



Geotechnical Subsurface Exploration and Laboratory Testing Data Report

2016-1A Emergency Bridge Replacement Package
SCDOT PIN P031819
S-19 (Highway 19 East) Bridge over Bug Swamp
Horry 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:

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December 11, 2016



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December 11, 2016

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

Subject: Geotechnical Subsurface Exploration and Laboratory Testing Data Report
2016-1A Emergency Bridge Replacement Package
SCDOT PIN P031819, S-19 (Highway 19 East) Bridge over Bug Swamp
Horry 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-19 (Highway 19 East) Bridge over Bug Swamp in Horry County, South Carolina. Our services were performed in general accordance with your work order Number FR#10-18-P031819 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 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-19 (Highway 19 East) at the culvert over Bug Swamp in Horry County, South Carolina. Highway S-19 is an asphalt paved two-lane highway. The area around the culvert and roadway is generally swampy, wooded or partly covered with brush. The ground surface elevation on the paved area ranges from approximately EL 51 to EL 54 and the elevations around the river banks and the immediately adjacent areas range from approximately EL 49 to EL 52. A site vicinity map is shown as Figure No. 1 and included in Appendix I of this report.

As a result of recent storm events, damage to the culvert and roadway has occurred and therefore replacement of the existing culvert is planned. For this purpose, subsurface exploration at the culvert 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 culvert. After completion of the subsurface explorations our licensed surveying subcontractor, Chao and Associates, Inc. of Columbia, South Carolina obtained the station, offset, GPS coordinates: horizontal state plane coordinates (northings and eastings), and ground surface elevations at each test hole location. All 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 our drilling subcontractor, William Walker Environmental Services LLC of West Columbia, South Carolina. The drilling was performed from December 7th through December 9th, 2016. The Standard Penetration Test (SPT) was performed at the boring locations in general accordance with ASTM D1586.

The drill rig used for this project was 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 sides of the existing culvert. The borings are designated as Soil Test Borings STB-401 and STB-402. The SPT tests were performed continuously from approximately 2 feet below 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 I of this report. Photographic documentation of the locations of STB-401 and STB-402 are also included in Appendix I 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 30, 2016. The two CPTs were performed close to each of the existing culvert in general accordance with ASTM D5778. The CPTs are designated as CPT-401 and CPT-402 and are identified on Figure No. 2 - Location Plan included in Appendix I of this report.

The equipment used for the exploration includes an electronic 15 cm² 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 will be provided via email along with this report. Photographic documentation of the CPT rig in operation at the locations of CPT-401 and CPT-402 are included in Appendix I and presented as Figures 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 culvert. 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 eight natural moisture content test (ASTM D2216), eight amount finer than No. 200 Sieve tests (ASTM D1140), and four Atterberg Limit tests (ASTM D4318) on several samples obtained from the borings.

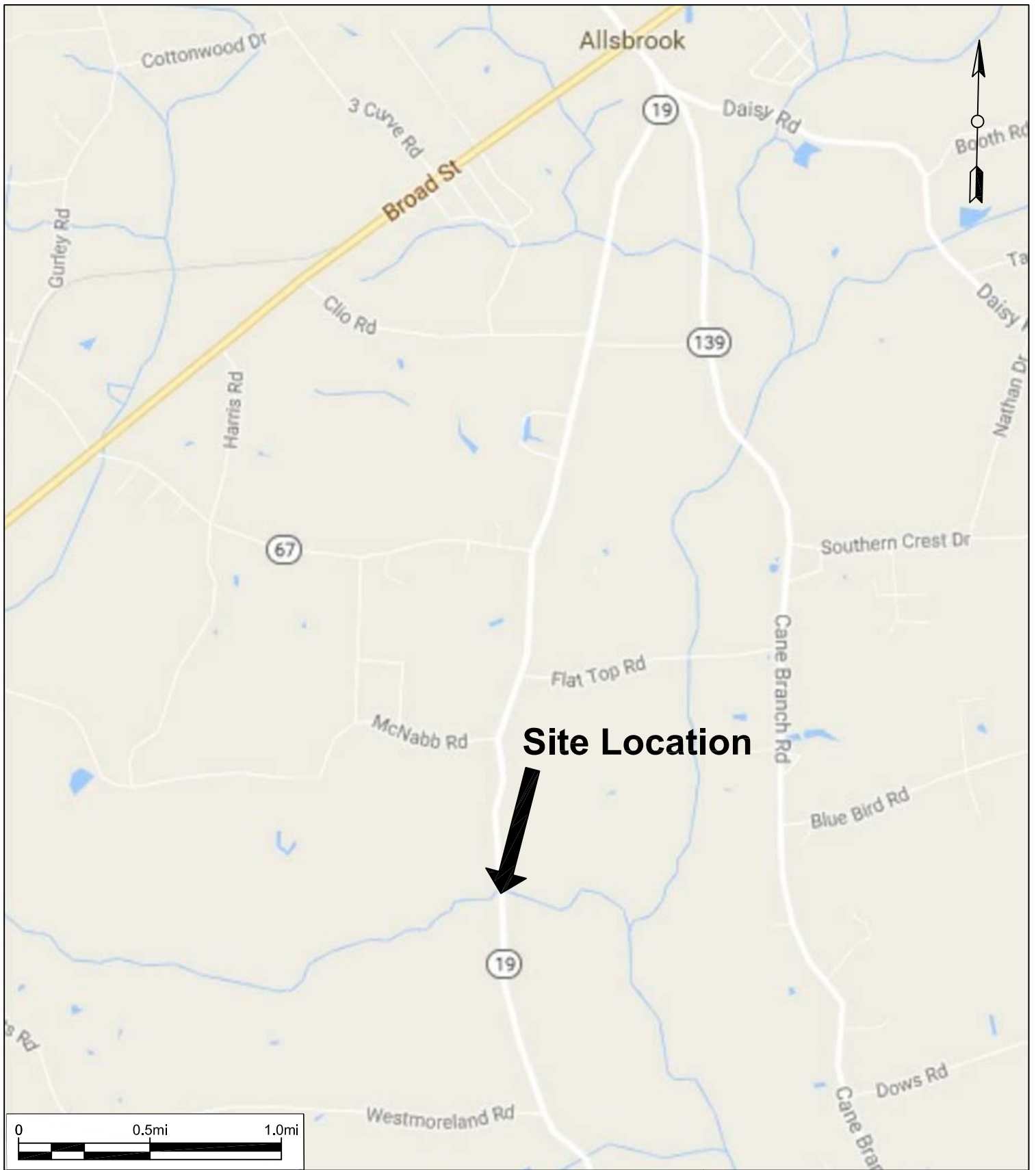
Laboratory test results were not available at the time of this reporting and will be provided in a subsequent Revision of this report.

