Geotechnical Data Report

S-13-138 (Bo Melton Loop)
Emergency Bridge Replacement over Little Black Creek
Chesterfield County, South Carolina

February 7, 2019
SCDOT Project ID.: P038246
Terracon Project No. 7318P119E

Prepared for:
South Carolina Department of Transportation
Columbia, South Carolina

Prepared by:
Terracon Consultants, Inc.
Columbia, South Carolina

February 7, 2019

South Carolina Department of Transportation
955 Park Street, Room 421
Columbia, South Carolina 29201

Attn: Mr. Trapp Harris, P.E.
Geotechnical Design Engineer – Design-Build Section

Re: Geotechnical Data Report
S-13-138 (Bo Melton Loop) Emergency BRO Little Black Creek
Chesterfield County, South Carolina
SCDOT Project ID.: P038246
Terracon Project Number: 7318P119E

Dear Mr. Harris:

Terracon Consultants Inc. (Terracon) has completed the geotechnical exploration and testing services for the above referenced project. These services were conducted in general accordance with the SCDOT Request for Subsurface Exploration and Laboratory Testing (SCDOT Project ID: P038246, authorized on November 5, 2018). This geotechnical data report presents the findings of the subsurface exploration and laboratory testing along with an overview of testing activities.

1.0 INTRODUCTION

The South Carolina Department of Transportation (SCDOT) has contracted Terracon to perform subsurface exploration and laboratory testing for the replacement of the S-13-138 (Bo Melton Loop) bridge over Little Black Creek in Chesterfield County, SC. The purpose of this work is to develop information relative to subsurface soil and groundwater conditions at the bridge location. No geotechnical recommendations are associated with the requested scope of study.

The following sections of this report contain a summary of the activities for our field exploration and laboratory testing. The logs of the borings, the Site Location Map and the Exploration Plan are included in Appendix A. The results of the laboratory testing performed on soil samples obtained from the site during the field exploration are included in Appendix B. Descriptions of the field exploration and laboratory testing are included in their respective appendices.

2.0 PROJECT DESCRIPTION

The project site is located at the bridge crossing of S-13-138 (Bo Melton Loop) and Little Black Creek in Chesterfield County, South Carolina. It is our understanding that the project will include the replacement of the previously damaged bridge with a new structure on the existing or similar horizontal alignment. The original structure appears to have been supported with round timber piles.

3.0 GEOTECHNICAL TESTING

The geotechnical exploration for this project was performed between December 11 and 13, 2018. The results of our field work and our associated laboratory testing is attached in Appendixes A and B of this report.

3.1 Field Exploration

Our field exploration at the site consisted of the following:

- Two (2) Standard Penetration Test (SPT) Borings (B-1 and B-2)

The tests were performed at the approximate locations provided by the SCDOT. A description of our testing methods and graphical logs outlining the soil conditions at each test location are presented in Appendix A. Test locations were established in the field by Terracon and surveyed by Construction Support Services, LLC, after completion. Photographs of the drill rig set up at each boring location are provided in Appendix A.

3.2 Laboratory Testing

The following laboratory tests were performed on the soil samples collected at the site.

- Ten (10) Natural Moisture Content Tests
- Six (6) No. 200 Wash Tests
- Three (3) Atterberg Limits Tests
- Six (6) Unconfined Compression Strength of Rock Tests

The general scope of the laboratory testing frequency was determined by the SCDOT. The laboratory procedures and results of the laboratory tests are presented in Appendix B.

4.0 CLOSURE

We appreciate the opportunity to be of service to you on this project. If you have any questions concerning this report or we may be of further service, please contact us.

Sincerely,
Terracon Consultants, Inc.

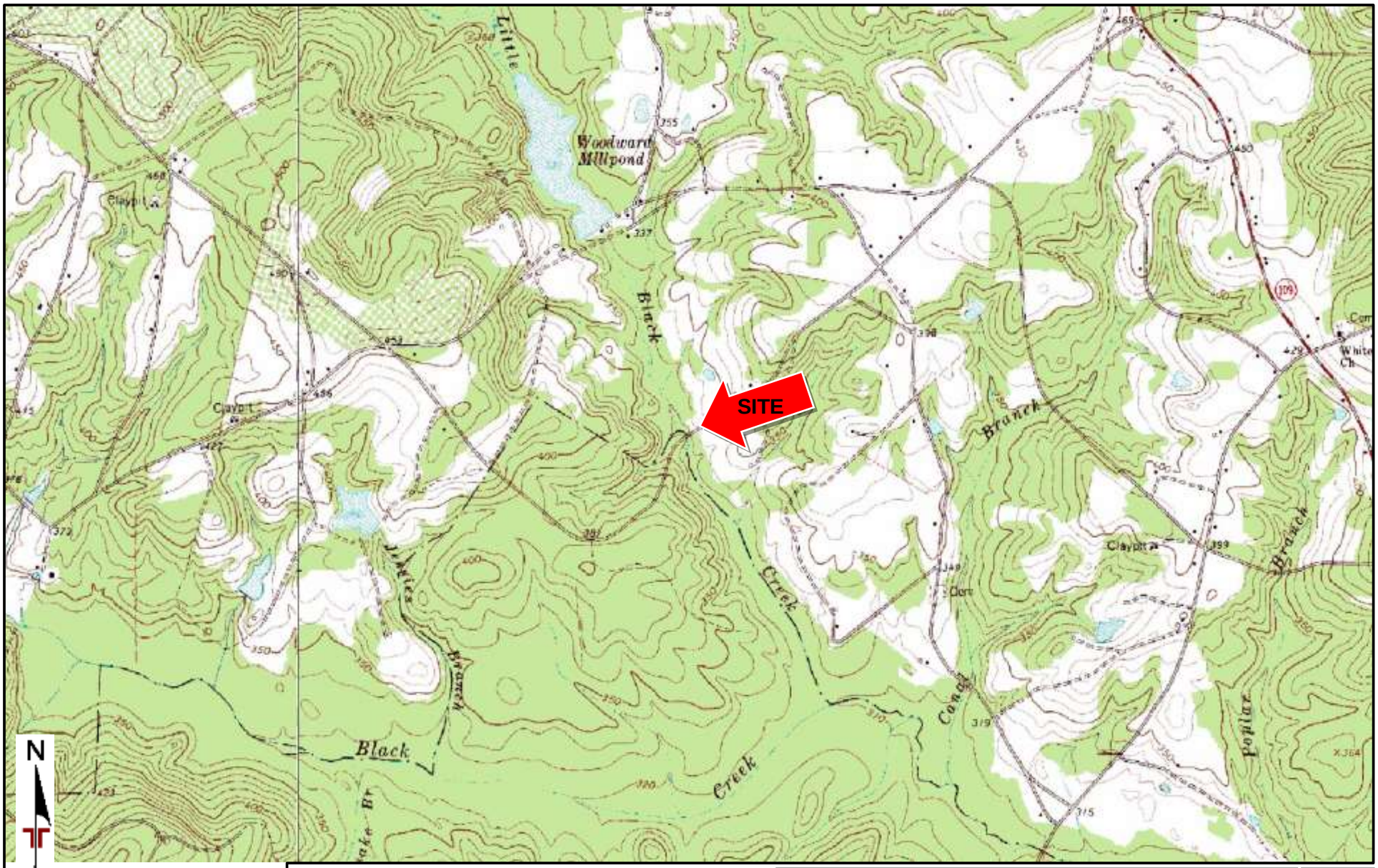
Ryan D. Starcher, E.I.T.
Senior Staff Engineer

Phillip A. Morrison, P.E.
Geotechnical Department Manager
SC Registration No. 17275

Attachments:
Appendix A
Appendix B
Appendix C

APPENDIX A
FIELD EXPLORATION

Exhibit A-1 – Site Location Map
Exhibit A-2 – Exploration Plan
Exhibit A-3 – Summary of Field Data
Exhibit A-4 – Field Exploration Description
Exhibit A-5 – Soil Description Terms
Exhibit A-6 – Rock Description Terms
Exhibit A-7 – Soil Rock Symbol Log
Exhibit A-8 – Boring Logs
Exhibit A-9 – Rock Photographic Log
Exhibit A-10 – Drill Rig Photograph Log



TOPOGRAPHIC MAP IMAGE COURTESY OF THE U.S. GEOLOGICAL SURVEY QUADRANGLES INCLUDE: JEFFERSON NE, SC (1/1/1968) and RUBY, SC (1/1/1968).

DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

Project Manager:	RDS
Drawn by:	PTK
Checked by:	RDS
Approved by:	PAM

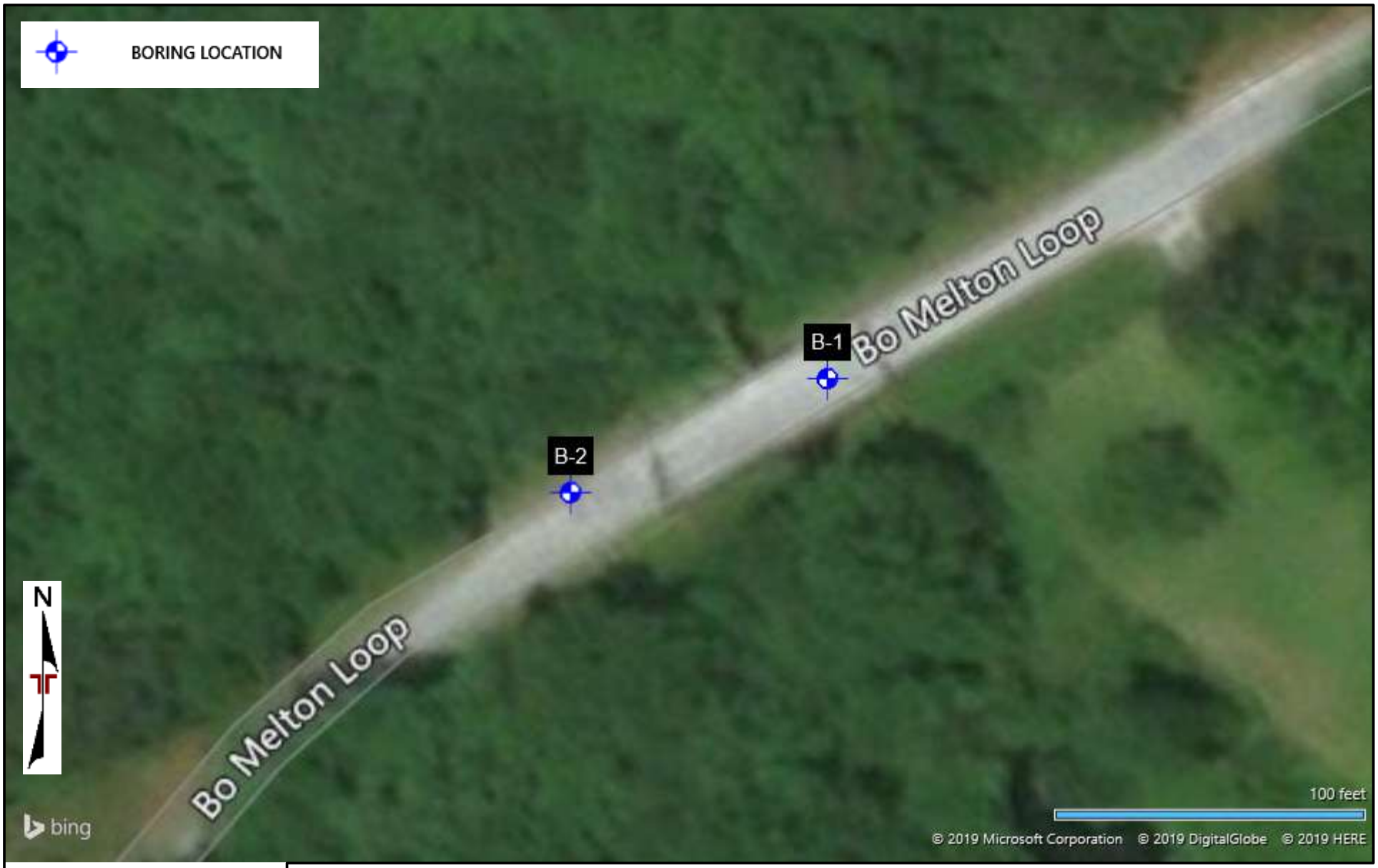
Project No.	7318P119E
Scale:	1"=2,000'
File Name:	A-1 & A-2
Date:	Feb. 2019

Terracon
521 Clemson Rd
Columbia, SC 29229-4307

SITE LOCATION MAP

S-13-138 (Bo Melton Loop)
RBO Little Black Creek
Chesterfield County, South Carolina

Exhibit
A-1



AERIAL PHOTOGRAPHY PROVIDED BY MICROSOFT BING MAPS

DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

Project Manager:	RDS
Drawn by:	PTK
Checked by:	RDS
Approved by:	PAM

Project No.	7318P119E
Scale:	AS SHOWN
File Name:	A-1 & A-2
Date:	Feb. 2019

Terracon
521 Clemson Rd
Columbia, SC 29229-4307

EXPLORATION PLAN

S-13-138 (Bo Melton Loop)
RBO Little Black Creek
Chesterfield County, South Carolina

Exhibit

A-2

Summary of Field Data

Test No.	Ground Elevation (ft)	Test Depth (ft.)	Northing	Easting	Latitude	Longitude
B-1	329.48	53.6	1036461.715	2231613.420	N34.679585	W80.229616
B-2	329.49	55.4	1036424.336	2231530.520	N34.679484	W80.229892

FIELD EXPLORATION DESCRIPTION

Overview

The general testing locations were provided by the SCDOT and located in the field by Terracon by taking measurements from existing structures. The borings were surveyed by Construction Support Services, LLC after testing and drilling was complete. The locations are shown on the appended Exploration Plan.

A field log of each test location was prepared by our field engineer. The final boring logs included with this report represent the engineer's description of the encountered conditions modified as necessary based on laboratory test results of the individual samples.

Soil Test Borings (STB)

All boring and sampling operations were conducted in general accordance with the following procedures:

- SCDOT Geotechnical Design Manual 2010
- ASTM D5783, “Standard Guide for Use of Direct Rotary Drilling with Water-Based Drilling Fluid for Geo-environmental Exploration”
- ASTM D1586 “Test Method for Penetration Test and Split-Barrel Sampling of Soils”
- ASTM D4220 “Standard Practices for Preserving and Transporting Soil”

Each boring was advanced using rotary wash drilling techniques to the planned termination depths. The sampling program is summarized in the following table:

Test ID	Total Depth	Interval of Continuous Sampling
B-1	100 feet or refusal and 20 feet of coring	0 to 10 feet
B-2	100 feet or refusal and 20 feet of coring	0 to 10 feet

Soil samples were obtained with a standard 1.4-inch I.D., 2-inch O.D., split-barrel sampler, also known as a standard split-spoon. The sampler is advanced into the soil a total of 18 to 24 inches by striking the drill rod using a 140-pound automatic hammer falling 30 inches. The number of blows required to advance the sampler for each of three to four, 6-inch increments is recorded. The sum of the number of blows for the second and third increments is called the “Standard Penetration Value”, or N-value (N_{meas}, blows per foot). The N-value, when properly evaluated, is an index to the soil strength.

