SANBORN HEAD

Geotechnical Engineering Report

WEATHERSFIELD STGP SGNL(72)

US Route 5 & Vermont Route 131

Weathersfield, Vermont

Prepared for: DuBois & King, Inc.

File No. 5609.00

March 20, 2023

SANBORN HEAD

187 Saint Paul Street, Suite 201
Burlington, VT 05401

Mr. Christopher Lathrop, P.E.
DuBois & King, Inc.
6 Green Tree Drive
South Burlington, VT 05403

March 20, 2023
File No. 5609.00

Re: Geotechnical Engineering Report
Weathersfield STPG SGNL(72)
US Route 5 & Vermont Route 131
Weathersfield, Vermont

Dear Mr. Lathrop:

Sanborn, Head & Associates, Inc. (Sanborn Head) is pleased to submit our geotechnical engineering report for the proposed traffic signal mast arms located at the intersection of US Route 5 (US-5) and Vermont Route 131 (VT-131) in Weathersfield, Vermont. Refer to the enclosed Figure 1 – Locus Plan for the general location of the project.

This report includes subsurface information and geotechnical design and construction recommendations for the proposed traffic signal mast arm foundations. Our recommendations are based in part on guidance from the Vermont Agency of Transportation (VTrans) publication titled, Materials & Research Engineering Instructions (MREI) 10-01 – Geotechnical Design Procedures for Mast Arm and Overhead Sign Support Foundations, dated March 9, 2010. Design recommendations are based on Load and Resistance Factor Design (LRFD) methods.

This report has been prepared by Sanborn Head on behalf of DuBois & King, Inc. (Client) in accordance with our subconsultant agreement dated January 25, 2023 and is subject to the limitations provided in Appendix A.

PURPOSE AND SCOPE

Sanborn Head observed subsurface explorations (e.g., test borings) and performed a geotechnical engineering evaluation for the proposed traffic signal mast arm foundations. Our scope of services included characterizing the subsurface conditions at the site, performing geotechnical engineering analyses, and providing geotechnical design and construction recommendations for the project.

SITE AND PROJECT DESCRIPTION

The site is a four-way, asphalt-surfaced intersection located at US-5 and VT-131 in Weathersfield, Vermont. The site is bordered by residential development to the northwest, Weathersfield Proctor Library (5181 US-5) to the northeast, Strobel's Service Center (5122 US-5) to the southwest, and Vermont Homestyle Bakery and Café (5075 US-5) to the southeast. Site grades are generally level and range between approximate elevation (El.) 410 feet and El. 414 feet.

We understand that four (4) traffic signal mast arms are proposed at each corner of the above-referenced intersection. Specific details regarding their geometry and foundation loading were not available at the time this report was prepared. We anticipate the foundations for the proposed mast arms will consist of drilled shaft construction with the foundation loading primarily in lateral shear and bending due to wind loads and off-set weight of the structure.

REGIONAL GEOLOGY

According to published geologic mapping titled "Surficial Geologic Map of Weathersfield, Vermont" by Stephen F. Wright, 2017, the subsurface materials at the site are mapped as a transition zone of fluvial terrace deposits and lacustrine sediments. The fluvial terrace deposits are generally described as *"stream terrace deposits well above the modern floodplain. "Old" alluvium on these terraces is generally less than two meters thick and has frequently been extracted revealing the underlying sediment."* The lacustrine sediments are generally described as "*interlayered fine sand, very fine sand, and silt deposited in Glacial Lake Hitchcock"*.

SUBSURFACE EXPLORATION

Sanborn Head observed four (4) test borings (SH-1 through SH-4) that were performed by New England Boring Contractors of Derry, New Hampshire on February 20 and 21, 2023. The test borings were performed to evaluate the subsurface conditions near the proposed traffic signal mast arm foundations. Test borings were located by tape measurements from existing site features and their approximate locations are shown on the enclosed Figure 2 - Subsurface Exploration Location Plan. Ground surface elevations shown on the boring logs were obtained from GPS data provided by Catamount Subsurface Investigations, LLC (CSI), who performed utility locating services for the test boring program.

Flush-jointed casing and rotary wash drilling methods were used to advance the test borings to depths between approximately 21 and 24 feet below existing ground surface (bgs) or between approximately El. 391 feet and El. 387 feet. Representative soil samples were obtained by split-barrel sampling procedures in general accordance with ASTM D-1586, and representative bedrock samples were obtained from test borings SH-1 and SH-4 using a NX-sized core barrel in general accordance with ASTM D-2113. Logs of the subsurface conditions encountered in the test borings are included in Appendix B.

The split-barrel sampling procedure utilizes a standard 2-inch-outside-diameter (O.D.) split-barrel sampler that is driven into the bottom of the boring with a 140-pound hammer falling 30 inches. The number of blows required to advance the sampler the middle 12 inches of a normal 24-inch penetration is recorded as the Standard Penetration Resistance Value (N-value). The blows are indicated on the boring logs at their depth of occurrence and provide an indication of the consistency or relative density of the material.

Groundwater levels were measured using a water level indicator in the open drill holes or inferred from the soil samples during drilling.

SUBSURFACE CONDITIONS

The subsurface profile encountered in the test borings generally consists of topsoil, existing fill, natural silt and sand deposits, and bedrock. The approximate thicknesses and generalized descriptions for each soil unit are provided in Table 1.

Table 1 – Summary of Soil Conditions

Stratum	Thickness (ft)	Elevation of Top of Stratum (ft)	General Description
Topsoil (TS)	0.3 to 0.5	414.3 to 410.0 (Ground Surface)	Loose to medium dense, brown to dark brown, fine to coarse SAND, little to some Silt, little to some Gravel, very few to few Organics. Moist.
Fill (F)	2.7 to 3.6	414.0 to 409.6	Very loose to dense, brown, fine to coarse SAND, little to some Gravel, little to some Silt. Moist.
Natural Silt & Sand (SS)	11.0 to 19.0	410.3 to 406.0	Loose to medium dense, brown to olive-brown (grn-brn), SILT, and to little Sand, little to no Gravel. Moist. (A-4) **or** Loose to medium dense, brown, fine to coarse SAND, and to little Silt, little to no Gravel. Moist. (A-2-4)
Bedrock (B)	- -	396.8 to 388.0	Bedrock cores were retrieved from test borings SH-1 and SH-4 and generally consist of "*Fair to good quality, hard, very slightly weathered, gray, fine-grained PHYLITTE. Joints spaced very close to moderately close (1 to 14-inches apart), dipping steep (60 degrees) to horizontal, moderately fractured to sound.*" Recovery: 88% to 92%. Rock Quality Designation (RQD): 73% to 76%. Bedrock depths in test borings SH-2 and SH-3 were inferred based on roller bit action and split spoon refusal.

Groundwater

Groundwater was encountered in each of the test borings within approximately 1 foot of the bedrock surface. Stabilized groundwater measurements were taken in test borings SH-1 and SH-2 at depths of approximately 20 and 17 feet bgs, respectively, or approximate El. 392.3 feet and El. 397.3 feet. Groundwater levels will vary depending on factors such as season, precipitation, construction activity, and other conditions, which may be different from those at the time of our observations.

GEOTECHNICAL LABORATORY TESTING

Sanborn Head sent four (4) representative soil samples from the test borings to GeoTesting Express, Inc. (GTX) of Acton, Massachusetts for geotechnical laboratory analysis. GTX performed particle size analyses on the four sample in accordance with ASTM D6913 (or AASHTO T 311). The laboratory testing results are provided in Appendix D.

