

Geotechnical Engineering Report
Replacement of Lake Avenue Culvert
Bristol, Connecticut

April 23, 2021

Freeman Project No.: 2019-0117.1

Prepared for:

WPS USA, Inc.
500 Winding Brook Drive
Glastonbury, Connecticut 06033

Prepared by:

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36 John Street
Hartford, CT 06106



Allison M. McCauliffe, P.E.
Sr. Geotechnical Engineer/Project Manager

TABLE OF CONTENTS

1.0	INTRODUCTION	1
1.1	Summary	1
1.2	Scope of Work	1
1.3	Authorization	1
1.4	Project Vertical Datum	1
2.0	SITE AND PROJECT DESCRIPTION	1
2.1	Site Description	1
2.2	Project Description	2
3.0	EXPLORATIONS.....	2
3.1	Subsurface Explorations.....	2
3.2	Laboratory Testing.....	2
4.0	SUBSURFACE CONDITIONS.....	2
4.1	Subsurface Conditions.....	2
5.0	GEOTECHNICAL ENGINEERING RECOMMENDATIONS.....	3
5.1	Culvert Foundation Recommendations.....	3
5.2	Foundation Recommendations.....	3
5.3	Cutoff Wall Recommendations.....	4
6.0	CONSTRUCTION CONSIDERATIONS.....	4
6.1	Cofferdam and Dewatering.....	4
6.2	Excavation.....	4
6.3	Reuse of Existing Soils.....	4
7.0	FUTURE SERVICES AND LIMITATIONS.....	5

ATTACHMENTS

Table

1. Summary of Subsurface Data

Figures

1. Site Location Map
2. Subsurface Exploration Location Plan
3. Subsurface Profile
4. Lateral Earth Pressures – Active Earth Pressures and At- Rest Pressures

Appendices

- A. Test Boring Logs
- B. Results of Laboratory Testing

1.0 INTRODUCTION

1.1 Summary

The Lake Avenue culvert carries Lake Avenue over Cussgutter Brook in Bristol, Connecticut. The culvert will be replaced with a new culvert. Currently a box culvert is anticipated to be installed. It is assumed that concrete headwall, endwall and wingwalls will be included in the design, as necessary.

Subsurface conditions consisted of Fill overlying Glaciofluvial Deposits. Several utilities run beneath the existing culvert. Subsurface explorations indicate that the proposed culvert will bear in the Glaciofluvial Deposit, which is suitable for foundation support. Headwalls, endwalls, and wingwalls may be designed as shallow spread footing foundations. We recommend that the culvert, headwall, and endwall, bear on a 12-inch-thick layer compacted Granular Fill placed over the natural Glaciofluvial Deposits. It is assumed cutoff walls will also be part of the design in accordance with standard CTDOT details. They should be constructed within the natural deposit with no Crushed Stone. We recommend that an additional cutoff wall be included below the middle of the culvert to reduce water flow beneath the culvert and through the crushed stone bearing layer.

1.2 Scope of Work

Freeman Companies, LLC performed the following tasks:

- Engaged a subsurface exploration contractor to conduct test borings at the site;
- Provided technical monitoring of the explorations;
- Arranged for a testing laboratory to conduct laboratory soil tests; and
- Evaluated the subsurface conditions and prepared this report containing geotechnical design recommendations and construction considerations.

1.3 Authorization

The work was completed in accordance with our agreement dated June 15, 2020.

1.4 Project Vertical Datum

Elevations in this report refer to the NAVD-88 datum.

2.0 SITE AND PROJECT DESCRIPTION

2.1 Site Description

The culvert carries Lake Ave over an Cussgutter Brook as shown on Figure 1 Project Location Map. The culvert is approximately 0.45 miles south of the intersection of Glenn Street and Lake Avenue. The street has one lane of traffic in each direction. The culvert is approximately 50-foot long, with a headwall and end wall.

2.2 Project Description

The existing culvert will be completely replaced with a concrete box culvert. It is assumed that the proposed culvert will be constructed within the same area as the existing culvert with a similar inlet and outlet inverts. The existing culvert alignment is shown on Figure 2, Subsurface Exploration Location Plan. A headwall and endwall with below-grade cutoff walls and wingwalls will be provided at each end.

3.0 EXPLORATIONS

3.1 Subsurface Explorations

New England Boring Contractors, Inc., drilled three test borings (S-1, S-2, and S-2A) on March 4, 2021 near the existing culvert using a truck-mounted drilling rig. Boring locations are shown on Figure 2, Exploration Location Plan.

Borings were drilled using 4-inch NW-size casing. Split-spoon samples were obtained with Standard Penetration Tests (SPTs) continuously through fill and at maximum 5 foot intervals thereafter. Borings were backfilled with cuttings upon completion and an asphalt cold patch was applied at the surface at locations in pavement.

Boring S-2 was terminated when the casing refused on a probable boulder at 3.5 feet. Boring S-1 and S-2A were terminated at the predetermined depth (32 feet) in natural soils.

A Freeman Companies geotechnical engineer observed the test borings, described the soil samples, and prepared test boring logs. Logs are provided in Appendix A.

3.2 Laboratory Testing

Four grain size distribution analyses (ASTM D422) were performed on representative soil samples to confirm visual classification and to aid in determining engineering properties. Tests were conducted by Geotesting Express, Inc., of Acton, Massachusetts. Results of laboratory testing are provided in Appendix B.

4.0 SUBSURFACE CONDITIONS

4.1 Subsurface Conditions

Subsurface conditions encountered in the explorations consist of Fill overlying Glaciofluvial Deposits as described below. A subsurface section of the culvert is provided in Figure 3. Subsurface data from the test borings are summarized on Table 1.

Table 2
 Subsurface Materials

THICKNESS (FT)	GENERALIZED DESCRIPTION
0 to 0.71	ASPHALT
8.8 to 9.4	FILL -Medium dense to dense, brown to gray brown, coarse to fine SAND, little to some coarse to fine gravel, trace to little silt.
Greater than 20.4	SAND (Glaciofluvial Deposits) – Medium dense to very dense, light brown to brown, coarse to fine SAND, trace to little coarse to fine gravel, trace silt.

Groundwater

Ground water levels were approximately 5.5 feet below ground surface, which corresponds with approximately Elevation 229.5 feet. Water levels are expected to be influenced primarily by water levels within the brook, but will vary with season, precipitation, temperature, and other factors.

5.0 GEOTECHNICAL ENGINEERING RECOMMENDATIONS

5.1 Culvert Foundation Recommendations

Based on subsurface conditions encountered in the test borings, the culvert will bear on the Glaciofluvial Deposits, except where existing utilities will remain beneath the culvert. These soils are suitable for support of the new culvert.

Groundwater is expected to be at or above the proposed invert grade and may cause subgrades to become unstable during excavation and culvert placement. An effective excavation dewatering system during construction will be required. We recommend that the culvert bear on a 12-inch-thick layer compacted Granular Fill (CTDOT M.02.01). Cutoff walls are proposed at each end of the culvert. We recommend that an additional cutoff wall be constructed beneath the middle of the culvert to reduce potential water flow through the fill.

