



# Revised Geotechnical Subsurface Exploration and Laboratory Testing Data Report

***2016-1A Emergency Bridge Replacement Package  
SCDOT PIN P031750  
S-45 (Lester Road) Bridge over Little Pee Dee Swamp  
Dillon County, South Carolina  
F&R Project No. 65U-0177***

Prepared For:



***South Carolina Department of Transportation  
Design Build Section  
955 Park Street  
Columbia, South Carolina 29201***

Prepared By:

***Froehling & Robertson, Inc.  
18 Woods Lake Road  
Greenville, South Carolina, 29607***

*December 15, 2016*



# FROEHLING & ROBERTSON, INC.

*Engineering Stability Since 1881*

18 Woods Lake Road  
Greenville, South Carolina 29607  
T 864.271.2840 | F 864.271.8124  
SC License No. C00056

December 15, 2016

Mr. Trapp Harris, PE  
South Carolina Department of Transportation  
Design Build Section  
955 Park Street  
Columbia, South Carolina 29201

Subject: Revised Geotechnical Subsurface Exploration and Laboratory Testing Data Report  
2016-1A Emergency Bridge Replacement Package  
SCDOT PIN P031750, S-45 (Lester Road) Bridge over Little Pee Dee Swamp  
Dillon County, South Carolina  
F&R Project No. 65U-0177

Dear Mr. Harris:

The purpose of this data report is to present the results of the subsurface exploration program and laboratory testing undertaken by Froehling & Robertson, Inc. (F&R) in connection with the 2016-1A Emergency Bridge Package which includes the S-45 (Lester Road) Bridge over Little Pee Dee Swamp in Dillon County, South Carolina. Our services were performed in general accordance with your work order Number FR#10-18-P031750 emailed to F&R on November 22, 2016, and as authorized by your office per our On-Call Contract with SCDOT (Contract Number S-147-14). The attached report presents our understanding of the project, reviews our exploration procedures, describes existing site and general subsurface conditions, and presents the results of our laboratory tests.



We have enjoyed working with you on this project. Please contact us if you have any questions regarding this report or if we may be of further service.

Sincerely,  
**FROEHLING & ROBERTSON, INC.**



Benedictus K. Azumah, PE  
Geotechnical Engineer  
SC PE License No. 33654

Marving L. Farmer, PE  
Senior Geotechnical Engineer  
SC PE License No. 32386

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Emergency Bridge Package.docx





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## 1.0 PURPOSE & SCOPE OF SERVICES

The purpose of the subsurface exploration and soil laboratory testing was to obtain preliminary subsurface condition information for use as geotechnical baseline information in connection with the proposed bridge replacement, a design build project.

F&R's scope of services included the following:

- Coordination of underground utility clearance with SC 811;
- Review of readily available geologic and subsurface information relative to the project site;
- Completion of two soil test borings to a depth of approximately 100 feet below the existing ground surface;
- Preparation of typed boring logs presented on The SCDOT soil test boring log template along with raw electronic data files in gINT format;
- Performing laboratory testing including up to eight natural moisture content tests, up to eight amount finer than No. 200 Sieve, and up to four Atterberg Limit tests on selected soil samples;
- Completion of two cone penetration tests to a depth of approximately 50 feet below the existing ground surface;
- Preparation of graphically illustrated CPT sounding logs and raw electronic CPT data files. We have provided these electronic data files in dot DAT, Comma-Separated Values (.CSV) and gINT (.GPJ) formats;
- Completion of one geophysical test at the bridge site using a Multi-Channel Analysis of Surface Waves (MASW) method;
- Completion of field surveys of subsurface test location to include stations, offsets, GPS coordinates in horizontal state plane coordinates (northings and eastings), and ground surface elevations at each test hole location;
- Preparation of this geotechnical data report by professional engineers.

F&R's geotechnical services did not include development of quantity estimates, preparation of plans and specifications, or the identification and evaluation of wetlands or other environmental aspects of the project site.



## **2.0 PROJECT INFORMATION**

### **2.1 Site and Project Description**

The project site is on South Carolina Highway S-45 (Lester Road) at the middle of the three bridges over Little Pee Dee Swamp in Dillon County, South Carolina. Highway S-45 is an asphalt paved two-lane highway. The area around the bridge and roadway is generally swampy, wooded or partly covered with brush. The ground surface elevation on the paved area is at approximately EL 79 and the elevations around the river banks and the immediately adjacent areas range from approximately El 70 to El 73. A site vicinity map is shown as Figure No. 1 and included in Appendix 1 of this report.

As a result of recent storm events, damage to portions or all of the bridge has occurred and therefore replacement of the existing bridge is planned. For this purpose, subsurface exploration at the bridge site is required.

F&R performed our subsurface exploration in accordance with the scope of services as described in your work order request to F&R which you submitted to us on November 22, 2016. F&R obtained the site location information from the Emergency Bridge Package 7 dot KMZ file dated November 21, 2016, which we received from your office on the same date. The project development information was provided to us through our communication with you and included in the work order request referenced above. Additional site details were obtained through our site visit.

### **2.2 Location Control**

The SPT borings, CPT soundings and geophysical testing locations were staked in the field by F&R personnel at locations close to the existing bridge. After completion of the subsurface explorations our licensed surveying subcontractor, Chao and Associates, Inc., of Columbia, South Carolina obtained the station, offset, GPS coordinates (latitude and longitude), horizontal state plane coordinates (northings and eastings), and ground surface elevations at each test hole location. Surveying was performed in accordance with the rules and regulations governing the practice of surveying in the State of South Carolina. Horizontal datum was referenced to SCSPCS and Vertical datum was referenced to NGVD88. These locations and elevations should be considered no more accurate than the methods and plans used to obtain them.



### 3.0 SUBSURFACE EXPLORATION PROCEDURES

#### 3.1 Soil Test Borings

The soil test borings were conducted by a joint effort between personnel from our firm and our drilling subcontractor, William Walker Environmental Services LLC, of West Columbia, South Carolina. The drilling was performed from November 22<sup>nd</sup> through 30<sup>th</sup>, 2016. The Standard Penetration Test (SPT) was performed at the boring locations in general accordance with ASTM D1586.

The drill rigs used for this project were an ATV-mounted CME-550X equipped with an automatic hammer and a truck-mounted CME-45B equipped with a safety hammer. The test holes were advanced using the mud rotary drilling technique.

The subsurface exploration program included two Standard Penetration Test (SPT) borings, each located as close as possible to opposite ends of the existing bridge. The borings are designated as Soil Test Borings STB-101 and STB-102. The SPT tests were performed continuously from the existing ground surface to a depth of 10 feet and at approximate 5-foot intervals thereafter until termination at a depth of approximately 100 feet below the existing ground surface. Approximate boring locations are identified on Figure No. 2 - Location Plan included in Appendix 1 of this report. Photographic documentation of the drill rigs in operation at the locations of STB-101 and STB-102 are also included in Appendix 1 and presented as Figure No. 3 and 4, respectively.

Soil samples were obtained with a standard 2" O.D. and 30" long split-spoon sampler with each SPT being driven with a 140-lb automatic hammer falling 30 inches. The number of blows required to drive the sampler each 6-inch increment of penetration was recorded and are shown on the boring logs. The first six-inch increment is used to seat the sampler with the sum of the second and third penetration increments being termed the SPT N-value. A representative portion of each disturbed split-spoon sample was collected with each SPT, placed in a bag, and returned to our laboratory for review.

The recovered split-spoon samples were visually classified by F&R engineers in general accordance with the ASTM D2488. The boring logs provided in Appendix II show the subsurface conditions encountered on the dates and at the approximate locations indicated. Groundwater observations at the time of drilling and after 24 hours are recorded on the boring logs.



By the nature of the work performed, the drilling activities result in disturbances to the site. The completed boreholes performed were backfilled with on-site soils. The borehole backfill may subside at some time following our work. F&R assumes no responsibility for borehole subsidence after completion of the field exploration and departing the site. For continued safety, the boreholes should be occasionally observed by others with any needed additional backfilling then being performed. The test boring logs are included with this report and presented in Appendix II.

### **3.2 Cone Penetration Testing**

The Cone Penetration Test (CPT) soundings conducted for our subsurface exploration were performed by our sub-contractor Palmetto Insitu, LLC, of Charleston, South Carolina, on November 22, 2016. The two CPTs were performed close to each of the existing bridge abutments in general accordance with ASTM D5778. The CPTs are designated as CPT-101 and CPT-102 and are identified on Figure No. 2 - Location Plan included in Appendix 1 of this report. Cone Penetration Tests CPT-101 and CPT-102 encountered refusal at depths of 37 feet and 42 feet, respectively.

The equipment used for the exploration includes an electronic 15 cm<sup>2</sup> Vertek seismic cone, hydraulically advanced into the soil using a Vertek S4 Scorpion CPT rig capable of 20 tons of thrust. The collected raw data was processed by Palmetto Insitu, LLC using Bentley's gINT V8i SS2 software (version 08.30.04.206) and Dataforensics, RapidCPT software (version 4.2.2.0). The legend used for the SBT correlations is based on Robertson and Campanella: 1990 and is included with the CPT results provided in Appendix III. An electronic file (in .CSV file format) containing the CPT results is being submitted under separate cover. Photographic documentation of the CPT rigs in operation at the locations of CPT-101 and CPT-102 are included in Appendix 1 and presented as Figure No. 5 and 6, respectively.

