

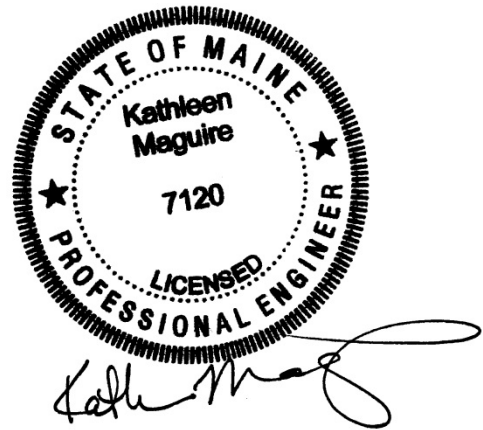
**MAINE DEPARTMENT OF TRANSPORTATION
HIGHWAY PROGRAM
GEOTECHNICAL SECTION
AUGUSTA, MAINE**

GEOTECHNICAL DESIGN REPORT

For the Replacement of:

**CROSS CULVERT #XC-86554
ROUTE 117
LIMINGTON, MAINE**

Prepared by:
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York County

WIN 22893.00
March 6, 2019

Soils Report 2019-05

PROJECT DETAILS

The purpose of this Geotechnical Design Report is to present subsurface information and make geotechnical design and construction recommendations for the replacement of an existing approximately 37-foot long, 40-inch diameter corrugated metal pipe (CMP) cross culvert (#XC-86554) on Route 117 in Limington. The existing culvert is failing, with heavy rust along the invert. The culvert is located approximately 0.05 of a mile east of Deer Ridge Road as shown in the attached Location Map. Route 117 is a Highway Corridor Priority 4 road.

The proposed replacement structure will be a 60-foot long, 72-inch diameter Reinforced Concrete Pipe (RCP) Class III culvert on a skew of approximately 2 degrees to the roadway centerline. The invert of the proposed culvert is approximately 9 feet below the existing road grade at the roadway centerline. The invert of the proposed culvert will be lined with approximately 2 feet (at the culvert centerline) of Special Fill to facilitate fish passage. The roadway embankment slopes at the proposed culvert inlet and outlet shall be no steeper than 2H:1V on the inlet end and 1.9H:1V with 2 feet of riprap on the outlet end to protect against erosion.

SUBSURFACE INVESTIGATION

One (1) boring (HB-LIMI-101) and one (1) probe (HB-LIMI-102) were drilled for this project on June 9, 2018 by Northern Test Boring (NTB) of Gorham, Maine using a track mounted drill rig. Exploration locations are shown on the attached Boring Location Plan & Interpretive Subsurface Profile with Boring Logs sheet. Details and sampling methods used, field data obtained, and soil and groundwater conditions encountered are shown on the attached boring logs.

The boring and probe were drilled using hollow stem auger and solid stem auger techniques, respectively. Soil samples were obtained in boring HB-LIMI-101 at 5-foot intervals using Standard Penetration Test (SPT) methods. The NTB drill rig is equipped with an automatic hammer to drive the split spoon. The NTB calibrated automatic hammer delivers approximately 63 percent more energy during driving than the standard rope and cathead system. All N-values discussed in this report are corrected values (N_{60}) computed by applying an average energy transfer factor of 0.977 to the raw field N-values. No soil samples were obtained in the probe.

The MaineDOT Geotechnical Team member selected the boring and probe locations, drilling methods, designated type and depth of sampling, reviewed field logs for accuracy and identified field and laboratory testing requirements. A NorthEast Transportation Training and Certification (NETTCP) certified Subsurface Investigator logged the subsurface conditions encountered. The boring and probe were located in the field by taping to surveyed site features after completion of the drilling program.

LABORATORY TESTING

A laboratory testing program was conducted to assist in soil classification, evaluation of engineering properties of the soils and geologic assessment of the project site. Laboratory testing consisted of four (4) standard grain size analyses with natural water content. The results of the

laboratory testing program are discussed in the following section and are shown on the attached boring logs, Laboratory Testing Summary Sheet, and Grain Size Distribution Curve sheet.

SUBSURFACE CONDITIONS

Subsurface conditions encountered at the test boring generally consisted of fill overlying native sand. An interpretive subsurface profile depicting the generalized soil stratigraphy at the boring location is shown on the attached Boring Location Plan & Interpretive Subsurface Profile with Boring Logs sheet.

Boring HB-LIMI-101 was drilled to a depth of approximately 17.0 feet below ground surface (bgs) and did not encounter a refusal surface. Probe HB-LIMI-102 was drilled to a depth of approximately 17.0 feet bgs and did not encounter a refusal surface.