Additionally, there are existing utilities that will remain beneath the proposed culvert. Care should be taken during construction to avoid disturbing the utilities. The design should confirm that the required cover is maintained and that bearing pressures are within pipe tolerances.

5.2 Foundation Recommendations

We recommend that headwall and endwalls be designed as spread footing foundations bearing on the Glaciofluvial Deposit at the proposed bearing grade soils in accordance with the following criteria:

Foundation Design Criteria

- **Foundation Subgrade Material:** Place a 12-inch thick layer of compacted Granular Fill (CTDOT M.02.01) over the undisturbed Glaciofluvial Deposit or utility trench fill subgrade.
- **Foundation Depth:** Minimum of 4 feet below the lowest adjacent ground surface plus additional embedment for scour protection, if necessary.
- **Backfill Material:** Place Pervious Structure Backfill (CTDOT M.02.05) behind the headwalls, endwalls, and wingwalls above a line defined by a 1V:1.5H slope extending up from the heel of the footing to grade.
- **Weep Holes:** 4-inch dia. weep holes at max 10 foot spacing, installed according to CTDOT specifications.
- **Lateral Earth Pressures:** Refer to Figure 4A – Active Earth Pressures. The recommended equivalent fluid unit weight of soil is shown on Figure 4.
- **Service Limit Bearing:** 4,000 pounds per square foot (psf). Resistance factor equals 1.0.
- **Strength Limit Bearing:** Nominal Bearing Resistance 12,000 psf. Resistance Factor equals 0.55 (AASHTO Table 11.5.7-1).

5.3 Cutoff Wall Recommendations

Cutoff walls are proposed at each end of the culvert. We recommend that the cutoff wall bear directly against the naturally deposited Glaciofluvial Deposits (Sand)). We recommend an additional cutoff wall be provided beneath the middle of the culvert to reduce water flow beneath the culvert.

6.0 CONSTRUCTION CONSIDERATIONS

6.1 Cofferdam and Dewatering

Soils at subgrade level are expected to be wet and may be unstable. Cofferdam and dewatering will be required. Steel sheet piling appears feasible. However, the presence of the existing utilities beneath the culvert will likely cause gaps in the cofferdam that will need to be bridged. The cofferdam should be designed to permit construction in the dry.

Subgrades will be below groundwater level and dewatering will be required. Open pumping from properly filtered sumps within a watertight cofferdam appears feasible. Contract documents should require that water levels be maintained at least one foot below the bottom of excavation at all times.

6.2 Excavation

Conventional excavation equipment appears practical. Excavation geometries should conform to OSHA excavation regulations contained in 29 CFR 1926, latest edition.

6.3 Reuse of Existing Soils

The existing soils to be excavated will include existing Fill and Glaciofluvial Deposits. These soils are expected to be unsuitable for reuse as Pervious Structure Backfill or Granular Fill due to a high silt content. Excavated soils may be suitable for reuse as embankment fill. However, silty soils are difficult to properly compact when wet and may need to be dried to achieve proper compaction. Drying the soils can be difficult and at times impractical, particularly during periods of cold and wet weather.

7.0 FUTURE SERVICES AND LIMITATIONS

We recommend that Freeman Companies be engaged during construction to

- Verify that soil conditions exposed in excavations are in general conformance with design assumption, and that the geotechnical aspects of construction are consistent with the project specifications.

This report was prepared for the exclusive use of WSP USA, Inc. and the project design team. The recommendations provided herein are based on the project information provided at the time of this report and may require modification if there are any changes in the nature, design, or location of the project.

The recommendations in this report are based in part on the data obtained from the subsurface explorations. The nature and extent of variations between explorations may not become evident until construction. If variations from the anticipated conditions are encountered, it may be necessary to revise the recommendations in this report.

Our professional services for this project have been performed in accordance with generally accepted engineering practices; no warranty, express or implied, is made.