GEOTECHNICAL RECOMMENDATIONS

We recommend the proposed traffic signal mast arms be supported by drilled shafts. The drilled shaft foundations should be designed and constructed in accordance with the AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals, 5th Edition 2009 and the AASHTO Standard Specifications for Highway Bridges 17th Edition, 2002.

The geotechnical design of the drilled shaft foundations should consider a free-head condition, account for any sloping of the finished grade, and consider all loads and load combinations, including axial, shear, flexural, and torsional effects. We recommend the drilled shafts be designed to develop their capacity in the fill and natural silty sand deposits. We recommend neglecting the upper two feet of soil surrounding the drilled shafts for side resistance contributions due to potential disturbance during construction. We anticipate the drilled shaft foundations will be between 24 and 36 inches in diameter and will extend to depths of up to 15 feet below proposed site grades.

The drilled shaft foundations should be sufficiently sized and extend to a depth that provides an appropriate factor of safety against collapse and such that lateral and vertical deflections are limited to 0.5-inches. Should the drilled shaft foundations extend into bedrock, lateral deflections within the bedrock should be limited to 0.0004 times the diameter of the drilled shaft foundation. The required embedment to resist lateral loading can be determined by either static (e.g., Brom's method) or elastic (e.g., p-y method) methods, and the required embedment to resist axial and torsional loading can be determined from the frictional resistance developed along the drilled shaft by the adjacent soils.

Depending on the method used to analyze the drilled shaft foundations, various geotechnical parameters may be required, which may include, as appropriate, total and effective unit weight (Y_T, Y_E), effective stress friction angle (ϕ'), effective cohesion (c'), stiffness modulus (k_s), passive earth pressure coefficient (K_p), and the frictional resistance developed along the drilled shaft by the adjacent soils (ultimate side resistance). Our recommended geotechnical parameters to be used in the design of the drilled shaft foundations are provided in Table 2.

Table 2 – Summary of Geotechnical Parameters

Stratum	Boring ID	Depth (ft)	Average $(N_1)_{60}$	Unit Weight (pcf)		c' (ksf)	ϕ' (deg)	k_s (ksi/in)		K_p	Ultimate Side Resistance (ksf)
				Y_T	Y_E			Above GWT	Below GWT		
F	SH-1/4	0 to 4	18	125	-	0	36	0.13	-	3.9	0.8
	SH-2/3	0 to 4									
SS	SH-1/4	4 to 15	14	115	-	0	34	0.10	-	3.5	
	SH-2/3	4 to 22									
B	SH-1/4	> 15	> 100	160	97.6	4.0	30	125	125	-	35
	SH-2/3	> 22									

1. The ultimate side resistance for stratums F and SS is based on an at-rest earth pressure coefficient (K_o) equal to 1.3 and a soil-shaft interface friction angle (δ') = ϕ' (per FHWA-NHI-18-024).
2. Ksf = kips per square foot; ksi = kips per square inch; pcf = pounds per cubic foot.
3. Reference Appendix C for delineation of generalized soil units (stratums) and references.

CONSTRUCTION CONSIDERATIONS

The drilled shaft excavations should be free of water, ice, frozen soil, and loose soils prior to installing the reinforcing steel and placing concrete. Concrete should be placed as soon as possible to minimize the potential for disturbance of the drilled shaft excavations. Should the in-

situ soils along the shaft or below the base become disturbed, the affected materials should be removed prior to placing concrete.

We anticipate that the overburden soils can be excavated by conventional drilling techniques. We recommend that the foundations be constructed by a method that will allow for inspection of the final excavation and proper construction of the drilled shaft foundations. Such methods may include the use of temporary casing to maintain the integrity of the drilled shaft excavations and to prevent potential collapse in the nonplastic, natural silty sand deposits.

Based on the anticipated lengths of the drilled shaft foundations, groundwater is not expected to be encountered during construction. However, if the drilled shafts extend below groundwater, temporary casing will also facilitate dewatering during construction of the drilled shafts. If dewatering during construction is not feasible, the contractor may consider placing concrete via a tremie pipe beginning at the bottom of the drilled shaft excavation.

CONSTRUCTION DOCUMENTS AND QUALITY CONTROL

If changes are made to the locations or types of structures, the recommendations in this report will need to be reviewed and may be subject to revision. We recommend Sanborn Head observe the installation of foundations to monitor actual conditions and to ensure compliance with the recommendations herein and project specifications.

We appreciate the opportunity to provide you with continued service. If you have any questions regarding the report, we can be reached at (802) 318-7489, or by email at dthabault@sanbornhead.com.

Very truly yours,
SANBORN, HEAD & ASSOCIATES, INC.

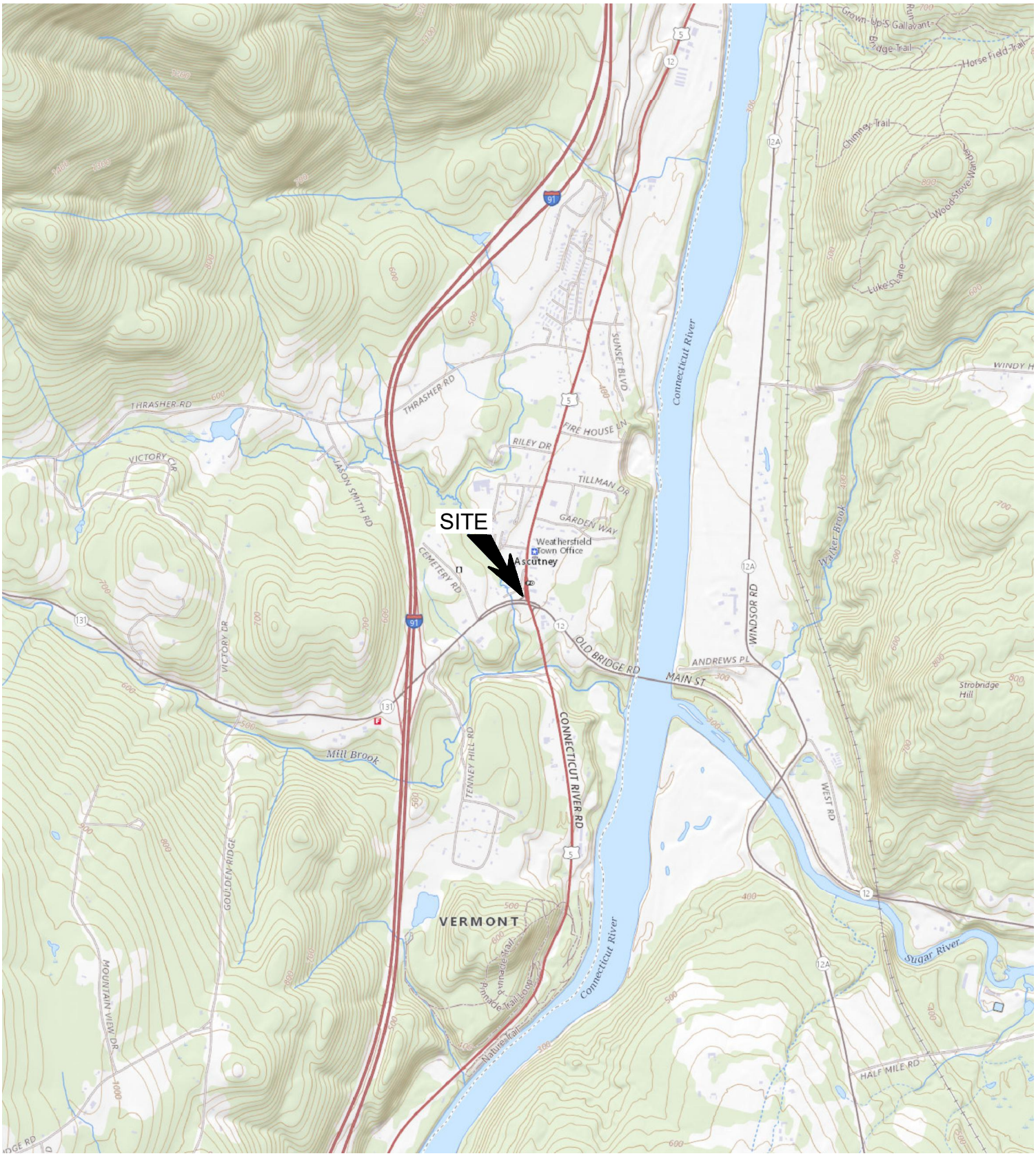
Ryan Henderson, M.S.	Daniel Thabault, P.E.	Shawn P. Kelley, Ph.D., P.E.
Senior Project Engineer	*Senior Project Engineer*	*Project Director*

