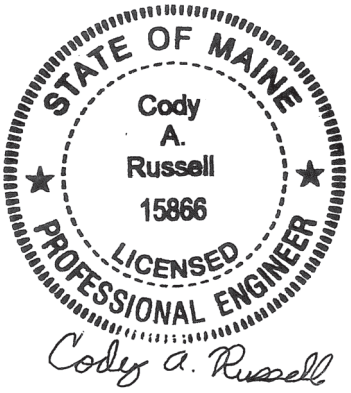
MAINE DEPARTMENT OF TRANSPORTATION
HIGHWAY PROGRAM
GEOTECHNICAL SECTION
AUGUSTA, MAINE

GEOTECHNICAL DESIGN REPORT

For the Replacement of

LARGE CULVERT #890444
ROUTE 129
SOUTH BRISTOL, MAINE

Prepared by:
Cody Russell, P.E.
Geotechnical Engineer



Reviewed by:
Kathleen Maguire, P.E.
Senior Geotechnical Engineer.

Lincoln County
WIN 24253.00

Soils Report 2022-24
Federal Project No. 2425300

October 7, 2022

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 60-inch diameter, 80-foot long corrugated metal pipe (CMP) large culvert (#890444) on Route 129 in South Bristol. The existing culvert is in poor condition. The culvert is located approximately 0.18 of a mile south of Clarks Cove Road as shown in the attached Location Map. Route 129 is a Highway Corridor Priority 4 road.

The proposed replacement structure will be a 117-inch span by 79-inch rise by 110-foot long pipe arch on a skew of approximately 1.7 degrees to the roadway centerline. The invert of the proposed culvert is approximately 16.5 feet below the existing road grade at the roadway centerline. To facilitate fish passage, Habitat Connectivity Design elements will be used inside the pipe arch culvert as shown on the Special Details Sheet in the Plans. The roadway embankment slopes at the proposed culvert inlet and outlet shall be no steeper than 2H:1V.

SUBSURFACE INVESTIGATION

One (1) boring (HB-SBR-101) and one (1) probe (HB-SBR-102) were drilled for this project on April 22, 2019 by the MaineDOT drill crew using a trailer 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.

Boring HB-SBR-101 was drilling using solid steam auger and cased wash boring drilling techniques. Probe HB-SBR-102 was drilled using solid stem auger techniques. Soil samples were obtained in boring HB-SBR-101 at 5-foot intervals using Standard Penetration Test (SPT) methods. The MaineDOT drill rig is equipped with an automatic hammer to drive the split spoon. The MaineDOT calibrated automatic hammer delivers approximately 56 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 0.928 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 Program (NETTCP) certified Subsurface Inspector logged the subsurface conditions encountered. The boring and probes 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 five (4) standard grain size analysis with natural water content, one (1) grain size analysis with hydrometer and natural water content, and one (1) Atterberg Limits test. 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 Curves.

SUBSURFACE CONDITIONS

Subsurface conditions encountered at the test boring and probe generally consisted of fill silt and sandy silt underlain by native clayey silt and silt. 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.

Boring HB-SBR-101 was drilled to a depth of approximately 27.0 feet below ground surface (bgs) and did not encounter a refusal surface. Probe HB-SBR-102 was drilled to a depth of approximately 25.5 bgs and did not encounter a refusal surface.

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

Approx. Depth BGS[1] (feet)	Soil Description	AASHTO[2] Classification	USCS[3]	WC%[4]
0 – 15.0	Fill Brown, moist to wet, silt, some fine to coarse sand, little to some gravel. Olive, wet, fine to coarse sandy silt, little gravel.	A-2-4 or A-4	SM	10.7-15.3
15.0 – 21.0	Grey, wet, clayey silt, trace fine sand.	A-4	CL	31.1
21.0 – 27.0	Grey, wet, silt, some fine to coarse sand, little to some gravel.	A-2-4	SM	12.8

[1]BGS = below ground surface
[2]AASHTO = American Association of State Highway and Transportation Officials
[3]USCS = Unified Soil Classification System
[4]WC% = Water content in percent

Three (3) N_{60}-values obtained in the fill ranged from 9 to 15 blows per foot (bpf) indicating that the fill is stiff in consistency. One (1) N_{60}-value obtained in the clayey silt was 6 bpf, indicating that the native clayey silt is medium stiff in consistency. Two (2) N_{60}-values obtained in the native silt were 9 and 28 bpf, indicating that the native silt is stiff to very stiff in consistency.

Groundwater was recorded at a depth of approximately 14.0 feet bgs in the boring. 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.

The following table summarizes the results of Atterberg Limits tests done on one (1) sample of the clayey silt:

Boring No. and Sample No.	Water Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index
HB-SBR-101 4D	31.1	29	20	9	1.23

Interpretation of these results indicate that the clayey silt has low plasticity. The clayey silt is on the verge of being a viscous liquid if disturbed. Overburden pressure and interparticle cementation is providing stability to keep the soil in its current state, but the slightest disturbance causing remolding could convert the soil into a viscous fluid.

GEOTECHNICAL DESIGN AND CONSTRUCTION RECOMMENDATIONS

Pipe Arch Culvert Construction – The proposed replacement structure will be a 117-inch span by 79-inch rise by 110-foot long pipe arch culvert on a skew of approximately 1.7 degrees to the roadway centerline. The pipe arch culvert shall be designed and constructed in accordance with MaineDOT Standard Specification 603.

The invert of the proposed culvert pipe ranges from approximately 57.75 feet at the inlet end to approximately 56.63 feet at the outlet end with a 1.0% slope. To facilitate fish passage, Habitat Connectivity Design elements will be used inside the pipe arch culvert as shown on the Special Details Sheet in the Plans.

The proposed structure shall be bedded on a 2-foot thick, geotextile wrapped, geogrid reinforced, crushed stone mat (Culvert Bedding Stone; Pay Item 203.55). The geogrid reinforcement shall meet the requirements of Special Provision 620, attached. The Reinforcement Geotextile shall meet the requirements of MaineDOT Standard Specification 722.01. The soils at the bedding elevation shall be excavated using a smooth-edged backhoe bucket to limit disturbance. Any disturbed soils at the bedding elevation resulting from excavation activities shall be removed by hand prior to placement of the geotextile wrapped, geogrid reinforced, crushed stone mat. All subgrade surfaces should be protected from construction traffic in order to limit disturbance. Groundwater and surface water levels shall be depressed sufficiently to allow work in the dry.

