



Geotechnical Baseline Report

SC 49 (Cross Keys Hwy) Bridge Replacement
over Fairforest Creek

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 Baseline Report for the SC 49 (Cross Keys Hwy.) Bridge Replacement over Fairforest Creek 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

A handwritten signature in black ink that reads 'Kiera Hughes'.

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



Lila Leon, P.E., Ph.D.
Senior Geotechnical Engineer

Contents

1	Introduction	1
1.1	Project Description	1
2	Investigative Procedures	1
2.1	Drilling and Sampling	1
2.2	Cone Penetrometer Testing	2
2.3	MASW Survey	2
2.4	Groundwater Conditions	2
2.5	Field Testing Summary	3
3	Laboratory Test Program	3
3.1	Soil and Rock Properties	4
4	Subsurface Conditions	4
4.1	Regional Geology	4
4.2	Soil and Rock Stratification	5
5	Seismic Conditions	5
5.1	Acceleration Design Response Spectrum (ADRS)	6
5.2	Shear Strength Loss (SSL)	6
6	Design and Construction Considerations	6
6.1	Foundations	6
6.2	Embankment Slopes	7
6.3	Corrosion and Deterioration	7
6.4	Embankment Construction	8
7	Limitations to Report	8
8	References	8

Tables

Table 2-1. Field Soil Testing Summary	3
Table 3-1. Laboratory Testing Summary	4
Table 4-1. Soil and Rock Stratification	5
Table 5-1. Seismic Design Parameters	6
Table 6-1. Corrosion Series Laboratory Testing Summary	7
Table 6-2. Bulk Sample Testing Summary	8

Appendices

- Appendix A. Site Vicinity Map, Test Location Plan, Subsurface Profile
- Appendix B. Boring Logs, Rock Core Photos, CPT Logs, MASW Profile
- Appendix C. Laboratory Testing
- Appendix D. ADRS Curves
- Appendix E. SPT Hammer Energy Calibration Report

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1 Introduction

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

This Geotechnical Baseline 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. Preliminary geotechnical considerations for design and construction are also included in this report.

1.1 Project Description

The project site is located near Union, approximately four miles southwest of the intersection of SC 49 with US 176. It is bound to the east by State Rd S-44-134 and to the west by Pebble Creek Dr. A Site Vicinity Map is included in Appendix A.

The existing bridge over Fairforest Creek is approximately 375 feet in length and 37 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 410 feet in length and will accommodate two 12-foot lanes with 10-foot shoulders. Construction is anticipated to be completed with a temporary detour of traffic.

2 Investigative Procedures

The geotechnical subsurface exploration at the project site was performed by F&ME Consultants in November 2022 and January 2023. 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 six (6) SPT borings were performed during the subsurface investigation, B-42 through B-47. Auger refusal was encountered in all borings at depths ranging between 8.0 feet to 42.0 feet. Advancement of the bridge borings B-42, B-43, B-44, B-45, B-46, and B-47 below auger refusal was accomplished with NQ rock coring techniques. These were terminated at depths of 23.0 feet and 52.7 feet.

The boring logs from the subsurface investigations are included in Appendix B. The borings were advanced by a 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 an energy ratio of 81.4%. The hammer energy ratio is identified on each boring log. SPT hammer energy measurements on the CME 45B drill rig were performed with a pile driving analyzer (PDA) and the SPT Hammer Energy Calibration Reports are included in Appendix E.

One (1) bulk sample was obtained at boring BS-5 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-19 and CPT-20) 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 29.8 feet and 27.0 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-10, performed on the existing bridge end where boring B-42 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 1114.6 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 15.2 feet for boring B-42. This depth corresponds to elevation 400.0 feet.

Groundwater level was recorded at the time of completion of soil drilling and/or rock coring at borings B-42, B-43, B-44, B-45, B-46 and B-47 at depths of 16.8 feet, 3.1 feet, 22.8 feet, 22.4 feet, 4.9 feet, and 17.4 feet from the existing ground/bridge deck. These depths correspond to elevations 398.4 feet, 393.3 feet, 391.8 feet, 391.9 feet, 392.6 feet, and 396.2 feet.

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

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 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-42	182+37	54 LT	34.68196	-81.6857	415.2	SPT/RC	52.7
B-43	183+13	53 LT	34.68193	-81.68594	396.4	SPT/RC	37.5
B-44	183+88	53 LT	34.68189	-81.68619	386.8	SPT/RC	35.0
B-45	184+67	53 LT	34.68185	-81.68644	385.8	SPT/RC	23.0
B-46	185+45	53 LT	34.68181	-81.68670	397.5	SPT/RC	30.0
B-47	186+48	55 LT	34.68176	-81.68704	413.6	SPT/RC	49.8
BS-5	182+22	77 LT	34.68191	-81.68563	412.7	BULK	5.0
CPT-19	182+42	53 LT	34.68196	-81.68570	415.1	CPT	29.8
CPT-20	186+50	54 LT	34.68176	-81.68704	413.6	CPT	27.0
MASW-10	near boring B-42					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	31
Atterberg Limits	14
Grain Size Analysis with Hydrometer	4
Grain Size Analysis with #200 Wash	1
#200 Wash	12
CU Triaxial	1
Unconfined Compression of Rock	16
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 44 and plasticity indices ranging from 0 to 22.

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, sixteen (16) unconfined compression tests were performed on recovered rock samples with unconfined strength results ranging from 6,570 psi to 17,770 psi. Results of laboratory testing are included in Appendix C.

4 Subsurface Conditions

4.1 Regional Geology

The bridge site is located on SC 49 in Union County, South Carolina and crosses over Fairforest Creek which is part of the Broad River watershed (DHEC, 2016). The bridge site lies within the Piedmont Physiographic Province of South Carolina. The Piedmont Province is bounded by the Blue Ridge Physiographic Province to the west and the Upper Coastal Plain Province to the east. Elevations throughout the Piedmont vary from 300 feet to 1,400 feet. The Piedmont Province is characterized by gently rolling topography, deeply weathered bedrock, few rock outcrops and complex geology with a multitude of rock types formed during the Paleozoic Era (250 to 570 MYA). The geology of this region is further complicated by the Alleghanian orogeny (325 to 260 MYA), the mountain building event which helped to form the present-day Appalachian Mountain chain, and subsequent deformation/metamorphism of the region (Butler, 1991). Soils overlying bedrock in the

Piedmont are typically considered to be residual soil (soil weathered in place from bedrock). However, Fairforest Creek provides a transport mechanism for soil eroded from higher elevations to be carried downstream and deposited at banks of the particular bridge site. The contact between soil and bedrock is not strongly defined and is often marked by an intermediate transition zone. The materials of this zone can be soil, partially decomposed rock, and fragments of the underlying bedrock.

4.2 Soil and Rock Stratification

In general, the soil profile is dominated by silty sand and sandy silt. These comprise the alluvial and residual soils overlying the granite bedrock. Bedrock was intercepted within a depth of 8.0 feet to 42.0 feet from the existing ground.

Roadway fill consisting of loose clayey sand, very loose to loose silty sand and loose to medium dense poorly-graded sand with silt was interpreted to range from 0.9 feet to 15.0 feet of the profile. Alluvium was sampled as silt with sand, silty sand and sandy silt. Residual soil underlying the roadway fill and alluvial soils range from loose to very dense silty sand to soft to stiff sandy lean clay. The thickness of the residual zone ranged from 5.5 feet to 30.0 feet. Granite makes up the bedrock underlying the project site. Recovered rock core was in general fresh to moderately weathered. Discontinuities were spaced very close, with planar and irregular, slickensided to rough joint surfaces. Rock core recovery ranged from 0 to 100 percent, RQD ranged from 0 to 100 percent, and rock unconfined compression testing revealed medium strong to very strong rock with values ranging from 6,570 psi to 17,770 psi.

A summary of the main strata intercepted by the soil test borings is provided in Table 4-1 below. A subsurface profile developed based on the collected soil and rock information is included in Appendix A.

Table 4-1. Soil and Rock Stratification

Geology	Top of Layer Elev. (ft)	USCS Soil Type	SPT-N ⁽¹⁾	Plasticity Index ⁽¹⁾	Fines Content ⁽¹⁾	REC / RQD
Roadway Fill	415.2-413.6	SC, SM, SP-SM	4-12 (7)	0	41-42 (42)	-
Alluvium	396.4-386.8	ML, SM	1-4 (3)	7	58	-
Residuum	403.2-383.8	CL, SC, SM, ML, SP-SM	3-100+ (64)	0-22 (9)	8-59 (36)	-
Rock	387.5-371.8	-	-	-	-	0-100% / 0-100% (75%) / (44%)

⁽¹⁾ Values in parentheses indicate the average of the values in the range

5 Seismic Conditions

The proposed bridge is classified as OC II. Per SCDOT GDM 2022, the bridge approach embankments shall be designed to meet the performance limits that are established by the design team based on the performance objectives for the bridge.

5.1 Acceleration Design Response Spectrum (ADRS)

The shear wave velocity results, as measured from the MASW test, were provided to SCDOT (Pre-Construction Support - Geotechnical Design Section). SCDOT used these results to determine the site amplification factors that would be used to correct for site effects the bedrock motion determined from regional probabilistic seismic hazard maps.

SCDOT provided a “3-Point Acceleration Design Response Spectrum” data sheet that included pseudo-spectral accelerations (PSA) for 5% critical damping and at selected frequencies, consistent with a Geologically Realistic condition (shear wave velocity, $V_s=2,500$ fps). PSA values were provided for the:

- Functional Evaluation Earthquake (FEE): 15% probability of exceedance in 75 years;
- Safety Evaluation Earthquake (SEE): 3% probability of exceedance in 75 years.

Table 5-1 below summarizes the peak ground acceleration (PGA), the short period acceleration (S_{DS}), and one-second period acceleration (S_{D1}) for the FEE and SEE earthquakes for the ground surface. A copy of the “3-Point Acceleration Design Response Spectrum” output form presenting the PSA data at the B-C boundary and the results of the ADRS analysis are included in Appendix D.

Table 5-1. Seismic Design Parameters

Seismic Design parameter	FEE	SEE
PGA	0.02 g	0.03 g
S_{DS}	0.04 g	0.07 g
S_{D1}	0.00 g	0.01 g

5.2 Shear Strength Loss (SSL)

Based on a preliminary review of the physical properties of the site soils, these do not appear to be susceptible to shear strength loss during the design earthquake.

6 Design and Construction Considerations

6.1 Foundations

Driven steel H-piles are anticipated to be the most feasible foundation type for the proposed bridge abutments. Based on Table 9-3 in SCDOT GDM 2022, assuming redundant piles, a resistance factor of 0.5 will be used for design if wave equation is applied for verification and a resistance factor of 0.65 will be used assuming Dynamic Monitoring (PDA) with wave equation analysis. It is anticipated that foundation piles will be installed following the approach embankment construction. If for any reason foundation piles will already be in-place when the approach embankment construction begins, foundation pile design must account for any downdrag loads subjected to the piles.

Due to the variability in the rock surface underlying the site, tip elevations are also anticipated to exhibit variability across the site. For piles driven to practical refusal, their

resistance will be limited by their structural resistance. Reinforced pile tips will be required to penetrate to dense soils and rock. The wave equation analysis should be performed for predicting the drivability of piles along with estimating stresses during driving and, in general, verifying the ability of the Contractor's selected hammer to drive the piles to the desired penetration while preventing overstressing.

For the bridge interior bents, drilled shafts socketed into rock appear to be the most appropriate foundation type due to potentially anticipated scour conditions. Installation of permanent casing will be required for the construction of drilled shafts socketed into rock. In this case, drilled shaft diameters should be a minimum of 6 inches larger than the column and the rock socket diameters. Permanent casing will need to extend a few inches into rock to ensure sufficient support is provided while advancing the drilled shaft excavation through the overlying saturated soils. For the design of the drilled shafts with rock sockets, a resistance factor of 0.60 for both side friction and end bearing will be used in accordance with Table 9-4 of the SCDOT GDM 2022, assuming redundant drilled shafts are used. It must be noted that side resistance along the cased length of the drilled shaft, anticipated to extend to the top of rock, will not be considered in the calculated axial resistances. Resistance factors for side friction and end bearing for the design of drilled shafts in soils and intermediate geomaterials (IGM) shall be in accordance with Table 9-4 of the SCDOT GDM 2022. Excavation for bridge foundations is expected to encounter PWR zones overlying bedrock as well as hard rock conditions within the competent bedrock.

6.2 Embankment Slopes

The potential that the footprint of the new bridge approach embankment side slopes lies within the floodplain soils, i.e., soft/loose alluvium, and associated slope instability triggering, appears very low. However, the assessment of the slope stability of the bridge approach embankments and evaluation of any necessary ground improvement measures must be explored during the design phase of the project.

6.3 Corrosion and Deterioration

Corrosion testing of a representative split spoon sample was performed by F&ME Consultants and the results are included in Appendix C. The full corrosion and deterioration testing results included pH, resistivity, chlorides and sulfates content and are summarized in Table 6-1 below.

Table 6-1. Corrosion Series Laboratory Testing Summary

Test Hole No.	Alignment	Station	Offset	Sample Depth (ft)	Chloride (ppm)	Sulfate (ppm)	pH	Restivity (ohm·cm)
B-44	SC 49	183+88	53 LT	4.0-6.0	10	21	6.4	14,720

Based on the criteria set forth in section 7.18 in SCDOT GDM 2022, the environmental classification of the project site is non-aggressive. Interpretation of these data shall be communicated with the structural engineer for the project.

6.4 Embankment Construction

Some fill quantities may be required for construction of the embankments on this project. Assuming that the majority of embankment construction will utilize the available on-site materials, a bulk sample obtained from the top 5 ft of existing embankment material along the alignment was used to provide a better characterization of the material locally available. The bulk samples were tested for soil classification and was also remolded and compacted to 95% of the Standard Proctor prior to being tested under CU Triaxial Compression. Results are summarized in Table 6-2 below.

Table 6-2. Bulk Sample Testing Summary

Sample No.	Station	Offset (ft)	Sample Depth (ft)	USCS Soil Type	Compaction		Shear Strength			
					Optimum Moisture (%)	Max Dry Density (pcf)	c' (psf)	ϕ' (°)	c (psf)	ϕ (°)
BS-5	182+22	77 LT	0.0-5.0	SC	13.0	116.1	93	34.7	320	12.2

7 Limitations to Report

This report has been prepared in general accordance with procedures in SCDOT GDM Chapter 21 and generally accepted soil and foundation engineering practices for specific application to the proposed SC 49 Bridge over Fairforest Creek in Union County, South Carolina. No other warranty expressed or implied is made. The Geotechnical Engineer of Record for the project must review the data submitted in this report and develop their own interpretation of the testing results as they apply to design. 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.

8 References

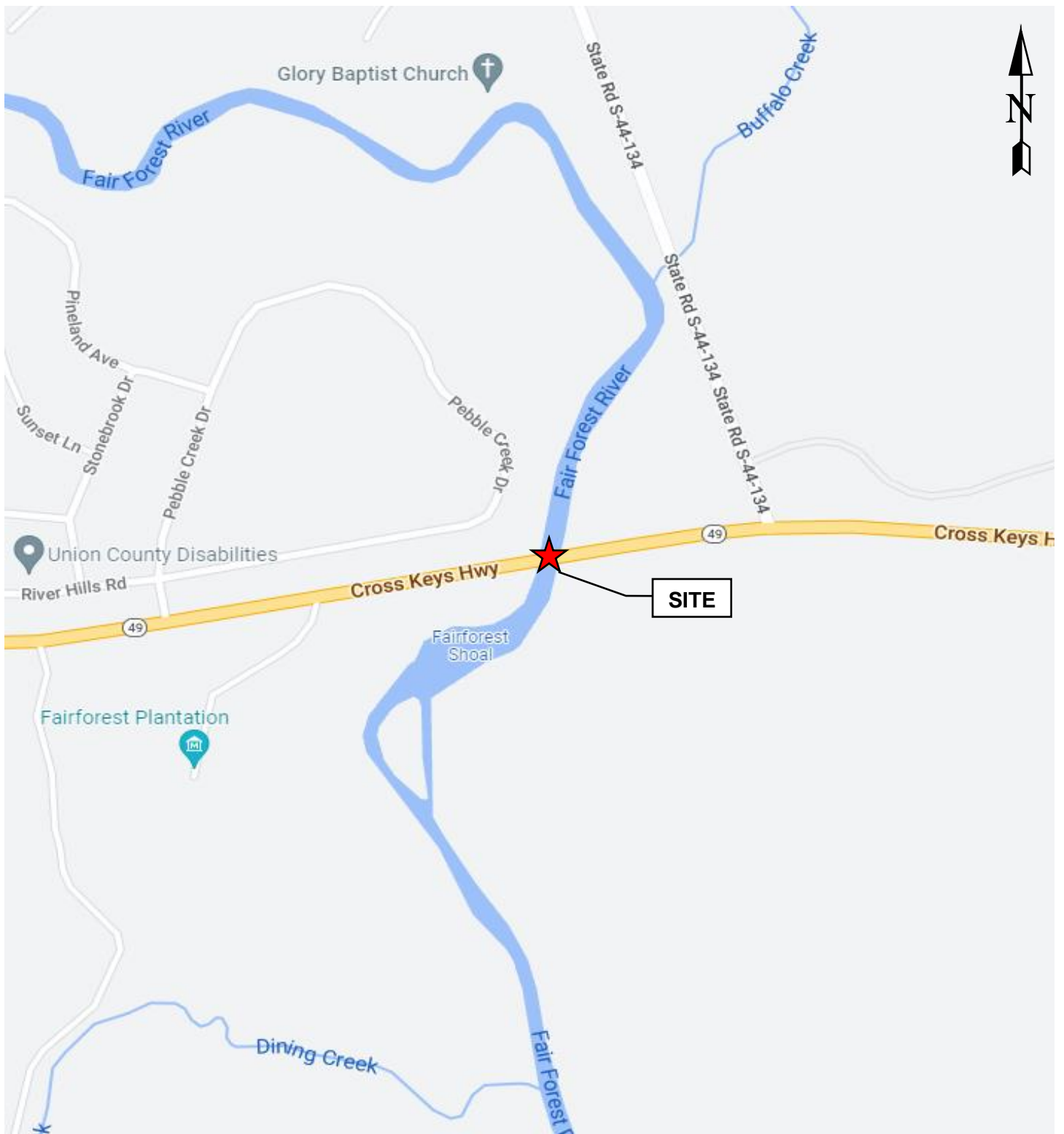
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SCDNR "Geologic Map of South Carolina", March 2012
<https://www.dnr.sc.gov/geology/>

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, Subsurface Profile



HDR ENGINEERING INC.
OF THE CAROLINAS

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

SC 49 (Cross Keys Hwy) over Fairforest Creek

COUNTY

UNION

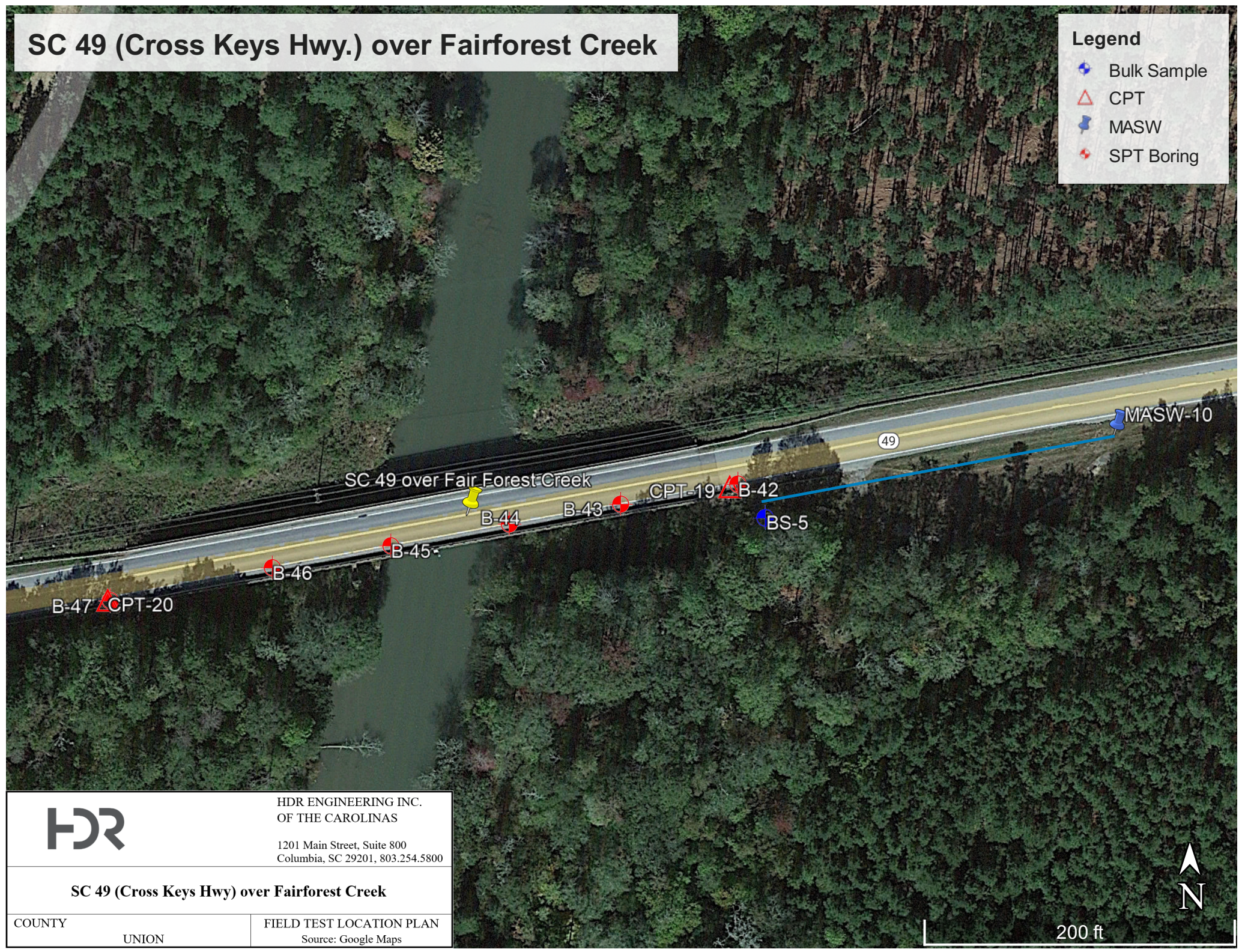
SITE VICINITY MAP

Source: Google Maps

SC 49 (Cross Keys Hwy.) over Fairforest Creek

Legend

- Bulk Sample
- CPT
- MASW
- SPT Boring



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SC 49 (Cross Keys Hwy) over Fairforest Creek

COUNTY

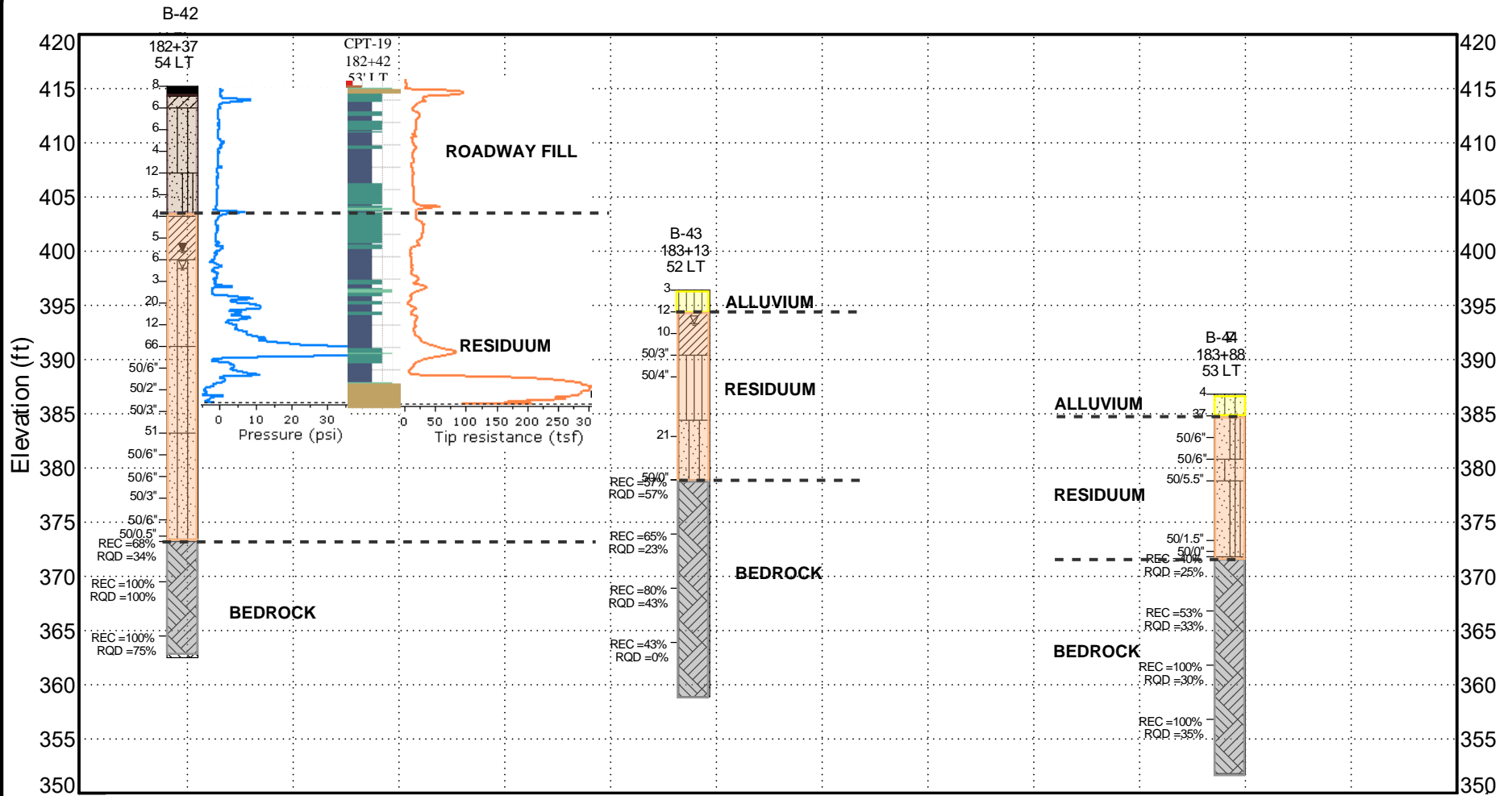
UNION

FIELD TEST LOCATION PLAN

Source: Google Maps



200 ft



BORING	ELEVATION	STATION	OFFSET
B-42	415.2	182+37	54 LT
B-43	396.4	183+13	52 LT
B-44	386.8	183+88	53 LT

- Roadway Fill** - Clayey Sand, Silty Sand, Poorly-graded Sand with silt (SC, SM, SP-SM/A-3, A-4)
- Alluvium** - Silty Sand, Sandy Silt, Silt with sand (SM, ML/A-2-4, A-4)
- Residuum** - Silty Sand, Clayey Sand, Sandy Lean Clay (SM, SP-SM, ML, SC, CL/A-2-4, A-4, A-6, A-7-6)
- Bedrock** - Granite



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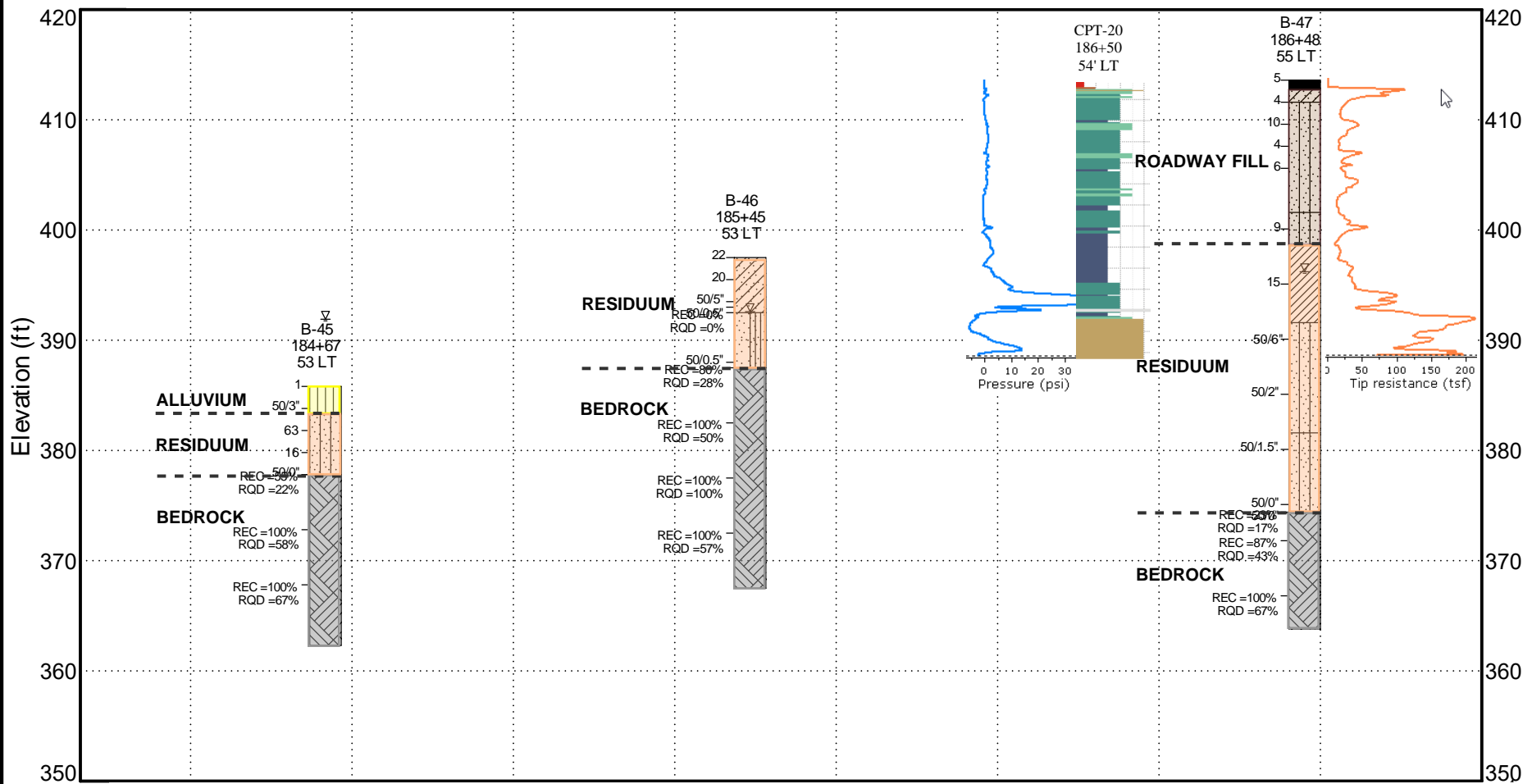
SUBSURFACE PROFILE

SC 49 over Fairforest Creek
Union, SC County, South Carolina

PROJECT ID.
P041238

DATE
Mar 2023

PLATE
1



BORING	ELEVATION	STATION	OFFSET
B-45	385.8	184+67	53 LT
B-46	397.5	185+45	53 LT
B-47	413.6	186+48	55 LT

- Roadway Fill - Clayey Sand, Silty Sand,
Poorly-graded Sand with silt
(SC, SM, SP-SM/A-3, A-4)
- Alluvium - Silty Sand, Sandy Silt, Silt with sand
(SM, ML/A-2-4, A-4)
- Residuum - Silty Sand, Clayey Sand, Sandy
Lean Clay
(SM, SP-SM, ML, SC, CL/A-2-4, A-4, A-6, A-7-6)
- Bedrock - Granite



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SUBSURFACE PROFILE

SC 49 over Fairforest Creek
Union, SC County, South Carolina

PROJECT ID.
P041238

DATE
Mar 2023

PLATE
2

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

SOIL CLASSIFICATION CHART

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

b

Moisture Condition

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

Angularity¹

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 Reaction³

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

Cementation³

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 Range¹

Gravel		Sand	
mm	Sieve size	mm	Sieve size
Fine	4.76 to 19.1	Fine	0.074 to 0.42
Coarse	19.1 to 76.2	Medium	0.42 to 2.00
		Coarse	4.00 to 4.76

h

Primary Soil Type^{1,2}

The primary soil type will be shown in all capital letters

i

USCS Soil Designation

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

j

AASHTO Soil Designation

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

¹Applies to coarse-grained soils (major portion retained on No. 200 sieve)²Applies to fine-grained soils (major portion passing No. 200 sieve)³Use as required**Figure 6-15, 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

<u>Descriptive Term</u>	<u>Criteria</u>
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.

<u>Size</u>		<u>Sieve size</u>
<u>Descriptor</u>	<u>mm</u>	
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
<u>Shape</u>		
<u>Descriptive Term</u>	<u>Criteria</u>	
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.

<u>Description</u>	<u>Recognition</u>
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****s****Discontinuity Width (millimeters)****t****Amount of Infilling**

F - Fault	W - Wide (12.5 – 50)	Su - Surface Stain
J - Joint	MW - Moderately Wide (2.5 – 12.5)	Sp - Spotty
Sh - Shear	N - Narrow (1.25 – 2.5)	Pa - Partially Filled
Fo - Foliation	VN - Very Narrow (< 1.25)	Fi - Filled
V - Vein	T - Tight (0)	No - None
B - Bedding		

u**Type of Infilling****v****Surface Shape of Joint****w****Discontinuity Spacing (feet)**

Cl - Clay	Wa - Wavy	EW - Extremely Wide (> 65)
Ca - Calcite	Pl - Planar	W - Wide (22 – 65)
Ch - Chloride	St - Stepped	M - Moderate (7.5 – 22)
Fe - Iron Oxide	Ir - Irregular	C - Close (2 – 7.5)
Gy - Gypsum/Talc		VC - Very Close (< 2)
H - Healed		
No - None		
Py - Pyrite		
Qz - Quartz		
Sd - Sand		

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)

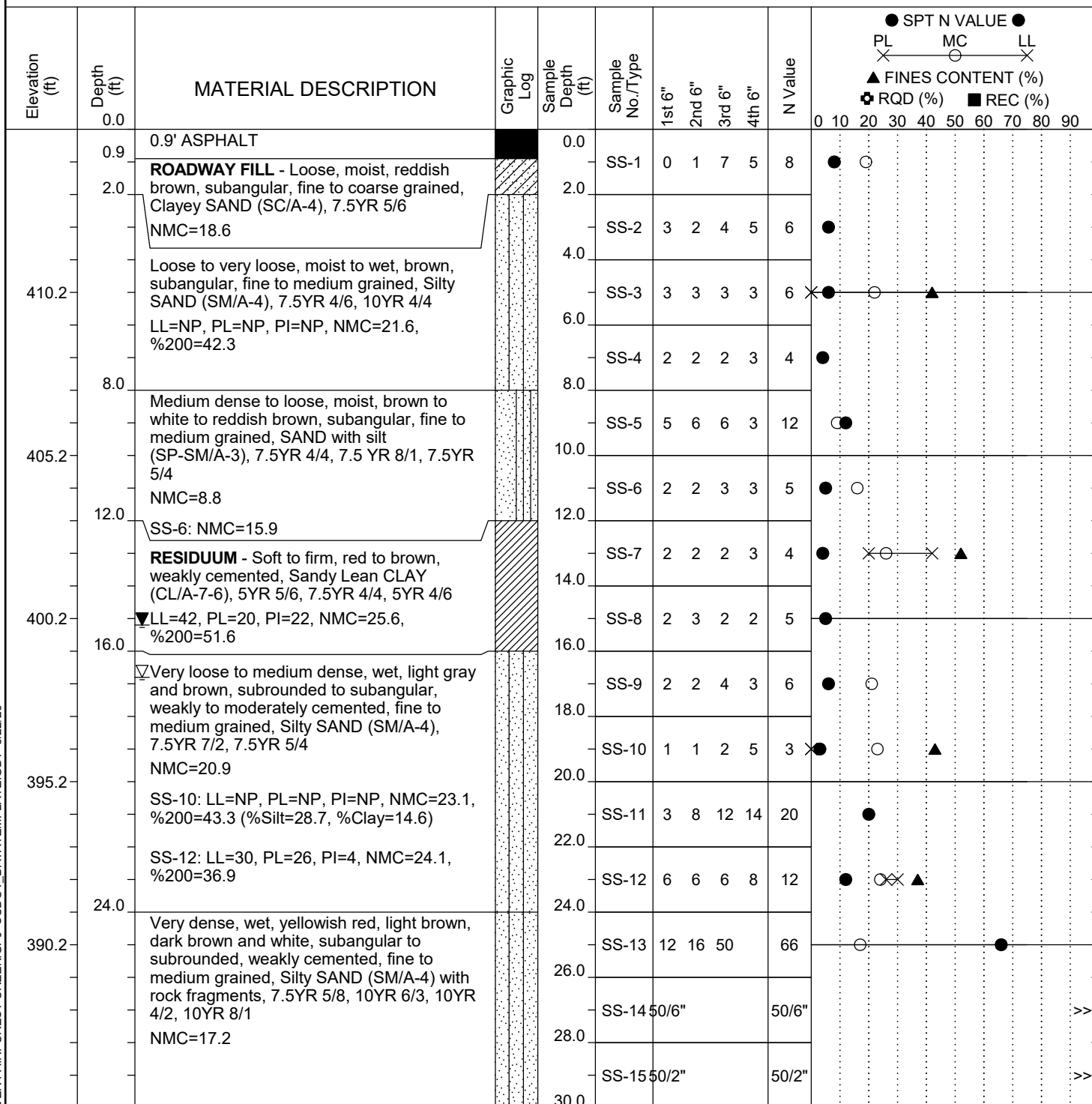


Appendix B. Subsurface Investigation

Boring Logs

SCDOT Soil Test Log

Project ID:	P041238	County:	Union, SC	Boring No.:	B-42
Site Description:	SC 49 over Fairforest Creek			Route:	SC 49
Eng./Geo.:	K. Hughes/HDR	Boring Location:	182+37	Offset:	54 LT
Elev.:	415.2 ft	Latitude:	34.68196	Longitude:	-81.6857
Date Started:	1/5/2023				
Total Depth:	52.7 ft	Soil Depth:	42 ft	Core Depth:	10.7 ft
Date Completed:	1/5/2023				
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 16.8 ft
24HR	15.2 ft				



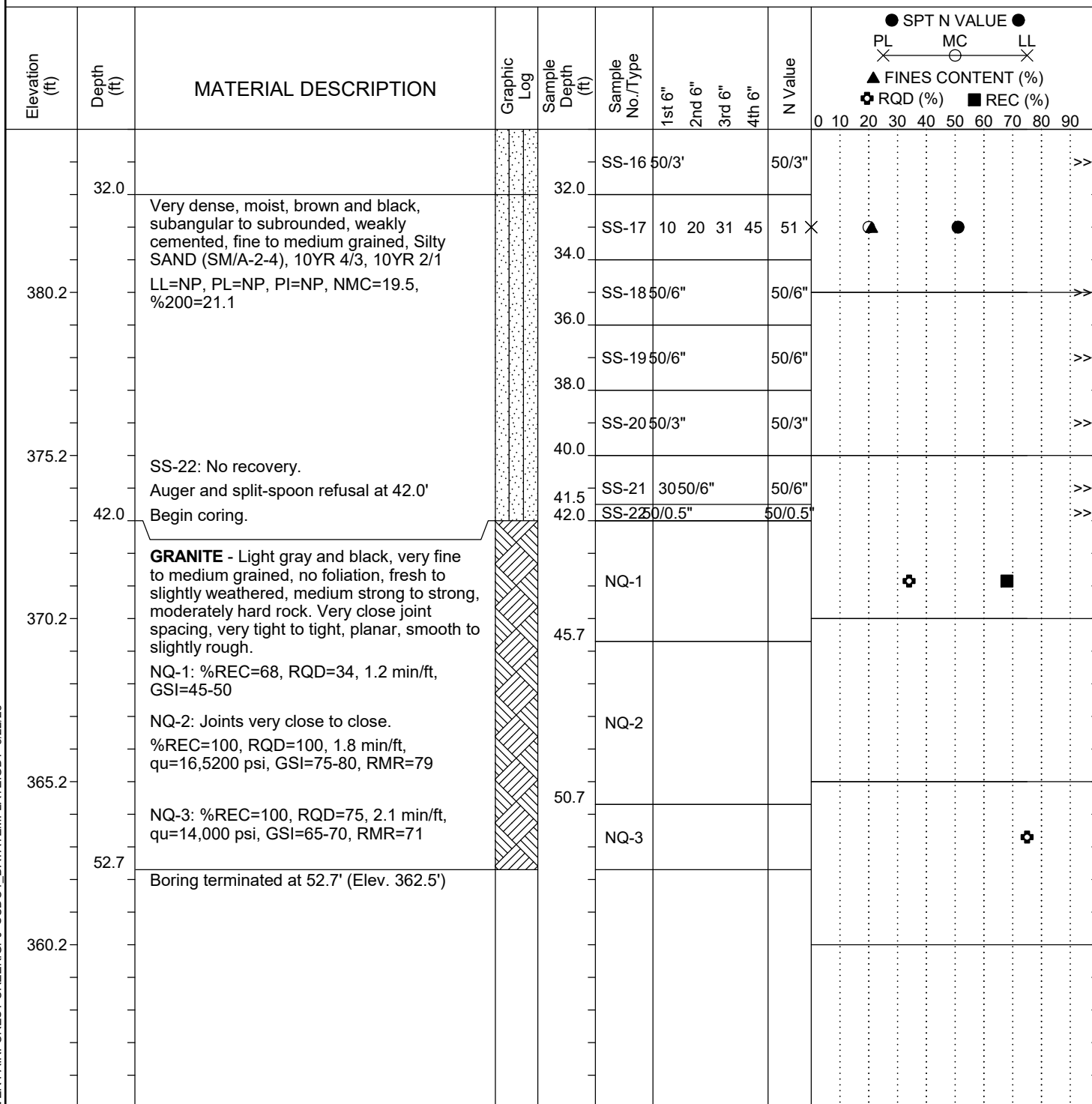
LEGEND

Continued Next Page

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

SCDOT Soil Test Log

Project ID:	P041238	County:	Union, SC	Boring No.:	B-42
Site Description:	SC 49 over Fairforest Creek			Route:	SC 49
Eng./Geo.:	K. Hughes/HDR	Boring Location:	182+37	Offset:	54 LT
Elev.:	415.2 ft	Latitude:	34.68196	Longitude:	-81.6857
Date Started:	1/5/2023				
Total Depth:	52.7 ft	Soil Depth:	42 ft	Core Depth:	10.7 ft
Date Completed:	1/5/2023				
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 16.8 ft
24HR	15.2 ft				



LEGEND

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

Rock Core Photos

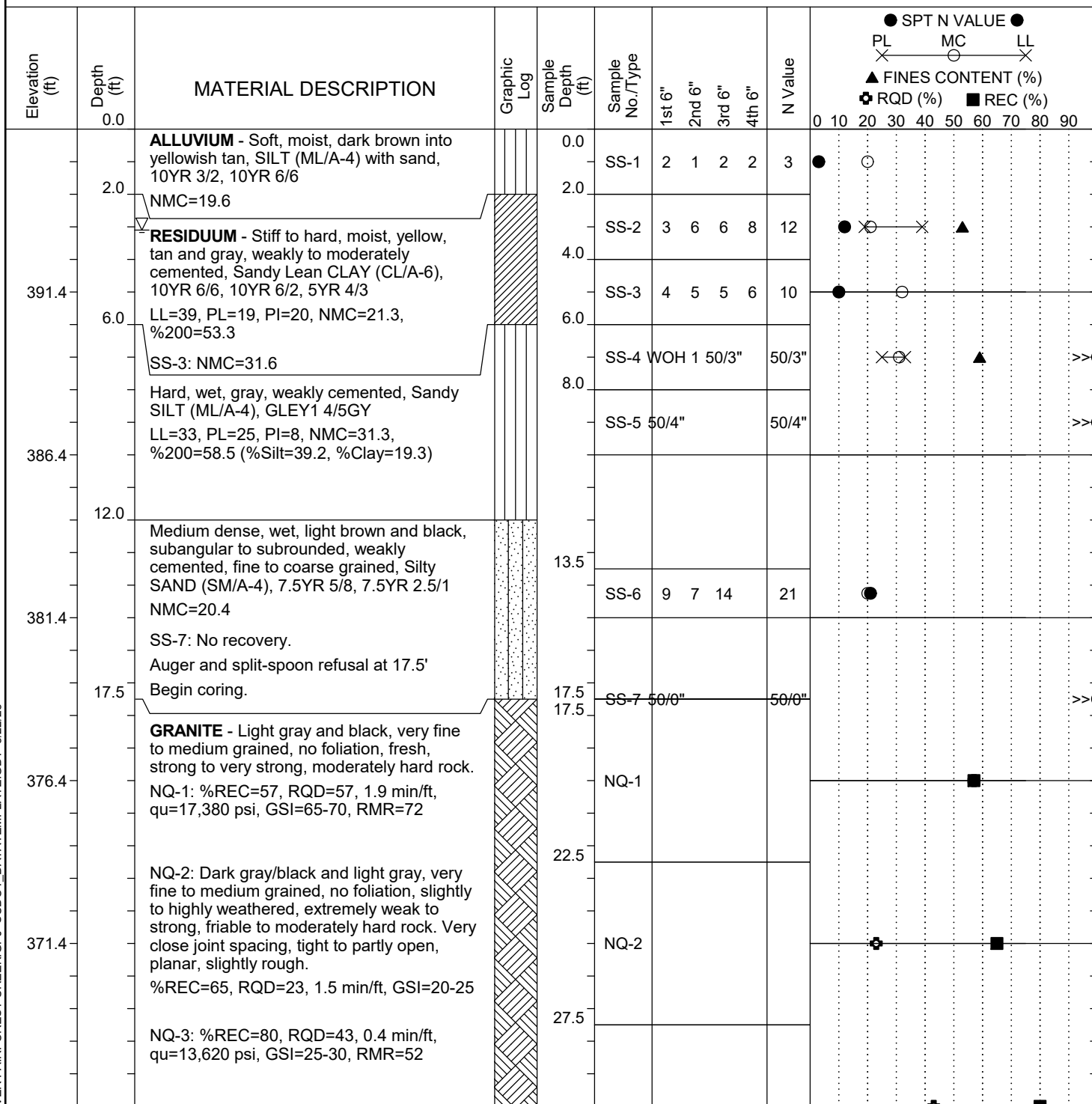
B-42

Box 1 of 1 (42.0' to 52.7')



SCDOT Soil Test Log

Project ID:	P041238	County:	Union, SC	Boring No.:	B-43
Site Description:	SC 49 over Fairforest Creek			Route:	SC 49
Eng./Geo.:	K. Hughes/HDR	Boring Location:	183+13	Offset:	52 LT
Elev.:	396.4 ft	Latitude:	34.68193	Longitude:	-81.68594
Date Started:	1/6/2023				
Total Depth:	37.5 ft	Soil Depth:	17.5 ft	Core Depth:	20 ft
Date Completed:	1/6/2023				
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 3.1 ft
24HR:	N.M.				



LEGEND

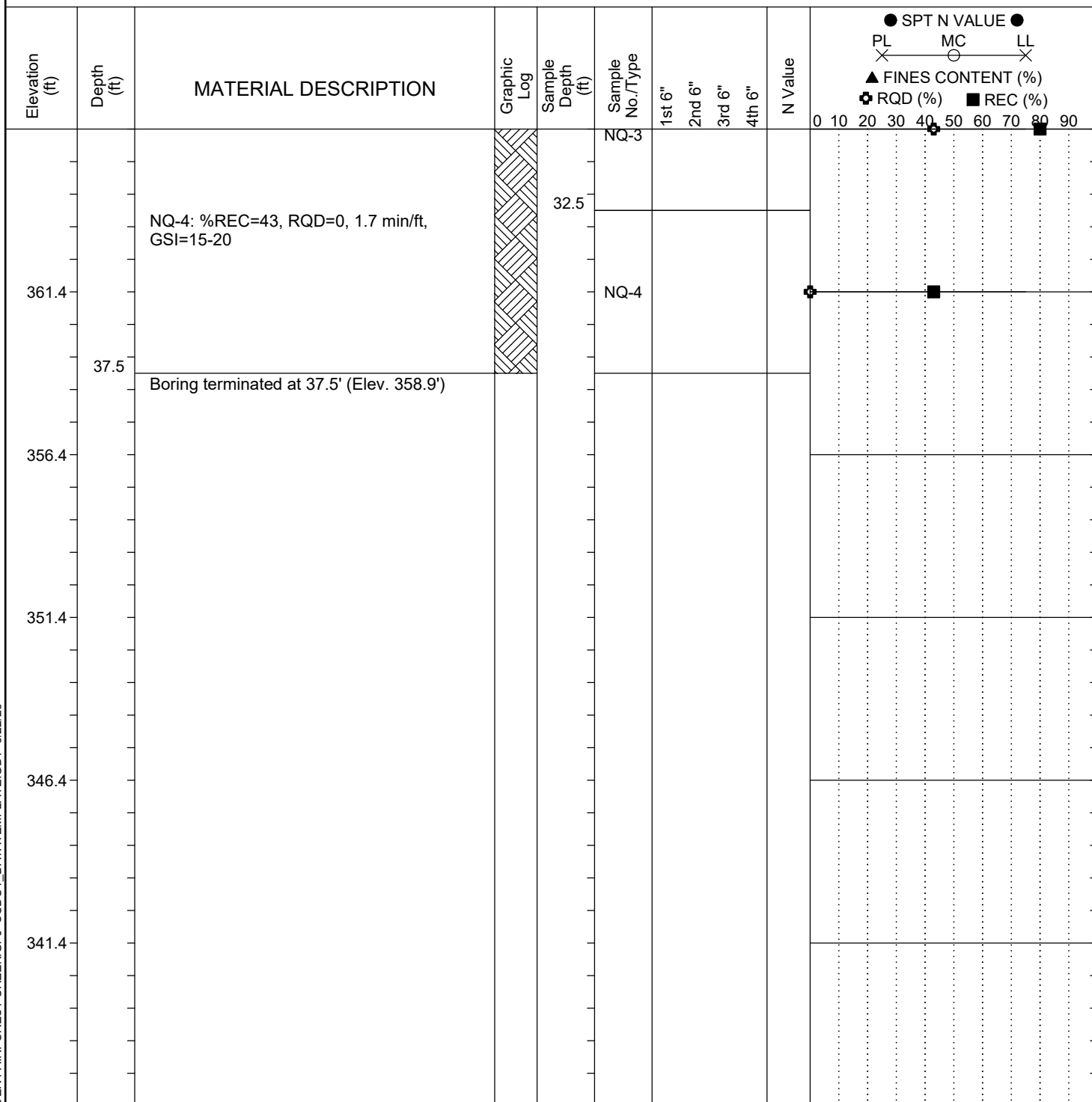
Continued Next Page

SC DOT SC 49 OVER FAIRFOREST CREEK.GPJ SCDOT DATATEMPLATE.GDT 3/22/23

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:	P041238	County:	Union, SC	Boring No.:	B-43
Site Description:	SC 49 over Fairforest Creek			Route:	SC 49
Eng./Geo.:	K. Hughes/HDR	Boring Location:	183+13	Offset:	52 LT
Elev.:	396.4 ft	Latitude:	34.68193	Longitude:	-81.68594
Date Started:	1/6/2023				
Total Depth:	37.5 ft	Soil Depth:	17.5 ft	Core Depth:	20 ft
Date Completed:	1/6/2023				
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 3.1 ft
24HR	N.M.				