RMH/DPT/SPK/LDN: rmh

Enclosed:
Figure 1 – Locus Plan
Figure 2 – Subsurface Exploration Location Plan
Appendix A – Limitations
Appendix B – Boring Logs
Appendix C – Boring Data Reduction
Appendix D – Laboratory Testing Results

P:\5600s\5609.00\Source Files\GT Report\20230320 Traffic Signal Mast Arm Foundations - GT Report.docx

Figures



NOTES:
USGS Topo basemap provided by ESRI through ArcGIS On-line.
Data refreshed October 2023.

Drawn By: D. Dombrowsky
Designed By: A. Lulias
Reviewed By: S. Kelley
Project No: 5609.00
Date: March 2023

SCALE: 1:25,000

SANBORN HEAD

Figure 1

Locus Plan

Geotechnical Engineering Report

WEATHERSFIELD STPG SGNL (72)
Weathersfield, Vermont

NOTES:

1. THE BASE MAP WAS DRAWN FROM GOOGLE EARTH. IMAGERY DATED 2014.
2. THE PROPOSED TRAFFIC SIGNAL MAST ARM LOCATIONS WERE DIGITIZE FROM A PLAN PREPARED BY DUBOIS & KING, INC. OF SOUTH BURLINGTON, VT.
3. TEST BORINGS DESIGNATED SH-1 THROUGH SH-4 WERE ADVANCED BY NEW ENGLAND BORING CONTRACTORS OF DERRY, NH AND OBSERVED BY SANBORN HEAD ON FEBRUARY 20 AND 21, 2023.
4. APPROXIMATE LOCATIONS OF EXPLORATIONS ARE BASED ON TAPED MEASUREMENTS MADE IN THE FIELD RELATIVE TO PROMINENT SITE FEATURES. THIS DATA SHOULD BE CONSIDERED ACCURATE ONLY TO THE DEGREE IMPLIED BY THE METHOD USED.

LEGEND:

SH-1 — APPROXIMATE LOCATION AND DESIGNATION OF TEST BORING OBSERVED BY SANBORN HEAD (FEBRUARY 2023)

APPROXIMATE LOCATION OF PROPOSED TRAFFIC SIGNAL MAST ARM

SANBORN HEAD

GRAPHICAL SCALE
20' 10' 0' 20' 40'

NO.	DATE	DESCRIPTION	BY

DRAWN BY: D. DOMBROWSKY
DESIGNED BY: A. LULIAS
REVIEWED BY: S. KELLEY
PROJECT MGR: D. THABAULT
PIC: S. KELLEY
DATE: MARCH 2023

GEOTECHNICAL ENGINEERING REPORT
WEATHERSFIELD STPG SGNL (72)
WEATHERSFEILD, VERMONT

SUBSURFACE EXPLORATION LOCATION PLAN

PROJECT NUMBER: 5609.00

FIGURE NUMBER: 2

Appendix A

Limitations

APPENDIX A
LIMITATIONS

1. The analyses, recommendations, and designs submitted in this report are based in part on the data obtained from subsurface explorations. The nature and extent of variations between these explorations may not become evident until construction. If variations then appear evident, it will be necessary to re-evaluate the recommendations of this report.

2. The generalized soil profile described in the text is intended to convey trends in subsurface conditions. The boundaries between strata are approximate and idealized, and have been developed by interpretation of widely spaced explorations and samples; actual soil transitions may be more or less gradual than indicated. For specific information, refer to the boring logs.

3. Water level readings have been made in the explorations at the times and under the conditions stated on the boring logs. These data have been reviewed and interpretations have been made in the text of this report. However, it must be noted that fluctuations in the level of the groundwater may occur due to variations in rainfall, temperature, and other factors differing from those occurring at the time measurements were made.

4. In the event that any changes in the nature, design, or locations of the proposed traffic signal mast arms are planned, the conclusions and recommendations contained in this report shall not be considered valid unless the changes are reviewed and conclusions of the report modified or verified in writing by Sanborn Head.

5. It is recommended that this firm be retained to provide soil engineering services during the excavation and foundation construction phases of the work. This is to observe compliance with the design concepts, specifications, or recommendations and to allow design changes in the event that subsurface conditions differ from those anticipated prior to the start of construction.

6. This report has been prepared for the exclusive use of DuBois & King, Inc. for the proposed traffic signal mast arms located at the intersection of US Route 5 and Vermont Route 131 in Weathersfield, Vermont in accordance with generally accepted soil and foundation engineering practices. No other warranty, expressed or implied, is made.

7. This soil engineering report has been prepared for this project by Sanborn Head for design purposes only and is not sufficient to prepare an accurate bid. Contractors wishing a copy of this report may secure it with the understanding that its scope is limited to design considerations only.

Appendix B

Boring Logs

STATE OF VERMONT
AGENCY OF TRANSPORTATION
CONSTRUCTION AND
MATERIALS BUREAU
CENTRAL LABORATORY

BORING LOG

WEATHERSFIELD
STPG SGNL(72)
US-5 & VT-131 in Weathersfield, VT

Boring No.: **SH-1**
Page No.: 1 of 1
Pin No.: 5609.00
Checked By: D. Thabault

Boring Crew: A. Lulias (Sanborn Head), P. Schofield (NEBC)
Date Started: 2/20/23 Date Finished: 2/20/23
VTSPG NAD83: N 330394.28 ft E 1664940.69 ft
Station: N/A Offset: N/A
Ground Elevation: 414.3 ft.

	Casing	Sampler
Type:	WB	SS
I.D.:	4 in	2 in
Hammer Wt:	140 lb.	140 lb.
Hammer Fall:	30 in.	30 in.
Hammer/Rod Type:	Auto/NW	
Rig: MOBILE B-48 TRUCK	C_E = 1.3	