The soil backfill shall consist of Granular Borrow (703.19) with a maximum particle size of 4 inches. The Granular Borrow backfill 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, to at least 92 percent of the AASHTO T-180 maximum dry density. In no case shall the backfill soil be compacted less than 92 percent of the AASHTO T-180 maximum dry density.

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 pipe arch 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 pipe arch culvert shall be protected against scour with riprap conforming to MaineDOT Standard Specification Section 703.26 Plain and

Hand Laid Riprap. 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 bedding material 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 may 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 proposed pipe arch culvert will require deep 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 gravelly 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.

The soils at the bedding elevation shall be excavated using a smooth-edged backhoe bucket to limit disturbance. Any disturbed soils at the bedding elevation resulting from excavation activities shall be removed by hand prior to placement of the geotextile wrapped, geogrid reinforced, crushed stone mat. All subgrade surfaces should be protected from construction traffic in order to limit disturbance. Groundwater and surface water levels shall be depressed sufficiently to allow work in the dry.

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 for specific application to the proposed replacement of large Culvert #890444 under Route 129 in South Bristol, 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 Sheet with Boring Logs
Key to Soil and Rock Descriptions and Terms
Boring Logs
Laboratory Testing Summary Sheet
Grain Size Distribution Curves
Atterberg Limits Plot
Special Provision 620 – Geotextile (Reinforcement Geogrid)