### **3.3 Geophysical Testing**

A Refraction Microtremor (ReMi) survey was performed at one location (array) longitudinal to the road and just to the north side of the bridge. The ReMi survey was conducted to provide estimated measurements of the soil shear wave velocity in the upper 100 feet. The dispersive characteristic of Rayleigh waves when traveling through a layered medium is measured from the surface, which makes the method nondestructive and nonintrusive. A seismic source (ambient "noise") is applied at the ground surface where vertical transducers record the propagation of surface waves. By analyzing the phase information for each frequency contained in the wave train, the Rayleigh and shear wave velocity can be determined. The data was processed using



SeisOpt® ReMi™ software to reveal a one-dimensional average shear-wave (S-wave) velocity structure for the array. The survey was performed to provide the average shear wave velocity to a depth of 100 feet used to determine the seismic Site Classification in accordance with Chapter 16 of the 2015 International Building Code (IBC). The result of the geophysical test is included in Appendix IV of this report.

## **4.0 LABORATORY TESTING**

### **4.1 Laboratory Testing**

Laboratory testing consisted of ten natural moisture content test (ASTM D2216), ten amount finer than No. 200 Sieve tests (ASTM D1140), and four Atterberg Limit tests (ASTM D4318) on several samples obtained from the borings.

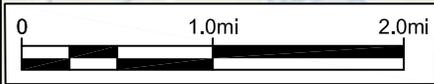
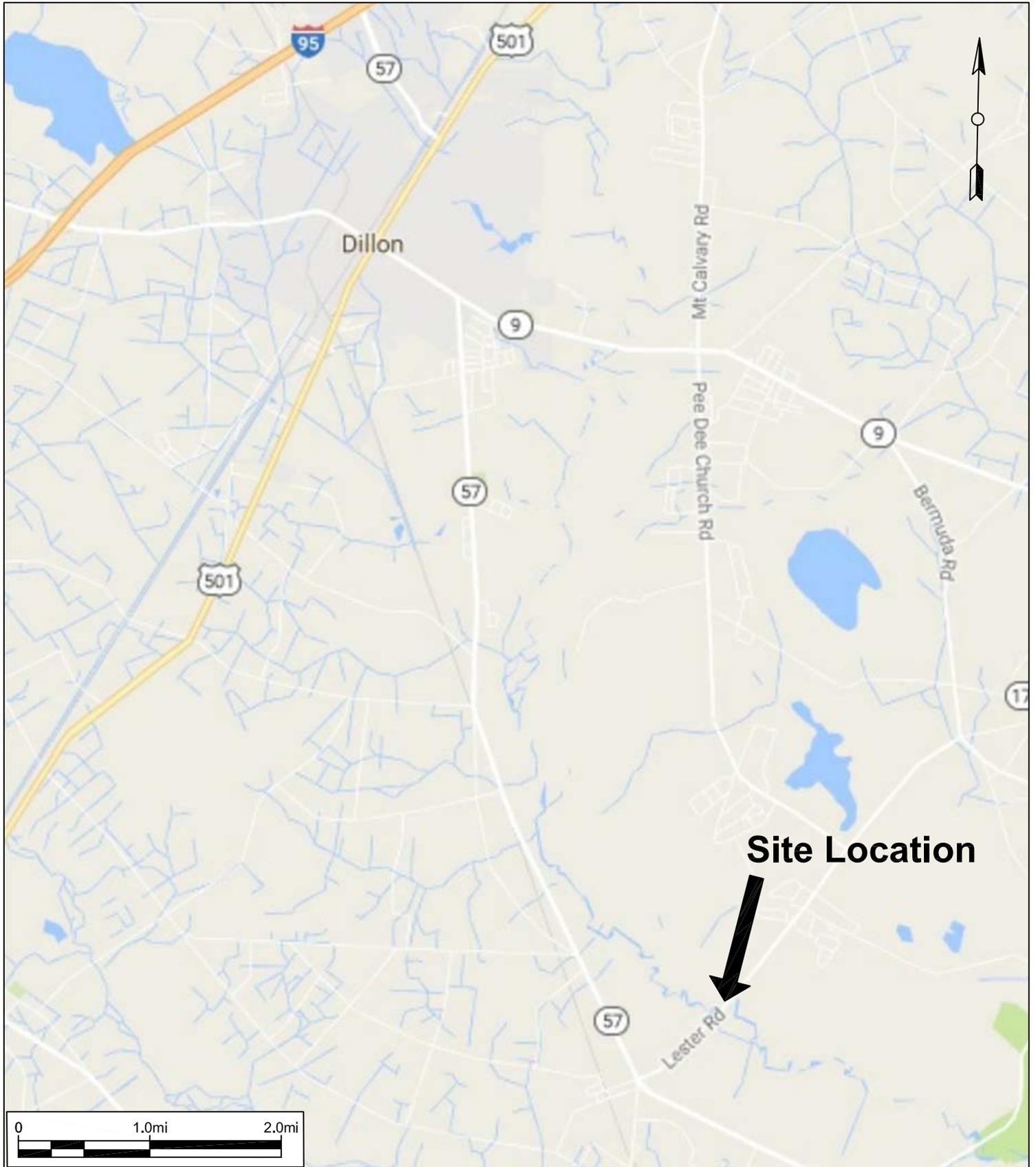
Laboratory test results are included in Appendix V of this report revision.

## **5.0 LIMITATIONS**

This report has been prepared for the exclusive use of South Carolina Department of Transportation – Design Build Section or their agent, for specific application to the S-45 (Lester Road) Bridge over Little Pee Dee Swamp project, in accordance with generally accepted soil and foundation engineering practices. No other warranty, express or implied, is made. Our investigation is based on site location information furnished to us; and generally accepted geotechnical engineering practice. The subsurface investigation logs included herein, do not reflect variations in subsurface conditions which could exist intermediate of the boring locations or in unexplored areas of the site. Should such variations become apparent during construction, it will be necessary to perform additional subsurface exploration based upon on-site observations of the conditions.



# APPENDIX I



**FROEHLING & ROBERTSON, INC.**  
 GEOTECHNICAL • ENGINEERS • MATERIALS

**DATE: 12/7/2016**

**CLIENT: SCDOT**

**PROJECT NO.: 65U-0177**

**Site Vicinity Map  
 Emergency Bridge Replacement - S-45 (Lester Rd)  
 Dillon County, South Carolina**

**FIG NO. 1**

**Drawing Legend:**

-  SPT Boring
-  CPT Boring



**FROEHLING & ROBERTSON, INC.**  
GEOTECHNICAL • ENGINEERS • MATERIALS

DATE: 12/7/2016

CLIENT: SCDOT

PROJECT NO.: 65U-0177

**Boring Location Map**  
**Emergency Bridge Replacement - S-45 (Lester Rd)**  
**Dillon County, South Carolina**

FIG NO. 2



Figure No. 3: Photograph of Soil Test Boring STB-101 Being Drilled



Figure No. 4: Photograph of Soil Test Boring STB-102 Being Drilled



Figure No. 5: Photograph of Cone Penetration Test CPT-101 Being Performed



Figure No. 6: Photograph of Cone Penetration Test CPT-102 Being Performed



## **APPENDIX II**



**KEY TO SOIL CLASSIFICATION**  
**Correlation of Penetration Resistance with**  
**Relative Density and Consistency**

<u>Sands and Gravels</u>		<u>Silts and Clays</u>	
No. of <u>Blows, N</u>	Relative <u>Density</u>	No. of <u>Blows, N</u>	<u>Consistency</u>
0 - 4	Very loose	0 - 2	Very soft
5 - 10	Loose	3 - 4	Soft
11 - 30	Medium dense	5 - 8	Firm
31 - 50	Dense	9 - 15	Stiff
Over 50	Very dense	16 - 30	Very stiff
		31 - 50	Hard
		Over 50	Very hard

**Particle Size Identification**

**(Unified Classification System)**

Boulders:	Diameter exceeds 12-in. (300-mm)
Cobbles:	3-in. (75-mm) to 12-in. (300-mm) diameter
Gravel:	<b>Coarse</b> - ¾-in. (19-mm) to 3 in. (75-mm) diameter <b>Fine</b> - No. 4 (4.75-mm) sieve to ¾-in. (19-mm) diameter
Sand:	<b>Coarse</b> – No. 10 (2.0-mm) to No. 4 (4.76 mm) sieve <b>Medium</b> – No. 40 (0.425-mm) to No. 10 (2.0-mm) sieve <b>Fine</b> - No. 200 (0.075-mm) to No. 40 (0.425-mm) sieve
Silt and Clay:	Less than No. 200 (0.075-mm) sieve

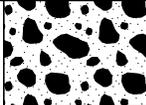
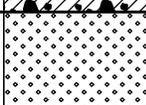
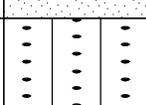
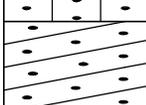
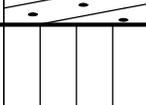
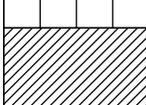
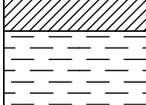
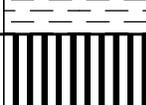
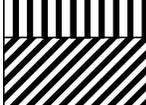
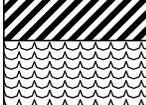
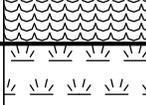
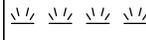
**Modifiers**

The modifiers provide our estimate of the amount of silt, clay or sand size particles in the soil sample.

