MAINE DEPARTMENT OF TRANSPORTATION
HIGHWAY PROGRAM
GEOTECHNICAL SECTION
AUGUSTA, MAINE

GEOTECHNICAL DESIGN REPORT

For the Construction of

MARSH COVE BRIDGE
RIVER ROAD
EDGECOMB, MAINE

Prepared by:
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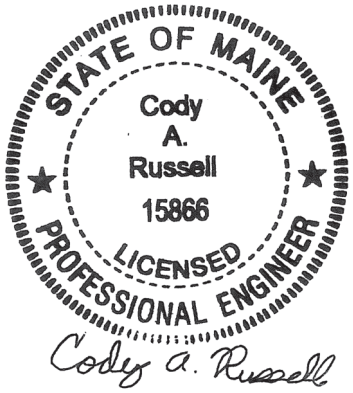

Reviewed by:
Cody Russell, P.E.
Geotechnical Engineer

Lincoln County
WIN 26799.00

Soils Report 2024-28
Bridge No. 6741

October 30, 2024

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Appendices

1.0 INTRODUCTION

The purpose of this Geotechnical Design Report is to present subsurface information and make geotechnical recommendations for the replacement of an existing cross culvert (#123913) on River Road in Edgecomb, Maine. A subsurface investigation has been completed at the site to evaluate subsurface conditions and to develop geotechnical design and construction recommendations for the replacement structure. This report presents the subsurface information obtained during the subsurface investigation and soil laboratory testing programs and provides design and construction recommendations and geotechnical design parameters for the culvert replacement.

The existing structure consists of an approximately 36-inch diameter, 52-foot long corrugated metal pipe (CMP). The CMP is in poor condition and does not meet the current Habitat Connectivity Design (HCD) requirements.

The proposed replacement structure will be a 128-inch span by 83-inch rise by 90-foot-long multi-plate pipe arch culvert on a skew of approximately 31 degrees to the roadway centerline. The invert of the proposed culvert is approximately 12 feet below the existing road grade at the roadway centerline. The roadway embankment slopes at the proposed culvert inlet and outlet shall be no steeper than 2H:1V on the inlet end and 1.5H:1V on the outlet end to protect against erosion.

2.0 GEOLOGIC SETTING

The existing culvert carries an unnamed stream under River Road in Edgecomb and is located approximately 0.94 of a mile north of McKay Road as shown on Sheet 1 – Location Map.

According to the Maine Geological Survey (MGS) map titled Reconnaissance Surficial Geology of the Bristol Quadrangle, Maine, Open File 76-34 (1976) the surficial soils at the site consist of Presumpscot Formation. Presumpscot Formation consists of glaciomarine silt, clay, and sand.

According to the map titled Bedrock Geologic Map of Maine (1985) published by the MGS, the bedrock in the vicinity of the site consists of calcareous sandstone and interbedded sandstone and impure limestone of the Bucksport Formation.

3.0 SUBSURFACE INVESTIGATION

One (1) probe (HB-EDG-101) and three (3) borings (HB-EDG-102, HB-EDG-103 and HB-EDG - 104) and were drilled near the proposed structure on January 12, 2021 by the MaineDOT drill crew using a trailer mounted drill rig. Exploration locations are shown on Sheet 2 – Boring Location Plan & Interpretive Subsurface Profile. Details and sampling methods used, field data obtained, and soil and groundwater conditions encountered are presented on the Boring Logs in Appendix A.

Probe HB-EDG-101 was drilled using solid stem auger techniques. No soil samples were obtained in the probe. Borings HB-EDG-102, HB-EDG-103, and HB-EDG-104 were drilled using solid stem auger, cased wash boring, and rock core drilling techniques. Soil samples were obtained in the borings 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 48 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 0.89 to the raw field N-values. Bedrock was cored in the borings using an NQ 2-inch core barrel and the Rock Core Designation (RQD) of the core was calculated.

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 in the boring and probe. The boring and probe were located in the field by taping to surveyed site features after completion of the drilling program.

4.0 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 nine (9) standard grain size analyses with natural water content, and two (2) standard grain size analyses with hydrometer and natural water content. The results of the laboratory testing program are discussed in the following section and are included in Appendix B – Laboratory Test Results. Laboratory test information is also shown on the Boring Logs in Appendix A.

