

Geotechnical Data Report

Vest to Franklin Force Main Charlotte, North Carolina

April 4, 2023 Terracon Project No. 71225194

Prepared for:

Charlotte Water Charlotte, North Carolina

Prepared by:

Terracon Consultants, Inc. Charlotte, North Carolina

Environmental Facilities Geotechnical Materials

April 4, 2023

Charlotte Water 5100 Brookshire Blvd. Charlotte, North Carolina 28216 Terracon GeoReport

Attn: Mr. Justin Webster, P.E.

P: 704-336-3017

E: Justin.Webster@charlottenc.gov

Re: Geotechnical Data Report

Vest to Franklin Force Main

820 Beatties Ford Rd. and 5200 Brookshire Blvd.

Charlotte, North Carolina

Terracon Project No. 71225194

Dear Mr. Webster:

We have completed the subsurface investigation and laboratory services for the above referenced project. This study was performed in general accordance with Terracon Proposal No. P71225194 dated October 6, 2022 and Charlotte Water Task Order 2020000923. This report presents the findings of the subsurface exploration and the results of our laboratory testing.

We appreciate the opportunity to be of service to you on this projection, any questions concerning this report or if we may be of further service, please contents.

Sincerely,

Terracon Consultants, Inc.

Frederick J.E. Brock, E.I.

Staff Engineer

Christopher R. Briggs, P.E.

Geotechnical Department Manager

4/5/2023

Attachments:

Exploration and Testing Procedures
Geotechnical Characterization

Site Location

Exploration Plan (7 pages)

Boring and Coring Logs (52 pages)

Subsurface Profiles at Select Crossings (4 pages)

Field Electrical Resistivity Results (6 pages)

Summary of Laboratory Results

Atterberg Limits

Grain Size Distribution (7 pages)

Corrosion Analysis

UU Triaxial Results (31 pages)

UC Soil Strength Results (15 pages)

General Notes

Unified Soil Classification System

Rock Classification Table

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Geotechnical Data Report

Vest to Franklin Force Main
820 Beatties Ford Rd. and 5200 Brookshire Blvd.
Charlotte, North Carolina
Terracon Project No. 71225194
April 4, 2023

INTRODUCTION

This report presents the results of our subsurface exploration and laboratory testing services performed for the proposed Vest to Franklin Force Main alignment to be located along several roads and utility easements between the Vest Water Treatment Plant (Vest) at 820 Beatties Ford Rd and the Franklin Wastewater Treatment Plant (Franklin) at 5200 Brookshire Blvd in Charlotte, North Carolina. The proposed Force Main is to be built at a length of 16,000 linear feet of 16" DIP.

The purpose of these services is to provide geotechnical engineering information and data relative to:

- Subsurface soil and rock conditions
- Groundwater conditions

- Advanced laboratory test results
- Electrical resistivity test results

The geotechnical engineering Scope of Services for this project included the advancement of 48 test borings to depths ranging from approximately 5 to 50 feet below existing site grades.

Charlotte Water provided Terracon with proposed approximate boring locations and boring depths. Terracon personnel provided the boring layout, based on the provided locations. Coordinates and elevations were largely provided by Stewart, Inc, with the exception of Borings BH-07.5, BH-43, and BH-44. These boring coordinates were obtained with a handheld GPS unit (estimated horizontal accuracy of about ±10 feet) and approximate elevations were obtained from Google Earth Pro. Proposed trenchless crossings are to be located at CSX Railroad (BH-35 to BH-38), NCDOT I-85 (BH-19 to BH-22), and the box culvert at Stewart Creek (BH-11 to BH-14). Open cut trenching is proposed at the remaining borings.

Vest to Franklin Force Main ■ Charlotte, North Carolina 5100 Brookshire Blvd. ■ Terracon Project No. 71225194



Per Stewart, Inc.:

THE COORDINATE SYSTEM FOR THIS PROJECT IS BASED ON N.C. N.A.D. 83 (N.S.R.S. 2011)AND THE ELEVATIONS ARE BASED ON N.A.V.D. 88. THE INITIAL POSITIONS WERE DETERMINED WITH A REAL TIME KINEMATIC GPS UNIT USING THE NORTH CAROLINA GEODETIC SURVEY REAL TIME NETWORK, AND WERE TIED TO THE FOLLOWING LOCALIZED CONTROL POINT PROVIDED BY AVIOIMAGE.

"HV-8" N: 555622.54' E: 1441209.68' ELE: 707.16'

Maps showing the site and boring locations are shown in the **Site Location** and **Exploration Plan**, respectively. The results of the laboratory testing performed on soil samples obtained from the site during the field exploration are included on the boring logs and as separate graphs in the **Exploration Results** section.

ATTACHMENTS

Vest to Franklin Force Main ■ Charlotte, North Carolina April 4, 2023 ■ Terracon Project No. 71225194



EXPLORATION AND TESTING PROCEDURES

Field Exploration

Number of Investigations	Depth ¹ (feet)	Location
48 Borings	5 to 50	Planned Alignment
6 Arrays of In-Situ Electrical Resistivity	NA ²	Planned I-85 Crossing

^{1.} Referenced from the existing ground surface.

Boring Layout and Elevations: Terracon personnel provided the boring layout with input from Black & Veatch. Coordinates and elevations were largely provided by Stewart, Inc. Boring BH-07.5, BH-43, and BH-44 coordinates were obtained with a handheld GPS unit (estimated horizontal accuracy of about ±10 feet) and approximate elevations were obtained from Google Earth Pro.

Boring ID	Latitude (°) ^{1,3}	Longitude (°) ^{1,3}	Elevation (feet) ^{2,4}
BH-01	35.2529938	-80.8565829	743.579
BH-02	35.2531838	-80.8579732	736.624
BH-03	35.2541186	-80.8590196	712.68
BH-04	35.2551723	-80.8589476	726.498
BH-05	35.2552564	-80.8600311	720.936
BH-06	35.2562132	-80.8608299	713.425
BH-07	35.2566326	-80.8626029	672.488
BH-07.5 ^{3,4}	35.256692	-80.862747	669
BH-08	35.2573227	-80.8635358	668.605
BH-09	35.2583367	-80.8645748	668.793
BH-10	35.258779	-80.8666158	682.058
BH-11	35.2593604	-80.8678746	682.474
BH-12A	35.2595756	-80.8682684	670.922
BH-12B	35.2595756	-80.8682684	670.922
BH-13	35.259672	-80.8685413	666.537
BH-14	35.259848	-80.8690624	679.99

^{2.} Not applicable.



Boring ID	Latitude (°) ^{1,3}	Longitude (°) ^{1,3}	Elevation (feet) ^{2,4}
BH-15	35.2609468	-80.870018	691.021
BH-16	35.2616343	-80.8713693	699.608
BH-17	35.2628263	-80.8726974	715.632
BH-18	35.2636203	-80.8736358	725.833
BH-19	35.2645041	-80.8746259	732.852
BH-20	35.2649476	-80.8750106	736.509
BH-20.5	35.2651668	-80.8752502	747.816
BH-21	35.2654	-80.8753633	744.579
BH-22	35.2658489	-80.8757234	743.623
BH-23	35.2659764	-80.8762608	748.981
BH-24	35.2662374	-80.8767153	749.286
BH-25	35.2676126	-80.8776323	758.569
BH-26	35.2680389	-80.8777736	759.921
BH-27	35.2691212	-80.8782491	762.04
BH-28	35.2705988	-80.878718	740.657
BH-29	35.2715899	-80.8793137	761.054
BH-30	35.2724064	-80.8798964	732.84
BH-31	35.2727416	-80.8802806	735.915
BH-32	35.2728532	-80.8804029	717.448
BH-33	35.2732384	-80.8806323	738.122
BH-34	35.2734108	-80.8808283	765.609
BH-35	35.2736081	-80.8810185	754.297
BH-36	35.2738556	-80.8812847	755.748
BH-37	35.2741338	-80.8818593	759.62
BH-38	35.2743779	-80.8820665	768.89
BH-39	35.2751977	-80.8820046	746.936
BH-40	35.2763358	-80.8826012	738.335
BH-41	35.2760991	-80.8839235	742.966
BH-42	35.2769831	-80.8848522	766.669
BH-43 ^{3,4}	35.27796493	-80.88581791	769

Vest to Franklin Force Main ■ Charlotte, North Carolina April 4, 2023 ■ Terracon Project No. 71225194



Boring ID	Latitude (°) ^{1,3}	Longitude (°) ^{1,3}	Elevation (feet) ^{2,4}
BH-44 ^{3,4,5}	35.27893102	-80.88685362	778
BH-45	35.2769492	-80.8839974	745.873
BH-46	35.2765518	-80.8862143	773.691

- Latitude and Longitude provided by Stewart, Inc. in N.A.D. 83 (N.S.R.S. 2011) Easting/Northing coordinate format.
- 2. Elevations provided by Stewart, Inc.
- 3. Borings BH-07.5, BH-43, and BH-44 Latitude and Longitude obtained using Terracon GIS mapping.
- 4. Borings BH-07.5, BH-43, and BH-44 Elevations obtained using Google Earth Pro.
- 5. BH-44 was not performed per the request of City of Charlotte and Black & Veatch.

Subsurface Exploration Procedures: We advanced the borings with both truck and ATV-mounted rotary drill rigs using continuous flight augers. Four samples were obtained in the upper 10 feet of each boring and at intervals of 5 feet thereafter. In the split-barrel sampling procedure, a standard 2-inch outer diameter split-barrel sampling spoon was driven into the ground by a 140-pound automatic hammer falling a distance of 30 inches. The number of blows required to advance the sampling spoon the last 12 inches of a normal 18-inch penetration is recorded as the Standard Penetration Test (SPT) resistance value. The SPT resistance values, also referred to as N-values, are indicated on the boring logs at the test depths. We observed and recorded groundwater levels during drilling and sampling. For safety purposes, all borings were backfilled with auger cuttings after their completion. Pavements were patched with cold-mix asphalt and/or pre-mixed concrete, as appropriate.

The sampling depths, penetration distances, and other sampling information was recorded on the field boring logs. The samples were placed in appropriate containers and taken to our soil laboratory for testing and classification by a Geotechnical Engineer. Our exploration team prepared field boring logs as part of the drilling operations. These field logs included visual classifications of the materials encountered during drilling and our interpretation of the subsurface conditions between samples. Final boring logs were prepared from the field logs. The final boring logs represent the Geotechnical Engineer's interpretation of the field logs and include modifications based on observations and tests of the samples in our laboratory.

Rock core was obtained in approximately 5-foot long runs using NQ-size, diamond-bit core barrel systems. The lithology, percent recovery (REC%) and rock quality designation (RQD) of the rock core were evaluated by a geotechnical engineer or geologist. The REC% was determined by summing the length of core recovered divided by the total length of the core run. The RQD is an index obtained by summing the lengths of competent rock core pieces that are 4 inches in length or longer divided by the total length of core run.

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Field Electrical Resistivity Testing

The in-situ field electrical resistivity surveys were performed in general accordance with the Wenner Four Point method (ASTM G57). Six arrays were performed using "A-spacing" as shown in the provided tables. The in-situ field resistivity test lines location and test results are attached in **Exploration Results** of this report. The results of these tests are expected to assist the designer of electrical grounding components for corrosion protection.

Laboratory Testing

The laboratory tests were assigned by the project engineer with assistance from the client to understand the engineering properties of the various soil strata, as necessary, for this project. Test results are attached in the **Laboratory Results** of this report. Procedural standards noted below are for reference to methodology in general. In some cases, variations to methods were applied because of local practice or professional judgment. Standards noted below include reference to other, related standards. Such references are not necessarily applicable to describe the specific test performed.

- ASTM D2216 Standard Test Methods for Laboratory Determination of Water (Moisture)
 Content of Soil and Rock by Mass
- ASTM D4318 Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
- ASTM D1140 Standard Test Methods for Determining the Amount of Material Finer than 75-µm (No. 200) Sieve in Soils by Washing
- ASTM D422 Standard Test Method for Particle-Size Analysis of Soils
- ASTM D2938 Standard Test Method for Unconfined Compressive Strength of Intact Rock Core Specimens
- ASTM G51 Standard Test Method for Measuring pH of Soil for Use in Corrosion Testing
- ASTM D516-07 Standard Test Method for Sulfate Ion in Water
- AWWA 4500-S D Sulfide by Methylene Blue
- ASTM D 512 Standard Test Methods for Chloride Ion In Water
- ASTM G 200 Standard Test Method for Measurement of Oxidation-Reduction Potential (ORP) of Soil
- AWWA 2520 B Salinity by Electrical Conductivity Method
- ASTM G57 Standard Test Method for Measurement of Soil Resistivity Using the Wenner Four-Electrode Method
- ASTM D 2850 Standard Test Method for Unconsolidated-Undrained Triaxial Compression Test on Cohesive Soils

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GEOTECHNICAL CHARACTERIZATION

Geology

The project site is located in the Piedmont Physiographic Province, an area underlain by ancient igneous and metamorphic rocks. The residual soils in this area are the product of in-place chemical weathering of rock. The typical residual soil profile consists of clayey soils near the surface where soil weathering is more advanced, underlain by sandy silts and silty sands that generally become harder with depth to the top of parent bedrock. Alluvial soils are typically present within floodplain areas along creeks and rivers in the Piedmont. According to the 1985 Geologic Map of North Carolina, the site is within the Charlotte Belt. The bedrock underlying the site generally consists of granitic rock.

The boundary between soil and rock in the Piedmont is not sharply defined. A transitional zone termed "partially weathered rock" is normally found overlying the parent bedrock. Partially weathered rock (PWR) is defined for engineering purposes as residual material with a standard penetration test resistance exceeding 100 blows per foot. The transition between hard/dense residual soils and partially weathered rock occurs at irregular depths due to variations in degree of weathering.

Groundwater is typically present in fractures within the partially weathered rock or underlying bedrock in upland areas of the Piedmont. Fluctuations in groundwater levels on the order of 2 to 4 feet are typical in residual soils and partially weathered rock in the Piedmont, depending on variations in precipitation, evaporation, and surface water runoff. Seasonal high groundwater levels are expected to occur during or just after the typically cooler months of the year (November through April).

Groundwater Conditions

The boreholes were observed while drilling and after completion for the presence and level of groundwater. The water levels observed in the boreholes can be found on the boring logs in **Exploration Results**, and are summarized in the following table.

Boring ID	Approximate Depth to Groundwater (feet) ¹	Approximate Elevation of Observed Groundwater (feet) ²
BH-07	9.5 (While drilling)	663.0
BH-07.5 ³	7.5 (While drilling)	661.5
BH-13	8.5 (While drilling)	658.0
BH-14	18.5 (While drilling)	661.5
BH-20.5	33.5 (While drilling)	714.5
BH-21	25.5 (At completion of drilling)	719.0
BH-31	8.5 (After 6 hours)	727.5

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Boring ID	Approximate Depth to Groundwater (feet) ¹	Approximate Elevation of Observed Groundwater (feet) ²
BH-32	6.5 (After 5 hours)	711.0
BH-45	13 (At completion of drilling)	733.0

- 1. Below ground surface.
- 2. Elevations provided by Stewart, Inc.
- 3. Elevation obtained using Google Earth Pro.

Groundwater was not observed in the remaining borings while drilling, or for the short duration the borings could remain open. However, this does not necessarily mean the borings terminated above groundwater, or the water levels summarized above are stable groundwater levels. Due to the low permeability of the soils encountered in the borings, a relatively long period may be necessary for a groundwater level to develop and stabilize in a borehole. Long term observations in piezometers or observation wells sealed from the influence of surface water are often required to define groundwater levels in materials of this type.

Groundwater level fluctuations occur due to seasonal variations in the amount of rainfall, runoff and other factors not evident at the time the borings were performed. Therefore, groundwater levels during construction or at other times in the life of the structure may be higher or lower than the levels indicated on the boring logs. The possibility of groundwater level fluctuations should be considered when developing the design and construction plans for the project.

SITE LOCATION AND EXPLORATION PLANS

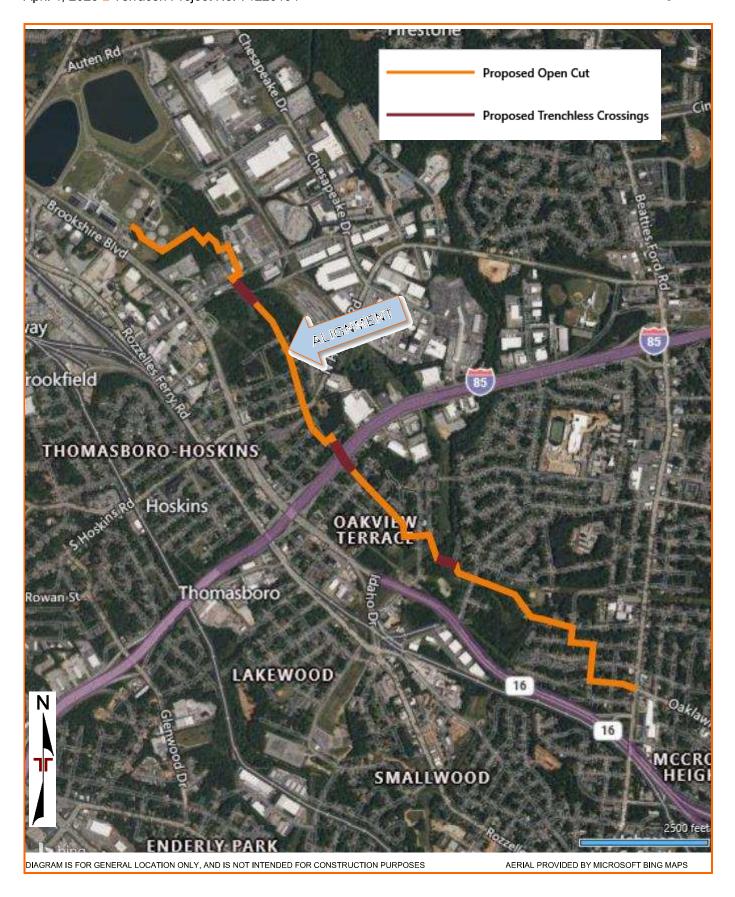
Contents:

Site Location Exploration Plan (7 pages)

Note: All attachments are one page unless noted above.