The borings were advanced to refusal of the drilling equipment and continued below this depth using diamond bit rock coring techniques. NQ2 sized cores were recovered from the borehole. The rock recovery ratios (REC, percentage of the total core run), Rock Quality Designation (RQD, percentage of the total core run of pieces greater than 4 inches) were recorded along with a

description of the rock. An explanation of the rock descriptions shown on the logs is provided in Exhibit 6. Photos of the recovered rock core specimens are provided on Exhibit A-9 of the Appendix.

Soil Classification provides a general guide to the engineering properties of various soil types and enables the engineer to apply his experience to current situations. In our exploration, samples obtained during drilling operations are examined and visually classified by a geotechnical engineer using the procedures outlined in ASTM D2487 - Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System). Laboratory testing was also performed on select split-spoon samples to evaluate index properties for further classification. The soils are described according to color, texture, and relative density or consistency (based on standard penetration resistance). The designations shown on the logs are described on Exhibit A-5.

Consistent with SCDOT GDM, the borings were drilled using mud rotary drilling techniques. As the drilling method introduces water into the borehole, time-of-drilling water levels could not be recorded. As noted on the boring log, the water levels of the borings were recorded at least 1 day after the start of drilling activities. These water levels are indicated on the boring logs. At the conclusion of the work, the boreholes were backfilled with sand and the borings were capped with cold-patch asphalt.

SOIL DESCRIPTION TERMS

Relative Density/Consistency Terms

Relative Density[1]

Descriptive Term	Relative Density	SPT Blow Count
Very Loose	0 to 15%	4 and less
Loose	16 to 35%	5 to 10
Medium Dense	36 to 65%	11 to 30
Dense	66 to 85%	31 to 50
Very Dense	86 to 100%	51 and more

Consistency[2]

Descriptive Term	Unconfined Compression Strength (q_u) (tsf)	SPT Blow Count
Very Soft	0.25 and less	2 and less
Soft	0.26 to 0.50	3 to 4
Firm	0.51 to 1.00	5 to 8
Stiff	1.01 to 2.00	9 to 15
Very Stiff	2.01 to 4.00	16 to 30
Hard	4.01 and more	31 and more

Moisture Condition

Descriptive Term	Criteria
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

Color

Describe the sample color while sample is still moist.

Angularity[1]

Descriptive Term	Criteria
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.

HCl Reaction[3]

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

Cementation[3]

Descriptive Term	Criteria
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

Particle-Size Range[1]

Gravel	Diameter, mm	Sieve Size
Fine	4.76 to 19.1	#4 to ¾ inch
Coarse	19.1 to 76.2	¾ inch to 3 inch

Sand	Diameter, mm	Sieve Size
Fine	0.074 to 0.42	#200 to #40
Medium	0.42 to 2.00	#40 to #10
Coarse	4.00 to 4.76	#10 to #4

Primary Soil Type[1, 2]

The primary soil type will be shown in all capital letters.

USCS Soil Designation

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

AASHTO Soil Designation

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

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

DESCRIPTION OF ROCK PROPERTIES

WEATHERING

Fresh	Rock fresh, crystals bright, few joints may show slight staining. Rock rings under hammer if crystalline.
Very slight	Rock generally fresh, joints stained, some joints may show thin clay coatings, crystals in broken face show bright. Rock rings under hammer if crystalline.
Slight	Rock generally fresh, joints stained, and discoloration extends into rock up to 1 in. Joints may contain clay. In granitoid rocks some occasional feldspar crystals are dull and discolored. Crystalline rocks ring under hammer.
Moderate	Significant portions of rock show discoloration and weathering effects. In granitoid rocks, most feldspars are dull and discolored; some show clayey. Rock has dull sound under hammer and shows significant loss of strength as compared with fresh rock.
Moderately severe	All rock except quartz discolored or stained. In granitoid rocks, all feldspars dull and discolored and majority show kaolinization. Rock shows severe loss of strength and can be excavated with geologist's pick.
Severe	All rock except quartz discolored or stained. Rock "fabric" clear and evident, but reduced in strength to strong soil. In granitoid rocks, all feldspars kaolinized to some extent. Some fragments of strong rock usually left.
Very severe	All rock except quartz discolored or stained. Rock "fabric" discernible, but mass effectively reduced to "soil" with only fragments of strong rock remaining.
Complete	Rock reduced to "soil". Rock "fabric" not discernible or discernible only in small, scattered locations. Quartz may be present as dikes or stringers.

HARDNESS (for engineering description of rock – not to be confused with Moh's scale for minerals)

Very hard	Cannot be scratched with knife or sharp pick. Breaking of hand specimens requires several hard blows of geologist's pick.
Hard	Can be scratched with knife or pick only with difficulty. Hard blow of hammer required to detach hand specimen.
Moderately hard	Can be scratched with knife or pick. Gouges or grooves to ¼ in. deep can be excavated by hard blow of point of a geologist's pick. Hand specimens can be detached by moderate blow.
Medium	Can be grooved or gouged 1/16 in. deep by firm pressure on knife or pick point. Can be excavated in small chips to pieces about 1-in. maximum size by hard blows of the point of a geologist's pick.
Soft	Can be gouged or grooved readily with knife or pick point. Can be excavated in chips to pieces several inches in size by moderate blows of a pick point. Small thin pieces can be broken by finger pressure.
Very soft	Can be carved with knife. Can be excavated readily with point of pick. Pieces 1-in. or more in thickness can be broken with finger pressure. Can be scratched readily by fingernail.

Joint, Bedding, and Foliation Spacing in Rock [a]		
Spacing	**Joints**	**Bedding/Foliation**
Less than 2 in.	Very close	Very thin
2 in. – 1 ft.	Close	Thin
1 ft. – 3 ft.	Moderately close	Medium
3 ft. – 10 ft.	Wide	Thick
More than 10 ft.	Very wide	Very thick

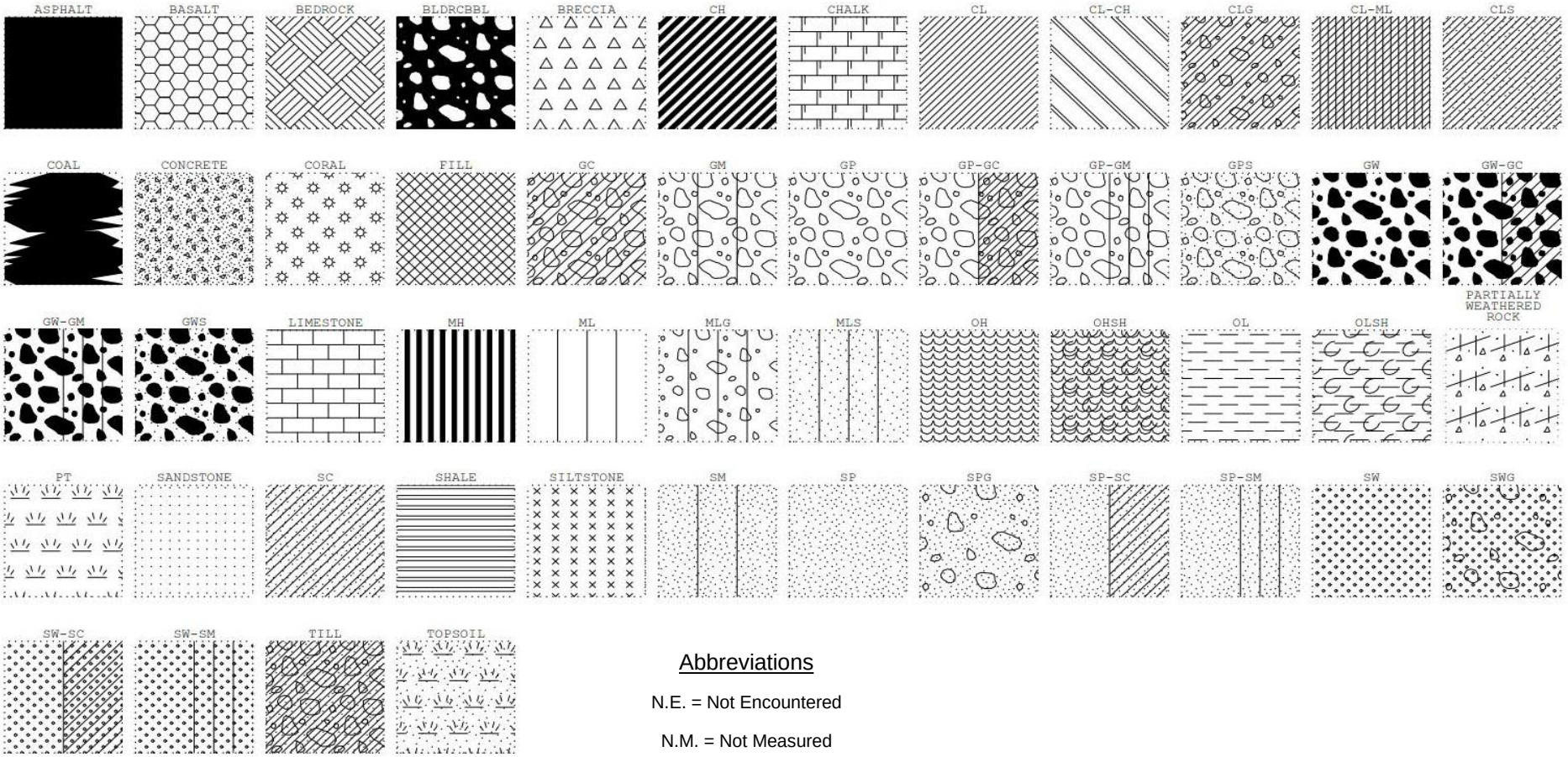
a. Spacing refers to the distance normal to the planes, of the described feature, which are parallel to each other or nearly so.

Rock Quality Designator (RQD) a	
RQD, as a percentage	**Diagnostic description**
Exceeding 90	Excellent
90 – 75	Good
75 – 50	Fair
50 – 25	Poor
Less than 25	Very poor

a. RQD (given as a percentage) = length of core in pieces 4 in. and longer/length of run.

Joint Openness Descriptors	
Openness	**Descriptor**
No Visible Separation	Tight
Less than 1/32 in.	Slightly Open
1/32 to 1/8 in.	Moderately Open
1/8 to 3/8 in.	Open
3/8 in. to 0.1 ft.	Moderately Wide
Greater than 0.1 ft.	Wide

References: American Society of Civil Engineers. Manuals and Reports on Engineering Practice - No. 56. Subsurface Investigation for Design and Construction of Foundations of Buildings. New York: American Society of Civil Engineers, 1976. U.S. Department of the Interior, Bureau of Reclamation, Engineering Geology Field Manual.



Abbreviations

N.E. = Not Encountered

N.M. = Not Measured

Project Manager:	PAM
Drawn by:	KJZ
Checked by:	KJZ
Approved by:	PAM

Project No.	7318P119E
Scale:	N.T.S.
File Name:	Soil – Rock – Log
Date:	February 7, 2019

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SOIL / ROCK / LOG SYMBOL LEGEND

SCDOT Soil Test Log

Project ID:	P038246			**County:**	Chesterfield	**Boring No.:**	B-1
Site Description:	S-13-138 (Bo Melton Loop) RBO Little Black Creek					**Route:**	S-13-138
Eng./Geo.:	RDS	**Boring Location:**		**Offset:**		**Alignment:**	Main
Elev.:	329.5 ft	**Latitude:**	34.679585	**Longitude:**	-80.229616	**Date Started:**	12/11/2018
Total Depth:	53.6 ft	**Soil Depth:**	33.1 ft	**Core Depth:**	20.5 ft	**Date Completed:**	12/12/2018
Bore Hole Diameter (in):	3	**Sampler Configuration**		**Liner Required:**	Y (N)	**Liner Used:**	Y (N)
Drill Machine:	CME-55/300	**Drill Method:**	RW	**Hammer Type:**	Automatic	**Energy Ratio:**	93.2%
Core Size:	NQ2	**Driller:**	AM	**Groundwater:**	**TOB** N.A.	**24HR**	7 ft

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Graphic Log	Sample Depth (ft)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	4th 6"	N Value
	0.0	Existin Roadway								
	0.5	ASPHALT (6 inches)		0.5						
	2.0	Loose, moist, reddish yellow, angular, non-reactive, weakly cemented, fine to medium, Silty SAND (SM) (A-2-4) 2.5YR 6/6 @SS-1 - NMC=15		2.0	SS-1	3	3	3		6
					SS-2	2	3	4	6	7
				4.0						
324.5	6.0	Loose to medium dense, moist, brownish yellow, angular, non-reactive, moderately cemented, fine to medium, Silty SAND (SM) (A-2-4) 10YR 6/6 @SS-2 - NMC=15			SS-3	5	7	9	12	16
				6.0						
	8.0	@SS-3 - NMC=11			SS-4	7	4	2	3	6
				8.0						
319.5		Loose, wet, greenish gray, angular, non-reactive, weakly cemented, fine, Silty SAND (SM) (A-2-4) GLEY 1 10Y 6/1			SS-5	4	6	7	6	13
	12.0	@SS-4 - NMC=14, %#200=32.4								
		Medium dense, wet, greenish gray, non-reactive, weakly cemented, fine, Silty SAND (SM) (A-2-4) GLEY 1 10Y 6/1		13.5	SS-6	5	4	5		9
314.5		@SS-5 - NMC=13, %#200=28.6, LL=NP, PL=NP, PI=NP								
	17.0	Loose, wet, mottled, angular to subangular, non-reactive, weakly cemented, coarse, GRAVEL (GP) (A-1)								
		Loose, wet, greenish gray, angular, non-reactive, weakly cemented, fine, Silty SAND (SM) (A-2-4) GLEY 10GY 6/1		18.5	SS-7	6	3	7		10
309.5										
	22.0	Very dense, wet, greenish gray, subangular, non-reactive, weakly cemented, fine, Silty SAND (SM) (A-2-4) GLEY 10GY 6/1		23.5	SS-8	11	20	49		69
304.5		@SS-8 - NMC=19, %#200=9.0, LL=36, PL=26, PI=10								
				28.5						
299.5					SS-9	50/2"				50/2"

SPT N VALUE

PL MC LL

FINES CONTENT (%)

0 10 20 30 40 50 60 70 80 90

>>

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	

SCDOT Soil Test Log

Project ID:	P038246			**County:**	Chesterfield	**Boring No.:**	B-1
Site Description:	S-13-138 (Bo Melton Loop) RBO Little Black Creek					**Route:**	S-13-138
Eng./Geo.:	RDS	**Boring Location:**		**Offset:**		**Alignment:**	Main
Elev.:	329.5 ft	**Latitude:**	34.679585	**Longitude:**	-80.229616	**Date Started:**	12/11/2018
Total Depth:	53.6 ft	**Soil Depth:**	33.1 ft	**Core Depth:**	20.5 ft	**Date Completed:**	12/12/2018
Bore Hole Diameter (in):	3	**Sampler Configuration**		**Liner Required:**	Y (N)	**Liner Used:**	Y (N)
Drill Machine:	CME-55/300	**Drill Method:**	RW	**Hammer Type:**	Automatic	**Energy Ratio:**	93.2%
Core Size:	NQ2	**Driller:**	AM	**Groundwater:**	**TOB** N.A.	**24HR**	7 ft