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-19 (Highway 19 East) Bridge over Bug 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

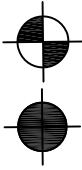
CLIENT: SCDOT

PROJECT NO.: 65U-0177

**Site Vicinity Map
 Emergency Bridge Replacement - S-19
 Horry County, South Carolina**

FIG. NO. 1

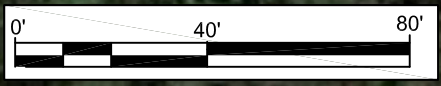
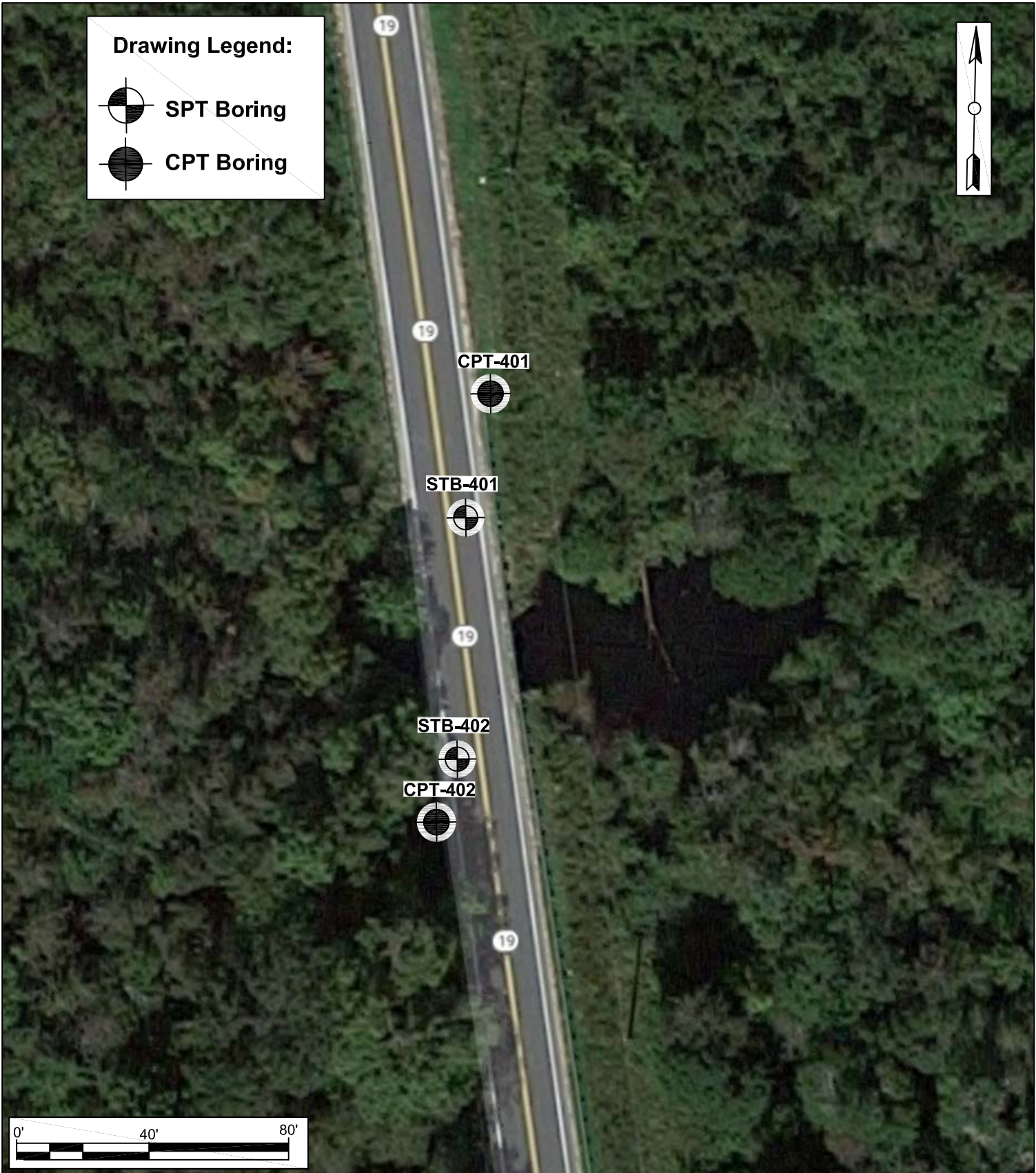
Drawing Legend:



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-19
Horry County, South Carolina**

FIG. NO. 2



Figure No. 3: Photograph of Soil Test Boring STB-401



Figure No. 4: Photograph of Soil Test Boring STB-402



Figure No. 5: Photograph of Cone Penetration Test CPT-401 Being Performed



Figure No. 6: Photograph of Cone Penetration Test CPT-402 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>	
<u>No. of Blows, N</u>	<u>Relative Density</u>	<u>No. of 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:	Coarse - ¾-in. (19-mm) to 3 in. (75-mm) diameter Fine - No. 4 (4.75-mm) sieve to ¾-in. (19-mm) diameter
Sand:	Coarse – No. 10 (2.0-mm) to No. 4 (4.76 mm) sieve Medium – No. 40 (0.425-mm) to No. 10 (2.0-mm) sieve Fine - No. 200 (0.075-mm) to No. 40 (0.425-mm) sieve
Silt and Clay:	Less than No. 200 (0.075-mm) sieve

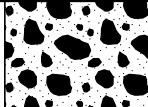



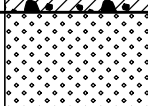
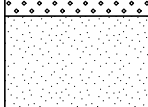
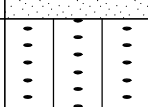
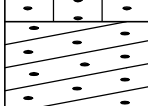
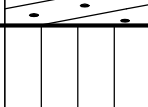
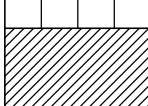

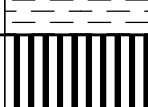
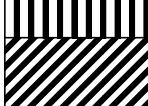
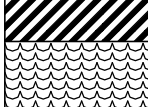
Modifiers

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

NOTE: DUAL SYMBOLS ARE USED TO INDICATE BORDERLINE SOIL CLASSIFICATIONS

SCDOT Soil Test Boring Log

File No.:	727.615	Project No. (PIN):	23546	County:	Beaufort/Jasper	Eng./Geo.:	A. Bore
Site Description:	RBO New River					Route:	SC 170/46
Boring No.:	B-722	Boring Location:	722+00	Offset:	5 ft LT	Alignment:	Mainline
Elev.:	1,500 ft	Latitude:	34.3750	Longitude:	81.0944	Date Started:	07/15/03
Total Depth:	45 ft	Soil Depth:	39 ft	Core Depth:	6 ft	Date Completed:	07/16/03
Bore Hole Diameter (in):	4.5	Sampler Configuration		Liner required:	Y N	Liner used:	Y N
Drill Machine:	CME-750	Drill Method:	Wash Rotary	Hammer Type:	Automatic	Energy Ratio:	100%
Core Size:	NQ Wireline	Driller:	I. Core	Groundwater:	TOB 7.5 ft	24 hr	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 Density¹</u>			<u>Consistency²</u>		
Descriptive Term	Relative Density	SPT Blow Count	Descriptive Term	Unconfined Compression Strength (q _u) (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 - Angularity¹