Groundwater Observations

Date	Depth (ft)	Notes
02/20/23	17.0	Slowly dropping

Depth (ft)	Strata (1)	CLASSIFICATION OF MATERIALS (Description)	Run (Dip deg.)	Core Rec. % (RQD %)	Drill Rate minutes/ft	Blows/6" (N Value)	Moisture Content %	Gravel %	Sand %	Fines %
		TOPSOIL, 0.0 ft - 0.3 ft								
		Visual Description:, Loose, fine to medium SAND, little Silt, few Organic particles, brn, Moist, Rec. = 0.8 ft, **-FILL-**				1-3-4-2 (7)				
		Visual Description:, Medium dense, fine to medium SAND, and Silt, little Gravel, brn, Moist, Rec. = 1.3 ft, **-FILL-**				1-2-9-12 (11*)				
5		Visual Description:, Medium dense, fine to coarse SAND, and Silt, little Gravel, brn, Moist, Rec. = 1.0 ft				9-12-14-13 (26)				
		Field Note:, Roller bit grinding from 5.5 to 6.5 feet bgs.								
		A-4, SaSi , dense, brn, Moist, Rec. = 0.9 ft				18-16-17-15 (33*)			45.8	54.2
		Visual Description:, Medium dense, fine SAND, and Silt, brn, Moist, Rec. = 0.6 ft				6-6-6-6 (12)				
10		Visual Description:, Medium dense, fine to medium SAND, and Silt, brn, Moist, Rec. = 0.7 ft				9-7-8-8 (15*)				
15		Visual Description:, Loose, fine to medium SAND, and Silt, brn, Moist, Rec. = 0.6 ft				3-5-5-7 (10)				
		Field Note:, Difficulty advancing casing from approximately 17.5 to 18 ft bgs, indicating likely top of weathered bedrock.	C-1	88 (73)	3.8					
20		18.0 ft - 23.0 ft, Gray, Fine-grained, PHYLLITE, joints close to moderately close, horizontal to moderately dipping. Hard, Very slightly weathered, slightly fractured to sound.			5 5.2 5.3 4					
		Hole stopped @ 23.0 ft								
25		Remarks: An "*" indicates the blow counts do not comply with ASTM D1586.								

Notes:
1. Stratification lines represent approximate boundary between material types. Transition may be gradual.
2. N Values have not been corrected for hammer energy. C_E is the hammer energy correction factor.
3. Water level readings have been made at times and under conditions stated. Fluctuations may occur due to other factors than those present at the time measurements were made.
4. Soil descriptions are based on modified burmister system when no soil laboratory testing was performed. AASHTO classifications are included where soil laboratory testing was performed.

STATE OF VERMONT
AGENCY OF TRANSPORTATION
CONSTRUCTION AND
MATERIALS BUREAU
CENTRAL LABORATORY

BORING LOG

WEATHERSFIELD
STPG SGNL(72)
US-5 & VT-131 in Weathersfield, VT

Boring No.: **SH-2**
Page No.: 1 of 1
Pin No.: 5609.00
Checked By: D. Thabault

Boring Crew: A. Lulias (Sanborn Head), P. Schofield (NEBC)
Date Started: 2/21/23 Date Finished: 2/21/23
VTSPG NAD83: N 330374.68 ft E 1665063.61 ft
Station: N/A Offset: N/A
Ground Elevation: 412.3 ft.

	Casing	Sampler
Type:	WB	SS
I.D.:	4 in	2 in
Hammer Wt:	140 lb.	140 lb.
Hammer Fall:	30 in.	30 in.
Hammer/Rod Type:	Auto/NW	
Rig: MOBILE B-48 TRUCK	C_E = 1.3	

Groundwater Observations

Date	Depth (ft)	Notes
02/21/23	20.0	Slowly dropping

Depth (ft)	Strata (1)	CLASSIFICATION OF MATERIALS (Description)	Blows/6" (N Value)	Moisture Content %	Gravel %	Sand %	Fines %
		TOPSOIL, 0.0 ft - 0.5 ft	1-6-12-16 (18)				
		Visual Description:, Medium dense, fine to coarse SAND, some Silt, little Gravel, few fine Roots, brn, Moist, Rec. = 1.3 ft, **-FILL-**					
		Field Note:, Roller bit grinding from 2 to 4 feet bgs. Difficulty advancing casing from approximately 2 to 9 feet bgs due to likely cobbles.	20-20-15-11 (35*)				
		Visual Description:, Dense, fine to coarse SAND, some Gravel, little Silt, brn, Moist, Rec. = 1.3 ft, **-FILL-**					
		Visual Description:, Medium dense, SILT, little Sand, grn-brn, Moist, Rec. = 1.2 ft	4-5-6-7 (11)				
5		Visual Description:, Medium dense, SILT, some Sand, little Gravel, grn-brn, Moist, Rec. = 1.3 ft	7-7-7-7 (14*)				
		A-4, SaSi , loose, grn-brn, Moist, Rec. = 0.9 ft	3-4-4-5 (8)		1.0	9.1	89.9
		Visual Description:, Medium dense, SILT, little Sand, grn-brn, Moist, Rec. = 0.9 ft	4-5-6-6 (11*)				
10							
		Visual Description:, Loose, fine to medium SAND, little Silt, gray, Moist, Rec. = 0.8 ft	2-3-5-6 (8)				
15							
		Visual Description:, Medium dense, fine to medium SAND, little Silt, gray, Moist, Rec. = 0.7 ft	4-4-10-9 (14)				
20							
		Field Note:, Driller indicated possible weathered bedrock from approximately 23 to 23.5 ft and likely competent rock below 23.5 ft based on drill action.					
		23.5 ft - 24.0 ft					
25		Hole stopped @ 24.0 ft					

Remarks:
An "*" indicates the blow counts do not comply with ASTM D1586.

Notes:
1. Stratification lines represent approximate boundary between material types. Transition may be gradual.
2. N Values have not been corrected for hammer energy. C_E is the hammer energy correction factor.
3. Water level readings have been made at times and under conditions stated. Fluctuations may occur due to other factors than those present at the time measurements were made.
4. Soil descriptions are based on modified burmister system when no soil laboratory testing was performed. AASHTO classifications are included where soil laboratory testing was performed.

STATE OF VERMONT
AGENCY OF TRANSPORTATION
CONSTRUCTION AND
MATERIALS BUREAU
CENTRAL LABORATORY

BORING LOG

WEATHERSFIELD
STPG SGNL(72)
US-5 & VT-131 in Weathersfield, VT

Boring No.: **SH-3**
Page No.: 1 of 1
Pin No.: 5609.00
Checked By: D. Thabault

Boring Crew: A. Lulias (Sanborn Head), P. Schofield (NEBC)
Date Started: 2/20/23 Date Finished: 2/20/23
VTSPG NAD83: N 330263.53 ft E 1665094.21 ft
Station: N/A Offset: N/A
Ground Elevation: 410.0 ft.

	Casing	Sampler
Type:	WB	SS
I.D.:	4 in	2 in
Hammer Wt:	140 lb.	140 lb.
Hammer Fall:	30 in.	30 in.
Hammer/Rod Type:	Auto/NW	
Rig: MOBILE B-48 TRUCK	C_E = 1.3	

Groundwater Observations

Date	Depth (ft)	Notes
02/20/23		Not stabilized

Depth (ft)	Strata (1)	CLASSIFICATION OF MATERIALS (Description)	Blows/6" (N Value)	Moisture Content %	Gravel %	Sand %	Fines %
		TOPSOIL, 0.0 ft - 0.4 ft					
		Visual Description:, Medium dense, fine to coarse SAND, some Gravel, little Silt, very few fine Roots, brn, Moist, Rec. = 1.1 ft, **-FILL-**	2-6-8-11 (14)				
		Visual Description:, Dense, fine to coarse SAND, some Gravel, little Silt, brn, Moist, Rec. = 1.0 ft, **-FILL-**	30-16-17-19 (33*)				
5		Visual Description:, Loose, SILT and Sand, grn-brn, Moist, Rec. = 0.8 ft	7-7-3-4 (10)				
		Visual Description:, Loose, SILT and Sand, grn-brn, Moist, Rec. = 0.6 ft	3-5-5-5 (10*)				
		Visual Description:, Loose, SILT, some Sand, grn-brn, Moist, Rec. = 0.7 ft	3-4-4-6 (8)				
10		Visual Description:, Loose, SILT and Sand, grn-brn, Moist, Rec. = 0.7 ft	5-4-5-6 (9*)				
		A-2-4, SiSa , loose, brn, Moist, Rec. = 0.8 ft	3-3-5-5 (8)			80.7	19.3
15							
		Visual Description:, Medium dense, fine to coarse SAND, little Gravel, little Silt, brn, Moist, Rec. = 0.6 ft	5-6-7-8 (13)				
20							
		Field Note:, Driller indicated top of probable bedrock encountered at approximately 22 ft and advanced the roller bit from approximately 22 to 23 ft.					
		Field Note:, No recovery.	100/1"				
		Hole stopped @ 23.1 ft					
25							

Remarks:
An "*" indicates the blow counts do not comply with ASTM D1586.