The table below summarizes the field and laboratory information obtained in boring HB-LIMI-101:

Approx. Depth BGS ¹ (feet)	Soil Description	AASHTO ² Classification	USCS ³	WC% ⁴
0 – 0.5	Pavement	--	--	--
0.5 – 8.0	Fill: Brown, damp to moist, fine to coarse SAND, little silt, trace gravel, wood from 5.5-6.0 feet bgs.	A-1-b	SM	6.2 to 46.0
8.0 – 17.0	Brown, wet, fine to coarse SAND, trace silt, trace gravel.	A-1-b	SP-SM or SP	15.2 to 24.9

¹BGS = below ground surface

²AASHTO = American Association of State Highway and Transportation Officials

³USCS = Unified Soil Classification System

⁴WC% = Water content in percent

Two (2) corrected N-values obtained in the fill sand ranged from 54 to 116 blows per foot (bpf) indicating that the fill sand very dense in consistency. Two (2) corrected N-values obtained in the native sand ranged from 20 bpf to 33 bpf indicating that the native sand is medium dense in consistency.

Groundwater was observed in boring HB-LIMI-101 at a depth of approximately 7.5 feet bgs. Groundwater was not recorded in the probe. Groundwater levels can be expected to fluctuate subject to seasonal variations, local soil conditions, topography, precipitation, and construction activity.

GEOTECHNICAL DESIGN AND CONSTRUCTION RECOMMENDATIONS

RCP Class III Culvert Construction – The proposed replacement structure will be a 60-foot long, 72-inch diameter RCP (Class III) culvert on a skew of approximately 2 degrees to the

roadway centerline. The proposed RCP shall be furnished and installed in accordance with MaineDOT Standard Specification 603.

The invert of the proposed RCP culvert ranges from approximately 434.20 feet at the inlet end to approximately 433.35 feet at the outlet end with a 1.4% slope. The culvert will be lined with approximately 2 feet of Special Fill to facilitate fish passage.

The full nature of the proposed culvert bearing surface will not become evident until the culvert excavation is made. Any cobbles or boulders encountered in excess of 6 inches shall be removed and replaced with compacted Granular Borrow Material for Underwater Backfill or Crushed Stone $\frac{3}{4}$ -Inch. The prepared subgrade shall be proof-rolled using a static roller to visually confirm the prepared subgrade is firm and stable. The exposed subgrade shall be free of ponded water so that bedding material placement and compaction can be completed in the dry.

The proposed structure shall be bedded on a 1-foot thick layer of Granular Borrow, Material for Underwater Backfill meeting the requirements of MaineDOT Standard Specification 703.19. The soil envelope and backfill shall consist of Standard Specification 703.19 - Granular Borrow with a maximum particle size of 4 inches. The granular borrow bedding and backfill material shall be placed in lifts of 6 to 8 inches loose measure and compacted to the manufacturer's specifications or, in the absence of manufacturer's specifications. The bedding and backfill soil shall be compacted to at least 92 percent of the AASHTO T-180 maximum dry density. All subgrade surfaces should be protected from construction traffic in order to limit disturbance.

Settlement – No settlement issues are anticipated at the site. No changes to the existing vertical or horizontal alignment are currently planned for this project. The proposed RCP culvert is larger than the existing culvert and will result in a net unloading of the site soils at the structure location. Any settlement due to elastic compression of the bedding material will be immediate and negligible.

Scour and Riprap – Both the inlet and outlet of the RCP culvert shall be protected against scour with riprap conforming to MaineDOT Standard Specification Section 703.26 Plain and Hand Laid Riprap. The roadway embankment slopes at the proposed culvert inlet and outlet shall be no steeper than 2H:1V on the inlet end and 1.9H:1V with 2 feet of riprap on the outlet end, All other slopes shall be no steeper than 2H:1V. No specific scour protection recommendations are needed other than armoring with riprap. The riprap on the slopes shall be underlain by a non-woven, Class 1 Erosion Control Geotextile meeting the requirements of MaineDOT Standard Specification 722.03 that is underlain by a 1-foot layer of protective aggregate cushion consisting of Granular Borrow Material for Underwater Backfill (703.19). The toe of the riprap sections shall be keyed into the existing soils 1 foot below the streambed elevation.

Construction Considerations – Construction activities will include construction of cofferdams and earth support systems to control stream flow during construction. Construction activities will also include common earth excavation. Construction of the RCP Class III culvert will require soil excavation. Earth support systems shall be implemented if laying back slopes is not feasible. It is likely that the use of complex (four-sided) braced excavations with dewatering will be necessary due to the depth of the excavation. If this is the case, adequate embedment into the native sand will

be necessary to allow for the excavation and maintenance of a stable excavation bottom. All earth support systems shall be designed by a Professional Engineer licensed in the State of Maine. Regardless of the method of excavation, all excavations and earth support systems shall meet all applicable OSHA regulations.

Any cobbles or boulders encountered in excess of 6 inches shall be removed and replaced with compacted Granular Borrow Material for Underwater Backfill (MaineDOT 703.19) or Crushed Stone $\frac{3}{4}$ -Inch (MaineDOT 703.13). All subgrade surfaces shall be proof-rolled using a static roller to provide a firm and stable surface and protected from any unnecessary construction equipment or traffic. If disturbance and rutting occur, the Contractor shall remove and replace disturbed areas with compacted Granular Borrow for Underwater Backfill (703.19) or Crushed Stone $\frac{3}{4}$ -Inch (703.13).