2019-0117.1

Lake Ave Culvert Replacement

Bristol, Connecticut

Table 1

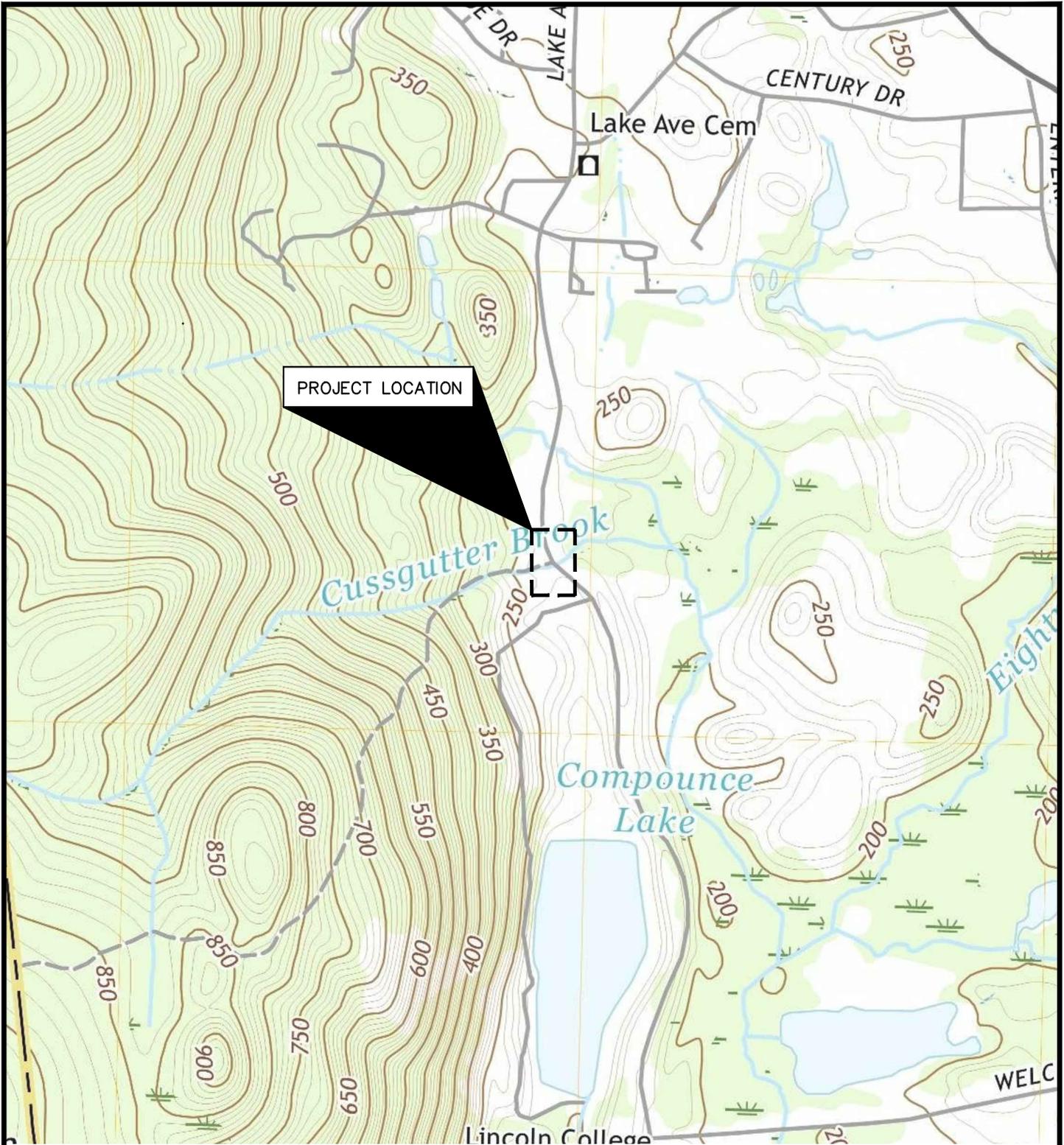
Subsurface Data

Boring No.	Ground Surface El.	Depth (ft.)	Thickness (ft.)			Groundwater		Bedrock	
			Asphalt	Fill	Glaciofluvial Deposit (Sand)	Depth (ft.)	Elevation	Depth (ft.)	Elevation
S-1	235.3	32.0	0.71	8.8	>22.5	5.5	229.8	--	--
S-2	235.0	3.5	0.6	>2.9	--	--	--	--	--
S-2A	234.9	30.4	0.6	9.4	>20.4	5.5	229.4	--	--

Notes:

1. Ground surface elevations are approximate and based upon information shown on Figure 2 Subsurface Exploration Location Plan
2. Groundwater levels were measured during drilling activities and may not represent stabilized conditions
3. ">" - Greater Than "--" - Not Encountered

FIGURES



USGS QUADRANGLE MAP
BRISTOL, CONNECTICUT
DATE 2018



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ELEVATE YOUR EXPECTATIONS

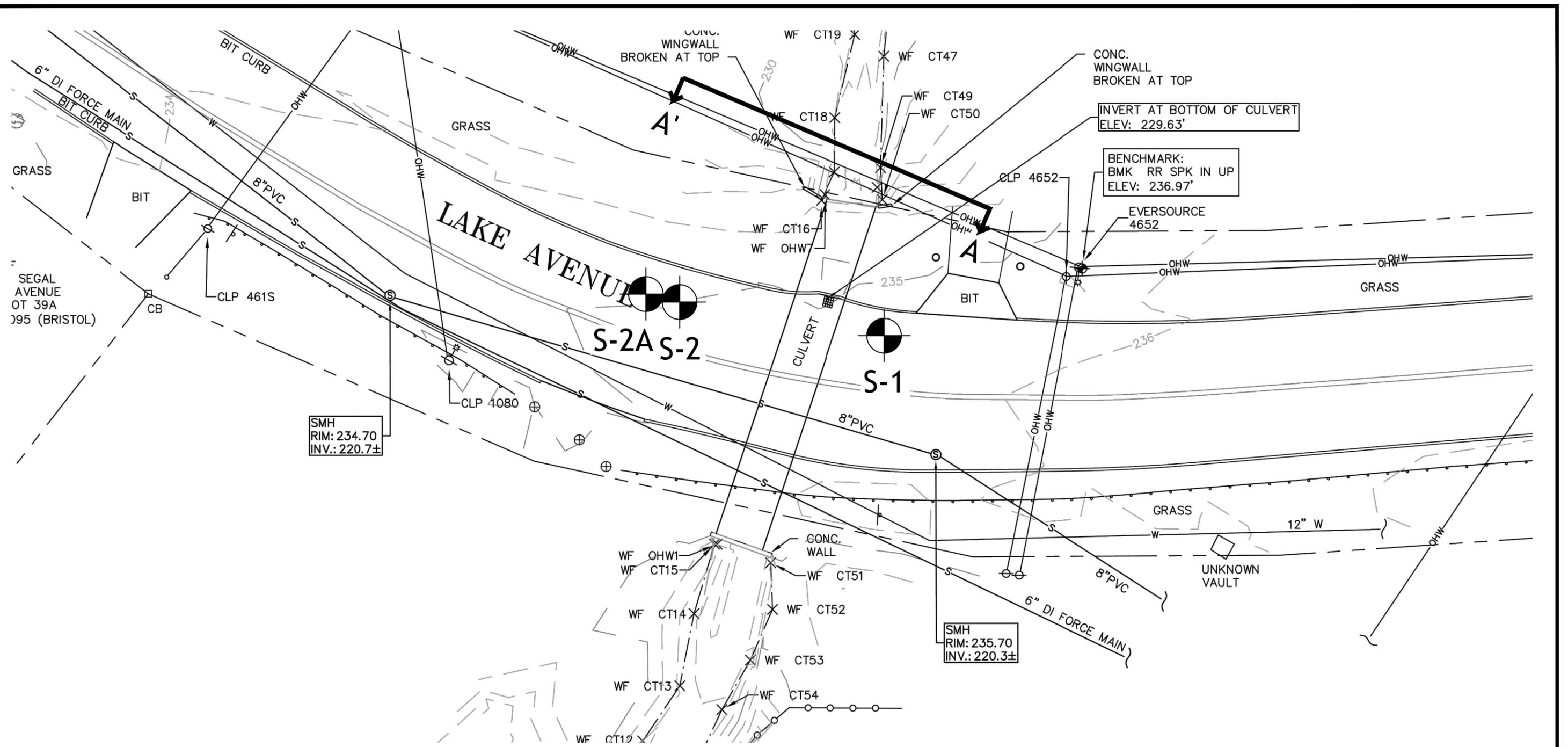
SITE LOCATION MAP
LAKE AVENUE CULVERT REPLACEMENT
BRISTOL, CONNECTICUT

DRAFTED: N.J.
 CHECKED: A.M.
 APPROVED: N.W.
 SCALED: 1"=1000'
 PROJECT NO.: 2019-0117.1
 DATE: 03/10/2021

SHEET NO.

FIGURE 1

Freeman Companies, LLC - C:\Users\johnson\AppData\Local\Temp\AcPublish...11356\Figure 2 and 3 - Lake Avenue.dwg Apr 19, 2021-10:02am Plotted By: njohnson

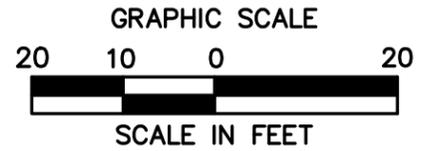


LEGEND:

S-1 TEST BORINGS

NOTES:

1. BASE PLAN PROVIDED BY WSP USA INC.
2. EXPLORATION LOCATIONS WERE TAPED FROM EXISTING FEATURES AND ARE APPROXIMATE
3. REFER TO FIGURE 3 FOR PROFILE A-A'
4. REFER TO THE TEXT AND APPENDICES FOR ADDITIONAL INFORMATION