<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 Reaction³

<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 - Cementation³

<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 Range¹

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

h - Primary Soil Type^{1,2}

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

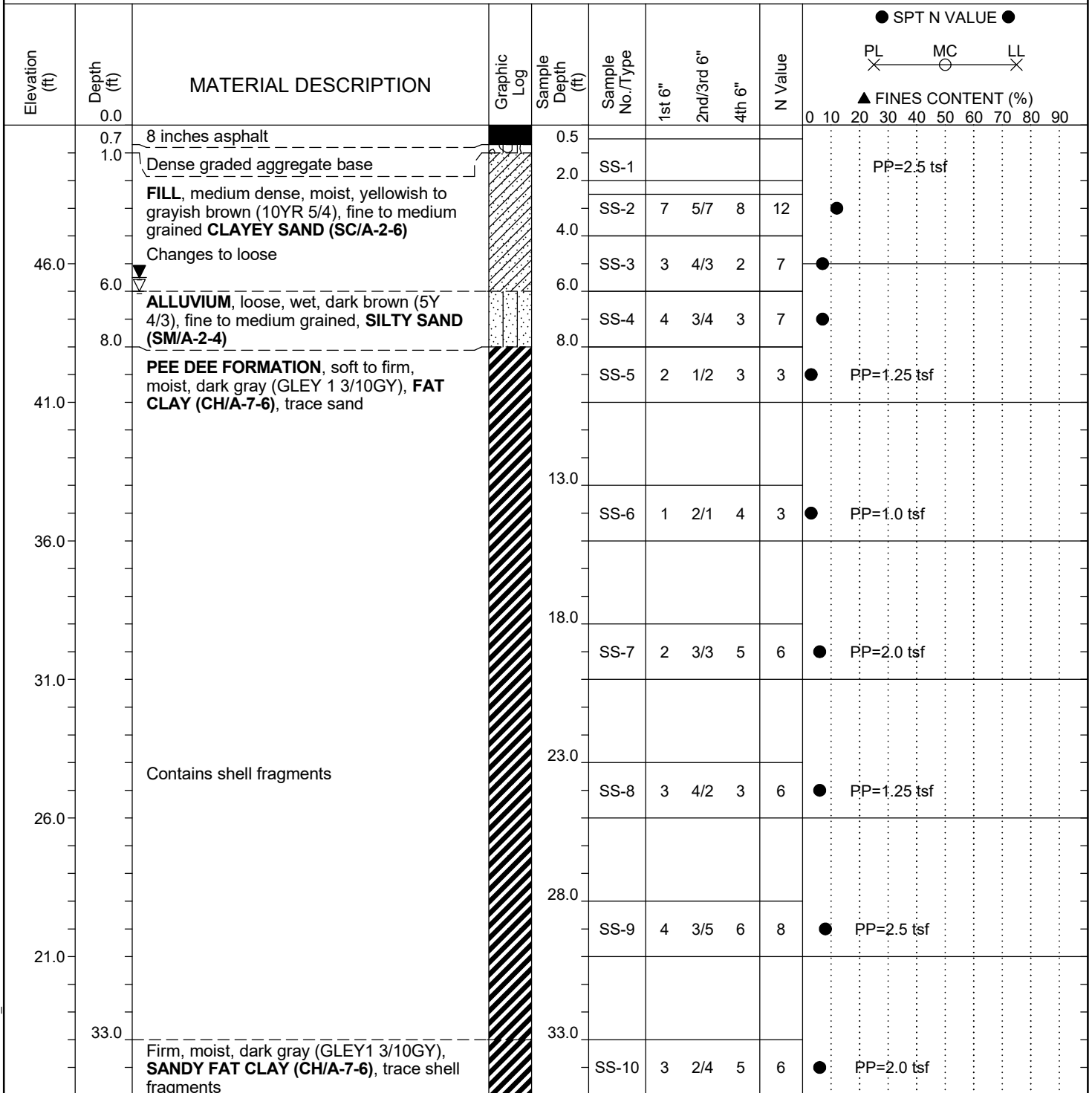
Indicate AASHTO soil designation as defined in AASHTO M-145 and ASTM D-3282

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

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

SCDOT Soil Test Boring Log

File No.:	Project No. (PIN):	P031819	County:	Horry County	Eng./Geo.:	B. Azumah
Site Description: 2016-1A Emergency Bridge Package					Route:	S-19
Boring No.:	STB-401	Boring Location:	-	Offset:	6.00 ft LT	Alignment: Existing
Elev.:	51.0 ft	Latitude:	33.973724	Longitude:	-78.955159	Date Started: 12/6/2016
Total Depth:	100 ft	Soil Depth:	100 ft	Core Depth:	N/A ft	Date Completed: 12/7/2016
Bore Hole Diameter (in):	4	Sampler Configuration		Liner Required:	Y (N)	Liner Used: Y (N)
Drill Machine:	CME-45B	Drill Method:	RW	Hammer Type:	Safety	Energy Ratio: 100%
Core Size:	N/A	Driller:	WWES, LLC	Groundwater:	TOB 6 ft	24HR 5.5 ft



LEGEND

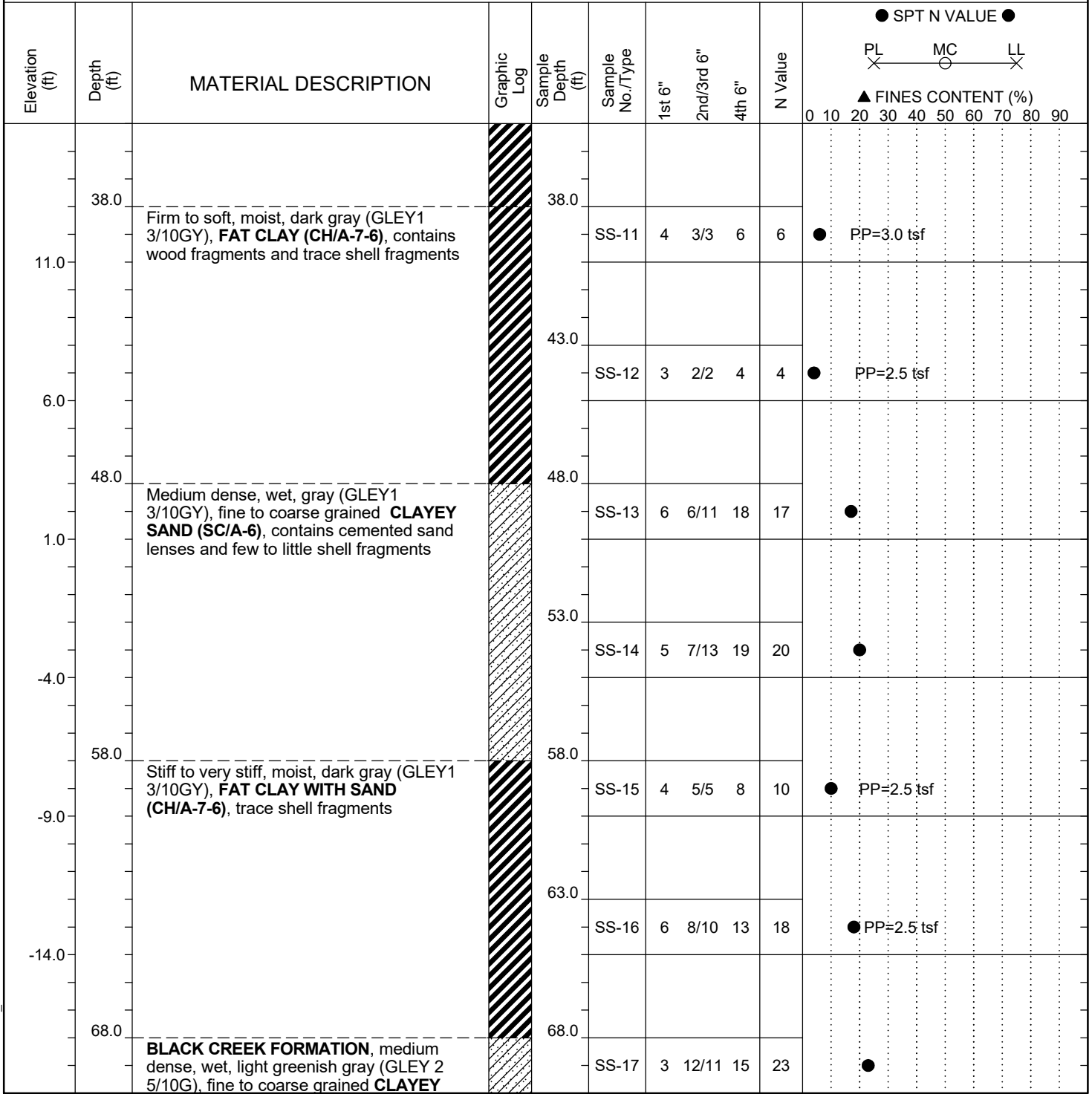
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SC_DOT_65U0177 S-19.GPJ SC_DOT.GDT 12/11/16

