Geotechnical Subsurface Data Report

SC 49 (Cross Keys Hwy) Bridge Replacement over Tyger River

Union County, SC

March 22, 2023

March 22, 2023

Mr. Trapp Harris, PE, DBIA
Geotechnical Engineer
Alternative Delivery
South Carolina Department of Transportation
955 Park Street
Columbia, SC 29201

Dear Mr. Harris,

We have completed the Geotechnical Subsurface Data Report for the SC 49 (Cross Keys Hwy.) Bridge Replacement over Tyger River in Union County, SC. Please call at your convenience if you have questions or comments. HDR appreciates the opportunity to provide geotechnical engineering services to the South Carolina Department of Transportation.

Sincerely,
HDR

Kiera Hughes

Kiera Hughes, E.I.T.
Engineer-in-Training

SOUTH CAROLINA
LICENSED PROFESSIONAL ENGINEER
No. 24736
03-22-2023
EVANGELIA LEON

SOUTH CAROLINA
HDR ENGINEERING, INC.
OF THE CAROLINAS
No. C0318
CERTIFICATE OF AUTHORIZATION

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1 Introduction

This Geotechnical Subsurface Data Report (GSDR) provides a characterization of the subsurface conditions to the South Carolina Department of Transportation (SCDOT) for the proposed SC 49 Bridge Replacement over Tyger River, in Union County, South Carolina. The proposed bridge intends to replace the existing bridge over Tyger River on Cross Keys Highway.

This Geotechnical Subsurface Data Report was prepared in general accordance with the 2022 SCDOT Geotechnical Design Manual (GDM). Geotechnical data including standard penetration testing (SPT), cone penetration testing (CPT), bulk sampling, rock cores, shear wave velocity measurements, and a variety of laboratory tests are presented herein to provide geological features and site conditions for the design of the proposed bridge. Geotechnical recommendations are not included in this report.

1.1 Project Description

The project site is located northwest of Union, approximately eleven miles southeast of the intersection of SC 49 with Interstate 26. It is bound to the west by Bombing Range Road and to the east by Meadow Woods Rd. A Site Vicinity Map is included in Appendix A.

The existing bridge over Tyger River is approximately 525 feet in length and 48 feet wide and will be removed and replaced with a new bridge along a shifted alignment. The proposed multi span replacement bridge will be approximately 564 feet in length and will accommodate two 12-foot lanes with 10-foot shoulders. Construction is anticipated to be completed with maintenance of traffic on the existing bridge.

2 Investigative Procedures

The geotechnical subsurface exploration at the project site was performed by F&ME Consultants in December 2022. The subsurface investigation consisted of standard penetration test (SPT) borings, rock core samples, bulk sample soil collection, CPTs, and shear wave velocity measurements with MASW testing.

A test location plan showing all testing locations is included in Appendix A. The boring logs, rock core photos, CPT logs, and MASW shear wave velocity profile from the subsurface investigation are included in Appendix B.

2.1 Drilling and Sampling

A total of seven (7) SPT borings were performed during the subsurface investigation, B-35 through B-41. Auger refusal was encountered in all borings at depths ranging between 13.5 feet to 95.0 feet. Advancement of the bridge borings B-36, B-37, B-38, B-39, B-40, and B-41 below auger refusal was accomplished with NQ rock coring techniques. These were terminated at depths of 45.0 feet and 62.8 feet.

The boring logs from the subsurface investigations are included in Appendix B. The borings were advanced by a CME 550X and CME 45B using mud rotary and driven casing drilling techniques. Soil sampling and penetration testing was performed in general accordance with ASTM D-1586 and ASTM D-1587. SPT's were typically conducted continuously in the top 10 feet of each boring followed by 5-foot intervals thereafter until auger refusal was encountered. SPT's were carried out utilizing a standard 1.4-inch I.D., 2-inch O.D, split barrel, or split-spoon sampler. Blow counts recorded at these intervals were produced from SPT hammer with energy ratios of 87.0% and 81.4%. The hammer energy ratios are identified on each boring log. SPT hammer energy measurements on the CME 550X, and CME 45B drill rig were performed with a pile driving analyzer (PDA) and the SPT Hammer Energy Calibration Reports are included in Appendix D.

One (1) bulk sample was obtained at boring BS-4 collectively from 5 feet below the existing ground surface from auger cuttings. The collected rock core samples were evaluated in the field and the percentage of core recovery (REC) and Rock Quality Designation (RQD) were recorded.

Recovered SPT, bulk sample, and rock cores were sent to the F&ME laboratory for testing.

2.2 Cone Penetrometer Testing

Two (2) cone penetrometer tests (CPT-17 and CPT-18) were performed by F&ME Consultants, Inc., one near each end bent of the existing bridge. Upon encountering refusal, the CPTs were terminated at depths of 53.4 feet and 29.1 feet. CPT sounding logs are included in Appendix B.

2.3 MASW Survey

Shear wave velocity measurements were obtained by F&ME Consultants from one (1) Multi-Channel Analysis of Surface Waves, MASW-9, performed on the existing bridge end where boring B-35 was drilled. Active survey data was obtained by a sledgehammer striking an aluminum block and polyethylene block and recording of the resulting vibrations. Passive survey data consisted of the collection of ambient background vibrations resulting from drilling equipment. The resulting shear-wave data from this investigation produced an average shear-wave velocity of 1116.9 ft/sec for the 0 to 100-foot interval. The MASW survey report is included in Appendix B.

2.4 Groundwater Conditions

The stabilized groundwater level recorded approximately 24 hours after completion of investigation operations indicated a groundwater depth of 22.5 feet and 29.1 feet for boring B-35 and B-41, respectively. These depths correspond to elevations 385.4 feet and 378.8 feet.

Groundwater level was recorded at the time of completion of soil drilling and/or rock coring at borings B-35, B-36, B-39, B-40 and B-41 at depths of 18.3 feet, 0.5 feet, 5.1 feet, 0.4 feet, and 28.8 feet. These depths correspond to elevations 389.6 feet, 380.4 feet, 376.9 feet, 380.1 feet, and 379.1 feet. The water level in the river was measured at 25.7 feet and 31.1 feet from the existing bridge deck at the locations of B-37 and B-38. These correspond to elevations of 382.0 feet and 376.6 feet for the river water levels at the time of drilling.

These reported groundwater levels are interpreted to be dependent upon seasonal fluctuations, individual event intensity and/or level of Tyger River.

2.5 Field Testing Summary

The field testing locations and other pertinent information are summarized in Table 2-1 below, and are also plotted on the field test location plan included in Appendix A.

Table 2-1. Field Soil Testing Summary

Test Hole No.	Station[a]	Offset (ft)	Latitude	Longitude	Top of Boring Elevation (ft)	Test Type	Total Depth (ft)
B-35	376+03	43 RT	34.66526	-81.73966	407.9	SPT/RC	95.0
B-36	375+13	42 RT	34.66547	-81.73952	380.9	SPT/RC	48.5
B-37	374+30	42 RT	34.66568	-81.73939	380.4	SPT/RC	58.5
B-38	373+28	43 RT	34.66593	-81.73924	374.2	SPT/RC	45.0
B-39	372+39	43 RT	34.66615	-81.73910	382.0	SPT/RC	52.9
B-40	371+36	42 RT	34.66640	-81.73894	380.5	SPT/RC	62.8
B-41	370+38	42 RT	34.66664	-81.73879	407.9	SPT/RC	61.2
BS-4	376+01	23 RT	34.66524	-81.73960	406.5	BULK	5.0
CPT-17	376+00	43 RT	34.66527	-81.73965	407.7	CPT	53.4
CPT-18	370+35	43 RT	34.66664	-81.73879	408.1	CPT	29.1
MASW-9	near boring B-35					MASW	100.0

[a] Stations based on latest SC 49 alignment.

3 Laboratory Test Program

Laboratory testing was performed by F&ME Consultants on representative samples collected from the geotechnical borings to obtain index and engineering properties. Geotechnical index property testing included natural moisture content, Atterberg limits, #200 wash, and sieve analysis. Engineering property tests included consolidated undrained (CU) triaxial compression, unconfined compression of rock, Standard Proctor, and corrosion series testing.

Laboratory testing was performed in general accordance with ASTM or AASHTO test procedures. Representative samples were classified in accordance with the AASHTO and Unified Soil Classification System (USCS). Table 3-1 summarizes the testing types and quantity of each test performed. For detailed laboratory information, refer to Appendix C.

Table 3-1. Laboratory Testing Summary

Test Type	Quantity
Natural Moisture Content	29
Atterberg Limits	24
Grain Size Analysis with Hydrometer	3
Grain Size Analysis with #200 Wash	4
#200 Wash	21
CU Triaxial	1
Unconfined Compression of Rock	14
Standard Proctor	1
Corrosion Series	1

3.1 Soil and Rock Properties

Split spoon soil samples from the preliminary geotechnical subsurface site exploration for this bridge site were grouped and classified into AASHTO and USCS soil classifications. According to the AASHTO Soil Classification System, the classifications of these samples ranged from A-2-4 to A-7-6. According to the Unified Soil Classification System, the classifications of these samples ranged from silty sand (SM) to sandy lean clay (CL). Tested samples yielded liquid limits ranging from 0 to 52 and plasticity indices ranging from 0 to 29.

Corrosion series test were performed on select split spoon samples. Standard proctor testing and remolded CU triaxial tests were performed on the collected bulk sample. Finally, fourteen (14) unconfined compression tests were performed on recovered rock samples with unconfined strength results ranging from 2,000 psi to 31,520 psi. Results of laboratory testing are included in Appendix C.

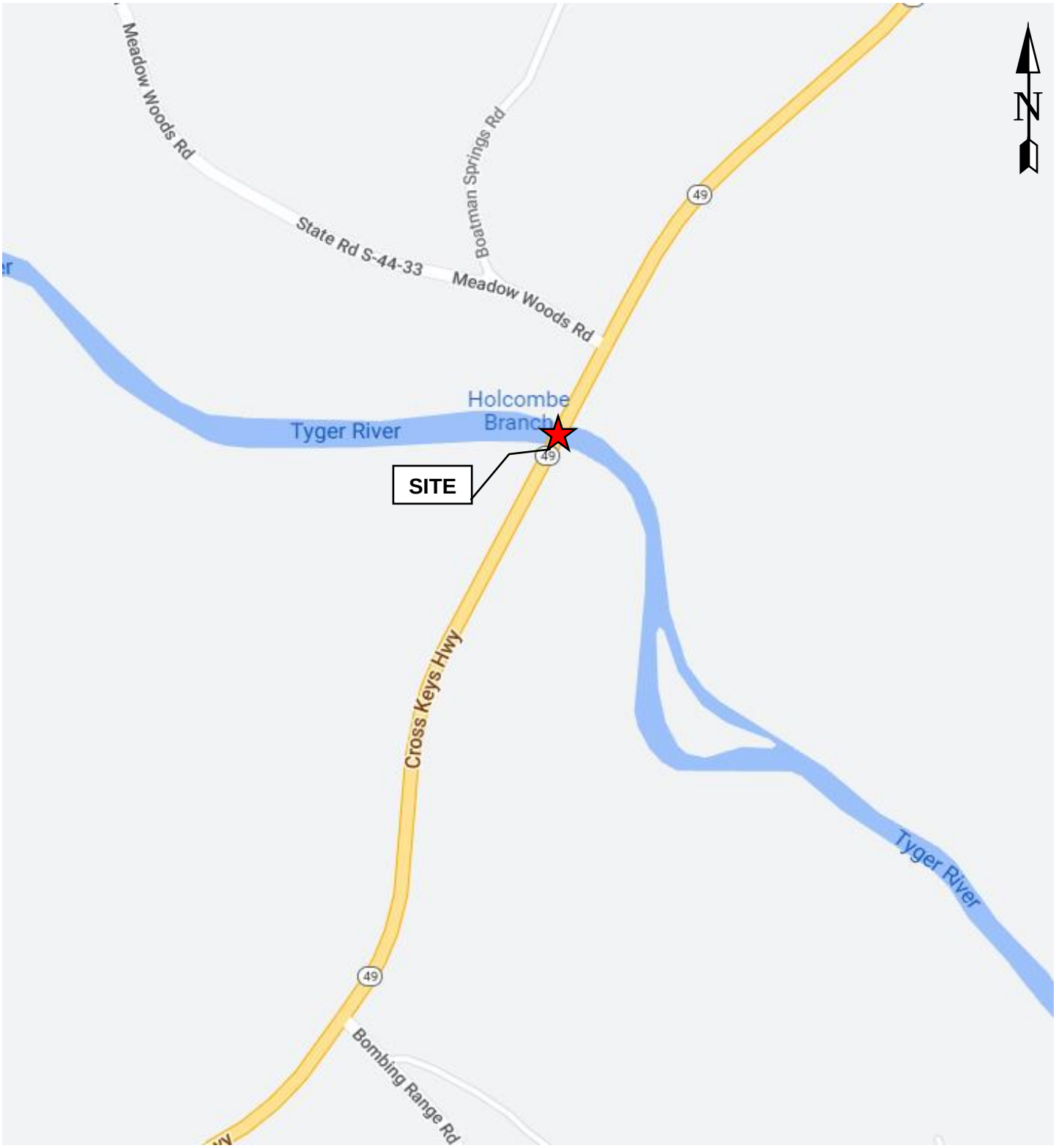
4 Limitations to Report

This report has been prepared for the exclusive use of the South Carolina Department of Transportation or their agent, for specific application to the proposed SC 49 Bridge over Tyger River in Union County, South Carolina in accordance with generally accepted soil and foundation engineering practices. No other warranty expressed or implied is made. 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.

5 References

SCDOT (2022) “Geotechnical Design Manual”, Version 3.0; https://www.scdot.org/business/pdf/geotech/SCDOT-Geotechnical-Design-Manual-2022.pdf

Appendix A. Site Vicinity Map, Test Location Plan



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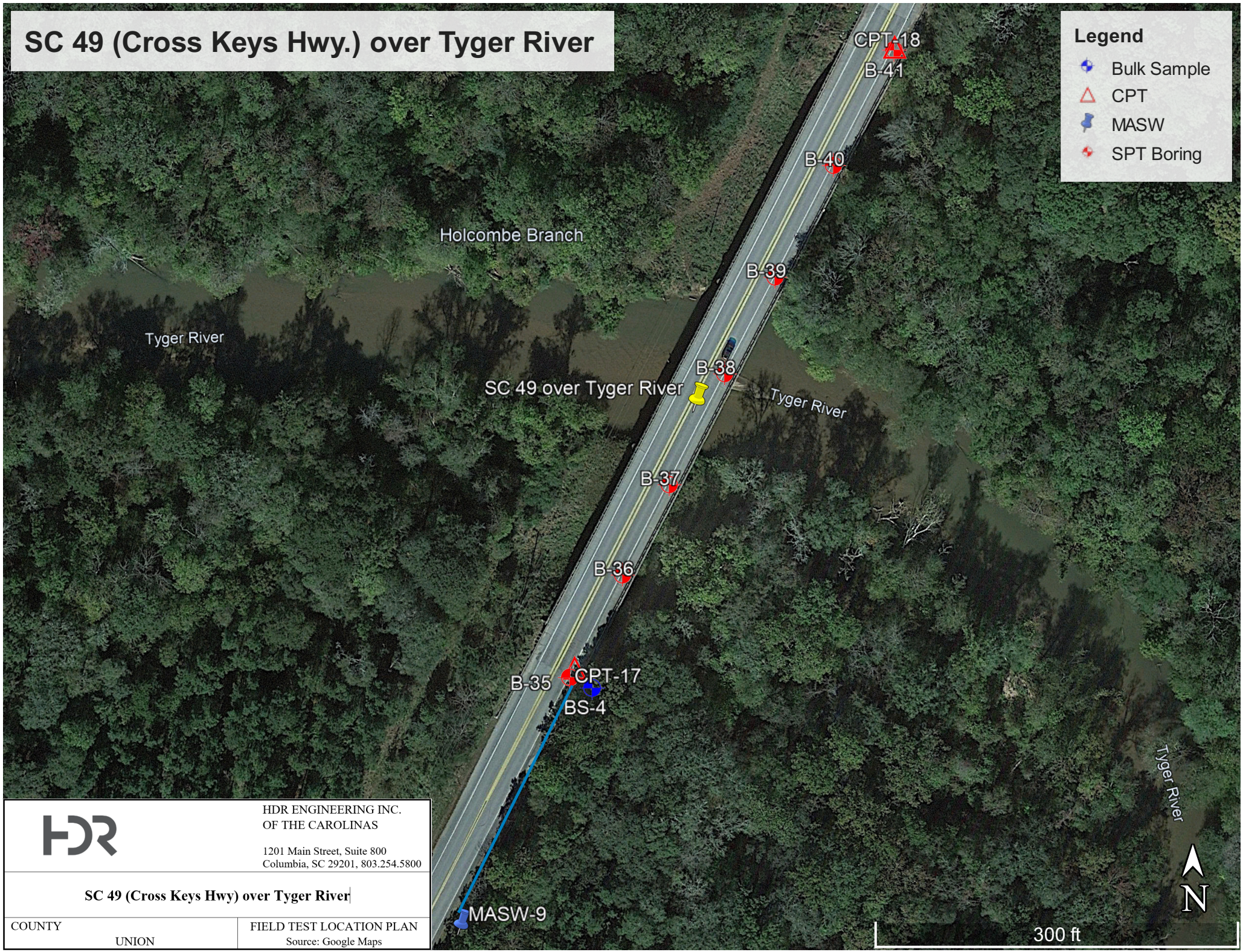
SC 49 (Cross Keys Hwy) over Tyger River

COUNTY	SITE VICINITY MAP
UNION	Source: Google Maps

SC 49 (Cross Keys Hwy.) over Tyger River



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SC 49 (Cross Keys Hwy) over Tyger River

COUNTY	FIELD TEST LOCATION PLAN
UNION	Source: Google Maps

Appendix B. Boring Logs, Rock Core Photos, CPT Logs, MASW Profile

SOIL CLASSIFICATION CHART

MAJOR DIVISIONS			SYMBOLS GRAPH	SYMBOLS LETTER	TYPICAL DESCRIPTIONS
COARSE GRAINED SOILS MORE THAN 50% OF MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE	GRAVEL AND GRAVELLY SOILS MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	CLEAN GRAVELS (LITTLE OR NO FINES)		GW	WELL-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
				GP	POORLY-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
		GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)		GM	SILTY GRAVELS, GRAVEL - SAND - SILT MIXTURES
				GC	CLAYEY GRAVELS, GRAVEL - SAND - CLAY MIXTURES
	SAND AND SANDY SOILS MORE THAN 50% OF COARSE FRACTION PASSING ON NO. 4 SIEVE	CLEAN SANDS (LITTLE OR NO FINES)		SW	WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
				SP	POORLY-GRADED SANDS, GRAVELLY SAND, LITTLE OR NO FINES
		SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)		SM	SILTY SANDS, SAND - SILT MIXTURES
				SC	CLAYEY SANDS, SAND - CLAY MIXTURES
FINE GRAINED SOILS MORE THAN 50% OF MATERIAL IS SMALLER THAN NO. 200 SIEVE SIZE	SILTS AND CLAYS	LIQUID LIMIT LESS THAN 50		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
				OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
	SILTS AND CLAYS	LIQUID LIMIT GREATER THAN 50		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILTY SOILS
				CH	INORGANIC CLAYS OF HIGH PLASTICITY
				OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
HIGHLY ORGANIC SOILS				PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS

NOTE: DUAL SYMBOLS ARE USED TO INDICATE BORDERLINE SOIL CLASSIFICATIONS

SCDOT Soil Test Log Descriptors

a - **Relative Density / Consistency Terms**

Relative Density[1]

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

Consistency[2]

Descriptive Term	Unconfined Compression Strength (q_u) (tsf)	SPT Blow Count
Very Soft	<0.25	<2
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	> 31

b **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

c **Color**

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

d **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

e **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

f **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

g **Particle-Size Range**[1]

Gravel

	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

	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

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

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

Figure 6-15, SCDOT Soil Test Log Descriptors – Soil

SCDOT Soil Test Log Descriptors

k **Rock Type**
Indicate type of rock encountered (i.e. granite, limestone, shale, slate, etc.)

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

m **Texture**
Describe the nonfracture structural features. Stratification is the layering of sedimentary rock and foliation is the layering of metaphoric rock

Descriptive Term	Criteria
Very Thickly Bedded	> 1.0 m
Thickly Bedded	0.5 to 1.0 m
Thinly Bedded	50 to 500 mm
Very Thinly Bedded	10 to 50 mm
Laminated	2.5 to 10 mm
Thinly Laminated	< 2.5 mm

n **Grain Size and Shape**
Describe the size and shape of all visible grains, typically used on sedimentary rock.

Size

Descriptor	mm	Sieve size
Very coarse grained	> 4.75	Grain sizes greater than popcorn kernels
Coarse grained	2.00 – 4.75	Individual grains easy to distinguish by eye
Medium grained	0.425 – 2.00	Individual grains distinguished by eye
Fine grained	0.075 – 0.425	Individual grains distinguished with difficulty
Very Fine grained	< 0.075	Individual grains cannot be distinguished by unaided eye

Shape

Descriptive Term	Criteria
Angular	Shows little wear: edges and corners are sharp
Subangular	Shows definite effects of wear; edges and corners are slightly rounded off
Subrounded	Shows considerable wear; edges and corners are rounded to smooth curves
Rounded	Shows extreme wear; edges and corners are smoother to broad curves
Well-rounded	Completely worn; edges and corners are not present

o **Weathering / Alteration**
Weathering is the physical disintegration of the minerals by atmospheric processes. Alteration is disintegration of the minerals by geothermal processes.

Description	Recognition
Residual Soil	Original minerals of rock have been entirely decomposed to secondary minerals, and original rock fabric is not apparent; material can be easily broken by hand
Completely Weathered / Altered	Original minerals of rock have been almost entirely decomposed to secondary minerals, although the original fabric may be intact; material can be granulated by hand
Highly Weathered / Altered	More than half of the rock is decomposed; rock is weakened so that a minimum 1-7/8 inch diameter sample can be easily broken readily by hand across rock fabric
Moderately Weathered / Altered	Rock is discolored and noticeably weakened, but less than half is decomposed; a minimum 1-7/8 inch diameter sample cannot be broken readily by hand across rock fabric
Slightly Weathered / Altered	Rock is slightly discolored, but not noticeably lower in strength than fresh rock
Fresh	Rock shows no discoloration, loss of strength, or other effect of weathering / alteration

Figure 6-16, SCDOT Soil Test Log Descriptors – Rock

SCDOT Soil Test Log Descriptors

p **Rock Strength**

Provide a qualitative assessment of the rock strength using either a geologic hammer or knife.

Description	Recognition	Approximately Uniaxial Compressive Strength (psi)
Extremely Weak Rock	Can be indented by thumbnail	35 – 150
Very Weak Rock	Can be peeled by pocket knife	150 –700
Weak Rock	Can be peeled with difficulty by pocket knife	700 – 3,500
Medium Strong Rock	Can be indented 3/16 inch with sharp end of pick	3,500 – 7,200
Strong Rock	Requires one hammer blow to fracture	7,200 – 14,500
Very Strong Rock	Requires many hammer blows to fracture	14,500 – 35,000
Extremely Strong Rock	Can only be chipped with hammer blows	> 35,000

q **Strike and Dip**

Dip of fracture surface measured relative to horizontal with bearing and direction (i.e. N30°down, etc.)

r **Discontinuity Type**

F - Fault
J - Joint
Sh - Shear
Fo - Foliation
V - Vein
B - Bedding

s **Discontinuity Width (millimeters)**

W - Wide (12.5 – 50)
MW - Moderately Wide (2.5 – 12.5)
N - Narrow (1.25 – 2.5)
VN - Very Narrow (< 1.25)
T - Tight (0)

t **Amount of Infilling**

Su - Surface Stain
Sp - Spotty
Pa - Partially Filled
Fi - Filled
No - None

u **Type of Infilling**

Cl - Clay
Ca - Calcite
Ch - Chloride
Fe - Iron Oxide
Gy - Gypsum/Talc
H - Healed
No - None
Py - Pyrite
Qz - Quartz
Sd - Sand

v **Surface Shape of Joint**

Wa - Wavy
Pl - Planar
St - Stepped
Ir - Irregular

w **Discontinuity Spacing (feet)**

EW Extremely Wide (> 65)
W Wide (22 – 65)
M Moderate (7.5 – 22)
C Close (2 – 7.5)
VC Very Close (< 2)

x **Roughness of Surface**

Slk - Slickensided (surface has smooth, glassy finish with visual evidence of striations)
S - Smooth (surface appears smooth and feels so to the touch)
SR - Slightly Rough (asperities on the discontinuity surfaces are distinguishable and can be felt)
R - Rough (some ridges and side-angle steps are evident; asperities are clearly visible, and discontinuity surface feels very abrasive
VR - Very Rough (near-vertical steps and ridges occur on the discontinuity surface)

Figure 6-17, SCDOT Soil Test Log Descriptors – Rock (con't)

Appendix B. Subsurface Investigation

Boring Logs

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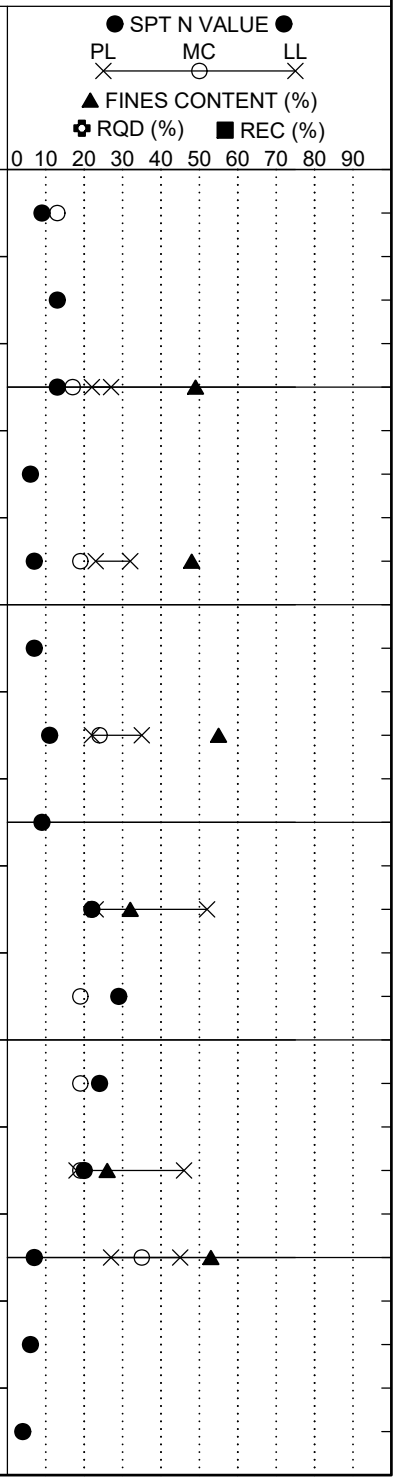
SCDOT Soil Test Log

Project ID:	P041237	**County:**	Union, SC	**Boring No.:**	B-35		
Site Description:	SC 49 over Tyger River			**Route:**	SC 49		
Eng./Geo.:	K. Hughes/HDR	**Boring Location:**	376+03	**Offset:**	43 RT	**Alignment:**	SC 49
Elev.:	407.9 ft	**Latitude:**	34.66526	**Longitude:**	-81.73966	**Date Started:**	12/5/2022
Total Depth:	95 ft	**Soil Depth:**	95 ft	**Core Depth:**	0 ft	**Date Completed:**	12/7/2022
Bore Hole Diameter (in):	2.97	**Sampler Configuration**		**Liner Required:**	Y (N)	**Liner Used:**	Y (N)
Drill Machine:	CME 550X	**Drill Method:**	RW	**Hammer Type:**	Automatic	**Energy Ratio:**	87%
Core Size:		**Driller:**	J. Phillips/F&ME	**Groundwater:**	**TOB** 18.3 ft	**24HR**	22.5 ft

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION
	0.0	
	1.0	1.0' ASPHALT
		ROADWAY FILL - Loose to medium dense, moist, reddish brown, subangular, fine to medium grained, Clayey SAND (SC/A-4) with gravel fragments. 7.5 YR 4/3
	4.0	NMC=13.1
402.9		Medium dense, moist, yellowish brown, subangular, fine to medium grained, Silty SAND (SM/A-4), 10YR 5/4
	6.0	LL=27, PL=22, PI=5, NMC=17.4, %200=48.5
		Loose, wet, reddish brown, yellowish red, subangular, fine to coarse grained, Clayey SAND (SC/A-4). 5YR 5/8, 7.5YR 6/8
397.9		LL=32, PL=23, PI=9, NMC=19.3, %200=47.9
	12.0	
		Stiff, wet, reddish brown, Sandy Lean CLAY (CL/A-6), 5YR 5/8. Contains angular, coarse gravel.
	14.0	LL=35, PL=22, PI=13, NMC=24.0, %200=55.4
392.9		Loose to medium dense, wet, dark brown, reddish brown and reddish orange, subangular, fine to medium grained, Clayey SAND (SC/A-2-7), 5YR 5/6, 5 YR 5/8, 7.5 YR 6/8
		LL=52, PL=23, PI=29, NMC=21.9, %200=32.4
387.9		
		SS-12: LL=46, PL=18, PI=28, NMC=18.7, %200=26.4
	24.0	
382.9		**ALLUVIUM** - Soft to firm, wet, reddish orange, Sandy SILT (ML/A-7-6). 5YR 5/8
		LL=45, PL=27, PI=18, NMC=35.2, %200=52.6
		SS-14: Contains angular, coarse gravel.

Sample Depth (ft)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	4th 6"	N Value
0.0	SS-1	0	0	9	9	9
2.0	SS-2	7	6	7	8	13
4.0	SS-3	7	7	6	7	13
6.0	SS-4	3	3	3	4	6
8.0	SS-5	3	4	3	4	7
10.0	SS-6	2	3	4	4	7
12.0	SS-7	4	5	6	7	11
14.0	SS-8	4	3	6	7	9
16.0	SS-9	5	12	10	19	22
18.0	SS-10	9	10	19	18	29
20.0	SS-11	7	12	12	15	24
22.0	SS-12	9	11	9	11	20
24.0	SS-13	2	3	4	3	7
26.0	SS-14	2	2	4	3	6
28.0	SS-15	2	1	3	1	4
30.0						



LEGEND

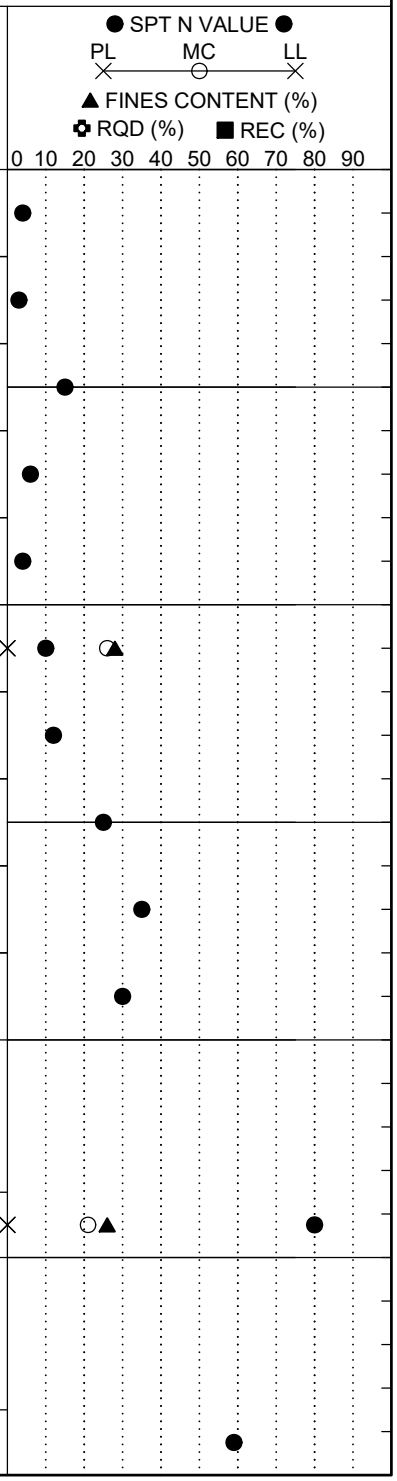
Continued Next Page

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:	P041237	**County:**	Union, SC	**Boring No.:**	B-35
Site Description:	SC 49 over Tyger River			**Route:**	SC 49
Eng./Geo.:	K. Hughes/HDR	**Boring Location:**	376+03	**Offset:**	43 RT
Alignment:	SC 49				
Elev.:	407.9 ft	**Latitude:**	34.66526	**Longitude:**	-81.73966
Date Started:	12/5/2022				
Total Depth:	95 ft	**Soil Depth:**	95 ft	**Core Depth:**	0 ft
Date Completed:	12/7/2022				
Bore Hole Diameter (in):	2.97	**Sampler Configuration**		**Liner Required:**	Y (N)
Liner Used:	Y (N)				
Drill Machine:	CME 550X	**Drill Method:**	RW	**Hammer Type:**	Automatic
Energy Ratio:	87%				
Core Size:		**Driller:**	J. Phillips/F&ME	**Groundwater:**	**TOB** 18.3 ft
24HR	22.5 ft				

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Sample Depth (ft)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	4th 6"	N Value
			32.0	SS-16	2	2	2	2	4
			34.0	SS-17	2	1	2	7	3
	34.0	**RESIDUUM** - Very loose to dense, wet, brown and white, subangular to subrounded, weakly cemented, fine to coarse grained, Silty SAND (SM/A-2-4). 10YR 7/4, N9.5 LL=NP, PL=NP, PI=NP, NMC=25.9, %200=27.6							
372.9			36.0	SS-18	3	7	8	10	15
			38.0	SS-19	3	2	4	6	6
			40.0	SS-20	3	1	3	7	4
367.9			42.0	SS-21	5	5	5	5	10
			44.0	SS-22	3	4	8	11	12
362.9			46.0	SS-23	4	10	15	12	25
			48.0	SS-24	8	15	20	27	35
				SS-25	15	14	16	12	30
357.9									
	52.5	Very dense, wet, greenish gray with brown, subangular, weakly cemented, fine to medium grained, Silty SAND (SM/A-2-4). GLEY1, 5G 3/1, 10YR 5/4 LL=NP, PL=NP, PI=NP, NMC=20.8, %200=25.9	53.5	SS-26	16	30	50		80
352.9									
			58.5	SS-27	16	22	37		59



LEGEND

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

SCDOT Soil Test Log

Project ID:	P041237	**County:**	Union, SC	**Boring No.:**	B-35		
Site Description:	SC 49 over Tyger River			**Route:**	SC 49		
Eng./Geo.:	K. Hughes/HDR	**Boring Location:**	376+03	**Offset:**	43 RT	**Alignment:**	SC 49
Elev.:	407.9 ft	**Latitude:**	34.66526	**Longitude:**	-81.73966	**Date Started:**	12/5/2022
Total Depth:	95 ft	**Soil Depth:**	95 ft	**Core Depth:**	0 ft	**Date Completed:**	12/7/2022
Bore Hole Diameter (in):	2.97	**Sampler Configuration**		**Liner Required:**	Y (N)	**Liner Used:**	Y (N)
Drill Machine:	CME 550X	**Drill Method:**	RW	**Hammer Type:**	Automatic	**Energy Ratio:**	87%
Core Size:		**Driller:**	J. Phillips/F&ME	**Groundwater:**	**TOB** 18.3 ft	**24HR**	22.5 ft

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Sample Depth (ft)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	4th 6"	N Value
			63.5	SS-28	32	50/3.5"			50/3.5"
342.9									
			68.5	SS-29	50/3"				50/3"
337.9									
	72.5	Very dense, wet, brown and white, subangular, weakly cemented, fine to coarse grained, poorly-graded SAND with silt (SP-SM/A-3). 10YR 6/2, N9.5	73.5	SS-30	50/6"				50/6"
332.9									
			78.5	SS-31	50/5.5"				50/5.5"
327.9									
			83.5	SS-32	50/3"				50/3"
322.9									
			88.5	SS-33	50/2"				50/2"

Graphic Log

● SPT N VALUE ●
PL MC LL
▲ FINES CONTENT (%)
✿ RQD (%) ■ REC (%)
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:	P041237	**County:**	Union, SC	**Boring No.:**	B-35
Site Description:	SC 49 over Tyger River			**Route:**	SC 49
Eng./Geo.:	K. Hughes/HDR	**Boring Location:**	376+03	**Offset:**	43 RT
Alignment:	SC 49				
Elev.:	407.9 ft	**Latitude:**	34.66526	**Longitude:**	-81.73966
Date Started:	12/5/2022				
Total Depth:	95 ft	**Soil Depth:**	95 ft	**Core Depth:**	0 ft
Date Completed:	12/7/2022				
Bore Hole Diameter (in):	2.97	**Sampler Configuration**		**Liner Required:**	Y (N)
Liner Used:	Y (N)				
Drill Machine:	CME 550X	**Drill Method:**	RW	**Hammer Type:**	Automatic
Energy Ratio:	87%				
Core Size:		**Driller:**	J. Phillips/F&ME	**Groundwater:**	**TOB** 18.3 ft
24HR	22.5 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 (%) ✿ RQD (%) ■ REC (%) 0 10 20 30 40 50 60 70 80 90
				93.5							
					SS-34	50/0.5"				50/0.5"	>>
312.9	95.0	Boring terminated at 95.0' (Elev. 312.9')									
307.9											
302.9											
297.9											
292.9											

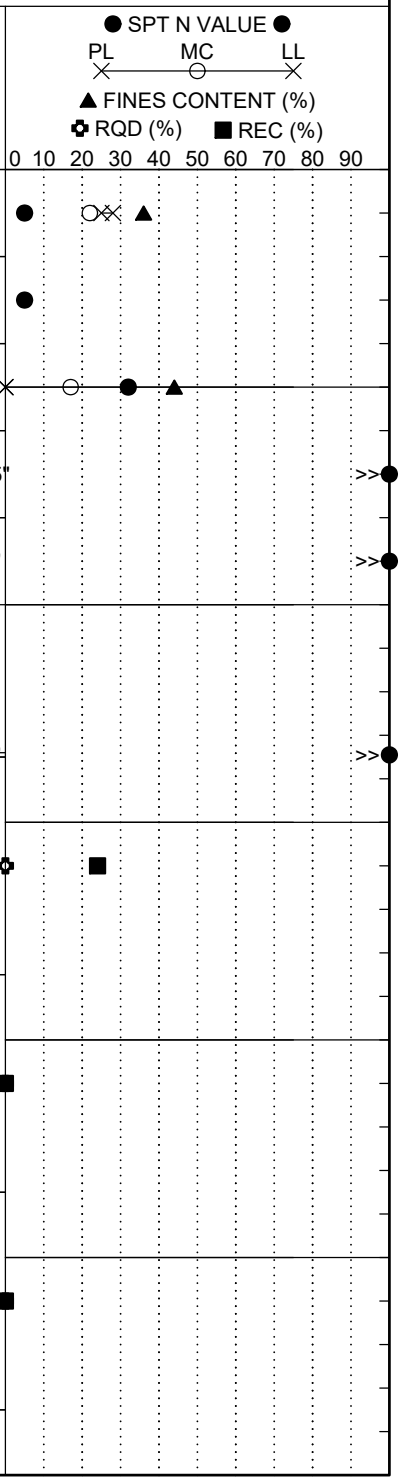
LEGEND

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:	P041237	**County:**	Union, SC	**Boring No.:**	B-36		
Site Description:	SC 49 over Tyger River			**Route:**	SC 49		
Eng./Geo.:	K. Hughes/HDR	**Boring Location:**	375+13	**Offset:**	42 RT	**Alignment:**	SC 49
Elev.:	380.9 ft	**Latitude:**	34.66548	**Longitude:**	-81.73952	**Date Started:**	12/19/2022
Total Depth:	48.5 ft	**Soil Depth:**	13.5 ft	**Core Depth:**	35 ft	**Date Completed:**	12/19/2022
Bore Hole Diameter (in):	2.97	**Sampler Configuration**		**Liner Required:**	Y (N)	**Liner Used:**	Y (N)
Drill Machine:	CME 45B	**Drill Method:**	RW	**Hammer Type:**	Automatic	**Energy Ratio:**	81.4%
Core Size:	NQ	**Driller:**	D. Harris/F&ME	**Groundwater:**	**TOB** 0.5 ft	**24HR**	1.7 ft

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Sample Depth (ft)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	4th 6"	N Value
	0.0	**ALLUVIUM** - Loose, moist to wet, reddish brown and red, subrounded to subangular, fine to coarse grained, Silty SAND (SM/A-4), 5YR 4/4, 5YR 5/8 LL=28, PL=25, PI=3, NMC=22.2, %200=36.0	0.0	SS-1	2	2	3	3	5
			2.0	SS-2	2	2	3	5	5
	4.0	**RESIDUUM** - Dense to very dense, orange to yellowish brown, subrounded to subangular, weakly cemented, fine to coarse grained, Silty SAND (SM/A-4), 7.5YR 6/8, 10YR 7/6 LL=NP, PL=NP, PI=NP, NMC=16.7, %200=44.4	4.0	SS-3	5	15	17	45	32
375.9			6.0	SS-4	27	50/3.5"			50/3.5"
		SS-5: No recovery.	8.0	SS-5	50/2"				50/2"
370.9		SS-6: No recovery. Auger and split-spoon refusal at 13.5' Begin coring.	13.4	SS-6	50/1"				50/1"
	13.5	**QUARTZ FELDSPAR GNEISS** - White, light gray and orange, very fine to fine grained, no foliation, slightly to moderately weathered, medium strong, moderately hard to low hardness rock. Very close joint spacing, very tight to tight, planar, slightly rough. Partially filled existing joints present. NQ-1: %REC=24, RQD=0, GSI=30-35	13.5	NQ-1					
365.9		NQ-2: %REC=0, RQD=0, 1.3 min/ft	18.5	NQ-2					
360.9		NQ-3: %REC=0, RQD=0, 0.7 min/ft	23.5	NQ-3					
355.9									
	28.5	Orange/brown and black, very fine, no foliation, moderately to highly weathered,	28.5						



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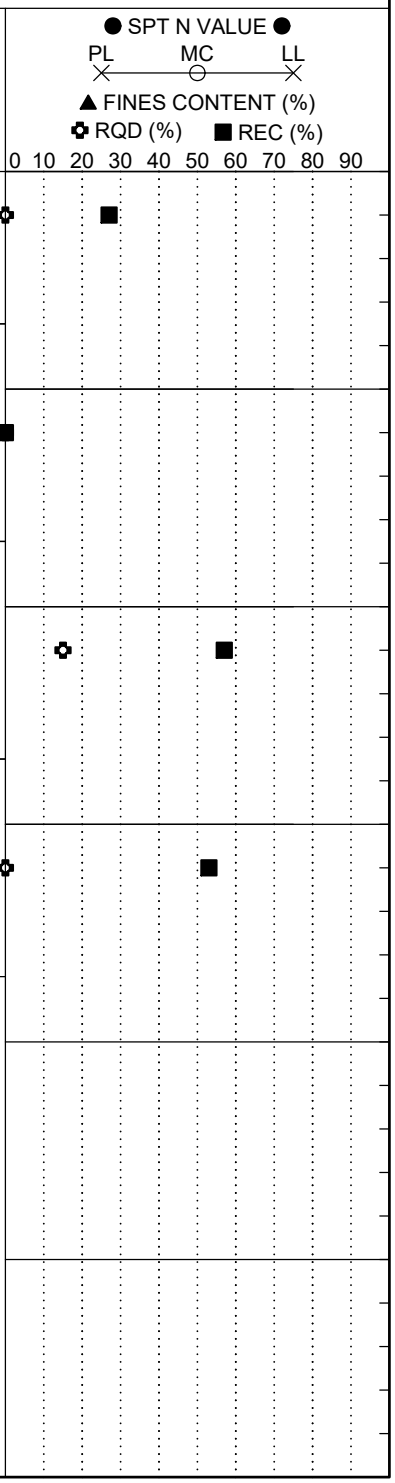
SAMPLER TYPE		DRILLING METHOD	
SS - Split Spoon	NQ - Rock Core, 1-7/8"	HSA - Hollow Stem Auger	RW - Rotary Wash
UD - Undisturbed Sample	CU - Cuttings	CFA - Continuous Flight Augers	RC - Rock Core
AWG - Rock Core, 1-1/8"	CT - Continuous Tube	DC - Driving Casing	

SCDOT Soil Test Log

Project ID:	P041237	**County:**	Union, SC	**Boring No.:**	B-36		
Site Description:	SC 49 over Tyger River			**Route:**	SC 49		
Eng./Geo.:	K. Hughes/HDR	**Boring Location:**	375+13	**Offset:**	42 RT	**Alignment:**	SC 49
Elev.:	380.9 ft	**Latitude:**	34.66548	**Longitude:**	-81.73952	**Date Started:**	12/19/2022
Total Depth:	48.5 ft	**Soil Depth:**	13.5 ft	**Core Depth:**	35 ft	**Date Completed:**	12/19/2022
Bore Hole Diameter (in):	2.97	**Sampler Configuration**		**Liner Required:**	Y (N)	**Liner Used:**	Y (N)
Drill Machine:	CME 45B	**Drill Method:**	RW	**Hammer Type:**	Automatic	**Energy Ratio:**	81.4%
Core Size:	NQ	**Driller:**	D. Harris/F&ME	**Groundwater:**	**TOB** 0.5 ft	**24HR**	1.7 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
		weak to very weak, friable to low hardness rock. Very close joint spacing, tight, planar and irregular, slightly rough to rough. NQ-4: %REC=27, RQD=0, 2.0 min/ft, GSI=20-25 NQ-5: %REC=0, RQD=0, 1.0 min/ft		33.5	NQ-4					
345.9					NQ-5					
	38.5	White, light gray and orange, very fine to fine grained, no foliation, slightly to moderately weathered, medium strong, moderately hard to low hardness rock. Very close joint spacing, very tight to tight, planar, slightly rough. Partially filled existing joints present. NQ-6: %REC=57, RQD=15, 0.8 min/ft, qu=2,000 psi, RMR=42, GSI=30-35		38.5						
340.9					NQ-6					
		Very fine to medium grained, slightly weathered, moderately hard to hard rock. NQ-7: %REC=53, RQD=0, 1.9 min/ft, GSI=35-40		43.5						
335.9					NQ-7					
	48.5	Boring terminated at 48.5' (Elev. 332.4')								
330.9										
325.9										



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

Rock Core Photos

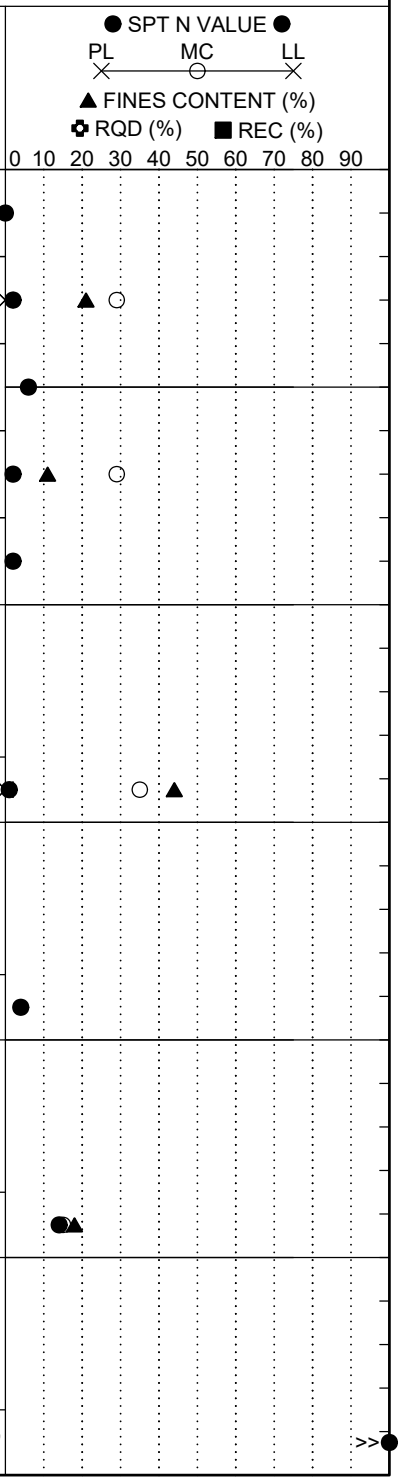
B-36
Box 1 of 2 (13.5’ to 43.5’)

B-36
Box 2 of 2 (43.5’ to 48.5’)

SCDOT Soil Test Log

Project ID:	P041237	**County:**	Union, SC	**Boring No.:**	B-37		
Site Description:	SC 49 over Tyger River			**Route:**	SC 49		
Eng./Geo.:	K. Hughes/HDR	**Boring Location:**	374+30	**Offset:**	42 RT	**Alignment:**	SC 49
Elev.:	380.4 ft	**Latitude:**	34.66568	**Longitude:**	-81.73939	**Date Started:**	12/16/2022
Total Depth:	58.5 ft	**Soil Depth:**	33.5 ft	**Core Depth:**	25 ft	**Date Completed:**	12/16/2022
Bore Hole Diameter (in):	2.97	**Sampler Configuration**		**Liner Required:**	Y (N)	**Liner Used:**	Y (N)
Drill Machine:	CME 45B	**Drill Method:**	RW	**Hammer Type:**	Automatic	**Energy Ratio:**	81.4%
Core Size:	NQ	**Driller:**	D. Harris/F&ME	**Groundwater:**	**TOB** -2 ft	**24HR**	N.M.

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Sample Depth (ft)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	4th 6"	N Value
	0.0	**ALLUVIUM** - Very loose, wet, brown and brownish red, subangular to subrounded, fine to medium grained, Silty SAND (SM/A-2-4), 7.5YR 4/3, 5YR 4/4 LL=NP, PL=NP, PI=NP, NMC=28.8, %200=21.2	0.0	SS-1	WOH	WOH	WOH	WOH	0
			2.0	SS-2	1	1	1	2	2
	4.0	Very loose to loose, wet, brown and brownish red, subangular to subrounded, fine to medium grained, poorly-graded SAND with silt (SP-SM/A-1-b), 7.5YR 4/3, 5YR 4/4 NMC=28.9, %200=10.5	4.0	SS-3	6	5	1	1	6
375.4			6.0	SS-4	WOH	1	1	1	2
			8.0	SS-5	2	1	1	1	2
370.4									
	12.0	Very loose, wet, browish gray, subangular, fine to coarse grained, Silty SAND (SM/A-4), 7.5YR 6/2, 10YR 5/3, 5Y 6/1 LL=NP, PL=NP, PI=NP, NMC=34.9, %200=43.7	13.5	SS-6	1	0	1		1
365.4									
			18.5	SS-7	1	2	2		4
360.4	21.0	**RESIDUUM** - Medium dense to very dense, wet, yellow and gray, subangular, weakly to moderately cemented, fine to coarse grained, Silty SAND (SM/A-2-4), 10YR 7/6, 10YR 5/3, 5Y 6/1 NMC=15.3 , %200=18.3	23.5	SS-8	35	10	4		14
355.4									
			28.5	SS-9	50/4"				50/4"



LEGEND

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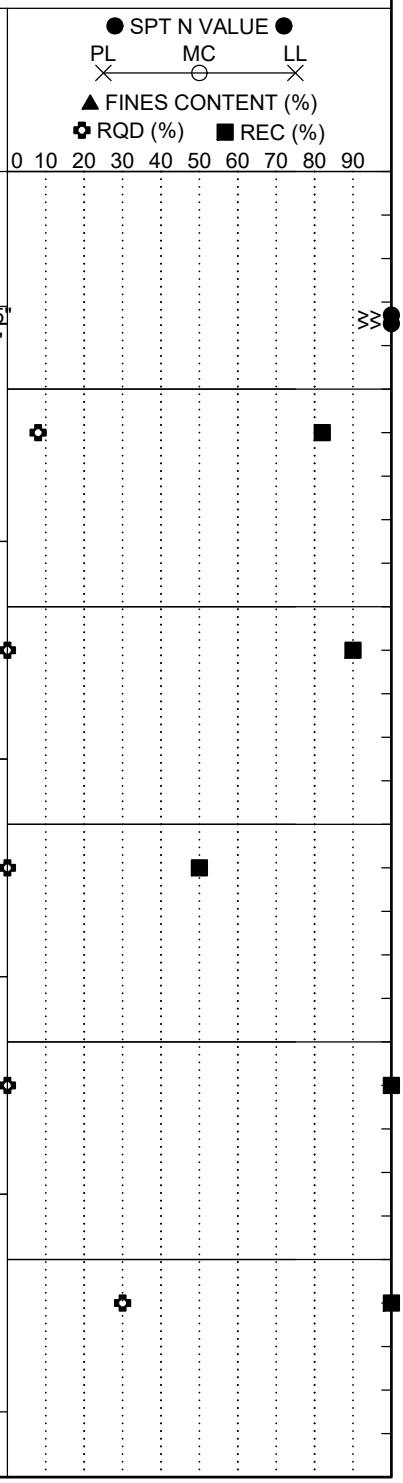
SAMPLER TYPE		DRILLING METHOD	
SS - Split Spoon	NQ - Rock Core, 1-7/8"	HSA - Hollow Stem Auger	RW - Rotary Wash
UD - Undisturbed Sample	CU - Cuttings	CFA - Continuous Flight Augers	RC - Rock Core
AWG - Rock Core, 1-1/8"	CT - Continuous Tube	DC - Driving Casing	

SCDOT Soil Test Log

Project ID:	P041237	**County:**	Union, SC	**Boring No.:**	B-37		
Site Description:	SC 49 over Tyger River			**Route:**	SC 49		
Eng./Geo.:	K. Hughes/HDR	**Boring Location:**	374+30	**Offset:**	42 RT	**Alignment:**	SC 49
Elev.:	380.4 ft	**Latitude:**	34.66568	**Longitude:**	-81.73939	**Date Started:**	12/16/2022
Total Depth:	58.5 ft	**Soil Depth:**	33.5 ft	**Core Depth:**	25 ft	**Date Completed:**	12/16/2022
Bore Hole Diameter (in):	2.97	**Sampler Configuration**		**Liner Required:**	Y (N)	**Liner Used:**	Y (N)
Drill Machine:	CME 45B	**Drill Method:**	RW	**Hammer Type:**	Automatic	**Energy Ratio:**	81.4%
Core Size:	NQ	**Driller:**	D. Harris/F&ME	**Groundwater:**	**TOB** -2 ft	**24HR**	N.M.

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Sample Depth (ft)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	4th 6"	N Value
		Auger and split-spoon refusal at 33.5'							
	33.5	Begin coring.	33.1						
			33.5	SS-10	50/4.5"				50/4.5"
			33.5	SS-11	50/0"				50/0"
345.4		**QUARTZ FELDSPAR GNEISS** - Pinkish white, dark gray, and black, very fine to medium grained, thinly laminated, slightly to completely weathered, very weak to medium strong, moderately hard to medium strong rock. Very close joint spacing, tight, planar and irregular, smooth to rough, with surface stains.		NQ-1					
		NQ-1: %REC=82, RQD=8, 2.9 min/ft, GSI=30-35	38.5						
340.4		Moderately to completely weathered.							
		NQ-2: %REC=90, RQD=0, 3.4 min/ft, GSI=25-30		NQ-2					
			43.5						
		Slightly to highly weathered.							
335.4		NQ-3: %REC=50, RQD=0, 2.0 min/ft, GSI=15-20		NQ-3					
			48.5						
		NQ-4: %REC=100, RQD=0, 2.3 min/ft, GSI=25-30							
330.4				NQ-4					
			53.5						
		Slightly to moderately weathered.							
325.4		NQ-5: %REC=100, RQD=30, 2.1 min/ft, qu=2,310, RMR=47, GSI=35-40		NQ-5					
	58.5	Boring terminated at 58.5' (Elev. 321.9')							



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 SC 49 OVER TYGER RIVER.GPJ SCDOT_DATATEMPLATE.GDT 3/22/23

Rock Core Photos

B-37
Box 1 of 3 (33.5’ to 43.5’)

B-37
Box 2 of 3 (43.5’ to 53.5’)

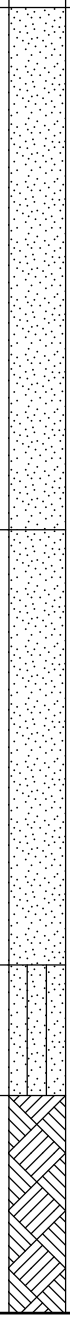
B-37
Box 3 of 3 (53.5’ to 58.5’)

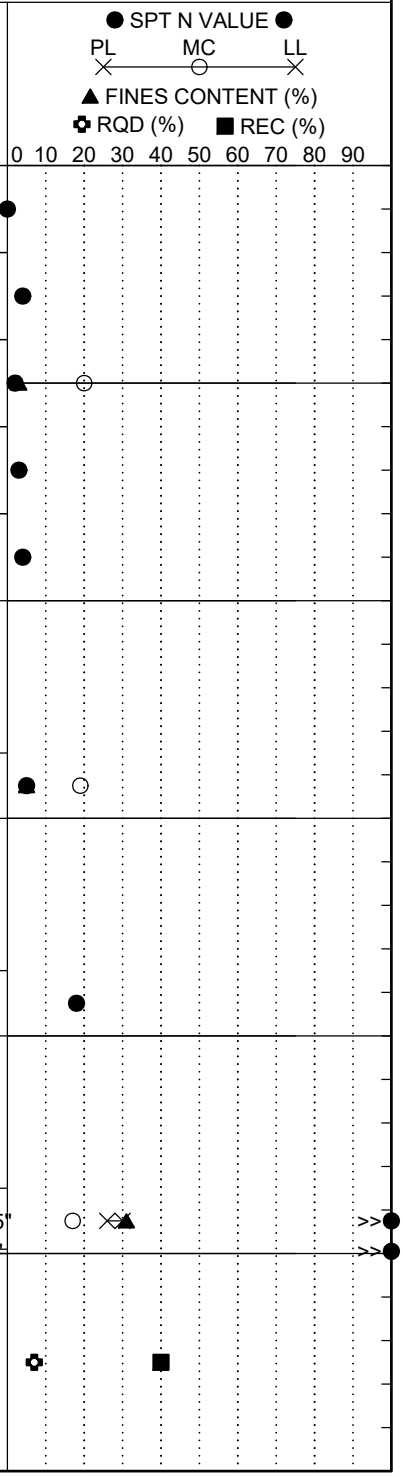
SCDOT Soil Test Log

Project ID:	P041237	**County:**	Union, SC	**Boring No.:**	B-38		
Site Description:	SC 49 over Tyger River			**Route:**	SC 49		
Eng./Geo.:	K. Hughes/HDR	**Boring Location:**	373+28	**Offset:**	43 RT	**Alignment:**	SC 49
Elev.:	374.2 ft	**Latitude:**	34.66593	**Longitude:**	-81.73924	**Date Started:**	12/20/2022
Total Depth:	45 ft	**Soil Depth:**	25 ft	**Core Depth:**	20 ft	**Date Completed:**	12/20/2022
Bore Hole Diameter (in):	2.97	**Sampler Configuration**		**Liner Required:**	Y (N)	**Liner Used:**	Y (N)
Drill Machine:	CME 45B	**Drill Method:**	RW	**Hammer Type:**	Automatic	**Energy Ratio:**	81.4%
Core Size:	NQ	**Driller:**	D. Harris/F&ME	**Groundwater:**	**TOB** -2.4 ft	**24HR**	N.M.

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Sample Depth (ft)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	4th 6"	N Value
	0.0	**ALLUVIUM** - Very loose, wet, brown, subrounded to subangular, fine to coarse grained, poorly-graded SAND (SP/A-1-b), 10YR 4/3 NMC=20.4, %200=3.3	0.0	SS-1	WOH	0	0	0	0
			2.0	SS-2	4	3	1	1	4
369.2			4.0	SS-3	2	1	1	1	2
			6.0	SS-4	3	1	2	2	3
			8.0	SS-5	2	2	2	1	4
364.2									
	12.0	**RESIDUUM** - Loose to medium dense, wet, brownish gray, subrounded to subangular, weakly cemented, fine to coarse grained, poorly-graded SAND (SP/A-1-b), 2.5Y 3/2 NMC=19.1, %200=4.9	13.5	SS-6	4	2	3		5
359.2									
		SS-7: Contains rock fragments.	18.5	SS-7	3	3	15		18
354.2									
	22.0	Very dense, wet, orange and white, subangular, weakly cemented, fine to coarse grained, Silty SAND (SM/A-2-4), 7.5YR 5/8, 7.5YR 8/1 LL=30, PL=26, PI=4, NMC=16.7, %200=30.7	23.5	SS-8	22	16	50/3.5"		50/3.5"
349.2	25.0	SS-9: No recovery. Auger and split spoon refusal at 25.0' Begin coring.	24.9 25.0	~~SS-9~~	~~50/1"~~				~~50/1"~~
				NQ-1					
		QUARTZ FELDSPAR GNEISS - Green, pink, white and light gray, very fine to fine	30.0						

Graphic Log





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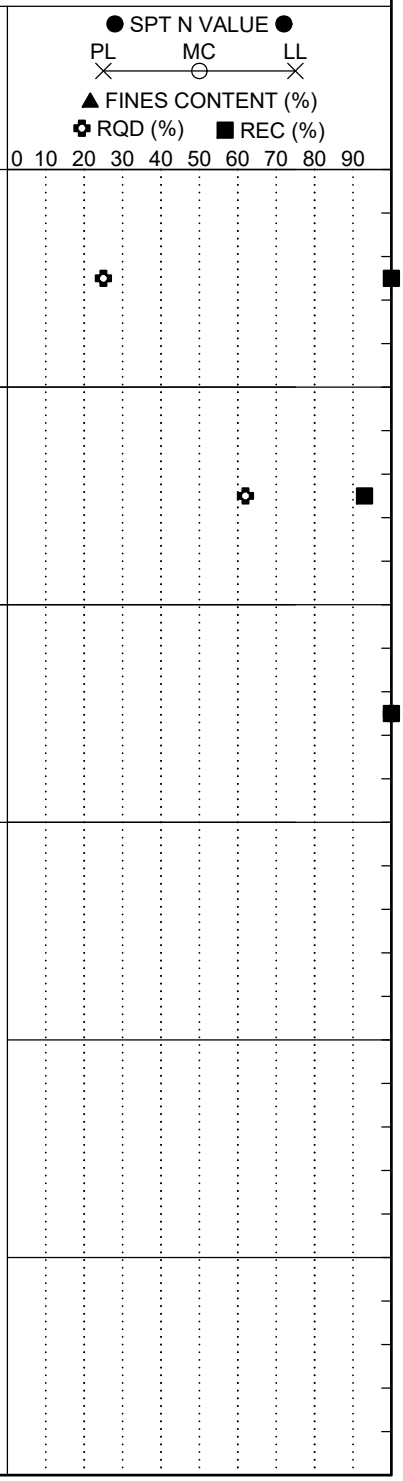
SAMPLER TYPE		DRILLING METHOD	
SS - Split Spoon	NQ - Rock Core, 1-7/8"	HSA - Hollow Stem Auger	RW - Rotary Wash
UD - Undisturbed Sample	CU - Cuttings	CFA - Continuous Flight Augers	RC - Rock Core
AWG - Rock Core, 1-1/8"	CT - Continuous Tube	DC - Driving Casing	

SCDOT Soil Test Log

Project ID:	P041237	**County:**	Union, SC	**Boring No.:**	B-38		
Site Description:	SC 49 over Tyger River			**Route:**	SC 49		
Eng./Geo.:	K. Hughes/HDR	**Boring Location:**	373+28	**Offset:**	43 RT	**Alignment:**	SC 49
Elev.:	374.2 ft	**Latitude:**	34.66593	**Longitude:**	-81.73924	**Date Started:**	12/20/2022
Total Depth:	45 ft	**Soil Depth:**	25 ft	**Core Depth:**	20 ft	**Date Completed:**	12/20/2022
Bore Hole Diameter (in):	2.97	**Sampler Configuration**		**Liner Required:**	Y (N)	**Liner Used:**	Y (N)
Drill Machine:	CME 45B	**Drill Method:**	RW	**Hammer Type:**	Automatic	**Energy Ratio:**	81.4%
Core Size:	NQ	**Driller:**	D. Harris/F&ME	**Groundwater:**	**TOB** -2.4 ft	**24HR**	N.M.

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Graphic Log	Sample Depth (ft)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	4th 6"	N Value
		grained, no foliation, slightly to highly weathered, strong to weak, moderately hard to hard rock. Very close joint spacing, tight to partly open, irregular, smooth to rough. Filled and partially filled existing joints present.			NQ-2					
		NQ-1: %REC=40, RQD=7, 4.6 min/ft, qu=22,740 psi, RMR=52, GSI=25-30		35.0						
339.2		Slightly weathered, strong to medium strong, hard rock. Very close to close joints, very tight, planar, smooth to slightly rough.								
		NQ-2: %REC=100, RQD=25, 7.2 min/ft, GSI=45-50			NQ-3					
		Dark gray/green, slightly weathered, weak to medium strong, low hardness to moderately hard rock.		40.0						
334.2		NQ-3: %REC=93, RQD=62, 5.6 min/ft, qu=27,920 psi, RMR=62, GSI=35-40								
		Fresh to slightly weathered, strong, hard rock. Close joint spacing, very tight, planar, slickensided to smooth.			NQ-4					
		NQ-4: %REC=100, RQD=100, 10.0 min/ft, qu=29,570 psi, RMR=66, GSI=75-80.								
329.2	45.0	NQ-4: qu=30,830 psi, RMR=69								
		Boring terminated at 45.0' (Elev. 329.2')								
324.2										
319.2										



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	

Rock Core Photos

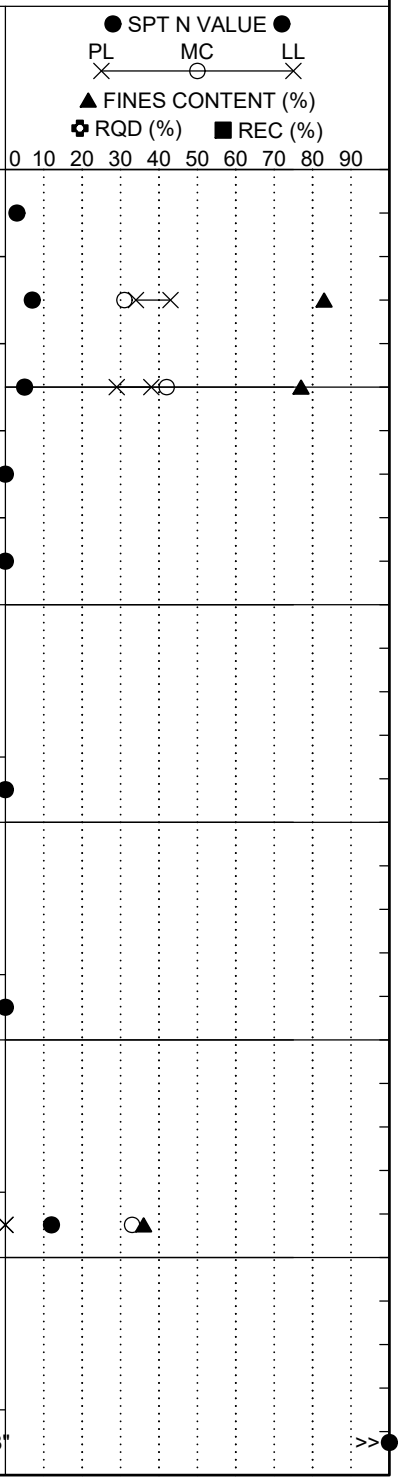
B-38
Box 1 of 2 (25.0’ to 35.0’)

B-38
Box 2 of 2 (35.0’ to 45.0’)

SCDOT Soil Test Log

Project ID:	P041237	**County:**	Union, SC	**Boring No.:**	B-39		
Site Description:	SC 49 over Tyger River			**Route:**	SC 49		
Eng./Geo.:	K. Hughes/HDR	**Boring Location:**	372+39	**Offset:**	43 RT	**Alignment:**	SC 49
Elev.:	382.0 ft	**Latitude:**	34.66615	**Longitude:**	-81.7391	**Date Started:**	12/14/2022
Total Depth:	52.9 ft	**Soil Depth:**	32.9 ft	**Core Depth:**	20 ft	**Date Completed:**	12/14/2022
Bore Hole Diameter (in):	2.97	**Sampler Configuration**		**Liner Required:**	Y (N)	**Liner Used:**	Y (N)
Drill Machine:	CME 45B	**Drill Method:**	RW	**Hammer Type:**	Automatic	**Energy Ratio:**	81.4%
Core Size:	NQ	**Driller:**	D. Harris/F&ME	**Groundwater:**	**TOB** 5.1 ft	**24HR**	N.M.