<u>Approximate Content</u>	<u>Modifiers</u>
≤ 5%:	Trace
5 to 10%:	Few
15 to 25%:	Little
30 to 45%:	Some
50 to 100%:	Mostly

<u>Field Moisture Description</u>	
Dry	Absence of moisture, dusty, dry to touch
Moist	Damp but no visible water
Wet	Visible free water, usually soil is below water table

# SOIL CLASSIFICATION CHART

MAJOR DIVISIONS			SYMBOLS		TYPICAL DESCRIPTIONS
			GRAPH	LETTER	
<p><b>COARSE GRAINED SOILS</b></p> <p>MORE THAN 50% OF MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE</p>	<p><b>GRAVEL AND GRAVELLY SOILS</b></p>	<p>CLEAN GRAVELS</p> <p>(LITTLE OR NO FINES)</p>		<b>GW</b>	WELL-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
		<p>GRAVELS WITH FINES</p> <p>(APPRECIABLE AMOUNT OF FINES)</p>		<b>GP</b>	POORLY-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
		<p>GRAVELS WITH FINES</p> <p>(APPRECIABLE AMOUNT OF FINES)</p>		<b>GM</b>	SILTY GRAVELS, GRAVEL - SAND - SILT MIXTURES
	<p><b>SAND AND SANDY SOILS</b></p>	<p>CLEAN SANDS</p> <p>(LITTLE OR NO FINES)</p>		<b>SW</b>	WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
				<b>SP</b>	POORLY-GRADED SANDS, GRAVELLY SAND, LITTLE OR NO FINES
		<p>SANDS WITH FINES</p> <p>(APPRECIABLE AMOUNT OF FINES)</p>		<b>SM</b>	SILTY SANDS, SAND - SILT MIXTURES
				<b>SC</b>	CLAYEY SANDS, SAND - CLAY MIXTURES
				<b>SC</b>	CLAYEY SANDS, SAND - CLAY MIXTURES
	<p><b>FINE GRAINED SOILS</b></p> <p>MORE THAN 50% OF MATERIAL IS SMALLER THAN NO. 200 SIEVE SIZE</p>	<p><b>SILTS AND CLAYS</b></p> <p>LIQUID LIMIT LESS THAN 50</p>		<b>ML</b>	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY
				<b>CL</b>	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
			<b>OL</b>	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY	
<p><b>SILTS AND CLAYS</b></p> <p>LIQUID LIMIT GREATER THAN 50</p>			<b>MH</b>	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILTY SOILS	
			<b>CH</b>	INORGANIC CLAYS OF HIGH PLASTICITY	
			<b>OH</b>	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS	
			<b>PT</b>	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS	
<p><b>HIGHLY ORGANIC SOILS</b></p>				<b>PT</b>	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS

NOTE: DUAL SYMBOLS ARE USED TO INDICATE BORDERLINE SOIL CLASSIFICATIONS

**SCDOT** Soil Test Boring Log

<b>File No.:</b>	727.615	<b>Project No. (PIN):</b>	23546	<b>County:</b>	Beaufort/Jasper	<b>Eng./Geo.:</b>	A. Bore
<b>Site Description:</b>	RBO New River					<b>Route:</b>	SC 170/46
<b>Boring No.:</b>	B-722	<b>Boring Location:</b>	722+00	<b>Offset:</b>	5 ft LT	<b>Alignment:</b>	Mainline
<b>Elev.:</b>	1,500 ft	<b>Latitude:</b>	34.3750	<b>Longitude:</b>	81.0944	<b>Date Started:</b>	07/15/03
<b>Total Depth:</b>	45 ft	<b>Soil Depth:</b>	39 ft	<b>Core Depth:</b>	6 ft	<b>Date Completed:</b>	07/16/03
<b>Bore Hole Diameter (in):</b>	4.5	<b>Sampler Configuration</b>		<b>Liner required:</b>	Y N	<b>Liner used:</b>	Y N
<b>Drill Machine:</b>	CME-750	<b>Drill Method:</b>	Wash Rotary	<b>Hammer Type:</b>	Automatic	<b>Energy Ratio:</b>	100%
<b>Core Size:</b>	NQ Wireline	<b>Driller:</b>	I. Core	<b>Groundwater:</b>	TOB 7.5 ft	<b>24 hr</b>	15 ft

Depth (feet)	Elevation (ft msl)	MATERIAL DESCRIPTION	Graphic Log	Sample Depth (feet)	Sample Type / No.	SPT N-Value														
						1 st	2 nd	3 rd	1	2	3	4	5	6	7	8	9	10		
		Soil Description a . b . c . d . e . f . g h . i . j . Munsell . LL PL . PI . NMC . % #200 Munsell = Munsell Color Chart Designation LL = Liquid Limit PL = Plastic Limit PI = Plasticity Index NMC = Natural Moisture Content % #200 = Percent Passing #200 Sieve																		
		Rock Description (as required) Lithologic description: rock type, color, texture, grain size, foliation, weathering and strength with k . l . m . n . o . p . q r . Munsell . RQD . %REC RMR Munsell = Munsell Color Chart Designation RQD = Rock Quality Designation %REC = Percent Recovery RMR = Rock Mass Rating																		

Figure 6-10, SCDOT Soil Test Boring Log

**SCDOT Soil Test Boring Log Descriptors**

**a - Relative Density / Consistency Terms**

<u>Relative Density</u> <sup>1</sup>			<u>Consistency</u> <sup>2</sup>		
Descriptive Term	Relative Density	SPT Blow Count	Descriptive Term	Unconfined Compression Strength (q <sub>u</sub> ) (tsf)	SPT Blow Count
Very Loose	0 to 15%	< 4	Very Soft	<0.25	<2
Loose	16 to 35%	5 to 10	Soft	0.26 to 0.50	3 to 4
Medium Dense	36 to 65%	11 to 30	Firm	0.51 to 1.00	5 to 8
Dense	66 to 85%	31 to 50	Stiff	1.01 to 2.00	9 to 15
Very Dense	86 to 100%	>51	Very Stiff	2.01 to 4.00	16 to 30
			Hard	>4.01	> 31

**b - Moisture Condition**

<u>Descriptive Term</u>	<u>Criteria</u>
Dry	Absence of moisture, dusty, dry to the touch
Moist	Damp but no visible water
Wet	Visible free water, usually in coarse-grained soils below the water table

**c - Color**

Describe the sample color while sample is still moist, using Munsell color chart.

**d - Angularity**<sup>1</sup>

<u>Descriptive Term</u>	<u>Criteria</u>
Angular	Particles have sharp edges and relatively plane sides with unpolished surfaces
Subangular	Particles are similar to angular description but have rounded edges
Subrounded	Particles have nearly plane sides but have well-rounded corners and edges
Rounded	Particles have smoothly curved sides and no edges

**e - HCl Reaction**<sup>3</sup>

<u>Descriptive Term</u>	<u>Criteria</u>
None Reactive	No visible reaction
Weakly Reactive	Some reaction, with bubbles forming slowly
Strongly Reactive	Violent reaction, with bubbles forming immediately

**f - Cementation**<sup>3</sup>

<u>Descriptive Term</u>	<u>Criteria</u>
Weakly Cemented	Crumbles or breaks with handling or little finger pressure
Moderately Cemented	Crumbles or breaks with considerable finger pressure
Strongly Cemented	Will not crumble or break with finger pressure

**g - Particle-Size Range**<sup>1</sup>

<u>Gravel</u>			<u>Sand</u>		
	mm	Sieve size		mm	Sieve size
Fine	4.76 to 19.1	#4 to ¾ inch	Fine	0.074 to 0.42	#200 to #40
Coarse	19.1 to 76.2	¾ inch to 3 inch	Medium	0.42 to 2.00	#40 to #10
			Coarse	4.00 to 4.76	#10 to #4

**h - Primary Soil Type**<sup>1,2</sup>

The primary soil type will be shown in all capital letters

**i - USCS Soil Designation**

Indicate USCS soil designation as defined in ASTM D-2487 and D-2488

**j - AASHTO Soil Designation**

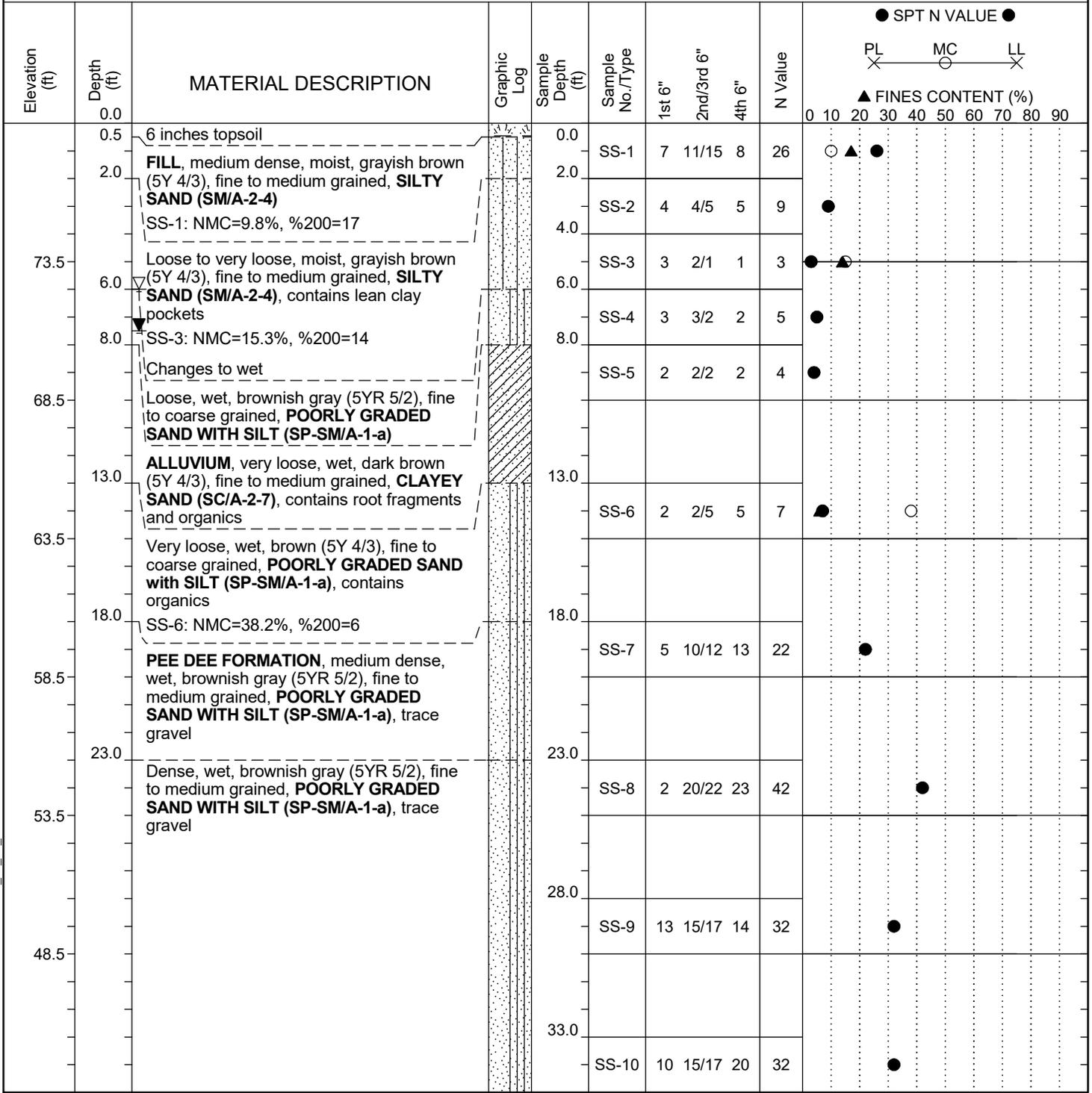
Indicate AASHTO soil designation as defined in AASHTO M-145 and ASTM D-3282