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

SCDOT Soil Test Boring Log

File No.:	Project No. (PIN):	P031819	County:	Horry County	Eng./Geo.:	B. Azumah	
Site Description:					2016-1A Emergency Bridge Package	Route:	S-19
Boring No.:	STB-401	Boring Location:	-	Offset:	6.00 ft LT	Alignment:	Existing
Elev.:	51.0 ft	Latitude:	33.973724	Longitude:	-78.955159	Date Started:	12/6/2016
Total Depth:	100 ft	Soil Depth:	100 ft	Core Depth:	N/A ft	Date Completed:	12/7/2016
Bore Hole Diameter (in):	4	Sampler Configuration		Liner Required:	Y (N)	Liner Used:	Y (N)
Drill Machine:	CME-45B	Drill Method:	RW	Hammer Type:	Safety	Energy Ratio:	100%
Core Size:	N/A	Driller:	IWWES. LLC	Groundwater:	TOB 6 ft	24HR	5.5 ft



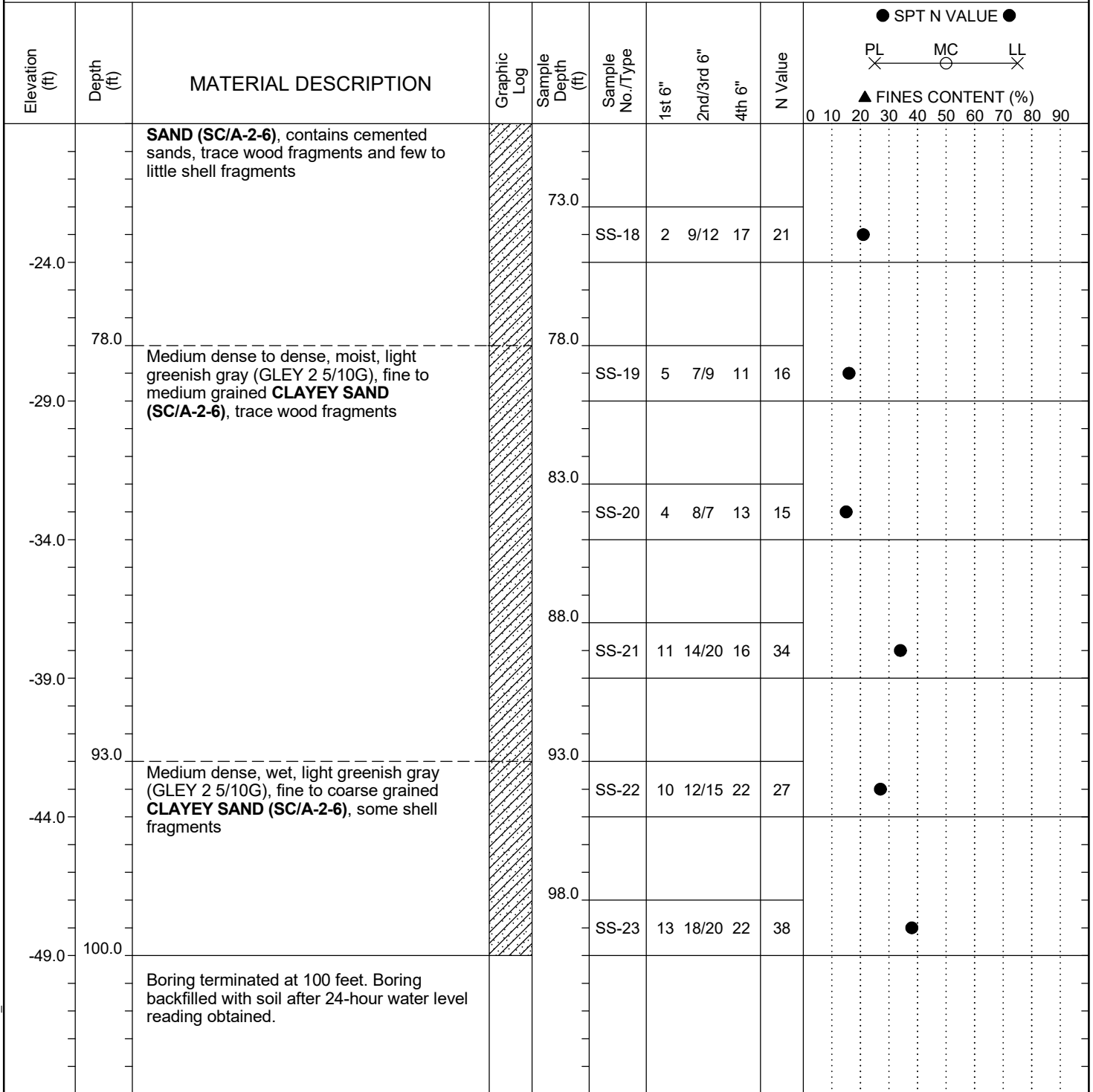
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SAMPLER TYPE		DRILLING METHOD	
SS - Split Spoon	NQ - Rock Core, 1-7/8"	HSA - Hollow Stem Auger	RW - Rotary Wash
ST - Shelby Tube	CU - Cuttings	CFA - Continuous Flight Augers	RC - Rock Core
AWG - Rock Core, 1-1/8"	CT - Continuous Tube	DC - Driving Casing	

SC.DOT 65U0177 S-19.GPJ SC_DOT.GDT 12/11/16

SCDOT Soil Test Boring Log

File No.:	Project No. (PIN): P031819	County: Horry County	Eng./Geo.: B. Azumah
Site Description: 2016-1A Emergency Bridge Package			Route: S-19
Boring No.: STB-401	Boring Location: -	Offset: 6.00 ft LT	Alignment: Existing
Elev.: 51.0 ft	Latitude: 33.973724	Longitude: -78.955159	Date Started: 12/6/2016
Total Depth: 100 ft	Soil Depth: 100 ft	Core Depth: N/A ft	Date Completed: 12/7/2016
Bore Hole Diameter (in): 4	Sampler Configuration	Liner Required: Y (N)	Liner Used: Y (N)
Drill Machine: CME-45B	Drill Method: RW	Hammer Type: Safety	Energy Ratio: 100%
Core Size: N/A	Driller: WWES. LLC	Groundwater: TOB 6 ft	24HR 5.5 ft