5.0 SUBSURFACE CONDITIONS

Subsurface conditions encountered in the test borings and probes generally consisted of sand fill underlain by silt underlain by sand underlain by bedrock. An interpretive subsurface profile depicting the generalized soil stratigraphy at the boring location is shown on Sheet 2 – Boring Location Plan & Interpretive Subsurface Profile.

5.1 Pavement and Fill Materials

The borings encountered approximately 5 inches of pavement at the ground surface. The pavement was underlain by fills soils consisting of:

- Brown and light brown, moist, fine to coarse sand, some gravel, trace silt.
- Brown, damp to moist, gravelly fine to coarse sand, trace to little silt, occasional small cobbles.

The thickness of the fill ranged from approximately 3.5 feet to 8.1 feet. N_{60}-values obtained in the fill ranged from 21 to 80 blows per foot (bpf) indicating that the fill is medium dense to very dense in consistency. Cobbles were encountered within the fill layer in borings HB-EDG-102 and HB-EDG-103.

Water contents from four (4) samples obtained within the fill ranged from approximately 2.6% to 6.2%. Grain size analyses conducted on four (4) samples of the fill resulted in the soil being classified as an A-1-a or A-1-b under the AASHTO Soils Classification System and a SM, SP-SM, or SW-SM under the Unified Soil Classification System.

5.2 Silt

The fill soils were underlain by silt consisting of:

- Brown, grey, and olive, wet, silt, some fine to coarse sand, trace to some gravel, trace to little clay, wood.

The thickness of the silt layers ranged from approximately 4.0 feet to 8.5 feet. N_{60}-values obtained in the silt ranged from 10 to 27 bpf indicating that the soil is stiff to very stiff in consistency.

Water contents from four (4) samples obtained within the silt ranged from approximately 18.4% to 39.7%. Grain size analyses conducted on four (4) samples of the native granular soils range resulted in the soil being classified as an A-4 under the AASHTO Soils Classification System and a CL or SC-SM under the Unified Soil Classification System.

5.3 Sand

The silt was underlain by sand consisting of:

- Grey, wet, silty fine to coarse sand, trace gravel.
- Brown and grey, wet, fine to coarse sand, some gravel, little silt, weathered rock.

The thickness of the sand layers ranged from approximately 3.0 feet to 6.2 feet. N_{60}-values obtained in the sand ranged from 18 to 134 bpf indicating that the sand is medium dense to very dense in consistency.

Water contents from three (3) samples obtained within the sand ranged from approximately 8.2% to 27.7%. Grain size analyses conducted on three (3) samples of the sand ranged resulted in the soil being classified as an A-1-b or A-4 under the AASHTO Soils Classification System and a SM under the Unified Soil Classification System.

5.4 Bedrock

Bedrock or a refusal surface was encountered at elevations ranging from approximately 36.3 feet to 39.6 feet in the vicinity of the proposed culvert. The approximate elevations of the top of bedrock or the refusal surface encountered at the boring and probe locations are presented in Appendix A – Boring Logs. Bedrock was cored in borings HB-EDG-102, and HB-EDG-104. The exact nature of the refusal surface was not determined in the probe.

The bedrock consists of calcareous sandstone and interbedded sandstone and impure limestone of the Bucksport Formation. The Rock Quality Designation (RQD) of the bedrock was determined to range from 0% to 80%, correlating to a Rock Quality of Very Poor to Good.

5.5 Groundwater

Groundwater was recorded at depth 9.0 feet bgs in boring HB-EDG-102. Groundwater levels can be expected to fluctuate subject to seasonal variations, local soil conditions, topography, precipitation, and construction activity.

6.0 GEOTECHNICAL DESIGN AND CONSTRUCTION RECOMMENDATIONS

The following sections discuss geotechnical recommendations for the design and construction of the proposed culvert.

6.1 Multi-plate Pipe Arch Culvert Design and Construction

The proposed replacement structure will consist of a 128-inch span by 83-inch rise by 90-foot-long multi-plate pipe arch culvert on a skew of approximately 30 degrees. The proposed culvert shall be designed and constructed in accordance with MaineDOT Standard Specification 603.