<sup>1</sup>Applies to coarse-grained soils (major portion retained on No. 200 sieve)  
<sup>2</sup>Applies to fine-grained soils (major portion passing No. 200 sieve)  
<sup>3</sup>Use as required

Figure 6-11, SCDOT Soil Test Boring Log Descriptors - Soil

# SCDOT Soil Test Log

<b>Project ID:</b> P031750	<b>County:</b> Dillon County	<b>Boring No.:</b> STB-101
<b>Site Description:</b> 2016-1A Emergency Bridge Package		<b>Route:</b> S-45
<b>Eng./Geo.:</b> B. Azumah	<b>Boring Location:</b> 46+48.87	<b>Offset:</b> 12.0 ft LT <b>Alignment:</b> Existing
<b>Elev.:</b> 78.5 ft	<b>Latitude:</b> 34.3329333	<b>Longitude:</b> -79.3243083 <b>Date Started:</b> 11/22/2016
<b>Total Depth:</b> 100 ft	<b>Soil Depth:</b> 100 ft	<b>Core Depth:</b> N/A ft <b>Date Completed:</b> 11/28/2016
<b>Bore Hole Diameter (in):</b> 4	<b>Sampler Configuration</b>	<b>Liner Required:</b> Y (N) <b>Liner Used:</b> Y (N)
<b>Drill Machine:</b> CME-45B	<b>Drill Method:</b> RW	<b>Hammer Type:</b> Safety <b>Energy Ratio:</b> 83.3%
<b>Core Size:</b> N/A	<b>Driller:</b> WWES, LLC	<b>Groundwater:</b> TOB 6 ft <b>24HR:</b> 7.5 ft



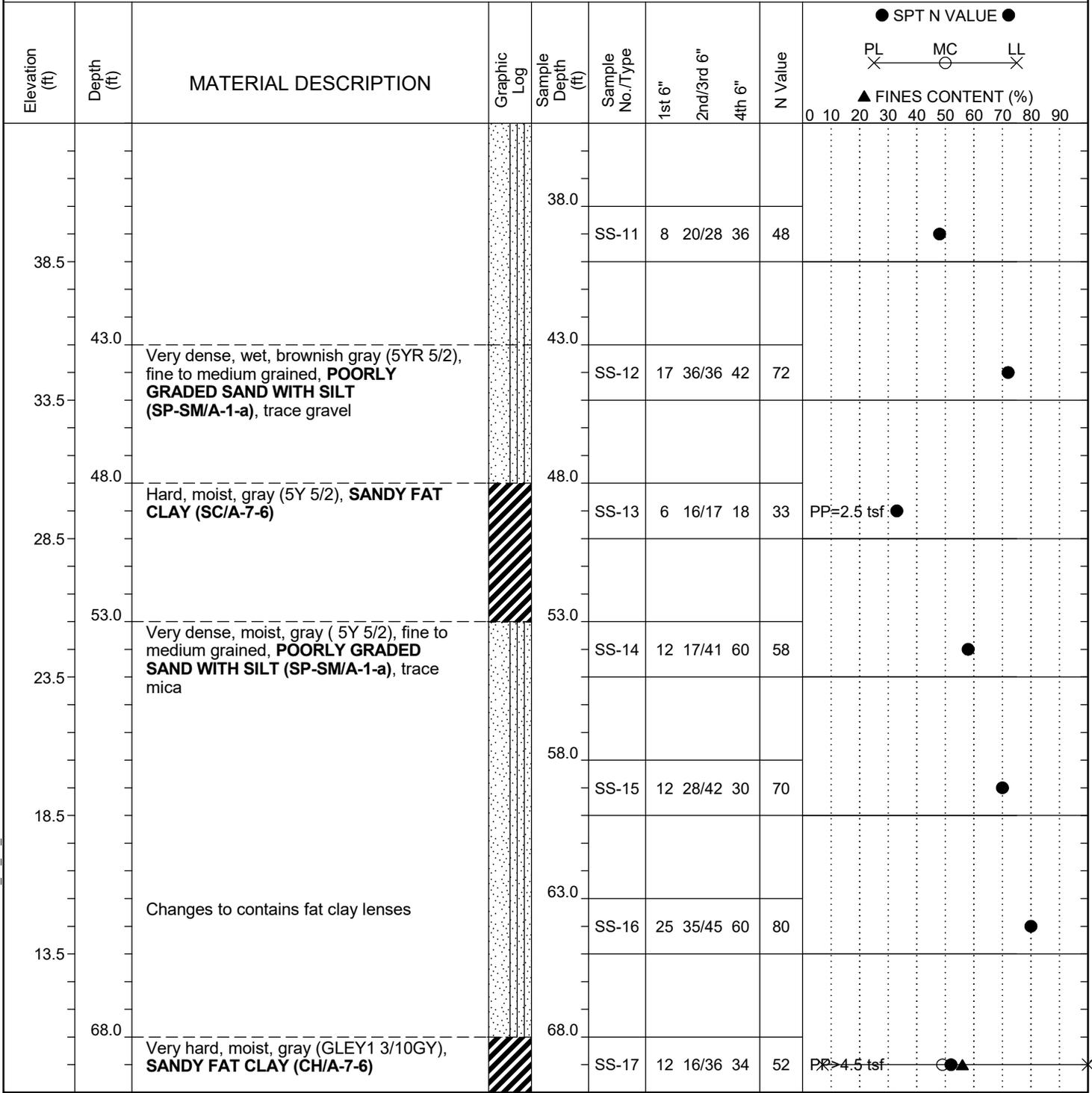
LEGEND Continued Next Page

SAMPLER TYPE		DRILLING METHOD	
SS - Split Spoon	NQ - Rock Core, 1-7/8"	HSA - Hollow Stem Auger	RW - Rotary Wash
UD - Undisturbed Sample	CU - Cuttings	CFA - Continuous Flight Augers	RC - Rock Core
AWG - Rock Core, 1-1/8"	CT - Continuous Tube	DC - Driving Casing	

SC\_DOT\_65U0177 S-45.GPJ SCDOT DATA TEMPLATE\_12\_30\_2014.GDT 12/15/16

# SCDOT Soil Test Log

<b>Project ID:</b> P031750	<b>County:</b> Dillon County	<b>Boring No.:</b> STB-101
<b>Site Description:</b> 2016-1A Emergency Bridge Package		<b>Route:</b> S-45
<b>Eng./Geo.:</b> B. Azumah	<b>Boring Location:</b> 46+48.87	<b>Offset:</b> 12.0 ft LT <b>Alignment:</b> Existing
<b>Elev.:</b> 78.5 ft	<b>Latitude:</b> 34.3329333	<b>Longitude:</b> -79.3243083 <b>Date Started:</b> 11/22/2016
<b>Total Depth:</b> 100 ft	<b>Soil Depth:</b> 100 ft	<b>Core Depth:</b> N/A ft <b>Date Completed:</b> 11/28/2016
<b>Bore Hole Diameter (in):</b> 4	<b>Sampler Configuration</b>	<b>Liner Required:</b> Y (N) <b>Liner Used:</b> Y (N)
<b>Drill Machine:</b> CME-45B	<b>Drill Method:</b> RW	<b>Hammer Type:</b> Safety <b>Energy Ratio:</b> 83.3%
<b>Core Size:</b> N/A	<b>Driller:</b> WWES, LLC	<b>Groundwater:</b> TOB 6 ft <b>24HR:</b> 7.5 ft