The Contractor shall control groundwater and surface water infiltration using temporary ditches, sumps, granular drainage blankets, stone ditch protection or hand-laid riprap with geotextile underlayment to divert groundwater and surface water as needed to maintain a stable excavation and allow work in the dry.

Using the excavated native soils as backfill around the culvert shall not be permitted. The native soils may only be used as Common Borrow in accordance with MaineDOT Standard Specifications 203 and 703.

The Contractor will have to excavate the existing subbase and subgrade fill soils in the vicinity of the culvert. These materials should not be used to re-base the roadway. Excavated subbase sand and gravel may be used as fill below roadway subgrade level in fill areas provided all other requirements of MaineDOT Standard Specifications 203 and 703 are met.

CLOSURE

This report has been prepared for the use of the MaineDOT Highway Program and their project design consultant for specific application to the proposed replacement of a cross culvert (#XC-86554) under Route 117 in Limington, Maine in accordance with generally accepted geotechnical and foundation engineering practices. No other intended use or warranty is expressed or implied.

In the event that any changes in the nature, design, or location of the proposed project are planned, this report should be reviewed by a geotechnical engineer to assess the appropriateness of the conclusions and recommendations and to modify the recommendations as appropriate to reflect the changes in design. These analyses and recommendations are based in part upon a limited subsurface investigation at discrete exploratory location completed at the site. If variations from the conditions encountered during the investigation appear evident during construction, it may also become necessary to re-evaluate the recommendations made in this report.

It is recommended that a geotechnical engineer be provided the opportunity for a review of the design and specifications in order that the earthwork and foundation recommendations and construction considerations presented in this report are properly interpreted and implemented in the design and specifications.

Attachments:

Location Map

Boring Location Plan & Interpretive Subsurface Profile with Boring Logs

Key to Soil and Rock Descriptions and Terms

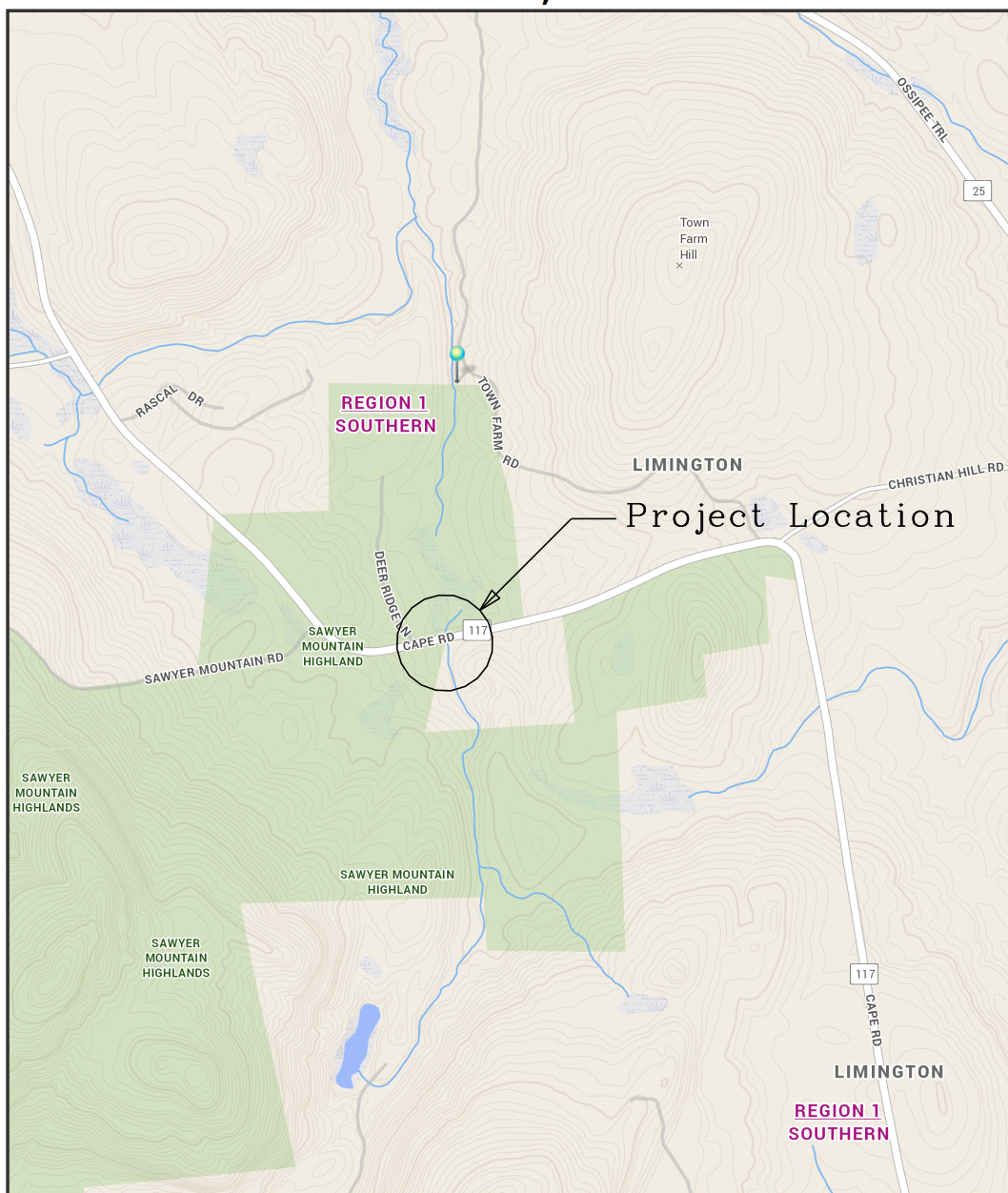
Boring Logs

Laboratory Testing Summary Sheet

Grain Size Distribution Curves



LIMINGTON, MAINE



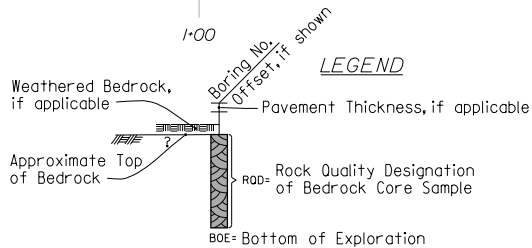
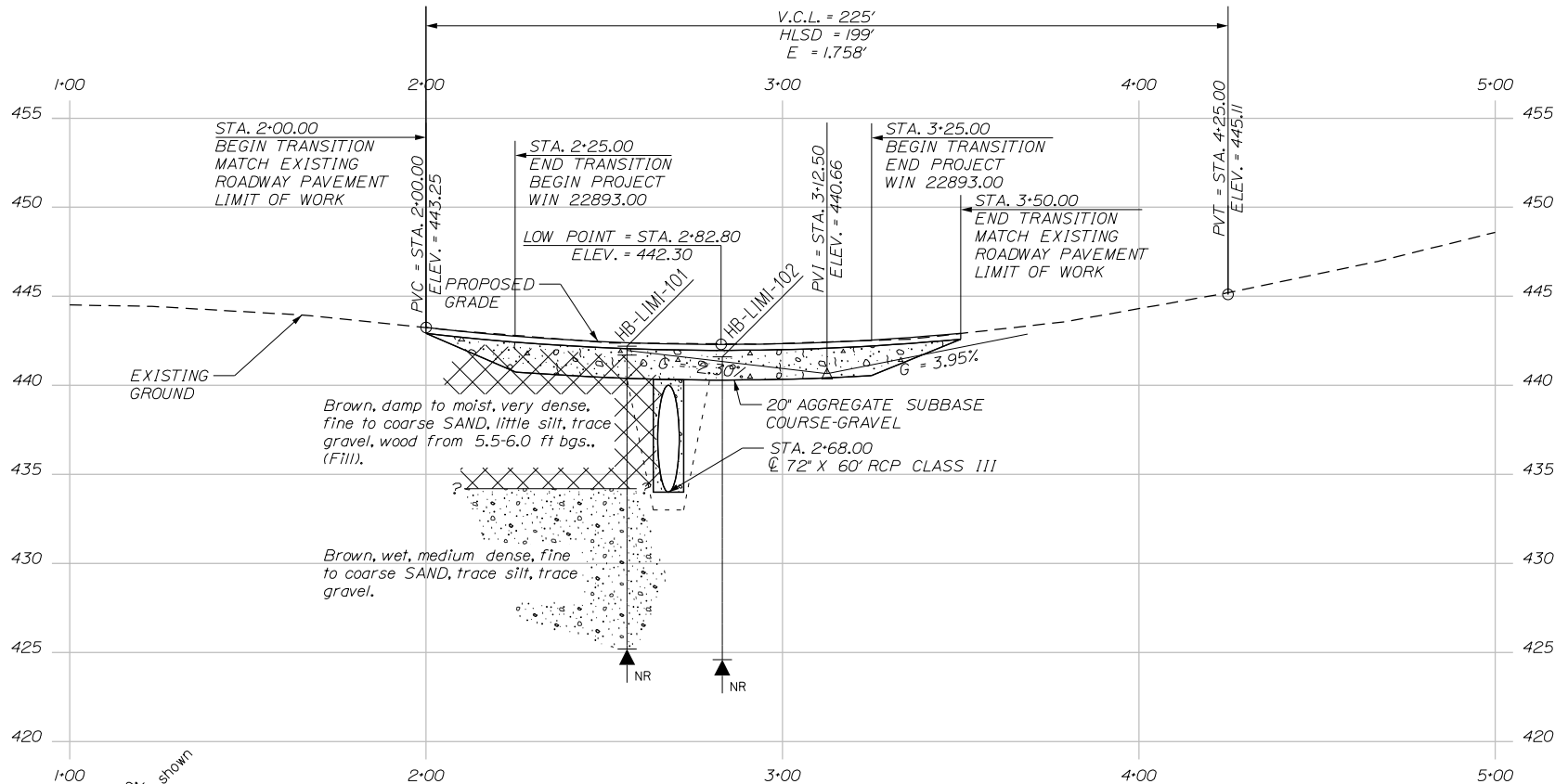
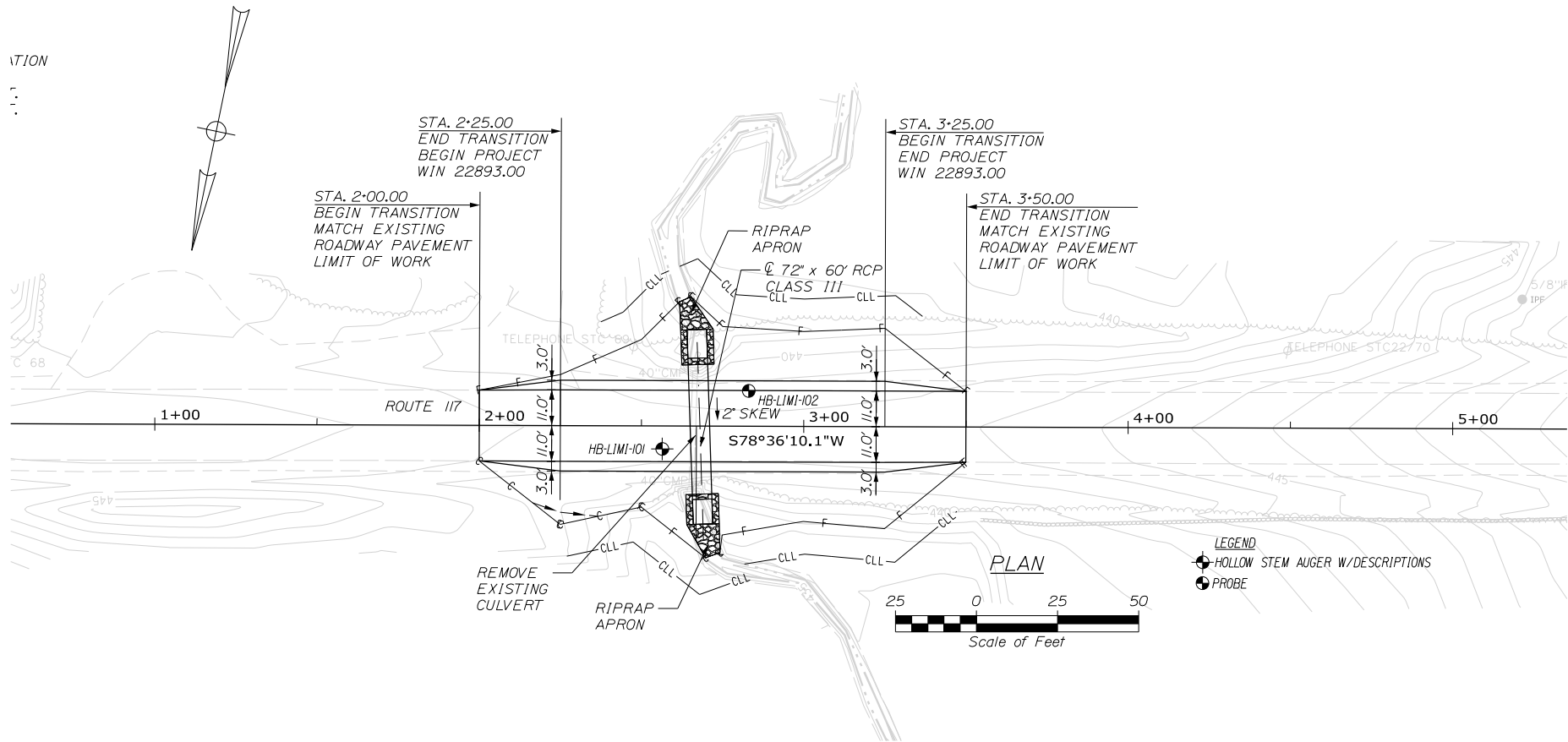
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0.25 Miles
1 inch = 0.27 miles

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SHEET NUMBER 1 OF 2	LIMINGTON ROUTE 117	STATE OF MAINE DEPARTMENT OF TRANSPORTATION	
		022893.00	
	LOCATION MAP	WIN 022893.00 HIGHWAY PLANS	

ATION



Note: This generalized interpretive soil profile is intended to convey trends in subsurface conditions. The boundaries between strata are approximate and idealized, and have been developed by interpretations of widely spaced explorations and samples. Actual soil and bedrock transitions may vary and are probably more erratic. For more specific information refer to the exploration logs.