Date: 7/21/2022

Division: GEOTECH

Username: terry.white

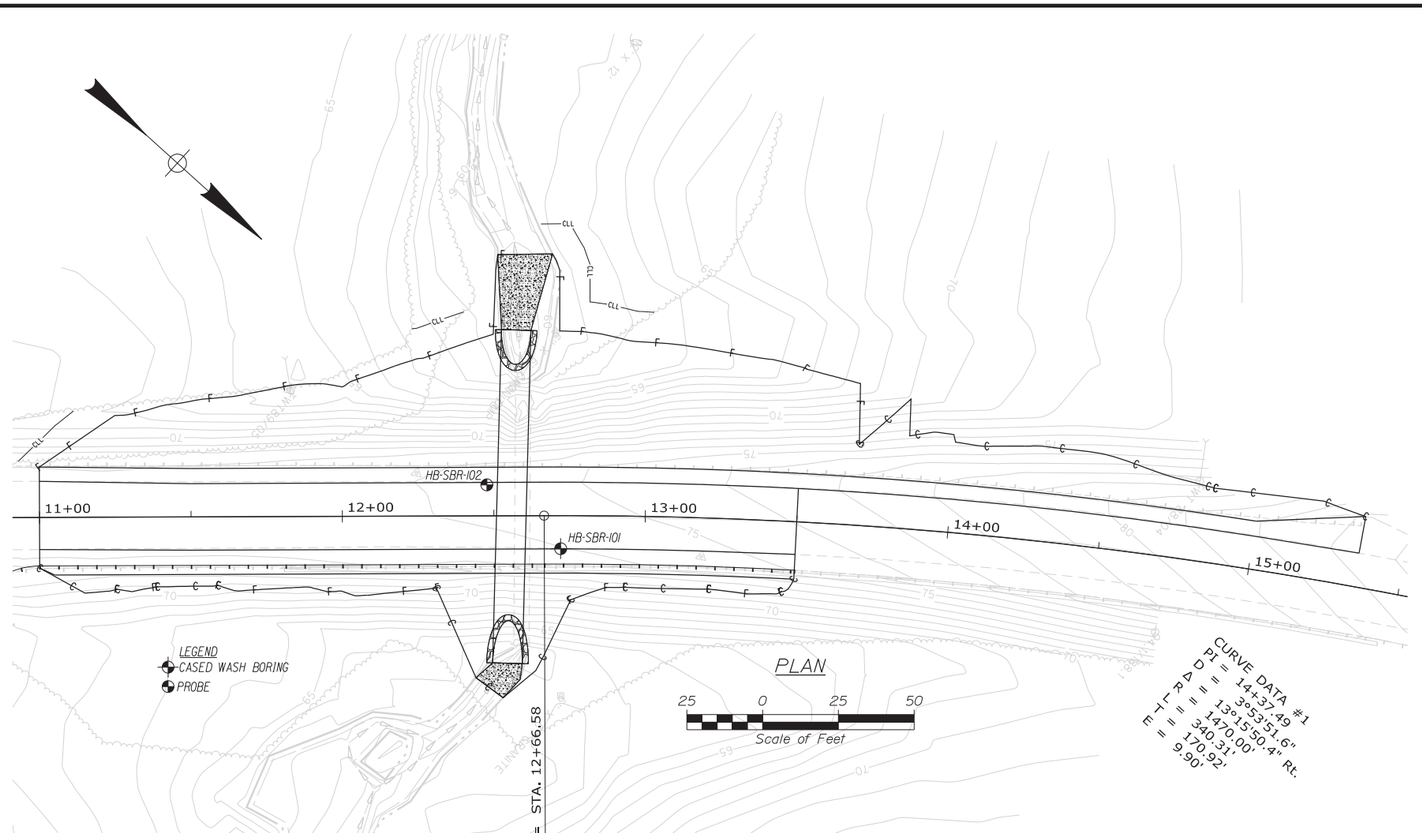
SOUTH BRISTOL, MAINE

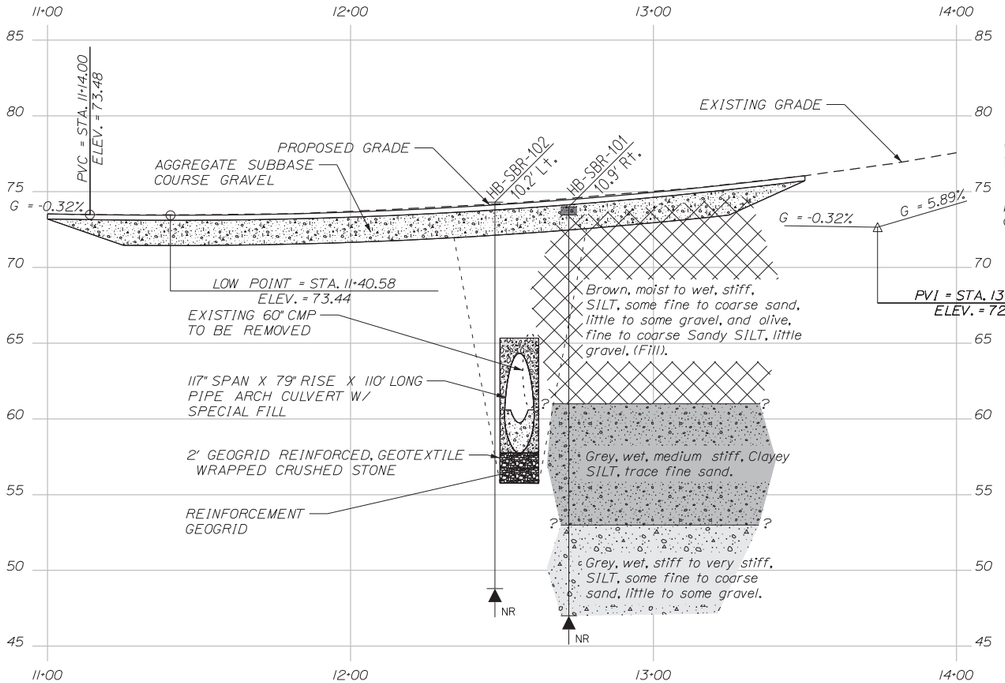
0.25 Miles

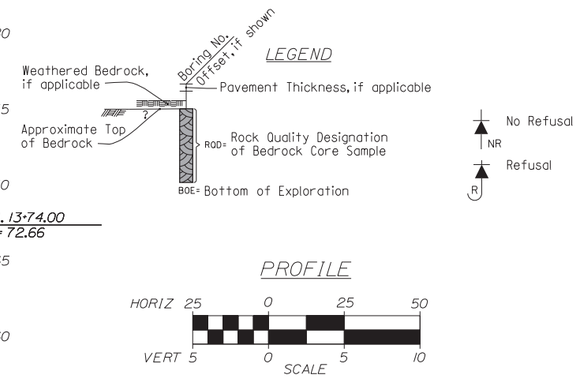
1 inch = 0.28 miles

Date: 7/21/2022
Time: 6:56:51 AM

SHEET NUMBER 1 OF 2	SOUTH BRISTOL ROUTE 129 LOCATION MAP	STATE OF MAINE DEPARTMENT OF TRANSPORTATION 2425300 WIN 24253.00 HIGHWAY PLANS







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
Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project: Route 129 Large Culvert
Location: South Bristol, Maine

Boring No.: HB-SBR-101
WIN: 24253.00

Driller:	MaineDOT	Elevation (ft.):	74.0
Operator:	Doggett/Niles	Datum:	NAVD88
Logged By:	B. Wilder	Rig Type:	CME 45C
Date Start/Finish:	4/22/2019	Drilling Method:	Cased Wash Boring
Boring Location:	12+72.1, 10.9 ft Rt.	Casing ID/OD:	NW-3"
Hammer Efficiency Factor:	0.928	Hammer Type:	Automatic ☒ Hydraulic ☐ Rope & Cathead ☐

Auger ID/OD:	5" Solid Stem		
Sampler:	Standard Split Spoon		
Hammer Wt./Fall:	140#/30"		
Core Barrel:	N/A		
Water Level*@	14.0 ft bgs.		

Definitions:
S = Split Spoon Sample
WO = Unsuccessful Split Spoon Sample Attempt
U = Thin Wall Tube Sample
WU = Unsuccessful Thin Wall Tube Sample Attempt
W = Unsuccessful Field Vane Shear Test Attempt
V = Field Vane Shear Test, PP= Pocket Penetrometer
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
q_u = Peak/Remolded Field Vane Undrained Shear Strength (psf)
$s_{u(lab)}$ = Lab Vane Undrained Shear Strength (psf)
q_u = Unconfined Compressive Strength (ksf)
N-uncorrected = Raw Field SPT N-value
N-corrected = Hammer Efficiency Factor * Rig Specific Hammer Correction Factor * Annular Exploration Factor
N_{60} = SPT N-value Corrected for Hammer Efficiency
N_{60} = Hammer Efficiency Factor/60/Hammer Correction Factor
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 No.	Rec./Rec. (in.)	Sample Depth (ft.)	Blows / 6 in. Resistance Strength (uncorrected or RQD (%)	N-uncorrected	N_{60}	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
0							SSA	73.5		6.5" HMA.	
										0.5	
	10	24/13	1.00 - 3.00	3/4/6/7	10	15				Brown, moist, stiff, SILT, some fine to coarse sand, some gravel. (Fill).	GM337224 A-2-4, SM WC=10.7%
5	20	24/16	5.00 - 7.00	2/2/4/7	6	9				Brown, wet, stiff, SILT, some fine to coarse sand, little gravel. (Fill).	GM337225 A-4, SM WC=14.0%
10	30	24/18	10.00 - 12.00	5/5/4/4	9	14		61.0		Olive, wet, stiff, fine to coarse Sandy SILT, little gravel. (Fill).	GM337131 A-2-4, SM WC=15.3%
										13.0	
15	40	24/20	15.00 - 17.00	2/2/2/2	4	6	9			Grey, wet, medium stiff, Clayey SILT, trace fine sand.	GM337132 A-4, CL WC=31.1% LL=29 PL=20 PI=9
							7				
							6				
							11				
20	50	24/12	20.00 - 22.00	2/2/4/6	6	9	13				
							10	53.0		21.0	
							22			Grey, wet, stiff, SILT, some fine to coarse sand, some gravel.	GM337133 A-2-4, SM WC=12.8%
							47				
25	60	24/17	25.00 - 27.00	15/10/8/14	18	28	105				
							98				
								47.0		Grey, wet, very stiff, SILT, some fine to coarse sand, little gravel.	GM337134 A-4, SM WC=9.9%
30										27.0 Bottom of Exploration at 27.0 feet below ground surface. NO REFUSAL	

Remarks:

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-SBR-101

Maine Department of Transportation
Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project: Route 129 Large Culvert
Location: South Bristol, Maine