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 FAIRFOREST CREEK.GPJ SCDOT_DATATEMPLATE.GDT 3/22/23

Rock Core Photos

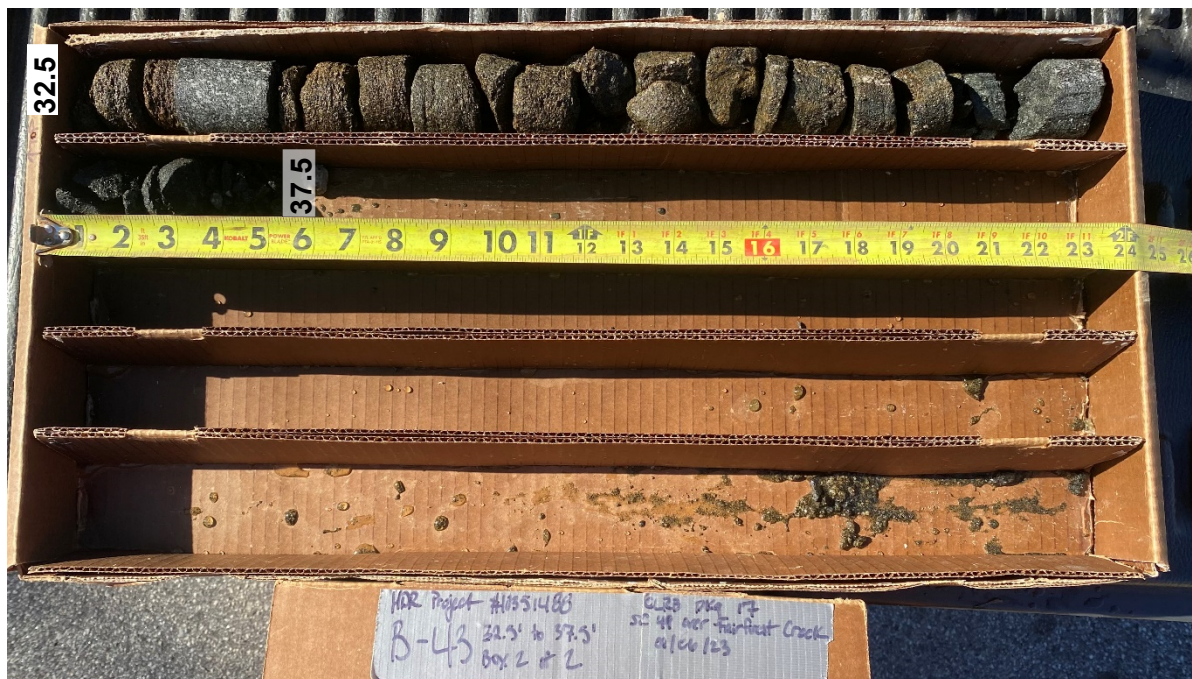
B-43

Box 1 of 2 (17.5' to 32.5')



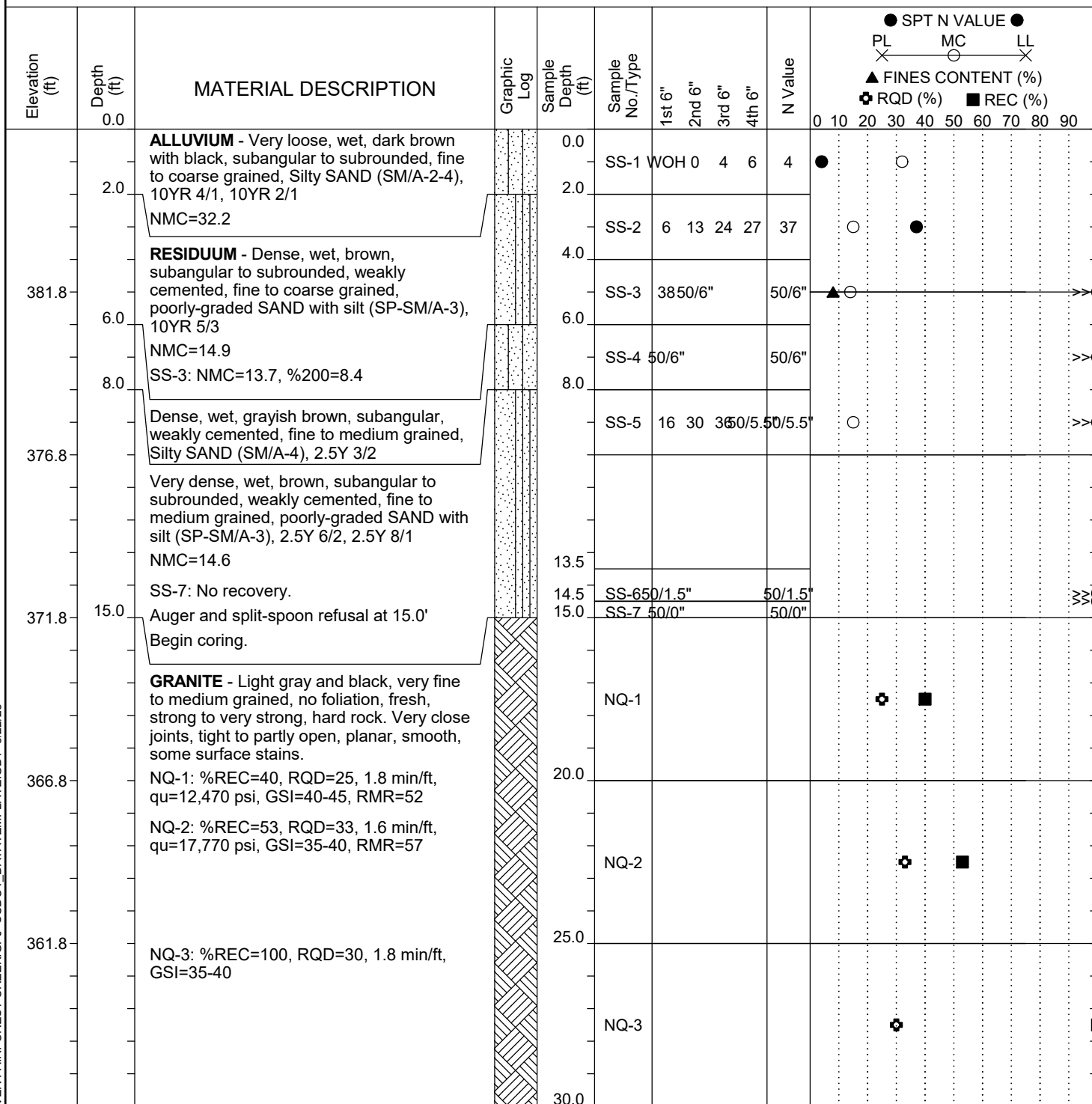
B-43

Box 2 of 2 (32.5' to 37.5')



SCDOT Soil Test Log

Project ID:	P041238	County:	Union, SC	Boring No.:	B-44
Site Description:	SC 49 over Fairforest Creek			Route:	SC 49
Eng./Geo.:	K. Hughes/HDR	Boring Location:	183+88	Offset:	53 LT
Elev.:	386.8 ft	Latitude:	34.68189	Longitude:	-81.68619
Date Started:	1/9/2023				
Total Depth:	35 ft	Soil Depth:	15 ft	Core Depth:	20 ft
Date Completed:	1/9/2023				
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 -5 ft
24HR	N.M.				



LEGEND

Continued Next Page

SC DOT SC 49 OVER FAIRFOREST CREEK.GPJ SCDOT DATATEMPLATE.GDT 3/22/23

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:	P041238	County:	Union, SC	Boring No.:	B-44
Site Description:	SC 49 over Fairforest Creek			Route:	SC 49
Eng./Geo.:	K. Hughes/HDR	Boring Location:	183+88	Offset:	53 LT
Elev.:	386.8 ft	Latitude:	34.68189	Longitude:	-81.68619
Date Started:	1/9/2023				
Total Depth:	35 ft	Soil Depth:	15 ft	Core Depth:	20 ft
Date Completed:	1/9/2023				
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 -5 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	● SPT N VALUE ● PL — MC — LL X — X — X ▲ FINES CONTENT (%) + RQD (%) ■ REC (%)
351.8	35.0	NQ-4: %REC=100, RQD=35, 2.9 min/ft, qu=12,760 psi, GSI=35-40, RMR=52			NQ-4						0 10 20 30 40 50 60 70 80 90 + 35 ■ 100
		Boring terminated at 35.0' (Elev. 351.8')									
346.8											
341.8											
336.8											
331.8											

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 FAIRFOREST CREEK.GPJ SCDOT_DATATEMPLATE.GDT 3/22/23

Rock Core Photos

B-44

Box 1 of 2 (15.0' to 30.0')



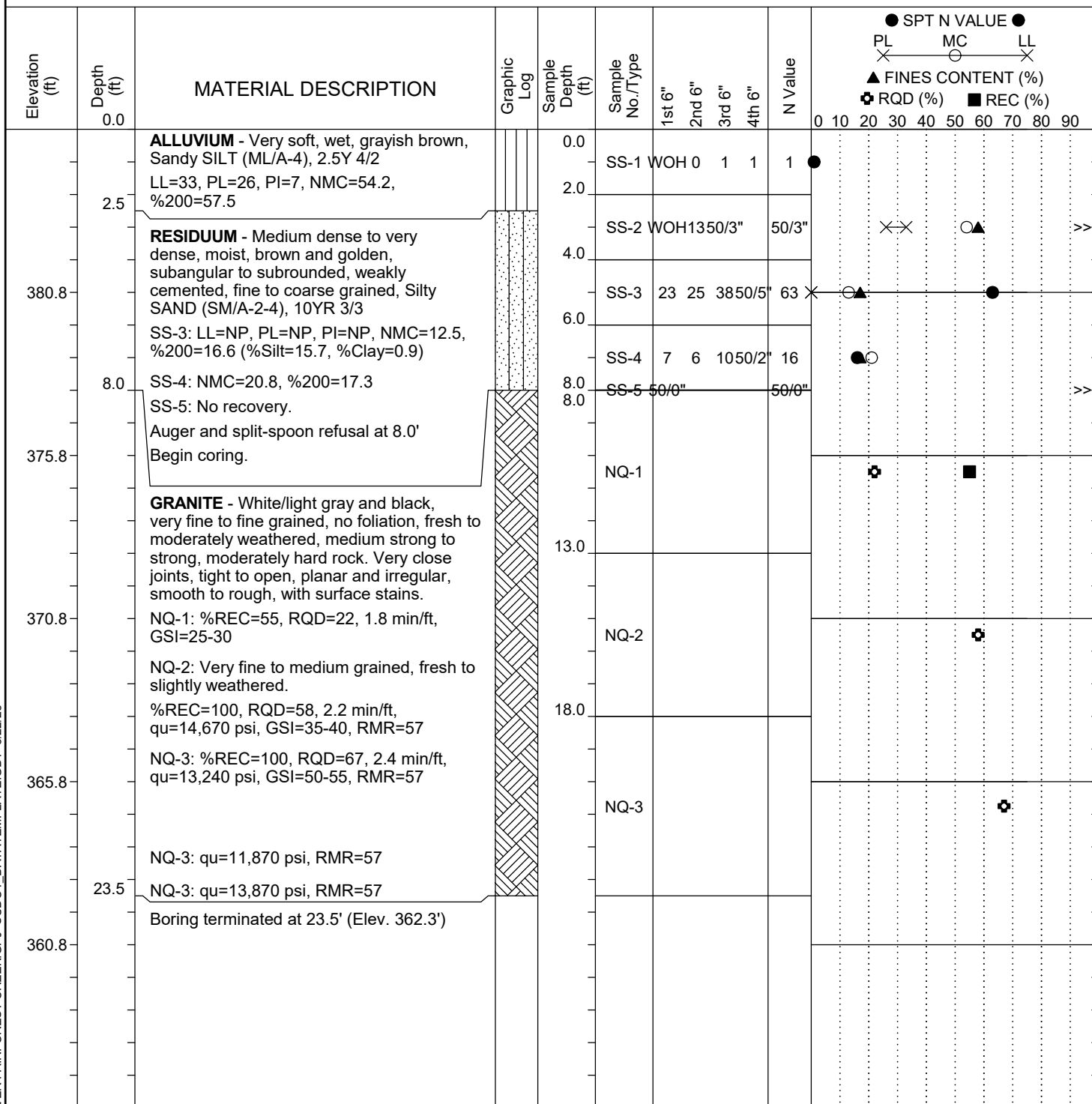
B-44

Box 2 of 2 (30.0' to 35.0')



SCDOT Soil Test Log

Project ID:	P041238	County:	Union, SC	Boring No.:	B-45
Site Description:	SC 49 over Fairforest Creek			Route:	SC 49
Eng./Geo.:	K. Hughes/HDR	Boring Location:	184+67	Offset:	53 LT
Elev.:	385.8 ft	Latitude:	34.68185	Longitude:	-81.68644
Date Started:	1/10/2023				
Total Depth:	23 ft	Soil Depth:	8 ft	Core Depth:	15 ft
Date Completed:	1/11/2023				
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 -6.1 ft
24HR	N.M.				



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 FAIRFOREST CREEK.GPJ SCDOT DATATEMPLATE.GDT 3/22/23

Rock Core Photos

B-45

Box 1 of 2 (8.0' to 18.0')



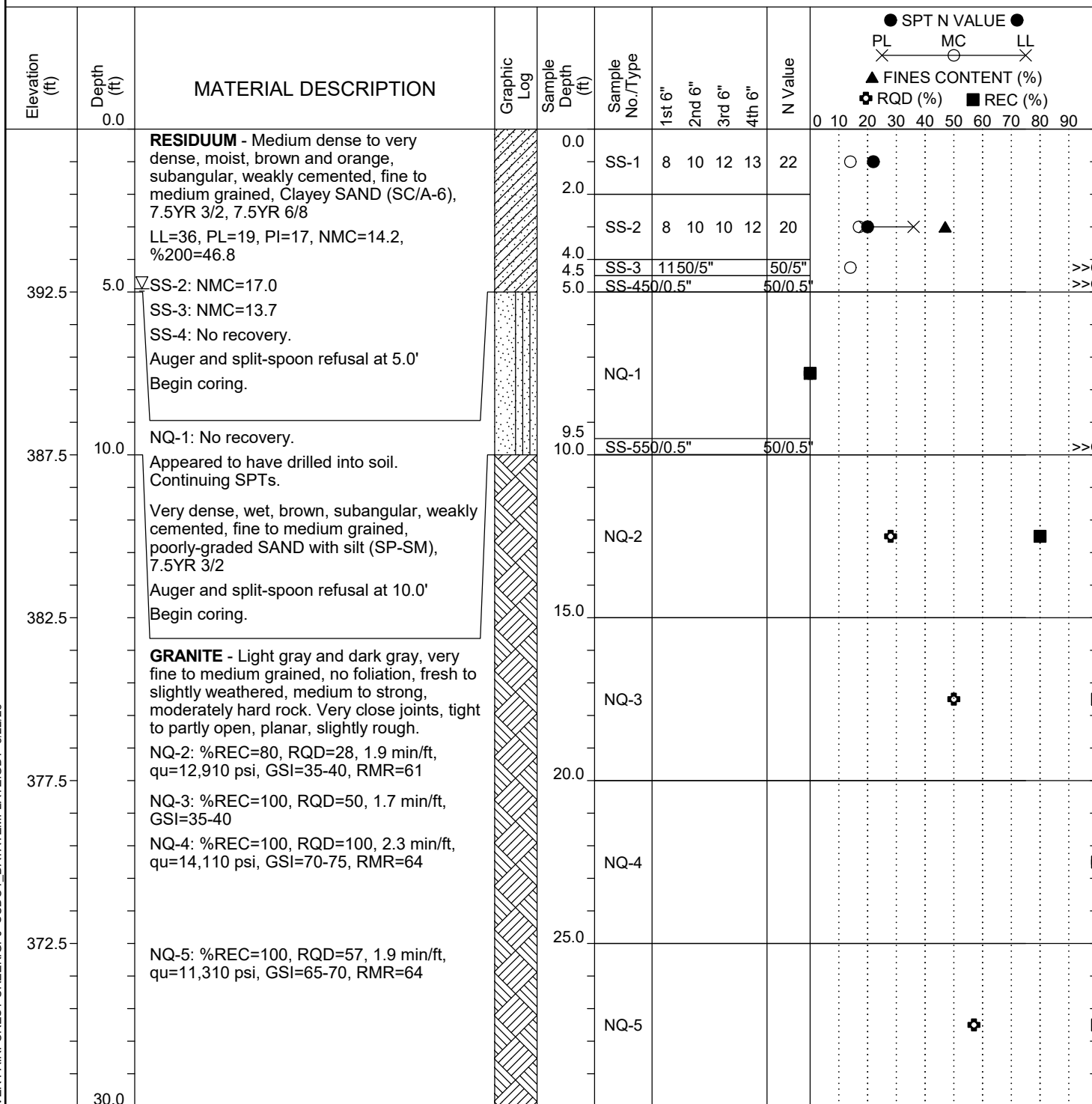
B-45

Box 2 of 2 (18.0' to 23.0')



SCDOT Soil Test Log

Project ID:	P041238	County:	Union, SC	Boring No.:	B-46
Site Description:	SC 49 over Fairforest Creek			Route:	SC 49
Eng./Geo.:	K. Hughes/HDR	Boring Location:	185+45	Offset:	53 LT
Elev.:	397.5 ft	Latitude:	34.68181	Longitude:	-81.6867
Date Started:	1/11/2023				
Total Depth:	30 ft	Soil Depth:	10 ft	Core Depth:	25 ft
Date Completed:	1/11/2023				
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 4.9 ft
24HR	N.M.				



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:	P041238			County:	Union, SC			Boring No.:	B-46			
Site Description:	SC 49 over Fairforest Creek							Route:	SC 49			
Eng./Geo.:	K. Hughes/HDR		Boring Location:	185+45		Offset:	53 LT		Alignment:	SC 49		
Elev.:	397.5 ft		Latitude:	34.68181		Longitude:	-81.6867		Date Started:	1/11/2023		
Total Depth:	30 ft		Soil Depth:	10 ft		Core Depth:	25 ft		Date Completed:	1/11/2023		
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 4.9 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	● SPT N VALUE ● PL — MC — LL X — X — X ▲ FINES CONTENT (%) + RQD (%) ■ REC (%)
		Boring terminated at 30.0' (Elev. 367.5')									0 10 20 30 40 50 60 70 80 90
362.5											
357.5											
352.5											
347.5											
342.5											

LEGEND

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

SC.DOT SC 49 OVER FAIRFOREST CREEK.GPJ SCDOT_DATATEMPLATE.GDT 3/22/23

Rock Core Photos

B-46

Box 1 of 2 (10.0' to 20.0')



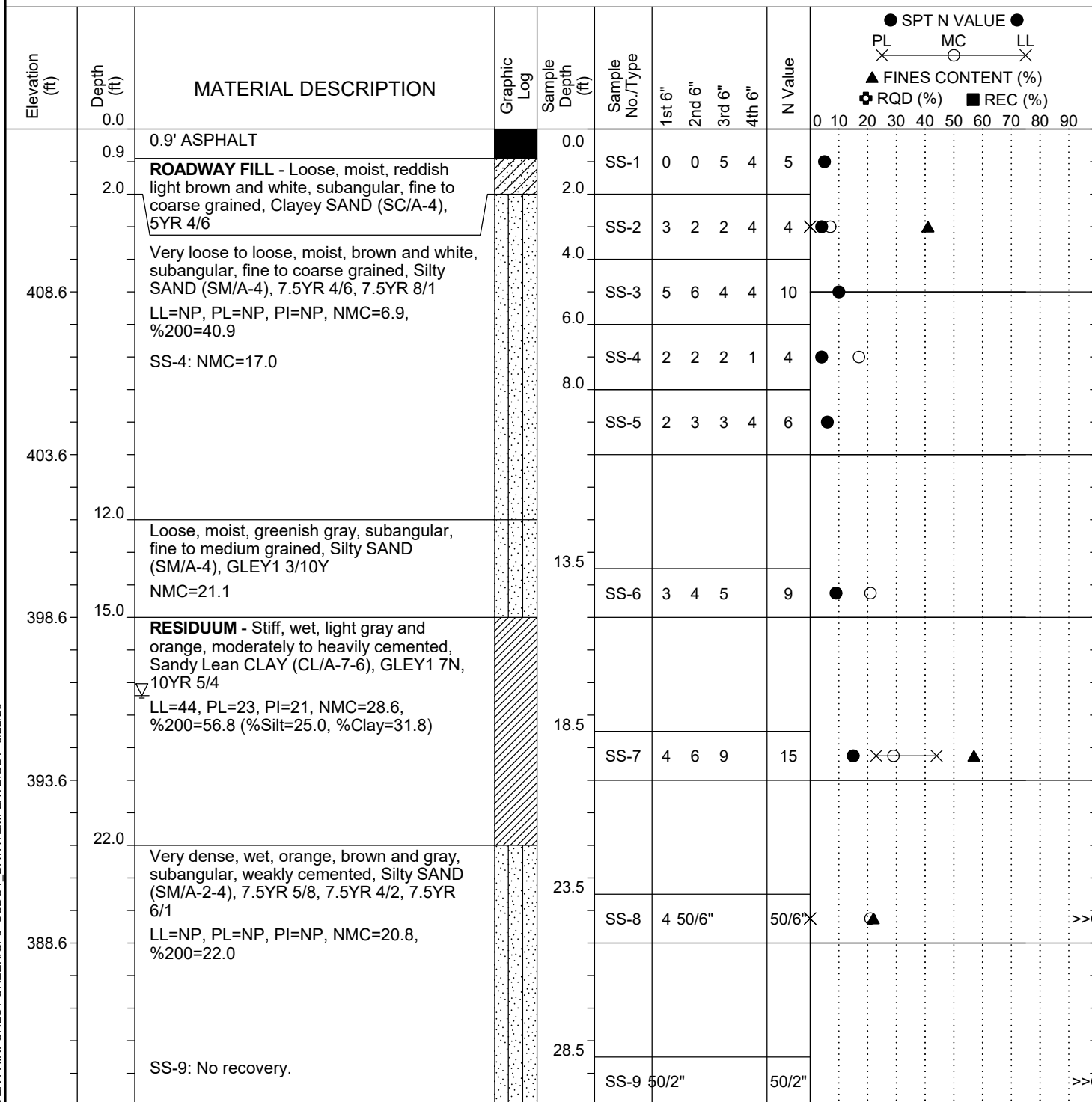
B-46

Box 2 of 2 (20.0' to 30.0')



SCDOT Soil Test Log

Project ID:	P041238	County:	Union, SC	Boring No.:	B-47
Site Description:	SC 49 over Fairforest Creek			Route:	SC 49
Eng./Geo.:	K. Hughes/HDR	Boring Location:	186+48	Offset:	55 LT
Elev.:	413.6 ft	Latitude:	34.68176	Longitude:	-81.68704
Date Started:	1/3/2023				
Total Depth:	49.8 ft	Soil Depth:	39.3 ft	Core Depth:	10.5 ft
Date Completed:	1/3/2023				
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 17.4 ft
24HR	N.M.				



LEGEND

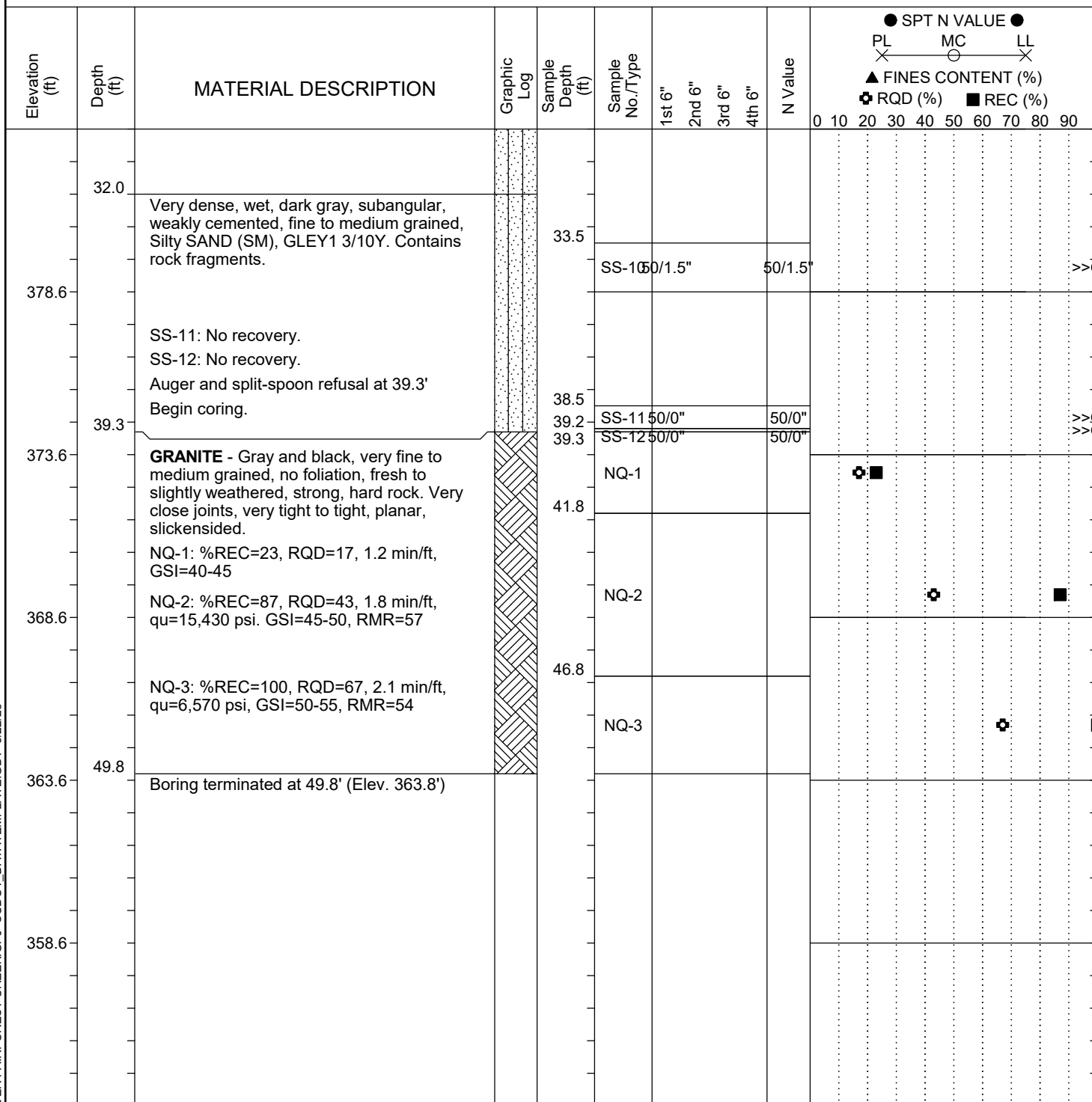
Continued Next Page

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

SC.DOT SC 49 OVER FAIRFOREST CREEK.GPJ SCDOT_DATATEMPLATE.GDT 3/22/23

SCDOT Soil Test Log

Project ID:	P041238	County:	Union, SC	Boring No.:	B-47
Site Description:	SC 49 over Fairforest Creek			Route:	SC 49
Eng./Geo.:	K. Hughes/HDR	Boring Location:	186+48	Offset:	55 LT
Elev.:	413.6 ft	Latitude:	34.68176	Longitude:	-81.68704
Date Started:	1/3/2023				
Total Depth:	49.8 ft	Soil Depth:	39.3 ft	Core Depth:	10.5 ft
Date Completed:	1/3/2023				
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 17.4 ft
24HR	N.M.				



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 FAIRFOREST CREEK.GPJ SCDOT DATATEMPLATE.GDT 3/22/23

Rock Core Photos

B-47

Box 1 of 1 (39.3' to 49.8')





Appendix B. Subsurface Investigation

CPT Logs

Total depth: 29.79 ft, Date: 11/18/2022

Surface Elevation: 415.10 ft

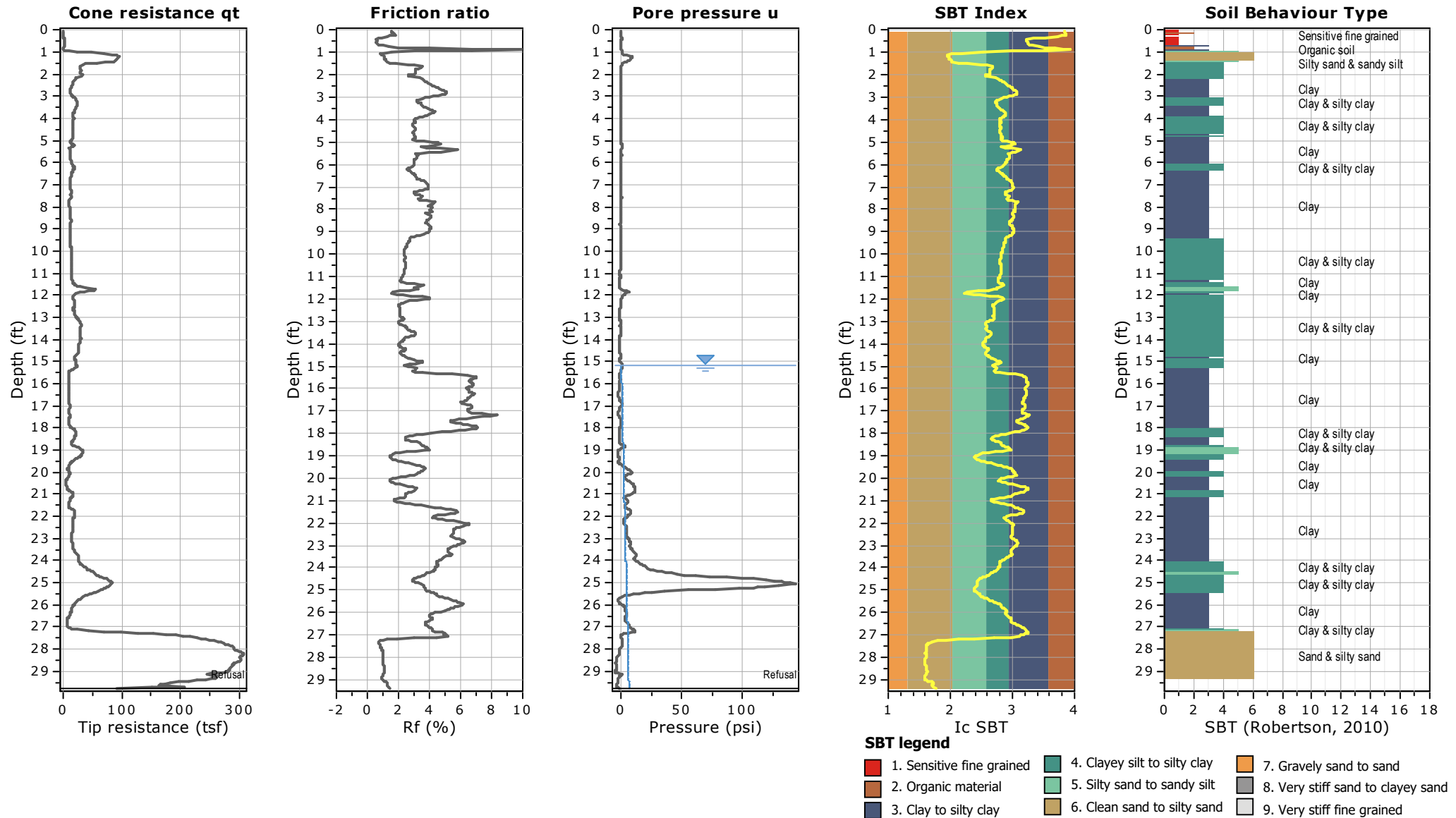
Coords: lat 34.681961° lon -81.685709°

Cone Type: DDG1330

Cone Operator: F&ME Consultants

Project: SC 49 over Fair Forest Creek

Location: Union County, SC



Total depth: 27.00 ft, Date: 11/18/2022

Surface Elevation: 413.60 ft

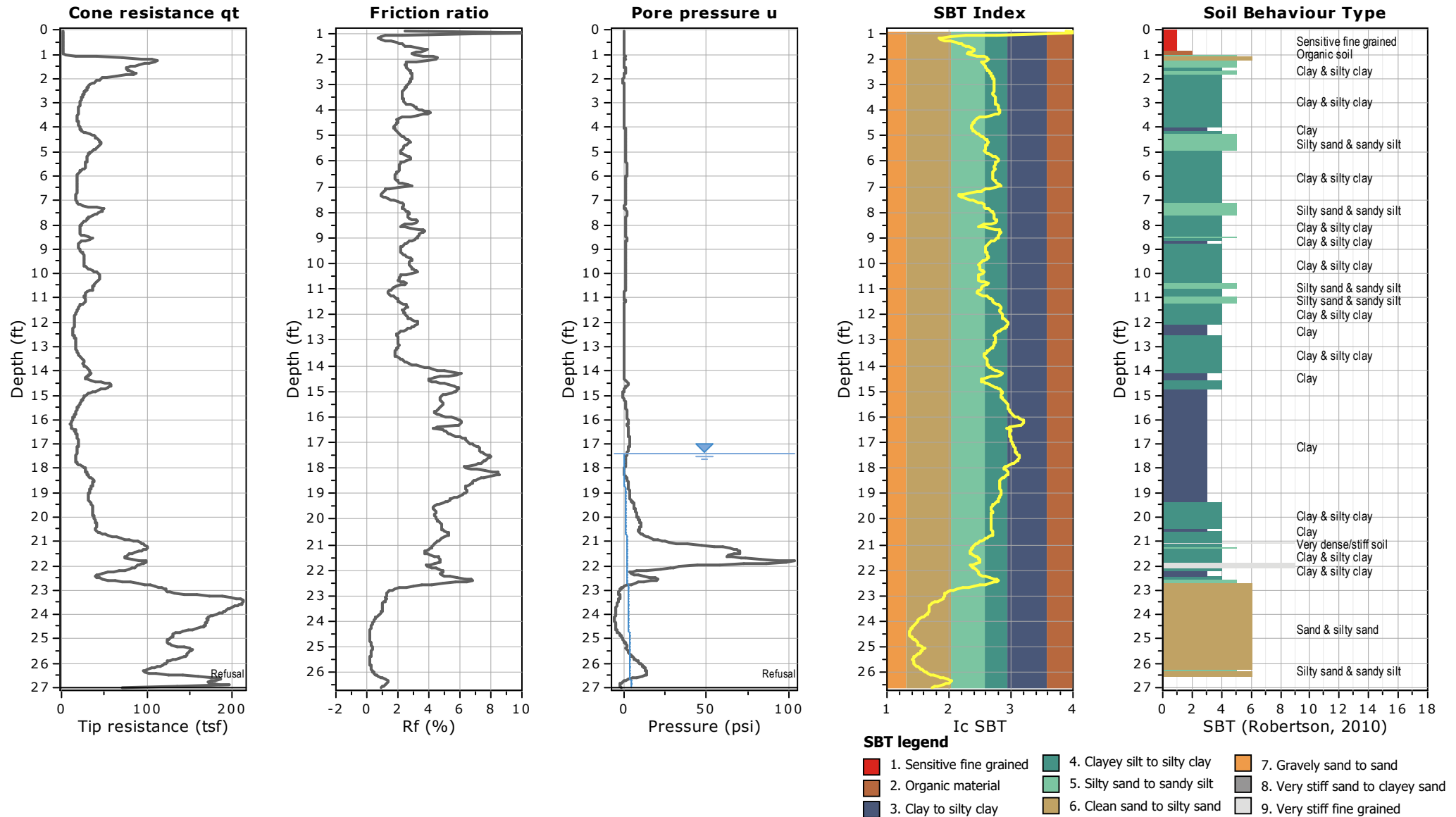
Coords: lat 34.681761° lon -81.687042°

Cone Type: DDG1330

Cone Operator: F&ME Consultants

Project: SC 49 over Fair Forest Creek

Location: Union County, SC





Appendix B. Subsurface Investigation

Multichannel Analysis of Surface Waves (MASW)

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 Fairforest Creek
Union County, South Carolina
F&ME Project No.: G6658.003

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 Fairforest Creek 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-10	1114.6 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,

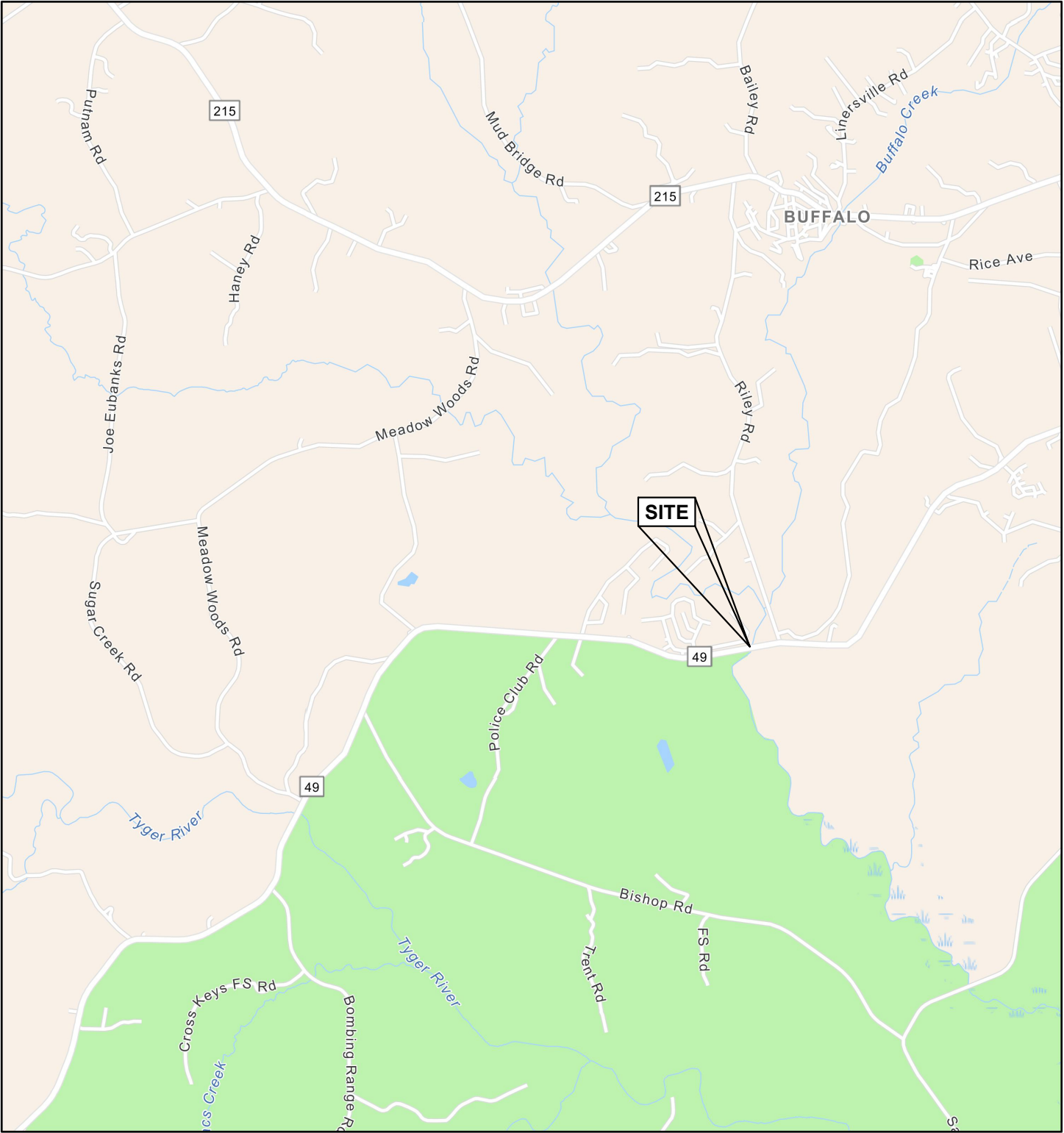
F&ME CONSULTANTS



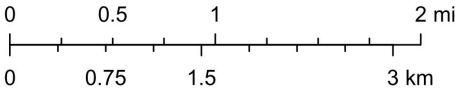
Alex M Chandler, EIT
Geotechnical Staff Professional



John F Hamilton, PE
Geotechnical Design Manager



1:72,000



F&ME CONSULTANTS, INC.
COLUMBIA, SC

SC 49 OVER FAIRFOREST CREEK
UNION COUNTY, SOUTH CAROLINA

SITE VICINITY MAP

F&ME JOB NO. G6658.003

SCALE: AS NOTED

FIGURE 1

4			
3			
2			
1			
REV.	BY	DATE	DESCRIPTION OF REVISION
TOPO.		DATE	
DWG.	CTC	DATE 2.20.23	GROUP -- --
R/W		DATE	



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COLUMBIA, SC

4			
3			
2			
1			
REV.	BY	DATE	DESCRIPTION OF REVISION
TOPO.		DATE	
DWG.	CTC	DATE 2.20.23	GROUP ____ - ____
R/W		DATE	

SC 49 OVER FAIRFOREST CREEK
UNION COUNTY, SOUTH CAROLINA

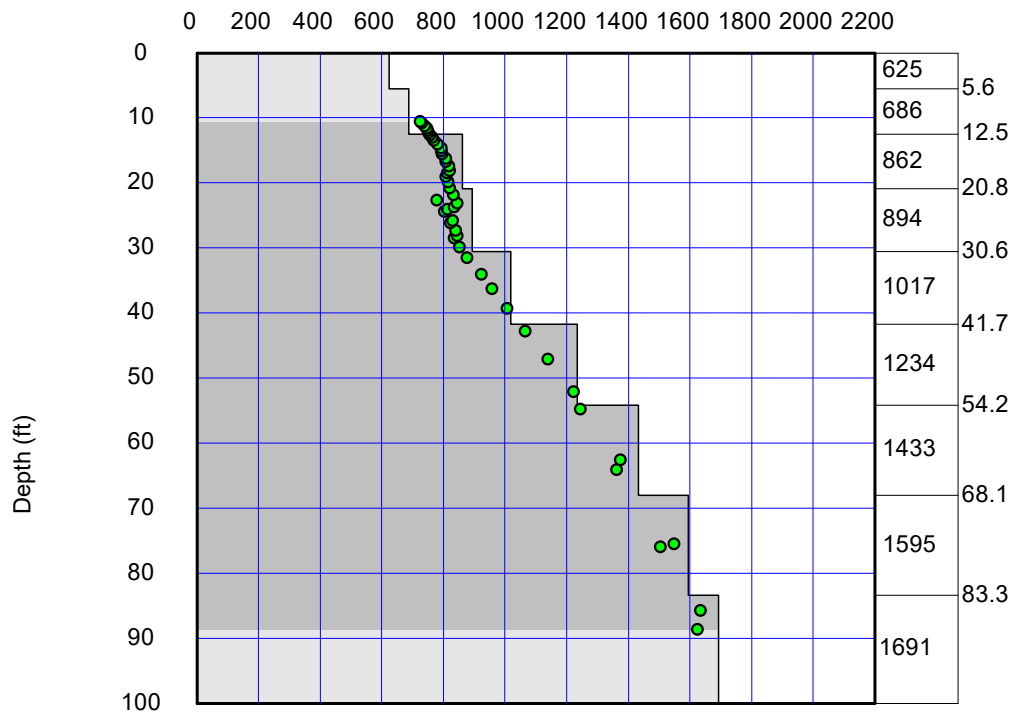
MASW LOCATION PLAN

F&ME JOB NO. G6658.003

SCALE: 1"=100'

FIGURE 2

S-wave velocity (ft/s)



S-wave velocity model (initial) : SC49FairForest FinalVs100.rst

Average Vs 100ft = 1114.6 ft/sec

Appendix C. Laboratory Testing



SUMMARY OF LABORATORY RESULTS

PAGE 1 OF 1

PROJECT ID P041238

PROJECT NAME SC 49 over Fairforest Creek

PROJECT COUNTY Union, SC

Borehole	Depth	Liquid Limit	Plastic Limit	Plasticity Index	Maximum Size (mm)	%<#200 Sieve	Classification	Water Content (%)	Dry Density (pcf)	Saturation (%)	Void Ratio
B-42	0.0							18.6			
B-42	4.0	NP	NP	NP	0.075	42	SM	21.6			
B-42	8.0							8.8			
B-42	10.0							15.9			
B-42	12.0	42	20	22	0.075	52	CL	25.6			
B-42	16.0				0.075	40	SM	20.9			
B-42	18.0	NP	NP	NP	0.075	43	SM	23.1			
B-42	22.0	30	26	4	0.075	37	SM	24.1			
B-42	24.0							17.2			
B-42	32.0	NP	NP	NP	0.075	21	SM	19.2			
B-43	0.0							19.6			
B-43	2.0	39	19	20	0.075	53	CL	21.3			
B-43	4.0							31.6			
B-43	6.0	33	25	8	0.075	59	ML	31.3			
B-43	13.5							20.4			
B-44	0.0							32.2			
B-44	2.0							14.9			
B-44	4.0				0.075	8	SP-SM	13.7			
B-44	8.0							14.6			
B-45	2.0	33	26	7	0.075	58	ML	54.2			
B-45	4.0	NP	NP	NP	0.075	17	SM	12.5			
B-45	6.0				0.075	17	SM	20.8			
B-46	0.0							14.2			
B-46	2.0	36	19	17	0.075	47	SC	17.0			
B-46	4.0							13.7			
B-47	2.0	NP	NP	NP	0.075	41	SM	6.9			
B-47	6.0							17.0			
B-47	13.5							21.1			
B-47	18.5	44	23	21	0.075	57	CL	28.6			
B-47	23.5	NP	NP	NP	0.075	22	SM	20.8			



Rock Coring Summary

PAGE 1 OF 1

PROJECT ID P041238

PROJECT NAME SC 49 over Fairforest 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-42	NQ-1	42.0	68	34						48
B-42	NQ-2	45.7	100	100	16520		2710	164	79	78
B-42	NQ-3	50.7	100	75	14000	0.20	1680	164	71	68
B-43	NQ-1	17.5	57	57	17380	0.13	2510	164	72	68
B-43	NQ-2	22.5	65	23						23
B-43	NQ-3	27.5	80	43	13620	0.18	5580	179	52	28
B-43	NQ-4	32.5	43	0						18
B-44	NQ-1	15.0	40	25	12470	0.23	1390	164	52	43
B-44	NQ-2	20.0	53	33	17770	0.24	6270	180	57	38
B-44	NQ-3	25.0	100	30						38
B-44	NQ-4	30.0	100	35	12760	0.34	7890	183	52	38
B-45	NQ-1	8.0	55	22						28
B-45	NQ-2	13.0	100	58	14670	0.14	5640	174	57	38
B-45	NQ-3	18.0	100	67	13240	0.27	2040	174	57	53
B-45	NQ-3	18.0	100	67	11870		6410	173	57	53
B-45	NQ-3	18.0	100	67	13870	0.15	5490	173	57	53
B-46	NQ-1	5.0	0	0						0
B-46	NQ-2	10.0	80	28	12910	0.15	2050	164	61	38
B-46	NQ-3	15.0	100	50						38
B-46	NQ-4	20.0	100	100	14110	0.23	4550	175	64	73
B-46	NQ-5	25.0	100	57	11310	0.26	3240	176	64	68
B-47	NQ-1	39.3	23	17						43
B-47	NQ-2	41.8	87	43	15430	0.17	4110	175	57	48
B-47	NQ-3	46.8	100	67	6570	0.15	3780	175	54	53