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Graphic Log	Sample Depth (ft)	Sample No./Type	1st 6" / 2nd 6" / 3rd 6" / 4th 6"	N Value	SPT N VALUE / PL MC LL / FINES CONTENT (%)
	33.1	REFUSAL AT 33.1 FEET - SET CASING AND BEGIN CORING		33.0	SS-10	50/1"	50/1"	>>
294.5		SEDIMENTARY SILTSTONE, greenish gray, laminated, fine, fresh, weak rock, B, N, Su, Cl, Pl & Ir, C, Slk & S (10GY 6/1)		33.1	NQ-1			REC=77.5%, RQD=73%
	37.1	@NQ-1: %Rec=77.5%, RQD=73%, GSI=40, RMR-39, 4 min/ft, q_u=2280 psi		37.1				
289.5		SEDIMENTARY SILTSTONE, greenish gray, laminated, fine, fresh, weak rock, B, N to VN, Su, Cl, Pl & St, VC & C, Slk & S (10GY 6/1)			NQ-2			REC=82%, RQD=37%
	42.2	@NQ-2: %Rec=82%, RQD=37%, GSI=35, RMR=38, 4 min/ft, q_u=1150 psi		42.2				
284.5		SEDIMENTARY SILTSTONE, greenish gray, laminated, fine, fresh, weak rock, B and Sh, MW to N, No, N/A, Ir, C & Vc, Slk & S (10GY 6/1)			NQ-3			REC=73%, RQD=21%
		@NQ-3: %Rec=73%, RQD=21%, GSI=35, 3 min/ft						
	47.2			47.2				
279.5		SEDIMENTARY SILTSTONE, greenish gray, laminated, fine, fresh, weak rock, B, N to VN, No, N/A, Pl & Ir, C & Vc, Slk & S (10GY 6/1)			NQ-4			REC=100%, RQD=39%
		@NQ-4: %Rec=100%, RQD=39%, GSI=35, RMR=39, 3 min/ft, q_u=3300 psi						
				52.1				
		@NQ-5: %Rec=100%, RQD=84%, GSI=45, 3 min/ft			NQ-5			REC=100%, RQD=84%
	53.6	BORING TERMINATED AT 53.6 FEET						
274.5								
269.5								

SC_DOT 7318P119E S-13-138 SCDOT.GPJ SCDOT DATA TEMPLATE_01_30_2015.GDT 2/7/19

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	

SCDOT Soil Test Log

Project ID:	P038246			**County:**	Chesterfield	**Boring No.:**	B-2
Site Description:	S-13-138 (Bo Melton Loop) RBO Little Black Creek					**Route:**	S-13-138
Eng./Geo.:	RDS	**Boring Location:**		**Offset:**		**Alignment:**	Main
Elev.:	329.5 ft	**Latitude:**	34.679484	**Longitude:**	-80.229892	**Date Started:**	12/12/2018
Total Depth:	55.4 ft	**Soil Depth:**	35.8 ft	**Core Depth:**	19.6 ft	**Date Completed:**	12/13/2018
Bore Hole Diameter (in):	3	**Sampler Configuration**		**Liner Required:**	Y (N)	**Liner Used:**	Y (N)
Drill Machine:	CME-55/300	**Drill Method:**	RW	**Hammer Type:**	Automatic	**Energy Ratio:**	93.2%
Core Size:	NQ2	**Driller:**	AM	**Groundwater:**	**TOB** N.A.	**24HR**	8.5 ft

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Graphic Log	Sample Depth (ft)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	4th 6"	N Value
	0.0	Existin Roadway								
	0.3	ASPHALT (3 inches)		0.3	SS-1	4	4	6	6	10
	2.0	Loose, moist, pink, angular, non-reactive, weakly cemented, fine to medium, SAND (SW) (A-3) 7.5YR 7/4		2.0	SS-2	4	3	2	2	5
324.5		Loose, moist, grayish brown, angular, non-reactive, weakly cemented, fine to medium, Silty SAND (SM) (A-2-4) 10YR 5/2		4.0	SS-3	2	4	5	6	9
	6.0	@SS-2 - NMC=11, %#200=12.8		6.0	SS-4	3	2	2	2	4
		@SS-3 - NMC=8, %#200=13.4		8.0	SS-5	1	2	2	2	4
319.5		Very loose, moist, grayish brown, angular to subangular, non-reactive, weakly cemented, fine to medium, Silty SAND (SM) (A-2-4) 10YR 5/2								
		@SS-4 - NMC=8								
	12.0			13.5	SS-6	3	3	3		6
314.5		Very loose to loose, wet, brownish yellow, angular, non-reactive, weakly cemented, fine, SAND (SW) (A-3) 10YR 5/3								
				18.5	SS-7	1	1	1		2
309.5										
	22.0									
		Hard, wet, greenish gray, non-reactive, SILT with sand (ML) (A-4(6)) GLEY 1 5G 5/1 to 10GY 6/1		23.5	SS-8	50/4"				50/4"
304.5										
				28.5	SS-9	50/5"				50/5"
		@SS-9 - NMC=19, %#200=76.6, LL=34, PL=26, PI=8								
299.5										

SPT N VALUE

PL MC LL

FINES CONTENT (%)

0 10 20 30 40 50 60 70 80 90

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	

SCDOT Soil Test Log

Project ID:	P038246			**County:**	Chesterfield	**Boring No.:**	B-2
Site Description:	S-13-138 (Bo Melton Loop) RBO Little Black Creek					**Route:**	S-13-138
Eng./Geo.:	RDS	**Boring Location:**		**Offset:**		**Alignment:**	Main
Elev.:	329.5 ft	**Latitude:**	34.679484	**Longitude:**	-80.229892	**Date Started:**	12/12/2018
Total Depth:	55.4 ft	**Soil Depth:**	35.8 ft	**Core Depth:**	19.6 ft	**Date Completed:**	12/13/2018
Bore Hole Diameter (in):	3	**Sampler Configuration**		**Liner Required:**	Y (N)	**Liner Used:**	Y (N)
Drill Machine:	CME-55/300	**Drill Method:**	RW	**Hammer Type:**	Automatic	**Energy Ratio:**	93.2%
Core Size:	NQ2	**Driller:**	AM	**Groundwater:**	**TOB** N.A.	**24HR**	8.5 ft

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Graphic Log	Sample Depth (ft)	Sample No./Type	1st 6" / 2nd 6" / 3rd 6" / 4th 6"	N Value	SPT N VALUE / PL MC LL / FINES CONTENT (%) 0 10 20 30 40 50 60 70 80 90
				33.5	SS-10	50/4"	50/4"	>>
294.5	35.8	REFUSAL AT 35.8 FEET - SET CASING AND BEGIN CORING		35.7	SS-11	50/0"	50/0"	>>
		SEDIMENTARY SILTSTONE, greenish gray, laminated, fine, fresh, weak rock, B, N, No, N/A, Pl & Ir, C, Slk & S (10GY 6/1) @NQ-1: %Rec=96%, RQD=41%, GSI=40, RMR=33, 5 min/ft, q_u=1360 psi		35.8	NQ-1			REC=96%, RQD=41%
289.5	40.8	SEDIMENTARY SILTSTONE, greenish gray, laminated, fine, fresh, weak rock, B, N to VN, No, N/A, Pl, C & VC, Slk & S (10GY 6/1) @NQ-2: %Rec=96%, RQD=43%, GSI=40, RMR=39, 4 min/ft, q_u=2100 psi		40.8	NQ-2			REC=100%, RQD=82%
284.5	45.4	SEDIMENTARY SILTSTONE, greenish gray, laminated, fine, fresh, weak rock, B, N, No, N/A, Pl & Ir, C, Slk & S (10GY 6/1) @NQ-3: %Rec=100%, RQD=40%, GSI=40, 3 min/ft		45.4	NQ-3			REC=100%, RQD=82%
279.5		@NQ-4: %Rec=100%, RQD=55%, GSI=40, RMR=39, 4 min/ft, q_u=2930 psi		50.2	NQ-4			REC=100%, RQD=54%
274.5	55.4	BORING TERMINATED AT 55.4 FEET						
269.5								

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 7318P119E S-13-138 SCDOT.GPJ SCDOT DATA TEMPLATE_01_30_2015.GDT 2/7/19

B-1 NQ-1:33.1-37.1 feet; NQ-2: 37.1-42.2 feet; and NQ-3: 42.2-47.2

B-1 NQ-3: 42.2-47.2 feet cont.; NQ-4: 47.2-52.1 feet; and NQ-5: 52.1-53.6 feet

B-2 NQ-1: 35.8-40.8 feet and NQ-2: 40.8-45.4 feet

B-2 NQ-3: 45.4-50.2 feet and NQ-4: 50.2-55.4 feet

Drill rig on B-1

Drill rig on B-2

APPENDIX B
LABORATORY TESTING

Exhibit B-1 – Laboratory Testing Description
Exhibit B-2 – Summary of Laboratory Data
Laboratory Data Sheets

LABORATORY TESTING DESCRIPTION

The samples collected during the field exploration were taken to our laboratory for additional testing. The laboratory testing program was developed by the SCDOT. Using the provided testing program, the laboratory tests were conducted on selected soil samples from the borings. The test results are presented in this appendix.

The laboratory test results were used to confirm the soil descriptions presented on the boring logs in Appendix A. Laboratory tests were performed in general accordance with the applicable ASTM, AASHTO, SCDOT or other accepted standards.

Selected soil samples obtained from the site were tested for the following engineering properties:

■ Materials Finer Than 75-µm (No. 200) Sieve	AASHTO T11/(ASTM D1140)
■ Liquid Limit, Plastic Limit and Plasticity Index of Soils	AASHTO T89/90/(ASTM D4318)
■ Determination of Moisture Content of Soils	AASHTO T265/(ASTM D2216)
■ Compressive Strength of Rock Cores	AASHTO T226/(ASTM D7012)

Summary of Laboratory Results

BORING ID	Depth (Ft.)	Liquid Limit	Plastic Limit	Plasticity Index	% Fines	Water Content (%)
B-1	0.5 - 2					15
B-1	2 - 4					15
B-1	4 - 6					11
B-1	6 - 8				32.4	14
B-1	8 - 10	NP	NP	NP	28.6	13
B-1	23.5 - 25	36	26	10	9.0	19
B-2	2 - 4				12.8	11
B-2	4 - 6				13.4	8
B-2	6 - 8					8
B-2	28.5 - 30	34	26	8	76.6	19

PROJECT: S-13-138 (Bo Melton Loop) RBO over Little Black Creek

SITE: Chesterfield County

Terracon
521 Clemson Rd
Columbia, SC

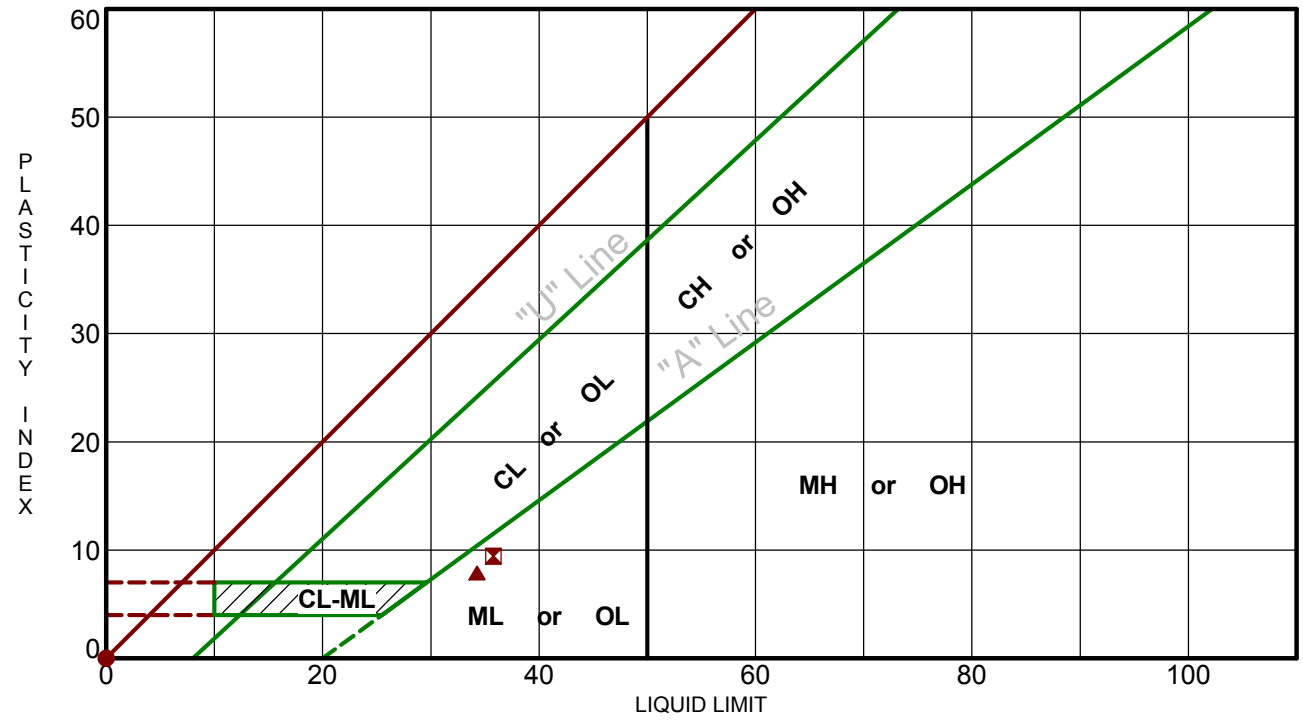
PROJECT NUMBER: 7318P119E

CLIENT: SCDOT
Columbia, SC

EXHIBIT: B-2

ATTERBERG LIMITS RESULTS

ASTM D4318



Boring ID	Depth	LL	PL	PI	Fines	AASHTO	Description
● B-1	8 - 10	NP	NP	NP	29	A-2-4 (0)	SILTY SAND
⊠ B-1	23.5 - 25	36	26	10	9	A-2-4 (0)	SILTY SAND
▲ B-2	28.5 - 30	34	26	8	77	A-4 (6)	SILT with SAND