**LEGEND**

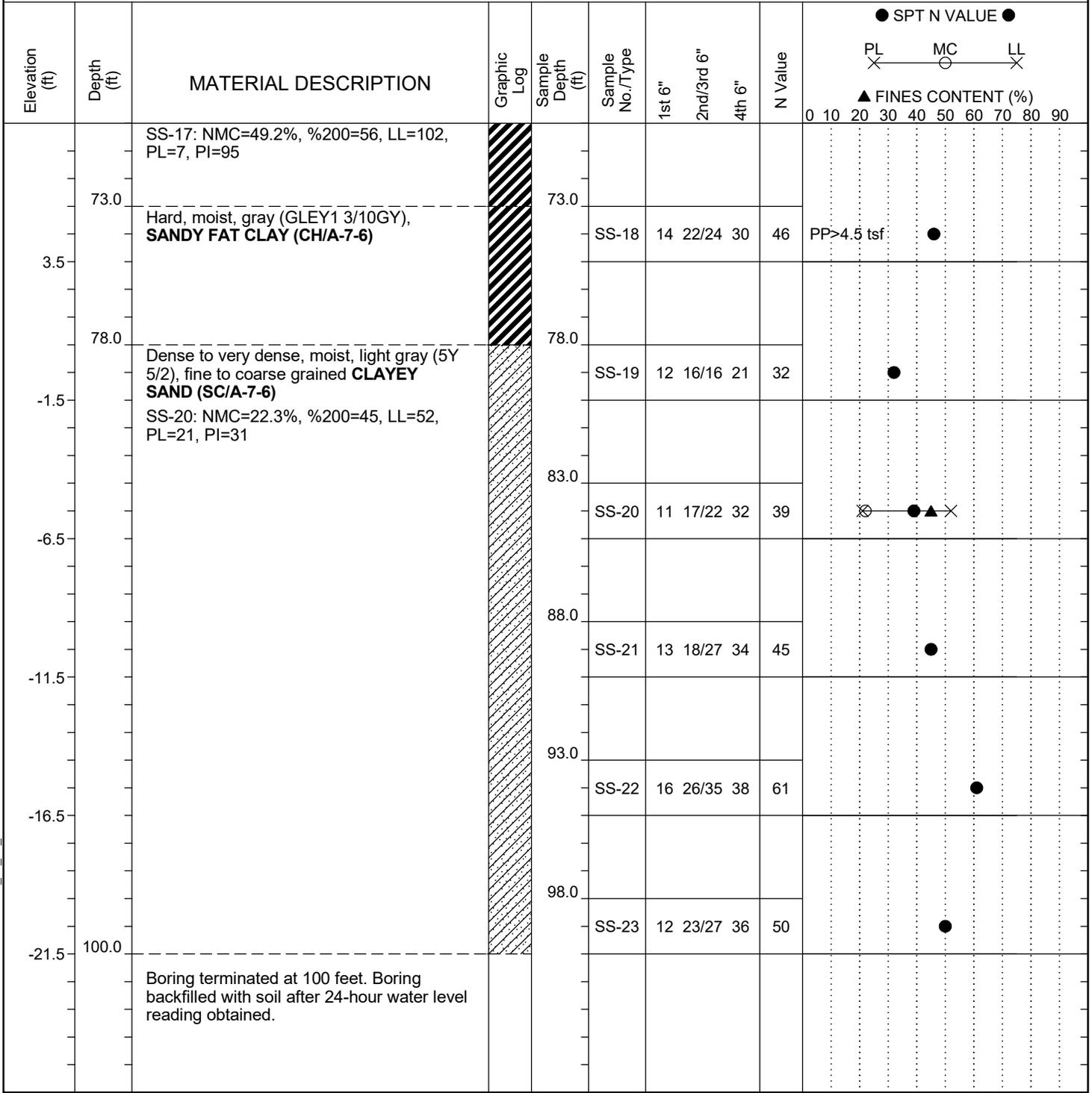
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<b>SAMPLER TYPE</b>		<b>DRILLING METHOD</b>	
SS - Split Spoon	NQ - Rock Core, 1-7/8"	HSA - Hollow Stem Auger	RW - Rotary Wash
UD - Undisturbed Sample	CU - Cuttings	CFA - Continuous Flight Augers	RC - Rock Core
AWG - Rock Core, 1-1/8"	CT - Continuous Tube	DC - Driving Casing	

SC\_DOT\_65U0177 S-45.GPJ SCDOT DATA TEMPLATE\_12\_30\_2014.GDT 12/15/16

# SCDOT Soil Test Log

<b>Project ID:</b> P031750	<b>County:</b> Dillon County	<b>Boring No.:</b> STB-101
<b>Site Description:</b> 2016-1A Emergency Bridge Package		<b>Route:</b> S-45
<b>Eng./Geo.:</b> B. Azumah	<b>Boring Location:</b> 46+48.87	<b>Offset:</b> 12.0 ft LT <b>Alignment:</b> Existing
<b>Elev.:</b> 78.5 ft	<b>Latitude:</b> 34.3329333	<b>Longitude:</b> -79.3243083 <b>Date Started:</b> 11/22/2016
<b>Total Depth:</b> 100 ft	<b>Soil Depth:</b> 100 ft	<b>Core Depth:</b> N/A ft <b>Date Completed:</b> 11/28/2016
<b>Bore Hole Diameter (in):</b> 4	<b>Sampler Configuration</b>	<b>Liner Required:</b> Y (N) <b>Liner Used:</b> Y (N)
<b>Drill Machine:</b> CME-45B	<b>Drill Method:</b> RW	<b>Hammer Type:</b> Safety <b>Energy Ratio:</b> 83.3%
<b>Core Size:</b> N/A	<b>Driller:</b> WWES, LLC	<b>Groundwater:</b> TOB 6 ft <b>24HR:</b> 7.5 ft



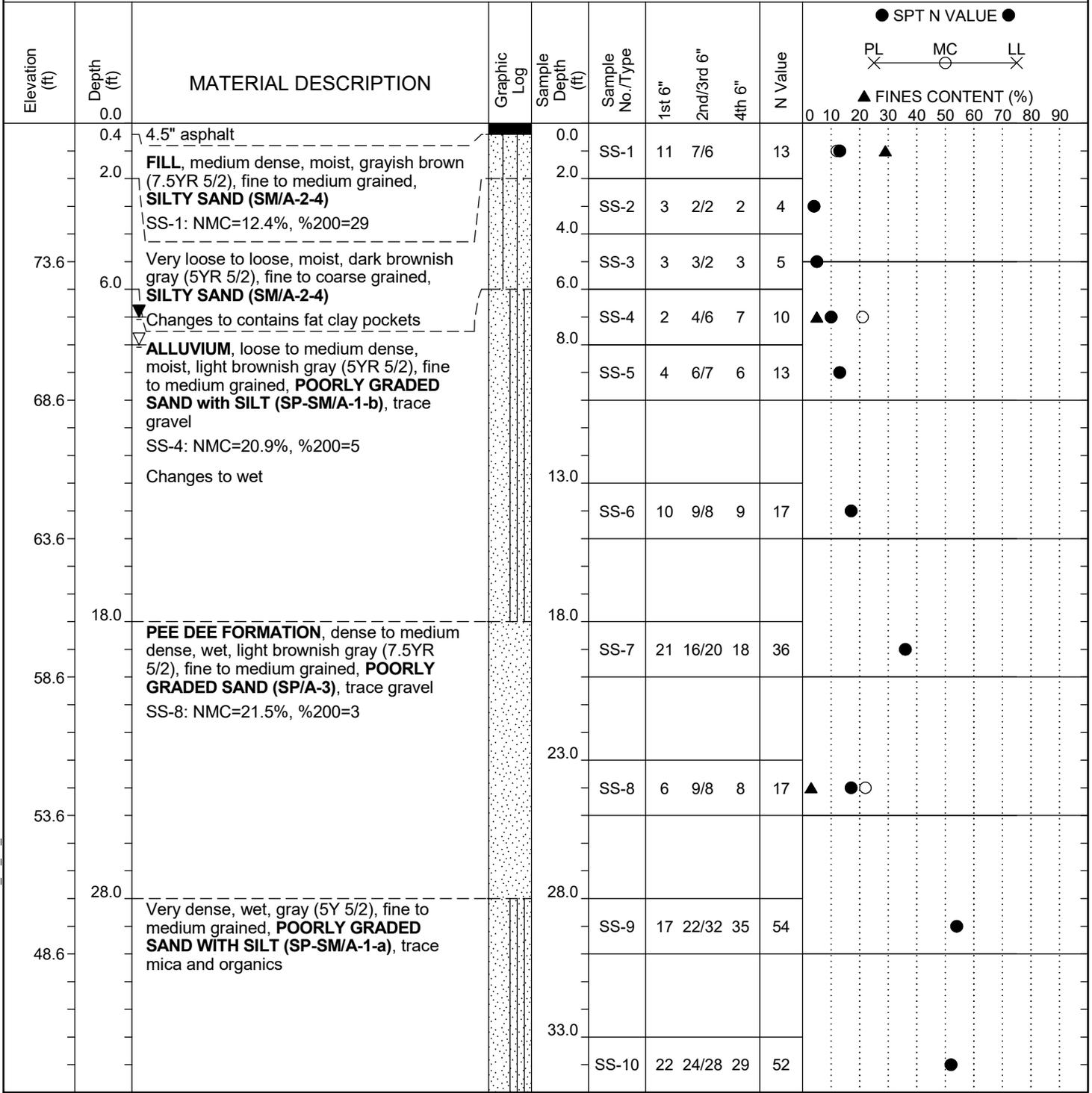
### LEGEND

SAMPLER TYPE		DRILLING METHOD	
SS - Split Spoon	NQ - Rock Core, 1-7/8"	HSA - Hollow Stem Auger	RW - Rotary Wash
UD - Undisturbed Sample	CU - Cuttings	CFA - Continuous Flight Augers	RC - Rock Core
AWG - Rock Core, 1-1/8"	CT - Continuous Tube	DC - Driving Casing	