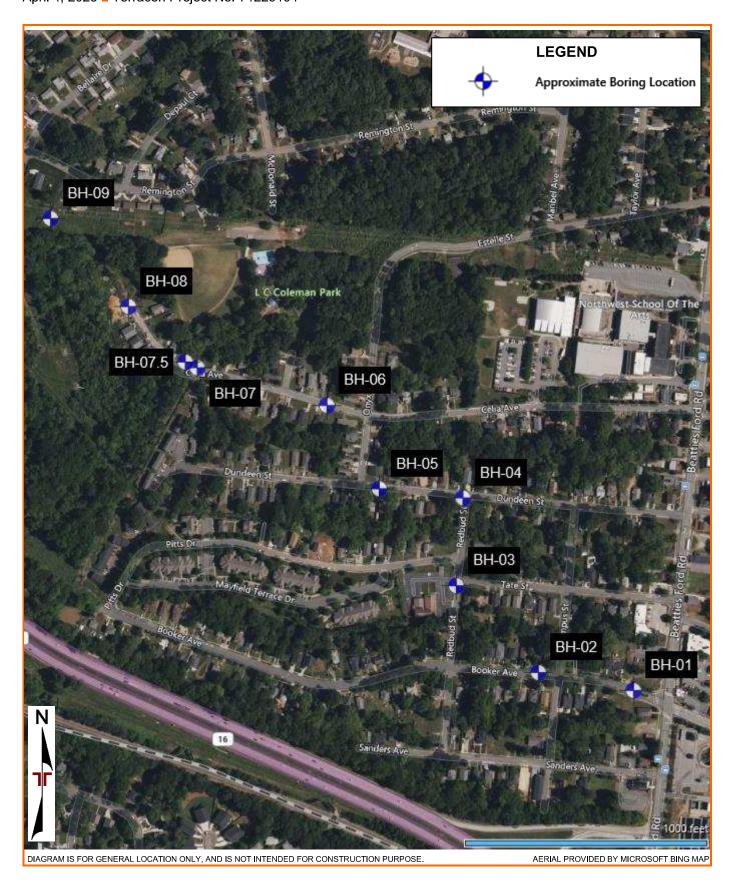
SITE LOCATION





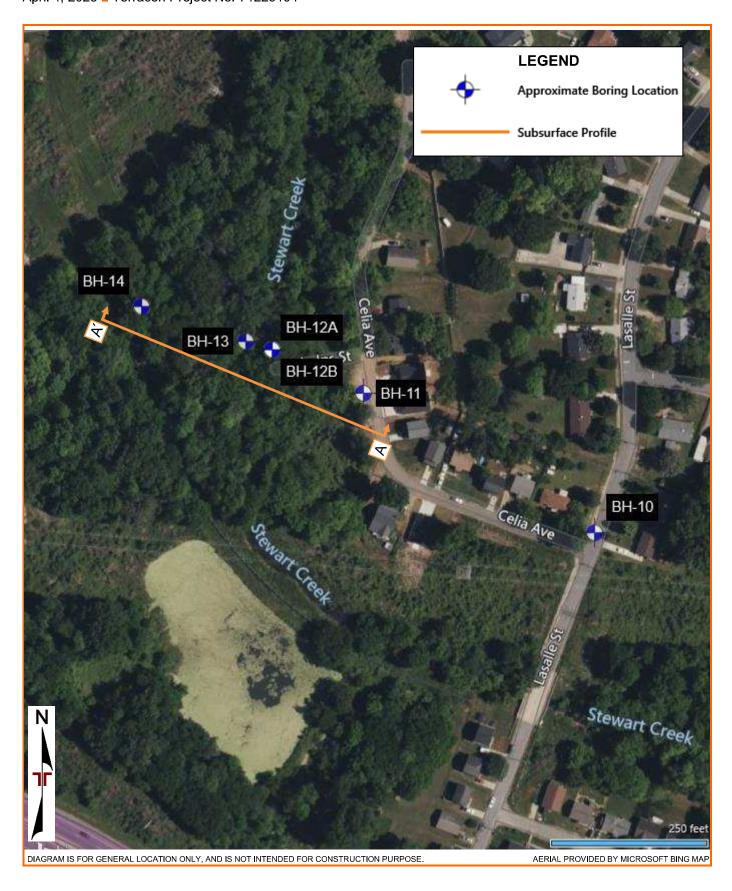
EXPLORATION PLAN – 1 of 7





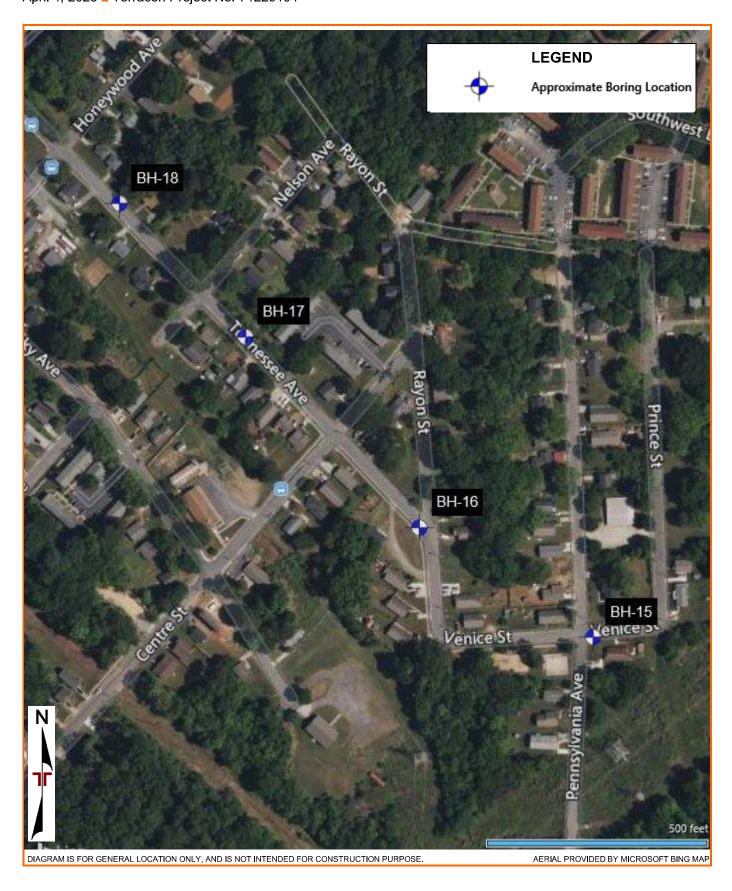
EXPLORATION PLAN - 2 of 7





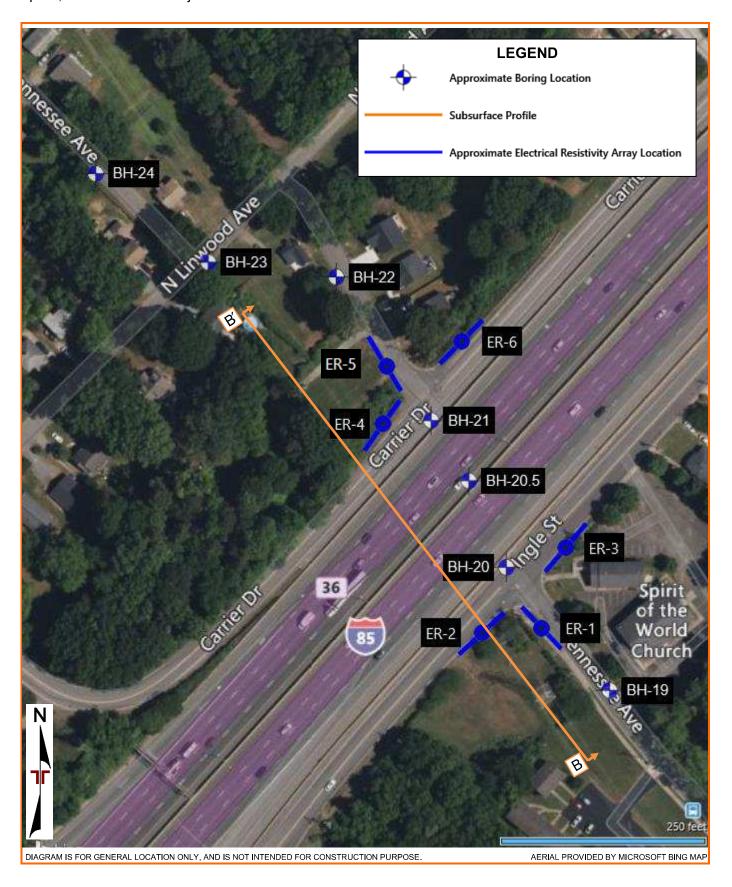
EXPLORATION PLAN - 3 of 7





EXPLORATION PLAN – 4 of 7





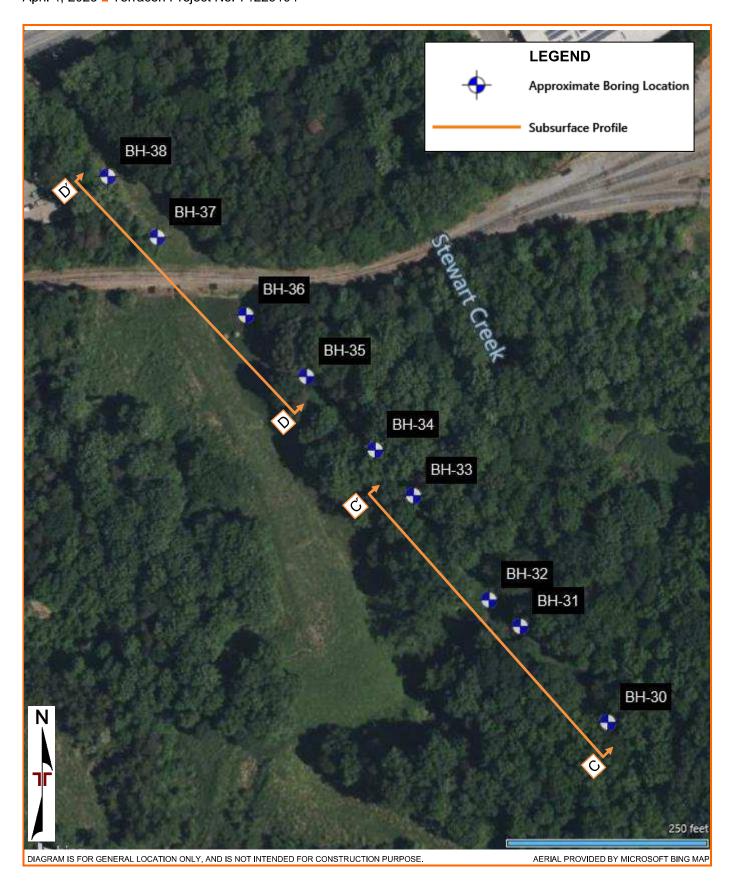
EXPLORATION PLAN - 5 of 7





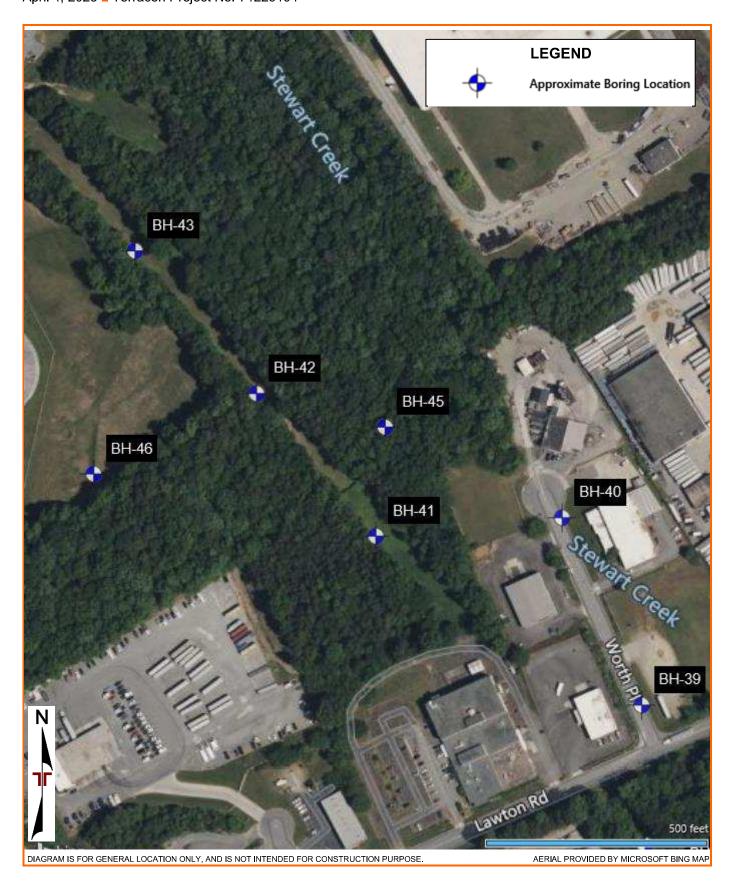
EXPLORATION PLAN - 6 of 7





EXPLORATION PLAN - 7 of 7





EXPLORATION RESULTS

Contents:

Boring and Coring Logs (BH-01 through BH-07, BH-07.5, BH-08 through BH-11, BH-12A, BH-12B, BH-13 through BH-20, BH-20.5, BH-21 through BH-43, B-45, B-46) (52 pages)
Subsurface Profiles at Select Crossings (4 pages)
Field Electrical Resistivity (6 pages)

Note: All attachments are one page unless noted above.

ROCK CORE PHOTOGRAPHS

Vest to Franklin Force Main ■ Charlotte, North Carolina April 4, 2023 ■ Terracon Project No. 71225194



Site Description: Charlotte, NC	County: Mecklenburg	Boring Location: BH-12B (1 of 2)
Driller: J. Cain	Core Size: NQ	Drill Machine: CME-550x
Geologist / Engineer: F. Brock	Total Core Length: 28.3 feet	Date: 10/28/2022

R-1 and R-2: Run 1: 6.9' to 10.4' and Run 2: 10.4' to 15.4'



R-3 and R-4: Run 3: 15.4' to 20.4' and Run 4: 20.4' to 25.4'



Notes:

- 1) Used NQ wireline core barrel
- 2) UC: Sample selected for Unconfined Compressive Strength of Intact Rock Core Specimens



Abandonment Method: Boring backfilled with auger cuttings and hole plug device upon completion.

ROCK CORE PHOTOGRAPHS

Vest to Franklin Force Main ■ Charlotte, North Carolina April 4, 2023 Terracon Project No. 71225194



Site Description: Charlotte, NC	County: Mecklenburg	Boring Location: BH-12B (2 of 2)
Driller: J. Cain	Core Size: NQ	Drill Machine: CME-550x
Geologist / Engineer: F. Brock	Total Core Length: 28.3 feet	Date: 10/28/2022

R-5 and R-6: Run 5: 25.4' to 30.2' and Run 6: 30.2' to 35.2'



Notes:

- 1) Used NQ wireline core barrel
- 2) UC: Sample selected for Unconfined Compressive Strength of Intact Rock Core Specimens



Abandonment Method:

Boring backfilled with auger cuttings and hole plug device upon completion.

ROCK CORE PHOTOGRAPHS

Vest to Franklin Force Main ■ Charlotte, North Carolina April 4, 2023 ■ Terracon Project No. 71225194

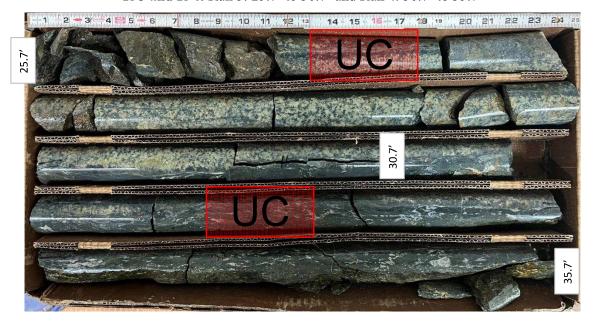


Site Description: Charlotte, NC	County: Mecklenburg	Boring Location: BH-13 (1 of 1)
Driller: J. Cain	Core Size: NQ	Drill Machine: CME-550x
Geologist / Engineer: M. Bovenzi	Total Core Length: 19.5 feet	Date: 10/24/2022

R-1 and R-2: Run 1: 16.2' to 20.7' and Run 2: 20.7' to 25.7'



R-3 and R-4: Run 3: 25.7' to 30.7' and Run 4: 30.7' to 35.7'



Notes:

- 1) Used NQ wireline core barrel
- 2) UC: Sample selected for Unconfined Compressive Strength of Intact Rock Core Specimens



Abandonment Method: Boring backfilled with auger cuttings and hole plug device upon completion.

ROCK CORE PHOTOGRAPHS

Vest to Franklin Force Main ■ Charlotte, North Carolina April 4, 2023 ■ Terracon Project No. 71225194



Site Description: Charlotte, NC	County: Mecklenburg	Boring Location: BH-14 (1 of 1)
Driller: J. Cain	Core Size: NQ	Drill Machine: CME-550x
Geologist / Engineer: F. Brock	Total Core Length: 9.0 feet	Date: 10/21/2022

R-1 and R-2: Run 1: 26.1' to 30.1' and Run 2: 30.1' to 35.1'

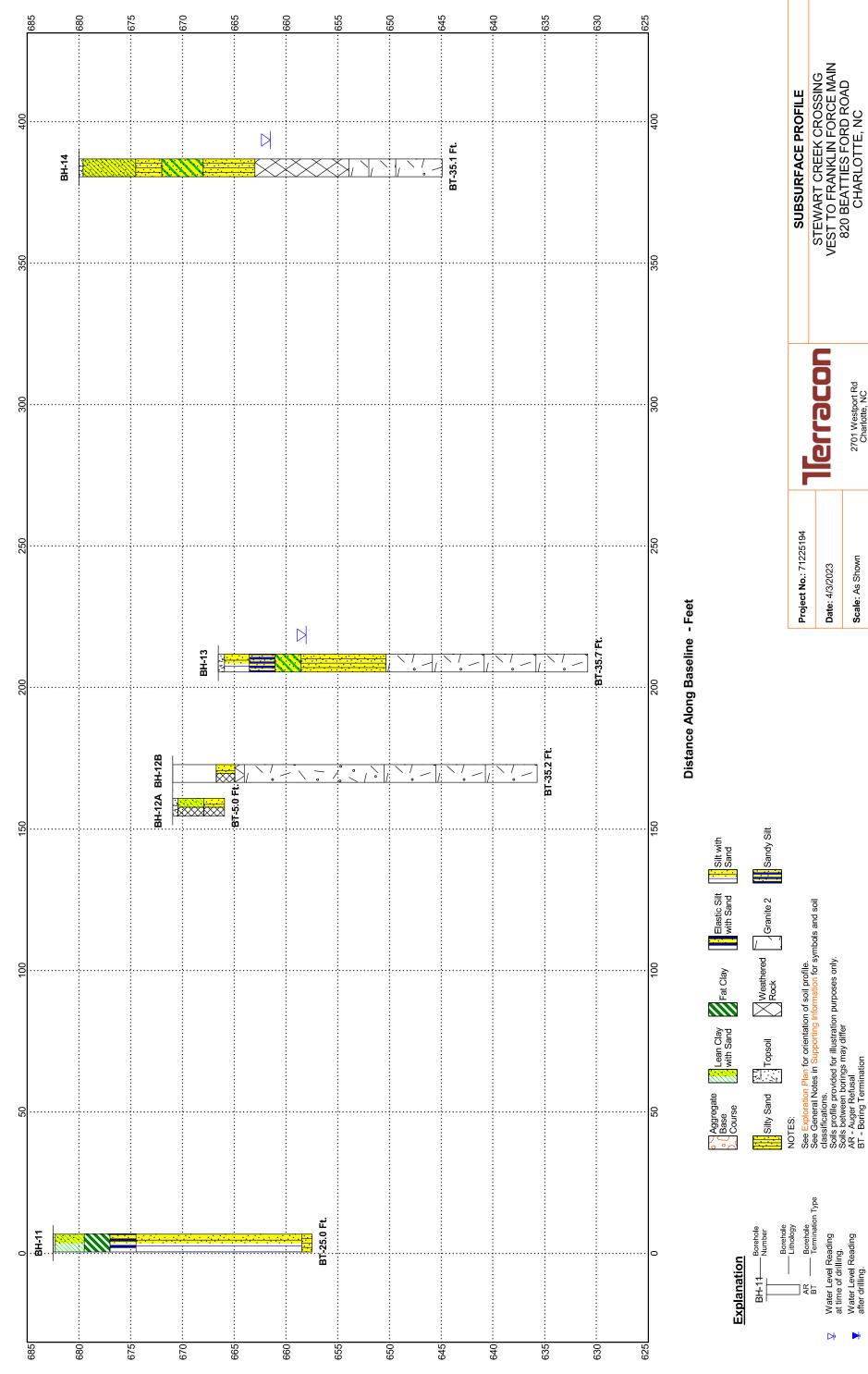


Notes:

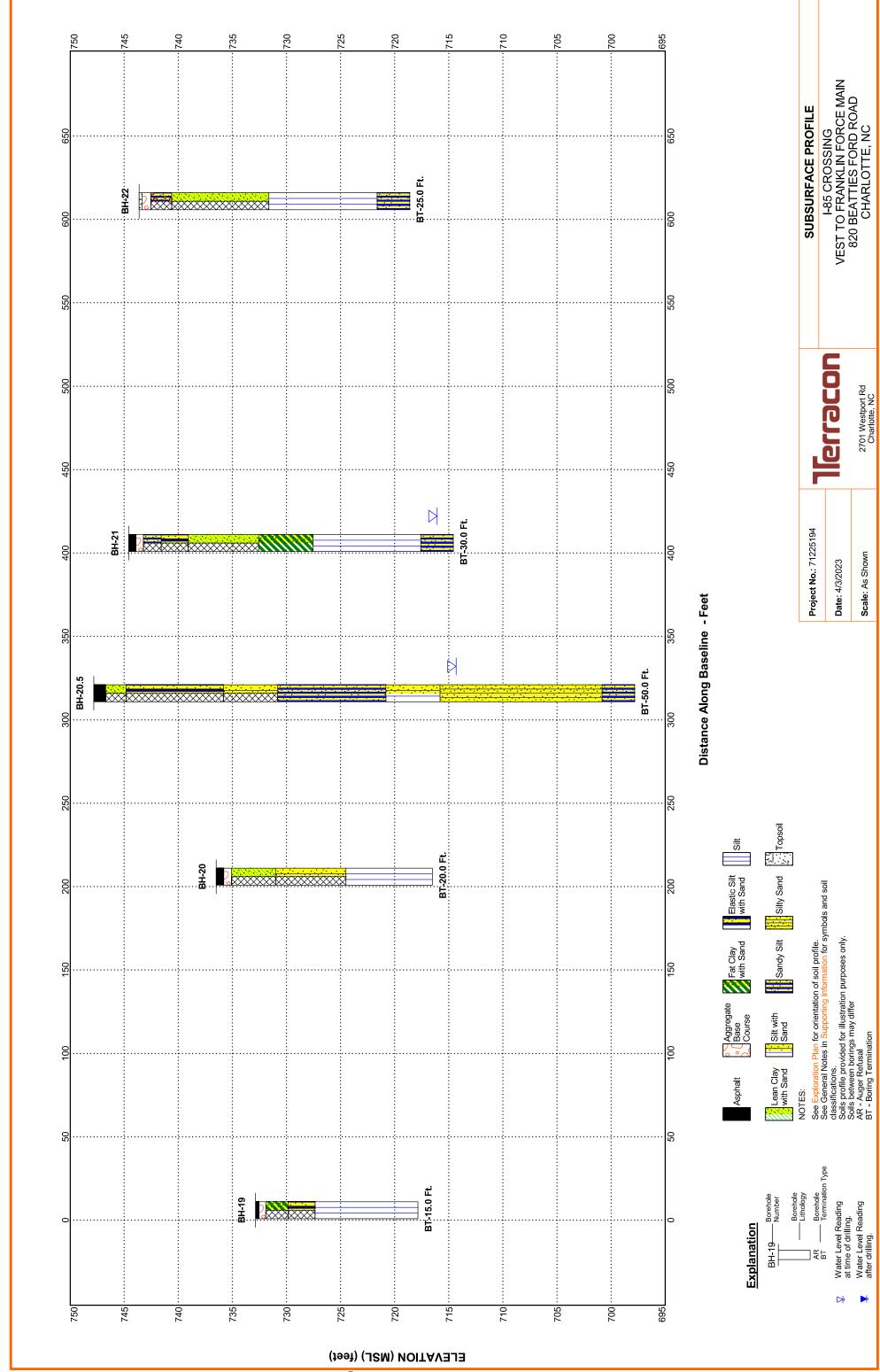
1) Used NQ wireline core barrel

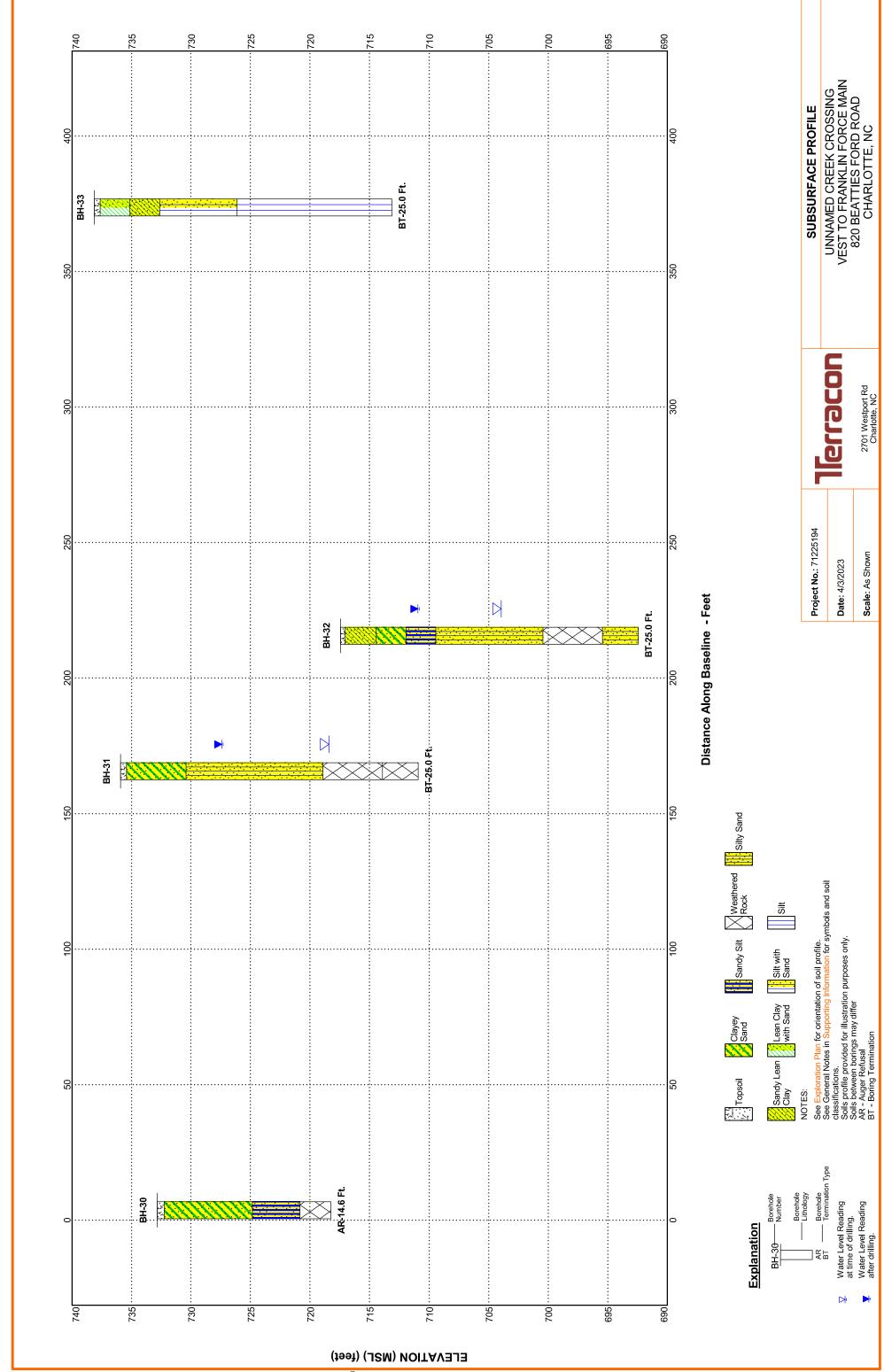


Abandonment Method: Boring backfilled with auger cuttings upon completion.



ELEVATION (MSL) (feet)





765

760

755

750

ELEVATION (MSL) (feet)

735

730

740

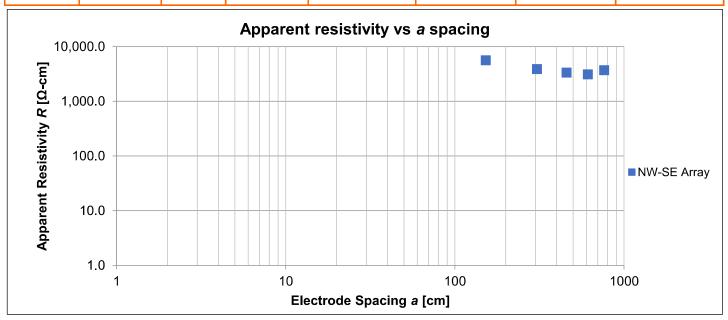
745

 \bowtie



Array Loc.		ER-1	
Instrument	Mini-Res	Weather	Sunny
Serial #	SN-324	Ground Cond.	Silty Sand
Cal. Check	YES	Tested By	Kevin Kepa
Test Date	February 8, 2023	Method	Wenner 4-pin (ASTM G57-06 (2012); IEEE 81-2012)
Notes & Conflicts		 None	

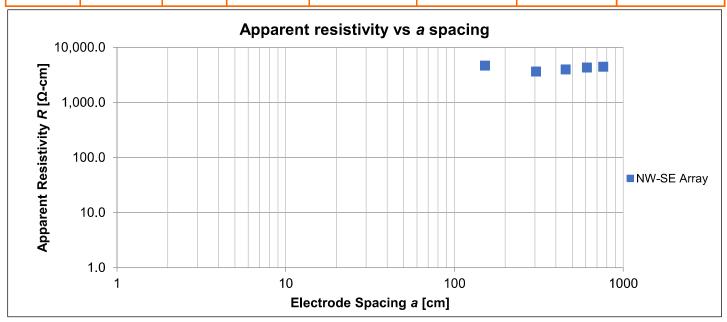
Electrode	Electrode Spacing a		de Depth <i>b</i>	NW-SE	Test		
[feet]	et] [centimeters] [inches] [c		[centimeters]	Measured Resistance <i>R</i>	Apparent Resistivity <i>p</i>	Measured Resistance <i>R</i>	Apparent Resistivity <i>p</i>
				Ω	[Ω-cm]	Ω	[Ω-cm]
5	152	3	8	5.902	5660		
10	305	6	15	2.028	3900		
15	457	9	23	1.173	3380		
20	610	12	30	0.810	3120		
25	762	12	30	0.776	3730		
				·			





Array Loc.		ER-2	
Instrument	Mini-Res	Weather	Cloudy
Serial #	SN-324	Ground Cond.	Silty Sand
Cal. Check	YES	Tested By	Kevin Kepa
Test Date	February 8, 2023	Method	Wenner 4-pin (ASTM G57-06 (2012); IEEE 81-2012)
Notes & Conflicts		 None	

Electrode	Electrode Spacing <i>a</i>		de Depth <i>b</i>	NW-SE	NW-SE Test		
[feet]	eet] [centimeters] [inches] [cen		[centimeters]	Measured Resistance <i>R</i>	Apparent Resistivity <i>p</i>	Measured Resistance <i>R</i>	Apparent Resistivity <i>p</i>
				Ω	[Ω-cm]	Ω	[Ω-cm]
5	152	3	8	4.833	4640		
10	305	6	15	1.882	3620		
15	457	9	23	1.371	3950		
20	610	12	30	1.118	4300		
25	762	12	30	0.924	4440		



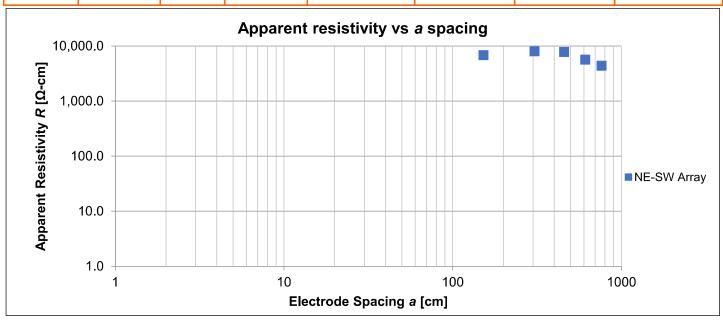


ER-3 Array Loc. Mini-Res Instrument Weather Sunny SN-324 Silty Sand Serial # **Ground Cond.** YES Kevin Kepa Cal. Check **Tested By** Method Wenner 4-pin (ASTM G57-06 (2012); IEEE 81-2012) February 8, 2023 **Test Date**

Notes &

Conflicts Underground gas line marked by public utility locator ~ 3ft away to left of electrodes, running alongside road.

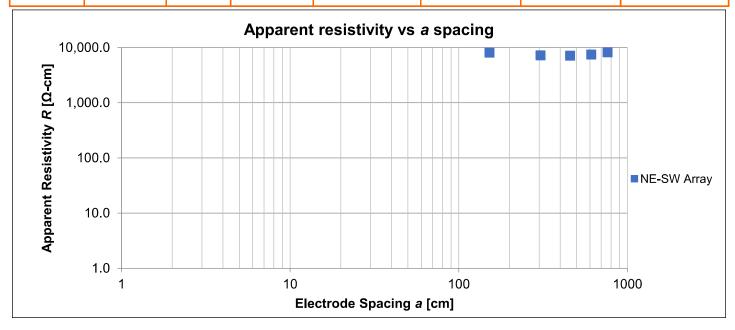
Electrode	Electrode Spacing a		de Depth <i>b</i>	NE-SW Test			
[feet]	[centimeters]	[inches]	[centimeters]	Measured Resistance <i>R</i>	Apparent Resistivity <i>p</i>	Measured Resistance <i>R</i>	Apparent Resistivity <i>p</i>
				Ω	[Ω-cm]	Ω	[Ω-cm]
5	152	3	8	7.087	6800		
10	305	6	15	4.151	7990		
15	457	9	23	2.693	7770		
20	610	12	30	1.471	5660		
25	762	12	30	0.915	4390		





Array Loc.		ER-4	
Instrument	Mini-Res	Weather	Sunny
Serial #	SN-324	Ground Cond.	Silty Sand
Cal. Check	12/15/2022	Tested By	Kevin Kepa
Test Date	2/8/2023	Method	Wenner 4-pin (ASTM G57-06 (2012); IEEE 81-2012)
Notes & Conflicts		 None	

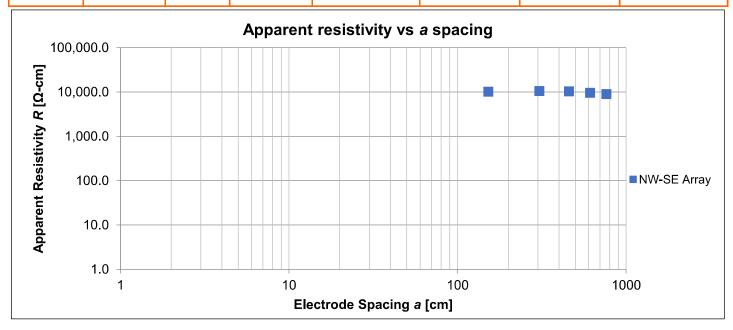
Electrode	Electrode Spacing <i>a</i>		de Depth <i>b</i>	NE-SW	NE-SW Test		
[feet]	feet] [centimeters] [inches]		[centimeters]	Measured Resistance <i>R</i>	Apparent Resistivity <i>p</i>	Measured Resistance <i>R</i>	Apparent Resistivity <i>p</i>
				Ω	[Ω-cm]	Ω	[Ω-cm]
5	152	3	8	8.452	8110		
10	305	6	15	3.764	7240		
15	457	9	23	2.488	7180		
20	610	12	30	1.953	7520		
25	762	12	30	1.710	8210		
				·			
				·			





Array Loc. ER-5 Instrument Mini-Res Weather Cloudy SN-324 Silty Sand Serial # **Ground Cond.** YES Kevin Kepa Cal. Check **Tested By** February 8, 2023 Wenner 4-pin (ASTM G57-06 (2012); IEEE 81-2012) **Test Date** Method Notes & **Conflicts** Underground communication utility marked by public utility locator running ~10ft to the right of electrodes.

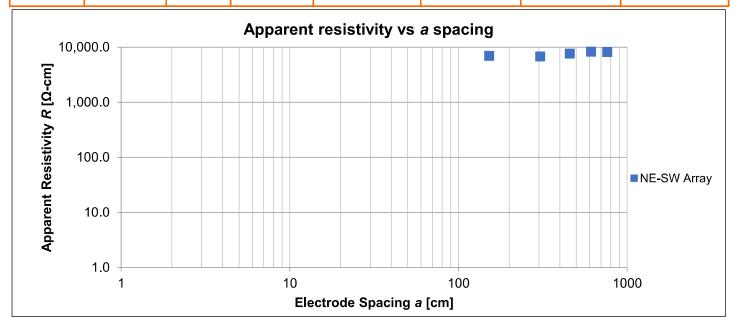
Electrode	Electrode Spacing a		de Depth <i>b</i>	NW-SE	NW-SE Test		
[feet]	t] [centimeters] [inches] [d		[centimeters]	Measured Resistance <i>R</i>	Apparent Resistivity <i>p</i>	Measured Resistance <i>R</i>	Apparent Resistivity <i>p</i>
				Ω	[Ω-cm]	Ω	[Ω-cm]
5	152	3	8	10.637	10210		
10	305	6	15	5.522	10630		
15	457	9	23	3.603	10390		
20	610	12	30	2.514	9680		
25	762	12	30	1.889	9070		
				·			
				·			





Array Loc.		ER-6	
Instrument	Mini-Res	Weather	Cloudy
Serial #	SN-324	Ground Cond.	Silty Sand
Cal. Check	YES	Tested By	Kevin Kepa
Test Date	February 8, 2023	Method	Wenner 4-pin (ASTM G57-06 (2012); IEEE 81-2012)
Notes & Conflicts			

Electrode	Electrode Spacing <i>a</i>		de Depth <i>b</i>	NE-SW	/ Test		
[feet]	et] [centimeters] [inches] [[centimeters]	Measured Resistance <i>R</i>	Apparent Resistivity <i>p</i>	Measured Resistance <i>R</i>	Apparent Resistivity <i>p</i>
				Ω	[Ω-cm]	Ω	[Ω-cm]
5	152	3	8	7.291	7000		
10	305	6	15	3.542	6820		
15	457	9	23	2.665	7690		
20	610	12	30	2.159	8310		
25	762	12	30	1.715	8230		
				·			
				·			



LABORATORY RESULTS

Contents:

Summary of Laboratory Results
Atterberg Limits
Grain Size Distribution (7 pages)
Corrosion Analysis

Unconsolidated Undrained Triaxial Test Results (BH-11, BH-14, BH-19, BH-20, BH-20.5, BH-21, BH-22, BH-32, BH-33, BH-37, and BH-38) (31 pages)

Unconfined Compression on Cohesive Soil Test Results (BH-03, BH-07, BH-09, BH-16, BH-26, BH-28, BH-40, and BH-45) (15 pages)

Note: All attachments are one page unless noted above.