PROJECT: S-13-138 (Bo Melton Loop) RBO over Little Black Creek

SITE: Chesterfield County

Terracon
521 Clemson Rd
Columbia, SC

PROJECT NUMBER: 7318P119E

CLIENT: SCDOT
Columbia, SC

EXHIBIT: B-3

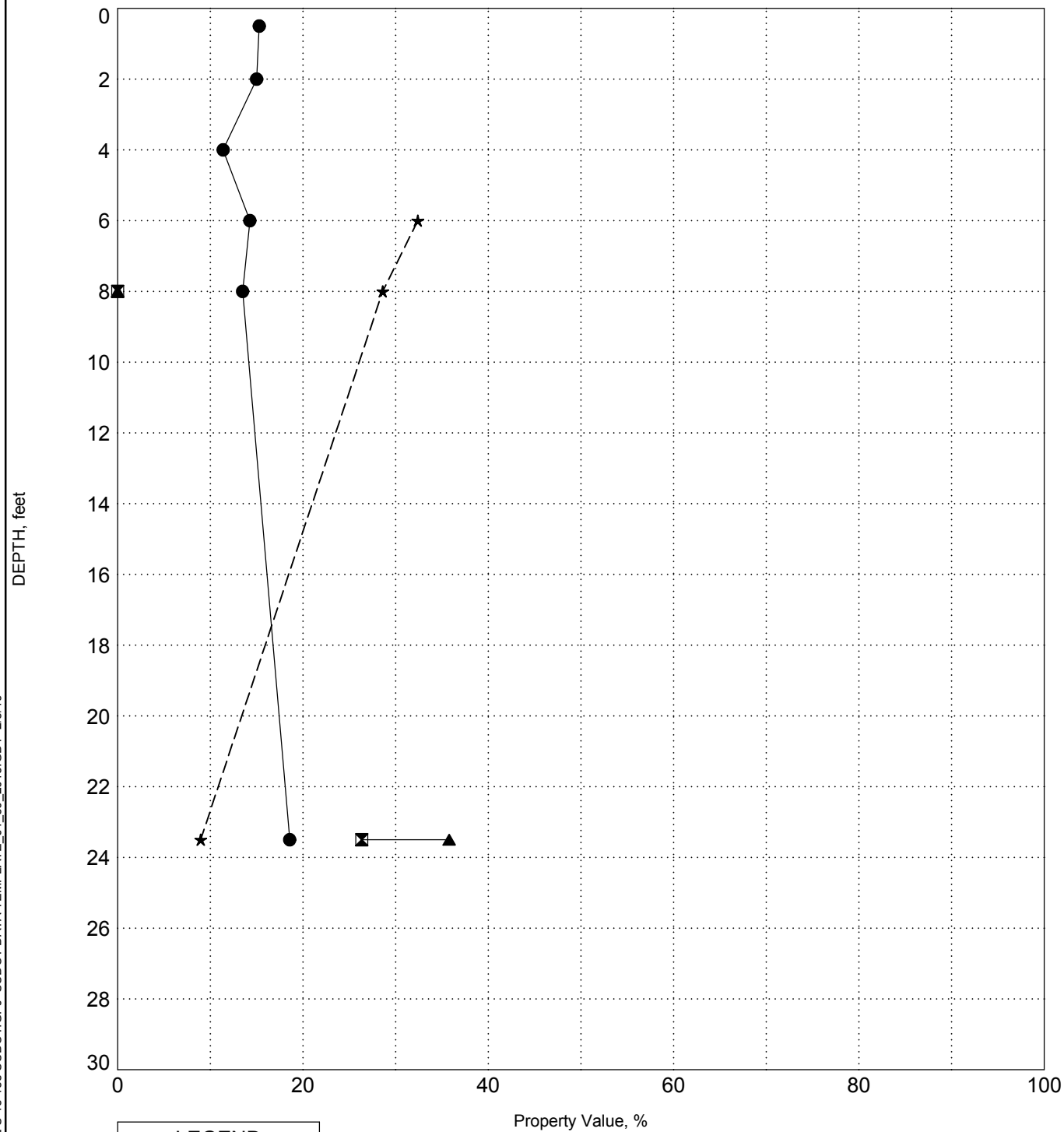
INDEX PROPERTIES VERSUS DEPTH

PROJECT ID P038246 **PROJECT NAME** S-13-138 (Bo Melton Loop) RBO Little Black Creek

PROJECT COUNTY Chesterfield

BORING B-1

SURFACE ELEVATION: 329.5



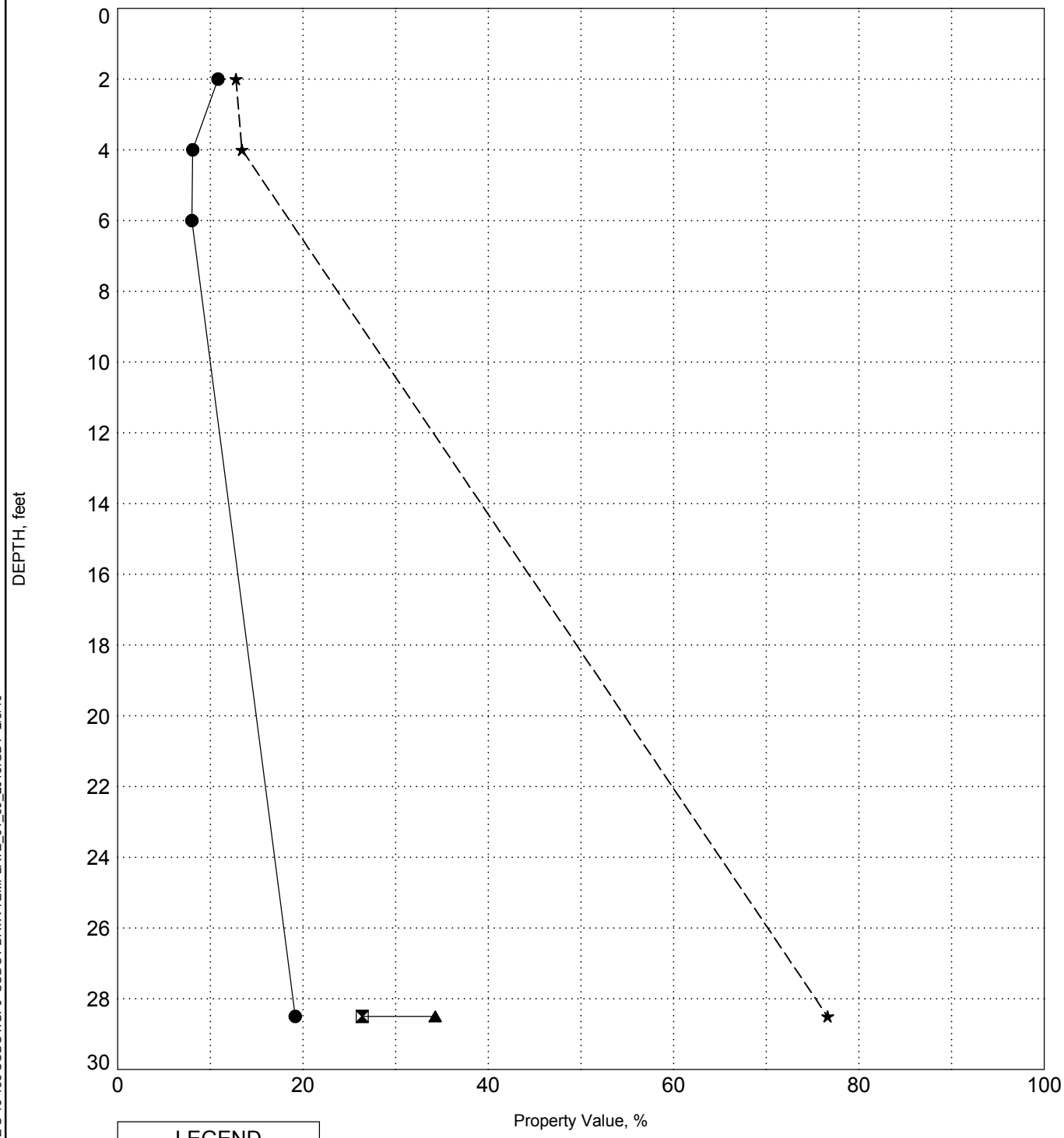
INDEX PROPERTIES VERSUS DEPTH

PROJECT ID P038246 **PROJECT NAME** S-13-138 (Bo Melton Loop) RBO Little Black Creek

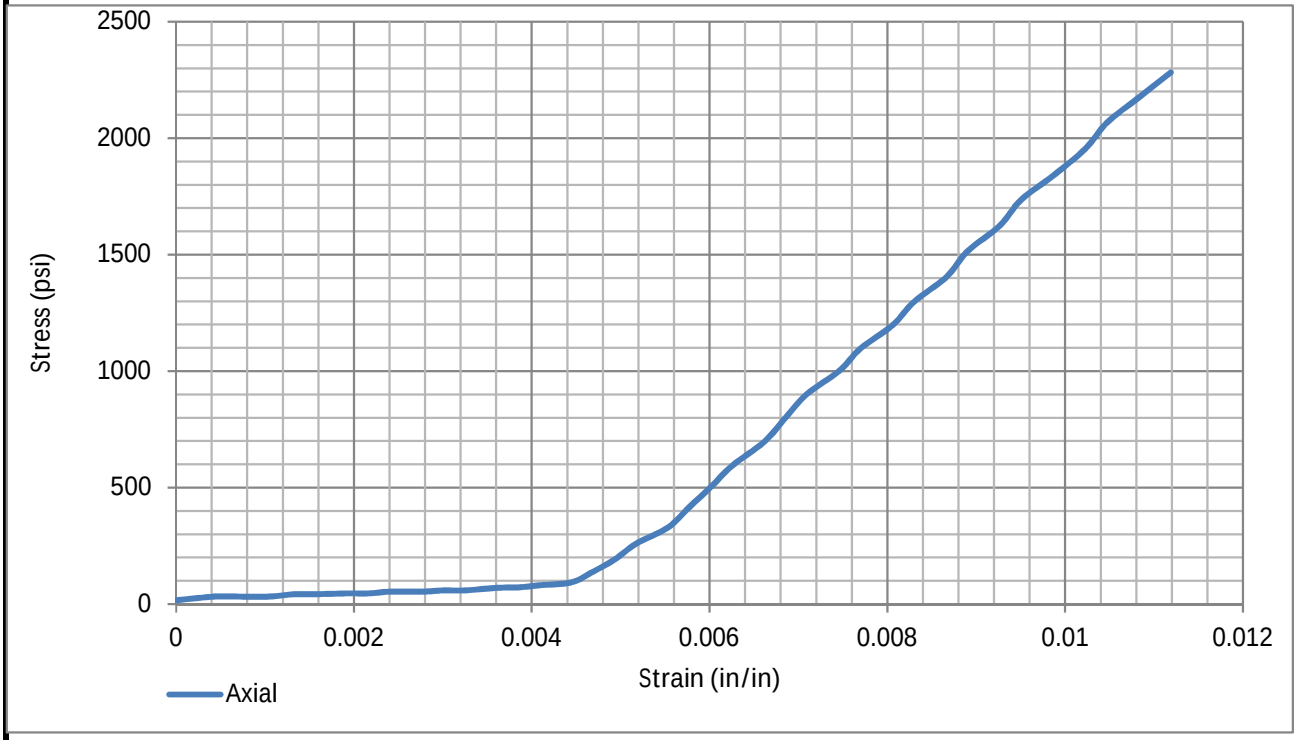
PROJECT COUNTY Chesterfield

BORING B-2

SURFACE ELEVATION: 329.5



COMPRESSIVE STRENGTH AND ELASTIC MODULUS OF INTACT ROCK ASTM D7012

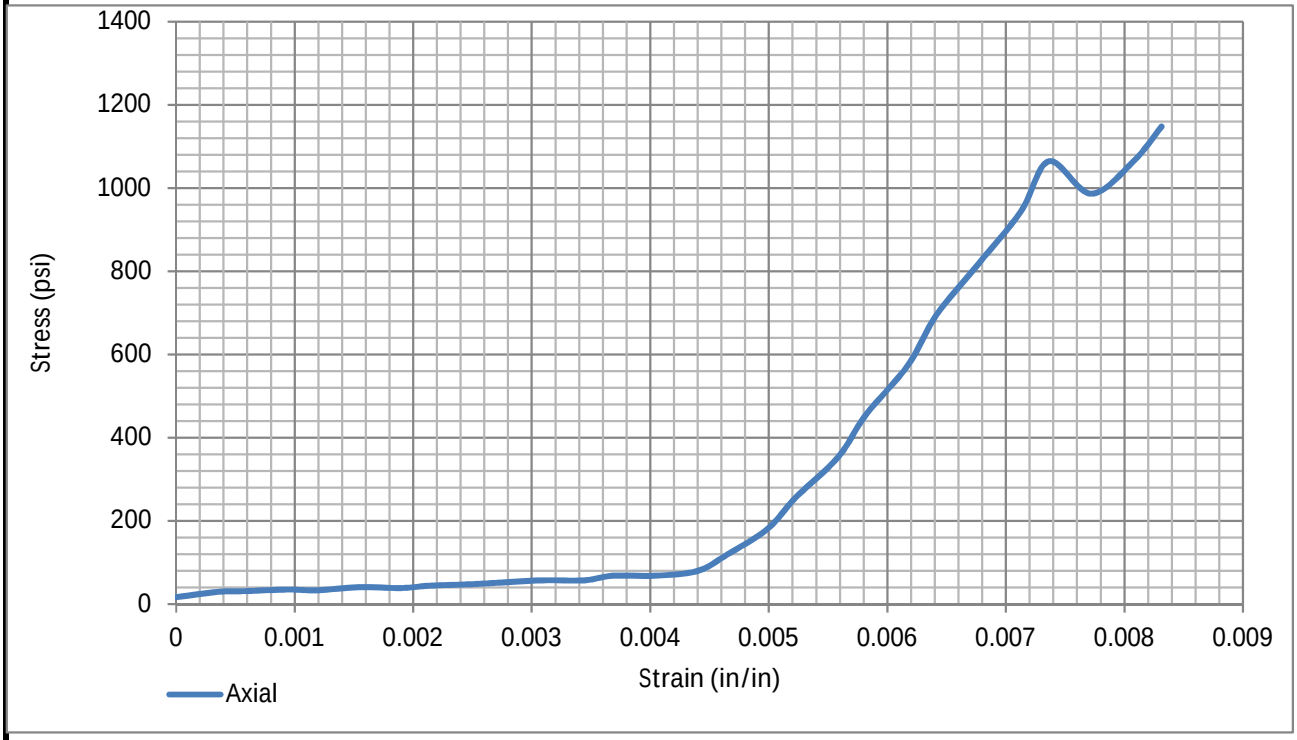


SAMPLE LOCATION			
Site:	S-13-138 RBO Little Black Creek		
Boring:	B-1	Depth (feet):	33.1-37.1
SPECIMEN INFORMATION			
Sample No.:	1	Mass (g):	533.57
Length (in.):	4.18	Diameter (in.):	1.99
L/D Ratio:	2.09	Density (pcf):	155.83
TEST RESULTS			
Failure Load (lbs):			7,127
Failure Strain (%):			1.12
Unconfined Compressive Strength (psi):			2,282
Elastic Modulus, E, (ksi):			
Poisson's Ratio, ν:			

Description:	GRAY SILTSTONE

CLIENT: SCDOT	Terracon Consulting Engineers & Scientists	LAB NO.: 720
PROJECT: Emergency bridge Package 2018-2		DATE TESTED: 1/29/19
		DATE REDUCED: 2/7/2019
PROJECT NO.: 7318119E		EXHIBIT:

COMPRESSIVE STRENGTH AND ELASTIC MODULUS OF INTACT ROCK ASTM D7012

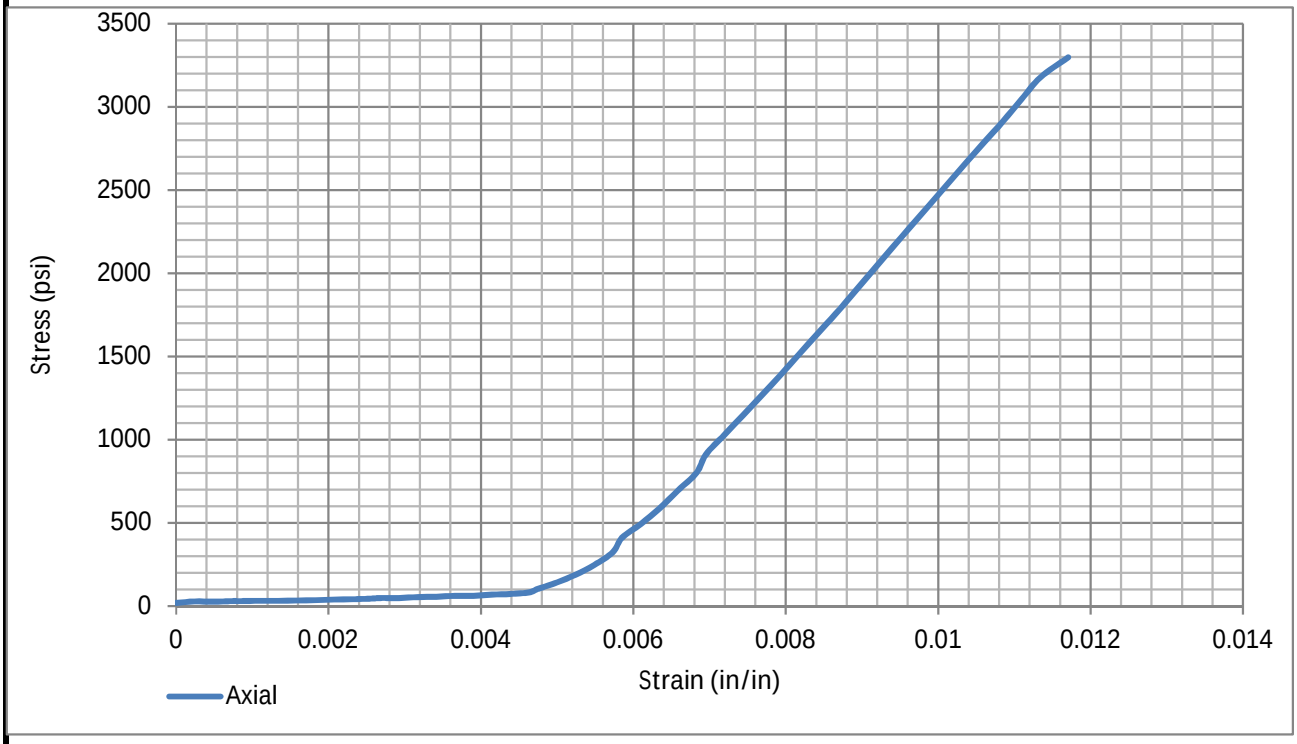


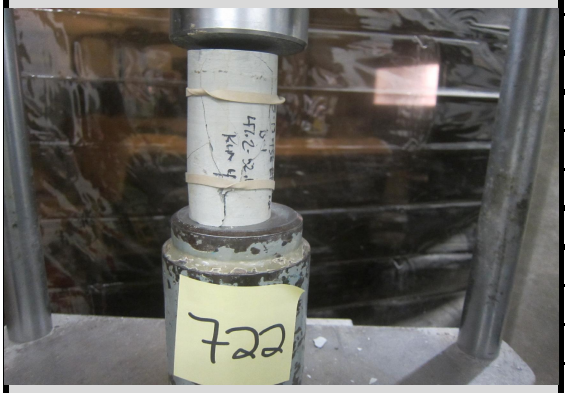
SAMPLE LOCATION			
Site:	S-13-138 RBO Little Black Creek		
Boring:	B-1	Depth (feet):	37.1-42.2
SPECIMEN INFORMATION			
Sample No.:	2	Mass (g):	552.32
Length (in.):	4.23	Diameter (in.):	1.99
L/D Ratio:	2.12	Density (pcf):	159.57
TEST RESULTS			
Failure Load (lbs):			3,578
Failure Strain (%):			0.83
Unconfined Compressive Strength (psi):			1,148
Elastic Modulus, E, (ksi):			
Poisson's Ratio, ν:			

Description:	GRAY SILTSTONE

CLIENT: SCDOT	Terracon Consulting Engineers & Scientists	LAB NO.: 721
PROJECT: Emergency bridge Package 2018-2		DATE TESTED: 1/29/19
		DATE REDUCED: 2/7/2019
PROJECT NO.: 7318119E		EXHIBIT:

COMPRESSIVE STRENGTH AND ELASTIC MODULUS OF INTACT ROCK ASTM D7012



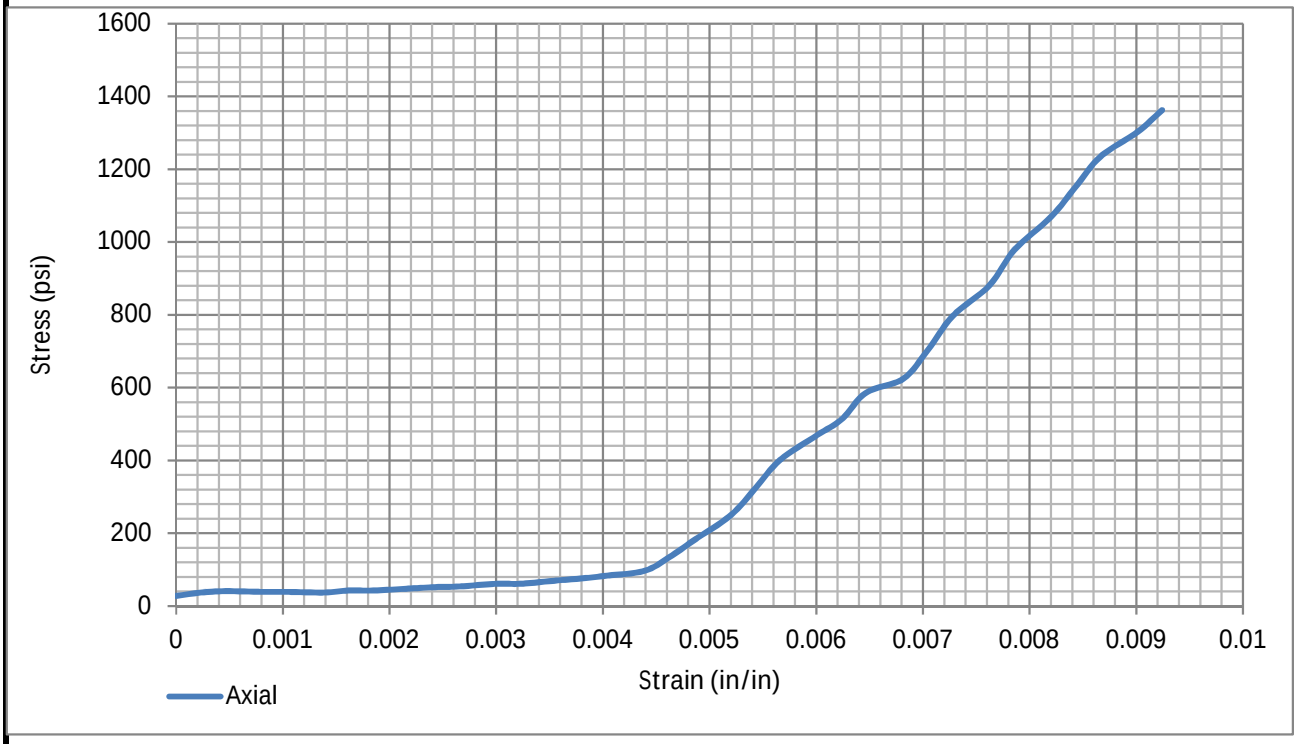


SAMPLE LOCATION			
Site:	S-13-138 RBO Little Black Creek		
Boring:	B-1	Depth (feet):	47.2-52.1
SPECIMEN INFORMATION			
Sample No.:	4	Mass (g):	528.63
Length (in.):	4.12	Diameter (in.):	1.98
L/D Ratio:	2.09	Density (pcf):	159.35
TEST RESULTS			
Failure Load (lbs):			10,113
Failure Strain (%):			1.17
Unconfined Compressive Strength (psi):			3,298
Elastic Modulus, E, (ksi):			
Poisson's Ratio, ν:			

Description:	GRAY SILTSTONE

CLIENT: SCDOT	Terracon Consulting Engineers & Scientists	LAB NO.: 722
PROJECT: Emergency bridge Package 2018-2		DATE TESTED: 1/29/19
		DATE REDUCED: 2/7/2019
PROJECT NO.: 7318119E		EXHIBIT:

COMPRESSIVE STRENGTH AND ELASTIC MODULUS OF INTACT ROCK ASTM D7012

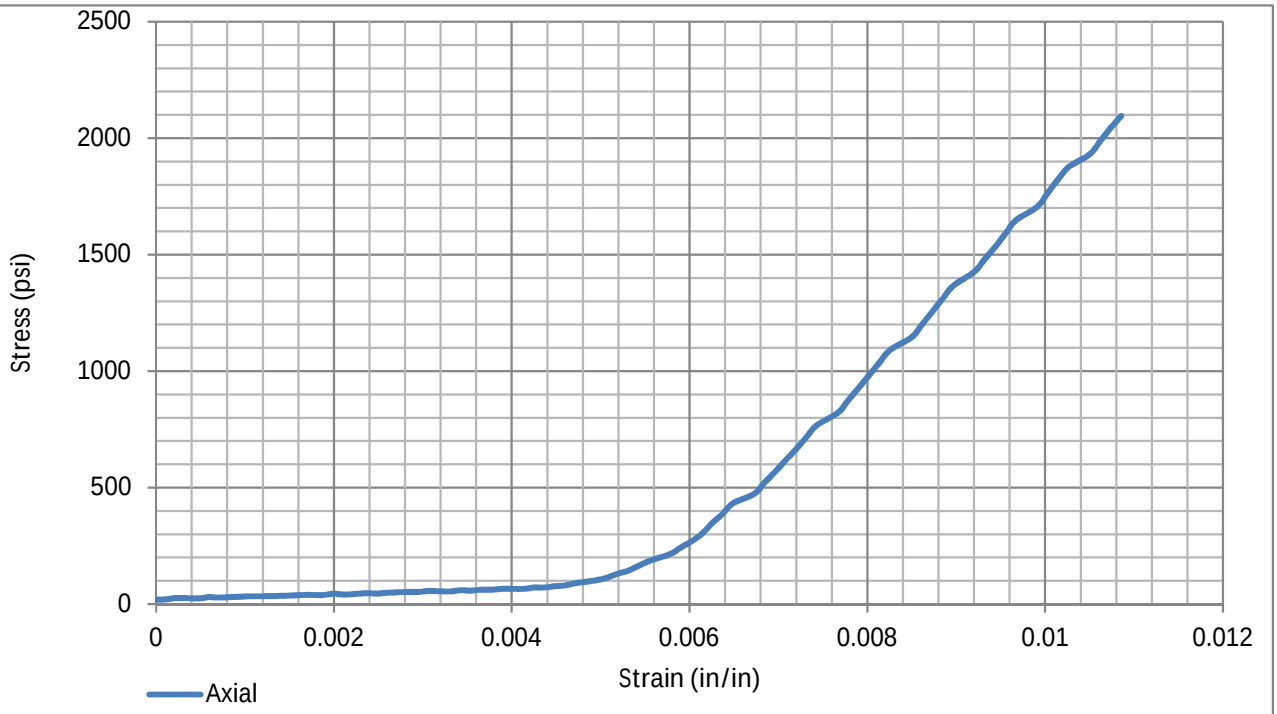


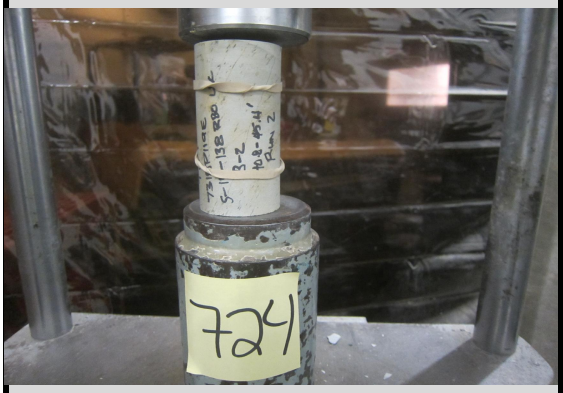
SAMPLE LOCATION			
Site:	S-13-138 RBO Little Black Creek		
Boring:	B-2	Depth (feet):	35.8-40.8
SPECIMEN INFORMATION			
Sample No.:	1	Mass (g):	558.03
Length (in.):	4.35	Diameter (in.):	1.98
L/D Ratio:	2.19	Density (pcf):	158.40
TEST RESULTS			
Failure Load (lbs):			4,203
Failure Strain (%):			0.92
Unconfined Compressive Strength (psi):			1,362
Elastic Modulus, E, (ksi):			
Poisson's Ratio, ν:			

Description:	GRAY SILTSTONE

CLIENT: SCDOT	Terracon Consulting Engineers & Scientists	LAB NO.: 723
PROJECT: Emergency bridge Package 2018-2		DATE TESTED: 1/29/19
		DATE REDUCED: 2/7/2019
PROJECT NO.: 7318119E		EXHIBIT:

COMPRESSIVE STRENGTH AND ELASTIC MODULUS OF INTACT ROCK ASTM D7012



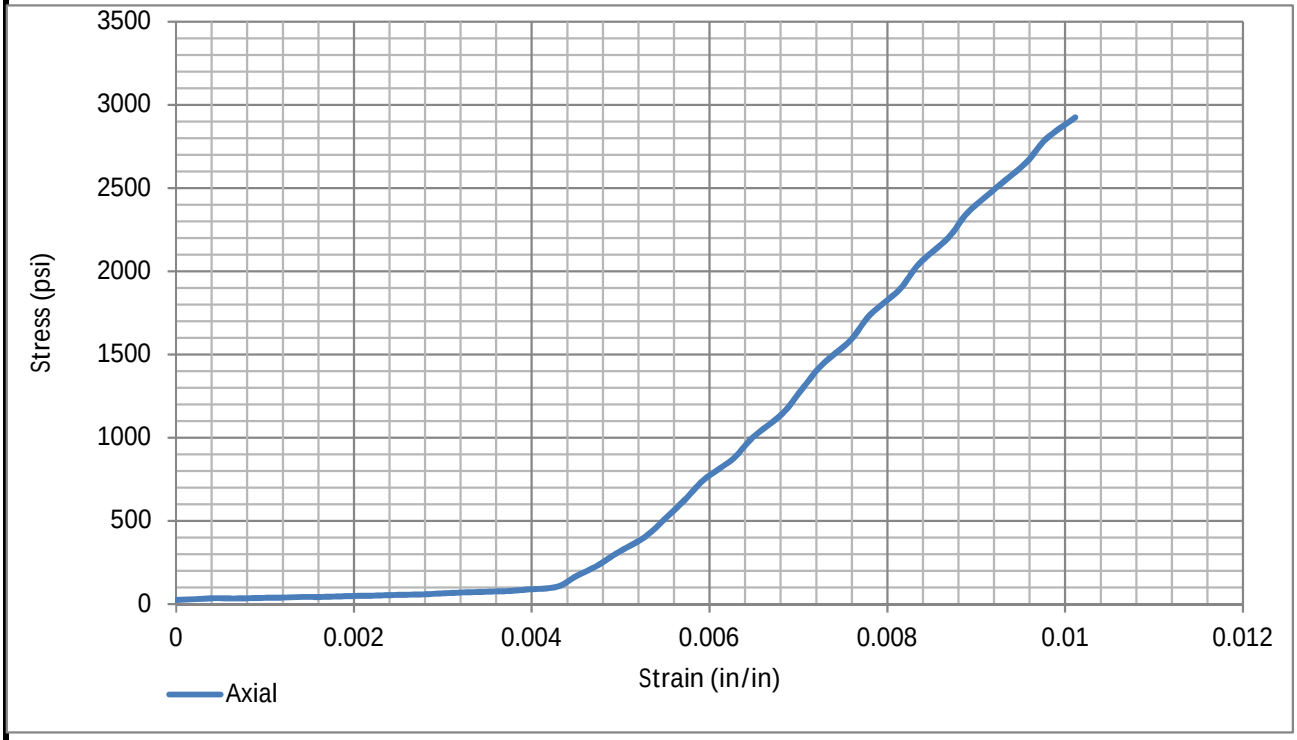


SAMPLE LOCATION			
Site:	S-13-138 RBO Little Black Creek		
Boring:	B-2	Depth (feet):	40.8-45.4
SPECIMEN INFORMATION			
Sample No.:	2	Mass (g):	556.75
Length (in.):	4.26	Diameter (in.):	1.98
L/D Ratio:	2.15	Density (pcf):	161.90
TEST RESULTS			
Failure Load (lbs):			6,444
Failure Strain (%):			1.09
Unconfined Compressive Strength (psi):			2,095
Elastic Modulus, E, (ksi):			
Poisson's Ratio, ν:			