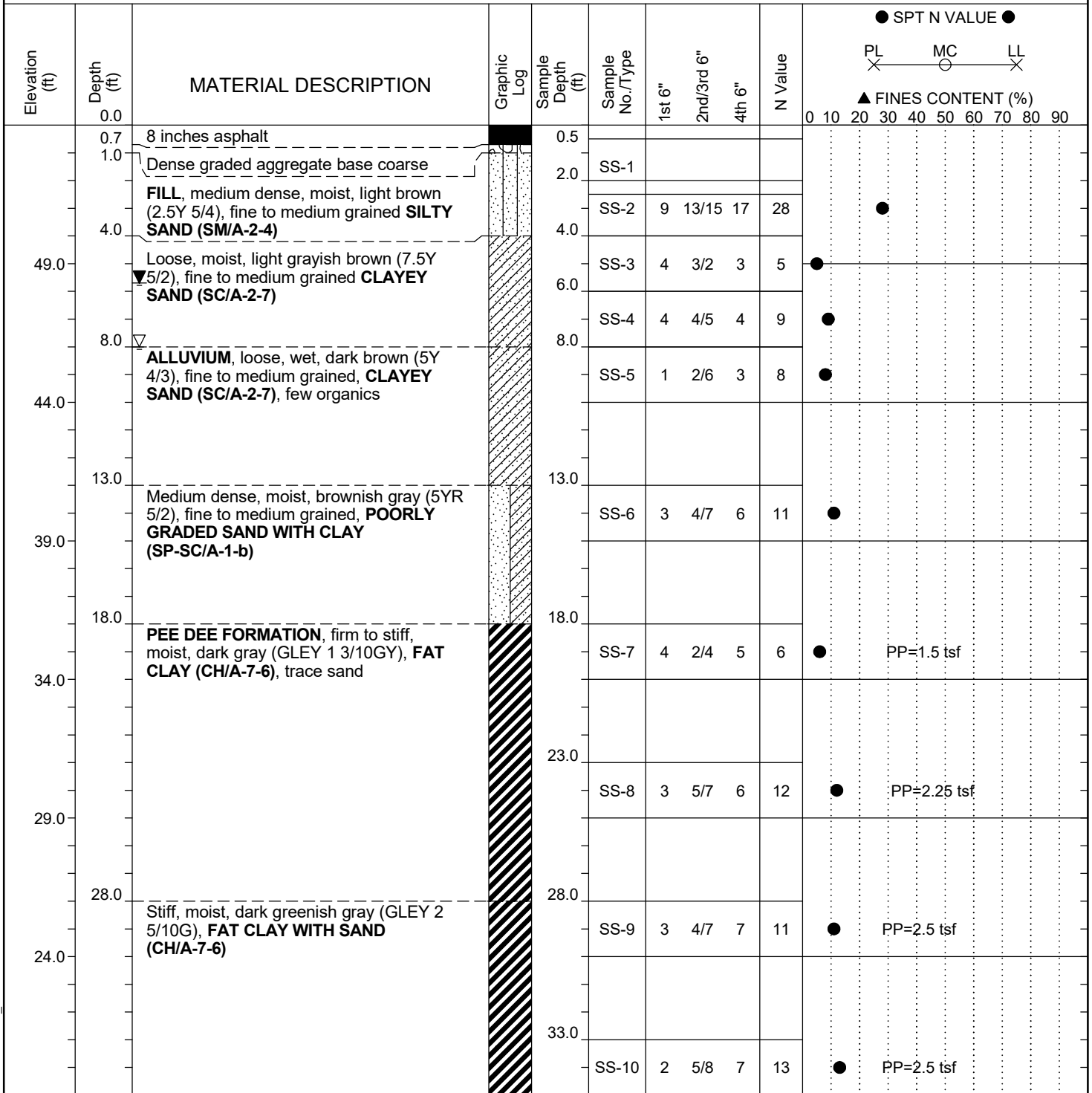
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SAMPLER TYPE		DRILLING METHOD	
SS - Split Spoon	NQ - Rock Core, 1-7/8"	HSA - Hollow Stem Auger	RW - Rotary Wash
ST - Shelby Tube	CU - Cuttings	CFA - Continuous Flight Augers	RC - Rock Core
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SC_DOT_65U0177 S-19.GPJ SC_DOT.GDT 12/11/16

SCDOT Soil Test Boring Log

File No.:	Project No. (PIN): P031819	County: Horry County	Eng./Geo.: B. Azumah
Site Description: 2016-1A Emergency Bridge Package			Route: S-19
Boring No.: STB-402	Boring Location: -	Offset: 6.00 ft LT	Alignment: Existing
Elev.: 54.0 ft	Latitude: 33.973454	Longitude: -78.955116	Date Started: 12/8/2016
Total Depth: 100 ft	Soil Depth: 100 ft	Core Depth: N/A ft	Date Completed: 12/9/2016
Bore Hole Diameter (in): 4	Sampler Configuration	Liner Required: Y (N)	Liner Used: Y (N)
Drill Machine: CME-45B	Drill Method: RW	Hammer Type: Safety	Energy Ratio: 100%
Core Size: N/A	Driller: WWES. LLC	Groundwater: TOB 8 ft	24HR: 5.7 ft