SUBSURFACE EXPLORATION LOCATION PLAN

REPLACEMENT OF LAKE AVENUE CULVERT BRISTOL, CONNECTICUT

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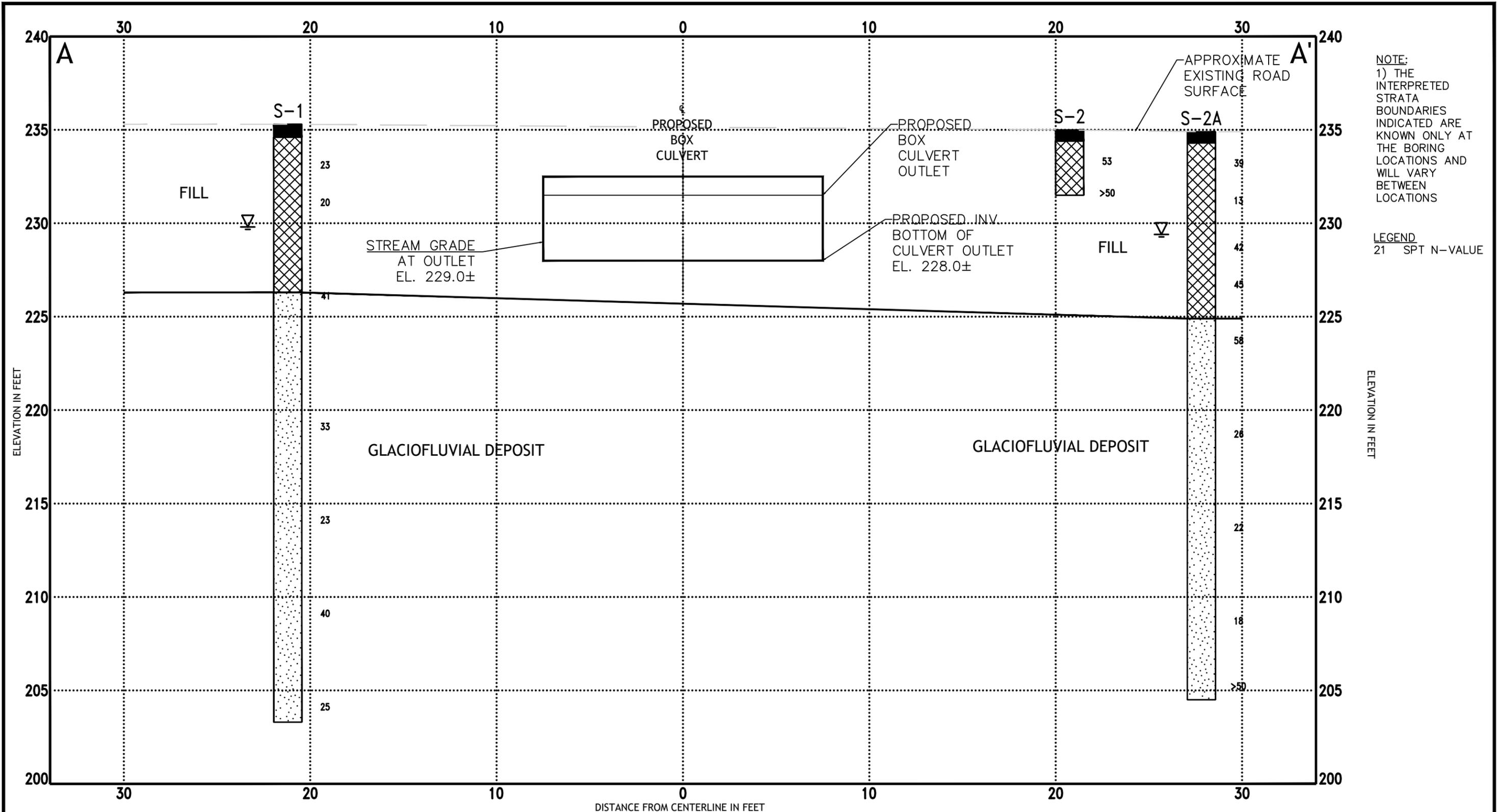
No.	Date	Description

REVISIONS

DRAWN: N.J.
 CHECKED: A.M.
 APPROVED: N.W.
 SCALE: 1"=20'
 PROJECT NO.: 2019-0117.1
 DATE: 03/12/2021

SHEET NO.
FIGURE 2

Freeman Companies, LLC - C:\Users\johnson\AppData\Local\Temp\AcPublish...13296\Figure 2 and 3 - Lake Avenue.dwg Apr 23, 2021-9:13am Plotted By: njohnson



NOTE:
1) THE INTERPRETED STRATA BOUNDARIES INDICATED ARE KNOWN ONLY AT THE BORING LOCATIONS AND WILL VARY BETWEEN LOCATIONS

LEGEND
21 SPT N-VALUE

SUBSURFACE EXPLORATION PROFILE A-A'

REPLACEMENT OF LAKE AVENUE CULVERT BRISTOL, CONNECTICUT

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LAND DEVELOPMENT | ENGINEERING DESIGN | CONSTRUCTION SERVICES

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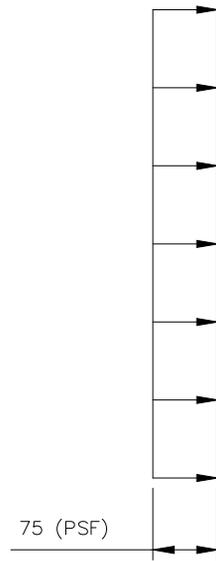
No.	Date	Description

REVISIONS

DRAWN: N.J.
CHECKED: A.M.
APPROVED: N.W.
SCALE: 1"=5'
PROJECT NO.: 2019-0117.1
DATE: 04/23/2021

SHEET NO.
FIGURE 3

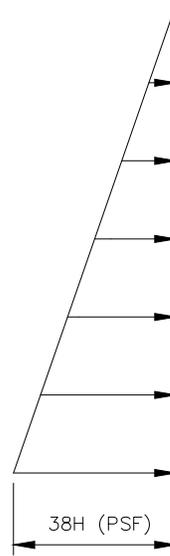
SURCHARGE



75 (PSF)

SURCHARGE LOAD

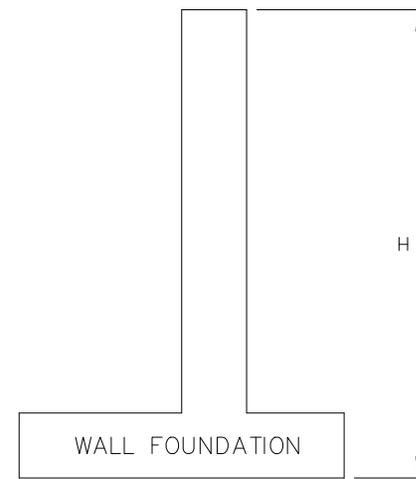
STATIC



38H (PSF)

ACTIVE EARTH PRESSURE

(NORMAL WT FILL)



WALL FOUNDATION

H

NOTES:

1. APPLIES TO WALLS THAT CAN DEFLECT AT THE TOP AND ASSUMES ACTIVE EARTH PRESSURES.
2. H IS MEASURED IN FEET
3. THE WALL SHOULD BE DRAINED BY PERVIOUS STRUCTURE BACKFILL (FORM 818 M.02.05) WITH A UNIT WEIGHT OF 125 PCF AND WEEPHOLES THROUGH THE WALL. THEREFORE, HYDROSTATIC PRESSURE IS NOT INCLUDED.
4. THESE PRESSURE DISTRIBUTIONS ASSUME HORIZONTAL BACKFILL BEHIND THE WALL.
5. SLIDING:
COEFFICIENT OF FRICTION BETWEEN FOOTING AND BASE= 0.55 (AASHTO TABLE 3.11.5.3-1) RESISTANCE FACTOR= 1.0 (AASHTO TABLE 11.5.7-1).
6. IGNORE PASSIVE RESISTANCE IN FRONT OF FOOTING.
7. SEISMIC LATERAL EARTH PRESSURES ARE NOT REQUIRED FOR SINGLE SPAN BRIDGES (AASHTO 4.7.4.2).