Description:	GRAY SILTSTONE

CLIENT: SCDOT	Terracon Consulting Engineers & Scientists	LAB NO.: 724
PROJECT: Emergency bridge Package 2018-2		DATE TESTED: 1/29/19
		DATE REDUCED: 2/7/2019
PROJECT NO.: 7318119E		EXHIBIT:

COMPRESSIVE STRENGTH AND ELASTIC MODULUS OF INTACT ROCK ASTM D7012



SAMPLE LOCATION			
Site:	S-13-138 RBO Little Black Creek		
Boring:	B-2	Depth (feet):	50.2-55.4
SPECIMEN INFORMATION			
Sample No.:	4	Mass (g):	589.54
Length (in.):	4.57	Diameter (in.):	1.98
L/D Ratio:	2.31	Density (pcf):	160.06
TEST RESULTS			
Failure Load (lbs):			8,979
Failure Strain (%):			1.01
Unconfined Compressive Strength (psi):			2,925
Elastic Modulus, E, (ksi):			
Poisson's Ratio, ν:			

Description:	GRAY SILTSTONE

CLIENT: SCDOT	Terracon Consulting Engineers & Scientists	LAB NO.: 725
PROJECT: Emergency bridge Package 2018-2		DATE TESTED: 1/29/19
		DATE REDUCED: 2/7/2019
PROJECT NO.: 7318119E		EXHIBIT:

APPENDIX C
SUPPORTING DOCUMENTS

Exhibit C-1 – Rig Calibration Documentation

DRILL RIG SPT HAMMER ENERGY CALIBRATION REPORT

Drill Rig Model CME-55 SN 359485
Terracon Drill Rig # 727
September 18, 2018

Prepared for:
Terracon Consultants, Inc.
Columbia, SC

Prepared by:
Terracon Consultants, Inc.
North Charleston, South Carolina

Terracon

September 18, 2018

Terracon Consultants, Inc.
521 Clemson Rd.
Columbia, SC 29229

Attn: Mr. Phillip Morrison, P.E.
P: 803-212-0062
E: pamorrison@terracon.com

Re: SPT Hammer Energy Calibration Report
Terracon Rig # 727, CME-55, SN:359485

Dear Mr. Morrison:

This report provides the Energy Transfer Ration (ETR) for the SPT hammer found on drill rig model CME-55, Drill Rig # 727 (Serial Number 359485).

If you have any questions concerning this report, or if we may be of further service, please contact us.

Sincerely,

Terracon Consultants, Inc.

Ryan Wakeford
Staff Engineer

Susheel R. Kolwalkar, Ph.D., P.E.
Senior Engineer

Zachary J. McIntosh
Field Engineer

SOUTH CAROLINA REGISTERED PROFESSIONAL ENGINEER SUSHEEL R. KOLWALKAR No. 33184 9/18/18

SOUTH CAROLINA TERRACON CONSULTANTS, INC. No. 2220 CERTIFICATE OF AUTHORIZATION

Attachments :

Exhibit A-1: Representative Blow
Exhibit A-2: PDA Equipment Calibrations
Exhibit A-3: SPT Calibration Data Plots and Tables
Exhibit A-4: Field Log

Terracon Consultants, Inc. 1450 Fifth Street West North Charleston, South Carolina 29405
P [843] 884 1234 F [843] 884 9234 terracon.com

Terracon

1.0 PROJECT INFORMATION

ITEM	DESCRIPTION
Drill Rig Identification	CME-55, SN 359485, DR # 727 (see photograph on cover page)
Drill Rig Owner	Terracon
Drill Rig Operator	Will B.
Testing Date	September 17, 2018
Testing Location	Terracon Parking Lot, Columbia, SC
Boring Identification	SB-1
Energy Measurement Depths	28.5 ft.; 33.5 ft.; 38.5 ft.; 43.5 ft.; 48.5 ft.
Hammer Type	Automatic
Boring Method	Hollow Stem Auger
Drill Rods	n AWJ n 1¾" outside diameter n 3/16" wall thickness
SPT Calibration Testing Equipment	n 2 foot AWJ rod instrumented w/ 2 strain gauges and 2 accelerometers n Model PAX Pile Driving Analyzer™ (PDA)
ASTM Methods Used	**ASTM D1586-11** – Standard Test Method for Standard Penetration Test and Split Barrel Sampling of Soils **ASTM D4633-16** – Standard Methods for Energy Measurement for Dynamic Penetrometers
SPT Calibration Personnel	R. Wakeford & Z. McIntosh

2.0 TEST RESULTS

Table 1: SPT Hammer Energy Calibration Testing Summary

Boring	Start Depth[1] (ft)	Rod Length[2] (ft)	Rod Sections[3] 2 ft	5 ft	10 ft	Measured Blow Counts (blows/6 inches) 1st Inc.	2nd Inc.	3rd Inc.	4th Inc.	SPT N_{meas} (bpf)	Soil Type[4]
SB-1	28.5	30.0	0	6	0	6	7	11	-	18	SC
	33.5	35.0	0	7	0	5	6	10	-	16	SC
	38.5	40.0	0	8	0	3	5	6	-	11	SC
	43.5	45.0	0	9	0	5	6	10	-	16	SC
	48.5	50.0	0	10	0	2	6	5	-	11	SC

1. Depth from existing ground surface to start of SPT
2. Total rod length from instrumentation to bottom of sampler
3. Two foot section is instrumented and is located at top of drill rods
4. Soil type provided by Terracon personnel

Drill Rig SPT Hammer Energy Calibration Report
CME-55, SN: 359485, DR # 727 ■ Columbia, SC
September 18, 2018

Terracon

Table 2: Energy Measurement and Analysis Summary

Boring	Start Depth[1] (ft)	SPT N_m (bpf)	No. of Blows[2]	EMX[3] (kip-ft) Max.	Min.	Ave.	Std. Dev.	ETR[3] (%) Ave.	Std. Dev.
SB-1	28.5	18	18	0.34	0.32	0.32	0.005	92.6	1.434
	33.5	16	16	0.33	0.32	0.32	0.004	92.1	1.281
	38.5	11	11	0.34	0.33	0.34	0.006	95.7	1.644
	43.5	16	16	0.34	0.31	0.32	0.009	92.2	2.577
	48.5	11	11	0.34	0.31	0.33	0.008	93.2	2.262
	Average:			**0.34**	**0.31**	**0.33**	**0.006**	**93.2**	**1.840**

1. Boring ID and depth from existing ground surface to start of SPT
2. Number of blows used in energy calibration analysis; limited to measurements recorded during the second and third 6-inch sampling intervals at each depth or during the first increment if refusal were encountered
3. EMX = Maximum Transferred Energy, ETR = Energy Transfer Ratio.

Table 3: Hammer Blow Rate Summary

Boring	Start Depth[1] (ft)	SPT N_{meas} (bpf)	No. of Blows[2]	BPM[3] Max.	Min.	Ave.	Std. Dev.
SB-1	28.5	18	18	54.3	52.8	53.6	0.381
	33.5	16	16	54.8	54.0	54.4	0.236
	38.5	11	11	55.5	53.9	54.5	0.520
	43.5	16	16	55.6	53.4	54.2	0.517
	48.5	11	11	55.2	53.8	54.4	0.469
	Average:			**55.1**	**53.6**	**54.2**	**0.425**

1. Boring ID and depth from existing ground surface to start of SPT.
2. Number of blows used in energy calibration analysis. Limited to measurements recorded during the second and third 6-inch sampling intervals at each depth or during the 1st increment if refusal conditions were encountered.
3. BPM = Blows per minute

3.0 CONCLUSIONS

3.1 Energy Transfer Ratio (ETR) and Hammer Efficiency Correction (CE)

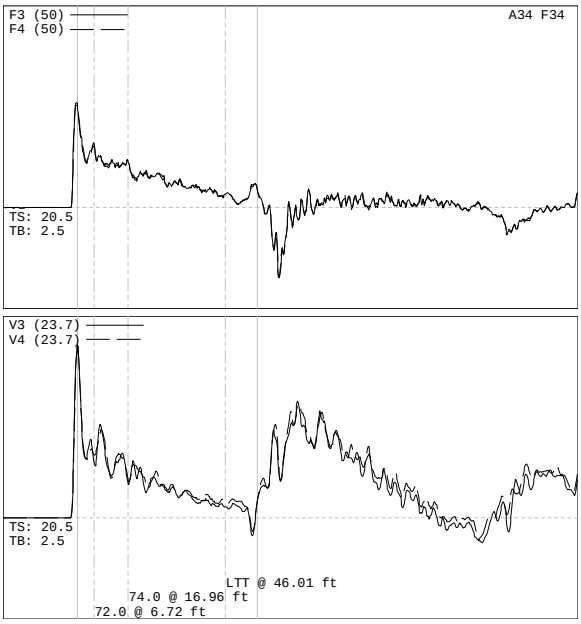
Based on our testing and subsequent analysis, drill rig CME-55 (No. 727) has an **ETR** of **93.2% ± 1.84%.** Based on this ETR, the hammer efficiency correction (C_E) is **1.55**.

Terracon

Exhibit A-1 Representative Blow

Terracon — Pile Driving Analyzer ®

COLUMBIA SPT RIG CAL — CME 55 SERIAL # 359485



Project Information
PROJECT: COLUMBIA SPT RIG CAL
PILE NAME: CME 55 SERIAL # 359485
DESCR: STB-1 48.5-50
OPERATOR: ZM
FILE: CME 55 SERIAL # 359485_6_Log.W01
9/17/2018 11:34:31 AM
Blow Number 11

Pile Properties
LE 53.70 ft
AR 1.18 in^2
EM 30000 ksi
SP 0.492 k/ft3
WS 16807.9 f/s
EA/C 2.1 ksec/ft
2L/C 6.40 ms
JC []
LP 49.80 ft

Quantity Results
ETR 94.9 (%)
CSX 21.8 ksi
CSB 0.0 ksi
BPM 54.3 bpm
EMX 0.332 k-ft
DMX 1.20 in
SFR kips
MEX 728 µE
VMX 20.4 f/s

Sensors
F3: [AWJ 1] 216.53 (1)
F4: [AWJ 2] 216.2 (1)
A3: [K0059] 317 mv/5000g's (1)
A4: [K5418] 382 mv/5000g's (1)
CLIP: OK

Version 2014.118

Drill Rig SPT Hammer Energy Calibration Report
CME-55, SN: 359485, DR # 727 ■ Columbia, SC
September 18, 2018

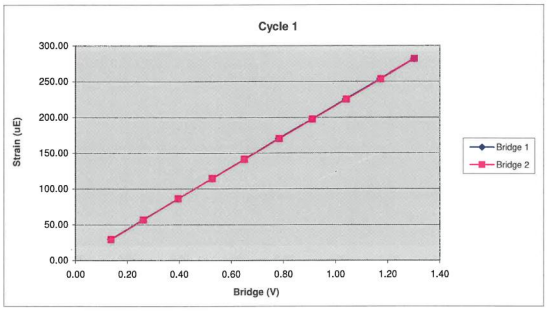
Terracon

Exhibit A-2 PDA Equipment Calibrations

267AWJ		Cycle 1		
Sample	**Force (lb)**	**Strain (µE)**	**Bridge 1 (V)**	**Bridge 2 (V)**
1	0.00	0.00	0.00	0.00
2	1034.65	29.80	0.14	0.14
3	1995.74	57.07	0.26	0.26
4	3021.54	86.56	0.40	0.40
5	4013.51	114.64	0.53	0.53
6	4945.09	141.59	0.65	0.65
7	5967.55	170.38	0.78	0.78
8	6935.72	197.78	0.91	0.91
9	7944.21	225.43	1.04	1.04
10	8935.59	253.69	1.17	1.17
11	9924.61	282.06	1.30	1.30

Bridge 1		**Bridge 2**	
Force Calibration (lb/V)	**7636.82**	**Force Calibration (lb/V)**	**7622.38**
Offset	-7.82	Offset	-11.05
Correlation	0.999996	Correlation	0.999997
Strain Calibration (µE/V)	**216.43**	**Strain Calibration (µE/V)**	**216.02**
Offset	0.60	Offset	0.51
Correlation	0.999996	Correlation	0.999993

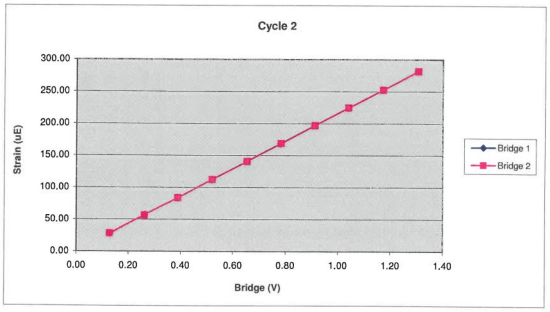
Force Strain Calibration	
EA (Kips)	**35284.30**
Offset	-29.01
Correlation	0.999989



267AWJ		Cycle 2		
Sample	**Force (lb)**	**Strain (µE)**	**Bridge 1 (V)**	**Bridge 2 (V)**
1	0.00	0.00	0.00	0.00
2	979.97	28.37	0.13	0.13
3	2002.82	57.00	0.26	0.26
4	2963.52	84.19	0.39	0.39
5	3965.12	112.62	0.52	0.52
6	4973.02	141.14	0.65	0.65
7	5964.01	169.18	0.78	0.78
8	6938.87	197.15	0.91	0.91
9	7932.41	224.93	1.04	1.04
10	8939.72	253.23	1.17	1.17
11	9962.18	281.86	1.30	1.31

Bridge 1		**Bridge 2**	
Force Calibration (lb/V)	**7634.65**	**Force Calibration (lb/V)**	**7626.42**
Offset	**-9.30**	Offset	**-6.45**
Correlation	**0.999997**	Correlation	**0.999997**
Strain Calibration (µE/V)	**215.81**	**Strain Calibration (µE/V)**	**215.58**
Offset	**0.30**	Offset	**0.38**
Correlation	**0.999997**	Correlation	**0.999996**