Boring No.: HB-SBR-102
WIN: 24253.00

Drilling Contractor:	MaineDOT	Elevation (ft.):	74.3
Operator:	Doggett/Niles	Datum:	NAVD88
Logged By:	B. Wilder	Rig Type:	CME 45C
Date Start/Finish:	4/22/2019	Drilling Method:	Solid Stem Auger
Boring Location:	12+47.7, 10.2 ft Lt.	Casing ID/OD:	N/A

Auger ID/OD:	5" Dia.		
Sampler:	N/A		
Hammer Wt./Fall:	N/A		
Core Barrel:	N/A		
Water Level*@	None Observed		

Definitions:
S = Split Spoon Sample
S = Sample off Auger Flights
B = Bucket Sample off Auger Flights
WO = Unsuccessful Split Spoon Sample Attempt
U = Thin Wall Tube Sample
WU = Unsuccessful Thin Wall Tube Sample Attempt
W = Unsuccessful Field Vane Shear Test Attempt
V = Field Vane Shear Test, PP= Pocket Penetrometer
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
WOH = Weight of 1 Person
q_u = Peak/Remolded Field Vane Undrained Shear Strength (psf)
$s_{u(lab)}$ = Lab Vane Undrained Shear Strength (psf)
q_u = Unconfined Compressive Strength (ksf)
N-uncorrected = Raw Field SPT N-value
N-corrected = Hammer Efficiency Factor * Rig Specific Hammer Correction Factor * Annular Exploration Factor
N_{60} = SPT N-value Corrected for Hammer Efficiency
N_{60} = Hammer Efficiency Factor/60/Hammer Correction Factor
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 No.	Rec./Rec. (in.)	Sample Depth (ft.)	Blows / 6 in. Resistance Strength (uncorrected or RQD (%)	N-value	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
0						SSA			Probe, no material descriptions given.	
5										
10										
15										
20										
25							48.8		Bottom of Exploration at 25.5 feet below ground surface. NO REFUSAL	25.5
27										

Refusal

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-SBR-102

STATE OF MAINE
DEPARTMENT OF TRANSPORTATION

2425300

WIN 24253.00

HIGHWAY PLANS

	BY	DATE
PROJ. MANAGER		
DESIGN-DETAILED		
CHECKED-REVIEWED	SIGNATURE	
DESIGN2-DETAILED2	C.RUSSELL	OCT 2022
DESIGN3-DETAILED3	T.WHITE	
REVISIONS 1	P.E. NUMBER	
REVISIONS 2		
REVISIONS 3		
REVISIONS 4	DATE	
FIELD CHANGES		

SOUTH BRISTOL
ROUTE 129

BORING LOCATION PLAN &
INTERPRETIVE SUBSURFACE PROFILE
WITH BORING LOGS

SHEET NUMBER
2
OF 2

UNIFIED SOIL CLASSIFICATION 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 (little or no fines)	GW	Well-graded gravels, gravel-sand mixtures, little or no fines.
			GP	Poorly-graded gravels, gravel sand mixtures, little or no fines.
		GRAVEL WITH FINES (Appreciable amount of fines)	GM	Silty gravels, gravel-sand-silt mixtures.
			GC	Clayey gravels, gravel-sand-clay mixtures.
	SANDS (more than half of coarse fraction is smaller than No. 4 sieve size)	CLEAN SANDS (little or no fines)	SW	Well-graded sands, Gravelly sands, little or no fines
			SP	Poorly-graded sands, Gravelly sand, little or no fines.
		SANDS WITH FINES (Appreciable amount of fines)	SM	Silty sands, sand-silt mixtures
			SC	Clayey sands, 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.
			CL	Inorganic clays of low to medium plasticity, Gravelly clays, Sandy clays, Silty clays, lean clays.
			OL	Organic silts and organic Silty clays of low plasticity.
	SILTS AND CLAYS (liquid limit greater than 50)		MH	Inorganic silts, micaceous or diatomaceous fine Sandy or Silty soils, elastic silts.
			CH	Inorganic clays of high plasticity, fat clays.
			OH	Organic clays of medium to high plasticity, organic silts.
	HIGHLY ORGANIC SOILS		Pt	Peat and other highly organic soils.

Desired Soil Observations (in this order, if applicable):

Color (Munsell color chart)
Moisture (dry, damp, moist, wet)
Density/Consistency (from above right hand side)
Texture (fine, medium, coarse, etc.)
Name (Sand, Silty Sand, Clay, etc., including portions - trace, little, etc.)
Gradation (well-graded, poorly-graded, uniform, etc.)
Plasticity (non-plastic, slightly plastic, moderately plastic, highly plastic)
Structure (layering, fractures, cracks, etc.)
Bonding (well, moderately, loosely, etc.,)
Cementation (weak, moderate, or strong)
Geologic Origin (till, marine clay, alluvium, etc.)
Groundwater level

Maine Department of Transportation
Geotechnical Section
Key to Soil and Rock Descriptions and Terms
Field Identification Information

MODIFIED BURMISTER SYSTEM

Descriptive Term	Portion of Total (%)
trace	0 - 10
little	11 - 20
some	21 - 35
adjective (e.g. Sandy, Clayey)	36 - 50

TERMS DESCRIBING DENSITY/CONSISTENCY

Coarse-grained soils (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).

Density of Cohesionless Soils	Standard Penetration Resistance N-Value (blows per foot)
Very loose	0 - 4
Loose	5 - 10
Medium Dense	11 - 30
Dense	31 - 50
Very Dense	> 50

Fine-grained soils (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.