Summary of Laboratory Results

			Cammary	00.00.0				Sheet 1 of 1
	BORING ID	Depth (Ft.)	Soil Classification USCS	Water Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	% Fines
	BH-01	3.5-5	ELASTIC SILT with SAND(MH)	24.4	66	33	33	74.2
	BH-02	1-2.5	FAT CLAY with SAND(CH)	26.1	65	32	33	84.5
	BH-05	3.5-5	ELASTIC SILT with SAND(MH)	24.5	74	39	35	71.3
	BH-06	1-2.5		20.6				
	BH-09	6-7.5	SANDY FAT CLAY(CH)	31.5	51	27	24	55.6
23	BH-10	3.5-5	SANDY ELASTIC SILT(MH)	25.9	50	29	21	61.5
- 2/8/	BH-11	5-7	ELASTIC SILT with SAND(MH)	42.7	79	36	43	83.9
[GD]	BH-16	1-2.5		22.2				
LATE	BH-18	3.5-5	ELASTIC SILT(MH)	42.8	73	47	26	98.1
TEMP	BH-19	2-4	FAT CLAY with SAND(CH)	33.0	61	28	33	81.0
ATA.	BH-20	1.8-3.8	LEAN CLAY with SAND(CL)	30.0	48	25	23	75.4
NC	BH-20.5	10-12	ELASTIC SILT with SAND(MH)	33.4	65	34	31	76.3
RAC	BH-21	14-16		46.2				92.8
臣	BH-23	3.5-5	ELASTIC SILT(MH)	42.5	71	42	29	96.3
N.GPJ	BH-25	6-7.5	SILT with SAND(ML)	24.0	47	28	19	76.3
MAI	BH-26	1-2.5		33.2				
RCE	BH-28	1-2.5	SANDY LEAN CLAY(CL)	22.9	44	21	23	62.1
N N	BH-30	3.5-5	CLAYEY SAND(SC)	13.0	28	15	13	49.6
δ N K L	BH-34	1-2.5	SANDY SILT(ML)	20.0	48	28	20	69.8
O FR	BH-35	3.5-5	SANDY FAT CLAY(CH)	20.0	61	31	30	68.0
ST T(BH-36	1-2.5		29.4				
34 VE	BH-36	8.5-10	ELASTIC SILT(MH)	29.1	55	40	15	95.6
22518	BH-39	3.5-5	SANDY LEAN CLAY(CL)	21.2	36	22	14	51.8
T 71	BH-40	3.5-5	SANDY SILT(ML)	20.9	42	37	5	53.1
RTRA	BH-46	6-7.5	ELASTIC SILT with SAND(MH)	41.9	60	43	17	84.9
RE NOT VALID IF SEPARATED FROM ORIGINAL REPORT. SMART LAB SUMMARY-PORTRAIT 71225194 VEST TO FRANKLIN FORCE MAIN GPJ TERRACON_DATATEMPLATE.GDT 2/8/23								
Ä								

PROJECT: Vest to Franklin Force Main

SITE: 820 Beatties Ford Road Charlotte, NC

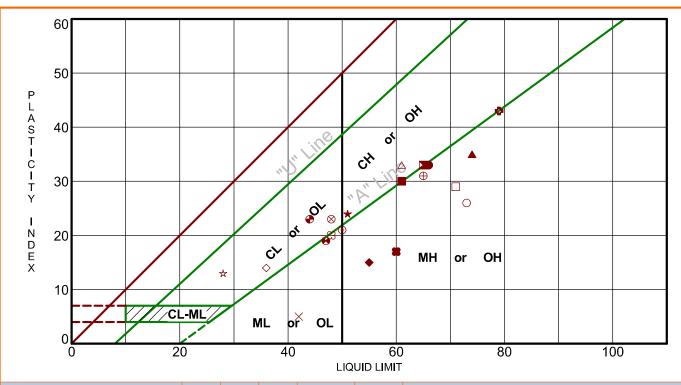


PROJECT NUMBER: 71225194

CLIENT: Charlotte Water Charlotte, NC

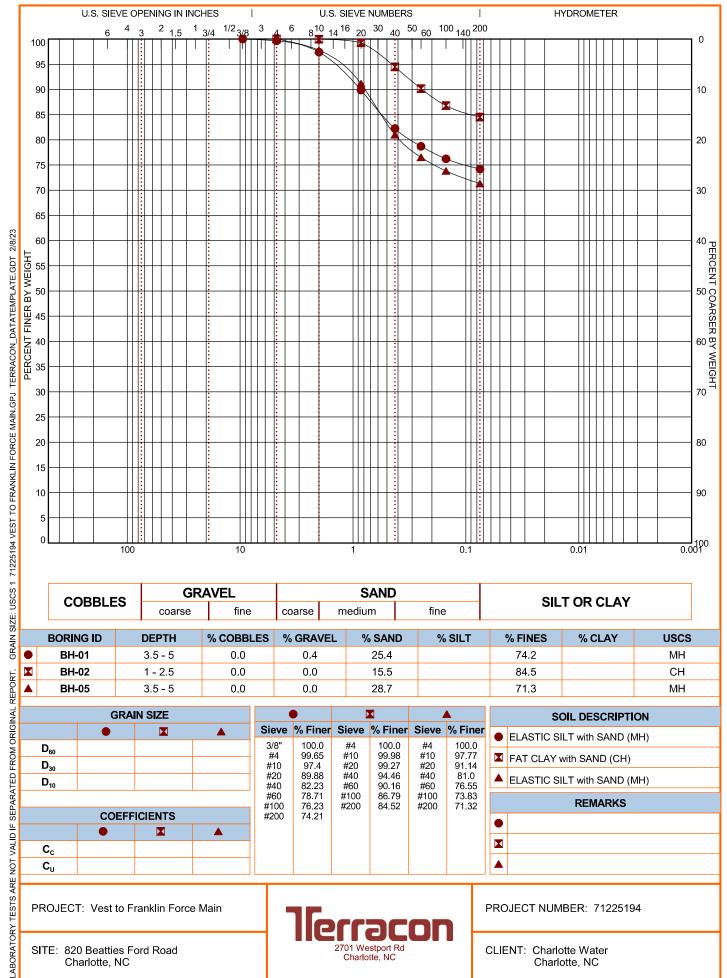
ATTERBERG LIMITS RESULTS

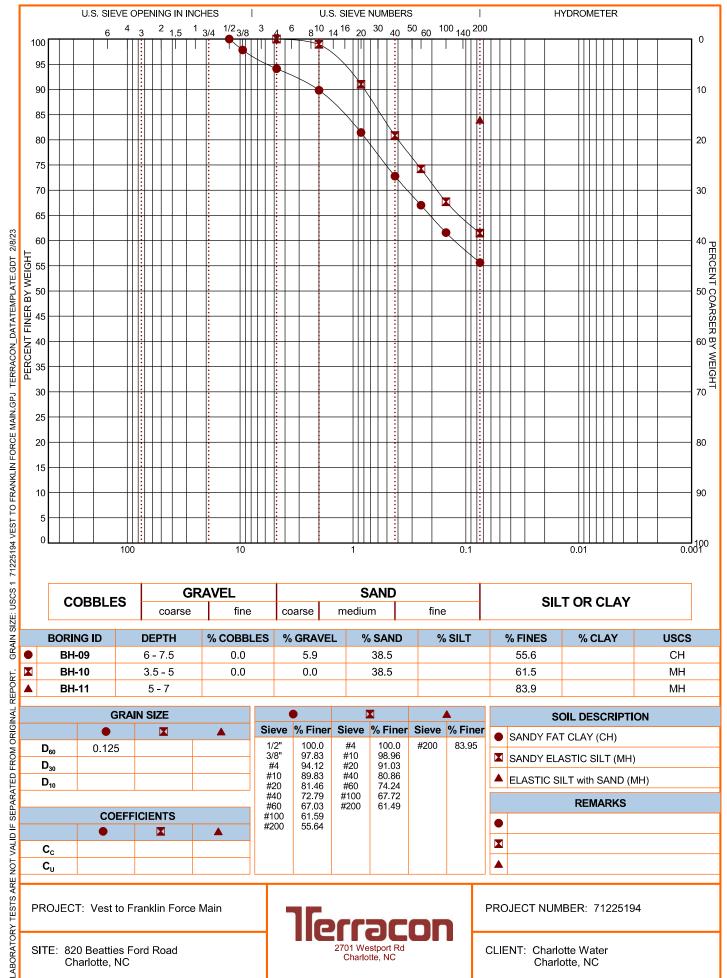
ASTM D4318

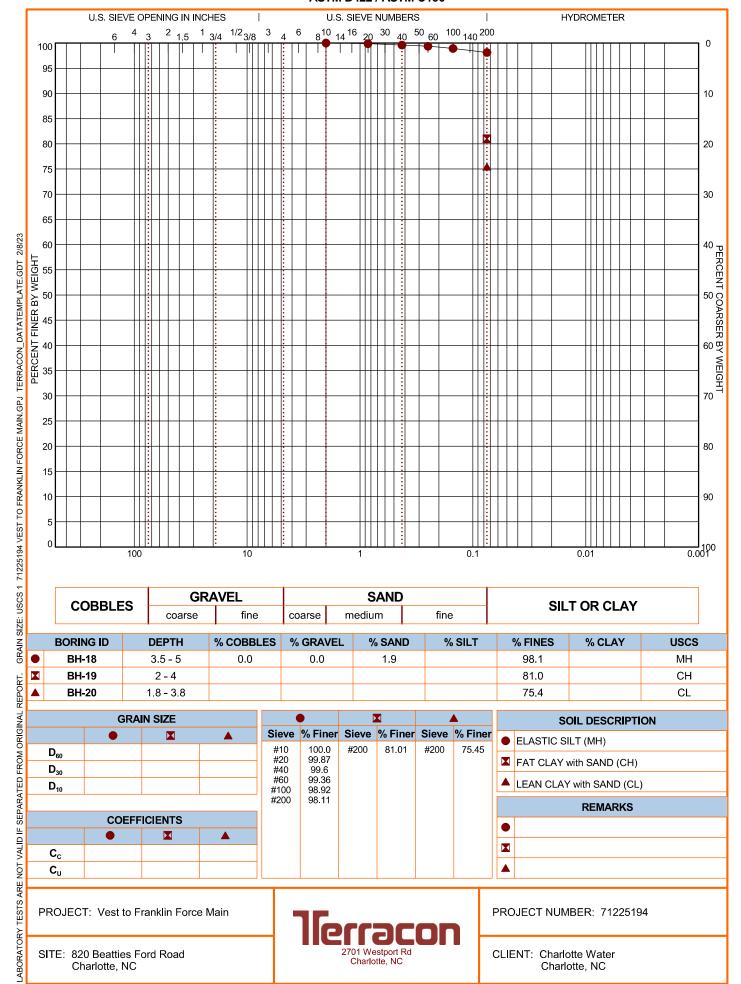


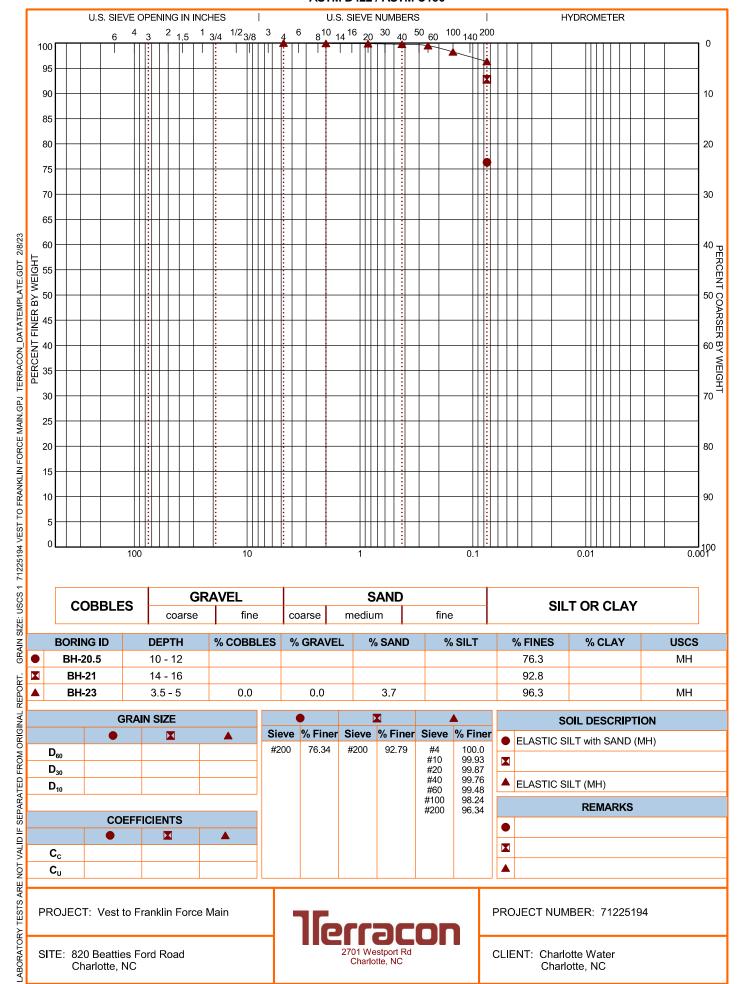
ATTERBERG LIMITS 71225194 VEST TO FRANKLIN FORCE MAIN.GPJ TERRACON_DATATEMPLATE.GDT 2/8/23		N 20 E X 10	///cL	-ML	*	JL oi	OL	60	
) TERR	Во	ring ID	Depth (Ft)	LL	PL	PI	Fines	USCS	Description
IN.GP.	•	BH-01	3.5 - 5	66	33	33	74.2	MH	ELASTIC SILT with SAND
CE MA		BH-02	1 - 2.5	65	32	33	84.5	СН	FAT CLAY with SAND
N FOR	A	BH-05	3.5 - 5	74	39	35	71.3	MH	ELASTIC SILT with SAND
SANKL	*	BH-09	6 - 7.5	51	27	24	55.6	СН	SANDY FAT CLAY
TO FF	•	BH-10	3.5 - 5	50	29	21	61.5	МН	SANDY ELASTIC SILT
4 VEST	۰	BH-11	5 - 7	79	36	43	83.9	МН	ELASTIC SILT with SAND
22519	0	BH-18	3.5 - 5	73	47	26	98.1	МН	ELASTIC SILT
ITS 71	Δ	BH-19	2 - 4	61	28	33	81.0	СН	FAT CLAY with SAND
3G LIM	\otimes	BH-20	1.8 - 3.8	48	25	23	75.4	CL	LEAN CLAY with SAND
ERBEF	Φ	BH-20.5	10 - 12	65	34	31	76.3	МН	ELASTIC SILT with SAND
- 1		BH-23	3.5 - 5	71	42	29	96.3	MH	ELASTIC SILT
PORT	•	BH-25	6 - 7.5	47	28	19	76.3	ML	SILT with SAND
AL RE	•	BH-28	1 - 2.5	44	21	23	62.1	CL	SANDY LEAN CLAY
SEPARATED FROM ORIGINAL REPORT.	☆	BH-30	3.5 - 5	28	15	13	49.6	SC	CLAYEY SAND
ROM (ස	BH-34	1 - 2.5	48	28	20	69.8	ML	SANDY SILT
ATED F		BH-35	3.5 - 5	61	31	30	68.0	СН	SANDY FAT CLAY
EPAR,	•	BH-36	8.5 - 10	55	40	15	95.6	MH	ELASTIC SILT
	\Diamond	BH-39	3.5 - 5	36	22	14	51.8	CL	SANDY LEAN CLAY
OT VAL	×	BH-40	3.5 - 5	42	37	5	53.1	ML	SANDY SILT
NRE NC	*	BH-46	6 - 7.5	60	43	17	84.9	MH	ELASTIC SILT with SAND
LABORATORY TESTS ARE NOT VALID IF	PF	ROJECT: Vest to	Franklin Force M	⁄lain		7	er:	acc	PROJECT NUMBER: 71225194
LABORATO	SITE: 820 Beatties Ford Road Charlotte, NC					2701 Westport Rd Charlotte, NC			CLIENT: Charlotte Water Charlotte, NC