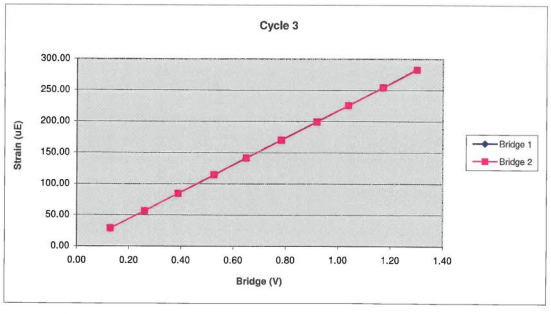
Force Strain Calibration	
EA (Kips)	**35375.85**
Offset	**-19.88**
Correlation	**0.999997**



267AWJ		Cycle 3		
Sample	**Force (lb)**	**Strain (µE)**	**Bridge 1 (V)**	**Bridge 2 (V)**
1	0.00	0.00	0.00	0.00
2	982.53	28.74	0.13	0.13
3	1993.97	56.89	0.26	0.26
4	2965.68	84.76	0.39	0.39
5	4014.49	114.61	0.53	0.53
6	4944.11	141.53	0.65	0.65
7	5962.04	170.43	0.78	0.78
8	6994.93	199.62	0.92	0.92
9	7922.38	225.92	1.04	1.04
10	8918.48	254.51	1.17	1.17
11	9909.26	283.02	1.30	1.30

Bridge 1		**Bridge 2**	
Force Calibration (lb/V)	**7625.63**	**Force Calibration (lb/V)**	**7613.58**
Offset	**-4.78**	Offset	**-1.05**
Correlation	**0.999999**	Correlation	**0.999998**
Strain Calibration (µE/V)	**217.34**	**Strain Calibration (µE/V)**	**217.00**
Offset	**0.23**	Offset	**0.33**
Correlation	**0.999995**	Correlation	**0.999998**

Force Strain Calibration	
EA (Kips)	**35085.96**
Offset	**-12.70**
Correlation	**0.999996**



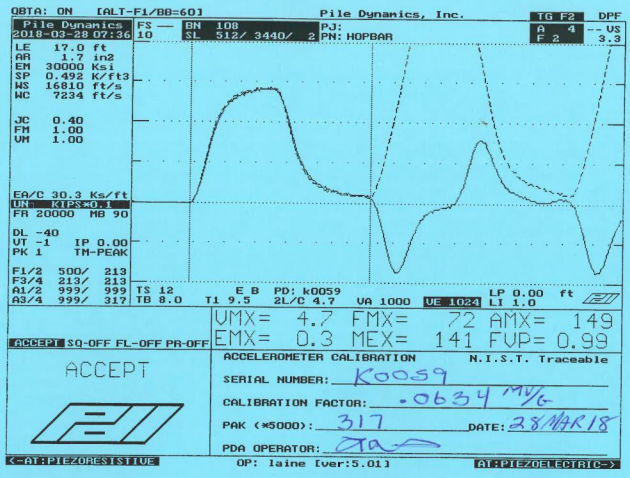
Bridge Excitation (V) 5
Shunt Resitor (ohm) 60.4k

Calibration Factors	**267AWJ**		
Bridge 1 (µE/V)	**216.53**	**Bridge 2 (µE/V)**	**216.20**
EA Factor (Kips)	**35248.70**	**Area (in^2)**	**1.17**

Calibrated by: David Brandt
Calibrated Date: 12/5/2016

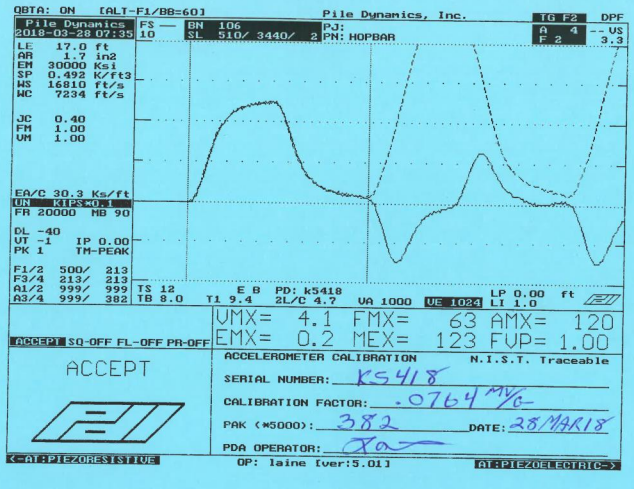
Pile Dynamics Inc
30725 Aurora Rd
Solon, OH 44139

Traceable to N.I.S.T.



Smart Sensor

Smart Chip Programmed By Z.W. **on** 28MAR18 **CRC Value** A7E0

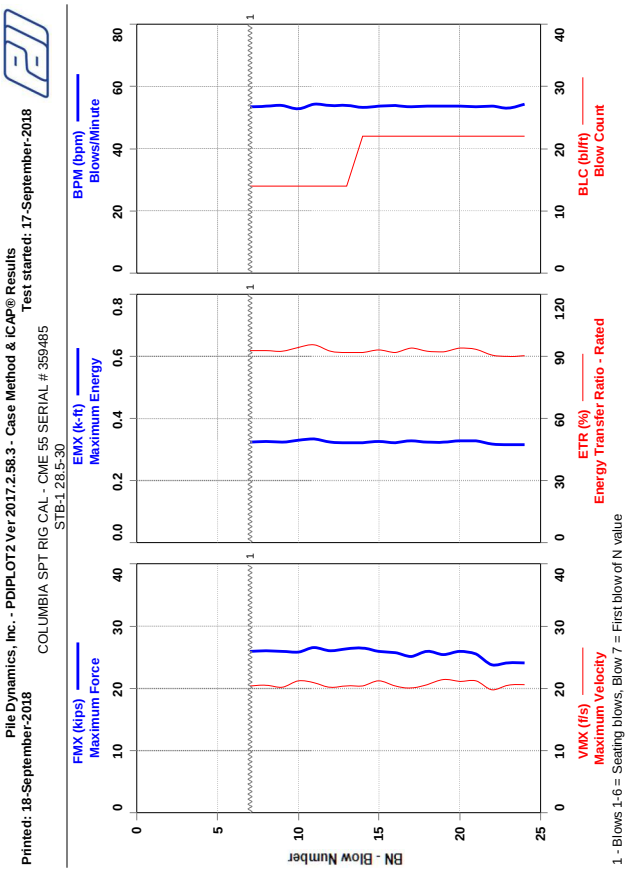


Smart Sensor

Smart Chip Programmed By Z.W. **on** 28MAR18 **CRC Value** 63AE

Terracon

Exhibit A-3 SPT Calibration Data Plots and Tables



COLUMBIA SPT RIG CAL - CME 55 SERIAL # 359485 STB-1 28.5-30
OP: ZM Date: 17-September-2018
AR: 1.18 in² SP: 0.492 k/ft³
LE: 33.70 ft EM: 30,000 ksi
WS: 16,807.9 f/s JC: 0.00

FMX: Maximum Force
VMX: Maximum Velocity
EMX: Maximum Energy
ETR: Energy Transfer Ratio - Rated
BPM: Blows/Minute
DMX: Maximum Displacement
CSX: Compression Stress Maximum

BL#	Depth ft	BLC bl/ft	FMX kips	VMX f/s	EMX k-ft	ETR (%)	BPM bpm	DMX in	CSX ksi
7	29.07	14	26	20.4	0.325	92.7	53.5	0.86	22.0
8	29.14	14	26	20.5	0.325	92.8	53.6	0.86	22.1
9	29.21	14	26	20.2	0.324	92.5	53.9	0.86	22.0
10	29.29	14	26	21.2	0.330	94.4	52.8	0.86	21.9
11	29.36	14	27	20.9	0.335	95.7	54.3	0.87	22.5
12	29.43	14	26	20.2	0.324	92.5	53.8	0.86	22.1
13	29.50	14	26	20.4	0.322	91.9	54.0	0.87	22.4
14	29.55	22	26	20.4	0.322	92.1	53.3	0.67	22.5
15	29.59	22	26	21.2	0.326	93.1	53.6	0.69	22.0
16	29.64	22	26	20.4	0.322	92.1	53.8	0.67	21.8
17	29.68	22	25	20.0	0.329	94.0	53.5	0.69	21.3
18	29.73	22	26	20.6	0.324	92.5	53.7	0.62	22.0
19	29.77	22	25	21.4	0.323	92.4	53.6	0.65	21.6
20	29.82	22	26	21.2	0.329	94.0	53.7	0.65	22.0
21	29.86	22	26	21.2	0.327	93.4	53.4	0.64	21.6
22	29.91	22	24	19.8	0.317	90.7	53.7	0.62	20.2
23	29.95	22	24	20.5	0.315	89.9	53.0	0.59	20.5
24	30.00	22	24	20.6	0.316	90.4	54.3	0.59	20.4
	Average		26	20.6	0.324	92.6	53.6	0.73	21.7
	Std. Dev.		1	0.5	0.005	1.4	0.4	0.11	0.7
	Maximum		27	21.4	0.335	95.7	54.3	0.87	22.5
	Minimum		24	19.8	0.315	89.9	52.8	0.59	20.2

Total number of blows analyzed: 18

BL# Sensors

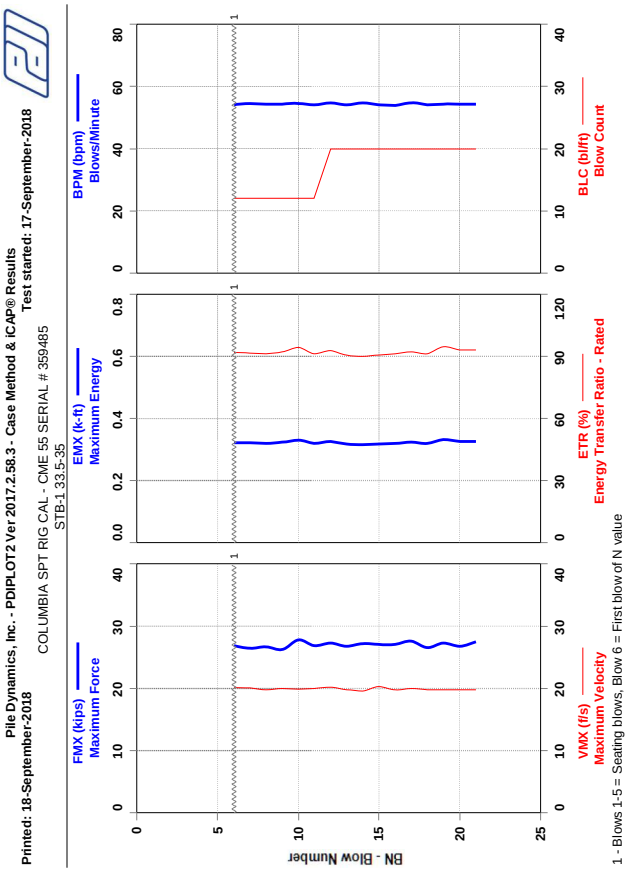
7-24 F3: [AWJ 1] 216.5 (1.00); F4: [AWJ 2] 216.2 (1.00); A3: [K0059] 317.0 (1.00); A4: [K5418] 382.0 (1.00)

BL# Comments

7 Blows 1-6 = Seating blows, Blow 7 = First blow of N value

Time Summary

Drive 25 seconds 10:58 AM - 10:58 AM BN 1 - 24



COLUMBIA SPT RIG CAL - CME 55 SERIAL # 359485 STB-1 33.5-35
OP: ZM Date: 17-September-2018
AR: 1.18 in² SP: 0.492 k/ft³
LE: 38.70 ft EM: 30,000 ksi
WS: 16,807.9 f/s JC: 0.00

FMX: Maximum Force
VMX: Maximum Velocity
EMX: Maximum Energy
ETR: Energy Transfer Ratio - Rated
BPM: Blows/Minute
DMX: Maximum Displacement
CSX: Compression Stress Maximum

BL#	Depth ft	BLC bl/ft	FMX kips	VMX f/s	EMX k-ft	ETR (%)	BPM bpm	DMX in	CSX ksi
6	34.08	12	27	20.1	0.322	92.0	54.2	1.14	22.8
7	34.17	12	26	20.1	0.321	91.7	54.6	1.09	22.4
8	34.25	12	27	19.8	0.320	91.4	54.3	1.05	22.6
9	34.33	12	26	20.0	0.323	92.2	54.4	1.01	22.2
10	34.42	12	28	19.9	0.330	94.3	54.6	1.14	23.6
11	34.50	12	27	20.0	0.320	91.5	54.1	1.00	22.8
12	34.55	20	27	20.2	0.325	92.8	54.7	0.89	23.2
13	34.60	20	27	19.8	0.317	90.7	54.2	0.85	22.7
14	34.65	20	27	19.6	0.315	90.0	54.7	0.81	23.0
15	34.70	20	27	20.3	0.318	90.8	54.2	0.75	22.9
16	34.75	20	27	19.7	0.320	91.3	54.0	0.81	22.9
17	34.80	20	28	20.0	0.323	92.3	54.8	0.77	23.4
18	34.85	20	27	19.8	0.320	91.4	54.2	0.77	22.5
19	34.90	20	27	19.8	0.331	94.7	54.4	0.81	23.1
20	34.95	20	27	19.7	0.327	93.3	54.4	0.74	22.7
21	35.00	20	28	19.7	0.326	93.2	54.4	0.71	23.3
	Average		27	19.9	0.322	92.1	54.4	0.89	22.9
	Std. Dev.		0	0.2	0.004	1.2	0.2	0.15	0.4
	Maximum		28	20.3	0.331	94.7	54.8	1.14	23.6
	Minimum		26	19.6	0.315	90.0	54.0	0.71	22.2

Total number of blows analyzed: 16

BL# Sensors

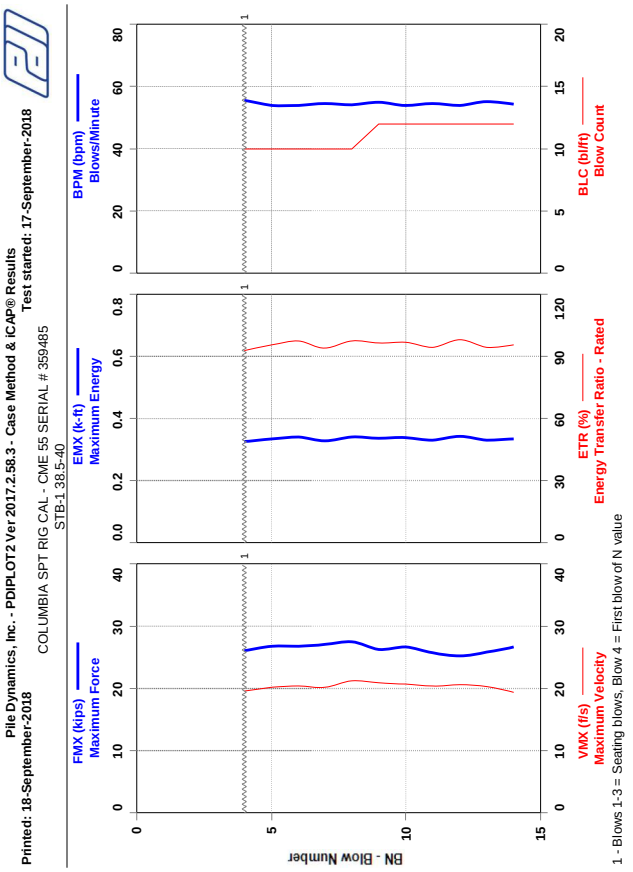
6-21 F3: [AWJ 1] 216.5 (1.00); F4: [AWJ 2] 216.2 (1.00); A3: [K0059] 317.0 (1.00); A4: [K5418] 382.0 (1.00)