Consistency of Cohesive soils	SPT N-Value (blows per foot)	Approximate Undrained Shear Strength (psf)	Field Guidelines
Very Soft	WOH, WOR, WOP, <2	0 - 250	Fist easily penetrates
Soft	2 - 4	250 - 500	Thumb easily penetrates
Medium Stiff	5 - 8	500 - 1000	Thumb penetrates with moderate effort
Stiff	9 - 15	1000 - 2000	Indented by thumb with great effort
Very Stiff	16 - 30	2000 - 4000	Indented by thumbnail
Hard	>30	over 4000	Indented by thumbnail with difficulty

Rock Quality Designation (RQD):

$$\text{RQD (\%)} = \frac{\text{sum of the lengths of intact pieces of core* > 4 inches}}{\text{length of core advance}}$$

*Minimum NQ rock core (1.88 in. OD of core)

Rock Quality Based on RQD

Rock Quality	RQD (%)
Very Poor	≤25
Poor	26 - 50
Fair	51 - 75
Good	76 - 90
Excellent	91 - 100

Desired Rock Observations (in this order, if applicable):

Color (Munsell color chart)
Texture (aphanitic, fine-grained, etc.)
Rock Type (granite, schist, sandstone, etc.)
Hardness (very hard, hard, mod. hard, etc.)
Weathering (fresh, very slight, slight, moderate, mod. severe, severe, etc.)
Geologic discontinuities/jointing:
-dip (horiz - 0-5 deg., low angle - 5-35 deg., mod. dipping - 35-55 deg., steep - 55-85 deg., vertical - 85-90 deg.)
-spacing (very close - <2 inch, close - 2-12 inch, mod. close - 1-3 feet, wide - 3-10 feet, very wide >10 feet)
-tightness (tight, open, or healed)
-infilling (grain size, color, etc.)
Formation (Waterville, Ellsworth, Cape Elizabeth, etc.)
RQD and correlation to rock quality (very poor, poor, etc.)
ref: ASTM D6032 and FHWA NHI-16-072 GEC 5 - Geotechnical Site Characterization, Table 4-12
Recovery (inch/inch and percentage)
Rock Core Rate (X.X ft - Y.Y ft (min:sec))

Sample Container Labeling Requirements:

WIN
Bridge Name / Town
Boring Number
Sample Number
Sample Depth
Blow Counts
Sample Recovery
Date
Personnel Initials

Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project: Route 129 Large Culvert
Location: South Bristol, Maine

Boring No.: HB-SBR-101
WIN: 24253.00

Driller:	MaineDOT	**Elevation (ft.)**	74.0	**Auger ID/OD:**	5" Solid Stem
Operator:	Daggett/Niles	**Datum:**	NAVD88	**Sampler:**	Standard Split Spoon
Logged By:	B. Wilder	**Rig Type:**	CME 45C	**Hammer Wt./Fall:**	140#/30"
Date Start/Finish:	4/22/2019; 08:30-12:00	**Drilling Method:**	Cased Wash Boring	**Core Barrel:**	N/A
Boring Location:	12+72.1, 10.9 ft Rt.	**Casing ID/OD:**	NW-3"	**Water Level*:**	14.0 ft bgs.
Hammer Efficiency Factor:	0.928	**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
N_{60} = SPT N-uncorrected Corrected for Hammer Efficiency
N_{60} = (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 No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N_{60}	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
0							SSA	73.5		6½" HMA.	
										0.5	
	1D	24/13	1.00 - 3.00	3/4/6/7	10	15				Brown, moist, stiff, SILT, some fine to coarse sand, some gravel, (Fill).	G#337224 A-2-4, SM WC=10.7%
5	2D	24/16	5.00 - 7.00	2/2/4/7	6	9				Brown, wet, stiff, SILT, some fine to coarse sand, little gravel, (Fill).	G#337225 A-4, SM WC=14.0%
10	3D	24/18	10.00 - 12.00	5/5/4/4	9	14				Olive, wet, stiff, fine to coarse Sandy SILT, little gravel, (Fill).	G#337131 A-2-4, SM WC=15.3%
								61.0		13.0	
15	4D	24/20	15.00 - 17.00	2/2/2/2	4	6	9			Grey, wet, medium stiff, Clayey SILT, trace fine sand.	G#337132 A-4, CL WC=31.1% LL=29 PL=20 PI=9
							7				
							6				
							11				
							13				
20	5D	24/12	20.00 - 22.00	2/2/4/6	6	9	10				
							22	53.0		21.0	
							47			Grey, wet, stiff, SILT, some fine to coarse sand, some gravel.	G#337133 A-2-4, SM WC=12.8%
							105				
25							98				

Remarks:

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.

Boring No.: HB-SBR-101

Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project: Route 129 Large Culvert
Location: South Bristol, Maine

Boring No.: HB-SBR-101
WIN: 24253.00

Driller:	MaineDOT	**Elevation (ft.)**	74.0	**Auger ID/OD:**	5" Solid Stem
Operator:	Daggett/Niles	**Datum:**	NAVD88	**Sampler:**	Standard Split Spoon
Logged By:	B. Wilder	**Rig Type:**	CME 45C	**Hammer Wt./Fall:**	140#/30"
Date Start/Finish:	4/22/2019; 08:30-12:00	**Drilling Method:**	Cased Wash Boring	**Core Barrel:**	N/A
Boring Location:	12+72.1, 10.9 ft Rt.	**Casing ID/OD:**	NW-3"	**Water Level*:**	14.0 ft bgs.
Hammer Efficiency Factor:	0.928	**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 140 lb. 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
N_{60} = SPT N-uncorrected Corrected for Hammer Efficiency
N_{60} = (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 No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N_{60}	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
25	6D	24/17	25.00 - 27.00	15/10/8/14	18	28		47.0		Grey, wet, very stiff, SILT, some fine to coarse sand, little gravel.	G#337134 A-4, SM WC=9.9%
										27.0 **Bottom of Exploration at 27.0 feet below ground surface.** NO REFUSAL	
30											
35											
40											
45											
50											

Remarks:

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.

Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project: Route 129 Large Culvert
Location: South Bristol, Maine

Boring No.: HB-SBR-102
WIN: 24253.00

Drilling Contractor:	MaineDOT	**Elevation (ft.)**	74.3	**Auger ID/OD:**	5" Dia.
Operator:	Daggett/Niles	**Datum:**	NAVD88	**Sampler:**	N/A
Logged By:	B. Wilder	**Rig Type:**	CME 45C	**Hammer Wt./Fall:**	N/A
Date Start/Finish:	4/22/2019; 08:30-12:00	**Drilling Method:**	Solid Stem Auger	**Core Barrel:**	N/A
Boring Location:	12+47.7, 10.2 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: Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-value	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
0						SSA			Probe, no material descriptions given.	
5										
10										
15										
20										
25										

Remarks:

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.

Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project: Route 129 Large Culvert
Location: South Bristol, Maine

Boring No.: HB-SBR-102
WIN: 24253.00

Drilling Contractor:	MaineDOT	**Elevation (ft.)**	74.3	**Auger ID/OD:**	5" Dia.
Operator:	Daggett/Niles	**Datum:**	NAVD88	**Sampler:**	N/A
Logged By:	B. Wilder	**Rig Type:**	CME 45C	**Hammer Wt./Fall:**	N/A
Date Start/Finish:	4/22/2019; 08:30-12:00	**Drilling Method:**	Solid Stem Auger	**Core Barrel:**	N/A
Boring Location:	12+47.7, 10.2 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: Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-value	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
25							48.8		25.5	
									Bottom of Exploration at 25.5 feet below ground surface. NO REFUSAL	
30										
35										
40										
45										
50										

Remarks:

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.

State of Maine - Department of Transportation

Laboratory Testing Summary Sheet

Town(s): South Bristol Work Number: 24253.00

Boring & Sample Identification Number	Station (Feet)	Offset (Feet)	Depth (Feet)	Reference Number	G.S.D.C. Sheet	W.C. %	L.L.	P.I.	Classification		
									Unified	AASHTO	Frost
HB-SBR-101, 1D	12+72.1	10.9 Rt.	1.0-3.0	337224	1	10.7			SM	A-2-4	II
HB-SBR-101, 2D	12+72.1	10.9 Rt.	5.0-7.0	337225	1	14.0			SM	A-4	III
HB-SBR-101, 3D	12+72.1	10.9 Rt.	10.0-12.0	337131	1	15.3			SM	A-2-4	III
HB-SBR-101, 4D	12+72.1	10.9 Rt.	15.0-17.0	337132	1	31.1	29	9	CL	A-4	IV
HB-SBR-101, 5D	12+72.1	10.9 Rt.	20.0-22.0	337133	1	12.8			SM	A-2-4	II
HB-SBR-101, 6D	12+72.1	10.9 Rt.	25.0-27.0	337134	1	9.9			SM	A-4	IV

Classification of these soil samples is in accordance with AASHTO Classification System M-145-40. This classification is followed by the "Frost Susceptibility Rating" from zero (non-frost susceptible) to Class IV (highly frost susceptible). The "Frost Susceptibility Rating" is based upon the MaineDOT and Corps of Engineers Classification Systems.

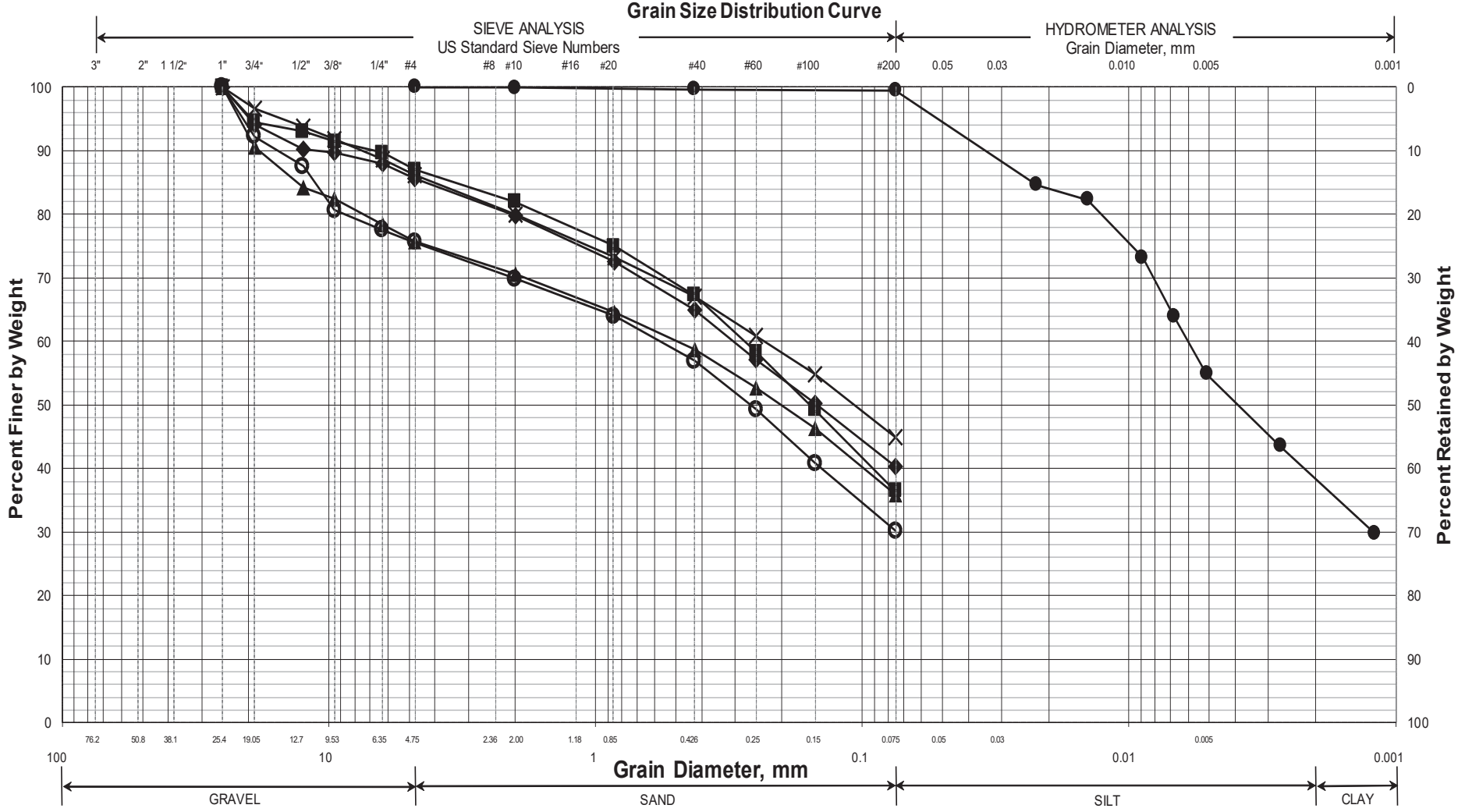
GSDC = Grain Size Distribution Curve as determined by AASHTO T 88-93 (1996) and/or ASTM D 422-63 (Reapproved 1998)

WC = water content as determined by AASHTO T 265-93 and/or ASTM D 2216-98

LL = Liquid limit as determined by AASHTO T 89-96 and/or ASTM D 4318-98 NP = Non Plastic