Notes:
1. Stratification lines represent approximate boundary between material types. Transition may be gradual.
2. N Values have not been corrected for hammer energy. C_E is the hammer energy correction factor.
3. Water level readings have been made at times and under conditions stated. Fluctuations may occur due to other factors than those present at the time measurements were made.
4. Soil descriptions are based on modified burmister system when no soil laboratory testing was performed. AASHTO classifications are included where soil laboratory testing was performed.

BORING LOG 5609.00 LOGS.GPJ VERMONT AOT.GDT 3/10/23

STATE OF VERMONT
AGENCY OF TRANSPORTATION
CONSTRUCTION AND
MATERIALS BUREAU
CENTRAL LABORATORY

BORING LOG

WEATHERSFIELD
STPG SGNL(72)
US-5 & VT-131 in Weathersfield, VT

Boring No.: **SH-4**
Page No.: 1 of 1
Pin No.: 5609.00
Checked By: D. Thabault

Boring Crew: A. Lulias (Sanborn Head), P. Schofield (NEBC)
Date Started: 2/21/23 Date Finished: 2/21/23
VTSPG NAD83: N 330298.09 ft E 1664984.94 ft
Station: N/A Offset: N/A
Ground Elevation: 410.7 ft.

	Casing	Sampler
Type:	WB	SS
I.D.:	4 in	2 in
Hammer Wt:	140 lb.	140 lb.
Hammer Fall:	30 in.	30 in.
Hammer/Rod Type:	Auto/NW	
Rig: MOBILE B-48 TRUCK	C_E = 1.3	

Groundwater Observations

Date	Depth (ft)	Notes
02/21/23		Not stabilized

Depth (ft)	Strata (1)	CLASSIFICATION OF MATERIALS (Description)	Run (Dip deg.)	Core Rec. % (RQD %)	Drill Rate minutes/ft	Blows/6" (N Value)	Moisture Content %	Gravel %	Sand %	Fines %
		TOPSOIL, 0.0 ft - 1.0 ft				3-5-5-3 (10)				
		Visual Description:, Loose, fine to medium SAND, some Silt, little Gravel, few fine Roots, Dark brown, Moist, Rec. = 0.6 ft, **-FILL-**								
		Visual Description:, Loose, fine to coarse SAND, little Gravel, little Silt, brn, Moist, Rec. = 0.8 ft, **-FILL-** Field Note:, Roller bit grinding from 2 to 3.5 feet bgs.				1-2-3-3 (5*)				
		A-4, SaGrSi , loose, grn-brn, Moist, Rec. = 1.1 ft				4-4-4-3 (8)		6.0	33.1	60.9
5		Visual Description:, Loose, SILT, and Sand, grn-brn, Moist, Rec. = 0.6 ft				4-4-6-8 (10*)				
		Visual Description:, Loose, SILT, and Sand, grn-brn, Moist, Rec. = 1.2 ft				3-4-4-4 (8)				
10		Visual Description:, Medium dense, SILT, and Sand, grn-brn, Moist, Rec. = 0.8 ft				3-5-7-6 (12*)				
		Visual Description:, Very dense, fine to medium SAND, little Silt, grn-brn, Moist, Rec. = 0.6 ft Field Note:, Weathered bedrock in cutting shoe.				5-6-100/5" (106)				
15		15.4 ft - 16.0 ft, No sample. Assumed weathered bedrock.								
		16.0 ft - 21.0 ft, Gray, Fine-grained, PHYLLITE, joints very close to moderately close, horizontal to shallow. Hard, moderately fractured to sound.	C-1	92 (73)	6.4 5.3 4.4 5.6 5.4					
20										
		Hole stopped @ 21.0 ft								
25										

Remarks:
An "*" indicates the blow counts do not comply with ASTM D1586.

Notes:
1. Stratification lines represent approximate boundary between material types. Transition may be gradual.
2. N Values have not been corrected for hammer energy. C_E is the hammer energy correction factor.
3. Water level readings have been made at times and under conditions stated. Fluctuations may occur due to other factors than those present at the time measurements were made.
4. Soil descriptions are based on modified burmister system when no soil laboratory testing was performed. AASHTO classifications are included where soil laboratory testing was performed.

BORING LOG 5609.00 LOGS.GPJ VERMONT AOT.GDT 3/10/23

Appendix C

Boring Data Reduction

BORING DATA REDUCTION

WEATHERSFIELD STPG SGNL(72) - US ROUTE 5 & VERMONT ROUTE 131, WEATHERSFIELD, VERMONT

Depth (ft)		Total Stress (tsf)	Pore Pressure (tsf)	Effective Stress (tsf)	Overburden Correction (C_N)	Energy Ratio (C_E)	Rod Length Correction (C_R)	SH-1 (Ground Surface ±El. 414.3')					SH-2 (Ground Surface ±El. 412.3')					SH-3 (Ground Surface ±El. 410.0')					SH-4 (Ground Surface ±El. 410.7')					Soil Stratigraphic Unit
Below Grade	Ground Water							N_M	N_{60}	$(N_1)_{60}$	ϕ'	D_R (%)	N_M	N_{60}	$(N_1)_{60}$	ϕ'	D_R (%)	N_M	N_{60}	$(N_1)_{60}$	ϕ'	D_R (%)	N_M	N_{60}	$(N_1)_{60}$	ϕ'	D_R (%)	
0	0	0.00	0.00	0.00				TOPSOIL					TOPSOIL					TOPSOIL					TOPSOIL					NO. 1 (F) Y = 125 pcf $(N_1)_{60}$ = 18 ϕ' = 36° D_R = 54%
1	0	0.06	0.00	0.06	1.70	1.30	0.75	7	7	12	33	44	18	18	30	41	71	14	14	23	39	62	10	10	17	36	53	
2	0	0.13	0.00	0.13	1.70	1.30	0.75	FILL					FILL					FILL					FILL					
3	0	0.19	0.00	0.19	1.70	1.30	0.75	11	11	18	37	55	35	34	58	45	98	33	32	55	45	95	5	5	8	31	37	
4	0	0.25	0.00	0.25	1.70	1.30	0.75																					
5	0	0.31	0.00	0.31	1.70	1.30	0.75	26	25	43	45	85	11	11	18	37	55	5	5	8	31	37	8	8	13	34	47	
6	0	0.37	0.00	0.37	1.70	1.30	0.75																					
7	0	0.42	0.00	0.42	1.54	1.30	0.75	33	32	50	45	91	14	14	21	38	59	10	10	15	35	50	10	10	15	35	50	
8	0	0.48	0.00	0.48	1.44	1.30	0.75																					
9	0	0.54	0.00	0.54	1.36	1.30	0.75	12	12	16	36	52	8	8	11	33	42	8	8	11	33	42	8	8	11	33	42	NO. 2 (SS) Y = 115 pcf $(N_1)_{60}$ = 14 ϕ' = 34° D_R = 47%
10	0	0.60	0.00	0.60	1.30	1.30	0.80	SILT & SAND															SILT & SAND					
11	0	0.65	0.00	0.65	1.24	1.30	0.80	15	16	19	37	57	11	11	14	35	49	9	9	12	33	44	12	12	15	35	51	
12	0	0.71	0.00	0.71	1.19	1.30	0.80																					
13	0	0.77	0.00	0.77	1.14	1.30	0.80											SILT & SAND										
14	0	0.83	0.00	0.83	1.10	1.30	0.85						SILT & SAND															
15	0	0.88	0.00	0.88	1.06	1.30	0.85																					
16	0	0.94	0.00	0.94	1.03	1.30	0.85	10	11	11	33	44	8	9	9	32	39	8	9	9	32	39						
17	0	1.00	0.00	1.00	1.00	1.30	0.85																BEDROCK (PHYLLITE)					
18	0	1.06	0.00	1.06	0.97	1.30	0.85																					
19	0	1.11	0.00	1.11	0.95	1.30	0.85	BEDROCK (PHYLLITE)																				NO. 3 (B) Y = 160 pcf $(N_1)_{60}$ = >100 c' = 4 ksf ϕ' = 30°
20	0	1.17	0.00	1.17	0.92	1.30	0.95						14	17	16	36	52	13	16	15	35	50						
21	1	1.23	0.03	1.20	0.91	1.30	0.95																					
22	2	1.29	0.06	1.22	0.90	1.30	0.95											INFERRED BEDROCK					Bottom of Exploration ±21.0'					
23	3	1.34	0.09	1.25	0.89	1.30	0.95																					
24	4	1.40	0.12	1.28	0.89	1.30	0.95	Bottom of Exploration ±23.0'					INFERRED BEDROCK					Bottom of Exploration ±23.1'										
25	5	1.48	0.16	1.32	0.87	1.30	0.95						Bottom of Exploration ±24.0'															
								TRAFFIC SIGNAL MAST ARM FOUNDATION					TRAFFIC SIGNAL MAST ARM FOUNDATION					TRAFFIC SIGNAL MAST ARM FOUNDATION					TRAFFIC SIGNAL MAST ARM FOUNDATION					