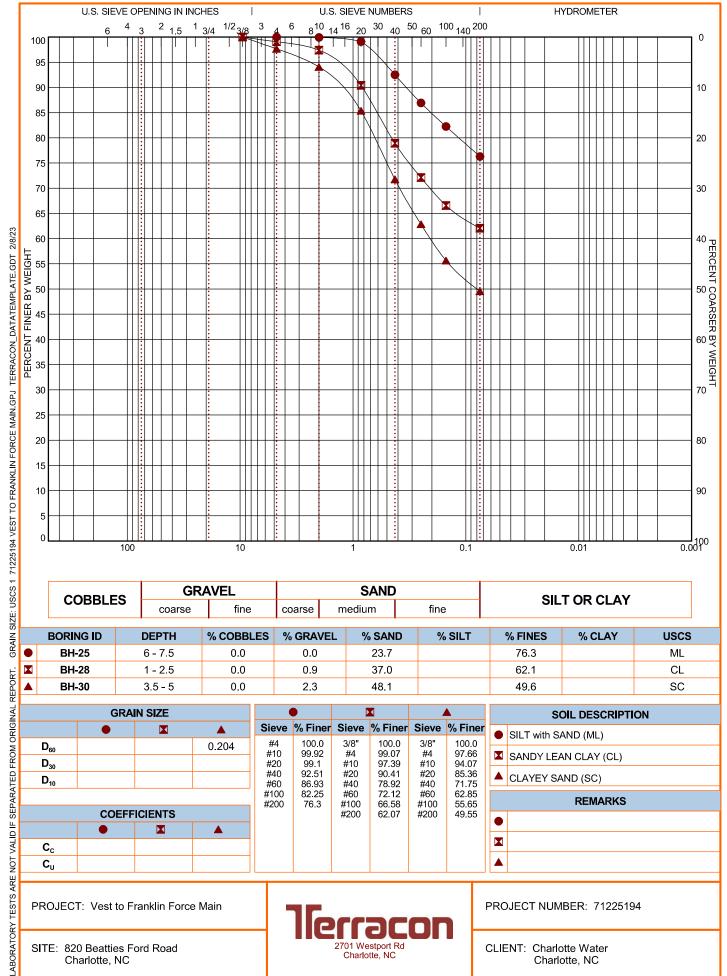


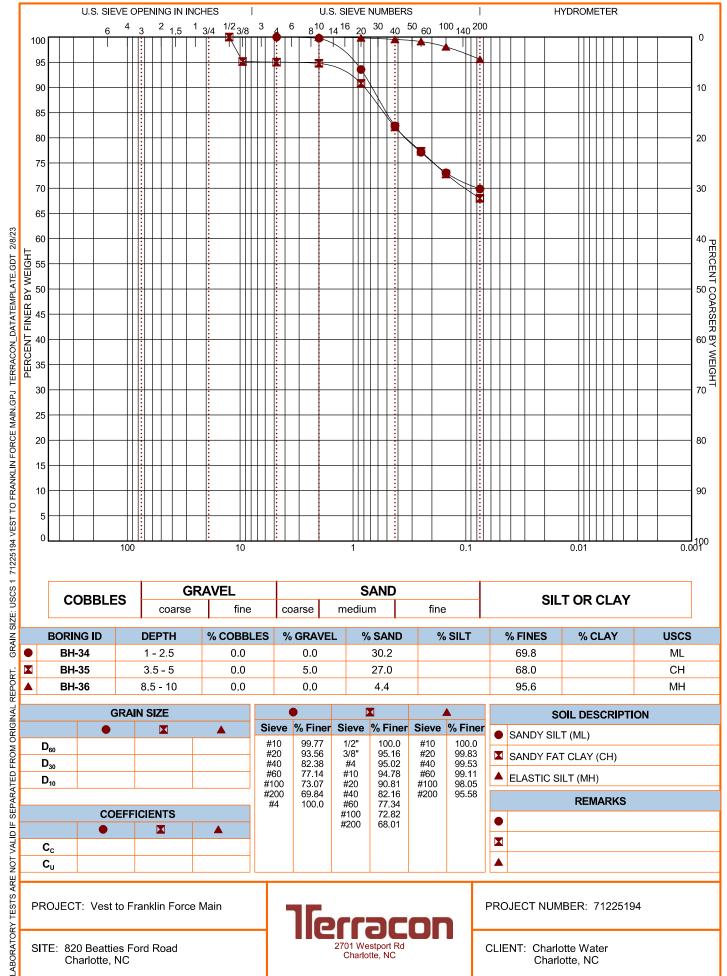


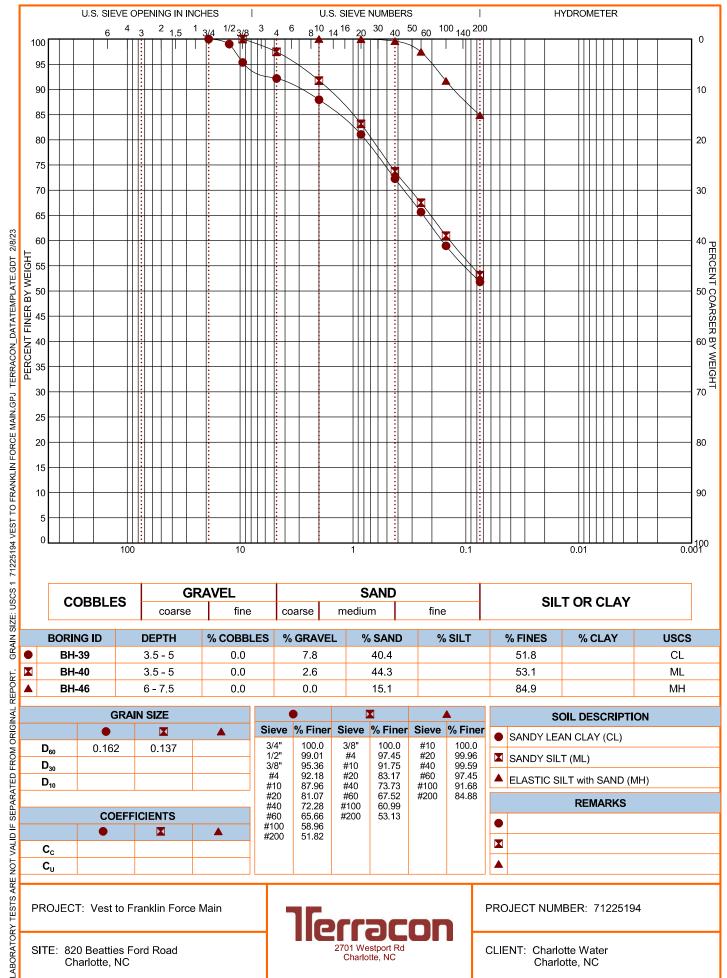














Client

Project

Charlotte Water Charlotte, NC Vest to Franklin Force Main

71225194

Date Received:

1/27/2023

Results from Corrosion Testing						
Sample Location	BH-06	BH-16	BH-26	BH-36		
Sample Depth (ft.)	1.0'-3.0'	1.0'-3.0'	1.0'-3.0'	1.0'-3.0'		
pH Analysis, ASTM G 51	7.19	6.93	5.65	6.25		
Water Soluble Sulfate (SO4), ASTM D 516-07 (mg/kg)	12	22	9	7		
Sulfides, AWWA 4500-S D, (mg/kg)	Nil	Nil	Nil	Nil		
Chlorides, ASTM D 512, (mg/kg)	72	42	40	38		
Red-Ox, ASTM G 200, (mV)	+411	+451	+536	+500		
Total Salts, AWWA 2520 B, (mg/kg)	103	112	53	16		
Resistivity (Saturated), ASTM G 57, (ohm-cm)	3900	4800	4500	20000		

Analyzed By:	ChrisAnne Ross
•	Field Geologist



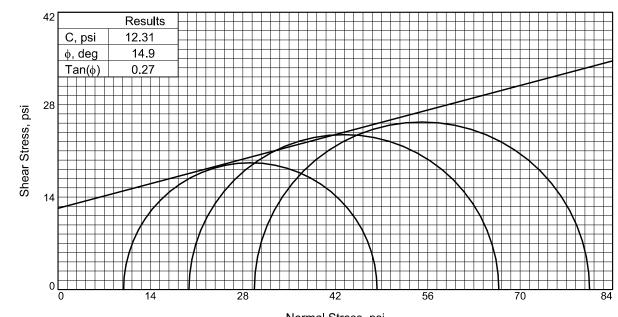
Terracon.com



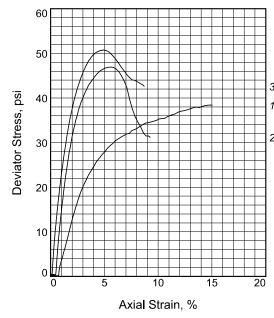




Specimen Failure Illustration



Normal Stress, psi



	Sample No.		1	2	3	
3	Initial	Water Content, % Dry Density, pcf Saturation, % Void Ratio Diameter, in. Height, in.	40.6 85.1 109.8 1.0166 2.865 5.799			
2	At Test	Water Content, % Dry Density, pcf Saturation, % Void Ratio Diameter, in. Height, in.	41.1 85.1 111.2 1.0166 2.865 5.799	47.0 74.1 99.5 1.2742 2.865 5.996	78.3 100.1 1.1528	
	Str	ain rate, in./min.	1.000	1.000	1.000	
	Ва	ck Pressure, psi	0.0	0.0	0.0	
	Се	II Pressure, psi	9.9	19.8	29.8	
	Fai	il. Stress, psi	38.4	46.9	50.8	
	Ult	. Stress, psi				
	σ₁ Failure, psi		48.3	66.8	80.5	
	σ_3	Failure, psi	9.9	19.8	29.8	

Type of Test:

Unconsolidated Undrained Sample Type: Un-disturbed

Description: Red Elastic SILT/Fat CLAY with

Sand

LL= 79 **PL=** 36 **PI=** 43

Specific Gravity= 2.75

Remarks: Percent Passing #200=83.9%

Client: Charlotte Water

Project: Vest to Franklin Force Main Beatties Ford Road

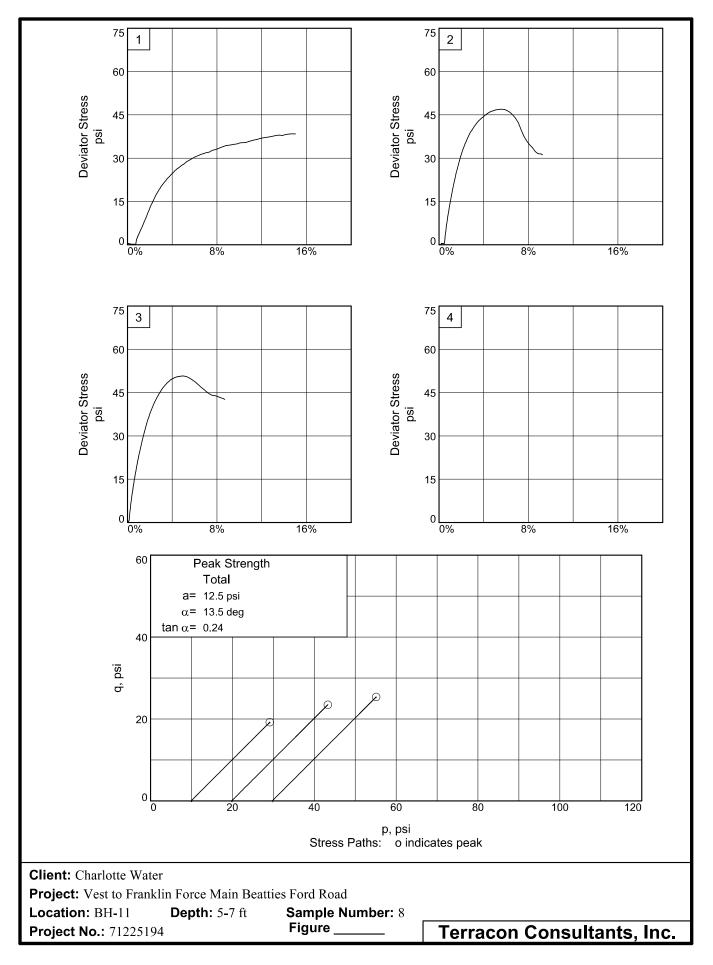
Charlotte, NC **Location**: BH-11

Sample Number: 8 Depth: 5-7 ft

Proj. No.: 71225194 Date Sampled:

TRIAXIAL SHEAR TEST REPORT Terracon Consultants, Inc. Charlotte, North Carolina

Figure BH-11





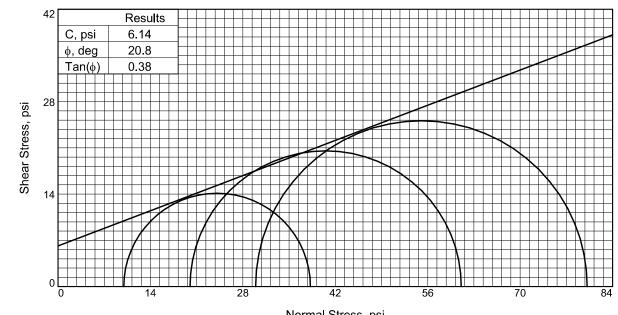
Terracon.com



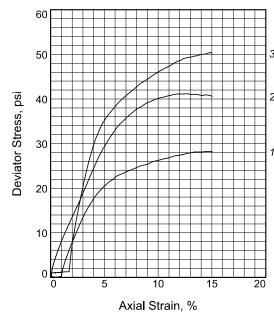




Specimen Failure Illustration



Normal Stress, psi



	Sa	mple No.	1	2	3	
3	Initial	Water Content, % Dry Density, pcf Saturation, % Void Ratio Diameter, in.	20.7 99.5 80.6 0.6942 2.863	2.862	96.4 83.8 0.7481 2.863	
		Height, in.	5.878	5.902	5.865	
1	əst	Water Content, % Dry Density, pcf	22.6 99.5 87.8	23.2 95.6 82.3	96.4	
	At Test	Saturation, % Void Ratio Diameter, in. Height, in.	0.6942 2.863 5.878	0.7628	0.7481 2.863	
	Strain rate, %/min. Back Pressure, psi		1.00	1.00	1.00	
			0.0	0.0	0.0	
	Се	II Pressure, psi	10.0	20.0	29.9	
	Fail. Stress, psi		28.3	41.1	50.2	
	Ult	. Stress, psi				
	σ_1	Failure, psi	38.2	61.1	80.2	
	σ_3	Failure, psi	10.0	20.0	29.9	

Type of Test:

Unconsolidated Undrained Sample Type: Un-disturbed

Description: Light Brown Silty SAND-SM

LL= 42 **PL=** 27 **PI=** 15

Specific Gravity= 2.7

Remarks: Percent Passing #200=43.6%

Client: Charlotte Water

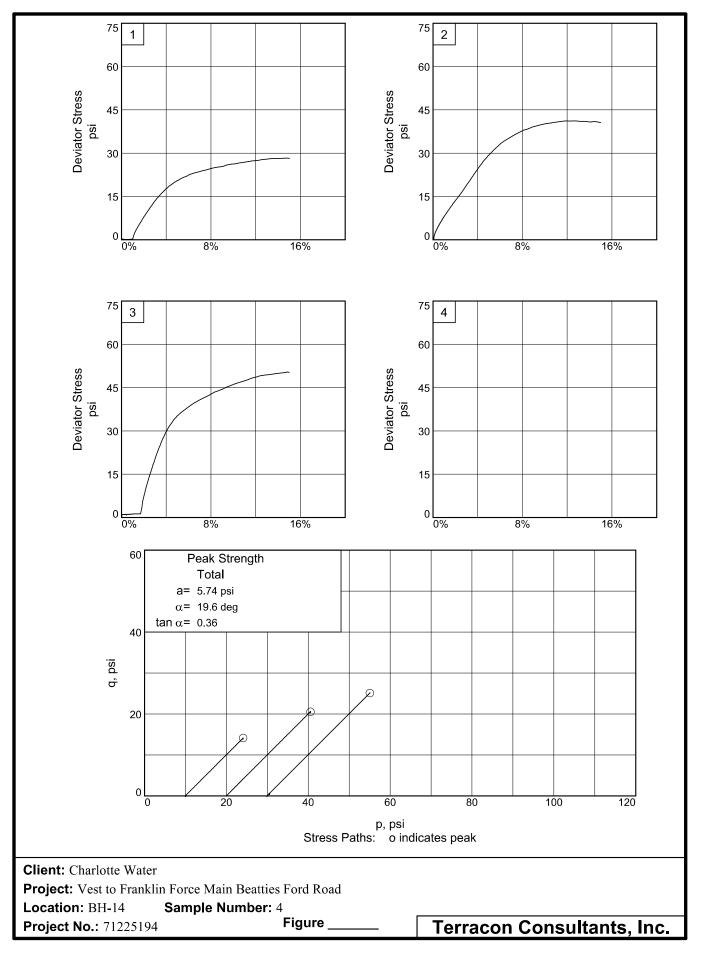
Project: Vest to Franklin Force Main Beatties Ford Road

Charlotte, NC Location: BH-14 Sample Number: 4

Proj. No.: 71225194 **Date Sampled:**

> TRIAXIAL SHEAR TEST REPORT Terracon Consultants, Inc. Charlotte, North Carolina

Figure BH-14

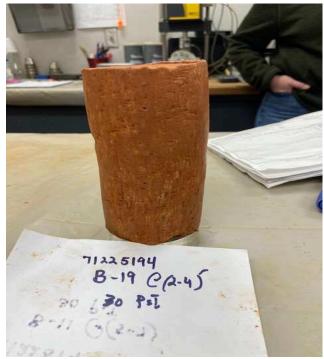




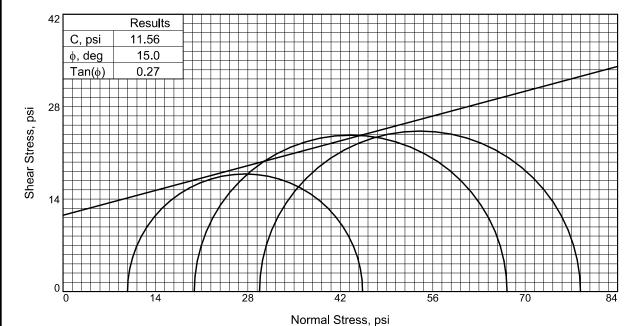
Terracon.com



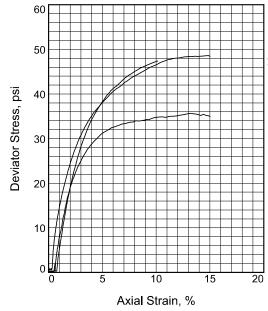




Specimen Failure Illustration







	Sa	mple No.	1	2	3	
		Water Content, %	30.4	27.4	33.0	
3	_	Dry Density, pcf	80.6	78.9	78.3	
2	<u>ia</u>	Saturation, %	75.3	65.0	77.3	
	Initia	Void Ratio	1.0903	1.1352	1.1520	
	_	Diameter, in.	2.865	2.865	2.866	
		Height, in.	6.020	5.910	6.027	
1						
		Water Content, %	31.4	31.4	31.3	
	يد	Dry Density, pcf	80.6	80.6	78.3	
	es	Saturation, %	77.7	77.7	73.3	
	At Test	Void Ratio	1.0903	1.0903	1.1520	
	⋖	Diameter, in.	2.865	2.865	2.866	
		·	6.020	5.910	6.027	
		Height, in.				
	Str	ain rate, %/min.	1.00	1.00	1.00	
	Ва	ck Pressure, psi	0.0	0.0	0.0	
	Се	II Pressure, psi	9.8	19.9	29.8	
	Fai	I. Stress, psi	35.6	47.4	48.6	
	Ult	. Stress, psi				
	σ1	Failure, psi	45.4	67.3	78.4	
	σ	Failure, psi	9.8	19.9	29.8	

Type of Test:

Unconsolidated Undrained Sample Type: Un-disturbed

Description: Red Fat CLAY with Sand-CH

LL= 61 **PL=** 28 **PI=** 33

Specific Gravity= 2.7

Remarks: Percent Passing #200=81.0%

Client: Charlotte Water

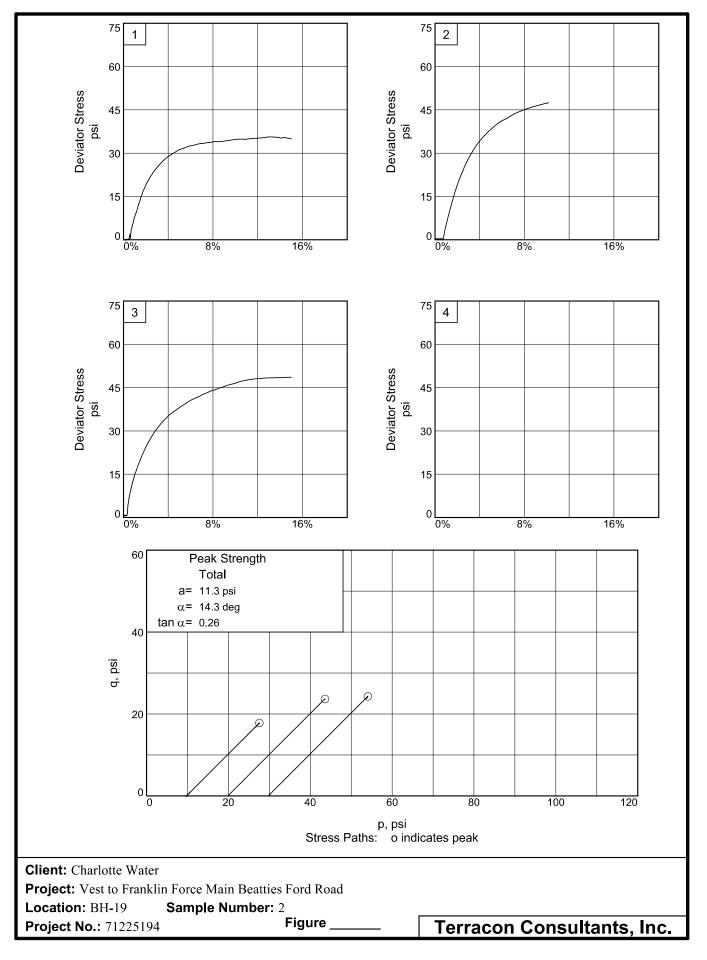
Project: Vest to Franklin Force Main Beatties Ford Road