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Sample Depth (ft)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	4th 6"	N Value
	0.0	**ALLUVIUM** - Very loose, moist, light brown into dark brown, subangular to subrounded, fine grained, Silty SAND (SM/A-2-4). 7.5YR 4/2	0.0	SS-1	WOH	1	2	1	3
	2.0	Firm to very soft, moist to wet, reddish brown and brownish gray, SILT (ML/A-5) with sand. 10YR 4/1	2.0	SS-2	2	3	4	4	7
377.0		LL=43, PL=34, PI=9, NMC=31.0, %200=82.6	4.0	SS-3	4	3	2	2	5
		SS-3: LL=38, PL=29, PI=9, NMC=41.8, %200=77.4	6.0	SS-4	WOH	0	0	0	0
			8.0	SS-5	WOH	0	0	0	0
372.0									
		SS-6: Reddish gray, 5YR 5/6, 10YR 4/1	13.5	SS-6	WOH	0	0	0	0
367.0									
			18.5	SS-7	1	WOH	0	0	0
362.0	21.5	**RESIDUUM** - Medium dense, wet, gray, subangular, weakly cemented, fine grained, Silty SAND (SM/A-2-4), GLEY1 5/N LL=NP, PL=NP, PI=NP, NMC=32.9, %200=35.5	23.5	SS-8	2	1	11		12
357.0	27.5	Very dense, wet, greenish gray and white, subangular, weakly cemented, fine to coarse grained, Silty SAND (SM/A-2-4) with rock fragments. 5Y 6/1, 5Y 6/2, N9.5	28.5	SS-9	50/1.3"				50/1.3"



LEGEND

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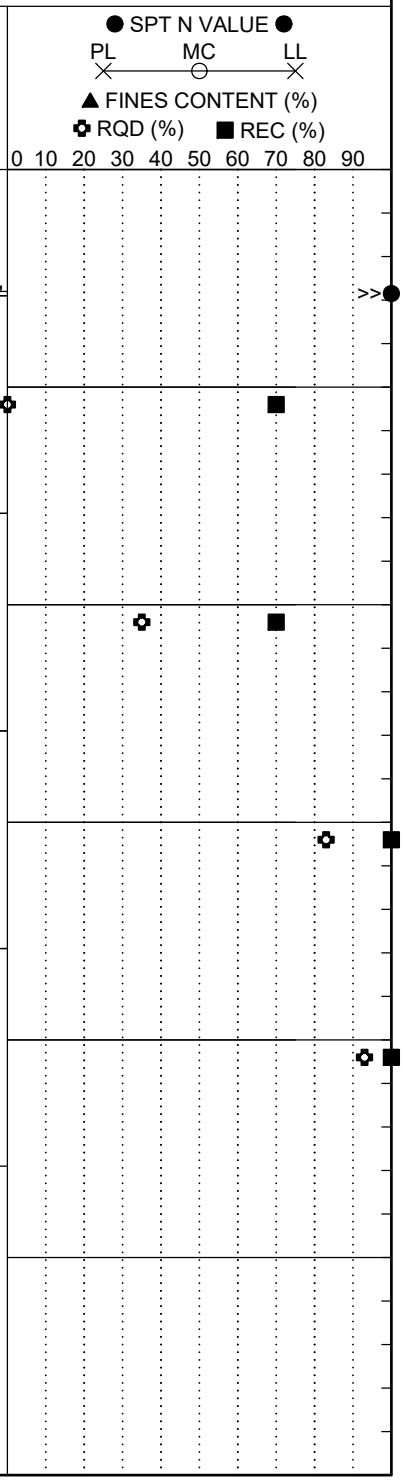
SAMPLER TYPE		DRILLING METHOD	
SS - Split Spoon	NQ - Rock Core, 1-7/8"	HSA - Hollow Stem Auger	RW - Rotary Wash
UD - Undisturbed Sample	CU - Cuttings	CFA - Continuous Flight Augers	RC - Rock Core
AWG - Rock Core, 1-1/8"	CT - Continuous Tube	DC - Driving Casing	

SCDOT Soil Test Log

Project ID:	P041237	**County:**	Union, SC	**Boring No.:**	B-39		
Site Description:	SC 49 over Tyger River			**Route:**	SC 49		
Eng./Geo.:	K. Hughes/HDR	**Boring Location:**	372+39	**Offset:**	43 RT	**Alignment:**	SC 49
Elev.:	382.0 ft	**Latitude:**	34.66615	**Longitude:**	-81.7391	**Date Started:**	12/14/2022
Total Depth:	52.9 ft	**Soil Depth:**	32.9 ft	**Core Depth:**	20 ft	**Date Completed:**	12/14/2022
Bore Hole Diameter (in):	2.97	**Sampler Configuration**		**Liner Required:**	Y (N)	**Liner Used:**	Y (N)
Drill Machine:	CME 45B	**Drill Method:**	RW	**Hammer Type:**	Automatic	**Energy Ratio:**	81.4%
Core Size:	NQ	**Driller:**	D. Harris/F&ME	**Groundwater:**	**TOB** 5.1 ft	**24HR**	N.M.

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Sample Depth (ft)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	4th 6"	N Value
		SS-10: No recovery. Auger and split-spoon refusal at 32.9' Begin coring.	32.8	SS-10	50/1"				50/1"
	32.9	**QUARTZ FELDSPAR GNEISS** - White and gray, very fine to medium grained, no foliation, slightly to highly weathered, weak to medium strong, low hardness to hard rock. Very close joint spacing, tight to partly open, planar, slightly rough to rough. NQ-1: %REC=70, RQD=0, 2.6 min/ft, GSI=25-30	32.9						
347.0				NQ-1					
	37.9	Greenish gray, pink and white, very fined grained, no foliation, slightly to moderately weathered, strong, very hard to hard rock. Very close joints, very tight, planar, smooth. Old partially filled joints. NQ-2: %REC=70, RQD=35, 4.5 min/ft, qu=12,300 psi, RMR= 52, GSI=30-35	37.9						
342.0				NQ-2					
		NQ-3: %REC=100, RQD=83, 4.8 min/ft, qu=19,850 psi, RMR=66, GSI=45-50	42.9						
337.0		NQ-3: qu=17,060, RMR=66		NQ-3					
		NQ-4: %REC=100, RQD=93, 4.5 min/ft, qu=26,780 psi, RMR=69, GSI=60-65	47.9						
332.0				NQ-4					
		NQ-4: qu=31,520 psi, RMR=72							
	52.9	Boring terminated at 52.9' (Elev. 329.1')							
327.0									



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

Rock Core Photos

B-39
Box 1 of 3 (32.9’ to 42.9’)

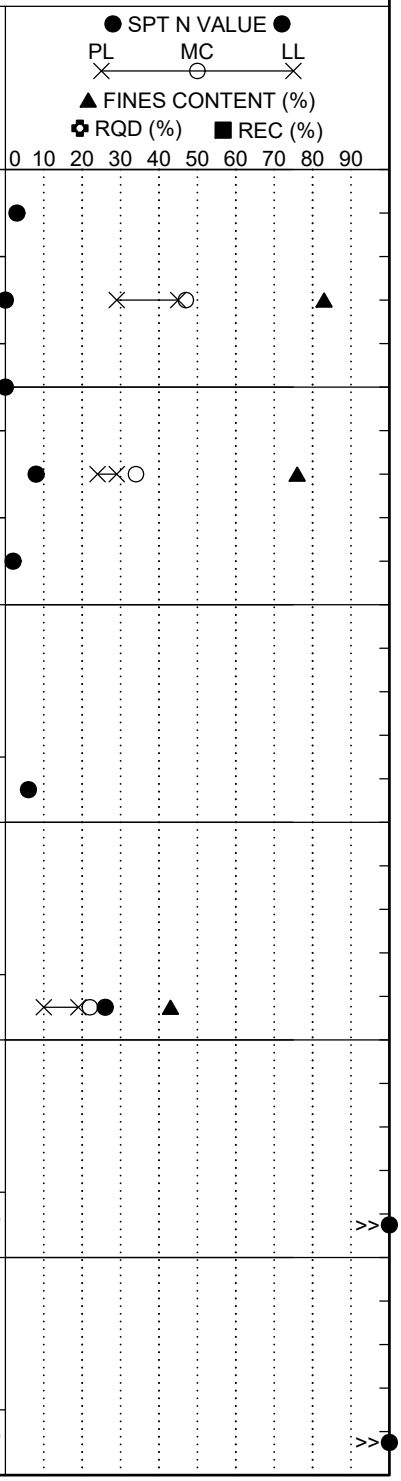
B-39
Box 2 of 3 (42.9’ to 47.9’)

B-39
Box 3 of 3 (49.7’ to 52.9’)

SCDOT Soil Test Log

Project ID:	P041237	**County:**	Union, SC	**Boring No.:**	B-40		
Site Description:	SC 49 over Tyger River			**Route:**	SC 49		
Eng./Geo.:	K. Hughes/HDR	**Boring Location:**	371+36	**Offset:**	42 RT	**Alignment:**	SC 49
Elev.:	380.5 ft	**Latitude:**	34.6664	**Longitude:**	-81.73894	**Date Started:**	12/13/2022
Total Depth:	62.8 ft	**Soil Depth:**	37.8 ft	**Core Depth:**	25 ft	**Date Completed:**	12/13/2022
Bore Hole Diameter (in):	2.97	**Sampler Configuration**		**Liner Required:**	Y (N)	**Liner Used:**	Y (N)
Drill Machine:	CME 45B	**Drill Method:**	RW	**Hammer Type:**	Automatic	**Energy Ratio:**	81.4%
Core Size:	NQ	**Driller:**	D. Harris/F&ME	**Groundwater:**	**TOB** 0.4 ft	**24HR**	N.M.

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Sample Depth (ft)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	4th 6"	N Value
	0.0	**ALLUVIUM** - Soft to very soft, moist, reddish brown and brownish gray, SILT (ML/A-7-6) with sand. 7.5YR 4/4, 10YR 4/1 LL=45, PL=29, PI=16, NMC=46.9, %200=83.1 (%Silt=48.2, %Clay=34.9)	0.0	SS-1	1	1	2	1	3
			2.0	SS-2	WOH	0	0	0	0
375.5			4.0	SS-3	WOH	0	0	0	0
	6.0	Very soft to firm, wet, grayish brown, SILT (ML/A-4) with sand. 10YR 4/2 LL=29, PL=24, PI=5, NMC=34.4, %200=76.1	6.0	SS-4	WOH	3	5	7	8
			8.0	SS-5	3	1	1	0	2
370.5									
			13.5	SS-6	1	2	4		6
365.5									
	17.5	**RESIDUUM** - Medium dense, wet, reddish brown and gray, subangular, weakly cemented, fine to medium grained, Clayey SAND (SC/A-4). Contains rock fragments. 10YR 4.2, 7.5YR 4/4 LL=29, PL=19, PI=10, NMC=21.9, %200=43.3	18.5	SS-7	4	12	14		26
360.5									
	22.5	Very dense, wet, reddish light brown, subangular, weakly cemented, fine to medium grained, Silty SAND (SM/A-2-4). 7.5YR 4/4	23.5	SS-8	50/4"				50/4"
355.5									
	27.5	Very dense, wet, orange, subangular, weakly cemented, fine to coarse grained, poorly-graded SAND with silt (SP-SM/A-3), 5YR 6/6. Contains rock fragments.	28.5	SS-9	9	50/5"			50/5"



LEGEND

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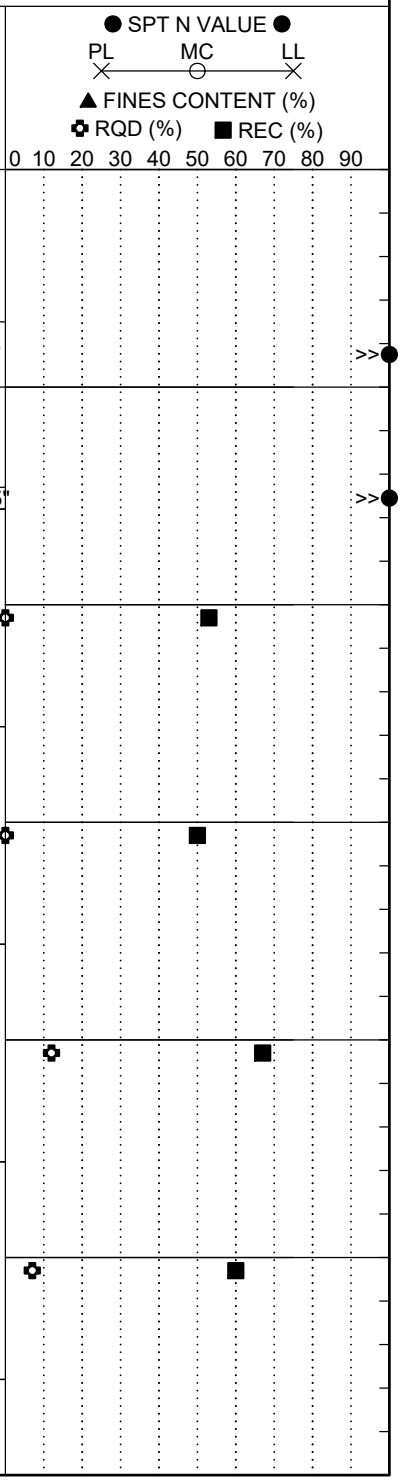
SAMPLER TYPE		DRILLING METHOD	
SS - Split Spoon	NQ - Rock Core, 1-7/8"	HSA - Hollow Stem Auger	RW - Rotary Wash
UD - Undisturbed Sample	CU - Cuttings	CFA - Continuous Flight Augers	RC - Rock Core
AWG - Rock Core, 1-1/8"	CT - Continuous Tube	DC - Driving Casing	

SCDOT Soil Test Log

Project ID:	P041237	**County:**	Union, SC	**Boring No.:**	B-40		
Site Description:	SC 49 over Tyger River			**Route:**	SC 49		
Eng./Geo.:	K. Hughes/HDR	**Boring Location:**	371+36	**Offset:**	42 RT	**Alignment:**	SC 49
Elev.:	380.5 ft	**Latitude:**	34.6664	**Longitude:**	-81.73894	**Date Started:**	12/13/2022
Total Depth:	62.8 ft	**Soil Depth:**	37.8 ft	**Core Depth:**	25 ft	**Date Completed:**	12/13/2022
Bore Hole Diameter (in):	2.97	**Sampler Configuration**		**Liner Required:**	Y (N)	**Liner Used:**	Y (N)
Drill Machine:	CME 45B	**Drill Method:**	RW	**Hammer Type:**	Automatic	**Energy Ratio:**	81.4%
Core Size:	NQ	**Driller:**	D. Harris/F&ME	**Groundwater:**	**TOB** 0.4 ft	**24HR**	N.M.

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Sample Depth (ft)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	4th 6"	N Value
		SS-10: No recovery	33.5	SS-10	50/2"				50/2"
345.5		Auger and split-spoon refusal at 37.8'	37.3						
	37.8	Begin coring.	37.8	SS-11	50/0.5"				50/0.5"
340.5		**QUARTZ FELDSPAR GNEISS** - Pink, white and gray, very fine to fine grained, no foliation, slightly to moderately weathered, weak, low hardness to moderately hard rock. Very close joints, partly open, planar, slightly rough. NQ-1: %REC=53, RQD=0, GSI=20-25		NQ-1					
		Highly weathered to residual soil, extremely weak to weak, low hardness to soft rock.	42.8						
335.5		NQ-2: %REC=50, RQD=0, 2.8 min/ft, GSI=5-10		NQ-2					
		NQ-3: %REC=67, RQD=12, 4.9 min/ft, qu=6,810 psi, RMR=44, GSI=25-30	47.8						
330.5				NQ-3					
		NQ-4: %REC=60, RQD=7, 4.4 min/ft, GSI=20-25	52.8						
325.5				NQ-4					
		NQ-5: %REC=100, RQD=48, 3.7 min/ft, qu=12,940 psi, RMR=52, GSI=35-40	57.8						



LEGEND

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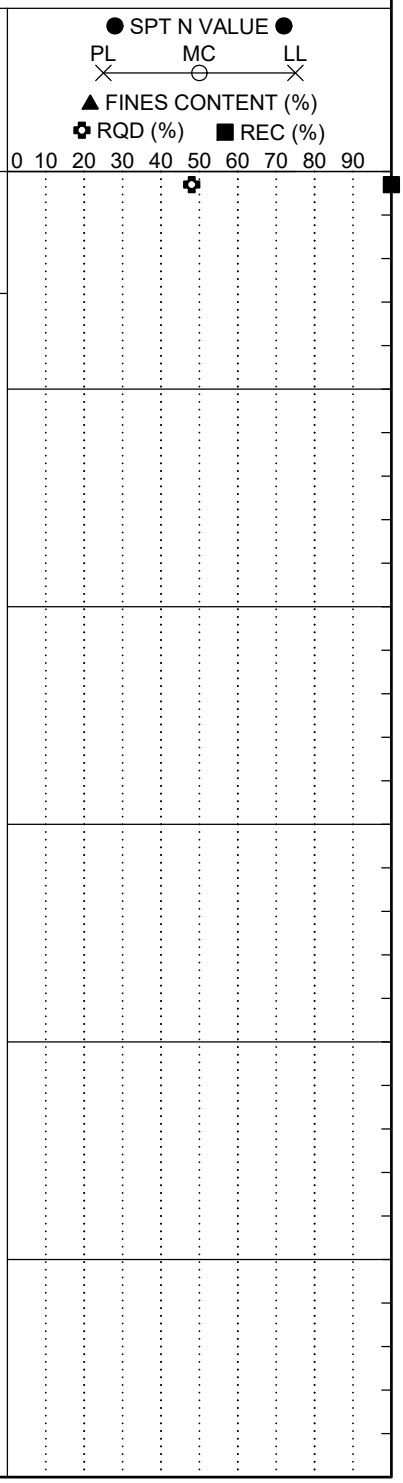
SAMPLER TYPE		DRILLING METHOD	
SS - Split Spoon	NQ - Rock Core, 1-7/8"	HSA - Hollow Stem Auger	RW - Rotary Wash
UD - Undisturbed Sample	CU - Cuttings	CFA - Continuous Flight Augers	RC - Rock Core
AWG - Rock Core, 1-1/8"	CT - Continuous Tube	DC - Driving Casing	

SCDOT Soil Test Log

Project ID:	P041237	**County:**	Union, SC	**Boring No.:**	B-40
Site Description:	SC 49 over Tyger River			**Route:**	SC 49
Eng./Geo.:	K. Hughes/HDR	**Boring Location:**	371+36	**Offset:**	42 RT
Alignment:	SC 49				
Elev.:	380.5 ft	**Latitude:**	34.6664	**Longitude:**	-81.73894
Date Started:	12/13/2022				
Total Depth:	62.8 ft	**Soil Depth:**	37.8 ft	**Core Depth:**	25 ft
Date Completed:	12/13/2022				
Bore Hole Diameter (in):	2.97	**Sampler Configuration**		**Liner Required:**	Y (N)
Liner Used:	Y (N)				
Drill Machine:	CME 45B	**Drill Method:**	RW	**Hammer Type:**	Automatic
Energy Ratio:	81.4%				
Core Size:	NQ	**Driller:**	D. Harris/F&ME	**Groundwater:**	**TOB** 0.4 ft
24HR	N.M.				

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Graphic Log	Sample Depth (ft)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	4th 6"	N Value
					NQ-5					
	62.8	NQ-5: qu=27,080 psi, RMR=57								
		Boring terminated at 62.8' (Elev. 317.7')								
315.5										
310.5										
305.5										
300.5										
295.5										



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	

Rock Core Photos

B-40
Box 1 of 3 (37.8’ to 47.8’)

B-40
Box 2 of 3 (47.8’ to 57.8’)

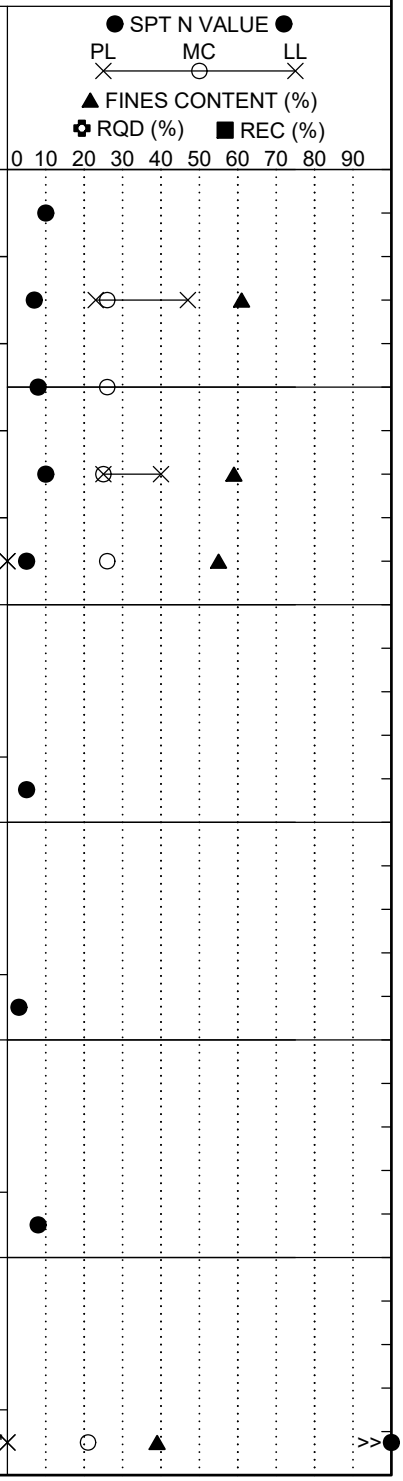
B-40
Box 3 of 3 (57.8’ to 62.8’)

SCDOT Soil Test Log

Project ID:	P041237	**County:**	Union, SC	**Boring No.:**	B-41
Site Description:	SC 49 over Tyger River			**Route:**	SC 49
Eng./Geo.:	K. Hughes/HDR	**Boring Location:**	370+38	**Offset:**	42 RT
Alignment:	SC 49				
Elev.:	407.9 ft	**Latitude:**	34.66664	**Longitude:**	-81.73879
Date Started:	12/8/2022				
Total Depth:	61.2 ft	**Soil Depth:**	49 ft	**Core Depth:**	12.7 ft
Date Completed:	12/8/2022				
Bore Hole Diameter (in):	2.97	**Sampler Configuration**		**Liner Required:**	Y (N)
Liner Used:	Y (N)				
Drill Machine:	CME 550X	**Drill Method:**	RW	**Hammer Type:**	Automatic
Energy Ratio:	87%				
Core Size:	NQ	**Driller:**	J. Phillips/F&ME	**Groundwater:**	**TOB** 28.8 ft
24HR	29.1 ft				

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION
	0.0	
	1.2	1.2' ASPHALT
	2.0	**ROADWAY FILL** - Loose, moist, brown and gray, subangular, fine to coarse grained, Clayey SAND (SC/A-6). Contains roadway aggregate. 10YR 5/3
402.9	6.0	Firm, moist, orange, Sandy Lean CLAY (CL/A-7-6) with sand. 5YR 4/6 LL=47, PL=23, PI=24, NMC=25.6, %200=61.0
397.9	8.0	Stiff, moist, orange and brown, Sandy Lean CLAY (CL/A-6). 5YR 4/6, 5YR 4/4, 7.5YR 4/8 LL=40, PL=25, PI=15, NMC=24.8, %200=59.4
392.9	12.0	**ALLUVIUM** - Firm, moist to wet, orange and brown, Sandy SILT (ML/A-4). 5YR 4/6, 5YR 4/4, 7.5YR 4/8 LL=NP, PL=NP, PI=NP, NMC=25.5, %200=54.9
387.9		Soft to firm, moist to wet, orange and brown, SILT (ML/A-7-6) with sand. 5YR 4/6, 5YR 4/4, 7.5YR 4/8
382.9	22.0	Loose, wet, brown, subangular, fine to coarse grained, Clayey SAND (SC/A-2-7). 5YR 4/4
	27.5	**RESIDUUM** - Very dense, wet, orangish brown, subangular, weakly cemented, fine to coarse grained, Silty SAND (SM/A-4). 7.5YR 5/6
	30.0	

Sample Depth (ft)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	4th 6"	N Value
0.0	SS-1	0	0	10	10	10
2.0	SS-2	4	3	4	5	7
4.0	SS-3	4	5	3	4	8
6.0	SS-4	3	4	6	4	10
8.0	SS-5	1	2	3	2	5
13.5	SS-6	3	2	3		5
18.5	SS-7	2	1	2		3
23.5	SS-8	3	3	5		8
28.5	SS-9	35	50/1"			50/1"



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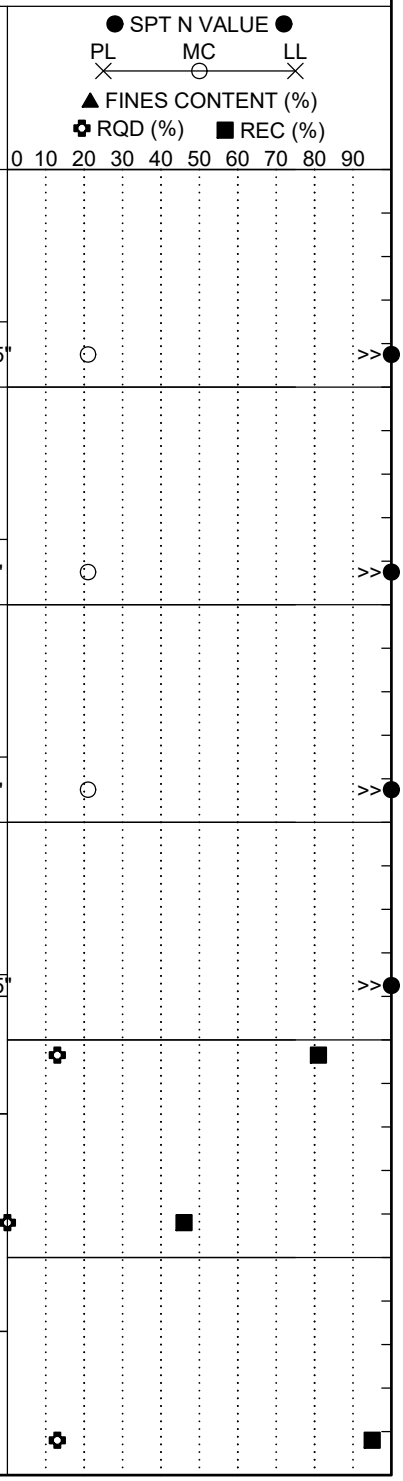
SAMPLER TYPE		DRILLING METHOD	
SS - Split Spoon	NQ - Rock Core, 1-7/8"	HSA - Hollow Stem Auger	RW - Rotary Wash
UD - Undisturbed Sample	CU - Cuttings	CFA - Continuous Flight Augers	RC - Rock Core
AWG - Rock Core, 1-1/8"	CT - Continuous Tube	DC - Driving Casing	

SCDOT Soil Test Log

Project ID:	P041237	**County:**	Union, SC	**Boring No.:**	B-41		
Site Description:	SC 49 over Tyger River			**Route:**	SC 49		
Eng./Geo.:	K. Hughes/HDR	**Boring Location:**	370+38	**Offset:**	42 RT	**Alignment:**	SC 49
Elev.:	407.9 ft	**Latitude:**	34.66664	**Longitude:**	-81.73879	**Date Started:**	12/8/2022
Total Depth:	61.2 ft	**Soil Depth:**	49 ft	**Core Depth:**	12.7 ft	**Date Completed:**	12/8/2022
Bore Hole Diameter (in):	2.97	**Sampler Configuration**		**Liner Required:**	Y (N)	**Liner Used:**	Y (N)
Drill Machine:	CME 550X	**Drill Method:**	RW	**Hammer Type:**	Automatic	**Energy Ratio:**	87%
Core Size:	NQ	**Driller:**	J. Phillips/F&ME	**Groundwater:**	**TOB** 28.8 ft	**24HR**	29.1 ft

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Sample Depth (ft)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	4th 6"	N Value
		LL=NP, PL=NP, PI=NP, NMC=20.8, %200=38.5							
		Very dense, wet, orangish brown, gray, and white, subangular, weakly cemented, fine to coarse grained, poorly-graded SAND with silt (SP-SM/A-3). 7.5YR 5/6	33.5	SS-10	50/5.5"				50/5.5"
372.9									
		SS-11: Contains rock fragments.	38.5	SS-11	50/1"				50/1"
367.9									
			43.5	SS-12	50/3"				50/3"
362.9		SS-13: No recovery. Auger and split-spoon refusal at 49.0' Begin coring.	48.5						
	49.0		49.0	SS-13	50/0.5"				50/0.5"
357.9		**QUARTZ FELDSPAR GNEISS** - Pink and gray with black, very fine to medium grained, laminated, slightly to highly weathered, weak to medium strong, friable to moderately hard rock. Very close joint spacing, tight to open, planar and irregular, very rough to slightly rough. NQ-1: %REC=81, RQD=13, 1.7 min/ft, GSI=20-25	51.7	NQ-1					
352.9		NQ-2: %REC=46, RQD=0, 3.0 min/ft, GSI=25-30	56.7	NQ-2					
		Compeltely to slightly weathered, extremely weak to strong rock. NQ-3: %REC=95, RQD=13, 1.6 min/ft, GSI=25-30		NQ-3					



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:	P041237	**County:**	Union, SC	**Boring No.:**	B-41
Site Description:	SC 49 over Tyger River			**Route:**	SC 49
Eng./Geo.:	K. Hughes/HDR	**Boring Location:**	370+38	**Offset:**	42 RT
Alignment:	SC 49				
Elev.:	407.9 ft	**Latitude:**	34.66664	**Longitude:**	-81.73879
Date Started:	12/8/2022				
Total Depth:	61.2 ft	**Soil Depth:**	49 ft	**Core Depth:**	12.7 ft
Date Completed:	12/8/2022				
Bore Hole Diameter (in):	2.97	**Sampler Configuration**		**Liner Required:**	Y (N)
Liner Used:	Y (N)				
Drill Machine:	CME 550X	**Drill Method:**	RW	**Hammer Type:**	Automatic
Energy Ratio:	87%				
Core Size:	NQ	**Driller:**	J. Phillips/F&ME	**Groundwater:**	**TOB** 28.8 ft
24HR	29.1 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
	61.7	Boring terminated at 61.7' (Elev. 346.2')								
342.9										
337.9										
332.9										
327.9										
322.9										

● SPT N VALUE ●
PL MC LL
▲ FINES CONTENT (%)
✿ RQD (%) ■ REC (%)
0 10 20 30 40 50 60 70 80 90

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	

Rock Core Photos

B-41
Box 1 of 1 (49.0’ to 61.2’)

Appendix B. Subsurface Investigation

CPT Logs

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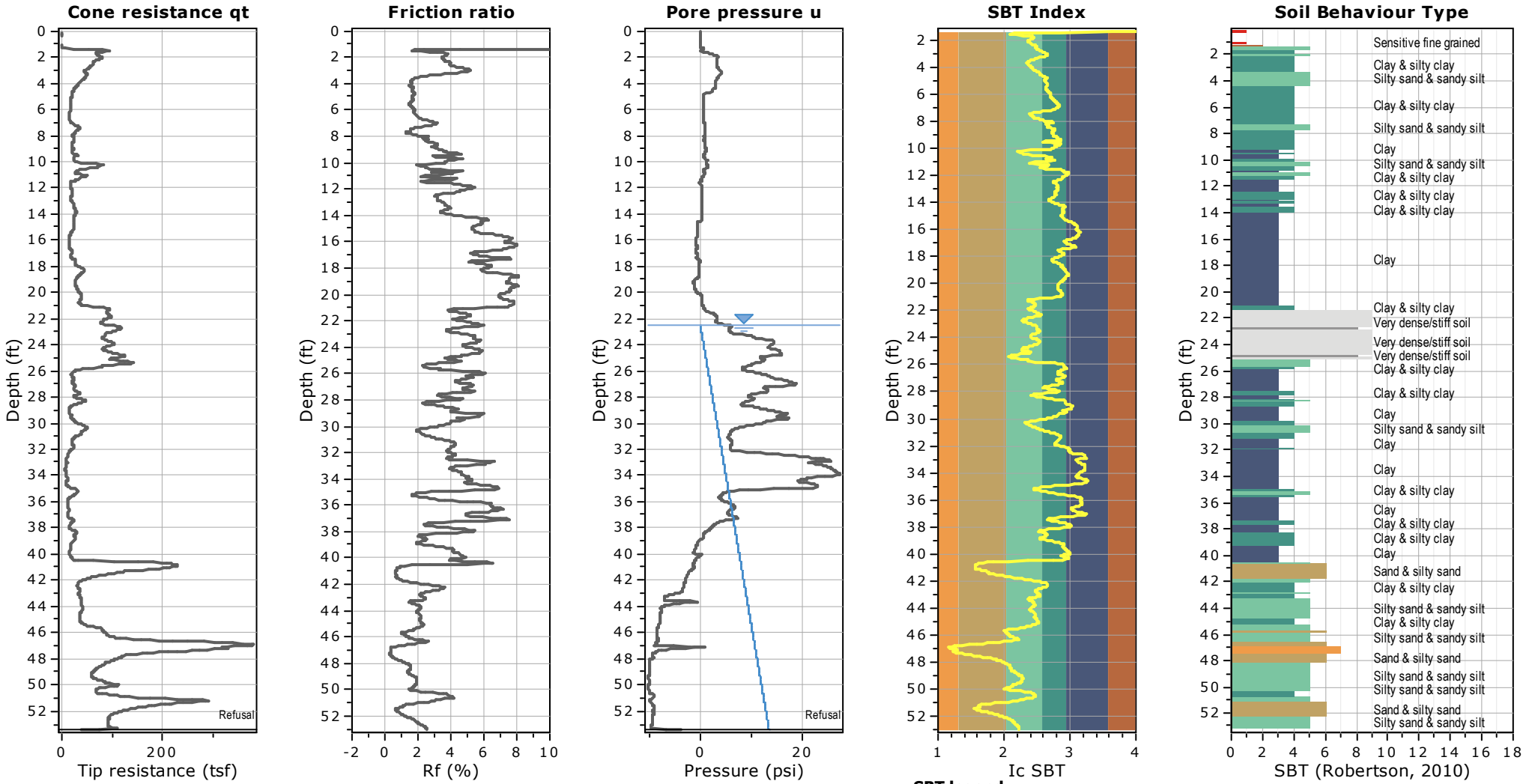
CPT-17

Total depth: 53.43 ft, Date: 11/17/2022
Surface Elevation: 407.70 ft
Coords: lat 34.665266° lon -81.739652°
Cone Type: DDG1330
Cone Operator: F&ME Consultants

Project: SC 49 over Tyger River
Location: Union County, SC



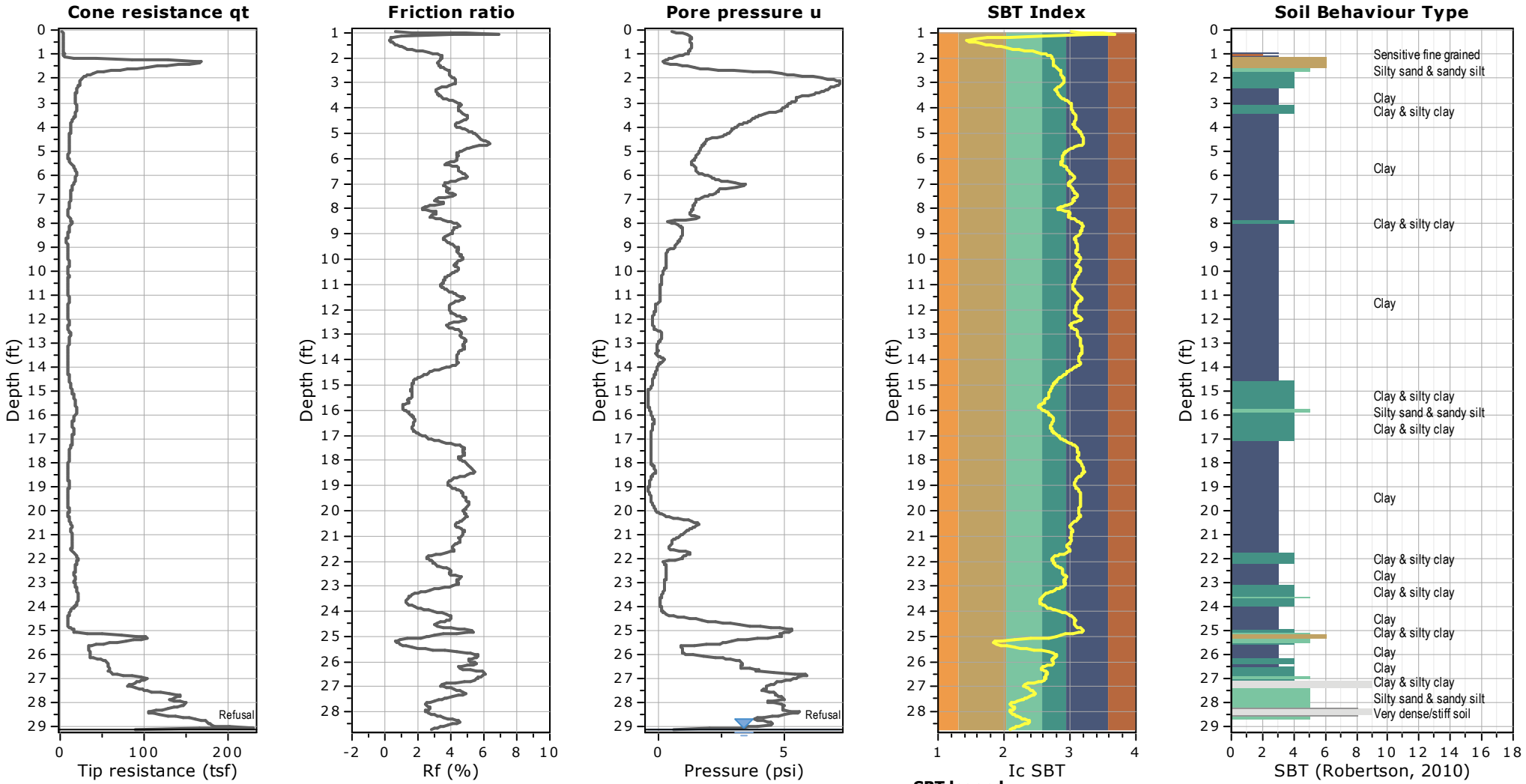
SBT legend

1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty clay
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to clayey sand
9. Very stiff fine grained

CPT-18

Total depth: 29.10 ft, Date: 11/17/2022
Surface Elevation: 408.10 ft
Coords: lat 34.666645° lon -81.738791°
Cone Type: DDG1330
Cone Operator: F&ME Consultants

Project: SC 49 over Tyger River
Location: Union County, SC



SBT legend

1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty clay
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to clayey sand
9. Very stiff fine grained

Appendix B. Subsurface Investigation

Multichannel Analysis of Surface Waves (MASW)

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February 28, 2023

Ms. Lila Leon, P.E., PhD
South Carolina Geotechnical Lead
HDR
1201 Main Street Suite 800
Columbia, South Carolina 29201

Re: Report of Multi-Channel Analysis of Surface Waves
SC-49 Replacement Bridge over Tyger River
Union County, South Carolina
F&ME Project No.: G6658.002

Dear Ms. Leon:

On January 18th, 2023, F&ME Consultants performed one (1) Multi-Channel Analysis of Surface Waves (MASW) test near the SC-49 bridge over Tyger River to determine the average shear wave velocity to a depth of 100 feet at the location. A 16-channel Geometrics ES-3000 seismograph with 4.5 Hz geophones was used for data collection. Active and Passive survey data was obtained using a 225-foot linear array with 16 geophones spaced at 15 feet.

A 16-pound sledge hammer striking an aluminum block and a polyethylene block were used as the energy source for the active survey. Ten (10) active shots were performed at various distances (25, 50, and 100 feet) off the array ends. Resultant vibrations were recorded with a sample rate of 0.5 milliseconds and a recording length of 2 seconds after each hammer blow. The data was stacked five times at each location to minimize the effect of unknown ambient vibrations commonly referred to as noise. The stacking process increases the signal to noise ratio.

The passive survey consisted of the collection of ambient background vibrations, which consisted of drilling equipment. Fifty (50) recordings with a record length of 32 seconds and a sample rate of 2 milliseconds were made during this phase of data acquisition.

Prior to departing the site, the data collected from both the passive and active surveys were reviewed and checked for variations from what would be typically expected from the prevailing area geology.

After completion of passive and active survey the data was processed and analyzed using Geometric's SeisImager software suite (Pickwin and WaveEq). This resulted in a one-dimensional subsurface shear wave velocity curve that is developed utilizing both the passive and active survey data. The data from the active survey defines the near surface shear wave velocities, while the passive survey data defines deeper shear wave velocities due to the lower frequencies. The resulting curve represents the average shear wave velocities below the surface arrays to a depth of 100 feet.

The resulting Shear Wave Velocity Curve, Vs100, for the location defined on Figure 1 of this report. The following table summarizes the average shear wave velocity (Vs100) at the aforementioned location.

Boring No.	Average Shear Wave Velocity (Vs100)
MASW-9	1116.9 ft/sec

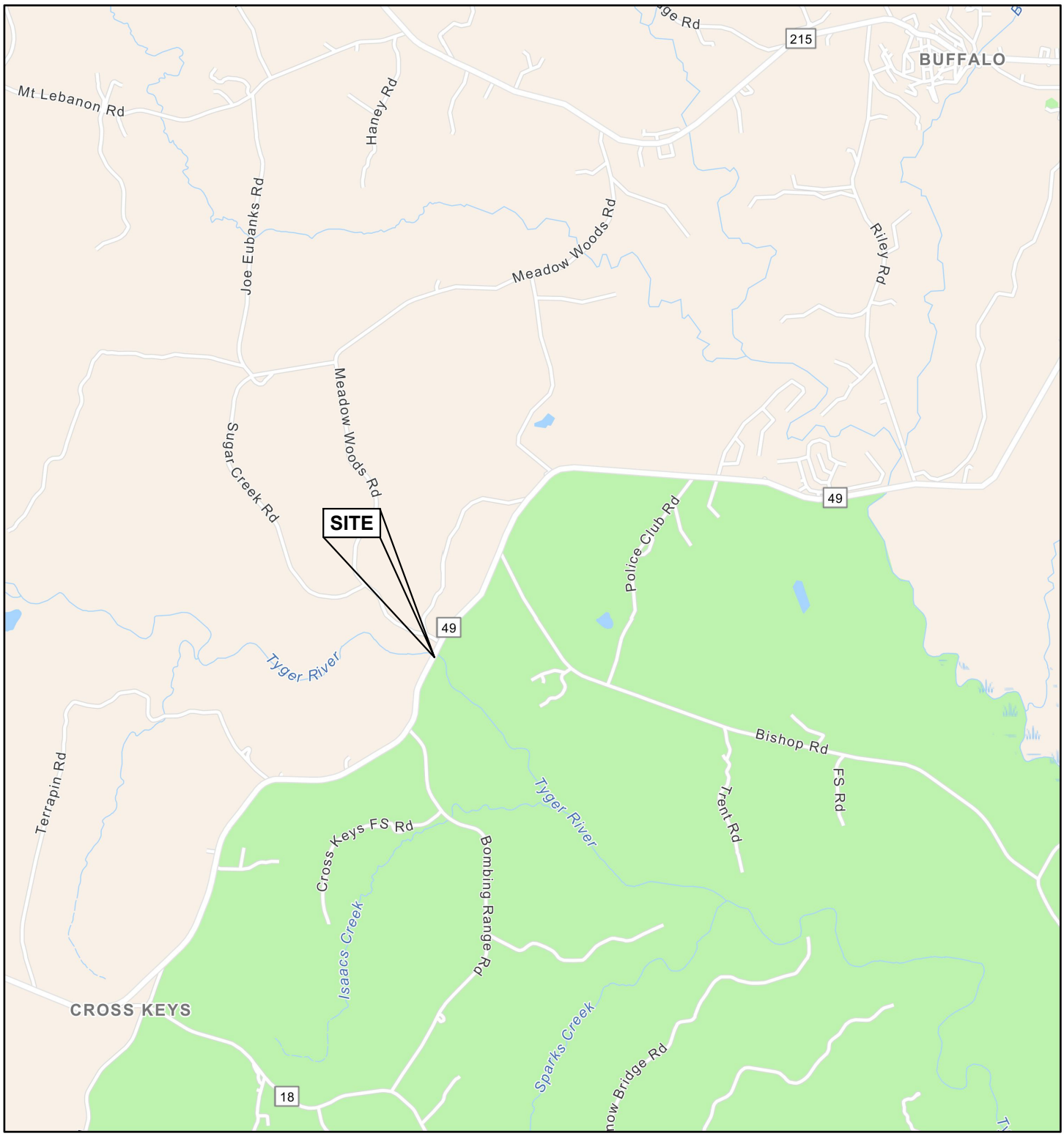
It has been a pleasure working for you on this project and we appreciate the opportunity to be of service. Please contact us if you have any questions or concerns.

Sincerely,

F&ME CONSULTANTS

Alex M Chandler, EIT
Geotechnical Staff Professional

John F Hamilton, PE
Geotechnical Design Manager



1:72,000

0 0.5 1 2 mi

0 0.75 1.5 3 km

F&ME CONSULTANTS, INC.
COLUMBIA, SC

REV.	BY	DATE	DESCRIPTION OF REVISION
4			
3			
2			
1			

TOPO. ____ DATE ____
DWG. CTC DATE 2.20.23 GROUP ____ – ____
R/W ____ DATE ____

SC 49 OVER TYGER RIVER
UNION COUNTY, SOUTH CAROLINA

SITE VICINITY MAP

F&ME JOB NO. G6658.002

SCALE: AS NOTED | **FIGURE 1**

F&ME CONSULTANTS, INC.
COLUMBIA, SC

REV.	BY	DATE	DESCRIPTION OF REVISION
4			
3			
2			
1			

TOPO. _____ DATE _____
DWG. CTC DATE 2.20.23
R/W _____ DATE _____

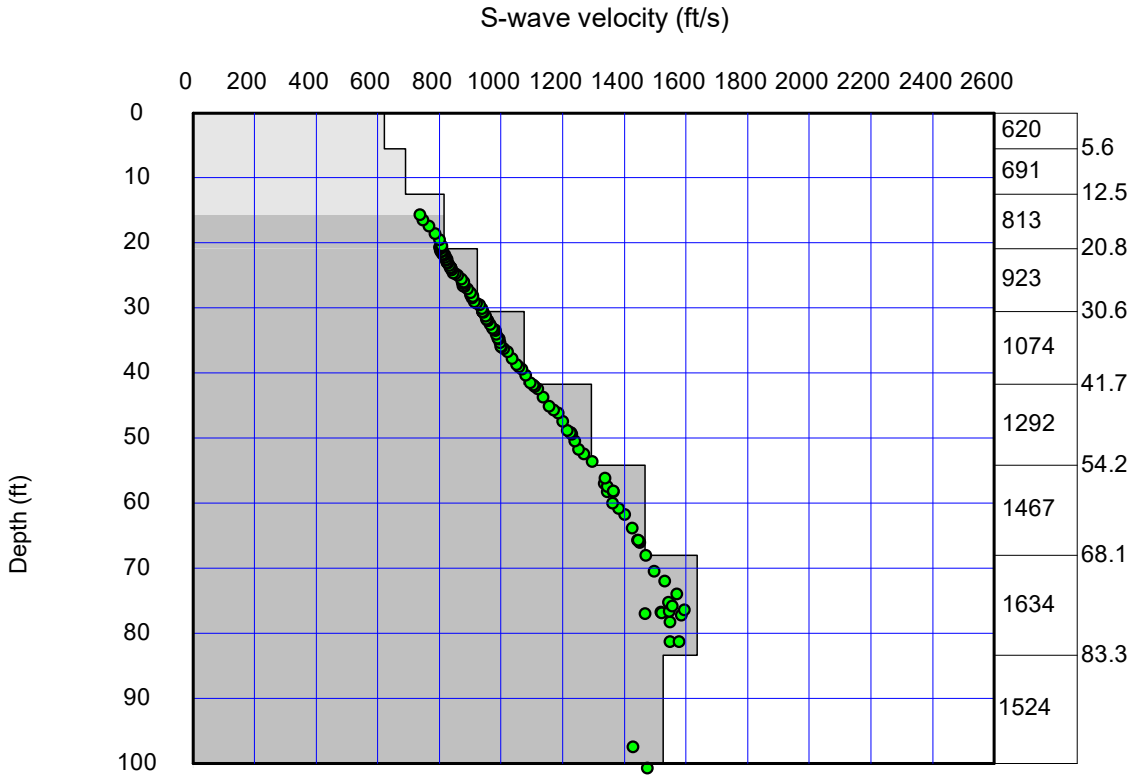
GROUP ____ – _____

SC 49 OVER TYGER RIVER
UNION COUNTY, SOUTH CAROLINA

MASW LOCATION PLAN

F&ME JOB NO. G6658.002

SCALE: 1"=100' | **FIGURE 2**



S-wave velocity model (initial) : SC49TygerR.rst

Average Vs 100ft = 1116.9 ft/sec

Appendix C. Laboratory Testing

SUMMARY OF LABORATORY RESULTS

PROJECT ID P041237 **PROJECT NAME** SC 49 over Tyger Creek

PROJECT COUNTY Union, SC

Borehole	Depth	Liquid Limit	Plastic Limit	Plasticity Index	Maximum Size (mm)	%<#200 Sieve	Class-ification	Water Content (%)	Dry Density (pcf)	Satur-ation (%)	Void Ratio
B-35	0.0						SC	13.1			
B-35	4.0	27	22	5	0.075	49	SM	17.4			
B-35	8.0	32	23	9	0.075	48	SC	19.3			
B-35	12.0	35	22	13	0.075	55	CL	24.0			
B-35	16.0	52	23	29	0.075	32	SC	21.9			
B-35	18.0	46	18	28	0.075	26	SC	18.7			
B-35	24.0	45	27	18	0.075	53	ML	35.2			
B-35	40.0	NP	NP	NP	0.075	28	SM	25.9			
B-35	53.5	NP	NP	NP	0.075	26	SM	20.8			
B-36	0.0	28	25	3	0.075	36	SM	22.2			
B-36	4.0	NP	NP	NP	0.075	44	SM	16.7			
B-37	2.0	NP	NP	NP	0.075	21	SM	28.8			
B-37	6.0				0.075	11	SP-SM	28.9			
B-37	13.5	NP	NP	NP	0.075	44	SM	34.9			
B-37	23.5				0.075	18	SM	15.3			
B-38	4.0				0.075	3	SP	20.4			
B-38	13.5				0.075	5	SP	19.1			
B-38	23.5	30	26	4	0.075	31	SM	16.7			
B-39	2.0	43	34	9	0.075	83	ML	31.0			
B-39	4.0	38	29	9	0.075	77	ML	41.8			
B-39	23.5	NP	NP	NP	0.075	36	SM	32.9			
B-40	2.0	45	29	16	0.075	83	ML	46.9			
B-40	6.0	29	24	5	0.075	76	ML	34.4			
B-40	18.5	29	19	10	0.075	43	SC	21.9			
B-41	2.0	47	23	24	0.075	61	CL	25.6			
B-41	6.0	40	25	15	0.075	59	CL	24.8			
B-41	8.0	NP	NP	NP	0.075	55	ML	25.5			
B-41	28.5	NP	NP	NP	0.075	39	SM	20.8			

Rock Coring Summary

PROJECT ID P041237 **PROJECT NAME** SC 49 over Tyger Creek

PROJECT COUNTY Union, SC

Borehole	Core Run Number	Core Run Top Depth	REC (%)	RQD (%)	q_u (psi)	Poisson's Ratio	Secant Modulus (ksi)	Unit Weight (pcf)	RMR	GSI
B-36	NQ-1	13.5	24	0						33
B-36	NQ-2	18.5	0	0						
B-36	NQ-3	23.5	0	0						
B-36	NQ-4	28.5	27	0						23
B-36	NQ-5	33.5	0	0						
B-36	NQ-6	38.5	57	15	2000		110	156	42	33
B-36	NQ-7	43.5	53	0						38
B-37	NQ-1	33.5	82	8						33
B-37	NQ-2	38.5	90	0						28
B-37	NQ-3	43.5	50	0						18
B-37	NQ-4	48.5	100	0						28
B-37	NQ-5	53.5	100	30	2310		129	154	47	38
B-38	NQ-1	25.0	40	7	22740	0.07	5460	165	52	28
B-38	NQ-2	30.0	100	25						48
B-38	NQ-3	35.0	93	62	27920	0.20	6720	164	62	38
B-38	NQ-4	40.0	100	100	29570	0.15	8470	165	66	78
B-38	NQ-4	40.0	100	100	30820	0.14	5330	164	69	78
B-39	NQ-1	32.9	70	0						28
B-39	NQ-2	37.9	70	35	12300	0.05	2490	164	52	33
B-39	NQ-3	42.9	100	83	19850	0.12	5860	165	66	48
B-39	NQ-3	42.9	100	83	17060		2380	164	66	48
B-39	NQ-4	47.9	100	93	26780		4940	163	69	63
B-39	NQ-4	47.9	100	93	31520	0.24	8610	164	72	63
B-40	NQ-1	37.8	53	0						23
B-40	NQ-2	42.8	50	0						8
B-40	NQ-3	47.8	67	12	6810	0.09	1500	161	44	28
B-40	NQ-4	52.8	60	7						23
B-40	NQ-5	57.8	100	48	12940		3190	162	52	38
B-40	NQ-5	57.8	100	48	27080	0.21	8910	164	57	38
B-41	NQ-1	49.0	81	13						23
B-41	NQ-2	51.7	46	0						28
B-41	NQ-3	56.7	95	13						28

