	99.8%
#20	1.1	98.9%	98.7%
#40	12.3	87.6%	87.5%
#60	36.1	63.7%	63.6%
#100	59.6	40.1%	40.1%
#200	82.8	16.8%	16.8%

Notes: Description of Sand & Gravel Particles Rounded ☐ Angular ☐ Hard & Durable ☐ Soft ☐ Weathered & Friable ☐

Maximum Particle Size:			Total Sand:	83.2%	< 4.74 mm and > 0.075 mm
% Gravel:	0.0%	< 75 mm and > 4.75 mm	Silt & Clay:	16.8%	< 0.075
Coarse Sand:	0.2%	< 4.75 mm and > 2.00 mm	Silt:	12.5%	< 0.075 and > 0.005 mm
Medium Sand:	12.3%	< 2.00 mm and > 0.425 mm	Clay:	4.3%	< 0.005 mm
Fine Sand:	70.7%	< 0.425 mm and > 0.075 mm	Colloids:		< 0.001 mm

Type: Mechanical Stirring Apparatus (A)
Dispersion Time: 1 min.
Sodium Hexametaphosphate: 40 g./ Liter

Control Cylinder ☒ **Composite Correction** ☐

Liquid Limit Plastic Limit Plastic Index Hydrometer: 151H ☐ 152H ☒

Time		Temp.	Hydrometer	Corrections		Hydrometer	Percent Passing		Effective Depth	Table 3	Diameter
Clock	T (Min.)	(0.5 °C)	Reading	Control Cylinder	Composite Correction	R	P(-#10) = (R x a / W) x 100	P (total) = P x % Passing #10	L	K	D = K x ((L/T)^1/2
	1	23.0	24.0	7.0		17.00	17.1%	17.0%	13.5	0.01317	0.04840
	2	23.0	16.5	7.0		9.50	9.5%	9.5%	14.7	0.01317	0.03575
	5	23.0	11.0	7.0		4.00	4.0%	4.0%	15.6	0.01317	0.02329
	15	23.0	9.5	7.0		2.50	2.5%	2.5%	15.9	0.01317	0.01355
	30	23.0	8.5	7.0		1.50	1.5%	1.5%	16.0	0.01317	0.00963
	60	23.0	8.5	7.0		1.50	1.5%	1.5%	16.0	0.01317	0.00681
	250	22.5	8.0	7.0		1.00	1.0%	1.0%	16.1	0.01325	0.00336
	1440	23.0	8.0	7.0		1.00	1.0%	1.0%	16.1	0.01317	0.00139

References: ASTM D 422: Particle Size Analysis of Soils ASTM D 421: Dry Preparation of Soil Samples ASTM D 854: Specific Gravity of Soils
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Effective Depth (cm)
L=L1+0.5(L2-(VB/A))
(152H) .164cm per increment,
V_B=67.0cm^3, L_2=14cm, A=27.8cm^2

Technician Name: Karen Warner / Jennifer Olsen *Certification #*

Technical Responsibility: Julie Petersen *Signature* *Position*

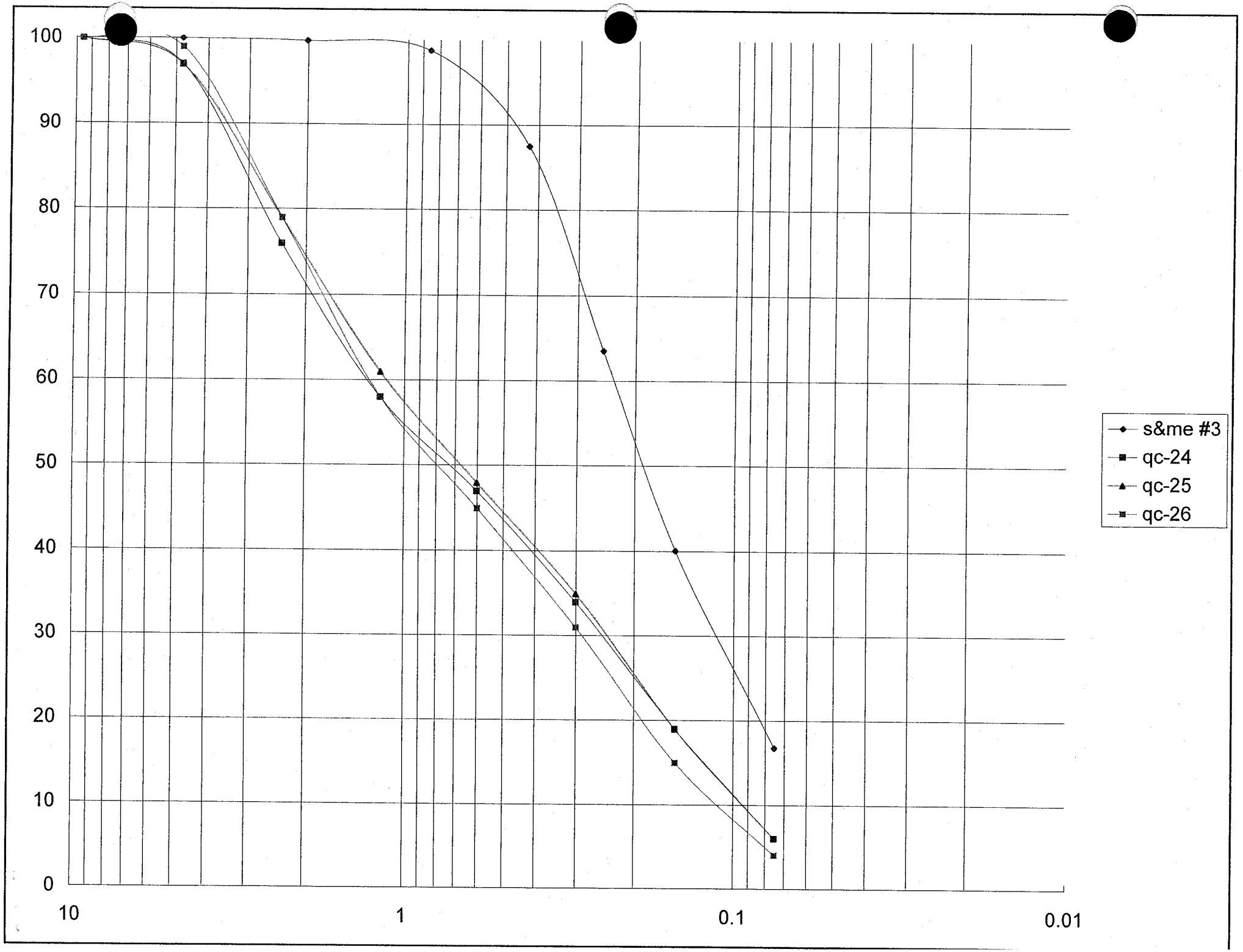
Plant Name : Statesville

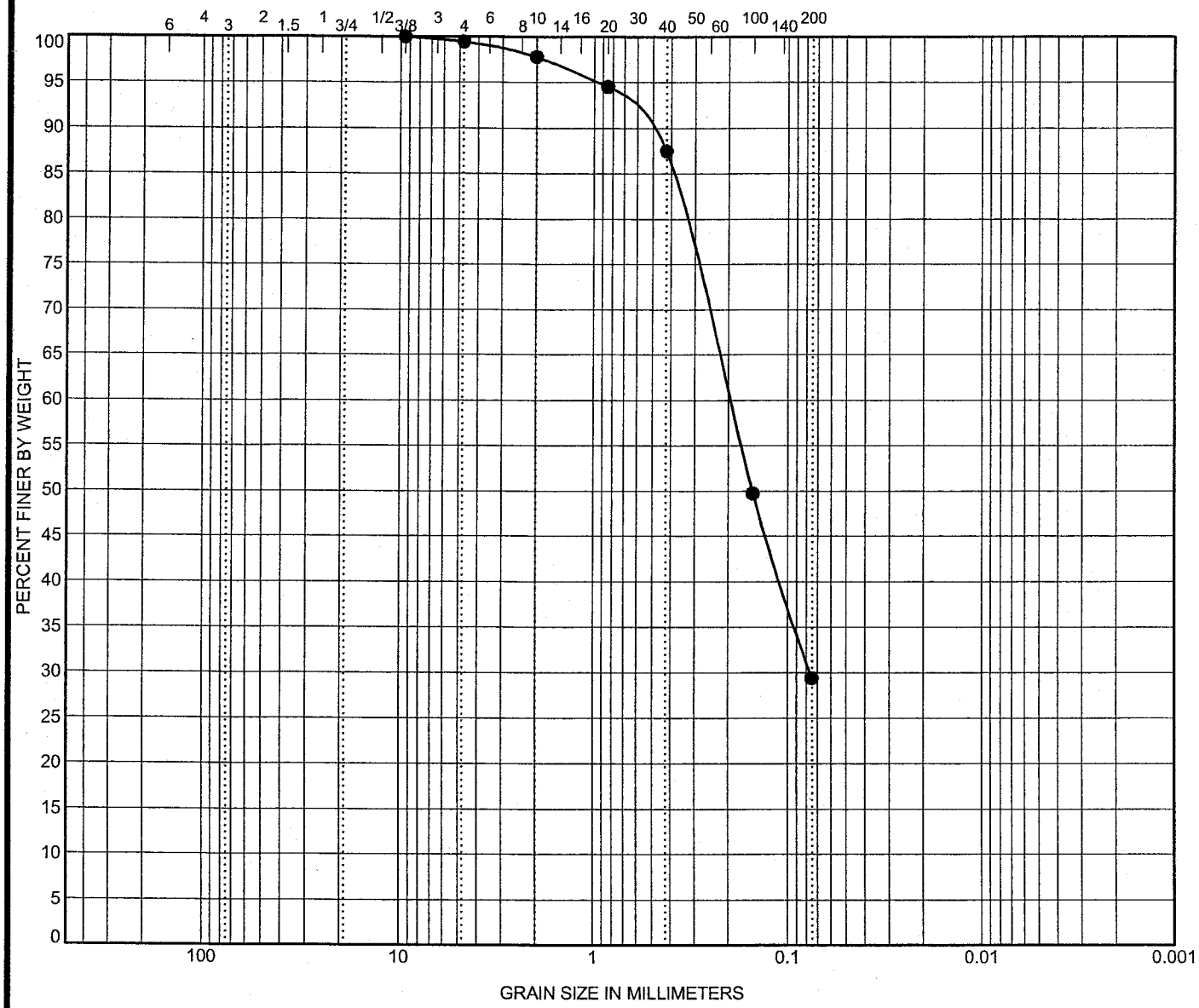
Product : 607 Washed Scgs

MMA Number : 628

NCDOT Number : CA 054

Screen Size		3/8"	#4	#8	#16	#30	#50	#100	#200
Average		100.0	97.7	78.0	59.0	46.7	33.3	17.7	5.3
Standard Deviation		0.0	1.2	1.7	1.7	1.5	2.1	2.3	1.2
Date	QC Number								
	QC-24	100	97	76	58	47	34	19	6.0
	QC-25	100	97	79	61	48	35	19	6.0
	QC-26	100	99	79	58	45	31	15	4.0


100
90
80
70
60
50
40
30
20
10
0
10
1
0.1
0.01
s&me #3
qc-24
qc-25
qc-26



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification	Description / Source	LL	PL	PI	Cc	Cu
●	**S-3**	**Fly Ash / On Site**					

	Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**S-3**	**9.5**	**0.199**	**0.076**		**0.5**	**70.0**	**29.4**	

ESP Associates, P.A.
engineering • surveying • planning
P.O. Box 7030
Charlotte, NC 28241
Telephone: 704.583.4949
Fax: 704.583.4950

GRAIN SIZE DISTRIBUTION

Project: Marshall - Gypsum Landfill CQA

Location: Catawba, North Carolina

Number: E3-UG45.400

3

June 21, 2006

Chas. H. Sells, Inc.
128 Overhill Drive
Mooresville, North Carolina 28117

Attention: Mr. William "Bill" Miller, P.E.

Reference: **SOIL STOCKPILE SAMPLING AND TESTING**
Duke Power – Marshall Steam Station – FGD Landfill
Terrell, North Carolina
S&ME Project 1356-06-403

Dear Mr. Miller:

As requested, S&ME, Inc. (S&ME), collected bulk samples from the FGD landfill soil stockpile area at the Marshall Steam Station at locations and depths requested by you on-site. This letter discusses the sampling activities performed on-site and corresponding soil laboratory results.

SAMPLING ACTIVITIES

On May 18, 2006, S&ME collected twelve bulk samples from the FGD landfill soil stockpile area. Bulk soil samples were collected using a rubber tire backhoe from twelve widely spaced locations. Soil samples are identified as S-1 through S-12. Samples S-1 through S-10 were collected at depths of four to five feet below land surface, and samples S-11 and S-12 were collected at the surface using a shovel.

All samples were collected at the locations determined by Chas H. Sell, Inc. under the direction of Bill Miller while on-site.

SOIL LABORATORY RESULTS

S&ME's soil laboratory performed grain size analyses with double hydrometer and atterburg limits on selected bulk samples. At Chas H. Sells, Inc. request, soil samples S-1, S-3, S-5, S-8, S-9, and S-12 were selected for soil testing. The results of the soil laboratory testing are included on the attached laboratory test data sheets for the selected soil samples.

S&ME appreciates this and every opportunity we have to be of service to you. We trust this information is responsive to your needs at this time. If you have any questions, please contact us at your convenience. Thank you for choosing S&ME.

Sincerely,

S&ME, Inc.

Julie R. Petersen, P.G.
Hydrogeologist

Christopher J.L. Stahl, P.E.
Senior Project Manager

Attachments: Soil Laboratory Test Data Sheets

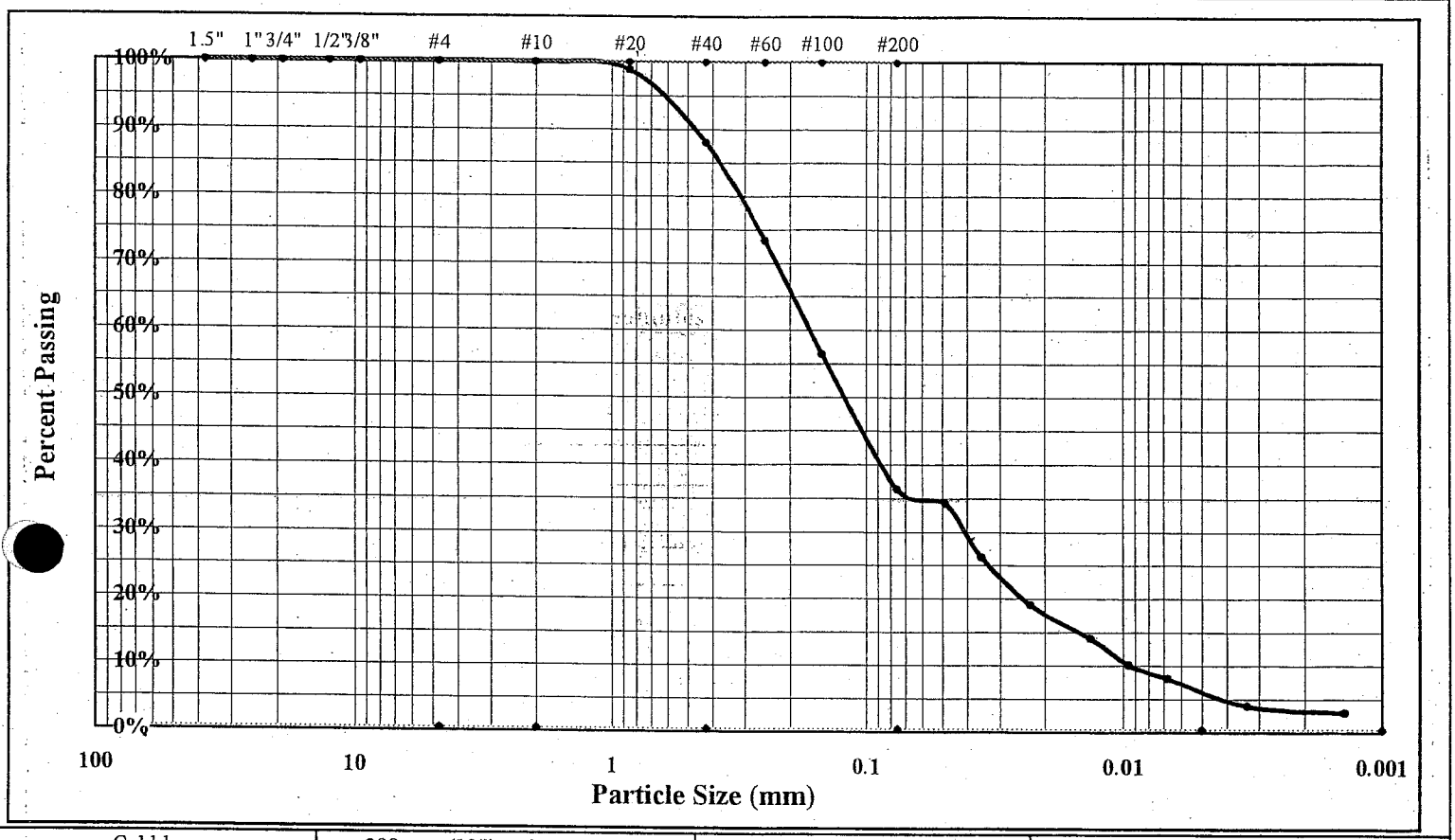
Particle Size Analysis of Soils

ASTM D 422

S&ME

S&ME Project #:	**1356-06-403**	Report Date:	6/5/06
Project Name:	**Marshall Steam Station Bulk Samples**	Test Date(s):	5/19-23/06
Client Name:	Duke Energy		
Client Address:			

Boring #:	S-1	Sample #:		Sample Date:	
Location:		Offset:		Depth:	4-5'
Sample Description:	Tan Orange Brown Micaceous Clayey Silty Sand (SM)				



Cobbles	< 300 mm (12") and > 75 mm (3")	Fine Sand	< 0.425 mm and > 0.075 mm (#200)
Gravel	< 75 mm and > 4.75 mm (#4)	Silt	< 0.075 and > 0.005 mm
Coarse Sand	< 4.75 mm and >2.00 mm (#10)	Clay	< 0.005 mm
Medium Sand	< 2.00 mm and > 0.425 mm (#40)	Colloids	< 0.001 mm

Maximum Particle Size	0	Gravel	0.0%	Silt	30.3%
Silt & Clay (% Passing #200)	36.3%	Sand	63.7%	Clay	6.0%
Apparent Relative Density (Assumed)	2.650	Moisture Content		Colloids	
Liquid Limit	NP	Plastic Limit	NP	Plastic Index	NP

Description of Sand & Gravel Particles Rounded ☐ Angular ☐ Hard & Durable ☐ Soft ☐ Weathered & Friable ☐

Mechanical Stirring Apparatus (A) Length of Dispersion Period: 1 min. Dispersing Agent: Sodium Hexametaphosphate: 40 g./ Liter

References: ASTM D 422: Particle Size Analysis of Soils ASTM D 421: Dry Preparation of Soil Samples
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils ASTM D 854: Specific Gravity of Soils
ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Technical Responsibility: Julie Peterson *Signature* *Position*