Charlotte, NC
Location: BH-19
Sample Number: 2

Proj. No.: 71225194 Date Sampled:

TRIAXIAL SHEAR TEST REPORT Terracon Consultants, Inc. Charlotte, North Carolina

Figure BH-19

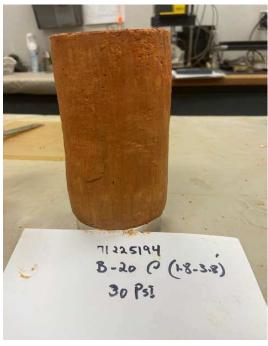




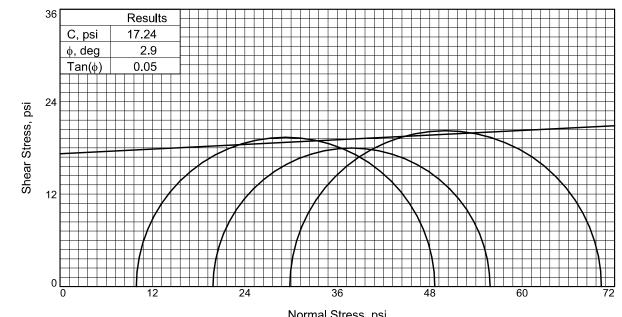
Terracon.com



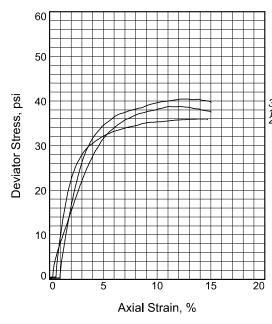




Specimen Failure Illustration



Normal Stress, psi



	Sample No.		1	2	3	
312	Initial	Water Content, % Dry Density, pcf Saturation, % Void Ratio Diameter, in. Height, in.	26.2 94.7 90.7 0.7803 2.863 5.888		89.2 0.9083 2.862	
	At Test	Water Content, % Dry Density, pcf Saturation, % Void Ratio Diameter, in. Height, in.	25.7 94.7 89.0 0.7803 2.863 5.888	30.6 87.2 88.5 0.9326	30.4 88.3 90.4 0.9083 2.862	
	Str	ain rate, %/min.	1.00	1.00	1.00	
	Ва	ck Pressure, psi	0.0	0.0	0.0	
	Се	II Pressure, psi	9.9	19.9	29.8	
	Fail. Stress, psi		38.7	36.0	40.4	
	Ult	. Stress, psi				
	σ_1	Failure, psi	48.7	55.8	70.3	
σ ₂ Failure. psi		9.9	19.9	29.8		

Type of Test:

Unconsolidated Undrained Sample Type: Un-Disturbed **Description:** Red Sandy CLAY-CL

LL= 48 **PL=** 25 **PI=** 23

Specific Gravity= 2.7

Remarks: Percent Passing #200=75.4%

Client: Charlotte Water

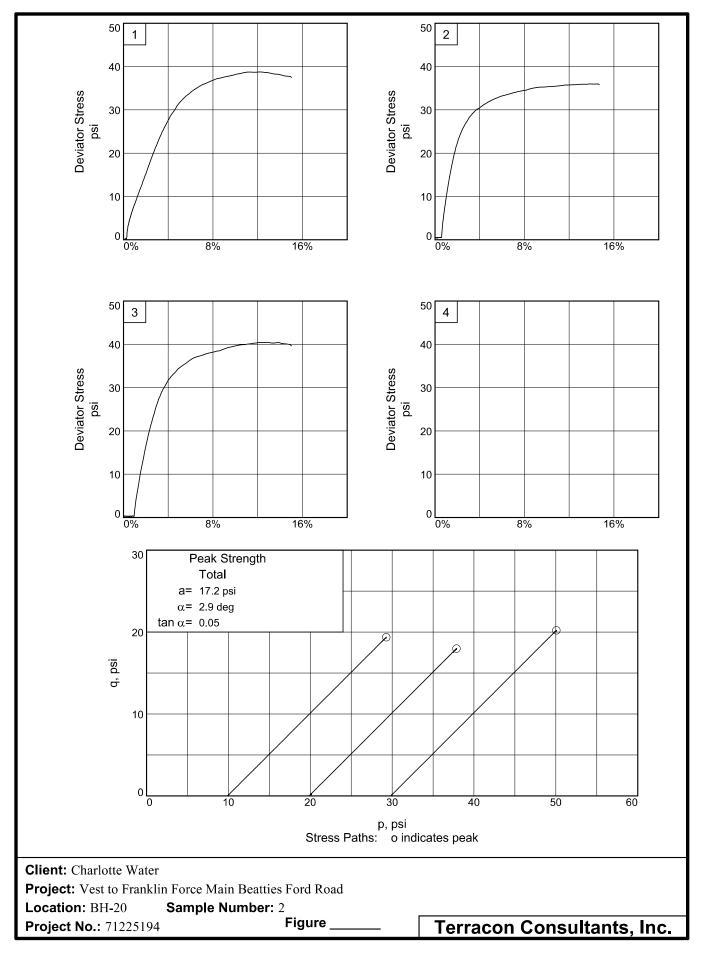
Project: Vest to Franklin Force Main Beatties Ford Road

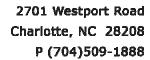
Charlotte, NC Location: BH-20 Sample Number: 2

Proj. No.: 71225194 **Date Sampled:**

> TRIAXIAL SHEAR TEST REPORT Terracon Consultants, Inc. Charlotte, North Carolina

Figure BH-20



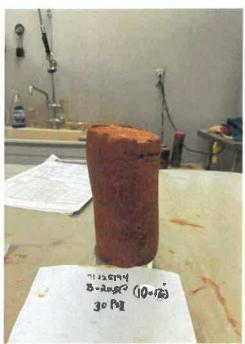




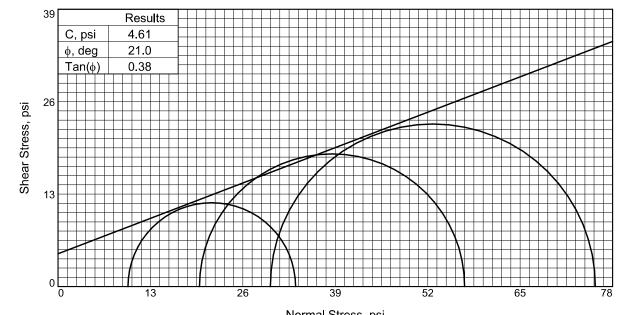
Terracon.com

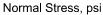


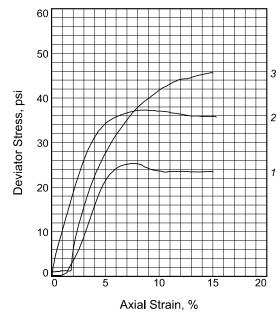




Specimen Failure Illustration







	Sa	mple No.	1	2	3	
3	Initial	Water Content, % Dry Density, pcf Saturation, % Void Ratio Diameter, in. Height, in.	30.6 80.0 74.6 1.1062 2.863 5.698	2.862	2.862	
1	At Test	Water Content, % Dry Density, pcf Saturation, % Void Ratio Diameter, in. Height, in.	31.9 80.0 77.8 1.1062 2.863 5.698			
	Strain rate, %/min. Back Pressure, psi Cell Pressure, psi Fail. Stress, psi		1.00	1.00	1.00	
			0.0	0.0	0.0	
			9.8	19.9	29.9	
			23.6	37.3	45.7	
	Ult	. Stress, psi				
σ₁ Failure, psi			33.4	57.2	75.6	
σ_3 Failure, psi			9.8	19.9	29.9	

Type of Test:

Unconsolidated Undrained Sample Type: Un-Disturbed

Description: Red Elastic SILT with Sand- MH

LL= 65 **PL=** 34 **PI=** 31

Specific Gravity= 2.7

Remarks: Percent Passing #200=76.3%

Client: Charlotte Water

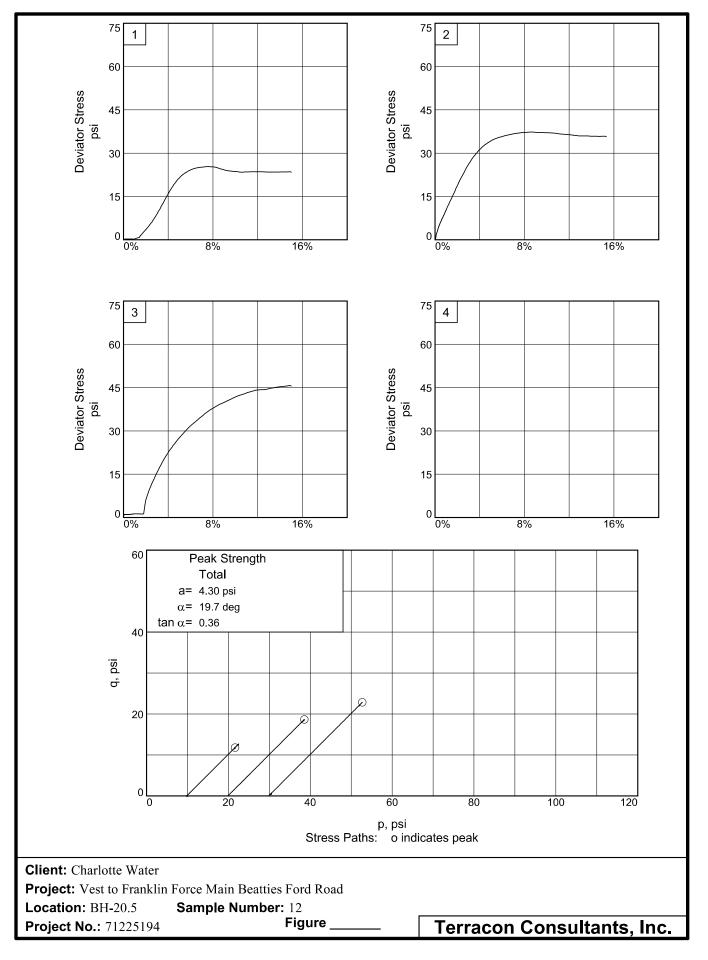
Project: Vest to Franklin Force Main Beatties Ford Road

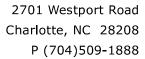
Charlotte, NC Location: BH-20.5 Sample Number: 12

Proj. No.: 71225194 **Date Sampled:**

> TRIAXIAL SHEAR TEST REPORT Terracon Consultants, Inc. Charlotte, North Carolina

Figure BH-20.5





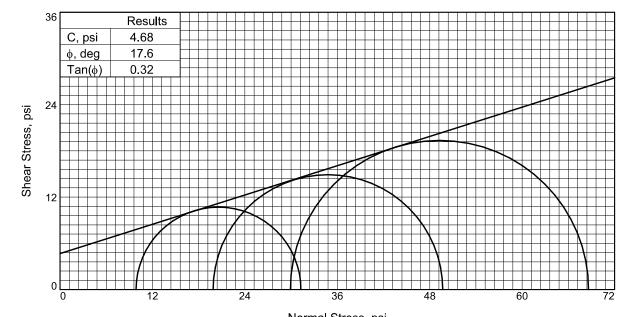




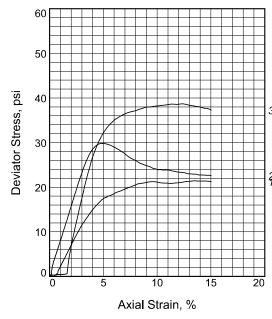




Specimen Failure Illustration



Normal Stress, psi



	Sa	mple No.	1	2	3	
	Initial	Water Content, % Dry Density, pcf Saturation, % Void Ratio	49.4 71.1 97.3 1.3702	45.6 68.6 84.4 1.4583	46.2 68.5 85.5 1.4598	
3	_	Diameter, in. Height, in.	2.862 5.654	2.863 5.806		
3	At Test	Water Content, % Dry Density, pcf Saturation, % Void Ratio Diameter, in. Height, in.	50.0 71.1 98.5 1.3702 2.862 5.654	38.5 68.6 71.4 1.4583 2.863 5.806	50.9 68.5 94.1 1.4598 2.871 6.036	
	Str	ain rate, %/min.	1.00	1.00	1.00	
	Ва	ck Pressure, psi	0.0	0.0	0.0	
	Се	II Pressure, psi	9.9	19.9	29.9	
	Fai	il. Stress, psi	21.4	29.8	38.7	
	Ult	. Stress, psi				
	σ_1	Failure, psi	31.3	49.7	68.6	
	σ_3	Failure, psi	9.9	19.9	29.9	

Type of Test:

Unconsolidated Undrained Sample Type: Un-Disturbed **Description:** Red Elastic SILT

Specific Gravity= 2.7

Remarks: Percent Passing #200=92.8%

Client: Charlotte Water

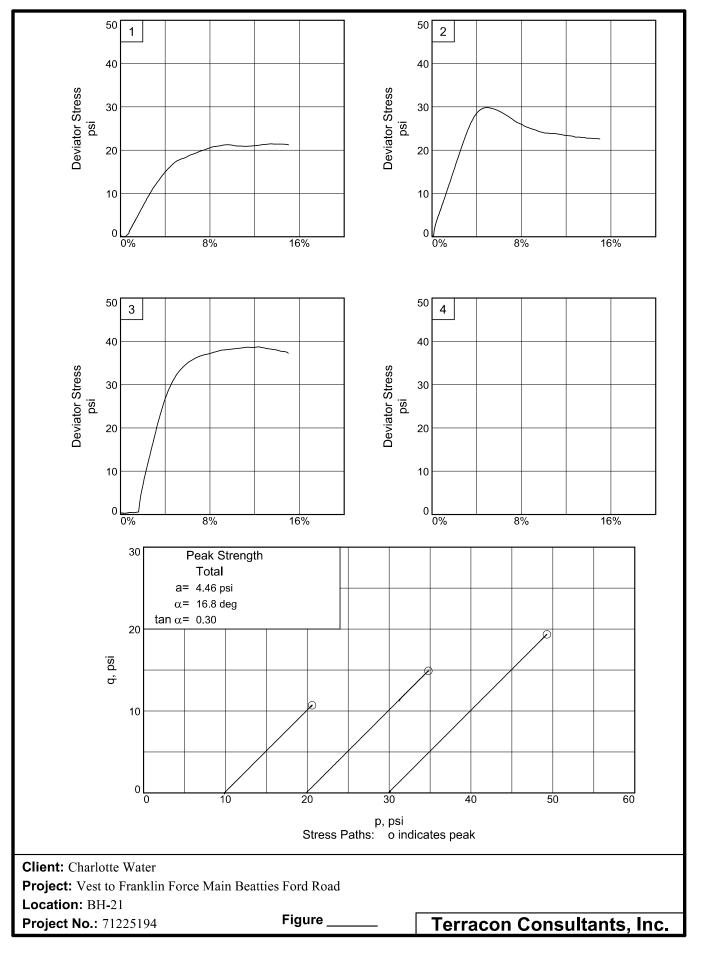
Project: Vest to Franklin Force Main Beatties Ford Road

Charlotte, NC Location: BH-21

Proj. No.: 71225194

Date Sampled:

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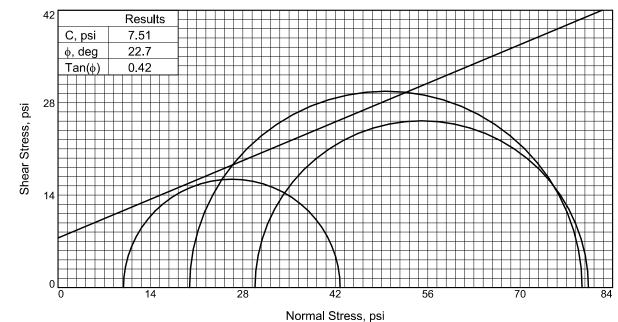




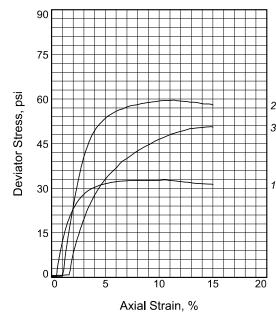




Specimen Failure Illustration







	Sa	mple No.	1	2	3	
	al	Water Content, % Dry Density, pcf Saturation, %	25.5 79.5 61.5	22.5 90.9 71.3		
	Initia	Void Ratio	1.1199	0.8536	1.1235	
2		Diameter, in. Height, in.	2.865 5.998			
3		Water Content, %	25.7			
	st	Dry Density, pcf	79.5			
	At Test	Saturation, %	61.9			
,	Αŧ	Void Ratio	1.1199	0.8536		
'		Diameter, in.	2.865			
		Height, in.	5.998	6.001	5.996	
	Str	ain rate, %/min.	1.00	1.00	1.00	
	Ва	ck Pressure, psi	0.0	0.0	0.0	
	Се	II Pressure, psi	9.9	19.9	29.8	
	Fai	il. Stress, psi	32.8	59.5	50.5	
	Ult. Stress, psi					
	σ_1	Failure, psi	42.7	79.4	80.3	
	σ_3	Failure, psi	9.9	19.9	29.8	

Type of Test:

Unconsolidated Undrained Sample Type: Un-disturbed

Description: Light Red-Brown CLAY with

Sand-CH

LL= 56 **PL=** 27 **PI=** 29

Specific Gravity= 2.7

Remarks: Percent Passing #200=76.0%

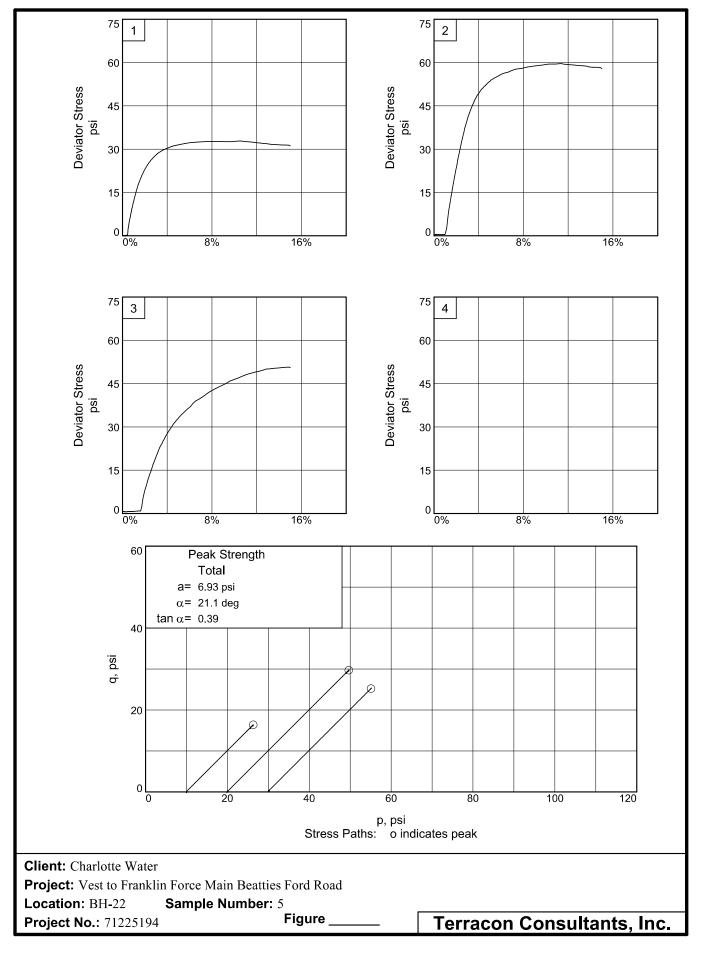
Client: Charlotte Water

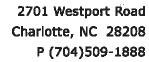
Project: Vest to Franklin Force Main Beatties Ford Road