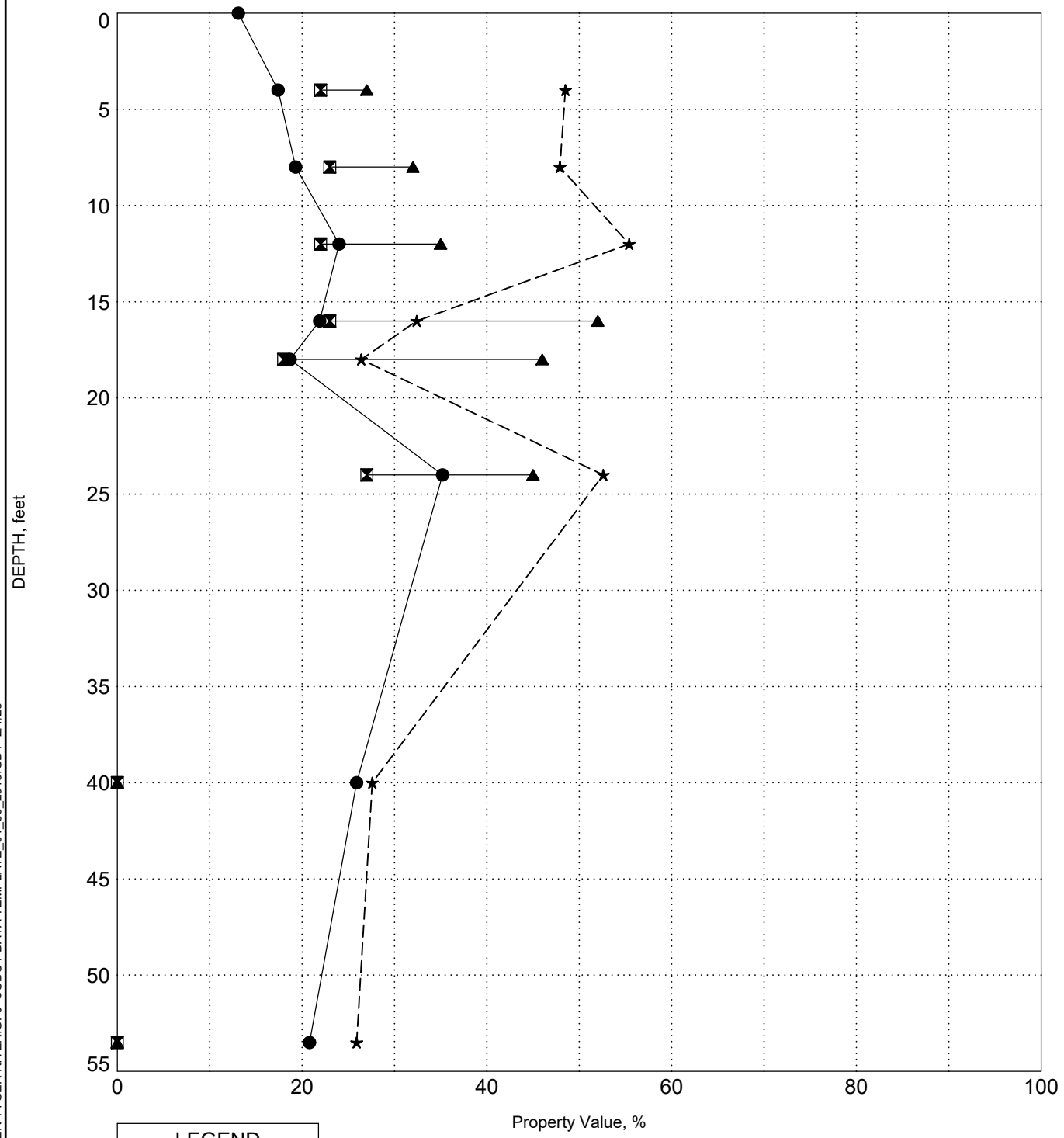
INDEX PROPERTIES VERSUS DEPTH

PROJECT ID P041237 **PROJECT NAME** SC 49 over Tyger Creek

PROJECT COUNTY Union, SC

BORING B-35

SURFACE ELEVATION: 407.9



LEGEND
● Water Content
⊠ Plastic Limit
▲ Liquid Limit
★ Fines

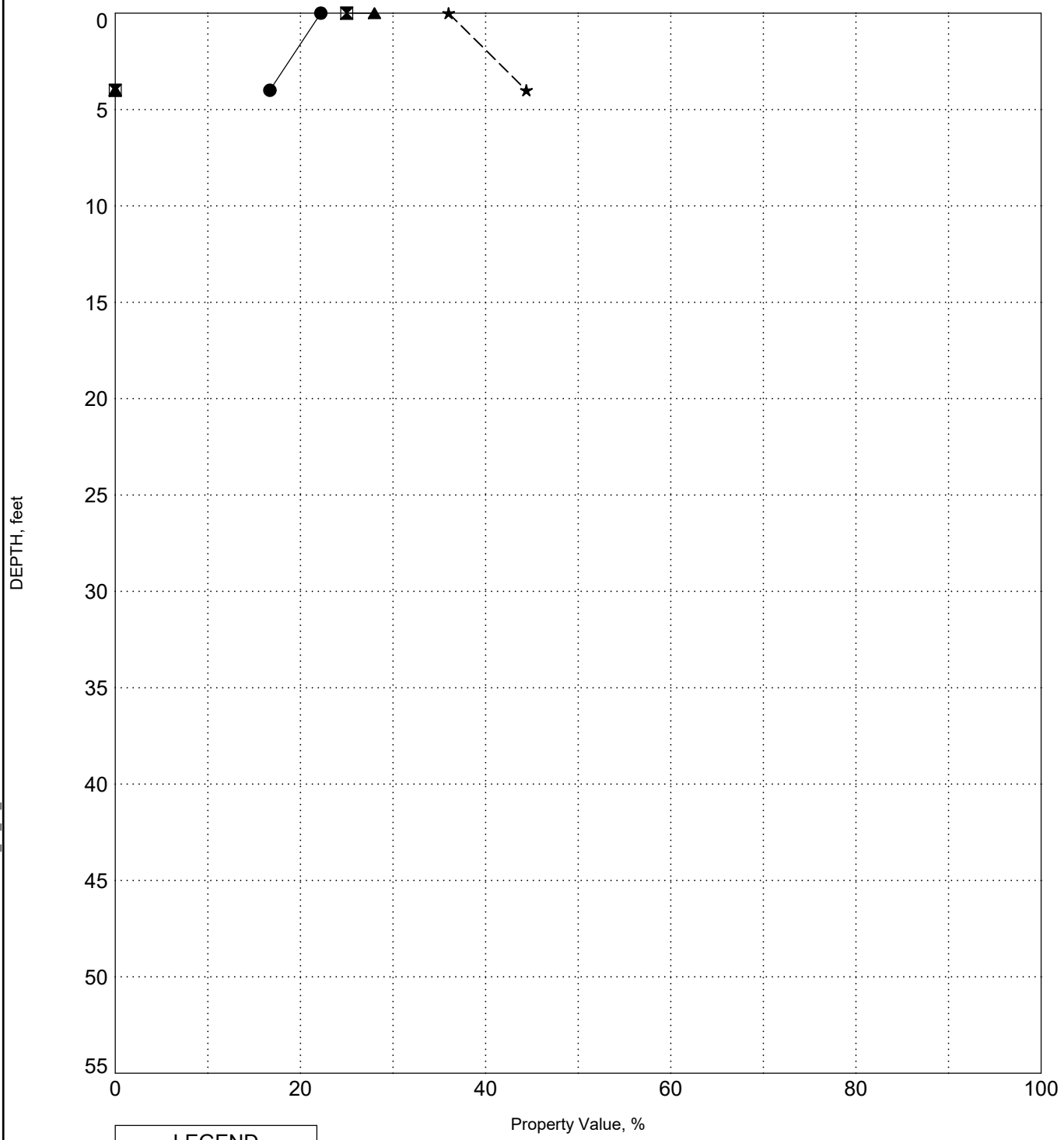
INDEX PROPERTIES VERSUS DEPTH

PROJECT ID P041237 **PROJECT NAME** SC 49 over Tyger Creek

PROJECT COUNTY Union, SC

BORING B-36

SURFACE ELEVATION: 380.9



LEGEND
● Water Content
⊠ Plastic Limit
▲ Liquid Limit
★ Fines

INDEX PROPS SC 49 OVER TYGER RIVER.GPJ SCDOT DATA TEMPLATE_01_30_2015.GDT 2/1/23

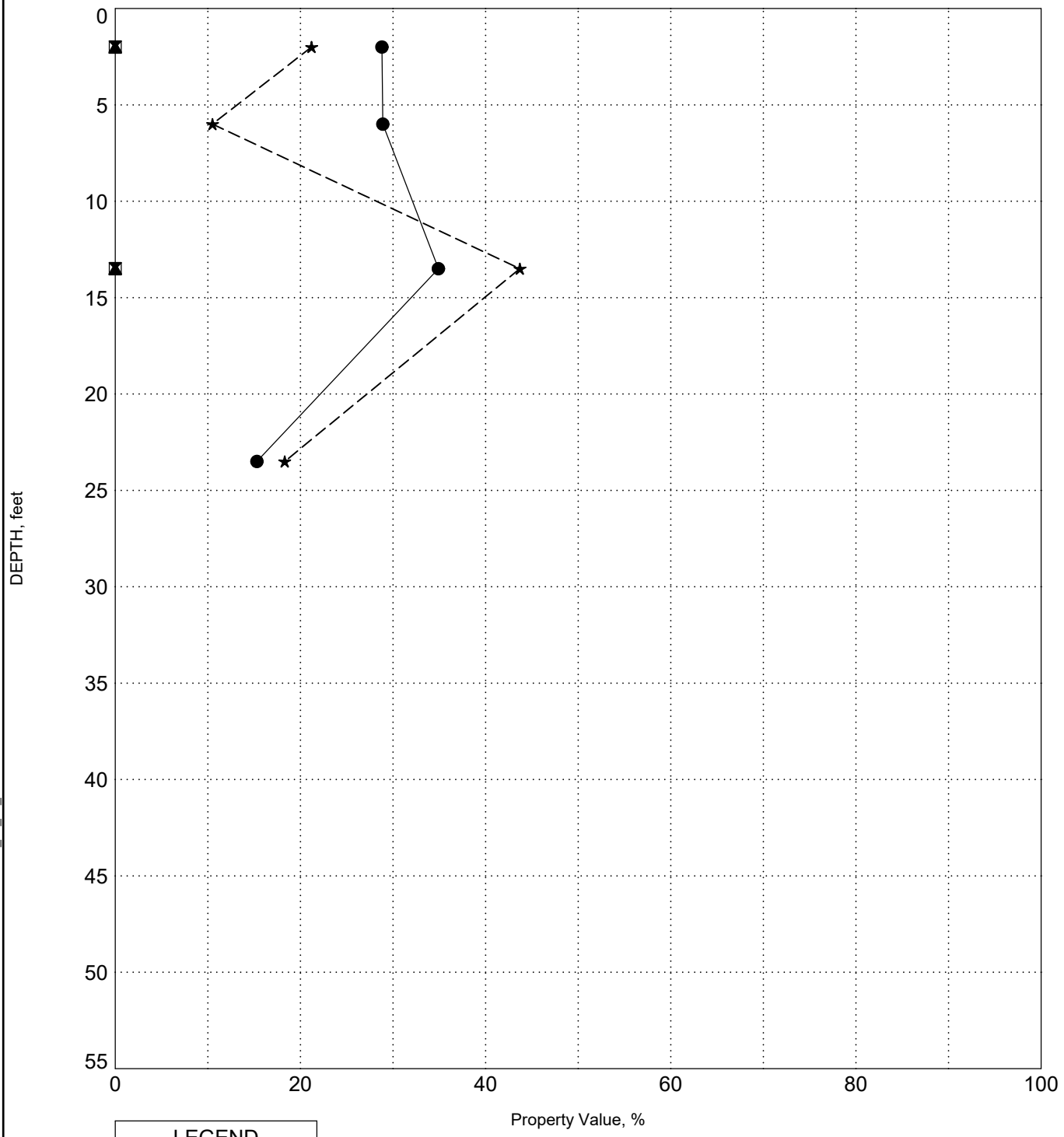
INDEX PROPERTIES VERSUS DEPTH

PROJECT ID P041237 **PROJECT NAME** SC 49 over Tyger Creek

PROJECT COUNTY Union, SC

BORING B-37

SURFACE ELEVATION: 380.4



LEGEND
● Water Content
⧗ Plastic Limit
▲ Liquid Limit
★ Fines

INDEX PROPS SC 49 OVER TYGER RIVER.GPJ SCDOT DATA TEMPLATE_01_30_2015.GDT 2/1/23

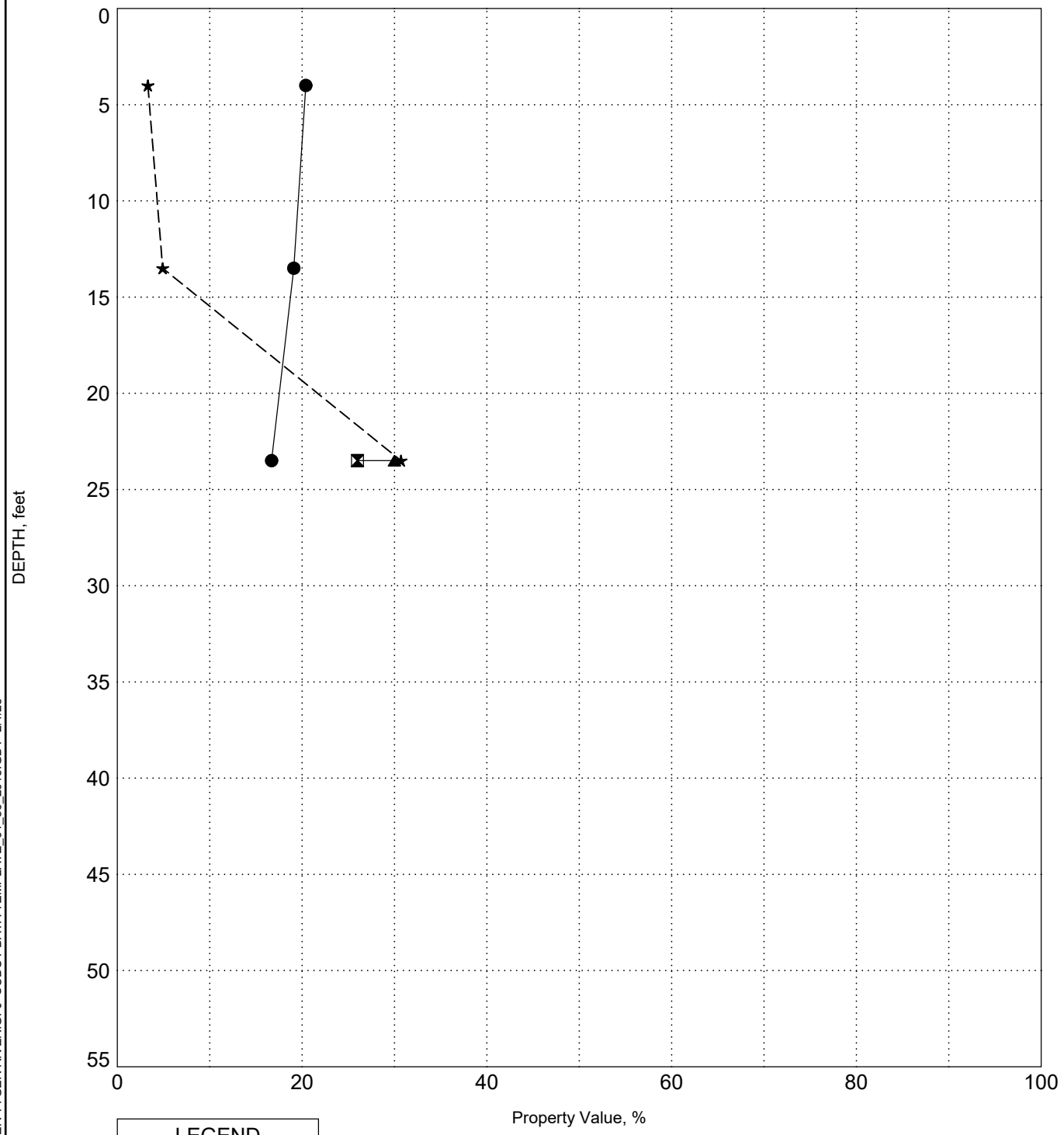
INDEX PROPERTIES VERSUS DEPTH

PROJECT ID P041237 **PROJECT NAME** SC 49 over Tyger Creek

PROJECT COUNTY Union, SC

BORING B-38

SURFACE ELEVATION: 374.2



LEGEND
● Water Content
⊠ Plastic Limit
▲ Liquid Limit
★ Fines

INDEX PROPS SC 49 OVER TYGER RIVER.GPJ SCDOT DATA TEMPLATE_01_30_2015.GDT 2/1/23

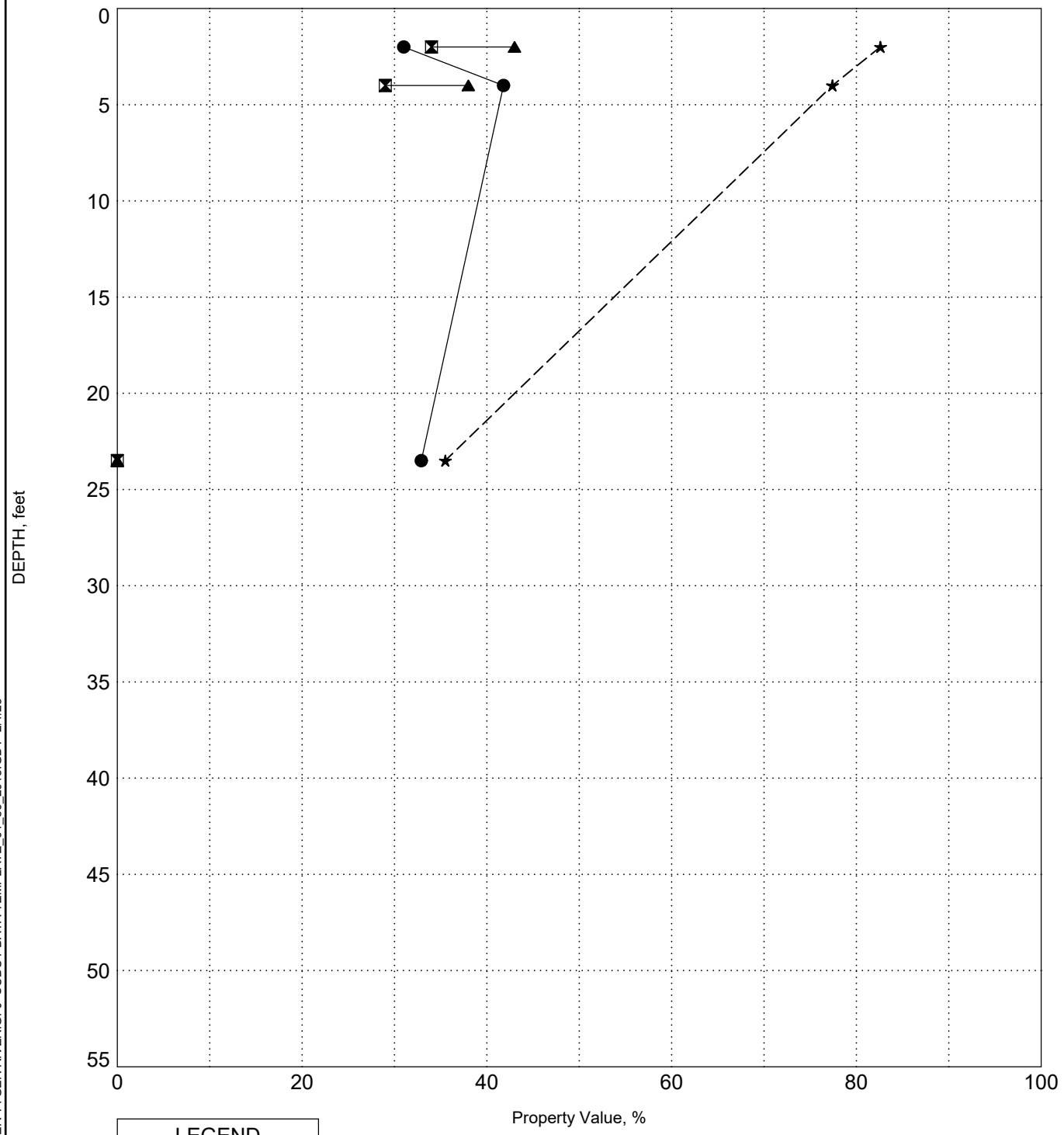
INDEX PROPERTIES VERSUS DEPTH

PROJECT ID P041237 **PROJECT NAME** SC 49 over Tyger Creek

PROJECT COUNTY Union, SC

BORING B-39

SURFACE ELEVATION: 382.0



LEGEND
● Water Content
⊠ Plastic Limit
▲ Liquid Limit
★ Fines

INDEX PROPS SC 49 OVER TYGER RIVER.GPJ SCDOT DATA TEMPLATE_01_30_2015.GDT 2/1/23

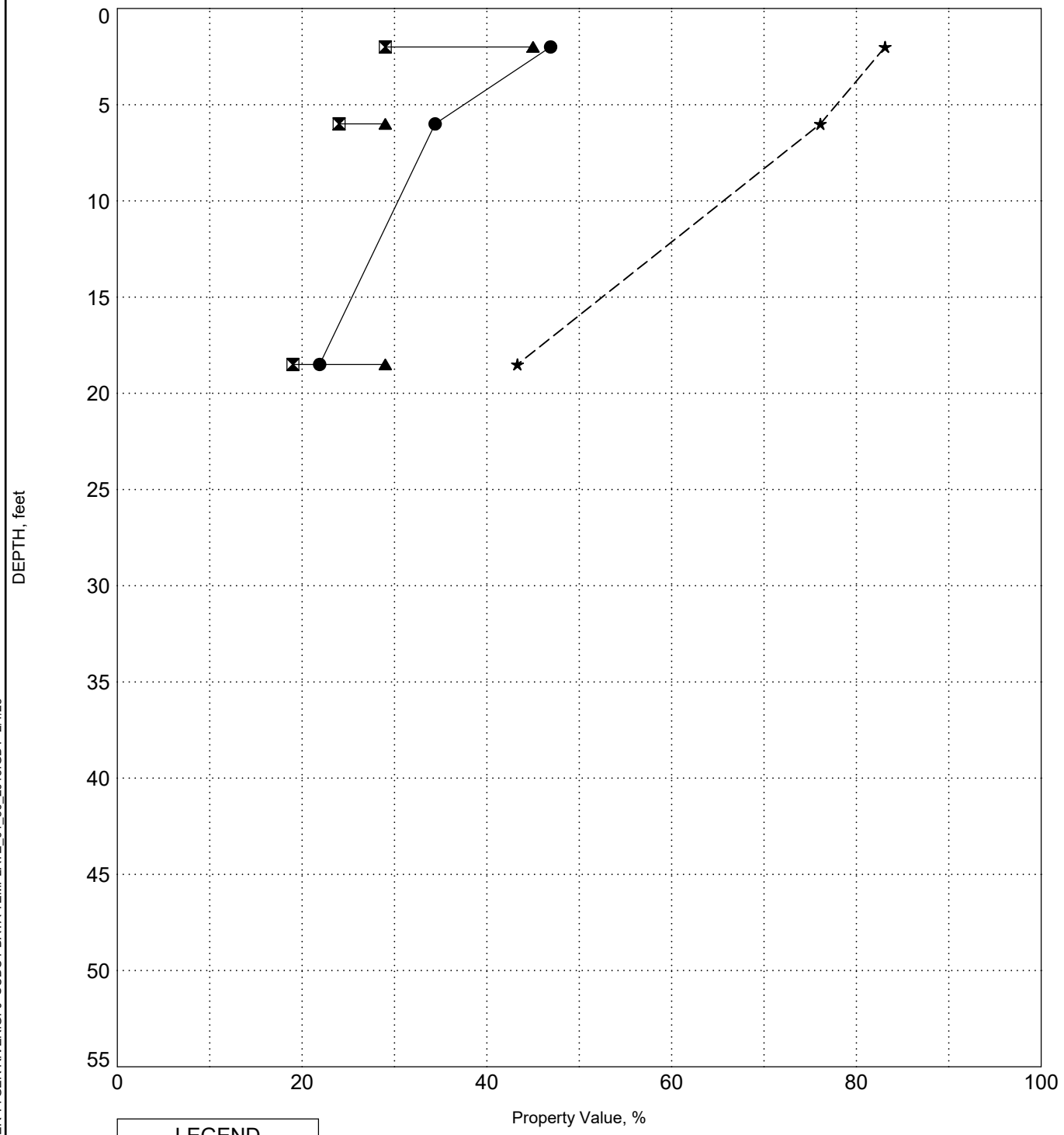
INDEX PROPERTIES VERSUS DEPTH

PROJECT ID P041237 **PROJECT NAME** SC 49 over Tyger Creek

PROJECT COUNTY Union, SC

BORING B-40

SURFACE ELEVATION: 380.5



LEGEND
● Water Content
⊠ Plastic Limit
▲ Liquid Limit
★ Fines

INDEX PROPS SC 49 OVER TYGER RIVER.GPJ SCDOT DATA TEMPLATE_01_30_2015.GDT 2/1/23

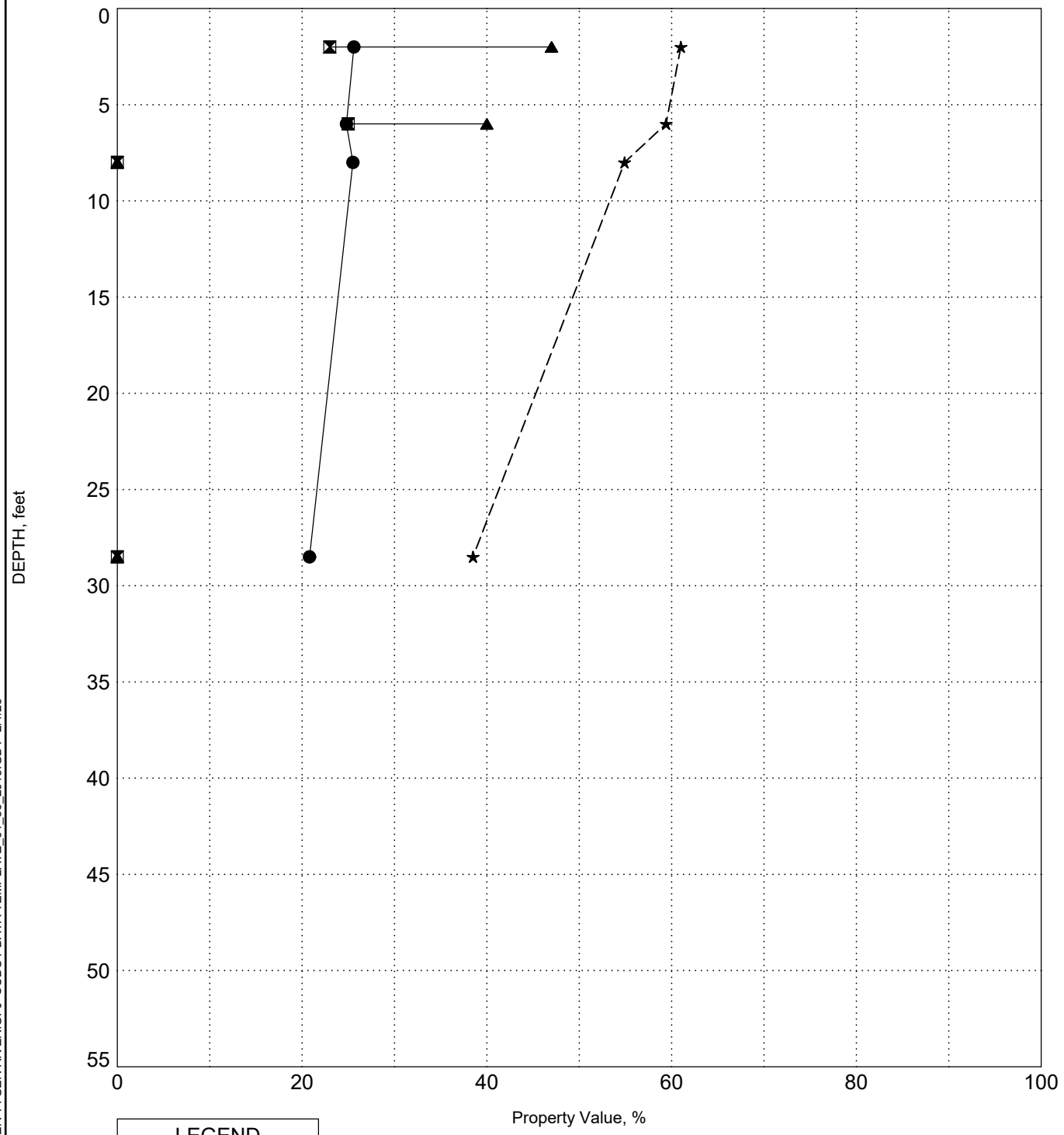
INDEX PROPERTIES VERSUS DEPTH

PROJECT ID P041237 **PROJECT NAME** SC 49 over Tyger Creek

PROJECT COUNTY Union, SC

BORING B-41

SURFACE ELEVATION: 407.9



LEGEND
● Water Content
⊠ Plastic Limit
▲ Liquid Limit
★ Fines

INDEX PROPS SC 49 OVER TYGER RIVER.GPJ SCDOT DATA TEMPLATE_01_30_2015.GDT 2/1/23

Laboratory Testing Procedures

Grain Size Distribution

Wash #200 Testing has been conducted following ASTM D1140 Standard Test Methods for Determining the Amount of Material Finer that 75-µm (No. 200) Sieve in Soils by Washing. Full grain size analysis was conducted on select samples following ASTM D6913 Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.

Hydrometer

Hydrometer grain size analysis for soils was conducted following ASTM D7928 Standard Test Method for Particle Size Analysis of Soils.

Atterberg Limits

Atterberg limits testing have been conducted following ASTM D4318 Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.

Moisture Content

Moisture content testing has been conducted following ASTM D2216 Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock.

Standard Proctor

Standard Proctor testing has been conducted following ASTM D698 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft 3 (600kN-m/m3)).

Consolidated-Undrained Triaxial Test

CU testing allows the soil specimen to be consolidated under a confining pressure prior to shear and has been conducted following ASTM D4767 Standard Test Method for Consolidated-Undrained Triaxial Compression Test for Cohesive Soils. The soil specimens in this case were bulk samples that were remolded and compacted to 95% of the Standard Proctor.

Corrosion Series

Corrosion series testing has been conducted including pH, chloride content, sulfate content, and resistivity. PH testing was conducted AASHTO T289 Standard Method of Test for Determining pH of Soil for Use is Corrosion Testing. Chloride content testing was conducted following AASHTO T291 Standard Method of Test for Determining Water-Soluble Chloride Ion Content in Soil. Sulfate content testing was conducted following AASHTO T290 Standard Method of Test for Determining Water-Soluble Sulfate Content in Soil. Resistivity testing was conducted following AASHTO T288 Standard Method of Test for Determining Minimum Laboratory Soil Resistivity.

Compressive Strength of Rock Cores

Compressive strength of rock cores has been conducted following ASTM D7012 Standard Test for Compressive Strength and Elastic Moduli of Intact Rock Core Specimens under Varying States of Stress and Temperatures.

Appendix C. Laboratory Testing

Split Spoon Samples

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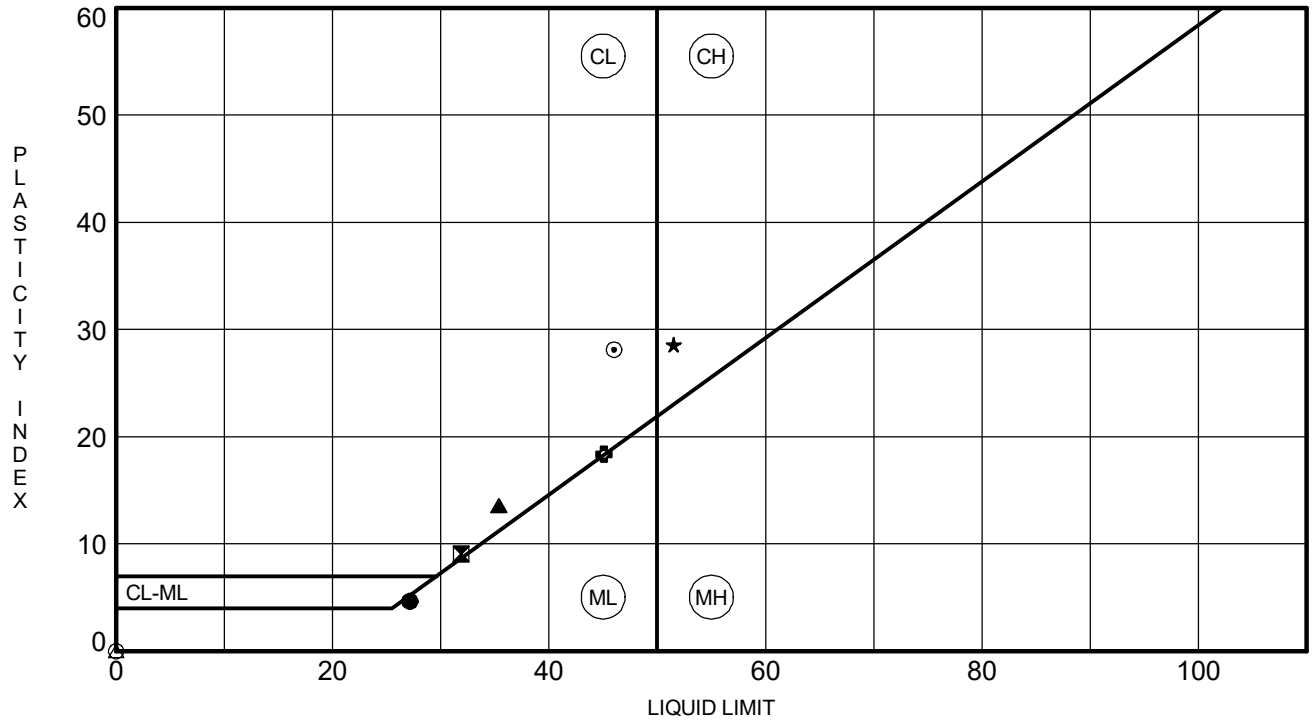
ATTERBERG LIMITS' RESULTS

PROJECT ID P041237 **PROJECT NAME** SC 49 over Tyger River

PROJECT COUNTY Union County, SC



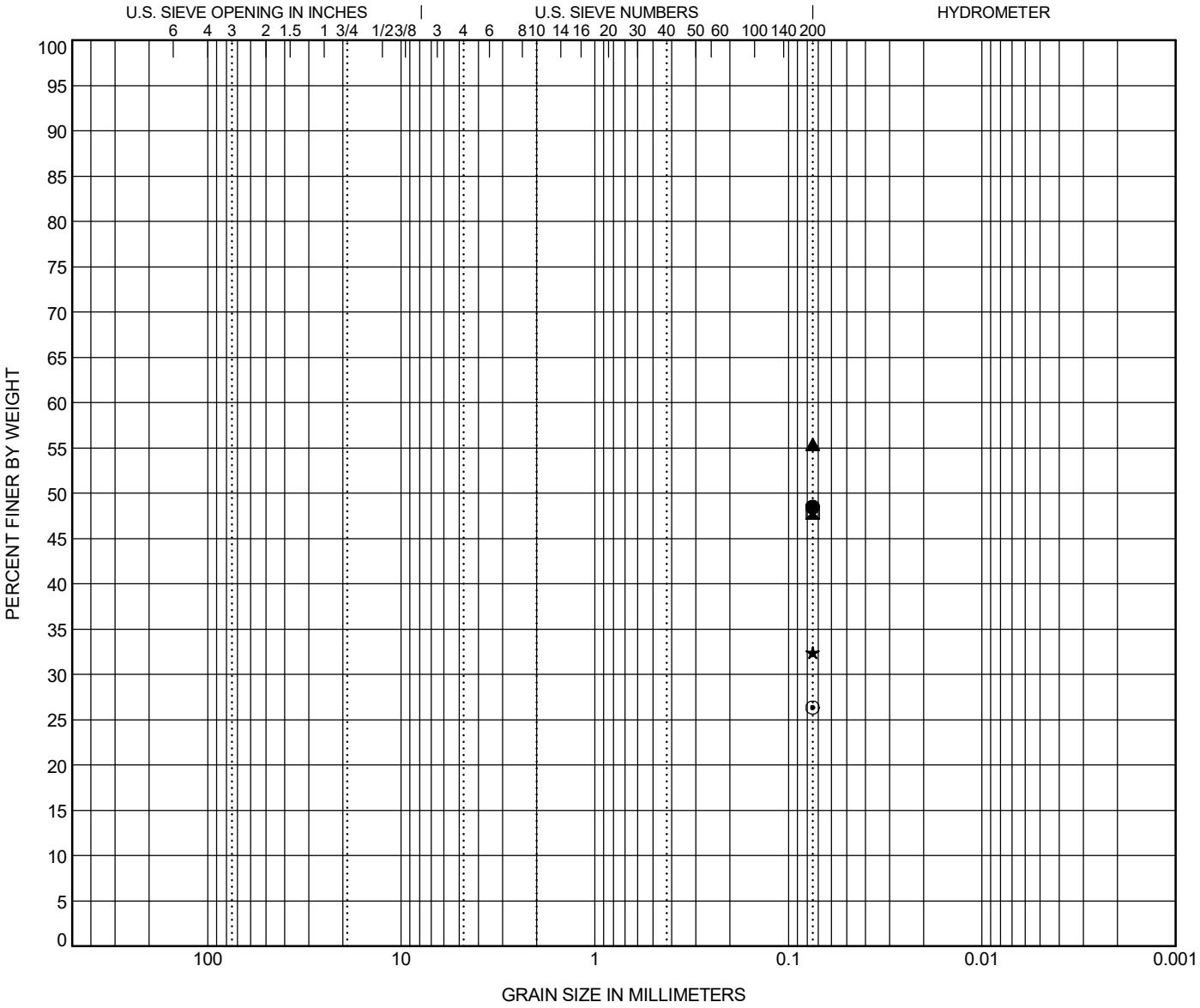
	BOREHOLE	DEPTH	LL	PL	PI	Fines	Classification
●	B-35	6.0	27	22	5	48	SILTY SAND (SM/A-4)
⊠	B-35	10.0	32	23	9	48	CLAYEY SAND (SC/A-4)
▲	B-35	14.0	35	22	13	55	SANDY LEAN CLAY (CL/A-6)
★	B-35	18.0	52	23	29	32	CLAYEY SAND (SC/A-2-7)
⊙	B-35	24.0	46	18	28	26	CLAYEY SAND (SC/A-2-7)
✿	B-35	26.0	45	27	18	53	SANDY SILT (ML/A-7-6)
○	B-35	42.0	NP	NP	NP	28	SILTY SAND (SM/A-2-4)
△	B-35	55.0	NP	NP	NP	26	SILTY SAND (SM/A-2-4)

ATTERBERG LIMITS G6658.002 - SC 49 RBO TYER RIVER.GPJ SCDOT DATA TEMPLATE_01_30_2015.GDT 1/24/23

GRAIN SIZE DISTRIBUTION

PROJECT ID P041237 **PROJECT NAME** SC 49 over Tyger River

PROJECT COUNTY Union County, SC



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

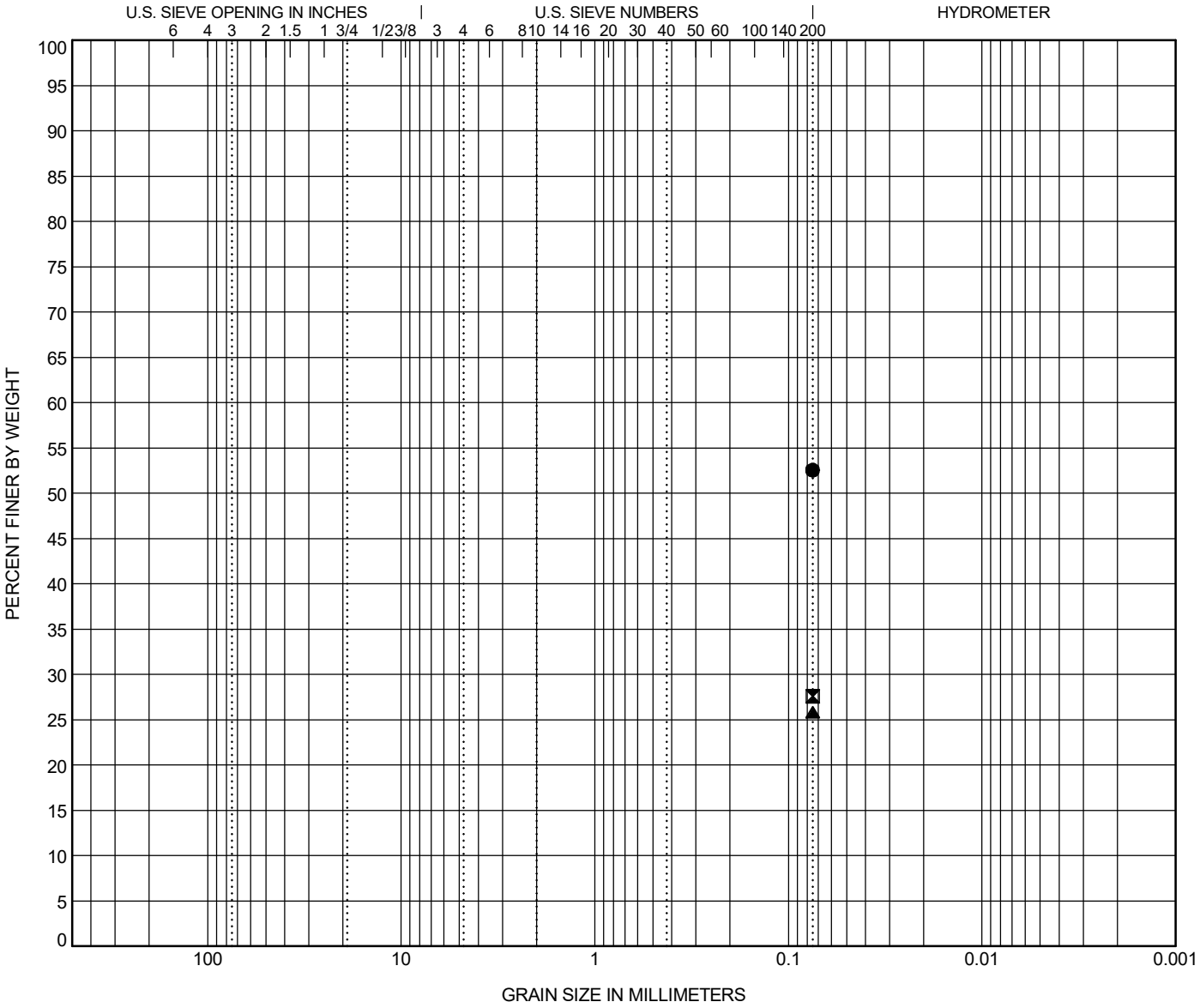
	BOREHOLE	DEPTH	Classification	LL	PL	PI	Cc	Cu
●	**B-35**	**6.0**	**SILTY SAND (SM/A-4)**	**27**	**22**	**5**		
⊠	**B-35**	**10.0**	**CLAYEY SAND (SC/A-4)**	**32**	**23**	**9**		
▲	**B-35**	**14.0**	**SANDY LEAN CLAY (CL/A-6)**	**35**	**22**	**13**		
★	**B-35**	**18.0**	**CLAYEY SAND (SC/A-2-7)**	**52**	**23**	**29**		
⊙	**B-35**	**24.0**	**CLAYEY SAND (SC/A-2-7)**	**46**	**18**	**28**		

	BOREHOLE	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**B-35**	**6.0**	**0.075**						**48.5**	
⊠	**B-35**	**10.0**	**0.075**						**47.9**	
▲	**B-35**	**14.0**	**0.075**						**55.4**	
★	**B-35**	**18.0**	**0.075**						**32.4**	
⊙	**B-35**	**24.0**	**0.075**						**26.4**	

GRAIN SIZE DISTRIBUTION

PROJECT ID P041237 **PROJECT NAME** SC 49 over Tyger River

PROJECT COUNTY Union County, SC



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	BOREHOLE	DEPTH	Classification	LL	PL	PI	Cc	Cu
●	**B-35**	**26.0**	**SANDY SILT (ML/A-7-6)**	**45**	**27**	**18**		
⊠	**B-35**	**42.0**	**SILTY SAND (SM/A-2-4)**	**NP**	**NP**	**NP**		
▲	**B-35**	**55.0**	**SILTY SAND (SM/A-2-4)**	**NP**	**NP**	**NP**		

	BOREHOLE	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**B-35**	**26.0**	**0.075**						**52.6**	
⊠	**B-35**	**42.0**	**0.075**						**27.6**	
▲	**B-35**	**55.0**	**0.075**						**25.9**	

F&ME CONSULTANTS, INC.

MOISTURE CONTENT DETERMINATION
(AASHTO T265)

PROJECT:	SC 49 over Tyger River	**SCDOT PROJECT ID:**	P041237
SAMPLE NUMBER:	22-3367	**DATE SAMPLE RECEIVED:**	12/22/2022
DESCRIPTION OF SOIL:	Various		
TESTED BY:	MW & JJW	**DATE SETUP:**	12/26/2022
WEIGHED BY:	TP	**DATE OF WEIGHING:**	12/27/2022

BORING NO.	B-35	B-35	B-35	B-35	B-35
SAMPLE NO.	SS-1	SS-3	SS-5	SS-7	SS-9
SAMPLE DEPTH (FT.)	0.0 - 2.0	4.0 - 6.0	8.0 - 10.0	12.0 - 14.0	16.0 - 18.0
WATER CONTENT, W%	13.1	17.4	19.3	24.0	21.9

BORING NO.	B-35	B-35	B-35	B-35	
SAMPLE NO.	SS-10/SS-11/SS-12	SS-13	SS-21	SS-26	
SAMPLE DEPTH (FT.)	18.0 - 24.0	24.0 - 26.0	40.0 - 42.0	53.5 - 55.0	
WATER CONTENT, W%	18.7	35.2	25.9	20.8	

BORING NO.					
SAMPLE NO.					
SAMPLE DEPTH (FT.)					
WATER CONTENT, W%					

BORING NO.					
SAMPLE NO.					
SAMPLE DEPTH (FT.)					
WATER CONTENT, W%					

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January 16, 2023

Project No. 2023-006-001

Mr. Alex Abernethy
F&ME Consultants, Inc.
3112 Devine Street
Columbia, SC 29205

Transmittal
Laboratory Test Results
SC 49 Tyger River G6658.002

Please find attached the laboratory test results for the above referenced project. The tests were outlined on the Project Verification Form that was transmitted to your firm prior to the testing. The testing was performed in general accordance with the methods listed on the enclosed data sheets. The test results are believed to be representative of the samples that were submitted for testing and are indicative only of the specimens that were evaluated. We have no direct knowledge of the origin of the samples and imply no position with regard to the nature of the test results, i.e. pass/fail and no claims as to the suitability of the material for its intended use.

The test data and all associated project information provided shall be held in strict confidence and disclosed to other parties only with authorization by our Client. The test data submitted herein is considered integral with this report and is not to be reproduced except in whole and only with the authorization of the Client and Geotechnics. The remaining sample materials for this project will be retained for a minimum of 90 days as directed by the Geotechnics' Quality Program.

We are pleased to provide these testing services. Should you have any questions or if we may be of further assistance, please contact our office.

Respectfully submitted,
Geotechnics, Inc.

Nathan Melaro
Director of Operations

We understand that you have a choice in your laboratory services and we thank you for choosing Geotechnics.

DCN: Data Transmittal Letter Date: 1/28/05 Rev.: 1

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CHLORIDE ION CONTENT IN SOILS

AASHTO T 291 - 94 (2018) (*Method B*)

Client:	F&ME Consultants, Inc.	Boring No.:	B-35
Client Reference:	SC 49 over Tyger River	Depth (ft):	18.0-24.0'
Project No.:	2023-006-001	Sample No.:	SS-10, SS-11 & SS-12
Lab ID:	2023-006-001-001	Description:	Orange Brown Soil

(- # 10 Sieve material)

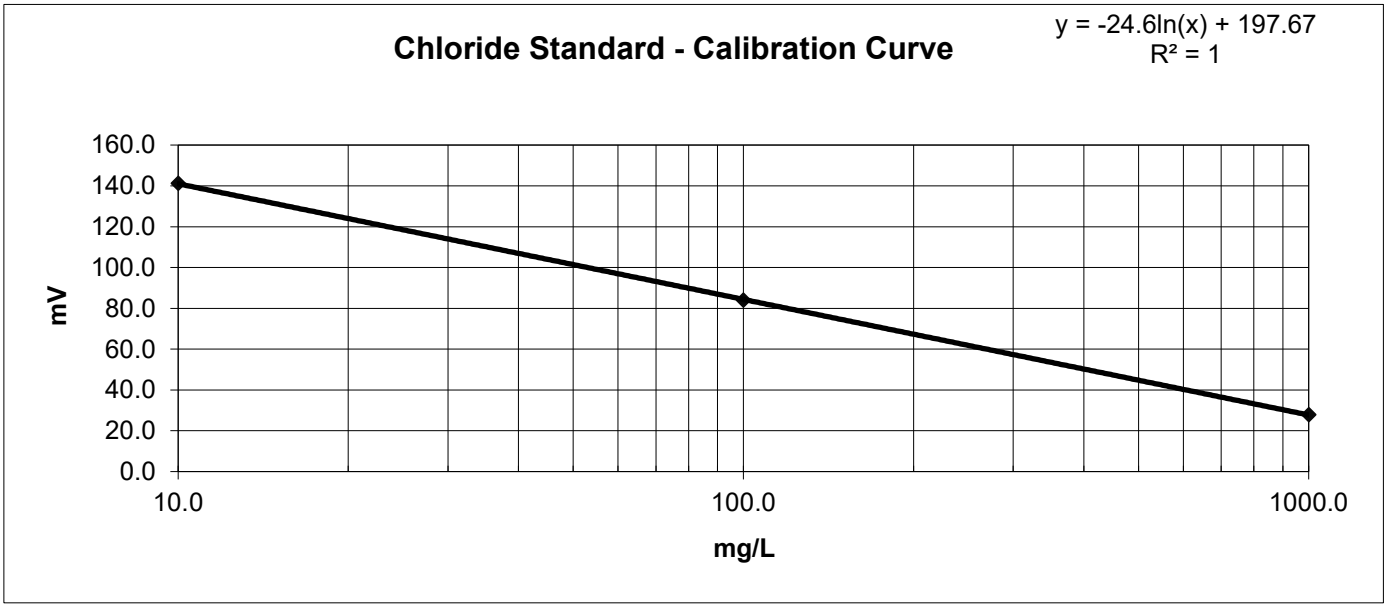
CHLORIDE STANDARD: CALIBRATION CURVE

STANDARD		MILLIVOLTS (mV)
10.0	mg/L	141.2
100.0	mg/L	84.0
1000.0	mg/L	27.9

MEASUREMENT OF CHLORIDES

		CONCENTRATION (mg/L)	CONCENTRATION (mg/kg)
Sample Weight (g):	100.0		
Water added to Sample (ml):	100.0		
Size of Sample Aliquot (ml):	25.0		
Sample Reading (mV):	155.5	5.55	5.55

Notes: 1) Samples and standards were buffered by the addition of an equal volume of the 0.2 M KNO_3 solution (1:1 volume).
2) Samples were dried for a minimum of 12 hours at 110 $^{+}/_{-}$ 5°C.



Notes:

Tested By	JAM	Date	1/12/23	Checked By	JLK	Date	1/13/23

DCN: CT-S63A DATE: 6/2/14 REVISION: 1

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REV 03/2021

pH Determination
(AASHTO T289)

Project Name:	SC 49 over Tyger River	SCDOT Project ID:	P041237
Sample Location:	B-35	Sample Elevation/Depth:	18.0 - 24.0
Description of Sample:	Clayey SAND (SC/A-2-7)	Date Sampled:	12/15/2022
Tested By:	R. Coldiron	Date Tested:	1/10/2023

FME Lab ID No.	22-3290			
Sample ID	B-35			
Depth (ft.)	18.0 - 24.0			
pH Value	5.86			
Temperature (˚C)	21.8			

Date Reviewed: 1/10/2023

Reviewed By: J. Hiers

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SOIL RESISTIVITY
(AASHTO T288)

Project Name:	SC 49 over Tyger River	SCDOT Project ID:	P041237
Location:	Union County, SC	FME Lab ID No.:	22-3367
Sampled By:	HDR	Date Sampled:	12/15/2022
Soil Description:	Clayey SAND (SC/A-2-7)	Date Received:	12/15/2022
Tested By:	CM	Date Tested:	1/4/2023

Boring No.	Sample Depth (ft.)	Minimum Soil Resistivity, Ω-cm
B-35	18.0 - 24.0	12,052

Date Reviewed: 1/18/2023 Reviewed By: J. Hiers

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Water-Soluble Sulfate Ion Content in Soil

AASHTO T 290-95 (2020)

Client:	F&ME Consultants, Inc.	Boring No.:	B-35
Client Reference:	SC 49 over Tyger River	Depth (ft):	18.0-24.0'
Project No.:	2023-006-001	Sample No.:	SS-10, SS-11 & SS-12
Lab ID:	2023-006-001-001	Soil Description:	Orange & Brown Soil

Sulfate Standard - Calibration Curve Spectrophotometer Readings

Sulfate Ion Concentrations (mg/L)								
0.0	4.0	10.0	20.0	30.0	40.0	60.0	80.0	100.0
Spectrophotometer Readings (FAU)								
Underrange	Underrange	8	18	36	61	126	165	247

Measurement of Barium Chloride Turbidity

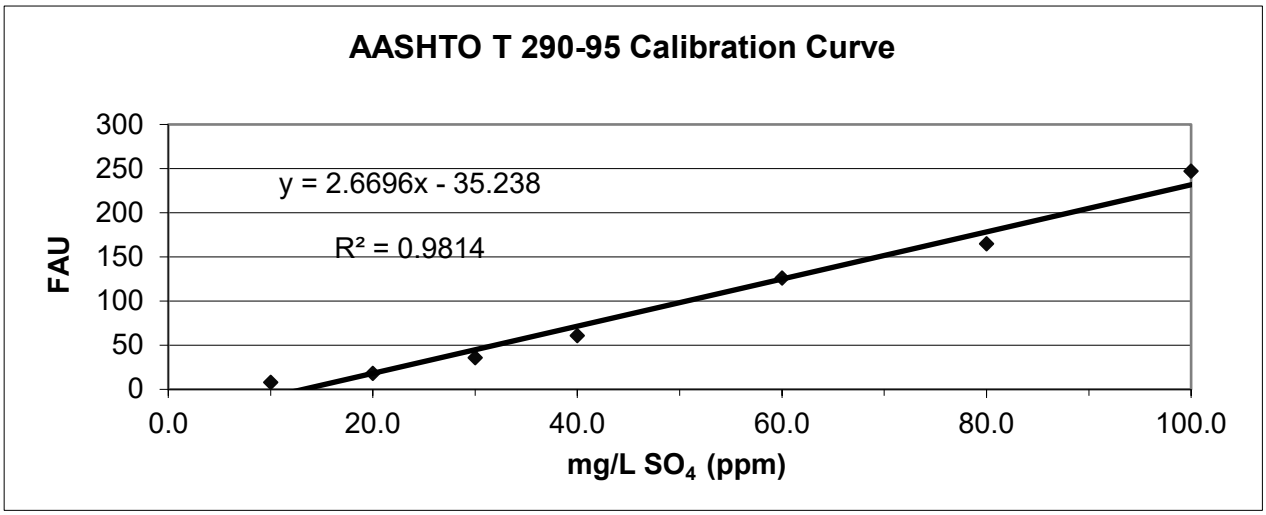
(Sample contains 5.0 mL NaCl solution and 0.3 g $BaCl_2 \cdot 2H_2O$)

Sample Weight (g):	100.0
Water added to Sample (mL):	300.0
Size of Sample Aliquot (mL):	50.0
Sample Reading (FAU):	14
Sample Diluted:	No
Sulfate Solution Added (ml):	5

Sample Moisture Content

Tare Number:	605
Weight of Tare & Wet Sample (g):	255.21
Weight of Tare & Dry Sample (g):	253.99
Weight of Tare (g):	85.91
Weight of Water (g):	1.22
Weight of Dry Sample (g):	168.08
Moisture Content (%):	0.73

Sample Sulfate Ion Concentration:	17.94	**mg/L SO_4 (ppm)**
Sample Sulfate Ion Content:	53.8	**mg/Kg SO_4 (not corrected for moisture)**
Sample Sulfate Ion Content:	54.2	**mg/Kg SO4 (corrected for moisture)**



Tested by: JAM Date: 1/13/23 Checked by: BRB Date: 1/16/2023

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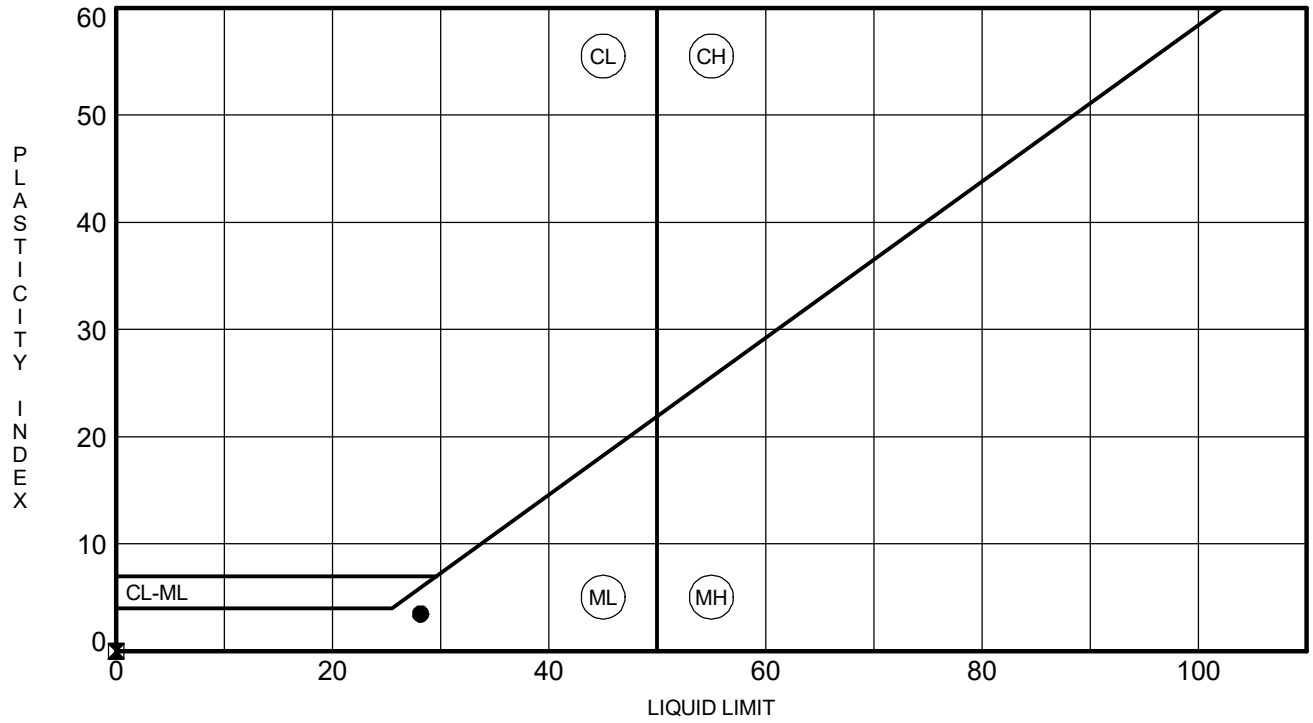
ATTERBERG LIMITS' RESULTS

PROJECT ID P041237 **PROJECT NAME** SC 49 over Tyger River

PROJECT COUNTY Union County, SC



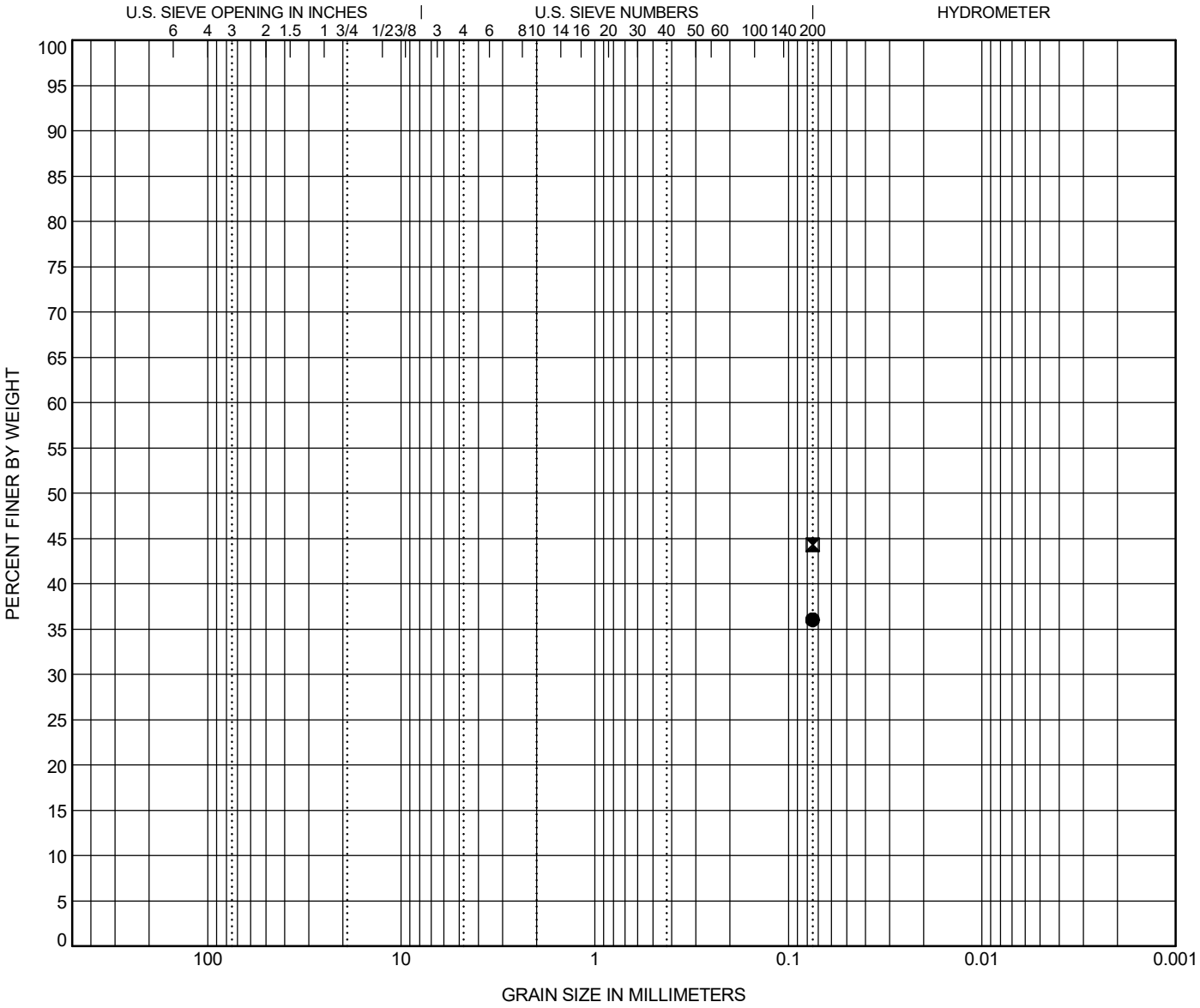
	BOREHOLE	DEPTH	LL	PL	PI	Fines	Classification
●	**B-36**	**2.0**	**28**	**25**	**3**	**36**	**SILTY SAND (SM/A-4)**
⧗	**B-36**	**6.0**	**NP**	**NP**	**NP**	**44**	**SILTY SAND (SM/A-4)**

ATTERBERG LIMITS G6658.002 - SC 49 RBO TYER RIVER.GPJ SCDOT DATA TEMPLATE_01_30_2015.GDT 1/24/23

GRAIN SIZE DISTRIBUTION

PROJECT ID P041237 **PROJECT NAME** SC 49 over Tyger River

PROJECT COUNTY Union County, SC



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	BOREHOLE	DEPTH	Classification	LL	PL	PI	Cc	Cu
●	**B-36**	**2.0**	**SILTY SAND (SM/A-4)**	**28**	**25**	**3**		
⊠	**B-36**	**6.0**	**SILTY SAND (SM/A-4)**	**NP**	**NP**	**NP**		

	BOREHOLE	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**B-36**	**2.0**	**0.075**						**36.0**	
⊠	**B-36**	**6.0**	**0.075**						**44.4**	

GRAIN SIZE G6658.002 - SC 49 RBO TYER RIVER.GPJ SCDOT DATA TEMPLATE_01_30_2015.GDT 1/24/23

F&ME CONSULTANTS, INC.

MOISTURE CONTENT DETERMINATION
(AASHTO T265)

PROJECT:	SC 49 over Tyger River	**SCDOT PROJECT ID:**	P041237
SAMPLE NUMBER:	22-3404	**DATE SAMPLE RECEIVED:**	12/22/2022
DESCRIPTION OF SOIL:	Various		
TESTED BY:	MW & JJW	**DATE SETUP:**	12/26/2022
WEIGHED BY:	TP	**DATE OF WEIGHING:**	12/27/2022

BORING NO.	B-36	B-36			
SAMPLE NO.	SS-1	SS-3			
SAMPLE DEPTH (FT.)	0.0 - 2.0	4.0 - 6.0			
WATER CONTENT, W%	22.2	16.7			

BORING NO.					
SAMPLE NO.					
SAMPLE DEPTH (FT.)					
WATER CONTENT, W%					

BORING NO.					
SAMPLE NO.					
SAMPLE DEPTH (FT.)					
WATER CONTENT, W%					

BORING NO.					
SAMPLE NO.					
SAMPLE DEPTH (FT.)					
WATER CONTENT, W%					

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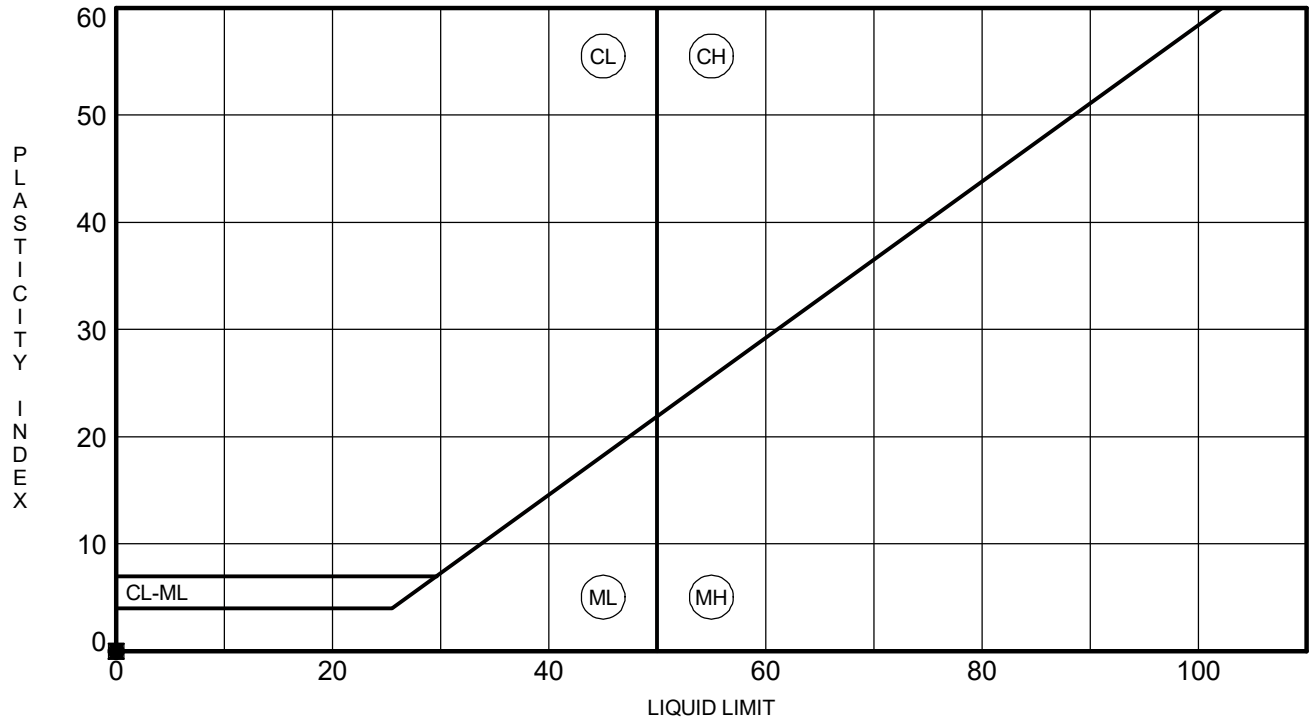
ATTERBERG LIMITS' RESULTS

PROJECT ID P041237 **PROJECT NAME** SC 49 over Tyger River

PROJECT COUNTY Union County, SC

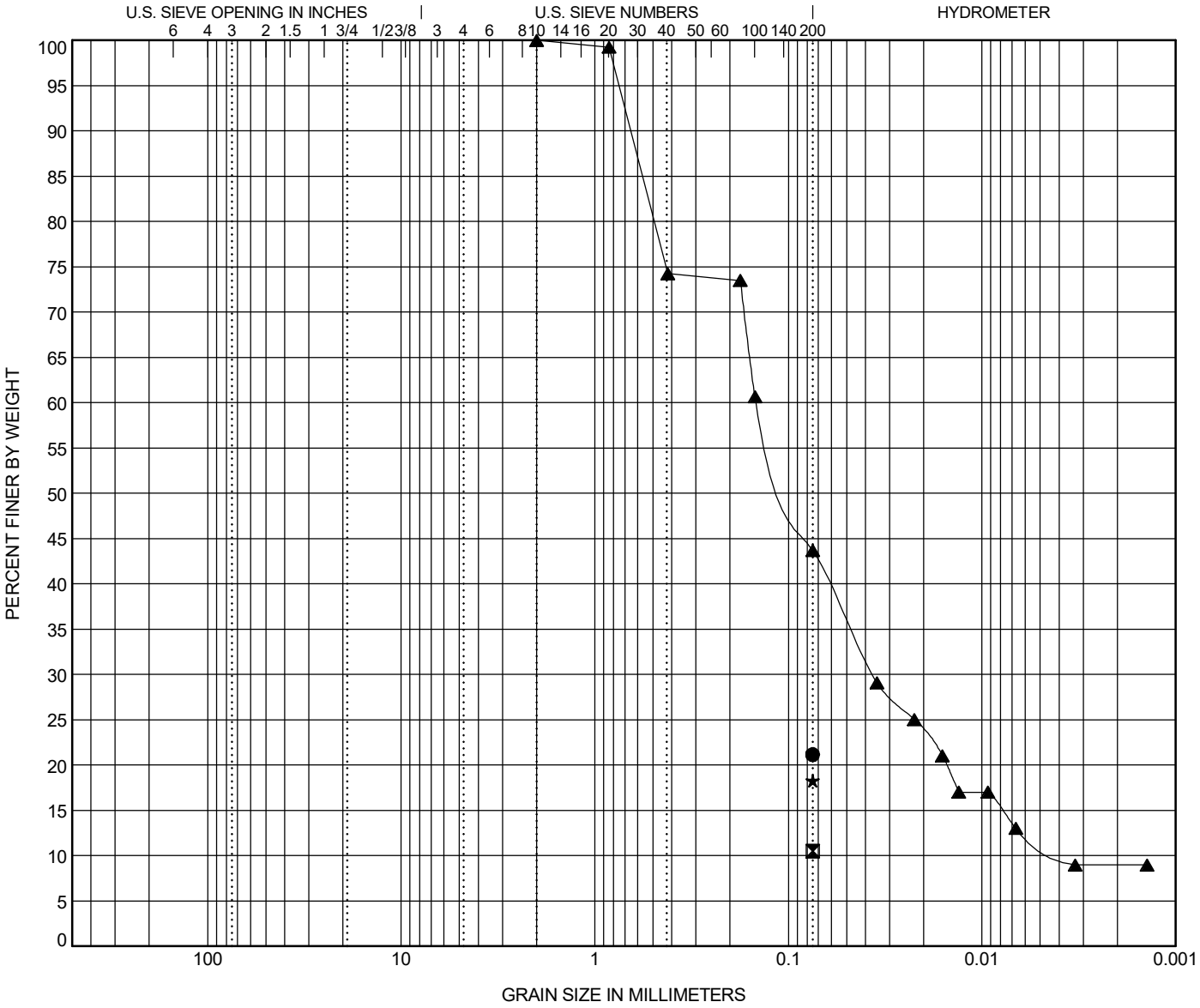


	BOREHOLE	DEPTH	LL	PL	PI	Fines	Classification
●	**B-37**	**4.0**	**NP**	**NP**	**NP**	**21**	**SILTY SAND (SM/A-2-4)**
⧗	**B-37**	**15.0**	**NP**	**NP**	**NP**	**44**	**SILTY SAND (SM/A-4)**

GRAIN SIZE DISTRIBUTION

PROJECT ID P041237 **PROJECT NAME** SC 49 over Tyger River

PROJECT COUNTY Union County, SC



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	BOREHOLE	DEPTH	Classification	LL	PL	PI	Cc	Cu
●	B-37	4.0	SILTY SAND (SM/A-2-4)	NP	NP	NP		
⊠	B-37	8.0	POORLY GRADED SAND with SILT (SP-SM)					
▲	B-37	15.0	SILTY SAND (SM/A-4)	NP	NP	NP	2.34	36.78
★	B-37	25.0	SILTY SAND (SM)					

	BOREHOLE	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	B-37	4.0	0.075						21.2	
⊠	B-37	8.0	0.075						10.5	
▲	B-37	15.0	2	0.145	0.037	0.004	0.0	56.3	32.4	11.3
★	B-37	25.0	0.075						18.3	

F&ME CONSULTANTS, INC.

MOISTURE CONTENT DETERMINATION
(AASHTO T265)

PROJECT:	SC 49 over Tyger River	**SCDOT PROJECT ID:**	P041237
SAMPLE NUMBER:	22-3405	**DATE SAMPLE RECEIVED:**	12/22/2022
DESCRIPTION OF SOIL:	Various		
TESTED BY:	MW & JJW	**DATE SETUP:**	12/26/2022
WEIGHED BY:	TP	**DATE OF WEIGHING:**	12/27/2022

BORING NO.	B-37	B-37	B-37	B-37	
SAMPLE NO.	SS-2	SS-4	SS-6	SS-8	
SAMPLE DEPTH (FT.)	2.0 - 4.0	6.0 - 8.0	13.5 - 15.0	23.5 - 25.0	
WATER CONTENT, W%	28.8	28.9	34.9	15.3	

BORING NO.					
SAMPLE NO.					
SAMPLE DEPTH (FT.)					
WATER CONTENT, W%					

BORING NO.					
SAMPLE NO.					
SAMPLE DEPTH (FT.)					
WATER CONTENT, W%					

BORING NO.					
SAMPLE NO.					
SAMPLE DEPTH (FT.)					
WATER CONTENT, W%					

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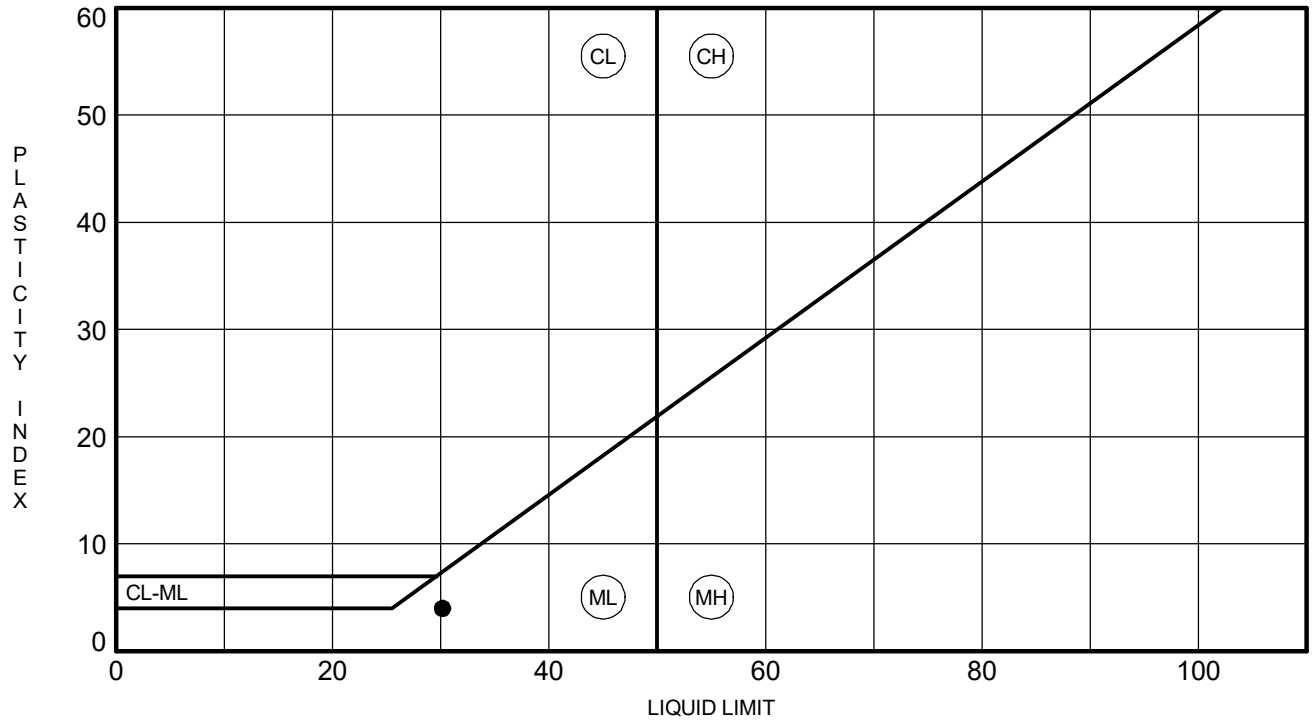
ATTERBERG LIMITS' RESULTS

PROJECT ID P041237 **PROJECT NAME** SC 49 over Tyger River

PROJECT COUNTY Union County, SC



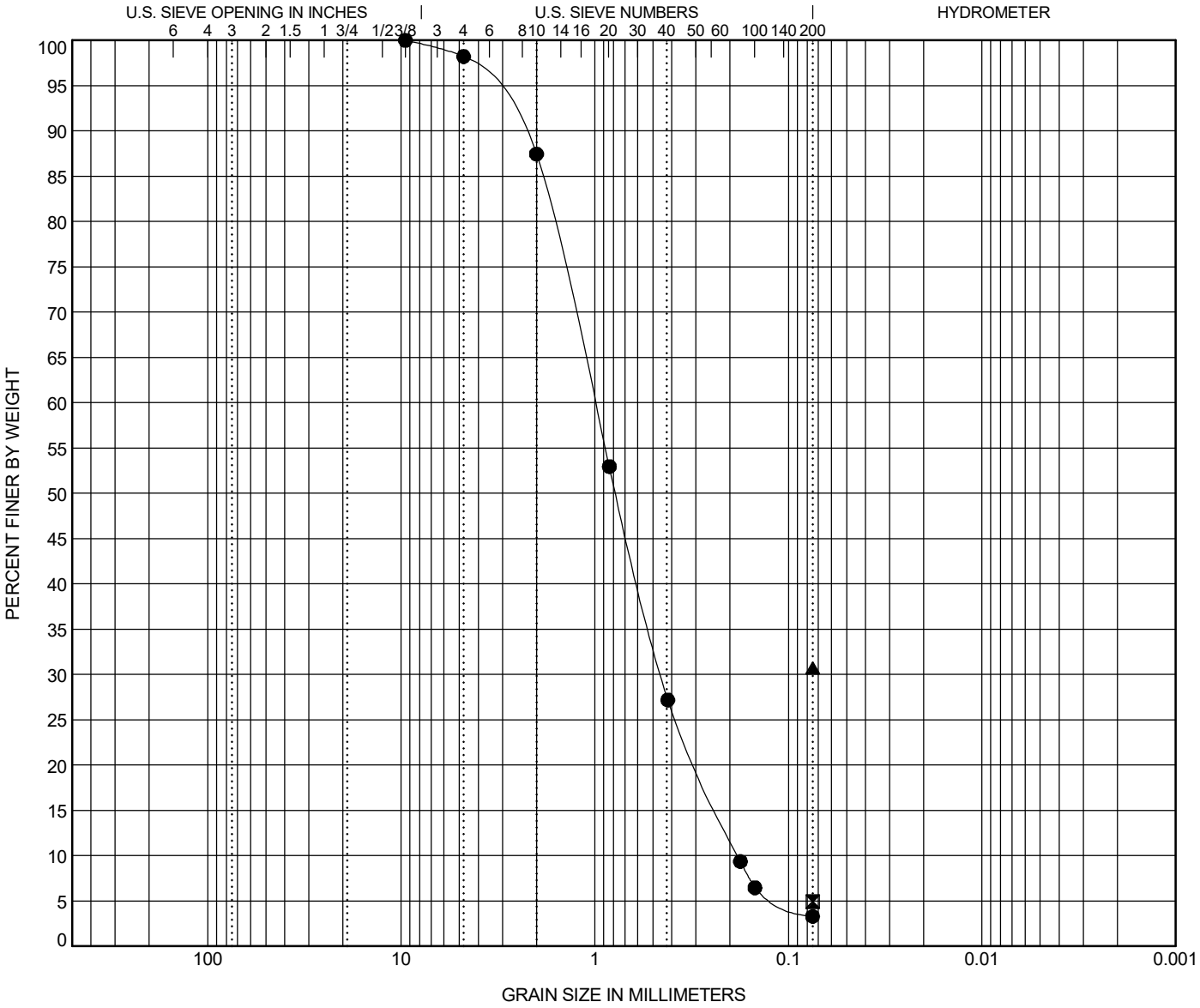
	BOREHOLE	DEPTH	LL	PL	PI	Fines	Classification
●	**B-38**	**25.0**	**30**	**26**	**4**	**31**	**SILTY SAND (SM/A-2-4)**

ATTERBERG LIMITS G6658.002 - SC 49 RBO TYER RIVER.GPJ SCDOT DATA TEMPLATE_01_30_2015.GDT 1/24/23

GRAIN SIZE DISTRIBUTION

PROJECT ID P041237 **PROJECT NAME** SC 49 over Tyger River

PROJECT COUNTY Union County, SC



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	BOREHOLE	DEPTH	Classification	LL	PL	PI	Cc	Cu
●	**B-38**	**6.0**	**POORLY GRADED SAND (SP)**				**1.12**	**5.50**
⊠	**B-38**	**15.0**	**POORLY GRADED SAND (SP)**					
▲	**B-38**	**25.0**	**SILTY SAND (SM/A-2-4)**	**30**	**26**	**4**		

	BOREHOLE	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**B-38**	**6.0**	**9.51**	**1.003**	**0.453**	**0.183**	**1.8**	**94.9**	**3.3**	
⊠	**B-38**	**15.0**	**0.075**						**4.9**	
▲	**B-38**	**25.0**	**0.075**						**30.7**	

GRAIN SIZE G6658.002 - SC 49 RBO TYER RIVER.GPJ SCDOT DATA TEMPLATE_01_30_2015.GDT 1/24/23

F&ME CONSULTANTS, INC.

