

To: Shaun Corbett, P.E., Rail and Aviation Project Manager
AJA CEE

From: August Arles, Geotechnical Engineer, Callie Ewald, P.E., Geotechnical Engineering Manager

Date: June 7th, 2022

Subject: Barre City STP 2691(3) Geotechnical Data Report

1.0 INTRODUCTION

As requested, we have completed our geotechnical investigation for the proposed mast arm foundation located along VT Route 14 at the intersection of the Washington County Railroad MM 8.1 and VT Route 14 in the city of Barry City, Vermont. The purpose of this project is the reconstruction of the existing at-grade crossing surface, replacement of the grade crossing active warning systems, site grading, and upgrading of the existing signing and marking on the highway approaches. Contained herein are the results of our subsurface investigation, geotechnical analysis, and design parameters as estimated according to the 2020 AASHTO LRFD *Bridge Design Specifications*.

2.0 FIELD INVESTIGATION

A field investigation was conducted by VTrans Geotechnical Engineering Section on May 23rd, 2022. One boring, B-101, was advanced to evaluate the subsurface profile to aid in the design and construction of the proposed mast arm foundation. A preliminary boring location was provided by Shaun Corbett, VTrans’ Rail Section Project Manager, in a Geotechnical Request Form dated April 20th, 2022. The boring was marked in the field by a member of the Geotechnical Engineering Section and VTrans drill crew on April 28th, 2022.

A summary of the final location of the boring can be found in Table 2.1 as well as in the attached Boring Location Plan. The values for Northings and Eastings, provided by Shaun Corbett in an email dated April 22nd, 2022, are based on the Vermont State Plan Grid Coordinate System NAD 83. Elevation for the boring, based on the North American Vertical Datum, NAVD 88, was then estimated using the design file x16v185dgn.dgn, dated May 2019. The location of the boring should be considered accurate only to the degree implied by the method used to determine it.

Table 2.1. Boring Locations and Elevations

Boring No.	Northing (ft.)	Easting (ft.)	Station	Offset (ft)	Approx. Ground Elevation (ft)
B-101	617298.7	1640234.8	MS 15+93	26.7 L	617.9

The boring was performed in general accordance with AASHTO T206, *Standard Method of Test for Penetration Test and Split-Barrel Sampling of Soils*. During boring operations, split spoon samples and standard penetration tests (SPT) were taken. B-101 was sampled continuously to a

depth of 11.8 feet (ft) below ground surface (bgs), and then at 5 ft intervals until a final depth of 26 ft bgs. No bedrock was encountered in B-101.

Soil samples were visually identified in the field and SPT blow counts were recorded on the boring log where applicable. All soil samples collected by VTrans were preserved and returned to the Construction and Materials Bureau Central Laboratory for testing and further evaluation. Upon completion of the laboratory testing, the boring log was revised to reflect the results of the laboratory classification analysis. The attached boring log displays the types of soil strata encountered and includes the laboratory test data, SPT data, and any pertinent observations made by the boring crew during drilling operations.

3.0 FIELD AND LABORATORY TESTINGS

The standard penetration resistance of in-situ soil is determined by the number of blows required to drive a 2-inch outside diameter (OD) split-barrel sampler 24 inches into the soil with a 140-pound hammer dropped from a height of 30 inches, in accordance with procedures specified in AASHTO T206. The number of blows required to drive the sampler each 6-inch increment is recorded, and the Standard Penetration Resistance (N-Value) is calculated as the sum of the blows over the second and third 6-inch intervals.

The SPT N-value is commonly used with established correlations to estimate several soil parameters, particularly the shear strength and density of cohesionless soils. The N-values provided on the boring log are raw values and have not been corrected for energy, borehole diameter, rod length, or overburden pressure.

The Vermont Agency of Transportation has determined a hammer correction value, C_E , to account for the efficiency of the SPT hammers on its drill rigs. A Diedrich D-25 rig was used for the boring, with a hammer energy correction factor of 1.45. This value, included on the boring log, was used in calculations to estimate soil parameters.

Geotechnical laboratory tests were performed on select samples to assist with soil classification and evaluate engineering properties of the soil. Grain size analyses were performed on soil samples in accordance with AASHTO T88, *Standard Method of Test for Particle Size Analysis of Soils*.

4.0 SOIL PROFILE

The following soil strata has been identified based on our review of the boring log and laboratory testing. It should be noted that groundwater elevation is subject to change given the fact that the borehole was generally left open for a short period of time. Because groundwater elevation can fluctuate seasonally and are affected by temperature and precipitation, groundwater may be encountered during construction when not previously noted on the log.

4.1 B-101: The ground surface elevation at B-101 was 617.9 ft. Groundwater was measured after drilling on May 23rd, 2022, at a depth of 10.8 ft bgs, corresponding to an approximate elevation of 607.1 ft.

Depth (Below Ground Surface Elevation)	Soil Profile
0-8 ft	Medium to Very Dense Gravelly Sandy Silt/ Gravelly Silty Sand
8-10 ft	Very Loose Silty Gravelly Sand
10-26 ft	Very Dense Sandy Gravel/Gravelly Sand

5.0 RECOMMENDATIONS

5.1 Design Guidelines

The Geotechnical Engineering Section of VTrans has developed *Materials and Research Engineering Instruction (MREI) 10-01*, which “standardizes VTrans’ foundation designs for overhead structures such as signal or sign bridges, mast arms, and strain poles during plan (preliminary and final) development or construction.” This document should be referenced for the contractors’ use and is available on the Agency’s website at the following address:

<https://outside.vermont.gov/agency/vtrans/external/docs/construction/03GeotechEng/Engineering/Mast%20Arm%20and%20Overhead%20Sign%20Support%20Foundations%20MREI%2010-01%20Engineering.pdf>

5.2 Design Parameters

Based on the results of the subsurface investigation and laboratory testing, relevant engineering properties of the in-situ soils were estimated as shown in Table 5.1. Engineering properties of common construction materials are shown in Table 5.2. These values should be used in the design of the mast arm foundations at this location.