INDEX PROPERTIES VERSUS DEPTH

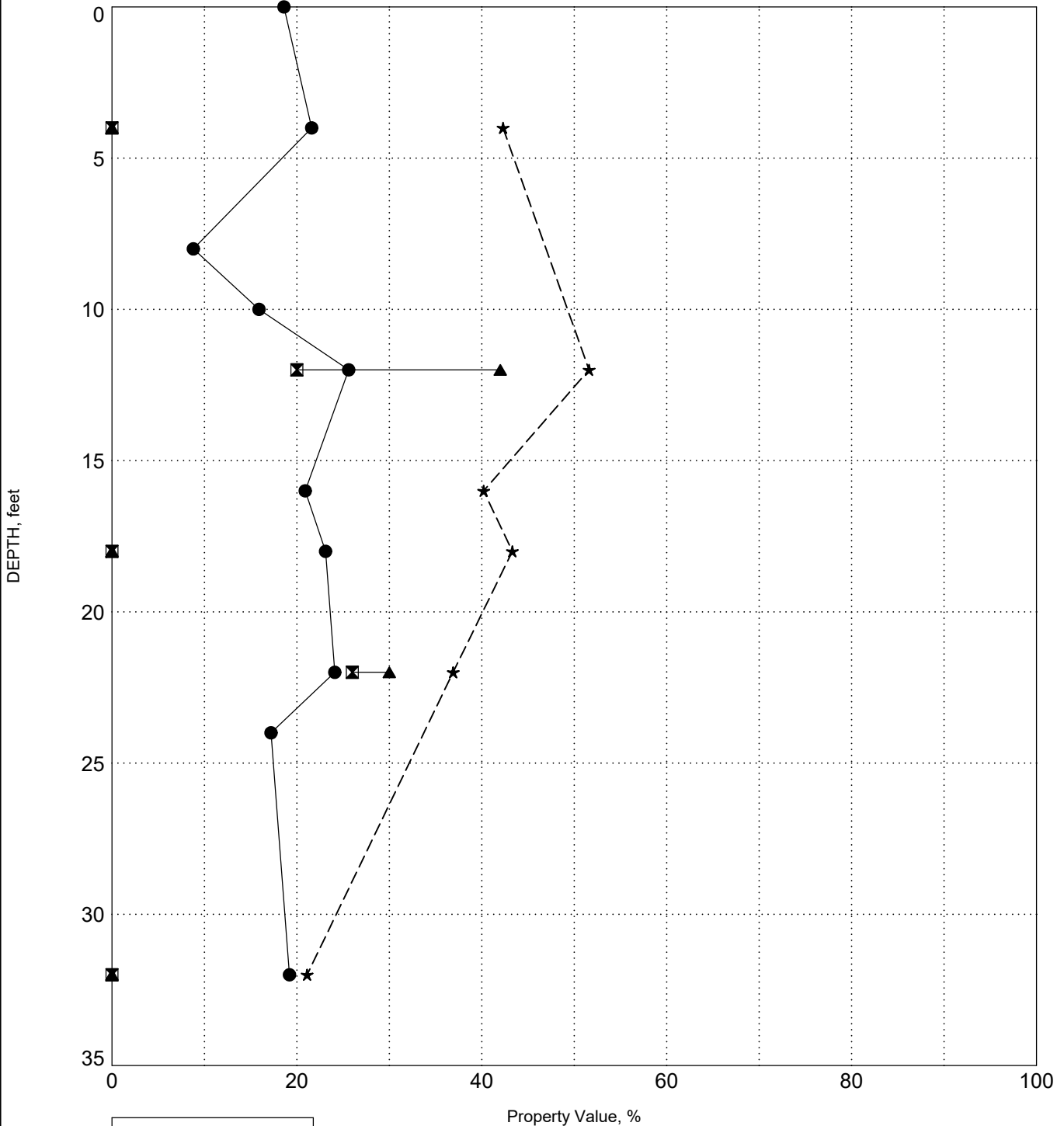
PROJECT ID P041238

PROJECT NAME SC 49 over Fairforest Creek

PROJECT COUNTY Union, SC

SURFACE ELEVATION: 415.2

BORING B-42



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



INDEX PROPERTIES VERSUS DEPTH

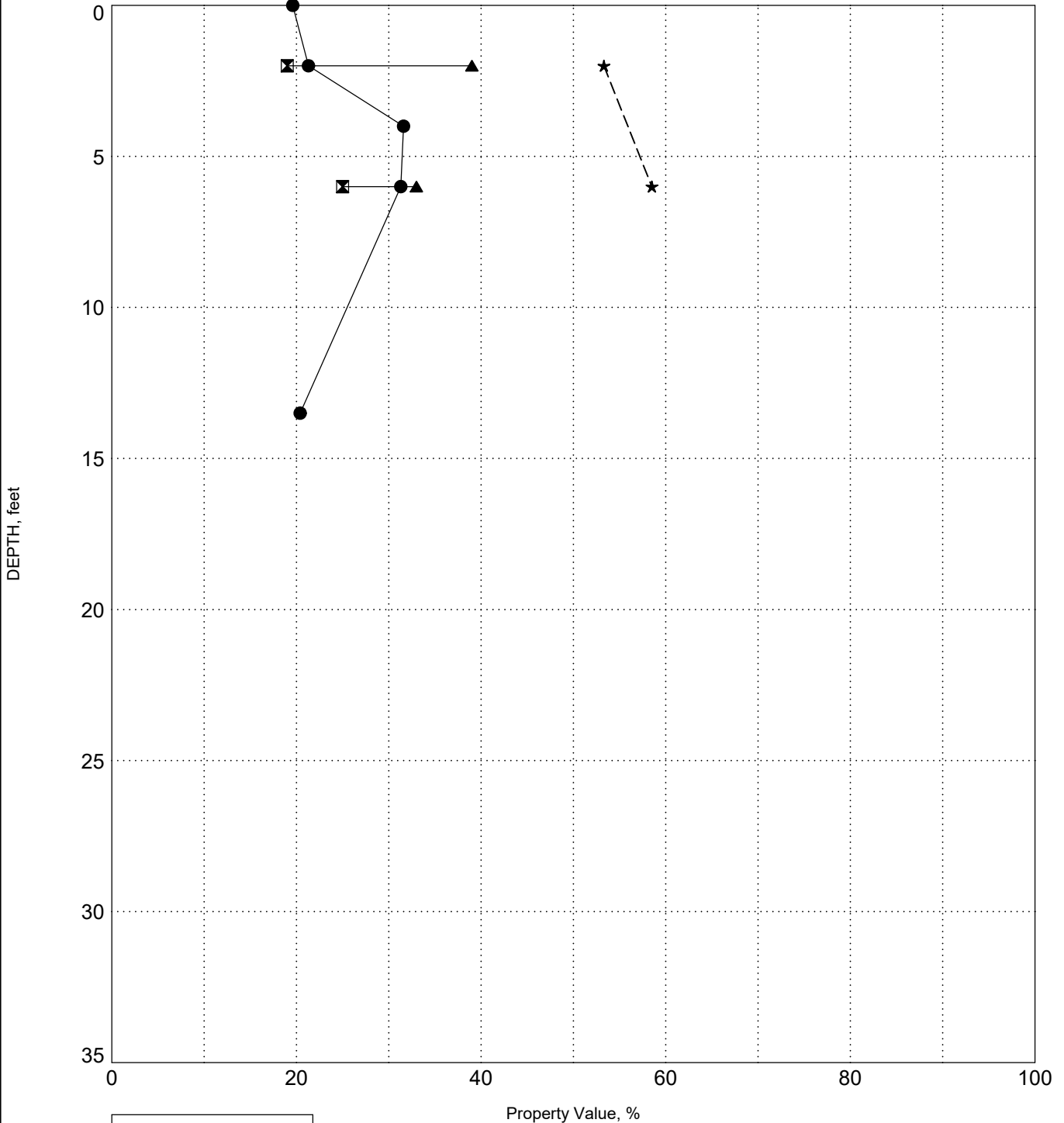
PROJECT ID P041238

PROJECT NAME SC 49 over Fairforest Creek

PROJECT COUNTY Union, SC

SURFACE ELEVATION: 396.4

BORING B-43



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



INDEX PROPERTIES VERSUS DEPTH

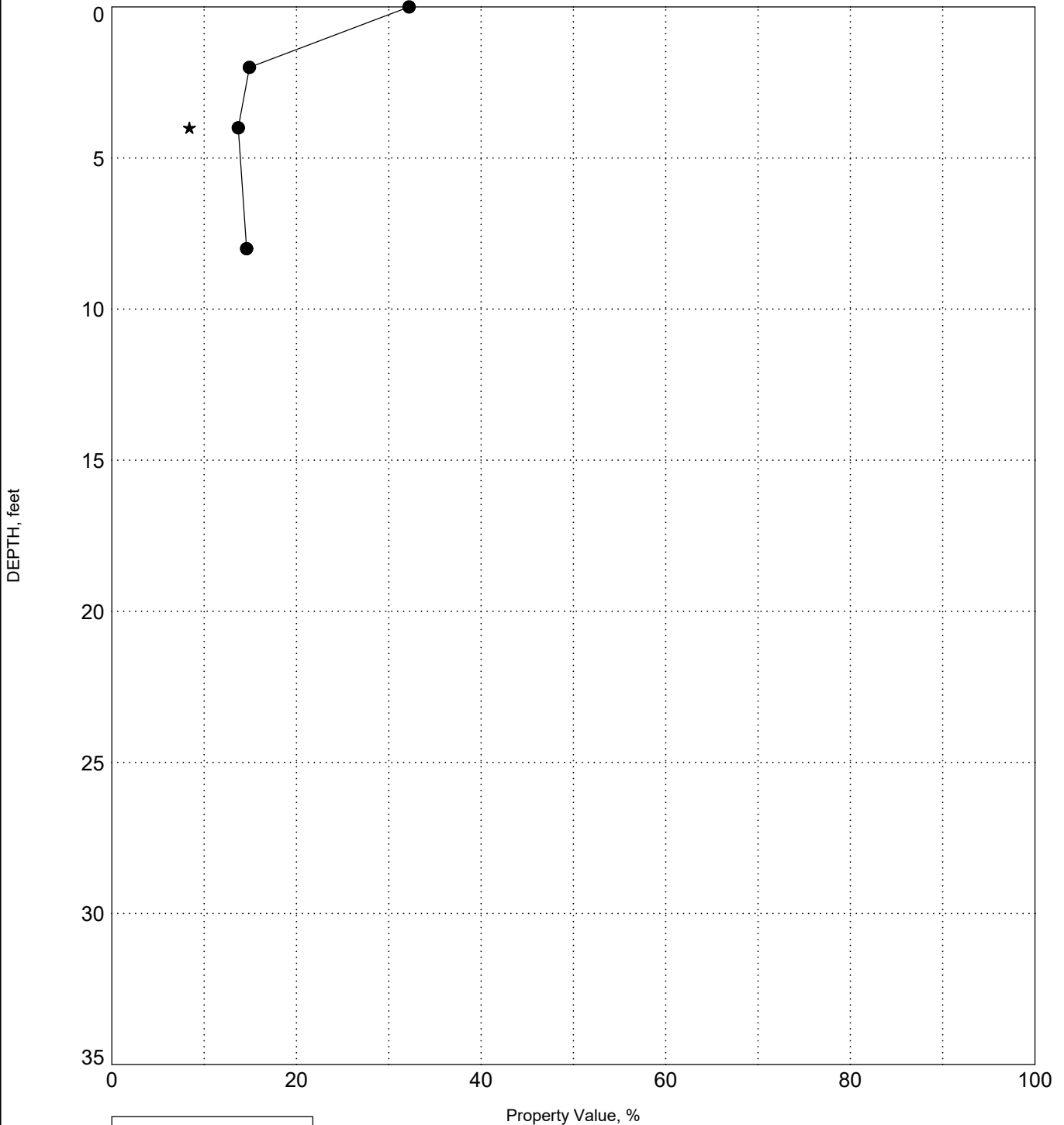
PROJECT ID P041238

PROJECT NAME SC 49 over Fairforest Creek

PROJECT COUNTY Union, SC

SURFACE ELEVATION: 386.8

BORING B-44



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



INDEX PROPERTIES VERSUS DEPTH

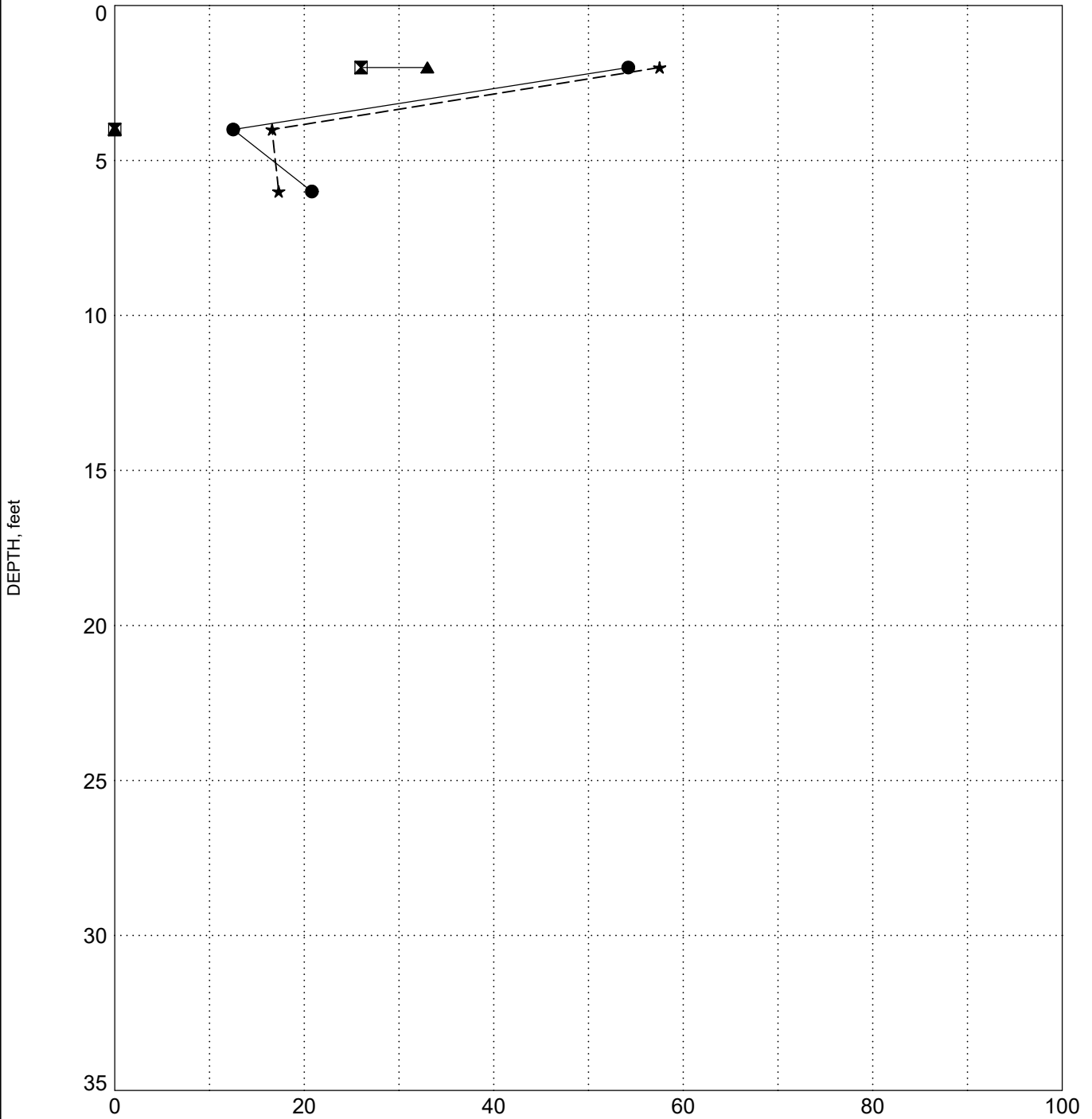
PROJECT ID P041238

PROJECT NAME SC 49 over Fairforest Creek

PROJECT COUNTY Union, SC

SURFACE ELEVATION: 385.8

BORING B-45



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



INDEX PROPERTIES VERSUS DEPTH

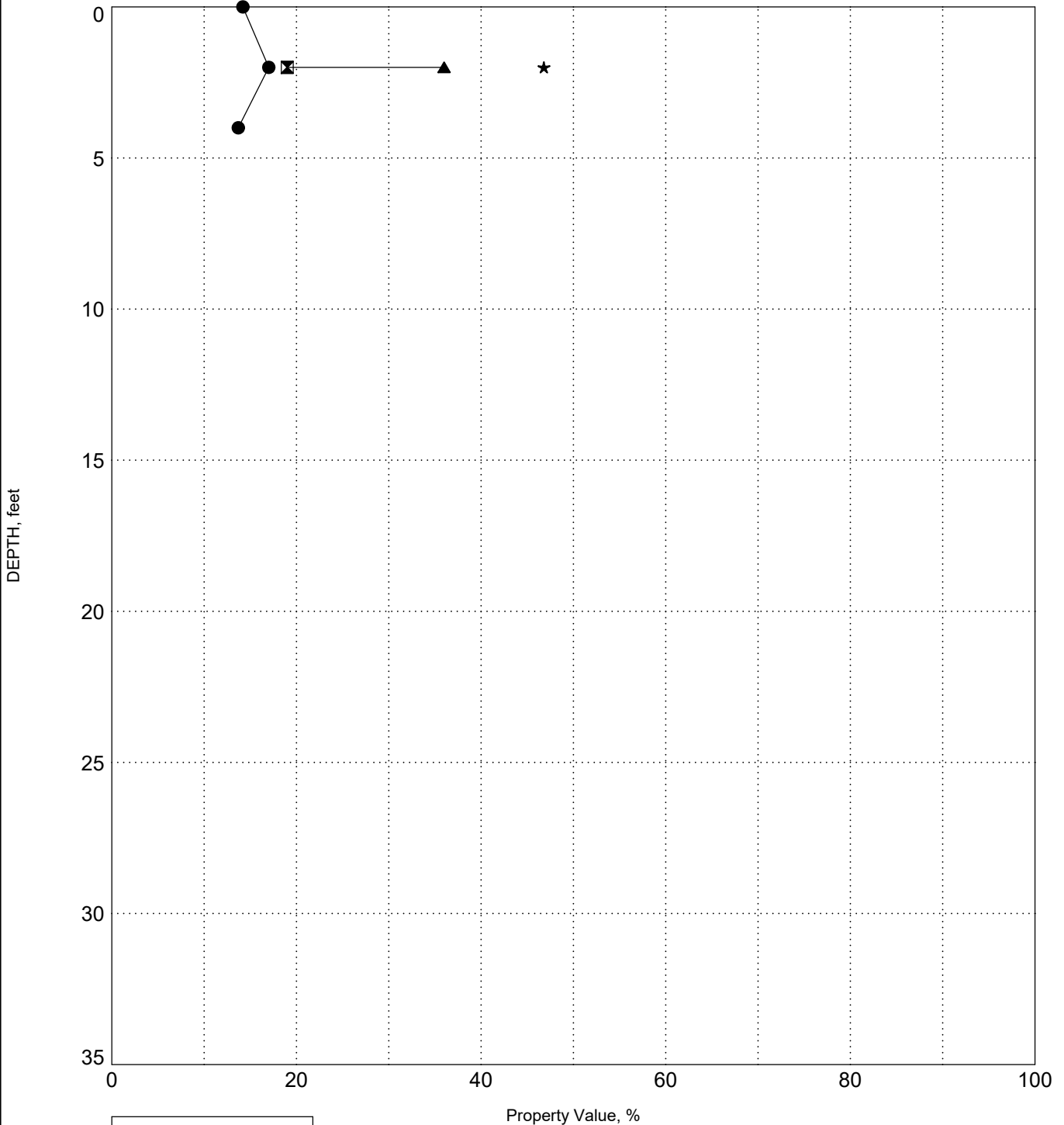
PROJECT ID P041238

PROJECT NAME SC 49 over Fairforest Creek

PROJECT COUNTY Union, SC

SURFACE ELEVATION: 397.5

BORING B-46



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



INDEX PROPERTIES VERSUS DEPTH

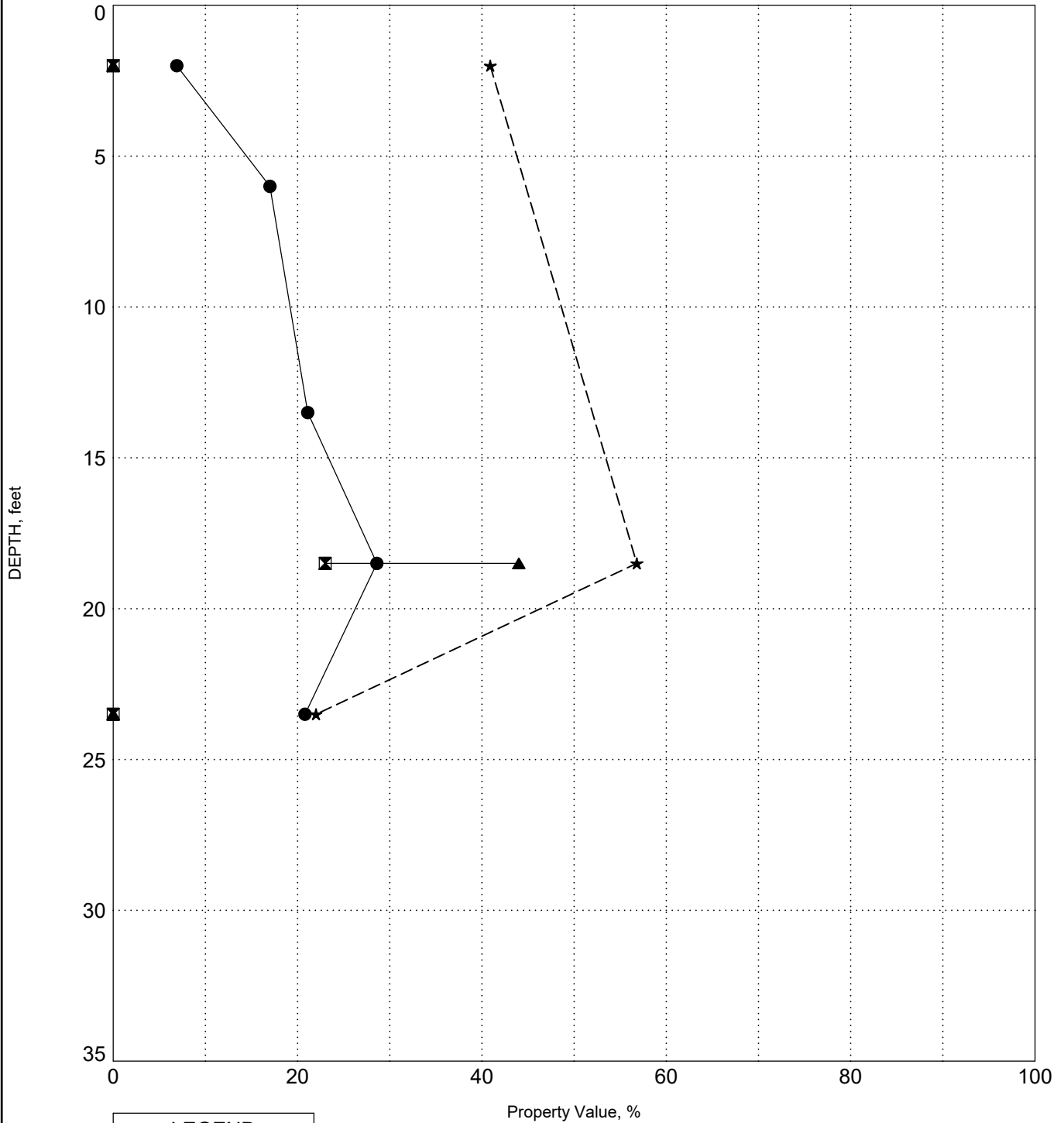
PROJECT ID P041238

PROJECT NAME SC 49 over Fairforest Creek

PROJECT COUNTY Union, SC

SURFACE ELEVATION: 413.6

BORING B-47



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



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 than 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/ft³ (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 in 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

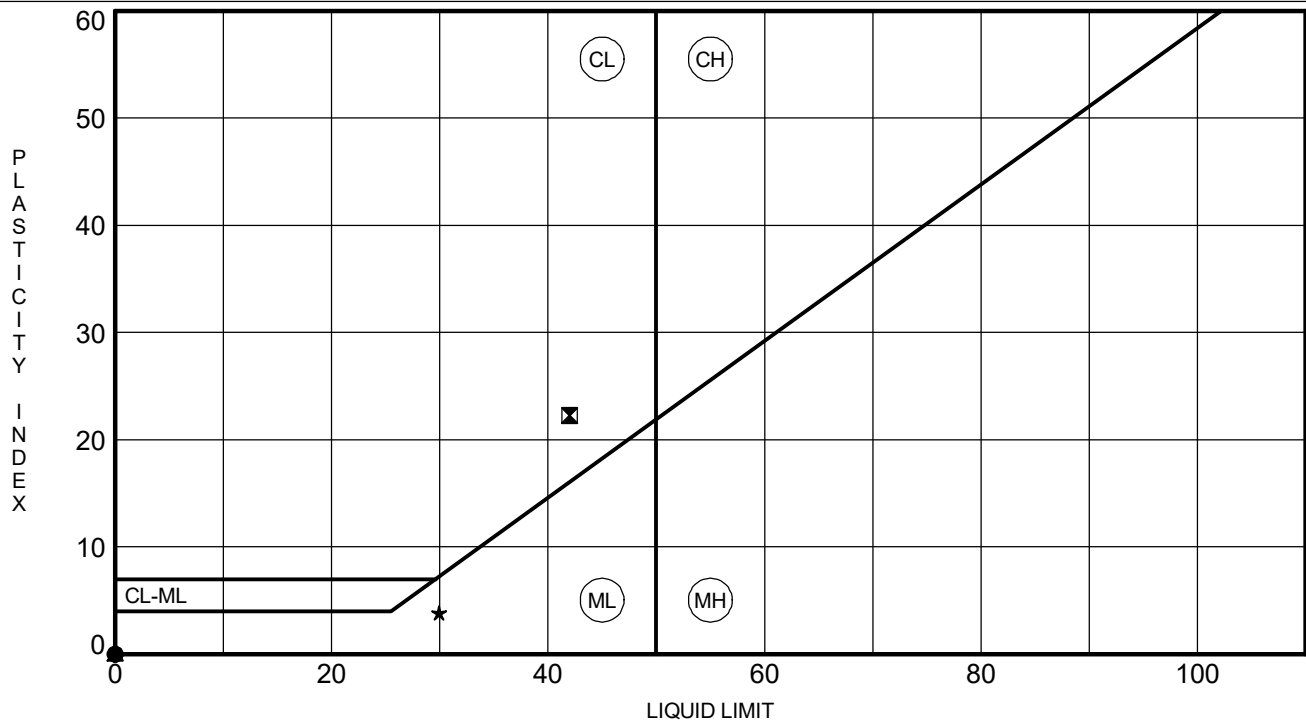
Split Spoon Samples

ATTERBERG LIMITS' RESULTS

PROJECT ID P041238

PROJECT NAME SC 49 Fairforest Creek

PROJECT COUNTY Union County

[illegible]

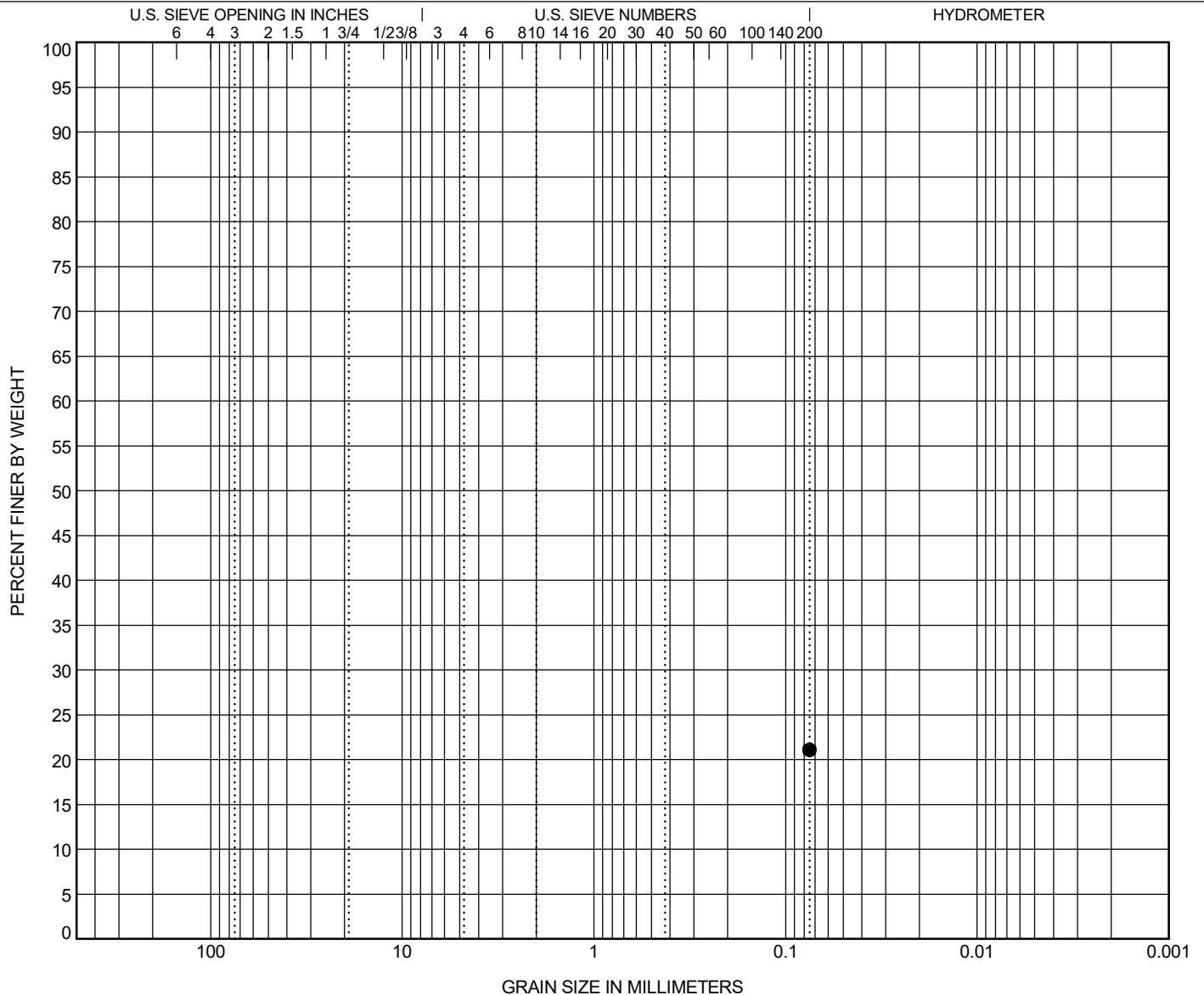


GRAIN SIZE DISTRIBUTION

PROJECT ID P041238

PROJECT NAME SC 49 Fairforest Creek

PROJECT COUNTY Union County



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

BOREHOLE	DEPTH	Classification					LL	PL	PI	Cc	Cu
● B-42	34.0	SILTY SAND (SM/A-2-4)					NP	NP	NP		
BOREHOLE	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay		
● B-42	34.0	0.075							21.1		

F&ME CONSULTANTS, INC.

MOISTURE CONTENT DETERMINATION (AASHTO T265)

PROJECT: SC 49 Fairforest Creek **SCDOT PROJECT ID:** P041238
SAMPLE NUMBER: 23-0114 **DATE SAMPLE RECEIVED:** 1/19/2023
DESCRIPTION OF SOIL: Various
TESTED BY: CM & DH **DATE SETUP:** 1/20/2023
WEIGHED BY: MD **DATE OF WEIGHING:** 1/23/2023

BORING NO.	B-42	B-42	B-42	B-42	B-42
SAMPLE NO.	SS-1	SS-3	SS-5	SS-6	SS-7
SAMPLE DEPTH (FT.)	0.0 - 2.0	4.0 - 6.0	8.0 - 10.0	10.0 - 12.0	12.0 - 14.0
WATER CONTENT, W%	18.6	21.6	8.8	15.9	25.6

BORING NO.	B-42	B-42	B-42	B-42	B-42
SAMPLE NO.	SS-9	SS-10	SS-12	SS-13	SS-17
SAMPLE DEPTH (FT.)	16.0 - 18.0	18.0 - 20.0	22.0 - 24.0	24.0 - 26.0	32.0 - 34.0
WATER CONTENT, W%	20.9	23.1	24.1	17.2	19.5

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

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



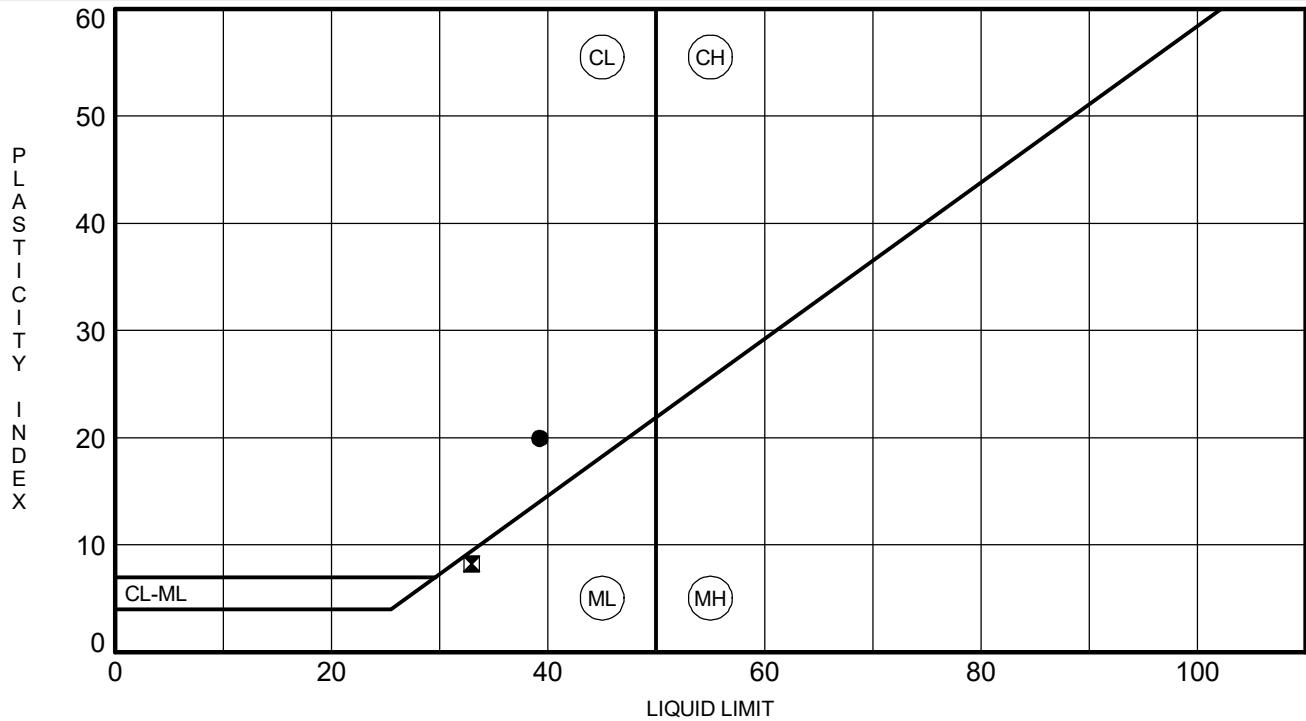
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ATTERBERG LIMITS' RESULTS

PROJECT ID P041238

PROJECT NAME SC 49 Fairforest Creek

PROJECT COUNTY Union County

[illegible]

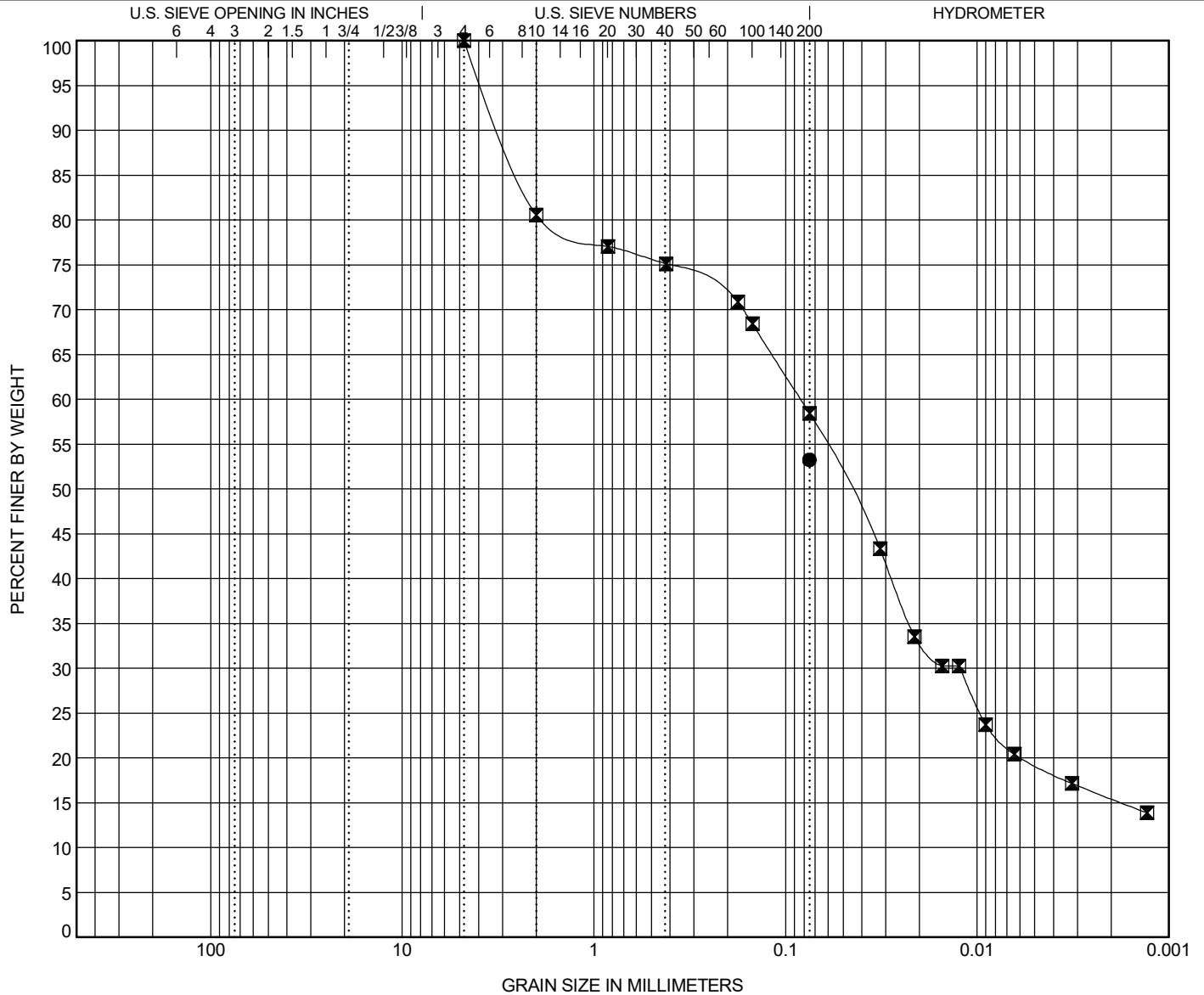


GRAIN SIZE DISTRIBUTION

PROJECT ID P041238

PROJECT NAME SC 49 Fairforest Creek

PROJECT COUNTY Union County



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

BOREHOLE	DEPTH	Classification					LL	PL	PI	Cc	Cu
● B-43	4.0	SANDY LEAN CLAY (CL/A-6)					39	19	20		
☒ B-43	8.0	SANDY SILT (ML/A-4)					33	25	8		
BOREHOLE	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt		%Clay	
● B-43	4.0	0.075						53.3			
☒ B-43	8.0	4.76	0.083	0.012		0.0	41.5	39.2		19.3	

F&ME CONSULTANTS, INC.

MOISTURE CONTENT DETERMINATION (AASHTO T265)

PROJECT: SC 49 Fairforest Creek **SCDOT PROJECT ID:** P041238
SAMPLE NUMBER: 23-0115 **DATE SAMPLE RECEIVED:** 1/19/2023
DESCRIPTION OF SOIL: Various
TESTED BY: CM & DH **DATE SETUP:** 1/20/2023
WEIGHED BY: MD **DATE OF WEIGHING:** 1/23/2023

BORING NO.	B-43	B-43	B-43	B-43	B-43
SAMPLE NO.	SS-1	SS-2	SS-3	SS-4	SS-6
SAMPLE DEPTH (FT.)	0.0 - 2.0	2.0 - 4.0	4.0 - 6.0	6.0 - 8.0	13.5 - 15.0
WATER CONTENT, W%	19.6	21.3	31.6	31.3	20.4

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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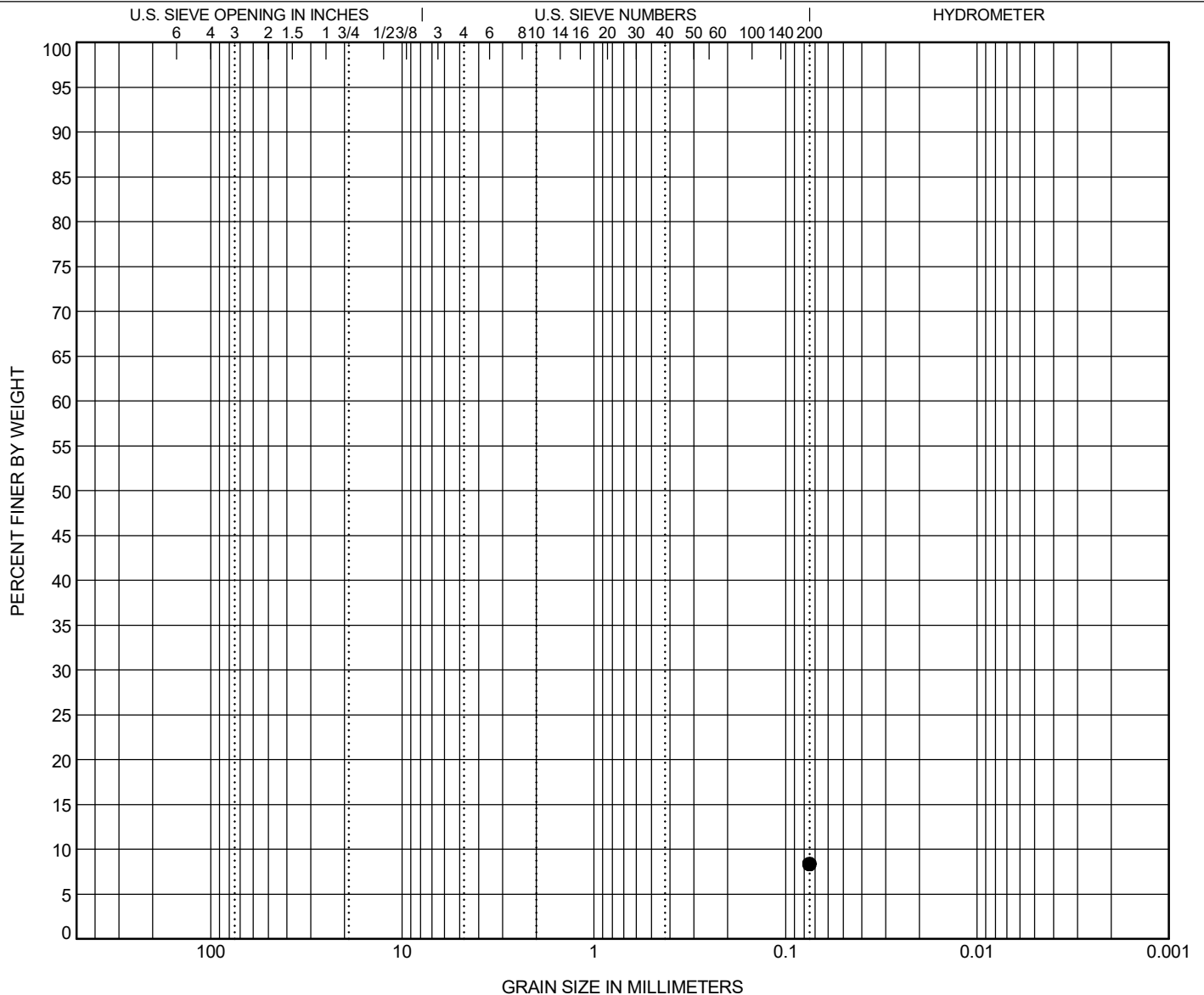


GRAIN SIZE DISTRIBUTION

PROJECT ID P041238

PROJECT NAME SC 49 Fairforest Creek

PROJECT COUNTY Union County



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

BOREHOLE	DEPTH	Classification					LL	PL	PI	Cc	Cu
● B-44	6.0	POORLY GRADED SAND (SP-SM) with SILT									
BOREHOLE	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt		%Clay	
● B-44	6.0	0.075						8.4			

F&ME CONSULTANTS, INC.

MOISTURE CONTENT DETERMINATION (AASHTO T265)

PROJECT: SC 49 Fairforest Creek **SCDOT PROJECT ID:** P041238
SAMPLE NUMBER: 23-0116 **DATE SAMPLE RECEIVED:** 1/19/2023
DESCRIPTION OF SOIL: Various
TESTED BY: CM & DH **DATE SETUP:** 1/20/2023
WEIGHED BY: MD **DATE OF WEIGHING:** 1/23/2023

BORING NO.	B-44	B-44	B-44	B-44	
SAMPLE NO.	SS-1	SS-2	SS-3	SS-5	
SAMPLE DEPTH (FT.)	0.0 - 2.0	2.0 - 4.0	4.0 - 6.0	8.0 - 10.0	
WATER CONTENT, W%	32.2	14.9	13.7	14.6	

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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CHLORIDE ION CONTENT IN SOILS

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

Client: F&ME Consultants, Inc.
 Client Reference: SC 49 Fairforest Cr.
 Project No.: 2023-076-001
 Lab ID: 2023-076-001-001

Boring No.: B-44
 Depth (ft): 4.0-6.0'
 Sample No.: SS-3
 Description: Brown Soil

(- # 10 Sieve material)

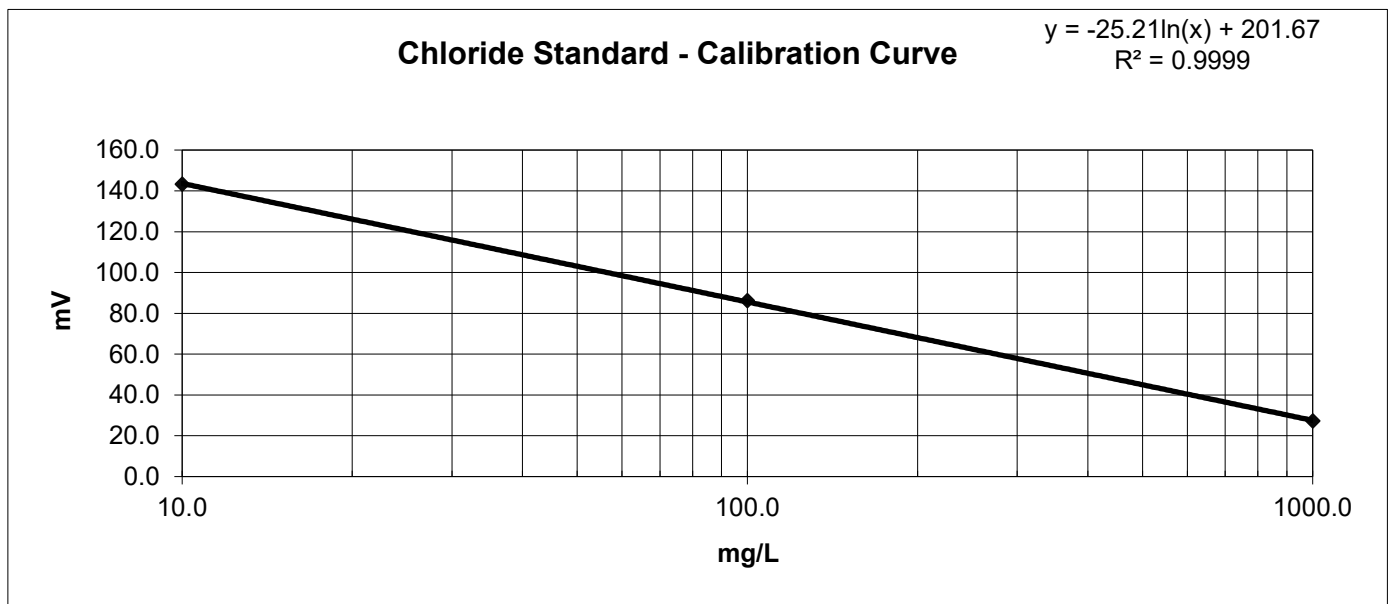
CHLORIDE STANDARD: CALIBRATION CURVE

STANDARD	MILLIVOLTS (mV)
10.0 mg/L	143.3
100.0 mg/L	86.2
1000.0 mg/L	27.2

MEASUREMENT OF CHLORIDES

Sample Weight (g):	100.0	CONCENTRATION	CONCENTRATION
Water added to Sample (ml):	100.0	(mg/L)	(mg/kg)
Size of Sample Aliquot (ml):	25.0		
Sample Reading (mV):	144.3	9.73	9.73

Notes: 1) Samples and standards were buffered by the addition of an equal volume of the 0.2 M KNO₃ solution (1:1 volume).
 2) Samples were dried for a minimum of 12 hours at 110 ± 5°C.



Notes:

Tested By JAM Date 2/14/23 Checked By JLK Date 2/15/23

F&ME CONSULTANTS
3112 Devine Street
Columbia, South Carolina 29205

pH Determination
(AASHTO T289)

Project Name:	SC 49 RBO Fairforest Creek	SCDOT Project ID:	P041238
Sample Location:	B-44	Sample Elev./Depth:	4.0 - 6.0
Sample Description:	Poorly Graded <u>SAND (SP-SM)</u> with Silt	Date Sampled:	1/19/2023
Tested By:	R. Coldiron	Date Tested:	1/23/2023

FME Lab ID No.	23-0194			
Sample ID	B-44			
Depth (ft.)	4.0 - 6.0			
pH Value	6.37			
Temperature (°C)	19.6			

Date Reviewed: 1/3/2023Reviewed By: J. Hiers

**SOIL RESISTIVITY
(AASHTO T288)**

Project Name:	SC 49 RBO Fairforest Creek	SCDOT Project ID:	P041238
Location:	Union County, SC	FME Lab ID No.:	23-0194
Sampled By:	HDR	Date Sampled:	1/19/2023
Soil Description:	Poorly Graded <u>SAND (SP-SM)</u> with Silt	Date Received:	1/19/2023
Tested By:	CM	Date Tested:	2/7/2023

Boring No.	Sample Depth (ft.)	Minimum Soil Resistivity, Ω -cm
B-44	4.0 - 6.0	14,720

Date Reviewed: 2/9/2023 Reviewed By: J. Hiers

Water-Soluble Sulfate Ion Content in Soil

AASHTO T 290-95 (2020)

Client: F&ME Consultants, Inc.
 Client Reference: SC 49 Fairforest Cr.
 Project No.: 2023-076-001
 Lab ID: 2023-076-001-001

Boring No.: B-44
 Depth (ft): 4.0-6.0'
 Sample No.: SS-3
 Soil Description: Brown Soil

Sulfate Standard - Calibration Curve Spectrophotometer Readings

<u>Sulfate Ion Concentrations (mg/L)</u>								
0.0	4.0	10.0	20.0	30.0	40.0	60.0	80.0	100.0
<u>Spectrophotometer Readings (FAU)</u>								
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 BaCl₂·2H₂O)

Sample Weight (g): 100.0
 Water added to Sample (mL): 300.0
 Size of Sample Aliquot (mL): 50.0
 Sample Reading (FAU): 20

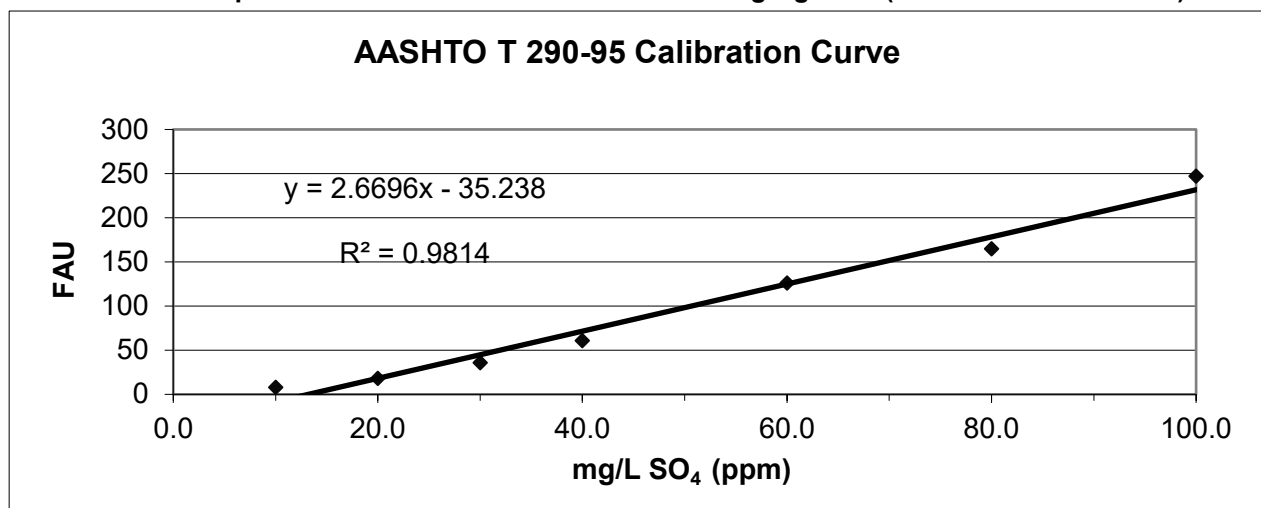
Sample Diluted: No

Sulfate Solution Added (ml): 0

Sample Moisture Content

Tare Number: 1694
 Weight of Tare & Wet Sample (g): 186.03
 Weight of Tare & Dry Sample (g): 185.82
 Weight of Tare (g): 83.16
 Weight of Water (g): 0.21
 Weight of Dry Sample (g): 102.66
 Moisture Content (%): 0.20

Sample Sulfate Ion Concentration:	20.69	mg/L SO ₄ (ppm)
Sample Sulfate Ion Content:	62.1	mg/Kg SO ₄ (not corrected for moisture)
Sample Sulfate Ion Content:	62.2	mg/Kg SO ₄ (corrected for moisture)



Tested by: JAM Date: 2/15/23 Checked by: BRB Date: 2/16/2023

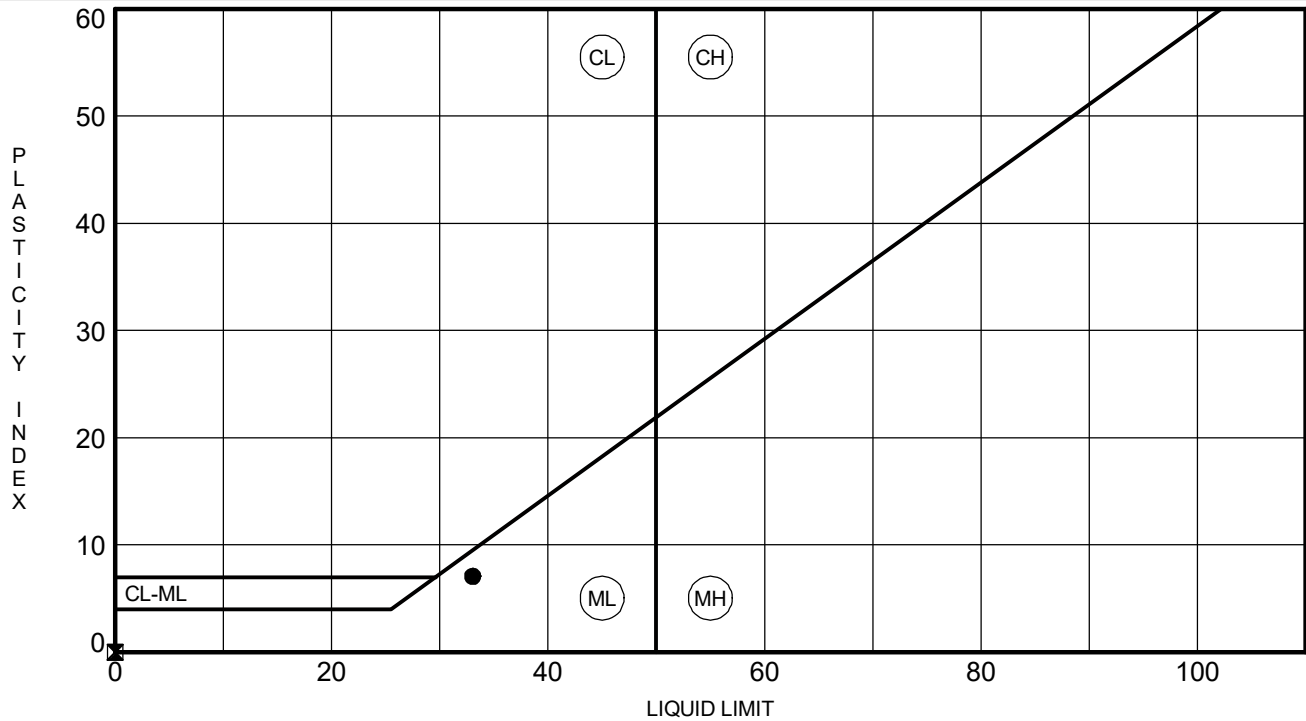
page 1 of 1 DCN: CT-S87 DATE: 3/5/2020 REVISION: 1

ATTERBERG LIMITS' RESULTS

PROJECT ID P041238

PROJECT NAME SC 49 Fairforest Creek

PROJECT COUNTY Union County

[illegible]

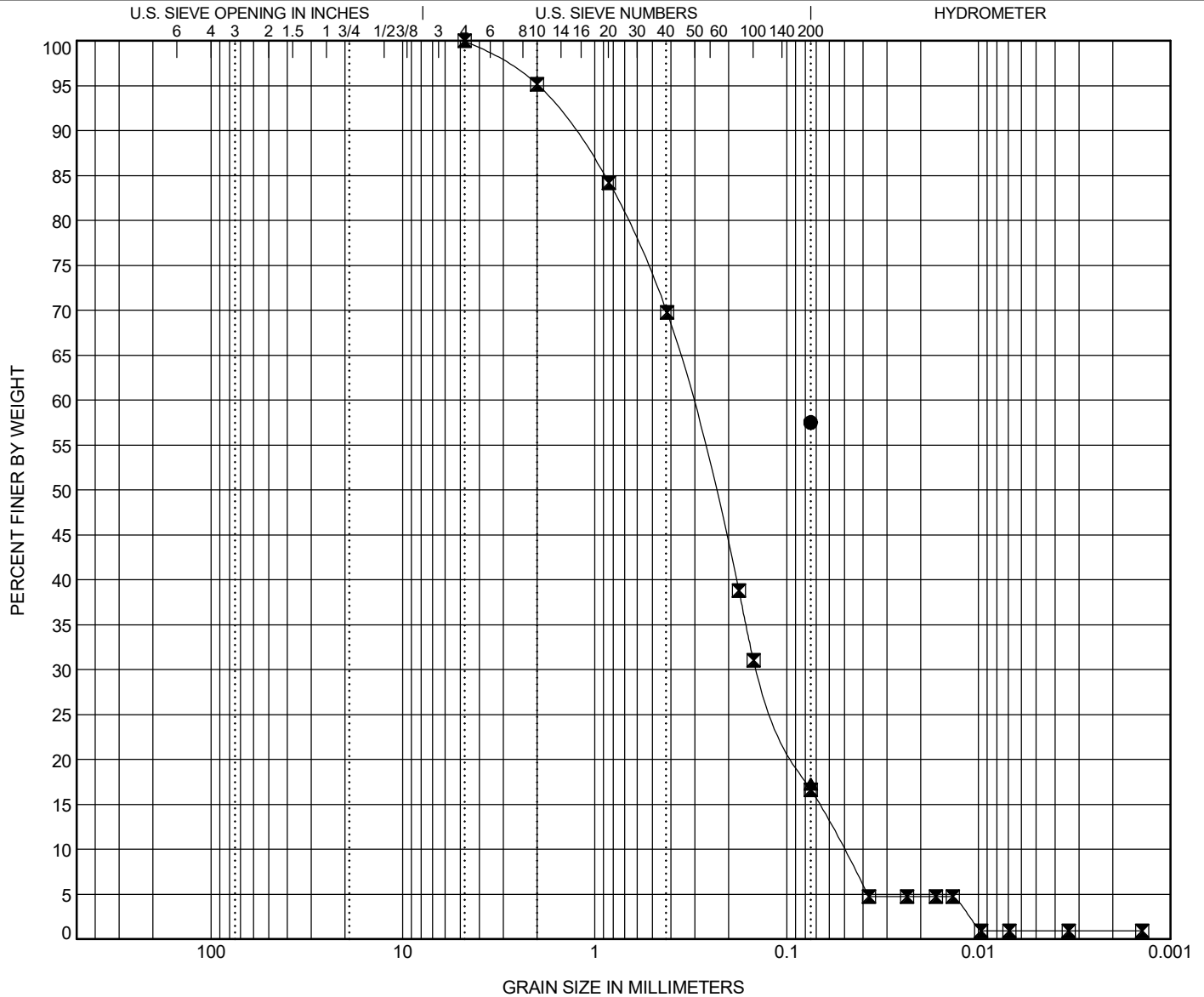


GRAIN SIZE DISTRIBUTION

PROJECT ID P041238

PROJECT NAME SC 49 Fairforest Creek

PROJECT COUNTY Union County



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

BOREHOLE	DEPTH	Classification					LL	PL	PI	Cc	Cu
● B-45	4.0	SANDY SILT (ML/A-4)					33	26	7		
☒ B-45	6.0	SILTY SAND (SM/A-2-4)					NP	NP	NP	1.24	6.30
▲ B-45	8.0	SILTY SAND (SM)									
BOREHOLE	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt		%Clay	
● B-45	4.0	0.075						57.5			
☒ B-45	6.0	4.76	0.32	0.142	0.051	0.0	83.3	15.7		0.9	
▲ B-45	8.0	0.075						17.3			

F&ME CONSULTANTS, INC.