Charlotte, NC Location: BH-22 Sample Number: 5

Proj. No.: 71225194 Date Sampled:

TRIAXIAL SHEAR TEST REPORT Terracon Consultants, Inc. Charlotte, North Carolina





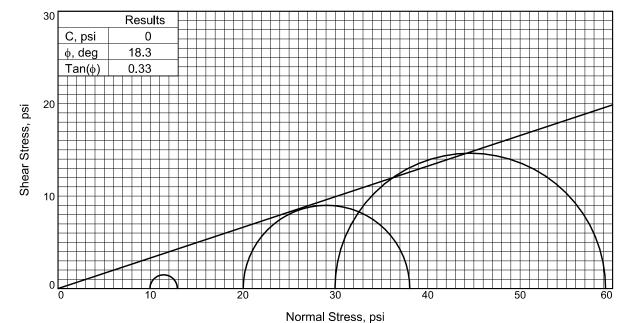


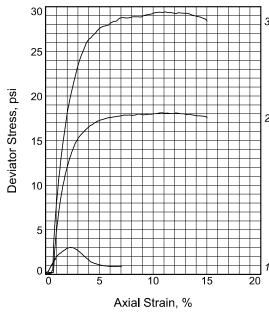






Specimen Failure Illustration





3	Sa	mple No.	1	2	3	
2	Initial	Water Content, % Dry Density, pcf Saturation, % Void Ratio Diameter, in. Height, in.	17.6 97.2 68.2 0.6703 2.865 5.718		20.8 98.2 82.9 0.6531 2.864 5.958	
	At Test	Water Content, % Dry Density, pcf Saturation, % Void Ratio Diameter, in. Height, in.	17.7 97.2 68.7 0.6703 2.865 5.718	21.9 100.8 93.2 0.6099 2.865 5.798	21.9 98.2 87.0 0.6531 2.864 5.958	
	Strain rate, %/min.		1.00	1.00	1.00	
	Back Pressure, psi 0		0.0	0.0	0.0	
1	Cell Pressure, psi		9.9	20.0	30.0	
	Fail. Stress, psi		3.0	18.0	29.3	
	Ult. Stress, psi					
	σ_1	Failure, psi	12.9	38.1	59.2	
	σ_3	Failure, psi	9.9	20.0	30.0	

Type of Test:

Unconsolidated Undrained Sample Type: Un-disturbed **Description:** Gray Silty SAND

LL= 27 **PL=** 17 **PI=** 10

Specific Gravity= 2.6

Remarks: Percent Passing #200=34.5%

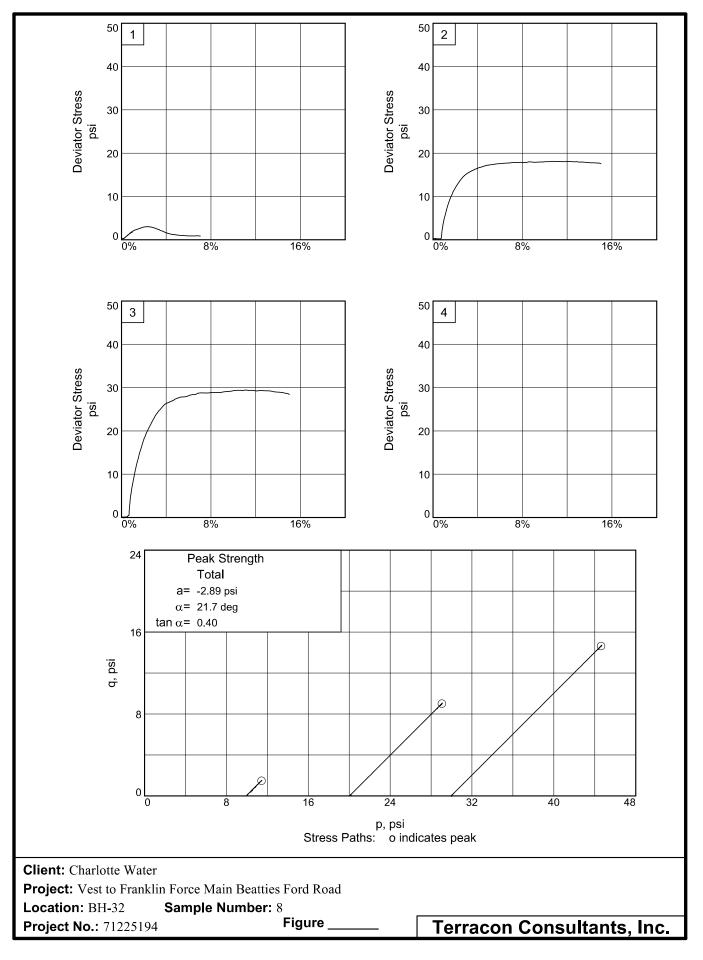
Client: Charlotte Water

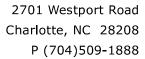
Project: Vest to Franklin Force Main Beatties Ford Road

Charlotte, NC Location: BH-32 Sample Number: 8

Proj. No.: 71225194 **Date Sampled:**

> TRIAXIAL SHEAR TEST REPORT Terracon Consultants, Inc. Charlotte, North Carolina





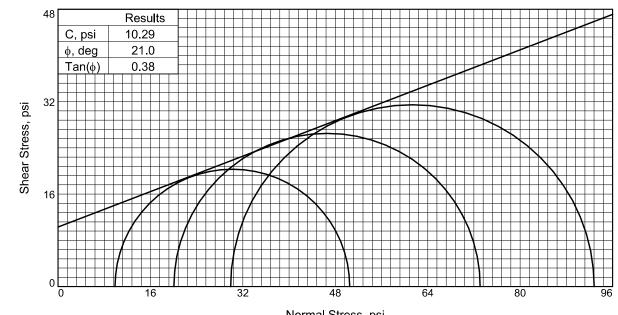




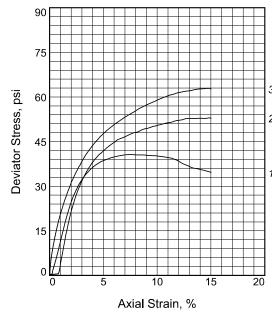




Specimen Failure Illustration



Normal Stress, psi



	Sa	mple No.	1	2	3	
3	Initial	Water Content, % Dry Density, pcf Saturation, % Void Ratio Diameter, in. Height, in.	18.1 83.1 47.5 1.0282 2.868 6.089	2.865	18.8 84.0 50.5 1.0069 2.862 6.005	
2	At Test	Water Content, % Dry Density, pcf Saturation, % Void Ratio Diameter, in. Height, in.	23.0 83.1 60.5 1.0282 2.868 6.089	18.8 77.5 43.1 1.1739 2.865 5.999	23.1 84.0 61.9 1.0069 2.862 6.005	
	Str	ain rate, %/min.	1.00	1.00	1.00	
	Ва	ck Pressure, psi	0.0	0.0	0.0	
	Се	II Pressure, psi	9.9	20.1	29.9	
	Fai	il. Stress, psi	40.6	53.0	62.9	
	Ult. Stress, psi					
	σ_1	Failure, psi	50.5	73.1	92.8	
	σ_3	Failure, psi	9.9	20.1	29.9	

Type of Test:

Unconsolidated Undrained Sample Type: Un-disturbed

Description: Light Reddish Brown Sandy SILT-

ML

LL= 45 **PL=** 29 **PI=** 16

Specific Gravity= 2.7

Remarks: Percent Passing #200=58.8%

Client: Charlotte Water

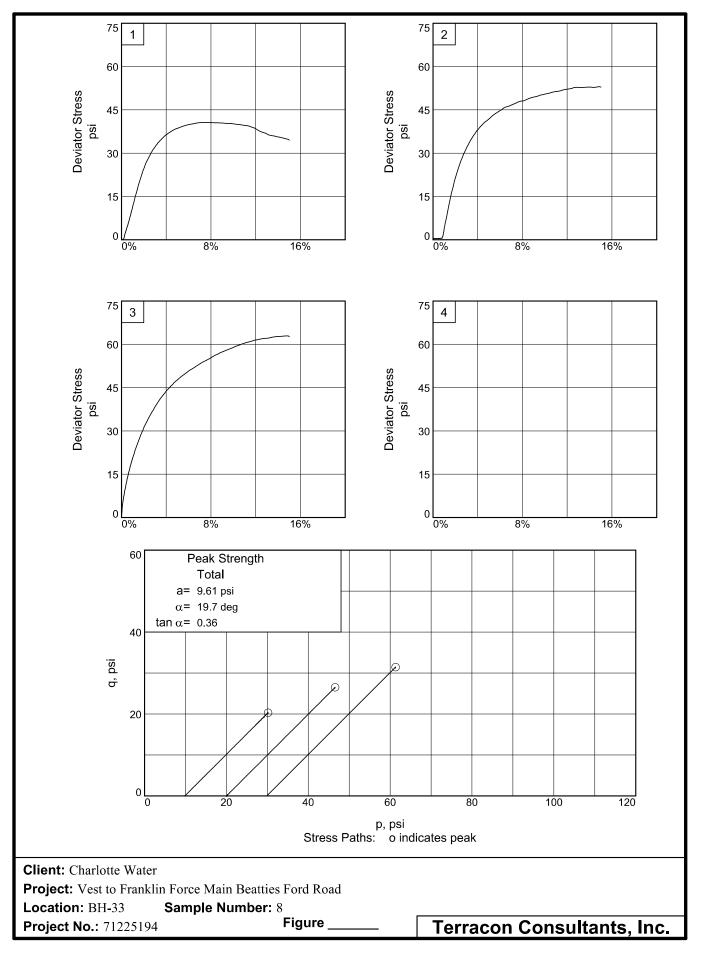
Project: Vest to Franklin Force Main Beatties Ford Road

Charlotte, NC Location: BH-33 Sample Number: 8

Proj. No.: 71225194 **Date Sampled:**

> TRIAXIAL SHEAR TEST REPORT Terracon Consultants, Inc. Charlotte, North Carolina

Figure Bh-33







р

Specimen Failure Illustration

Laboratory test results unobtainable due to specimen collapse.

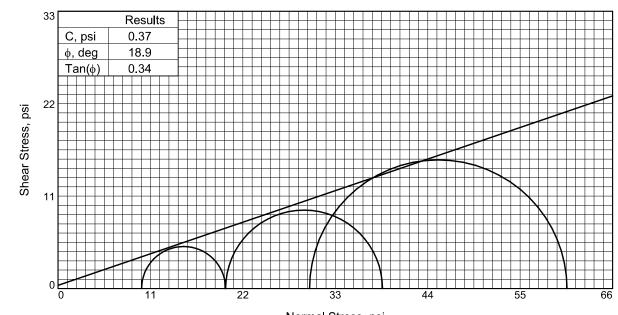




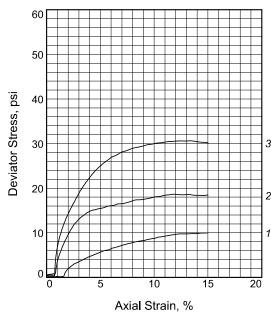




Specimen Failure Illustration



Normal Stress, psi



	Sa	mple No.	1	2	3	
	Initial	Water Content, % Dry Density, pcf Saturation, % Void Ratio Diameter, in. Height, in.	48.6 68.5 88.7 1.5063 2.861 4.606	26.2 91.3 83.5 0.8457 2.861 5.906		
3	At Test	Water Content, % Dry Density, pcf Saturation, % Void Ratio Diameter, in.	43.6 68.5 79.6 1.5063 2.861	25.9 91.3 82.5 0.8457 2.861	34.0 85.5 94.5 0.9710 2.861	
	Ctr	Height, in.	4.606	5.906	5.918	
1	Ва	ain rate, %/min. ck Pressure, psi Il Pressure, psi	1.00 0.0 9.9	1.00 0.0 19.9	1.00 0.0 29.9	
		il. Stress, psi	10.0	18.7	30.6	
	Ult	Stress, psi				
	σ_1	Failure, psi	19.9	38.6	60.6	
	σ_3	Failure, psi	9.9	19.9	29.9	

Type of Test:

Unconsolidated Undrained Sample Type: Un-disturbed

Description: Brown Elastic SILT-MH

LL= 53 **PL=** 30 **PI=** 23

Specific Gravity= 2.75

Remarks: Percent Passing #200= 83.2%

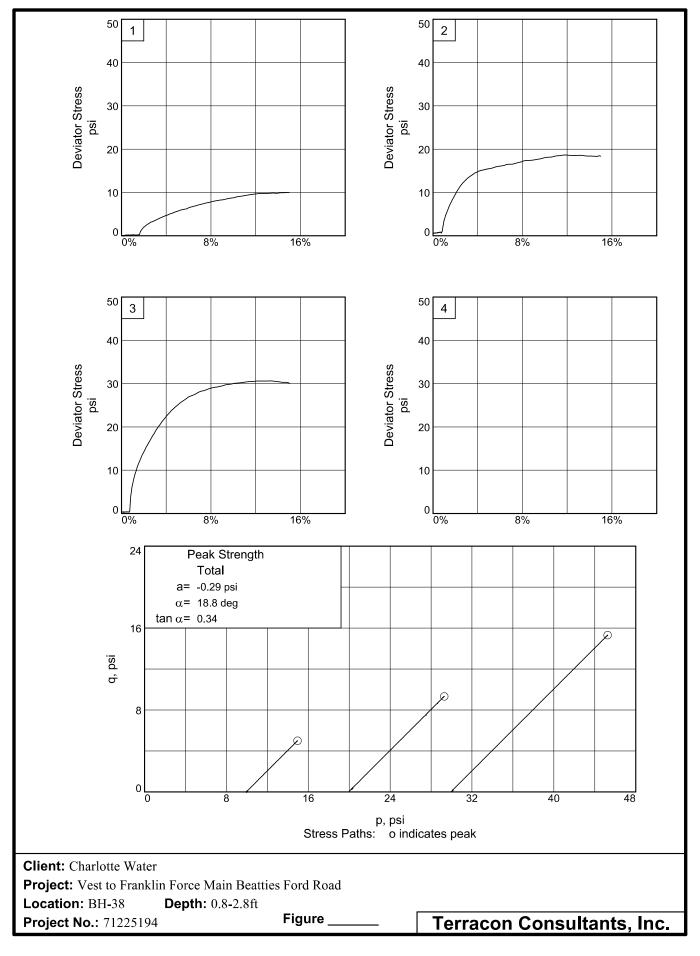
Client: Charlotte Water

Project: Vest to Franklin Force Main Beatties Ford Road

Charlotte, NC **Location:** BH-38 **Depth:** 0.8-2.8ft

Proj. No.: 71225194 Date Sampled:

TRIAXIAL SHEAR TEST REPORT Terracon Consultants, Inc. Charlotte, North Carolina



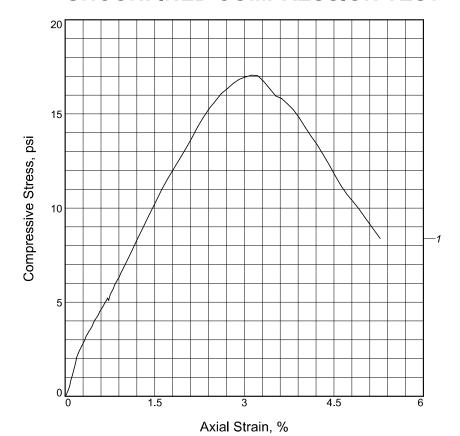




Unconfined Compression

Specimen Failure Illustration





Sample No.	1		
Unconfined strength, psi	17.06		
Undrained shear strength, psi	8.53		
Failure strain, %	3.1		
Strain rate, %/min.	1.00		
Water content, %	21.5		
Wet density, pcf	123.4		
Dry density, pcf	101.6		
Saturation, %	88.0		
Void ratio	0.6584		
Specimen diameter, in.	2.861		
Specimen height, in.	5.890		
Height/diameter ratio	2.06		

Description: Gray Fat CLAY with Sand-CH

LL = 59 **PL** = 22 **Pl** = 37 **GS**= 2.7 **Type:** Un-disturbed

Project No.: 71225194

Date Sampled:

Remarks:

Percent Passing #200=75.3%

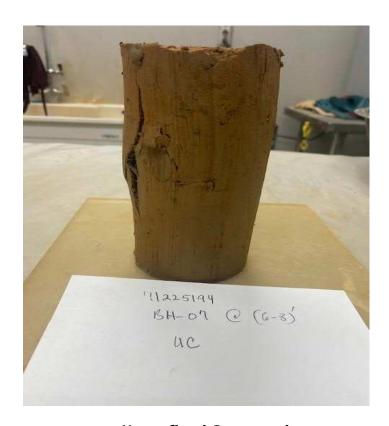
Client: Charlotte Water

Project: Vest to Franklin Force Main Beatties Ford Road

Charlotte, NC
Location: BH-03
Sample Number: 2

UNCONFINED COMPRESSION TEST Terracon Consultants, Inc. Charlotte, North Carolina

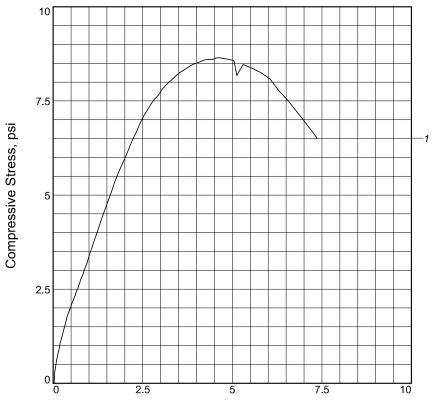




Unconfined Compression

<u>Specimen Failure Illustration</u>





Axial Strain, %

Sample No.	1	
Unconfined strength, psi	8.65	
Undrained shear strength, psi	4.32	
Failure strain, %	4.6	
Strain rate, %/min.	1.00	
Water content, %	35.3	
Wet density, pcf	118.9	
Dry density, pcf	87.9	
Saturation, %	103.8	
Void ratio	0.9186	
Specimen diameter, in.	2.861	
Specimen height, in.	5.780	
Height/diameter ratio	2.02	

Description: Brown CLAY with Sand-CL

LL = 41 **PL** = 23 **Pl** = 18 **GS**= 2.7 **Type:** Un-disturbed

Project No.: 71225194

Date Sampled:

Remarks:

Percent Passing #200=72.9%

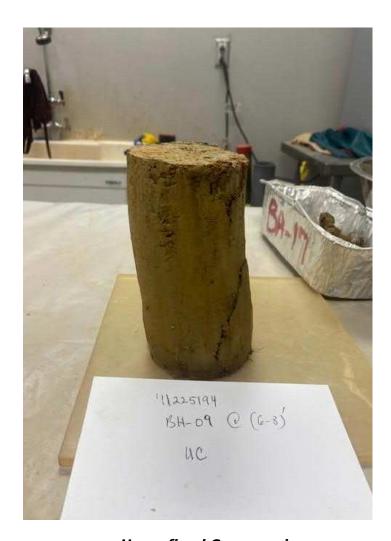
Client: Charlotte Water

Project: Vest to Franklin Force Main Beatties Ford Road

Charlotte, NC
Location: BH-07
Sample Number: 5

UNCONFINED COMPRESSION TEST Terracon Consultants, Inc. Charlotte, North Carolina

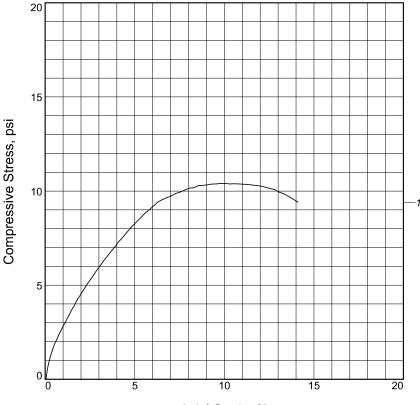




Unconfined Compression

Specimen Failure Illustration





Axial Strain, %

Sample No.	1		
Unconfined strength, psi	10.40		
Undrained shear strength, psi	5.20		
Failure strain, %	10.0		
Strain rate, %/min.	1.00		
Water content, %	34.8		
Wet density, pcf	112.7		
Dry density, pcf	83.7		
Saturation, %	92.5		
Void ratio	1.0150		
Specimen diameter, in.	2.862		
Specimen height, in.	5.997		
Height/diameter ratio	2.10		

Description: Light Brown CLAY-CH

Project No.: 71225194

Date Sampled:

Remarks

Percent Passing #200=73.3%

Client: Charlotte Water

Project: Vest to Franklin Force Main Beatties Ford Road

Charlotte, NC
Location: BH-09
Sample Number: 5

UNCONFINED COMPRESSION TEST
Terracon Consultants, Inc.
Charlotte, North Carolina

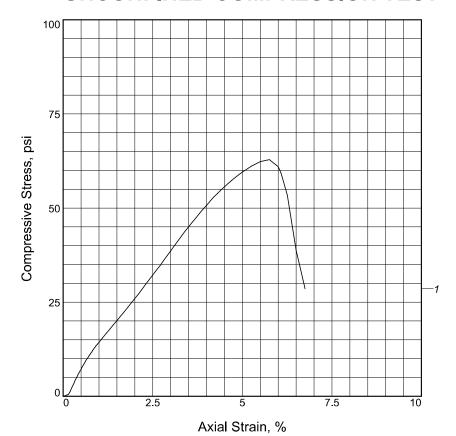




Unconfined Compression

<u>Specimen Failure Illustration</u>





1		
62.85		
31.43		
5.8		
1.00		
25.2		
123.8		
98.9		
96.6		
0.7037		
2.853		
5.971		
2.09		
	31.43 5.8 1.00 25.2 123.8 98.9 96.6 0.7037 2.853 5.971	31.43 5.8 1.00 25.2 123.8 98.9 96.6 0.7037 2.853 5.971

Description: Red Fat CLAY with Sand- CH

Project No.: 71225194

Date Sampled:

Remarks:

Percent Passing #200=70.8%

Client: Charlotte Water

Project: Vest to Franklin Force Main Beatties Ford Road

Charlotte, NC **Location**: BH-16

UNCONFINED COMPRESSION TEST Terracon Consultants, Inc.

Figure BH-16 Terracon Consultants, Inc Charlotte, North Carolina





Unconfined Compression

Specimen Failure Illustration

Laboratory test results unobtainable due to specimen collapse.

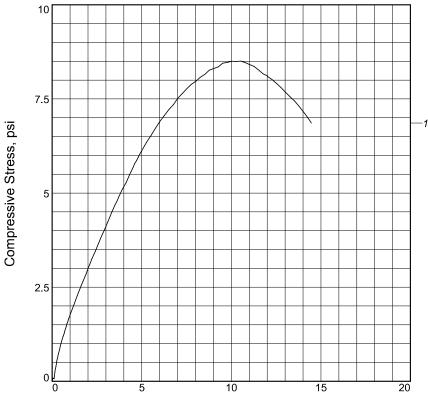




Unconfined Compression

<u>Specimen Failure Illustration</u>

UNCONFINED COMPRESSION TEST



Axial Strain, %	1
-----------------	---

Sample No.	1		
Unconfined strength, psi	8.50		
Undrained shear strength, psi	4.25		
Failure strain, %	10.5		
Strain rate, %/min.	1.00		
Water content, %	31.2		
Wet density, pcf	120.2		
Dry density, pcf	91.6		
Saturation, %	100.3		
Void ratio	0.8407		
Specimen diameter, in.	2.862		
Specimen height, in.	5.775		
Height/diameter ratio	2.02		

Description: Brown Sandy SILT-ML

Project No.: 71225194

Date Sampled:

Remarks:

Percent Passing #200=65.9%

Client: Charlotte Water

Project: Vest to Franklin Force Main Beatties Ford Road

Charlotte, NC
Location: BH-28
Sample Number: 5

UNCONFINED COMPRESSION TEST
Terracon Consultants, Inc.
Charlotte, North Carolina

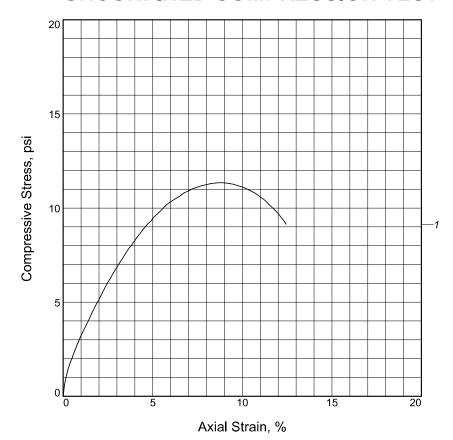




Unconfined Compression

<u>Specimen Failure Illustration</u>





Sample No.	1	
Unconfined strength, psi	11.35	
Undrained shear strength, psi	5.67	
Failure strain, %	8.8	
Strain rate, %/min.	1.00	
Water content, %	N/A	
Wet density, pcf	N/A	
Dry density, pcf	N/A	
Saturation, %	N/A	
Void ratio	N/A	
Specimen diameter, in.	2.856	
Specimen height, in.	6.080	
Height/diameter ratio	2.13	

Description: Grayish Brown Sandy CLAY- CH

Project No.: 71225194

Date Sampled:

Remarks

Percent Passing #200=67.1%

Client: Charlotte Water

Project: Vest to Franklin Force Main Beatties Ford Road

Charlotte, NC
Location: BH-40
Sample Number: 5

UNCONFINED COMPRESSION TEST Terracon Consultants, Inc. Charlotte, North Carolina

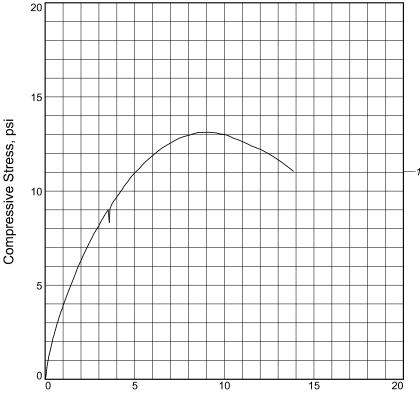




Unconfined Compression

<u>Specimen Failure Illustration</u>





Axial Strain, %

Sample No.	1		
Unconfined strength, psi	13.13		
Undrained shear strength, psi	6.56		
Failure strain, %	9.0		
Strain rate, %/min.	1.00		
Water content, %	N/A		
Wet density, pcf	N/A		
Dry density, pcf	N/A		
Saturation, %	N/A		
Void ratio	N/A		
Specimen diameter, in.	2.853		
Specimen height, in.	5.794		
Height/diameter ratio	2.03		

Description: Light Red-Brown Sandy CLAY- CH

LL = 81 **PL** = 23 **PI** = 58 **GS**= **Type:** Un-disturbed

Project No.: 71225194

Date Sampled:

Remarks

Percent Passing #200=69.6%

Client: Charlotte Water

Project: Vest to Franklin Force Main Beatties Ford Road

Charlotte, NC
Location: BH-45
Sample Number: 6

UNCONFINED COMPRESSION TEST
Terracon Consultants, Inc.
Charlotte, North Carolina

SUPPORTING INFORMATION

Contents:

General Notes
Unified Soil Classification System
Rock Classification

Note: All attachments are one page unless noted above.

GENERAL NOTES

DESCRIPTION OF SYMBOLS AND ABBREVIATIONS

Vest to Franklin Force Main ☐ Charlotte, NC Terracon Project No. 71225194



SAMPLING	WATER LEVEL	FIELD TESTS	
	_ <u></u> Water Initially Encountered	N	Standard Penetration Test Resistance (Blows/Ft.)
Auger Cuttings Rock Core	Water Level After a Specified Period of Time	(HP)	Hand Penetrometer
Obstantia V	Water Level After a Specified Period of Time	(T)	Torvane
Shelby Tube Split Spoon	Cave In Encountered	(DCP)	Dynamic Cone Penetrometer
	Water levels indicated on the soil boring logs are the levels measured in the borehole at the times indicated. Groundwater level variations will occur	UC	Unconfined Compressive Strength
	over time. In low permeability soils, accurate determination of groundwater levels is not possible with short term water level	(PID)	Photo-lonization Detector
	observations.	(OVA)	Organic Vapor Analyzer

DESCRIPTIVE SOIL CLASSIFICATION

Soil classification as noted on the soil boring logs is based Unified Soil Classification System. Where sufficient laboratory data exist to classify the soils consistent with ASTM D2487 "Classification of Soils for Engineering Purposes" this procedure is used. ASTM D2488 "Description and Identification of Soils (Visual-Manual Procedure)" is also used to classify the soils, particularly where insufficient laboratory data exist to classify the soils in accordance with ASTM D2487. In addition to USCS classification, coarse grained soils are classified on the basis of their in-place relative density, and fine-grained soils are classified on the basis of their consistency. See "Strength Terms" table below for details. The ASTM standards noted above are for reference to methodology in general. In some cases, variations to methods are applied as a result of local practice or professional judgment.

LOCATION AND ELEVATION NOTES

Exploration point locations as shown on the Exploration Plan and as noted on the soil boring logs in the form of Latitude and Longitude are approximate. See Exploration and Testing Procedures in the report for the methods used to locate the exploration points for this project. Surface elevation data annotated with +/- indicates that no actual topographical survey was conducted to confirm the surface elevation. Instead, the surface elevation was approximately determined from topographic maps of the area.

STRENGTH TERMS				
RELATIVE DENSITY OF COARSE-GRAINED SOILS CONSISTENCY OF FINE-GRAINED SOILS				
(More than 50% retained on No. 200 sieve.) Density determined by Standard Penetration Resistance		(50% or more passing the No. 200 sieve.) Consistency determined by laboratory shear strength testing, field visual-manua procedures or standard penetration resistance		esting, field visual-manual
Descriptive Term (Density)	Standard Penetration or N-Value Blows/Ft.	Descriptive Term (Consistency) Unconfined Compressive Strength (Consistency) Qu, (tsf) Standard Penetration of N-Value Blows/Ft.		
Very Loose	0 - 3	Very Soft	less than 0.25	0 - 1
Loose	4 - 9	Soft	0.25 to 0.50	2 - 4
Medium Dense	10 - 29	Medium Stiff	0.50 to 1.00	4 - 8
Dense	30 - 50	Stiff	1.00 to 2.00	8 - 15
Very Dense	> 50	Very Stiff	2.00 to 4.00	15 - 30
		Hard	> 4.00	> 30

RELEVANCE OF SOIL BORING LOG

The soil boring logs contained within this document are intended for application to the project as described in this document. Use of these soil boring logs for any other purpose may not be appropriate.



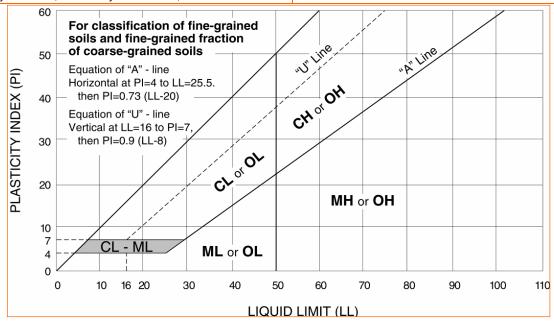
				Soil Classification	
Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests A				Group Symbol	Group Name ^B
Gravels: More than		Clean Gravels:	Cu ≥ 4 and 1 ≤ Cc ≤ 3 ^E	GW	Well-graded gravel F
	Gravels: More than 50% of	Less than 5% fines ^C	Cu < 4 and/or [Cc<1 or Cc>3.0] E	GP	Poorly graded gravel ^F
	coarse fraction retained on No. 4 sieve	Gravels with Fines:	Fines classify as ML or MH	GM	Silty gravel F, G, H
Coarse-Grained Soils: More than 50% retained	retained on No. 4 sieve	More than 12% fines ^c	Fines classify as CL or CH	GC	Clayey gravel ^{F, G, H}
on No. 200 sieve	Sands: 50% or more of coarse fraction passes No. 4 sieve	Clean Sands:	Cu ≥ 6 and 1 ≤ Cc ≤ 3 ^E	SW	Well-graded sand
		Less than 5% fines D	Cu < 6 and/or [Cc<1 or Cc>3.0] E	SP	Poorly graded sand
		Sands with Fines: More than 12% fines D	Fines classify as ML or MH	SM	Silty sand ^{G, H, I}
			Fines classify as CL or CH	sc	Clayey sand ^{G, H, I}
		Inorganic:	PI > 7 and plots on or above "A"	CL	Lean clay K, L, M
	Silts and Clays:		PI < 4 or plots below "A" line J	ML	Silt K, L, M
Fine-Grained Soils: 50% or more passes the	Liquid limit less than 50	Organic:	Liquid limit - oven dried < 0.75	OL	Organic clay K, L, M, N
			Liquid limit - not dried		Organic silt K, L, M, O
No. 200 sieve	Silts and Clays: Liquid limit 50 or more Organic:		PI plots on or above "A" line	CH	Fat clay ^{K, L, M}
			PI plots below "A" line	MH	Elastic Silt K, L, M
			Liquid limit - oven dried	< 0.75 OH	Organic clay K, L, M, P
		Liquid limit - not dried	011	Organic silt K, L, M, Q	
Highly organic soils:	Primarily organic matter, dark in color, and organic odor			PT	Peat

- A Based on the material passing the 3-inch (75-mm) sieve.
- B If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.
- Gravels with 5 to 12% fines require dual symbols: GW-GM well-graded gravel with silt, GW-GC well-graded gravel with clay, GP-GM poorly graded gravel with silt, GP-GC poorly graded gravel with clay.
- Sands with 5 to 12% fines require dual symbols: SW-SM well-graded sand with silt, SW-SC well-graded sand with clay, SP-SM poorly graded sand with silt, SP-SC poorly graded sand with clay.

E Cu =
$$D_{60}/D_{10}$$
 Cc = $\frac{(D_{30})^2}{D_{10} \times D_{60}}$

- F If soil contains ≥ 15% sand, add "with sand" to group name.
- ^G If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.

- HIf fines are organic, add "with organic fines" to group name.
- If soil contains ≥ 15% gravel, add "with gravel" to group name.
- J If Atterberg limits plot in shaded area, soil is a CL-ML, silty clay.
- KIf soil contains 15 to 29% plus No. 200, add "with sand" or "with gravel," whichever is predominant.
- L If soil contains ≥ 30% plus No. 200 predominantly sand, add "sandy" to group name.
- MIf soil contains ≥ 30% plus No. 200, predominantly gravel, add "gravelly" to group name.
- NPI ≥ 4 and plots on or above "A" line.
- OPI < 4 or plots below "A" line.
- PI plots on or above "A" line.
- QPI plots below "A" line.



DESCRIPTION OF ROCK PROPERTIES



WEATHERING		
Term	Description	
Unweathered	No visible sign of rock material weathering, perhaps slight discoloration on major discontinuity surfaces.	
Slightly weathered	Discoloration indicates weathering of rock material and discontinuity surfaces. All the rock material may be discolored by weathering and may be somewhat weaker externally than in its fresh condition.	
Moderately weathered	Less than half of the rock material is decomposed and/or disintegrated to a soil. Fresh or discolored rock is present either as a continuous framework or as corestones.	
Highly weathered	More than half of the rock material is decomposed and/or disintegrated to a soil. Fresh or discolored rock is present either as a discontinuous framework or as corestones.	
Completely weathered	All rock material is decomposed and/or disintegrated to soil. The original mass structure is still largely intact.	
Residual soil	All rock material is converted to soil. The mass structure and material fabric are destroyed. There is a large change in volume, but the soil has not been significantly transported.	

STRENGTH OR HARDNESS			
Description	Description Field Identification		
Extremely weak	Indented by thumbnail	40-150 (0.3-1)	
Very weak	Crumbles under firm blows with point of geological hammer, can be peeled by a pocket knife	150-700 (1-5)	
Weak rock	Can be peeled by a pocket knife with difficulty, shallow indentations made by firm blow with point of geological hammer	700-4,000 (5-30)	
Medium strong	Cannot be scraped or peeled with a pocket knife, specimen can be fractured with single firm blow of geological hammer	4,000-7,000 (30-50)	
Strong rock Specimen requires more than one blow of geological hammer to fracture it 7,000-15,000 (50-100)		7,000-15,000 (50-100)	
Very strong	Specimen requires many blows of geological hammer to fracture it	15,000-36,000 (100-250)	
Extremely strong	Extremely strong Specimen can only be chipped with geological hammer >36,000 (>250)		

DISCONTINUITY DESCRIPTION				
Fracture Spacing (Join	ts, Faults, Other Fractures)	Bedding Spacing (May Include Foliation or Banding)		
Description	Spacing	Description Spacing		
Extremely close	< ¾ in (<19 mm)	Laminated	< ½ in (<12 mm)	
Very close	³ ⁄ ₄ in – 2-1/2 in (19 - 60 mm)	Very thin	½ in – 2 in (12 – 50 mm)	
Close	2-1/2 in – 8 in (60 – 200 mm)	Thin	2 in – 1 ft. (50 – 300 mm)	
Moderate	8 in – 2 ft. (200 – 600 mm)	Medium	1 ft. – 3 ft. (300 – 900 mm)	
Wide	2 ft. – 6 ft. (600 mm – 2.0 m)	Thick	3 ft. – 10 ft. (900 mm – 3 m)	
Very Wide	6 ft. – 20 ft. (2.0 – 6 m)	Massive	> 10 ft. (3 m)	
·				

<u>Discontinuity Orientation (Angle)</u>: Measure the angle of discontinuity relative to a plane perpendicular to the longitudinal axis of the core. (For most cases, the core axis is vertical; therefore, the plane perpendicular to the core axis is horizontal.) For example, a horizontal bedding plane would have a 0-degree angle.

ROCK QUALITY DESIGNATION (RQD) 1			
Description	RQD Value (%)		
Very Poor	0 - 25		
Poor	25 – 50		
Fair	50 – 75		
Good	75 – 90		
Excellent	90 - 100		

^{1.} The combined length of all sound and intact core segments equal to or greater than 4 inches in length, expressed as a percentage of the total core run length.

Reference: U.S. Department of Transportation, Federal Highway Administration, Publication No FHWA-NHI-10-034, December 2009 <u>Technical Manual for Design and Construction of Road Tunnels – Civil Elements</u>