Maine Department of Transportation				Project: Route 117 Cross Culvert		Boring No.: HB-LIMI-101	
Self/Book Exploration Log				Location: Limington, Maine		WIN: 22893.00	
US CUSTOMARY UNITS							
Drillers	Northern Test Boring	Elevation (ft.)	442.2	Auger ID/OD:	2.25/4.25"		
Operator:	Mithelton	Driller:	NAV088	Sampler:	Standard Split Spoon		
Logged By:	S. W. Loder	Rtg. Type:	Standard 0-50 Ticks	Sampler Wt./Falls:	140W/30"		
Date Started/Finished:	6/9/2018 07:30-10:30	Drilling Method:	Hand Low Stem Auger	Core Barrel:	N/A		
Boring Location:	2256.4, 7.1 ft E.	Coating ID/OD:	N/A	Water Level:	7.5 ft bgs.		
Hammer Efficiency Factor:	0.977	Hammer Type:	Automatic 80	Hydraulic:	☐ Open & Closed		
Soil/Stratigraphic Data				Soil/Stratigraphic Data			
1 - Split Spoon Sample				2 - Non Core Sample			
3 - Sample off Auger Flights				4 - Non Core Sample			
5 - Unsuccessful Split Spoon Sample Attempt				6 - Unsuccessful Split Spoon Sample Attempt			
7 - Thin Wall Tube Sample				8 - Thin Wall Tube Sample			
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UNIFIED SOIL CLASSIFICATION SYSTEM					MODIFIED BURMISTER SYSTEM				
MAJOR DIVISIONS			GROUP SYMBOLS	TYPICAL NAMES					
COARSE-GRAINED SOILS (more than half of material is larger than No. 200 sieve size)	GRAVELS (more than half of coarse fraction is larger than No. 4 sieve size)	CLEAN GRAVELS	GW	Well-graded gravels, gravel-sand mixtures, little or no fines.	Descriptive Term		Portion of Total (%)		
		(little or no fines)	GP	Poorly-graded gravels, gravel sand mixtures, little or no fines.	trace	0 - 10			
					little	11 - 20			
					some	21 - 35			
					adjective (e.g. sandy, clayey)		36 - 50		
	SANDS (more than half of coarse fraction is smaller than No. 4 sieve size)	CLEAN SANDS	SW	Well-graded sands, gravelly sands, little or no fines	TERMS DESCRIBING DENSITY/CONSISTENCY				
		(little or no fines)	SP	Poorly-graded sands, gravelly sand, little or no fines.					
		SANDS WITH FINES (Appreciable amount of fines)	GM	Silty gravels, gravel-sand-silt mixtures.	<u>Coarse-grained soils</u> (more than half of material is larger than No. 200 sieve): Includes (1) clean gravels; (2) silty or clayey gravels; and (3) silty, clayey or gravelly sands. Density is rated according to standard penetration resistance (N-value).				
GC			Clayey gravels, gravel-sand-clay mixtures.						
FINE-GRAINED SOILS (more than half of material is smaller than No. 200 sieve size)	SILTS AND CLAYS (liquid limit less than 50)		ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands, or clayey silts with slight plasticity.	Density of Cohesionless Soils		Standard Penetration Resistance N-Value (blows per foot)		
			CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.	Very loose	0 - 4			
					Loose	5 - 10			
					Medium Dense	11 - 30			
					Dense	31 - 50			
					Very Dense	> 50			
	SILTS AND CLAYS (liquid limit greater than 50)		SM	Silty sands, sand-silt mixtures	<u>Fine-grained soils</u> (more than half of material is smaller than No. 200 sieve): Includes (1) inorganic and organic silts and clays; (2) gravelly, sandy or silty clays; and (3) clayey silts. Consistency is rated according to undrained shear strength as indicated.				
			SC	Clayey sands, sand-clay mixtures.					
		HIGHLY ORGANIC SOILS				<u>Approximate Undrained Shear Strength (psf)</u>			