MOISTURE CONTENT DETERMINATION
(AASHTO T265)

PROJECT:	SC 49 over Tyger River	**SCDOT PROJECT ID:**	P041237
SAMPLE NUMBER:	22-3406	**DATE SAMPLE RECEIVED:**	12/22/2022
DESCRIPTION OF SOIL:	Various		
TESTED BY:	MW & JJW	**DATE SETUP:**	12/26/2022
WEIGHED BY:	TP	**DATE OF WEIGHING:**	12/27/2022

BORING NO.	B-38	B-38	B-38		
SAMPLE NO.	SS-3	SS-6	SS-8		
SAMPLE DEPTH (FT.)	4.0 - 6.0	13.5 - 15.0	23.5 - 25.0		
WATER CONTENT, W%	20.4	19.1	16.7		

BORING NO.					
SAMPLE NO.					
SAMPLE DEPTH (FT.)					
WATER CONTENT, W%					

BORING NO.					
SAMPLE NO.					
SAMPLE DEPTH (FT.)					
WATER CONTENT, W%					

BORING NO.					
SAMPLE NO.					
SAMPLE DEPTH (FT.)					
WATER CONTENT, W%					

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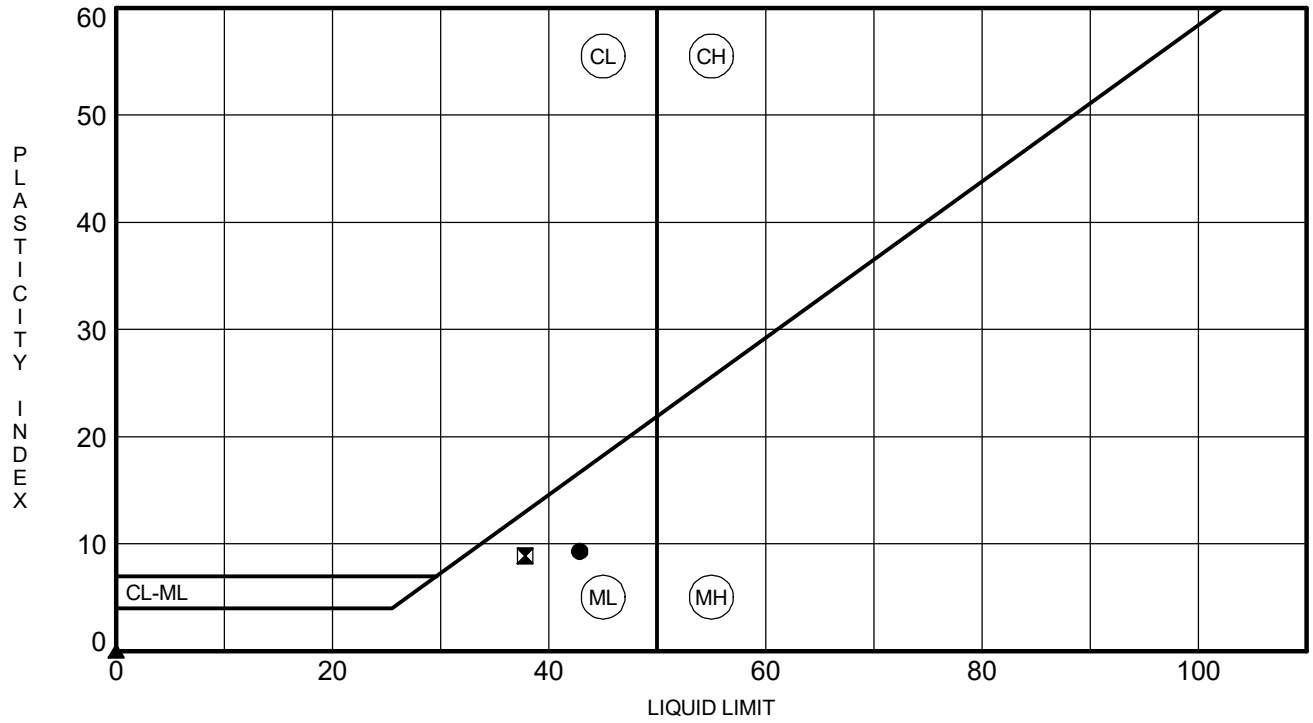
ATTERBERG LIMITS' RESULTS

PROJECT ID P041237 **PROJECT NAME** SC 49 over Tyger River

PROJECT COUNTY Union County, SC



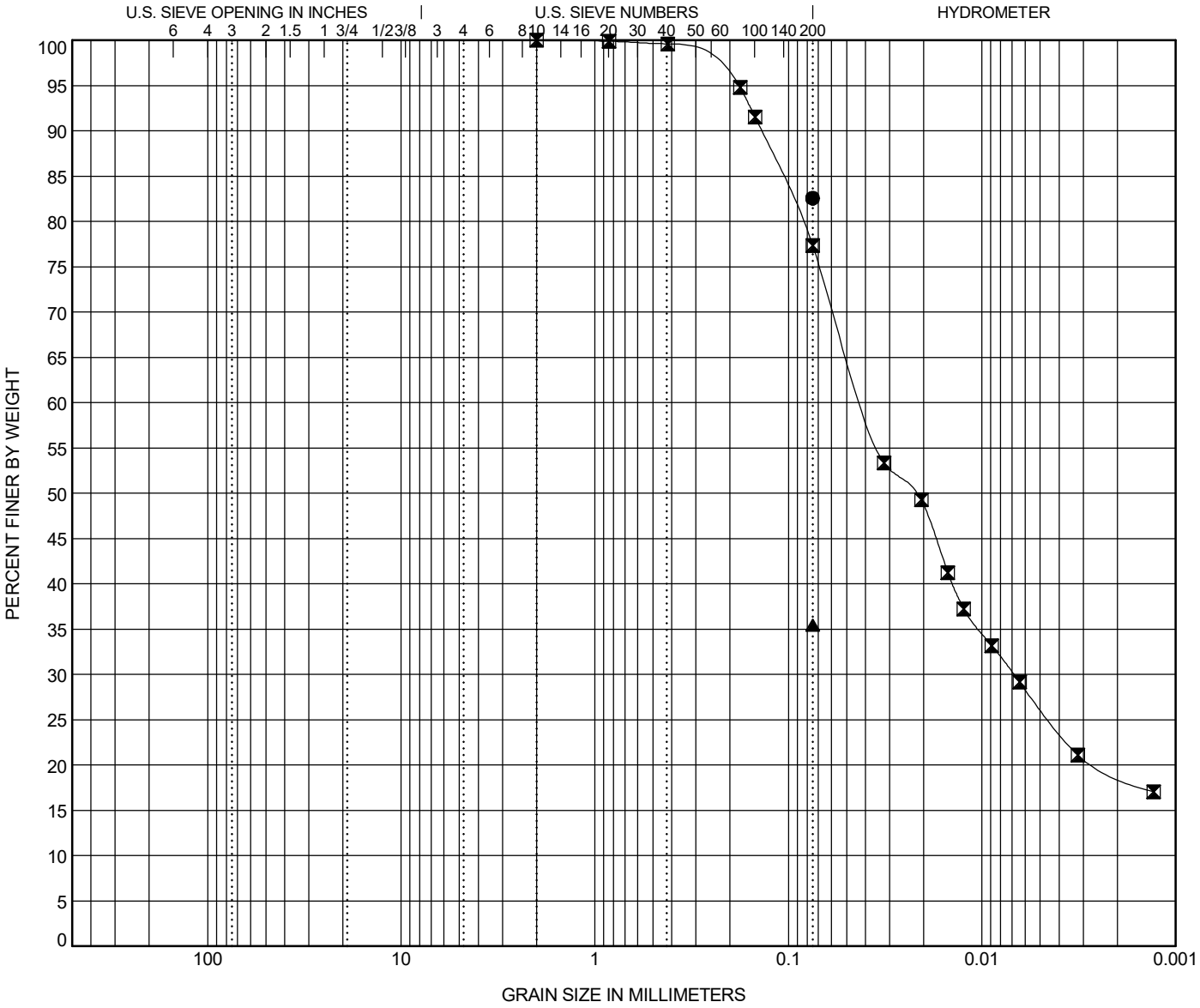
	BOREHOLE	DEPTH	LL	PL	PI	Fines	Classification
●	**B-39**	**4.0**	**43**	**34**	**9**	**83**	**SILT with SAND (ML/A-5)**
⊠	**B-39**	**6.0**	**38**	**29**	**9**	**77**	**SILT with SAND (ML/A-4)**
▲	**B-39**	**25.0**	**NP**	**NP**	**NP**	**35**	**SILTY SAND (SM/A-2-4)**

ATTERBERG LIMITS G6658.002 - SC 49 RBO TYER RIVER.GPJ SCDOT DATA TEMPLATE_01_30_2015.GDT 1/24/23

GRAIN SIZE DISTRIBUTION

PROJECT ID P041237 **PROJECT NAME** SC 49 over Tyger River

PROJECT COUNTY Union County, SC



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	BOREHOLE	DEPTH	Classification	LL	PL	PI	Cc	Cu
●	**B-39**	**4.0**	**SILT with SAND (ML/A-5)**	**43**	**34**	**9**		
⊠	**B-39**	**6.0**	**SILT with SAND (ML/A-4)**	**38**	**29**	**9**		
▲	**B-39**	**25.0**	**SILTY SAND (SM/A-2-4)**	**NP**	**NP**	**NP**		

	BOREHOLE	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**B-39**	**4.0**	**0.075**						**82.6**	
⊠	**B-39**	**6.0**	**2**	**0.041**	**0.007**		**0.0**	**22.6**	**51.1**	**26.3**
▲	**B-39**	**25.0**	**0.075**						**35.5**	

F&ME CONSULTANTS, INC.

MOISTURE CONTENT DETERMINATION
(AASHTO T265)

PROJECT:	SC 49 over Tyger River	**SCDOT PROJECT ID:**	P041237
SAMPLE NUMBER:	22-3368	**DATE SAMPLE RECEIVED:**	12/22/2022
DESCRIPTION OF SOIL:	Various		
TESTED BY:	MW & JJW	**DATE SETUP:**	12/26/2022
WEIGHED BY:	TP	**DATE OF WEIGHING:**	12/27/2022

BORING NO.	B-39	B-39	B-39		
SAMPLE NO.	SS-2	SS-3	SS-8		
SAMPLE DEPTH (FT.)	2.0 - 4.0	4.0 - 6.0	23.5 - 25.0		
WATER CONTENT, W%	31.0	41.8	32.9		

BORING NO.					
SAMPLE NO.					
SAMPLE DEPTH (FT.)					
WATER CONTENT, W%					

BORING NO.					
SAMPLE NO.					
SAMPLE DEPTH (FT.)					
WATER CONTENT, W%					

BORING NO.					
SAMPLE NO.					
SAMPLE DEPTH (FT.)					
WATER CONTENT, W%					

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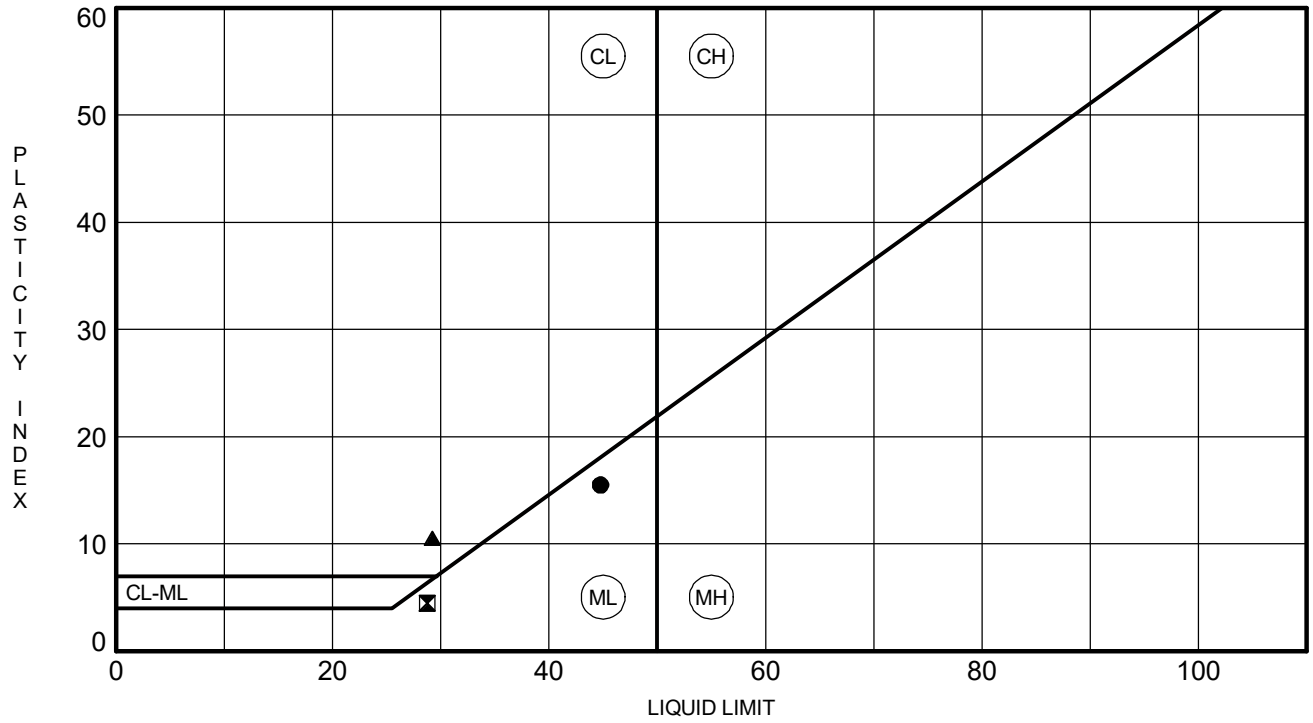
ATTERBERG LIMITS' RESULTS

PROJECT ID P041237 **PROJECT NAME** SC 49 over Tyger River

PROJECT COUNTY Union County, SC



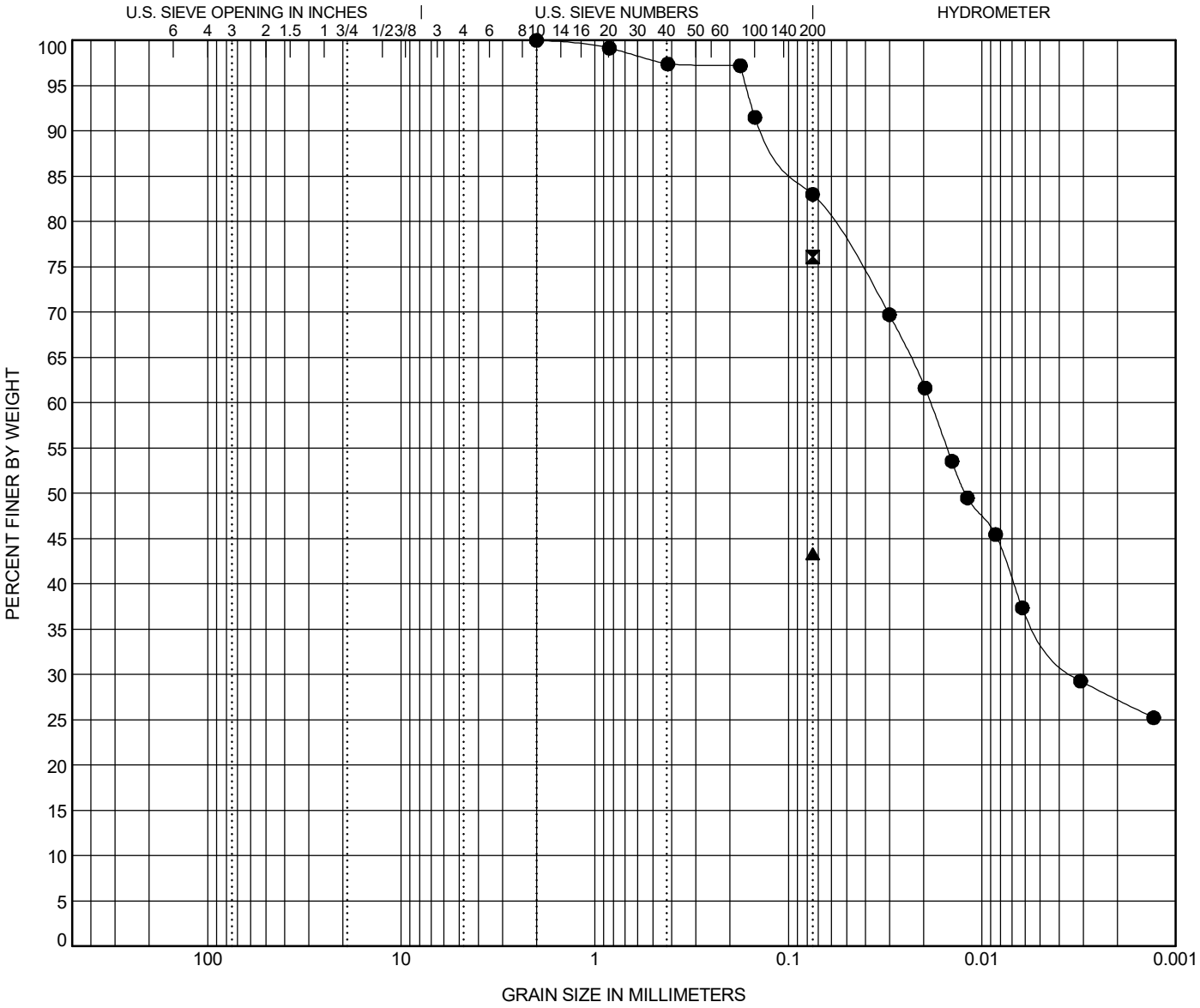
	BOREHOLE	DEPTH	LL	PL	PI	Fines	Classification
●	**B-40**	**4.0**	**45**	**29**	**16**	**83**	**SILT with SAND (ML/A-7-6)**
⧗	**B-40**	**8.0**	**29**	**24**	**5**	**76**	**SILT with SAND (ML/A-4)**
▲	**B-40**	**20.0**	**29**	**19**	**10**	**43**	**CLAYEY SAND (SC/A-4)**

ATTERBERG LIMITS G6658.002 - SC 49 RBO TYER RIVER.GPJ SCDOT DATA TEMPLATE_01_30_2015.GDT 1/24/23

GRAIN SIZE DISTRIBUTION

PROJECT ID P041237 **PROJECT NAME** SC 49 over Tyger River

PROJECT COUNTY Union County, SC



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	BOREHOLE	DEPTH	Classification	LL	PL	PI	Cc	Cu
●	**B-40**	**4.0**	**SILT with SAND (ML/A-7-6)**	**45**	**29**	**16**		
⊠	**B-40**	**8.0**	**SILT with SAND (ML/A-4)**	**29**	**24**	**5**		
▲	**B-40**	**20.0**	**CLAYEY SAND (SC/A-4)**	**29**	**19**	**10**		

	BOREHOLE	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**B-40**	**4.0**	**2**	**0.018**	**0.003**		**0.0**	**17.0**	**48.2**	**34.9**
⊠	**B-40**	**8.0**	**0.075**						**76.1**	
▲	**B-40**	**20.0**	**0.075**						**43.3**	

F&ME CONSULTANTS, INC.

MOISTURE CONTENT DETERMINATION
(AASHTO T265)

PROJECT:	SC 49 over Tyger River	**SCDOT PROJECT ID:**	P041237
SAMPLE NUMBER:	22-3369	**DATE SAMPLE RECEIVED:**	12/22/2022
DESCRIPTION OF SOIL:	Various		
TESTED BY:	MW & JJW	**DATE SETUP:**	12/26/2022
WEIGHED BY:	TP	**DATE OF WEIGHING:**	12/27/2022

BORING NO.	B-40	B-40	B-40		
SAMPLE NO.	SS-2	SS-4	SS-7		
SAMPLE DEPTH (FT.)	2.0 - 4.0	6.0 - 8.0	18.5 - 20.0		
WATER CONTENT, W%	46.9	34.4	21.9		

BORING NO.					
SAMPLE NO.					
SAMPLE DEPTH (FT.)					
WATER CONTENT, W%					

BORING NO.					
SAMPLE NO.					
SAMPLE DEPTH (FT.)					
WATER CONTENT, W%					

BORING NO.					
SAMPLE NO.					
SAMPLE DEPTH (FT.)					
WATER CONTENT, W%					

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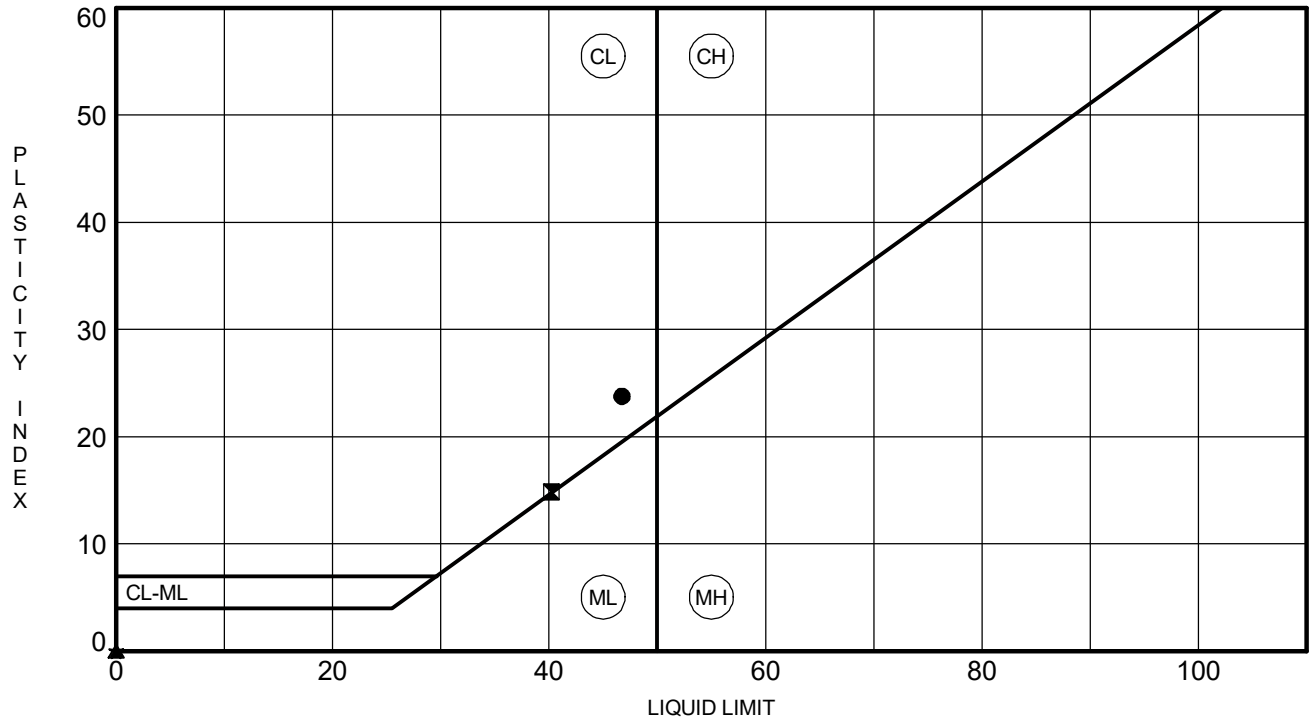
ATTERBERG LIMITS' RESULTS

PROJECT ID P041237 **PROJECT NAME** SC 49 over Tyger River

PROJECT COUNTY Union County, SC



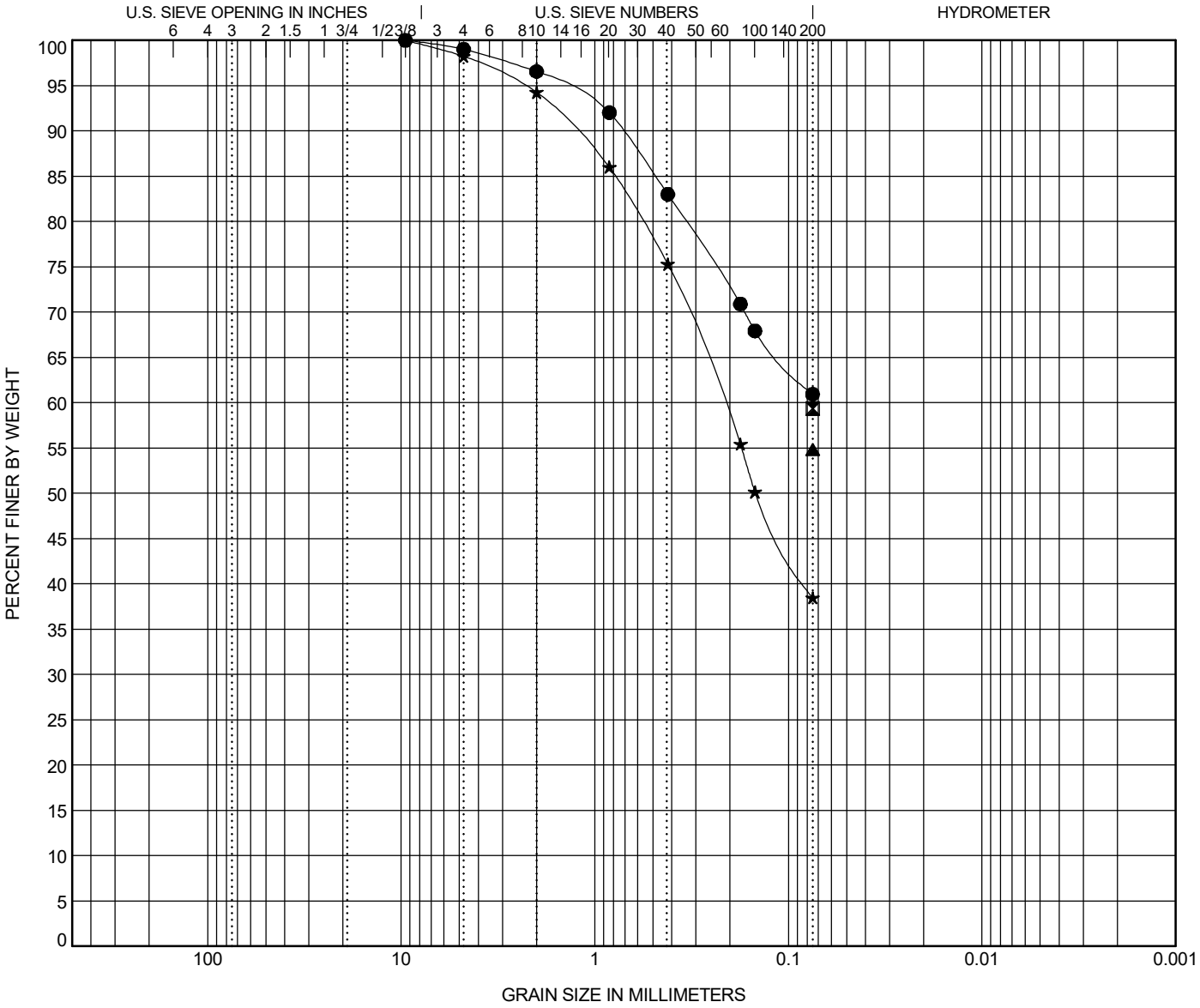
	BOREHOLE	DEPTH	LL	PL	PI	Fines	Classification
●	**B-41**	**6.0**	**47**	**23**	**24**	**61**	**SANDY LEAN CLAY (CL/A-7-6)**
⧗	**B-41**	**8.0**	**40**	**25**	**15**	**59**	**SANDY LEAN CLAY (CL/A-6)**
▲	**B-41**	**10.0**	**NP**	**NP**	**NP**	**55**	**SANDY SILT (ML/A-4)**
★	**B-41**	**45.0**	**NP**	**NP**	**NP**	**38**	**SILTY SAND (SM/A-4)**

ATTERBERG LIMITS G6658.002 - SC 49 RBO TYER RIVER.GPJ SCDOT DATA TEMPLATE_01_30_2015.GDT 1/26/23

GRAIN SIZE DISTRIBUTION

PROJECT ID P041237 **PROJECT NAME** SC 49 over Tyger River

PROJECT COUNTY Union County, SC



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	BOREHOLE	DEPTH	Classification	LL	PL	PI	Cc	Cu
●	**B-41**	**6.0**	**SANDY LEAN CLAY (CL/A-7-6)**	**47**	**23**	**24**		
⊠	**B-41**	**8.0**	**SANDY LEAN CLAY (CL/A-6)**	**40**	**25**	**15**		
▲	**B-41**	**10.0**	**SANDY SILT (ML/A-4)**	**NP**	**NP**	**NP**		
★	**B-41**	**45.0**	**SILTY SAND (SM/A-4)**	**NP**	**NP**	**NP**		

	BOREHOLE	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**B-41**	**6.0**	**9.51**				**1.0**	**38.1**	**60.9**	
⊠	**B-41**	**8.0**	**0.075**						**59.4**	
▲	**B-41**	**10.0**	**0.075**						**54.9**	
★	**B-41**	**45.0**	**9.51**	**0.216**			**1.8**	**59.8**	**38.5**	

GRAIN SIZE G6658.002 - SC 49 RBO TYER RIVER.GPJ SCDOT DATA TEMPLATE_01_30_2015.GDT 1/26/23

F&ME CONSULTANTS, INC.

MOISTURE CONTENT DETERMINATION
(AASHTO T265)

PROJECT:	SC 49 over Tyger River	**SCDOT PROJECT ID:**	P041237
SAMPLE NUMBER:	22-3370	**DATE SAMPLE RECEIVED:**	12/22/2022
DESCRIPTION OF SOIL:	Various		
TESTED BY:	MW & JJW	**DATE SETUP:**	12/26/2022
WEIGHED BY:	TP	**DATE OF WEIGHING:**	12/27/2022

BORING NO.	B-41	B-41	B-41	B-41	
SAMPLE NO.	SS-2/SS-3	SS-4	SS-5	SS-9/SS-10/SS-11 & SS-12	
SAMPLE DEPTH (FT.)	2.0 - 6.0	6.0 - 8.0	8.0 - 10.0	28.5 - 45.0	
WATER CONTENT, W%	25.6	24.8	25.5	20.8	

BORING NO.					
SAMPLE NO.					
SAMPLE DEPTH (FT.)					
WATER CONTENT, W%					

BORING NO.					
SAMPLE NO.					
SAMPLE DEPTH (FT.)					
WATER CONTENT, W%					

BORING NO.					
SAMPLE NO.					
SAMPLE DEPTH (FT.)					
WATER CONTENT, W%					

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Appendix C. Laboratory Testing

Bulk Samples

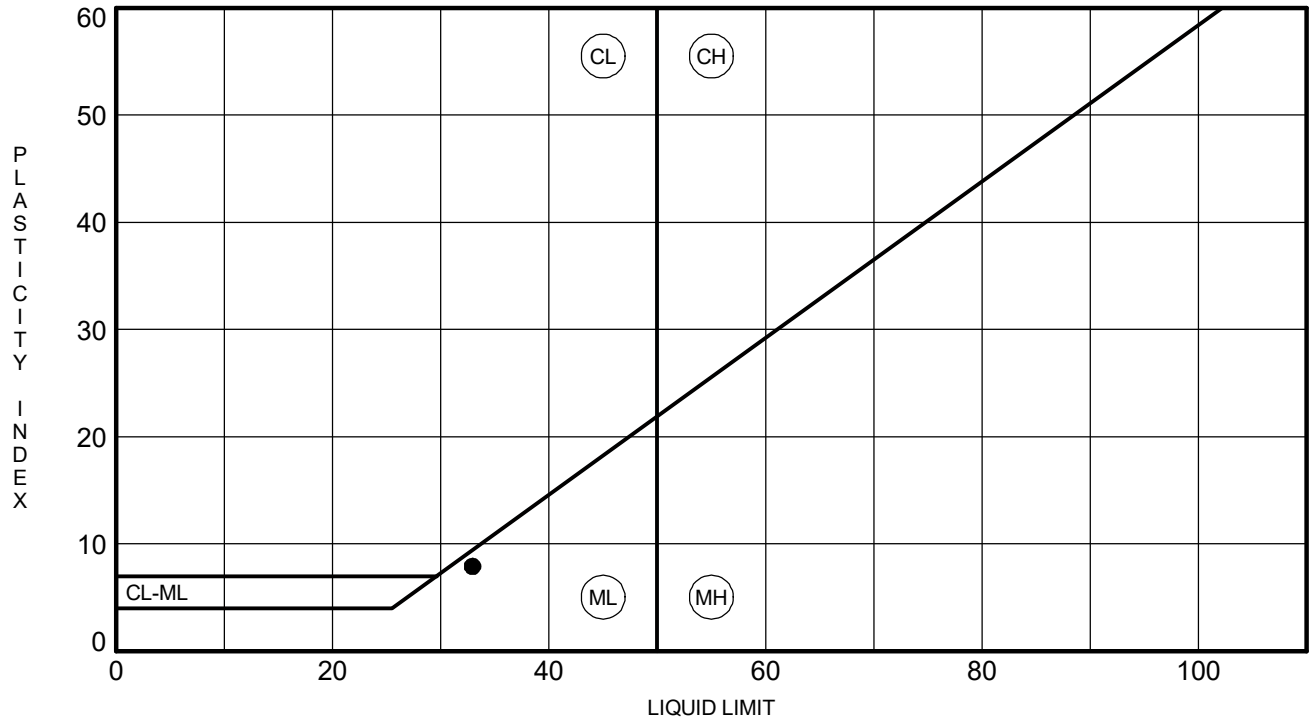
hdrinc.com

1201 Main Street, Suite 800 Columbia, SC 29201
T 803.254.5800

ATTERBERG LIMITS' RESULTS

PROJECT ID P041237 **PROJECT NAME** SC 49 over Tyger River

PROJECT COUNTY Union County, SC

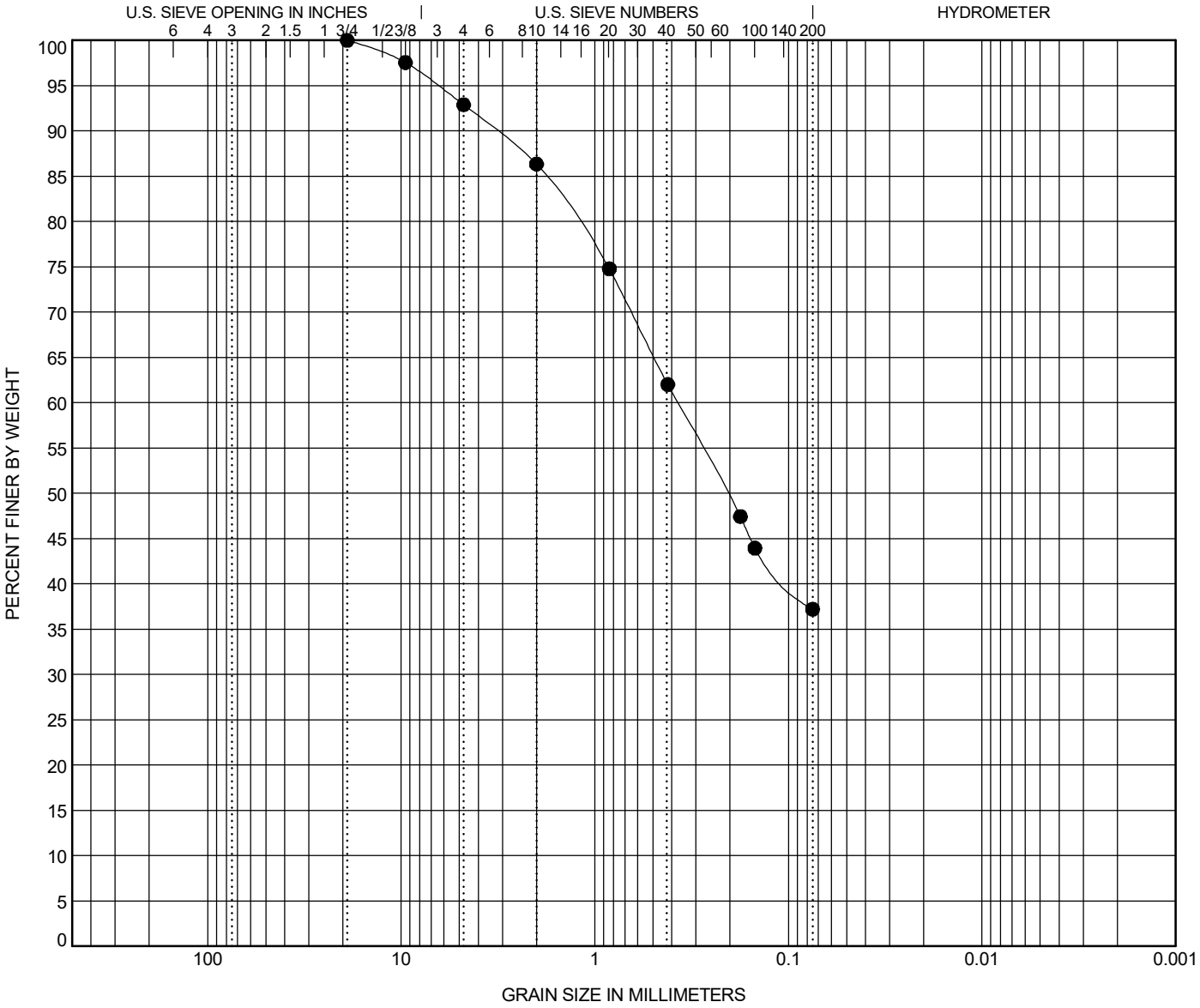


	BOREHOLE	DEPTH	LL	PL	PI	Fines	Classification
●	**BS-4**	**5.0**	**33**	**25**	**8**	**37**	**SILTY SAND (SM/A-4)**

GRAIN SIZE DISTRIBUTION

PROJECT ID P041237 **PROJECT NAME** SC 49 over Tyger River

PROJECT COUNTY Union County, SC



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	BOREHOLE	DEPTH	Classification	LL	PL	PI	Cc	Cu
●	**BS-4**	**5.0**	**SILTY SAND (SM/A-4)**	**33**	**25**	**8**		

	BOREHOLE	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**BS-4**	**5.0**	**19**	**0.373**			**7.1**	**55.7**	**37.2**	

F&ME CONSULTANTS, INC.

MOISTURE CONTENT DETERMINATION
(AASHTO T265)

PROJECT:	SC 49 over Tyger River	**SCDOT PROJECT ID:**	P041237
SAMPLE NUMBER:	22-3407	**DATE SAMPLE RECEIVED:**	12/22/2022
DESCRIPTION OF SOIL:	Silty SAND (SM/A-4)		
TESTED BY:	MW & JJW	**DATE SETUP:**	12/26/2022
WEIGHED BY:	TP	**DATE OF WEIGHING:**	12/27/2022

BORING NO.	BS-4				
SAMPLE NO.	--				
SAMPLE DEPTH (FT.)	0.0 - 5.0				
WATER CONTENT, W%	17.8				

BORING NO.					
SAMPLE NO.					
SAMPLE DEPTH (FT.)					
WATER CONTENT, W%					

BORING NO.					
SAMPLE NO.					
SAMPLE DEPTH (FT.)					
WATER CONTENT, W%					

BORING NO.					
SAMPLE NO.					
SAMPLE DEPTH (FT.)					
WATER CONTENT, W%					

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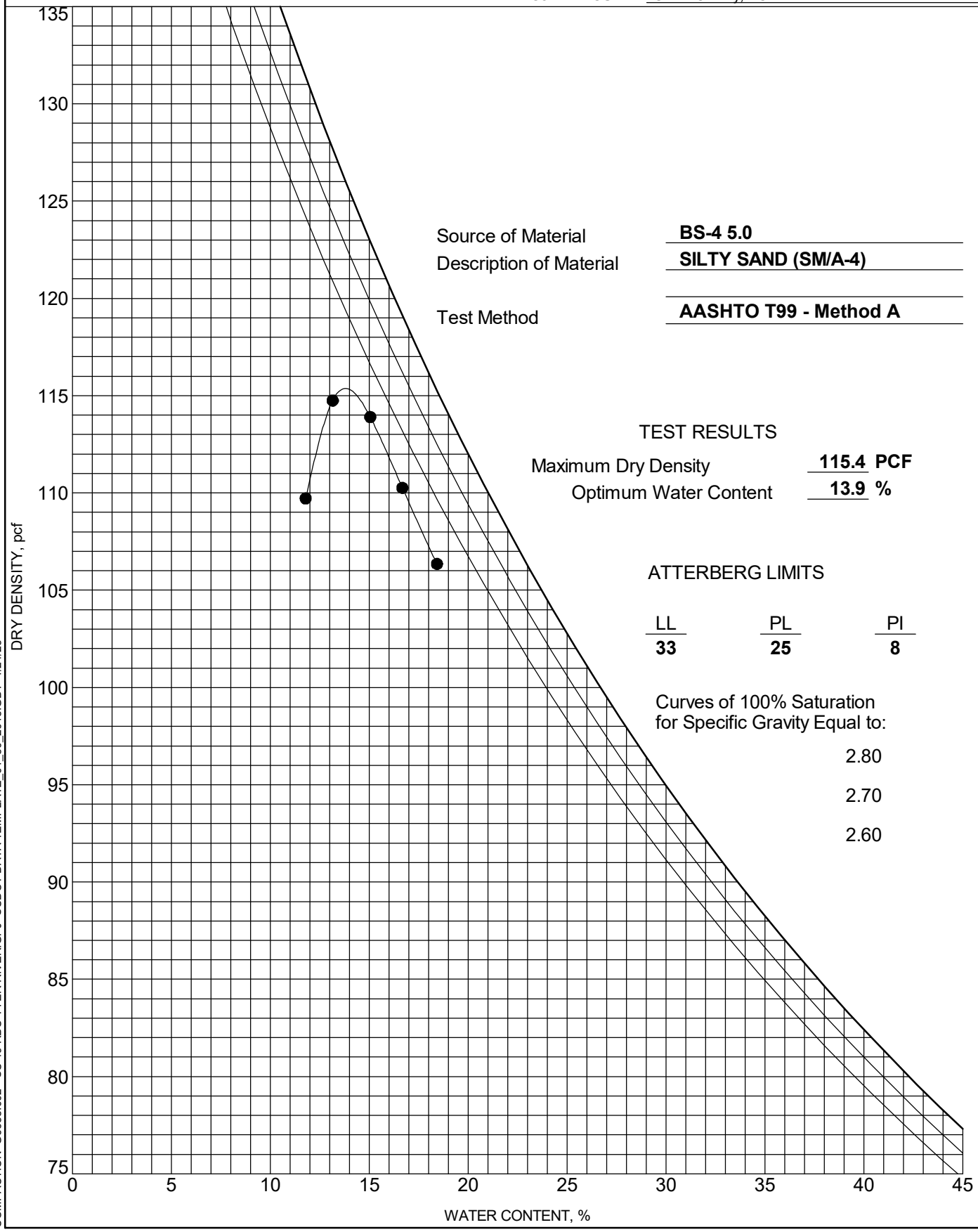
MOISTURE-DENSITY RELATIONSHIP

PROJECT ID P041237 **PROJECT NAME** SC 49 over Tyger River

PROJECT COUNTY Union County, SC



Source of Material **BS-4 5.0**

Description of Material **SILTY SAND (SM/A-4)**

Test Method **AASHTO T99 - Method A**

TEST RESULTS

Maximum Dry Density **115.4** **PCF**

Optimum Water Content **13.9** **%**

ATTERBERG LIMITS

LL	PL	PI
33	**25**	**8**

Curves of 100% Saturation for Specific Gravity Equal to:

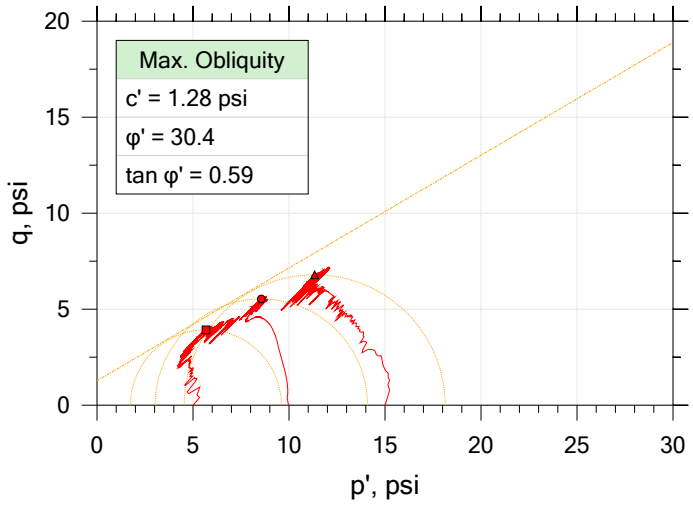
2.80

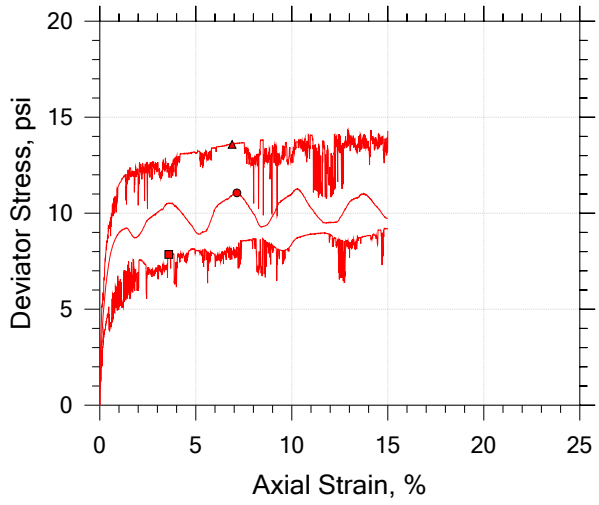
2.70

2.60

COMPACTION G6658.002 - SC 49 RBO TYER RIVER.GPJ SCDOT DATA TEMPLATE_01_30_2015.GDT 1/24/23

Consolidated Undrained by AASHTO T297



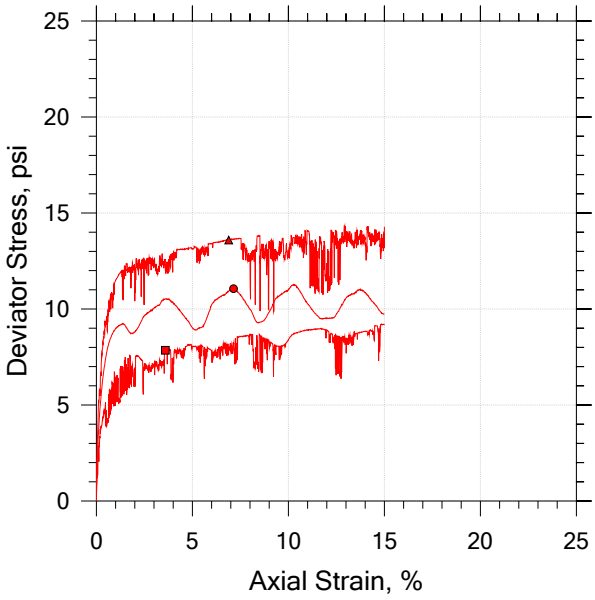


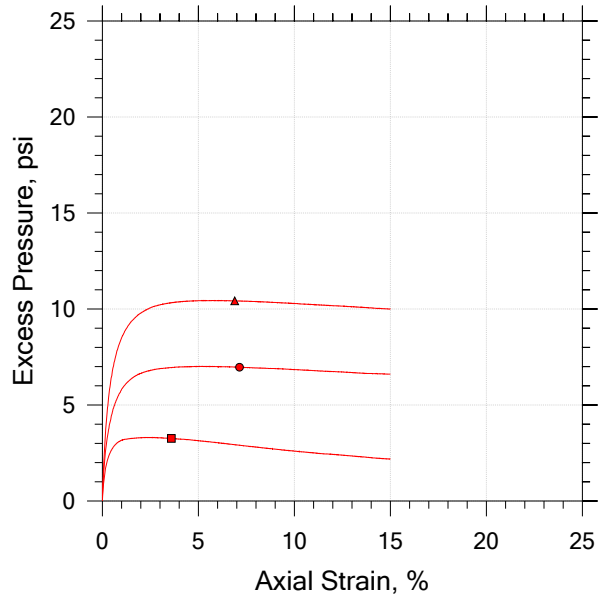
Symbol		■	●	▲	
Sample ID		22-3407	22-3407	22-3407	
Depth		0.0' - 5.0'	0.0' - 5.0'	0.0' - 5.0'	
Test Number		A	B	C	
Initial	Height, in	6.000	6.000	6.000	
	Diameter, in	2.800	2.800	2.800	
	Moisture Content (from Cuttings), %	15.4	15.4	15.5	
	Dry Density, pcf	108.	108.	108.	
	Saturation (Wet Method), %	75.8	75.8	76.0	
	Void Ratio	0.546	0.546	0.547	
Final	Moisture Content, %	19.4	18.8	18.2	
	Dry Density, pcf	110.	111.	113.	
	Cross-Sectional Area (Method A), in²	6.073	6.016	5.982	
	Saturation, %	100.0	100.0	100.0	
	Void Ratio	0.520	0.503	0.487	
	Back Pressure, psi	101.0	98.64	98.00	
Vertical Effective Consolidation Stress, psi		4.994	9.943	14.94	
Horizontal Effective Consolidation Stress, psi		5.005	9.988	15.01	
Vertical Strain after Consolidation, %		0.09979	0.3826	0.9685	
Volumetric Strain after Consolidation, %		1.133	2.535	3.571	
Time to 50% Consolidation, min		0.6700	0.7000	0.7000	
Shear Strength, psi		3.928	5.532	6.795	
Strain at Failure, %		3.59	7.14	6.89	
Strain Rate, %/min		0.05000	0.05000	0.05000	
Deviator Stress at Failure, psi		7.856	11.06	13.59	
Effective Minor Principal Stress at Failure, psi		1.742	3.025	4.540	
Effective Major Principal Stress at Failure, psi		9.598	14.09	18.13	
B-Value		0.94	0.94	0.92	

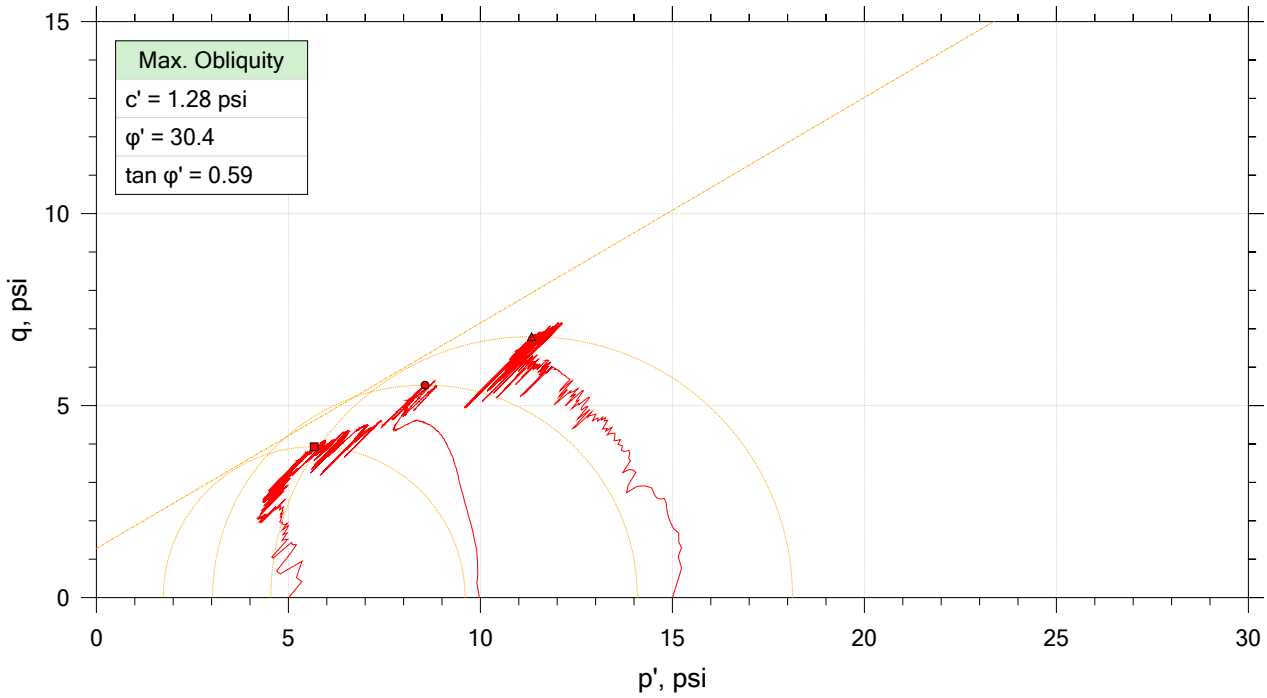
Notes:
- Before Shear Saturation set to 100% for phase calculation.
- Moisture Content determined by ASTM D2216.
- Atterberg Limits determined by ASTM D4318.
- Deviator Stress includes membrane correction.
- Values for c and φ determined from best-fit straight line for the specific test conditions. Actual strength parameters may vary and should be determined by an engineer for site conditions.

Project Name: SC 49 over Tyger River	Location: Union County	SCDOT Project ID: P041237
Boring Number: BS-4	Tester: RMC	Checker: WAP/ WJG
Sample Number: 22-3407	Test Date: 1/3/2023	Depth: 0.0' - 5.0'
Test Number: ABC	Preparation: Remolded	Elevation:
Description: Silty SAND (SM/A-4) LL=33, PL=25, PI=8, %200=37.2		
Remarks: Max Dry Density=115.4 pcf, OMC=13.9%, Samples Molded at 95%		

Consolidated Undrained by AASHTO T297



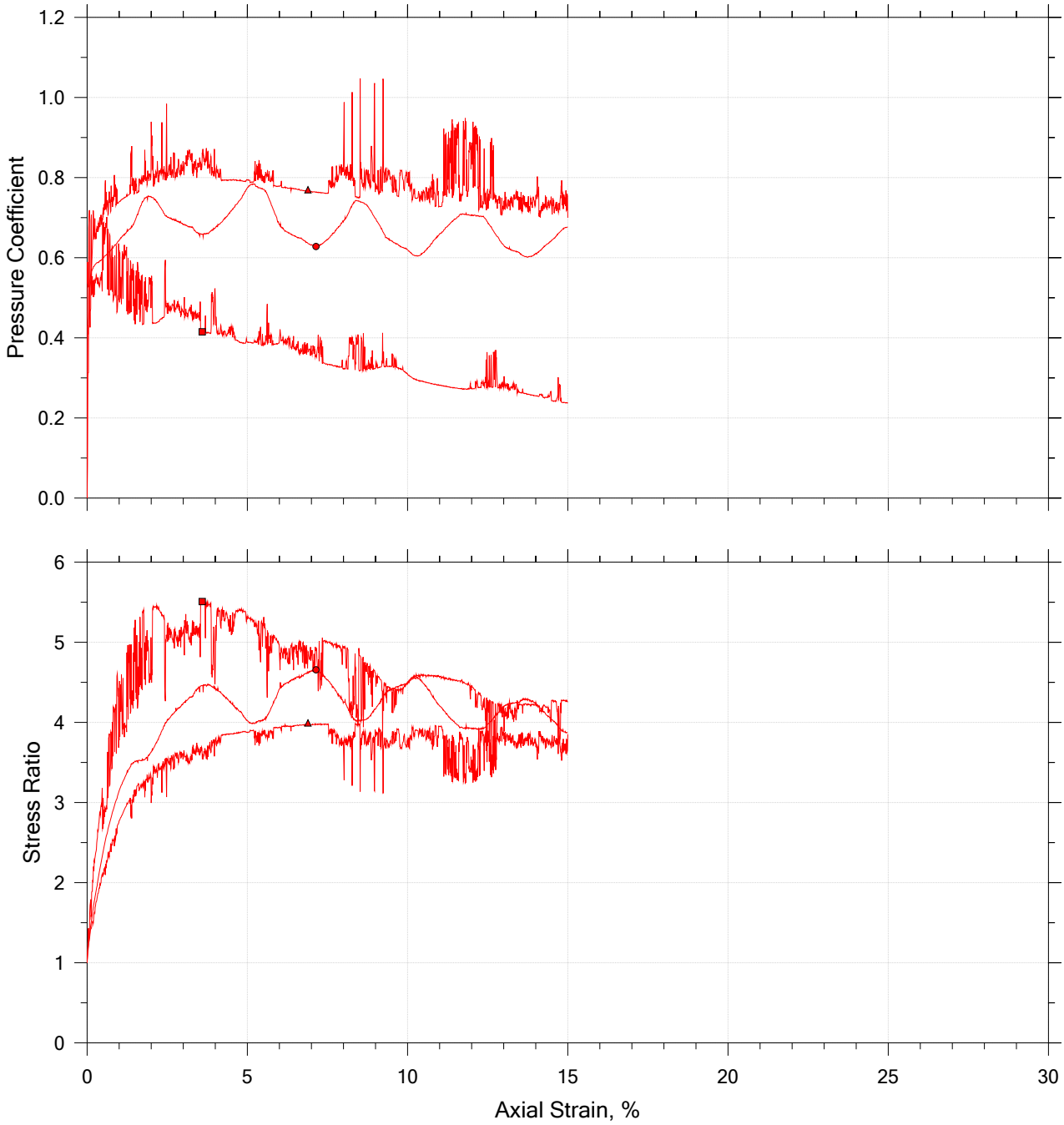




	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
■	22-3407	A	0.0' - 5.0'	RMC	1/3/2023	WAP/ WJG	1/9/2023	BS-4.A.dat
●	22-3407	B	0.0' - 5.0'	RMC	1/5/2023	WAP/ WJG	1/9/2022	BS-4.B.dat
▲	22-3407	C	0.0' - 5.0'	WAP/RMC	1/5/2023	WAP/ WJG	1/9/2023	BS-4.C.dat

Project Name: SC 49 over Tyger River	Location: Union County	SCDOT Project ID: P041237
Boring Number: BS-4	Tester: RMC	Checker: WAP/ WJG
Sample Number: 22-3407	Test Date: 1/3/2023	Depth: 0.0' - 5.0'
Test Number: ABC	Preparation: Remolded	Elevation:
Description: Silty SAND (SM/A-4) LL=33, PL=25, PI=8, %200=37.2		
Remarks: Max Dry Density=115.4 pcf, OMC=13.9%, Samples Molded at 95%		

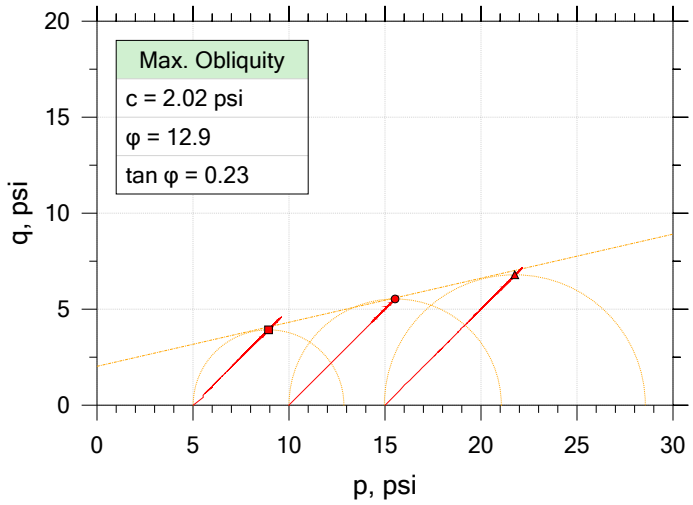
Consolidated Undrained by AASHTO T297

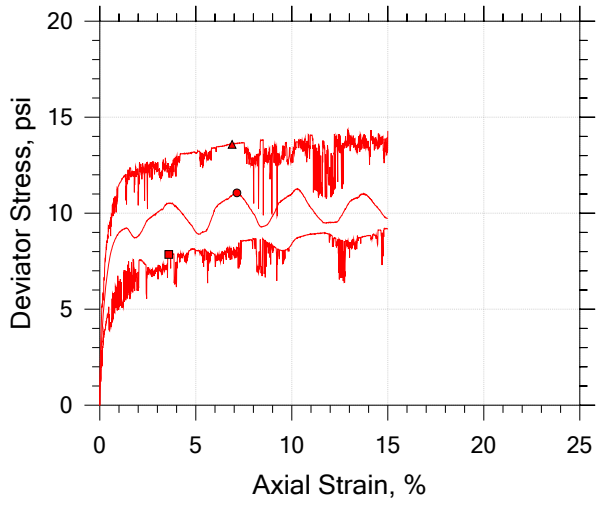


	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
■	22-3407	A	0.0' - 5.0'	RMC	1/3/2023	WAP/ WJG	1/9/2023	BS-4.A.dat
●	22-3407	B	0.0' - 5.0'	RMC	1/5/2023	WAP/ WJG	1/9/2022	BS-4.B.dat
▲	22-3407	C	0.0' - 5.0'	WAP/RMC	1/5/2023	WAP/ WJG	1/9/2023	BS-4.C.dat

Project Name: SC 49 over Tyger River	Location: Union County	SCDOT Project ID: P041237
Boring Number: BS-4	Tester: RMC	Checker: WAP/ WJG
Sample Number: 22-3407	Test Date: 1/3/2023	Depth: 0.0' - 5.0'
Test Number: ABC	Preparation: Remolded	Elevation:
Description: Silty SAND (SM/A-4) LL=33, PL=25, PI=8, %200=37.2		
Remarks: Max Dry Density=115.4 pcf, OMC=13.9%, Samples Molded at 95%		

Consolidated Undrained by AASHTO T297



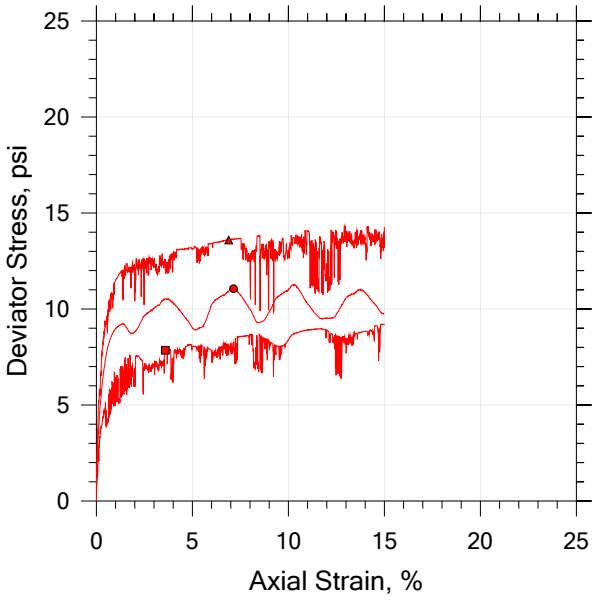


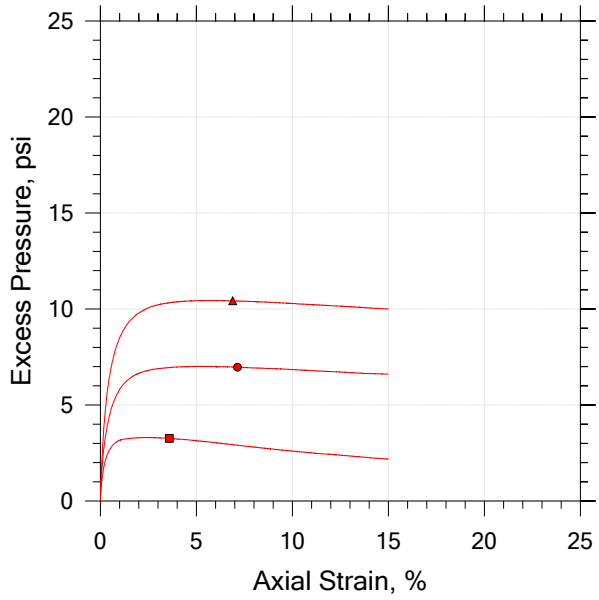
Symbol		■	●	▲	
Sample ID		22-3407	22-3407	22-3407	
Depth		0.0' - 5.0'	0.0' - 5.0'	0.0' - 5.0'	
Test Number		A	B	C	
Initial	Height, in	6.000	6.000	6.000	
	Diameter, in	2.800	2.800	2.800	
	Moisture Content (from Cuttings), %	15.4	15.4	15.5	
	Dry Density, pcf	108.	108.	108.	
	Saturation (Wet Method), %	75.8	75.8	76.0	
	Void Ratio	0.546	0.546	0.547	
Final	Moisture Content, %	19.4	18.8	18.2	
	Dry Density, pcf	110.	111.	113.	
	Cross-Sectional Area (Method A), in²	6.073	6.016	5.982	
	Saturation, %	100.0	100.0	100.0	
	Void Ratio	0.520	0.503	0.487	
	Back Pressure, psi	101.0	98.64	98.00	
Vertical Effective Consolidation Stress, psi		4.994	9.943	14.94	
Horizontal Effective Consolidation Stress, psi		5.005	9.988	15.01	
Vertical Strain after Consolidation, %		0.09979	0.3826	0.9685	
Volumetric Strain after Consolidation, %		1.133	2.535	3.571	
Time to 50% Consolidation, min		0.6700	0.7000	0.7000	
Shear Strength, psi		3.928	5.532	6.795	
Strain at Failure, %		3.59	7.14	6.89	
Strain Rate, %/min		0.05000	0.05000	0.05000	
Deviator Stress at Failure, psi		7.856	11.06	13.59	
Effective Minor Principal Stress at Failure, psi		1.742	3.025	4.540	
Effective Major Principal Stress at Failure, psi		9.598	14.09	18.13	
B-Value		0.94	0.94	0.92	

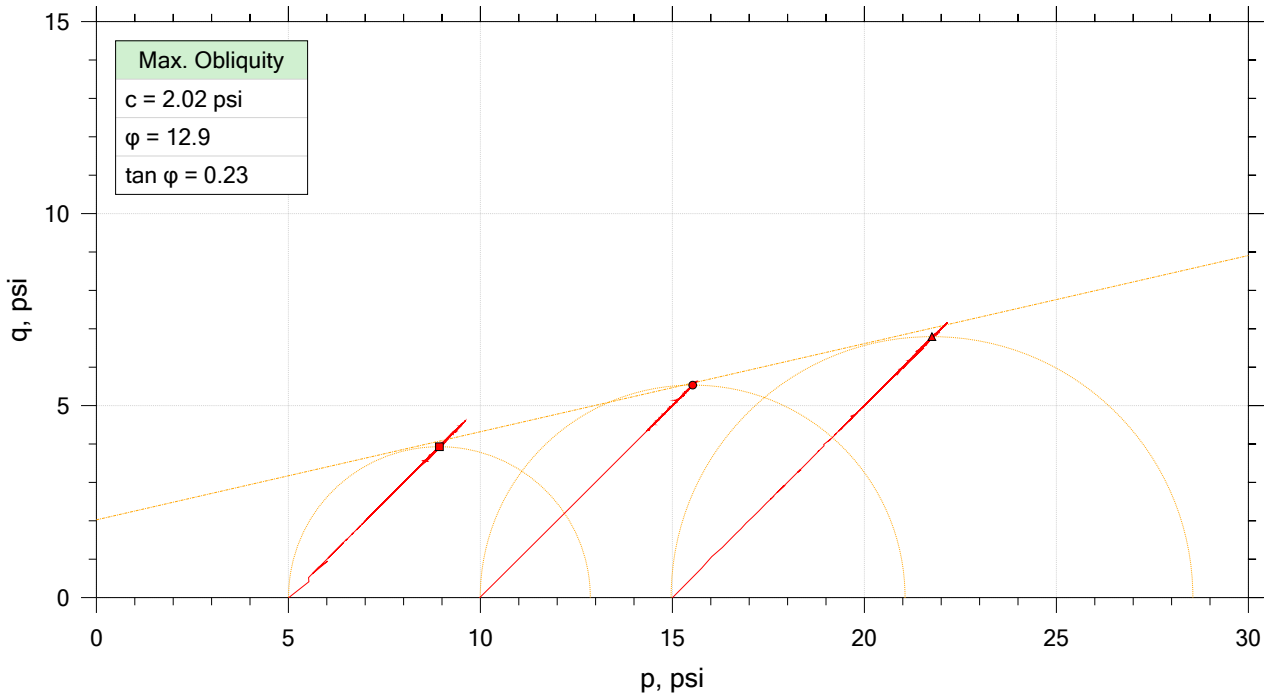
Notes:
- Before Shear Saturation set to 100% for phase calculation.
- Moisture Content determined by ASTM D2216.
- Atterberg Limits determined by ASTM D4318.
- Deviator Stress includes membrane correction.
- Values for c and φ determined from best-fit straight line for the specific test conditions. Actual strength parameters may vary and should be determined by an engineer for site conditions.