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LATERAL EARTH PRESSURES
ACTIVE EARTH PRESSURES
REPLACEMENT OF LAKE AVENUE CULVERT
BRISTOL, CONNECTICUT

DRAFTED:	N.J.
CHECKED:	A.M.
APPROVED:	N.W.
SCALED:	N.T.S.
PROJECT NO.:	2019-0117.1
DATE:	04/08/2020

FIG.

FIGURE 4

APPENDIX A
TEST BORING LOGS

Driller: D. Griffen	Connecticut DOT Boring Report Format	Hole No.: S-1
Inspector: N. Johnson	Town: Bristol	Stat./Offset:
Engineer: A. McCauliffe	Project No.: 2019-0117.1	Northing: 795569
Start Date: 3-4-21	Route No.:	Easting: 952532.5
Finish Date: 3-4-21	Bridge No.:	Surface Elevation: 235.3

Project Description: Lake Avenue Culvert Replacement

Casing Size/Type: 4-in Casing	Sampler Type/Size: 1-3/8 inch ID	Core Barrel Type: N/A
Hammer Wt.: 300lb Fall: 30in.	Hammer Wt.: 140lb Fall: 30in.	

Groundwater Observations: 5.5 ATD

Depth (ft)	SAMPLES					Generalized Strata Description	Material Description and Notes	Elevation (ft)	
	Sample Type/No.	Blows on Sampler per 6 inches							Pen. (in.)
0							ASPHALT FILL	Asphalt Pavement (8.5")	235
	S-1	4	10	13	14	24	16	Brown c-f SAND, little c-f gravel, trace silt, 2" lense quartz fragments near bottom of Split Spoon	
	S-2	14	9	11	17	24	6	[TOP S2] Gray Brown c-f SAND, some m-f gravel, trace silt	
5	S-3	21	50/5"			11	5	[BOTTOM S2] Gray brown c-f GRAVEL, some c-f sand, trace silt	230
								[TOP S3] Brown gray c-f SAND, little c-f gravel, trace silt, top 3" S3	
	S-4	9	12	29	22	24	8	[BOTTOM S3] White c-f GRAVEL, some f sand, quartz, bottom 2" S3	
10								Gray brown c-f GRAVEL, some c-f sand, trace silt, quartz fragments	225
								SAND (Glaciofluvial Deposit)	
15	S-5	13	17	16	17	24	13	Brown c-f SAND, trace silt	220
20	S-6	8	11	12	16	24	12	Light Brown c-f SAND, trace f gravel, trace silt	215
25	S-7	9	15	25	31	24	24	Light Brown c-f SAND, little c-f gravel, trace silt	210
30	S-8	9	12	13	15	24	12	Light Brown c-f SAND, little c-f gravel, trace silt	205
35								END OF BORING 32ft	

Sample Type: S = Split Spoon C = Core UP = Undisturbed Piston V = Vane Shear Test
Proportions Used: Trace = 1 - 10%, Little = 10 - 20%, Some = 20 - 35%, And = 35 - 50%

Total Penetration in Earth: 32ft Rock: 0ft	NOTES:	Sheet 1 of 1
No. of Soil Samples: 8 No. of Core Runs: 0		SM-001-M REV. 1/02

Driller: D. Griffen	Connecticut DOT Boring Report Format	Hole No.: S-2
Inspector: N. Johnson	Town: Bristol	Stat./Offset:
Engineer: A. McCauliffe	Project No.: 2019-0117.1	Northing: 795624.1
Start Date: 3-4-21	Route No.:	Easting: 952502.2
Finish Date: 3-4-21	Bridge No.:	Surface Elevation: 235.0

Project Description: Lake Avenue Culvert Replacement

Casing Size/Type: 4-in Casing	Sampler Type/Size: 1-3/8 inch ID	Core Barrel Type: N/A
Hammer Wt.: 300lb Fall: 30in.	Hammer Wt.: 140lb Fall: 30in.	

Groundwater Observations: Not Encountered

Depth (ft)	SAMPLES					Generalized Strata Description	Material Description and Notes	Elevation (ft)	
	Sample Type/No.	Blows on Sampler per 6 inches							Pen. (in.)
0						ASPAHLT	Asphalt Pavement (7")	235	
	S-1	14	13	40	50	24	12		
	S-2	39	50/5"			11	7		
							[TOP S1] Brown c-f SAND, little c-f gravel, trace silt, top 10" S1 [BOTTOM S1] Gray c-f gravel, little c-f sand, trace silt, flecks of mica, bottom 2" S1 [TOP S2] Brown c-f SAND, some c-f gravel, top 3" S2 [BOTTOM S2] Gray c-f GRAVEL, some f sand, trace silt, possible weathered rock, bottom 4" S2 Refusal on Augers at 3.5ft on probable boulder END OF BORING 3.5ft		
5								230	
10								225	

Sample Type: S = Split Spoon C = Core UP = Undisturbed Piston V = Vane Shear Test
 Proportions Used: Trace = 1 - 10%, Little = 10 - 20%, Some = 20 - 35%, And = 35 - 50%

Total Penetration in Earth: 3.5ft Rock: 0ft	NOTES:	Sheet 1 of 1
No. of Soil Samples: 2 No. of Core Runs: 0		SM-001-M REV. 1/02

Driller: D. Griffen	Connecticut DOT Boring Report Format	Hole No.: S-2A
Inspector: N. Johnson	Town: Bristol	Stat./Offset:
Engineer: A. McCauliffe	Project No.: 2019-0117.1	Northing: 795613.5
Start Date: 3-4-21	Route No.:	Easting: 952497.3
Finish Date: 3-4-21	Bridge No.:	Surface Elevation: 234.9

Project Description: Lake Avenue Culvert Replacement

Casing Size/Type: 4-in Casing	Sampler Type/Size: 1-3/8 inch ID	Core Barrel Type: N/A
Hammer Wt.: 300lb Fall: 30in.	Hammer Wt.: 140lb Fall: 30in.	