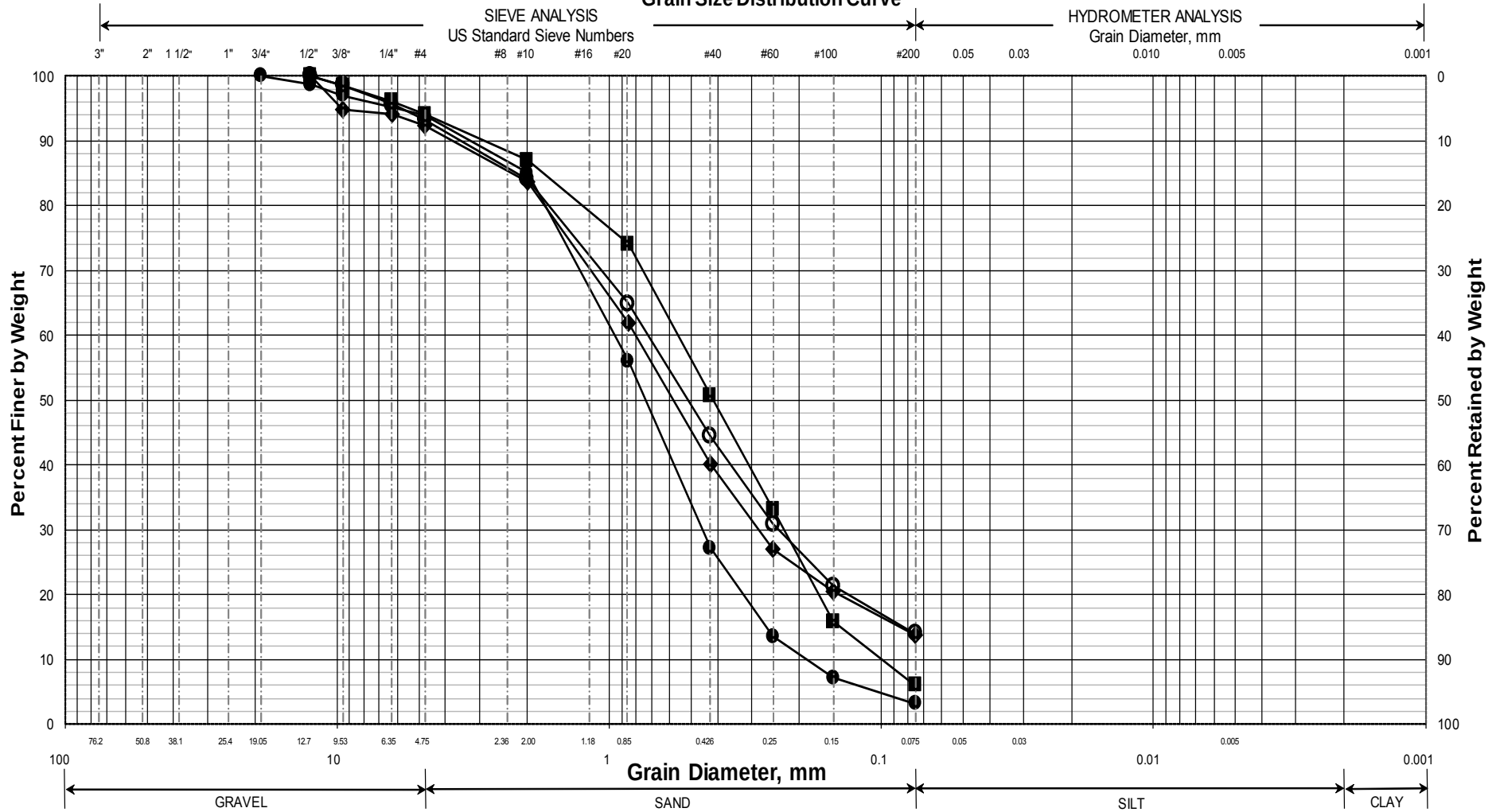
Maine Department of Transportation Soil/Rock Exploration Log US CUSTOMARY UNITS				Project: Route 117 Cross Culvert Location: Limington, Maine				Boring No.: HB-LIMI-101 WIN: 22893.00				
Driller: Northern Test Boring				Elevation (ft.): 442.2				Auger ID/OD: 2.25/6.25"				
Operator: Mike/Ian				Datum: NAVD88				Sampler: Standard Split Spoon				
Logged By: B. Wilder				Rig Type: Diedrich D-50 Track				Hammer Wt./Fall: 140#/30"				
Date Start/Finish: 6/9/2018; 07:30-10:30				Drilling Method: Hollow Stem Auger				Core Barrel: N/A				
Boring Location: 2+56.4, 7.1 ft Rt.				Casing ID/OD: N/A				Water Level*: 7.5 ft bgs.				
Hammer Efficiency Factor: 0.977				Hammer Type: Automatic ☒ Hydraulic ☐ Rope & Cathead ☐								
Definitions: D = Split Spoon Sample MD = Unsuccessful Split Spoon Sample Attempt U = Thin Wall Tube Sample MU = Unsuccessful Thin Wall Tube Sample Attempt V = Field Vane Shear Test, PP = Pocket Penetrometer MV = Unsuccessful Field Vane Shear Test Attempt R = Rock Core Sample SSA = Solid Stem Auger HSA = Hollow Stem Auger RC = Roller Cone WOH = Weight of 140lb. Hammer WOR/C = Weight of Rods or Casing WO1P = Weight of One Person S_u = Peak/Remolded Field Vane Undrained Shear Strength (psf) S_u(lab) = Lab Vane Undrained Shear Strength (psf) q_p = Unconfined Compressive Strength (ksf) N-uncorrected = Raw Field SPT N-value Hammer Efficiency Factor = Rig Specific Annual Calibration Value N₆₀ = SPT N-uncorrected Corrected for Hammer Efficiency N₆₀ = (Hammer Efficiency Factor/60%)*N-uncorrected T_v = Pocket Torvane Shear Strength (psf) WC = Water Content, percent LL = Liquid Limit PL = Plastic Limit PI = Plasticity Index G = Grain Size Analysis C = Consolidation Test												
Depth (ft.)	Sample Information								Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N ₆₀	Casing Blows					
0							HSA	441.7		6" HMA.	0.5	
	1D	24/18	2.00 - 4.00	22/31/40/21	71	116				Brown, damp, very dense, fine to coarse SAND, little silt, trace gravel, (Fill).		G#303180 A-1-b, SM WC=6.2%
5	2D	24/12	5.00 - 7.00	8/25/8/6	33	54				Brown, moist, very dense, fine to coarse SAND, little silt, trace gravel, wood from 5.5-6.0 ft bgs, (Fill).		G#303181 A-1-b, SM WC=46.0%
								434.2		Brown, wet, medium dense, fine to coarse SAND, trace silt, trace gravel.	8.0	G#303182 A-2-4, SP-SM WC=24.9%
10	3D	24/12	10.00 - 12.00	7/7/7/7	14	23				Brown, wet, medium dense, fine to coarse SAND, trace gravel, trace silt.		G#303183 A-1-b, SP WC=15.2%
15	4D	24/20	15.00 - 17.00	4/4/8/9	12	20				Bottom of Exploration at 17.0 feet below ground surface. NO REFUSAL	17.0	
20												
25												
Remarks: Auto Hammer #377												
Stratification lines represent approximate boundaries between soil types; transitions may be gradual. * Water level readings have been made at times and under conditions stated. Groundwater fluctuations may occur due to conditions other than those present at the time measurements were made.											Page 1 of 1 Boring No.: HB-LIMI-101	