S&ME, INC. 9751 Southern Pine Blvd., Charlotte, NC 28273 1356-06-403S1 HYDRO.xls

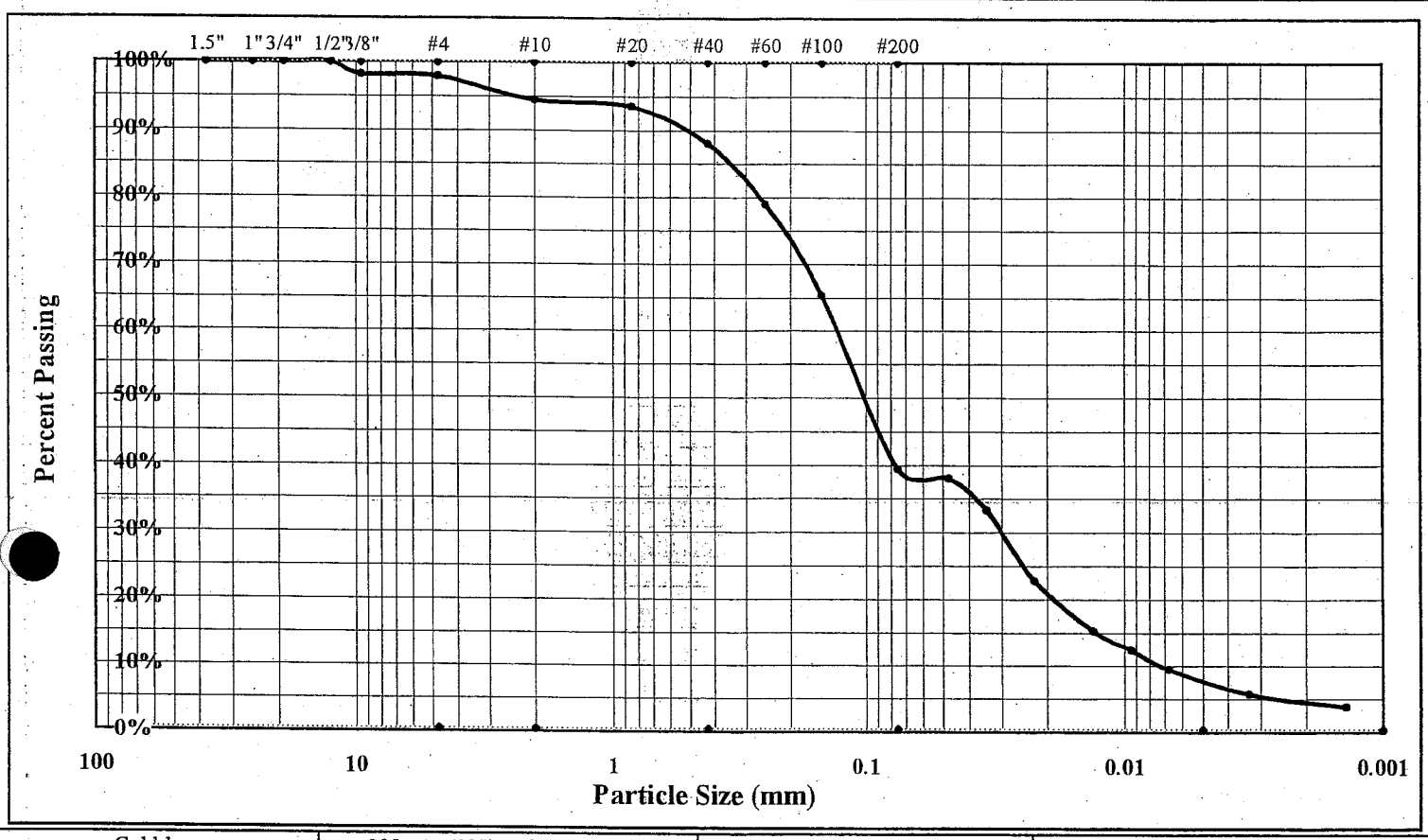
Particle Size Analysis of Soils

ASTM D 422

S&ME

S&ME Project #:	**1356-06-403**	Report Date:	6/5/06
Project Name:	**Marshall Steam Station Bulk Samples**	Test Date(s):	5/19-23/06
Client Name:	Duke Energy		
Client Address:			

Boring #:	S-3	Sample #:		Sample Date:	
Location:		Offset:		Depth:	4-5'
Sample Description:	Tan Brown Micaceous Clayey Silty Sand (SM)				



Cobbles	< 300 mm (12") and > 75 mm (3")	Fine Sand	< 0.425 mm and > 0.075 mm (#200)
Gravel	< 75 mm and > 4.75 mm (#4)	Silt	< 0.075 and > 0.005 mm
Coarse Sand	< 4.75 mm and >2.00 mm (#10)	Clay	< 0.005 mm
Medium Sand	< 2.00 mm and > 0.425 mm (#40)	Colloids	< 0.001 mm

Maximum Particle Size	0	Gravel	2.1%	Silt	31.9%
Silt & Clay (% Passing #200)	39.4%	Sand	58.6%	Clay	7.5%
Apparent Relative Density (Assumed)	2.650	Moisture Content		Colloids	
Liquid Limit	39	Plastic Limit	38	Plastic Index	1

Description of Sand & Gravel Particles Rounded ☐ Angular ☐ Hard & Durable ☐ Soft ☐ Weathered & Friable ☐

Mechanical Stirring Apparatus (A) Length of Dispersion Period: 1 min. Dispersing Agent: Sodium Hexametaphosphate 40 g/Liter 0

References: ASTM D 422: Particle Size Analysis of Soils ASTM D 421: Dry Preparation of Soil Samples
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils ASTM D 854: Specific Gravity of Soils
ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Technical Responsibility: Julie Peterson *Signature* *Position*

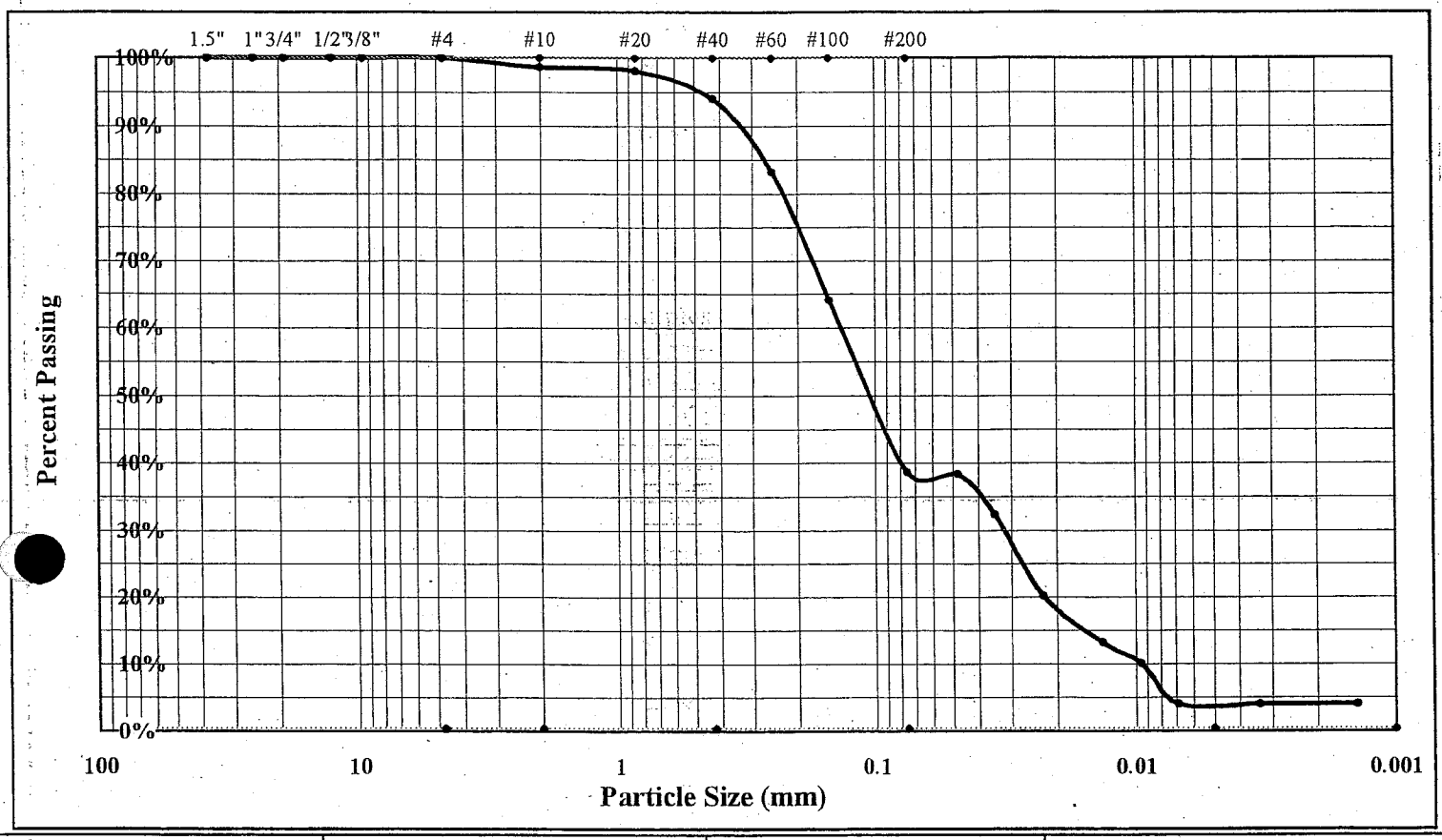
Particle Size Analysis of Soils

ASTM D 422

S&ME

S&ME Project #:	**1356-06-403**	Report Date:	6/2/06
Project Name:	**Marshall Steam Station Bulk Samples**	Test Date(s):	5/19-23/06
Client Name:	Duke Energy		
Client Address:			

Boring #:	S-5	Sample #:		Sample Date:	5/18/06
Location:		Offset:		Depth:	4-5'
Sample Description:	Brown Tan Micaceous Clayey Silty Sand (SM)				



Cobbles	< 300 mm (12") and > 75 mm (3")	Fine Sand	< 0.425 mm and > 0.075 mm (#200)
Gravel	< 75 mm and > 4.75 mm (#4)	Silt	< 0.075 and > 0.005 mm
Coarse Sand	< 4.75 mm and >2.00 mm (#10)	Clay	< 0.005 mm
Medium Sand	< 2.00 mm and > 0.425 mm (#40)	Colloids	< 0.001 mm

Maximum Particle Size	0	Gravel	0.0%	Silt	34.6%
Silt & Clay (% Passing #200)	38.6%	Sand	61.4%	Clay	4.0%
Apparent Relative Density (Assumed)	2.650	Moisture Content		Colloids	
Liquid Limit	NP	Plastic Limit	NP	Plastic Index	NP

Description of Sand & Gravel Particles Rounded ☐ Angular ☐ Hard & Durable ☐ Soft ☐ Weathered & Friable ☐

Mechanical Stirring Apparatus (A) Length of Dispersion Period: 1 min. Dispersing Agent: Sodium Hexametaphosphate: 40 g./ Liter

References: ASTM D 422: Particle Size Analysis of Soils ASTM D 421: Dry Preparation of Soil Samples
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils ASTM D 854: Specific Gravity of Soils
ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Technical Responsibility: Julie Peterson *Signature* *Position*

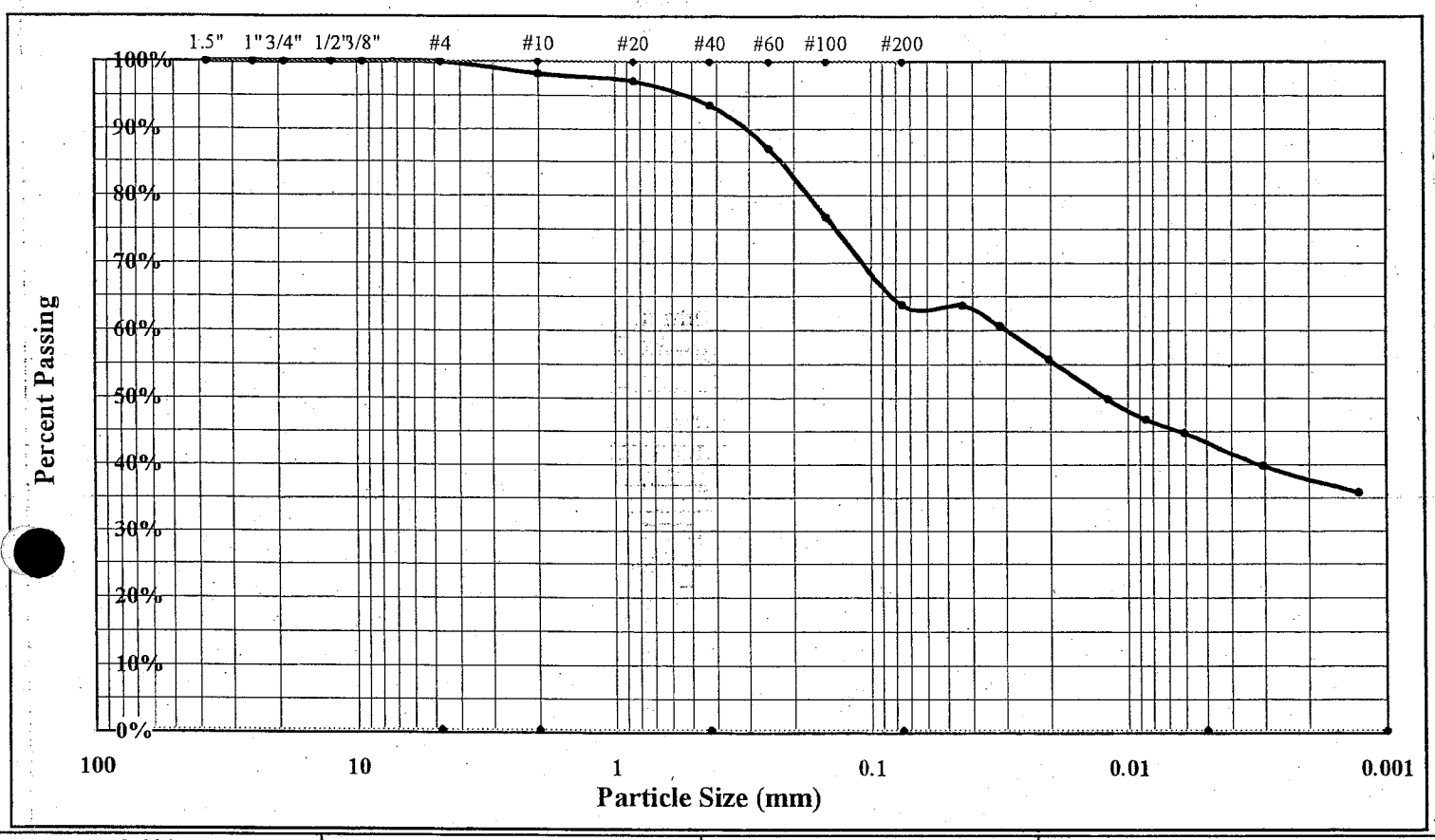
Particle Size Analysis of Soils

ASTM D 422

S&ME

S&ME Project #:	**1356-06-403**	Report Date:	6/5/06
Project Name:	**Marshall Steam Station Bulk Samples**	Test Date(s):	5/19-23/06
Client Name:	Duke Energy		
Client Address:			

Boring #:	S-8	Sample #:		Sample Date:	
Location:		Offset:		Depth:	4-5'
Sample Description:	Red Orange Brown Micaceous Sandy Clayey Silt (MH)				



Cobbles	< 300 mm (12") and > 75 mm (3")	Fine Sand	< 0.425 mm and > 0.075 mm (#200)
Gravel	< 75 mm and > 4.75 mm (#4)	Silt	< 0.075 and > 0.005 mm
Coarse Sand	< 4.75 mm and >2.00 mm (#10)	Clay	< 0.005 mm
Medium Sand	< 2.00 mm and > 0.425 mm (#40)	Colloids	< 0.001 mm

Maximum Particle Size	0	Gravel	0.0%	Silt	20.8%
Silt & Clay (% Passing #200)	63.8%	Sand	36.2%	Clay	43.0%
Apparent Relative Density (Assumed)	2.650	Moisture Content		Colloids	
Liquid Limit	62	Plastic Limit	37	Plastic Index	25

Description of Sand & Gravel Particles Rounded ☐ Angular ☐ Hard & Durable ☐ Soft ☐ Weathered & Friable ☐

Mechanical Stirring Apparatus (A) Length of Dispersion Period: 1 min. Dispersing Agent: Sodium Hexametaphosphate: 40 g./ Liter

References: ASTM D 422: Particle Size Analysis of Soils ASTM D 421: Dry Preparation of Soil Samples
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils ASTM D 854: Specific Gravity of Soils
ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Technical Responsibility: Julie Peterson *Jason Rivers for* Signature Position

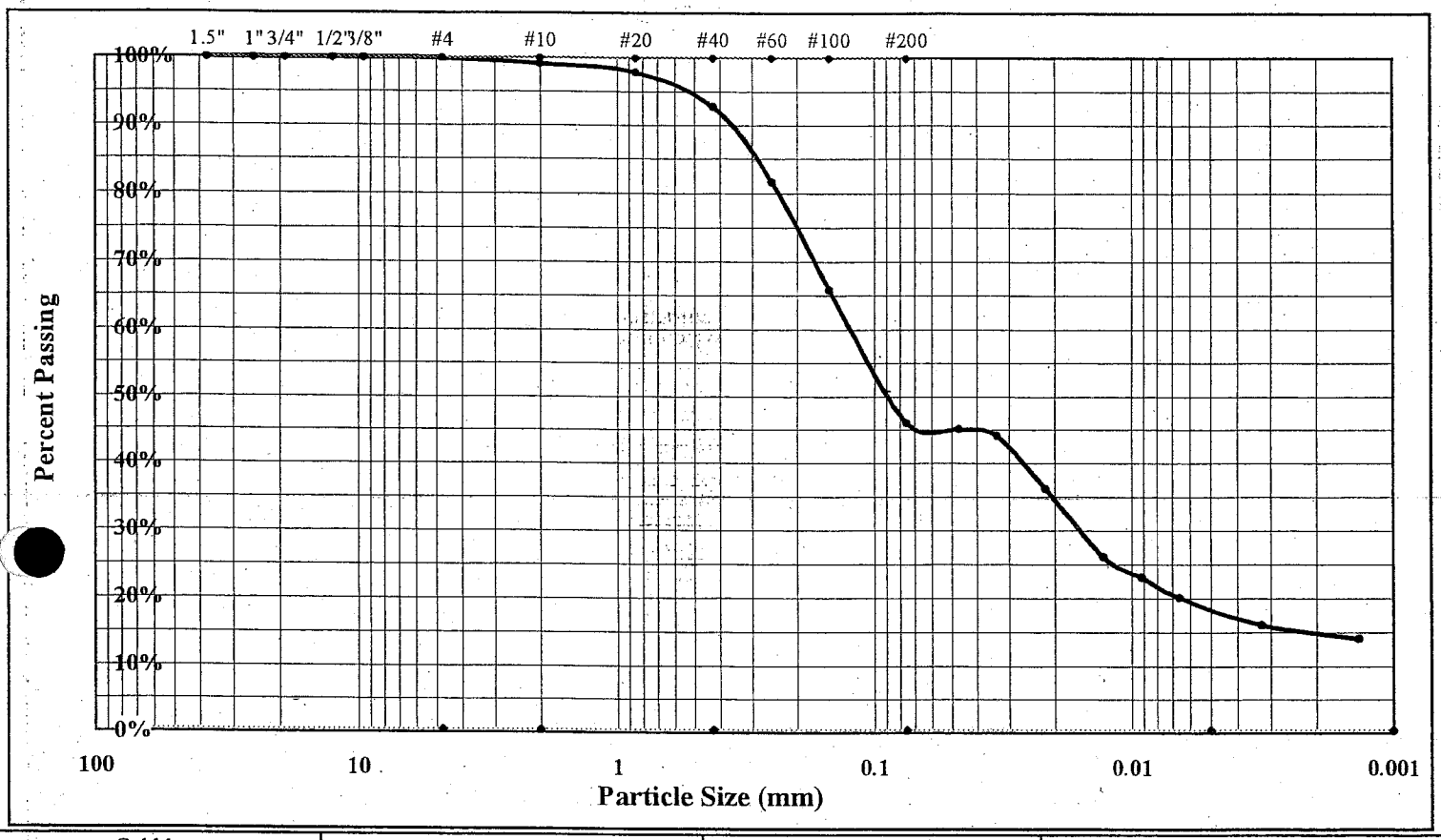
Particle Size Analysis of Soils

ASTM D 422

S&ME

S&ME Project #:	**1356-06-403**	Report Date:	6/2/06
Project Name:	**Marshall Steam Station Bulk Samples**	Test Date(s):	5/19-23/06
Client Name:	Duke Energy		
Client Address:			

Boring #:	S-9	Sample #:		Sample Date:	5/18/06
Location:		Offset:		Depth:	4-5'
Sample Description:	Brown Orange Micaceous Clayey Silty Sand (SM)				



Cobbles	< 300 mm (12") and > 75 mm (3")	Fine Sand	< 0.425 mm and > 0.075 mm (#200)
Gravel	< 75 mm and > 4.75 mm (#4)	Silt	< 0.075 and > 0.005 mm
Coarse Sand	< 4.75 mm and >2.00 mm (#10)	Clay	< 0.005 mm
Medium Sand	< 2.00 mm and > 0.425 mm (#40)	Colloids	< 0.001 mm

Maximum Particle Size	0	Gravel	0.1%	Silt	28.0%
Silt & Clay (% Passing #200)	46.0%	Sand	53.9%	Clay	18.0%
Apparent Relative Density (Assumed)	2.650	Moisture Content		Colloids	
Liquid Limit	53	Plastic Limit	46	Plastic Index	7

Description of Sand & Gravel Particles Rounded ☐ Angular ☐ Hard & Durable ☐ Soft ☐ Weathered & Friable ☐

Mechanical Stirring Apparatus (A) Length of Dispersion Period: 1 min. Dispersing Agent: Sodium Hexametaphosphate: 40 g./ Liter

References: ASTM D 422: Particle Size Analysis of Soils ASTM D 421: Dry Preparation of Soil Samples
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils ASTM D 854: Specific Gravity of Soils
ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Technical Responsibility: Julie Peterson for