Groundwater Observations: 5.5 ATD

Depth (ft)	SAMPLES					Generalized Strata Description	Material Description and Notes	Elevation (ft)		
	Sample Type/No.	Blows on Sampler per 6 inches							Pen. (in.)	Rec. (in.)
0							ASPHALT FILL	Asphalt Pavement (7")		
	S-1	18	21	18	13	24	10		Brown c-f SAND, little c-f gravel, trace silt	
	S-2	4	4	9	17	24	12		Brown c-f SAND, little silt, trace m-f gravel	
5										
	S-3	16	26	16	10	24	14		Brown c-f SAND, some c-f gravel, little silt, 2" lense gray f sand and rock fragments in middle of spoon	
	S-4	15	20	25	37	24	16		Brown c-f SAND, some c-f gravel, trace silt, rock fragments, 1" lense light gray f sand and gravel near bottom of spoon	
10									[Augered through boulder 9' to 10']	
	S-5	22	26	32	21	24	12		SAND (Glaciofluvial Deposit) Brown and gray c-f SAND, some c-f gravel, little silt, rock fragments	
15										
	S-6	12	13	13	18	24	14		Light Brown c-f SAND, trace m-f gravel, trace silt	
20										
	S-7	10	10	12	19	24	24		Light Brown c-f SAND, little c-f gravel, trace silt, 2" lense of f gravel in middle of spoon	
25										
	S-8	8	9	9	14	24	24		Light Brown c-f SAND, trace f gravel, trace silt	
30										
	S-9	50/5"				5	0		No Recovery	
									END OF BORING 30.4ft	
35										

Sample Type: S = Split Spoon C = Core UP = Undisturbed Piston V = Vane Shear Test
Proportions Used: Trace = 1 - 10%, Little = 10 - 20%, Some = 20 - 35%, And = 35 - 50%

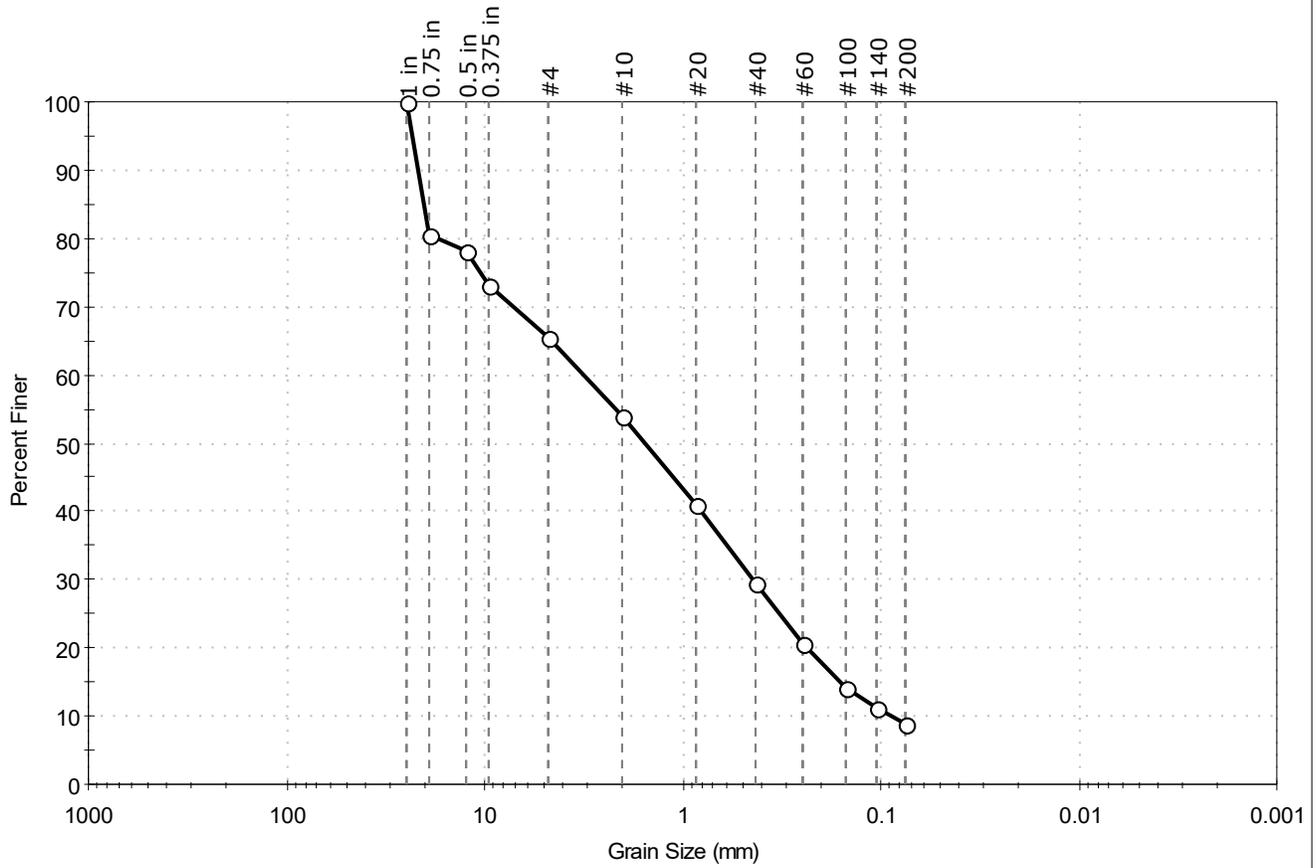
Total Penetration in Earth: 30.4ft Rock: 0ft	NOTES: Offset approximately 5ft north of S-2 to confirm shallow refusal	Sheet 1 of 1
No. of Soil Samples: 7	No. of Core Runs: 0	SM-001-M REV. 1/02

APPENDIX B
RESULTS OF LABORATORY TESTING



Client:	Freeman Companies, LLC		
Project:	Lake Ave Culvert Replacement		
Location:	Bristol, CT	Project No:	GTX-313327
Boring ID:	S-1	Sample Type:	bag
Sample ID:	S2	Test Date:	03/18/21
Depth :	3-5	Test Id:	613094
Test Comment:	---		
Visual Description:	Moist, brown sand with silt and gravel		
Sample Comment:	---		

Particle Size Analysis - ASTM D6913



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	34.4	56.7	8.9

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
1 in	25.00	100		
0.75 in	19.00	80		
0.5 in	12.50	78		
0.375 in	9.50	73		
#4	4.75	66		
#10	2.00	54		
#20	0.85	41		
#40	0.42	29		
#60	0.25	21		
#100	0.15	14		
#140	0.11	11		
#200	0.075	8.9		

<u>Coefficients</u>	
D ₈₅ = 20.2503 mm	D ₃₀ = 0.4399 mm
D ₆₀ = 3.1429 mm	D ₁₅ = 0.1606 mm
D ₅₀ = 1.5443 mm	D ₁₀ = 0.0885 mm
C _u = 35.513	C _c = 0.696