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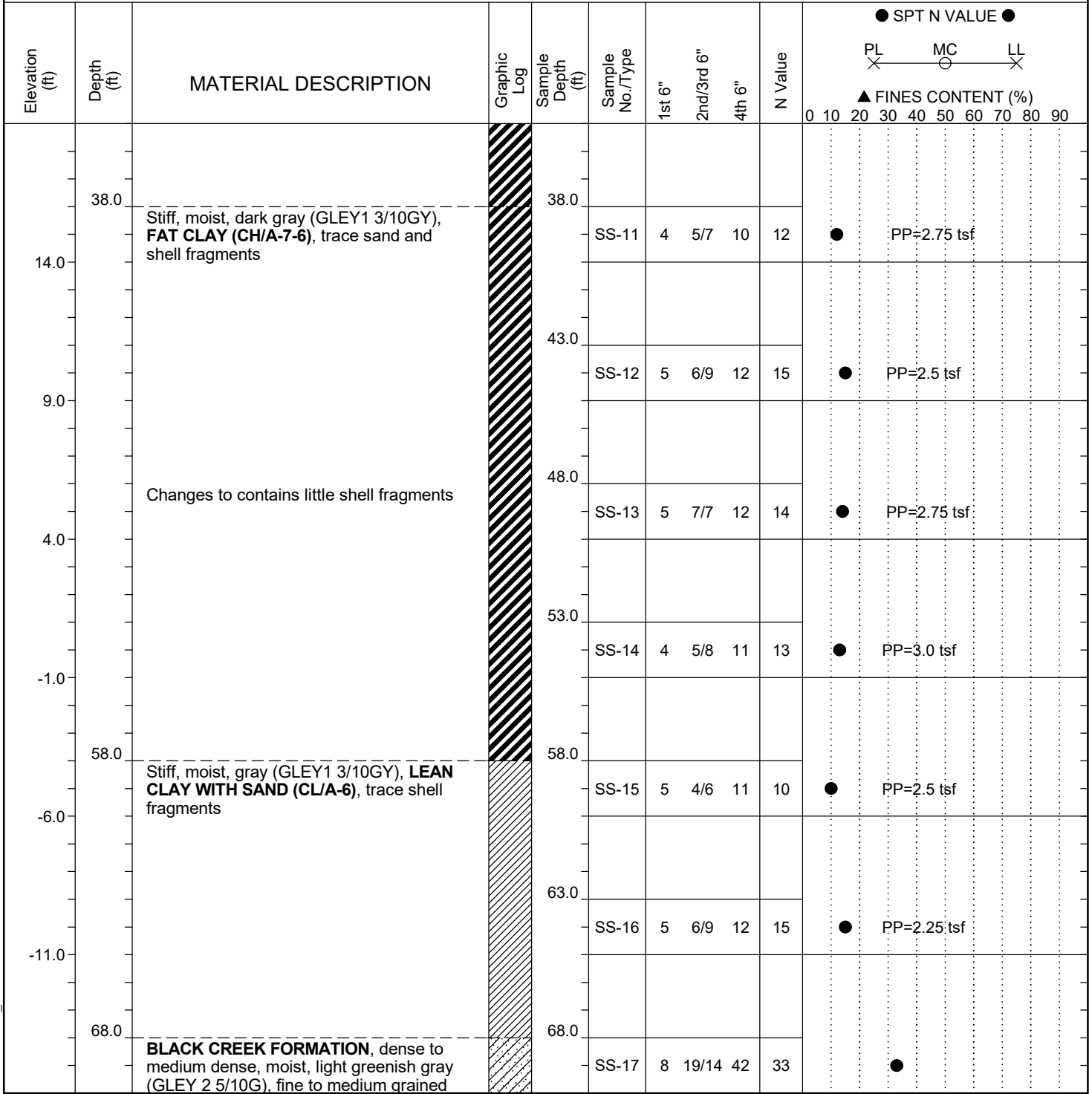
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SC_DOT_65U0177 S-19.GPJ SC_DOT.GDT 12/11/16

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

SCDOT Soil Test Boring Log

File No.:	Project No. (PIN): P031819	County: Horry County	Eng./Geo.: B. Azumah
Site Description: 2016-1A Emergency Bridge Package			Route: S-19
Boring No.: STB-402	Boring Location: -	Offset: 6.00 ft LT	Alignment: Existing
Elev.: 54.0 ft	Latitude: 33.973454	Longitude: -78.955116	Date Started: 12/8/2016
Total Depth: 100 ft	Soil Depth: 100 ft	Core Depth: N/A ft	Date Completed: 12/9/2016
Bore Hole Diameter (in): 4	Sampler Configuration	Liner Required: Y (N)	Liner Used: Y (N)
Drill Machine: CME-45B	Drill Method: RW	Hammer Type: Safety	Energy Ratio: 100%
Core Size: N/A	Driller: WWES. LLC	Groundwater: TOB 8 ft	24HR: 5.7 ft



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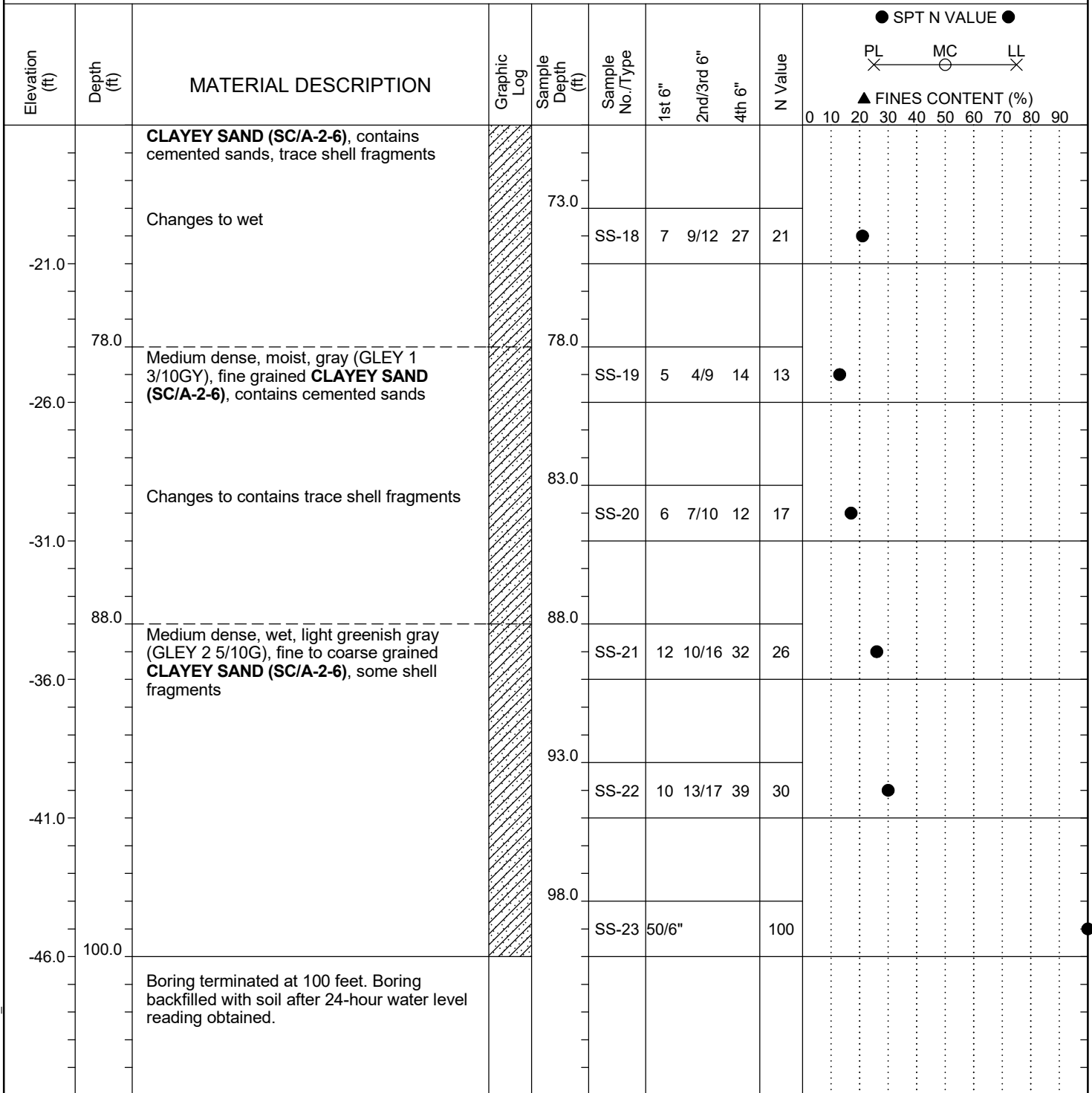
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SC_DOT_65U0177 S-19.GPJ SC_DOT.GDT 12/11/16