NOTES:

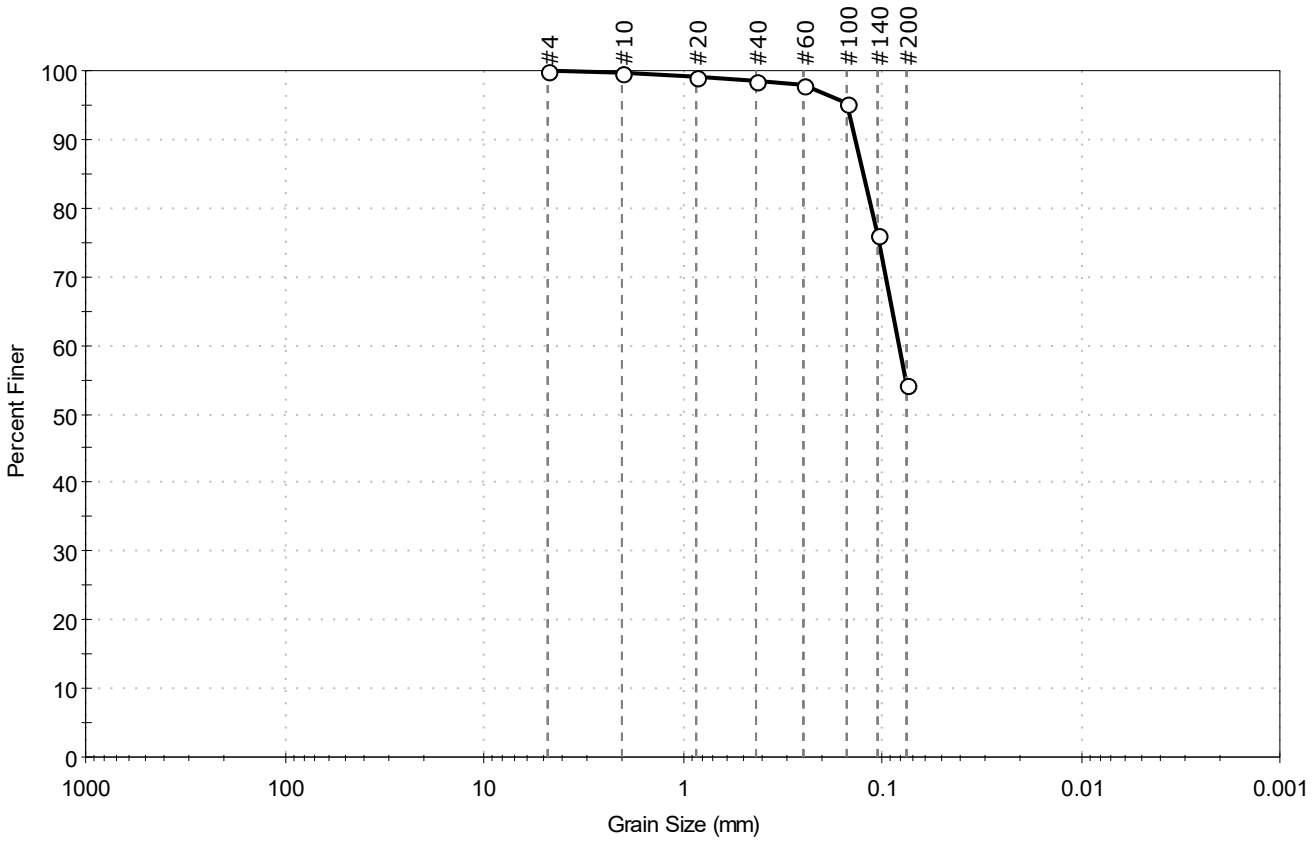
1. THE CORRECTED STANDARD PENETRATION RESISTANCE VALUE ($N_1)_{60}$ WAS LIMITED TO 40 BLOWS PER FOOT FOR EFFECTIVE STRESS FRICTION ANGLE (ϕ') CALCULATIONS.
   THE FIELD MEASURED STANDARD PENETRATION RESISTANCE VALUE (N_M) IS SHOWN AS PRESENTED ON THE BORING LOGS.
2. THE CORRECTED STANDARD PENETRATION RESISTANCE VALUE ($N_1)_{60}$ WAS LIMITED TO 60 BLOWS PER FOOT FOR RELATIVE DENSITY (D_R) CALCULATIONS.
   THE FIELD MEASURED STANDARD PENETRATION RESISTANCE VALUE (N_M) IS SHOWN AS PRESENTED ON THE BORING LOGS.
3. OVERBURDEN CORRECTION (C_N) BY LIAO AND WHITMAN (1986).
4. ENERGY RATIO CORRECTION (C_E) BY IDRISS & BOULANGER (2008), AFTER SEED ET AL. (1984), SKEMPTON (1986), NCEER (1997).
5. ROD LENGTH CORRECTION (C_R) BY IDRISS & BOULANGER (2008), AFTER YOUD ET AL. (2001).
6. N_{60} CALCULATION BY IDRISS & BOULANGER (2008).
7. $(N_1)_{60}$ CALCULATION BY LIAO AND WHITMAN (1986).
8. EFFECTIVE STRESS FRICTION ANGLE CORRELATION (ϕ') BY MAYNE ET AL. (2002).
9. RELATIVE DENSITY CORRELATION (D_R) BY MAYNE ET AL. (2001) FHWA MANUAL.