PI = Plasticity Index as determined by AASHTO 90-96 and/or ASTM D4318-98

Maine Department of Transportation
Grain Size Distribution Curve

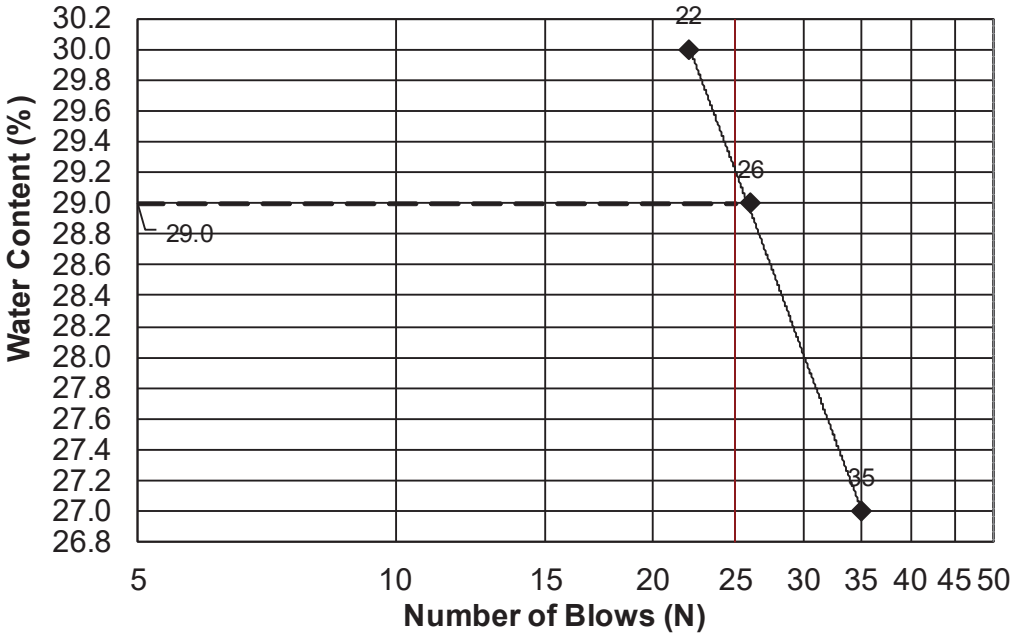


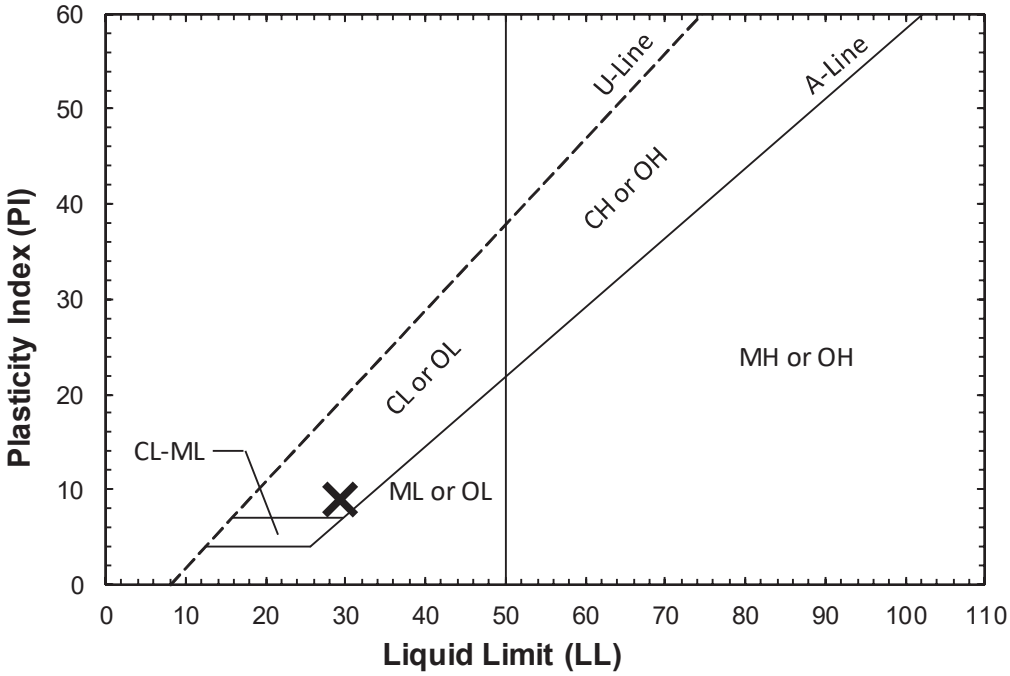
UNIFIED CLASSIFICATION

	Boring/Sample No.	Station	Offset, ft	Depth, ft	Description	WC, %	LL	PL	PI
○	HB-SBR-101/1D	12+72.1	10.9 RT	1.0-3.0	SILT, some sand, some gravel.	10.7			
◆	HB-SBR-101/2D	12+72.1	10.9 RT	5.0-7.0	SILT, some sand, little gravel.	14.0			
■	HB-SBR-101/3D	12+72.1	10.9 RT	10.0-12.0	Sandy SILT, little gravel.	15.3			
●	HB-SBR-101/4D	12+72.1	10.9 RT	15.0-17.0	Clayey SILT, trace sand.	31.1	29	20	9
▲	HB-SBR-101/5D	12+72.1	10.9 RT	20.0-22.0	SILT, some sand, some gravel.	12.8			
×	HB-SBR-101/6D	12+72.1	10.9 RT	25.0-27.0	SILT, some sand, little gravel.	9.9			

WIN
024253.00
Town
South Bristol
Reported by/Date
WHITE, TERRY A 9/6/2022

TOWN	South Bristol	Reference No.	337132
WIN	024253.00	Water Content, %	31.1
Sampled	4/22/2019	Liquid Limit @ 25 blows (T 89), %	29
Boring No./Sample No.	HB-SBR-101/4D	Plastic Limit (T 90), %	20
Station	12+72.1	Plasticity Index (T 90), %	9
Depth	15.0-17.0	Tested By	BBURR





SPECIAL PROVISION
SECTION 620 – GEOTEXTILES
(Reinforcement Geogrid)

Amend Standard Specification 620 – GEOTEXTILES to include the following:

620.01 Description This work shall consist of furnishing and installing Reinforcement Geogrid within the Culvert Bedding Stone in accordance with these specifications and in reasonably close conformity with the lines, grades, and dimensions shown on the plans or as directed by the Resident.