SC\_DOT\_65U0177 S-45.GPJ SCDOT DATA TEMPLATE\_12\_30\_2014.GDT 12/15/16

# SCDOT Soil Test Log

<b>Project ID:</b> P031750		<b>County:</b> Dillon County		<b>Boring No.:</b> STB-102	
<b>Site Description:</b> 2016-1A Emergency Bridge Package				<b>Route:</b> S-45	
<b>Eng./Geo.:</b> B. Azumah		<b>Boring Location:</b> 45+31.72		<b>Offset:</b> 5.5 ft RT	<b>Alignment:</b> Existing
<b>Elev.:</b> 78.6 ft	<b>Latitude:</b> 34.3326528	<b>Longitude:</b> -79.3245083	<b>Date Started:</b> 11/28/2016		
<b>Total Depth:</b> 100 ft	<b>Soil Depth:</b> 100 ft	<b>Core Depth:</b> N/A ft	<b>Date Completed:</b> 11/30/2016		
<b>Bore Hole Diameter (in):</b> 4		<b>Sampler Configuration</b>		<b>Liner Required:</b> Y (N)	<b>Liner Used:</b> Y (N)
<b>Drill Machine:</b> CME-550X	<b>Drill Method:</b> RW	<b>Hammer Type:</b> Automatic		<b>Energy Ratio:</b> 85.5%	
<b>Core Size:</b> N/A	<b>Driller:</b> F&R, Inc.	<b>Groundwater:</b> TOB	8 ft	24HR	7 ft



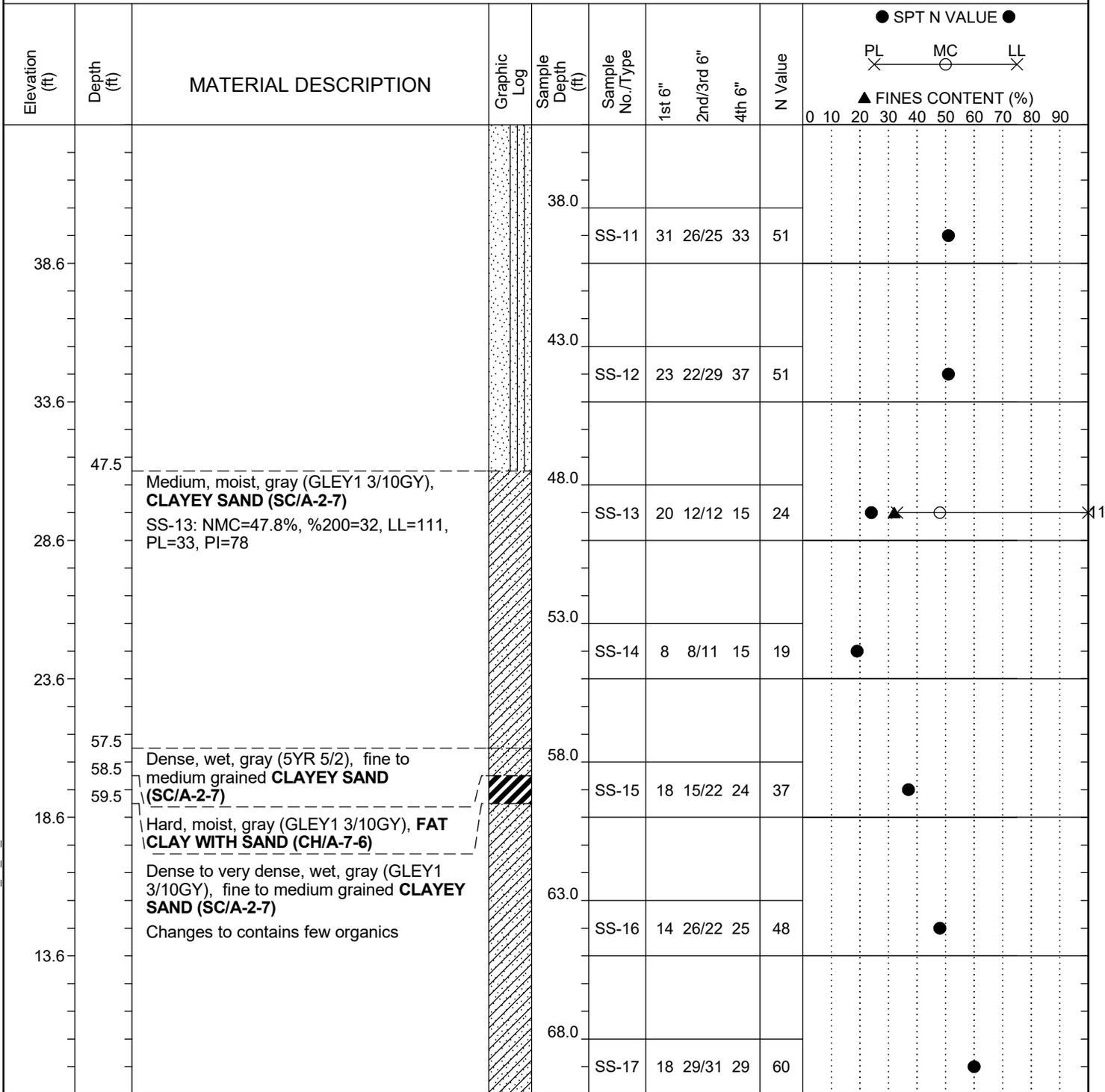
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<b>SAMPLER TYPE</b>		<b>DRILLING METHOD</b>	
SS - Split Spoon	NQ - Rock Core, 1-7/8"	HSA - Hollow Stem Auger	RW - Rotary Wash
UD - Undisturbed Sample	CU - Cuttings	CFA - Continuous Flight Augers	RC - Rock Core
AWG - Rock Core, 1-1/8"	CT - Continuous Tube	DC - Driving Casing	

SC\_DOT\_65U0177\_S-45.GPJ\_SCDOT DATA TEMPLATE\_12\_30\_2014.GDT\_12/15/16

# SCDOT Soil Test Log

<b>Project ID:</b> P031750	<b>County:</b> Dillon County	<b>Boring No.:</b> STB-102
<b>Site Description:</b> 2016-1A Emergency Bridge Package		<b>Route:</b> S-45
<b>Eng./Geo.:</b> B. Azumah	<b>Boring Location:</b> 45+31.72	<b>Offset:</b> 5.5 ft RT <b>Alignment:</b> Existing
<b>Elev.:</b> 78.6 ft	<b>Latitude:</b> 34.3326528	<b>Longitude:</b> -79.3245083 <b>Date Started:</b> 11/28/2016
<b>Total Depth:</b> 100 ft	<b>Soil Depth:</b> 100 ft	<b>Core Depth:</b> N/A ft <b>Date Completed:</b> 11/30/2016
<b>Bore Hole Diameter (in):</b> 4	<b>Sampler Configuration</b>	<b>Liner Required:</b> Y (N) <b>Liner Used:</b> Y (N)
<b>Drill Machine:</b> CME-550X	<b>Drill Method:</b> RW	<b>Hammer Type:</b> Automatic <b>Energy Ratio:</b> 85.5%
<b>Core Size:</b> N/A	<b>Driller:</b> F&R, Inc.	<b>Groundwater:</b> TOB 8 ft <b>24HR</b> 7 ft