Project Name: SC 49 over Tyger River	Location: Union County	SCDOT Project ID: P041237
Boring Number: BS-4	Tester: RMC	Checker: WAP/ WJG
Sample Number: 22-3407	Test Date: 1/3/2023	Depth: 0.0' - 5.0'
Test Number: ABC	Preparation: Remolded	Elevation:
Description: Silty SAND (SM/A-4) LL=33, PL=25, PI=8, %200=37.2		
Remarks: Max Dry Density=115.4 pcf, OMC=13.9%, Samples Molded at 95%		

Consolidated Undrained by AASHTO T297



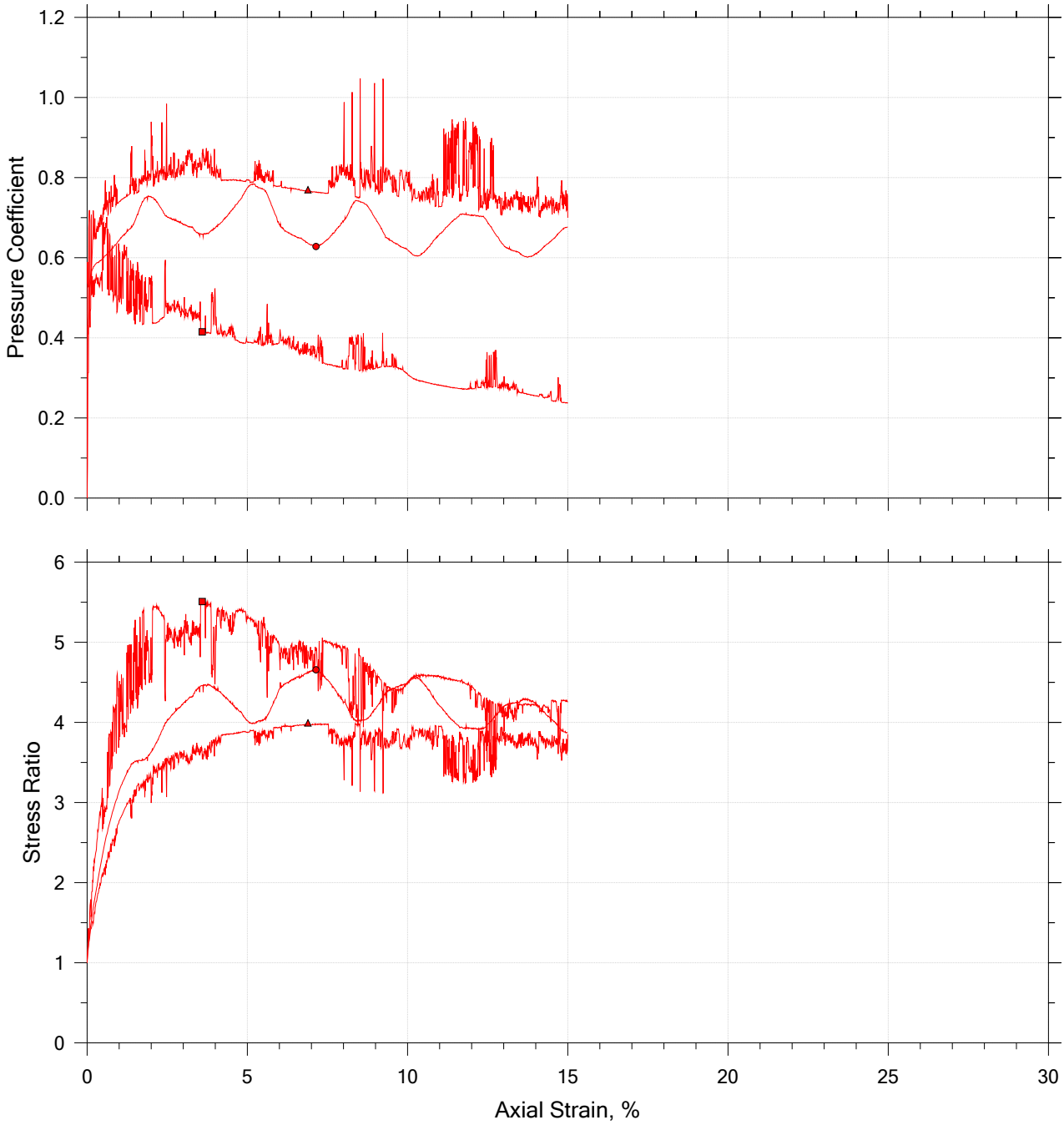




	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
■	22-3407	A	0.0' - 5.0'	RMC	1/3/2023	WAP/ WJG	1/9/2023	BS-4.A.dat
●	22-3407	B	0.0' - 5.0'	RMC	1/5/2023	WAP/ WJG	1/9/2022	BS-4.B.dat
▲	22-3407	C	0.0' - 5.0'	WAP/RMC	1/5/2023	WAP/ WJG	1/9/2023	BS-4.C.dat

Project Name: SC 49 over Tyger River	Location: Union County	SCDOT Project ID: P041237
Boring Number: BS-4	Tester: RMC	Checker: WAP/ WJG
Sample Number: 22-3407	Test Date: 1/3/2023	Depth: 0.0' - 5.0'
Test Number: ABC	Preparation: Remolded	Elevation:
Description: Silty SAND (SM/A-4) LL=33, PL=25, PI=8, %200=37.2		
Remarks: Max Dry Density=115.4 pcf, OMC=13.9%, Samples Molded at 95%		

Consolidated Undrained by AASHTO T297



	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
■	22-3407	A	0.0' - 5.0'	RMC	1/3/2023	WAP/ WJG	1/9/2023	BS-4.A.dat
●	22-3407	B	0.0' - 5.0'	RMC	1/5/2023	WAP/ WJG	1/9/2022	BS-4.B.dat
▲	22-3407	C	0.0' - 5.0'	WAP/RMC	1/5/2023	WAP/ WJG	1/9/2023	BS-4.C.dat

Project Name: SC 49 over Tyger River	Location: Union County	SCDOT Project ID: P041237
Boring Number: BS-4	Tester: RMC	Checker: WAP/ WJG
Sample Number: 22-3407	Test Date: 1/3/2023	Depth: 0.0' - 5.0'
Test Number: ABC	Preparation: Remolded	Elevation:
Description: Silty SAND (SM/A-4) LL=33, PL=25, PI=8, %200=37.2		
Remarks: Max Dry Density=115.4 pcf, OMC=13.9%, Samples Molded at 95%		

Appendix C. Laboratory Testing

Rock Cores

hdrinc.com

1201 Main Street, Suite 800 Columbia, SC 29201
T 803.254.5800

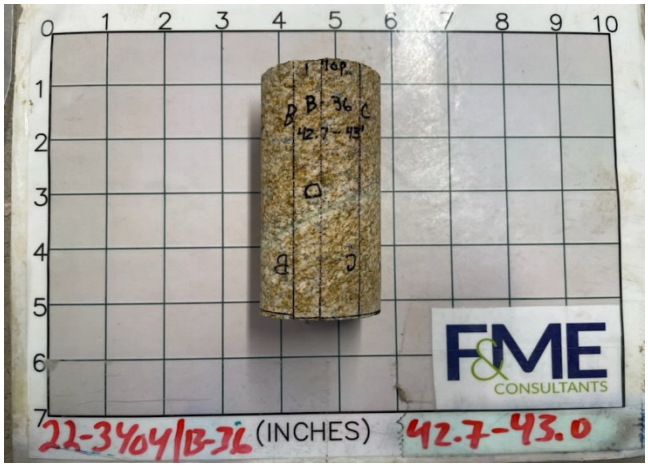
Compressive Strength and Elastic Moduli of Intact Rock Core Specimens
ASTM D7012 - Method D / SC-T-39

Project	SC 49 RBO Tyger River			Date	1/27/2023
Project No.	G6658.002	Sample Diameter (in.)	1.867	Tested By	WAP
SCDOT ID	P041237	Sample Length (in.)	3.822	Reviewed By	WJG
Boring	B-36	Unit Weight (pcf)	155.8	Core Size	NQ
Sample No.	NQ-6 / 22-3404	L/D Ratio	2.05	Recovery	57%
Depth	42.7' - 43.0'	Load Rate (psi/sec)	20	RQD	15%
Description	Brown/White/Black Quartz Feldspar Gneiss				

Test Data

Percent of Failure Load	Strain (10^{-6}) Axial	Strain (10^{-6}) Radial	Load (lbs)	Compressive Stress (psi)	Secant Modulus x10^6 (psi)	Poisson's Ratio
10%	Sample Preload Range					
20%						
30%	-12209	118	1,619	591	0.10	0.01
40%	-15329	93	2,164	791	0.10	0.01
50%	-20009	-60	2,798	1,022	0.10	0.00
60%	-22226	-280	3,263	1,192	0.11	-0.01
70%	-24356	-660	3,811	1,392	0.11	-0.03
80%	-27064	-1637	4,324	1,580	0.12	-0.06
90%	-30014	-2618	4,693	1,714	0.11	-0.09
100%	-33760	-4883	5,460	1,994		

Sample Photos

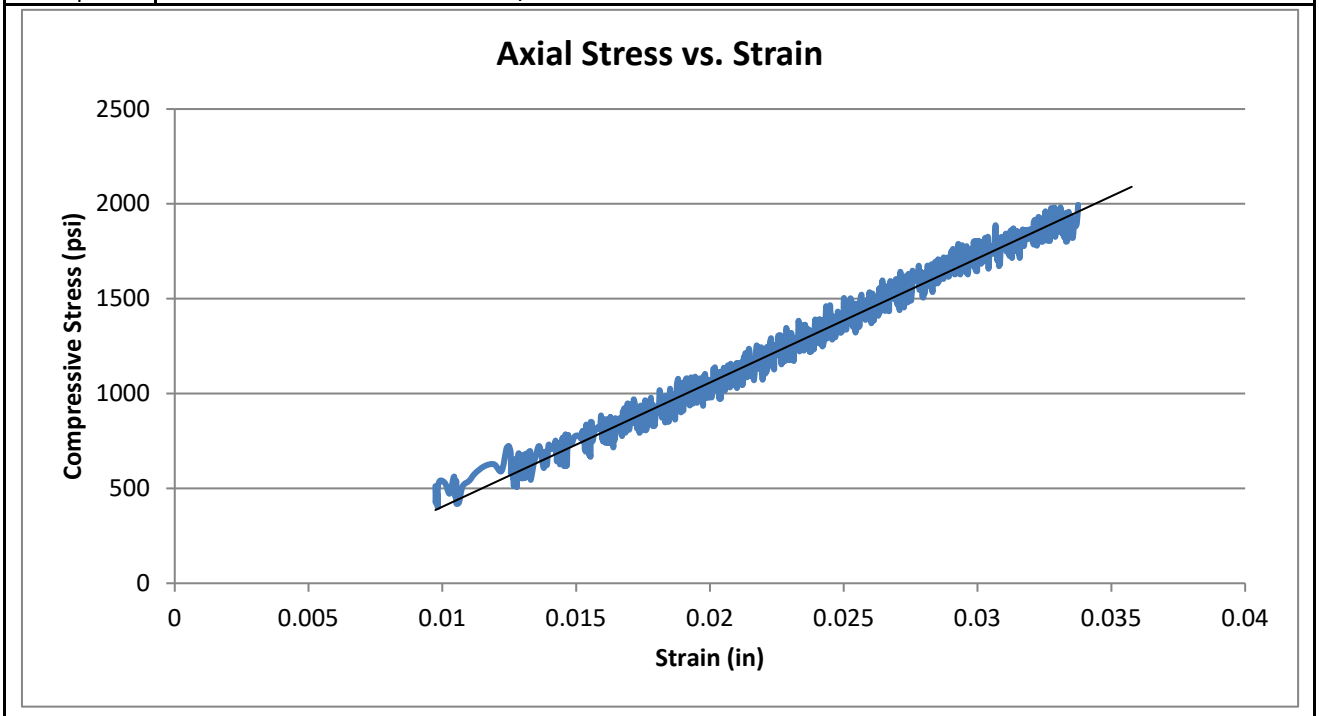


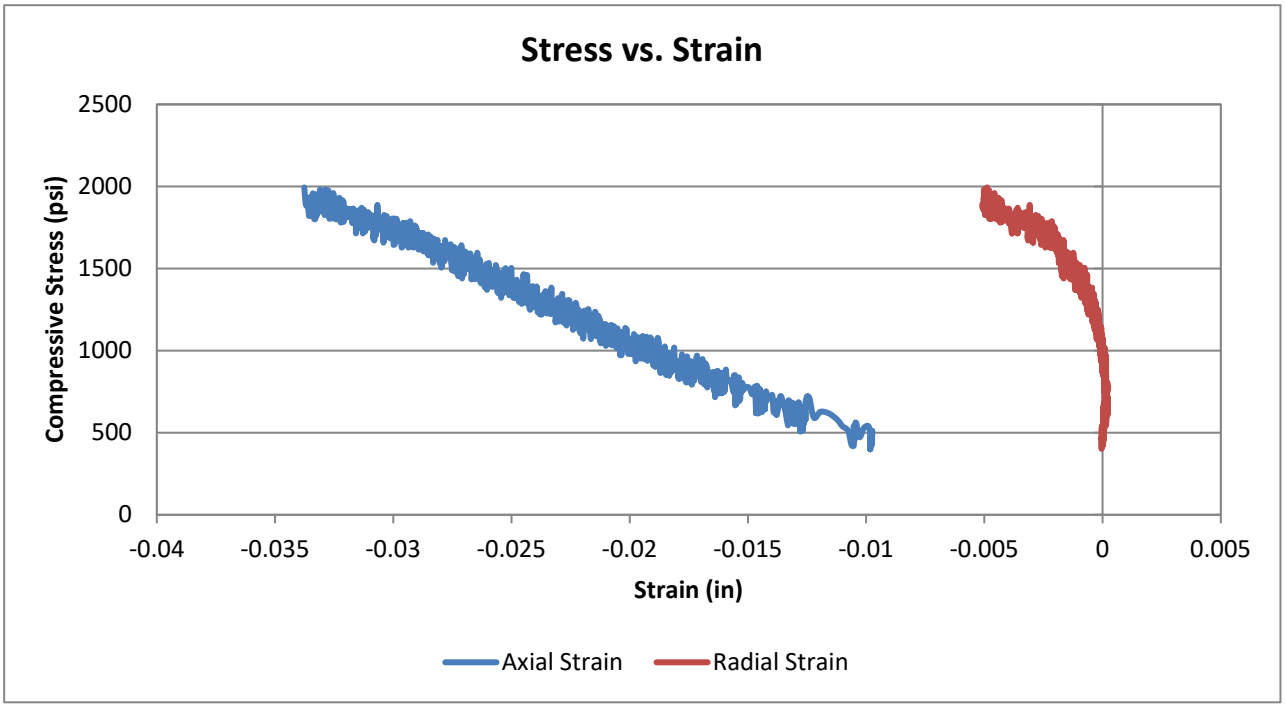
Test Results

Unconfined Compressive Strength (psi)	**2,000**	Elastic Modulus (psi)	1.10E+05
		Poisson's Ratio in Elastic Range	N/A
Comments	Elastic range was taken as between 0.02 and 0.03 inches of axial strain. This range was chosen to avoid any non-linear behavior from the initial loading and the inflection point at the end of the elastic range. Poission's Ratio data from this sample was not valid and is not reported.		

Compressive Strength and Elastic Moduli of Intact Rock Core Specimens
ASTM D7012 - Method D / SC-T-39

Project	SC 49 RBO Tyger River			Date	1/27/2023
Project No.	G6658.002	Sample Diameter (in.)	1.867	Tested By	WAP
SCDOT ID	P041237	Sample Length (in.)	3.822	Reviewed By	WJG
Boring	B-36	Unit Weight (pcf)	155.8	Core Size	NQ
Sample No.	NQ-6 / 22-3404	L/D Ratio	2.05	Recovery	57%
Depth	42.7' - 43.0'	Load Rate (psi/sec)	20	RQD	15%
Description	Brown/White/Black Quartz Feldspar Gneiss				





Compressive Strength and Elastic Moduli of Intact Rock Core Specimens
ASTM D7012 - Method D / SC-T-39

Project	SC 49 RBO Tyger River			Date	1/27/2023
Project No.	G6658.002	Sample Diameter (in.)	1.873	Tested By	WAP
SCDOT ID	P041237	Sample Length (in.)	3.89	Reviewed By	WJG
Boring	B-37	Unit Weight (pcf)	154.2	Core Size	NQ
Sample No.	NQ-5 / 22-3405	L/D Ratio	2.08	Recovery	100%
Depth	54.2' - 54.5'	Load Rate (psi/sec)	20	RQD	30%
Description	Gray/White/Brown Quartz Feldspar Gneiss				

Test Data

Percent of Failure Load	Strain (10^{-6}) Axial	Strain (10^{-6}) Radial	Load (lbs)	Compressive Stress (psi)	Secant Modulus $x10^6$ (psi)	Poisson's Ratio
10%	Sample Preload Range					
20%						
30%	-14250	19	2,034	738	0.10	0.00
40%	-16633	121	2,708	983	0.12	0.01
50%	-19043	119	3,389	1,230	0.13	0.01
60%	-21494	30	4,072	1,478	0.14	0.00
70%	-23960	-980	4,768	1,731	0.14	-0.04
80%	-27289	-1441	5,409	1,963	0.14	-0.05
90%	-31131	-2623	6,060	2,199	0.14	-0.08
100%	-31659	-2695	6,373	2,313		

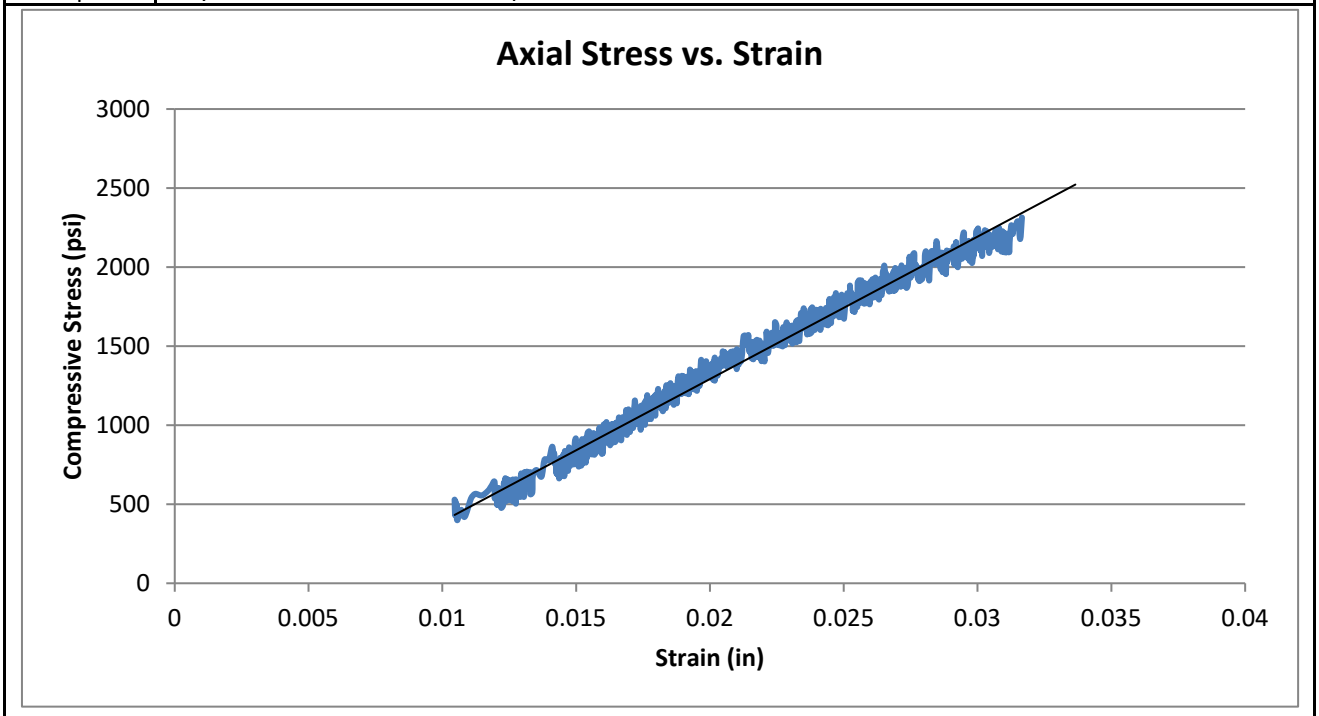
Sample Photos

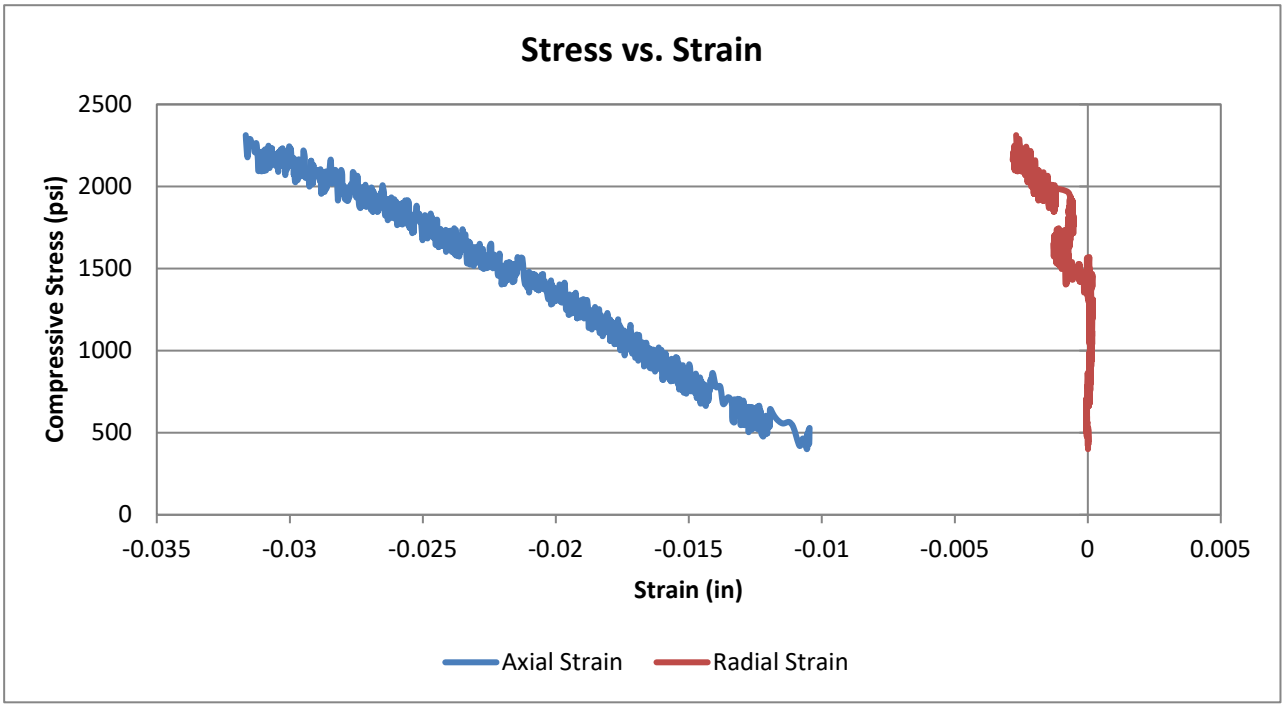
Test Results

Unconfined Compressive Strength (psi)	**2,310**	Elastic Modulus (psi)	1.29E+05
		Poisson's Ratio in Elastic Range	N/A
Comments	Elastic range was taken as between 0.015 and 0.025 inches of axial strain. This range was chosen to avoid any non-linear behavior from the initial loading and the inflection point at the end of the elastic range. Poission's Ratio data from this sample was not valid and is not reported.		

Compressive Strength and Elastic Moduli of Intact Rock Core Specimens
ASTM D7012 - Method D / SC-T-39

Project	SC 49 RBO Tyger River			Date	1/27/2023
Project No.	G6658.002	Sample Diameter (in.)	1.873	Tested By	WAP
SCDOT ID	P041237	Sample Length (in.)	3.89	Reviewed By	WJG
Boring	B-37	Unit Weight (pcf)	154.2	Core Size	NQ
Sample No.	NQ-5 / 22-3405	L/D Ratio	2.08	Recovery	100%
Depth	54.2' - 54.5'	Load Rate (psi/sec)	20	RQD	30%
Description	Gray/White/Brown Quartz Feldspar Gneiss				





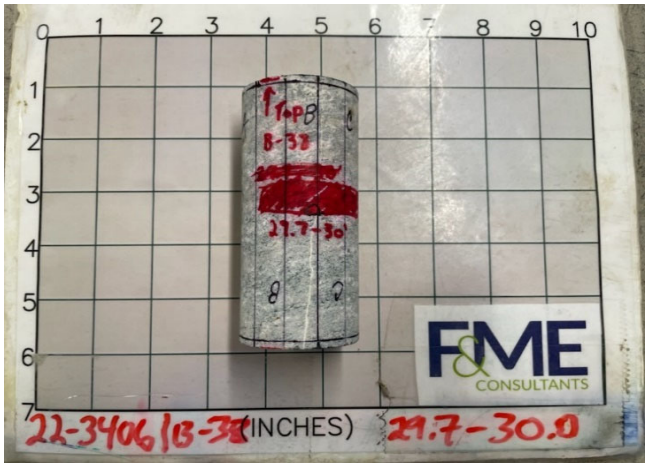
Compressive Strength and Elastic Moduli of Intact Rock Core Specimens
ASTM D7012 - Method D / SC-T-39

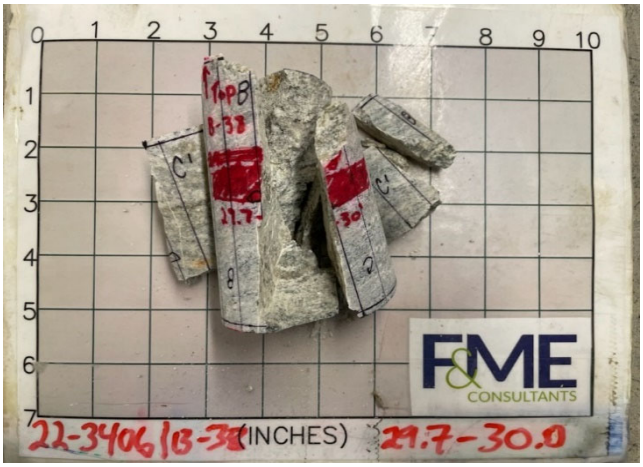
Project	SC 49 RBO Tyger River			Date	1/27/2023
Project No.	G6658.002	Sample Diameter (in.)	1.869	Tested By	WAP
SCDOT ID	P041237	Sample Length (in.)	4.092	Reviewed By	WJG
Boring	B-38	Unit Weight (pcf)	164.5	Core Size	NQ
Sample No.	NQ-1 / 22-3406A	L/D Ratio	2.19	Recovery	40%
Depth	29.7' - 30.0'	Load Rate (psi/sec)	20	RQD	7%
Description	White/Gray/Blue Quartz Feldspar Gneiss				

Test Data

Percent of Failure Load	Strain (10^{-6}) Axial	Strain (10^{-6}) Radial	Load (lbs)	Compressive Stress (psi)	Secant Modulus $x10^6$ (psi)	Poisson's Ratio
10%	-985	-15	6,275	2,287	4.65	-0.02
20%	-1819	62	12,301	4,484	4.93	0.03
30%	-2633	152	18,731	6,827	5.19	0.06
40%	-3360	216	24,976	9,104	5.42	0.06
50%	-4047	324	31,266	11,396	5.63	0.08
60%	-4724	431	37,499	13,668	5.79	0.09
70%	-5389	540	43,760	15,950	5.92	0.10
80%	-6060	243	49,861	18,174	6.00	0.04
90%	-6804	263	56,047	20,429	6.01	0.04
100%	-8055	331	62,387	22,740		

Sample Photos



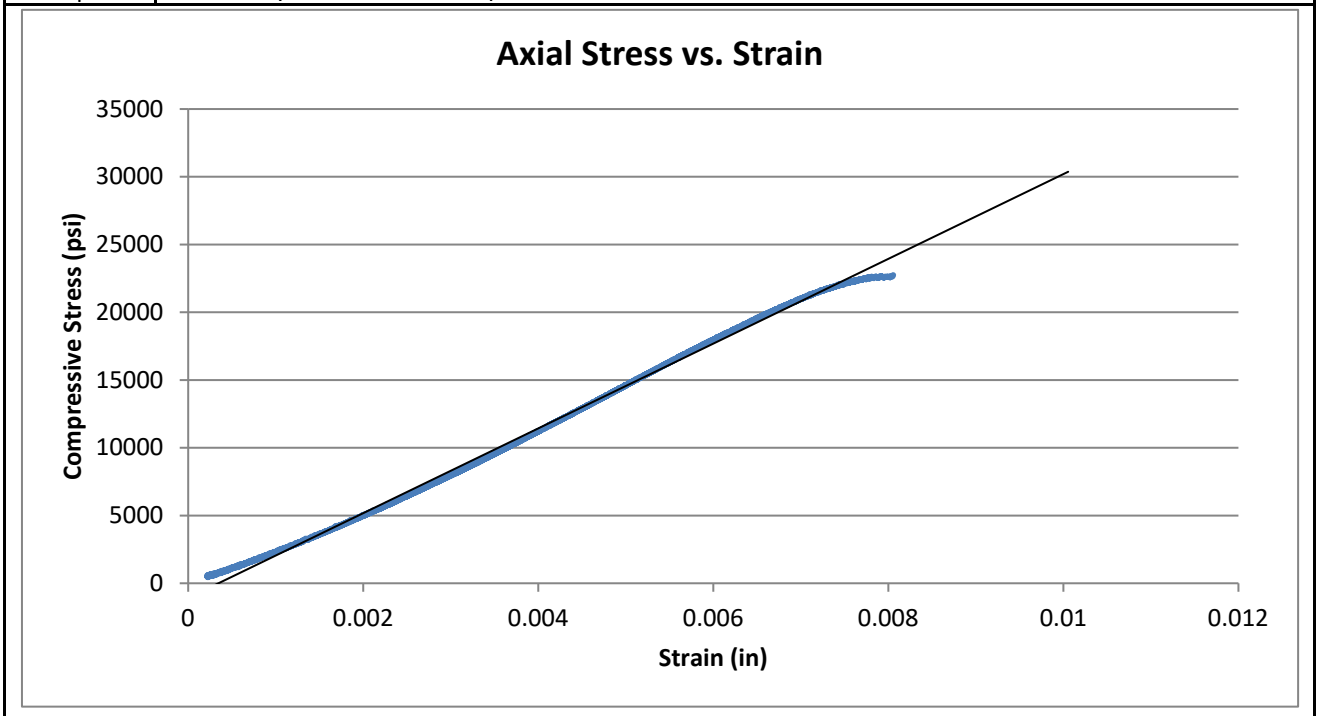


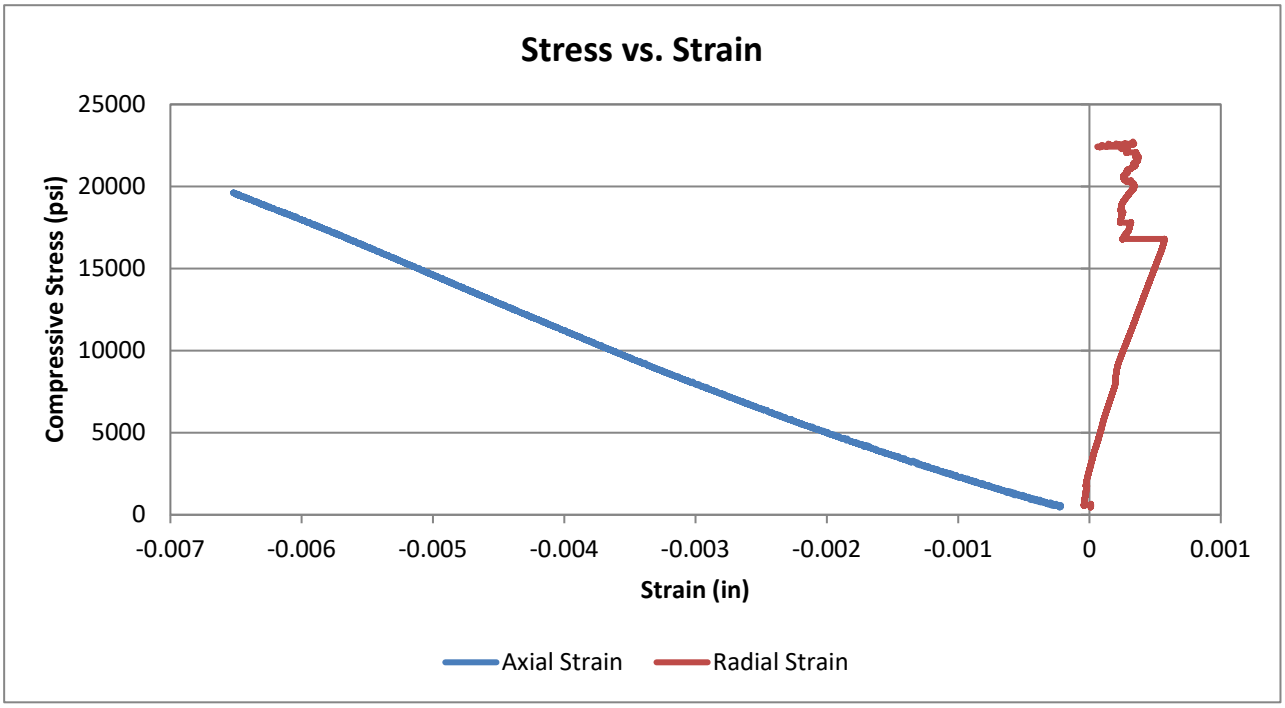
Test Results

Unconfined Compressive Strength (psi)	**22,740**	Elastic Modulus (psi)	5.46E+06
		Poisson's Ratio in Elastic Range	0.07
Comments	Elastic range was taken as between 0.002 and 0.005 inches of axial strain. This range was chosen to avoid any non-linear behavior from the initial loading and the inflection point at the end of the elastic range.		

Compressive Strength and Elastic Moduli of Intact Rock Core Specimens
ASTM D7012 - Method D / SC-T-39

Project	SC 49 RBO Tyger River			Date	1/27/2023
Project No.	G6658.002	Sample Diameter (in.)	1.869	Tested By	WAP
SCDOT ID	P041237	Sample Length (in.)	4.092	Reviewed By	WJG
Boring	B-38	Unit Weight (pcf)	164.5	Core Size	NQ
Sample No.	NQ-1 / 22-3406A	L/D Ratio	2.19	Recovery	40%
Depth	29.7' - 30.0'	Load Rate (psi/sec)	20	RQD	7%
Description	White/Gray/Blue Quartz Feldspar Gneiss				





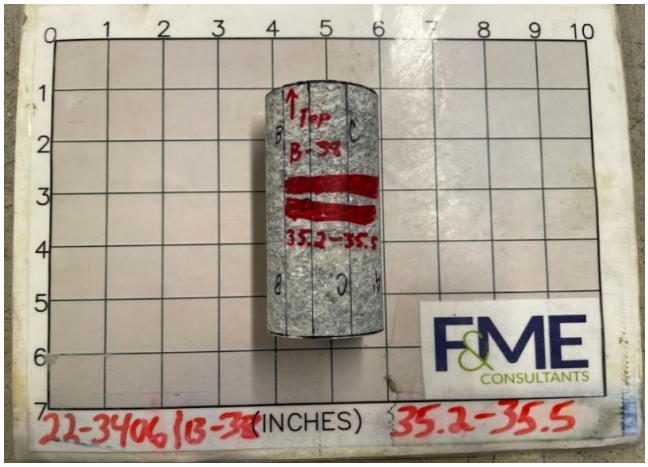
Compressive Strength and Elastic Moduli of Intact Rock Core Specimens
ASTM D7012 - Method D / SC-T-39

Project	SC 49 RBO Tyger River			Date	1/27/2023
Project No.	G6658.002	Sample Diameter (in.)	1.874	Tested By	WAP
SCDOT ID	P041237	Sample Length (in.)	3.962	Reviewed By	WJG
Boring	B-38	Unit Weight (pcf)	163.9	Core Size	NQ
Sample No.	NQ-3 / 22-3406B	L/D Ratio	2.11	Recovery	93%
Depth	35.2' - 35.5'	Load Rate (psi/sec)	30	RQD	62%
Description	White/Gray/Blue Quartz Feldspar Gneiss				

Test Data

Percent of Failure Load	Strain (10^{-6}) Axial	Strain (10^{-6}) Radial	Load (lbs)	Compressive Stress (psi)	Secant Modulus $x10^6$ (psi)	Poisson's Ratio
10%	-962	175	7,711	2,796	5.81	0.18
20%	-1871	325	15,407	5,586	5.97	0.17
30%	-2680	480	23,104	8,377	6.25	0.18
40%	-3426	640	30,800	11,167	6.52	0.19
50%	-4126	807	38,535	13,971	6.77	0.20
60%	-4801	984	46,212	16,754	6.98	0.20
70%	-5466	1178	53,912	19,546	7.15	0.22
80%	-6126	1397	61,572	22,323	7.29	0.23
90%	-6794	1660	69,311	25,129	7.40	0.24
100%	-7505	2103	77,014	27,922		

Sample Photos

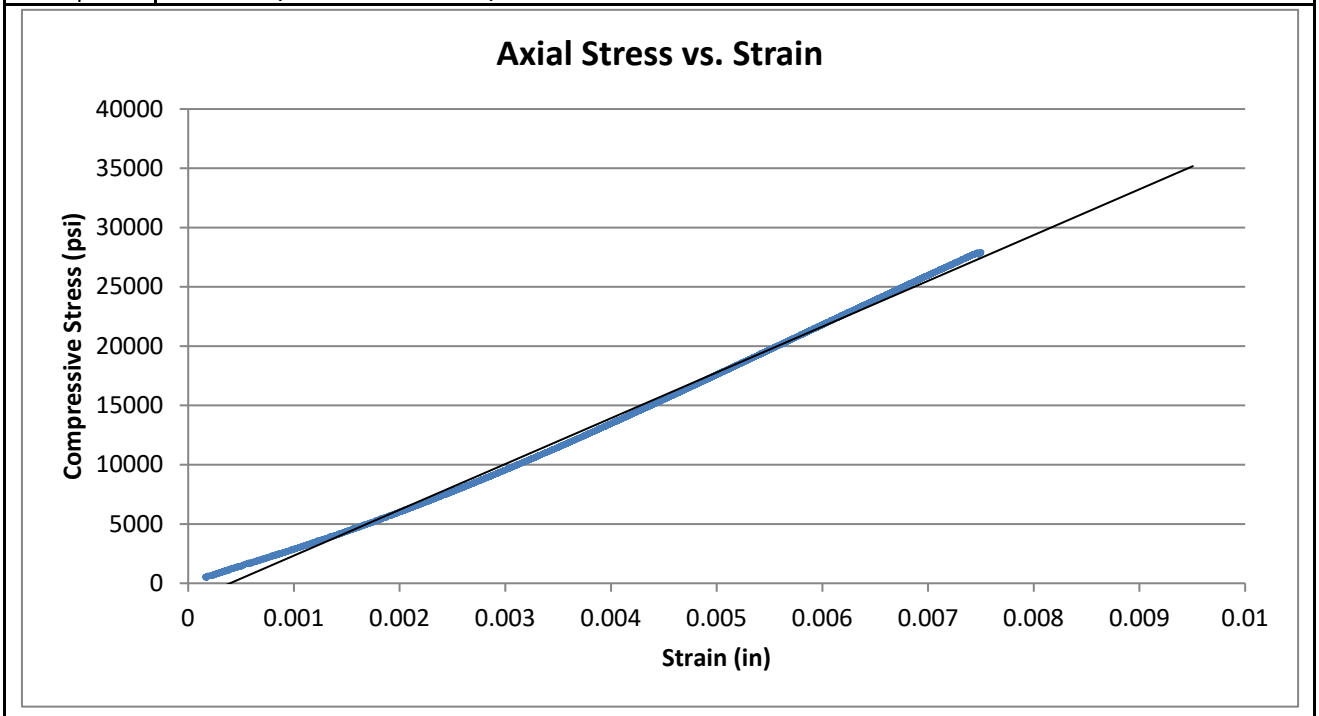


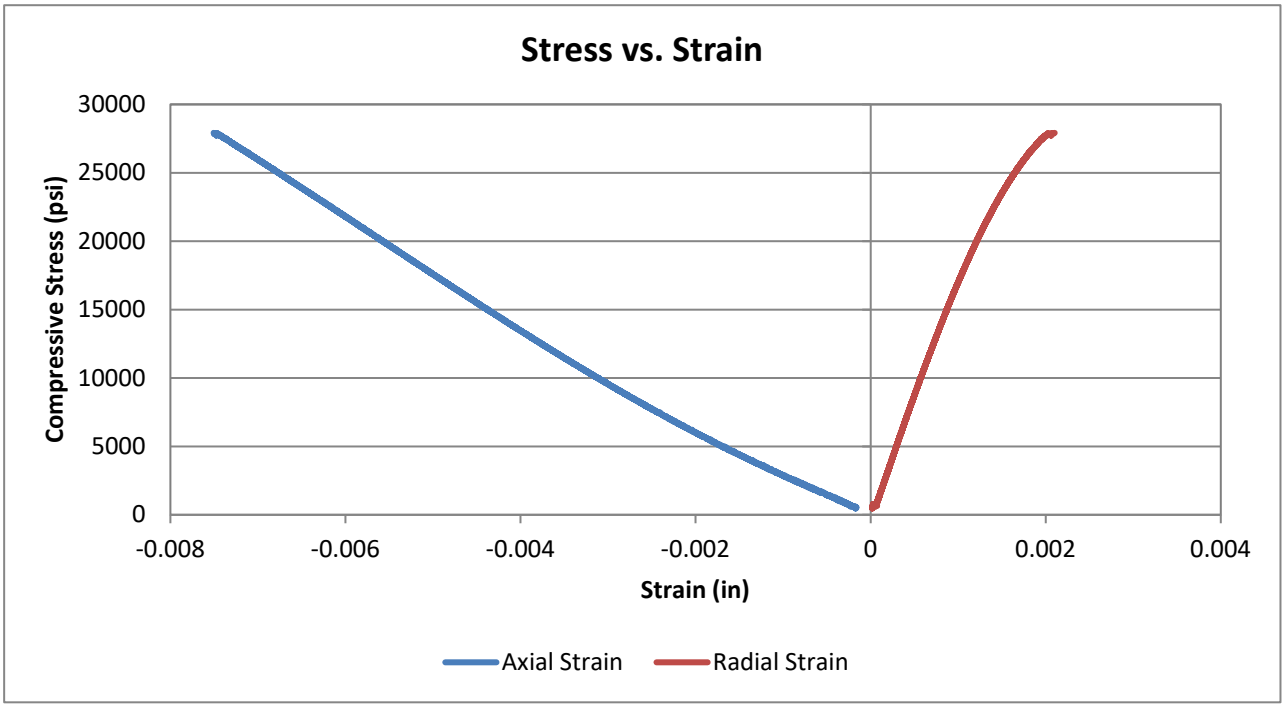
Test Results

Unconfined Compressive Strength (psi)	**27,920**	Elastic Modulus (psi)	6.72E+06
		Poisson's Ratio in Elastic Range	0.20
Comments	Elastic range was taken as between 0.002 and 0.006 inches of axial strain. This range was chosen to avoid any non-linear behavior from the initial loading and the inflection point at the end of the elastic range.		

Compressive Strength and Elastic Moduli of Intact Rock Core Specimens
ASTM D7012 - Method D / SC-T-39

Project	SC 49 RBO Tyger River			Date	1/27/2023
Project No.	G6658.002	Sample Diameter (in.)	1.874	Tested By	WAP
SCDOT ID	P041237	Sample Length (in.)	3.962	Reviewed By	WJG
Boring	B-38	Unit Weight (pcf)	163.9	Core Size	NQ
Sample No.	NQ-3 / 22-3406B	L/D Ratio	2.11	Recovery	93%
Depth	35.2' - 35.5'	Load Rate (psi/sec)	30	RQD	62%
Description	White/Gray/Blue Quartz Feldspar Gneiss				





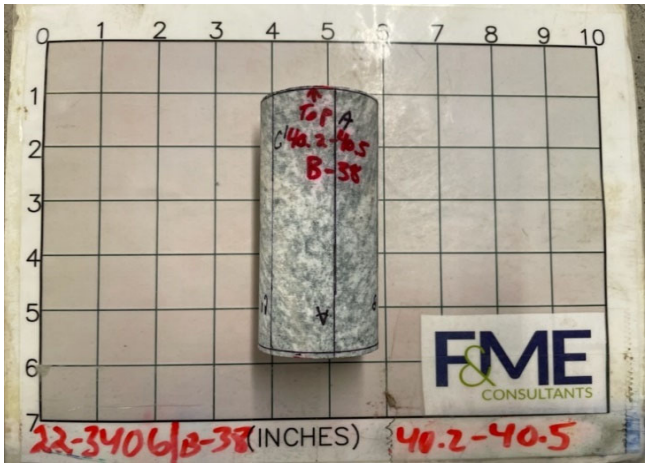
Compressive Strength and Elastic Moduli of Intact Rock Core Specimens
ASTM D7012 - Method D / SC-T-39

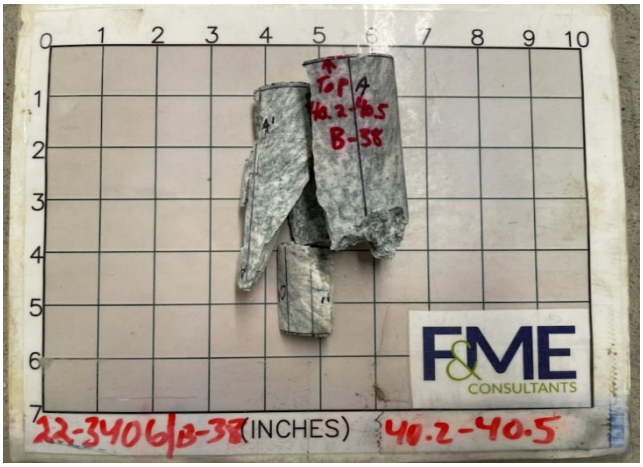
Project	SC 49 RBO Tyger River			Date	1/27/2023
Project No.	G6658.002	Sample Diameter (in.)	1.875	Tested By	WAP
SCDOT ID	P041237	Sample Length (in.)	4	Reviewed By	WJG
Boring	B-38	Unit Weight (pcf)	164.7	Core Size	NQ
Sample No.	NQ-4 / 22-3406C	L/D Ratio	2.13	Recovery	100%
Depth	40.2' - 40.5'	Load Rate (psi/sec)	30	RQD	100%
Description	White/Gray/Blue Quartz Feldspar Gneiss				

Test Data

Percent of Failure Load	Strain (10^{-6}) Axial	Strain (10^{-6}) Radial	Load (lbs)	Compressive Stress (psi)	Secant Modulus $x10^6$ (psi)	Poisson's Ratio
10%	-729	93	8,241	2,985	8.19	0.13
20%	-1466	191	16,367	5,928	8.09	0.13
30%	-2164	289	24,423	8,845	8.18	0.13
40%	-2841	396	32,666	11,831	8.33	0.14
50%	-3493	504	40,828	14,786	8.47	0.14
60%	-4126	624	48,991	17,743	8.60	0.15
70%	-4751	749	57,147	20,697	8.71	0.16
80%	-5368	880	65,330	23,660	8.81	0.16
90%	-5974	1023	73,407	26,585	8.90	0.17
100%	-6788	1913	81,654	29,572		

Sample Photos



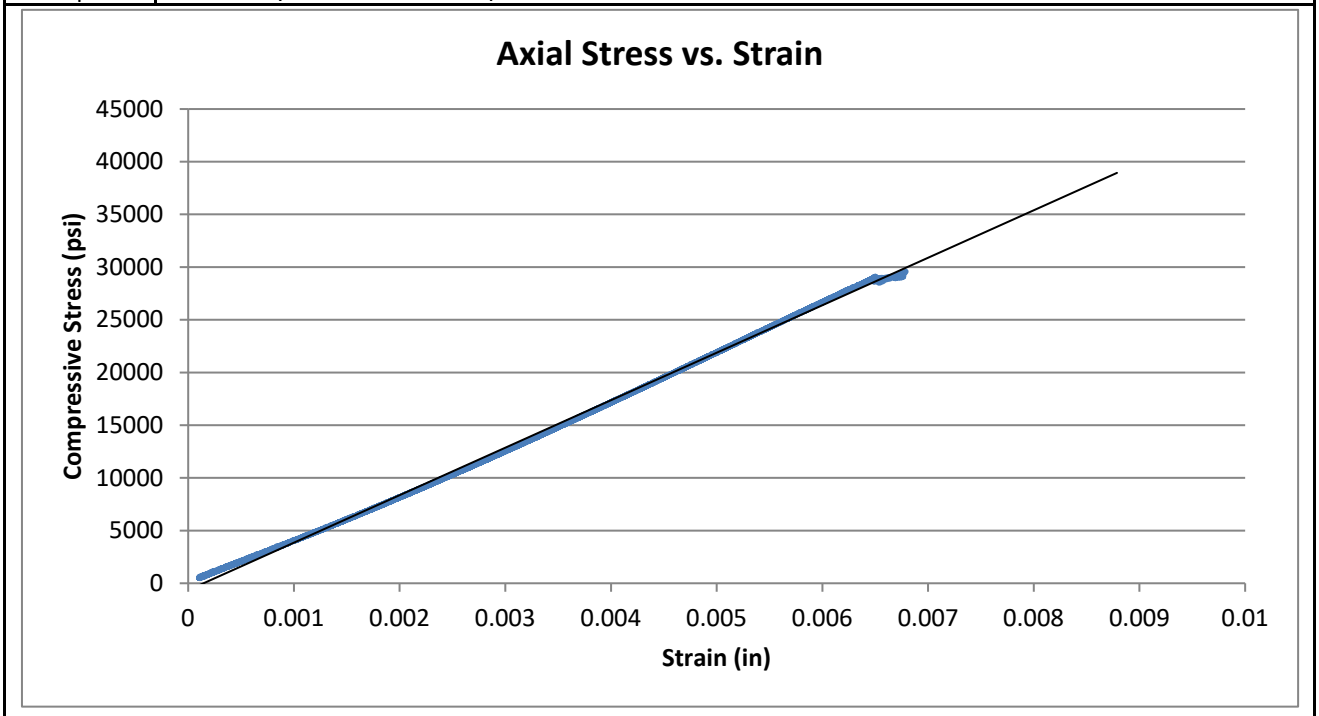


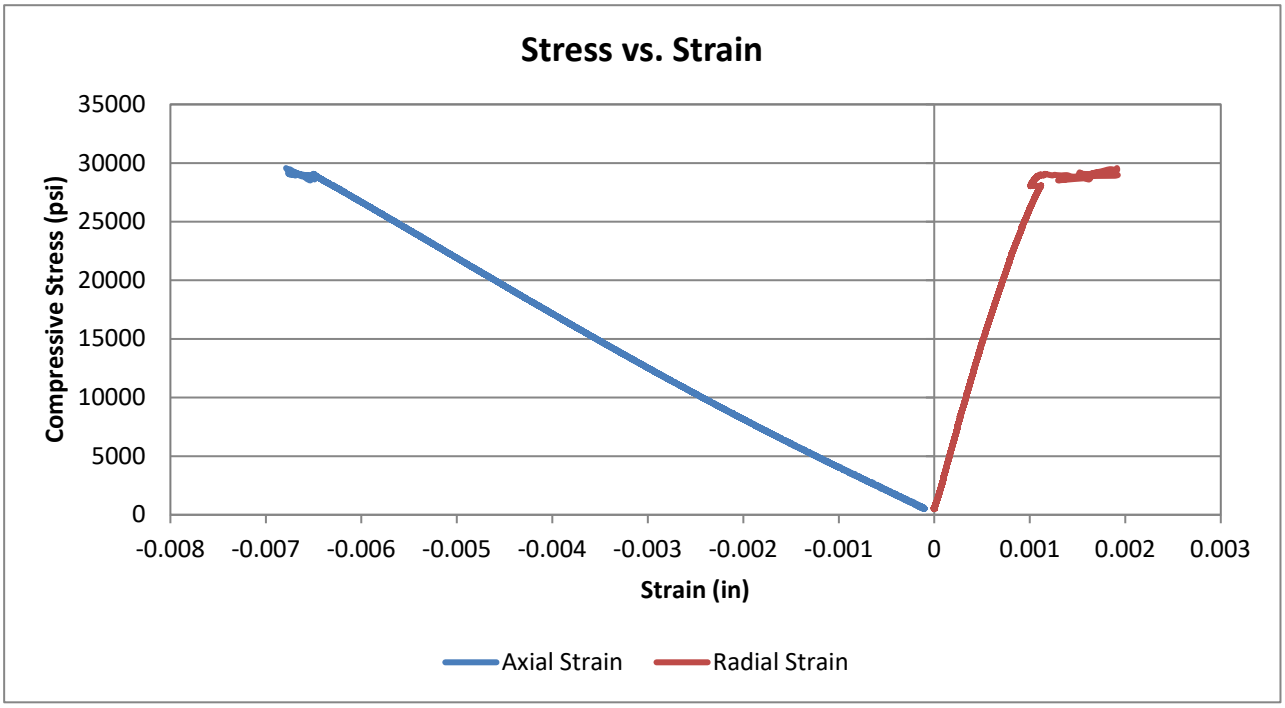
Test Results

Unconfined Compressive Strength (psi)	**29,570**	Elastic Modulus (psi)	8.47E+06
		Poisson's Ratio in Elastic Range	0.15
Comments	Elastic range was taken as between 0.002 and 0.005 inches of axial strain. This range was chosen to avoid any non-linear behavior from the initial loading and the inflection point at the end of the elastic range.		

Compressive Strength and Elastic Moduli of Intact Rock Core Specimens
ASTM D7012 - Method D / SC-T-39

Project	SC 49 RBO Tyger River			Date	1/27/2023
Project No.	G6658.002	Sample Diameter (in.)	1.875	Tested By	WAP
SCDOT ID	P041237	Sample Length (in.)	4	Reviewed By	WJG
Boring	B-38	Unit Weight (pcf)	164.7	Core Size	NQ
Sample No.	NQ-4 / 22-3406C	L/D Ratio	2.13	Recovery	100%
Depth	40.2' - 40.5'	Load Rate (psi/sec)	30	RQD	100%
Description	White/Gray/Blue Quartz Feldspar Gneiss				





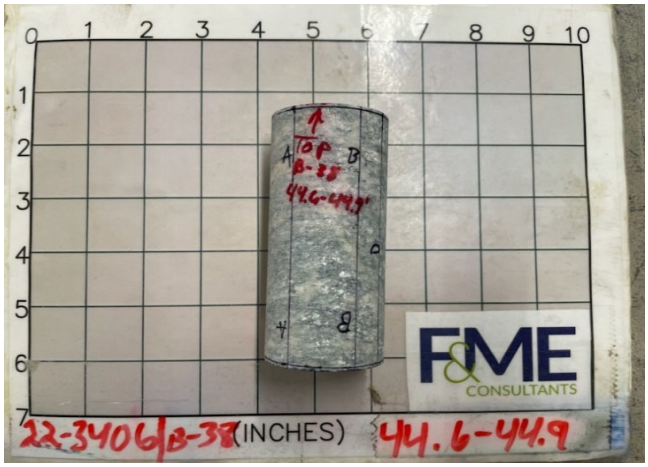
Compressive Strength and Elastic Moduli of Intact Rock Core Specimens
ASTM D7012 - Method D / SC-T-39

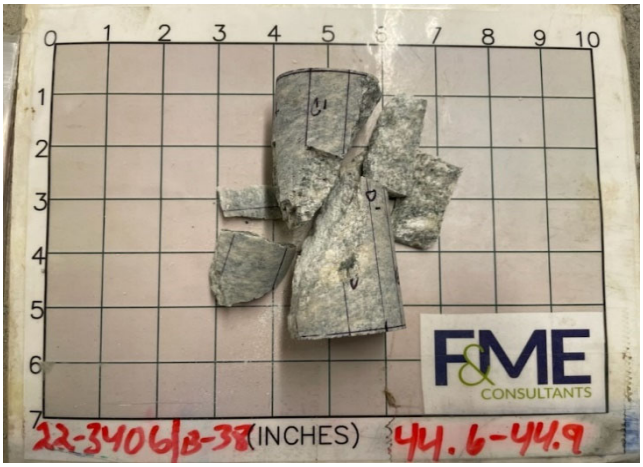
Project	SC 49 RBO Tyger River			Date	1/27/2023
Project No.	G6658.002	Sample Diameter (in.)	1.876	Tested By	WAP
SCDOT ID	P041237	Sample Length (in.)	3.968	Reviewed By	WJG
Boring	B-38	Unit Weight (pcf)	164.4	Core Size	NQ
Sample No.	NQ-4 / 22-3406D	L/D Ratio	2.12	Recovery	100%
Depth	44.6' - 44.9'	Load Rate (psi/sec)	30	RQD	100%
Description	Gray/White/Blue Quartz Feldspar Gneiss				

Test Data

Percent of Failure Load	Strain (10^{-6}) Axial	Strain (10^{-6}) Radial	Load (lbs)	Compressive Stress (psi)	Secant Modulus $x10^6$ (psi)	Poisson's Ratio
10%	-1685	135	8,511	3,079	3.66	0.08
20%	-2865	317	17,036	6,163	4.30	0.11
30%	-3784	466	25,547	9,242	4.89	0.12
40%	-4599	629	34,096	12,335	5.36	0.14
50%	-5352	809	42,587	15,407	5.76	0.15
60%	-6059	1014	51,154	18,506	6.11	0.17
70%	-6749	1268	59,631	21,573	6.39	0.19
80%	-7422	1618	68,143	24,653	6.64	0.22
90%	-8065	2121	76,627	27,722	6.87	0.26
100%	-5989	4220	85,190	30,820		

Sample Photos



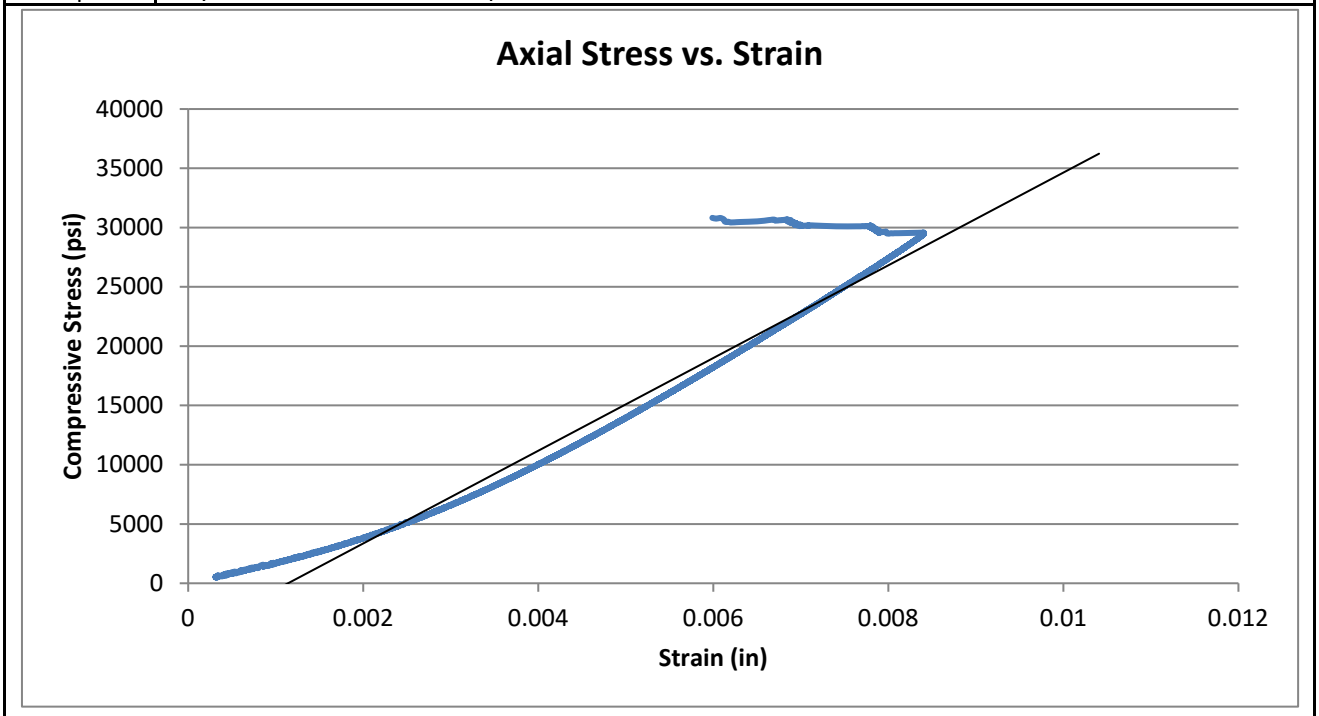


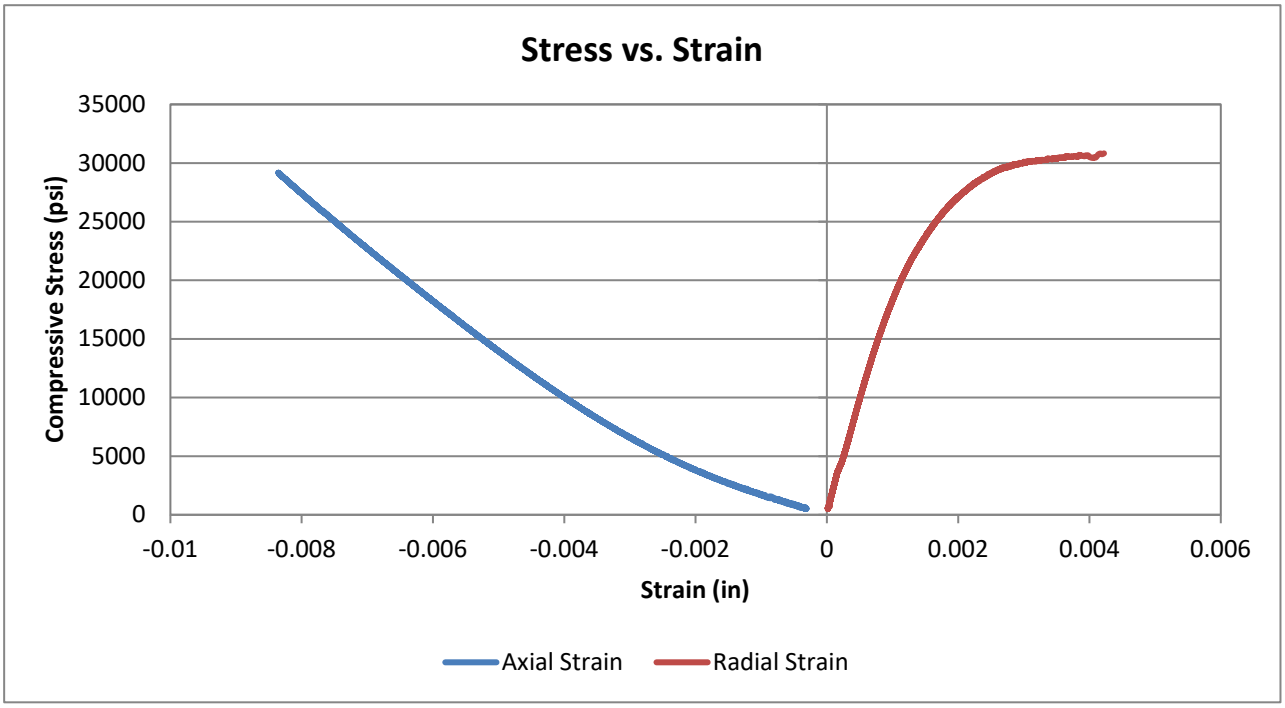
Test Results

Unconfined Compressive Strength (psi)	**30,820**	Elastic Modulus (psi)	5.33E+06
		Poisson's Ratio in Elastic Range	0.14
Comments	Elastic range was taken as between 0.003 and 0.006 inches of axial strain. This range was chosen to avoid any non-linear behavior from the initial loading and the inflection point at the end of the elastic range.		

Compressive Strength and Elastic Moduli of Intact Rock Core Specimens
ASTM D7012 - Method D / SC-T-39

Project	SC 49 RBO Tyger River			Date	1/27/2023
Project No.	G6658.002	Sample Diameter (in.)	1.876	Tested By	WAP
SCDOT ID	P041237	Sample Length (in.)	3.968	Reviewed By	WJG
Boring	B-38	Unit Weight (pcf)	164.4	Core Size	NQ
Sample No.	NQ-4 / 22-3406D	L/D Ratio	2.12	Recovery	100%
Depth	44.6' - 44.9'	Load Rate (psi/sec)	30	RQD	100%
Description	Gray/White/Blue Quartz Feldspar Gneiss				





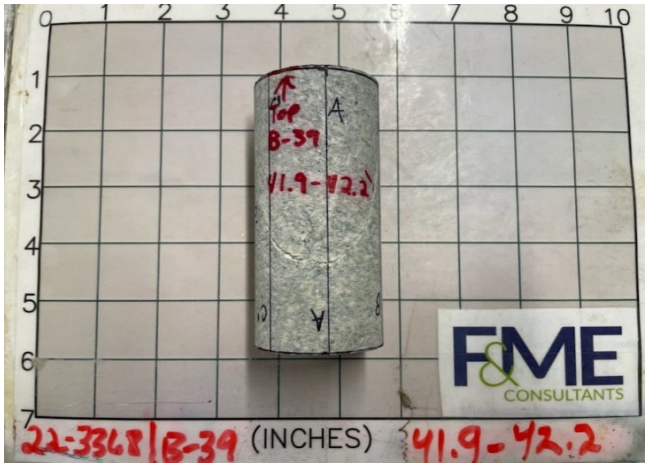
Compressive Strength and Elastic Moduli of Intact Rock Core Specimens
ASTM D7012 - Method D / SC-T-39

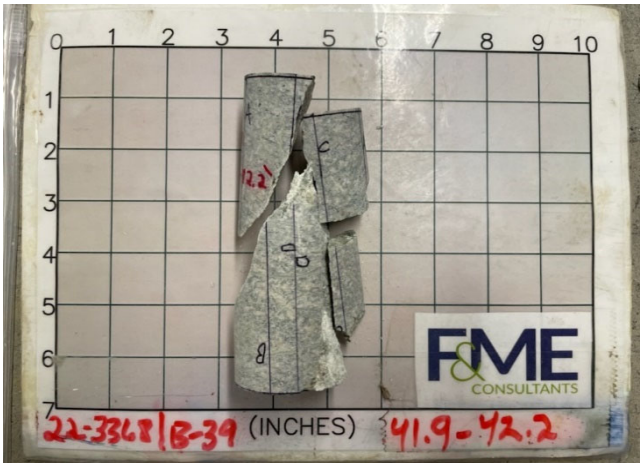
Project	SC 49 RBO Tyger River			Date	1/27/2023
Project No.	G6658.002	Sample Diameter (in.)	1.871	Tested By	WAP
SCDOT ID	P041237	Sample Length (in.)	3.978	Reviewed By	WJG
Boring	B-39	Unit Weight (pcf)	163.6	Core Size	NQ
Sample No.	NQ-2 / 22-3368A	L/D Ratio	2.13	Recovery	70%
Depth	41.9' - 42.2'	Load Rate (psi/sec)	30	RQD	35%
Description	Gray/White/Blue Quartz Feldspar Gneiss				

Test Data

Percent of Failure Load	Strain (10^{-6}) Axial	Strain (10^{-6}) Radial	Load (lbs)	Compressive Stress (psi)	Secant Modulus $x10^6$ (psi)	Poisson's Ratio
10%	-1220	66	3,377	1,228	2.01	0.05
20%	-2024	122	6,769	2,462	2.43	0.06
30%	-2872	169	10,132	3,685	2.57	0.06
40%	-3818	215	13,577	4,938	2.59	0.06
50%	-4959	271	16,941	6,162	2.48	0.05
60%	-6028	330	20,283	7,377	2.45	0.05
70%	-7215	371	23,662	8,606	2.39	0.05
80%	-8225	416	27,043	9,836	2.39	0.05
90%	-9280	479	30,452	11,076	2.39	0.05
100%	-10810	1096	33,805	12,295		

Sample Photos



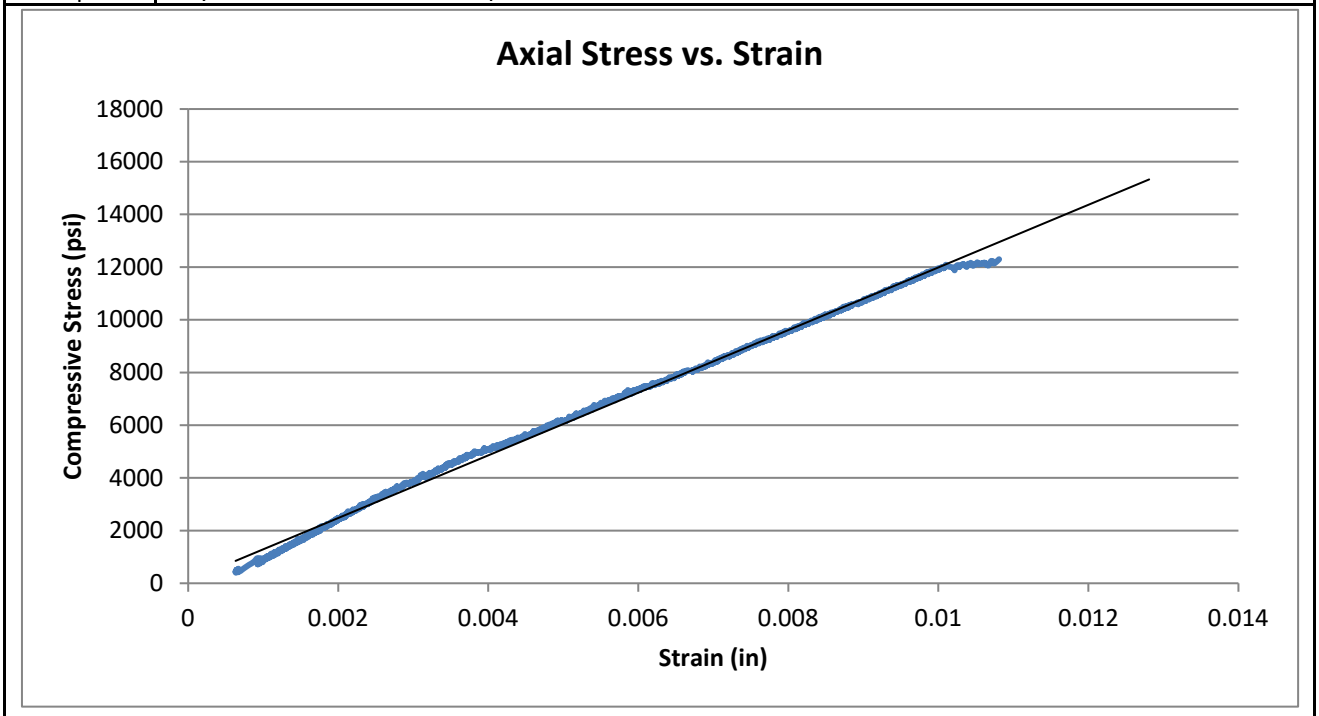


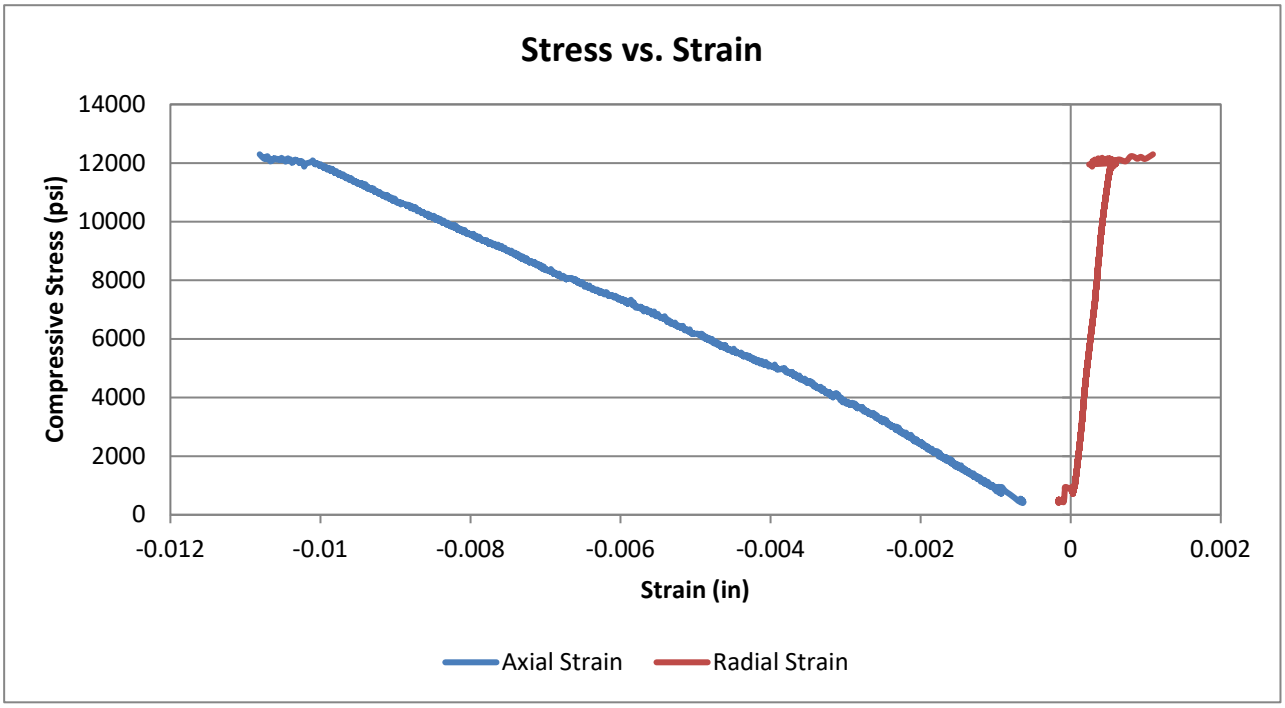
Test Results

Unconfined Compressive Strength (psi)	**12,300**	Elastic Modulus (psi)	2.49E+06
		Poisson's Ratio in Elastic Range	0.05
Comments	Elastic range was taken as between 0.003 and 0.007 inches of axial strain. This range was chosen to avoid any non-linear behavior from the initial loading and the inflection point at the end of the elastic range.		