620.02 Material Reinforcement Geogrid shall consist of a regular network of integrally connected, polymeric tensile elements with aperture geometry sufficient to permit significant mechanical interlock with the surrounding soil, aggregate or other material. The Reinforcement Geogrid structure shall be dimensionally stable to retain its geometry under construction stresses and shall have high resistance to damage during construction, ultraviolet degradation, and all forms of chemical and biological degradation encountered in the soil being reinforced.

The Reinforcement Geogrid shall meet or exceed the Minimum Average Roll Values (MARV) of the properties in Table 1. Acceptable manufacturers for Reinforcement Geogrids must be approved by the Resident.

Table 1 - Physical Property Requirements
(Biaxial Reinforcement Geogrid)

Reinforcement Geogrid Mechanical Property	Test Method	Minimum Average Roll Value (MARV)[1]
Tensile strength at 5% Strain MD or XD	ASTM D 6637	1,200 lb/ft
Rib Junction Strength	GRI-GG2	1,000 lb/ft in both directions
Aperture Openings		Between 0.75 and 3 inches
Percent Open Area		50 to 80%

[1] Values are minimum average roll values determined in accordance with ASTM D 4759

A biaxial Reinforcement Geogrid shall be used in this application.

620.03 Placement Reinforcement Geogrid shall be installed, in accordance with the manufacturer's recommendations, unless otherwise modified by this Special Provision. The Reinforcement Geogrid shall be placed within the layers of Crushed Stone Bedding at the proper elevation and alignment as shown on the Plans or as directed by the Resident.

1. The Reinforcement Geogrid shall be placed in continuous longitudinal strips. Splicing along the length will not be allowed. Reinforcement Geogrid shall be oriented such that the roll length runs either parallel or perpendicular to the construction centerline. The Contractor shall verify correct orientation of the Reinforcement Geogrid.

2. Reinforcement Geogrid may be temporarily secured in-place with staples, pins, sand bags or backfill as required by fill properties, fill placement procedures, or weather conditions, or as directed by the Resident.

3. Coverage of less than 100 percent shall not be allowed.

4. The Reinforcement Geogrid shall be lightly anchored and pulled taut to reduce any slack as directed by the Resident.

5. Fill shall not be dumped directly onto the Reinforcement Geogrid. It shall be dumped at the edge of the Reinforcement Geogrid or on a previous course of fill with a minimum compacted depth of 8 inches.

6. The Reinforcement Geogrid shall be covered with fill materials within 7 days of placement to protect against unnecessary exposure.

7. Fill may then be pushed onto the Reinforcement Geogrid using a track mounted bulldozer. At no time shall construction equipment be allowed directly onto the Reinforcement Geogrid. Track mounted equipment shall be allowed on previous courses of fill with a minimum compacted depth of 8 inches. Smooth drum roller compaction equipment shall be allowed on previous courses of fill with a minimum compacted depth of 8 inches and spread fill with a minimum depth of 12 inches, loose measure. At no time shall rubber tired or sheeps-foot rollers be allowed onto the reinforced fill. Turning of vehicles should be kept to a minimum to prevent tracks from displacing the fill and damaging the Reinforcement Geogrid. Sudden breaking and sharp turning shall be avoided. Equipment speeds over 10 MPH shall not be allowed.

8. Placement, spreading, and compaction of soil on top of the Reinforcement Geogrid shall advance from one end of the Reinforcement Geogrid and move towards the other. Care shall be taken to minimize the development of wrinkles and to ensure that the Reinforcement Geogrid doesn't move from its position during fill placement. A spotter shall observe all fill placement operations to ensure the Reinforcement Geogrid does not slip, achieves the minimum coverage specified on the Plans, and is not damaged by the work.

9. Fill shall be compacted as specified in (1) the Standard Specifications or (2) to at least 90 percent of the maximum dry density determined in accordance with AASHTO T-180, whichever is greater. Density testing shall be made at a minimum frequency of one (1) test per lift or as otherwise specified in the Standard Specifications. Care shall be taken not to drive test apparatus through the Reinforcement Geogrid tensile elements.

10. All rutting formed during construction shall be filled with new Culvert Bedding Stone. In no case shall rutting be filled by blading down

620.04 Overlap Adjacent rolls of Reinforcement Geogrid shall be overlapped a minimum of 1 foot.

620.05 Seams Seams along adjacent lengths of Reinforcement Geogrid shall be tied together with hog rings or cable ties every 3 to 6 feet.

620.06 Certification Prior to construction the Contractor shall submit to the Resident the Manufacturer’s certification that the Reinforcement Geogrid supplied has been evaluated in full compliance with this Specification and is fit for long-term, critical soil reinforcement applications.

The Contractor's submittal package shall include, but not be limited to, actual tests for tension/creep, durability/aging, construction damage, and quality control tensile testing.

620.08 Shipment, Storage, Protection, and Repair of Fabric The Contractor shall check the Reinforcement Geogrid upon delivery to ensure that the proper material has been received. Each Reinforcement Geogrid roll shall be shipped in a protective bag and clearly marked with roll number, lot number, geogrid style and principle strength direction. During all periods of shipment and storage, the Reinforcement Geogrid shall be protected from temperatures greater than 140°F and all deleterious materials that might otherwise become affixed to the Reinforcement Geogrid and effect its performance. The manufacturer's recommendations shall be followed with regard to protection from direct sunlight. The Reinforcement Geogrid shall be stored off the ground in a clean, dry environment out of the pathway of construction equipment.

Any Reinforcement Geogrid damage shall be repaired or replaced in accordance with the manufacturer's recommendations. The Contractor shall replace any Reinforcement Geogrid damaged during installation at no additional cost to the Department.

620.09 Method of Measurement Reinforcement Geogrid will be measured by the number of Square Yards of surface area installed. Overlaps for connections, splices, patches, and repairs of damaged Reinforcement Geogrid, etc. are incidental to this Pay Item.

620.10 Basis of Payment Reinforcement Geogrid placement will be paid for per Square Yard in-place which shall be full compensation for all off-loading, inspection, storage, labor, materials, equipment, tools and any incidentals to complete the installation.

Payment will be made under:

Pay Item	Pay Unit
620.65 Reinforcement Geogrid	Square Yard