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

SCDOT Soil Test Boring Log

File No.:	Project No. (PIN): P031819	County: Horry County	Eng./Geo.: B. Azumah
Site Description: 2016-1A Emergency Bridge Package			Route: S-19
Boring No.: STB-402	Boring Location: -	Offset: 6.00 ft LT	Alignment: Existing
Elev.: 54.0 ft	Latitude: 33.973454	Longitude: -78.955116	Date Started: 12/8/2016
Total Depth: 100 ft	Soil Depth: 100 ft	Core Depth: N/A ft	Date Completed: 12/9/2016
Bore Hole Diameter (in): 4	Sampler Configuration	Liner Required: Y (N)	Liner Used: Y (N)
Drill Machine: CME-45B	Drill Method: RW	Hammer Type: Safety	Energy Ratio: 100%
Core Size: N/A	Driller: WWES. LLC	Groundwater: TOB 8 ft	24HR 5.7 ft



LEGEND

SAMPLER TYPE		DRILLING METHOD	
SS - Split Spoon	NQ - Rock Core, 1-7/8"	HSA - Hollow Stem Auger	RW - Rotary Wash
ST - Shelby Tube	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-19.GPJ SC_DOT.GDT 12/11/16



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 cm² 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-19
 Horry County, SC
 Project Number :16-126

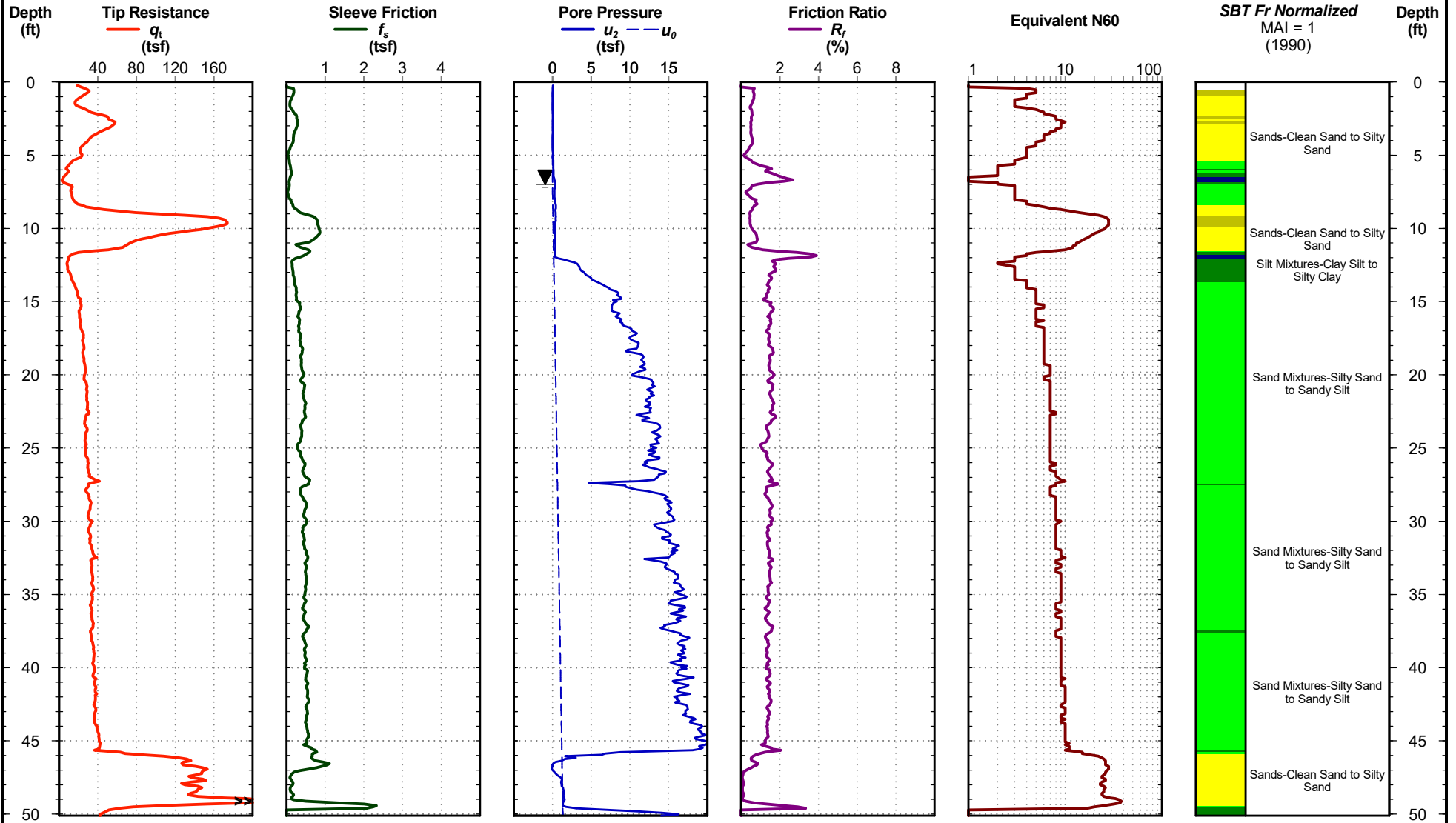
Cone Penetration Test

CPT-401

Date: Nov. 30, 2016
 Estimated Water Depth: 7 ft
 Rig/Operator: M. Cox | J. Croom

Northing:
 Easting:
 Elevation:

Total Depth: 50.1 ft
 Termination Criteria: Target Depth
 Cone Size: 1.75



CPT REPORT - STANDARD S-19.GPJ DF STD US LAB.GDT 12/8/16

CPT-401



S-19
 Horry County, SC
 Project Number :16-126

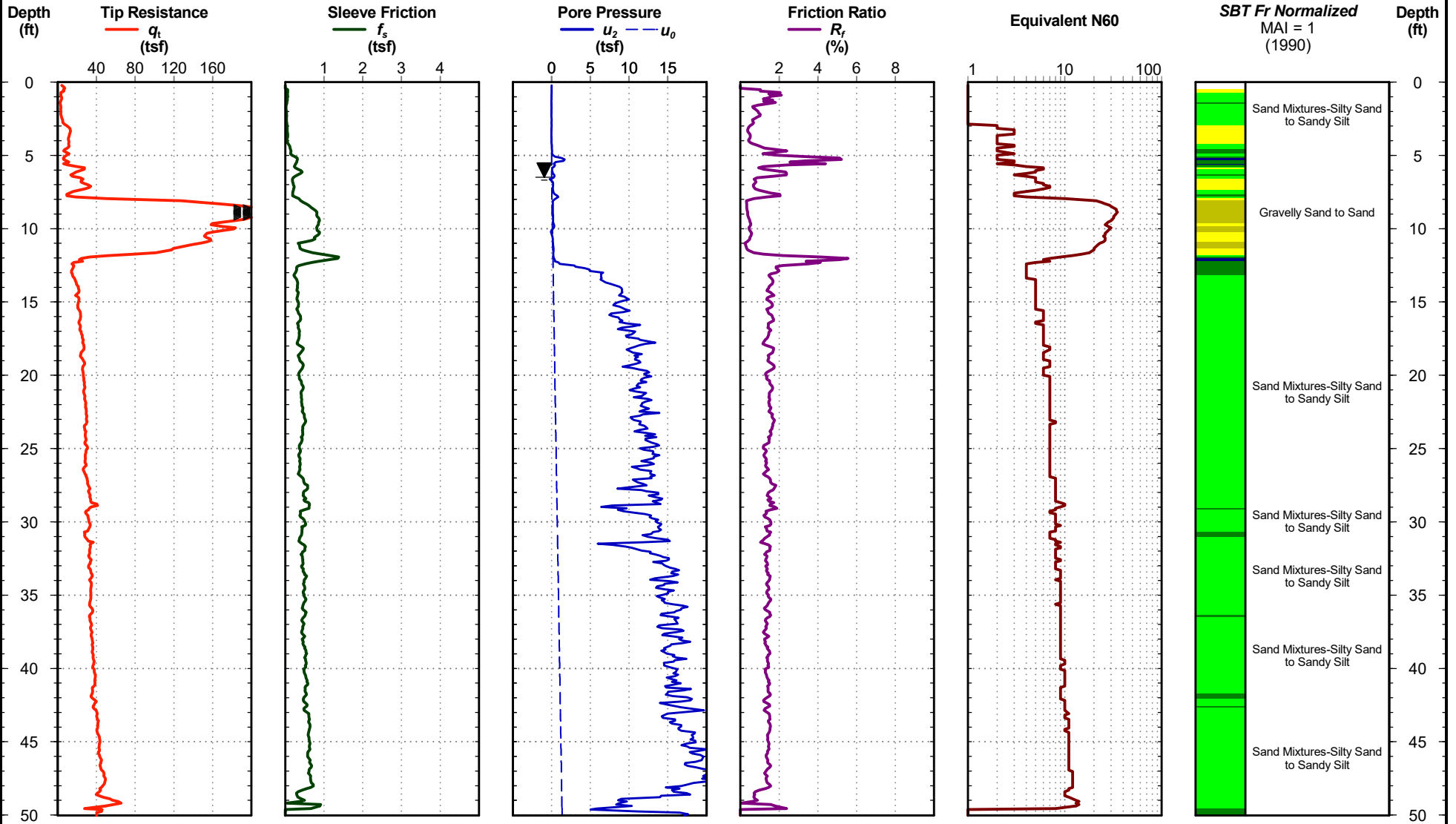
Cone Penetration Test

CPT-402

Date: Nov. 30, 2016
 Estimated Water Depth: 6.5 ft
 Rig/Operator: M. Cox | J. Croom

Northing:
 Easting:
 Elevation:

Total Depth: 50.0 ft
 Termination Criteria: Target Depth
 Cone Size: 1.75



CPT REPORT - STANDARD S-19.GPJ DF STD US LAB.GDT 12/8/16

CPT-402



APPENDIX IV



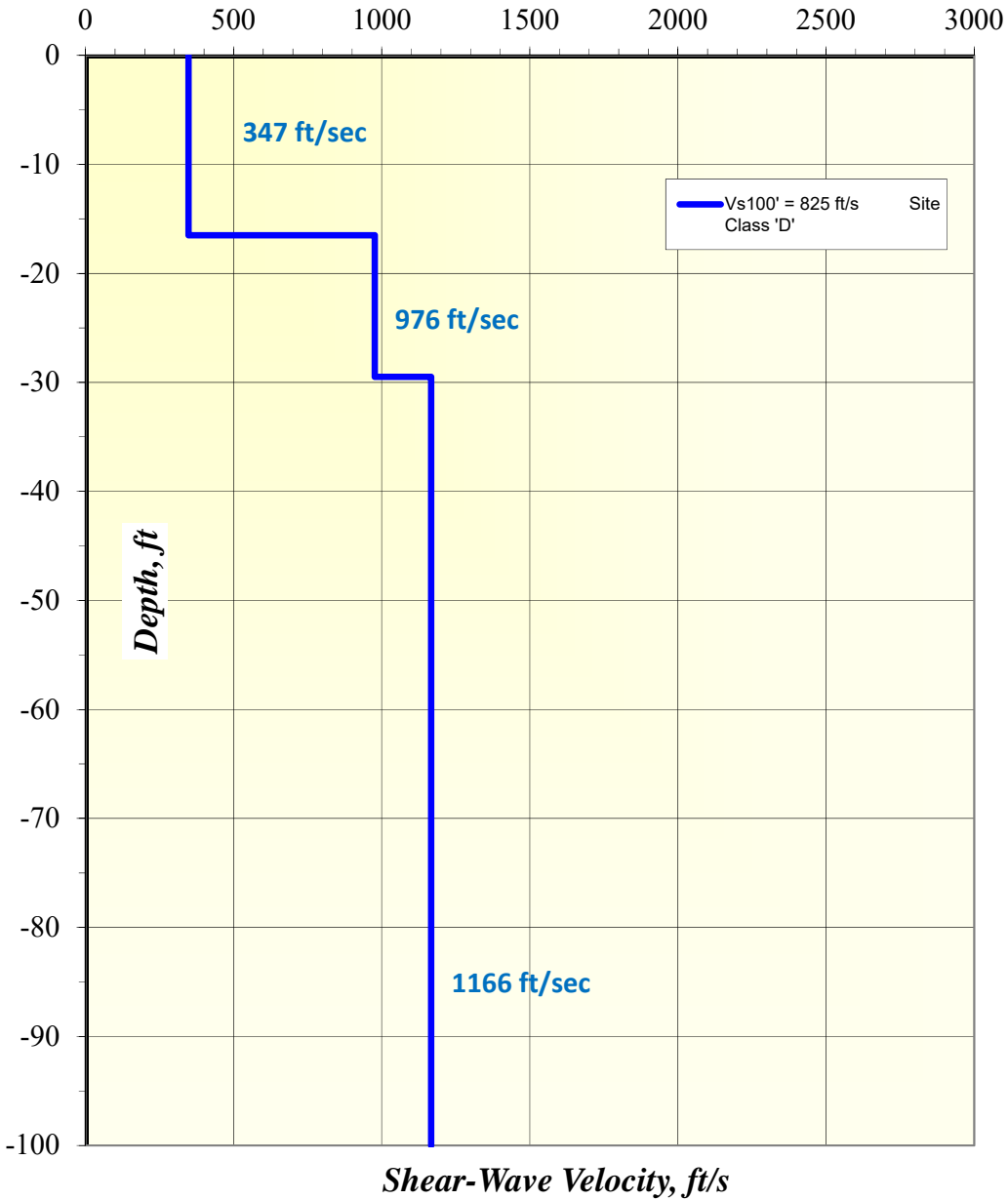
FROEHLING & ROBERTSON, INC.

Refraction Microtremor (REMI) Results

Project: 2016-1A Emergency Bridge Package S-19, Horry Co. SC
Client: SCDOT Geotechnical Design Group

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

Vs Model





HQ: 3015 DUMBARTON ROAD RICHMOND, VIRGINIA 23228 T 804.264.2701 F 804.264.1202 www.fandr.com

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