Compressive Strength and Elastic Moduli of Intact Rock Core Specimens
ASTM D7012 - Method D / SC-T-39

Project	SC 49 RBO Tyger River			Date	1/27/2023
Project No.	G6658.002	Sample Diameter (in.)	1.871	Tested By	WAP
SCDOT ID	P041237	Sample Length (in.)	3.978	Reviewed By	WJG
Boring	B-39	Unit Weight (pcf)	163.6	Core Size	NQ
Sample No.	NQ-2 / 22-3368A	L/D Ratio	2.13	Recovery	70%
Depth	41.9' - 42.2'	Load Rate (psi/sec)	30	RQD	35%
Description	Gray/White/Blue Quartz Feldspar Gneiss				





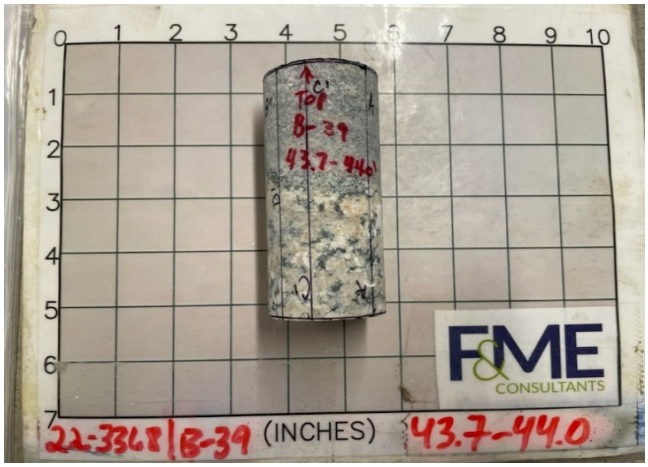
Compressive Strength and Elastic Moduli of Intact Rock Core Specimens
ASTM D7012 - Method D / SC-T-39

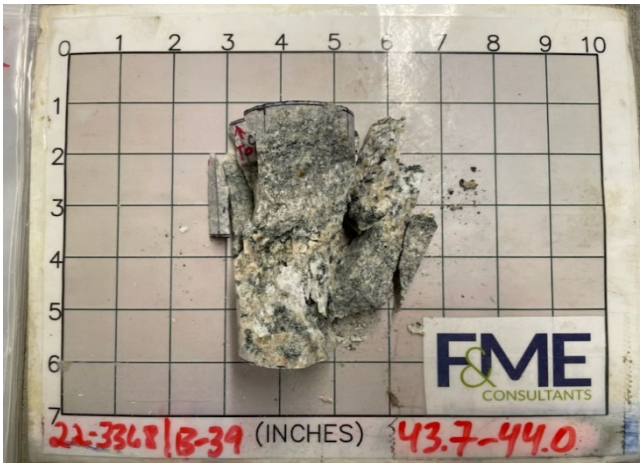
Project	SC 49 RBO Tyger River			Date	1/27/2023
Project No.	G6658.002	Sample Diameter (in.)	1.871	Tested By	WAP
SCDOT ID	P041237	Sample Length (in.)	3.961	Reviewed By	WJG
Boring	B-39	Unit Weight (pcf)	164.8	Core Size	NQ
Sample No.	NQ-3 / 22-3368B	L/D Ratio	2.12	Recovery	100%
Depth	43.7' - 44.0'	Load Rate (psi/sec)	30	RQD	83%
Description	Gray/White/Blue Quartz Feldspar Gneiss				

Test Data

Percent of Failure Load	Strain (10^{-6}) Axial	Strain (10^{-6}) Radial	Load (lbs)	Compressive Stress (psi)	Secant Modulus $x10^6$ (psi)	Poisson's Ratio
10%	-612	150	5,433	1,976	6.46	0.24
20%	-1447	203	10,975	3,992	5.52	0.14
30%	-2144	266	16,333	5,941	5.54	0.12
40%	-2809	327	21,849	7,947	5.66	0.12
50%	-3407	377	27,182	9,886	5.80	0.11
60%	-3980	459	32,726	11,903	5.98	0.12
70%	-4550	544	38,199	13,893	6.11	0.12
80%	-5113	719	43,668	15,883	6.21	0.14
90%	-5716	836	49,112	17,863	6.25	0.15
100%	-3937	562	54,570	19,848		

Sample Photos



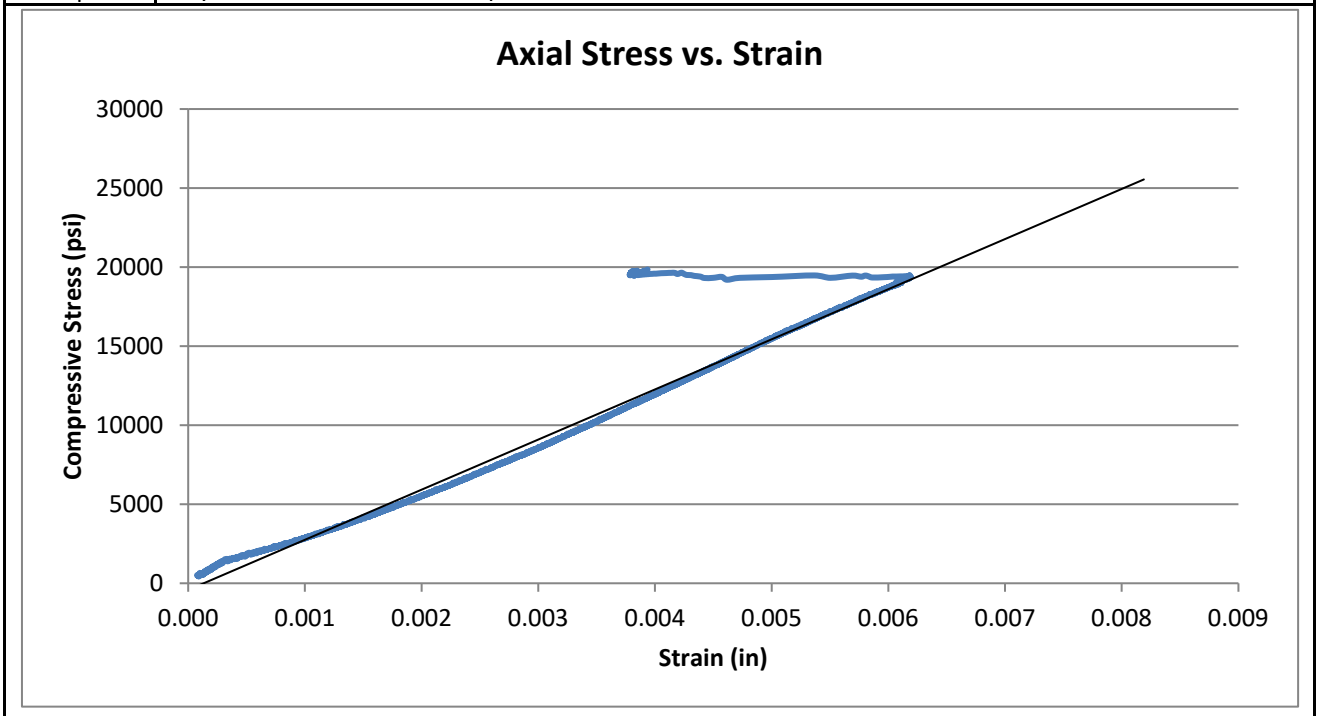


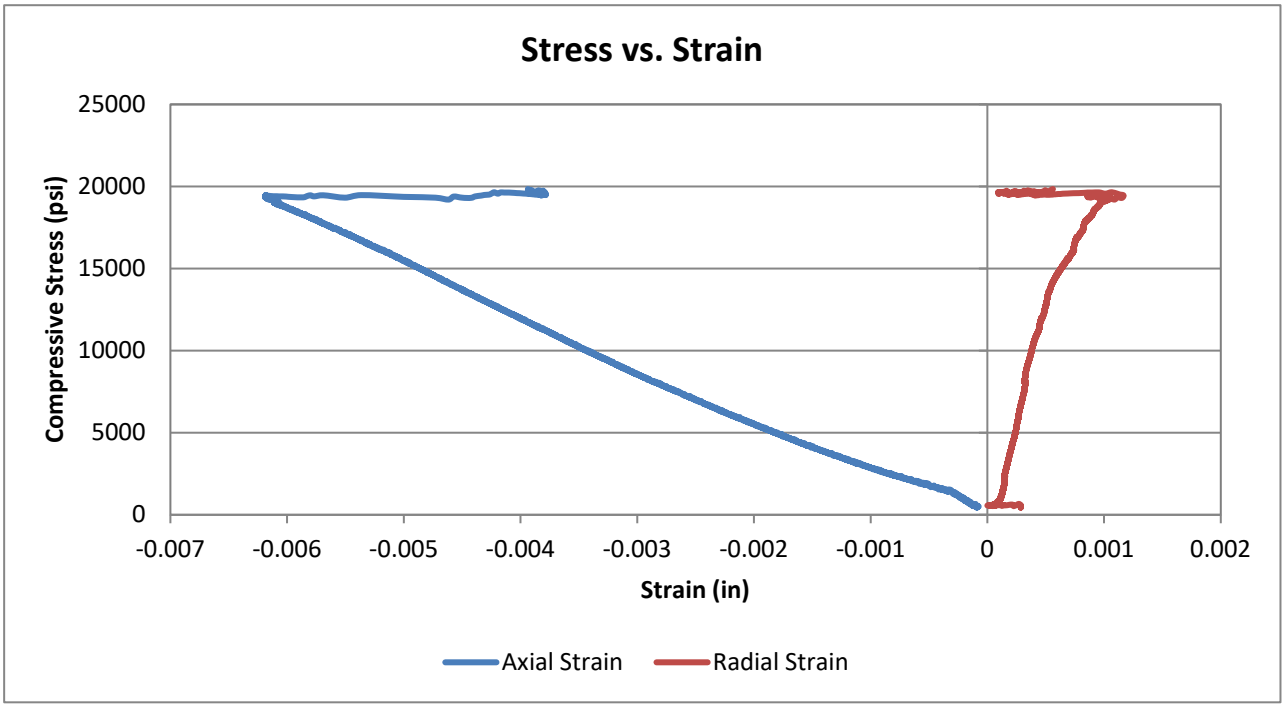
Test Results

Unconfined Compressive Strength (psi)	**19,850**	Elastic Modulus (psi)	5.86E+06
		Poisson's Ratio in Elastic Range	0.12
Comments	Elastic range was taken as between 0.002 and 0.005 inches of axial strain. This range was chosen to avoid any non-linear behavior from the initial loading and the inflection point at the end of the elastic range.		

Compressive Strength and Elastic Moduli of Intact Rock Core Specimens
ASTM D7012 - Method D / SC-T-39

Project	SC 49 RBO Tyger River			Date	1/27/2023
Project No.	G6658.002	Sample Diameter (in.)	1.871	Tested By	WAP
SCDOT ID	P041237	Sample Length (in.)	3.961	Reviewed By	WJG
Boring	B-39	Unit Weight (pcf)	164.8	Core Size	NQ
Sample No.	NQ-3 / 22-3368B	L/D Ratio	2.12	Recovery	100%
Depth	43.7' - 44.0'	Load Rate (psi/sec)	30	RQD	83%
Description	Gray/White/Blue Quartz Feldspar Gneiss				





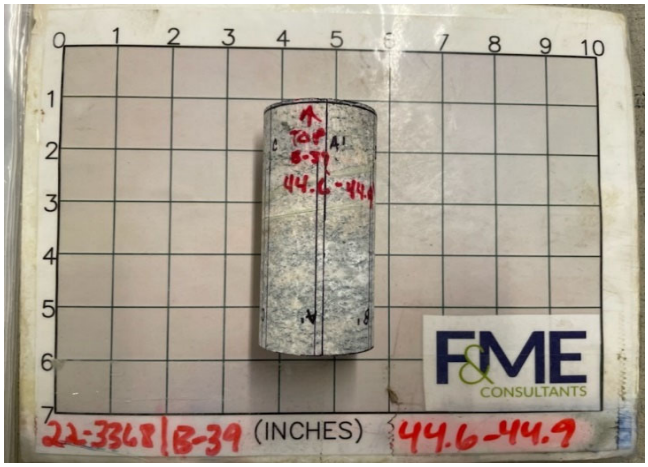
Compressive Strength and Elastic Moduli of Intact Rock Core Specimens
ASTM D7012 - Method D / SC-T-39

Project	SC 49 RBO Tyger River			Date	1/27/2023
Project No.	G6658.002	Sample Diameter (in.)	1.869	Tested By	WAP
SCDOT ID	P041237	Sample Length (in.)	3.957	Reviewed By	WJG
Boring	B-39	Unit Weight (pcf)	163.8	Core Size	NQ
Sample No.	NQ-3 / 22-3368C	L/D Ratio	2.12	Recovery	100%
Depth	44.6' - 44.9'	Load Rate (psi/sec)	30	RQD	83%
Description	Gray/White/Blue Quartz Feldspar Gneiss				

Test Data

Percent of Failure Load	Strain (10^{-6}) Axial	Strain (10^{-6}) Radial	Load (lbs)	Compressive Stress (psi)	Secant Modulus $x10^6$ (psi)	Poisson's Ratio
10%	-2754	-20	4,767	1,737	1.26	-0.01
20%	-3964	2	9,253	3,373	1.70	0.00
30%	-4913	19	14,041	5,118	2.08	0.00
40%	-5688	29	18,721	6,824	2.40	0.01
50%	-6375	36	23,452	8,548	2.68	0.01
60%	-6997	39	28,014	10,211	2.92	0.01
70%	-7601	76	32,744	11,935	3.14	0.01
80%	-8202	93	37,471	13,658	3.33	0.01
90%	-8822	110	42,127	15,355	3.48	0.01
100%	-9585	88	46,803	17,059		

Sample Photos



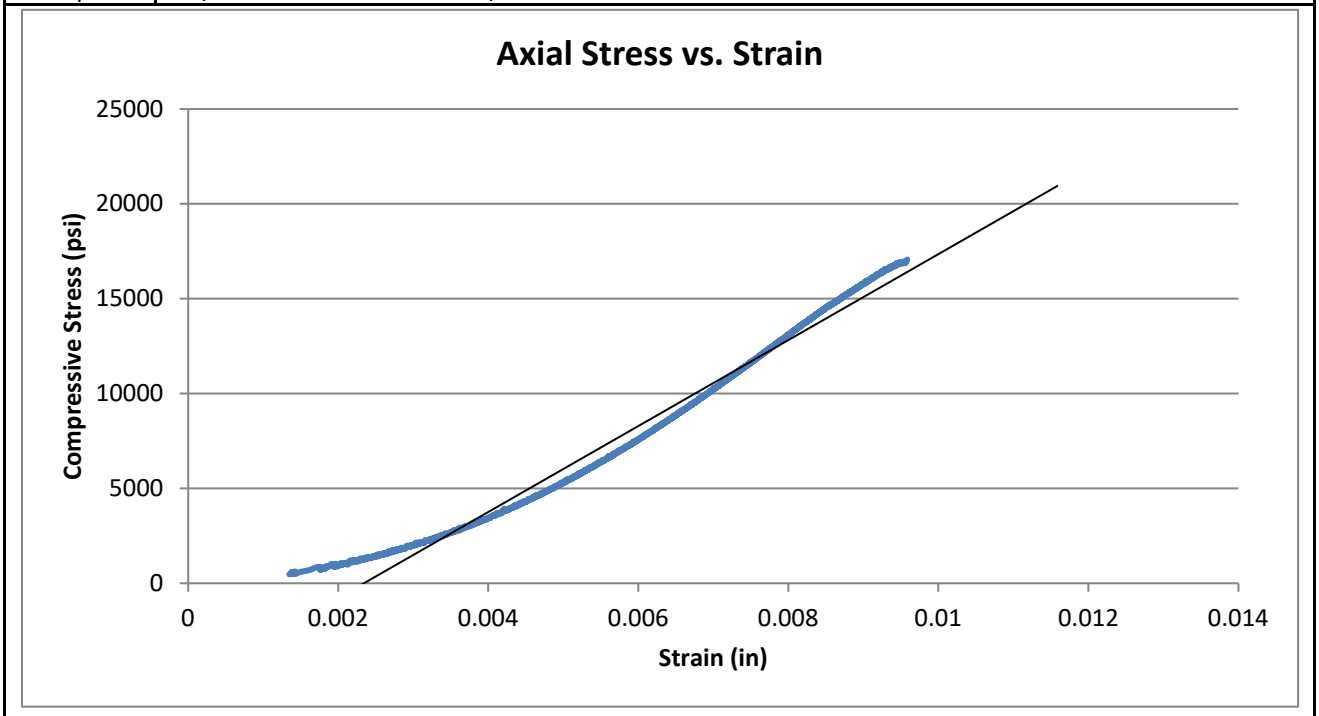
Test Results

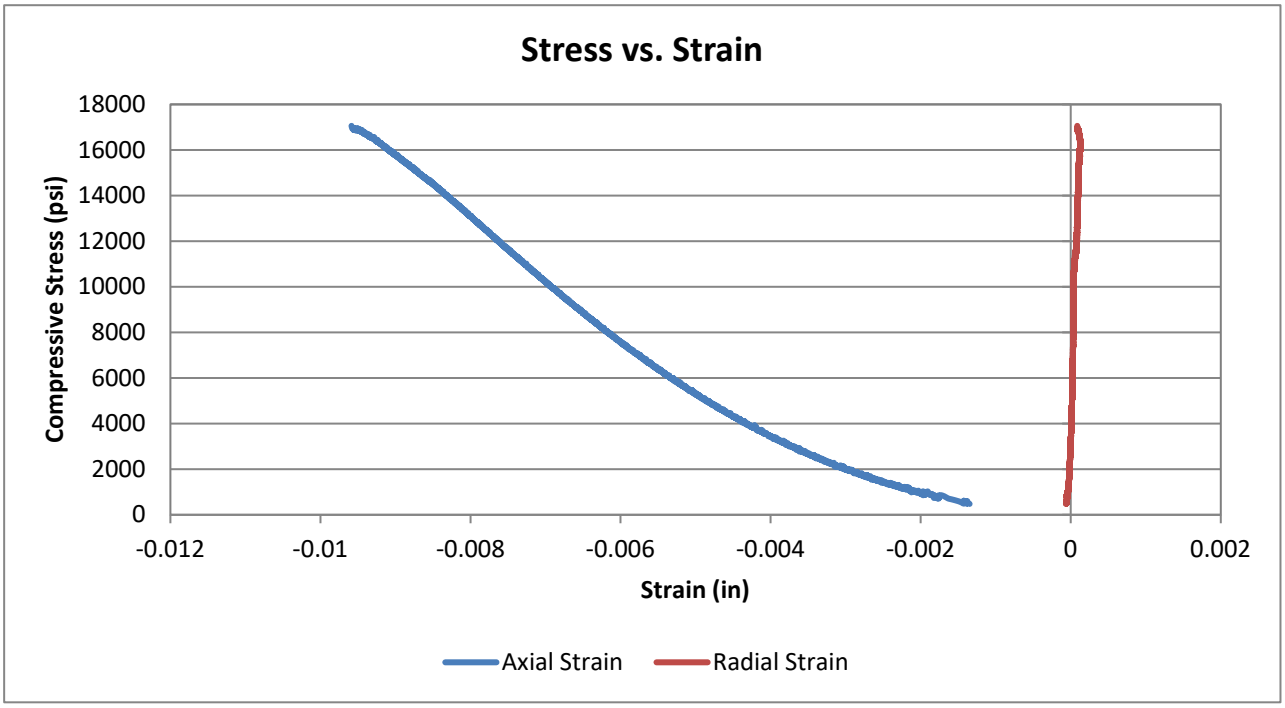
Unconfined Compressive Strength (psi)	**17,060**	Elastic Modulus (psi)	2.38E+06
		Poisson's Ratio in Elastic Range	N/A

Comments: Elastic range was taken as between 0.004 and 0.007 inches of axial strain. This range was chosen to avoid any non-linear behavior from the initial loading and the inflection point at the end of the elastic range. Poission's Ratio data from this sample is not valid and is not reported.

Compressive Strength and Elastic Moduli of Intact Rock Core Specimens
ASTM D7012 - Method D / SC-T-39

Project	SC 49 RBO Tyger River			Date	1/27/2023
Project No.	G6658.002	Sample Diameter (in.)	1.869	Tested By	WAP
SCDOT ID	P041237	Sample Length (in.)	3.957	Reviewed By	WJG
Boring	B-39	Unit Weight (pcf)	163.8	Core Size	NQ
Sample No.	NQ-3 / 22-3368C	L/D Ratio	2.12	Recovery	100%
Depth	44.6' - 44.9'	Load Rate (psi/sec)	30	RQD	83%
Description	Gray/White/Blue Quartz Feldspar Gneiss				





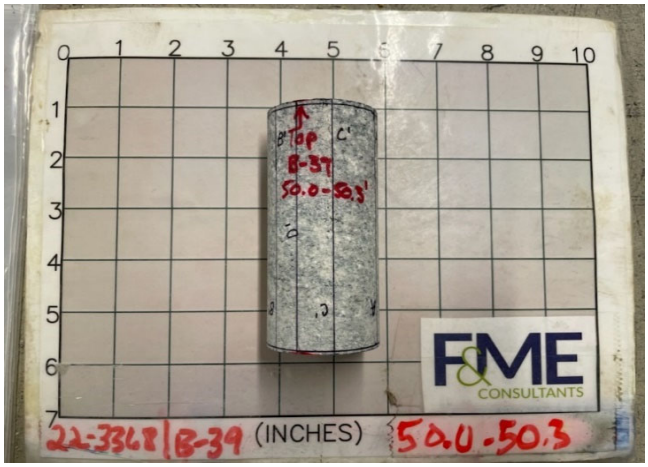
Compressive Strength and Elastic Moduli of Intact Rock Core Specimens
ASTM D7012 - Method D / SC-T-39

Project	SC 49 RBO Tyger River			Date	1/27/2023
Project No.	G6658.002	Sample Diameter (in.)	1.869	Tested By	WAP
SCDOT ID	P041237	Sample Length (in.)	4.034	Reviewed By	WJG
Boring	B-39	Unit Weight (pcf)	162.9	Core Size	NQ
Sample No.	NQ-4 / 22-3368D	L/D Ratio	2.16	Recovery	100%
Depth	50.0' - 50.3'	Load Rate (psi/sec)	30	RQD	93%
Description	Gray/White/Blue Quartz Feldspar Gneiss				

Test Data

Percent of Failure Load	Strain (10^{-6}) Axial	Strain (10^{-6}) Radial	Load (lbs)	Compressive Stress (psi)	Secant Modulus $x10^6$ (psi)	Poisson's Ratio
10%	-1330	-1672	7,371	2,687	4.04	-1.26
20%	-2414	-1431	14,630	5,332	4.42	-0.59
30%	-3332	-1312	22,097	8,054	4.83	-0.39
40%	-4127	-1246	29,343	10,695	5.18	-0.30
50%	-4870	-1203	36,726	13,386	5.50	-0.25
60%	-5576	-1180	44,052	16,057	5.76	-0.21
70%	6463	-3216	51,412	18,739	N/A	0.50
80%	6031	-3987	58,796	21,431	N/A	0.66
90%	5302	-3893	66,123	24,101	N/A	0.73
100%	4506	595	73,474	26,781		

Sample Photos

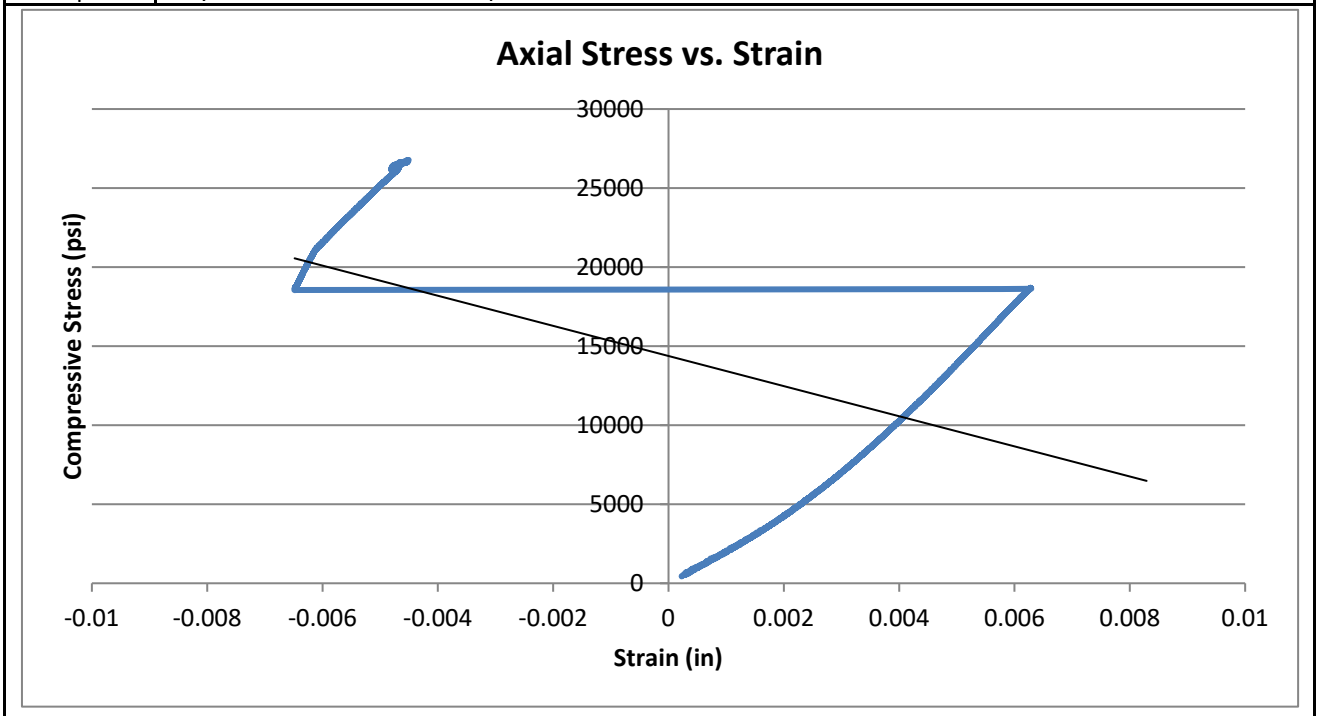


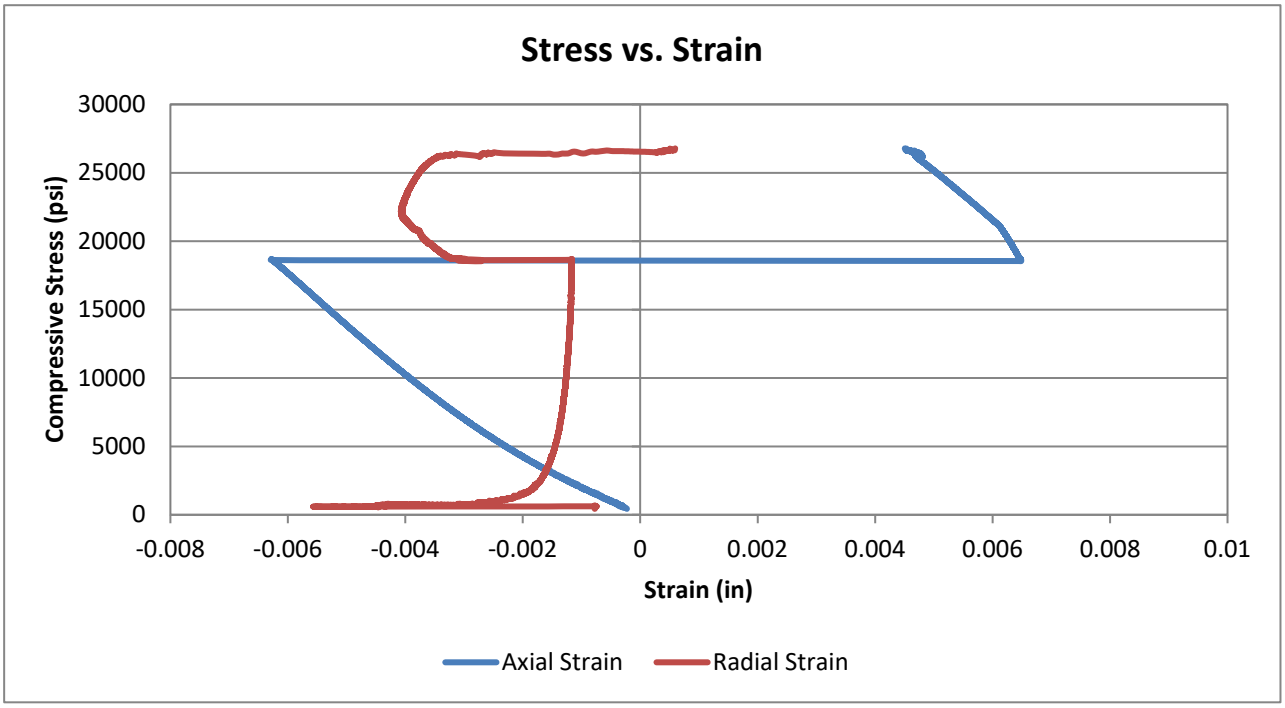
Test Results

Unconfined Compressive Strength (psi)	**26,780**	Elastic Modulus (psi)	4.94E+06
		Poisson's Ratio in Elastic Range	N/A
Comments	Elastic range was taken as between 0.002 and 0.005 inches of axial strain. This range was chosen to avoid any non-linear behavior from the initial loading and the inflection point at the end of the elastic range. Poission's Ratio data from this sample is not valid and is not reported. Sample experienced a partial areound 18,500 psi.		

Compressive Strength and Elastic Moduli of Intact Rock Core Specimens
ASTM D7012 - Method D / SC-T-39

Project	SC 49 RBO Tyger River			Date	1/27/2023
Project No.	G6658.002	Sample Diameter (in.)	1.869	Tested By	WAP
SCDOT ID	P041237	Sample Length (in.)	4.034	Reviewed By	WJG
Boring	B-39	Unit Weight (pcf)	162.9	Core Size	NQ
Sample No.	NQ-4 / 22-3368D	L/D Ratio	2.16	Recovery	100%
Depth	50.0' - 50.3'	Load Rate (psi/sec)	30	RQD	93%
Description	Gray/White/Blue Quartz Feldspar Gneiss				





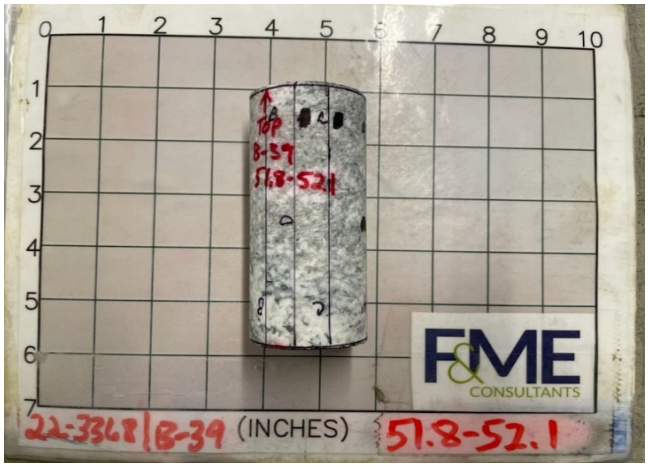
Compressive Strength and Elastic Moduli of Intact Rock Core Specimens
ASTM D7012 - Method D / SC-T-39

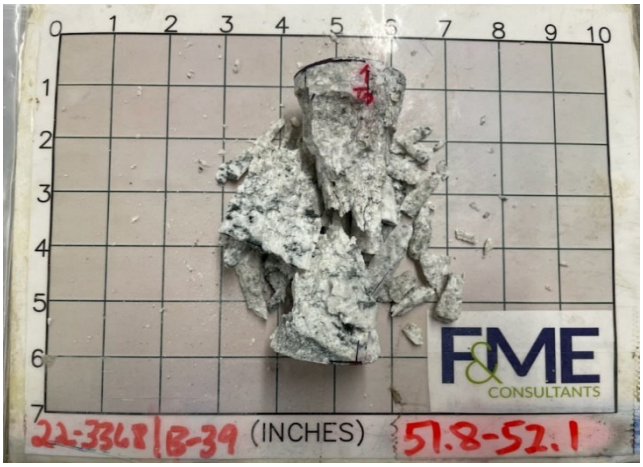
Project	SC 49 RBO Tyger River			Date	1/27/2023
Project No.	G6658.002	Sample Diameter (in.)	1.869	Tested By	WAP
SCDOT ID	P041237	Sample Length (in.)	4.017	Reviewed By	WJG
Boring	B-39	Unit Weight (pcf)	163.8	Core Size	NQ
Sample No.	NQ-4 / 22-3368E	L/D Ratio	2.15	Recovery	100%
Depth	51.8' - 52.1'	Load Rate (psi/sec)	30	RQD	93%
Description	White/Gray/Blue Quartz Feldspar Gneiss				

Test Data

Percent of Failure Load	Strain (10^{-6}) Axial	Strain (10^{-6}) Radial	Load (lbs)	Compressive Stress (psi)	Secant Modulus $x10^6$ (psi)	Poisson's Ratio
10%	-791	185	8,631	3,146	7.96	0.23
20%	-1541	343	17,243	6,285	8.16	0.22
30%	-2271	514	25,995	9,475	8.34	0.23
40%	-2962	691	34,555	12,595	8.51	0.23
50%	-3635	877	43,192	15,743	8.66	0.24
60%	-4307	1078	51,886	18,912	8.78	0.25
70%	-4970	1304	60,541	22,067	8.88	0.26
80%	-5653	1575	69,189	25,219	8.92	0.28
90%	-6330	1932	77,837	28,371	8.96	0.31
100%	-75416	6750	86,473	31,519		

Sample Photos



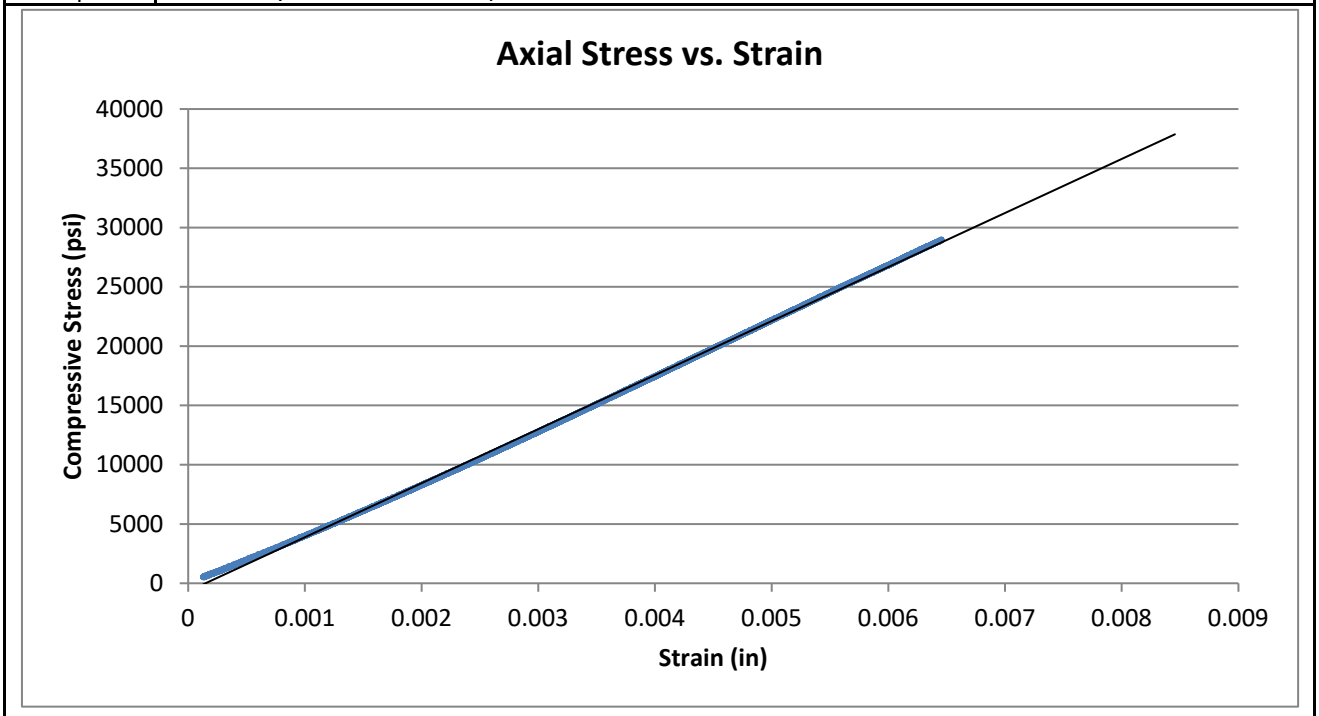


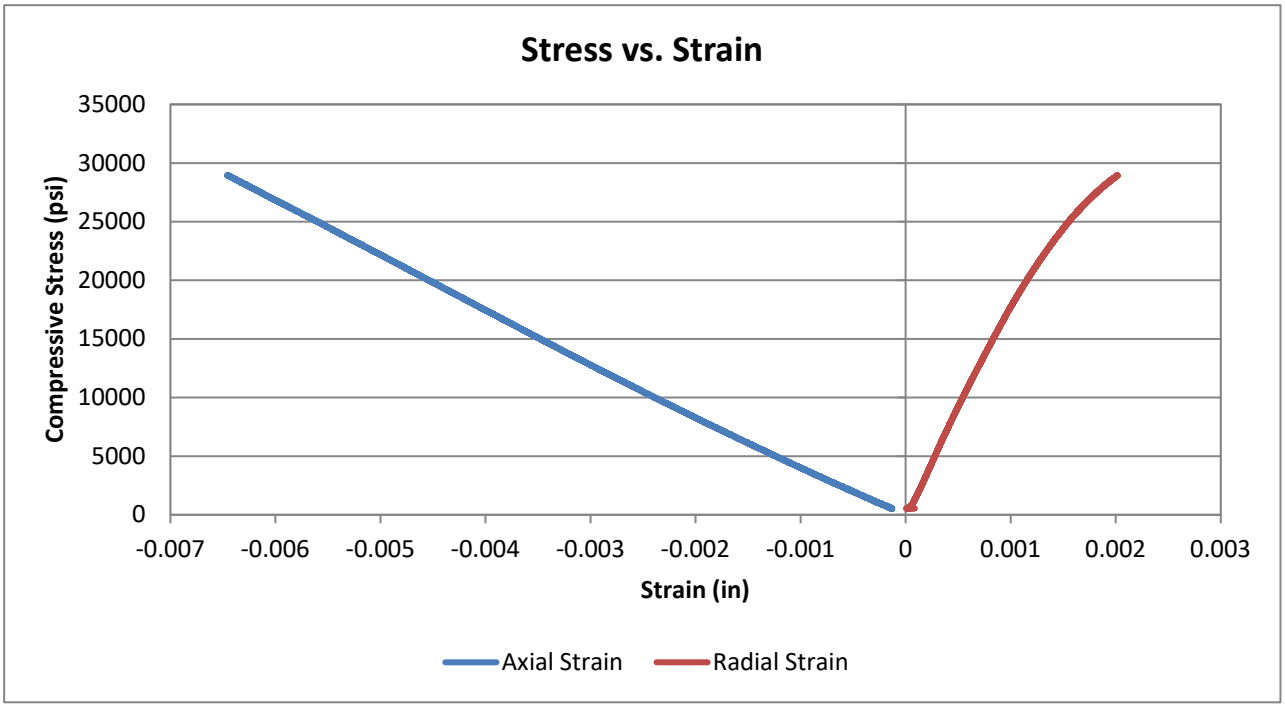
Test Results

Unconfined Compressive Strength (psi)	**31,520**	Elastic Modulus (psi)	8.61E+06
		Poisson's Ratio in Elastic Range	0.24
Comments	Elastic range was taken as between 0.002 and 0.005 inches of axial strain. This range was chosen to avoid any non-linear behavior from the initial loading and the inflection point at the end of the elastic range.		

Compressive Strength and Elastic Moduli of Intact Rock Core Specimens
ASTM D7012 - Method D / SC-T-39

Project	SC 49 RBO Tyger River			Date	1/27/2023
Project No.	G6658.002	Sample Diameter (in.)	1.869	Tested By	WAP
SCDOT ID	P041237	Sample Length (in.)	4.017	Reviewed By	WJG
Boring	B-39	Unit Weight (pcf)	163.8	Core Size	NQ
Sample No.	NQ-4 / 22-3368E	L/D Ratio	2.15	Recovery	100%
Depth	51.8' - 52.1'	Load Rate (psi/sec)	30	RQD	93%
Description	White/Gray/Blue Quartz Feldspar Gneiss				





Compressive Strength and Elastic Moduli of Intact Rock Core Specimens
ASTM D7012 - Method D / SC-T-39

Project	SC 49 RBO Tyger River			Date	1/27/2023
Project No.	G6658.002	Sample Diameter (in.)	1.865	Tested By	WAP
SCDOT ID	P041237	Sample Length (in.)	4.036	Reviewed By	WJG
Boring	B-40	Unit Weight (pcf)	160.6	Core Size	NQ
Sample No.	NQ-3 / 22-3369A	L/D Ratio	2.16	Recovery	67%
Depth	49.3' - 49.6'	Load Rate (psi/sec)	20	RQD	12%
Description	White/Gray/Pink Quartz Feldspar Gneiss				

Test Data

Percent of Failure Load	Strain (10^{-6}) Axial	Strain (10^{-6}) Radial	Load (lbs)	Compressive Stress (psi)	Secant Modulus $x10^6$ (psi)	Poisson's Ratio
10%	-1161	37	1,840	674	1.16	0.03
20%	-2075	89	3,748	1,372	1.32	0.04
30%	-2837	175	5,539	2,028	1.43	0.06
40%	-3627	296	7,416	2,715	1.50	0.08
50%	-4454	461	9,389	3,437	1.54	0.10
60%	-5172	633	11,177	4,091	1.58	0.12
70%	-5982	870	13,058	4,780	1.60	0.15
80%	-6781	1125	14,863	5,441	1.60	0.17
90%	-7690	1327	16,707	6,116	1.59	0.17
100%	-8830	1194	18,606	6,811		

Sample Photos

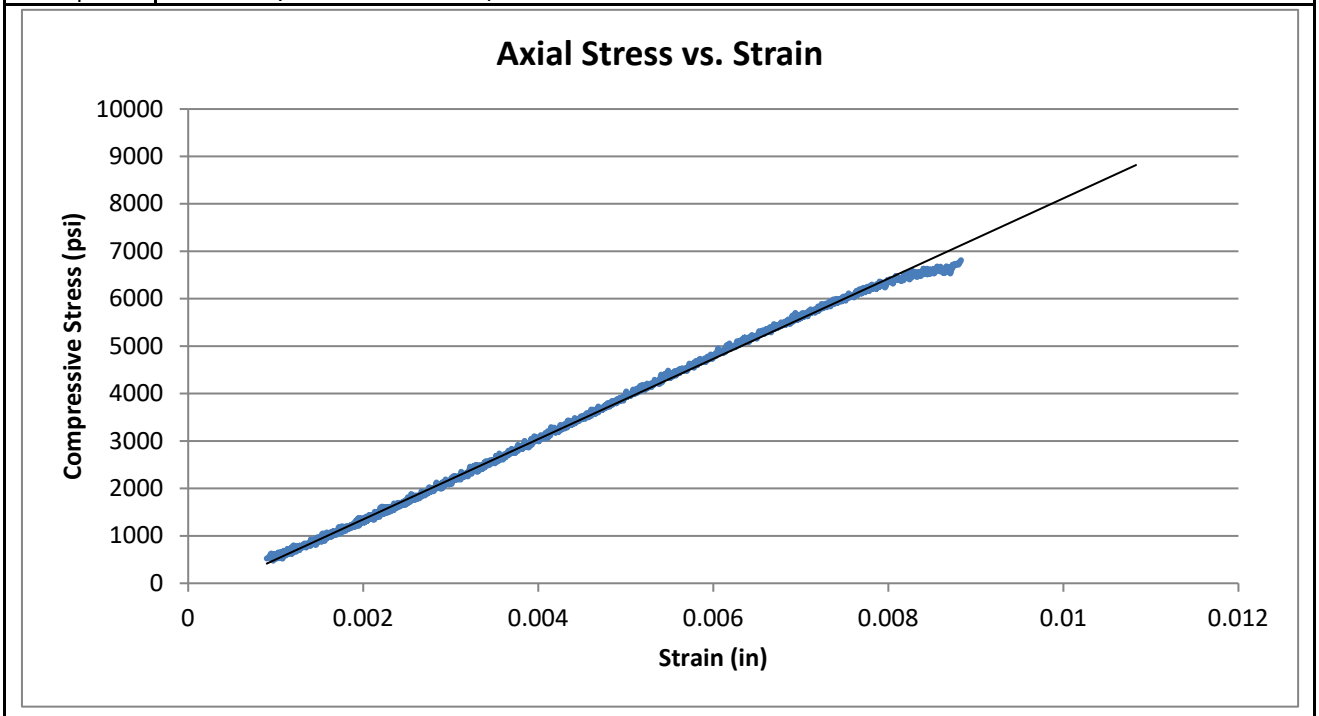
Test Results

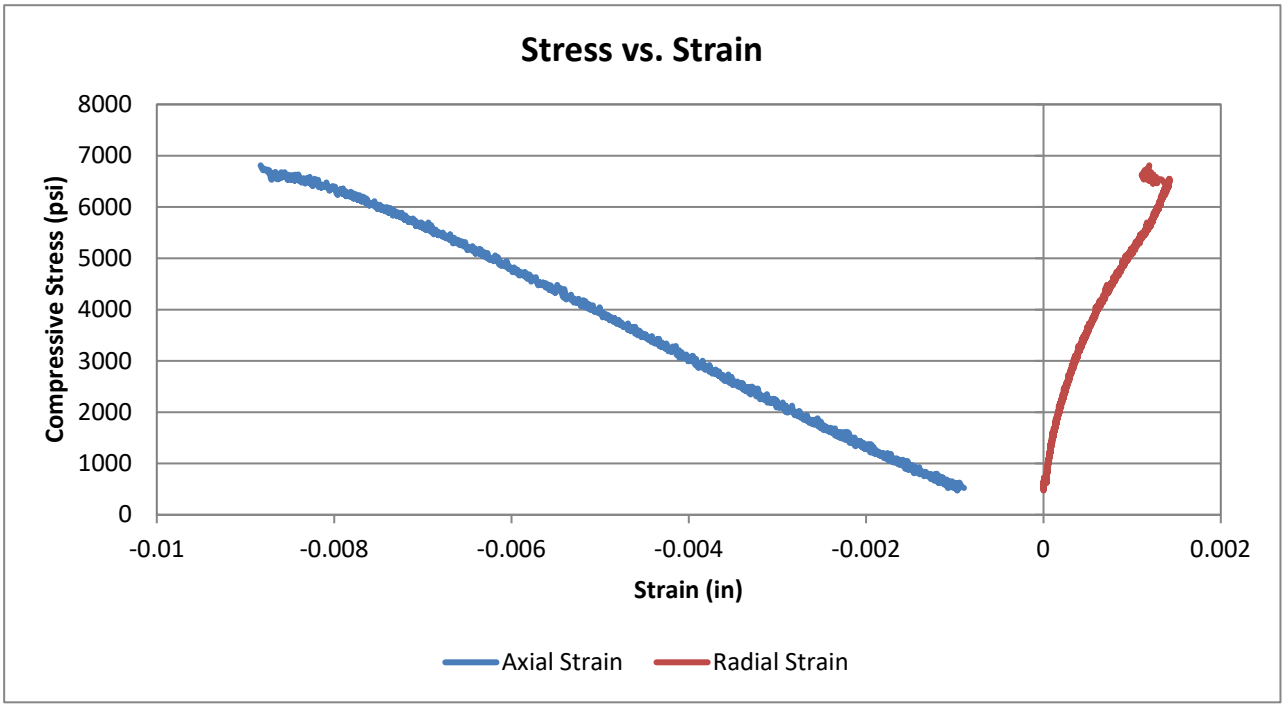
Unconfined Compressive Strength (psi)	**6,810**	Elastic Modulus (psi)	1.50E+06
		Poisson's Ratio in Elastic Range	0.09

Comments: Elastic range was taken as between 0.002 and 0.006 inches of axial strain. This range was chosen to avoid any non-linear behavior from the initial loading and the inflection point at the end of the elastic range.

Compressive Strength and Elastic Moduli of Intact Rock Core Specimens
ASTM D7012 - Method D / SC-T-39

Project	SC 49 RBO Tyger River			Date	1/27/2023
Project No.	G6658.002	Sample Diameter (in.)	1.865	Tested By	WAP
SCDOT ID	P041237	Sample Length (in.)	4.036	Reviewed By	WJG
Boring	B-40	Unit Weight (pcf)	160.6	Core Size	NQ
Sample No.	NQ-3 / 22-3369A	L/D Ratio	2.16	Recovery	67%
Depth	49.3' - 49.6'	Load Rate (psi/sec)	20	RQD	12%
Description	White/Gray/Pink Quartz Feldspar Gneiss				





Compressive Strength and Elastic Moduli of Intact Rock Core Specimens
ASTM D7012 - Method D / SC-T-39

Project	SC 49 RBO Tyger River			Date	1/27/2023
Project No.	G6658.002	Sample Diameter (in.)	1.869	Tested By	WAP
SCDOT ID	P041237	Sample Length (in.)	3.914	Reviewed By	WJG
Boring	B-40	Unit Weight (pcf)	162.2	Core Size	NQ
Sample No.	NQ-5 / 22-3369B	L/D Ratio	2.09	Recovery	100%
Depth	58.3' - 58.6'	Load Rate (psi/sec)	20	RQD	48%
Description	White/Gray/Pink Quartz Feldspar Gneiss				

Test Data

Percent of Failure Load	Strain (10^{-6}) Axial	Strain (10^{-6}) Radial	Load (lbs)	Compressive Stress (psi)	Secant Modulus $x10^6$ (psi)	Poisson's Ratio
10%	-1132	-121	3,518	1,282	2.27	-0.11
20%	-1969	-195	7,067	2,576	2.62	-0.10
30%	-2677	-123	10,681	3,893	2.91	-0.05
40%	-3291	-131	14,129	5,150	3.13	-0.04
50%	-3868	335	17,711	6,456	3.34	0.09
60%	-4471	188	21,294	7,761	3.47	0.04
70%	-5055	117	24,802	9,040	3.58	0.02
80%	-5651	70	28,422	10,360	3.67	0.01
90%	-6236	24	31,955	11,647	3.74	0.00
100%	-6634	5	35,494	12,937		

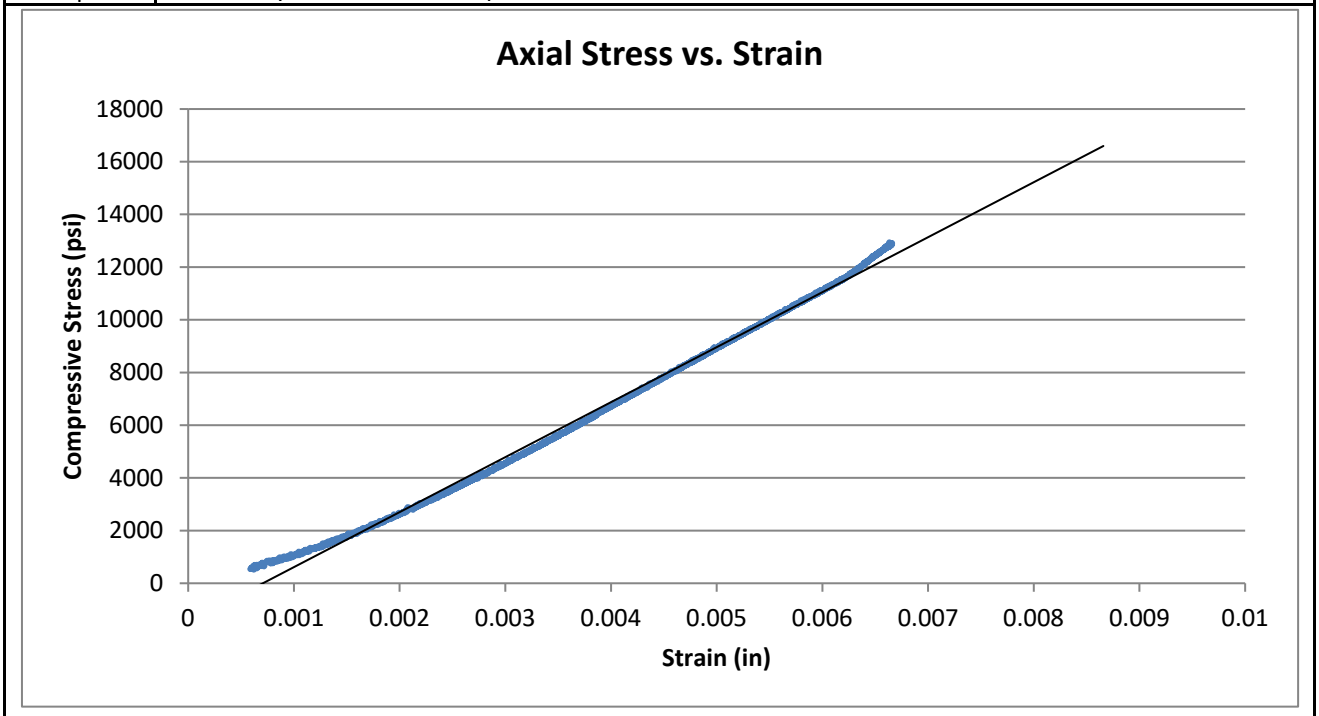
Sample Photos

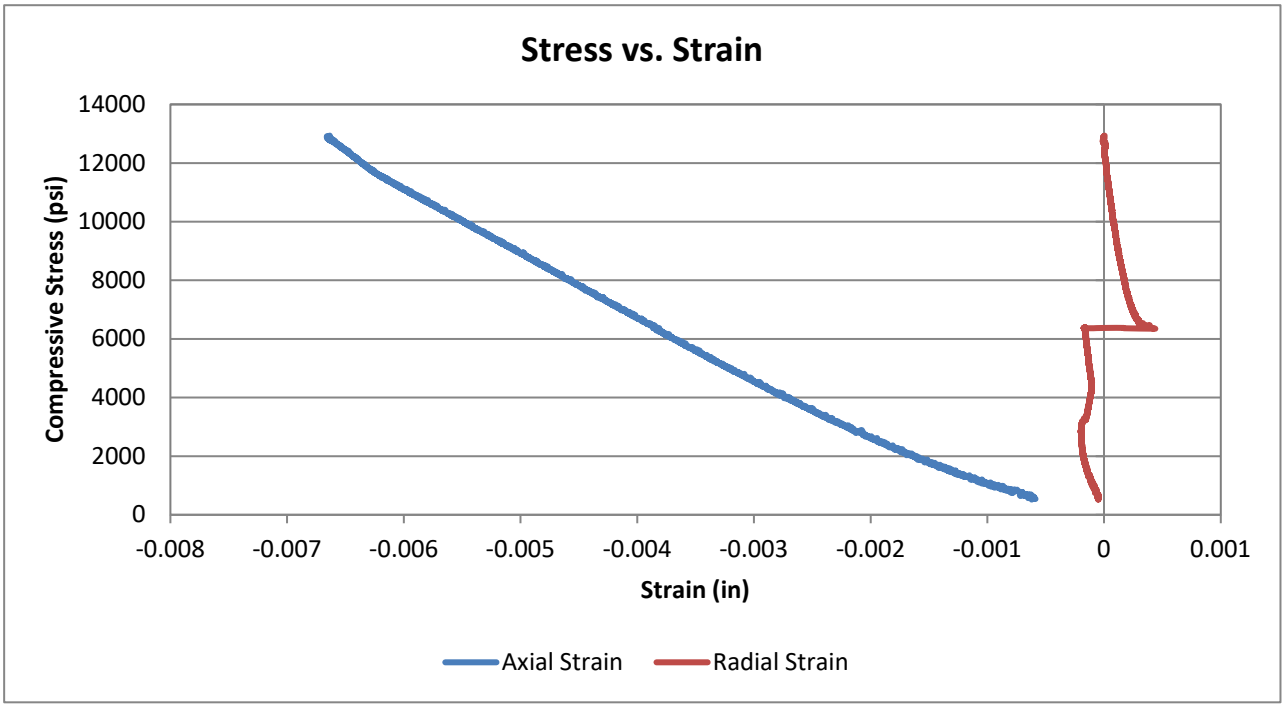
Test Results

Unconfined Compressive Strength (psi)	**12,940**	Elastic Modulus (psi)	3.19E+06
		Poisson's Ratio in Elastic Range	N/A
Comments	Elastic range was taken as between 0.002 and 0.005 inches of axial strain. This range was chosen to avoid any non-linear behavior from the initial loading and the inflection point at the end of the elastic range. Poission's Ratio data from this sample is not valid and is not reported.		

Compressive Strength and Elastic Moduli of Intact Rock Core Specimens
ASTM D7012 - Method D / SC-T-39

Project	SC 49 RBO Tyger River			Date	1/27/2023
Project No.	G6658.002	Sample Diameter (in.)	1.869	Tested By	WAP
SCDOT ID	P041237	Sample Length (in.)	3.914	Reviewed By	WJG
Boring	B-40	Unit Weight (pcf)	162.2	Core Size	NQ
Sample No.	NQ-5 / 22-3369B	L/D Ratio	2.09	Recovery	100%
Depth	58.3' - 58.6'	Load Rate (psi/sec)	20	RQD	48%
Description	White/Gray/Pink Quartz Feldspar Gneiss				





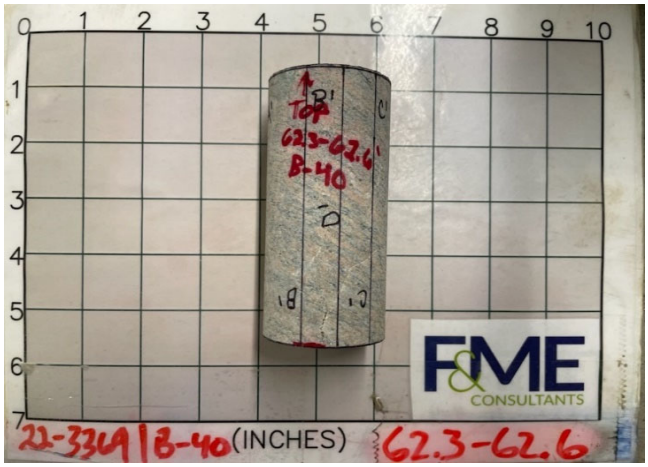
Compressive Strength and Elastic Moduli of Intact Rock Core Specimens
ASTM D7012 - Method D / SC-T-39

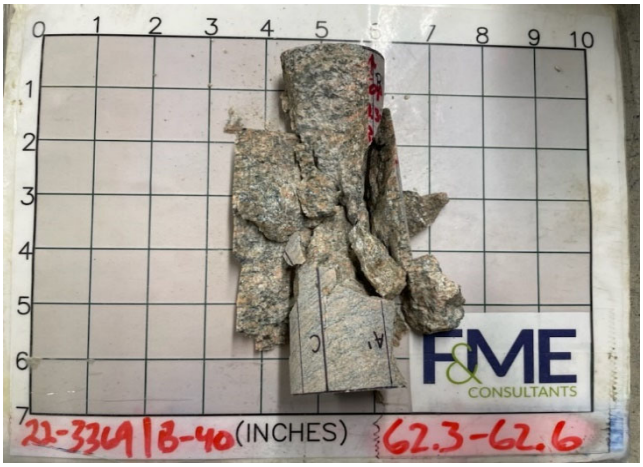
Project	SC 49 RBO Tyger River			Date	1/27/2023
Project No.	G6658.002	Sample Diameter (in.)	1.868	Tested By	WAP
SCDOT ID	P041237	Sample Length (in.)	4.036	Reviewed By	WJG
Boring	B-40	Unit Weight (pcf)	163.6	Core Size	NQ
Sample No.	NQ-5 / 22-3369C	L/D Ratio	2.16	Recovery	100%
Depth	62.3' - 62.6'	Load Rate (psi/sec)	20	RQD	48%
Description	White/Gray/Pink Quartz Feldspar Gneiss				

Test Data

Percent of Failure Load	Strain (10^{-6}) Axial	Strain (10^{-6}) Radial	Load (lbs)	Compressive Stress (psi)	Secant Modulus $x10^6$ (psi)	Poisson's Ratio
10%	-646	154	7,484	2,731	8.46	0.24
20%	-1257	285	14,831	5,412	8.61	0.23
30%	-1857	407	22,227	8,110	8.74	0.22
40%	-2448	518	29,649	10,819	8.84	0.21
50%	-3040	635	37,187	13,569	8.93	0.21
60%	-3611	751	44,522	16,245	9.00	0.21
70%	-4196	875	51,943	18,953	9.03	0.21
80%	-4792	1018	59,383	21,668	9.04	0.21
90%	-5401	1188	66,694	24,336	9.01	0.22
100%	-18344	1639	74,206	27,077		

Sample Photos



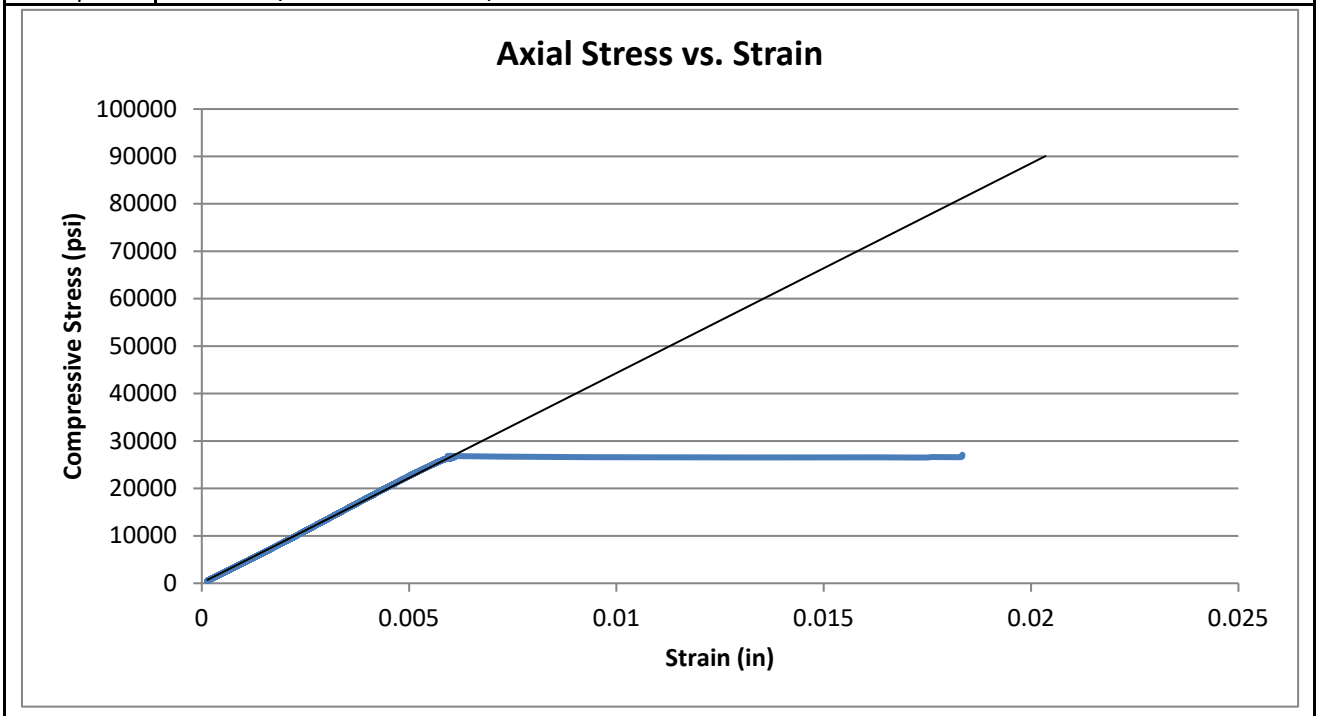


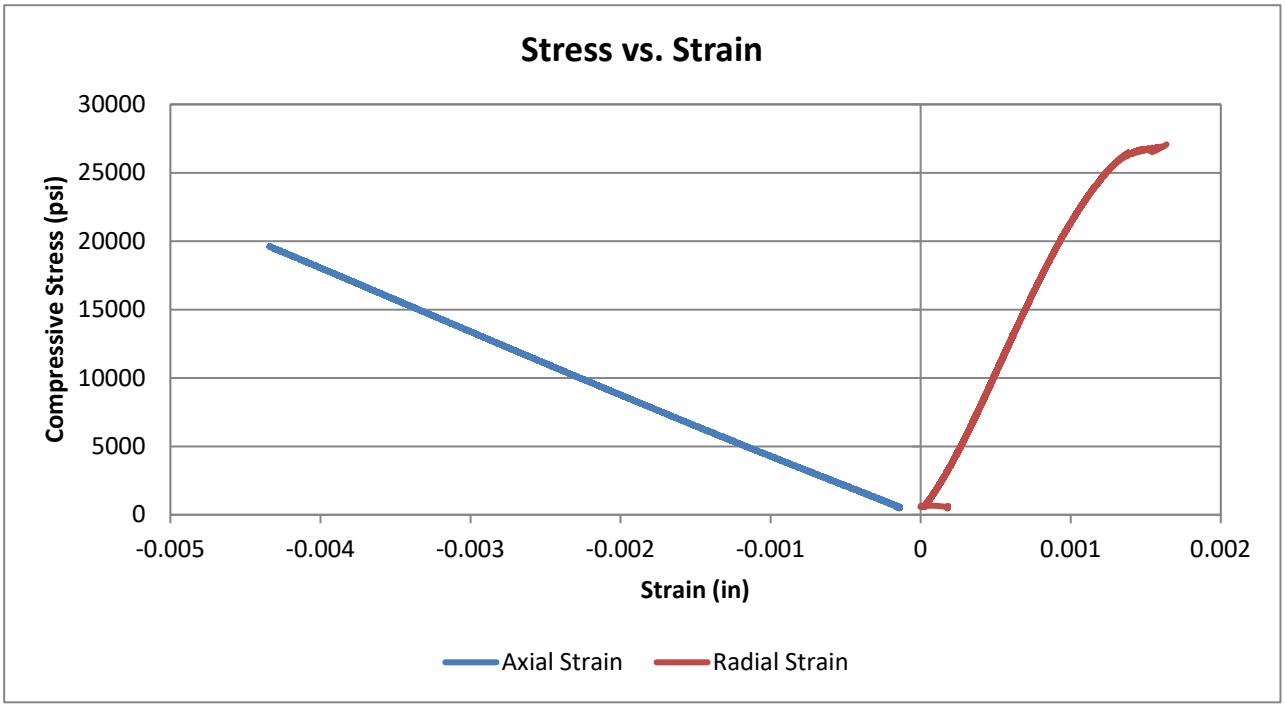
Test Results

Unconfined Compressive Strength (psi)	**27,080**	Elastic Modulus (psi)	8.91E+06
		Poisson's Ratio in Elastic Range	0.21
Comments	Elastic range was taken as between 0.002 and 0.004 inches of axial strain. This range was chosen to avoid any non-linear behavior from the initial loading and the inflection point at the end of the elastic range.		