Appendix D

Laboratory Testing Results

Client:	Sanborn, Head & Associates, Inc.				
Project:	Weathersfield STPG SGNL (72)				
Location:	Weathersfield, VT			Project No:	GTX-316825
Boring ID:	SH-1	Sample Type:	bag	Tested By:	ckg
Sample ID:	S-4	Test Date:	02/27/23	Checked By:	ank
Depth :	6-8	Test Id:	706610		
Test Comment:	---				
Visual Description:	Moist, dark brown sandy silt				
Sample Comment:	---				

Particle Size Analysis - ASTM D6913



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	0.0	45.8	54.2

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	100		
#20	0.85	99		
#40	0.42	99		
#60	0.25	98		
#100	0.15	95		
#140	0.11	76		
#200	0.075	54		

Coefficients

D_{85} = 0.1243 mm	D_{30} = N/A
D_{60} = 0.0821 mm	D_{15} = N/A
D_{50} = N/A	D_{10} = N/A
C_u = N/A	C_c = N/A

Classification

ASTM N/A

AASHTO Silty Soils (A-4 (0))

Sample/Test Description

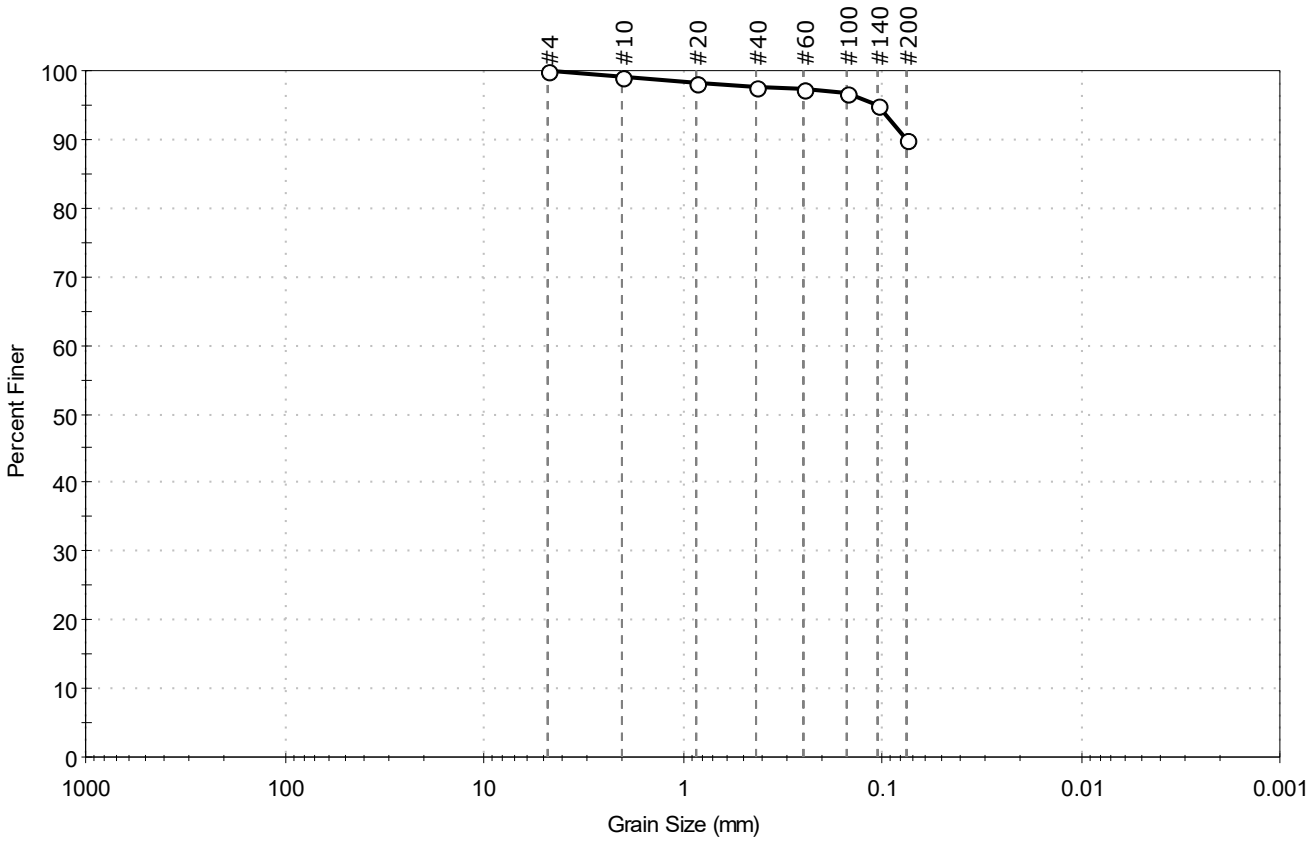
Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

GeoTesting EXPRESS

Client:	Sanborn, Head & Associates, Inc.				
Project:	Weathersfield STPG SGNL (72)				
Location:	Weathersfield, VT			Project No:	GTX-316825
Boring ID:	SH-2	Sample Type:	bag	Tested By:	ckg
Sample ID:	S-5	Test Date:	02/27/23	Checked By:	ank
Depth :	8-10	Test Id:	706611		
Test Comment:	---				
Visual Description:	Moist, dark brown silt				
Sample Comment:	---				

Particle Size Analysis - ASTM D6913



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	0.0	10.1	89.9

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	99		
#20	0.85	98		
#40	0.42	98		
#60	0.25	97		
#100	0.15	97		
#140	0.11	95		
#200	0.075	90		