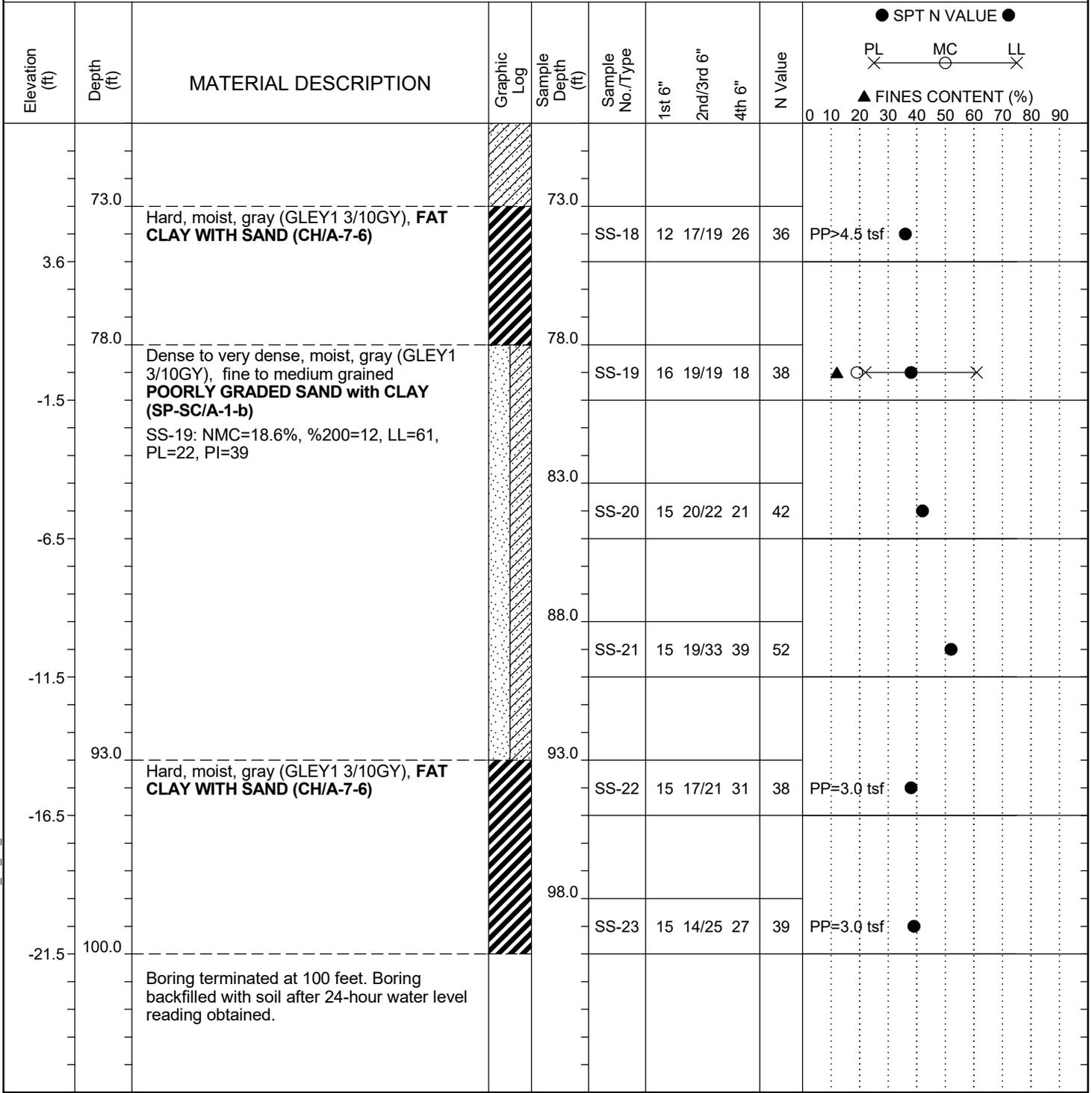
### LEGEND

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SAMPLER TYPE		DRILLING METHOD	
SS - Split Spoon	NQ - Rock Core, 1-7/8"	HSA - Hollow Stem Auger	RW - Rotary Wash
UD - Undisturbed Sample	CU - Cuttings	CFA - Continuous Flight Augers	RC - Rock Core
AWG - Rock Core, 1-1/8"	CT - Continuous Tube	DC - Driving Casing	

# SCDOT Soil Test Log

<b>Project ID:</b> P031750	<b>County:</b> Dillon County	<b>Boring No.:</b> STB-102
<b>Site Description:</b> 2016-1A Emergency Bridge Package		<b>Route:</b> S-45
<b>Eng./Geo.:</b> B. Azumah	<b>Boring Location:</b> 45+31.72	<b>Offset:</b> 5.5 ft RT <b>Alignment:</b> Existing
<b>Elev.:</b> 78.6 ft	<b>Latitude:</b> 34.3326528	<b>Longitude:</b> -79.3245083 <b>Date Started:</b> 11/28/2016
<b>Total Depth:</b> 100 ft	<b>Soil Depth:</b> 100 ft	<b>Core Depth:</b> N/A ft <b>Date Completed:</b> 11/30/2016
<b>Bore Hole Diameter (in):</b> 4	<b>Sampler Configuration</b>	<b>Liner Required:</b> Y (N) <b>Liner Used:</b> Y (N)
<b>Drill Machine:</b> CME-550X	<b>Drill Method:</b> RW	<b>Hammer Type:</b> Automatic <b>Energy Ratio:</b> 85.5%
<b>Core Size:</b> N/A	<b>Driller:</b> F&R, Inc.	<b>Groundwater:</b> TOB 8 ft <b>24HR</b> 7 ft



### LEGEND

SAMPLER TYPE		DRILLING METHOD	
SS - Split Spoon	NQ - Rock Core, 1-7/8"	HSA - Hollow Stem Auger	RW - Rotary Wash
UD - Undisturbed Sample	CU - Cuttings	CFA - Continuous Flight Augers	RC - Rock Core
AWG - Rock Core, 1-1/8"	CT - Continuous Tube	DC - Driving Casing	

SC\_DOT\_65U0177 S-45.GPJ SCDOT DATA TEMPLATE\_12\_30\_2014.GDT 12/15/16



## **APPENDIX III**



Geotechnical Exploration

Thank you for your trust in PalmettoINSITU, LLC to perform your field exploration.

### Test Methods:

PalmettoINSITU performs in-situ testing in general accordance with the currently published ASTM procedures along with generally acceptable industry practices. Applicable procedures include:

- Piezo Cone Penetration Tests (CPTu): D5778-xx
- Marchetti Flat Plate Dilatometer (DMT): ASTM D6635-xx
- Seismic Piezo Cone Penetration Tests (SCPTu) ASTM D7400-xx

### Instrumentation:

- All of PalmettoINSITU's probes are manufactured and are calibrated at least annually by Vertek.
- The equipment used for the exploration includes electronic 15 cm<sup>2</sup> cones with serial numbers listed within the electronic file.
- PalmettoINSITU's Marchetti Flat Plate Dilatometer equipment is provided by GPE, Inc and is calibrated at least annually.

### Rig:

- PalmettoINSITU uses a Vertek S4 Scorpion rig capable of 20 tons of thrust. The push system is conveyed and hydraulically powered by a Bobcat T770.

### Software:

- PalmettoINSITU uses Bentley's, gINT and Dataforensic's, RapidCPT to process and output the raw data collected.
- Currently, PalmettoINSITU is using version of gINT is V8i SS2 Version 08.30.04.206 and our current version of RapidCPT is 4.2.2.0.

### SBT Material Correlations Legend (Robertson and Campanella: 1990):

	1 – Sensitive, Fine Grained Soils		4 – Silt Mixtures-Clay Silt to Silty Clay		7 – Gravelly Sand to Sand
	2 – Organic Soils, Peats		5 – Sand Mixtures-Silty Sand to Sandy Silt		8 – Very Stiff Clay to Clayey Sand
	3 – Clays-Clay to Silty Clay		6 – Sands-Clean Sand to Silty Sand		9 – Very Stiff Fine Grained Soils