The approximate invert of the proposed culvert ranges from an elevation of 43.00 feet at the inlet to 40.00 feet at the outlet with a 3.3% slope. To facilitate fish passage, Habitat Connectivity Design elements will be used inside the multi-plate pipe arch culvert as shown on the Streambed Details Sheet in the Plans.

The full nature of the culvert bearing surface will not become evident until the culvert excavation is made. Any cobbles or boulders in excess of 6 inches encountered at the bedding elevation shall be removed and replaced with compacted Granular Borrow Material for Underwater Backfill or Crushed Stone ¾-Inch. Any disturbed soils at the bedding elevation resulting from excavation activities should be removed by hand prior to placement of the bedding material. 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.

6.2 Oversteepened Slopes at Culvert Outlet

A 1.5H:1V slope is proposed at culvert outlet. In accordance with AASHTO LRFD Bridge Design Specifications 9th Edition 2020 (LRFD) Article 11.6.3.7 evaluation of earth slopes where geotechnical parameters are well-defined shall achieve a factor of safety of 1.3 (equivalent to a resistance factor of 0.75). Analysis of the proposed 1.5H:1V slopes using Geostudio Slope/W software determined that riprap armor was necessary for the slopes to achieve a factor of safety of 1.3 or greater. The critical slope was analyzed assuming 3-feet of plain riprap will armor the full height of the slope. The analysis of the proposed slope resulted in an acceptable factor of safety of 1.346. Appendix C – Slope Stability Analyses presents the stability results from this analysis. The stability analyses were based on subsurface conditions encountered in borings drilled in the vicinity of the slopes.

The slope shall be armored with 3 feet of riprap conforming to MaineDOT Standard Specification Section 703.26 Plain Riprap and Hand Laid Riprap underlain by a 1-foot layer of protective aggregate cushion conforming to MaineDOT Standard Specification 703.19 Granular Borrow Material for Underwater Backfill that is underlain by a non-woven Class 1 erosion control geotextile that meets the requirements for MaineDOT Standard Specification 722.03.

6.3 Bedrock Removal and Subgrade Preparation

The approximate invert of the proposed culvert ranges from an elevation of 43.00 feet at the inlet to 40.00 feet at the outlet. Constructing the culvert at this elevation may require removal of bedrock. The need for and depth of weathered bedrock removal will vary over the length of the multi-plate pipe arch culvert. The bottom elevation of the excavation shall take into account the wall thickness of the culvert bottom and the required 1-foot layer of bedding material. The boring indicates that the Rock Quality of the bedrock is very poor to good with an RQD of approximately 0 to 80 percent.

The bedrock surface shall be prepared in accordance with MaineDOT standard practices. The nature, slope, and degree of fracturing in the bedrock bearing surfaces will not be evident until the excavation from the multi-plate pipe arch culvert is made. Construction activities should not be permitted to create any open fissures in the bedrock to remain. Any irregularities in the existing bedrock surface or irregularities created during the excavation process should be backfilled with crushed stone to the bottom of the required bedding material.

The Contractor shall remove any overburden soil and bedrock that can be removed using ordinary excavation equipment to expose the proposed bearing surface at the required elevation. The cleanliness and condition of the bedrock surface should be confirmed and accepted by the Resident prior to placing the structural bedding material. If soil is encountered at bedding material subgrade it shall be proof-rolled using multiple passes of a static roller to achieve a firm and stable surface for construction. Any cobbles, boulders, or loose bedrock encountered in excess of 6 inches shall be removed and replaced with compacted Granular Borrow Material for Underwater Backfill or Crushed Stone ¾-Inch.

Blasting shall be conducted in accordance with MaineDOT Standard Specifications Sections 105.2.7 and 203. The Contractor is required to conduct pre- and post-blast surveys, as well as blast

vibrations monitoring at nearby structures in accordance with industry standards at the time of the blast.

It is anticipated that there will be seepage of water from fractures and joints exposed in the bedrock surface. Water should be controlled by pumping from sumps. The Contractor should maintain the excavation so that all work is completed in the dry.