Compressive Strength and Elastic Moduli of Intact Rock Core Specimens
ASTM D7012 - Method D / SC-T-39

Project	SC 49 RBO Tyger River			Date	1/27/2023
Project No.	G6658.002	Sample Diameter (in.)	1.868	Tested By	WAP
SCDOT ID	P041237	Sample Length (in.)	4.036	Reviewed By	WJG
Boring	B-40	Unit Weight (pcf)	163.6	Core Size	NQ
Sample No.	NQ-5 / 22-3369C	L/D Ratio	2.16	Recovery	100%
Depth	62.3' - 62.6'	Load Rate (psi/sec)	20	RQD	48%
Description	White/Gray/Pink Quartz Feldspar Gneiss				





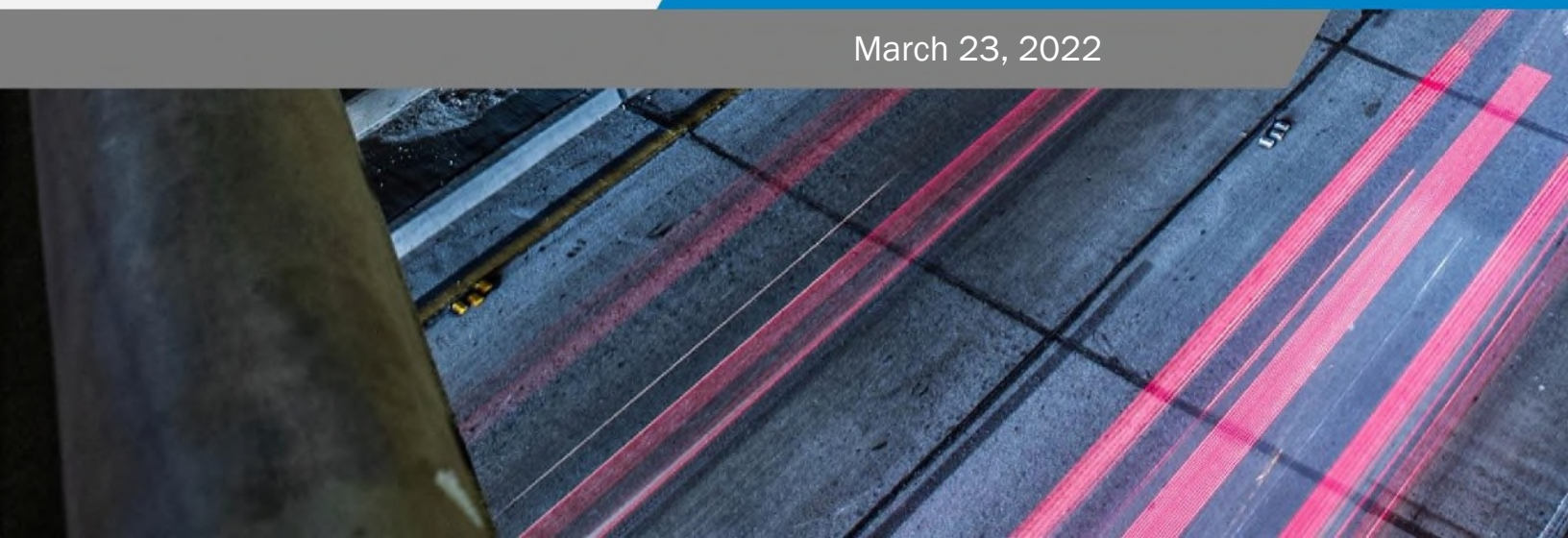
Appendix D. SPT Hammer Energy Calibration Report

CAROLINAS GEOTECHNICAL GROUP

Report of SPT Hammer Energy

Prepared for:
Breccia Construction, LLC
620-B Industrial Way
Chester, South Carolina 29706

March 23, 2022



CAROLINAS GEOTECHNICAL GROUP

N.C. Firm License: P-1904

2400 Crownpoint Executive Drive
Suite 800
Charlotte, NC 28227

(980) 339-8684
contact@carolinasgeotech.com
www.carolinasgeotech.com

March 23, 2022

Mr. Jarod S. Ford
Breccia Construction, LLC
620-B Industrial Way
Chester, South Carolina 29706

SUBJECT: **Report of SPT Hammer Energy**
Breccia Construction, LLC CME 45B Trailer Rig (SN 303304)
Chester, South Carolina
CG2 Project No.: 240021095

Dear Mr. Ford:

Carolinas Geotechnical Group, PLLC (CG2) has completed the Standard Penetration Test (SPT) energy measurements on the automatic hammer mounted on a Breccia Construction, LLC (Breccia) CME 45B trailer-mounted drill rig with a serial number of 303304, see attached Drill Rig Photo Log. This service was performed by Mr. Robert E. Kral, PE on March 11, 2022. SPT energy testing was performed in general accordance with ASTM D4633 and the most recent revision of the North Carolina Department of Transportation (NCDOT), Geotechnical Engineering Unit's requirements. The testing procedures, equipment used during testing, and detailed results are presented in this report.

CG2 recommends Breccia submit this Report of SPT Hammer Energy to the NCDOT Geotechnical Engineering Unit for review and approval no later than April 8, 2022.

DYNAMIC TESTING METHODOLOGY

Testing was performed using a model SPT (Serial No. 4549 TB) Pile Driving Analyzer™ (PDA) manufactured by Pile Dynamics, Inc. The PDA was used to record and interpret data from two piezoresistive accelerometers (Serial Nos. K11957 and K10959) bolted to a 2-foot long AWJ drill rod (SN 528AWJ) internally instrumented with two strain transducers. The instrumented AWJ drill rod has a cross-sectional area of 1.19 square inches, an outside diameter of approximately 1.75 inches, and an inside diameter of 1.25 inches at the gauge location. The accelerometers and strain gauges, which are mounted on opposing axis near the middle of the instrumented rod, monitor acceleration and strain for each hammer blow. The analyzer converts the data to velocities and forces and computes the maximum transferred hammer energies with the "EFV" method described in ASTM D4633. Preliminary results are recorded and displayed in real-time for each blow. Calibration sheets for the PDA, accelerometers, and the instrumented rod are included in the Appendix III.

TESTING AND OBSERVATIONS

CG2 personnel was on site March 11, 2022 to observe and perform high-strain dynamic testing during SPT sampling on the CME 45B trailer-mounted drill rig operated by D. Harris of Breccia. The measurements were taken during drilling operations at 1817 Lowrys Highway in Chester, South Carolina (Chester County). The approximate coordinates (not professionally surveyed) for the test location are 34.770585, -81.245517. No Soil Test Boring Log was maintained. SPT energy measurements were recorded during three intervals at depths of approximately 28½, 33½, and 38½ feet below the existing ground surface. The information presented in the table below summarizes the equipment tested and tooling used during the SPT energy measurements.

Table 1: SPT Field Data

Drill Rig Information	
Manufacturer	CME
Model	45B
Serial Number	303304
Operator	D. Harris
Carrier	Trailer
Hammer Information	
Model / Type	CME / Auto
Serial Number	N/A
Anvil Height (inches)	11.5
Anvil Diameter (inches)	2.5
Drop Height (inches)	30
Ram Weight (pounds)	140
Ram Serial Number	N/A
Drilling and Instrumented Rod Information	
Drill Rod Type	AWJ
OD (inches)	1.75
ID (inches)	1.25
Cross-Sectional Area (in^2)	1.19
Typical Lengths (feet)	5
Instrumented Rod Type	AWJ (SN 528)
OD (inches)	1.75
ID (inches)	1.25
Cross-Sectional Area (in^2)	1.19
Total Instrumented Rod Length (feet)	2.00
Length Below Gages (feet)	0.70
Split-Spoon Length (feet)	2.85

DYNAMIC TESTING RESULTS

The total rod length from the instrumentation to the tip of the split-spoon sampler was determined by adding 3.6 feet to the required drill rod length at each sample depth. Based on the test data, the automatic hammer on the CME 45B Trailer-mounted drill rig operated at a rate of about 53.2 to 61.4 blows per minute (BPM) during dynamic testing. The measured transferred hammer energy (EFV) ranged from 273.5 to 298.0 foot-pounds, which corresponds to Energy Transfer Ratio (ETR) values of 78.2 to 85.1%, respectively.

The SPT Energy Measurement Data Summary tables in the Appendix present the test data from every hammer blow at each sampling interval along with representative force and velocity traces for each test interval. The reported blow counts, obtained by the drill rig personnel, and a summary of the test data and average computed hammer energy and transfer ratio values are provided in Table 2. Plots and tables of the following are also included in the Appendix and present the test data with depth for each test interval:

- Penetration vs. BLC
- Penetration vs. FMX
- Penetration vs. EFV
- Penetration vs. CSX
- Penetration vs. VMX
- Penetration vs. ETR
- Average ETR vs. Rod Length
- ETR vs. Rod Length

Table 2: Summary of Dynamic Testing Results

Data Set ID	Sample Depth (ft)	Drill Rod Length (ft)	Instrumentation to Sampler Tip Length (ft)	Blows per 6" Increment / N-value	Soil Sample Description (Piedmont Residual)	Avg. BPM	Avg. EFV (ft-lbs)	Avg. ETR (%)
1	28½ - 30	30	33.6	4-6-7 / 13	SA SILT	53.4	277.5	79.3
2	33½ - 35	35	38.6	3-5-6 / 11	SA SILT	58.3	291.4	83.3
3	38½ - 40	40	43.6	4-6-9 / 15	SA SILT	55.5	286.8	81.9
					Overall Average	55.6	285.0	81.4

The average hammer rate, transferred energy, and transfer ratio were calculated for each depth interval. Per ASTM D4633, only the blows from the final foot of each sample interval (i.e., the blows that determine the N-value) were included when computing the average values shown in Table 2. The overall average transferred hammer energy for the automatic hammer on the CME 45B trailer-mounted drill rig (for all the depth intervals tested) was 285.0 foot-pounds, with an average ETR of 81.4%.

LIMITATIONS OF REPORT

This report has been prepared in accordance with generally accepted geotechnical engineering practice for specific application to this project. The information contained in this report were based on the applicable standards of our profession in this geographic area at the time this report was prepared. No other warranty, express or implied, is made.

CLOSING

CG2 is pleased to have the opportunity to provide these services to you. If you have questions concerning the content of this report, or if CG2 can be of further service, please contact CG2 at (980) 339-8684.

Sincerely,
Carolinas Geotechnical Group, PLLC

DocuSigned by:
D. Matthew Brewer
386129C0A4C1462...
D. Matthew Brewer, PE
Senior Project Engineer

DocuSigned by:
Robert E Kral
8AD703B2A8484F4...
Robert E. Kral, PE
Senior Project Engineer
NC Registration No. 042642

NORTH CAROLINA PROFESSIONAL SEAL 042642 ENGINEER ROBERT E. KRAL

Appendices:

- Appendix I - CME 45B Trailer Rig (SN 303304) SPT Energy Measurements Summary Plots and Tables
- Appendix II - SPT Hammer Energy Field Form (Field Log) and Drill Rig Photo Log
- Appendix III - Instrumented Rod and Accelerometer Calibration Sheets
- Appendix IV - Certificate of Proficiency

APPENDIX I

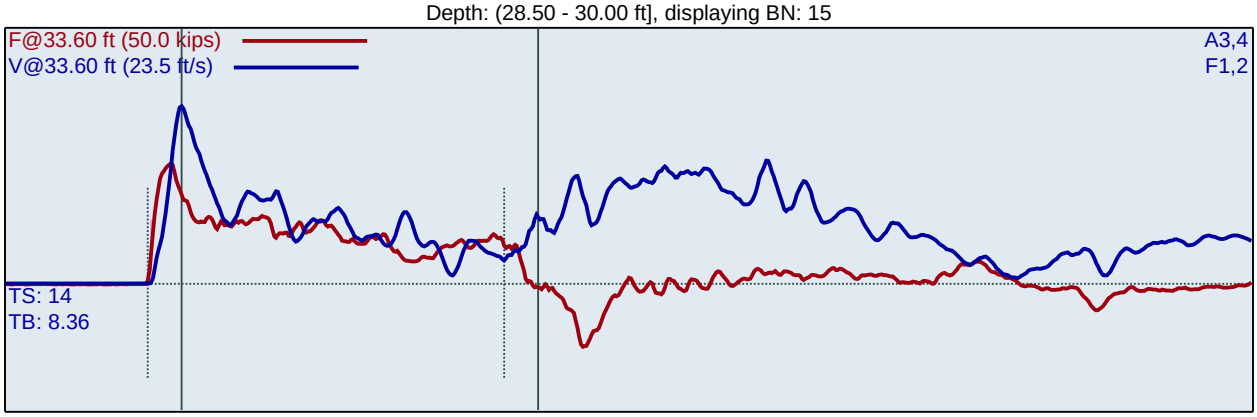
CME 45B (SN 303304)
REK
B-1

B-1
Interval start: 3/11/2022

AR: 1.19 in^2
LE: 33.60 ft
WS: 16807.9 ft/s

SP: 0.492 k/ft3
EM: 30000 ksi

Depth: (28.50 - 30.00 ft], displaying BN: 15



F1 : [528AWJ1] 205.26 PDICAL (1) FF1
F2 : [528AWJ2] 205.86 PDICAL (1) FF1

A3 (PR): [K11957] 407.045 mv/6.4v/5000g (1) VF1
A4 (PR): [K10959] 417.27 mv/6.4v/5000g (1) VF1

BPM: Blows/Minute
FMX: Maximum Force
VMX: Maximum Velocity
DMX: Maximum Displacement

CSX: Compression Stress Maximum
DFN: Final Displacement
EFV: Maximum Energy
ETR: Energy Transfer Ratio - Rated

LP	BL#	BC	BPM	FMX	VMX	DMX	CSX	DFN	EFV	ETR
ft		/6"	bpm	kips	ft/s	in	ksi	in	ft-lb	%
28.63	1	4	1.9	23.8	15.1	2.0	20.0	1.5	258.9	74.0
28.75	2	4	52.7	25.1	15.4	1.6	21.1	1.5	269.5	77.0
28.88	3	4	53.1	25.1	15.7	1.6	21.1	1.5	272.5	77.8
29.00	4	4	53.5	24.6	15.4	1.5	20.7	1.5	269.5	77.0
29.08	5	6	53.4	25.0	15.6	1.2	21.0	1.0	273.5	78.2
29.17	6	6	53.3	24.8	15.7	1.1	20.8	1.0	274.5	78.4
29.25	7	6	53.4	24.6	15.7	1.1	20.7	1.0	277.2	79.2
29.33	8	6	53.3	24.7	16.0	1.1	20.8	1.0	274.8	78.5
29.42	9	6	53.4	24.6	16.0	1.1	20.6	1.0	275.4	78.7
29.50	10	6	53.7	24.3	15.9	1.1	20.4	1.0	276.7	79.1
29.57	11	7	53.3	24.6	16.3	1.0	20.7	0.9	281.6	80.4
29.64	12	7	53.3	24.1	16.2	1.1	20.2	0.9	279.6	79.9
29.71	13	7	53.5	23.8	16.1	1.1	20.0	0.9	280.2	80.0
29.79	14	7	53.7	23.7	16.5	1.0	19.9	0.9	278.2	79.5
29.86	15	7	53.2	23.6	16.3	1.0	19.8	0.9	277.1	79.2
29.93	16	7	53.4	23.3	15.7	0.9	19.6	0.9	278.7	79.6
30.00	17	7	53.5	23.2	17.1	0.9	19.5	0.9	280.6	80.2
		Average	53.4	24.2	16.1	1.1	20.3	0.9	277.5	79.3
		Std Dev	0.1	0.6	0.4	0.1	0.5	0.1	2.4	0.7
		Maximum	53.7	25.0	17.1	1.2	21.0	1.0	281.6	80.4
		Minimum	53.2	23.2	15.6	0.9	19.5	0.9	273.5	78.2

N-value: 13

Sample Interval Time: 17.92 seconds.

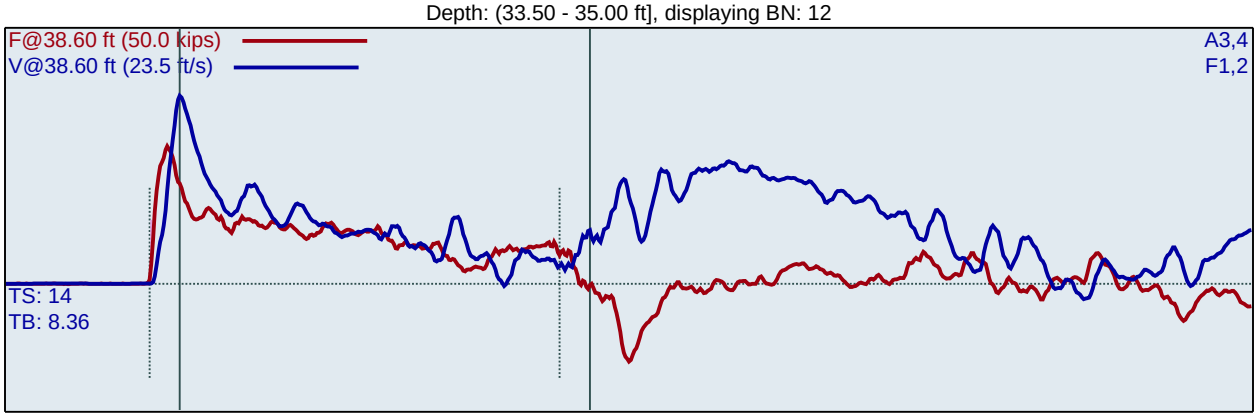
CME 45B (SN 303304)
REK
B-1

B-1
Interval start: 3/11/2022

AR: 1.19 in^2
LE: 38.60 ft
WS: 16807.9 ft/s

SP: 0.492 k/ft3
EM: 30000 ksi

Depth: (33.50 - 35.00 ft], displaying BN: 12



F1 : [528AWJ1] 205.26 PDICAL (1) FF1
F2 : [528AWJ2] 205.86 PDICAL (1) FF1

A3 (PR): [K11957] 407.045 mv/6.4v/5000g (1) VF1
A4 (PR): [K10959] 417.27 mv/6.4v/5000g (1) VF1

LP ft	BL#	BC /6"	BPM bpm	FMX kips	VMX ft/s	DMX in	CSX ksi	DFN in	EFV ft-lb	ETR %
33.67	1	3	1.9	27.2	16.3	2.3	22.8	2.0	290.7	83.0
33.83	2	3	60.1	27.7	17.1	2.0	23.2	2.0	300.3	85.8
34.00	3	3	60.9	27.7	17.1	2.0	23.3	2.0	302.3	86.4
34.10	4	5	61.4	27.6	16.8	1.3	23.2	1.2	293.7	83.9
34.20	5	5	58.8	27.3	16.7	1.3	22.9	1.2	286.9	82.0
34.30	6	5	57.9	27.1	16.9	1.2	22.8	1.2	288.5	82.4
34.40	7	5	57.7	27.5	17.0	1.2	23.2	1.2	288.2	82.3
34.50	8	5	57.9	26.7	16.8	1.2	22.5	1.2	292.5	83.6
34.58	9	6	57.8	26.6	17.0	1.1	22.4	1.0	290.0	82.9
34.67	10	6	58.1	26.9	17.0	1.0	22.6	1.0	287.6	82.2
34.75	11	6	58.1	26.6	17.1	1.0	22.4	1.0	288.5	82.4
34.83	12	6	57.8	26.9	17.3	1.0	22.6	1.0	298.0	85.1
34.92	13	6	58.1	26.5	17.2	1.0	22.3	1.0	295.9	84.6
35.00	14	6	58.2	26.2	17.0	1.0	22.0	1.0	295.4	84.4
		Average	58.3	26.9	17.0	1.1	22.6	1.1	291.4	83.3
		Std Dev	1.0	0.4	0.2	0.1	0.4	0.1	3.7	1.1
		Maximum	61.4	27.6	17.3	1.3	23.2	1.2	298.0	85.1
		Minimum	57.7	26.2	16.7	1.0	22.0	1.0	286.9	82.0

N-value: 11

Sample Interval Time: 13.30 seconds.

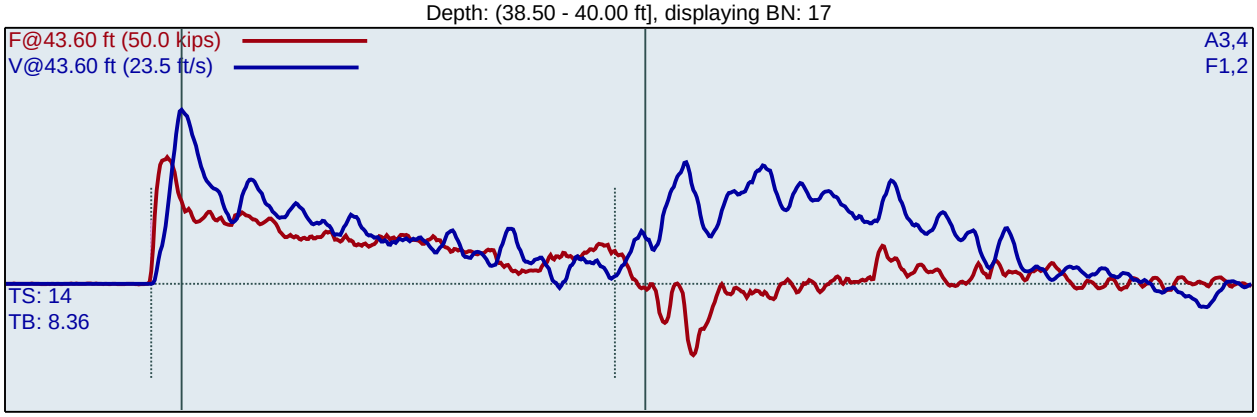
CME 45B (SN 303304)
REK
B-1

B-1
Interval start: 3/11/2022

AR: 1.19 in^2
LE: 43.60 ft
WS: 16807.9 ft/s

SP: 0.492 k/ft3
EM: 30000 ksi

Depth: (38.50 - 40.00 ft], displaying BN: 17



F1 : [528AWJ1] 205.26 PDICAL (1) FF1
F2 : [528AWJ2] 205.86 PDICAL (1) FF1

A3 (PR): [K11957] 407.045 mv/6.4v/5000g (1) VF1
A4 (PR): [K10959] 417.27 mv/6.4v/5000g (1) VF1

LP ft	BL#	BC /6"	BPM bpm	FMX kips	VMX ft/s	DMX in	CSX ksi	DFN in	EFV ft-lb	ETR %
38.63	1	4	1.9	26.6	16.9	2.2	22.3	1.5	303.5	86.7
38.75	2	4	59.6	25.2	16.8	1.8	21.2	1.5	301.7	86.2
38.88	3	4	59.9	25.2	16.3	1.5	21.2	1.5	295.2	84.3
39.00	4	4	56.8	24.6	16.3	1.5	20.7	1.5	291.6	83.3
39.08	5	6	55.7	24.9	16.0	1.2	20.9	1.0	290.3	82.9
39.17	6	6	55.5	24.9	16.0	1.2	21.0	1.0	290.4	83.0
39.25	7	6	56.0	24.7	16.2	1.2	20.8	1.0	288.0	82.3
39.33	8	6	55.4	25.2	16.2	1.1	21.2	1.0	287.7	82.2
39.42	9	6	55.7	25.1	15.8	1.0	21.1	1.0	283.1	80.9
39.50	10	6	55.3	24.9	15.8	1.0	21.0	1.0	288.5	82.4
39.56	11	9	55.5	24.5	16.0	0.8	20.6	0.7	286.8	82.0
39.61	12	9	55.7	24.6	16.0	0.8	20.7	0.7	284.4	81.3
39.67	13	9	55.4	24.4	16.2	0.8	20.5	0.7	289.2	82.6
39.72	14	9	55.4	24.4	15.9	0.8	20.5	0.7	283.6	81.0
39.78	15	9	55.3	24.7	15.9	0.8	20.7	0.7	287.0	82.0
39.83	16	9	55.5	24.0	15.6	0.8	20.2	0.7	284.1	81.2
39.89	17	9	55.6	24.8	16.0	0.7	20.8	0.7	283.9	81.1
39.94	18	9	55.6	24.4	15.7	0.7	20.5	0.7	284.9	81.4
40.00	19	9	55.4	24.2	16.2	0.8	20.3	0.7	289.6	82.7
		Average	55.5	24.7	16.0	0.9	20.7	0.8	286.8	81.9
		Std Dev	0.2	0.3	0.2	0.2	0.3	0.2	2.5	0.7
		Maximum	56.0	25.2	16.2	1.2	21.2	1.0	290.4	83.0
		Minimum	55.3	24.0	15.6	0.7	20.2	0.7	283.1	80.9

N-value: 15

Sample Interval Time: 19.28 seconds.

Summary of SPT Test Results

Project: CME 45B (SN 303304), Test Date: 3/11/2022

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

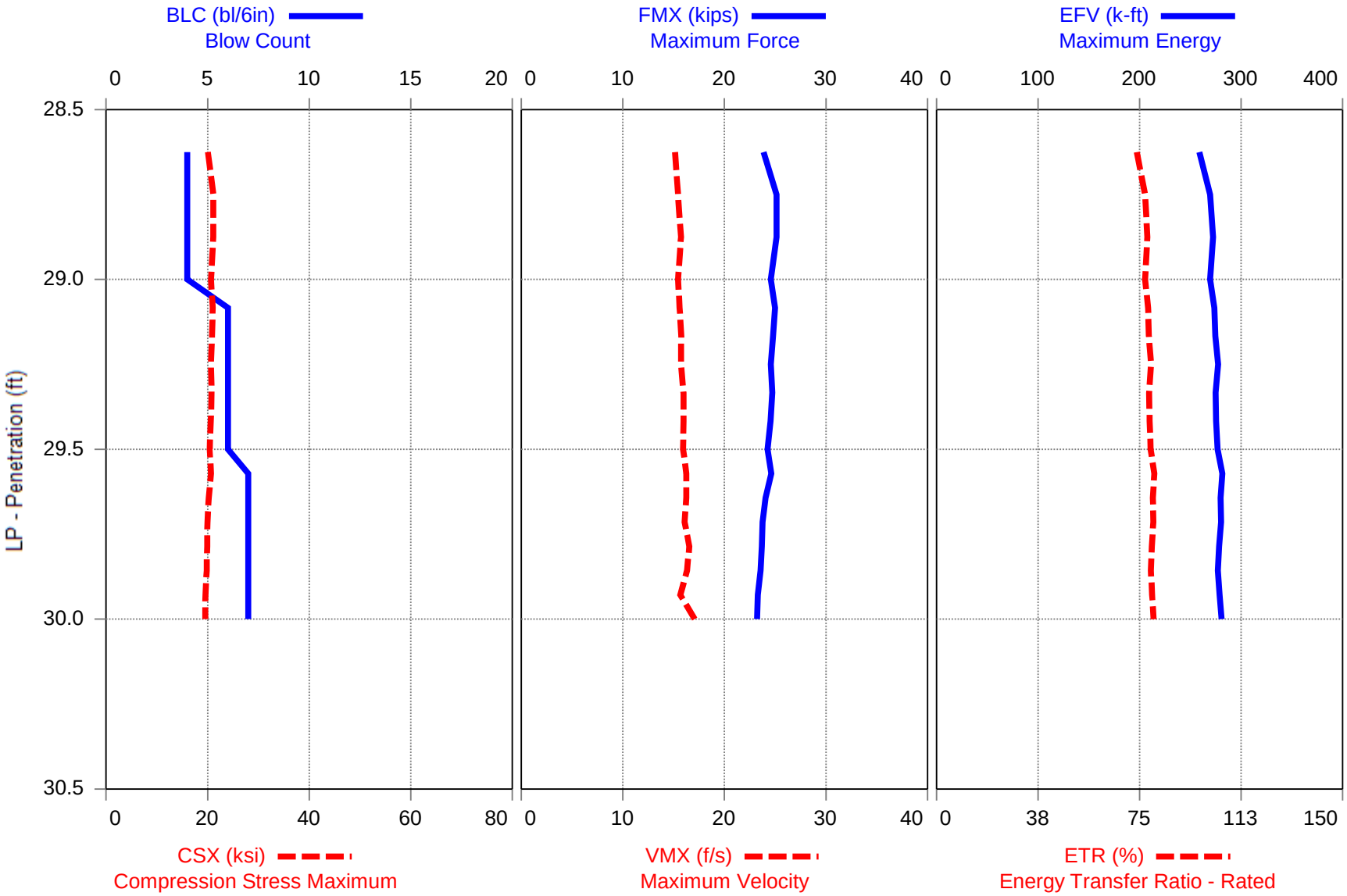
Instr. Length ft	Start Depth ft	Final Depth ft	Blows Applied /6"	**N Value**	**N60 Value**	Average BPM bpm	Average FMX kips	Average VMX ft/s	Average DMX in	Average CSX ksi	Average DFN in	Average EFV ft-lb	Average ETR %
33.60	28.50	30.00	**4-6-7**	**13**	**17**	53.4	24.2	16.1	1.1	20.3	0.9	277.5	79.3
38.60	33.50	35.00	**3-5-6**	**11**	**14**	58.3	26.9	17.0	1.1	22.6	1.1	291.4	83.3
43.60	38.50	40.00	**4-6-9**	**15**	**20**	55.5	24.7	16.0	0.9	20.7	0.8	286.8	81.9
					Overall Average Values:	55.6	25.1	16.3	1.0	21.1	0.9	285.0	81.4
					Standard Deviation:	2.0	1.2	0.5	0.2	1.0	0.2	6.3	1.8
					Overall Maximum Value:	61.4	27.6	17.3	1.3	23.2	1.2	298.0	85.1
					Overall Minimum Value:	53.2	23.2	15.6	0.7	19.5	0.7	273.5	78.2

Pile Dynamics, Inc. - PDIPLOT2 Ver 2021.1.61.0 - Case Method & iCAP® Results

Printed: 23-March-2022

Test started: 11-March-2022

CME 45B (SN 303304) - 28.5 TO 30.0

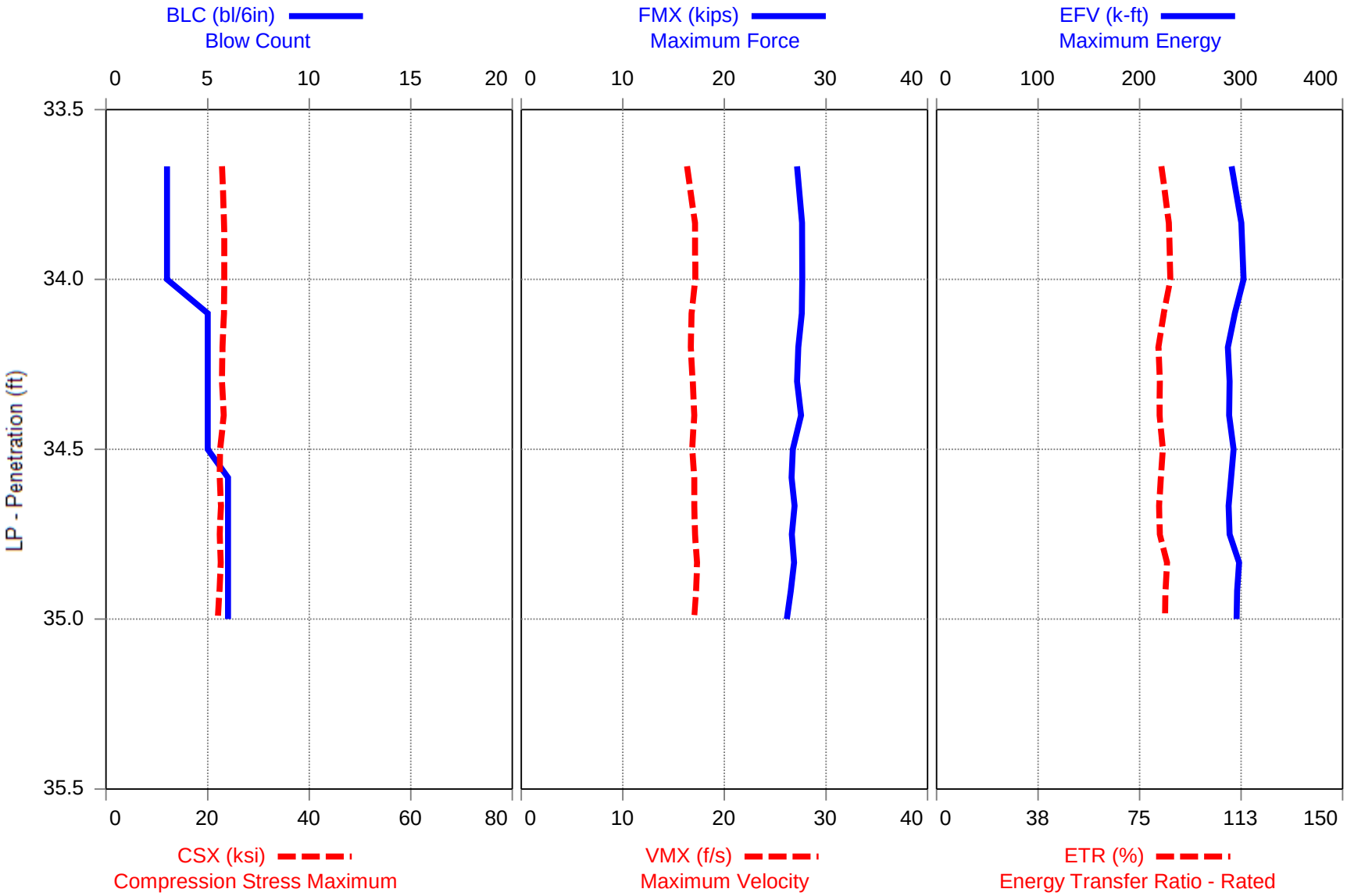


Pile Dynamics, Inc. - PDIPLOT2 Ver 2021.1.61.0 - Case Method & iCAP® Results

Printed: 23-March-2022

Test started: 11-March-2022

CME 45B (SN 303304) - 33.5 TO 35.0

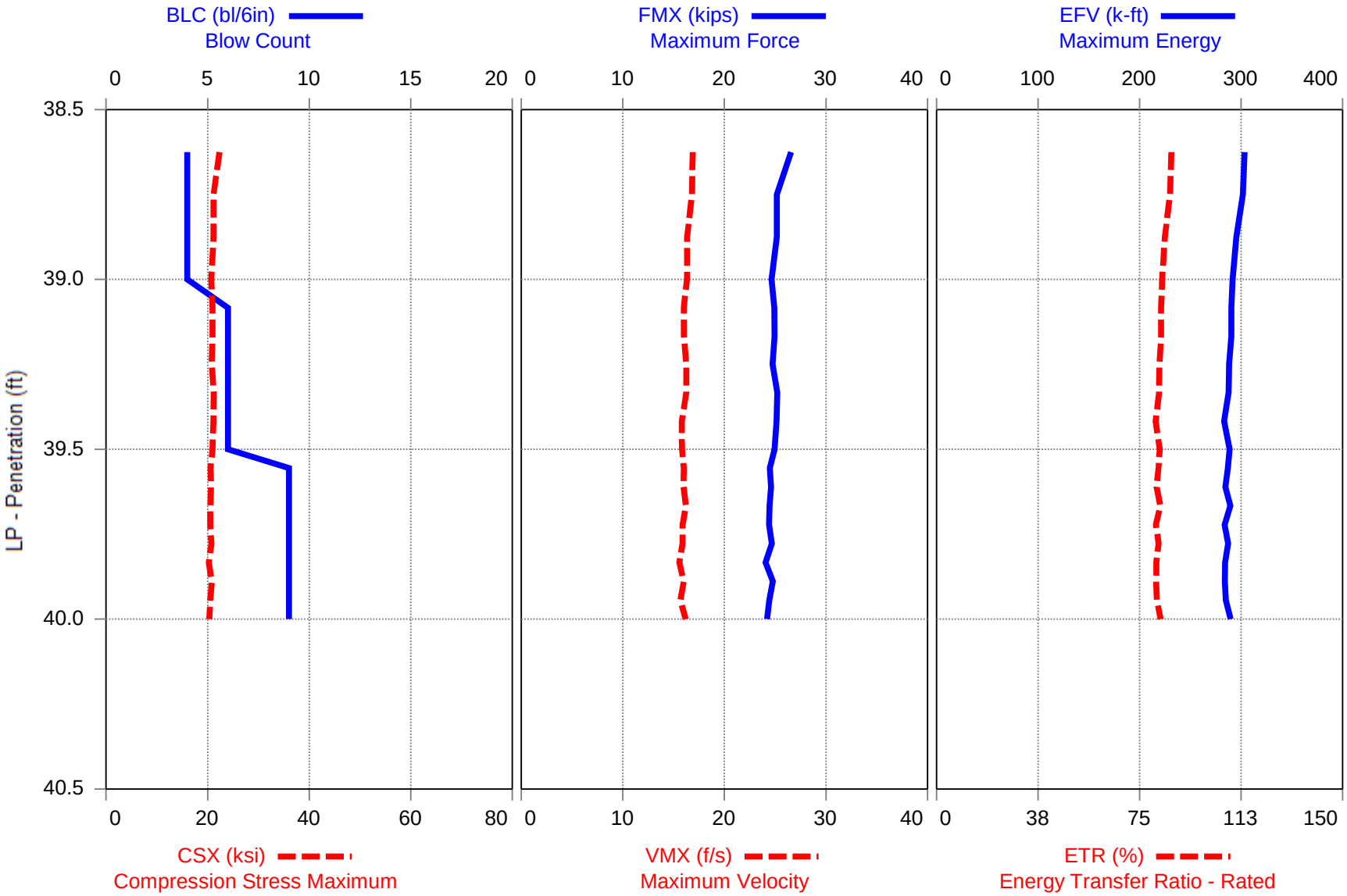


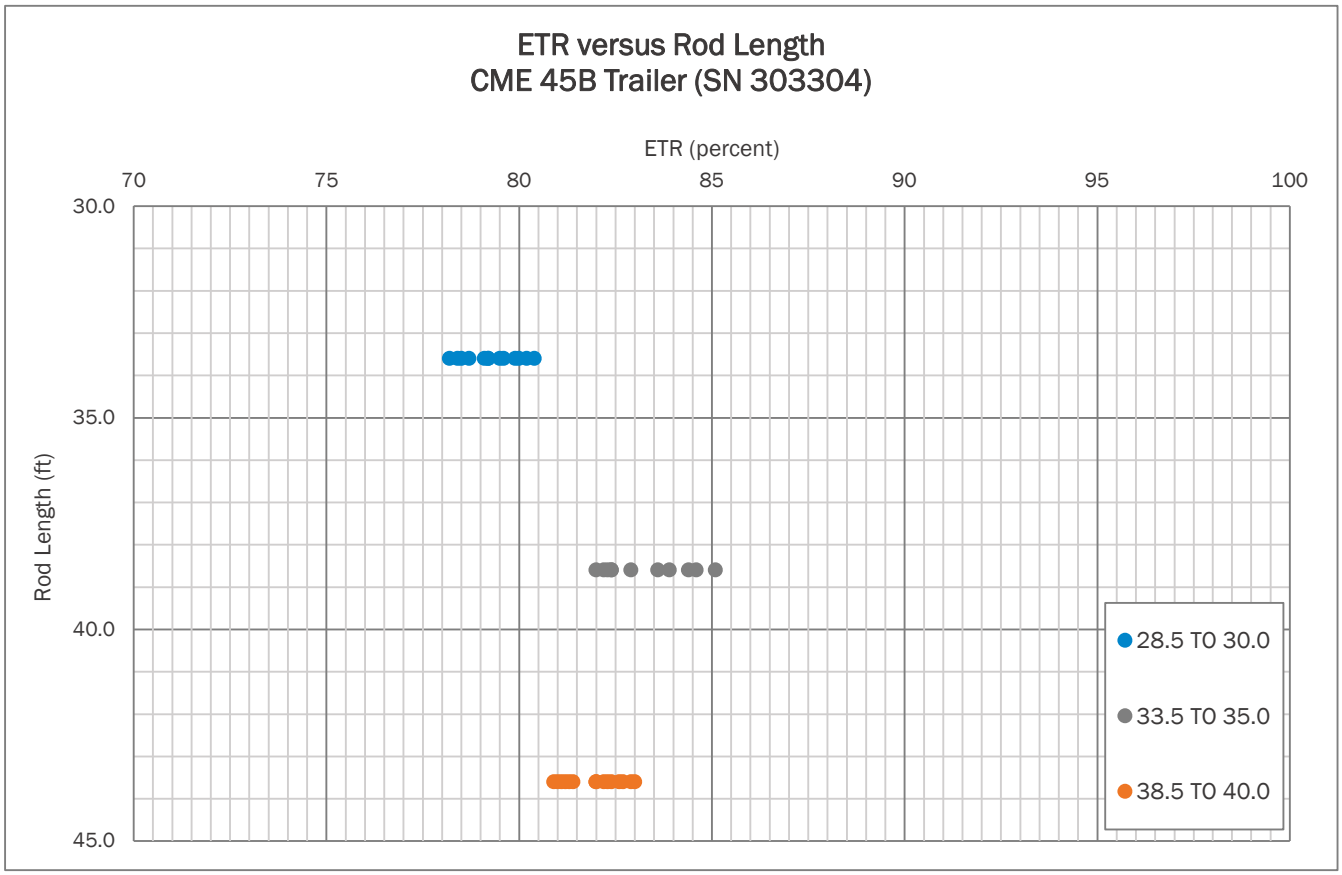
Pile Dynamics, Inc. - PDIPLOT2 Ver 2021.1.61.0 - Case Method & iCAP® Results

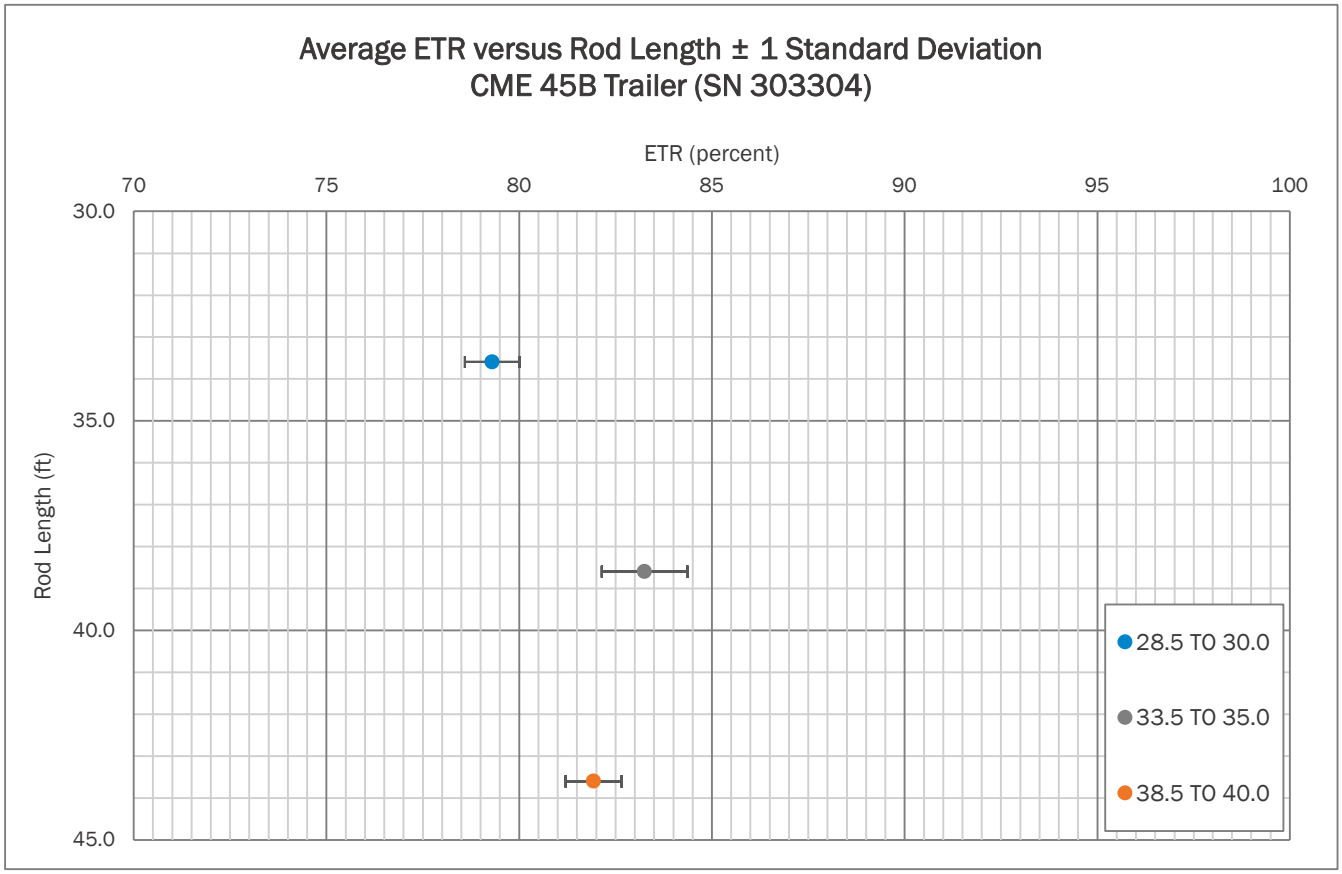
Printed: 23-March-2022

Test started: 11-March-2022

CME 45B (SN 303304) - 38.5 TO 40.0




ETR versus Rod Length
CME 45B Trailer (SN 303304)
ETR (percent)
70
75
80
85
90
95
100
Rod Length (ft)
30.0
35.0
40.0
45.0
28.5 TO 30.0
33.5 TO 35.0
38.5 TO 40.0


Average ETR versus Rod Length ± 1 Standard Deviation
CME 45B Trailer (SN 303304)
ETR (percent)
70
75
80
85
90
95
100
Rod Length (ft)
30.0
35.0
40.0
45.0
28.5 TO 30.0
33.5 TO 35.0
38.5 TO 40.0

APPENDIX II

SPT Hammer Energy Field Form

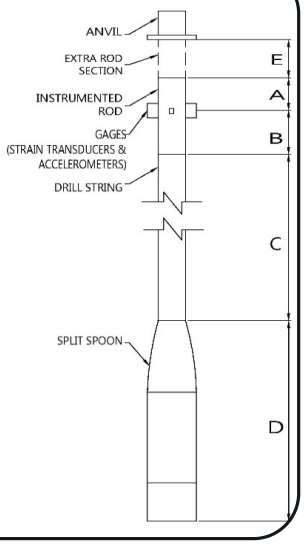
Project:	SPT HAMMER ENERGY	**Date:**	3/11/2022
Project No.:	240021095	**Weather:**	50's CLOUDY
Boring No.:	B-1	**Drill Rod Type:**	AWJ

On-site Personnel

Drilling Company:	BRECCIA CONSTRUCTION, LLC
Rig Operator:	D. HARRIS
Engr/Geologist:	N/A
Client Rep.:	N/A
Analyzer Oper.:	R. KRAL

Rod Info

(A + E) Impact Surface to Gages Length:	1.36	ft
(B) Instr. Rod Length below Gages:	0.70	ft
(A) + (B) Instr. Rod Length:	2.00	ft
(D) Spoon Length:	2.85	ft
(E) Rod Length Above Instr. Rod (if applicable):	0.06	ft
Instr. Rod S/N:	528AWJ	
Instr. Rod Outside Dia.:	1.75	in.
Instr. Rod Area:	1.19	in^2
PDA Make/Model:	SPT	
PDA Serial No.:	4549 TB	
Calib. Pulse Test (y/n):	Y	



Rig/Hammer Info

Drill Rig Make/Model:	CME 45B
Carrier Type:	TRAILER
Rig Serial No.:	303304 (DR-1)
Hammer Type/Model:	CME
Hammer Serial No.:	N/A
Hammer Drop System:	AUTO
Lubrication Condition:	PER MANUFACTURER
Manufacturer Recommended Operation Rate (bpm):	55
Drop Height (in.):	30
Hammer Weight (lbs):	140
Anvil Dimension (in.):	11.5
Drilling Method:	2.25 HSA

Gage Info

Gage		Serial No.	Calibration No.
Accel.	A3	K11957	407.00
	A4	K10959	417.30
Strain	F3	528AWJ-1	205.26
	F4	528AWJ-2	205.86

Date of Test	Test Depth Increment (ft to ft)	Test Time Start / Stop (military)	Length of Drill String (ft) *(C)*	(LE) Length below Gages (ft) *(B) + (C) + (D)*	Avg. Meas. Hammer Rate (BPM)	SPT Blow Counts 6"	12"	18"	N-Value	Drop Height in Tolerance (y/n)	Soil Class.
11-Mar	28.5 TO 30.0	0830/0830	30	33.6	53	4	6	7	13	Y	SA SI
11-Mar	33.5 TO 35.0	0837/0837	35	38.6	57	3	5	6	11	Y	SA SI
11-Mar	38.5 TO 40.0	0842/0843	40	43.6	56	4	6	9	15	Y	SA SI

Notes:
TESTING PERFORMED AT 1817 LOWRYS HIGHWAY IN CHESTER, SOUTH CAROLINA (CHESTER COUNTY). THE APPROXIMATE COORDINATES ARE 34.770585, -81.245517.

NOTE: (1) Note any unusual hammer operating conditions that affect the hammer performance, or changes in operating conditions (e.g. veritcality, weather, or lubrication between trials). (2) Note any changes in rod diameter along drill string and record locations of short rod sections.

Prepared By (print/signature) — Date: 3/11/2022

Figure No. 1: Rear View of Drill Rig

Figure No. 2: Side View of Drill Rig

Figure No. 3: Serial Number Plate

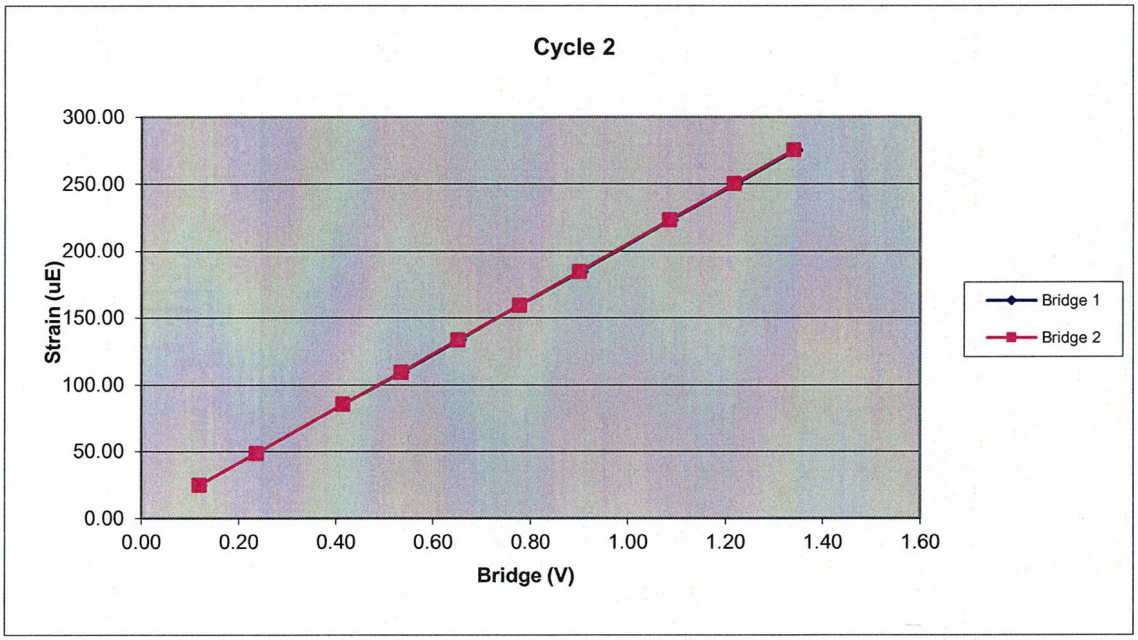
Figure No. 4: Automatic Hammer

APPENDIX III

528AWJ		Cycle 2		
Sample	**Force (lb)**	**Strain (µE)**	**Bridge 1 (V)**	**Bridge 2 (V)**
1	0.00	0.00	0.00	0.00
2	905.16	24.61	0.12	0.12
3	1753.20	48.18	0.24	0.24
4	3064.74	84.99	0.42	0.41
5	3947.87	108.99	0.54	0.53
6	4813.36	133.40	0.65	0.65
7	5727.49	159.02	0.78	0.78
8	6643.67	184.17	0.90	0.90
9	8004.82	222.89	1.09	1.09
10	8980.07	249.70	1.22	1.22
11	9885.91	275.04	1.35	1.34

Bridge 1		**Bridge 2**	
Force Calibration (lb/V)	**7340.27**	**Force Calibration (lb/V)**	**7362.32**
Offset	**12.98**	Offset	**13.21**
Correlation	**1.000000**	Correlation	**0.999999**
Strain Calibration (µE/V)	**204.74**	**Strain Calibration (µE/V)**	**205.35**
Offset	**-0.39**	Offset	**-0.39**
Correlation	**0.999993**	Correlation	**0.999995**

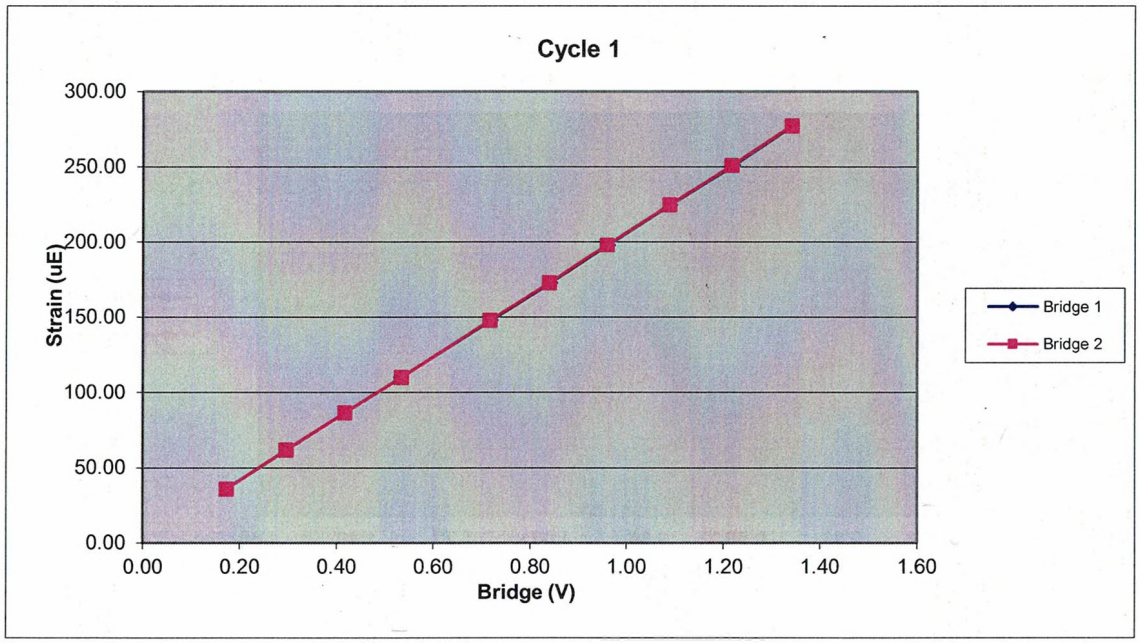
Force Strain Calibration	
EA (Kips)	**35851.72**
Offset	**27.08**
Correlation	**0.999996**



528AWJ		Cycle 1		
Sample	**Force (lb)**	**Strain (μE)**	**Bridge 1 (V)**	**Bridge 2 (V)**
1	0.00	0.00	0.00	0.00
2	1278.49	35.63	0.17	0.17
3	2188.92	61.59	0.30	0.30
4	3085.11	86.16	0.42	0.42
5	3944.56	110.01	0.53	0.54
6	5284.17	147.69	0.72	0.72
7	6199.57	172.59	0.84	0.84
8	7071.20	197.80	0.96	0.96
9	8023.54	224.47	1.09	1.09
10	8958.62	250.45	1.22	1.22
11	9876.55	276.81	1.34	1.34

Bridge 1		**Bridge 2**	
Force Calibration (lb/V)	**7346.16**	**Force Calibration (lb/V)**	**7359.87**
Offset	9.71	Offset	6.72
Correlation	0.999998	Correlation	0.999999
Strain Calibration (μE/V)	**205.65**	**Strain Calibration (μE/V)**	**206.03**
Offset	0.08	Offset	-0.01
Correlation	0.999990	Correlation	0.999993

Force Strain Calibration	
EA (Kips)	**35721.25**
Offset	7.11
Correlation	0.999990



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

Calibration Factors	528AWJ		
Bridge 1 (µE/V)	205.26	Bridge 2 (µE/V)	205.86
EA Factor (Kips)	35777.05	Area (in^2)	1.19

Calibrated by: _____
Calibrated Date: 1/28/2021

Pile Dynamics Inc
30725 Aurora Rd
Solon, OH 44139

Traceable to N.I.S.T.

Accelerometer Calibration Certificate
Pile Dynamics, Inc.

Calibrated by Pile Dynamics, Inc.
Calibration performed on 19Apr2021

Serial No:	K10959	**Temperature:**	21.0 °C
Model:	PR	**Humidity:**	38%
Calibrated on:	Channel 3 on 8G 5161 LE		

Ref Acc 1:	69096! 978 g's/volt	**Cal on:**	27Jan2021
Ref Acc 2:	69132! 960 g's/volt	**Cal on:**	09Feb2021

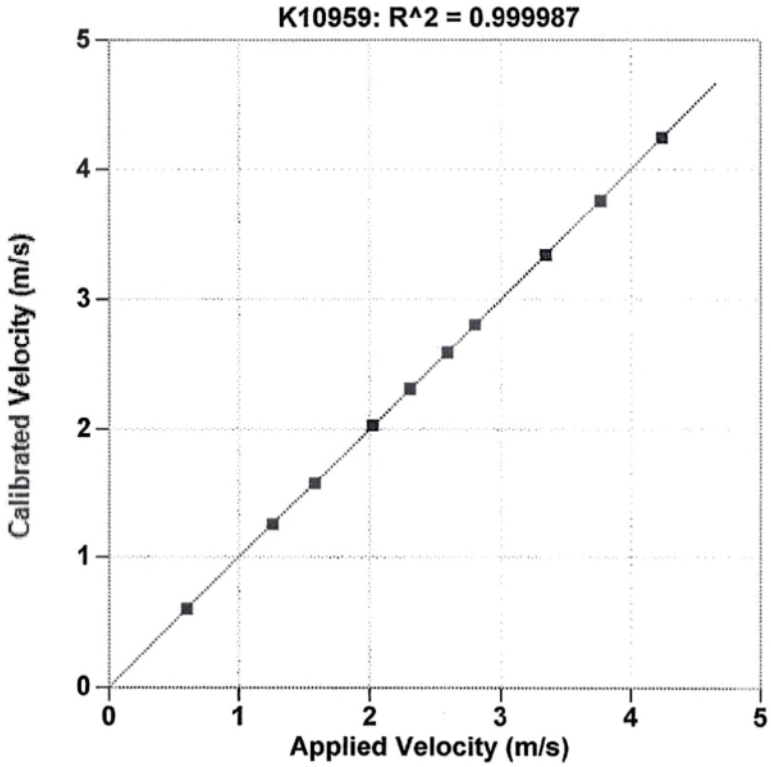
Reference accelerometer calibrations are traceable to the United States National Institute of Standards and Technology (NIST).

PDA CALIBRATION FACTOR

417.3 mv/5000g
(83.5 µv/g)
R^2: 0.999987 [Chip programmed]

Operator: William Johnson

Signed



Reference Velocity	S/N K10959 Velocity
m/s	m/s
0.600	0.600
1.260	1.255
1.578	1.577
2.021	2.028
2.306	2.311
2.590	2.590
2.801	2.806
3.346	3.344
3.767	3.762
4.241	4.241

Maximum Acceleration: 938 g's

Accelerometer Calibration Certificate
Pile Dynamics, Inc.

Calibrated by Pile Dynamics, Inc.
Calibration performed on 22Jan2021

Serial No:	K10960	**Temperature:**	20.0 °C
Model:	PR	**Humidity:**	28%
Calibrated on:	Channel 4 on 8G 5161 LE		

Ref Acc 1:	63479! 1080 g's/volt	**Cal on:**	09Sep2020
Ref Acc 2:	65538! 1040 g's/volt	**Cal on:**	27Jan2020

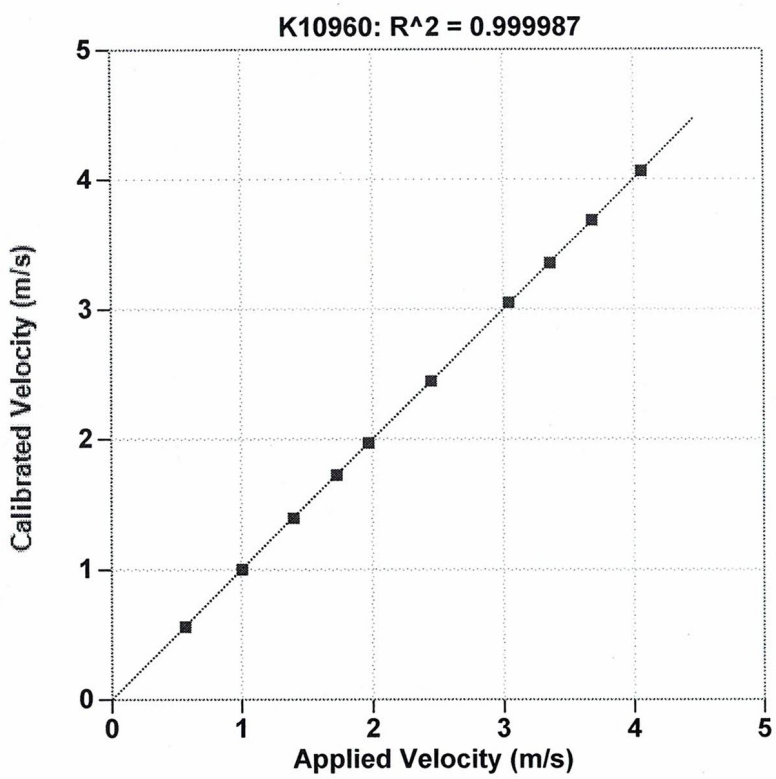
Reference accelerometer calibrations are traceable to the United States National Institute of Standards and Technology (NIST).

PDA CALIBRATION FACTOR

425.7 mv/5000g
(85.1 μv/g)
R^2: 0.999987 [Chip programmed]

Operator: William Johnson

Signed



Reference Velocity	S/N K10960 Velocity
m/s	m/s
0.568	0.564
1.006	1.001
1.400	1.393
1.728	1.726
1.969	1.970
2.447	2.448
3.043	3.051
3.359	3.356
3.683	3.684
4.063	4.062

Maximum Acceleration: 889 g's

Accelerometer Calibration Certificate
Pile Dynamics, Inc.

Calibrated by Pile Dynamics, Inc.
Calibration performed on MAR 2 2021

Serial No:	K11957	**Temperature:**	20.0 °C
Model:	PR	**Humidity:**	27%
Calibrated on:	Channel 4 on 8G 5161 LE		

Ref Acc 1:	63479! 1079 g's/volt	**Cal on:**	22Jan2021
Ref Acc 2:	65538! 1043 g's/volt	**Cal on:**	22Jan2021

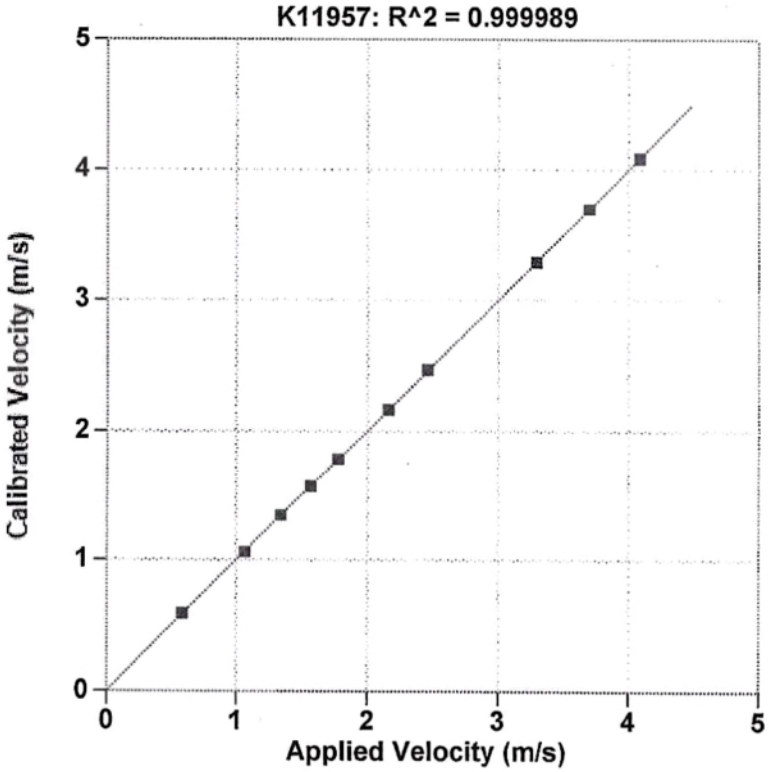
Reference accelerometer calibrations are traceable to the United States National Institute of Standards and Technology (NIST).

PDA CALIBRATION FACTOR

407.0 mv/5000g
(81.4 µv/g)
R^2: 0.999989 [Chip programmed]

Operator: William Johnson

Signed



Reference Velocity	S/N K11957 Velocity
m/s	m/s
0.588	0.589
1.066	1.061
1.344	1.345
1.571	1.570
1.779	1.783
2.161	2.164
2.458	2.465
3.294	3.291
3.701	3.700
4.089	4.086

Maximum Acceleration: 894 g's

APPENDIX IV

PDCA
PILE DRIVING CONTRACTORS ASSOCIATION

Pile Dynamics, Inc.