Signature Position

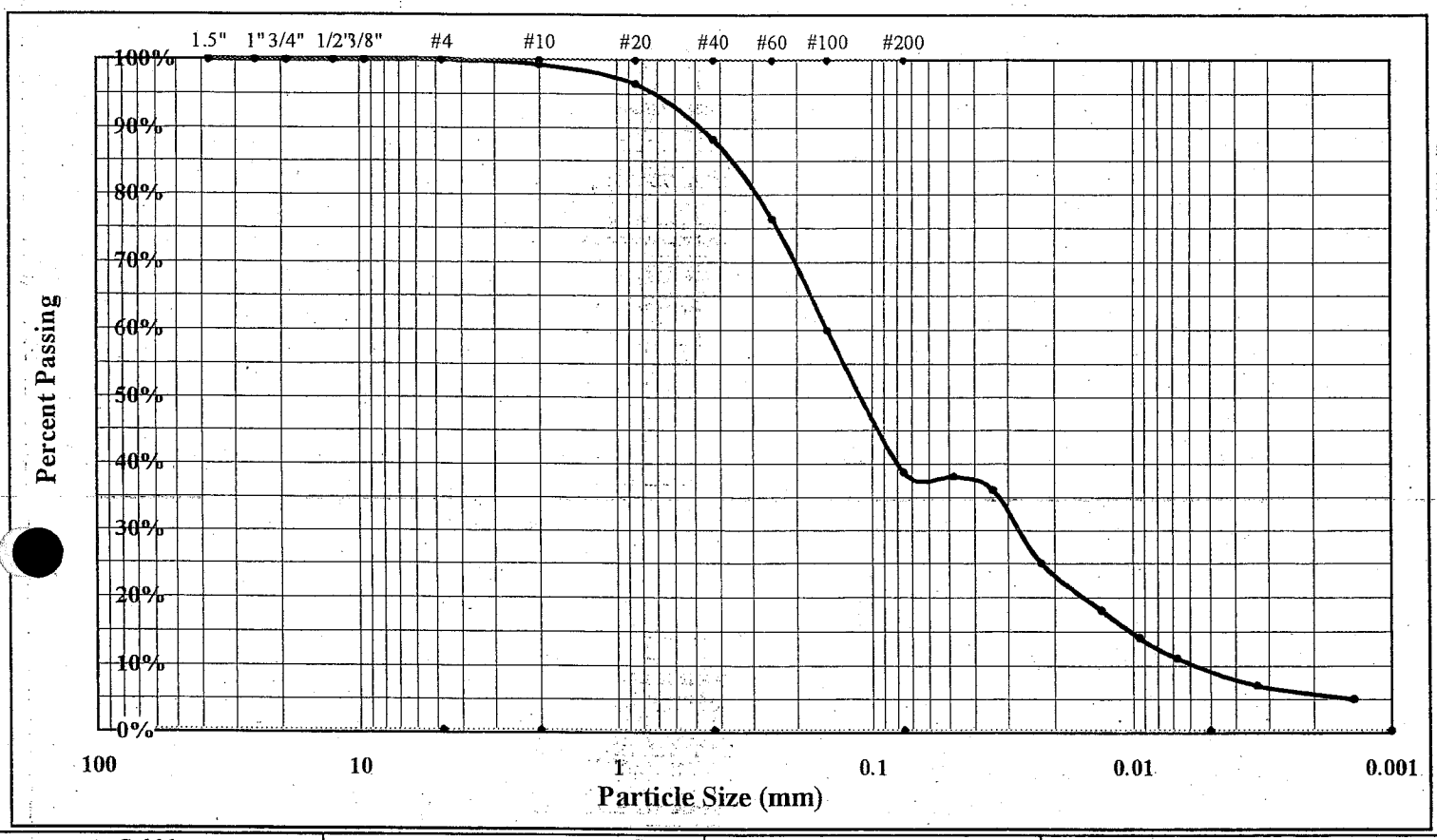
Particle Size Analysis of Soils

ASTM D 422

S&ME

S&ME Project #:	**1356-06-403**	Report Date:	6/4/06
Project Name:	**Marshall Steam Station Bulk Samples**	Test Date(s):	5/19-23/06
Client Name:	Duke Energy		
Client Address:			

Boring #:	S-12	Sample #:		Sample Date:	
Location:		Offset:		Depth:	1'
Sample Description:	Tan Brown Micaceous Clayey Silty Sand (SM)				



Cobbles	< 300 mm (12") and > 75 mm (3")	Fine Sand	< 0.425 mm and > 0.075 mm (#200)
Gravel	< 75 mm and > 4.75 mm (#4)	Silt	< 0.075 and > 0.005 mm
Coarse Sand	< 4.75 mm and >2.00 mm (#10)	Clay	< 0.005 mm
Medium Sand	< 2.00 mm and > 0.425 mm (#40)	Colloids	< 0.001 mm

Maximum Particle Size	0	Gravel	0.0%	Silt	29.7%
Silt & Clay (% Passing #200)	38.7%	Sand	61.3%	Clay	9.0%
Apparent Relative Density (Assumed)	2.650	Moisture Content		Colloids	
Liquid Limit	42	Plastic Limit	39	Plastic Index	3

Description of Sand & Gravel Particles Rounded ☐ Angular ☐ Hard & Durable ☐ Soft ☐ Weathered & Friable ☐

Mechanical Stirring Apparatus (A) Length of Dispersion Period: 1 min. Dispersing Agent: Sodium Hexametaphosphate: 40 g./ Liter

References: ASTM D 422: Particle Size Analysis of Soils ASTM D 421: Dry Preparation of Soil Samples
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils ASTM D 854: Specific Gravity of Soils
ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Technical Responsibility: Julie Peterson for

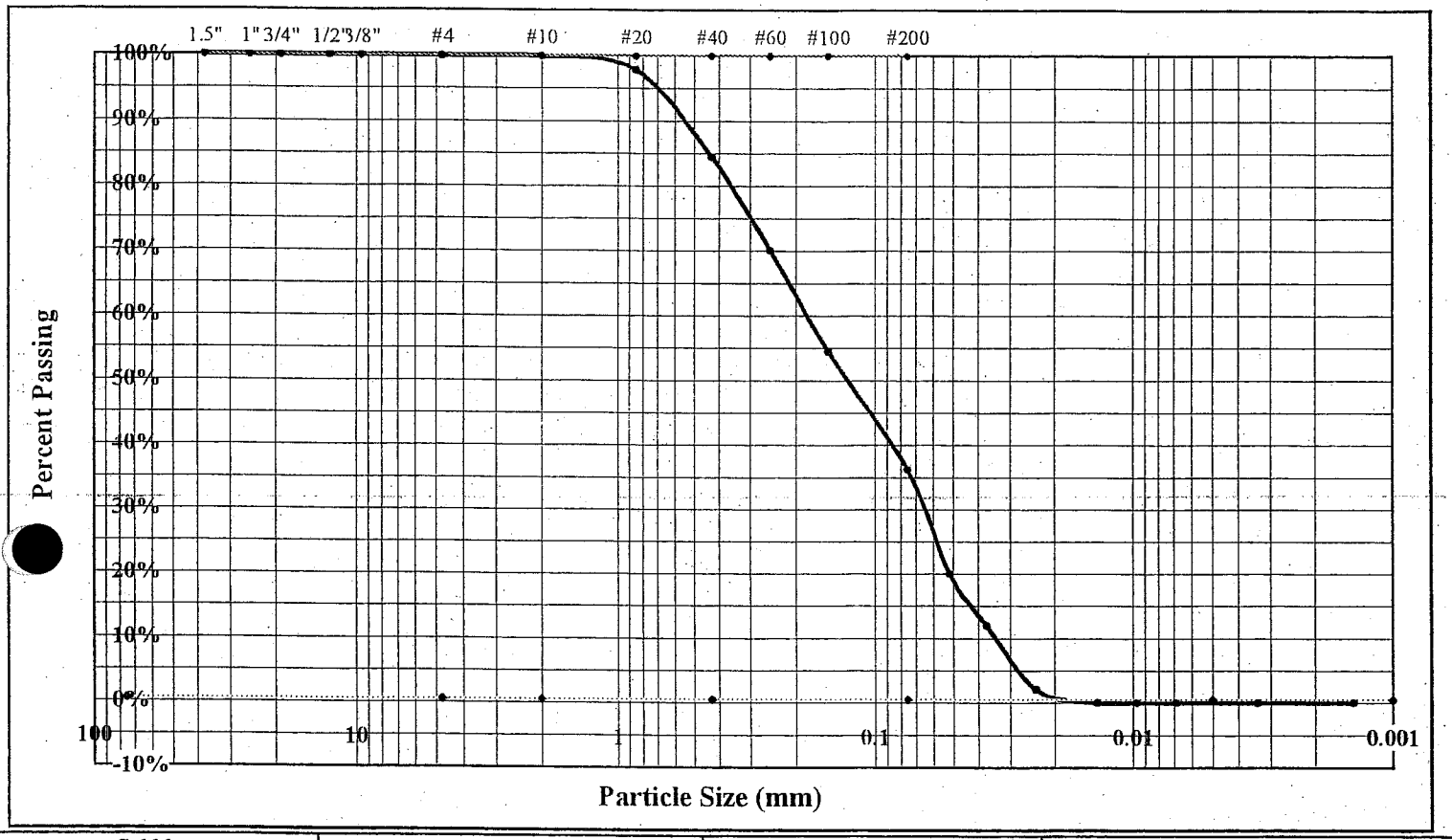
Signature Position

Particle Size Analysis of Soils

S&ME

S&ME Project #:	**1356-06-403**	Report Date:	6/1/06
Project Name:	**Marshall Steam Station Bulk Samples**	Test Date(s):	5/19-23/06
Client Name:	Duke Energy		
Client Address:			

Boring #:	S-1	Sample #:		Sample Date:	
Location:		Offset:		Depth:	4-5'
Sample Description:	Tan Orange Brown Micaceous Clayey Silty Sand (SM)			ASTM D4221	



Cobbles	< 300 mm (12") and > 75 mm (3")	Fine Sand	< 0.425 mm and > 0.075 mm (#200)
Gravel	< 75 mm and > 4.75 mm (#4)	Silt	< 0.075 and > 0.005 mm
Coarse Sand	< 4.75 mm and >2.00 mm (#10)	Clay	< 0.005 mm
Medium Sand	< 2.00 mm and > 0.425 mm (#40)	Colloids	< 0.001 mm

Maximum Particle Size	0	Gravel	0.1%	Silt	36.2%
Silt & Clay (% Passing #200)	36.2%	Sand	63.7%	Clay	0.0%
Apparent Relative Density (Assumed)	2.650			Colloids	
Liquid Limit	NP	Plastic Limit	NP	Plastic Index	NP

Description of Sand & Gravel Particles Rounded ☐ Angular ☐ Hard & Durable ☐ Soft ☐ Weathered & Friable ☐

0 Length of Dispersion Period: 0 Dispersing Agent: Distilled Water 0

References: ASTM D 422: Particle Size Analysis of Soils ASTM D 421: Dry Preparation of Soil Samples

ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils 0

ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

ASTM D 4221 Dispersive Characteristics of Clay Soil by Double Hydrometer

Technical Responsibility: Julie Peterson

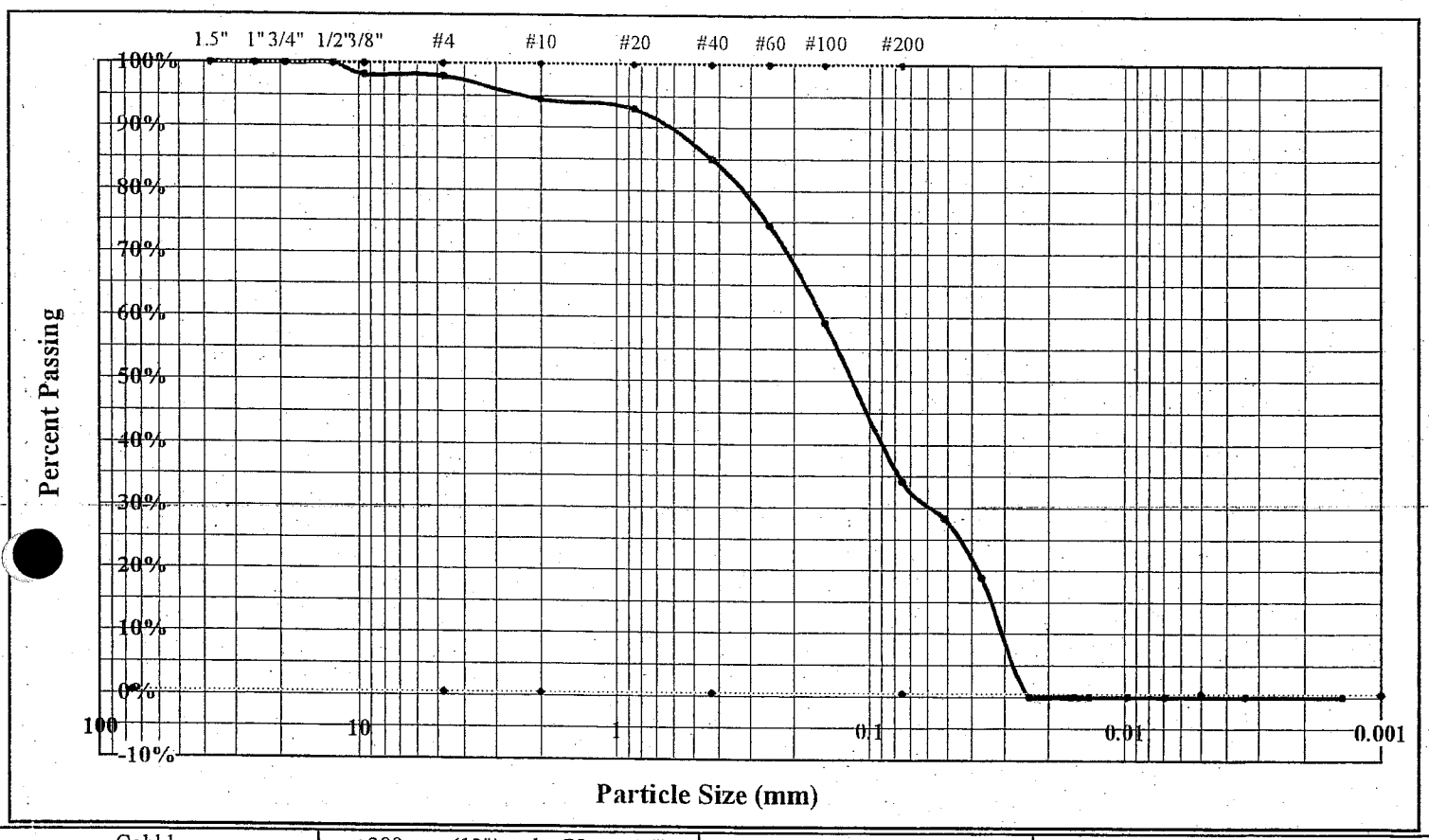
Signature Position

Particle Size Analysis of Soils

S&ME

S&ME Project #:	**1356-06-403**	Report Date:	6/1/06
Project Name:	**Marshall Steam Station Bulk Samples**	Test Date(s):	5/19-23/06
C[illegible] Name:	Duke Energy		
Client Address:			

Boring #:	S-3	Sample #:		Sample Date:	
Location:		Offset:		Depth:	4-5'
Sample Description:	Tan Brown Micaceous Clayey Silty Sand (SM)			ASTM D4421	



Cobbles	< 300 mm (12") and > 75 mm (3")	Fine Sand	< 0.425 mm and > 0.075 mm (#200)
Gravel	< 75 mm and > 4.75 mm (#4)	Silt	< 0.075 and > 0.005 mm
Coarse Sand	< 4.75 mm and >2.00 mm (#10)	Clay	< 0.005 mm
Medium Sand	< 2.00 mm and > 0.425 mm (#40)	Colloids	< 0.001 mm

Maximum Particle Size	0	Gravel	2.1%	Silt	34.2%
Silt & Clay (% Passing #200)	34.2%	Sand	63.8%	Clay	0.0%
Apparent Relative Density (Assumed)	2.650	Moisture Content		Colloids	
Liquid Limit	39	Plastic Limit	38	Plastic Index	1

Description of Sand & Gravel Particles Rounded ☐ Angular ☐ Hard & Durable ☐ Soft ☐ Weathered & Friable ☐

0 Length of Dispersion Period: 0 Dispersing Agent: Distilled Water 0

References: ASTM D 422: Particle Size Analysis of Soils ASTM D 421: Dry Preparation of Soil Samples

ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils 0

A[illegible]D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

ASTM D 4221:Dispersive Characteristics of Clay Soil by Double Hydrometer

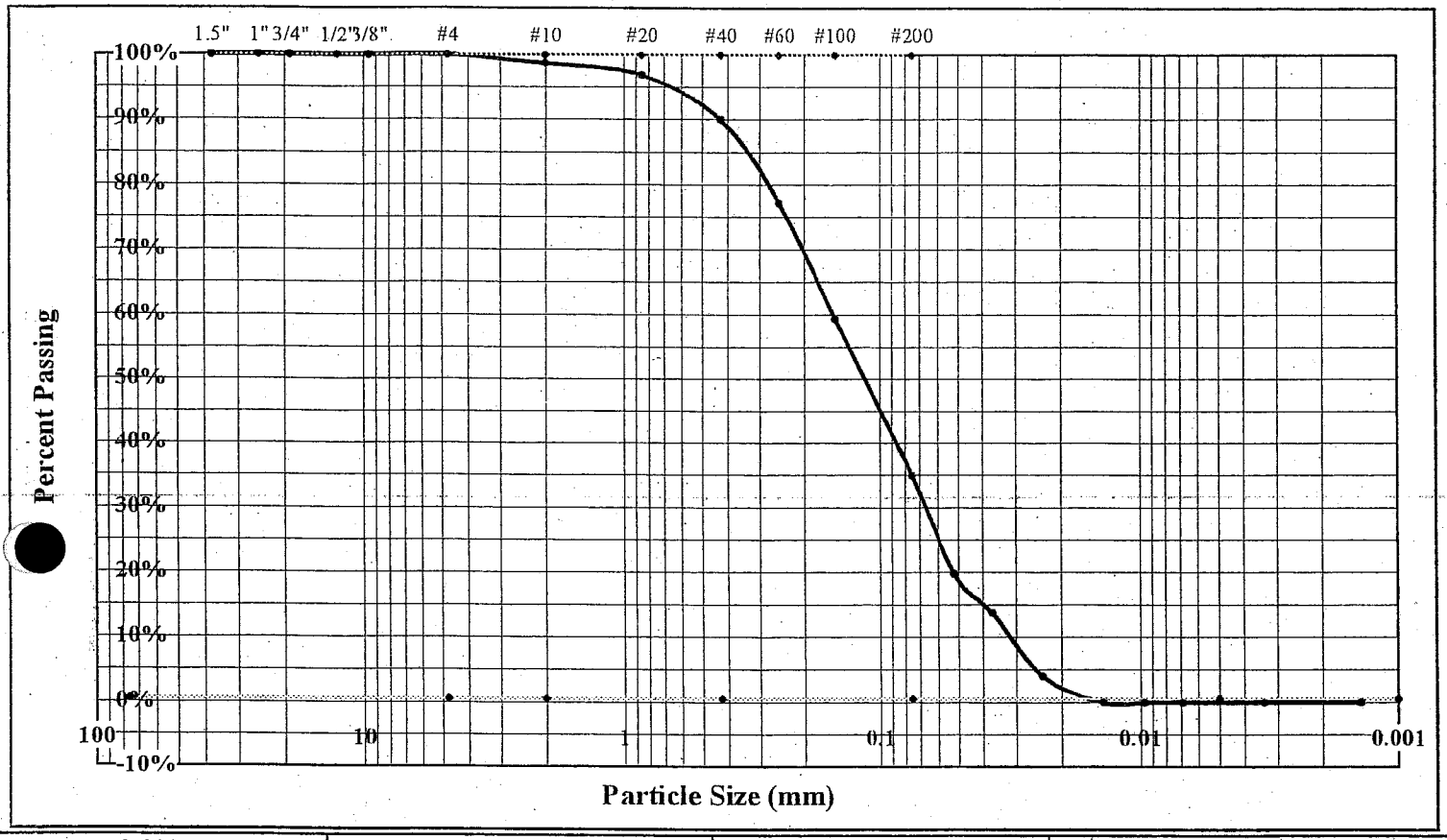
Technical Responsibility: Julie Peterson *Signature* *Position*

Particle Size Analysis of Soils

S&ME

S&ME Project #:	**1356-06-403**	Report Date:	6/1/06
Project Name:	**Marshall Steam Station Bulk Samples**	Test Date(s):	5/19-23/06
Client Name:	Duke Energy		
Client Address:			

Boring #:	S-5	Sample #:		Sample Date:	
Location:		Offset:		Depth:	4-5'
Sample Description:	Brown Tan Micaceous Clayey Silty Sand (SM)			ASTM D4221	