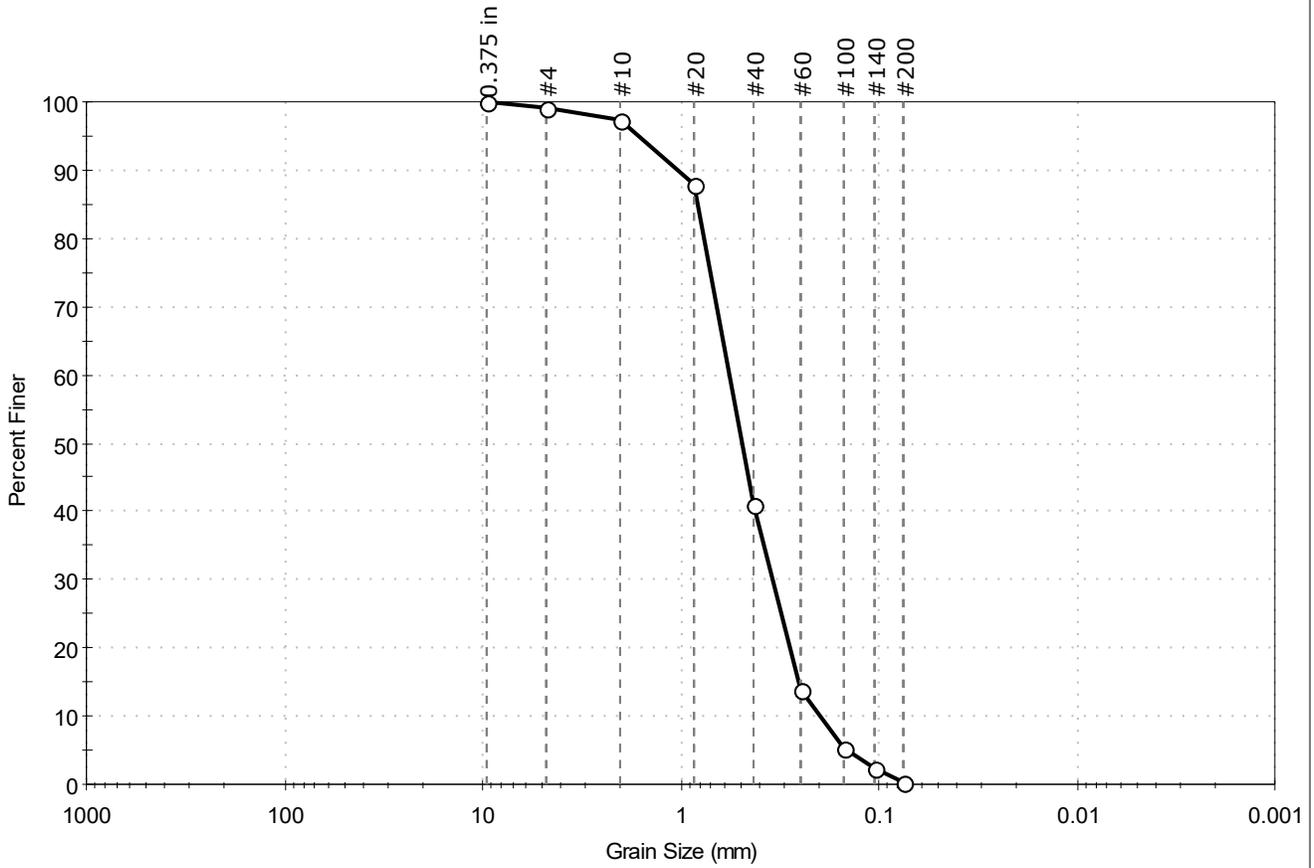
<u>Classification</u>	
ASTM	N/A
AASHTO	Stone Fragments, Gravel and Sand (A-1-b (1))

<u>Sample/Test Description</u>
Sand/Gravel Particle Shape : ANGULAR
Sand/Gravel Hardness : HARD



Client:	Freeman Companies, LLC		Project No:	GTX-313327	
Project:	Lake Ave Culvert Replacement				
Location:	Bristol, CT				
Boring ID:	S-1	Sample Type:	bag	Tested By:	ckg
Sample ID:	S6	Test Date:	03/18/21	Checked By:	jsc
Depth :	20-22	Test Id:	613095		
Test Comment:	---				
Visual Description:	Moist, brown sand				
Sample Comment:	---				

Particle Size Analysis - ASTM D6913



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	0.9	98.8	0.3

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.375 in	9.50	100		
#4	4.75	99		
#10	2.00	97		
#20	0.85	88		
#40	0.42	41		
#60	0.25	14		
#100	0.15	5		
#140	0.11	2		
#200	0.075	0.3		

Coefficients	
D ₈₅ = 0.8141 mm	D ₃₀ = 0.3425 mm
D ₆₀ = 0.5621 mm	D ₁₅ = 0.2560 mm
D ₅₀ = 0.4847 mm	D ₁₀ = 0.1990 mm
C _u = 2.825	C _c = 1.049

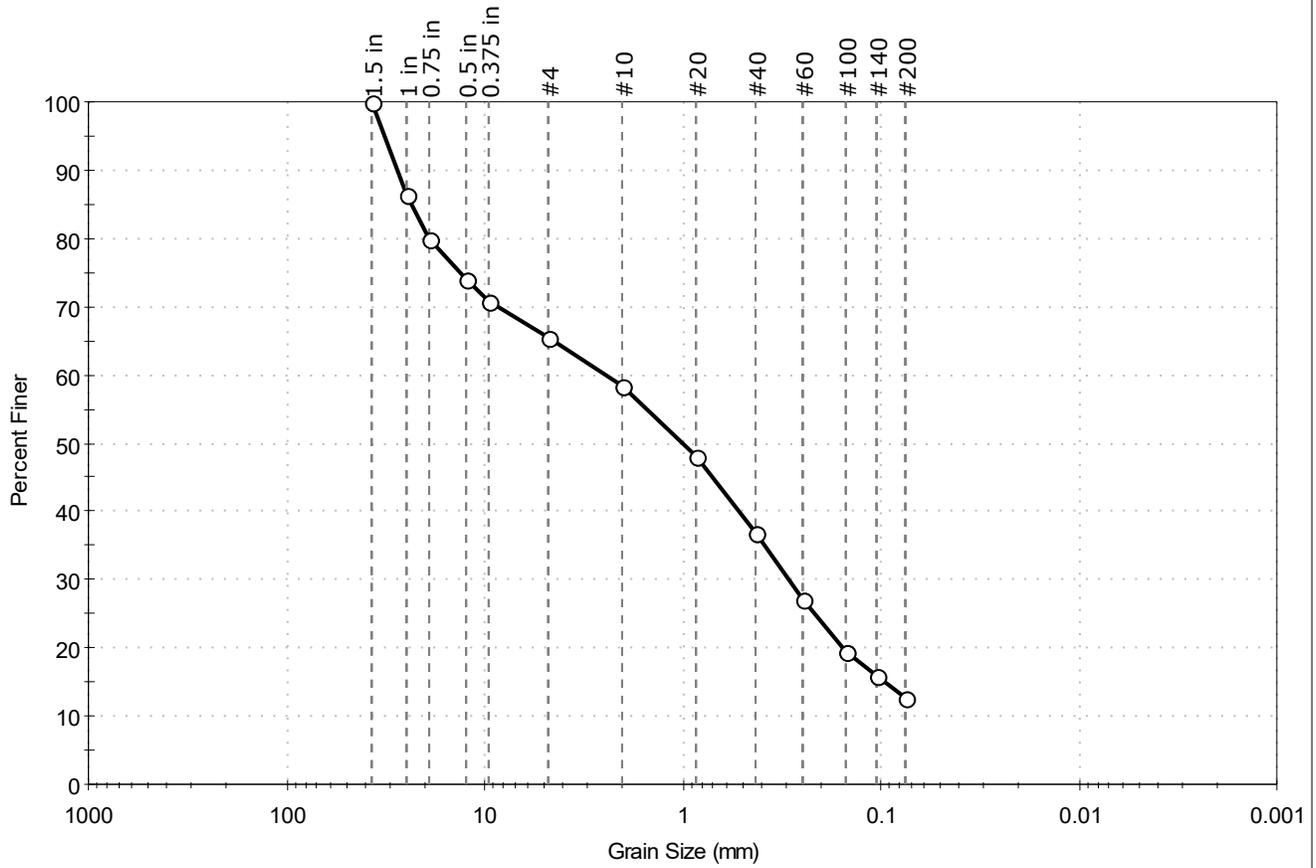
Classification	
ASTM	Poorly graded SAND (SP)
AASHTO	Stone Fragments, Gravel and Sand (A-1-b (1))