This documents that

Robert E. Kral
Carolinas Geotechnical Group

has on May 20, 2016 achieved the rank of

ADVANCED

on the **Dynamic Measurement and Analysis Proficiency Test.**

The individual identified on this document demonstrated to the degree granted above an understanding of theory, data quality evaluation, interpretation and signal matching for high strain dynamic testing of deep foundations. ***It is recommended* that Individuals at the Advanced level seek Master or Expert levels through additional study within six years of the date of this document.**

The ability of the individual named to provide appropriate knowledge and advice on a specific project is not implied or warranted by the Pile Driving Contractors Association or Pile Dynamics, Inc. **This certificate can be verified at www.PDAproficiencytest.com.** The Pile Driving Contractors Association or Pile Dynamics, Inc. assumes no liability for foundation testing and analysis work performed by the bearer of this certificate.

Steven A. Hall, Executive Director
Pile Driving Contractors Association

Garland Likins, Senior Partner
Pile Dynamics, Inc.

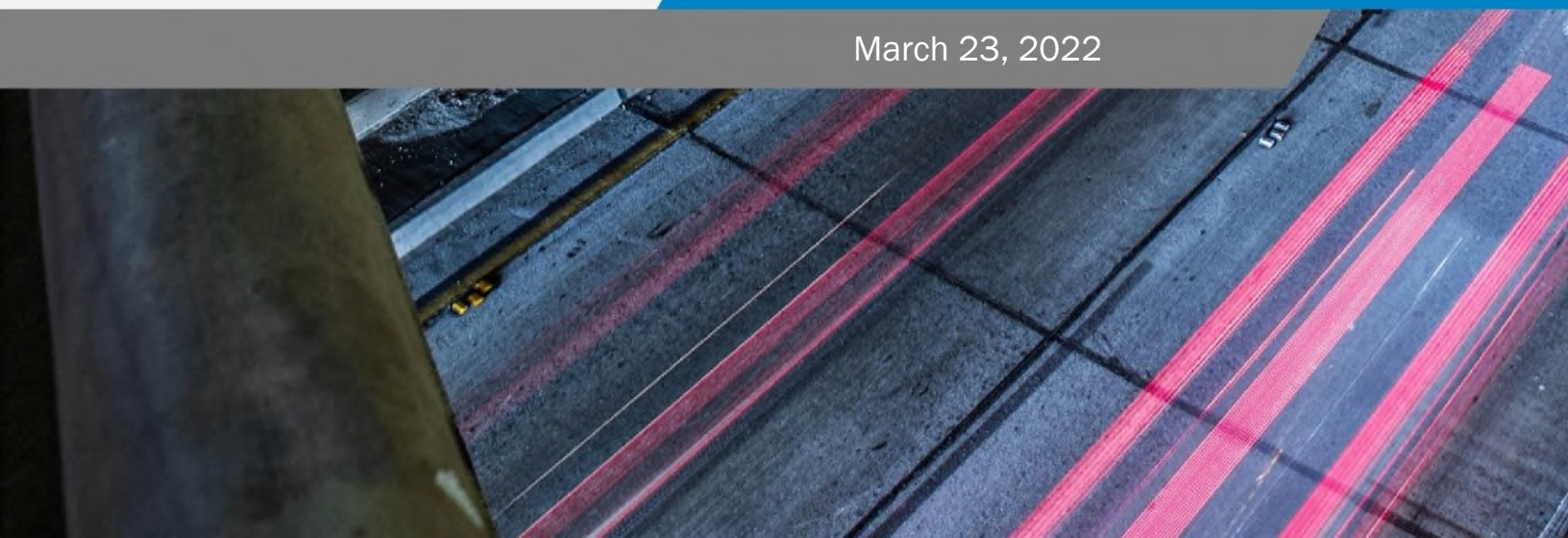
No. 2072

CAROLINAS GEOTECHNICAL GROUP

Report of SPT Hammer Energy

Prepared for:
Breccia Construction, LLC
620-B Industrial Way
Chester, South Carolina 29706

March 23, 2022



CAROLINAS GEOTECHNICAL GROUP

N.C. Firm License: P-1904

2400 Crownpoint Executive Drive
Suite 800
Charlotte, NC 28227

(980) 339-8684
contact@carolinasgeotech.com
www.carolinasgeotech.com

March 23, 2022

Mr. Jarod S. Ford
Breccia Construction, LLC
620-B Industrial Way
Chester, South Carolina 29706

SUBJECT: **Report of SPT Hammer Energy**
Breccia Construction, LLC CME 550X ATV Rig (SN 294593)
Chester, South Carolina
CG2 Project No.: 240021095

Dear Mr. Ford:

Carolinas Geotechnical Group, PLLC (CG2) has completed the Standard Penetration Test (SPT) energy measurements on the automatic hammer mounted on a Breccia Construction, LLC (Breccia) CME 550X ATV-mounted drill rig with a serial number of 294593, see attached Drill Rig Photo Log. This service was performed by Mr. Robert E. Kral, PE on March 11, 2022. SPT energy testing was performed in general accordance with ASTM D4633 and the most recent revision of the North Carolina Department of Transportation (NCDOT), Geotechnical Engineering Unit's requirements. The testing procedures, equipment used during testing, and detailed results are presented in this report.

CG2 recommends Breccia submit this Report of SPT Hammer Energy to the NCDOT Geotechnical Engineering Unit for review and approval no later than April 8, 2022.

DYNAMIC TESTING METHODOLOGY

Testing was performed using a model SPT (Serial No. 4549 TB) Pile Driving Analyzer™ (PDA) manufactured by Pile Dynamics, Inc. The PDA was used to record and interpret data from two piezoresistive accelerometers (Serial Nos. K11957 and K10959) bolted to a 2-foot long AWJ drill rod (SN 528AWJ) internally instrumented with two strain transducers. The instrumented AWJ drill rod has a cross-sectional area of 1.19 square inches, an outside diameter of approximately 1.75 inches, and an inside diameter of 1.25 inches at the gauge location. The accelerometers and strain gauges, which are mounted on opposing axis near the middle of the instrumented rod, monitor acceleration and strain for each hammer blow. The analyzer converts the data to velocities and forces and computes the maximum transferred hammer energies with the "EFV" method described in ASTM D4633. Preliminary results are recorded and displayed in real-time for each blow. Calibration sheets for the PDA, accelerometers, and the instrumented rod are included in the Appendix III.

TESTING AND OBSERVATIONS

CG2 personnel was on site March 11, 2022 to observe and perform high-strain dynamic testing during SPT sampling on the CME 550X ATV-mounted drill rig operated by R. Huffstetler of Breccia. The measurements were taken during drilling operations at 1817 Lowrys Highway in Chester, South Carolina (Chester County). The approximate coordinates (not professionally surveyed) for the test location are 34.770561, -81.245581. No Soil Test Boring Log was maintained. SPT energy measurements were recorded during three intervals at depths of approximately 28½, 33½, and 38½, feet below the existing ground surface. The information presented in the table below summarizes the equipment tested and tooling used during the SPT energy measurements.

Table 1: SPT Field Data

Drill Rig Information	
Manufacturer	CME
Model	550X
Serial Number	294593
Operator	R. Huffstetler
Carrier	ATV
Hammer Information	
Model / Type	CME / Auto
Serial Number	N/A
Anvil Height (inches)	11.5
Anvil Diameter (inches)	2.5
Drop Height (inches)	30
Ram Weight (pounds)	140
Ram Serial Number	N/A
Drilling and Instrumented Rod Information	
Drill Rod Type	AWJ
OD (inches)	1.75
ID (inches)	1.25
Cross-Sectional Area (in^2)	1.19
Typical Lengths (feet)	5
Instrumented Rod Type	AWJ (SN 528)
OD (inches)	1.75
ID (inches)	1.25
Cross-Sectional Area (in^2)	1.19
Total Instrumented Rod Length (feet)	2.00
Length Below Gages (feet)	0.70
Split-Spoon Length (feet)	2.85

DYNAMIC TESTING RESULTS

The total rod length from the instrumentation to the tip of the split-spoon sampler was determined by adding 3.6 feet to the required drill rod length at each sample depth. Based on the test data, the automatic hammer on the CME 550X ATV-mounted drill rig operated at a rate of about 56.9 to 59.1 blows per minute (BPM) during dynamic testing. The measured transferred hammer energy (EFV) ranged from 278.9 to 324.9 foot-pounds, which corresponds to Energy Transfer Ratio (ETR) values of 79.7 to 92.8%, respectively.

The SPT Energy Measurement Data Summary tables in the Appendix present the test data from every hammer blow at each sampling interval along with representative force and velocity traces for each test interval. The reported blow counts, obtained by the drill rig personnel, and a summary of the test data and average computed hammer energy and transfer ratio values are provided in Table 2. Plots and tables of the following are also included in the Appendix and present the test data with depth for each test interval:

- Penetration vs. BLC
- Penetration vs. FMX
- Penetration vs. EFV
- Penetration vs. CSX
- Penetration vs. VMX
- Penetration vs. ETR
- Average ETR vs. Rod Length
- ETR vs. Rod Length

Table 2: Summary of Dynamic Testing Results

Data Set ID	Sample Depth (ft)	Drill Rod Length (ft)	Instrumentation to Sampler Tip Length (ft)	Blows per 6" Increment / N-value	Soil Sample Description (Piedmont Residual)	Avg. BPM	Avg. EFV (ft-lbs)	Avg. ETR (%)
1	28½ - 30	30	33.6	4-7-9 / 16	SA SILT	57.9	293.4	83.8
2	33½ - 35	35	38.6	4-6-8 / 14	SA SILT	58.6	312.1	89.2
3	38½ - 40	40	43.6	3-4-6 / 10	SA SILT	58.5	312.0	89.1
					Overall Average	58.3	304.6	87.0

The average hammer rate, transferred energy, and transfer ratio were calculated for each depth interval. Per ASTM D4633, only the blows from the final foot of each sample interval (i.e., the blows that determine the N-value) were included when computing the average values shown in Table 2. The overall average transferred hammer energy for the automatic hammer on the CME 550X ATV-mounted drill rig (for all the depth intervals tested) was 304.6 foot-pounds, with an average ETR of 87.0%.

LIMITATIONS OF REPORT

This report has been prepared in accordance with generally accepted geotechnical engineering practice for specific application to this project. The information contained in this report were based on the applicable standards of our profession in this geographic area at the time this report was prepared. No other warranty, express or implied, is made.

CLOSING

CG2 is pleased to have the opportunity to provide these services to you. If you have questions concerning the content of this report, or if CG2 can be of further service, please contact CG2 at (980) 339-8684.

Sincerely,
Carolinas Geotechnical Group, PLLC

DocuSigned by:
D. Matthew Brewer
386129C0A4C1462...
D. Matthew Brewer, PE
Senior Project Engineer

DocuSigned by:
Robert E Kral
8AD703B2A8484F4...
Robert E. Kral, PE
Senior Project Engineer
NC Registration No. 042642

NORTH CAROLINA PROFESSIONAL SEAL 042642 ENGINEER ROBERT E. KRAL

Appendices:

- Appendix I - CME 550X ATV Rig (SN 294593) SPT Energy Measurements Summary Plots and Tables
- Appendix II - SPT Hammer Energy Field Form (Field Log) and Drill Rig Photo Log
- Appendix III - Instrumented Rod and Accelerometer Calibration Sheets
- Appendix IV - Certificate of Proficiency

APPENDIX I

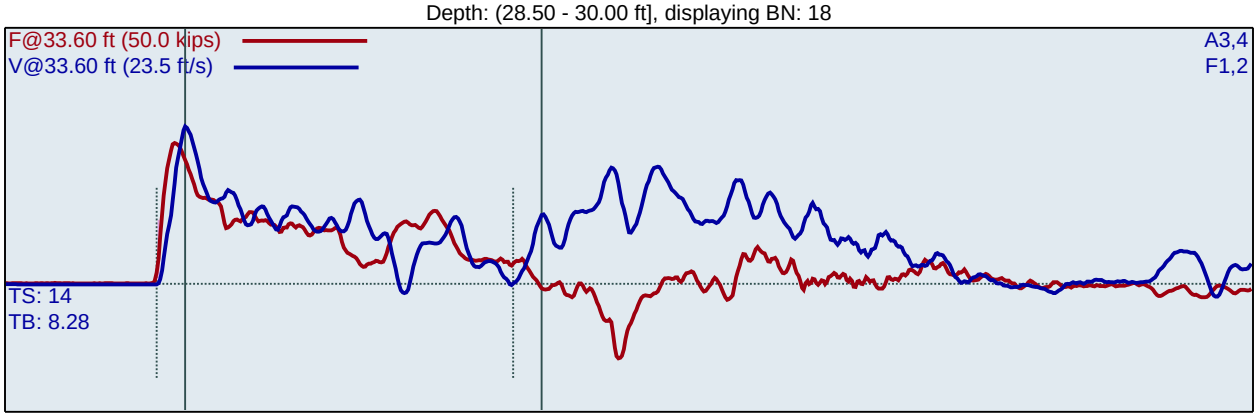
CME 550X (SN 294593)
REK
B-4

B-4
Interval start: 3/11/2022

AR: 1.19 in^2
LE: 33.60 ft
WS: 16807.9 ft/s

SP: 0.492 k/ft3
EM: 30000 ksi

Depth: (28.50 - 30.00 ft], displaying BN: 18



F1 : [528AWJ1] 205.26 PDICAL (1) FF1
F2 : [528AWJ2] 205.86 PDICAL (1) FF1

A3 (PR): [K11957] 407.045 mv/6.4v/5000g (1) VF1
A4 (PR): [K10959] 417.27 mv/6.4v/5000g (1) VF1

BPM: Blows/Minute
FMX: Maximum Force
VMX: Maximum Velocity
DMX: Maximum Displacement

CSX: Compression Stress Maximum
DFN: Final Displacement
EFV: Maximum Energy
ETR: Energy Transfer Ratio - Rated

LP	BL#	BC	BPM	FMX	VMX	DMX	CSX	DFN	EFV	ETR
ft		/6"	bpm	kips	ft/s	in	ksi	in	ft-lb	%
28.63	1	4	1.9	25.9	15.6	1.7	21.8	1.5	255.9	73.1
28.75	2	4	48.5	25.4	15.0	1.5	21.4	1.5	273.4	78.1
28.88	3	4	53.5	25.8	15.0	1.5	21.7	1.5	287.5	82.1
29.00	4	4	56.4	25.6	15.5	1.6	21.5	1.5	318.9	91.1
29.07	5	7	57.0	25.9	14.9	1.3	21.7	0.9	301.8	86.2
29.14	6	7	56.9	25.7	15.6	1.2	21.6	0.9	311.6	89.0
29.21	7	7	57.6	25.8	15.2	1.1	21.7	0.9	300.2	85.8
29.29	8	7	57.4	26.3	15.8	1.1	22.1	0.9	300.9	86.0
29.36	9	7	57.9	26.3	14.5	1.0	22.1	0.9	303.6	86.7
29.43	10	7	58.0	26.7	15.5	0.9	22.4	0.9	296.7	84.8
29.50	11	7	57.8	26.4	15.2	0.9	22.2	0.9	297.2	84.9
29.56	12	9	58.1	27.0	15.1	0.9	22.7	0.7	298.4	85.3
29.61	13	9	58.3	27.5	15.2	0.9	23.1	0.7	297.8	85.1
29.67	14	9	58.1	26.9	14.9	0.8	22.6	0.7	292.8	83.6
29.72	15	9	58.2	26.9	14.4	0.8	22.6	0.7	284.8	81.4
29.78	16	9	58.5	27.2	14.6	0.8	22.8	0.7	288.2	82.4
29.83	17	9	58.5	26.9	14.3	0.8	22.6	0.7	278.9	79.7
29.89	18	9	58.2	27.5	14.5	0.7	23.1	0.7	281.7	80.5
29.94	19	9	58.3	27.1	14.3	0.7	22.8	0.7	279.1	79.7
30.00	20	9	58.2	27.5	14.5	0.7	23.1	0.7	280.6	80.2
		Average	57.9	26.7	14.9	0.9	22.5	0.7	293.4	83.8
		Std Dev	0.5	0.6	0.5	0.2	0.5	0.1	9.7	2.8
		Maximum	58.5	27.5	15.8	1.3	23.1	0.9	311.6	89.0
		Minimum	56.9	25.7	14.3	0.7	21.6	0.7	278.9	79.7

N-value: 16

Sample Interval Time: 19.99 seconds.

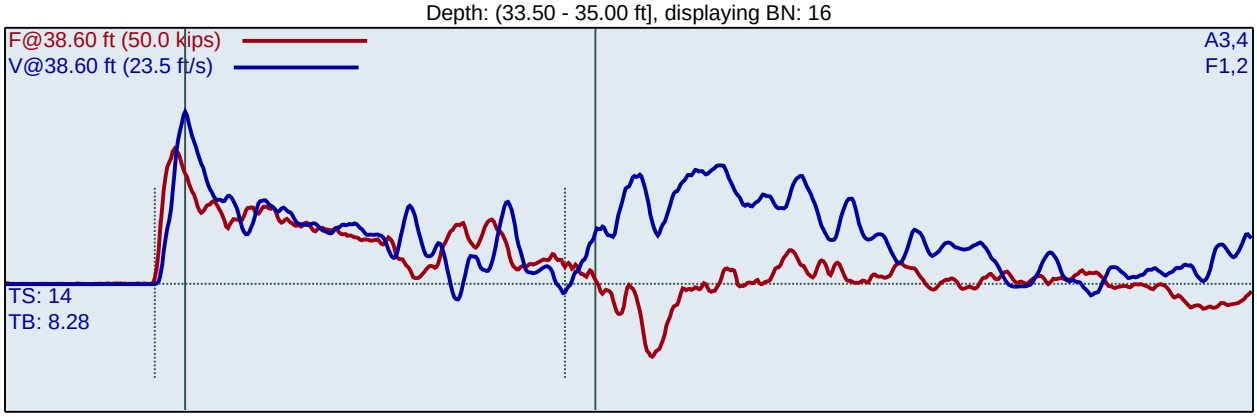
CME 550X (SN 294593)
REK
B-4

B-4
Interval start: 3/11/2022

AR: 1.19 in^2
LE: 38.60 ft
WS: 16807.9 ft/s

SP: 0.492 k/ft3
EM: 30000 ksi

Depth: (33.50 - 35.00 ft], displaying BN: 16



F1 : [528AWJ1] 205.26 PDICAL (1) FF1
F2 : [528AWJ2] 205.86 PDICAL (1) FF1

A3 (PR): [K11957] 407.045 mv/6.4v/5000g (1) VF1
A4 (PR): [K10959] 417.27 mv/6.4v/5000g (1) VF1

LP	BL#	BC	BPM	FMX	VMX	DMX	CSX	DFN	EFV	ETR
ft		/6"	bpm	kips	ft/s	in	ksi	in	ft-lb	%
33.63	1	4	1.9	26.7	15.8	2.0	22.4	1.5	277.0	79.1
33.75	2	4	53.0	26.2	16.2	1.5	22.0	1.5	289.7	82.8
33.88	3	4	56.1	26.4	16.2	1.5	22.2	1.5	320.7	91.6
34.00	4	4	57.4	26.5	16.6	1.5	22.3	1.5	332.4	95.0
34.08	5	6	58.1	26.8	16.7	1.1	22.5	1.0	315.1	90.0
34.17	6	6	58.2	27.1	16.6	1.1	22.7	1.0	309.7	88.5
34.25	7	6	58.7	27.2	16.8	1.1	22.9	1.0	316.1	90.3
34.33	8	6	58.6	26.2	16.5	1.0	22.0	1.0	315.5	90.1
34.42	9	6	58.6	26.4	16.5	1.0	22.2	1.0	317.3	90.7
34.50	10	6	58.6	26.7	16.4	1.0	22.4	1.0	319.3	91.2
34.56	11	8	58.6	26.2	16.6	0.8	22.0	0.7	304.0	86.9
34.63	12	8	58.9	26.5	16.2	0.8	22.2	0.7	311.7	89.0
34.69	13	8	58.4	26.7	16.7	0.8	22.4	0.7	315.8	90.2
34.75	14	8	59.1	26.3	16.1	0.8	22.1	0.7	308.5	88.2
34.81	15	8	58.8	27.1	16.3	0.8	22.8	0.7	311.2	88.9
34.88	16	8	58.7	26.4	15.8	0.8	22.1	0.7	310.5	88.7
34.94	17	8	58.6	26.4	15.9	0.8	22.1	0.7	306.6	87.6
35.00	18	8	59.0	26.3	15.9	0.8	22.1	0.7	307.8	87.9
		Average	58.6	26.6	16.4	0.9	22.3	0.9	312.1	89.2
		Std Dev	0.3	0.3	0.3	0.1	0.3	0.1	4.3	1.2
		Maximum	59.1	27.2	16.8	1.1	22.9	1.0	319.3	91.2
		Minimum	58.1	26.2	15.8	0.8	22.0	0.7	304.0	86.9

N-value: 14

Sample Interval Time: 17.58 seconds.

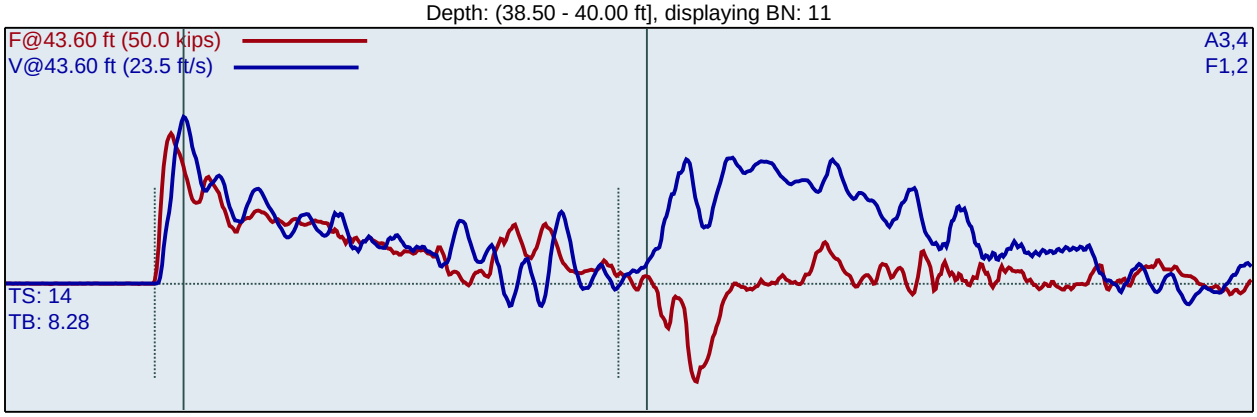
CME 550X (SN 294593)
REK
B-4

B-4
Interval start: 3/11/2022

AR: 1.19 in^2
LE: 43.60 ft
WS: 16807.9 ft/s

SP: 0.492 k/ft3
EM: 30000 ksi

Depth: (38.50 - 40.00 ft], displaying BN: 11



F1 : [528AWJ1] 205.26 PDICAL (1) FF1
F2 : [528AWJ2] 205.86 PDICAL (1) FF1

A3 (PR): [K11957] 407.045 mv/6.4v/5000g (1) VF1
A4 (PR): [K10959] 417.27 mv/6.4v/5000g (1) VF1

LP	BL#	BC	BPM	FMX	VMX	DMX	CSX	DFN	EFV	ETR
ft		/6"	bpm	kips	ft/s	in	ksi	in	ft-lb	%
38.67	1	3	1.9	28.0	15.2	2.0	23.5	2.0	277.0	79.2
38.83	2	3	54.1	28.1	15.5	2.0	23.6	2.0	321.3	91.8
39.00	3	3	56.4	29.4	15.7	2.0	24.7	2.0	314.0	89.7
39.13	4	4	57.6	27.8	15.5	1.5	23.3	1.5	309.2	88.3
39.25	5	4	58.5	28.4	15.6	1.5	23.8	1.5	312.7	89.4
39.38	6	4	58.1	28.2	15.4	1.5	23.7	1.5	324.9	92.8
39.50	7	4	58.9	29.7	15.7	1.5	24.9	1.5	317.1	90.6
39.58	8	6	58.4	28.5	15.5	1.1	24.0	1.0	310.1	88.6
39.67	9	6	58.6	28.1	15.5	1.1	23.6	1.0	312.8	89.4
39.75	10	6	58.7	29.1	15.4	1.1	24.4	1.0	307.5	87.8
39.83	11	6	58.6	29.4	15.3	1.1	24.7	1.0	311.1	88.9
39.92	12	6	58.6	27.9	15.0	1.1	23.4	1.0	307.6	87.9
40.00	13	6	58.7	28.5	15.1	1.0	24.0	1.0	307.1	87.7
		Average	58.5	28.6	15.4	1.3	24.0	1.2	312.0	89.1
		Std Dev	0.3	0.6	0.2	0.2	0.5	0.2	5.2	1.5
		Maximum	58.9	29.7	15.7	1.5	24.9	1.5	324.9	92.8
		Minimum	57.6	27.8	15.0	1.0	23.3	1.0	307.1	87.7

N-value: 10

Sample Interval Time: 12.41 seconds.

Summary of SPT Test Results

Project: CME 550X (SN 294593), Test Date: 3/11/2022

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

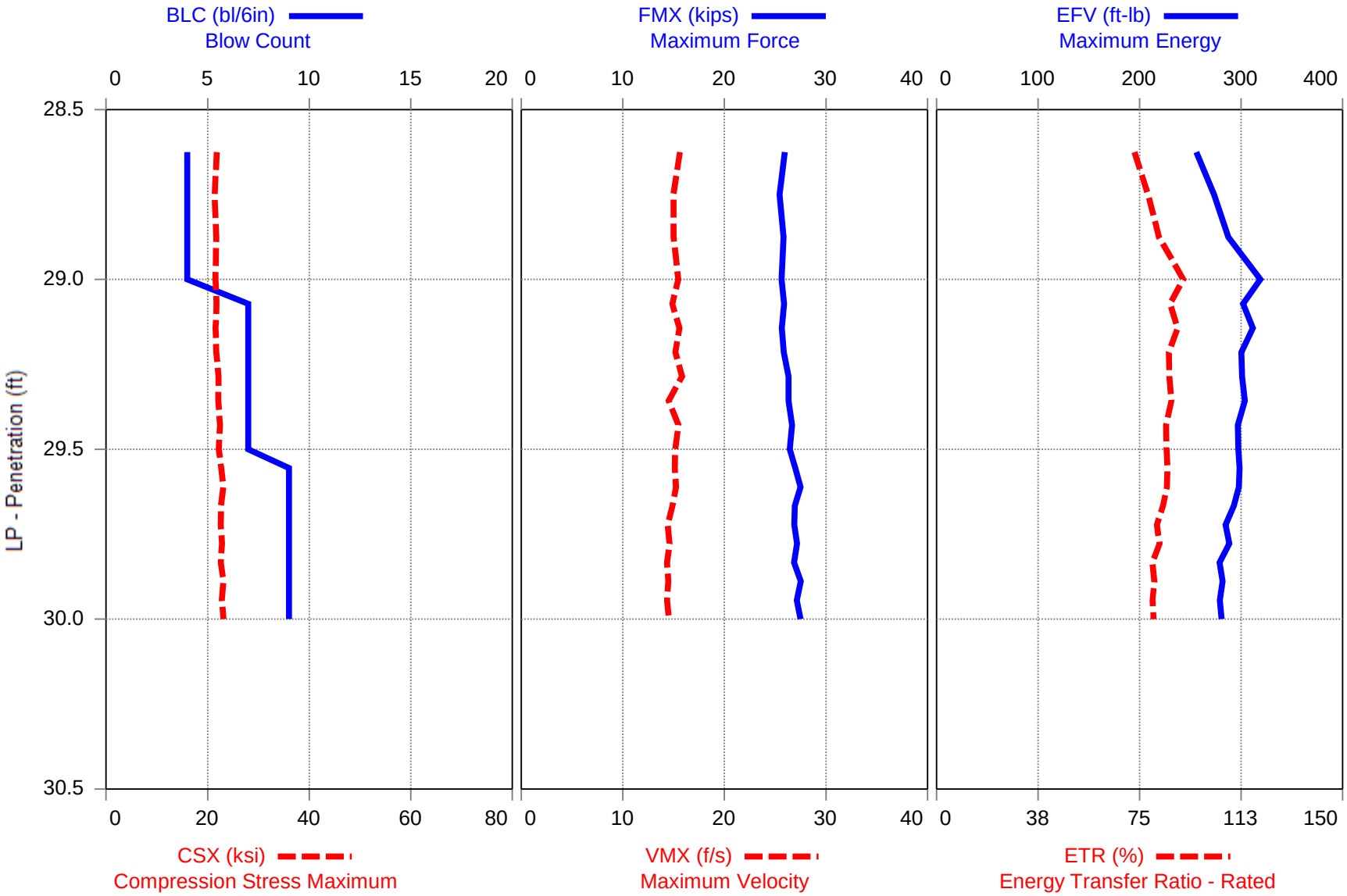
Instr. Length ft	Start Depth ft	Final Depth ft	Blows Applied /6"	**N Value**	**N60 Value**	Average BPM bpm	Average FMX kips	Average VMX ft/s	Average DMX in	Average CSX ksi	Average DFN in	Average EFV ft-lb	Average ETR %
33.60	28.50	30.00	**4-7-9**	**16**	**23**	57.9	26.7	14.9	0.9	22.5	0.7	293.4	83.8
38.60	33.50	35.00	**4-6-8**	**14**	**20**	58.6	26.6	16.4	0.9	22.3	0.9	312.1	89.2
43.60	38.50	40.00	**3-4-6**	**10**	**14**	58.5	28.6	15.4	1.3	24.0	1.2	312.0	89.1
					Overall Average Values:	58.3	27.1	15.5	1.0	22.8	0.9	304.6	87.0
					Standard Deviation:	0.5	1.0	0.7	0.2	0.8	0.2	11.6	3.3
					Overall Maximum Value:	59.1	29.7	16.8	1.5	24.9	1.5	324.9	92.8
					Overall Minimum Value:	56.9	25.7	14.3	0.7	21.6	0.7	278.9	79.7

Pile Dynamics, Inc. - PDIPLOT2 Ver 2021.1.61.0 - Case Method & iCAP® Results

Printed: 23-March-2022

Test started: 11-March-2022

CME 550X (SN 294593) - 28.5 TO 30.0

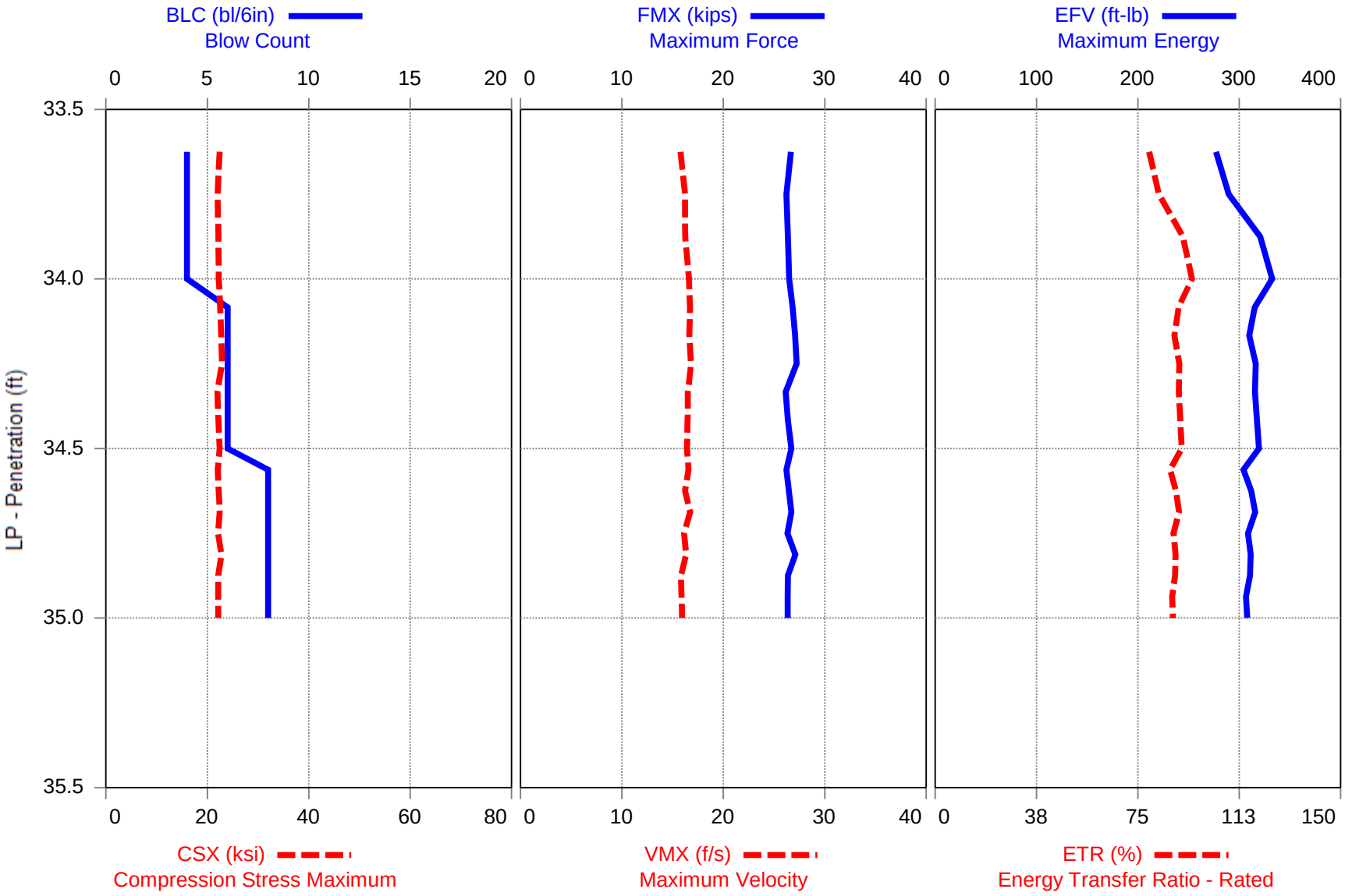


Pile Dynamics, Inc. - PDIPLOT2 Ver 2021.1.61.0 - Case Method & iCAP® Results

Printed: 23-March-2022

Test started: 11-March-2022

CME 550X (SN 294593) - 33.5 TO 35.0

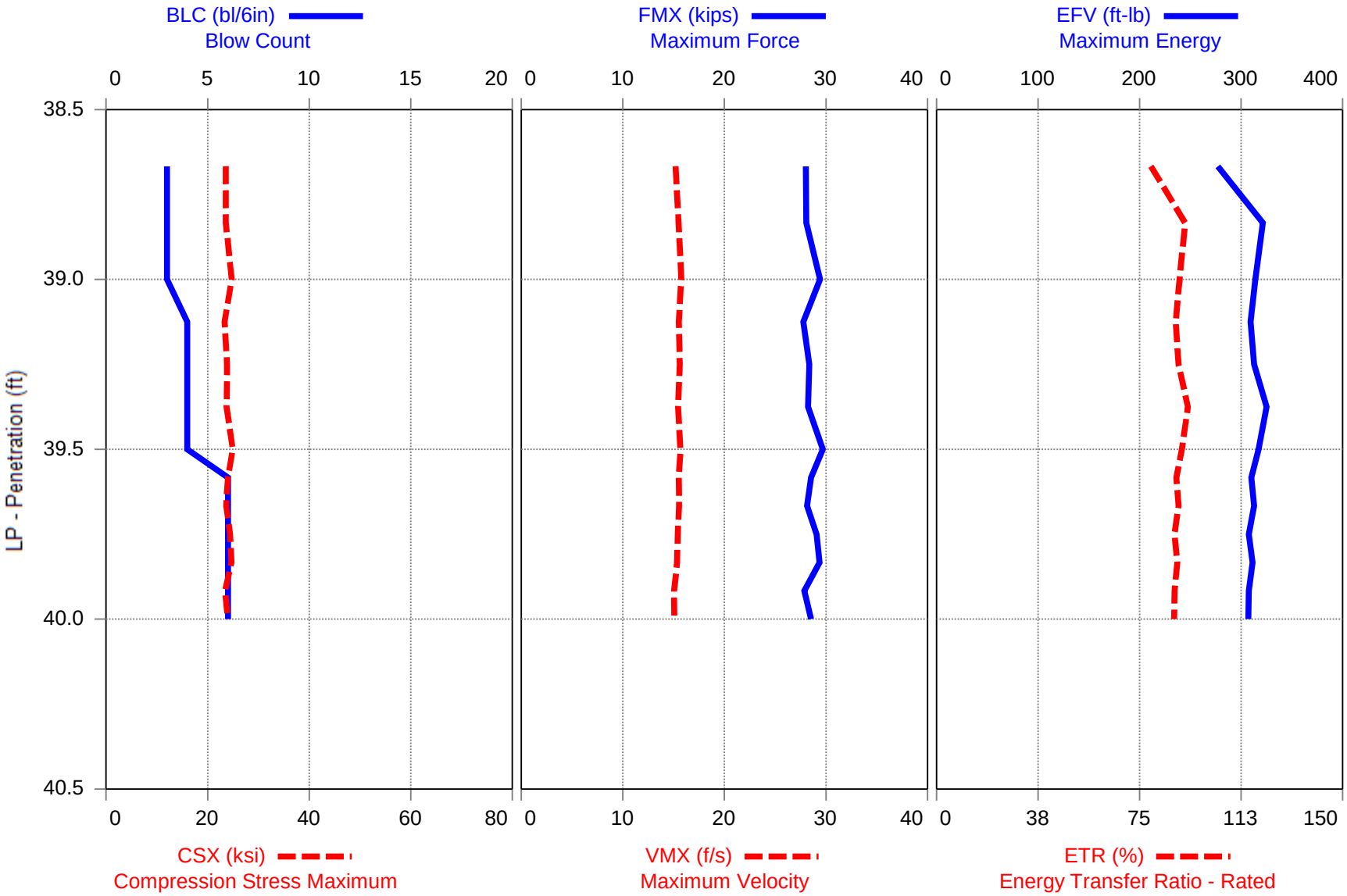


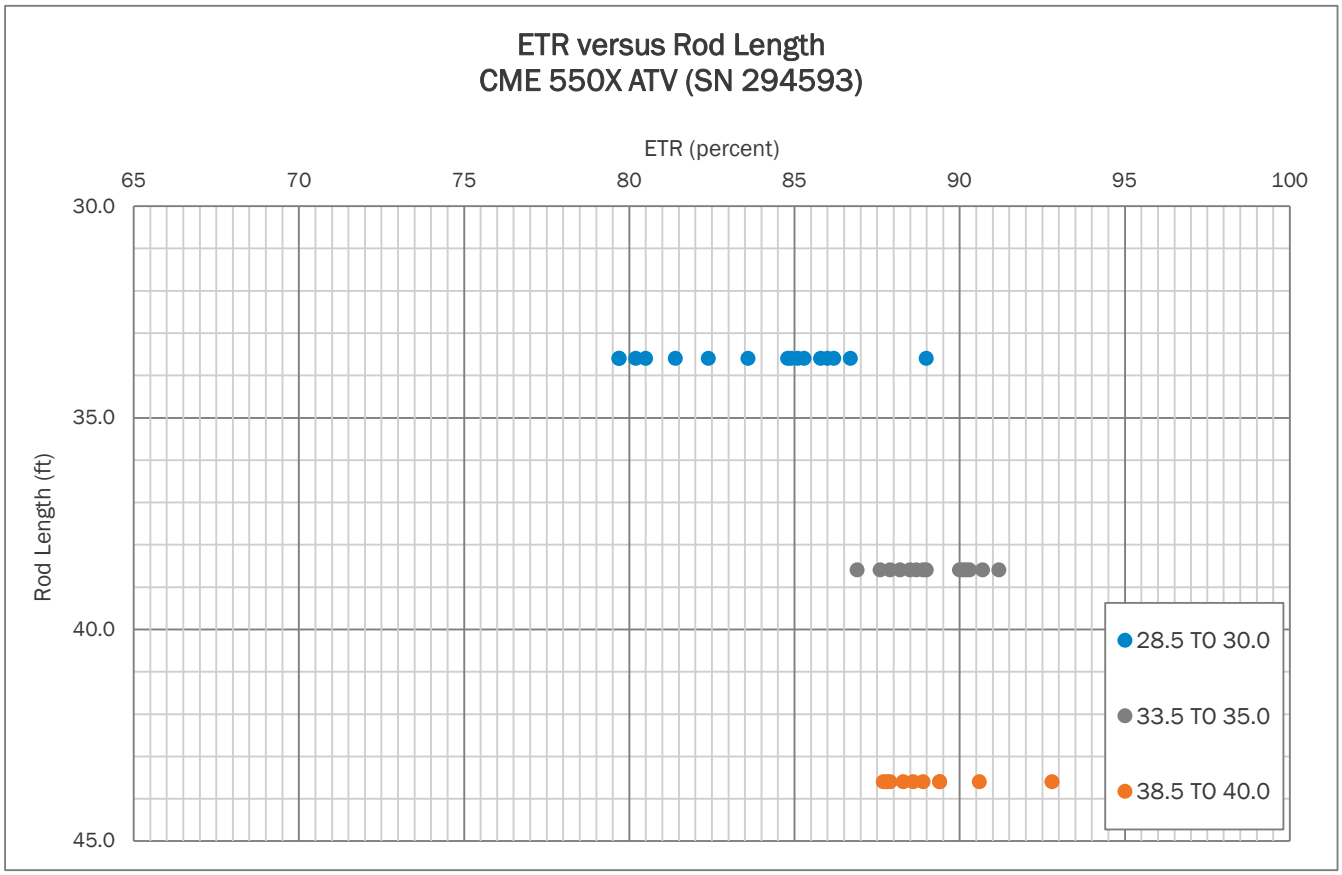
Pile Dynamics, Inc. - PDIPLOT2 Ver 2021.1.61.0 - Case Method & iCAP® Results

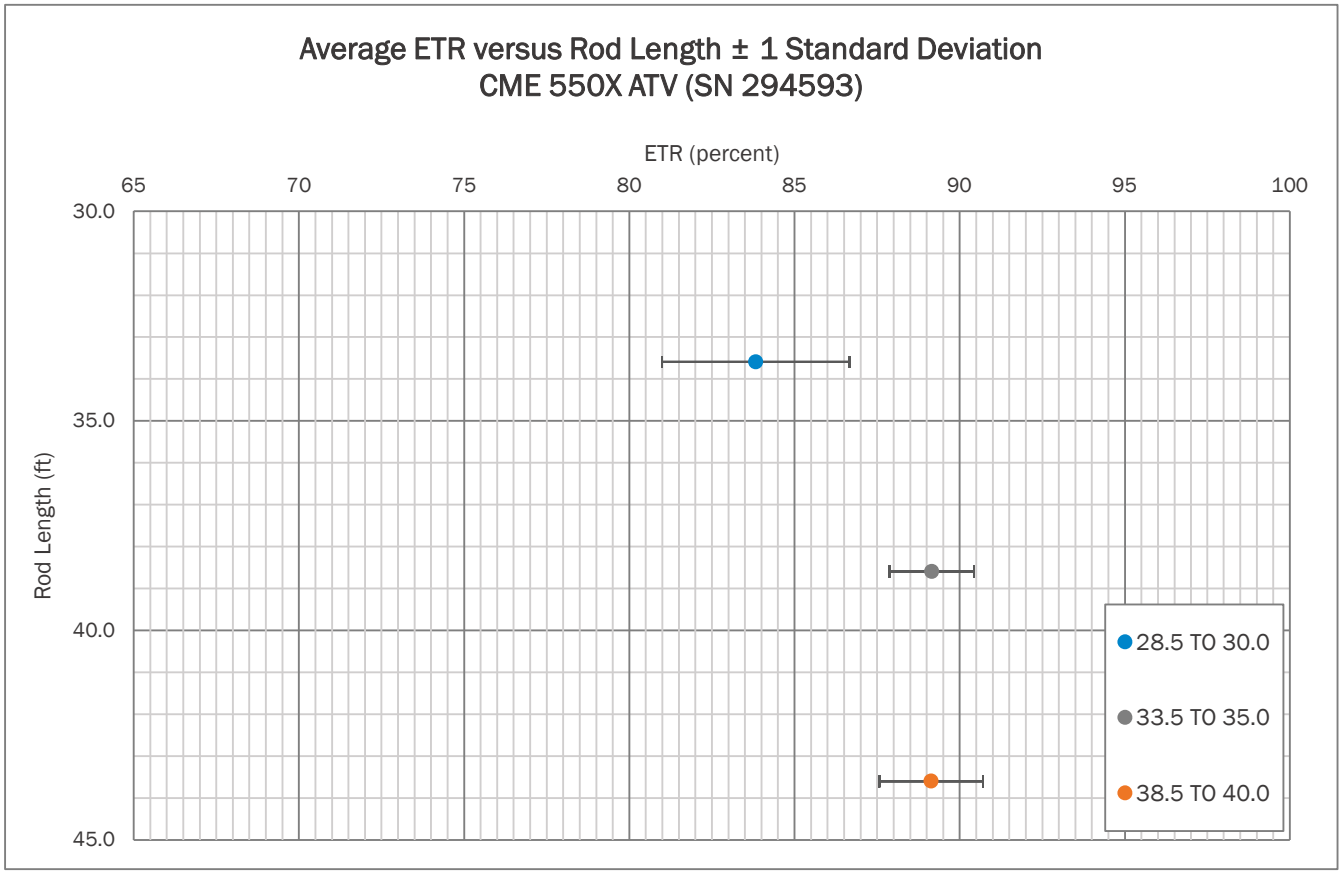
Printed: 23-March-2022

Test started: 11-March-2022

CME 550X (SN 294593) - 38.5 TO 40.0




ETR versus Rod Length
CME 550X ATV (SN 294593)
ETR (percent)
65
70
75
80
85
90
95
100
Rod Length (ft)
30.0
35.0
40.0
45.0
28.5 TO 30.0
33.5 TO 35.0
38.5 TO 40.0


Average ETR versus Rod Length ± 1 Standard Deviation
CME 550X ATV (SN 294593)
ETR (percent)
65
70
75
80
85
90
95
100
Rod Length (ft)
30.0
35.0
40.0
45.0
28.5 TO 30.0
33.5 TO 35.0
38.5 TO 40.0

APPENDIX II

SPT Hammer Energy Field Form

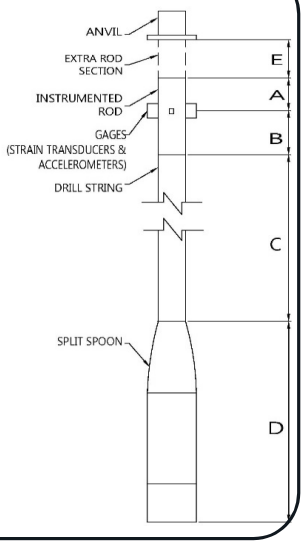
Project:	SPT HAMMER ENERGY	**Date:**	3/11/2022
Project No.:	240021095	**Weather:**	50's CLOUDY
Boring No.:	B-4	**Drill Rod Type:**	AWJ

On-site Personnel

Drilling Company:	BRECCIA CONSTRUCTION, LLC
Rig Operator:	R. HUFFSTETLER
Engr/Geologist:	N/A
Client Rep.:	N/A
Analyzer Oper.:	R. KRAL

Rod Info

(A + E) Impact Surface to Gages Length:	1.36	ft
(B) Instr. Rod Length below Gages:	0.70	ft
(A) + (B) Instr. Rod Length:	2.00	ft
(D) Spoon Length:	2.85	ft
(E) Rod Length Above Instr. Rod (if applicable):	0.06	ft
Instr. Rod S/N:	528AWJ	
Instr. Rod Outside Dia.:	1.75	in.
Instr. Rod Area:	1.19	in^2
PDA Make/Model:	SPT	
PDA Serial No.:	4549 TB	
Calib. Pulse Test (y/n):	Y	



Rig/Hammer Info

Drill Rig Make/Model:	CME 550X
Carrier Type:	ATV
Rig Serial No.:	294593 (DR-4)
Hammer Type/Model:	CME
Hammer Serial No.:	N/A
Hammer Drop System:	AUTO
Lubrication Condition:	PER MANUFACTURER
Manufacturer Recommended	
Operation Rate (bpm):	55
Drop Height (in.):	30
Hammer Weight (lbs):	140
Anvil Dimension (in.):	11.5
Drilling Method:	2.25 HSA

Gage Info

Gage		Serial No.	Calibration No.
Accel.	A3	K11957	407.00
	A4	K10959	417.30
Strain	F3	528AWJ-1	205.26
	F4	528AWJ-2	205.86

Date of Test	Test Depth Increment (ft to ft)	Test Time Start / Stop (military)	Length of Drill String (ft) *(C)*	(LE) Length below Gages (ft) *(B) + (C) + (D)*	Avg. Meas. Hammer Rate (BPM)	SPT Blow Counts 6"	12"	18"	N-Value	Drop Height in Tolerance (y/n)	Soil Class.
11-Mar	28.5 TO 30.0	0855/0856	30	33.6	57	4	7	9	16	Y	SA SI
11-Mar	33.5 TO 35.0	0902/0902	35	38.6	58	4	6	8	14	Y	SA SI
11-Mar	38.5 TO 40.0	0909/0909	40	43.6	58	3	4	6	10	Y	SA SI

Notes:
TESTING PERFORMED AT 1817 LOWRYS HIGHWAY IN CHESTER, SOUTH CAROLINA (CHESTER COUNTY). THE APPROXIMATE COORDINATES ARE 34.770561, -81.245581.

NOTE: (1) Note any unusual hammer operating conditions that affect the hammer performance, or changes in operating conditions (e.g. veritcality, weather, or lubrication between trials). (2) Note any changes in rod diameter along drill string and record locations of short rod sections.

Digitally signed by: Robert E. Kral

Prepared By (print/signature)

3/11/2022
Date

Figure No. 1: Rear View of Drill Rig

Figure No. 2: Side View of Drill Rig

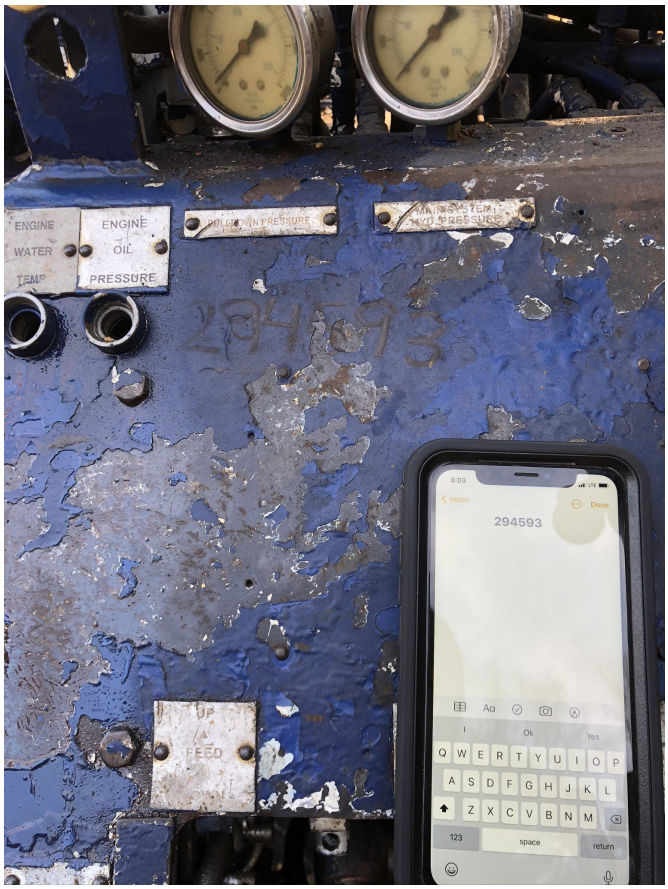


Figure No. 3: Serial Number Plate

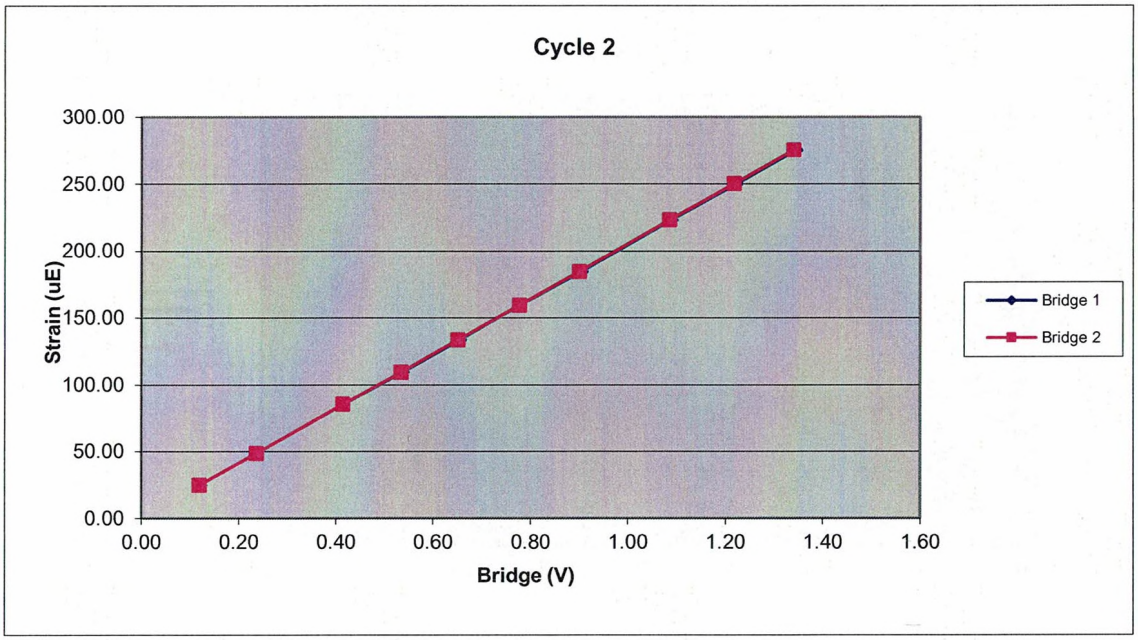
Figure No. 4: Automatic Hammer

APPENDIX III

528AWJ		Cycle 2		
Sample	**Force (lb)**	**Strain (µE)**	**Bridge 1 (V)**	**Bridge 2 (V)**
1	0.00	0.00	0.00	0.00
2	905.16	24.61	0.12	0.12
3	1753.20	48.18	0.24	0.24
4	3064.74	84.99	0.42	0.41
5	3947.87	108.99	0.54	0.53
6	4813.36	133.40	0.65	0.65
7	5727.49	159.02	0.78	0.78
8	6643.67	184.17	0.90	0.90
9	8004.82	222.89	1.09	1.09
10	8980.07	249.70	1.22	1.22
11	9885.91	275.04	1.35	1.34

Bridge 1		**Bridge 2**	
Force Calibration (lb/V)	**7340.27**	**Force Calibration (lb/V)**	**7362.32**
Offset	**12.98**	Offset	**13.21**
Correlation	**1.000000**	Correlation	**0.999999**
Strain Calibration (µE/V)	**204.74**	**Strain Calibration (µE/V)**	**205.35**
Offset	**-0.39**	Offset	**-0.39**
Correlation	**0.999993**	Correlation	**0.999995**

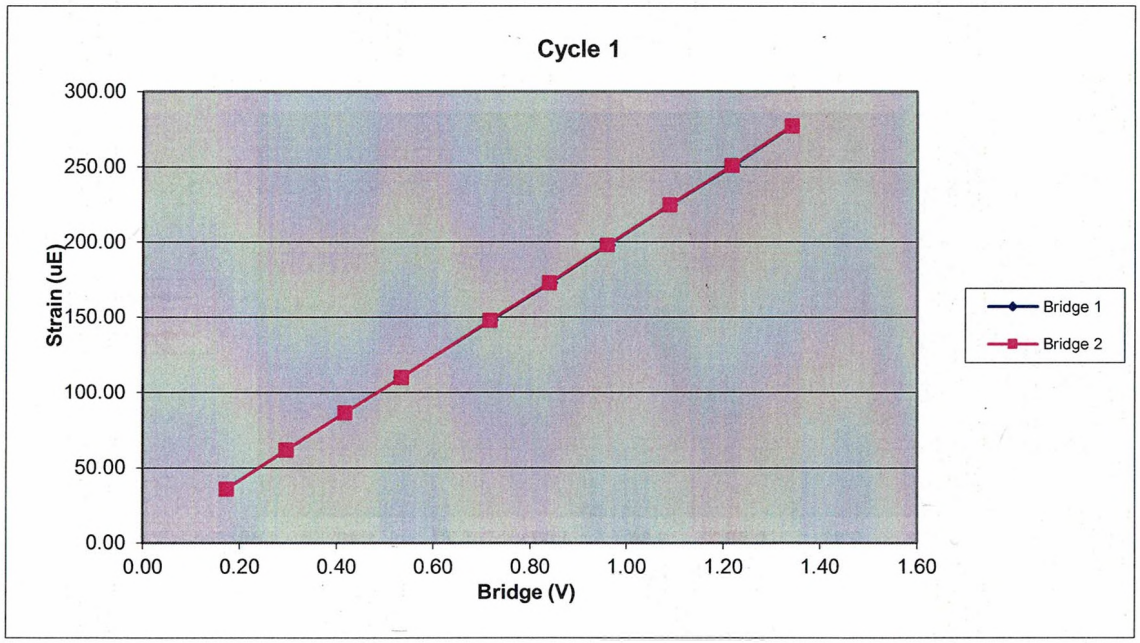
Force Strain Calibration	
EA (Kips)	**35851.72**
Offset	**27.08**
Correlation	**0.999996**



528AWJ		Cycle 1		
Sample	**Force (lb)**	**Strain (μE)**	**Bridge 1 (V)**	**Bridge 2 (V)**
1	0.00	0.00	0.00	0.00
2	1278.49	35.63	0.17	0.17
3	2188.92	61.59	0.30	0.30
4	3085.11	86.16	0.42	0.42
5	3944.56	110.01	0.53	0.54
6	5284.17	147.69	0.72	0.72
7	6199.57	172.59	0.84	0.84
8	7071.20	197.80	0.96	0.96
9	8023.54	224.47	1.09	1.09
10	8958.62	250.45	1.22	1.22
11	9876.55	276.81	1.34	1.34

Bridge 1		**Bridge 2**	
Force Calibration (lb/V)	**7346.16**	**Force Calibration (lb/V)**	**7359.87**
Offset	9.71	Offset	6.72
Correlation	0.999998	Correlation	0.999999
Strain Calibration (μE/V)	**205.65**	**Strain Calibration (μE/V)**	**206.03**
Offset	0.08	Offset	-0.01
Correlation	0.999990	Correlation	0.999993

Force Strain Calibration	
EA (Kips)	**35721.25**
Offset	7.11
Correlation	0.999990



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

Calibration Factors	528AWJ		
Bridge 1 (µE/V)	205.26	Bridge 2 (µE/V)	205.86
EA Factor (Kips)	35777.05	Area (in^2)	1.19

Calibrated by: _____
Calibrated Date: 1/28/2021

Pile Dynamics Inc
30725 Aurora Rd
Solon, OH 44139

Traceable to N.I.S.T.

Accelerometer Calibration Certificate
Pile Dynamics, Inc.

Calibrated by Pile Dynamics, Inc.
Calibration performed on 19Apr2021

Serial No:	K10959	**Temperature:**	21.0 °C
Model:	PR	**Humidity:**	38%
Calibrated on:	Channel 3 on 8G 5161 LE		

Ref Acc 1:	69096! 978 g's/volt	**Cal on:**	27Jan2021
Ref Acc 2:	69132! 960 g's/volt	**Cal on:**	09Feb2021

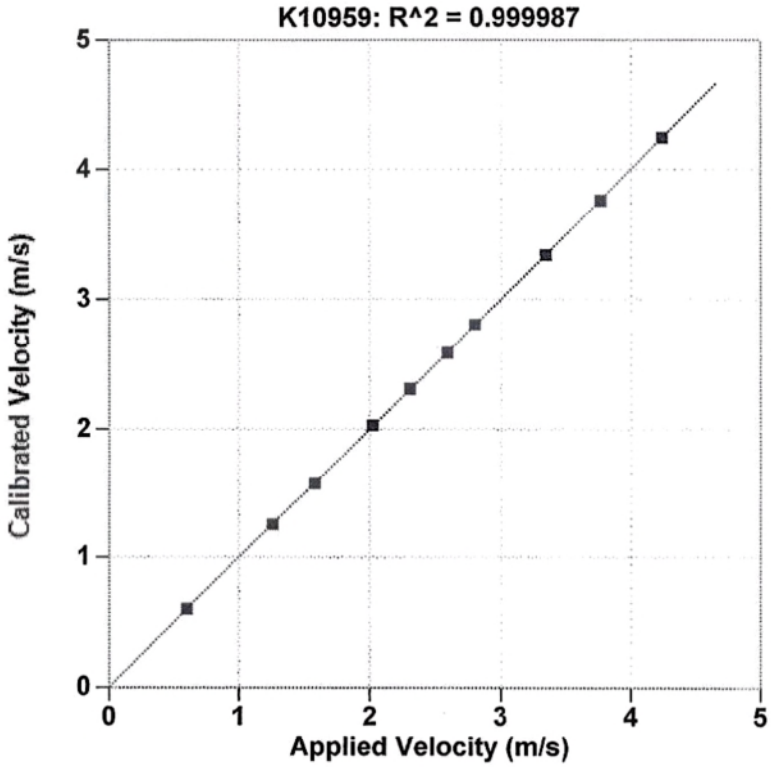
Reference accelerometer calibrations are traceable to the United States National Institute of Standards and Technology (NIST).

PDA CALIBRATION FACTOR

417.3 mv/5000g
(83.5 µv/g)
R^2: 0.999987 [Chip programmed]

Operator: William Johnson

Signed



Reference Velocity	S/N K10959 Velocity
m/s	m/s
0.600	0.600
1.260	1.255
1.578	1.577
2.021	2.028
2.306	2.311
2.590	2.590
2.801	2.806
3.346	3.344
3.767	3.762
4.241	4.241

Maximum Acceleration: 938 g's

Accelerometer Calibration Certificate
Pile Dynamics, Inc.

Calibrated by Pile Dynamics, Inc.
Calibration performed on 22Jan2021

Serial No:	K10960	**Temperature:**	20.0 °C
Model:	PR	**Humidity:**	28%
Calibrated on:	Channel 4 on 8G 5161 LE		

Ref Acc 1:	63479! 1080 g's/volt	**Cal on:**	09Sep2020
Ref Acc 2:	65538! 1040 g's/volt	**Cal on:**	27Jan2020

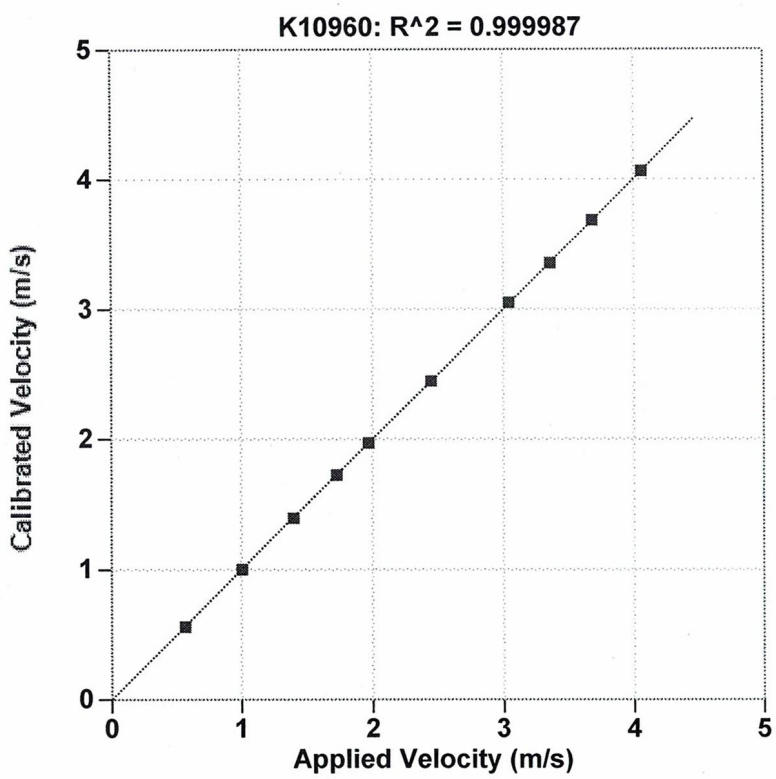
Reference accelerometer calibrations are traceable to the United States National Institute of Standards and Technology (NIST).

PDA CALIBRATION FACTOR

425.7 mv/5000g
(85.1 μv/g)
R^2: 0.999987 [Chip programmed]

Operator: William Johnson

Signed



Reference Velocity	S/N K10960 Velocity
m/s	m/s
0.568	0.564
1.006	1.001
1.400	1.393
1.728	1.726
1.969	1.970
2.447	2.448
3.043	3.051
3.359	3.356
3.683	3.684
4.063	4.062

Maximum Acceleration: 889 g's

Accelerometer Calibration Certificate
Pile Dynamics, Inc.

Calibrated by Pile Dynamics, Inc.
Calibration performed on MAR 2 2021

Serial No:	K11957	**Temperature:**	20.0 °C
Model:	PR	**Humidity:**	27%
Calibrated on:	Channel 4 on 8G 5161 LE		

Ref Acc 1:	63479! 1079 g's/volt	**Cal on:**	22Jan2021
Ref Acc 2:	65538! 1043 g's/volt	**Cal on:**	22Jan2021

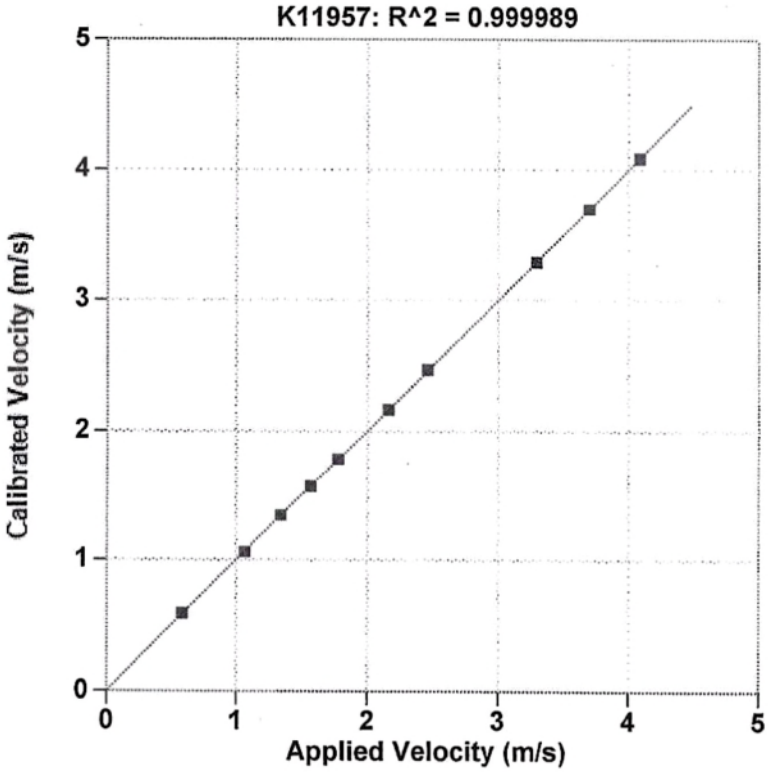
Reference accelerometer calibrations are traceable to the United States National Institute of Standards and Technology (NIST).

PDA CALIBRATION FACTOR

407.0 mv/5000g
(81.4 µv/g)
R^2: 0.999989 [Chip programmed]

Operator: William Johnson

Signed



Reference Velocity	S/N K11957 Velocity
m/s	m/s
0.588	0.589
1.066	1.061
1.344	1.345
1.571	1.570
1.779	1.783
2.161	2.164
2.458	2.465
3.294	3.291
3.701	3.700
4.089	4.086

Maximum Acceleration: 894 g's

APPENDIX IV

PDCA
PILE DRIVING CONTRACTORS ASSOCIATION

Pile Dynamics, Inc.

This documents that

Robert E. Kral
Carolinas Geotechnical Group

has on May 20, 2016 achieved the rank of

ADVANCED

on the **Dynamic Measurement and Analysis Proficiency Test.**

The individual identified on this document demonstrated to the degree granted above an understanding of theory, data quality evaluation, interpretation and signal matching for high strain dynamic testing of deep foundations. ***It is recommended* that Individuals at the Advanced level seek Master or Expert levels through additional study within six years of the date of this document.**

The ability of the individual named to provide appropriate knowledge and advice on a specific project is not implied or warranted by the Pile Driving Contractors Association or Pile Dynamics, Inc. **This certificate can be verified at www.PDAproficiencytest.com.** The Pile Driving Contractors Association or Pile Dynamics, Inc. assumes no liability for foundation testing and analysis work performed by the bearer of this certificate.

Steven A. Hall, Executive Director
Pile Driving Contractors Association

Garland Likins, Senior Partner
Pile Dynamics, Inc.

No. 2072