Cobbles	< 300 mm (12") and > 75 mm (3")	Fine Sand	< 0.425 mm and > 0.075 mm (#200)
Gravel	< 75 mm and > 4.75 mm (#4)	Silt	< 0.075 and > 0.005 mm
Coarse Sand	< 4.75 mm and >2.00 mm (#10)	Clay	< 0.005 mm
Medium Sand	< 2.00 mm and > 0.425 mm (#40)	Colloids	< 0.001 mm

Maximum Particle Size	0	Gravel	0.0%	Silt	35.0%
Silt & Clay (% Passing #200)	35.0%	Sand	65.0%	Clay	0.0%
Apparent Relative Density (Assumed)	2.650	Moisture Content		Colloids	
Liquid Limit	NP	Plastic Limit	NP	Plastic Index	NP

Description of Sand & Gravel Particles Rounded ☐ Angular ☐ Hard & Durable ☐ Soft ☐ Weathered & Friable ☐

0 Length of Dispersion Period: 0 Dispersing Agent: Distilled Water 0

References: ASTM D 422: Particle Size Analysis of Soils; ASTM D 421: Dry Preparation of Soil Samples; ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils; ASTM D 854: Specific Gravity of Soils; ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System); ASTM D 4221: Dispersive Characteristics of Clay Soil by Double Hydrometer

Technical Responsibility: Julie Peterson

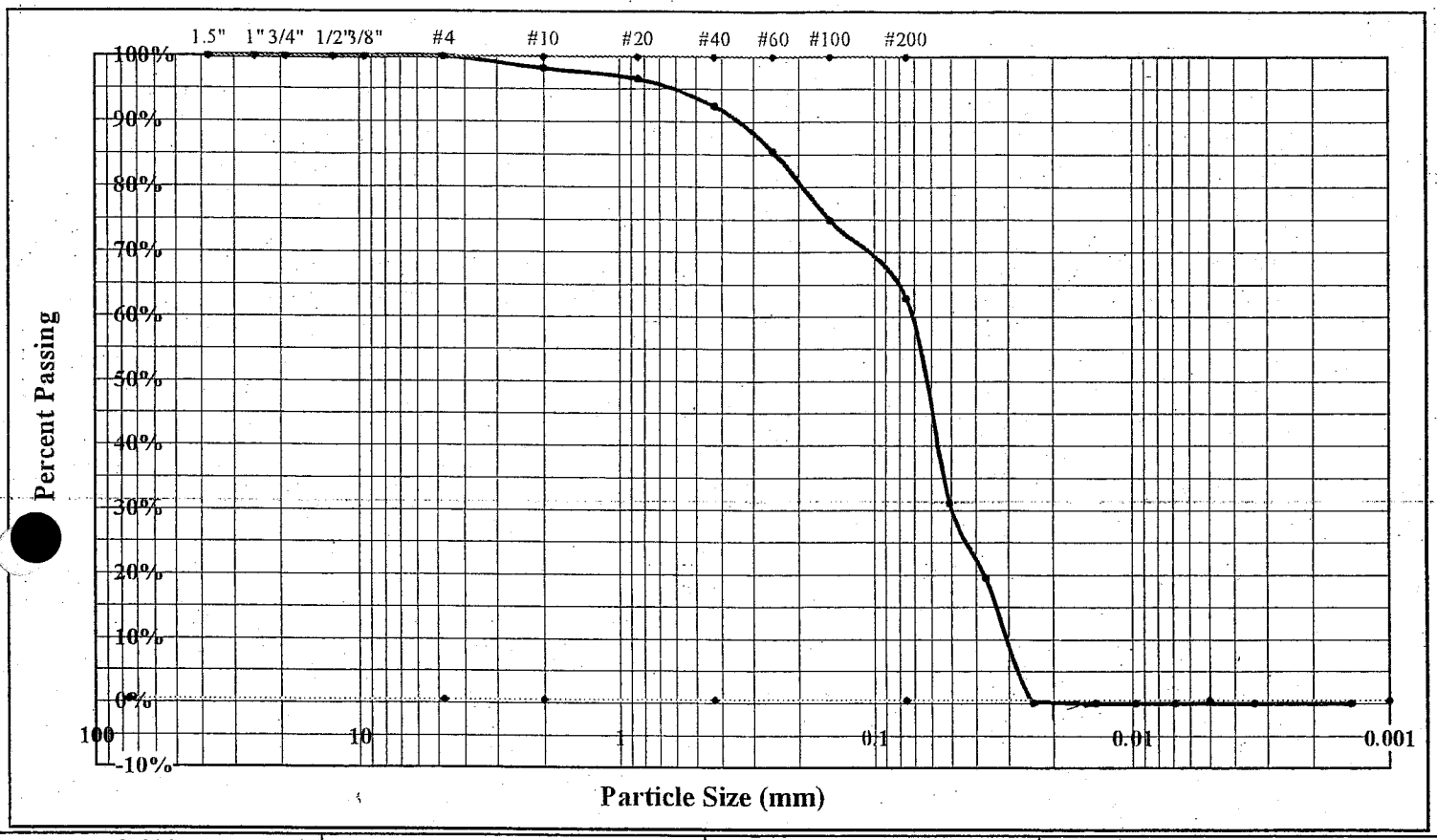
Signature Position

Particle Size Analysis of Soils

S&ME

S&ME Project #:	**1356-06-403**	Report Date:	6/1/06
Project Name:	**Marshall Steam Station Bulk Samples**	Test Date(s):	5/19-23/06
Client Name:	Duke Energy		
Client Address:			

Boring #:	S-8	Sample #:		Sample Date:	
Location:		Offset:		Depth:	4-5'
Sample Description:	Red Orange Brown Micaceous Sandy Clayey Silt (MH)			ASTM D4221	



Cobbles	< 300 mm (12") and > 75 mm (3")	Fine Sand	< 0.425 mm and > 0.075 mm (#200)
Gravel	< 75 mm and > 4.75 mm (#4)	Silt	< 0.075 and > 0.005 mm
Coarse Sand	< 4.75 mm and >2.00 mm (#10)	Clay	< 0.005 mm
Medium Sand	< 2.00 mm and > 0.425 mm (#40)	Colloids	< 0.001 mm

Maximum Particle Size	0	Gravel	0.0%	Silt	62.9%
Silt & Clay (% Passing #200)	62.9%	Sand	37.1%	Clay	0.0%
Apparent Relative Density (Assumed)	2.650	Moisture Content		Colloids	
Liquid Limit	62	Plastic Limit	37	Plastic Index	25

Description of Sand & Gravel Particles Rounded ☐ Angular ☐ Hard & Durable ☐ Soft ☐ Weathered & Friable ☐

0 Length of Dispersion Period: 0 Dispersing Agent: Distilled Water 0

References: ASTM D 422: Particle Size Analysis of Soils ASTM D 421: Dry Preparation of Soil Samples

ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils 0

ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

ASTM D4221: Dispersive Characteristics of Clay Soil by Double Hydrometer

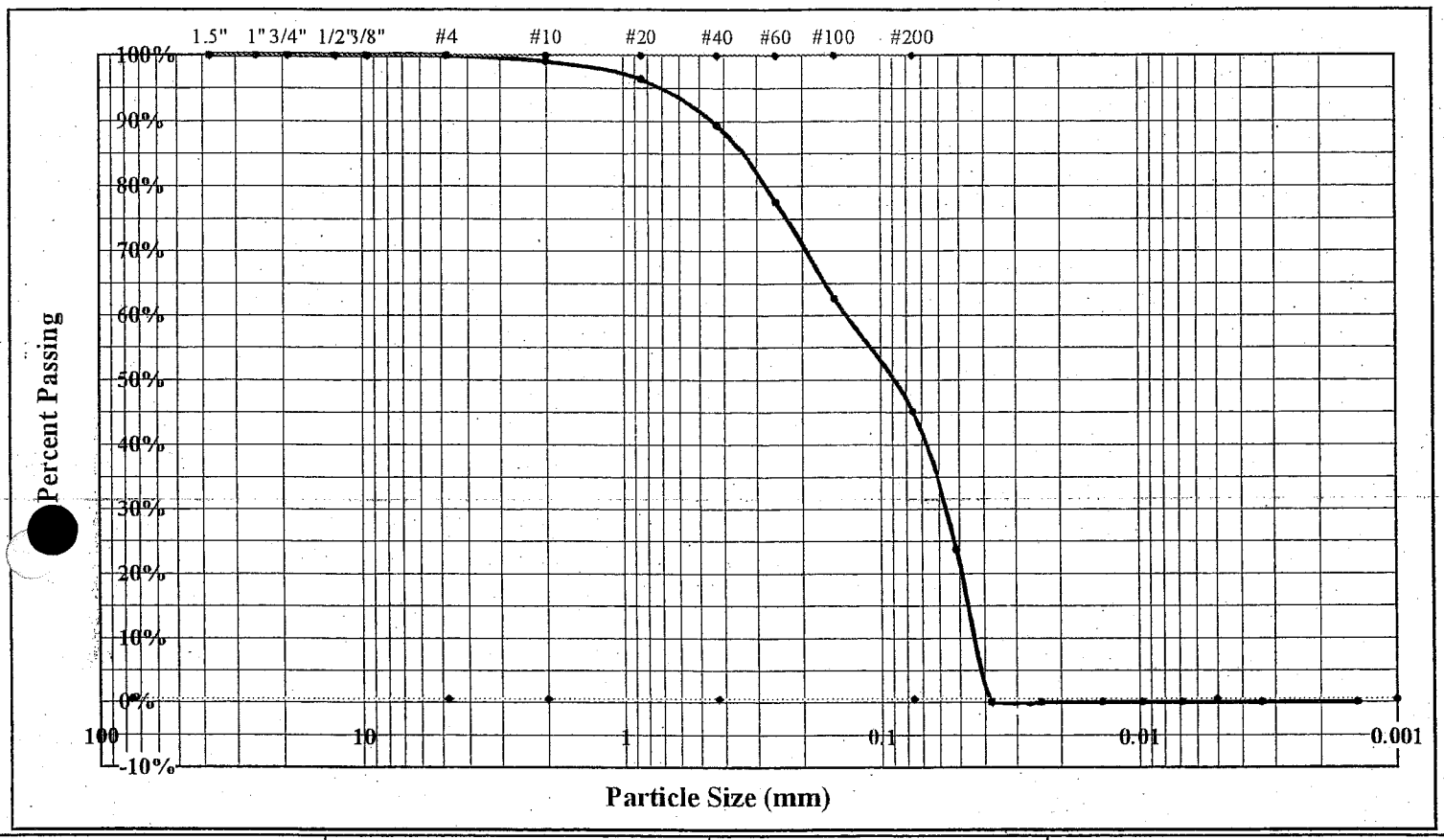
Technical Responsibility: Julie Peterson *Signature* *Position*

Particle Size Analysis of Soils

S&ME

S&ME Project #:	**1356-06-403**	Report Date:	6/1/06
Project Name:	**Marshall Steam Station Bulk Samples**	Test Date(s):	5/19-23/06
Client Name:	Duke Energy		
Client Address:			

Boring #:	S-9	Sample #:		Sample Date:	
Location:		Offset:		Depth:	4-5'
Sample Description:	Brown Orange Micaceous Clayey Silty Sand (SM)			ASTM D4221	



Cobbles	< 300 mm (12") and > 75 mm (3")	Fine Sand	< 0.425 mm and > 0.075 mm (#200)
Gravel	< 75 mm and > 4.75 mm (#4)	Silt	< 0.075 and > 0.005 mm
Coarse Sand	< 4.75 mm and >2.00 mm (#10)	Clay	< 0.005 mm
Medium Sand	< 2.00 mm and > 0.425 mm (#40)	Colloids	< 0.001 mm

Maximum Particle Size	0	Gravel	0.1%	Silt	45.0%
Silt & Clay (% Passing #200)	45.0%	Sand	54.9%	Clay	0.0%
Apparent Relative Density (Assumed)	2.650	Moisture Content		Colloids	
Liquid Limit	53	Plastic Limit	46	Plastic Index	7

Description of Sand & Gravel Particles Rounded ☐ Angular ☐ Hard & Durable ☐ Soft ☐ Weathered & Friable ☐

0 Length of Dispersion Period: 0 Dispersing Agent: Distilled Water 0

References: ASTM D 422: Particle Size Analysis of Soils ASTM D 421: Dry Preparation of Soil Samples

ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils 0

ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

ASTM D4221: Dispersive Characteristics of Clay Soil by Double Hydrometer

Technical Responsibility: Julie Peterson

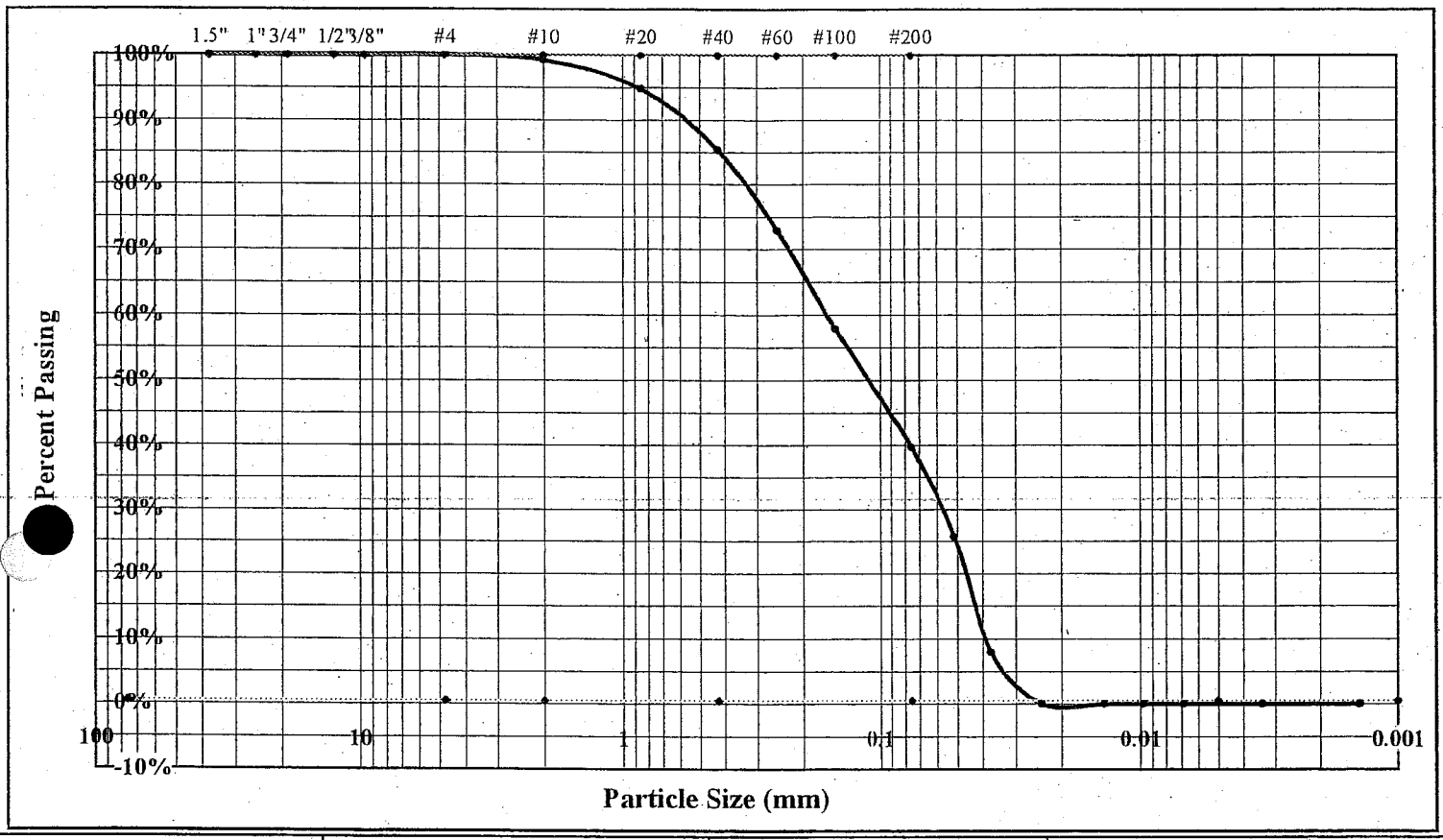
Signature Position

Particle Size Analysis of Soils

S&ME

S&ME Project #:	**1356-06-403**	Report Date:	6/4/06
Project Name:	**Marshall Steam Station Bulk Samples**	Test Date(s):	5/19-23/06
Client Name:	Duke Energy		
Client Address:			

Boring #:	S-12	Sample #:		Sample Date:	
Location:		Offset:		Depth:	1'
Sample Description:	Tan Brown Micaceous Clayey Silty Sand (SM)			ASTM D4221	



Cobbles	< 300 mm (12") and > 75 mm (3")	Fine Sand	< 0.425 mm and > 0.075 mm (#200)
Gravel	< 75 mm and > 4.75 mm (#4)	Silt	< 0.075 and > 0.005 mm
Coarse Sand	< 4.75 mm and >2.00 mm (#10)	Clay	< 0.005 mm
Medium Sand	< 2.00 mm and > 0.425 mm (#40)	Colloids	< 0.001 mm

Maximum Particle Size	0	Gravel	0.0%	Silt	39.7%
Silt & Clay (% Passing #200)	39.7%	Sand	60.3%	Clay	0.0%
Apparent Relative Density (Assumed)	2.650	Moisture Content		Colloids	
Liquid Limit	42	Plastic Limit	39	Plastic Index	3

Description of Sand & Gravel Particles Rounded ☐ Angular ☐ Hard & Durable ☐ Soft ☐ Weathered & Friable ☐

0 Length of Dispersion Period: 0 Dispersing Agent: Distilled Water 0

References: ASTM D 422: Particle Size Analysis of Soils ASTM D 421: Dry Preparation of Soil Samples

ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils 0

ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

ASTM D4221: Dispersive Characteristics of Clay Soil by Double Hydrometer

Technical Responsibility: Julie Peterson

Signature Position

Liquid Limit, Plastic Limit, and Plastic Index

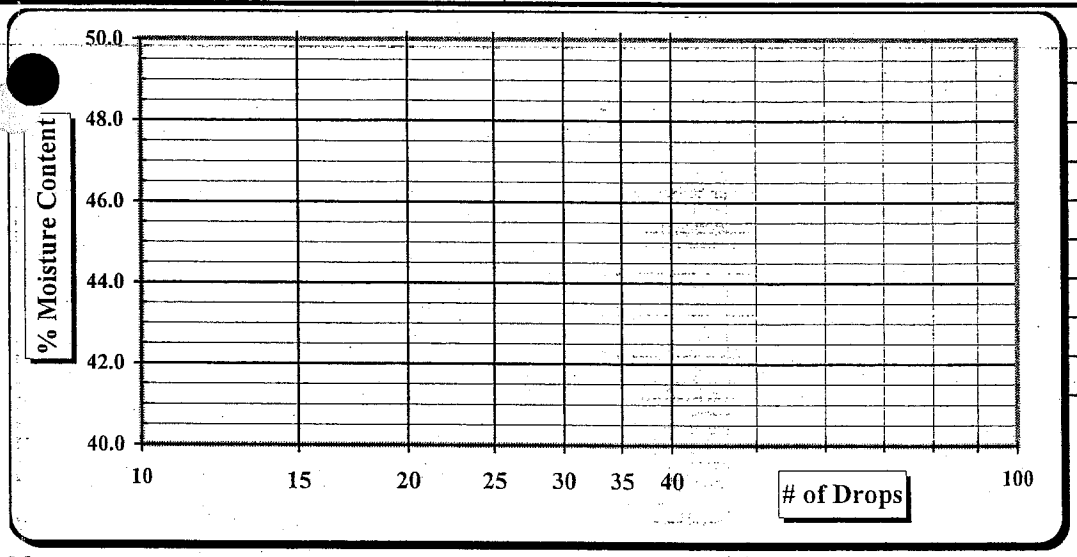
S&ME

Project #: **1356-06-403**
Project Name: Marshall Steam Station Bulk Samples
Client Name: Duke Energy
Client Address:

Report Date: 6/4/06
Test Date(s): 5/19-6/3/06

Boring #: S-1 Sample #: Sample Date: 5/18/06
Location: Offset: Depth: 4-5'
Sample Description: Tan Orange Brown Micaceous Clayey Silty Sand (SM)

Pan #		Liquid Limit						Plastic Limit		
	Test #	1	2	3	4	5	6	1	2	3
	Tare #									
A	Tare Weight									
B	Wet Soil Weight + A									
C	Dry Soil Weight + A									
D	Water Weight (B-C)									
E	Dry Soil Weight (C-A)									
F	% Moisture Content (D/E)*100									
N	# OF DROPS							*Moisture Contents determined by ASTM D 2216*		
LL	LL = F * FACTOR									
Ave.	Average									