6.4 Settlement

No settlement issues are anticipated at the site. The proposed multi-plate pipe arch culvert will be constructed at a new location east (up station) of the existing. The multi-plate 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 bedrock, subgrade soils, and bedding material will be immediate and negligible.

6.5 Scour and Riprap

Both the inlet and outlet of the multi-plate 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 at the inlet end and 1.5H:1V at the outlet end. No specific scour protection recommendations are needed other than armoring with riprap. The riprap on the slopes shall be underlain by a 1-foot layer of protective aggregate cushion consisting of Granular Borrow Material for Underwater Backfill (703.19) that is underlain by a non-woven, Class 1 Erosion Control Geotextile meeting the requirements of MaineDOT Standard Specification 722.03. The toe of the riprap sections shall be keyed into the existing soils 1 foot below the streambed elevation.

6.6 Seismic Design Considerations

In conformance with LRFD Article 3.10.1, seismic analysis is not required for buried structures, except where they cross active faults. There are no known active faults in Maine; therefore, seismic analysis is not required.

6.7 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 multi-plate 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 sand or bedrock 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 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.

7.0 CLOSURE

This report has been prepared for the use of the MaineDOT Highway Program for specific application to the proposed replacement of an existing large culvert (#123913) under River Road in Edgecomb, Maine in accordance with generally accepted geotechnical and foundation engineering practices. No other intended use or warranty is expressed or implied.

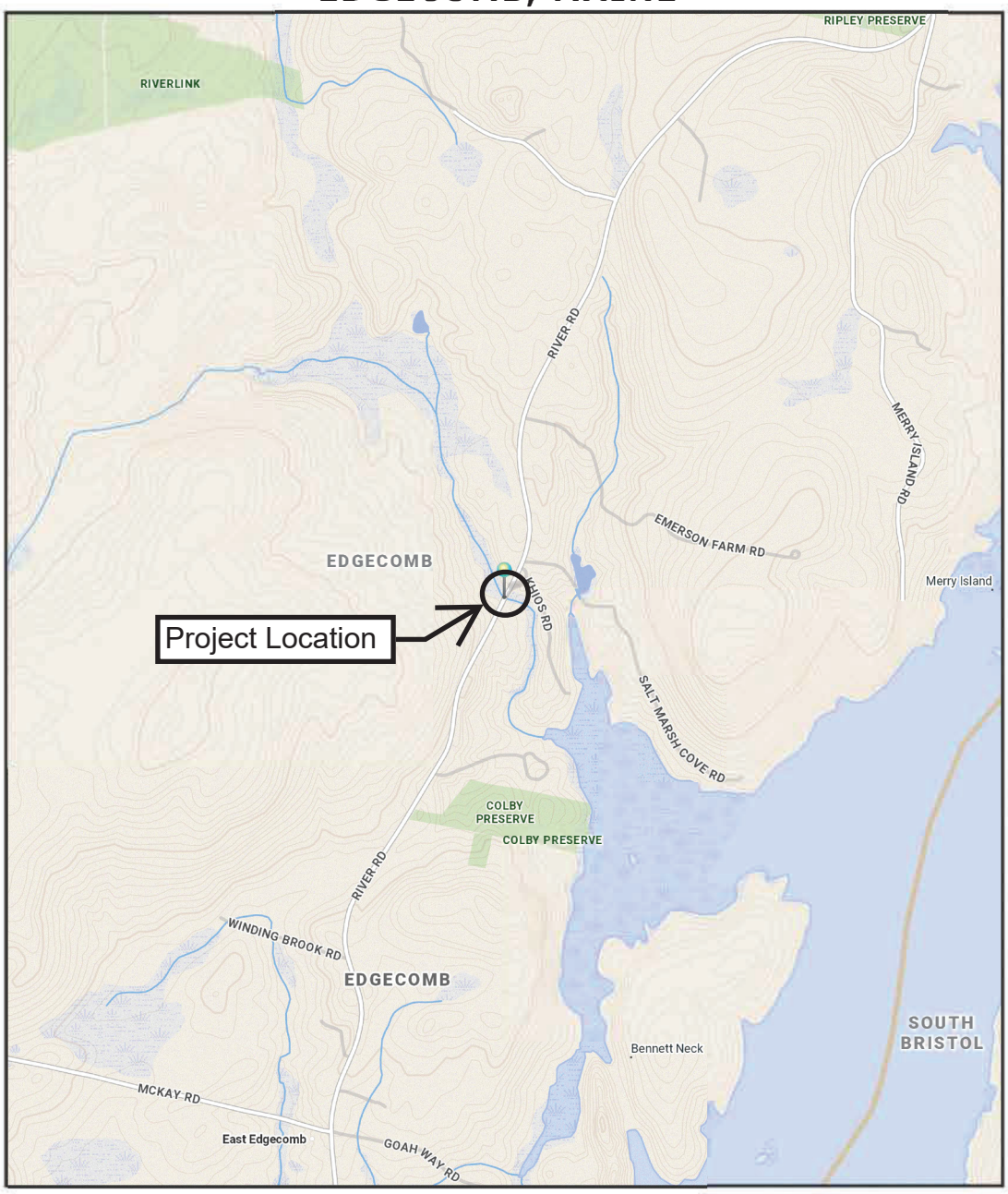
In the event that any changes in the nature, design, or location of the proposed project are planned, this report should be reviewed by a geotechnical engineer to assess the appropriateness of the conclusions and recommendations and to modify the recommendations as appropriate to reflect the changes 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.