MOISTURE CONTENT DETERMINATION (AASHTO T265)

PROJECT: SC 49 Fairforest Creek **SCDOT PROJECT ID:** P041238
SAMPLE NUMBER: 23-0117 **DATE SAMPLE RECEIVED:** 1/19/2023
DESCRIPTION OF SOIL: Various
TESTED BY: CM & DH **DATE SETUP:** 1/20/2023
WEIGHED BY: MD **DATE OF WEIGHING:** 1/23/2023

BORING NO.	B-45	B-45	B-45		
SAMPLE NO.	SS-2	SS-3	SS-4		
SAMPLE DEPTH (FT.)	2.0 - 4.0	4.0 - 6.0	6.0 - 8.0		
WATER CONTENT, W%	54.2	12.5	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%					



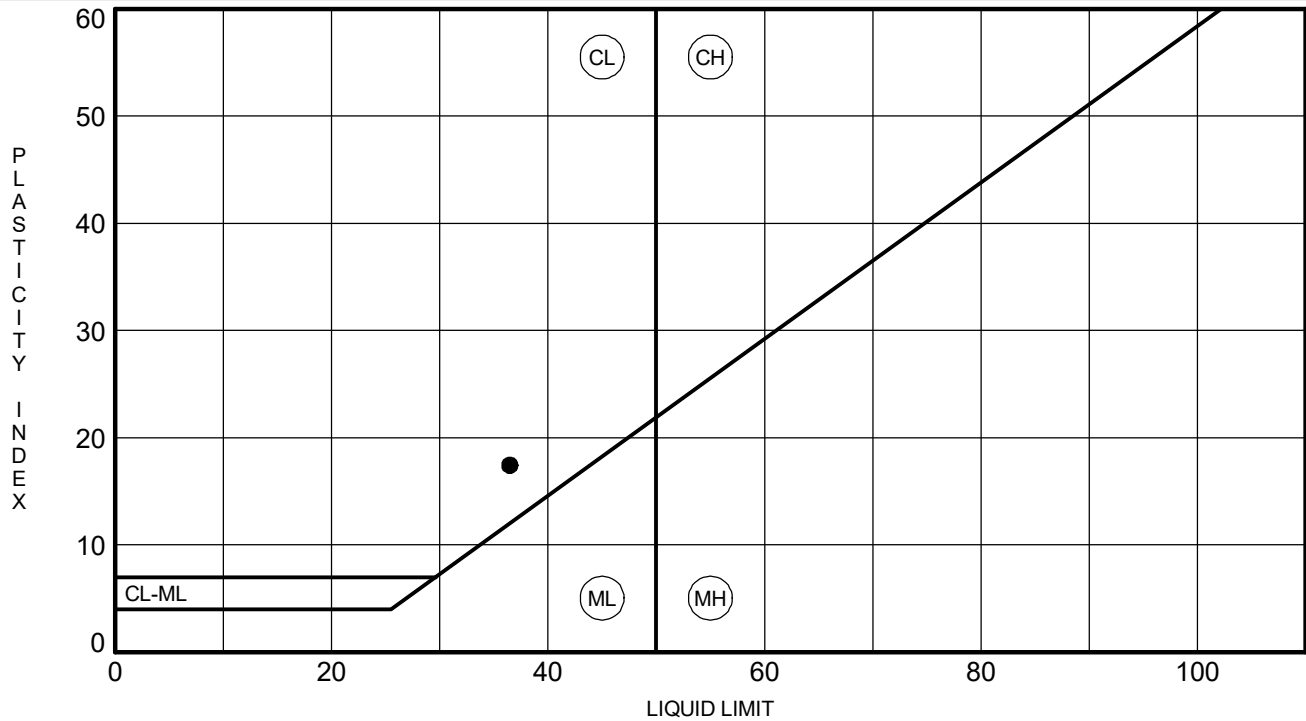
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ATTERBERG LIMITS' RESULTS

PROJECT ID P041238

PROJECT NAME SC 49 Fairforest Creek

PROJECT COUNTY Union County

[illegible]

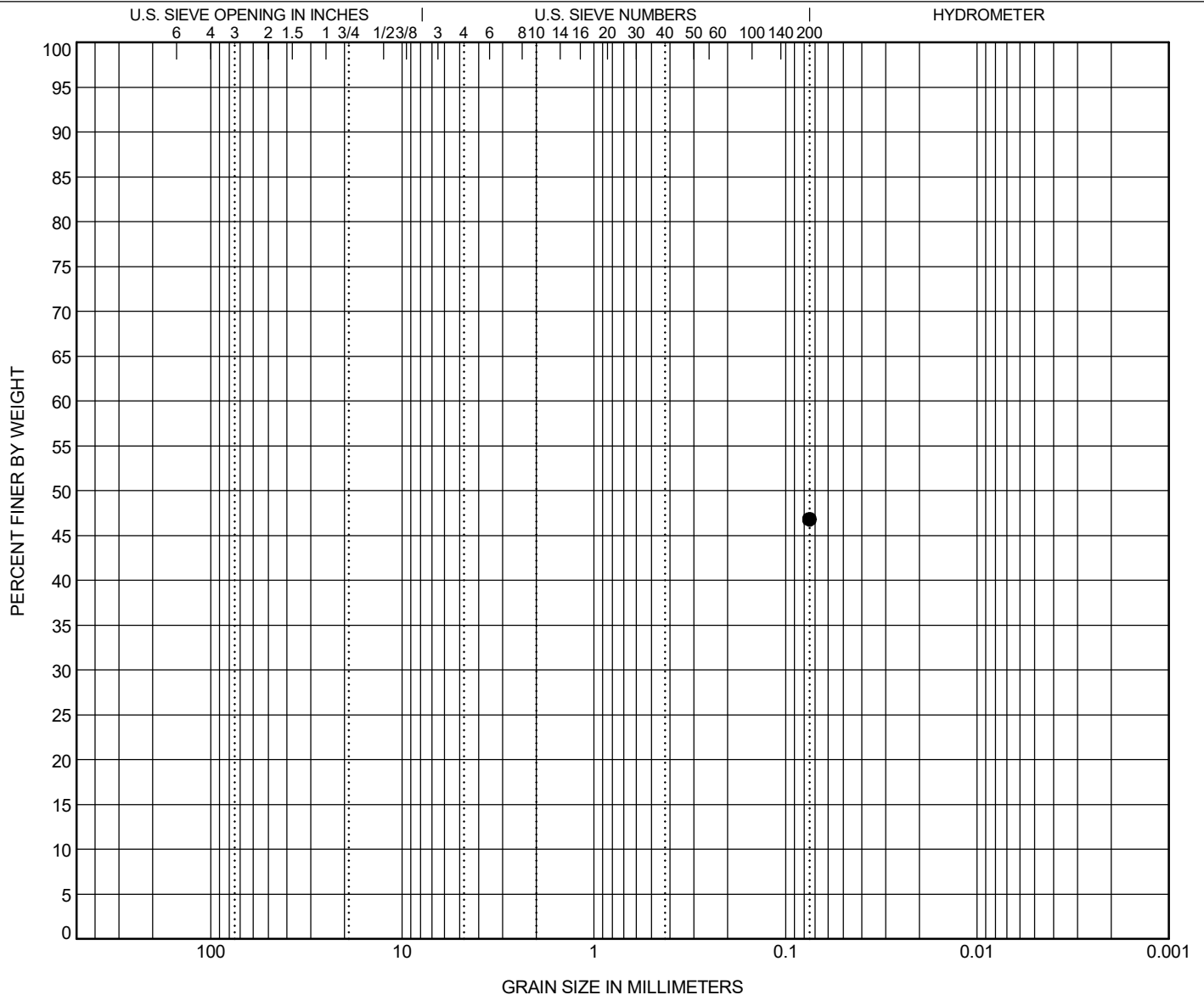


GRAIN SIZE DISTRIBUTION

PROJECT ID P041238

PROJECT NAME SC 49 Fairforest Creek

PROJECT COUNTY Union County



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

BOREHOLE	DEPTH	Classification					LL	PL	PI	Cc	Cu
● B-46	4.0	CLAYEY SAND (SC/A-6)					36	19	17		
BOREHOLE	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay		
● B-46	4.0	0.075							46.8		

F&ME CONSULTANTS, INC.

MOISTURE CONTENT DETERMINATION (AASHTO T265)

PROJECT: SC 49 Fairforest Creek **SCDOT PROJECT ID:** P041238
SAMPLE NUMBER: 23-0118 **DATE SAMPLE RECEIVED:** 1/19/2023
DESCRIPTION OF SOIL: Various
TESTED BY: CM & DH **DATE SETUP:** 1/20/2023
WEIGHED BY: MD **DATE OF WEIGHING:** 1/23/2023

BORING NO.	B-46	B-46	B-46		
SAMPLE NO.	SS-1	SS-2	SS-3		
SAMPLE DEPTH (FT.)	0.0 - 2.0	2.0 - 4.0	4.0 - 6.0		
WATER CONTENT, W%	14.2	17.0	13.7		

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%					



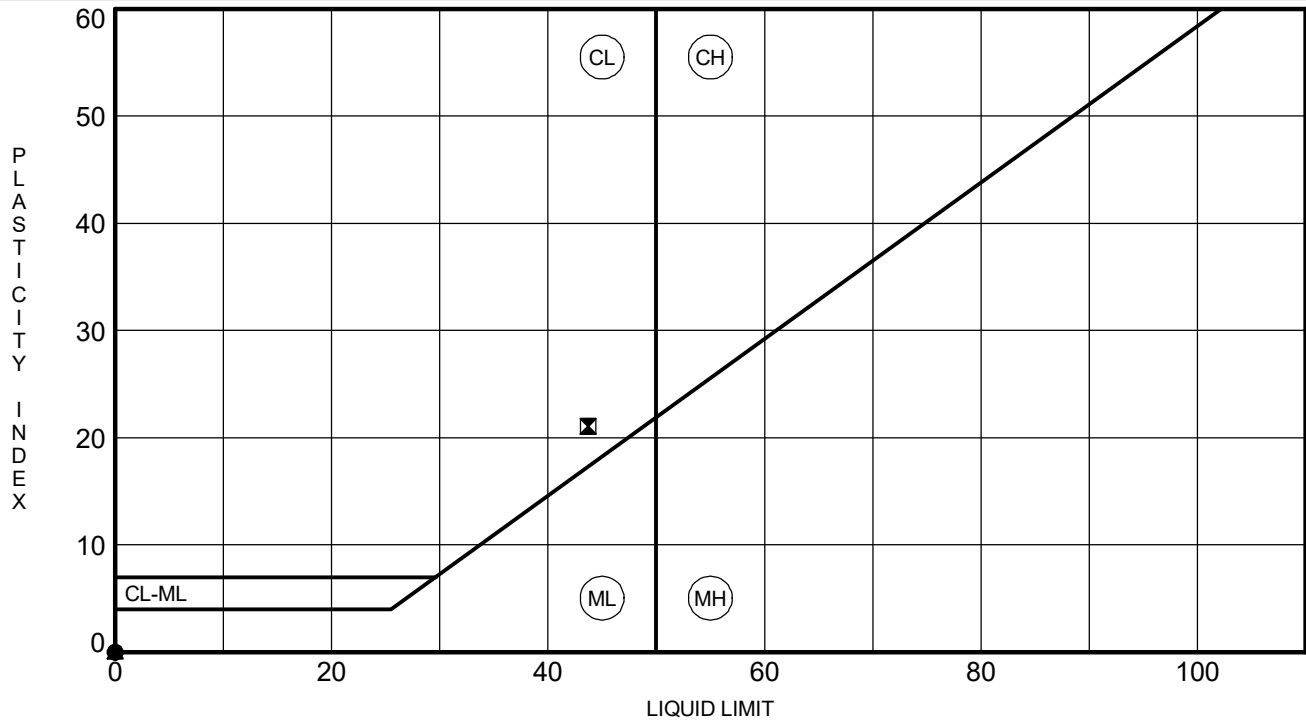
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ATTERBERG LIMITS' RESULTS

PROJECT ID P041238

PROJECT NAME SC 49 Fairforest Creek

PROJECT COUNTY Union County

[illegible]

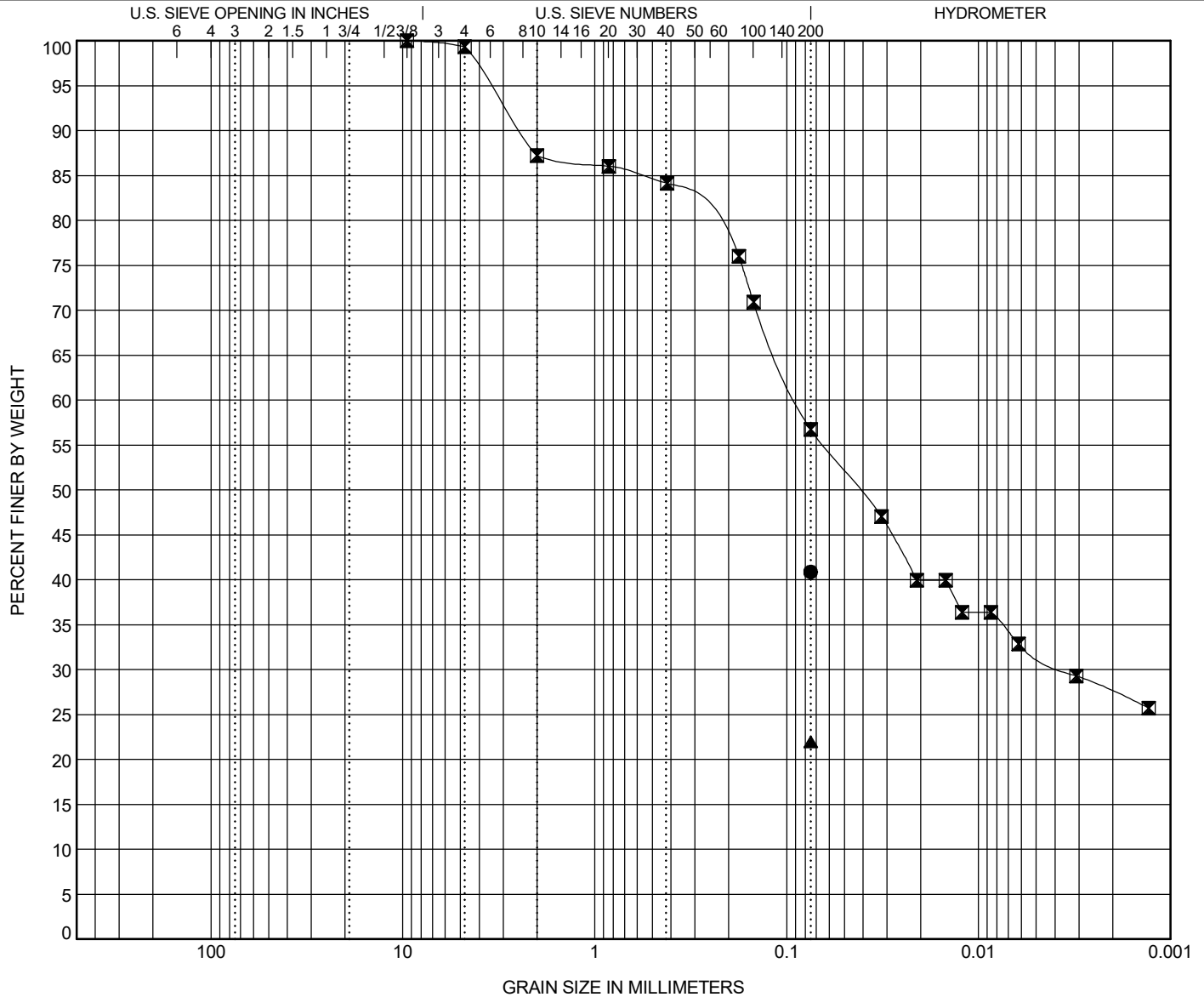


GRAIN SIZE DISTRIBUTION

PROJECT ID P041238

PROJECT NAME SC 49 Fairforest Creek

PROJECT COUNTY Union County



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

BOREHOLE	DEPTH	Classification					LL	PL	PI	Cc	Cu
● B-47	4.0	SILTY SAND (SM/A-4)					NP	NP	NP		
☒ B-47	20.0	SANDY LEAN CLAY (CL/A-7-6)					44	23	21		
▲ B-47	25.0	SILTY SAND (SM/A-2-4)					NP	NP	NP		
BOREHOLE	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt		%Clay	
● B-47	4.0	0.075						40.9			
☒ B-47	20.0	9.51	0.088	0.004		0.7	42.6	25.0		31.8	
▲ B-47	25.0	0.075						22.0			

F&ME CONSULTANTS, INC.

MOISTURE CONTENT DETERMINATION (AASHTO T265)

PROJECT: SC 49 Fairforest Creek **SCDOT PROJECT ID:** P041238
SAMPLE NUMBER: 23-0119 **DATE SAMPLE RECEIVED:** 1/19/2023
DESCRIPTION OF SOIL: Various
TESTED BY: CM & DH **DATE SETUP:** 1/20/2023
WEIGHED BY: MD **DATE OF WEIGHING:** 1/23/2023

BORING NO.	B-47	B-47	B-47	B-47	B-47
SAMPLE NO.	SS-2	SS-4	SS-6	SS-7	SS-8
SAMPLE DEPTH (FT.)	2.0 - 4.0	6.0 - 8.0	13.5 - 15.0	18.5 - 20.0	23.5 - 25.0
WATER CONTENT, W%	6.9	17.0	21.1	28.6	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

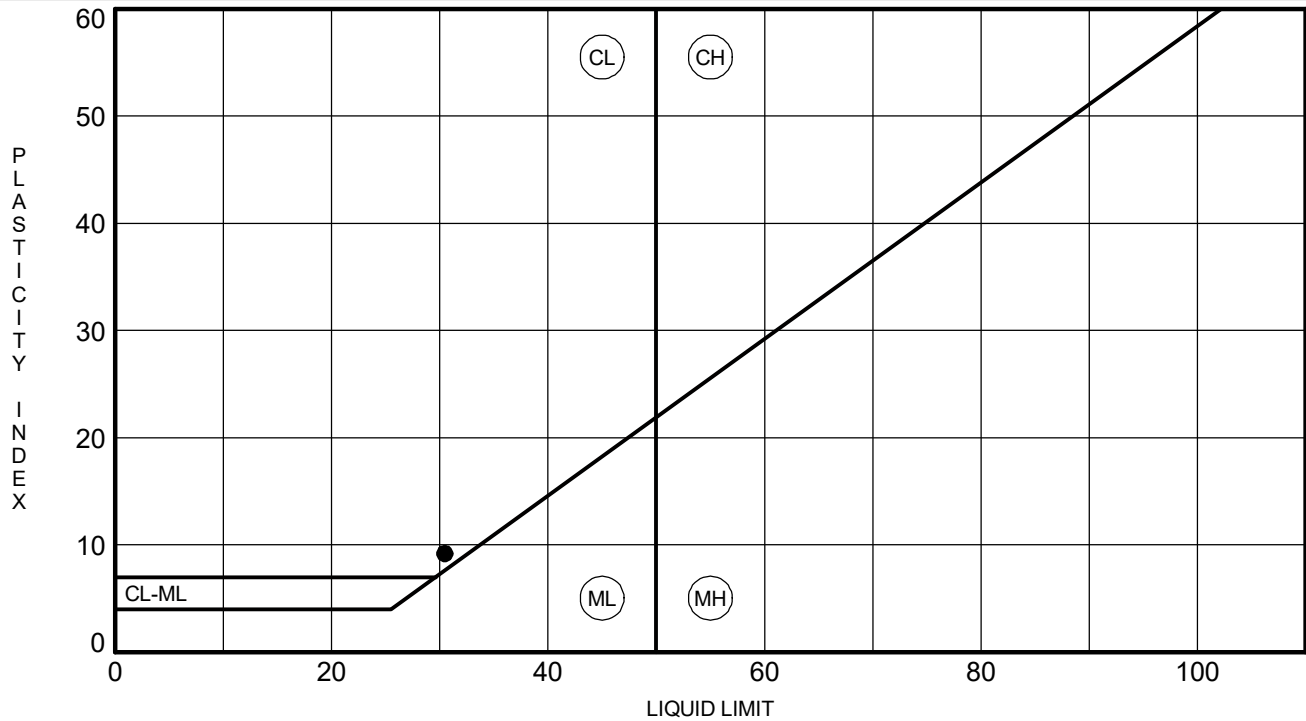
Bulk Samples

ATTERBERG LIMITS' RESULTS

PROJECT ID P041238

PROJECT NAME SC 49 Fairforest Creek

PROJECT COUNTY Union County

[illegible]

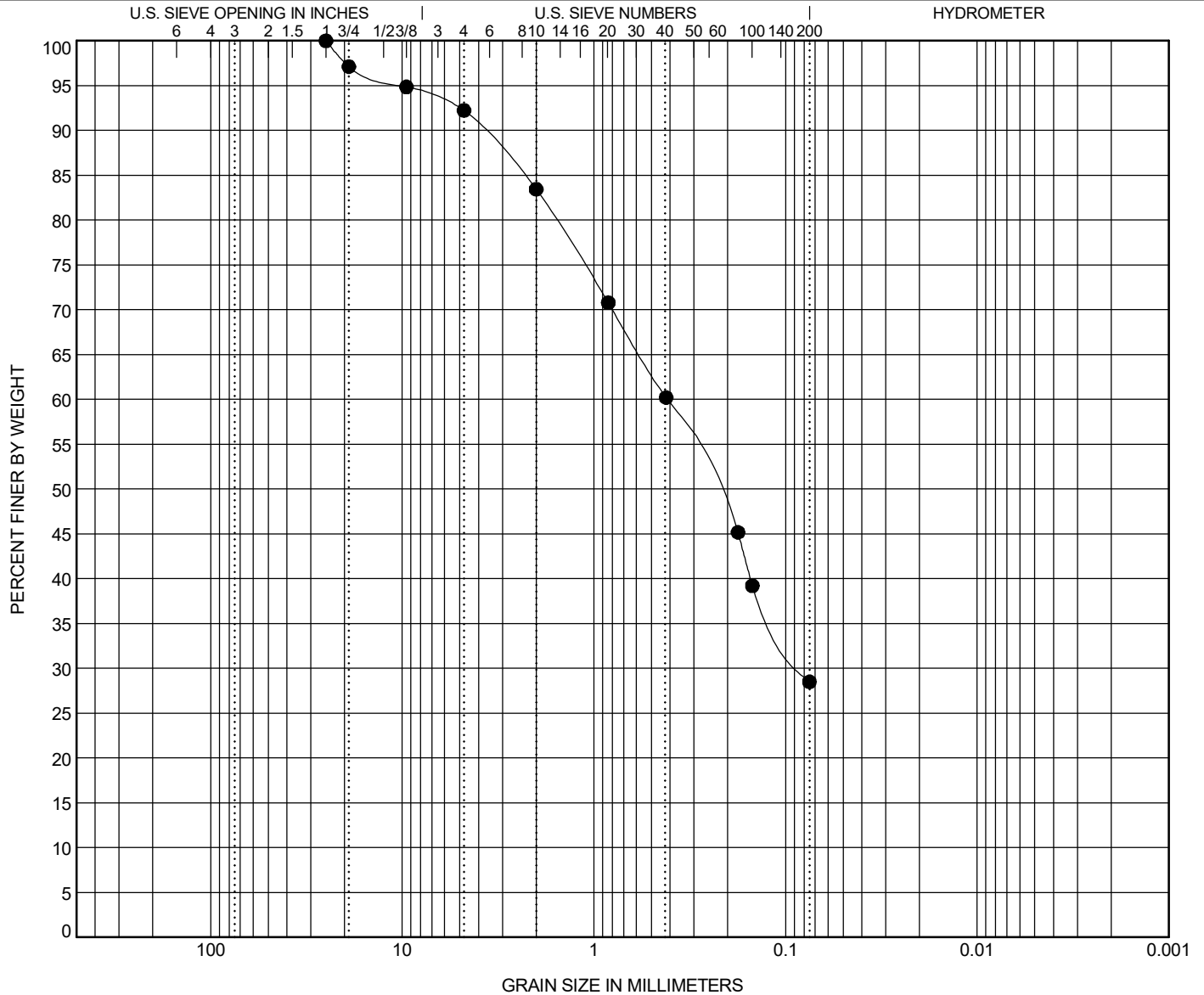


GRAIN SIZE DISTRIBUTION

PROJECT ID P041238

PROJECT NAME SC 49 Fairforest Creek

PROJECT COUNTY Union County



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

BOREHOLE	DEPTH	Classification					LL	PL	PI	Cc	Cu
● BS-5	5.0	CLAYEY SAND (SC/A-2-4)					30	21	9		
BOREHOLE	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt		%Clay	
● BS-5	5.0	25	0.415	0.083		7.8	63.7	28.5			

F&ME CONSULTANTS, INC.

MOISTURE CONTENT DETERMINATION (AASHTO T265)

PROJECT: SC 49 Fairforest Creek **SCDOT PROJECT ID:** P041238
SAMPLE NUMBER: 23-0120 **DATE SAMPLE RECEIVED:** 1/19/2023
DESCRIPTION OF SOIL: Clayey SAND (SC/A-2-4)
TESTED BY: CM & DH **DATE SETUP:** 1/20/2023
WEIGHED BY: MD **DATE OF WEIGHING:** 1/23/2023

BORING NO.	BS-5				
SAMPLE NO.	--				
SAMPLE DEPTH (FT.)	0.0 - 5.0				
WATER CONTENT, W%	17.5				

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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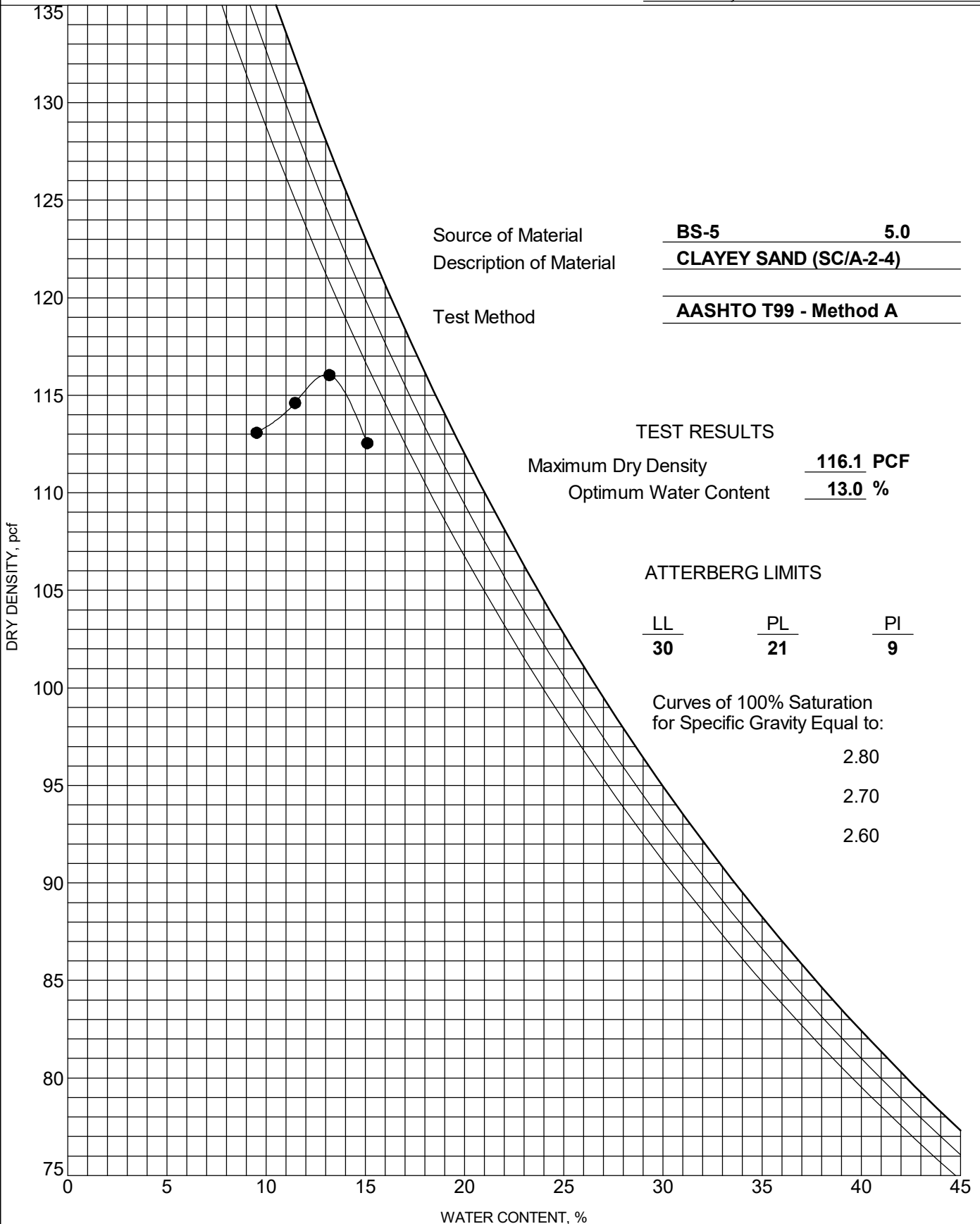


MOISTURE-DENSITY RELATIONSHIP

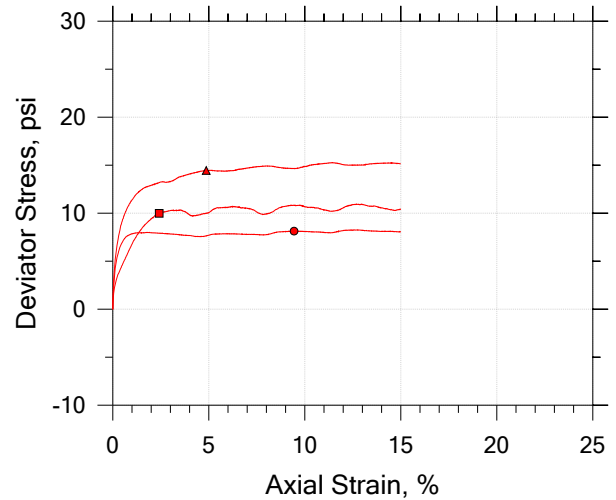
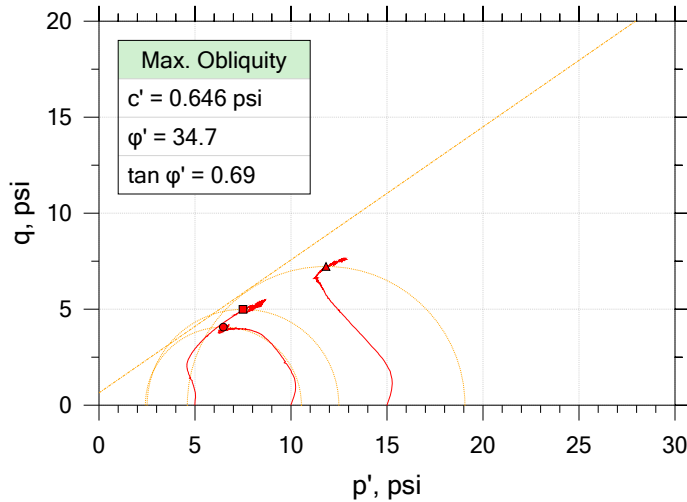
PROJECT ID P041238

PROJECT NAME SC 49 Fairforest Creek

PROJECT COUNTY Union County



Consolidated Undrained by AASHTO T297

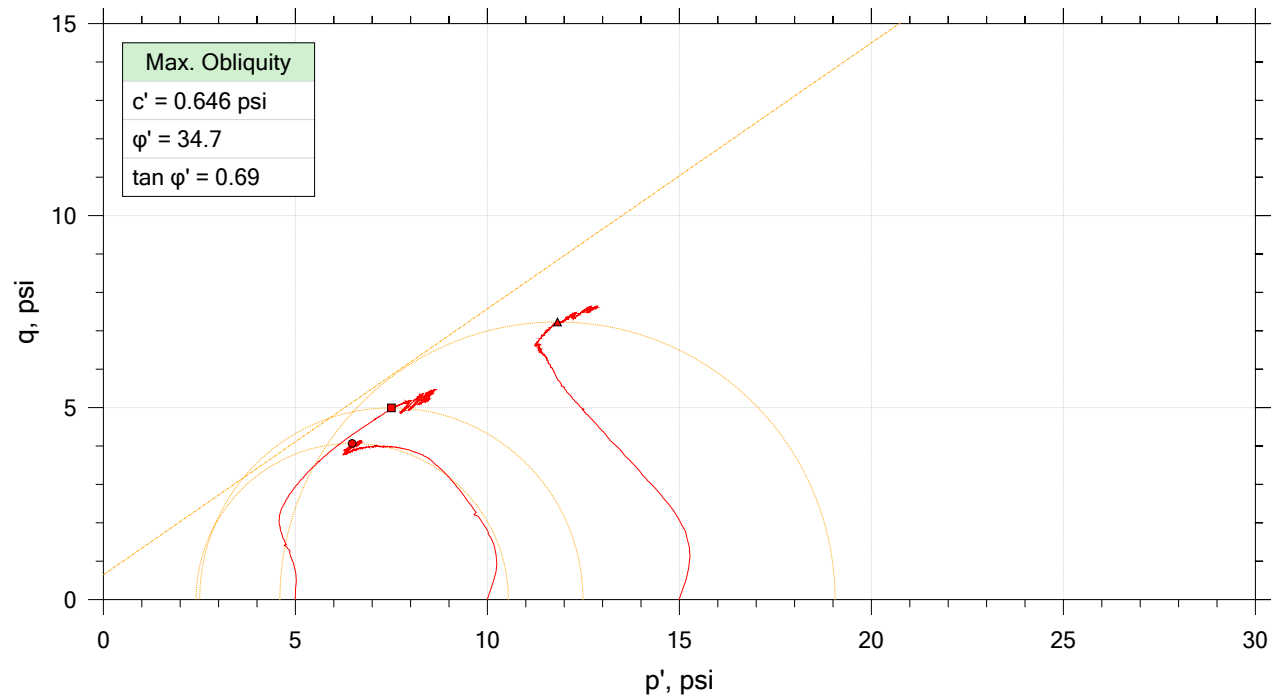
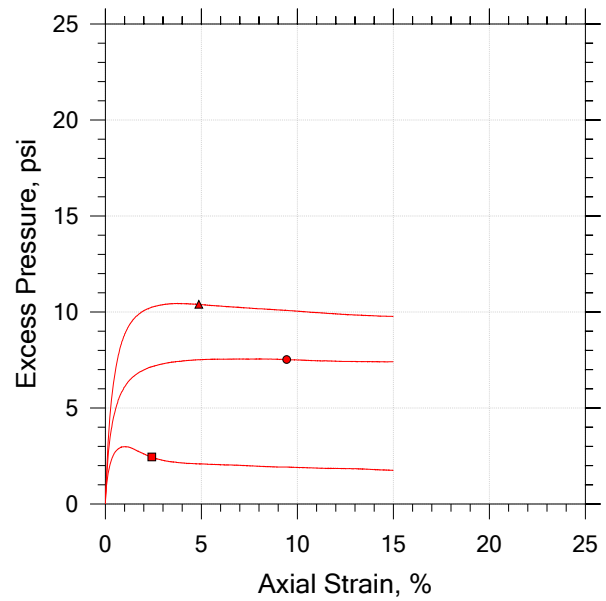
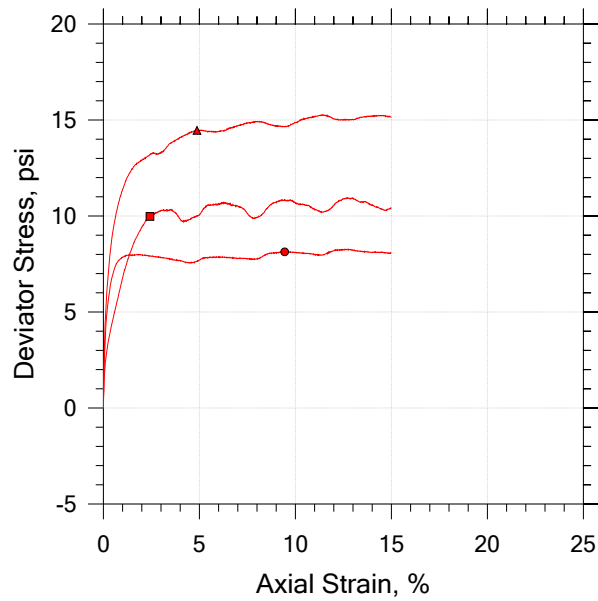


Symbol	■	●	▲	
Sample ID	23-0117	23-0117	23-0117	
Depth	0.0' - 5.0'	0.0' - 5.0'	0.0' - 5.0'	
Test Number	A.2	B.2	C.2	
Initial				
Height, in	6.000	6.000	6.000	
Diameter, in	2.800	2.800	2.800	
Moisture Content (from Cuttings), %	13.1	12.7	14.4	
Dry Density, pcf	110.	125.	109.	
Saturation (Wet Method), %	67.7	0.0	72.0	
Void Ratio	0.518	0.666	0.535	
Final				
Moisture Content, %	18.2	17.4	17.9	
Dry Density, pcf	112.	114.	113.	
Cross-Sectional Area (Method A), in ²	6.070	6.004	5.989	
Saturation, %	100.0	100.0	100.0	
Void Ratio	0.488	0.302	0.480	
Back Pressure, psi	100.8	100.8	98.00	
Vertical Effective Consolidation Stress, psi	4.980	9.971	14.93	
Horizontal Effective Consolidation Stress, psi	4.997	9.996	15.00	
Vertical Strain after Consolidation, %	0.1765	0.3571	0.7763	
Volumetric Strain after Consolidation, %	0.8807	2.561	3.319	
Time to 50% Consolidation, min	0.2600	0.0000	2.000	
Shear Strength, psi	4.990	4.066	7.230	
Strain at Failure, %	2.42	9.44	4.87	
Strain Rate, %/min	0.0005000	0.0005000	0.0005000	
Deviator Stress at Failure, psi	9.981	8.133	14.46	
Effective Minor Principal Stress at Failure, psi	2.508	2.411	4.597	
Effective Major Principal Stress at Failure, psi	12.49	10.54	19.06	
B-Value	0.94	0.92	0.93	


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 Fairforest Creek	Location: Union County	Project Number: G6659.003
	Boring Number: BS-5	Tester: RMC	Checker: WAP/ WJG
	Sample Number: 23-0117	Test Date: 2/7/2023	Depth: 0.0' - 5.0'
	Test Number: A.2B.2C.2	Preparation: Remolded	Elevation:
	Description: Clayey SAND (SC/A-7-6) LL=30, PL=21, PI=3, %200=28.5		
	Remarks: Max Dry Density=116.1 pcf, OMC=13.0%, Samples Molded at 95%		

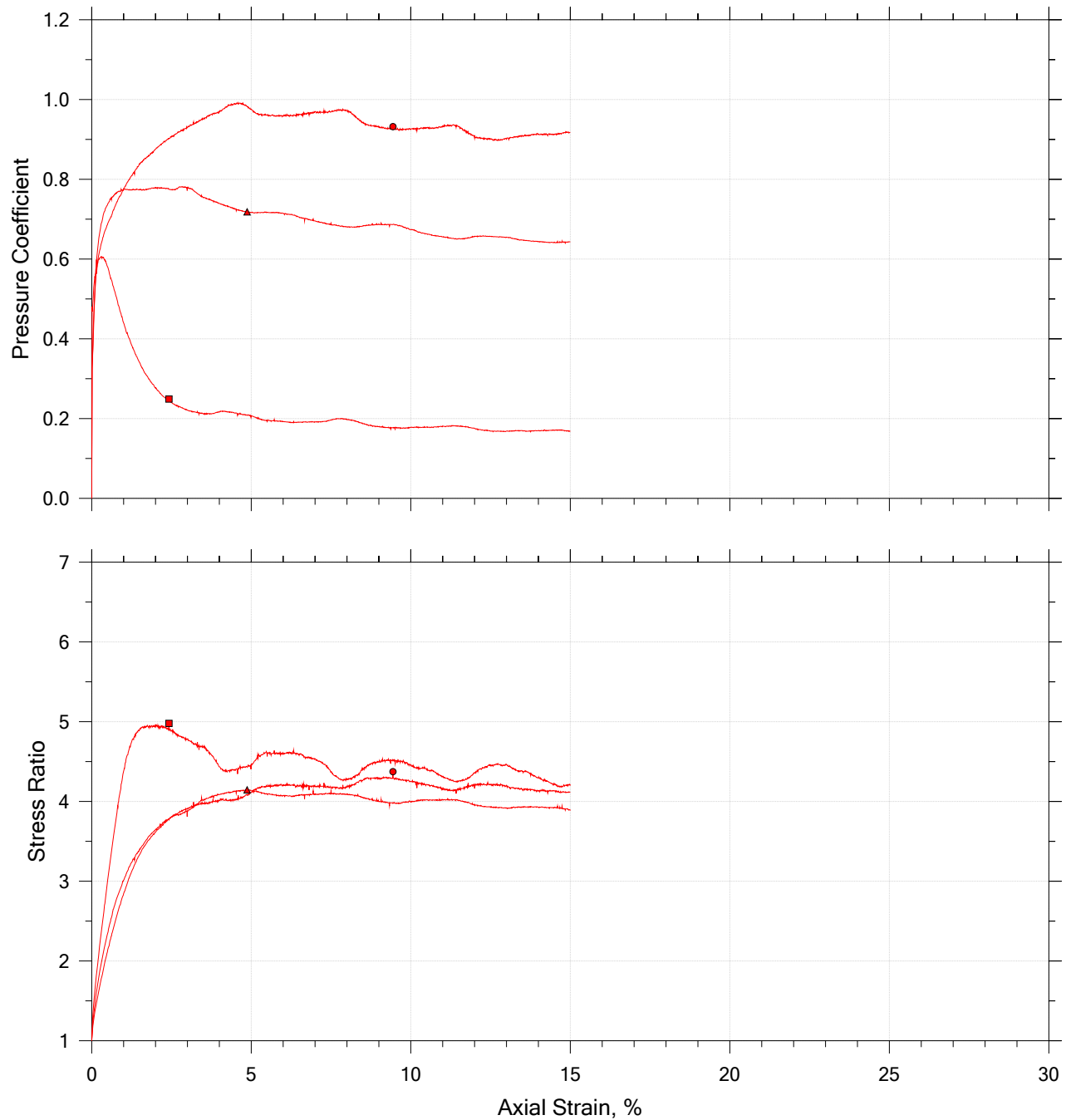
Consolidated Undrained by AASHTO T297




	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
■	23-0117	A.2	0.0' - 5.0'	RMC	2/7/2023	WAP/ WJG	2/15/2023	BS-5.A_attempt 2.dat
●	23-0117	B.2	0.0' - 5.0'	RMC	2/7/2023	WAP/ WJG	2/15/2023	BS-5.B_attempt 2.dat
▲	23-0117	C.2	0.0' - 5.0'	WAP/RMC	2/7/2023	WAP/ WJG	2/15/2023	BS-5.C_attempt2.dat

	Project Name: SC 49 Fairforest Creek	Location: Union County	Project Number: G6659.003
	Boring Number: BS-5	Tester: RMC	Checker: WAP/ WJG
	Sample Number: 23-0117	Test Date: 2/7/2023	Depth: 0.0' - 5.0'
	Test Number: A.2B.2C.2	Preparation: Remolded	Elevation:
	Description: Clayey SAND (SC/A-7-6) LL=30, PL=21, PI=3, %200=28.5		
	Remarks: Max Dry Density=116.1 pcf, OMC=13.0%, Samples Molded at 95%		

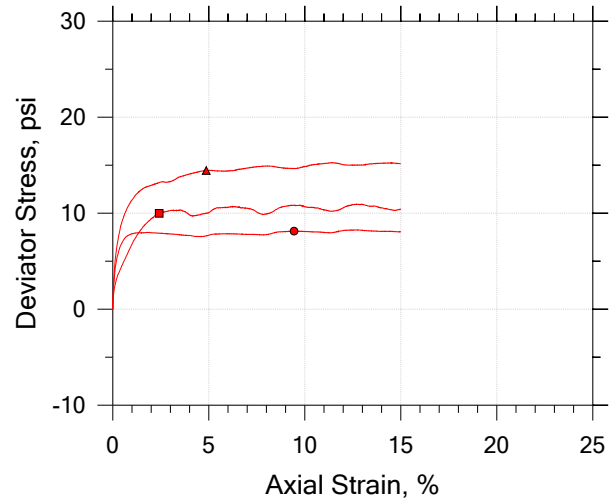
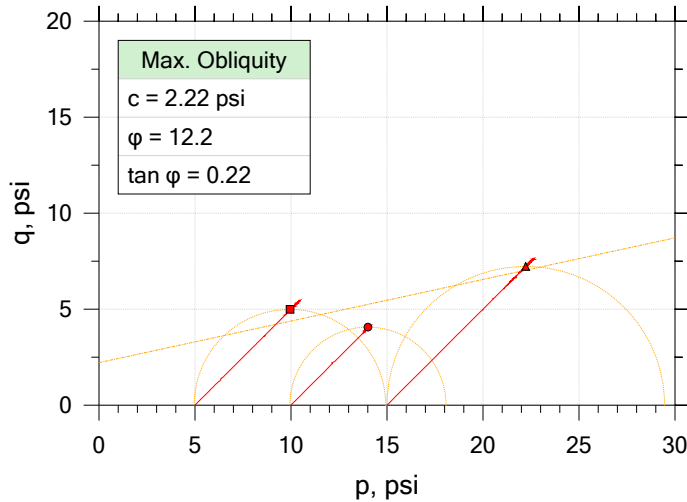
Consolidated Undrained by AASHTO T297



	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
■	23-0117	A.2	0.0' - 5.0'	RMC	2/7/2023	WAP/ WJG	2/15/2023	BS-5.A_attempt 2.dat
●	23-0117	B.2	0.0' - 5.0'	RMC	2/7/2023	WAP/ WJG	2/15/2023	BS-5.B_attempt 2.dat
▲	23-0117	C2	0.0' - 5.0'	WAP/RMC	2/7/2023	WAP/ WJG	2/15/2023	BS-5.C_attempt2.dat

	Project Name: SC 49 Fairforest Creek	Location: Union County	Project Number: G6659.003
	Boring Number: BS-5	Tester: RMC	Checker: WAP/ WJG
	Sample Number: 23-0117	Test Date: 2/7/2023	Depth: 0.0' - 5.0'
	Test Number: A.2B.2C.2	Preparation: Remolded	Elevation:
	Description: Clayey SAND (SC/A-7-6) LL=30, PL=21, PI=3, %200=28.5		
	Remarks: Max Dry Density=116.1 pcf, OMC=13.0%, Samples Molded at 95%		