One Point Liquid Limit			
N	Factor	N	Factor
20	0.974	26	1.005
21	0.979	27	1.009
22	0.985	28	1.014
23	0.990	29	1.018
24	0.995	30	1.022
25	1.000		

Notes: Estimate the % Retained on the #40 Sieve

Special Sampling Methods:

Sample Preparation:	Wet Preparation	☐	Dry Preparation	☒	Air Dried ☒	NP, Non-Plastic	☒
Liquid limit Test:	Multipoint Method	☐	One-point Method	☐		Liquid Limit	
Classification:	ASTM D 2487	☒	AASHTO M 145	☐		Plastic Limit	
Liquid limit Test:	ASTM D 4318	☒	AASHTO T 89	☐		Plastic Index	
Plastic limit Test:	ASTM D 4318	☒	AASHTO T 90	☐		Group Symbol	SM

Technician Name: Karen Warner

Technical Responsibility: Julie Peterson

Certification #

Signature

Position

Liquid Limit, Plastic Limit, and Plastic Index

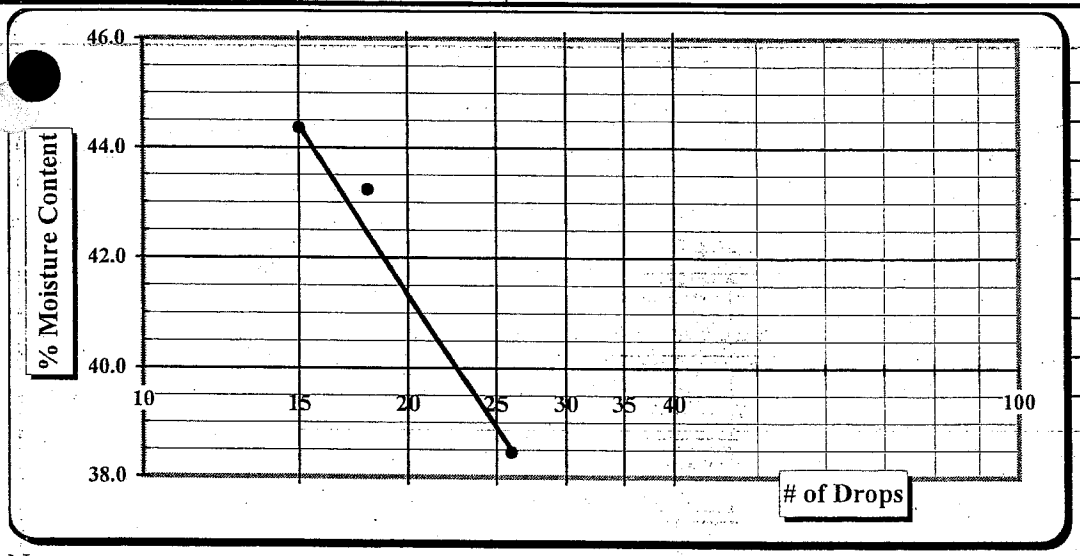
S&ME

Project #: **1356-06-403**
Project Name: Marshall Steam Station Bulk Samples
Client Name: Duke Energy
Client Address:

Report Date: 6/4/06
Test Date(s): 5/19-6/3/06

Boring #: S-3 Sample #: Sample Date: 5/18/06
Location: Offset: Depth: 4-5'
Sample Description: Tan Brown Micaceous Clayey Silty Sand (SM)

Pan #		Liquid Limit						Plastic Limit		
	Test #	1	2	3	4	5	6	1	2	3
	Tare #	FF	PP	KK				14	3	
A	Tare Weight	16.89	16.48	16.05				**14.00**	15.75	
B	Wet Soil Weight + A	28.52	25.16	25.65				20.44	21.88	
C	Dry Soil Weight + A	25.29	22.54	22.70				18.66	20.17	
D	Water Weight (B-C)	3.23	2.62	2.95				1.78	1.71	
E	Dry Soil Weight (C-A)	8.40	6.06	6.65				4.66	4.42	
F	% Moisture Content (D/E)*100	38.5%	43.2%	44.4%				38.2%	38.7%	
N	# OF DROPS	26	18	15				*Moisture Contents determined by ASTM D 2216*		
LL	LL = F * FACTOR									
Ave.	Average							38.4%		



One Point Liquid Limit			
N	Factor	N	Factor
20	0.974	26	1.005
21	0.979	27	1.009
22	0.985	28	1.014
23	0.990	29	1.018
24	0.995	30	1.022
25	1.000		

Notes: Estimate the % Retained on the #40 Sieve

Special Sampling Methods:

Sample Preparation:	Wet Preparation ☐	Dry Preparation ☒	Air Dried ☒	NP, Non-Plastic	☐
Liquid limit Test:	Multipoint Method ☒	One-point Method ☐		Liquid Limit	39
Classification:	ASTM D 2487 ☒	AASHTO M 145 ☐		Plastic Limit	38
Liquid limit Test:	ASTM D 4318 ☒	AASHTO T 89 ☐		Plastic Index	1
Plastic limit Test:	ASTM D 4318 ☒	AASHTO T 90 ☐		Group Symbol	SM

Technician Name: Karen Warner
Certification #

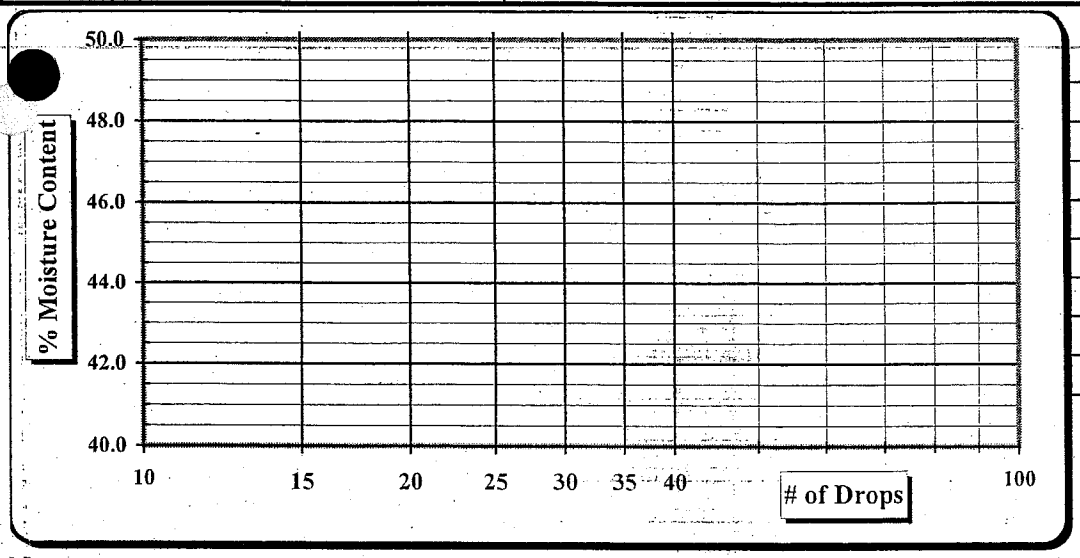
Technical Responsibility: Julie Peterson
Signature: Jan Ken for
Position:

Liquid Limit, Plastic Limit, and Plastic Index

S&ME

Project #: **1356-06-403** Report Date: 6/4/06
Project Name: Marshall Steam Station Bulk Sample Test Date(s): 5/19-6/3/06
Client Name: Duke Energy
Client Address:
Boring #: S-5 Sample #: Sample Date: 5/18/06
Location: Offset: Depth: 4-5'
Sample Description: Brown Tan Micaceous Clayey Silty Sand (SM)

Pan #		Liquid Limit						Plastic Limit		
	Test #	1	2	3	4	5	6	1	2	3
	Tare #									
A	Tare Weight									
B	Wet Soil Weight + A									
C	Dry Soil Weight + A									
D	Water Weight (B-C)									
E	Dry Soil Weight (C-A)									
F	% Moisture Content (D/E)*100									
N	# OF DROPS							*Moisture Contents determined by ASTM D 2216*		
LL	LL = F * FACTOR									
Ave.	Average									



One Point Liquid Limit			
N	Factor	N	Factor
20	0.974	26	1.005
21	0.979	27	1.009
22	0.985	28	1.014
23	0.990	29	1.018
24	0.995	30	1.022
25	1.000		

Notes: Estimate the % Retained on the #40 Sieve

Special Sampling Methods:

Sample Preparation:	Wet Preparation ☐	Dry Preparation ☒	Air Dried ☒	NP, Non-Plastic	☒
Liquid limit Test:	Multipoint Method ☐	One-point Method ☐		Liquid Limit	
Classification:	ASTM D 2487 ☒	AASHTO M 145 ☐		Plastic Limit	
Liquid limit Test:	ASTM D 4318 ☒	AASHTO T 89 ☐		Plastic Index	
Plastic limit Test:	ASTM D 4318 ☒	AASHTO T 90 ☐		Group Symbol	SM

Technician Name: Karen Warner

Technical Responsibility: Julie Peterson

Certification #

Signature

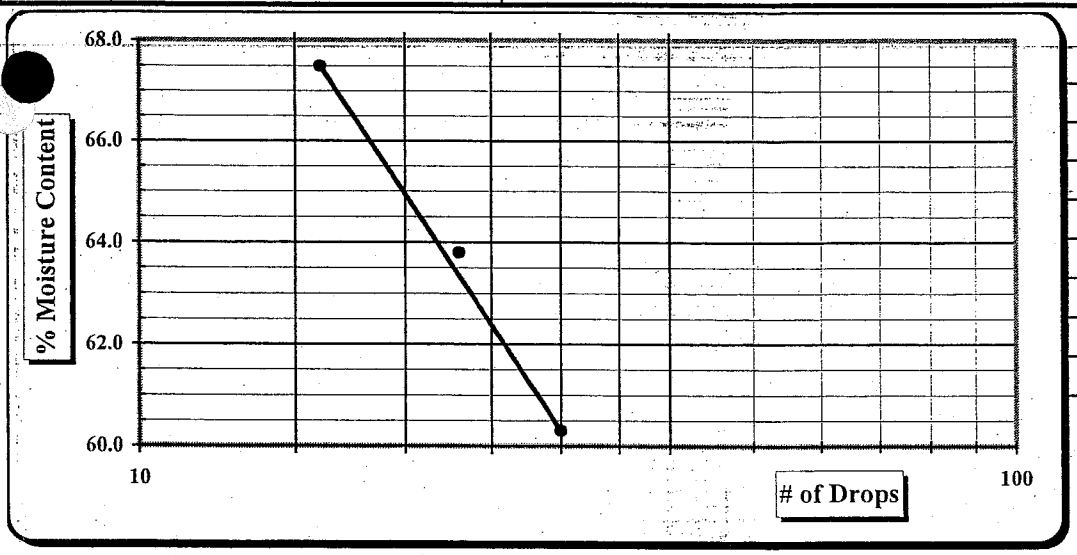
Position

Liquid Limit, Plastic Limit, and Plastic Index

S&ME

Project #: **1356-06-403** Report Date: 6/4/06
Project Name: Marshall Steam Station Bulk Samples Test Date(s): 5/19-6/3/06
Client Name: Duke Energy
Client Address:
Boring #: S-8 Sample #: Sample Date: 5/18/06
Location: Offset: Depth: 4-5'
Sample Description: Red Orange Brown Micaceous Sandy Clayey Silt (MH)

Pan #		Liquid Limit						Plastic Limit		
	Test #	1	2	3	4	5	6	1	2	3
	Tare #	36	2	25				27	49	
A	Tare Weight	15.68	15.76	14.34				**13.92**	15.67	
B	Wet Soil Weight + A	23.07	24.13	23.72				20.69	21.28	
C	Dry Soil Weight + A	20.29	20.87	19.94				18.88	19.78	
D	Water Weight (B-C)	2.78	3.26	3.78				1.81	1.50	
E	Dry Soil Weight (C-A)	4.61	5.11	5.60				4.96	4.11	
F	% Moisture Content (D/E)*100	60.3%	63.8%	67.5%				36.5%	36.5%	
N	# OF DROPS	30	23	16				*Moisture Contents determined by ASTM D 2216*		
LL	LL = F * FACTOR									
Ave.	Average							36.5%		



One Point Liquid Limit			
N	Factor	N	Factor
20	0.974	26	1.005
21	0.979	27	1.009
22	0.985	28	1.014
23	0.990	29	1.018
24	0.995	30	1.022
25	1.000		

Notes: Estimate the % Retained on the #40 Sieve

Special Sampling Methods:

Sample Preparation:	Wet Preparation ☐	Dry Preparation ☒	Air Dried ☒	NP, Non-Plastic	☐
Liquid limit Test:	Multipoint Method ☒	One-point Method ☐		Liquid Limit	62
Classification:	ASTM D 2487 ☒	AASHTO M 145 ☐		Plastic Limit	37
Liquid limit Test:	ASTM D 4318 ☒	AASHTO T 89 ☐		Plastic Index	25
Plastic limit Test:	ASTM D 4318 ☒	AASHTO T 90 ☐		Group Symbol	MH

Technician Name: Karen Warner

Technical Responsibility: Julie Peterson

Certification #

Signature

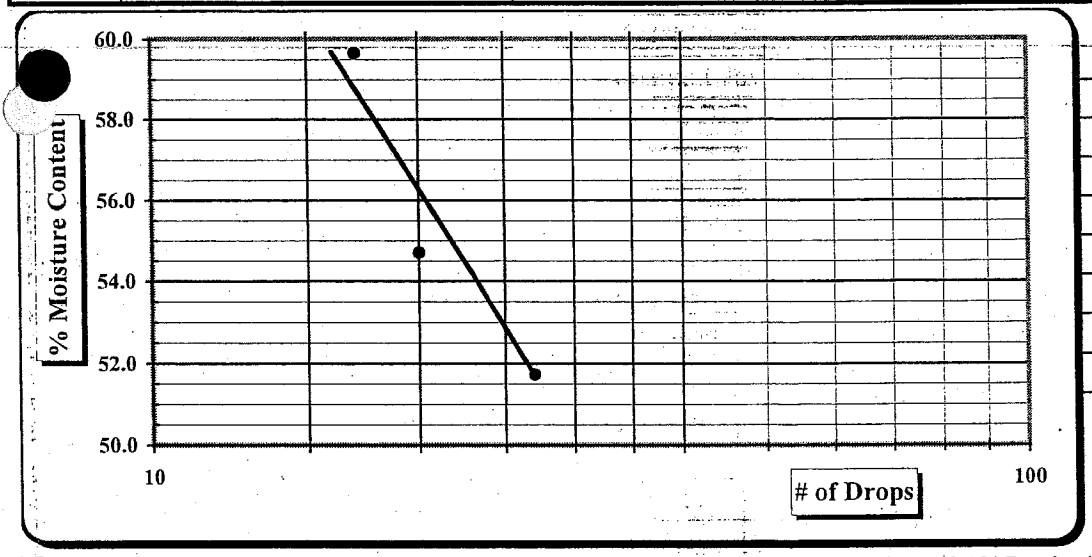
Position

Liquid Limit, Plastic Limit, and Plastic Index

S&ME

Project #: **1356-06-403** Report Date: 6/4/06
Project Name: Marshall Steam Station Bulk Samples Test Date(s): 5/19-6/3/06
Client Name: Duke Energy
Client Address:
Boring #: S-9 Sample #: Sample Date: 5/18/06
Location: Offset: Depth: 4-5'
Sample Description: Brown Orange Micaceous Clayey Silty Sand (SM)

Pan #		Liquid Limit						Plastic Limit		
	Test #	1	2	3	4	5	6	1	2	3
	Tare #	43	32	MM				RR	58	
A	Tare Weight	13.84	13.92	16.61				**16.96**	15.81	
B	Wet Soil Weight + A	22.58	21.47	26.11				23.11	23.60	
C	Dry Soil Weight + A	19.60	18.80	22.56				21.19	21.15	
D	Water Weight (B-C)	2.98	2.67	3.55				1.92	2.45	
E	Dry Soil Weight (C-A)	5.76	4.88	5.95				4.23	5.34	
F	% Moisture Content (D/E)*100	51.7%	54.7%	59.7%				45.4%	45.9%	
N	# OF DROPS	27	20	17				*Moisture Contents determined by ASTM D 2216*		
LL	LL = F * FACTOR									
Ave.	Average							45.6%		



One Point Liquid Limit			
N	Factor	N	Factor
20	0.974	26	1.005
21	0.979	27	1.009
22	0.985	28	1.014
23	0.990	29	1.018
24	0.995	30	1.022
25	1.000		

Notes: Estimate the % Retained on the #40 Sieve

Special Sampling Methods:

Sample Preparation:	Wet Preparation ☐	Dry Preparation ☒	Air Dried ☒	NP, Non-Plastic	☐
Liquid limit Test:	Multipoint Method ☒	One-point Method ☐		Liquid Limit	53
Classification:	ASTM D 2487 ☒	AASHTO M 145 ☐		Plastic Limit	46
Liquid limit Test:	ASTM D 4318 ☒	AASHTO T 89 ☐		Plastic Index	7
Plastic limit Test:	ASTM D 4318 ☒	AASHTO T 90 ☐		Group Symbol	SM

Technician Name: Karen Warner

Technical Responsibility: Julie Peterson

Certification #

Signature

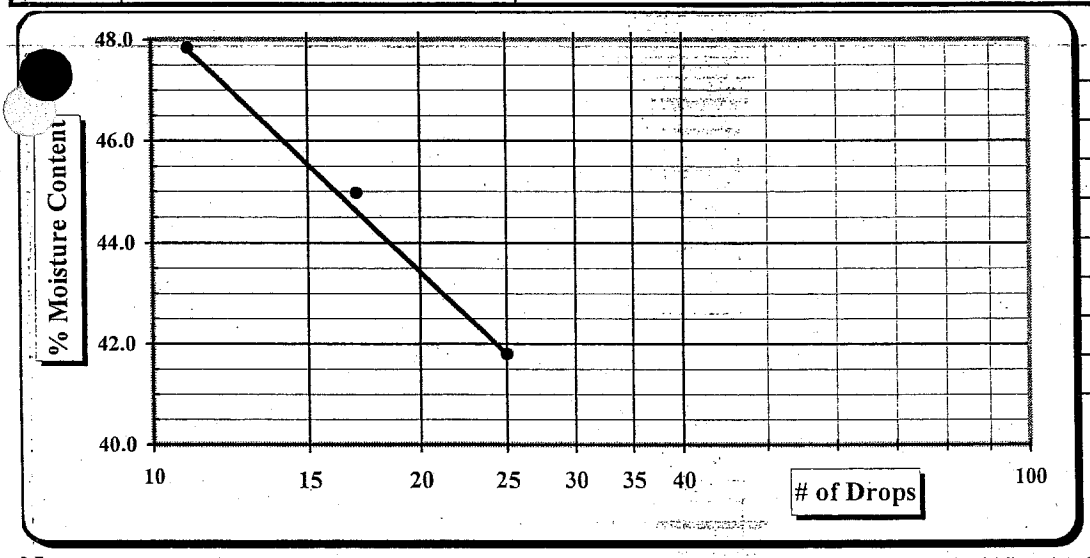
Position

Liquid Limit, Plastic Limit, and Plastic Index

S&ME

Project #: **1356-06-403** Report Date: 6/4/06
Project Name: Marshall Steam Station Bulk Samples Test Date(s): 5/19-6/3/06
Client Name: Duke Energy
Client Address:
Boring #: S-12 Sample #: Sample Date: 5/18/06
Location: Offset: Depth: 1'
Sample Description: Tan Brown Micaceous Clayey Silty Sand (SM)

Pan #		Liquid Limit						Plastic Limit		
	Test #	1	2	3	4	5	6	1	2	3
	Tare #	57	6	51				28	53	
A	Tare Weight	13.91	14.06	15.76				**14.08**	15.81	
B	Wet Soil Weight + A	21.78	23.44	24.32				19.70	22.16	
C	Dry Soil Weight + A	19.46	20.53	21.55				18.14	20.38	
D	Water Weight (B-C)	2.32	2.91	2.77				1.56	1.78	
E	Dry Soil Weight (C-A)	5.55	6.47	5.79				4.06	4.57	
F	% Moisture Content (D/E)*100	41.8%	45.0%	47.8%				38.4%	38.9%	
N	# OF DROPS	25	17	11				*Moisture Contents determined by ASTM D 2216*		
LL	LL = F * FACTOR									
Ave.	Average							38.7%		



One Point Liquid Limit			
N	Factor	N	Factor
20	0.974	26	1.005
21	0.979	27	1.009
22	0.985	28	1.014
23	0.990	29	1.018
24	0.995	30	1.022
25	1.000		

Notes: Estimate the % Retained on the #40 Sieve

Special Sampling Methods:

Sample Preparation:	Wet Preparation ☐	Dry Preparation ☒	Air Dried ☒	NP, Non-Plastic	☐
Liquid limit Test:	Multipoint Method ☒	One-point Method ☐		Liquid Limit	42
Classification:	ASTM D 2487 ☒	AASHTO M 145 ☐		Plastic Limit	39
Liquid limit Test:	ASTM D 4318 ☒	AASHTO T 89 ☐		Plastic Index	3
Plastic limit Test:	ASTM D 4318 ☒	AASHTO T 90 ☐		Group Symbol	SM

Technician Name: Karen Warner

Technical Responsibility: Julie Peterson

Certification #

Signature

Position

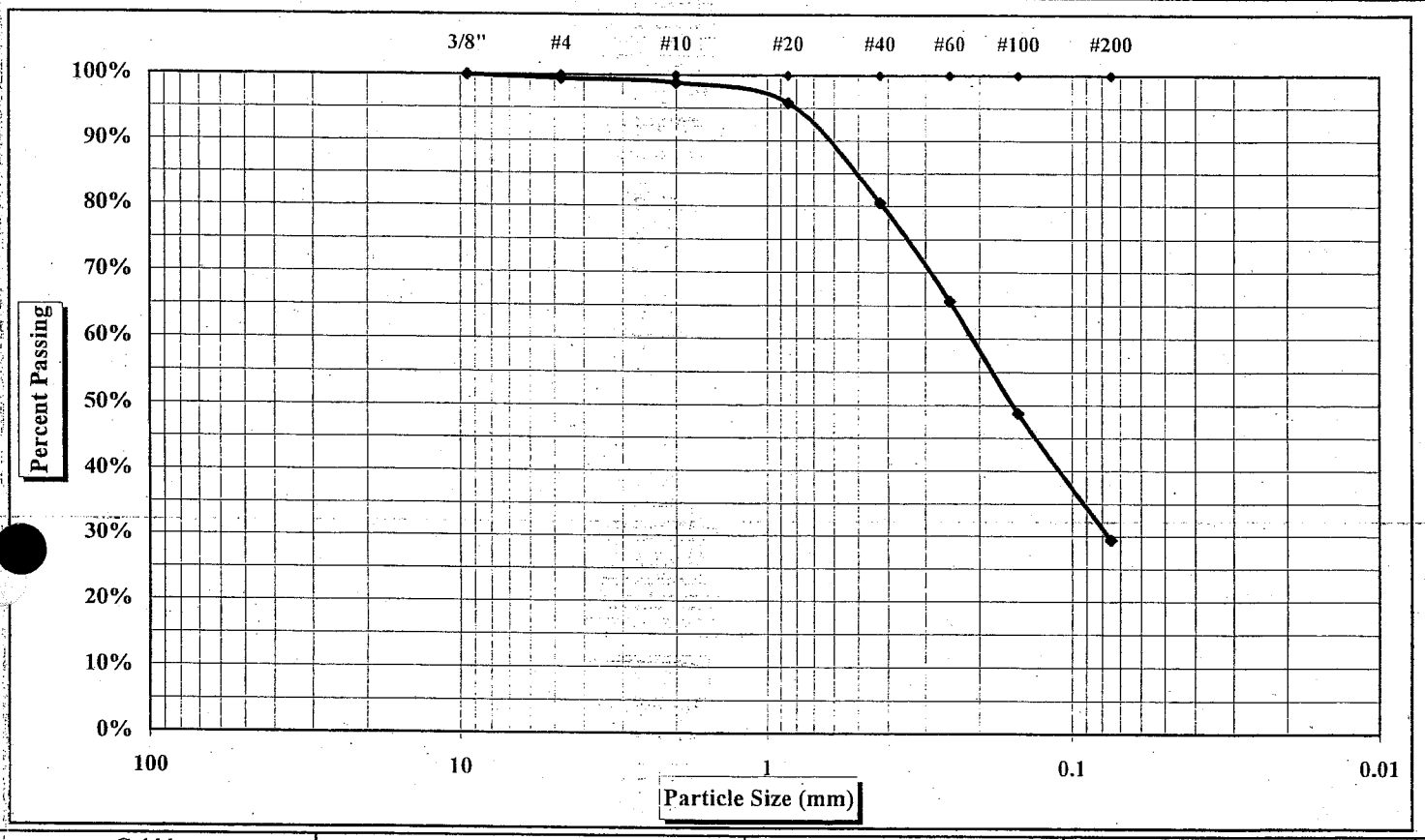
Particle Size Analysis of Soils

ASTM D 422

S&ME

S&ME Project #:	**1356-06-403**	Report Date:	6/1/06
Project Name:	**Marshall Steam Station Bulk Samples**	Test Date(s):	5/19-24/06
Client Name:	Duke Energy		
Client Address:			

Boring #:	S-1	Sample #:		Sample Date:	
Location:		Offset:		Depth:	4-5'
Sample Description:	Tan Orange Brown Micaceous Clayey Silty Sand (SM)				



Cobbles	< 300 mm (12") and > 75 mm (3")	Fine Sand	< 0.425 mm and > 0.075 mm (#200)
Gravel	< 75 mm and > 4.75 mm (#4)	Silt	< 0.075 and > 0.005 mm
Coarse Sand	< 4.75 mm and >2.00 mm (#10)	Clay	< 0.005 mm
Medium Sand	< 2.00 mm and > 0.425 mm (#40)	Colloids	< 0.001 mm

Maximum Particle Size	0.0%	Gravel	1%	Medium Sand	18%
Silt & Clay (% Passing #200)	29.5%	Coarse Sand	1%	Fine Sand	51%
Apparent Relative Density		Moisture Content	18.1%	Organic Content	
Liquid Limit	NP	Plastic Limit	NP	Plastic Index	NP

Description of Sand & Gravel

Rounded ☐ Angular ☐ Hard & Durable ☐ Soft ☐ Weathered & Friable ☐

References: ASTM D 422: Particle Size Analysis of Soils

Hydrometer portion of test method not utilized.

ASTM D 421: Dry Preparation of Soil Samples

ASTM D 854: Specific Gravity of Soils

ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils

ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Technical Responsibility: Julie Peterson

Signature

Position

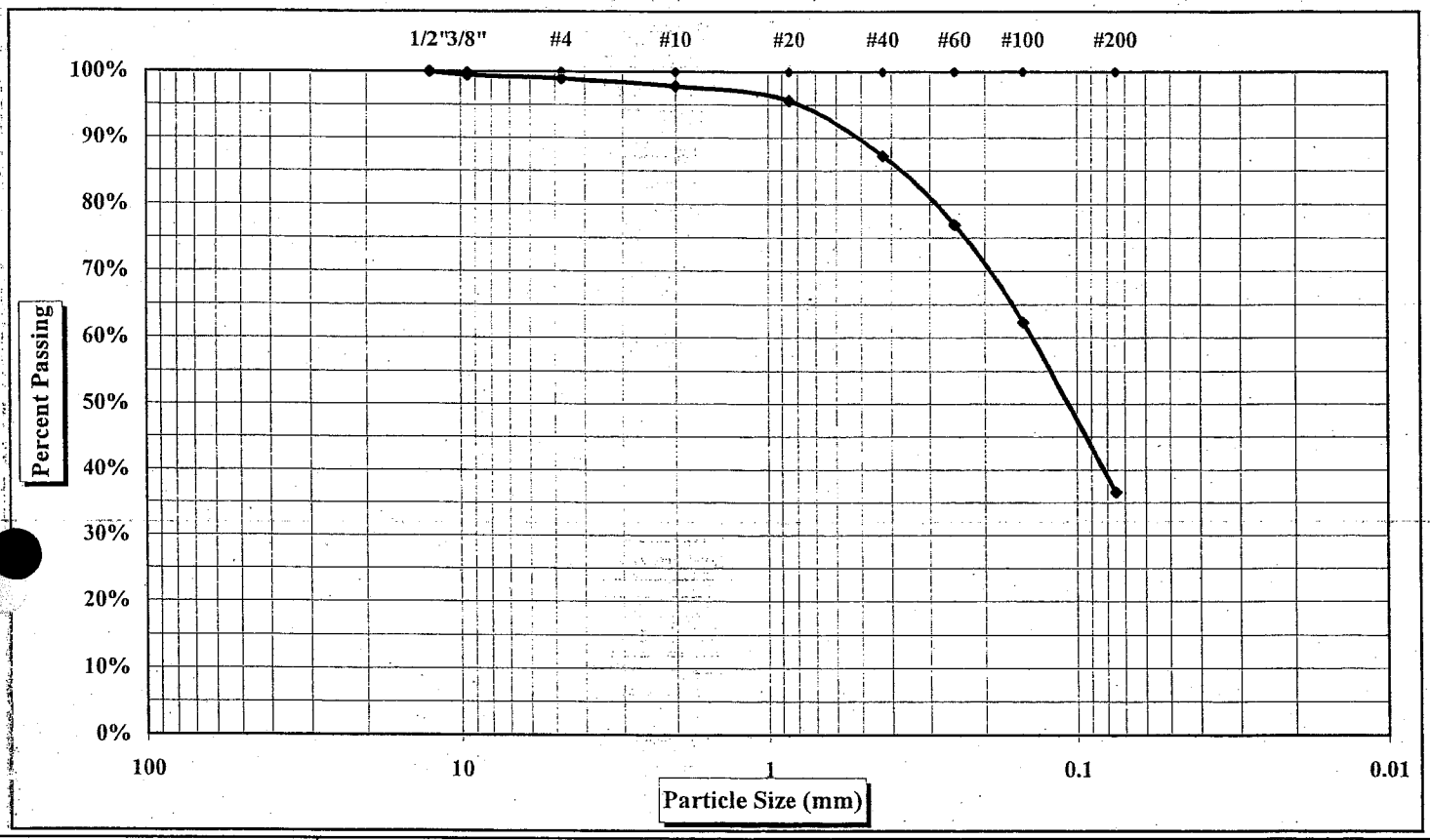
Particle Size Analysis of Soils

ASTM D 422

S&ME

S&ME Project #:	**1356-06-403**	Report Date:	6/1/06
Project Name:	**Marshall Steam Station Bulk Samples**	Test Date(s):	5/19-24/06
Client Name:	Duke Energy		
Client Address:			

Boring #:	S-3	Sample #:		Sample Date:	5/18/06
Location:		Offset:		Depth:	4-5'
Sample Description:	Tan Brown Micaceous Clayey Silty Sand (SM)				



Cobbles	< 300 mm (12") and > 75 mm (3")	Fine Sand	< 0.425 mm and > 0.075 mm (#200)
Gravel	< 75 mm and > 4.75 mm (#4)	Silt	< 0.075 and > 0.005 mm
Coarse Sand	< 4.75 mm and >2.00 mm (#10)	Clay	< 0.005 mm
Medium Sand	< 2.00 mm and > 0.425 mm (#40)	Colloids	< 0.001 mm

Maximum Particle Size	0.0%	Gravel	1%	Medium Sand	11%
Silt & Clay (% Passing #200)	36.6%	Coarse Sand	1%	Fine Sand	51%
Apparent Relative Density		Moisture Content	22.7%	Organic Content	
Liquid Limit	39	Plastic Limit	38	Plastic Index	1

Description of Sand & Gravel

Rounded ☐ Angular ☐ Hard & Durable ☐ Soft ☐ Weathered & Friable ☐

References: ASTM D 422: Particle Size Analysis of Soils *Hydrometer portion of test method not utilized.*

ASTM D 421: Dry Preparation of Soil Samples ASTM D 854: Specific Gravity of Soils

ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils

ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

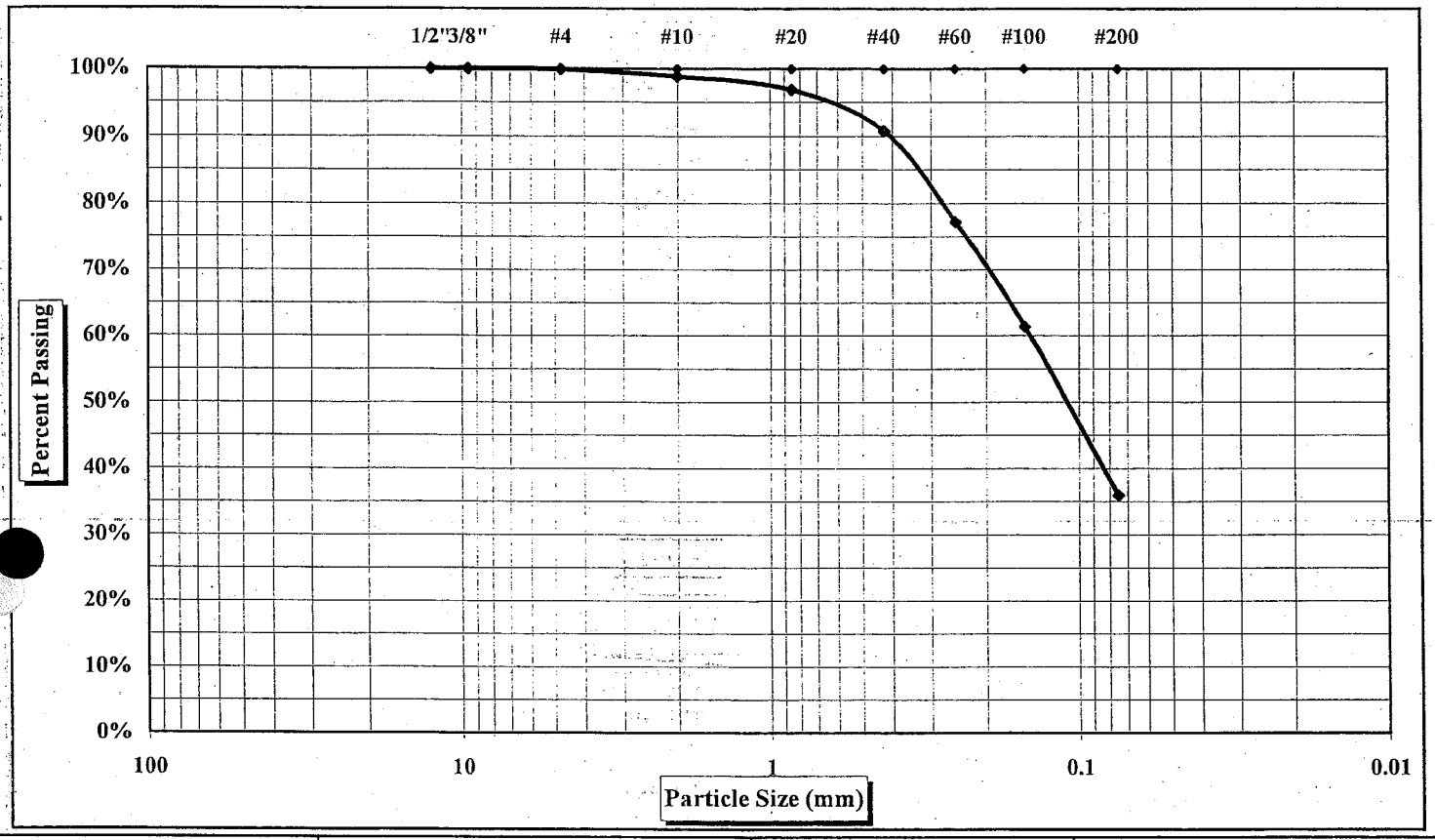
Technical Responsibility: Julie Peterson *Signature* *Position*

Particle Size Analysis of Soils

ASTM D 422

S&ME Project #:	**1356-06-403**	Report Date:	6/1/06
Project Name:	**Marshall Steam Station Bulk Samples**	Test Date(s):	5/19-24/06
Client Name:	Duke Energy		
Client Address:			

Boring #:	S-5	Sample #:		Sample Date:	5/18/06
Location:		Offset:		Depth:	4-5'
Sample Description:	Brown Tan Micaceous Clayey Silty Sand (SM)				



Cobbles	< 300 mm (12") and > 75 mm (3")	Fine Sand	< 0.425 mm and > 0.075 mm (#200)
Gravel	< 75 mm and > 4.75 mm (#4)	Silt	< 0.075 and > 0.005 mm
Coarse Sand	< 4.75 mm and >2.00 mm (#10)	Clay	< 0.005 mm
Medium Sand	< 2.00 mm and > 0.425 mm (#40)	Colloids	< 0.001 mm

Maximum Particle Size	0.0%	Gravel	0%	Medium Sand	8%
Silt & Clay (% Passing #200)	35.9%	Coarse Sand	1%	Fine Sand	55%
Apparent Relative Density		Moisture Content	24.5%	Organic Content	
Liquid Limit	NP	Plastic Limit	NP	Plastic Index	NP

Description of Sand & Gravel

Rounded ☐ Angular ☐ Hard & Durable ☐ Soft ☐ Weathered & Friable ☐

References: ASTM D 422: Particle Size Analysis of Soils *Hydrometer portion of test method not utilized.*

ASTM D 421: Dry Preparation of Soil Samples ASTM D 854: Specific Gravity of Soils

ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils

ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Technical Responsibility: Julie Peterson *Signature* *Position*

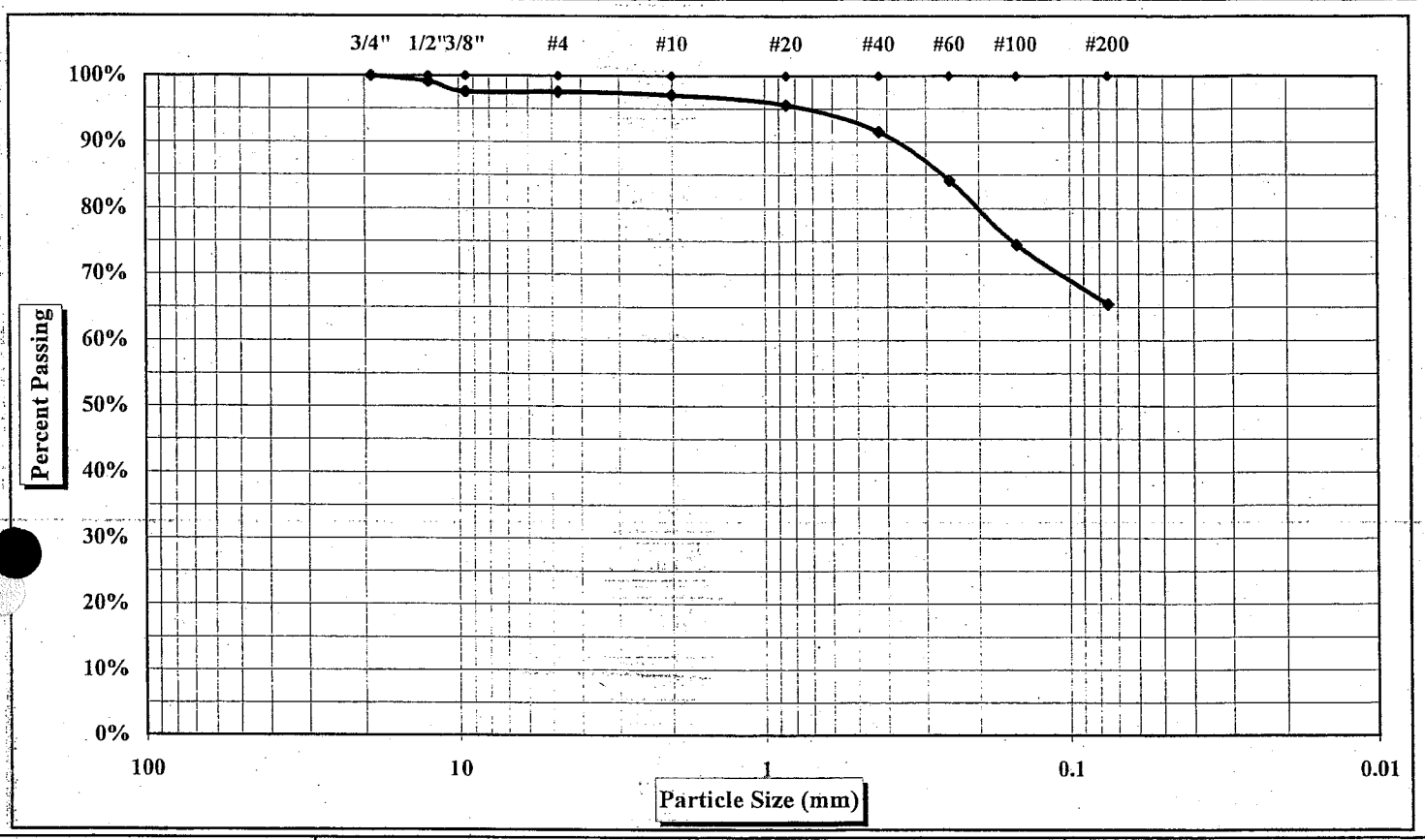
Particle Size Analysis of Soils

ASTM D 422

S&ME

S&ME Project #:	**1356-06-403**	Report Date:	6/1/06
Project Name:	**Marshall Steam Station Bulk Samples**	Test Date(s):	5/19-24/06
Client Name:	Duke Energy		
Client Address:			