Maine Department of Transportation Soil/Rock Exploration Log US CUSTOMARY UNITS				Project: Route 117 Cross Culvert Location: Limington, Maine				Boring No.: HB-LIMI-102 WIN: 22893.00			
Drilling Contractor: Northern Test Boring				Elevation (ft.): 441.6				Auger ID/OD: 5" Dia.			
Operator: Mike/Ian				Datum: NAVD88				Sampler: N/A			
Logged By: B. Wilder				Rig Type: Diedrich D-50 Track				Hammer Wt./Fall: N/A			
Date Start/Finish: 6/9/2018; 07:30-10:30				Drilling Method: Solid Stem Auger				Core Barrel: N/A			
Boring Location: 2+83.1, 10.9 ft Lt.				Casing ID/OD: N/A				Water Level*: None Observed			
Definitions: D = Spilt Spoon Sample S = Sample off Auger Flights B = Bucket Sample off Auger Flights MD = Unsuccessful Split Spoon Sample Attempt U = Thin Wall Tube Sample MV = Unsuccessful Field Vane Shear Test Attempt V = Field Vane Shear Test, PP= Pocket Penetrometer MU = Unsuccessful Thin Wall Tube Sample Attempt R = Rock Core Sample SSA = Solid Stem Auger HSA = Hollow Stem Auger RC = Roller Cone WOH = Weight of 140lb. Hammer WOR/C = Weight of Rods or Casing WO1P = Weight of 1 Person S_u = Peak/Remolded Field Vane Undrained Shear Strength (psf) S_u(lab) = Lab Vane Undrained Shear Strength (psf) q_p = Unconfined Compressive Strength (ksf) N-value = Raw Field SPT N-value T_v = Pocket Torvane Shear Strength (psf) WC = Water Content, percent ≈ = Similar or Equal too LL = Liquid Limit PL = Plastic Limit PI = Plasticity Index G = Grain Size Analysis C = Consolidation Test											
Depth (ft.)	Sample Information								Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.	
	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (6 in.) Shear Strength (psf) or RQD (%)	N-value	Casing Blows	Elevation (ft.)	Graphic Log			
0						SSA			Probe, no soil samples taken.		
5											
10											
15											
20											
25											
Remarks:											
Stratification lines represent approximate boundaries between soil types; transitions may be gradual.										Page 1 of 1	
* Water level readings have been made at times and under conditions stated. Groundwater fluctuations may occur due to conditions other than those present at the time measurements were made.										Boring No.: HB-LIMI-102	

Work Number: 22893.00

1 of 1

Maine Department of Transportation Grain Size Distribution Curve



UNIFIED CLASSIFICATION

	Boring/Sample No.	Station	Offset, ft	Depth, ft	Description	WC, %	LL	PL	PI
○	HB-LIMI-101/1D	2+56.4	7.1 RT	2.0-4.0	SAND, little silt, trace gravel.	6.2			
◆	HB-LIMI-101/2D	2+56.4	7.1 RT	5.0-7.0	SAND, little silt, trace gravel.	46			
■	HB-LIMI-101/3D	2+56.4	7.1 RT	10.0-12.0	SAND, trace silt, trace gravel.	24.9			
●	HB-LIMI-101/4D	2+56.4	7.1 RT	15.0-17.0	SAND, trace gravel, trace silt.	15.2			
▲									
X									

WIN
022893.00
Town
Limington
Reported by/Date
WHITE, TERRY A 2/11/2019