Sample/Test Description	
Sand/Gravel Particle Shape :	---
Sand/Gravel Hardness :	---



Client:	Freeman Companies, LLC		
Project:	Lake Ave Culvert Replacement		
Location:	Bristol, CT	Project No:	GTX-313327
Boring ID:	S-2A	Sample Type:	bag
Sample ID:	S3	Test Date:	03/19/21
Depth :	5-7	Test Id:	613096
Test Comment:	---		
Visual Description:	Moist, brown silty sand with gravel		
Sample Comment:	---		

Particle Size Analysis - ASTM D6913



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	34.5	52.8	12.7

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
1.5 in	37.50	100		
1 in	25.00	86		
0.75 in	19.00	80		
0.5 in	12.50	74		
0.375 in	9.50	71		
#4	4.75	65		
#10	2.00	58		
#20	0.85	48		
#40	0.42	37		
#60	0.25	27		
#100	0.15	19		
#140	0.11	16		
#200	0.075	13		

<u>Coefficients</u>	
D ₈₅ = 23.5962 mm	D ₃₀ = 0.2916 mm
D ₆₀ = 2.4654 mm	D ₁₅ = 0.0971 mm
D ₅₀ = 1.0076 mm	D ₁₀ = N/A
C _u = N/A	C _c = N/A

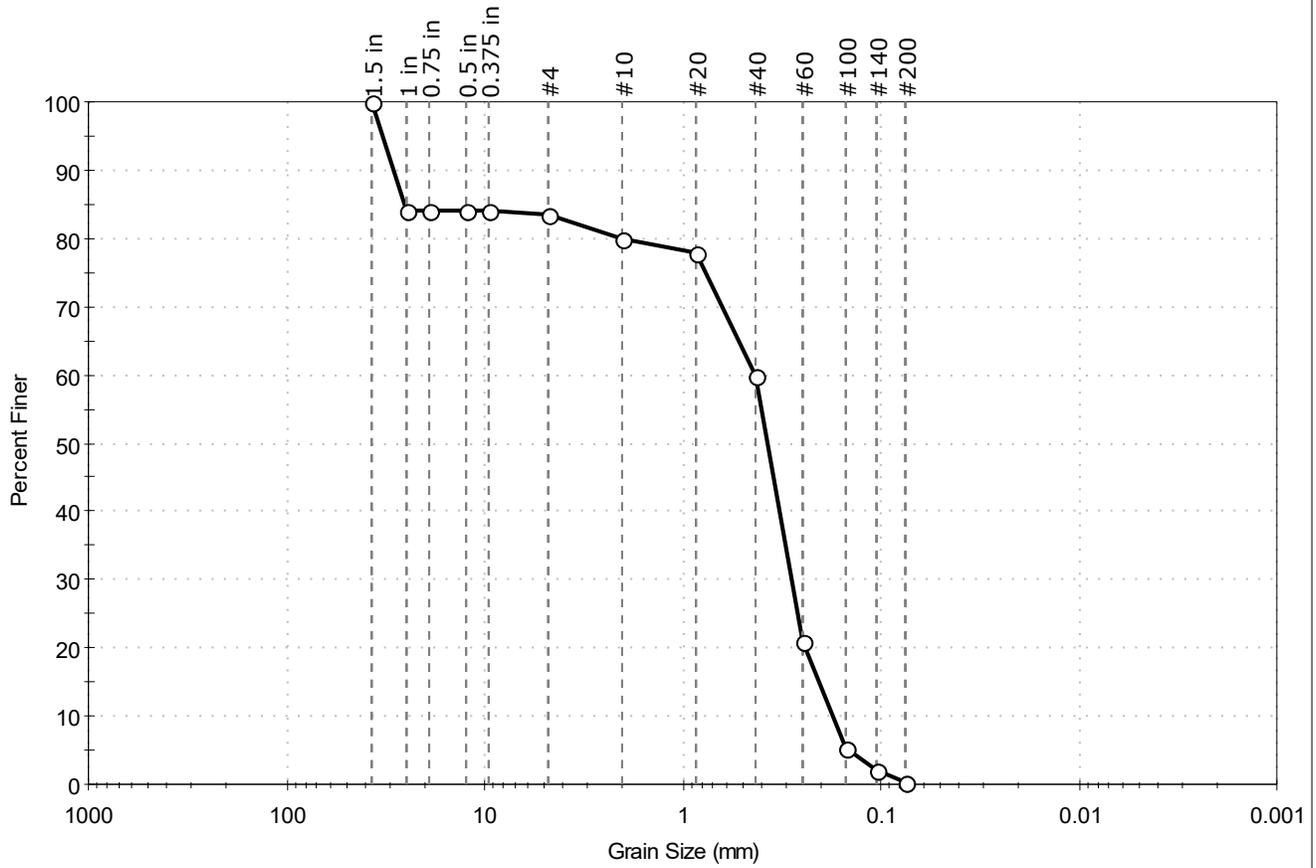
<u>Classification</u>	
ASTM	N/A
AASHTO	Stone Fragments, Gravel and Sand (A-1-b (0))

<u>Sample/Test Description</u>
Sand/Gravel Particle Shape : ANGULAR
Sand/Gravel Hardness : HARD



Client:	Freeman Companies, LLC		
Project:	Lake Ave Culvert Replacement		
Location:	Bristol, CT	Project No:	GTX-313327
Boring ID:	S-2A	Sample Type:	bag
Sample ID:	S7	Test Date:	03/18/21
Depth :	20-22	Checked By:	jsc
		Test Id:	613097
Test Comment:	---		
Visual Description:	Moist, reddish brown sand with gravel		
Sample Comment:	--		

Particle Size Analysis - ASTM D6913



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	16.5	83.1	0.4

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
1.5 in	37.50	100		
1 in	25.00	84		
0.75 in	19.00	84		
0.5 in	12.50	84		
0.375 in	9.50	84		
#4	4.75	83		
#10	2.00	80		
#20	0.85	78		
#40	0.42	60		
#60	0.25	21		
#100	0.15	5		
#140	0.11	2		
#200	0.075	0.4		

Coefficients	
D ₈₅ = 25.5827 mm	D ₃₀ = 0.2831 mm
D ₆₀ = 0.4289 mm	D ₁₅ = 0.2064 mm
D ₅₀ = 0.3720 mm	D ₁₀ = 0.1754 mm
C _u = 2.445	C _c = 1.065

Classification	
ASTM	Poorly graded SAND with Gravel (SP)
AASHTO	Fine Sand (A-3 (1))

Sample/Test Description	
Sand/Gravel Particle Shape : ANGULAR	
Sand/Gravel Hardness : HARD	