Boring #: S-8	Sample #:	Sample Date:	5/18/06
Location:	Offset:	Depth:	4-5'
Sample Description:	Red Orange Brown Micaceous Sandy Clayey Silt (MH)		



Cobbles	< 300 mm (12") and > 75 mm (3")	Fine Sand	< 0.425 mm and > 0.075 mm (#200)
Gravel	< 75 mm and > 4.75 mm (#4)	Silt	< 0.075 and > 0.005 mm
Coarse Sand	< 4.75 mm and >2.00 mm (#10)	Clay	< 0.005 mm
Medium Sand	< 2.00 mm and > 0.425 mm (#40)	Colloids	< 0.001 mm

Maximum Particle Size	0.0%	Gravel	2%	Medium Sand	6%
Silt & Clay (% Passing #200)	65.4%	Coarse Sand	0%	Fine Sand	26%
Apparent Relative Density		Moisture Content	27.3%	Organic Content	
Liquid Limit	62	Plastic Limit	37	Plastic Index	25

Description of Sand & Gravel

Rounded ☐ Angular ☐ Hard & Durable ☐ Soft ☐ Weathered & Friable ☐

References: ASTM D 422: Particle Size Analysis of Soils *Hydrometer portion of test method not utilized.*

ASTM D 421: Dry Preparation of Soil Samples ASTM D 854: Specific Gravity of Soils

ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils

ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Technical Responsibility: Julie Peterson *Signature* *Position*

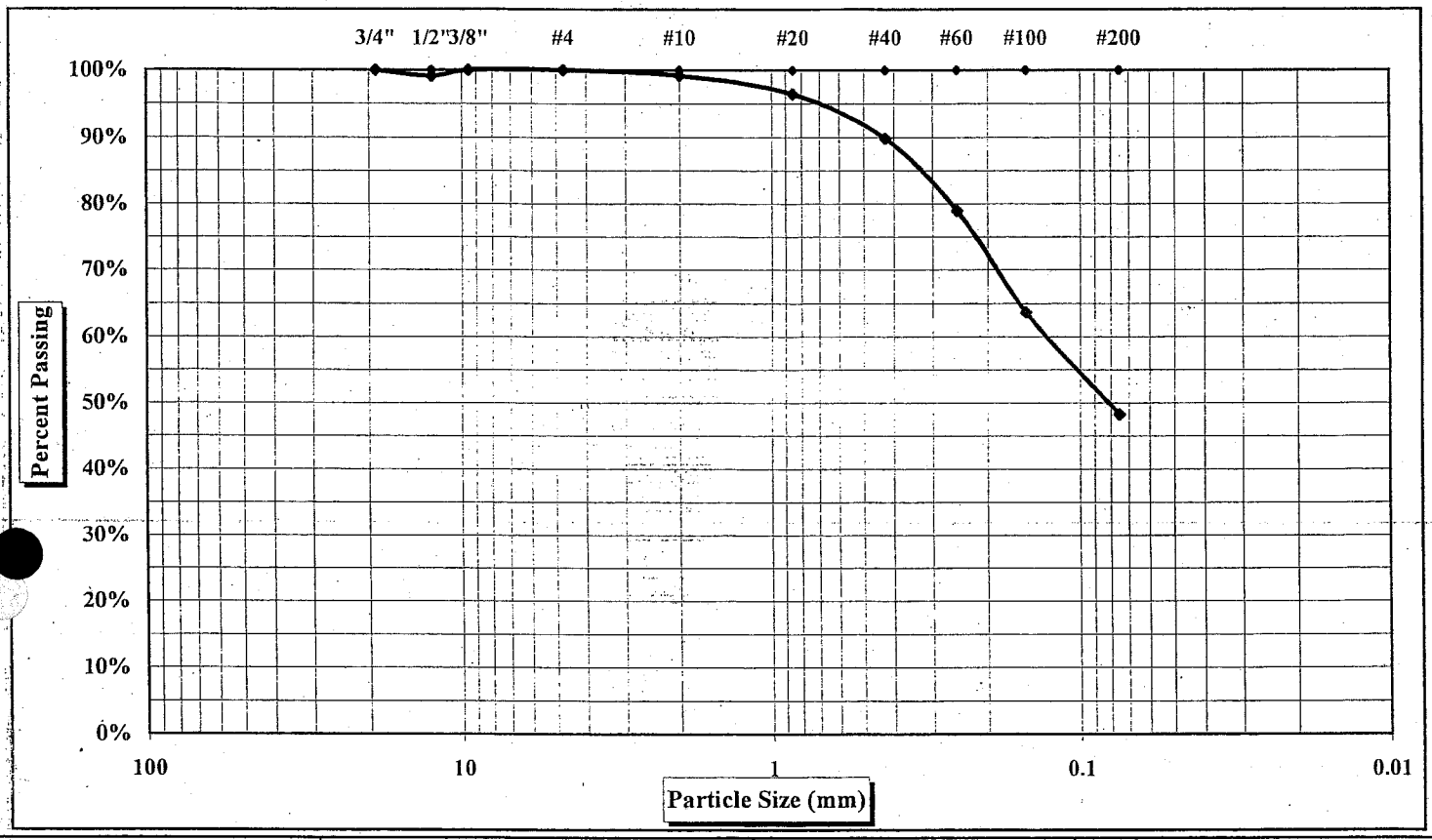
Particle Size Analysis of Soils

ASTM D 422

S&ME

S&ME Project #:	**1356-06-403**	Report Date:	6/1/06
Project Name:	**Marshall Steam Station Bulk Samples**	Test Date(s):	5/19-24/06
Client Name:	Duke Energy		
Client Address:			

Boring #: S-9	Sample #:	Sample Date:	5/18/06
Location:	Offset:	Depth:	4-5'
Sample Description:	Brown Orange Micaceous Clayey Silty Sand (SM)		



Cobbles	< 300 mm (12") and > 75 mm (3")	Fine Sand	< 0.425 mm and > 0.075 mm (#200)
Gravel	< 75 mm and > 4.75 mm (#4)	Silt	< 0.075 and > 0.005 mm
Coarse Sand	< 4.75 mm and >2.00 mm (#10)	Clay	< 0.005 mm
Medium Sand	< 2.00 mm and > 0.425 mm (#40)	Colloids	< 0.001 mm

Maximum Particle Size	0.0%	Gravel	0%	Medium Sand	9%
Silt & Clay (% Passing #200)	48.3%	Coarse Sand	1%	Fine Sand	42%
Apparent Relative Density		Moisture Content	28.3%	Organic Content	
Liquid Limit	53	Plastic Limit	46	Plastic Index	7

Description of Sand & Gravel

Rounded ☐ Angular ☐ Hard & Durable ☐ Soft ☐ Weathered & Friable ☐

References: ASTM D 422: Particle Size Analysis of Soils *Hydrometer portion of test method not utilized.*

ASTM D 421: Dry Preparation of Soil Samples ASTM D 854: Specific Gravity of Soils

ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils

ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Technical Responsibility: Julie Peterson

Signature Position

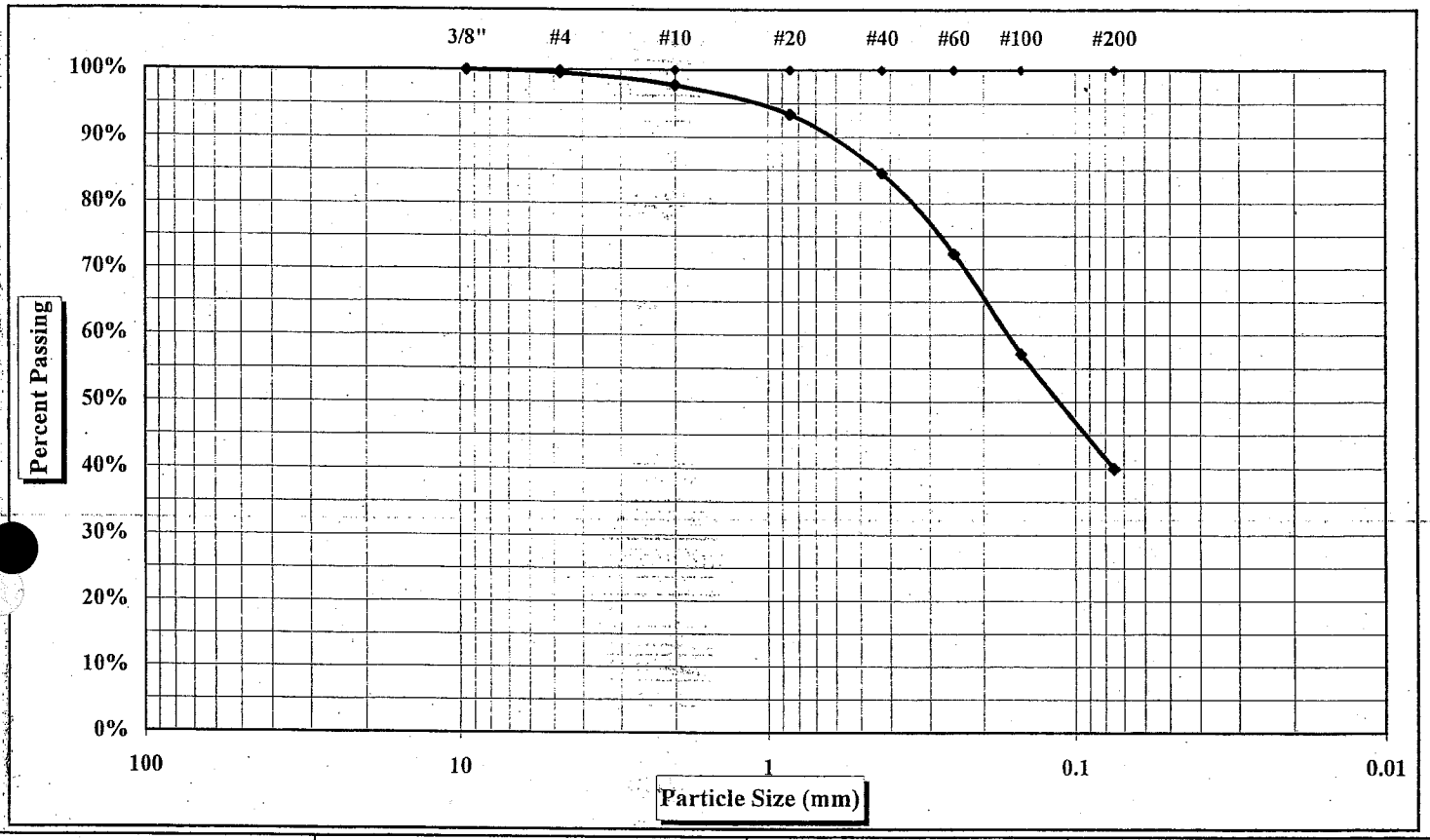
Particle Size Analysis of Soils

ASTM D 422

S&ME

S&ME Project #:	**1356-06-403**	Report Date:	6/1/06
Project Name:	**Marshall Steam Station Bulk Samples**	Test Date(s):	5/19-24/06
Client Name:	Duke Energy		
Client Address:			

Boring #: S-12	Sample #:	Sample Date:	5/18/06
Location:	Offset:	Depth:	1'
Sample Description:	Tan Brown Micaceous Clayey Silty Sand (SM)		



Cobbles	< 300 mm (12") and > 75 mm (3")	Fine Sand	< 0.425 mm and > 0.075 mm (#200)
Gravel	< 75 mm and > 4.75 mm (#4)	Silt	< 0.075 and > 0.005 mm
Coarse Sand	< 4.75 mm and >2.00 mm (#10)	Clay	< 0.005 mm
Medium Sand	< 2.00 mm and > 0.425 mm (#40)	Colloids	< 0.001 mm

Maximum Particle Size	0.0%	Gravel	0%	Medium Sand	13%
Silt & Clay (% Passing #200)	40.0%	Coarse Sand	2%	Fine Sand	45%
Apparent Relative Density		Moisture Content	29.6%	Organic Content	
Liquid Limit	42	Plastic Limit	39	Plastic Index	3

Description of Sand & Gravel

Rounded ☐ Angular ☐ Hard & Durable ☐ Soft ☐ Weathered & Friable ☐

References: ASTM D 422: Particle Size Analysis of Soils *Hydrometer portion of test method not utilized.*

ASTM D 421: Dry Preparation of Soil Samples ASTM D 854: Specific Gravity of Soils

ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils

ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Technical Responsibility: Julie Peterson

Signature *Position*

4

Quantity and Depth of Operational Cover Report

*Volumes are based on Field Survey Data and Truck Counts

Material Quantities:

Approximate Total Volume of Operational Cover Material:	55,473 CY
Approximate Volume of "Bottom Ash":	21,158 CY
Approximate Volume of Sand:	1,840 CY
Approximate Volume of Stockpiled Soil in Slopes:	32,475 CY

Material Depths:

Approximate area of "Bottom Ash" and Sand use:	560,065 SF
Average Depth of "Bottom Ash" and Sand:	1.11 FT

$$\frac{22{,}998 \text{ CY} \times 27 \text{ CF/CY}}{560{,}065 \text{ SF}}$$

Depth of the material installed on slopes varied due to variance between 3:1 subgrade slope and 4:1 operational cover slope.

5

RÖCHLING
Engineered Plastics

Polystone® G
Product range

Polystone® G Selection Table	Material Description	Standard Color
Natural	Standard high-density polyethylene, FDA/USDA accepted	Opaque white
Colors	Available in standard and custom colors	Assorted
Cut-Rite	Food preparation cutting boards, textured both sides, NSF 51 listed and FDA/USDA accepted	Natural and assorted
Play-Tec	Designed for playground structures, textured both sides, U.V. stabilized	Assorted solid and co-extruded
Marine-Tec	Designed for boat builders with a unique texture on both sides, U.V. stabilized	Assorted marine colors
Marine-Tec lite	Special foamed core reduces weight by as much as 20%	Assorted marine colors
Polystone	Bathroom partitions, textured both sides (available in HDPE or PP)	Assorted solid and granite
Pipe Grade	Special grade for the HDPE pipe market, U.V. stabilized	Black

Polystone® G (HDPE)

Sheets, extruded
1/16" - 1-1/2" x 48" x 96"
1/16" - 1-1/2" x 48" x 120"
1/16" - 1-1/2" x 60" x 120"
Sheets up to 120" wide available upon request

Sheets, pressed
1-3/4" - 4" x 48" x 96"
1-3/4" - 4" x 48" x 120"
1-3/4" - 4" x 96" x 240"
Sheets up to 8" thick available upon request

East
Röchling Engineered Plastics, P.O. Box 2729, Gastonia, NC 28053
(800) 541-4419, Fax: (704) 922-7651, Email rep@roechling-plastics.us
West
Röchling Engineered Plastics, 2040 Carlos Avenue, Ontario, CA 91761
(800) 545-5177, Fax: (909) 923-3280, Email rep@roechling-plastics.us

RÖCHLING
Engineered Plastics

Polystone® G
Physical properties

Physical Properties		Polystone ® G (HDPE)	
Property	Units	ASTM Test	Value
Density	gm/cm³	D792	0.95
Tensile Strength at Yield	psi	D638	3000
Flexural Modulus	psi	D790	15,000
Izod Impact-Notched @ 73°	ft-lbs/inch	D256	3.1
Heat Deflection Temperature 73°	°F@66 psi	D648	175
Mean Coefficient of Linear Thermal Expansion	in/in/°F	D696	1.1×10^{-4}
Hardness	Shore D	D785	67
Water Absorption	%	D570	0<0.1

Values shown are averages and should not be used as contractual property values. Specific property value requirements should be specified in the purchase agreement.

East
Röchling Engineered Plastics, P.O. Box 2729, Gastonia, NC 28053
(800) 541-4419, Fax: (704) 922-7651, Email rep@roechling-plastics.us
West
Röchling Engineered Plastics, 2040 Carlos Avenue, Ontario, CA 91761
(800) 545-5177, Fax: (909) 923-3280, Email rep@roechling-plastics.us

ISO 9001:2000 DQS CERT RÖCHLING QUALITY

Updated 12-20-03 DVK

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RÖCHLING
Engineered Plastics

POLYSTONE G
High Density Polyethylene
Pipe Grade

Parameters	ASTM Method	Typical	Units
Density, Black	D4883	0.955	g/cc
Melt Index	D1238	12.5	g/10min
Tensile Strength @ yield (2 in/min)	D638	3300	Psi
Elongation @ Break (2 in/min)	D638	>800	%
Flexural Modulus	D790	120,000	psi
Hardness (shore D)	D2240	68	
Vicat Softening Point	D1525	259	F
Brittleness Temperature	D746	<-180	F

Data represents typical values and should not be used as a specification

Listed with the Plastic Pipe Institute as PE3408 and PE80

QUALITY WINS • ISO 9001 • DQS CERT 2000 • RÖCHLING Engineered Plastics

Röchling Engineered Plastics
P.O. Box 2729, Gastonia, NC 28053-2729
Tel: 704-922-7814 Fax: 704-922-7651

Röchling Engineered Plastics
2040 Carlos Avenue, Ontario, CA 91761
Tel: 909-923-6601 Fax: 909-923-3280

HDPE Pipe

High-Density Polyethylene Pipe

Introduction

ISCO Industries, LLC is the largest high-density polyethylene pipe distributor in North America. ISCO can serve your needs anywhere in the USA. ISCO offers a complete package of HDPE piping products. Butt fusion machines are offered for sale or rental. Fusion technicians are available to provide on-site training or assistance to your project. Please call 1-800-345-ISCO for all your HDPE piping needs.

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Markets for High-Density Polyethylene Pipe

User	Applications	Special Requirements
Landfills	Gas collection systems	ASTM
	Leachate Collection Systems	ASTM
	Perforated Pipe	ASTM
	Dual Containment Piping	State requirements EPA listed chemicals
Industrial	Underground Fire Protection Piping	Factor Mutual
	Pulp & Paper/Wood Products	ASTM D 3350 & F 714
	Acid Sewers	ASTM D 3350 & F 714
	Slurry Piping	ASTM D 3350 & F 714
	Caustic Sewers	ASTM D 3350 & F 714
	Potable Water	NSF 61, ASTM D 3350
	Raw Water	ASTM D 3350
	Dual Containment Piping	EPA & State requirements
Irrigation	Golf Course	ASTM D 3350
	Industrial	ASTM D 3350
Municipal	Drinking Water	NSF 61, AWWA C 906 & ASTM D 3350
	Sanitary Sewers	ASTM D 3350
	Reclaimed Water	ASTM D 3350
	Spray fields	ASTM D 3350
	Gas Distribution Piping	ASTM D 2513 & DOT
	Ocean Outfalls	ASTM D 3350
Trenchless Installations		
	Pipe Bursting	ASTM D 3350
	Directional Drilling	ASTM F 1962
	Sliplining	ASTM F 585
Highway Drainage		
	Culvert Rehabilitation	ASTM D 3350, State DOT
Geothermal	Heating and Cooling Systems	IGSHPA
Oil & Gas Gathering		
	Gas Gathering	ASTM 2513
	Salt Water	ASTM D 3350
Electrical/Telecommunications		
	Conduit	ASTM D 3350, UL
	Telecommunications	ASTM D 3350
Fittings	Molded	ASTM D 3262-97
	Fabricated	ASTM 1472
	Electrofusion	ASTM F 1042

HDPE Pipe

1-800-345-ISCO

www.isco-pipe.com

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HDPE Pipe

Specifications for HDPE Pipe
The properties of high-density polyethylene pipe are described using ASTM D 3350-02, "Standard Specification for Polyethylene Plastic Pipe and Fittings Materials". This ASTM Standard provides cell classifications that define the physical properties of the resin used to make the HDPE pipe.

Most HDPE pipe is made with a cell classification of PE 345464C. The meaning of this cell classification is provided in the table below:

ISCO Standard HDPE Resin Specifications

PROPERTY VALUE		SPECIFICATION	UNIT	NOMINAL
Material Designation		PPI / ASTM		PE3408
Material Classification		ASTM D 1248		III C 5 P34
Cell Classification		ASTM D 3350-02		345464C
Density	(3)	ASTM D 1505	g/cm3	.955 to .957
Melt Index	(4)	ASTM D 1238	gm/ 10 min	.10 to .15
Flexural Modulus	(5)	ASTM D 790	psi	110 to 140,000
Tensile Strength	(4)	ASTM D 638	psi	3,200 min.
Slow Crack Growth				
ESCR		ASTM D 1693	hours in 100% igepal	>5,000
PENT	(6)	ASTM F 1473	hours	>100
HDB @ 73 deg F	(4)	ASTM D 1693	psi	1,600
UV Stabilizer	C	ASTM D 1603	%C	2 to 2.5%

Types of Polyethylene Pipe
All polyethylene pipe is not the same. The Plastic Pipe Institute's "Engineering Properties of Polyethylene" shows that polyethylene with a density of greater than 0.941 (with no additives) is high-density. Materials with a density of 0.926 to .94 are medium density and those with a density of between. 90 and .925 are low density.