Consolidated Undrained by AASHTO T297

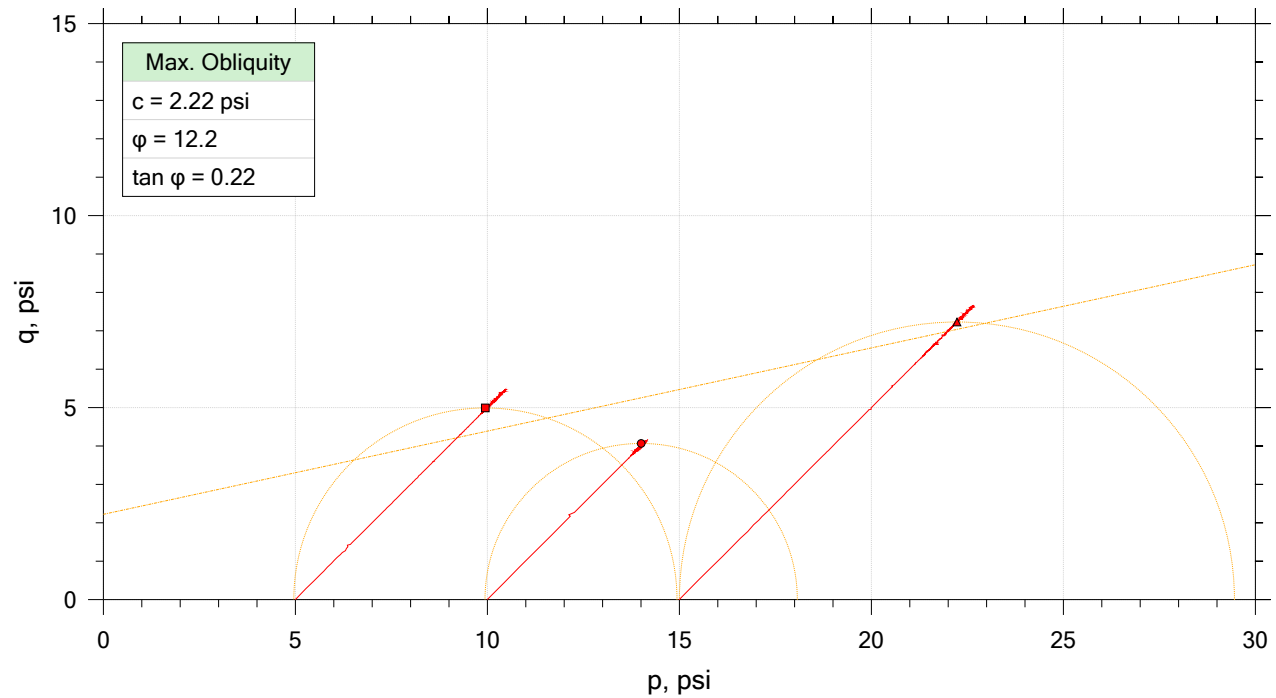
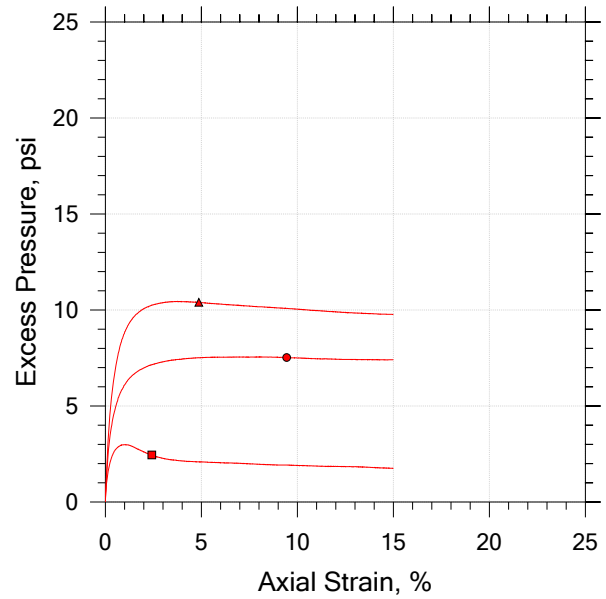
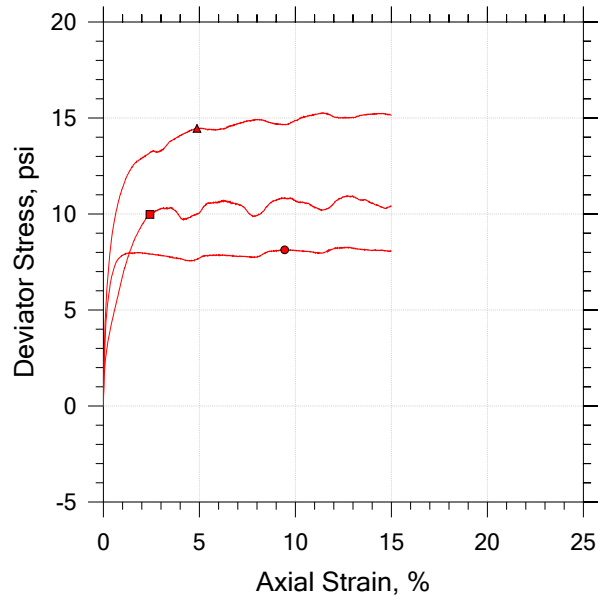


Symbol	■	●	▲	
Sample ID	23-0117	23-0117	23-0117	
Depth	0.0' - 5.0'	0.0' - 5.0'	0.0' - 5.0'	
Test Number	A.2	B.2	C.2	
Initial				
Height, in	6.000	6.000	6.000	
Diameter, in	2.800	2.800	2.800	
Moisture Content (from Cuttings), %	13.1	12.7	14.4	
Dry Density, pcf	110.	125.	109.	
Saturation (Wet Method), %	67.7	66.6	72.0	
Void Ratio	0.518	0.342	0.535	
Final				
Moisture Content, %	18.2	11.3	17.9	
Dry Density, pcf	112.	114.	113.	
Cross-Sectional Area (Method A), in ²	6.070	6.004	5.989	
Saturation, %	100.0	100.0	100.0	
Void Ratio	0.488	0.302	0.480	
Back Pressure, psi	100.8	100.8	98.00	
Vertical Effective Consolidation Stress, psi	4.980	9.971	14.93	
Horizontal Effective Consolidation Stress, psi	4.997	9.996	15.00	
Vertical Strain after Consolidation, %	0.1765	0.3571	0.7763	
Volumetric Strain after Consolidation, %	0.8807	2.561	3.319	
Time to 50% Consolidation, min	0.2600	0.0000	2.000	
Shear Strength, psi	4.990	4.066	7.230	
Strain at Failure, %	2.42	9.44	4.87	
Strain Rate, %/min	0.0005000	0.0005000	0.0005000	
Deviator Stress at Failure, psi	9.981	8.133	14.46	
Effective Minor Principal Stress at Failure, psi	2.508	2.411	4.597	
Effective Major Principal Stress at Failure, psi	12.49	10.54	19.06	
B-Value	0.94	0.92	0.93	


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 Fairforest Creek	Location: Union County	Project Number: G6659.003
	Boring Number: BS-5	Tester: RMC	Checker: WAP/ WJG
	Sample Number: 23-0117	Test Date: 2/7/2023	Depth: 0.0' - 5.0'
	Test Number: A.2B.2C.2	Preparation: Remolded	Elevation:
	Description: Clayey SAND (SC/A-7-6) LL=30, PL=21, PI=3, %200=28.5		
	Remarks: Max Dry Density=116.1 pcf, OMC=13.0%, Samples Molded at 95%		

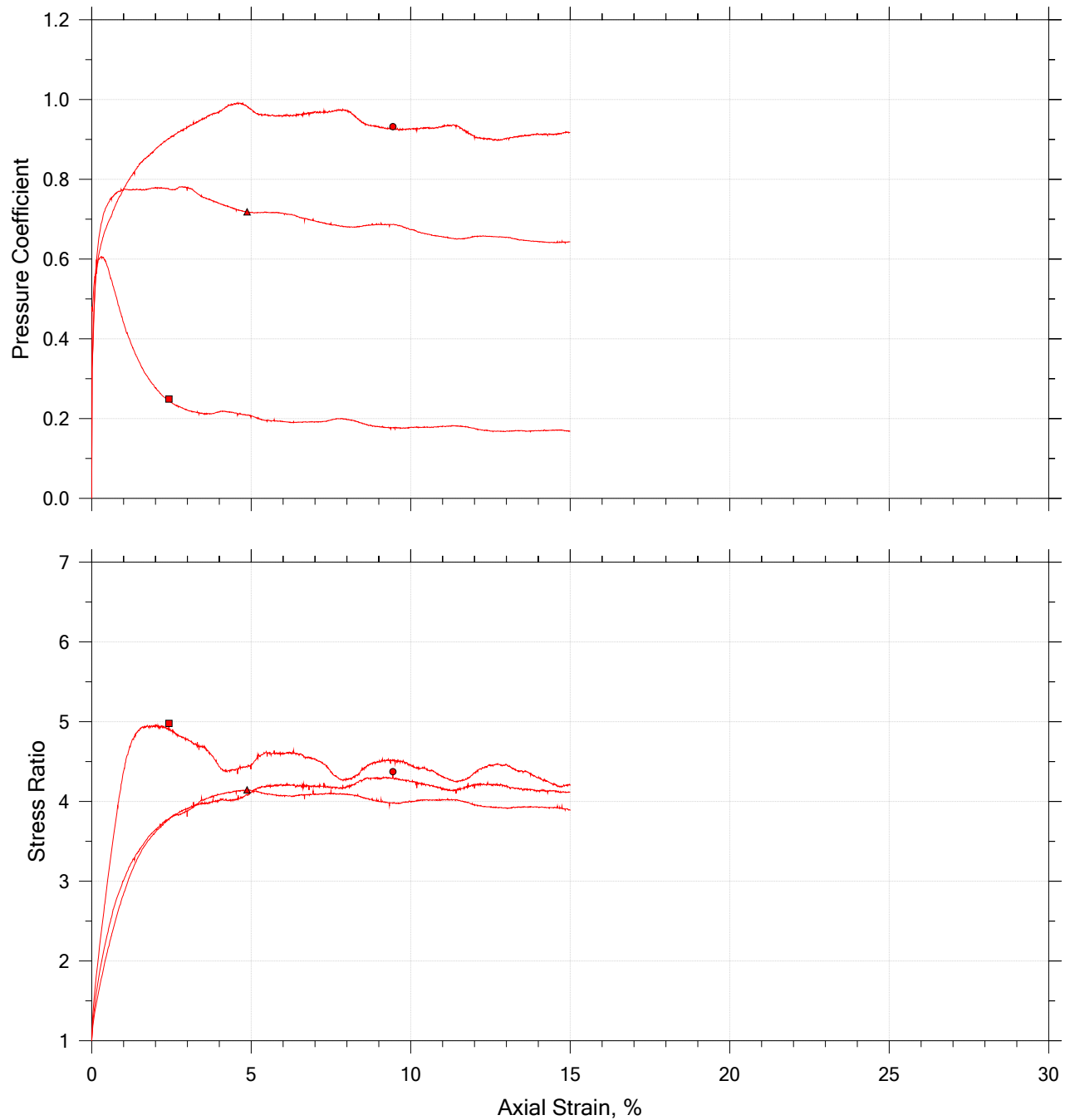
Consolidated Undrained by AASHTO T297




	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
■	23-0117	A.2	0.0' - 5.0'	RMC	2/7/2023	WAP/ WJG	2/15/2023	BS-5.A_attempt 2.dat
●	23-0117	B.2	0.0' - 5.0'	RMC	2/7/2023	WAP/ WJG	2/15/2023	BS-5.B_attempt 2.dat
▲	23-0117	C.2	0.0' - 5.0'	WAP/RMC	2/7/2023	WAP/ WJG	2/15/2023	BS-5.C_attempt2.dat

	Project Name: SC 49 Fairforest Creek	Location: Union County	Project Number: G6659.003
	Boring Number: BS-5	Tester: RMC	Checker: WAP/ WJG
	Sample Number: 23-0117	Test Date: 2/7/2023	Depth: 0.0' - 5.0'
	Test Number: A.2B.2C.2	Preparation: Remolded	Elevation:
	Description: Clayey SAND (SC/A-7-6) LL=30, PL=21, PI=3, %200=28.5		
	Remarks: Max Dry Density=116.1 pcf, OMC=13.0%, Samples Molded at 95%		

Consolidated Undrained by AASHTO T297



	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
■	23-0117	A.2	0.0' - 5.0'	RMC	2/7/2023	WAP/ WJG	2/15/2023	BS-5.A_attempt 2.dat
●	23-0117	B.2	0.0' - 5.0'	RMC	2/7/2023	WAP/ WJG	2/15/2023	BS-5.B_attempt 2.dat
▲	23-0117	C2	0.0' - 5.0'	WAP/RMC	2/7/2023	WAP/ WJG	2/15/2023	BS-5.C_attempt2.dat

	Project Name: SC 49 Fairforest Creek	Location: Union County	Project Number: G6659.003
	Boring Number: BS-5	Tester: RMC	Checker: WAP/ WJG
	Sample Number: 23-0117	Test Date: 2/7/2023	Depth: 0.0' - 5.0'
	Test Number: A.2B.2C.2	Preparation: Remolded	Elevation:
	Description: Clayey SAND (SC/A-7-6) LL=30, PL=21, PI=3, %200=28.5		
	Remarks: Max Dry Density=116.1 pcf, OMC=13.0%, Samples Molded at 95%		



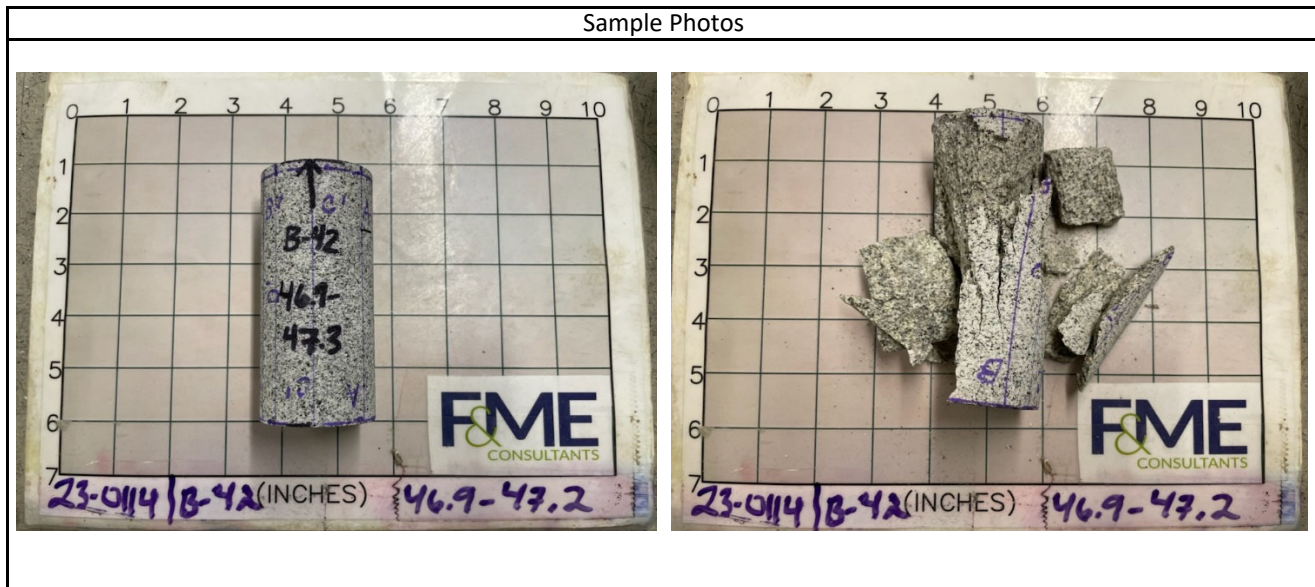
Appendix C. Laboratory Testing

Rock Cores

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

Project	SC 49 RBO Fairforest Creek			Date	2/8/2023
Project No.	G6658.003	Sample Diameter (in.)	1.865	Tested By	WAP
SCDOT ID	P041238	Sample Length (in.)	4.152	Reviewed By	WJG
Boring	B-42	Unit Weight (pcf)	164.4	Core Size	NQ
Sample No.	NQ-2 / 23-0114A	L/D Ratio	2.23	Recovery	100%
Depth	46.9' - 47.2'	Load Rate (psi/sec)	20	RQD	100%
Description	Black/White/Gray Granite				

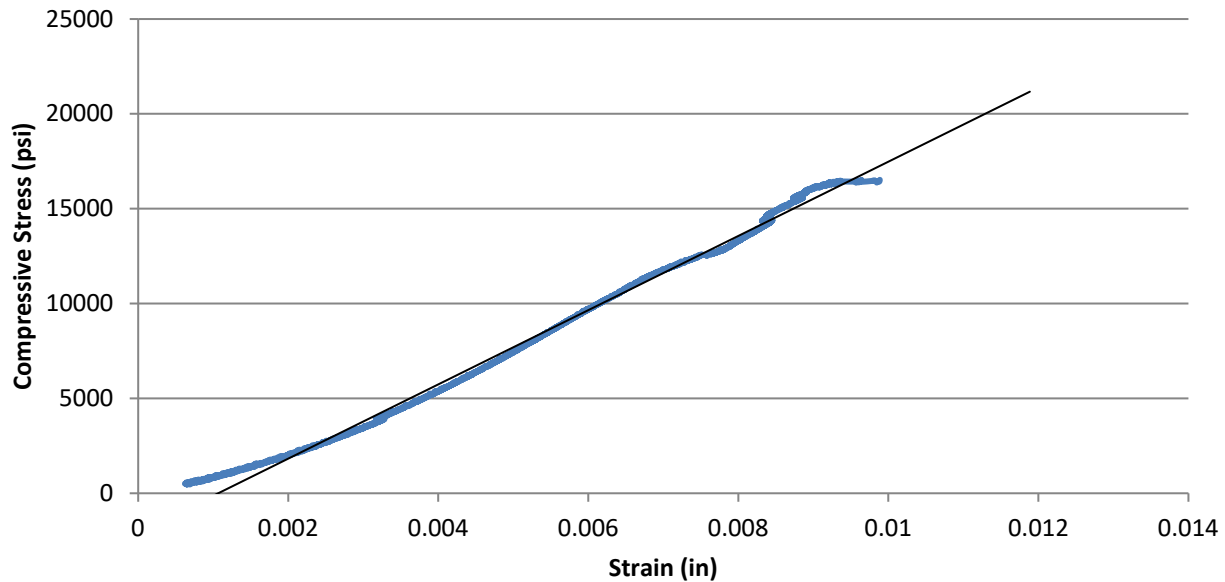
Test Data						
Percent of Failure Load	Strain (10^{-6})		Load (lbs)	Compressive Stress (psi)	Secant Modulus $\times 10^6$ (psi)	Poisson's Ratio
	Axial	Radial				
10%	-1721	69	4,541	1,662	1.93	0.04
20%	-2886	215	9,073	3,321	2.30	0.07
30%	-3779	-368	13,540	4,957	2.62	-0.10
40%	-4611	-191	18,043	6,605	2.86	-0.04
50%	-5369	13	22,585	8,268	3.08	0.00
60%	-6108	259	27,088	9,916	3.25	0.04
70%	-6865	1092	31,502	11,532	3.36	0.16
80%	-7961	3716	36,108	13,218	3.32	0.47
90%	-8496	3584	40,661	14,884	3.50	0.42
100%	-9886	10823	45,131	16,521		



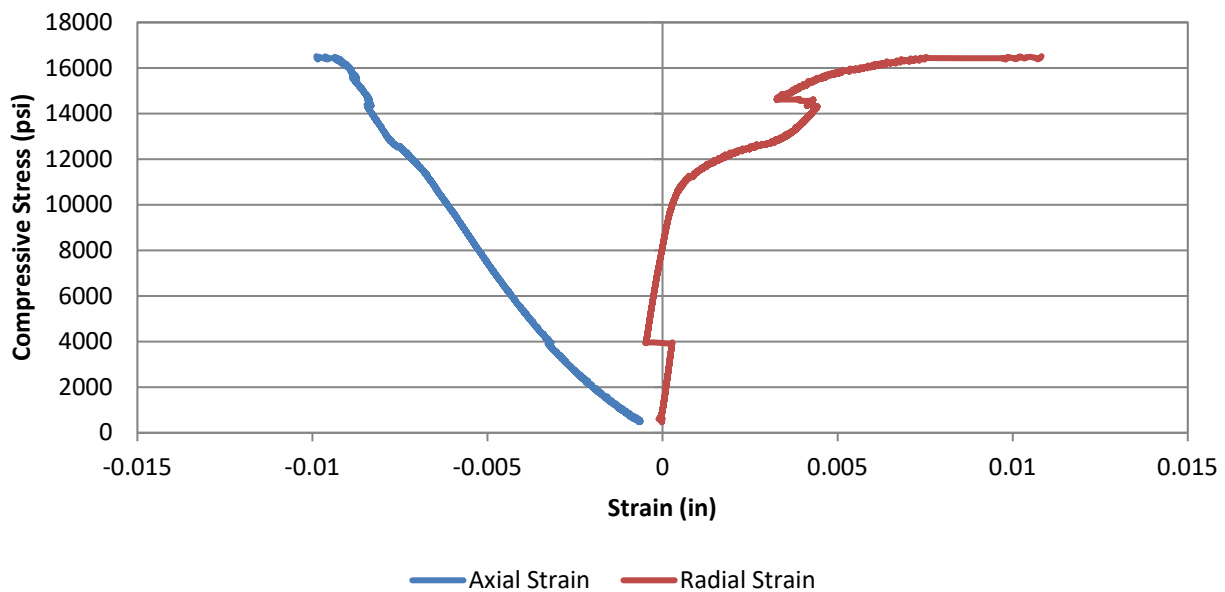
Test Results			
Unconfined Compressive Strength (psi)		16,520	Elastic Modulus (psi)
			2.71E+06
			Poisson's Ratio in Elastic Range
			N/A
Comments	Elastic range was taken as between 0.002 and 0.006 inches of axial strain. This range was chosen to avoid any non-linear behavior from the initial loading and the inflection point at the end of the elastic range. Lateral strain data for this sample does not appear reasonable or consistent. As such, a Poisson's Ratio value is not provided.		

Project	SC 49 RBO Fairforest Creek			Date	2/8/2023
Project No.	G6658.003	Sample Diameter (in.)	1.865	Tested By	WAP
SCDOT ID	P041238	Sample Length (in.)	4.152	Reviewed By	WJG
Boring	B-42	Unit Weight (pcf)	164.4	Core Size	NQ
Sample No.	NQ-2 / 23-0114A	L/D Ratio	2.23	Recovery	100%
Depth	46.9' - 47.2'	Load Rate (psi/sec)	20	RQD	100%
Description	Black/White/Gray Granite				

Axial Stress vs. Strain



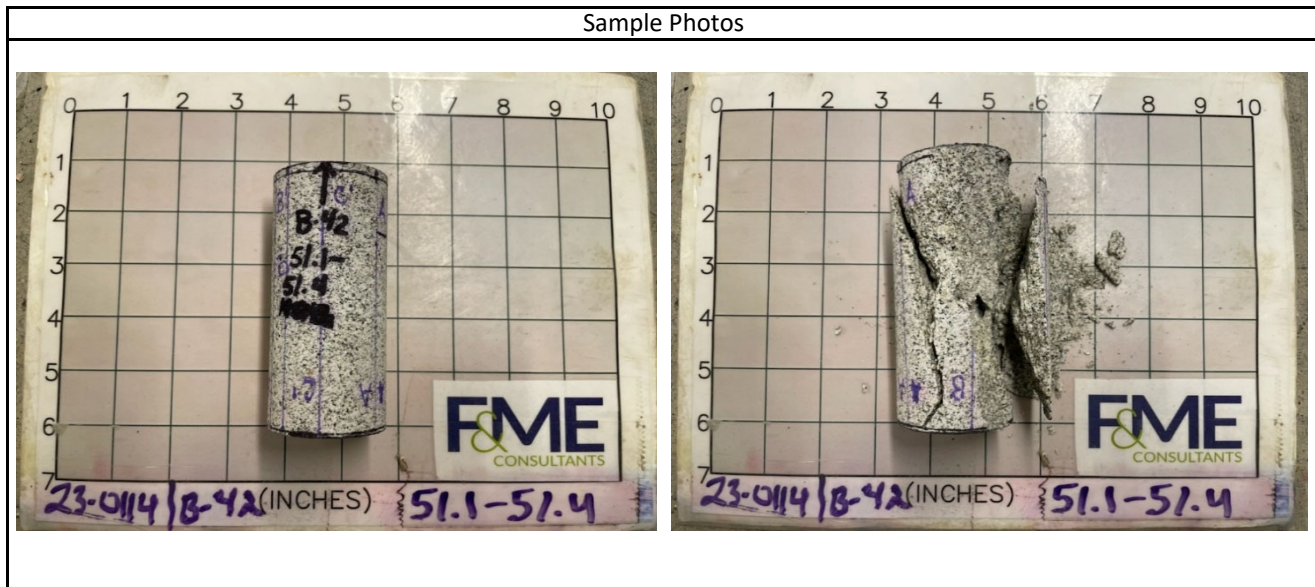
Stress vs. Strain



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

Project	SC 49 RBO Fairforest Creek			Date	2/8/2023
Project No.	G6658.003	Sample Diameter (in.)	1.865	Tested By	WAP
SCDOT ID	P041238	Sample Length (in.)	4.163	Reviewed By	WJG
Boring	B-42	Unit Weight (pcf)	163.5	Core Size	NQ
Sample No.	NQ-3 / 23-0114B	L/D Ratio	2.23	Recovery	100%
Depth	51.1' - 51.4'	Load Rate (psi/sec)	20	RQD	75%
Description	Black/White/Gray Granite				

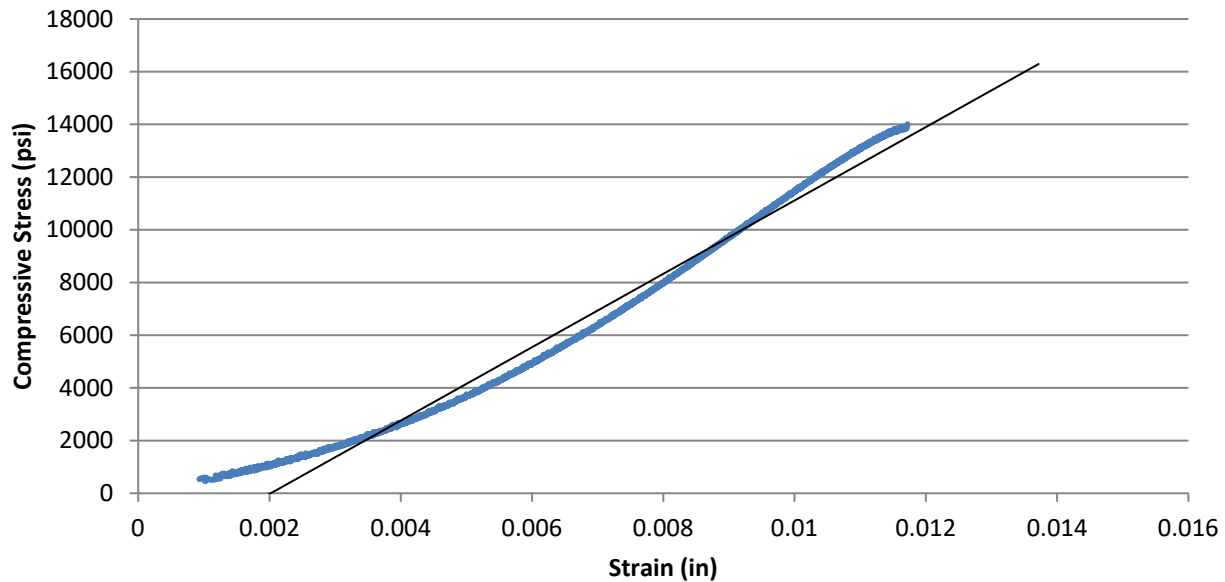
Test Data						
Percent of Failure Load	Strain (10^{-6})		Load (lbs)	Compressive Stress (psi)	Secant Modulus $\times 10^6$ (psi)	Poisson's Ratio
	Axial	Radial				
10%	-2518	432	3,830	1,402	1.11	0.17
20%	-4199	701	7,664	2,806	1.34	0.17
30%	-5397	970	11,431	4,185	1.55	0.18
40%	-6483	1300	15,322	5,609	1.73	0.20
50%	-7394	1669	19,191	7,025	1.90	0.23
60%	-8244	2097	22,934	8,395	2.04	0.25
70%	-9038	2441	26,757	9,795	2.17	0.27
80%	-9842	3107	30,561	11,187	2.27	0.32
90%	-10674	4054	34,427	12,602	2.36	0.38
100%	-11719	11731	38,250	14,002		



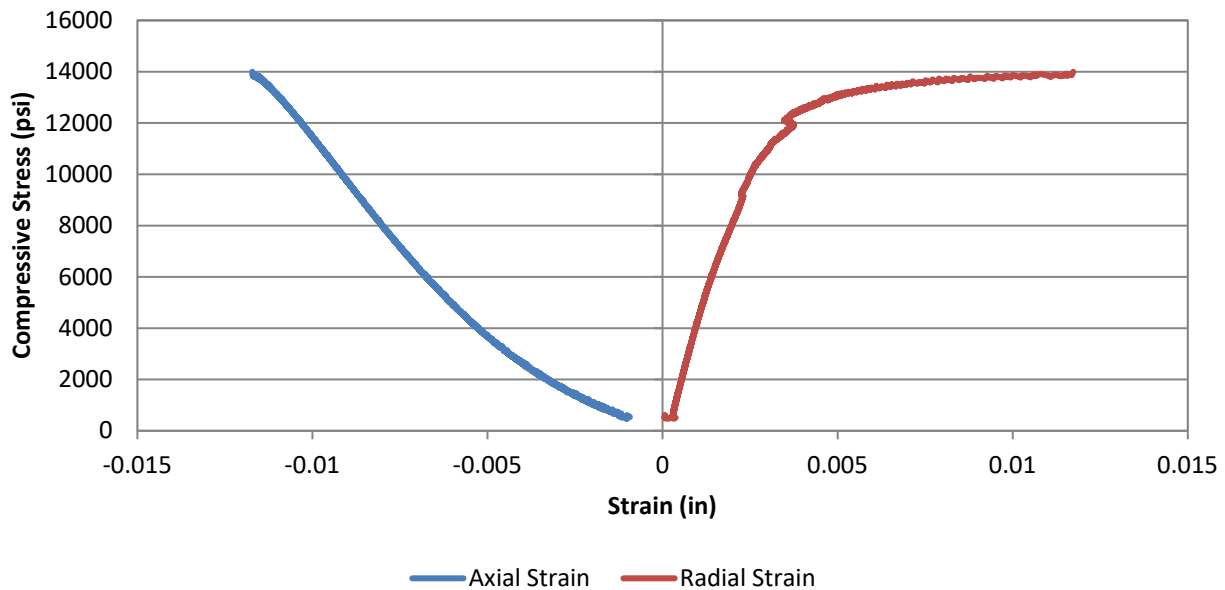
Test Results				
Unconfined Compressive Strength (psi)		14,000	Elastic Modulus (psi)	1.68E+06
			Poisson's Ratio in Elastic Range	0.20
Comments	Elastic range was taken as between 0.004 and 0.008 inches of axial strain. This range was chosen to avoid any non-linear behavior from the initial loading and the inflection point at the end of the elastic range.			

Project	SC 49 RBO Fairforest Creek			Date	2/8/2023
Project No.	G6658.003	Sample Diameter (in.)	1.865	Tested By	WAP
SCDOT ID	P041238	Sample Length (in.)	4.163	Reviewed By	WJG
Boring	B-42	Unit Weight (pcf)	163.5	Core Size	NQ
Sample No.	NQ-3 / 23-0114B	L/D Ratio	2.23	Recovery	100%
Depth	51.1' - 51.4'	Load Rate (psi/sec)	20	RQD	75%
Description	Black/White/Gray Granite				

Axial Stress vs. Strain



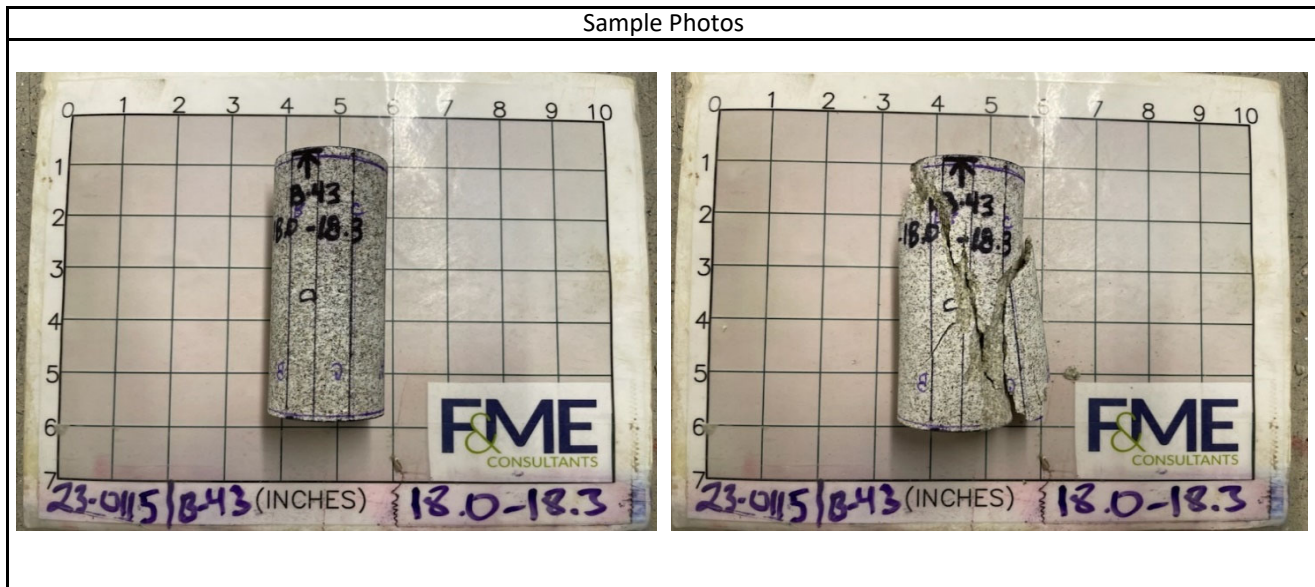
Stress vs. Strain



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

Project	SC 49 RBO Fairforest Creek			Date	2/8/2023
Project No.	G6658.003	Sample Diameter (in.)	1.865	Tested By	WAP
SCDOT ID	P041238	Sample Length (in.)	4.209	Reviewed By	WJG
Boring	B-43	Unit Weight (pcf)	163.6	Core Size	NQ
Sample No.	NQ-1 / 23-0115A	L/D Ratio	2.26	Recovery	57%
Depth	18.0' - 18.3'	Load Rate (psi/sec)	20	RQD	57%
Description	Black/White/Gray Granite				

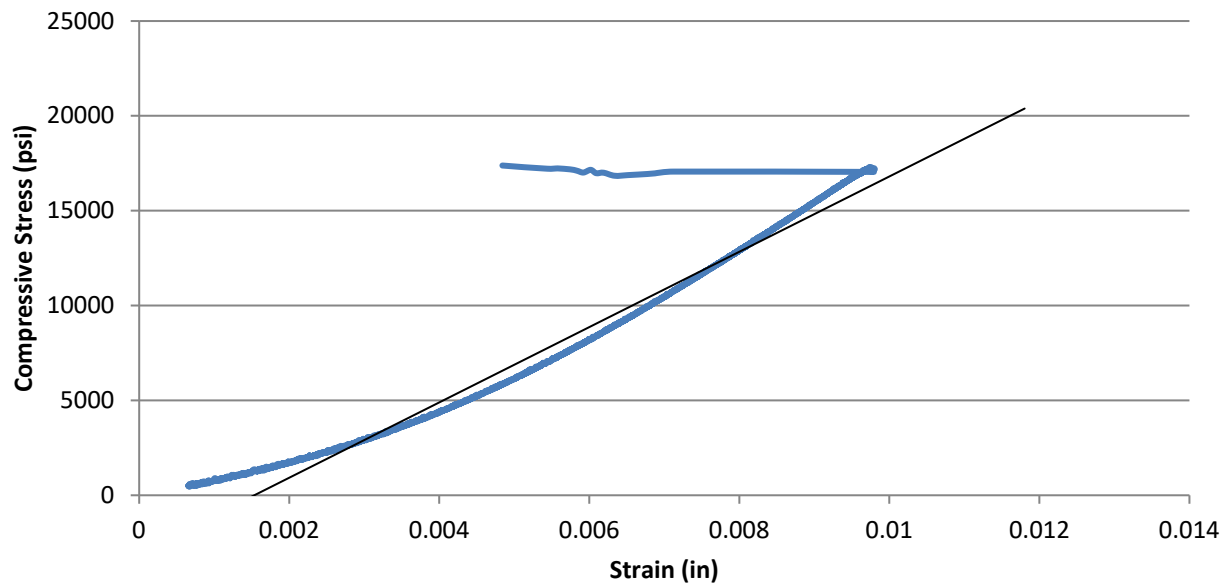
Test Data						
Percent of Failure Load	Strain (10^{-6})		Load (lbs)	Compressive Stress (psi)	Secant Modulus $\times 10^6$ (psi)	Poisson's Ratio
	Axial	Radial				
10%	-2010	95	4,748	1,738	1.73	0.05
20%	-3386	289	9,425	3,450	2.04	0.09
30%	-4499	499	14,280	5,227	2.32	0.11
40%	-5406	721	18,994	6,953	2.57	0.13
50%	-6226	973	23,760	8,697	2.79	0.16
60%	-6966	1268	28,408	10,399	2.99	0.18
70%	-7696	1660	33,282	12,183	3.17	0.22
80%	-8393	2151	37,965	13,897	3.31	0.26
90%	-9071	2850	42,725	15,640	3.45	0.31
100%	-4842	4024	47,478	17,380		



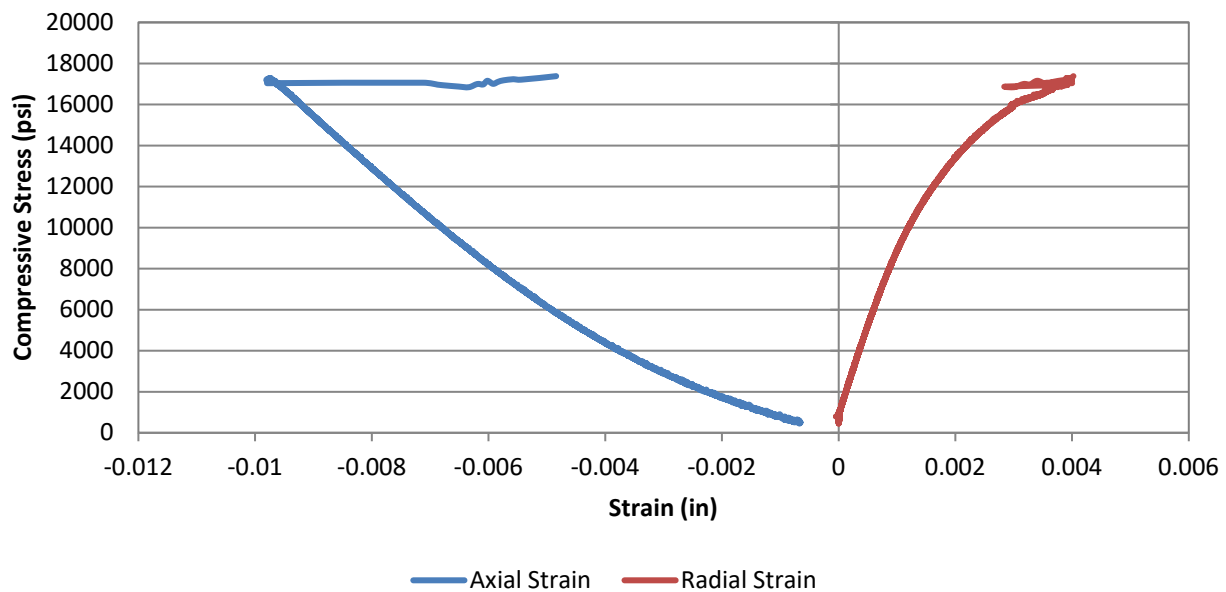
Test Results			
Unconfined Compressive Strength (psi)		17,380	Elastic Modulus (psi)
			2.51E+06
			Poisson's Ratio in Elastic Range
			0.13
Comments	Elastic range was taken as between 0.003 and 0.007 inches of axial strain. This range was chosen to avoid any non-linear behavior from the initial loading and the inflection point at the end of the elastic range.		

Project	SC 49 RBO Fairforest Creek			Date	2/8/2023
Project No.	G6658.003	Sample Diameter (in.)	1.865	Tested By	WAP
SCDOT ID	P041238	Sample Length (in.)	4.209	Reviewed By	WJG
Boring	B-43	Unit Weight (pcf)	163.6	Core Size	NQ
Sample No.	NQ-1 / 23-0115A	L/D Ratio	2.26	Recovery	57%
Depth	18.0' - 18.3'	Load Rate (psi/sec)	20	RQD	57%
Description	Black/White/Gray Granite				

Axial Stress vs. Strain



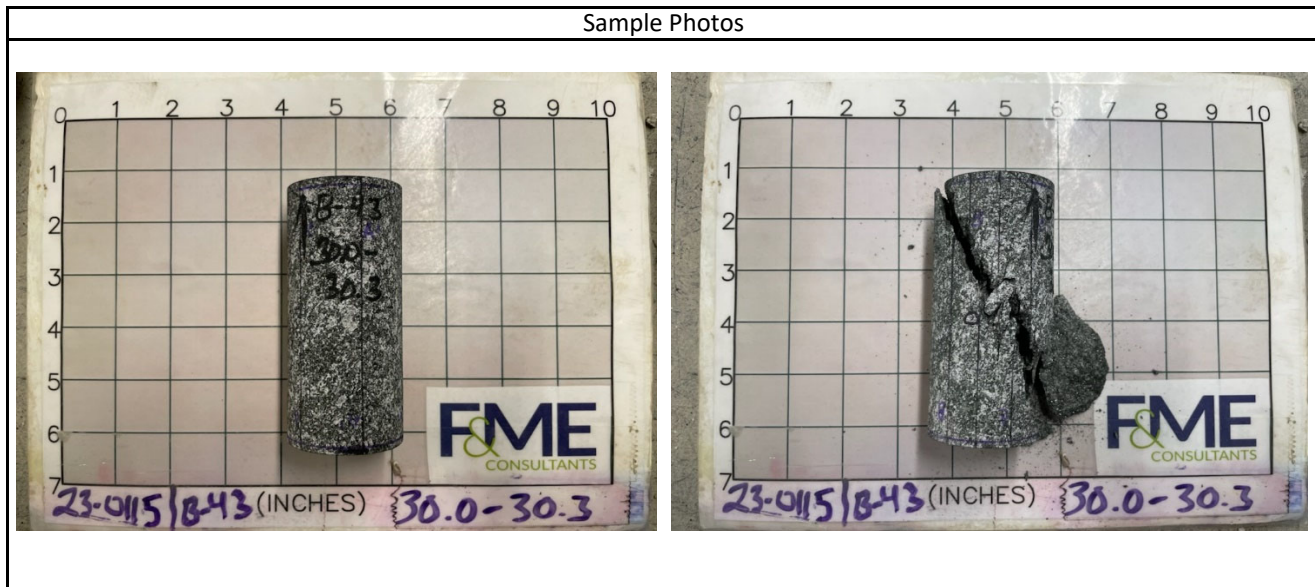
Stress vs. Strain



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

Project	SC 49 RBO Fairforest Creek			Date	2/8/2023
Project No.	G6658.003	Sample Diameter (in.)	1.865	Tested By	WAP
SCDOT ID	P041238	Sample Length (in.)	4.214	Reviewed By	WJG
Boring	B-43	Unit Weight (pcf)	178.6	Core Size	NQ
Sample No.	NQ-3 / 23-0115B	L/D Ratio	2.26	Recovery	80%
Depth	30.0' - 30.3'	Load Rate (psi/sec)	20	RQD	43%
Description	Black/White/Gray Granite				

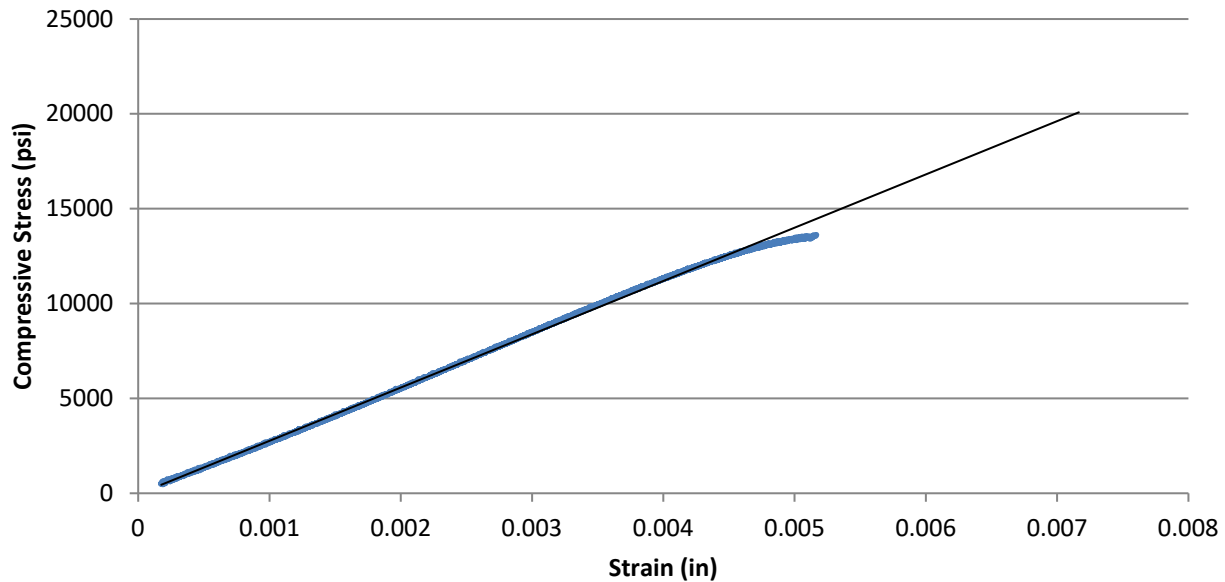
Test Data						
Percent of Failure Load	Strain (10^{-6})		Load (lbs)	Compressive Stress (psi)	Secant Modulus $\times 10^6$ (psi)	Poisson's Ratio
	Axial	Radial				
10%	-499	1	3,751	1,373	5.51	0.00
20%	-1009	93	7,458	2,730	5.41	0.09
30%	-1503	193	11,182	4,093	5.45	0.13
40%	-1964	303	14,898	5,453	5.55	0.15
50%	-2429	433	18,602	6,809	5.61	0.18
60%	-2888	583	22,332	8,175	5.66	0.20
70%	-3365	782	26,098	9,553	5.68	0.23
80%	-3846	1068	29,760	10,894	5.66	0.28
90%	-4387	1626	33,501	12,263	5.59	0.37
100%	-5165	4127	37,201	13,618		



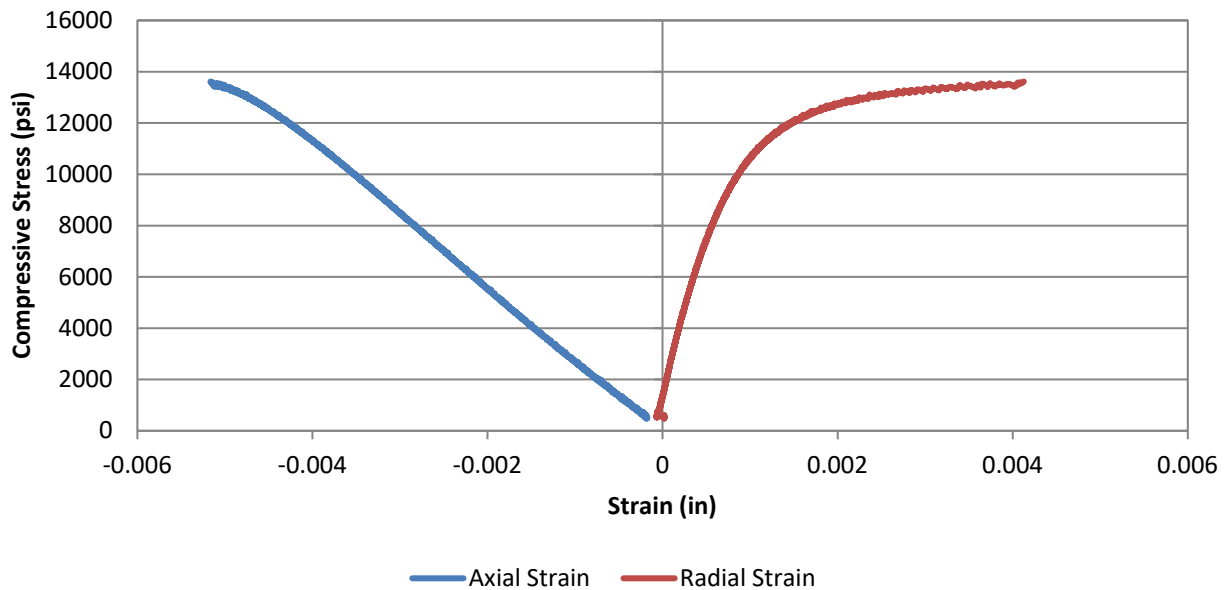
Test Results			
Unconfined Compressive Strength (psi)		13,620	Elastic Modulus (psi)
			5.58E+06
			Poisson's Ratio in Elastic Range
			0.18
Comments	Elastic range was taken as between 0.001 and 0.004 inches of axial strain. This range was chosen to avoid any non-linear behavior from the initial loading and the inflection point at the end of the elastic range.		