It is recommended that values of K_o be used for calculating earth pressures where the structure is not allowed to deflect longitudinally, away from or into the retained soil mass. Values for K_a should be utilized for an active earth pressure condition where the structure is moving away from the soil mass and K_p where the structure is moving toward the soil mass. The design earth pressure coefficients are based on horizontal surfaces (non-sloping fill) and a vertical structure.

The borehole was generally only open for a short time period during the drilling and clean-up activities. The soils were mostly granular in nature. Since groundwater elevations can fluctuate seasonally and are affected by temperature and precipitation, a groundwater level of 2 foot below the ground surface is recommended for design.

Table 5.1: Engineering Properties of In-Situ Soils Layers

	M. to V. Dense GrSiSa/ GrSaSi	V. Loose SiGrSa	V. Dense GrSa
Unit Weight, γ (lb/ft ³)	125	100	135
Internal Friction Angle, ϕ (deg)	38	28	38
Coefficient of Friction, f			
-mass concrete cast against soil	0.55	0.45	0.57
-soil against precast/formed concrete	0.40	0.31	0.49
Active Earth Pressure Coefficient, K_a			
	0.24	0.36	0.24
Passive Earth Pressure Coefficient, K_p			
	4.20	2.77	4.20
At-Rest Earth Pressure Coefficient, K_o			
	0.38	0.53	0.38

Table 5.2: Engineering Properties of Construction Materials

	703.01A – Granular Borrow	704.08 – Granular Backfill for Structures
Unit Weight, γ (lb/ft ³)	130	140
Internal Friction Angle, ϕ (deg)	32	34
Coefficient of Friction, f		
-mass concrete cast against soil	0.45	0.55
-soil against precast/formed concrete	0.40	0.48
Active Earth Pressure Coefficient, K_a		
	0.31	0.28
Passive Earth Pressure Coefficient, K_p		
	3.26	3.54
At-Rest Earth Pressure Coefficient, K_o		
	0.47	0.44

6.0 CONCLUSION

If you have any questions or would like to discuss this report, please contact us via email. Computer generated boring log is attached and available in the <M:\Projects\16v185\MaterialsResearch> folder.

Reviewed by: Eric Denardo

Enclosures: Boring Location Plan (1 Page)
Boring Log (1 Page)

cc: Electronic Read File/MG
Project File/CEE
AJA



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

BORING LOG

Barre City
 STP 2691(3)
 VT Route 14

Boring No.: B-101
 Page No.: 1 of 1
 Pin No.: 16v185
 Checked By: AJA

Boring Crew: McGinley, Monette, Zottola
 Date Started: 5/23/22 Date Finished: 5/23/22
 VTSPG NAD83: N 617298.70 ft E 1640234.80 ft
 Station: MS 15+93 Offset: 26.7 L
 Ground Elevation: 617.9 ft

Casing WB Sampler SS
 Type: WB SS
 I.D.: 3 in 1.5 in
 Hammer Wt: N.A. 140 lb.
 Hammer Fall: N.A. 30 in.
 Hammer/Rod Type: Auto/AWJ
 Rig: Diedrich D25 C_E = 1.45

Groundwater Observations

Date	Depth (ft)	Notes
05/23/22	10.8	WT After Drilling

Depth (ft)	Strata (1)	CLASSIFICATION OF MATERIALS (Description)	Blows/6" (N Value)	Moisture Content %	Gravel %	Sand %	Fines %
5		A-4, GrSaSi, brn, Dry, Rec. = 0.8 ft	4-16-47-8 (63)	12.4	26.8	35.2	38.0
		A-2-4, SaSiGr, brn, Dry, Rec. = 0.8 ft	9-5-9-7 (14)	8.9	42.1	28.6	29.3
10		A-4, GrSaSi, brn, Dry, Rec. = 1.2 ft	8-7-8-10 (15)	12.5	20.1	38.1	41.8
		A-1-b, GrSa, brn, Dry, Rec. = 0.6 ft	19-16-17-16 (33)	4.2	37.9	48.5	13.6
15		A-2-4, SiGrSa, brn, Dry, Rec. = 0.3 ft	WOR-WOR-WOR-12 (WOR)	9.3	31.9	39.3	28.8
		A-1-b, GrSa, brn, Dry, Rec. = 1.4 ft, Field Note: Refusal @ 11.8", 100 blows. RC Cleanout 12.5'-14.0'	16-24-36-R@5" (60)	4.4	37.4	44.8	17.8
20		A-1-a, SaGr, brn, MTW, Rec. = 1.1 ft, Field Note: RC Cleanout 16.0'-19.0'	18-15-18-20 (33)	10.8	57.1	30.6	12.3
		A-1-b, GrSa, brn-gry, Wet, Rec. = 0.8 ft, Field Note: RC Cleanout 22.5'-24.0'	20-19-19-16 (38)	12.8	38.3	43.4	18.3
25		A-1-a, SaGr, brn, MTW, Rec. = 0.9 ft	25-19-23-27 (42)	8.8	56.9	31.1	12.0
Hole stopped @ 26.0 ft							
Remarks: Hole Collapsed @ 15.9'							

BORING LOG BARRE CITY STP 2691(3).GPJ VERMONT AOT.GDT 6/6/22

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. "bgs" is used as the shorthand stand in for "Below Ground Surface".