Coefficients

D_{85} = N/A	D_{30} = N/A
D_{60} = N/A	D_{15} = N/A
D_{50} = N/A	D_{10} = N/A
C_u = N/A	C_c = N/A

Classification

ASTM N/A

AASHTO Silty Soils (A-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

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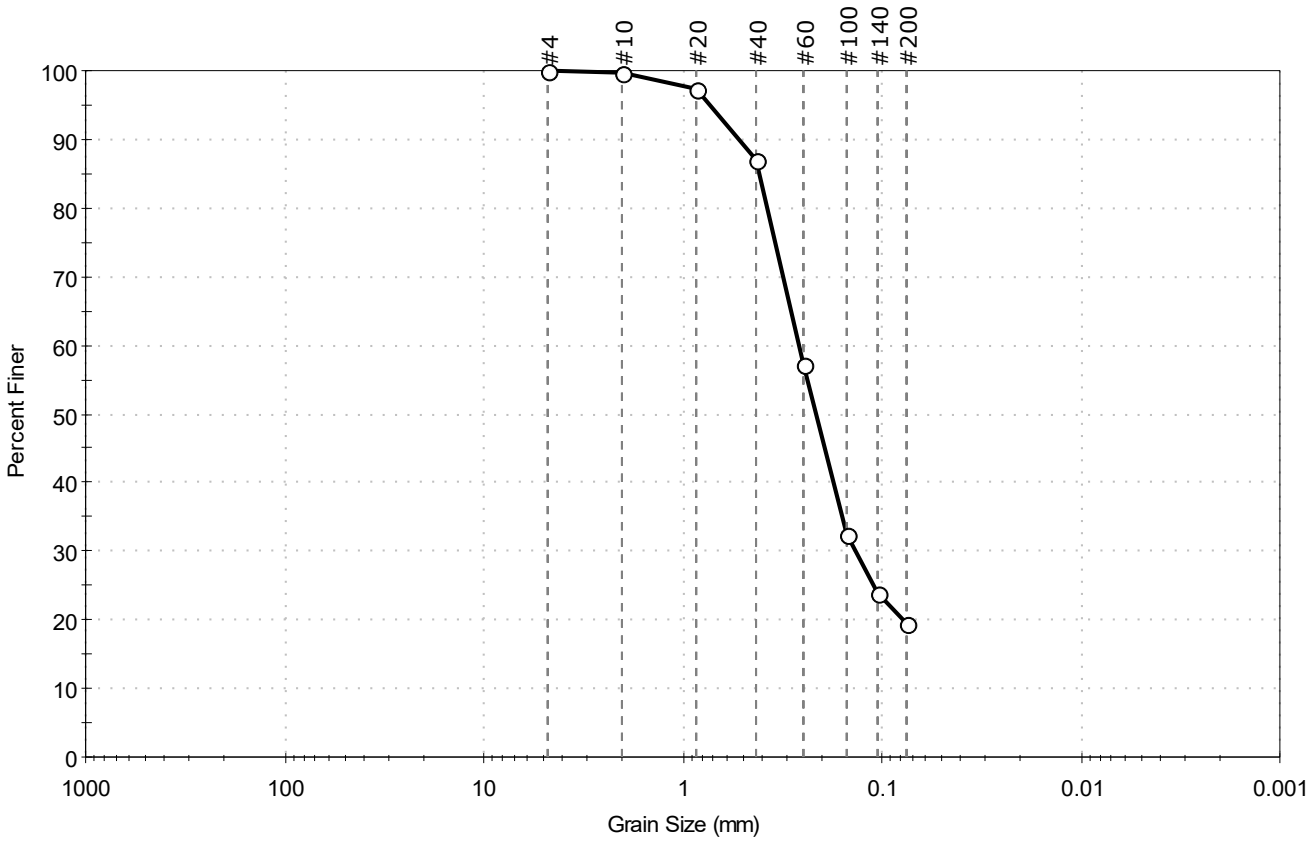
Client:	Sanborn, Head & Associates, Inc.				
Project:	Weathersfield STPG SGNL (72)				
Location:	Weathersfield, VT			Project No:	GTX-316825
Boring ID:	SH-3	Sample Type:	bag	Tested By:	ckg
Sample ID:	S-7	Test Date:	02/27/23	Checked By:	ank
Depth :	14-16	Test Id:	706612		
Test Comment:	---				
Visual Description:	Moist, dark brown silty sand				
Sample Comment:	---				

Particle Size Analysis - ASTM D6913



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	0.0	80.7	19.3

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	100		
#20	0.85	97		
#40	0.42	87		
#60	0.25	57		
#100	0.15	33		
#140	0.11	24		
#200	0.075	19		

Coefficients

D_{85} = 0.4108 mm	D_{30} = 0.1353 mm
D_{60} = 0.2624 mm	D_{15} = N/A
D_{50} = 0.2150 mm	D_{10} = N/A
C_u = N/A	C_c = N/A

Classification

ASTM N/A

AASHTO Silty Gravel and Sand (A-2-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

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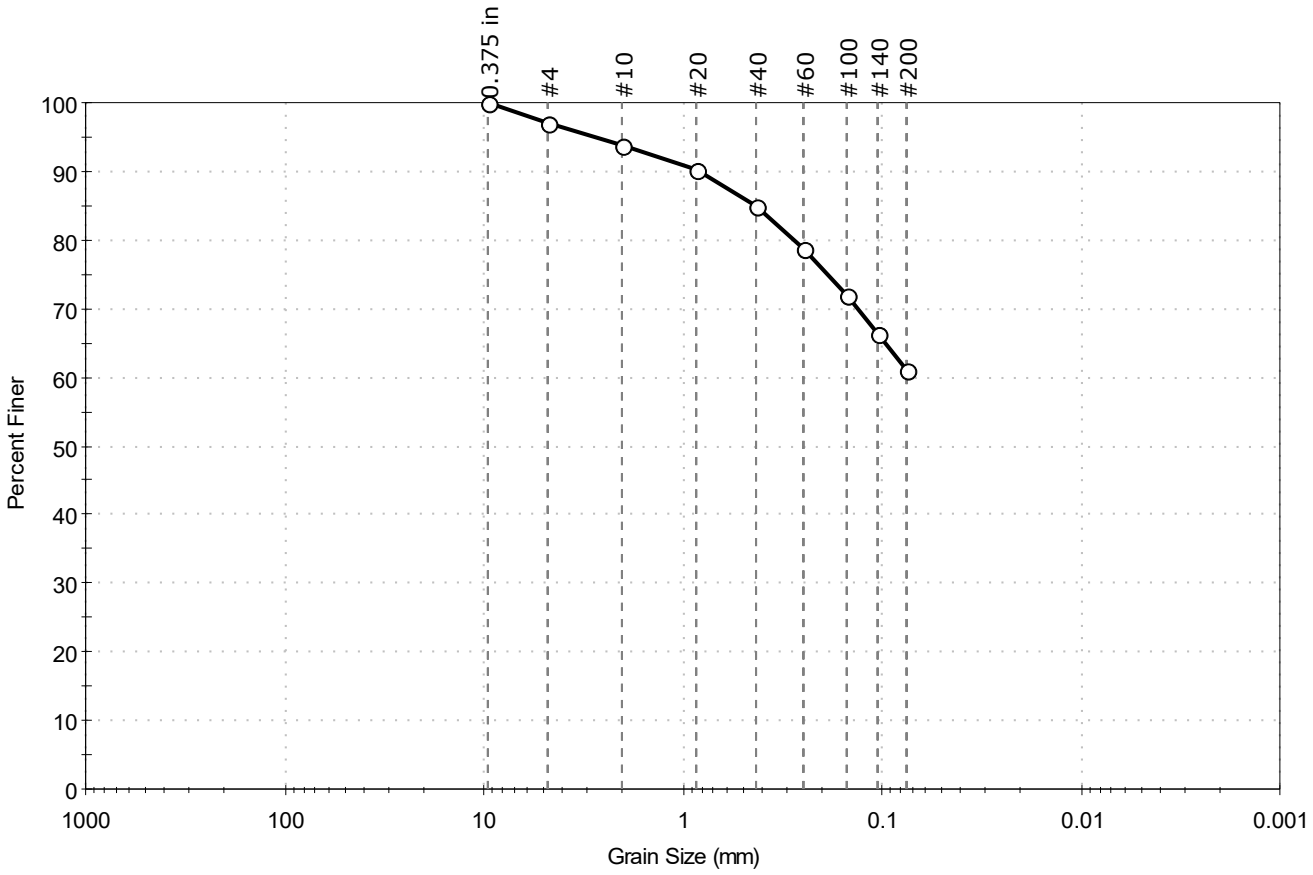
Client:	Sanborn, Head & Associates, Inc.				
Project:	Weathersfield STPG SGNL (72)				
Location:	Weathersfield, VT			Project No:	GTX-316825
Boring ID:	SH-4	Sample Type:	bag	Tested By:	ckg
Sample ID:	S-3	Test Date:	02/27/23	Checked By:	ank
Depth :	4-6	Test Id:	706613		
Test Comment:	---				
Visual Description:	Moist, dark brown sandy silt				
Sample Comment:	---				

Particle Size Analysis - ASTM D6913



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	3.1	36.0	60.9

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.375 in	9.50	100		
#4	4.75	97		
#10	2.00	94		
#20	0.85	90		
#40	0.42	85		
#60	0.25	79		
#100	0.15	72		
#140	0.11	66		
#200	0.075	61		

Coefficients

D_{85} = 0.4243 mm D_{30} = N/A
D_{60} = N/A D_{15} = N/A
D_{50} = N/A D_{10} = N/A
C_u = N/A C_c = N/A

Classification

ASTM N/A

AASHTO Silty Soils (A-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

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