Project	SC 49 RBO Fairforest Creek			Date	2/8/2023
Project No.	G6658.003	Sample Diameter (in.)	1.865	Tested By	WAP
SCDOT ID	P041238	Sample Length (in.)	4.214	Reviewed By	WJG
Boring	B-43	Unit Weight (pcf)	178.6	Core Size	NQ
Sample No.	NQ-3 / 23-0115B	L/D Ratio	2.26	Recovery	80%
Depth	30.0' - 30.3'	Load Rate (psi/sec)	20	RQD	43%
Description	Black/White/Gray Granite				

Axial Stress vs. Strain



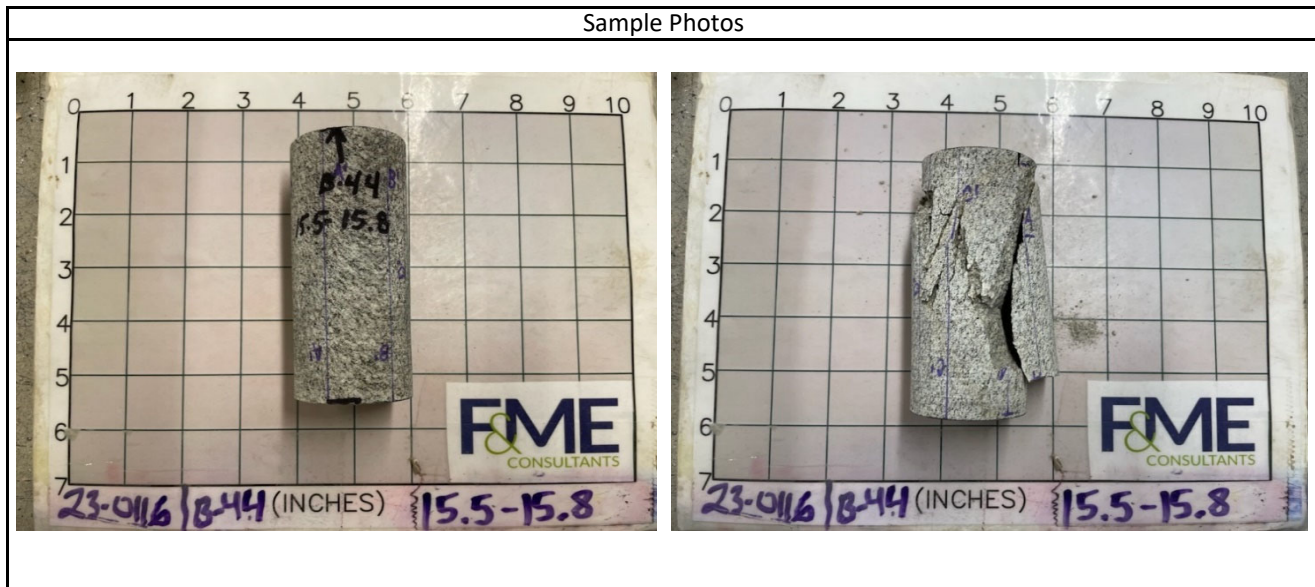
Stress vs. Strain



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

Project	SC 49 RBO Fairforest Creek			Date	2/8/2023
Project No.	G6658.003	Sample Diameter (in.)	1.863	Tested By	WAP
SCDOT ID	P041238	Sample Length (in.)	4.156	Reviewed By	WJG
Boring	B-44	Unit Weight (pcf)	164.3	Core Size	NQ
Sample No.	NQ-1 / 23-0116A	L/D Ratio	2.23	Recovery	40%
Depth	15.5' - 15.8'	Load Rate (psi/sec)	20	RQD	25%
Description	Black/White/Gray Granite				

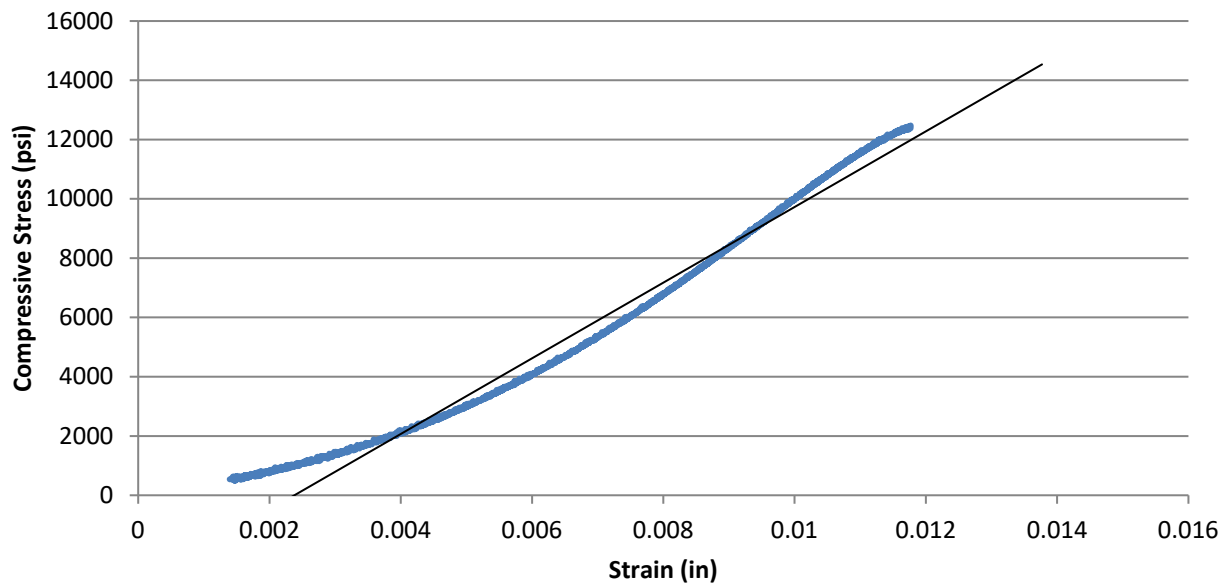
Test Data						
Percent of Failure Load	Strain (10^{-6})		Load (lbs)	Compressive Stress (psi)	Secant Modulus $\times 10^6$ (psi)	Poisson's Ratio
	Axial	Radial				
10%	-2849	349	3,447	1,265	0.89	0.12
20%	-4494	788	6,766	2,482	1.10	0.18
30%	-5706	1232	10,241	3,757	1.32	0.22
40%	-6747	1669	13,610	4,993	1.48	0.25
50%	-7655	2020	17,019	6,243	1.63	0.26
60%	-8461	2088	20,427	7,493	1.77	0.25
70%	-9238	1969	23,829	8,742	1.89	0.21
80%	-9996	1838	27,247	9,996	2.00	0.18
90%	-10787	2080	30,677	11,254	2.09	0.19
100%	-11770	3550	34,005	12,475		



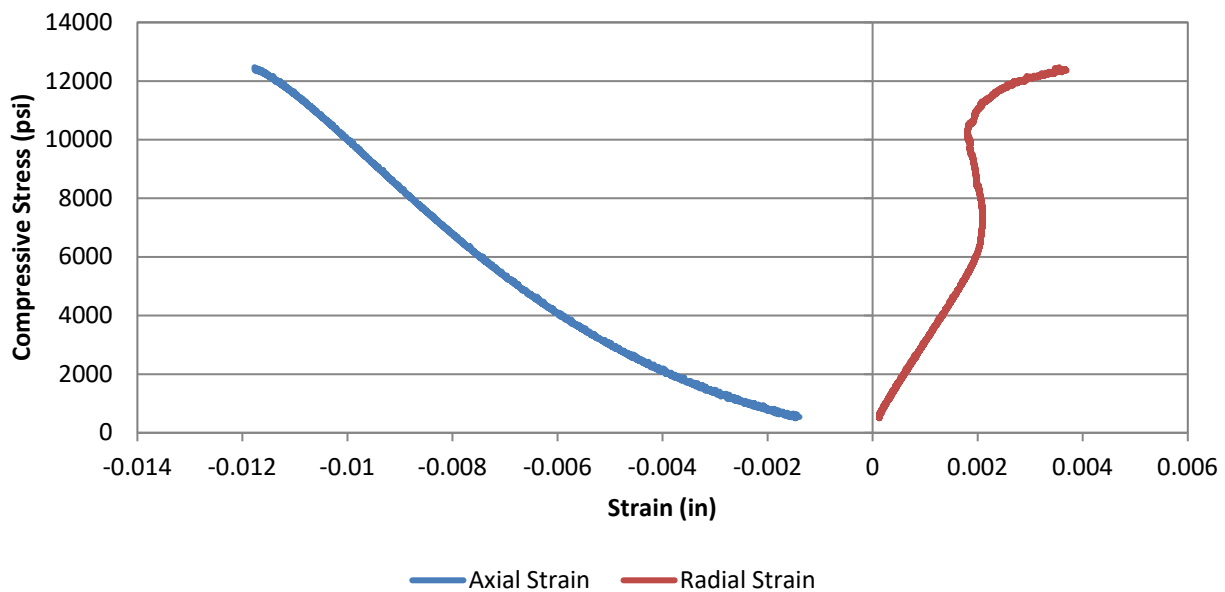
Test Results			
Unconfined Compressive Strength (psi)		12,470	Elastic Modulus (psi)
			1.39E+06
			Poisson's Ratio in Elastic Range
			0.23
Comments	Elastic range was taken as between 0.004 and 0.008 inches of axial strain. This range was chosen to avoid any non-linear behavior from the initial loading and the inflection point at the end of the elastic range.		

Project	SC 49 RBO Fairforest Creek			Date	2/8/2023
Project No.	G6658.003	Sample Diameter (in.)	1.863	Tested By	WAP
SCDOT ID	P041238	Sample Length (in.)	4.156	Reviewed By	WJG
Boring	B-44	Unit Weight (pcf)	164.3	Core Size	NQ
Sample No.	NQ-1 / 23-0116A	L/D Ratio	2.23	Recovery	40%
Depth	15.5' - 15.8'	Load Rate (psi/sec)	20	RQD	25%
Description	Black/White/Gray Granite				

Axial Stress vs. Strain



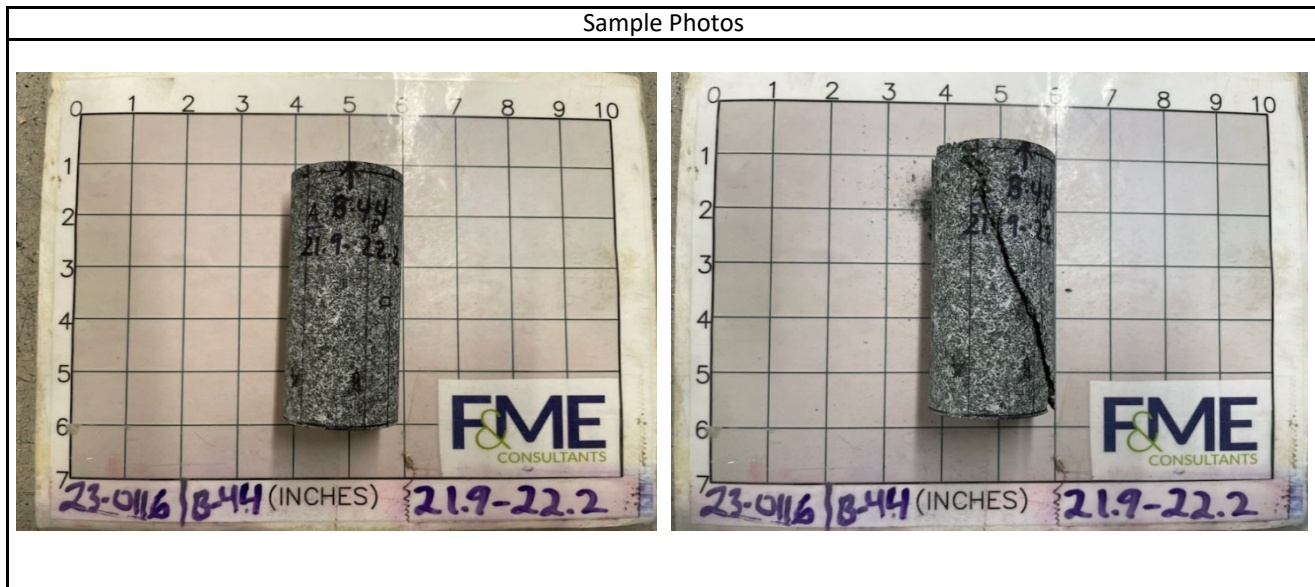
Stress vs. Strain



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

Project	SC 49 RBO Fairforest Creek			Date	2/8/2023
Project No.	G6658.003	Sample Diameter (in.)	1.857	Tested By	WAP
SCDOT ID	P041238	Sample Length (in.)	4.131	Reviewed By	WJG
Boring	B-44	Unit Weight (pcf)	180.3	Core Size	NQ
Sample No.	NQ-2 / 23-0116B	L/D Ratio	2.22	Recovery	53%
Depth	21.9' - 22.2'	Load Rate (psi/sec)	20	RQD	33%
Description	Black/White/Gray Granite				

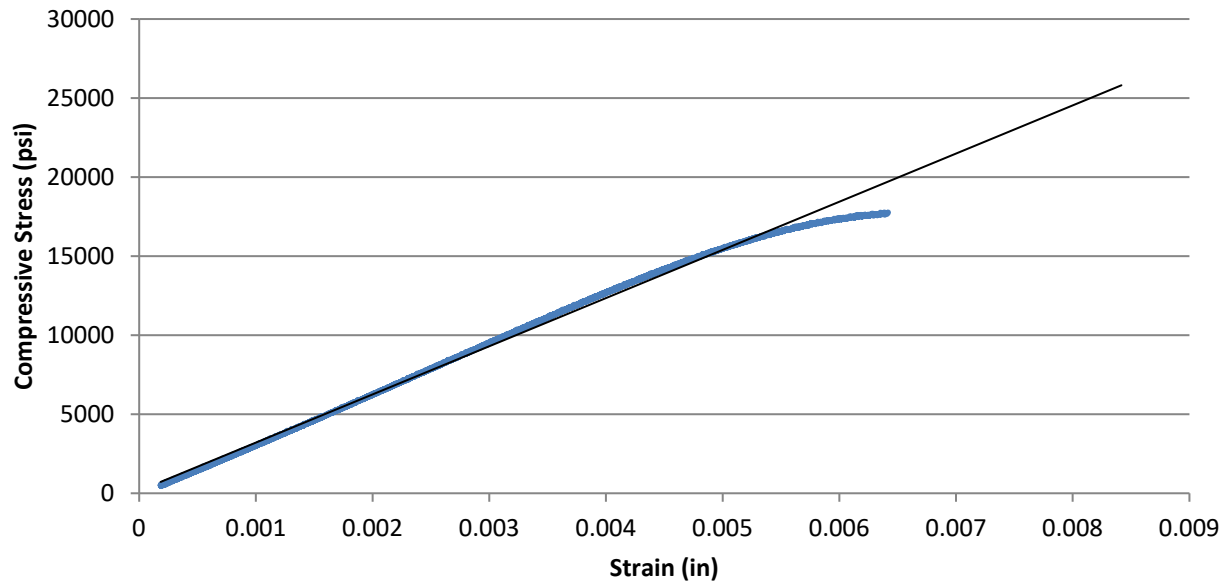
Test Data						
Percent of Failure Load	Strain (10^{-6})		Load (lbs)	Compressive Stress (psi)	Secant Modulus $\times 10^6$ (psi)	Poisson's Ratio
	Axial	Radial				
10%	-593	130	4,810	1,776	5.99	0.22
20%	-1165	229	9,649	3,563	6.12	0.20
30%	-1713	355	14,417	5,323	6.22	0.21
40%	-2263	507	19,232	7,101	6.27	0.22
50%	-2805	684	24,041	8,876	6.33	0.24
60%	-3334	889	28,859	10,655	6.39	0.27
70%	-3906	1150	33,563	12,392	6.34	0.29
80%	-4521	1480	38,511	14,219	6.29	0.33
90%	-5219	1762	43,313	15,992	6.13	0.34
100%	-6418	1458	48,117	17,766		



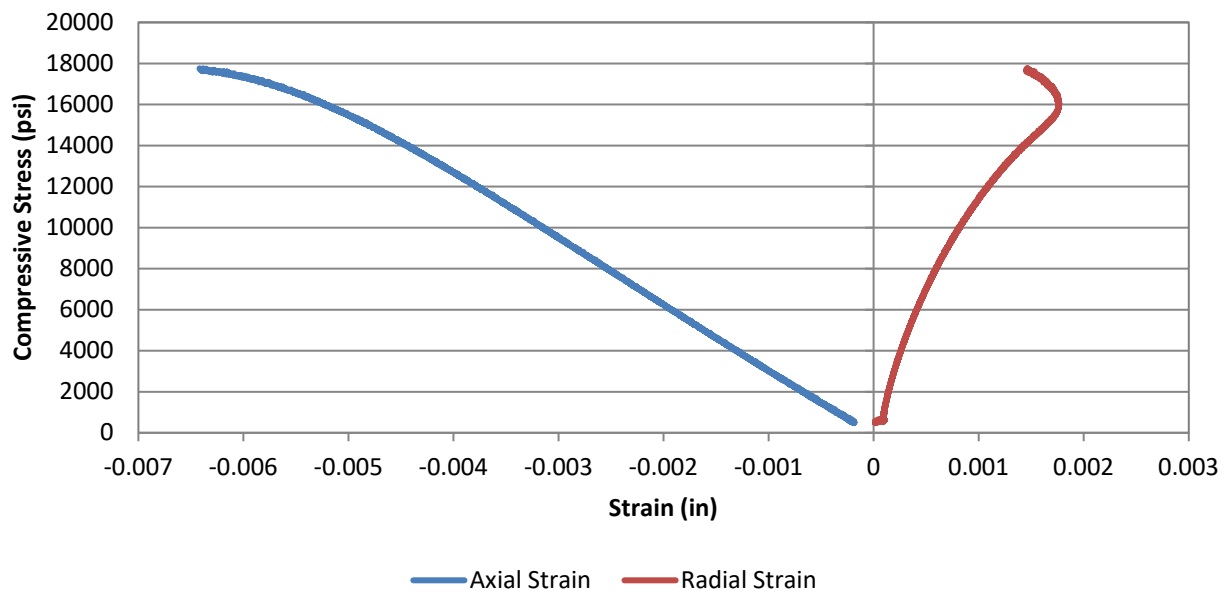
Test Results			
Unconfined Compressive Strength (psi)		17,770	Elastic Modulus (psi)
			6.27E+06
			Poisson's Ratio in Elastic Range
			0.24
Comments	Elastic range was taken as between 0.001 and 0.004 inches of axial strain. This range was chosen to avoid any non-linear behavior from the initial loading and the inflection point at the end of the elastic range.		

Project	SC 49 RBO Fairforest Creek			Date	2/8/2023
Project No.	G6658.003	Sample Diameter (in.)	1.857	Tested By	WAP
SCDOT ID	P041238	Sample Length (in.)	4.131	Reviewed By	WJG
Boring	B-44	Unit Weight (pcf)	180.3	Core Size	NQ
Sample No.	NQ-2 / 23-0116B	L/D Ratio	2.22	Recovery	53%
Depth	21.9' - 22.2'	Load Rate (psi/sec)	20	RQD	33%
Description	Black/White/Gray Granite				

Axial Stress vs. Strain



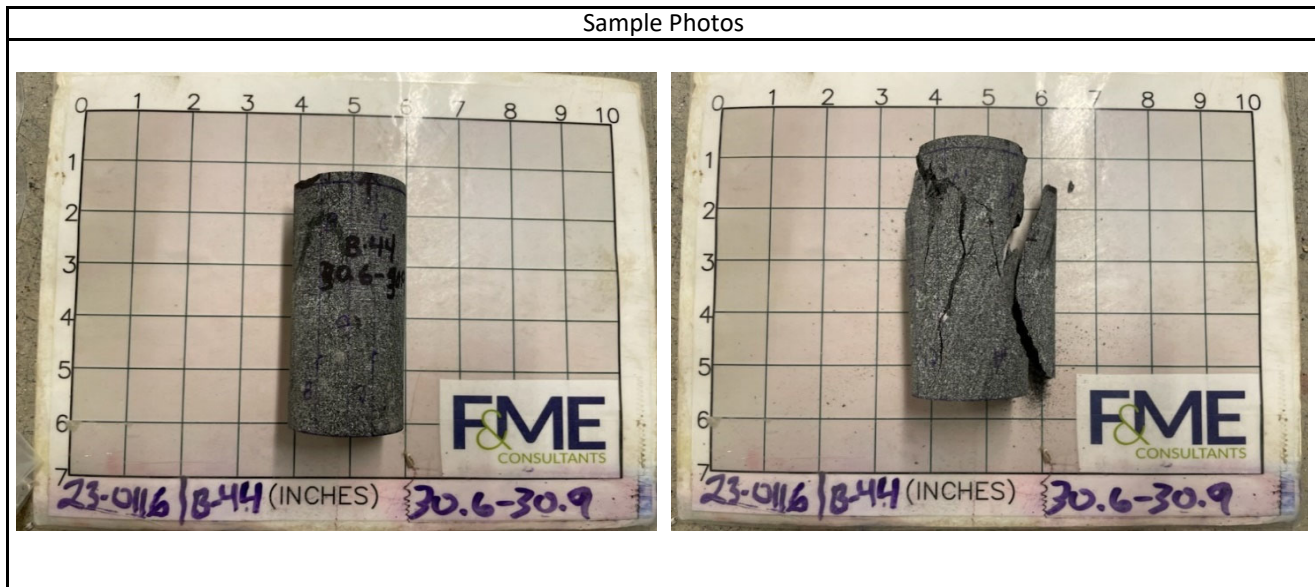
Stress vs. Strain



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

Project	SC 49 RBO Fairforest Creek			Date	2/8/2023
Project No.	G6658.003	Sample Diameter (in.)	1.862	Tested By	WAP
SCDOT ID	P041238	Sample Length (in.)	4.075	Reviewed By	WJG
Boring	B-44	Unit Weight (pcf)	182.5	Core Size	NQ
Sample No.	NQ-4 / 23-0116C	L/D Ratio	2.19	Recovery	100%
Depth	30.6' - 30.9'	Load Rate (psi/sec)	20	RQD	35%
Description	Black/White/Gry Granite				

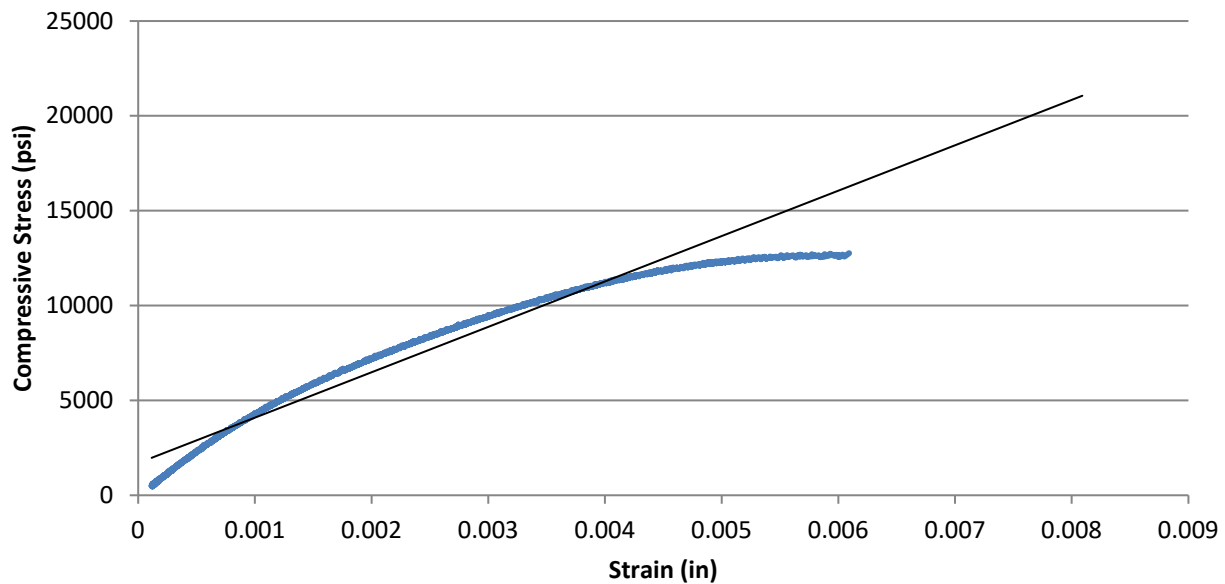
Test Data						
Percent of Failure Load	Strain (10^{-6})		Load (lbs)	Compressive Stress (psi)	Secant Modulus $\times 10^6$ (psi)	Poisson's Ratio
	Axial	Radial				
10%	-278	37	3,490	1,282	9.23	0.13
20%	-543	124	6,935	2,547	9.38	0.23
30%	-883	245	10,489	3,852	8.72	0.28
40%	-1246	395	13,870	5,094	8.18	0.32
50%	-1672	613	17,446	6,407	7.66	0.37
60%	-2194	926	20,889	7,671	6.99	0.42
70%	-2776	1360	24,374	8,951	6.45	0.49
80%	-3411	1992	27,824	10,218	5.99	0.58
90%	-4199	3174	31,286	11,490	5.47	0.76
100%	-6092	4323	34,749	12,761		



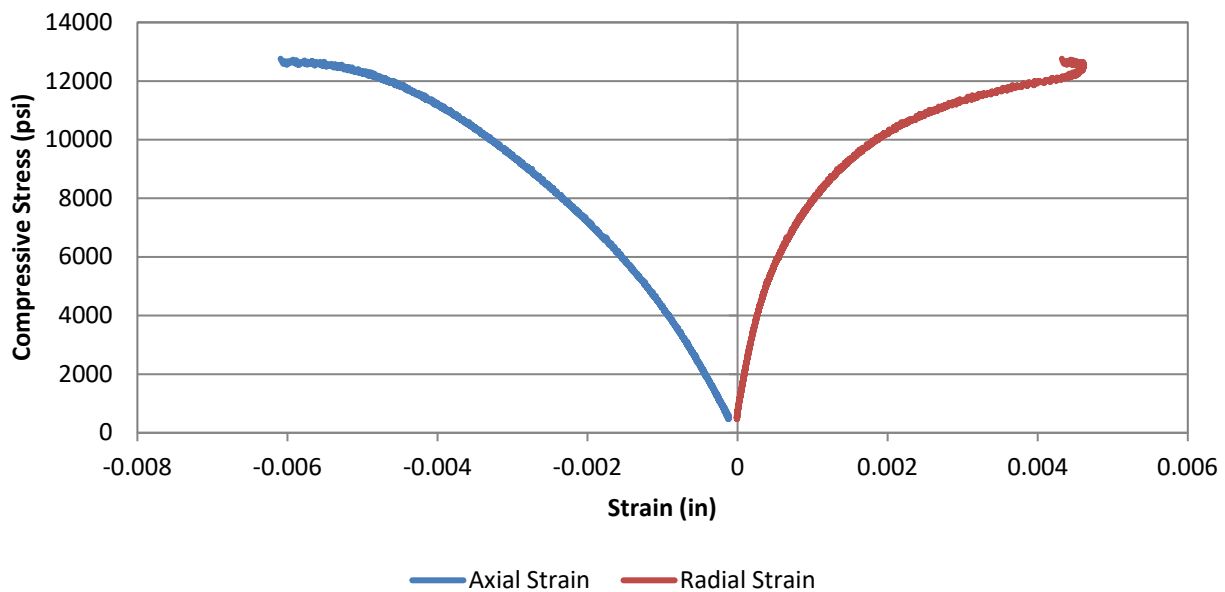
Test Results			
Unconfined Compressive Strength (psi)		12,760	Elastic Modulus (psi)
			7.89E+06
			Poisson's Ratio in Elastic Range
			0.34
Comments	Elastic range was taken as between 0.001 and 0.002 inches of axial strain. This range was chosen to avoid any non-linear behavior from the initial loading and the inflection point at the end of the elastic range.		

Project	SC 49 RBO Fairforest Creek			Date	2/8/2023
Project No.	G6658.003	Sample Diameter (in.)	1.862	Tested By	WAP
SCDOT ID	P041238	Sample Length (in.)	4.075	Reviewed By	WJG
Boring	B-44	Unit Weight (pcf)	182.5	Core Size	NQ
Sample No.	NQ-4 / 23-0116C	L/D Ratio	2.19	Recovery	100%
Depth	30.6' - 30.9'	Load Rate (psi/sec)	20	RQD	35%
Description	Black/White/Gry Granite				

Axial Stress vs. Strain



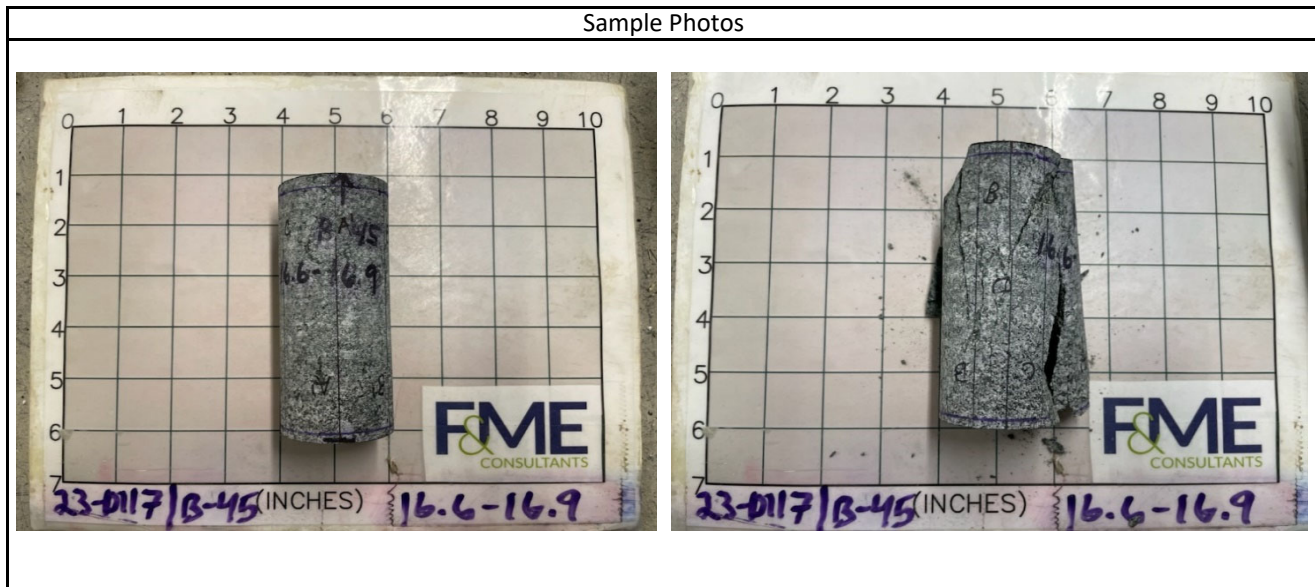
Stress vs. Strain



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

Project	SC 49 RBO Fairforest Creek			Date	2/8/2023
Project No.	G6658.003	Sample Diameter (in.)	1.859	Tested By	WAP
SCDOT ID	P041238	Sample Length (in.)	4.231	Reviewed By	WJG
Boring	B-45	Unit Weight (pcf)	173.6	Core Size	NQ
Sample No.	NQ-2 / 23-0117A	L/D Ratio	2.28	Recovery	100%
Depth	16.6' - 16.9'	Load Rate (psi/sec)	20	RQD	58%
Description	Black/White/Gray Granite				

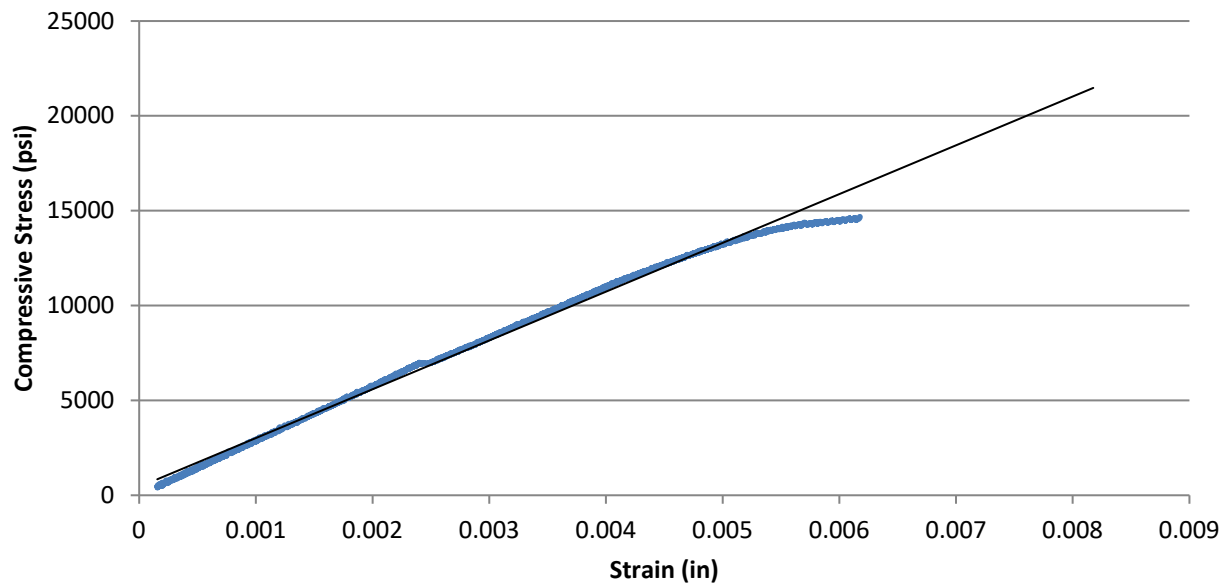
Test Data						
Percent of Failure Load	Strain (10^{-6})		Load (lbs)	Compressive Stress (psi)	Secant Modulus $\times 10^6$ (psi)	Poisson's Ratio
	Axial	Radial				
10%	-504	89	3,959	1,459	5.79	0.18
20%	-1030	158	7,969	2,936	5.70	0.15
30%	-1530	219	11,909	4,388	5.74	0.14
40%	-2046	285	15,961	5,881	5.75	0.14
50%	-2624	350	19,966	7,356	5.61	0.13
60%	-3174	416	23,848	8,786	5.54	0.13
70%	-3723	489	27,803	10,243	5.50	0.13
80%	-4303	563	31,820	11,723	5.45	0.13
90%	-4992	704	35,865	13,213	5.29	0.14
100%	-6176	2394	39,819	14,670		



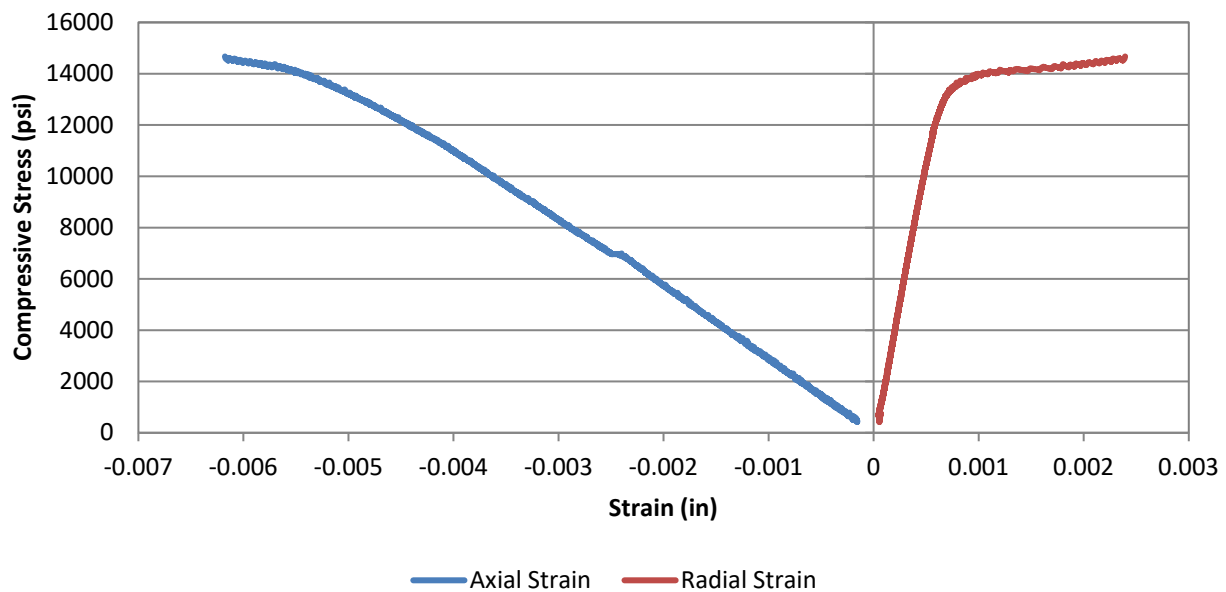
Test Results			
Unconfined Compressive Strength (psi)		14,670	Elastic Modulus (psi)
			5.64E+06
			Poisson's Ratio in Elastic Range
			0.14
Comments	Elastic range was taken as between 0.001 and 0.004 inches of axial strain. This range was chosen to avoid any non-linear behavior from the initial loading and the inflection point at the end of the elastic range.		

Project	SC 49 RBO Fairforest Creek			Date	2/8/2023
Project No.	G6658.003	Sample Diameter (in.)	1.859	Tested By	WAP
SCDOT ID	P041238	Sample Length (in.)	4.231	Reviewed By	WJG
Boring	B-45	Unit Weight (pcf)	173.6	Core Size	NQ
Sample No.	NQ-2 / 23-0117A	L/D Ratio	2.28	Recovery	100%
Depth	16.6' - 16.9'	Load Rate (psi/sec)	20	RQD	58%
Description	Black/White/Gray Granite				

Axial Stress vs. Strain



Stress vs. Strain



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

Project	SC 49 RBO Fairforest Creek			Date	2/8/2023
Project No.	G6658.003	Sample Diameter (in.)	1.855	Tested By	WAP
SCDOT ID	P041238	Sample Length (in.)	4.07	Reviewed By	WJG
Boring	B-45	Unit Weight (pcf)	174.1	Core Size	NQ
Sample No.	NQ-3 / 23-0117B	L/D Ratio	2.19	Recovery	100%
Depth	18.7' - 19.0'	Load Rate (psi/sec)	20	RQD	67%
Description	Black/White/Gray Granite				

Test Data						
Percent of Failure Load	Strain (10^{-6})		Load (lbs)	Compressive Stress (psi)	Secant Modulus $\times 10^6$ (psi)	Poisson's Ratio
	Axial	Radial				
10%	-745	70	3,571	1,321	3.55	0.09
20%	-1409	179	7,155	2,648	3.76	0.13
30%	-2039	316	10,747	3,977	3.90	0.16
40%	-2623	473	14,362	5,314	4.05	0.18
50%	-3140	639	17,892	6,621	4.22	0.20
60%	-3649	838	21,449	7,937	4.35	0.23
70%	-4139	1074	25,029	9,261	4.48	0.26
80%	-4656	1433	28,639	10,597	4.55	0.31
90%	-5201	1989	32,277	11,943	4.59	0.38
100%	-12809	3724	35,786	13,242		

Sample Photos

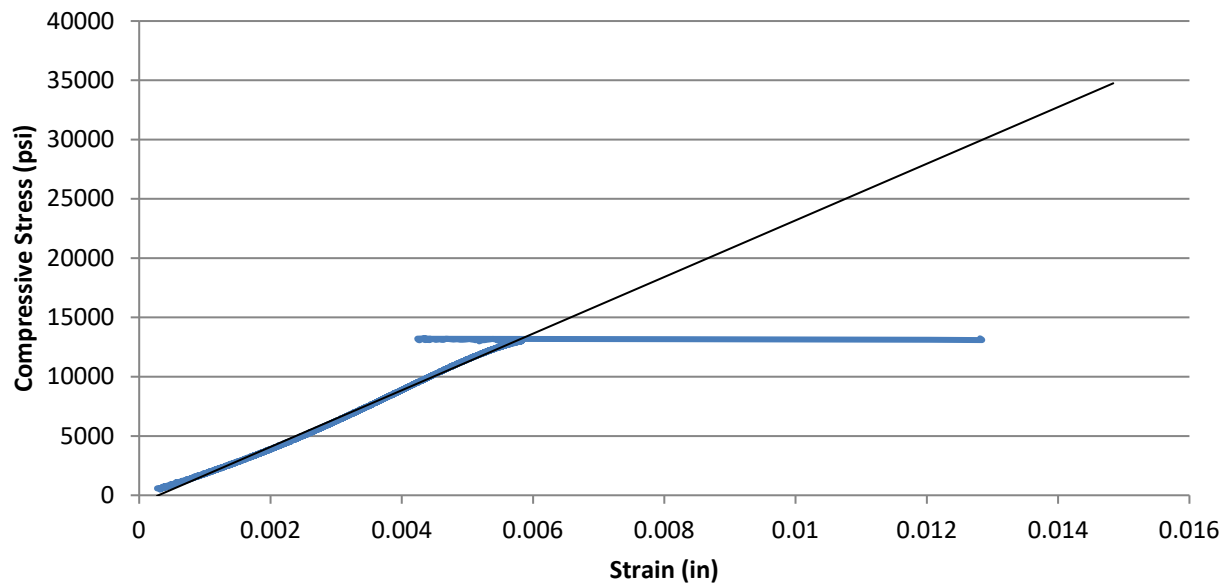


Test Results

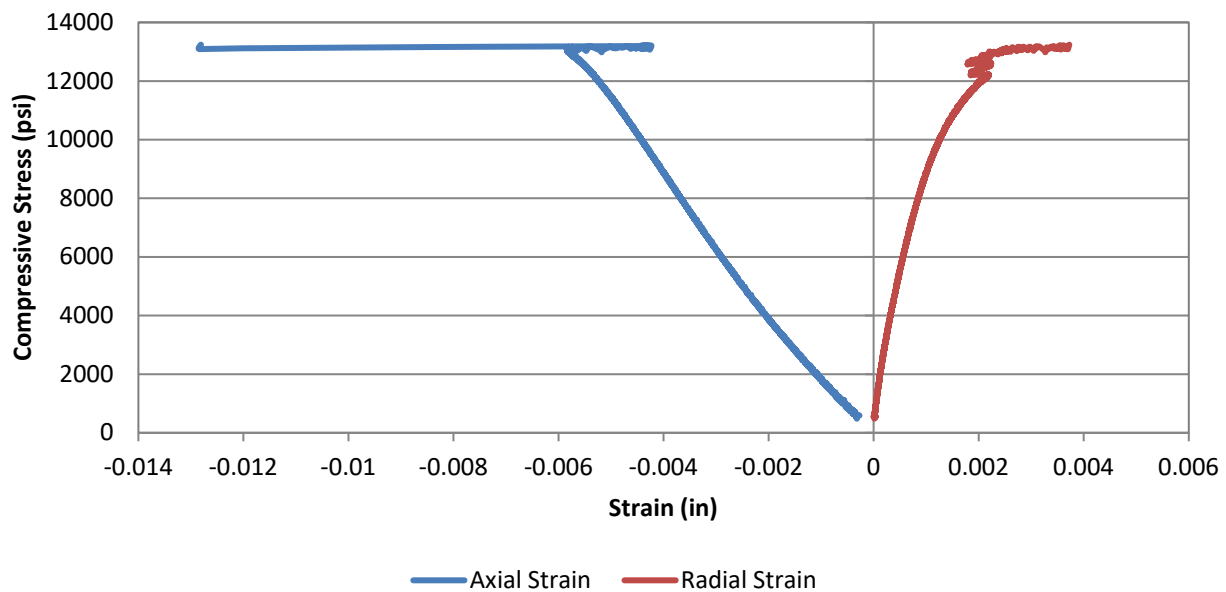
Unconfined Compressive Strength (psi)		13,240	Elastic Modulus (psi)	2.04E+06
			Poisson's Ratio in Elastic Range	0.27
Comments	Elastic range was taken as between 0.002 and 0.004 inches of axial strain. This range was chosen to avoid any non-linear behavior from the initial loading and the inflection point at the end of the elastic range.			

Project	SC 49 RBO Fairforest Creek			Date	2/8/2023
Project No.	G6658.003	Sample Diameter (in.)	1.855	Tested By	WAP
SCDOT ID	P041238	Sample Length (in.)	4.07	Reviewed By	WJG
Boring	B-45	Unit Weight (pcf)	174.1	Core Size	NQ
Sample No.	NQ-3 / 23-0117B	L/D Ratio	2.19	Recovery	100%
Depth	18.7' - 19.0'	Load Rate (psi/sec)	20	RQD	67%
Description	Black/White/Gray Granite				

Axial Stress vs. Strain



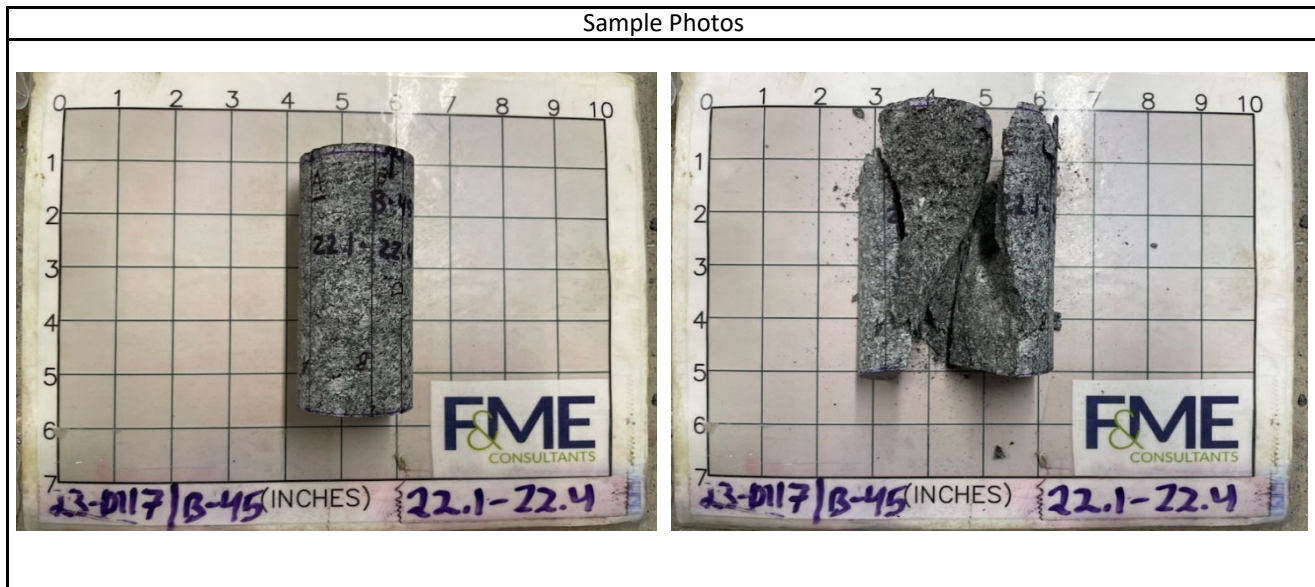
Stress vs. Strain



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

Project	SC 49 RBO Fairforest Creek			Date	2/8/2023
Project No.	G6658.003	Sample Diameter (in.)	1.862	Tested By	WAP
SCDOT ID	P041238	Sample Length (in.)	4.147	Reviewed By	WJG
Boring	B-45	Unit Weight (pcf)	173.3	Core Size	NQ
Sample No.	NQ-3 / 23-0117C	L/D Ratio	2.23	Recovery	100%
Depth	22.1' - 22.4'	Load Rate (psi/sec)	20	RQD	67%
Description	Black/White/Gray Granite				

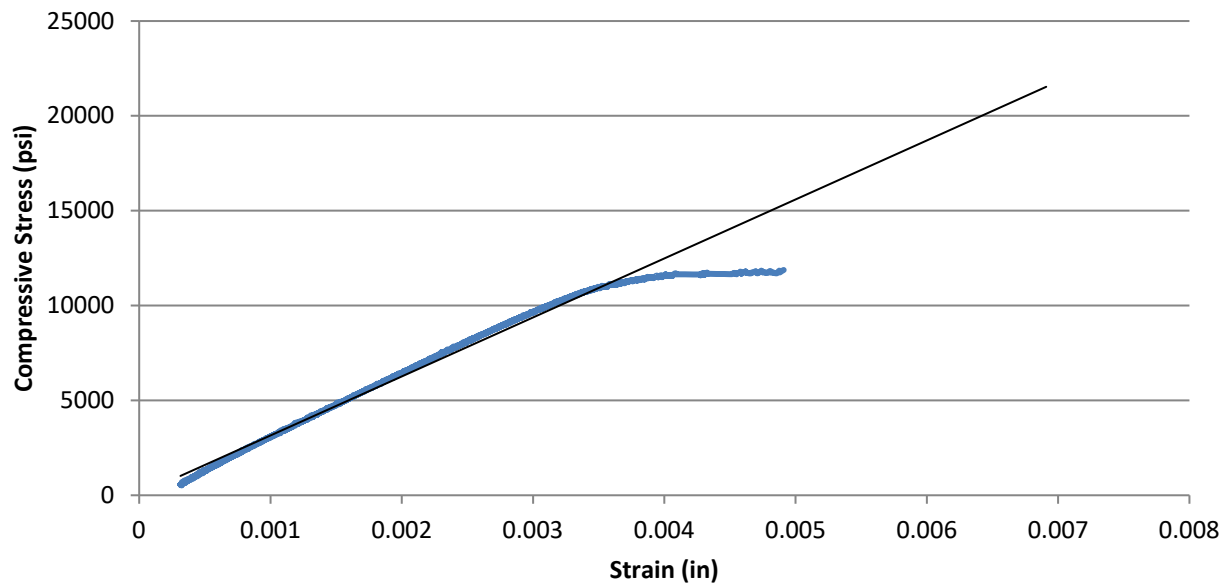
Test Data						
Percent of Failure Load	Strain (10^{-6})		Load (lbs)	Compressive Stress (psi)	Secant Modulus $\times 10^6$ (psi)	Poisson's Ratio
	Axial	Radial				
10%	-477	1014	3,297	1,211	5.08	2.13
20%	-793	1016	6,417	2,357	5.94	1.28
30%	-1133	1069	9,602	3,526	6.23	0.94
40%	-1480	1131	12,842	4,716	6.37	0.76
50%	-1836	1200	16,120	5,920	6.45	0.65
60%	-2199	1278	19,380	7,117	6.47	0.58
70%	-2565	1370	22,612	8,304	6.47	0.53
80%	-2942	1472	25,828	9,485	6.45	0.50
90%	-3379	1611	29,082	10,680	6.32	0.48
100%	-4909	2492	32,327	11,872		



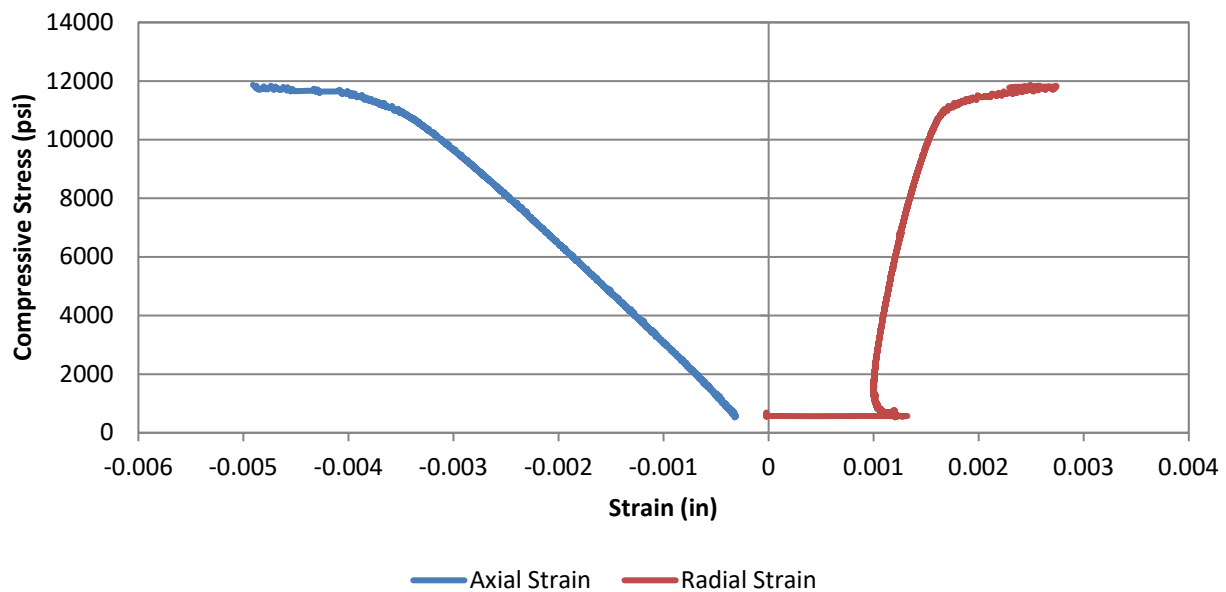
Test Results				
Unconfined Compressive Strength (psi)		11,870	Elastic Modulus (psi)	6.41E+06
			Poisson's Ratio in Elastic Range	N/A
Comments	Elastic range was taken as between 0.001 and 0.003 inches of axial strain. This range was chosen to avoid any non-linear behavior from the initial loading and the inflection point at the end of the elastic range. Lateral strain data appears unreasonable. As such, Poisson's Ratio is not provided.			