**S-45**  
**Dillion County, SC**  
 Project Number :16-126

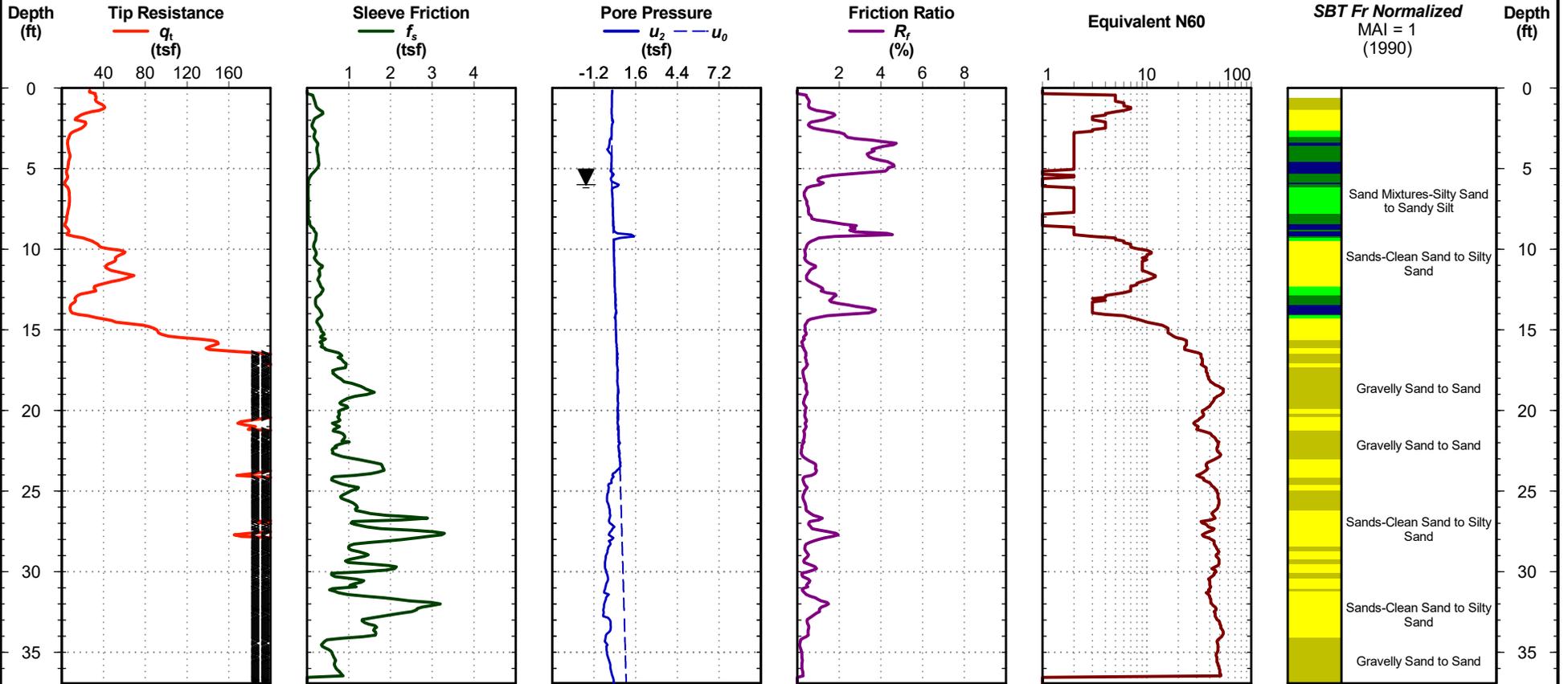
# Cone Penetration Test

# CPT-101

**Date:** Nov. 22, 2016  
**Estimated Water Depth:** 6 ft  
**Rig/Operator:** M. Cox | J. Croom

**Northing:** 913535.2610  
**Easting:** 2505840.5120  
**Elevation:** 78.263 ft

**Total Depth:** 36.9 ft  
**Termination Criteria:** Maximum Reaction Force  
**Cone Size:** 1.75



CPT REPORT - STANDARD S-45.GPJ DF STD US LAB.GDT\_12/8/16

# CPT-101



S-45  
Dillion County, SC  
Project Number :16-126

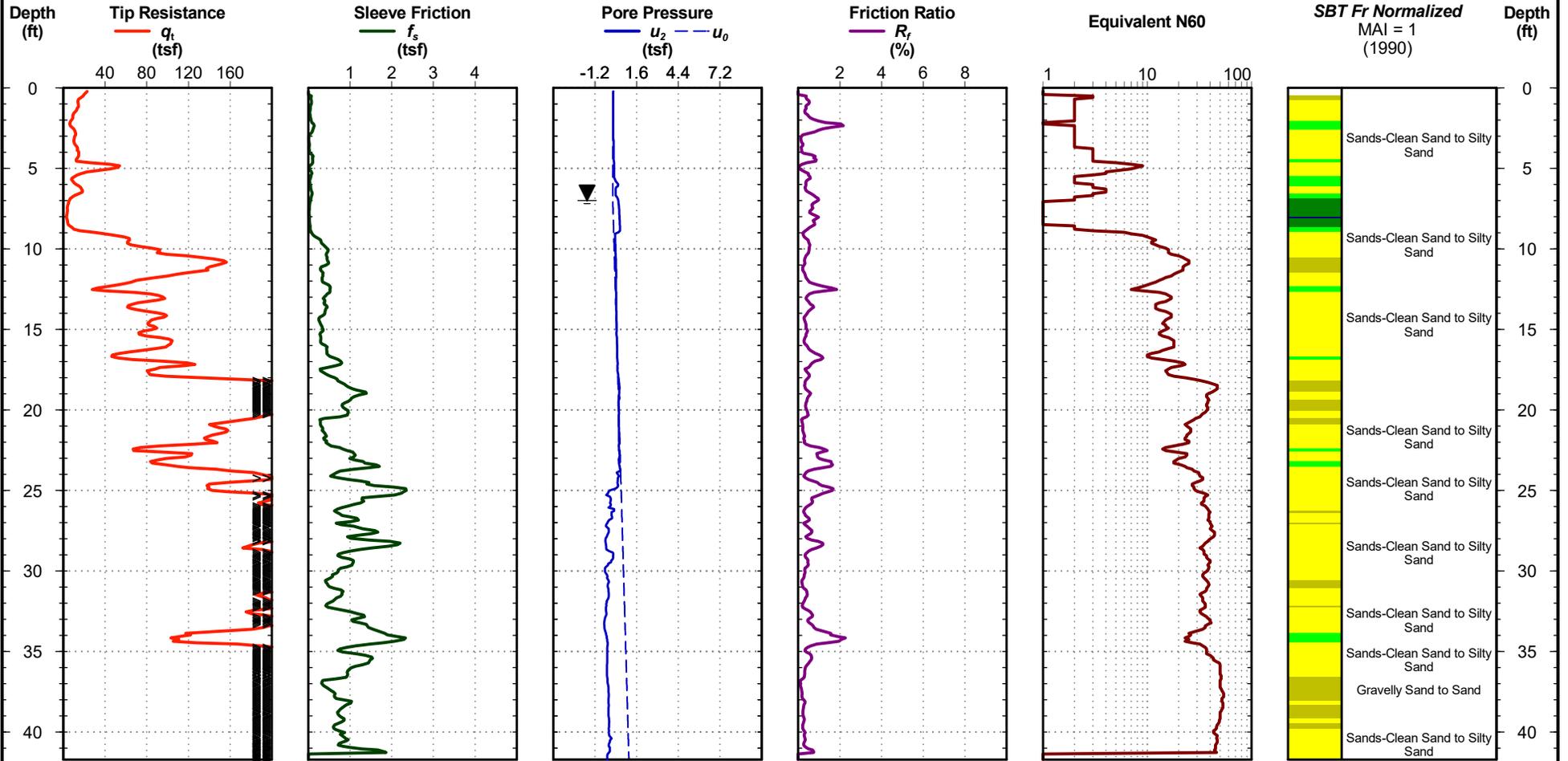
# Cone Penetration Test

# CPT-102

Date: Nov. 22, 2016  
Estimated Water Depth: 7 ft  
Rig/Operator: M. Cox | J. Croom

Northing: 913464.7470  
Easting: 2505752.7530  
Elevation: 78.442 ft

Total Depth: 41.7 ft  
Termination Criteria: Maximum Reaction Force  
Cone Size: 1.75



CPT REPORT - STANDARD S-45.GPJ\_DF STD US LAB.GDT\_12/8/16

# CPT-102



## **APPENDIX IV**



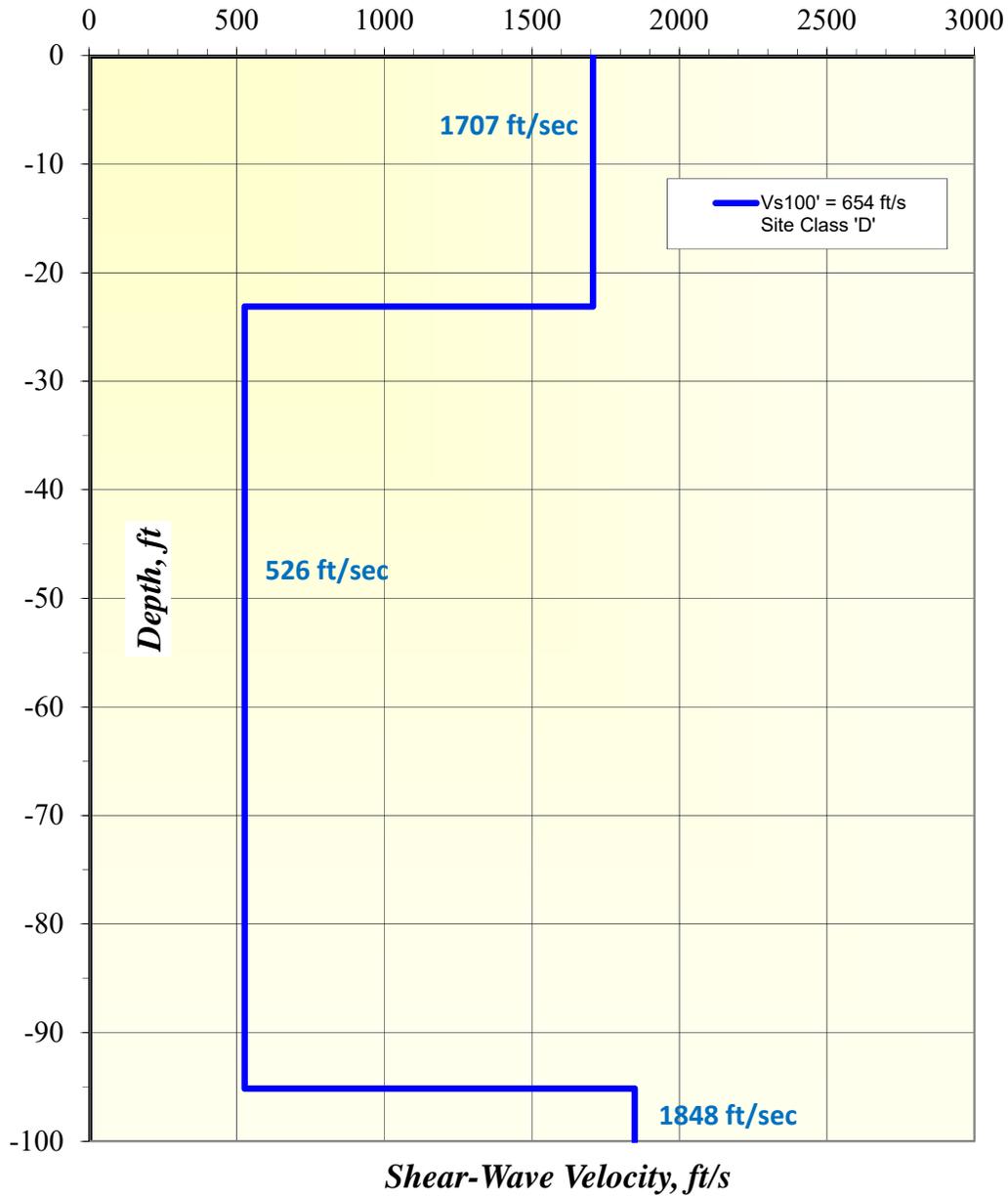
FROEHLING & ROBERTSON, INC.

### Refraction Microtremor (REMI) Results

**Project:** 2016-1A Emergency Bridge Package S-45, Dillon Co. SC  
**Client:** SCDOT Geotechnical Design Group

**Report Date:** 12/1/16  
**Record No.:** 65U-0177

### Vs Model





## **APPENDIX V**



# SUMMARY OF LABORATORY RESULTS

PROJECT ID P031750

PROJECT NAME 2016-1A Emergency Bridge Package

PROJECT COUNTY Dillon County

Borehole	Depth	Liquid Limit	Plastic Limit	Plasticity Index	Maximum Size (mm)	%<#200 Sieve	Classification	Water Content (%)	Dry Density (pcf)	Saturation (%)	Void Ratio
STB-101	0.0				0.075	17	SM	9.8			
STB-101	4.0				0.075	14	SM	15.3			
STB-101	13.0				0.075	6	SP-SM	38.2			
STB-101	68.0	102	7	95	0.075	56	CH	49.2			
STB-101	83.0	52	21	31	0.075	45	SC	22.3			
STB-102	0.0				0.075	29	SM	12.4			
STB-102	6.0				0.075	5	SP-SM	20.9			
STB-102	23.0				0.075	3	SP	21.5			
STB-102	48.0	111	33	78	0.075	32	SC	47.8			
STB-102	78.0	61	22	39	0.075	12	SP-SM	18.6			



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HQ: 3015 DUMBARTON ROAD RICHMOND, VIRGINIA 23228 T 804.264.2701 F 804.264.1202 [www.fandr.com](http://www.fandr.com)

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