BL# Comments

6 Blows 1-5 = Seating blows, Blow 6 = First blow of N value

Time Summary

Drive 22 seconds 11:05 AM - 11:05 AM BN 1 - 21



COLUMBIA SPT RIG CAL - CME 55 SERIAL # 359485 STB-1 38.5-40
OP: ZM Date: 17-September-2018
AR: 1.18 in² SP: 0.492 k/ft³
LE: 43.70 ft EM: 30,000 ksi
WS: 16,807.9 f/s JC: 0.00

FMX: Maximum Force
VMX: Maximum Velocity
EMX: Maximum Energy
ETR: Energy Transfer Ratio - Rated
BPM: Blows/Minute
DMX: Maximum Displacement
CSX: Compression Stress Maximum

BL#	Depth ft	BLC bl/ft	FMX kips	VMX f/s	EMX k-ft	ETR (%)	BPM bpm	DMX in	CSX ksi
4	39.10	10	26	19.5	0.325	92.9	55.5	1.42	22.0
5	39.20	10	27	20.2	0.334	95.6	54.0	1.30	22.7
6	39.30	10	27	20.4	0.341	97.4	54.0	1.26	22.7
7	39.40	10	27	20.1	0.329	93.9	54.5	1.20	22.9
8	39.50	10	27	21.2	0.341	97.6	54.2	1.20	23.3
9	39.58	12	26	20.9	0.338	96.4	54.9	1.04	22.3
10	39.67	12	27	20.7	0.339	96.9	53.9	1.11	22.6
11	39.75	12	26	20.3	0.331	94.5	54.5	1.11	21.8
12	39.83	12	25	20.6	0.343	98.0	54.0	1.17	21.4
13	39.92	12	26	20.2	0.331	94.5	55.1	1.10	21.9
14	40.00	12	27	19.4	0.334	95.5	54.4	1.12	22.6
	Average		26	20.3	0.335	95.8	54.5	1.18	22.4
	Std. Dev.		1	0.5	0.006	1.6	0.5	0.10	0.5
	Maximum		27	21.2	0.343	98.0	55.5	1.42	23.3
	Minimum		25	19.4	0.325	92.9	53.9	1.04	21.4

Total number of blows analyzed: 11

BL# Sensors

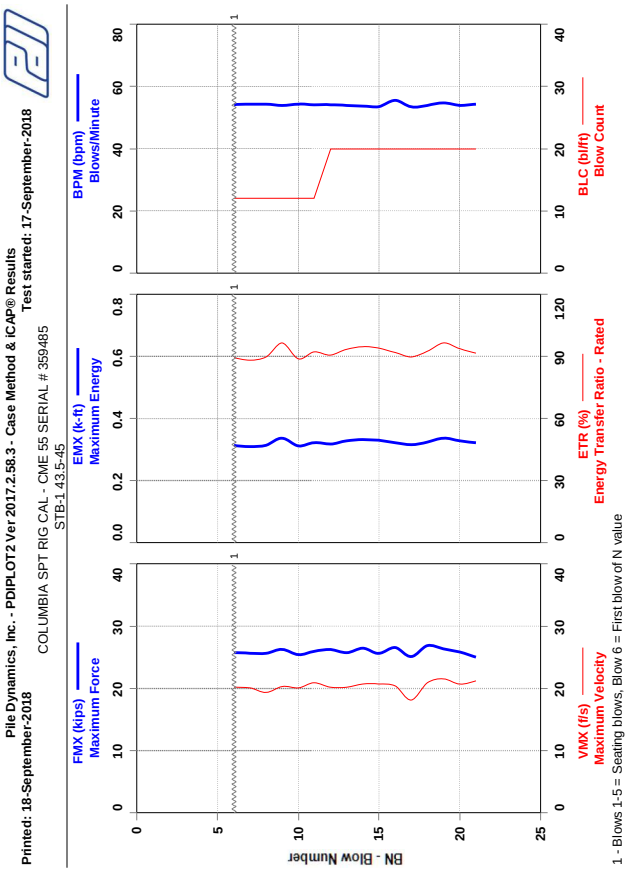
4-14 F3: [AWJ 1] 216.5 (1.00); F4: [AWJ 2] 216.2 (1.00); A3: [K0059] 317.0 (1.00); A4: [K5418] 382.0 (1.00)

BL# Comments

4 Blows 1-3 = Seating blows, Blow 4 = First blow of N value

Time Summary

Drive 14 seconds 11:14 AM - 11:14 AM BN 1 - 14



COLUMBIA SPT RIG CAL - CME 55 SERIAL # 359485 STB-1 43.5-45
OP: ZM Date: 17-September-2018
AR: 1.18 in² SP: 0.492 k/ft³
LE: 48.70 ft EM: 30,000 ksi
WS: 16,807.9 f/s JC: 0.00

FMX: Maximum Force
VMX: Maximum Velocity
EMX: Maximum Energy
ETR: Energy Transfer Ratio - Rated
BPM: Blows/Minute
DMX: Maximum Displacement
CSX: Compression Stress Maximum

BL#	Depth ft	BLC bl/ft	FMX kips	VMX f/s	EMX k-ft	ETR (%)	BPM bpm	DMX in	CSX ksi
6	44.08	12	26	20.2	0.313	89.4	54.2	1.01	21.9
7	44.17	12	26	20.1	0.309	88.2	54.3	1.00	21.8
8	44.25	12	26	19.3	0.314	89.8	54.3	1.00	21.7
9	44.33	12	26	20.3	0.338	96.4	53.9	1.20	22.3
10	44.42	12	25	20.1	0.311	88.8	54.4	1.00	21.5
11	44.50	12	26	20.9	0.323	92.2	54.1	1.00	22.0
12	44.55	20	26	20.2	0.318	90.7	54.2	0.79	22.2
13	44.60	20	26	20.2	0.327	93.5	54.0	0.93	21.8
14	44.65	20	26	20.7	0.332	94.8	53.7	0.77	22.4
15	44.70	20	26	20.7	0.329	94.0	53.5	0.78	21.7
16	44.75	20	27	20.4	0.322	92.0	55.6	0.72	22.5
17	44.80	20	25	18.1	0.315	89.9	53.4	0.69	21.3
18	44.85	20	27	20.9	0.323	92.4	54.0	0.62	22.8
19	44.90	20	26	21.6	0.338	96.6	54.8	0.75	22.3
20	44.95	20	26	20.7	0.328	93.7	54.0	0.70	21.9
21	45.00	20	25	21.3	0.321	91.6	54.4	0.65	21.2
	Average		26	20.4	0.322	92.1	54.2	0.85	22.0
	Std. Dev.		1	0.8	0.009	2.5	0.5	0.16	0.4
	Maximum		27	21.6	0.338	96.6	55.6	1.20	22.8
	Minimum		25	18.1	0.309	88.2	53.4	0.62	21.2

Total number of blows analyzed: 16

BL# Sensors

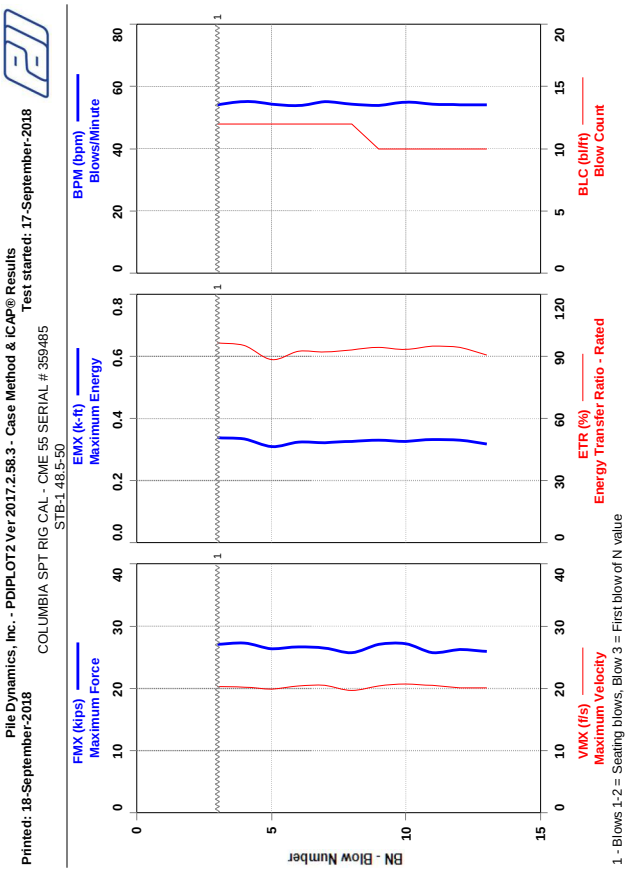
6-21 F3: [AWJ 1] 216.5 (1.00); F4: [AWJ 2] 216.2 (1.00); A3: [K0059] 317.0 (1.00); A4: [K5418] 382.0 (1.00)

BL# Comments

6 Blows 1-5 = Seating blows, Blow 6 = First blow of N value

Time Summary

Drive 22 seconds 11:25 AM - 11:26 AM BN 1 - 21



Pile Dynamics, Inc. Page 1
Case Method & iCAP® Results PDIPLOT2 2017.2.58.3 - Printed 18-September-2018

COLUMBIA SPT RIG CAL - CME 55 SERIAL # 359485 STB-1 48.5-50
OP: ZM Date: 17-September-2018
AR: 1.18 in² SP: 0.492 k/ft³
LE: 53.70 ft EM: 30,000 ksi
WS: 16,807.9 f/s JC: 0.00

FMX: Maximum Force
VMX: Maximum Velocity
EMX: Maximum Energy
ETR: Energy Transfer Ratio - Rated
BPM: Blows/Minute
DMX: Maximum Displacement
CSX: Compression Stress Maximum

BL#	Depth ft	BLC bl/ft	FMX kips	VMX f/s	EMX k-ft	ETR (%)	BPM bpm	DMX in	CSX ksi
3	49.08	12	27	20.3	0.338	96.5	54.1	1.27	22.9
4	49.17	12	27	20.2	0.333	95.3	55.2	1.03	23.1
5	49.25	12	26	19.9	0.310	88.4	54.4	1.00	22.4
6	49.33	12	27	20.4	0.324	92.5	53.8	1.00	22.6
7	49.42	12	26	20.5	0.322	92.1	55.1	1.00	22.4
8	49.50	12	26	19.7	0.326	93.3	54.3	1.03	21.8
9	49.60	10	27	20.4	0.331	94.5	54.0	1.20	22.9
10	49.70	10	27	20.7	0.327	93.4	55.0	1.20	23.0
11	49.80	10	26	20.4	0.332	94.9	54.3	1.20	21.8
12	49.90	10	26	20.1	0.330	94.3	54.2	1.20	22.2
13	50.00	10	26	20.1	0.317	90.6	54.2	1.21	22.0
	Average		27	20.2	0.326	93.2	54.4	1.12	22.5
	Std. Dev.		1	0.3	0.008	2.2	0.4	0.10	0.5
	Maximum		27	20.7	0.338	96.5	55.2	1.27	23.1
	Minimum		26	19.7	0.310	88.4	53.8	1.00	21.8

Total number of blows analyzed: 11

BL# Sensors

3-13 F3: [AWJ 1] 216.5 (1.00); F4: [AWJ 2] 216.2 (1.00); A3: [K0059] 317.0 (1.00); A4: [K5418] 382.0 (1.00)

BL# Comments

3 Blows 1-2 = Seating blows, Blow 3 = First blow of N value

Time Summary

Drive 13 seconds 11:34 AM - 11:34 AM BN 1 - 13

Exhibit A-4 Field Log

Terracon

ARRIVAL TIME: 10:50
DEPART TIME: 19:00
TOTAL TRAVEL: 5 Hours
TOTAL TIME: 7 Hours
CLIENT REP: N/A
MILEAGE: 188

SPT HAMMER CALIBRATION FIELD WORKSHEET

PROJECT NAME: Columbia, SC
PROJECT NO.: N/A
BORING NO.: STB-1
CLIENT: Terracon
DATE: 9.17.18
TERRACON REP: Columbia
PDA MODEL/SN: PAX 3756
TERRACON RIG # DR#: DR 727

DRILL RIG DATA

Type/Transport: Track
Manufacturer: CME-55
Model No.:
Serial No: 359485
Year Built: 2008
Modifications: N/A
Maint. Schedule: As needed

SPT HAMMER DATA

Type: Auto
Manufacturer: CME
Lifting Mechanism: Chain
Model No.: -
Serial No: -
Hammer Weight: 140 lbs
Hammer Operator(s): Will BK Jason

PDA INPUT DATA

Operator:	OP	ZM	Elastic Modulus (ksi):	EM	3000
Project No./Location:	PJ	Columbia, SC	Specific Weight (kips/ft³):	SP	0.492
Rig Model & SN:	PN	CME-55	Wave Speed (ft/sec):	WS	16808
Hammer Type, LM, Rods:	PD	Auto, Chain, AWJ	Increment Length (ft):	LI	0.5
Drill Rod Area (in²):	AR	1.18	Sampling Freq. (kHz):	FR	50

TRANSDUCER INFORMATION

Gage	SN	Calibration
F1/F3:	AWJ-1	516.53
F2/F4:	AWJ-8	516.20
A1/A3:	K0059	317
A2/A4:	K5418	382

NOTES: Instrumentation to Bottom of Rod Length
10.8" Inches = 0.875' Feet
SPLIT SPOON SAMPLER LENGTH 2.83'
Guage to Bottom of Cal. Rod length 3.71' + Rod
[1] LE is Measured from the Center of the Strain Guages to the bottom of Split Spoon Sampler

SPT TESTING INFORMATION

Start Time	Soil	Stick Up Length (ft)	Depth (ft) Start	Depth (ft) End	[1]LE (ft)	Rods & Lengths	PDA Blows Start	PDA Blows End	SPT Blows 1st 6"	SPT Blows 2nd 6"	SPT Blows 3rd 6"	N ~~4th 6"~~
						2ft 5ft 10ft						
~~10:55~~	SC	52.5	23.5	25	28.7	2ft (5ft)x3 10ft	1	39	8	12	18	30
11:00	SC	52.5	28.5	30	33.7	2ft (5ft)x6 10ft	1	25	6	7	11	18
11:07	SC	53.75	33.5	35	38.7	2ft (5ft)x7 10ft	1	22	5	6	10	16
11:16	SC	56	38.5	40	43.7	2ft (5ft)x8 10ft	1	15	3	5	6	11
11:28	SC	58	43.5	45	48.7	2ft (5ft)x9 10ft	4	25	5	6	10	16
11:36	SC	42.5	48.5	50	53.7	2ft (5ft)x10 10ft	2	15	2	6	5	11
						2ft 5ft 10ft						
						2ft 5ft 10ft						

Individual pairs of F or V signals versus time shall be very similar for good quality data.
If you see Force goes negative before 2L/C after impact, drill rod joints should be carefully tightened for good quality data

PICTURE NUMBERS ~~AND INFO: Take~~ Photo of Each Rigs, Boring Locations at the Site
Driling Method: (ie. Hollow Stem Augers, Mud Rotary....)

Terracon SPT Rig Calibration Worksheet.xlsx

Rod OD: 1 7/8"