Project	SC 49 RBO Fairforest Creek			Date	2/8/2023
Project No.	G6658.003	Sample Diameter (in.)	1.862	Tested By	WAP
SCDOT ID	P041238	Sample Length (in.)	4.147	Reviewed By	WJG
Boring	B-45	Unit Weight (pcf)	173.3	Core Size	NQ
Sample No.	NQ-3 / 23-0117C	L/D Ratio	2.23	Recovery	100%
Depth	22.1' - 22.4'	Load Rate (psi/sec)	20	RQD	67%
Description	Black/White/Gray Granite				

Axial Stress vs. Strain



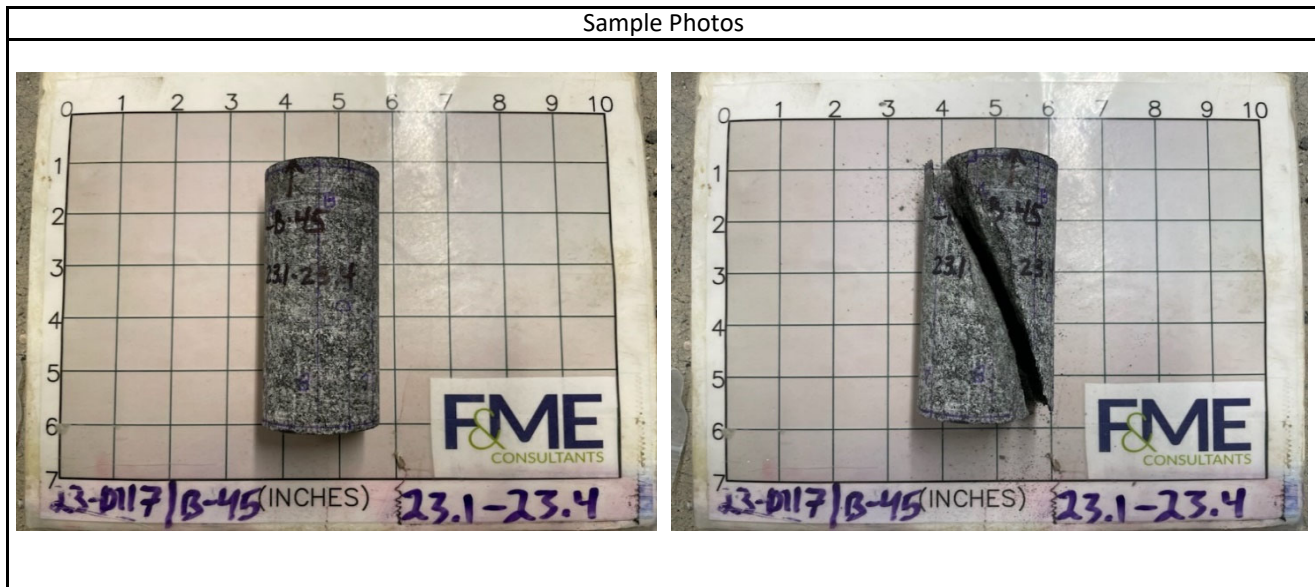
Stress vs. Strain



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

Project	SC 49 RBO Fairforest Creek			Date	2/8/2023
Project No.	G6658.003	Sample Diameter (in.)	1.864	Tested By	WAP
SCDOT ID	P041238	Sample Length (in.)	4.193	Reviewed By	WJG
Boring	B-45	Unit Weight (pcf)	173.2	Core Size	NQ
Sample No.	NQ-3 / 23-0117D	L/D Ratio	2.25	Recovery	100%
Depth	23.1' - 23.4'	Load Rate (psi/sec)	20	RQD	67%
Description	Black/White/Gray Granite				

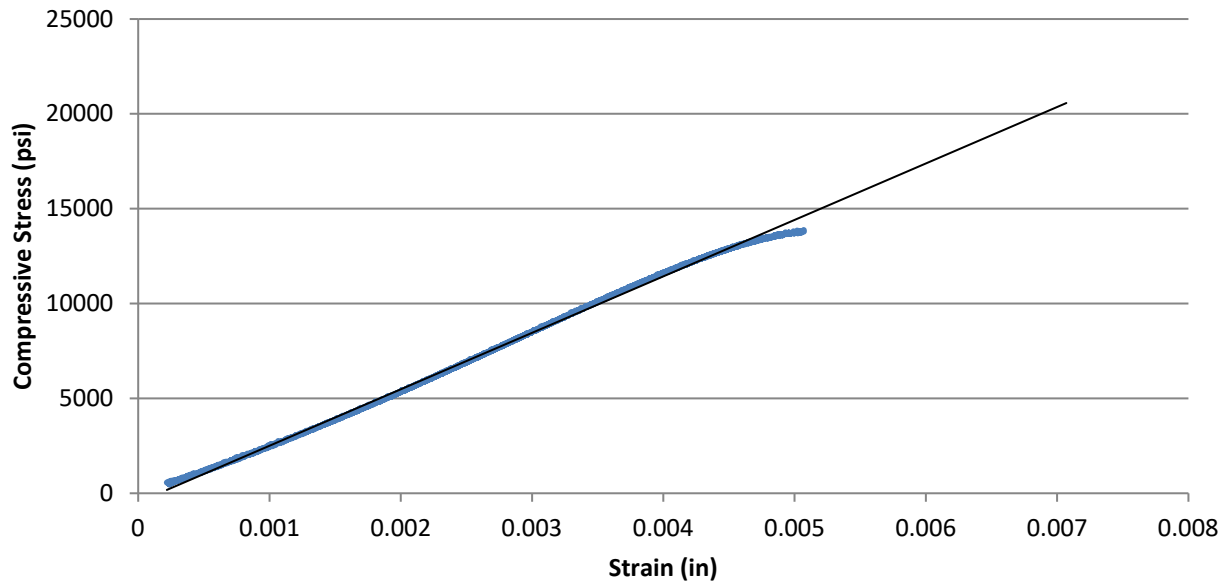
Test Data						
Percent of Failure Load	Strain (10^{-6})		Load (lbs)	Compressive Stress (psi)	Secant Modulus $\times 10^6$ (psi)	Poisson's Ratio
	Axial	Radial				
10%	-576	76	3,704	1,357	4.72	0.13
20%	-1099	132	7,540	2,763	5.03	0.12
30%	-1602	200	11,389	4,173	5.21	0.12
40%	-2068	275	15,166	5,558	5.38	0.13
50%	-2498	353	18,937	6,939	5.56	0.14
60%	-2939	448	22,734	8,331	5.67	0.15
70%	-3374	571	26,510	9,715	5.76	0.17
80%	-3822	751	30,255	11,087	5.80	0.20
90%	-4324	1088	34,029	12,470	5.77	0.25
100%	-5070	2496	37,860	13,874		



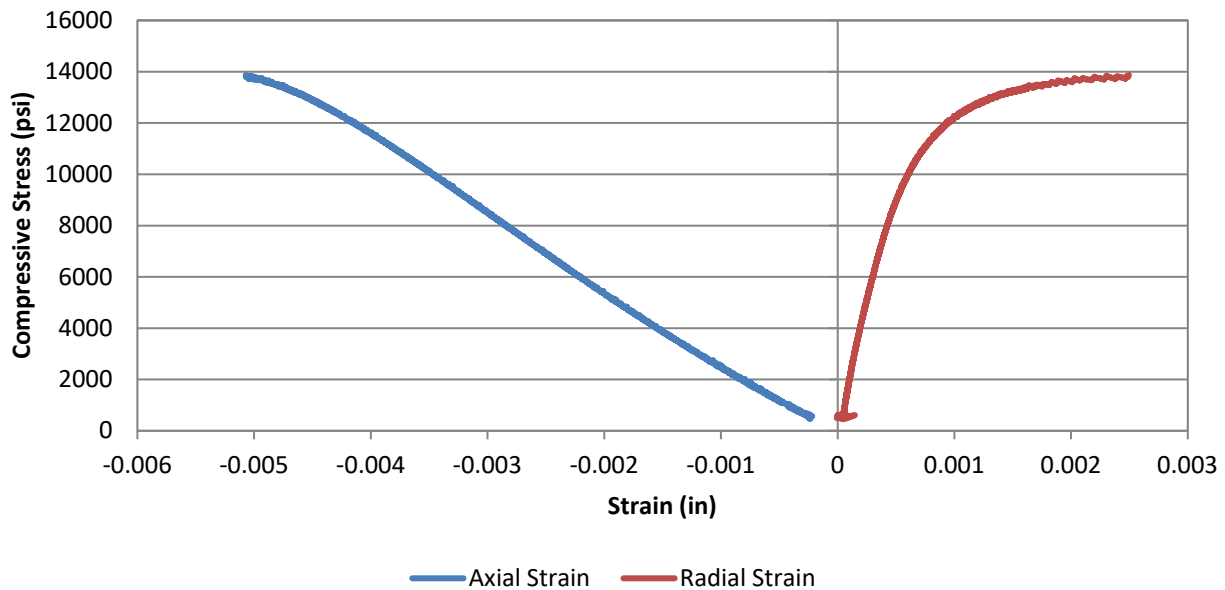
Test Results			
Unconfined Compressive Strength (psi)		13,870	Elastic Modulus (psi)
			5.49E+06
			Poisson's Ratio in Elastic Range
			0.15
Comments	Elastic range was taken as between 0.001 and 0.004 inches of axial strain. This range was chosen to avoid any non-linear behavior from the initial loading and the inflection point at the end of the elastic range.		

Project	SC 49 RBO Fairforest Creek			Date	2/8/2023
Project No.	G6658.003	Sample Diameter (in.)	1.864	Tested By	WAP
SCDOT ID	P041238	Sample Length (in.)	4.193	Reviewed By	WJG
Boring	B-45	Unit Weight (pcf)	173.2	Core Size	NQ
Sample No.	NQ-3 / 23-0117D	L/D Ratio	2.25	Recovery	100%
Depth	23.1' - 23.4'	Load Rate (psi/sec)	20	RQD	67%
Description	Black/White/Gray Granite				

Axial Stress vs. Strain



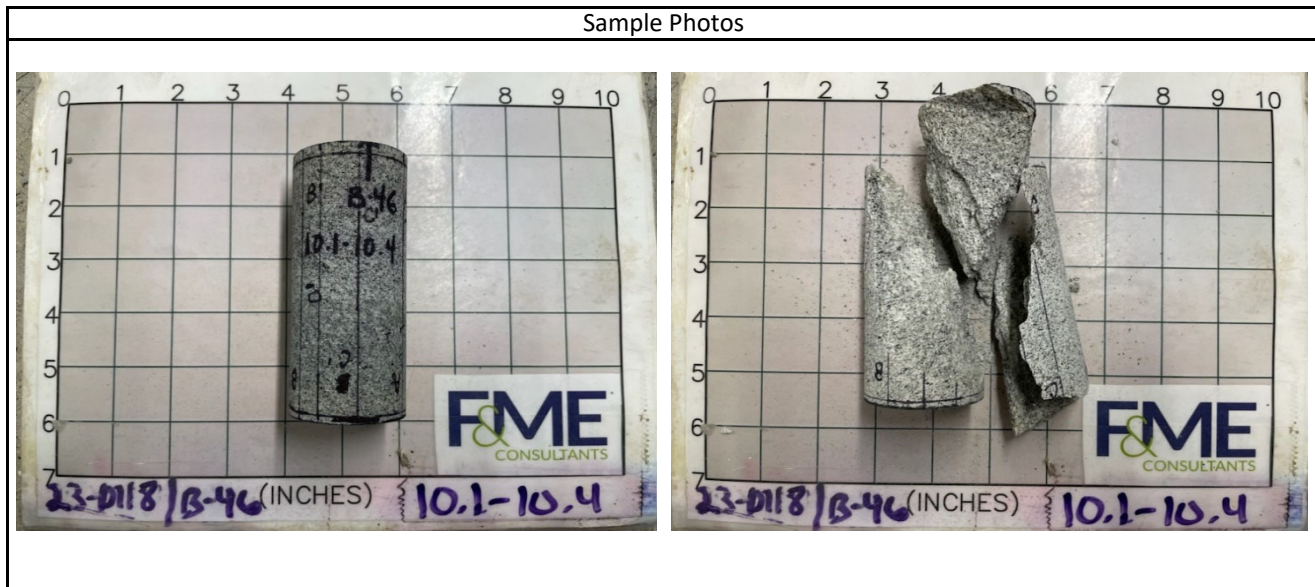
Stress vs. Strain



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

Project	SC 49 RBO Fairforest Creek			Date	2/8/2023
Project No.	G6658.003	Sample Diameter (in.)	1.836	Tested By	WAP
SCDOT ID	P041238	Sample Length (in.)	4.223	Reviewed By	WJG
Boring	B-46	Unit Weight (pcf)	164.1	Core Size	NQ
Sample No.	NQ-2 / 23-0118A	L/D Ratio	2.30	Recovery	80%
Depth	10.1' - 10.4'	Load Rate (psi/sec)	20	RQD	28%
Description	Black/White/Gray Granite				

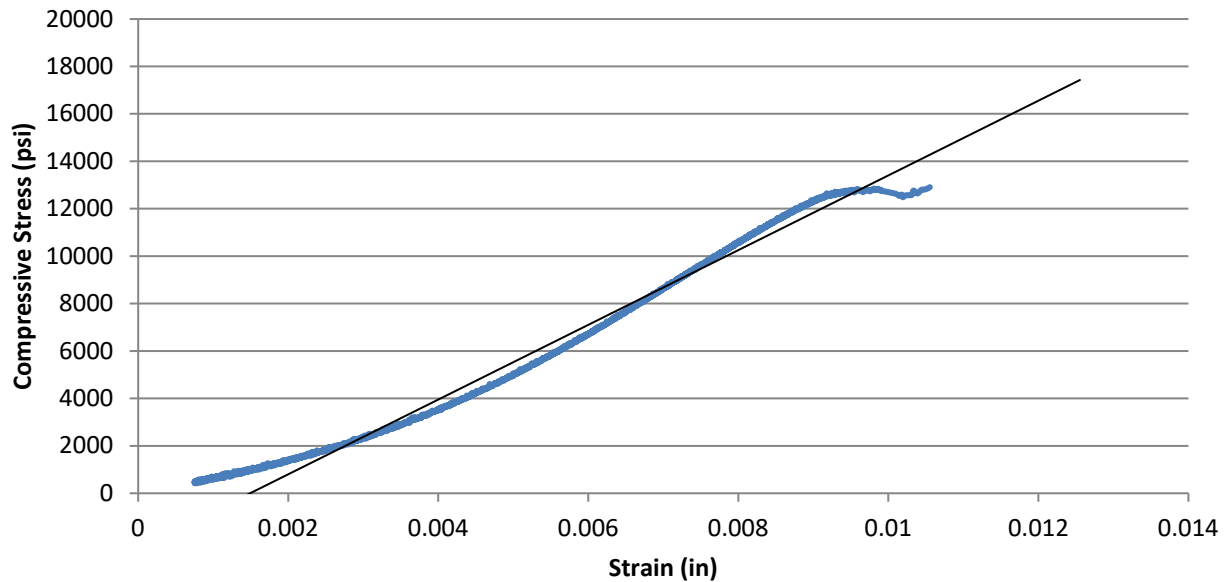
Test Data						
Percent of Failure Load	Strain (10^{-6})		Load (lbs)	Compressive Stress (psi)	Secant Modulus $\times 10^6$ (psi)	Poisson's Ratio
	Axial	Radial				
10%	-1905	145	3,408	1,287	1.35	0.08
20%	-3226	315	6,821	2,576	1.60	0.10
30%	-4270	519	10,319	3,898	1.83	0.12
40%	-5066	730	13,611	5,141	2.03	0.14
50%	-5848	1001	17,076	6,450	2.21	0.17
60%	-6547	1318	20,502	7,744	2.37	0.20
70%	-7216	1719	23,992	9,062	2.51	0.24
80%	-7866	2249	27,364	10,336	2.63	0.29
90%	-8576	3098	30,792	11,631	2.71	0.36
100%	-10555	3878	34,166	12,905		



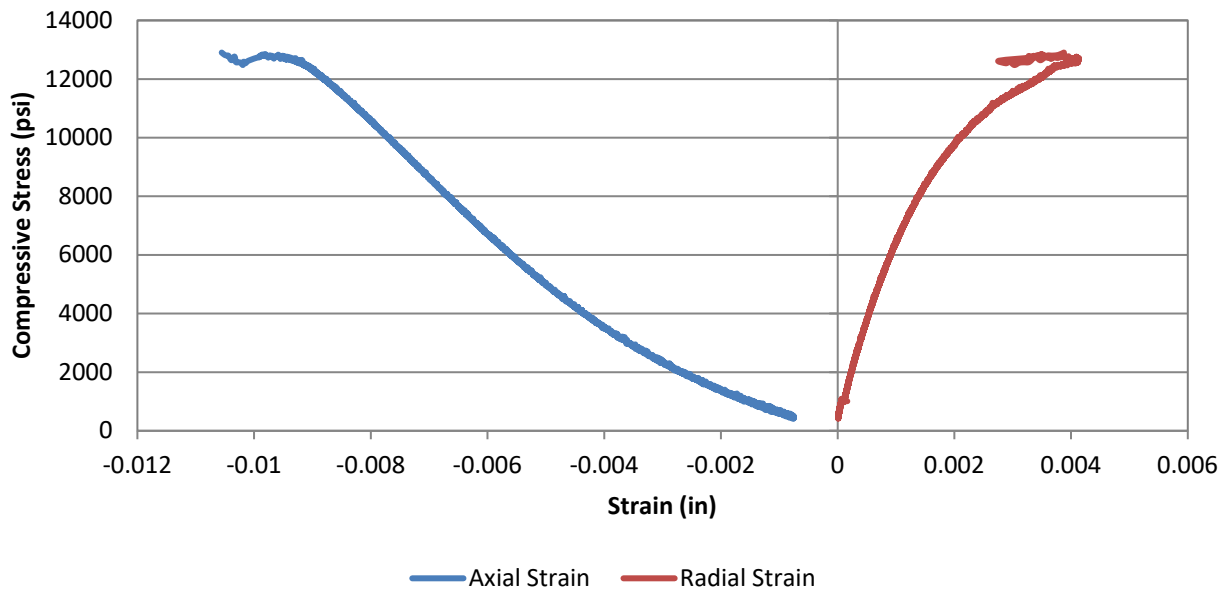
Test Results				
Unconfined Compressive Strength (psi)		12,910	Elastic Modulus (psi)	2.05E+06
			Poisson's Ratio in Elastic Range	0.15
Comments	Elastic range was taken as between 0.003 and 0.007 inches of axial strain. This range was chosen to avoid any non-linear behavior from the initial loading and the inflection point at the end of the elastic range.			

Project	SC 49 RBO Fairforest Creek			Date	2/8/2023
Project No.	G6658.003	Sample Diameter (in.)	1.836	Tested By	WAP
SCDOT ID	P041238	Sample Length (in.)	4.223	Reviewed By	WJG
Boring	B-46	Unit Weight (pcf)	164.1	Core Size	NQ
Sample No.	NQ-2 / 23-0118A	L/D Ratio	2.30	Recovery	80%
Depth	10.1' - 10.4'	Load Rate (psi/sec)	20	RQD	28%
Description	Black/White/Gray Granite				

Axial Stress vs. Strain



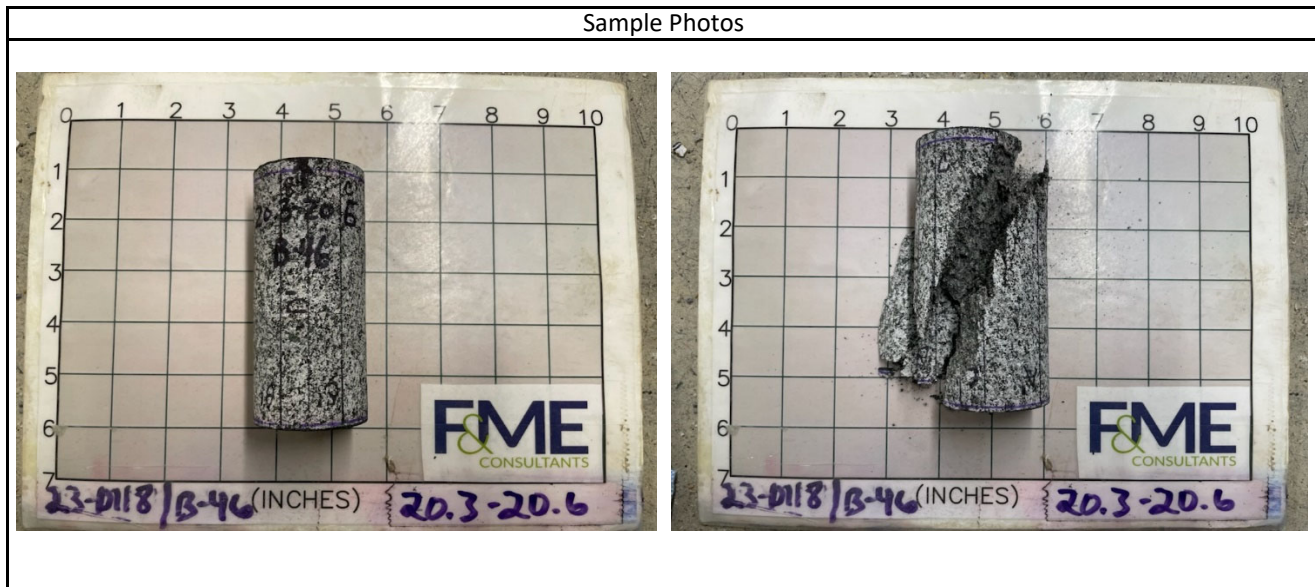
Stress vs. Strain



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

Project	SC 49 RBO Fairforest Creek			Date	2/8/2023
Project No.	G6658.003	Sample Diameter (in.)	1.859	Tested By	WAP
SCDOT ID	P041238	Sample Length (in.)	4.243	Reviewed By	WJG
Boring	B-46	Unit Weight (pcf)	175.4	Core Size	NQ
Sample No.	NQ-4 / 23-0118B	L/D Ratio	2.28	Recovery	100%
Depth	20.3' - 20.6'	Load Rate (psi/sec)	20	RQD	100%
Description	Black/White/Gray Granite				

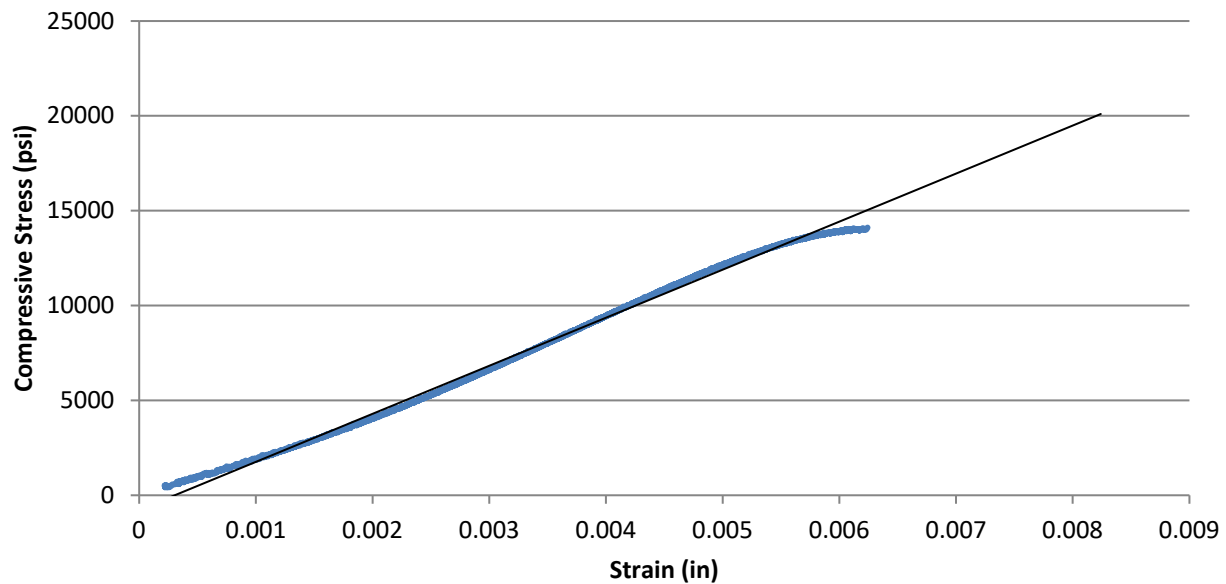
Test Data						
Percent of Failure Load	Strain (10^{-6})		Load (lbs)	Compressive Stress (psi)	Secant Modulus $\times 10^6$ (psi)	Poisson's Ratio
	Axial	Radial				
10%	-760	55	3,875	1,428	3.76	0.07
20%	-1455	159	7,661	2,823	3.88	0.11
30%	-2087	289	11,571	4,263	4.09	0.14
40%	-2633	435	15,339	5,651	4.29	0.17
50%	-3150	610	19,102	7,038	4.47	0.19
60%	-3654	830	22,976	8,465	4.63	0.23
70%	-4163	1124	26,930	9,922	4.77	0.27
80%	-4667	1542	30,653	11,293	4.84	0.33
90%	-5232	2264	34,439	12,688	4.85	0.43
100%	-6241	4798	38,297	14,110		



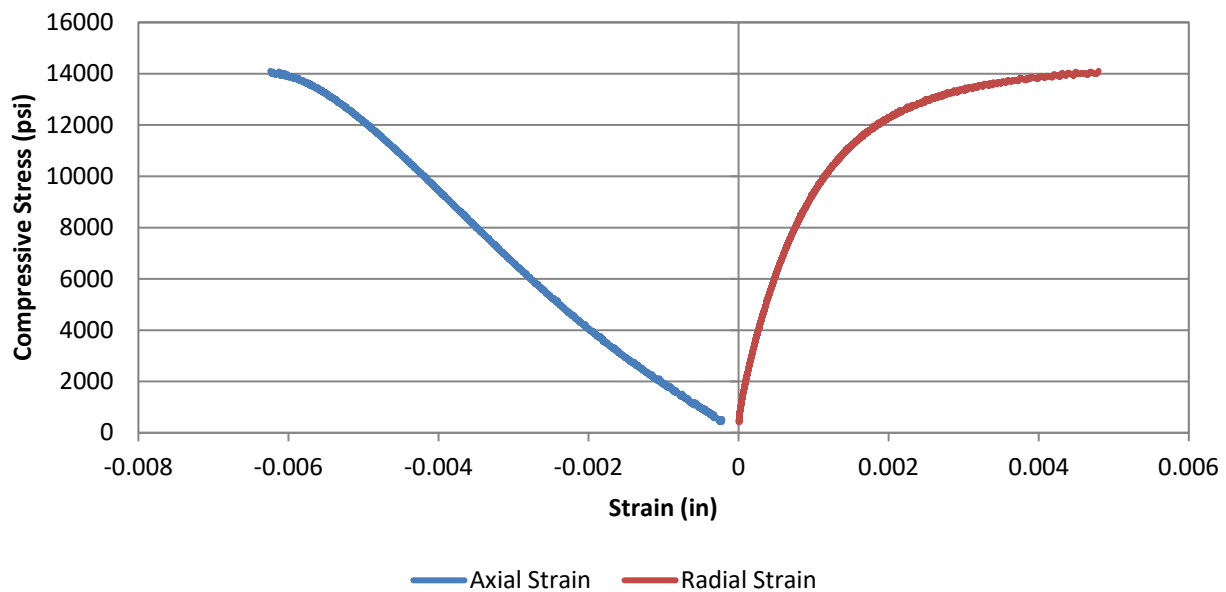
Test Results			
Unconfined Compressive Strength (psi)		14,110	Elastic Modulus (psi)
			4.55E+06
			Poisson's Ratio in Elastic Range
			0.23
Comments	Elastic range was taken as between 0.002 and 0.005 inches of axial strain. This range was chosen to avoid any non-linear behavior from the initial loading and the inflection point at the end of the elastic range.		

Project	SC 49 RBO Fairforest Creek			Date	2/8/2023
Project No.	G6658.003	Sample Diameter (in.)	1.859	Tested By	WAP
SCDOT ID	P041238	Sample Length (in.)	4.243	Reviewed By	WJG
Boring	B-46	Unit Weight (pcf)	175.4	Core Size	NQ
Sample No.	NQ-4 / 23-0118B	L/D Ratio	2.28	Recovery	100%
Depth	20.3' - 20.6'	Load Rate (psi/sec)	20	RQD	100%
Description	Black/White/Gray Granite				

Axial Stress vs. Strain



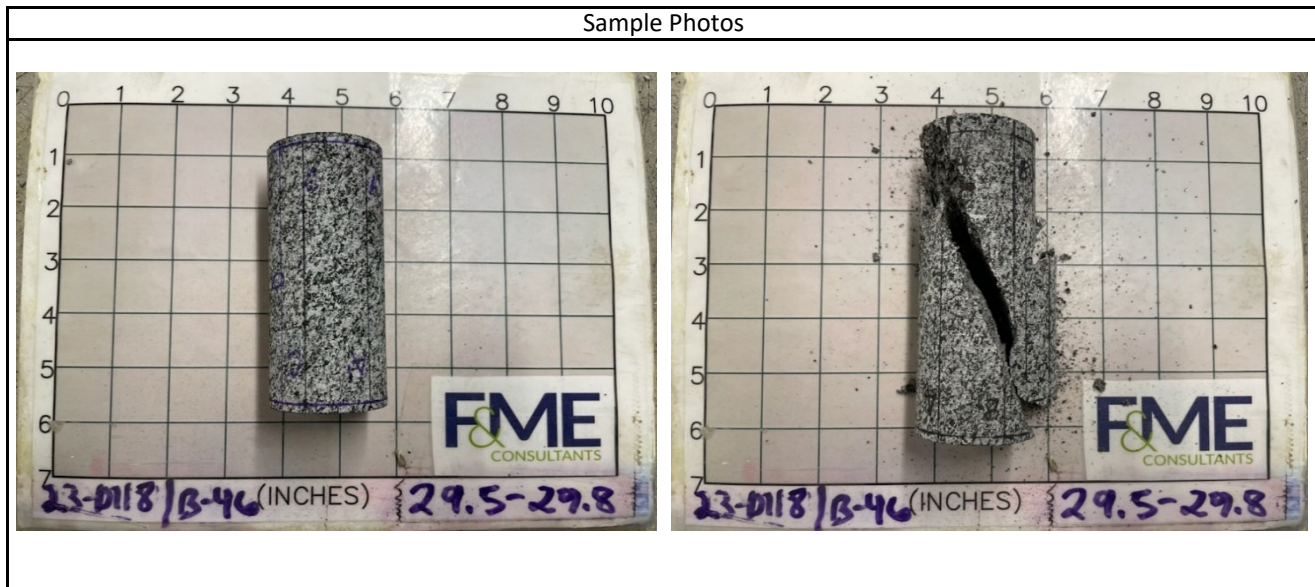
Stress vs. Strain



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

Project	SC 49 RBO Fairforest Creek			Date	2/8/2023
Project No.	G6658.003	Sample Diameter (in.)	1.857	Tested By	WAP
SCDOT ID	P041238	Sample Length (in.)	4.258	Reviewed By	WJG
Boring	B-46	Unit Weight (pcf)	175.9	Core Size	NQ
Sample No.	NQ-5 / 23-0118C	L/D Ratio	2.29	Recovery	100%
Depth	29.5' - 29.8'	Load Rate (psi/sec)	20	RQD	57%
Description	Black/White/Gray Granite				

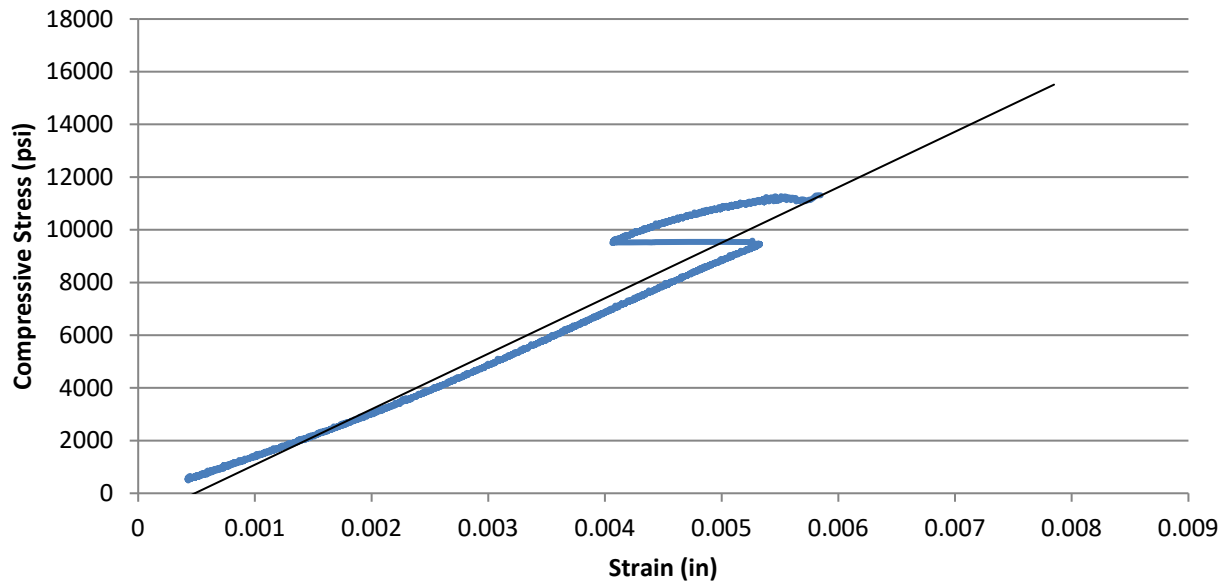
Test Data						
Percent of Failure Load	Strain (10^{-6})		Load (lbs)	Compressive Stress (psi)	Secant Modulus $\times 10^6$ (psi)	Poisson's Ratio
	Axial	Radial				
10%	-802	201	3,013	1,112	2.77	0.25
20%	-1549	371	6,157	2,273	2.93	0.24
30%	-2213	537	9,153	3,380	3.05	0.24
40%	-2826	700	12,256	4,525	3.20	0.25
50%	-3410	918	15,319	5,656	3.32	0.27
60%	-3956	1169	18,327	6,767	3.42	0.30
70%	-4522	1482	21,408	7,904	3.50	0.33
80%	-5092	1881	24,390	9,005	3.54	0.37
90%	-4440	2705	27,541	10,169	4.58	0.61
100%	-5848	3546	30,621	11,306		



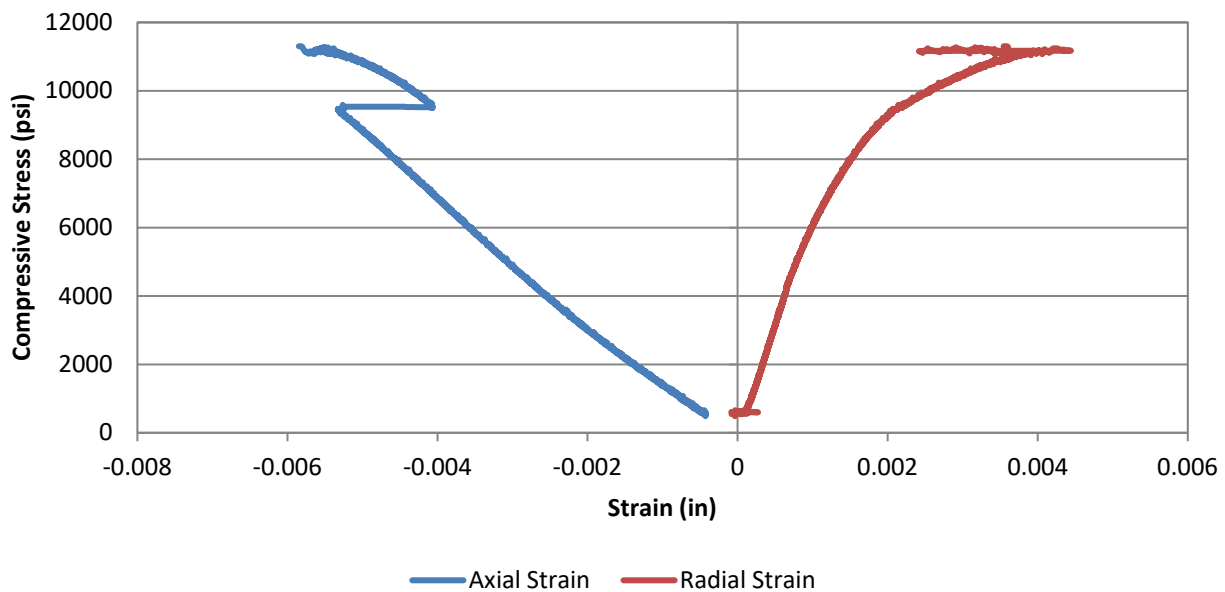
Test Results			
Unconfined Compressive Strength (psi)		11,310	Elastic Modulus (psi)
			3.24E+06
			Poisson's Ratio in Elastic Range
			0.26
Comments	Elastic range was taken as between 0.002 and 0.004 inches of axial strain. This range was chosen to avoid any non-linear behavior from the initial loading and the inflection point at the end of the elastic range. Sample exhibited a partial failure at 9,500 psi.		

Project	SC 49 RBO Fairforest Creek			Date	2/8/2023
Project No.	G6658.003	Sample Diameter (in.)	1.857	Tested By	WAP
SCDOT ID	P041238	Sample Length (in.)	4.258	Reviewed By	WJG
Boring	B-46	Unit Weight (pcf)	175.9	Core Size	NQ
Sample No.	NQ-5 / 23-0118C	L/D Ratio	2.29	Recovery	100%
Depth	29.5' - 29.8'	Load Rate (psi/sec)	20	RQD	57%
Description	Black/White/Gray Granite				

Axial Stress vs. Strain



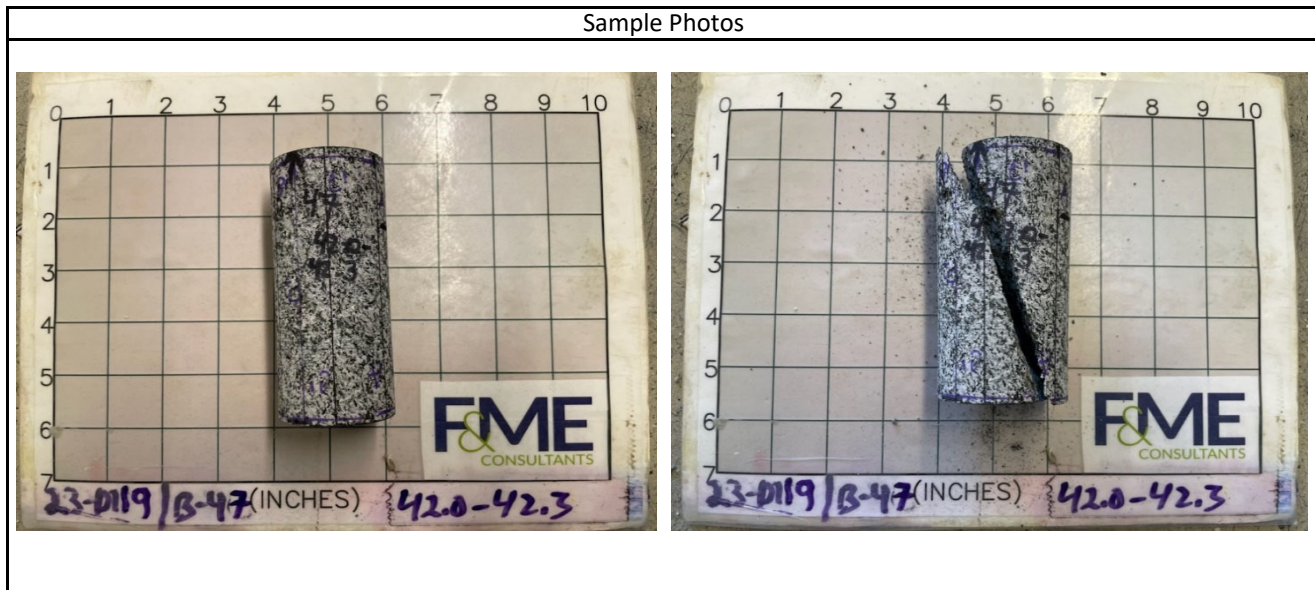
Stress vs. Strain



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

Project	SC 49 RBO Fairforest Creek			Date	2/8/2023
Project No.	G6658.003	Sample Diameter (in.)	1.866	Tested By	WAP
SCDOT ID	P041238	Sample Length (in.)	4.225	Reviewed By	WJG
Boring	B-47	Unit Weight (pcf)	175.3	Core Size	NQ
Sample No.	NQ-2 / 23-0119A	L/D Ratio	2.26	Recovery	87%
Depth	42.0' - 42.3'	Load Rate (psi/sec)	20	RQD	43%
Description	Black/White/Gray Granite				

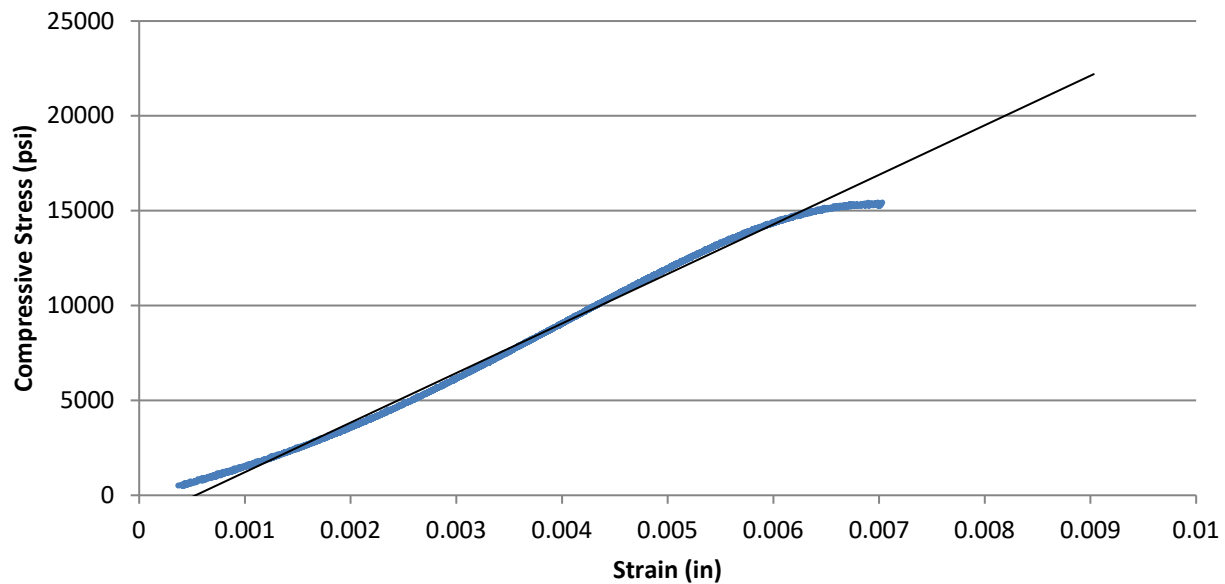
Test Data						
Percent of Failure Load	Strain (10^{-6})		Load (lbs)	Compressive Stress (psi)	Secant Modulus $\times 10^6$ (psi)	Poisson's Ratio
	Axial	Radial				
10%	-1010	88	4,273	1,562	3.09	0.09
20%	-1791	217	8,487	3,103	3.47	0.12
30%	-2431	356	12,658	4,629	3.81	0.15
40%	-3000	515	16,859	6,165	4.11	0.17
50%	-3540	698	21,084	7,710	4.36	0.20
60%	-4064	910	25,321	9,259	4.56	0.22
70%	-4469	1116	28,516	10,427	4.67	0.25
80%	-5140	1595	33,783	12,353	4.81	0.31
90%	-5757	2378	37,942	13,874	4.82	0.41
100%	-7030	4531	42,198	15,430		



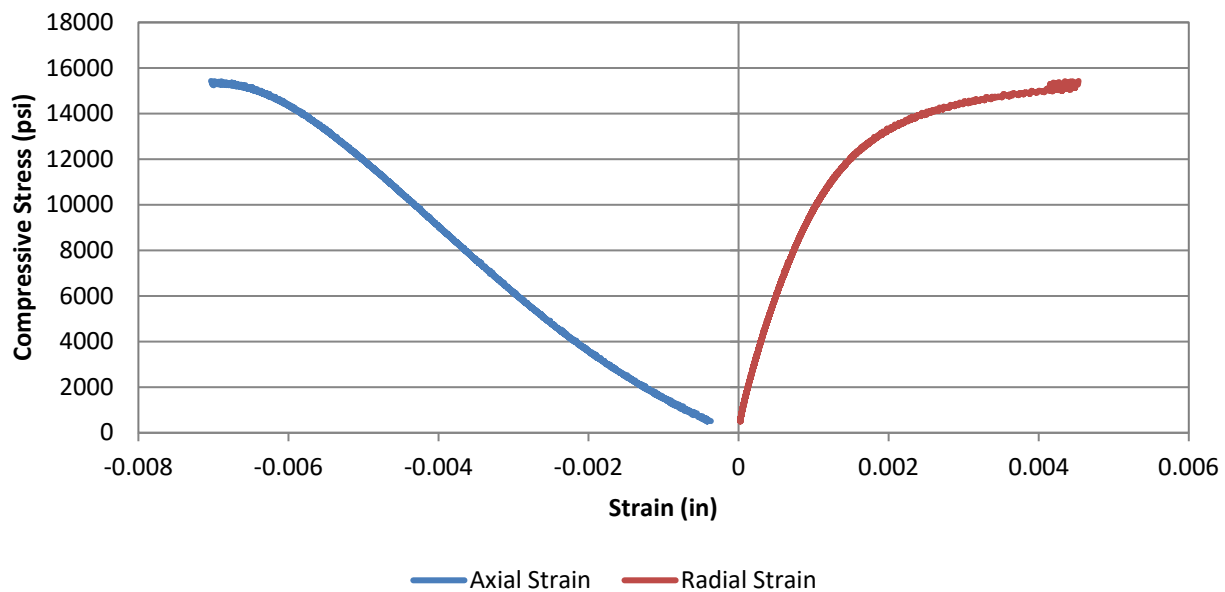
Test Results				
Unconfined Compressive Strength (psi)		15,430	Elastic Modulus (psi)	4.11E+06
			Poisson's Ratio in Elastic Range	0.17
Comments	Elastic range was taken as between 0.002 and 0.004 inches of axial strain. This range was chosen to avoid any non-linear behavior from the initial loading and the inflection point at the end of the elastic range.			

Project	SC 49 RBO Fairforest Creek			Date	2/8/2023
Project No.	G6658.003	Sample Diameter (in.)	1.866	Tested By	WAP
SCDOT ID	P041238	Sample Length (in.)	4.225	Reviewed By	WJG
Boring	B-47	Unit Weight (pcf)	175.3	Core Size	NQ
Sample No.	NQ-2 / 23-0119A	L/D Ratio	2.26	Recovery	87%
Depth	42.0' - 42.3'	Load Rate (psi/sec)	20	RQD	43%
Description	Black/White/Gray Granite				

Axial Stress vs. Strain



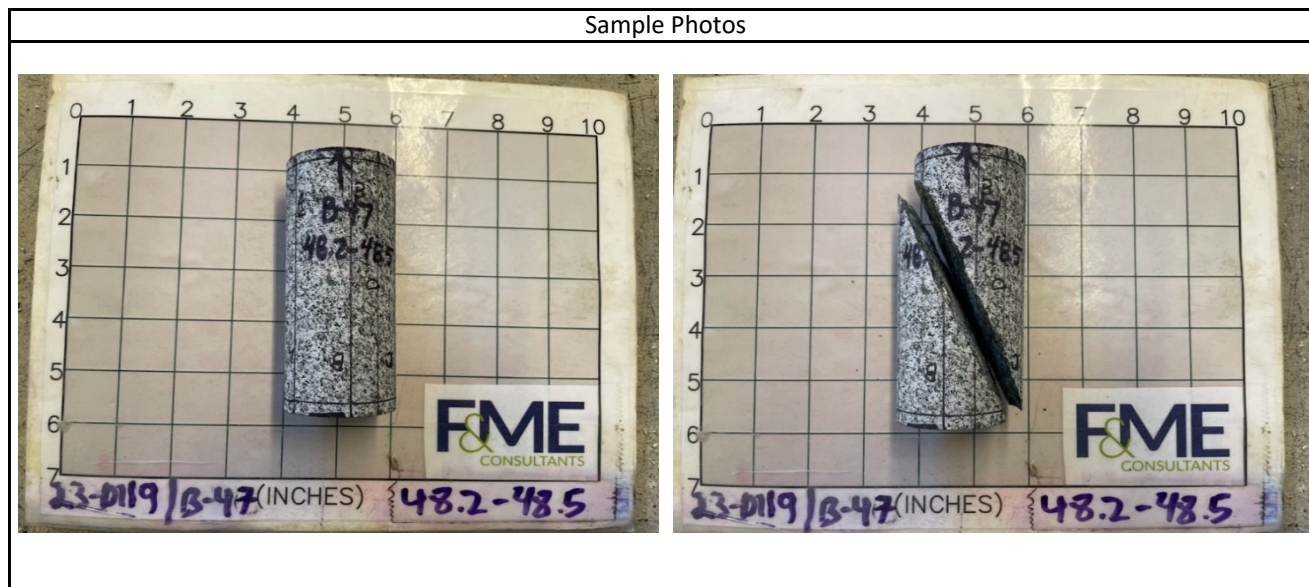
Stress vs. Strain



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

Project	SC 49 RBO Fairforest Creek			Date	2/8/2023
Project No.	G6658.003	Sample Diameter (in.)	1.864	Tested By	WAP
SCDOT ID	P041238	Sample Length (in.)	4.293	Reviewed By	WJG
Boring	B-47	Unit Weight (pcf)	175.1	Core Size	NQ
Sample No.	NQ-3 / 23-0119B	L/D Ratio	2.30	Recovery	100%
Depth	48.2' - 48.5'	Load Rate (psi/sec)	20	RQD	67%
Description	Black/White/Gray Granite				

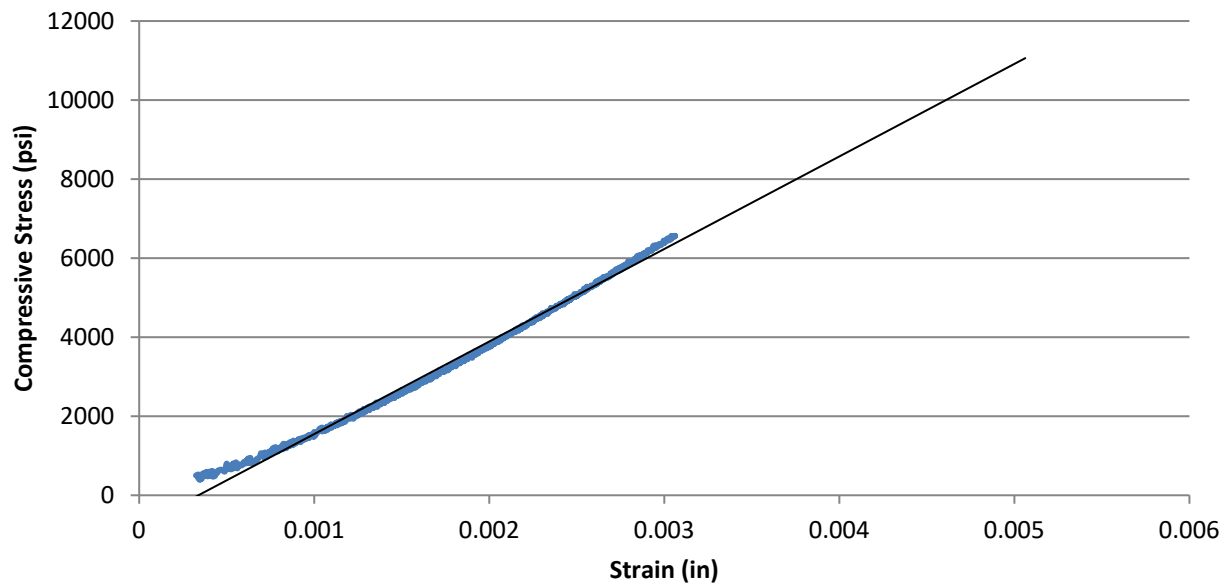
Test Data						
Percent of Failure Load	Strain (10^{-6})		Load (lbs)	Compressive Stress (psi)	Secant Modulus $\times 10^6$ (psi)	Poisson's Ratio
	Axial	Radial				
10%	-470	37	1,774	650	2.77	0.08
20%	-880	86	3,558	1,304	2.96	0.10
30%	-1215	137	5,386	1,974	3.25	0.11
40%	-1516	191	7,181	2,631	3.47	0.13
50%	-1786	246	8,979	3,290	3.69	0.14
60%	-2066	307	10,734	3,934	3.81	0.15
70%	-2326	368	12,588	4,613	3.97	0.16
80%	-2574	432	14,363	5,263	4.09	0.17
90%	-2820	500	16,153	5,919	4.20	0.18
100%	-3062	579	17,914	6,565		



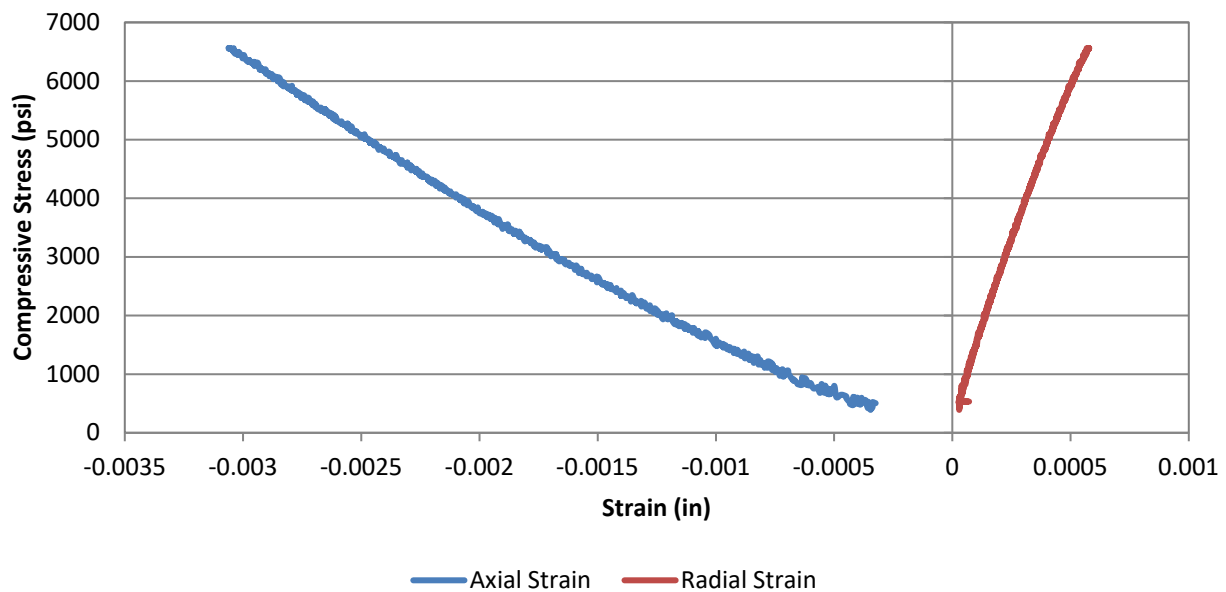
Test Results				
Unconfined Compressive Strength (psi)		6,570	Elastic Modulus (psi)	3.78E+06
			Poisson's Ratio in Elastic Range	0.15
Comments	Elastic range was taken as between 0.001 and 0.003 inches of axial strain. This range was chosen to avoid any non-linear behavior from the initial loading and the inflection point at the end of the elastic range.			