Density influences key properties in polyethylene materials. As the density increases, the tensile strength increases. Also the chemical resistance increases.

Traditionally, medium density polyethylene resin has been used to make pipe for gas distribution. When medium density was selected for gas pipe, it had better stress crack resistance than other resins.

As new resins and manufacturing processes have been developed, high and medium density polyethylene resins have improved in their ability to handle stress and stress cracking agents.

The current test to determine stress crack resistance is the PENT test. The PENT Test is run in accordance with ASTM F 1473-97, " Standard Test Method for Notch Tensile Test to Measure the Resistance to Slow Crack Growth of Polyethylene Pipes and Resins". This test requires that slow crack growth test be run on samples of extruded pipe.

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The first Environmental Stress Crack (ESCR) testing was conducted on compression molded tensile bars. As resin manufacturing techniques have improved, samples no longer failed using the ESCR test methods. ESCR testing uses strong detergents at elevated temperatures to evaluate resins.

The PENT test is a good test of resistance to slow crack growth and related failures induced by the presence of stressing agents. Since this test is conducted using HDPE pipe, it is a better test to determine the best resins to use for piping applications.

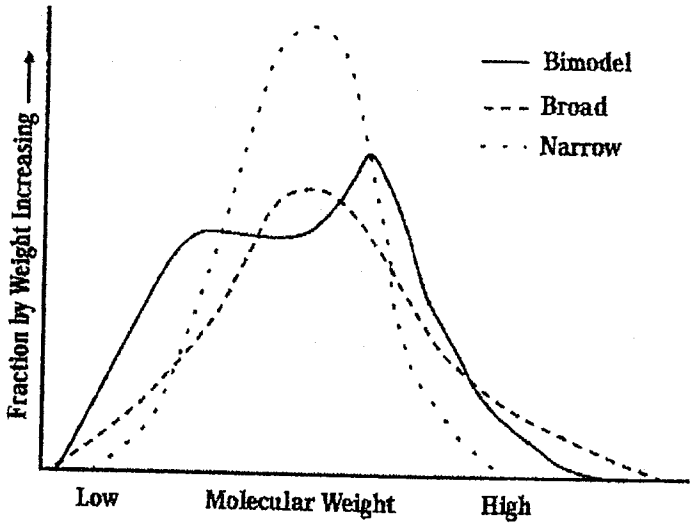
Traditional broad molecular weight resins are used to produce most high-density polyethylene pipe. Typical PENT Test values for these HDPE pipes are 100 to 600 hours.

The Chart below shows the modular weight distribution for Bimodal, Broad and Narrow molecular weight resins.

Molecular Weight Distribution

The dotted line shows a typical molecular weight distribution for a narrow molecular weight HDPE resin. The dashes show just the distribution for a broad molecular weight HDPE. The solid line shows the distribution of a bimodal HDPE resin.

The properties of the HDPE resin can be changed because of the molecular distribution. Density and melt index also are important in tailoring the properties of the HDPE resin.



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Typical IPS HDPE Pipe Sizes

Pipe Size Nominal	Actual Ratio	Dimension Ratio	Pressure rating, 73°F psi	Minimum Wall	Average ID	Weight
5"	5.375"	DR 11	160	0.489"	4.358"	3.272
5"	5.375"	DR 17	100	0.316"	4.718"	2.197
5"	5.375"	DR 21	80	0.256"	4.843"	1.801
5"	5.375"	DR 26	64	0.207"	4.944"	1.186
5"	5.563"	DR 7	267	0.795"	3.909"	5.172
5"	5.563"	DR 9	200	0.618"	4.278"	4.182
5"	5.563"	DR 11	160	0.506"	4.511"	3.505
5"	5.563"	DR 13.5	128	0.412"	4.706"	2.912
5"	5.563"	DR 15.5	110	0.359"	4.816"	2.564
5"	5.563"	DR 17	100	0.327"	4.883"	2.353
5"	5.563"	DR 21	80	0.265"	5.012"	1.929
5"	5.563"	DR 26	64	0.214"	5.118"	1.574
5"	5.563"	DR 32.5	51	0.171"	5.207"	1.27
6"	6.625"	DR 7	267	0.946"	4.657"	7.336
6"	6.625"	DR 9	200	0.736"	5.094"	5.932
6"	6.625"	DR 11	160	0.602"	5.373"	4.971
6"	6.625"	DR 13.5	128	0.491"	5.604"	4.13
6"	6.625"	DR 15.5	110	0.427"	5.737"	3.637
6"	6.625"	DR 17	100	0.390"	5.814"	3.338
6"	6.625"	DR 21	80	0.315"	5.970"	2.736
6"	6.625"	DR 26	64	0.255"	6.095"	2.233
6"	6.625"	DR 32.5	51	0.204"	6.201"	1.801
7"	7.125"	DR 11	160	0.648"	5.777"	5.75
7"	7.125"	DR 17	100	0.419"	6.253"	3.86
7"	7.125"	DR 21	80	0.339"	6.420"	3.165
7"	7.125"	DR 26	64	0.274"	6.555"	2.582
7"	7.125"	DR 32.5	51	0.219"	6.669"	2.083
8"	8.625"	DR 7	267	1.232"	6.062"	12.433
8"	8.625"	DR 9	200	0.958"	6.632"	10.054
8"	8.625"	DR 11	160	0.784"	6.994"	8.425
8"	8.625"	DR 13.5	128	0.639"	7.296"	7.001

***Blue Bold indicates standard/more readily avaliable items.**

HDPE Pipe

Typical IPS HDPE Pipe Sizes

Pipe Size Nominal	Actual Ratio	Dimension Ratio	Pressure rating, 73°F psi	Minimum Wall	Average ID	Weight
8"	8.625"	DR 17	100	0.507"	7.570"	5.657
8"	8.625"	DR 21	80	0.411"	7.770"	4.637
8"	8.625"	DR 26	64	0.332"	7.934"	3.784
8"	8.625"	DR 32.5	51	0.265"	8.074"	3.053
10"	10.750"	DR 7	267	1.536"	7.555"	19.314
10"	10.750"	DR 9	200	1.194"	8.266"	15.618
10"	**10.750"**	**DR 11**	**160**	**0.977"**	**8.718"**	**13.089**
10"	10.750"	DR 13.5	128	0.796"	9.094"	10.875
10"	10.750"	DR 15.5	110	0.694"	9.306"	9.576
10"	**10.750"**	**DR 17**	**100**	**0.632"**	**9.435"**	**8.788**
10"	10.750"	DR 21	80	0.512"	9.685"	7.204
10"	10.750"	DR 26	64	0.413"	9.891"	5.878
10"	10.750"	DR 32.5	51	0.331"	10.062"	4.742
12"	12.750"	DR 7	267	1.821"	8.962"	27.17
12"	12.750"	DR 9	200	1.417"	9.803"	21.97
12"	**12.750"**	**DR 11**	**160**	**1.150"**	**10.339"**	**18.412**
12"	12.750"	DR 13.5	128	0.944"	10.786"	15.298
12"	12.750"	DR 15.5	110	0.823"	11.038"	13.471
12"	**12.750"**	**DR 17**	**100**	**0.750"**	**11.190"**	**12.362**
12"	12.750"	DR 21	80	0.607"	11.487"	10.134
12"	12.750"	DR 26	64	0.490"	11.731"	8.269
12"	12.750"	DR 32.5	51	0.392"	11.935"	6.671
14"	14.000"	DR 7	267	2.000"	9.840"	32.758
14"	14.000"	DR 9	200	1.556"	10.764"	26.489
14"	**14.000"**	**DR 11**	**160**	**1.273"**	**11.352"**	**22.199**
14"	14.000"	DR 13.5	128	1.037"	11.843"	18.445
14"	14.000"	DR 15.5	110	0.903"	12.122"	16.242
14"	**14.000"**	**DR 17**	**100**	**0.824"**	**12.286"**	**14.905**
14"	14.000"	DR 21	80	0.667"	12.613"	12.218
14"	14.000"	DR 26	64	0.538"	12.881"	9.97

***Blue Bold indicates standard/more readily avaliable items.**

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Typical IPS HDPE Pipe Sizes

Pipe Size Nominal	Actual Ratio	Dimension Ratio	Pressure rating, 73°F psi	Minimum Wall	Average ID	Weight
32"	32.000"	DR 13.5	128	2.370"	27.070"	96.367
32"	32.000"	DR 15.5	110	2.065"	27.705"	84.855
32"	32.000"	DR 17	100	1.882"	28.065"	77.869
32"	32.000"	DR 21	80	1.524"	28.830"	63.835
32"	32.000"	DR 26	64	1.231"	29.440"	52.086
32"	**32.000"**	**DR 32.5**	**51**	**0.985"**	**29.951"**	**42.023**
36"	36.000"	DR 15.5	110	2.323"	31.168"	107.395
36"	**36.000"**	**DR 17**	**100**	**2.118"**	**31.595"**	**98.553**
36"	36.000"	DR 21	80	1.714"	32.434"	80.791
36"	36.000"	DR 26	64	1.385"	33.119"	65.922
36"	**36.000"**	**DR 32.5**	**51**	**1.108"**	**33.696"**	**53.186**
42"	42.000"	DR 15.5	110	2.710"	36.363"	146.176
42"	42.000"	DR 17	100	2.471"	36.860"	134.141
42"	42.000"	DR 21	80	2.000"	37.840"	109.966
42"	42.000"	DR 26	64	1.615"	38.641"	89.727
42"	**42.000"**	**DR 32.5**	**51**	**1.292"**	**39.313"**	**72.392**
48"	48.000"	DR 17	100	2.824"	42.126"	175.205
48"	48.000"	DR 21	80	2.286"	43.245"	143.629
48"	48.000"	DR 26	64	1.846"	44.160"	117.194
48"	**48.000"**	**DR 32.5**	**51**	**1.477"**	**44.928"**	**94.552**
51.5"	51.500"	DR 21	80	2.452"	46.400"	165.339
51.5"	51.500"	DR 26	64	1.981"	47.380"	134.908
51.5"	51.500"	DR 32.5	51	1.585"	48.203"	108.844
54"	54.000"	DR 21	80	2.571"	48.652"	181.781
54"	54.000"	DR 26	64	2.077"	49.680"	148.324
→ **54"**	**54.000"**	**DR 32.5**	**51**	**1.662"**	**50.543"**	**119.668**
63"	63.209"	DR 21	80	3.000"	58.849"	247.8
63"	63.209"	DR 26	64	2.421"	58.076"	202.01
63"	**63.209"**	**DR 32.5**	**50**	**1.937"**	**59.102"**	**162.98**

***Blue Bold indicates standard/more readily avaliable items.**

HDPE Pipe

1-800-345-ISCO

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HDPE Pipe

DIPS HDPE Pipe Sizes

Pipe Size Nominal	Actual O.D.	Dimension Ratio	Pressure rating, 73°F psi	Minimum Wall	Average ID	Weight
3"	3.96"	DR 9	200	0.440"	3.045"	2.119
3"	3.96"	DR 11	160	0.360"	3.211"	1.776
3"	3.96"	DR 13.5	128	0.294"	3.348"	1.476
3"	3.96"	DR 17	100	0.233"	3.475"	1.192
3"	3.96"	DR 26	64	0.153"	3.642"	0.798
4"	4.80"	DR 9	200	0.533"	3.691"	3.114
4"	**4.80"**	**DR 11**	**160**	**0.437"**	**3.891"**	**2.609**
4"	4.80"	DR 13.5	128	0.356"	4.060"	2.168
4"	**4.80"**	**DR 17**	**100**	**0.283"**	**4.211"**	**1.752**
4"	4.80"	DR 26	64	0.189"	4.407"	1.172
6"	6.90"	DR 9	200	0.767"	5.305"	6.434
6"	**6.90"**	**DR 11**	**160**	**0.628"**	**5.594"**	**5.392**
6"	6.90"	DR 13.5	128	0.512"	5.835"	4.480
6"	**6.90"**	**DR 17**	**100**	**0.406"**	**6.056"**	**3.620**
6"	6.90"	DR 26	64	0.266"	6.347"	2.422
8"	9.05"	DR 9	200	1.006"	6.958"	11.069
8"	**9.05"**	**DR 11**	**160**	**0.823"**	**7.338"**	**9.276**
8"	9.05"	DR 13.5	128	0.670"	7.656"	7.708
8"	**9.05"**	**DR 17**	**100**	**0.533"**	**7.941"**	**6.228**
8"	9.05"	DR 26	64	0.348"	8.326"	4.166
10"	11.10"	DR 9	200	1.233"	8.535"	16.652
10"	**11.10"**	**DR 11**	**160**	**1.009"**	**9.001"**	**13.955**
10"	11.10"	DR 13.5	128	0.823"	9.338"	11.595
10"	**11.10"**	**DR 17**	**100**	**0.653"**	**9.742"**	**9.369**
10"	11.10"	DR 26	64	0.427"	10.212"	6.267
12"	13.20"	DR 9	200	1.467"	10.149"	23.548
12"	**13.20"**	**DR 11**	**160**	**1.200"**	**10.704"**	**19.734**
12"	13.20"	DR 13.5	128	0.978"	11.166"	16.397
12"	**13.20"**	**DR 17**	**100**	**0.777"**	**11.584"**	**13.250**
12"	13.20"	DR 26	64	0.508"	12.143"	8.863

***Blue Bold indicates standard/more readily avaliable items.**

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HIGH DENSITY POLYETHYLENE PIPE
Typical Physical Properties***

Property	Specification	Unit	Nominal Value
Material Designation	PPI / ASTM		PE 3408
Material Classification	ASTM D-1248		III C 5 P34
Cell Classification	ASTM D3350-99		345464C
-Density (3)	ASTM D-1505	gm/cm3	0.955
-Melt Index (4)	ASTM D-1238 (216 kg/190iC)	gm/10 min.	0.11*
-Flex Modulus (5)	ASTM D-790	psi	135,000
-Tensile Strength (4)	ASTM D-638	psi	3,200
PENT (6)	ASTM F-1473	Hours	>100
-HDB @73i F (4)	ASTM D-2837	psi	1,600
-HDB @ 140 Deg F	ASTM D-2837	psi	800
-U-V Stabilizer (C)	ASTM D-1603	% C	2.5
Hardness	ASTM D-2240	Shore "D"	65
Compressive Strength (yield)	ASTM D-695	psi	1,600
Tensile Strength @ Yield (Type IV Spec.)	ASTM D-638 (2"/min.)	psi	3,200
Elongation @ Yield	ASTM D-638	%, minimum	8
Tensile Strength @ Break (Type IV Spec.)	ASTM D-638	psi	5,000
Elongation @ Break	ASTM D-638	%, minimum	750
Modulus of Elasticity	ASTM D-638	psi	130,000
PENT (6)	ASTM F-1473	Hours	>100
(Cond. A, B, C: Mold. Slab)	ASTM D-1693	Fo, Hours	>5,000
(Compressed Ring - pipe)	ASTM F-1248	Fo, Hours	>3,500
Slow Crack Growth	Battelle Method	Days to Failure	>64
Impact Strength (IZOD) (.125Ó Thick)	ASTM D-256 (Method A)	In-lb / in notch	42
Linear Thermal Expansion Coef.	ASTM D-696	in / in/iF	1.2x10-4
Thermal Conductivity	ASTM D-177	BTU-in/ft2/ hrs/ degreesF	2.7
Brittleness Temp.	ASTM D-746	degrees F	< -180
Vicat Soft. Temp.	ASTM D-1525	degrees F	257
Heat Fusion Cond.	ASTM D-1525	@ psi degrees F	75 @ 400

*** This list of typical physical properties is intended for basic characterization of the material and does not represent specific determinations of specifications. The physical properties values reported herein were determined on compression molded specimens prepared in accordance with Procedure C of ASTM D 1928 and may differ from specimens taken from pipe.
** Tests were discontinued because no failures and no indication of stress crackinitiation.
* Average Melt Index value with a standard deviation of 0.01

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Typical Sizes and Dimensions for Iron Pipe Size (IPS)
PE3408 High Density Polyethylene (HDPE) Pipe

Pressure Rating		DR 17 (100psi)			DR 21 (80psi)			DR 26 (65psi)			DR 32.5 (50psi)		
Nominal Size	Actual O.D.	Min. wall	Average I.D.	Weight lb/lf	Min. wall	Average I.D.	Weight lb/lf	Min. wall	Average I.D.	Weight lb/lf	Min. wall	Average I.D.	Weight lb/lf
2"	2.375"	0.140"	2.084"	0.429	---	---	---	---	---	---	---	---	---
3"	3.500"	0.206"	3.072"	0.932	---	---	---	---	---	---	---	---	---
4"	4.500"	0.265"	3.949"	1.540	0.214"	4.055"	1.262	0.173"	4.140"	1.030	0.138"	4.213"	0.831
5"	5.375"	0.316"	4.718"	2.197	0.256"	4.843"	1.801	0.207"	4.944"	1.470	0.165"	5.032"	1.186
5"	5.563"	0.327"	4.883"	2.353	0.265"	5.012"	1.929	0.214"	5.118"	1.574	0.171"	5.207"	1.270
6"	6.625"	0.390"	5.814"	3.338	0.315"	5.970"	2.736	0.255"	6.095"	2.233	0.204"	6.201"	1.801
7"	7.125"	0.419"	6.253"	3.860	0.339"	6.420"	3.165	0.274"	6.555"	2.582	0.219"	6.669"	2.083
8"	8.625"	0.507"	7.570"	5.657	0.411"	7.770"	4.637	0.332"	7.934"	3.784	0.265"	8.074"	3.053
10"	10.750"	0.632"	9.435"	8.788	0.512"	9.685"	7.204	0.413"	9.891"	5.878	0.331"	10.062"	4.742
12"	12.750"	0.750"	11.190"	12.362	0.607"	11.487"	10.134	0.490"	11.731"	8.269	0.392"	11.935"	6.671
14"	14.000"	0.824"	12.286"	14.905	0.667"	12.613"	12.218	0.538"	12.881"	9.970	0.431"	13.104"	8.044
16"	16.00"	0.941"	14.043"	19.467	0.762"	14.415"	15.959	0.615"	14.721"	13.022	0.492"	14.977"	10.506
18"	18.00"	1.059"	15.797"	24.638	0.857"	16.217"	20.198	0.692"	16.561"	16.480	0.544"	16.868"	13.296
20"	20.00"	1.176"	17.554"	30.418	0.952"	18.020"	24.936	0.769"	18.400"	20.346	0.615"	18.721"	16.415
22"	22.00"	1.294"	19.308"	36.805	1.048"	19.820"	30.172	0.846"	20.240"	24.619	0.677"	20.592"	19.863
24"	24.00"	1.412"	21.063"	43.801	1.143"	21.623"	35.907	0.923"	22.080"	29.299	0.738"	22.465"	23.638
26"	26.00"	1.529"	22.820"	51.406	1.238"	23.425"	42.141	1.000"	23.920"	34.385	0.800"	24.336"	27.742
28"	28.00"	1.647"	24.574"	59.618	1.333"	25.227"	48.874	1.077"	25.760"	39.879	0.862"	26.207"	32.174
30"	30.00"	1.765"	26.329"	68.439	1.429"	27.028"	56.105	1.154"	27.600"	45.779	0.923"	28.080"	36.934
32"	32.00"	1.882"	28.085"	77.869	1.524"	28.830"	63.835	1.231"	29.440"	52.086	0.985"	29.951"	42.023
36"	36.00"	2.118"	31.595"	98.553	1.714"	32.435"	80.791	1.385"	33.119"	65.922	1.108"	33.695"	53.186
42"	42.00"	2.471"	36.860"	134.141	2.000"	37.840"	109.966	1.615"	38.641"	89.727	1.292"	39.313"	72.392
48"	48.00"	2.824	42.126"	175.205	2.286"	43.245"	143.629	1.846"	44.160"	117.194	1.477"	44.928"	94.552
52"	51.50"	---	---	---	2.452	46.400"	165.339	1.981"	47.380"	134.908	1.585"	48.203"	108.844
54"	54.00"	---	---	---	2.571	48.652"	181.781	2.077"	49.680"	148.324	1.662"	50.543"	119.668

NOTE:

- Pressures are based on using water at 23°C (73°F) and are determined by using standard formulas for the industry.
- Average inside diameter calculated using nominal OD and minimum wall plus 4% for use in estimating fluid flows. Actual ID will vary.
- Service factors should be utilized to compensate for the effect of substances other than water, and for other temperatures.
- Fusion equipment rental available for all sizes.
- Other piping sizes or DR's may be available upon request.
- HDPE piping meets ASTM F 714. HDPE pipe meeting ASTM D 2513 is available upon request.

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6

Leachate Collection System – Header Pipe Installation

Leachate Collection System – Header & Collection Pipe Connection

Leachate Collection System – Collection Pipe Installation

Operational Cover Installation

Operational Cover Installation

Completed Operational Cover, Armored Channel and Slope (seeding partially complete)

Completed Operational Cover