Project	SC 49 RBO Fairforest Creek			Date	2/8/2023
Project No.	G6658.003	Sample Diameter (in.)	1.864	Tested By	WAP
SCDOT ID	P041238	Sample Length (in.)	4.293	Reviewed By	WJG
Boring	B-47	Unit Weight (pcf)	175.1	Core Size	NQ
Sample No.	NQ-3 / 23-0119B	L/D Ratio	2.30	Recovery	100%
Depth	48.2' - 48.5'	Load Rate (psi/sec)	20	RQD	67%
Description	Black/White/Gray Granite				

Axial Stress vs. Strain



Stress vs. Strain



Appendix D. ADRS Curves

3-Point Acceleration Design Response Spectrum

SCDOT v3.1.1 - 11/29/2022

Project ID:	P041238	Latitude:	34.6819
Route:	SC 49	County:	44 - Union
Project:	SC 49 over Fairforest Creek		
		Longitude:	81.6863

Designer:	N. Harman - Support
Date:	2/2/2023

Design EQ	PGA	S _{DS}	S _{D1}	M _W	R	PGV	D ₅₋₉₅	T' _o
	g	g	g	-	km	inches/sec	sec	sec
FEE	0.02	0.04	0.00	7.30	207.90	0.18	51.02	0.03
SEE	0.03	0.07	0.01	6.48	144.37	0.41	32.37	0.09

Fundamental Period of Structure, T ₀ [*]	Range of Interest		V _{s,H} [*]	H	T _{NH}	
	sec				sec	
sec	0.5*T ₀	2.0*T ₀	ft/sec	ft	(4*H)/V _{s,H} [*]	(6*H)/V _{s,H} [*]
0.00	0.00	0.00	693.09	42.00	0.22	0.36
0.00	0.00	0.00	H = B-C Boundary			

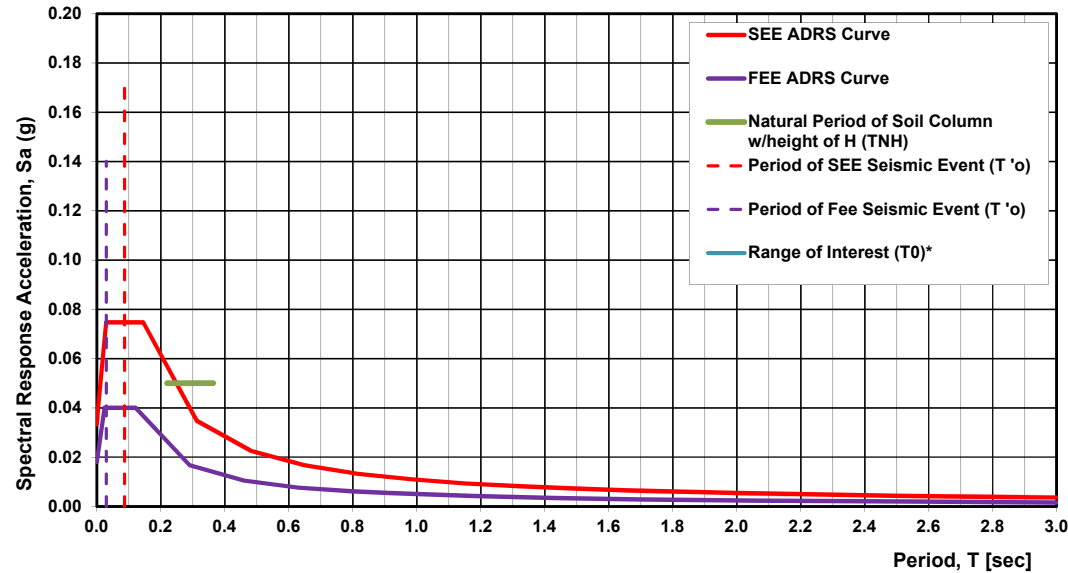
H = B-C Boundary

Damping:	5%
Geologic Condition:	Geologically Realistic (Q = 100)*
ADRS Location within Soil Column:	SCP
	At Ground Surface

South Carolina Piedmont

*Same Geologic Condition as used in SCENARIO_PC (2006)

SC Seismic ADRS Curve



FEE Data

T	S _a
0.00	0.018
0.00	0.022
0.01	0.025
0.01	0.029
0.02	0.033
0.02	0.036
0.02	0.040
0.03	0.040
0.04	0.040
0.05	0.040
0.06	0.040
0.06	0.040
0.07	0.040
0.08	0.040
0.09	0.040
0.10	0.040
0.11	0.040
0.11	0.040
0.12	0.040
0.29	0.017
0.46	0.011
0.63	0.008
0.80	0.006
0.97	0.005
1.14	0.004
1.31	0.004
1.48	0.003
1.65	0.003
1.81	0.003
1.98	0.002
2.15	0.002
2.32	0.002
2.49	0.002
2.66	0.002
2.83	0.002
3.00	0.002

SEE Data

T	S _a
0.00	0.033
0.00	0.040
0.01	0.047
0.01	0.054
0.02	0.061
0.02	0.068
0.02	0.075
0.03	0.075
0.04	0.075
0.05	0.075
0.06	0.075
0.07	0.075
0.08	0.075
0.09	0.075
0.10	0.075
0.11	0.075
0.12	0.075
0.13	0.075
0.14	0.075
0.15	0.075
0.31	0.035
0.48	0.023
0.65	0.017
0.82	0.013
0.98	0.011
1.15	0.009
1.32	0.008
1.49	0.007
1.66	0.007
1.82	0.006
1.99	0.005
2.16	0.005
2.33	0.005
2.50	0.004
2.66	0.004
2.83	0.004
3.00	0.004

Appendix E. SPT Hammer Energy Calibration Report

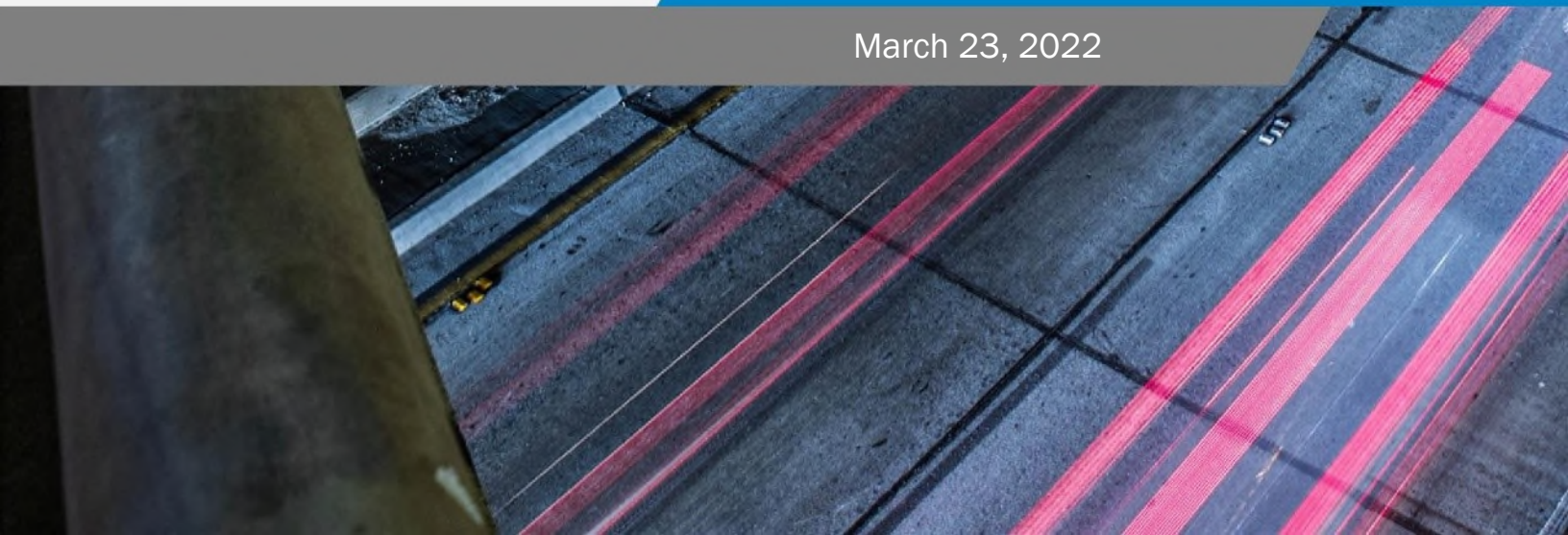


**CAROLINAS
GEOTECHNICAL
GROUP**

Report of SPT Hammer Energy

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

March 23, 2022





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.

Report of SPT Hammer Energy
Chester, South Carolina
CG2 Project No.: 240021095

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

Report of SPT Hammer Energy
Chester, South Carolina
CG2 Project No.: 240021095

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

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%.

Report of SPT Hammer Energy
Chester, South Carolina
CG2 Project No.: 240021095

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:

386129C0A4C1462...
D. Matthew Brewer, PE
Senior Project Engineer

DocuSigned by:

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



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



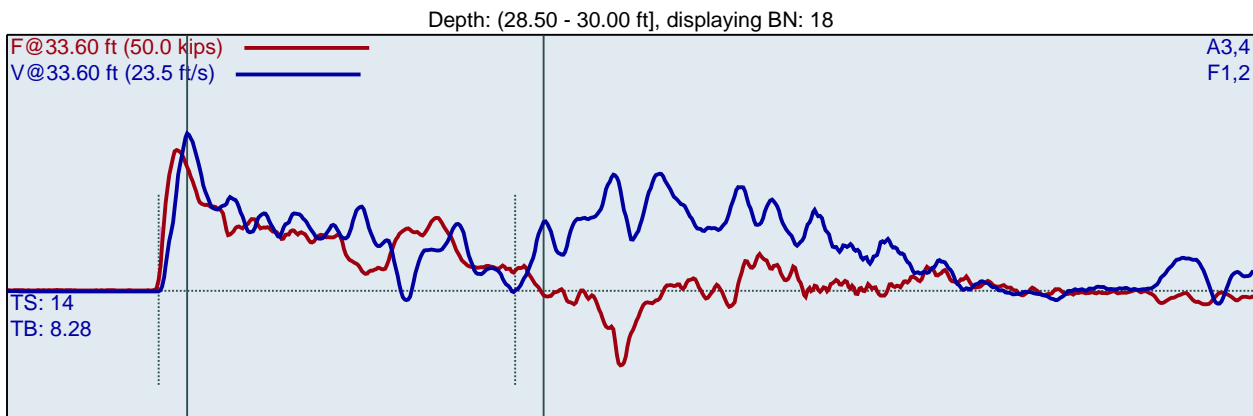
APPENDIX I

CME 550X (SN 294593)
REK
B-4

B-4
Interval start: 3/11/2022

AR: 1.19 in²
LE: 33.60 ft
WS: 16807.9 ft/s

SP: 0.492 k/ft³
EM: 30000 ksi



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

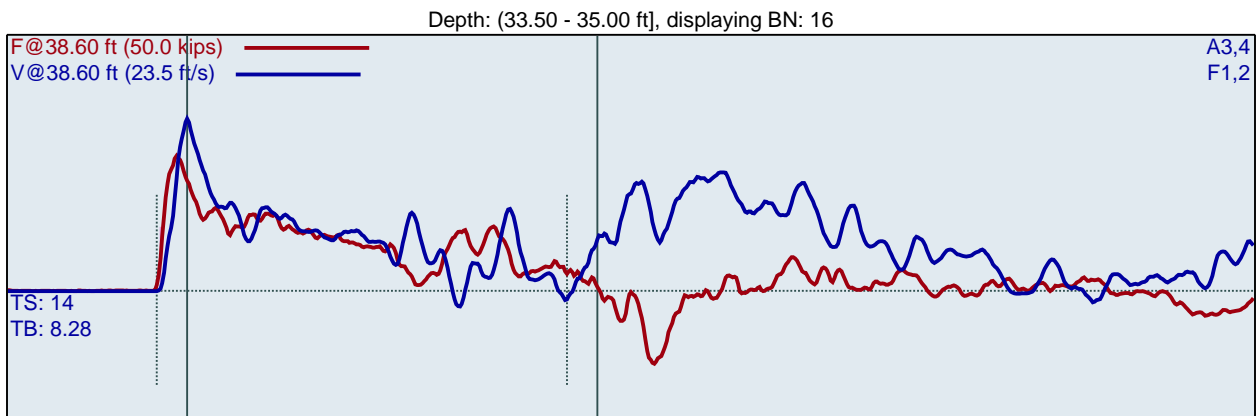
Sample Interval Time: 19.99 seconds.

CME 550X (SN 294593)
REK
B-4

B-4
Interval start: 3/11/2022

AR: 1.19 in²
LE: 38.60 ft
WS: 16807.9 ft/s

SP: 0.492 k/ft³
EM: 30000 ksi



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 %
33.63	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

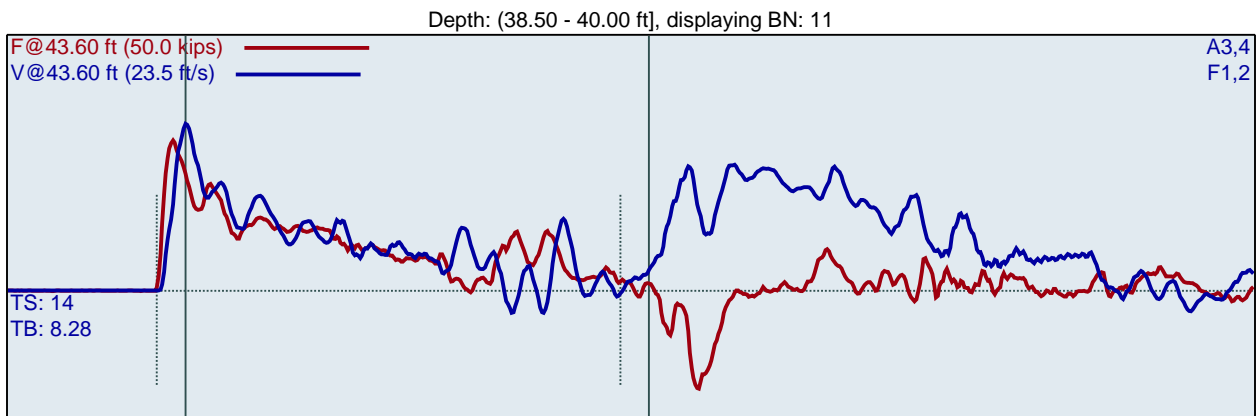
Sample Interval Time: 17.58 seconds.

CME 550X (SN 294593)
REK
B-4

B-4
Interval start: 3/11/2022

AR: 1.19 in²
LE: 43.60 ft
WS: 16807.9 ft/s

SP: 0.492 k/ft³
EM: 30000 ksi



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 %
38.67	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

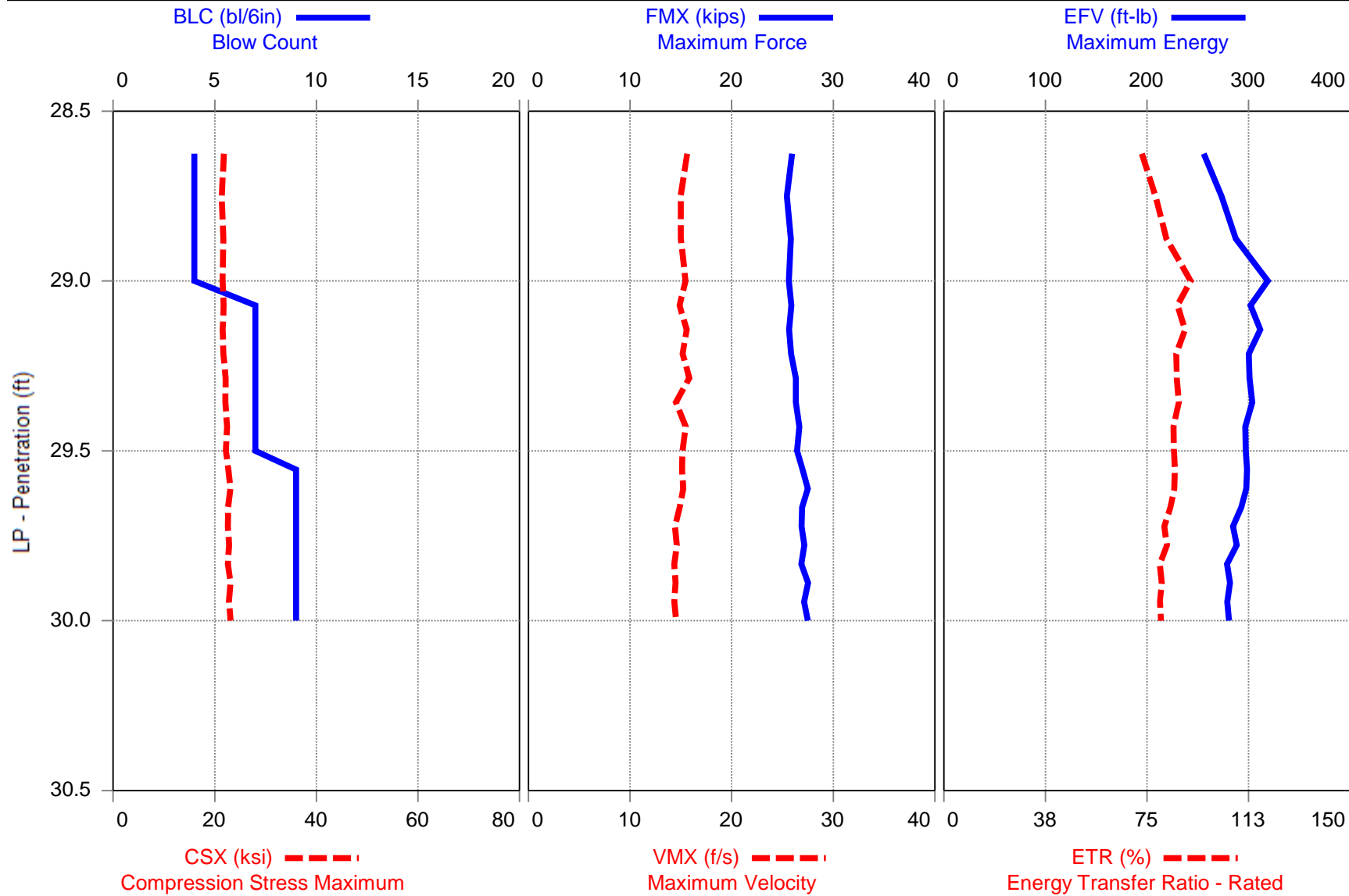
N-value: 10

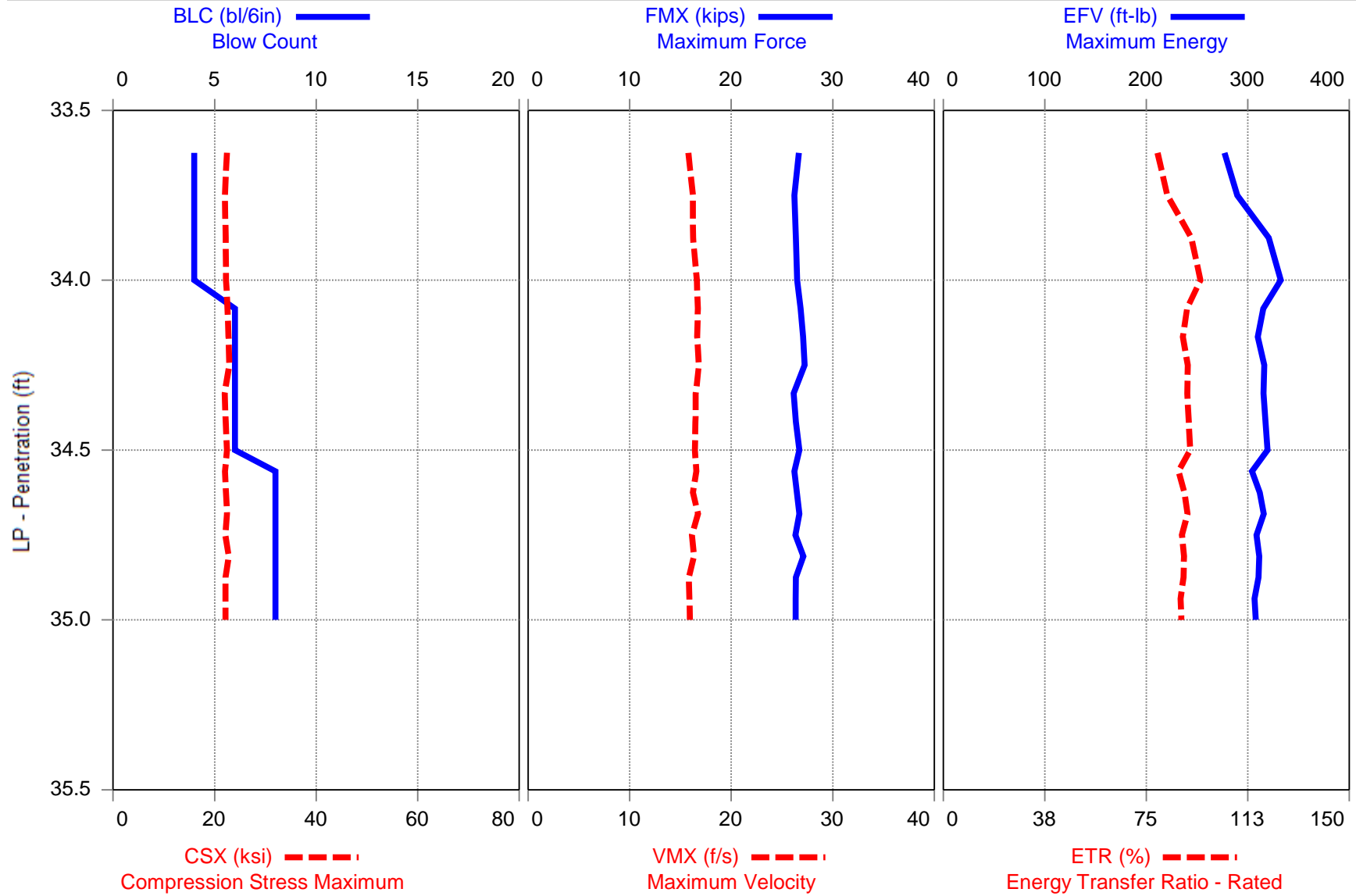
Sample Interval Time: 12.41 seconds.

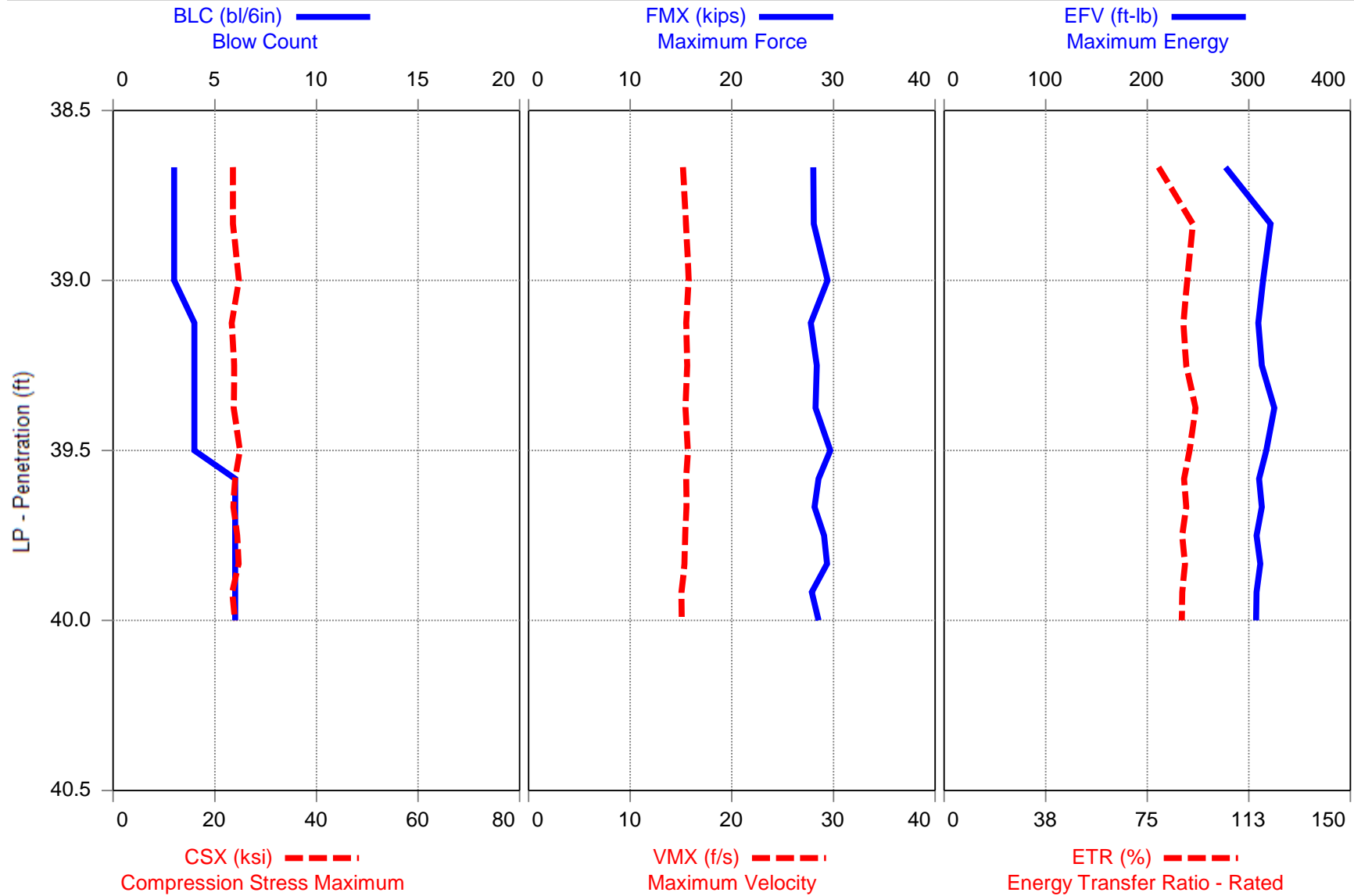
Summary of SPT Test Results

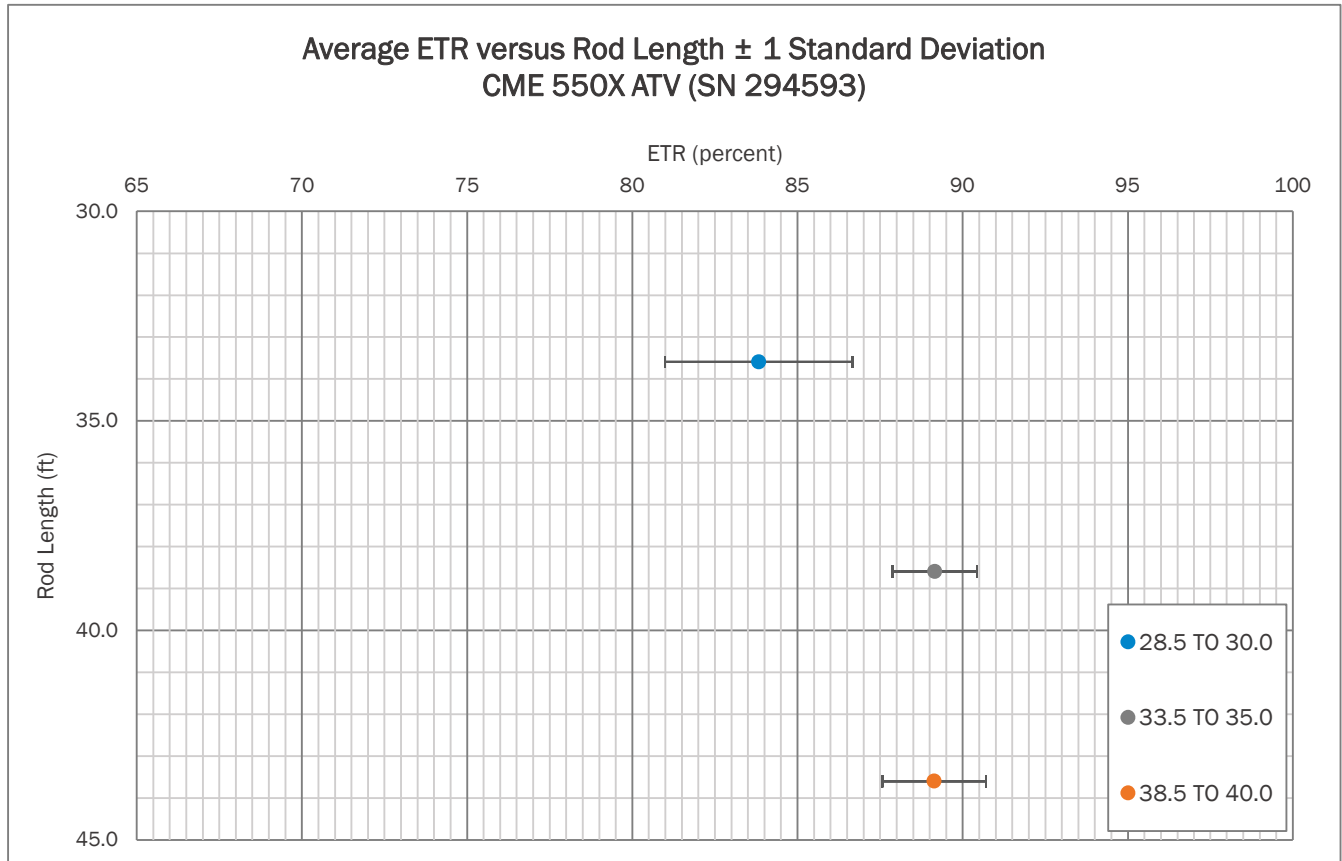
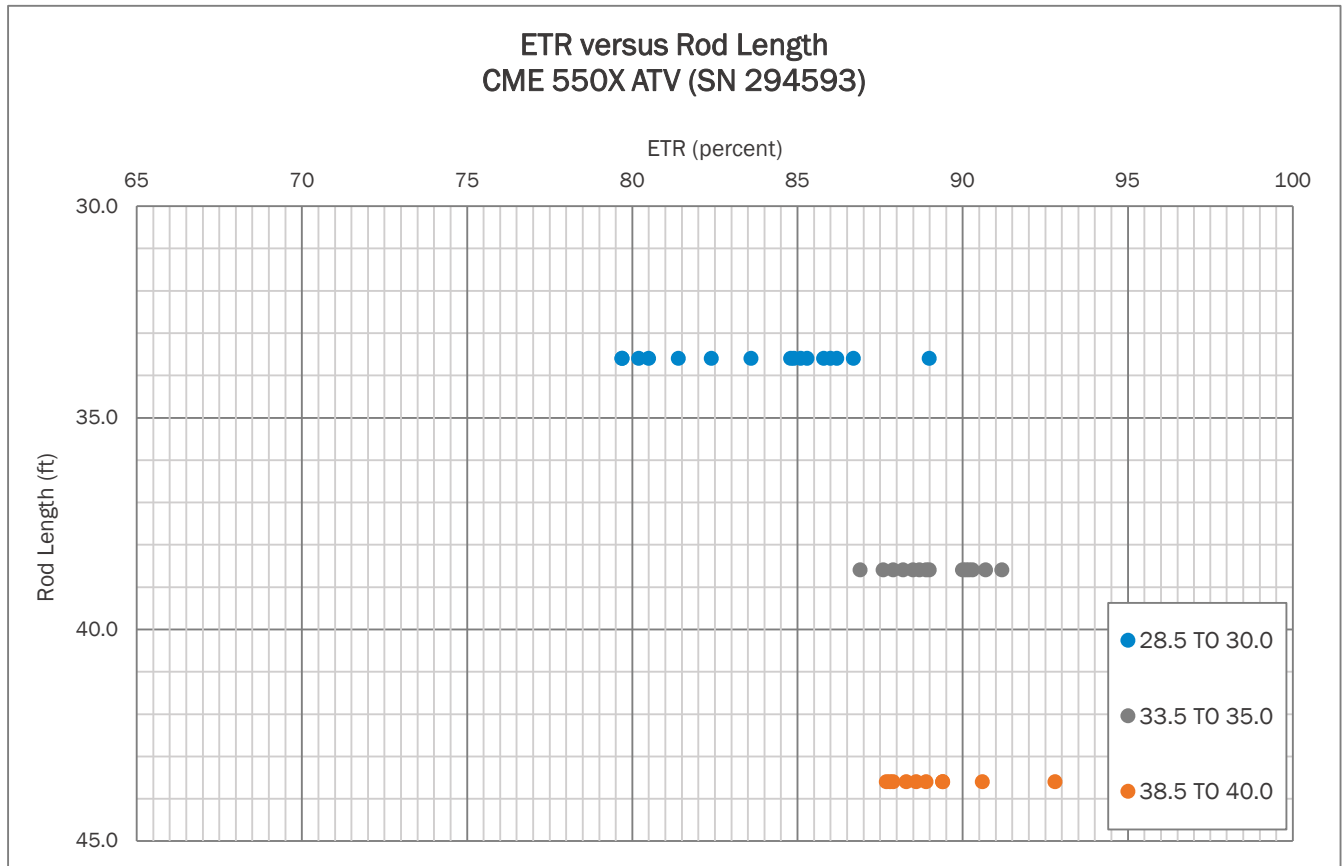
Project: CME 550X (SN 294593), Test Date: 3/11/2022

BPM: Blows/Minute						CSX: Compression Stress Maximum							
FMX: Maximum Force						DFN: Final Displacement							
VMX: Maximum Velocity						EFV: Maximum Energy							
DMX: Maximum Displacement						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











APPENDIX II

SPT Hammer Energy Field Form

Project: SPT HAMMER ENERGY
 Project No.: 240021095
 Boring No.: B-4

Date: 3/11/2022
 Weather: 50's CLOUDY
 Drill Rod Type: AWJ

On-site Personnel

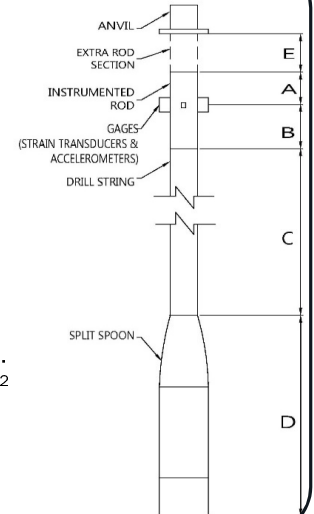
Drilling Company: BRECCIA CONSTRUCTION, LLC
 Rig Operator: R. HUFFSTETLER
 Engr/Geologist: N/A
 Client Rep.: N/A
 Analyzer Oper.: R. KRAL

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

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 in²
 PDA Make/Model: SPT
 PDA Serial No.: 4549 TB
 Calib. Pulse Test (y/n): Y



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				Drop Height in Tolerance (y/n)	Soil Class.
						6"	12"	18"	N-Value		
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. verticality, 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

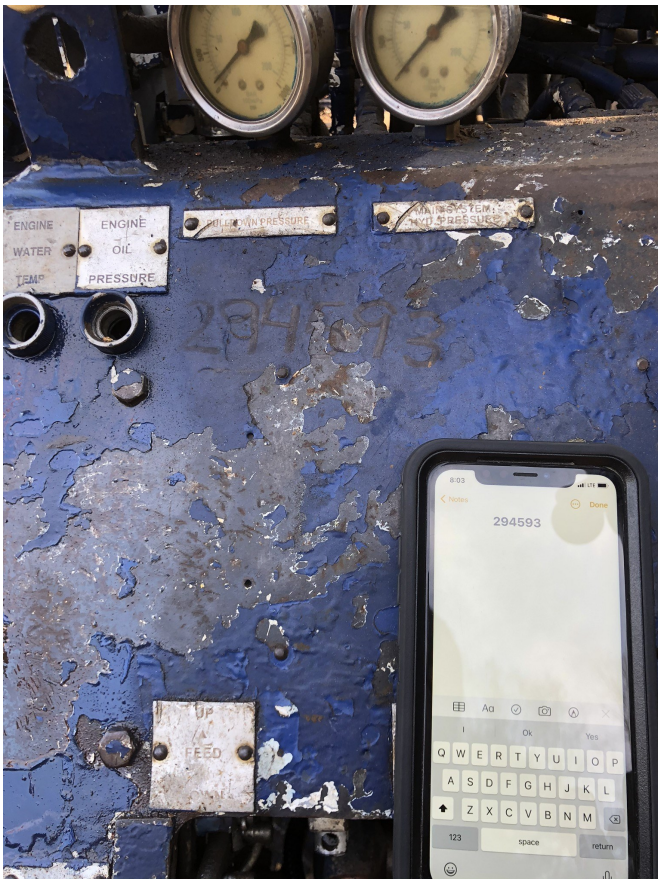


Figure No. 3: Serial Number Plate



Figure No. 4: Automatic Hammer

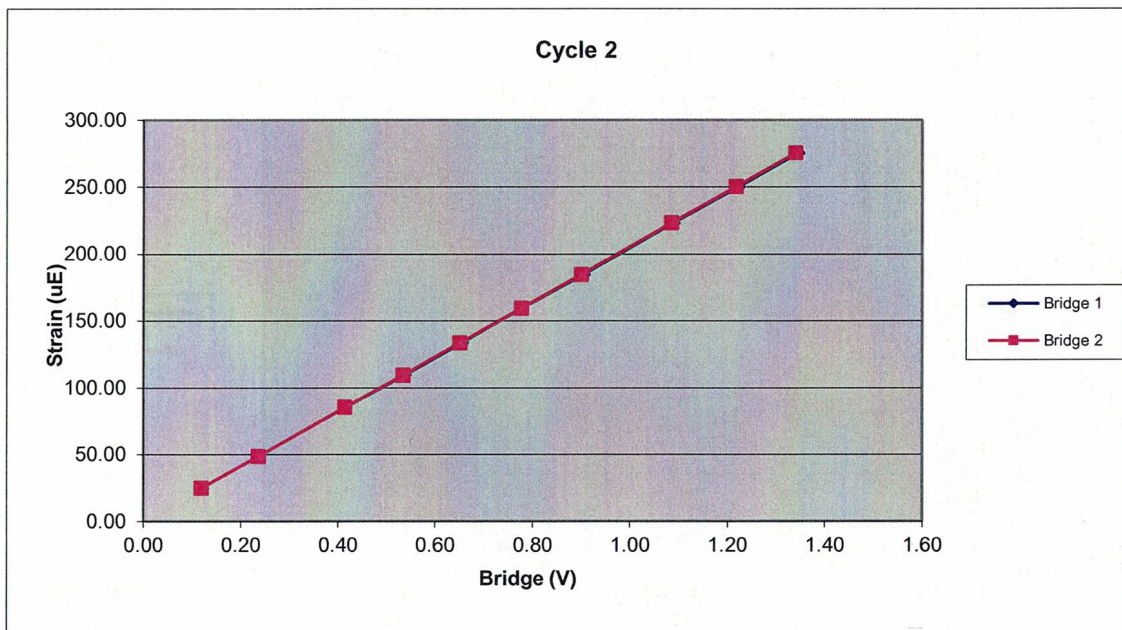


APPENDIX III

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 ($\mu\text{E}/\text{V}$)	204.74	Strain Calibration ($\mu\text{E}/\text{V}$)	205.35
Offset	-0.39	Offset	-0.39
Correlation	0.999993	Correlation	0.999995

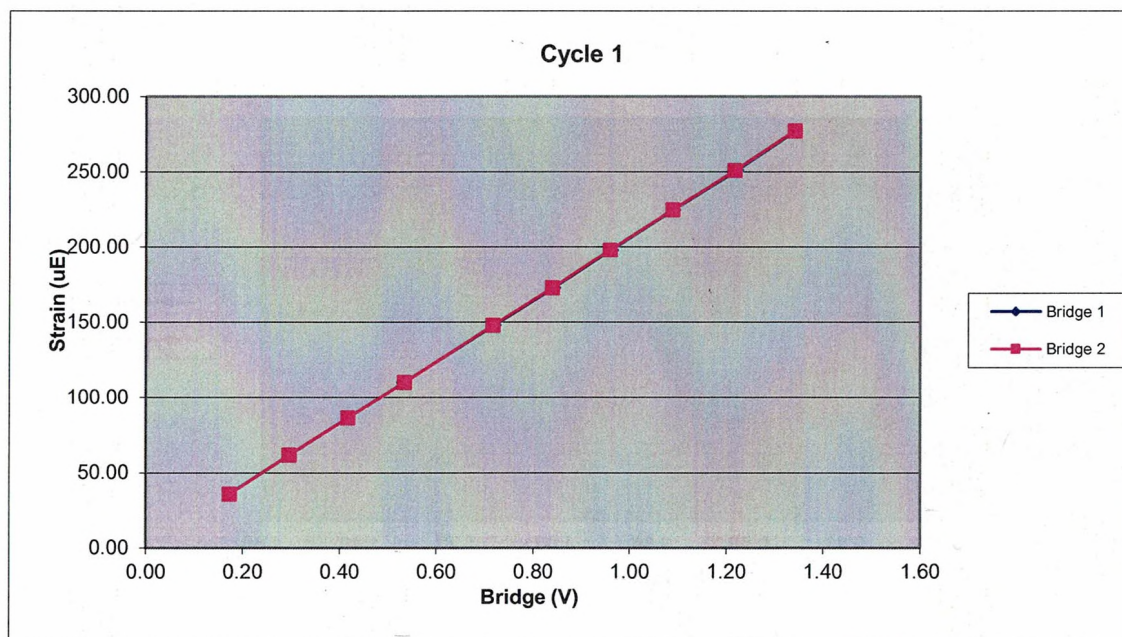
Force Strain Calibration	
EA (Kips)	35851.72
Offset	27.08
Correlation	0.999996



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 ($\mu\text{E/V}$)	205.65	Strain Calibration ($\mu\text{E/V}$)	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 Resistor (ohm) 60.4k

Calibration Factors	528AWJ		
Bridge 1 ($\mu\text{E/V}$)	205.26	Bridge 2 ($\mu\text{E/V}$)	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

PDA CALIBRATION FACTOR

417.3 mv/5000g

(83.5 μ v/g)

R²: 0.999987 [Chip programmed]

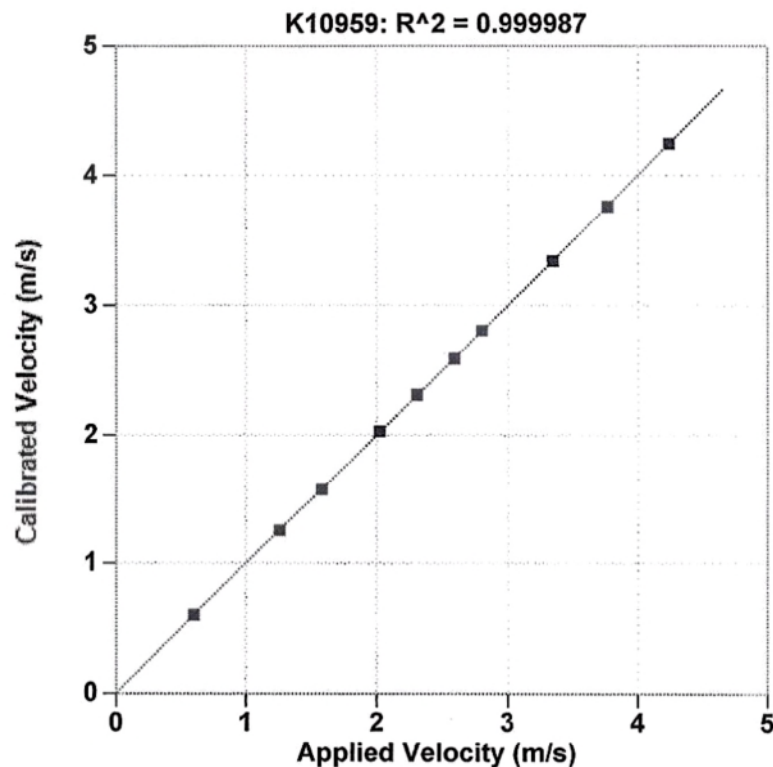
Operator: William Johnson

Ref Acc 1: 69096! Cal on: 27Jan2021
978 g's/volt

Ref Acc 2: 69132! Cal on: 09Feb2021
960 g's/volt

Signed

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



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

PDA CALIBRATION FACTOR

425.7 mv/5000g

(85.1 $\mu\text{v/g}$)

R²: 0.999987 [Chip programmed]

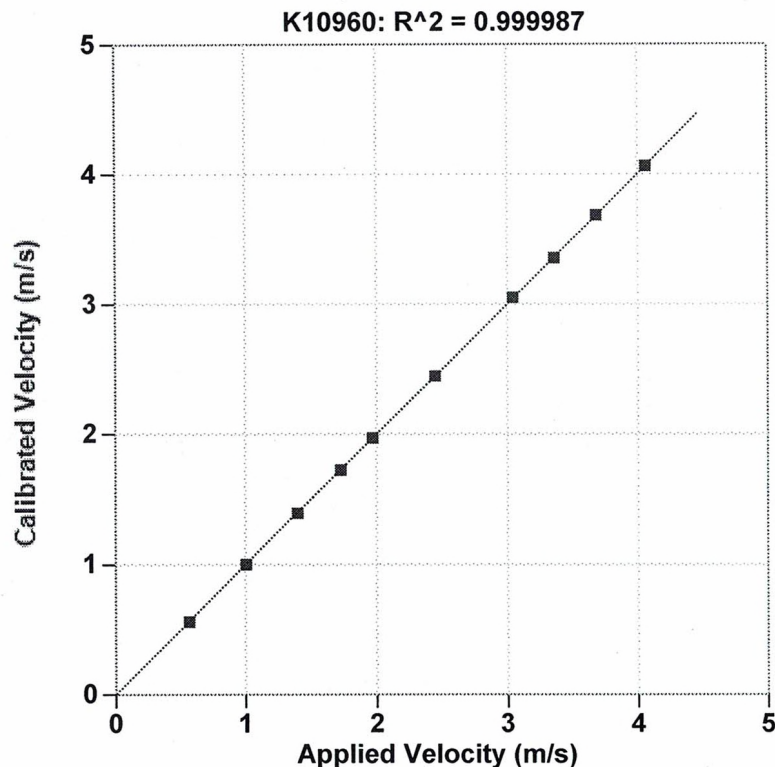
Operator: William Johnson

Ref Acc 1: 63479! Cal on: 09Sep2020
1080 g's/volt

Ref Acc 2: 65538! Cal on: 27Jan2020
1040 g's/volt


Signed

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



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

PDA CALIBRATION FACTOR

407.0 mv/5000g

(81.4 μ v/g)

R²: 0.999989 [Chip programmed]

Operator: William Johnson

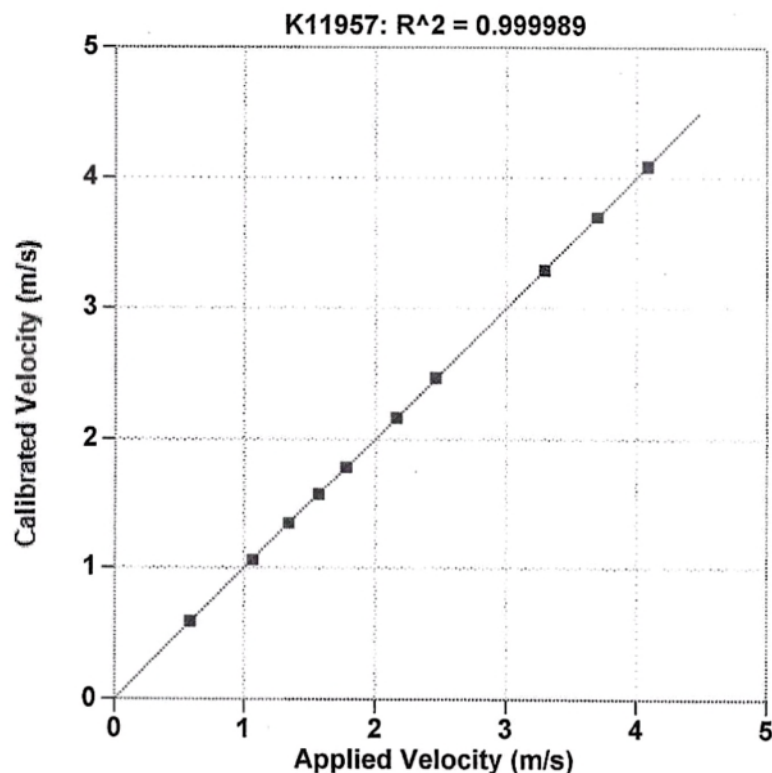
Ref Acc 1: 63479! Cal on: 22Jan2021
1079 g's/volt

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

William Johnson

Signed

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



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



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