Sheets

Date: 10/9/2024
Division: GEOTECH
Username: Terry.White

EDGECOMB, MAINE



0.25 Miles
1 inch = 0.28 miles

Date: 10/9/2024
Time: 10:54:36 AM

SHEET NUMBER		STATE OF MAINE DEPARTMENT OF TRANSPORTATION
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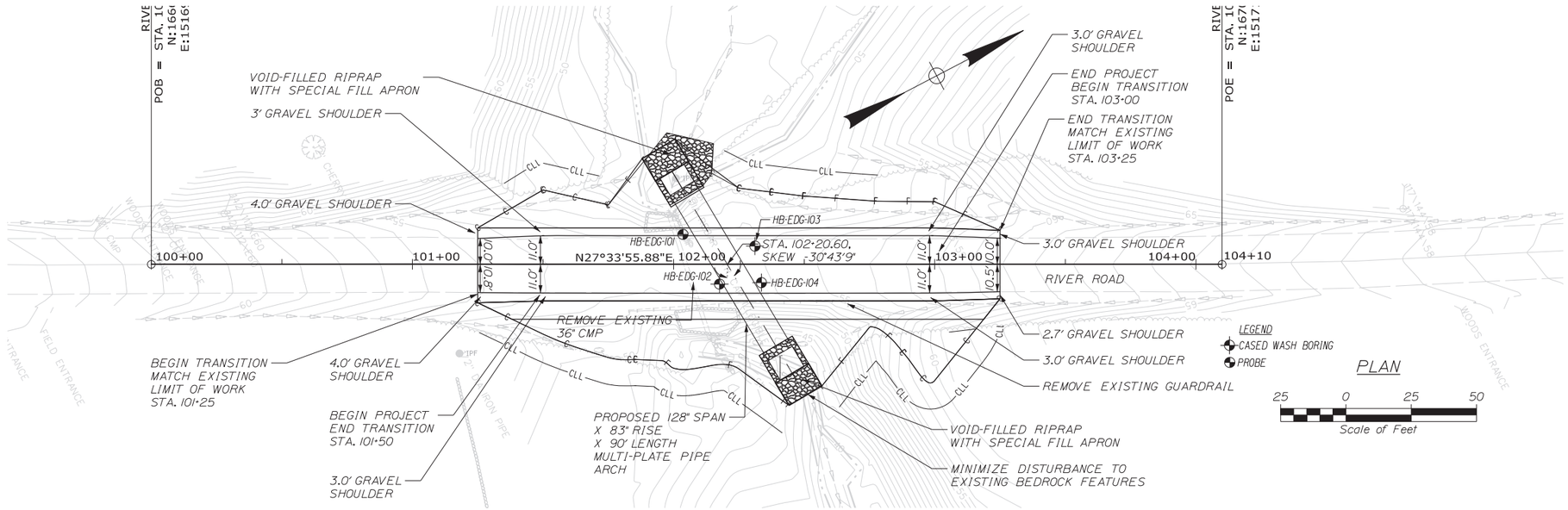
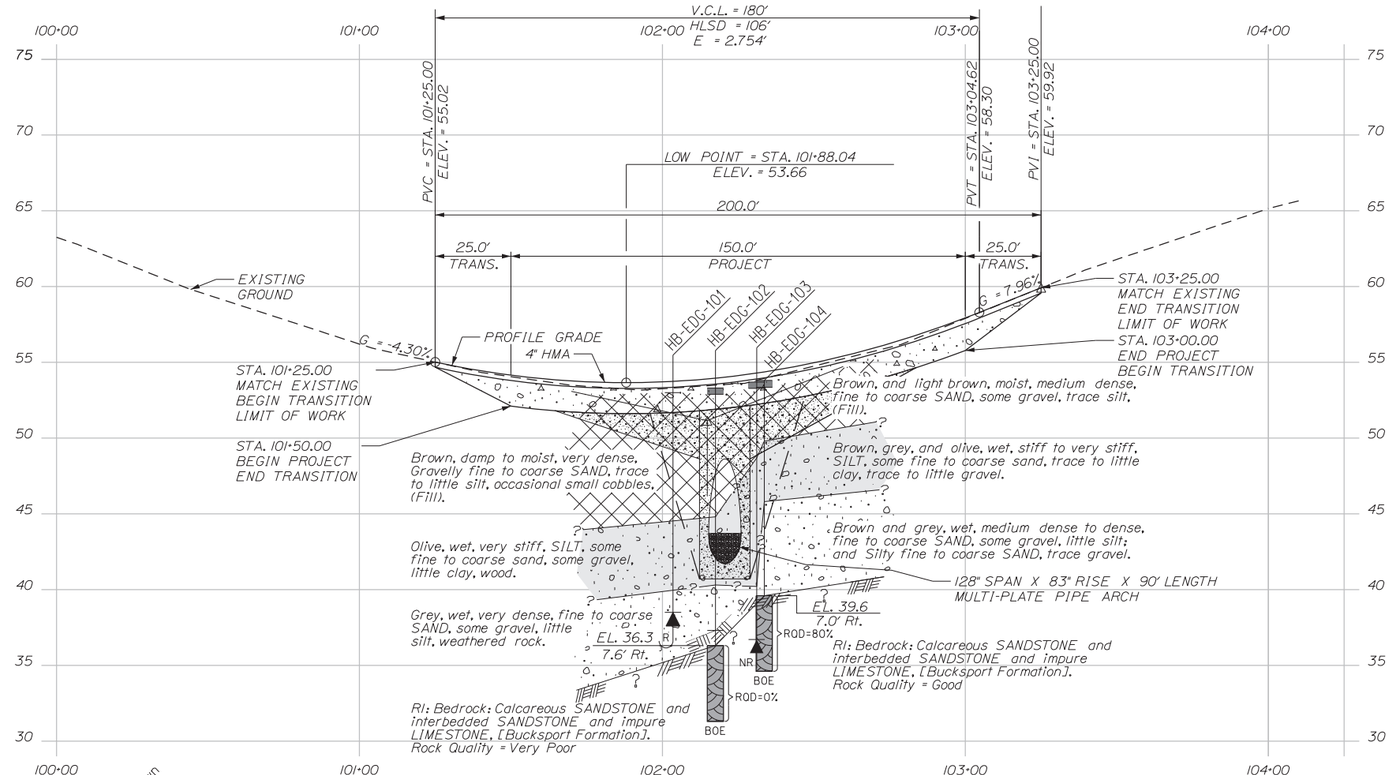
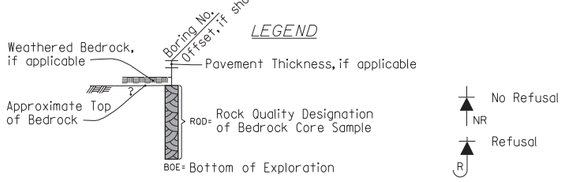
OF 2	LOCATION MAP	WIN 26799.00 HIGHWAY PLANS







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.

STATE OF MAINE
DEPARTMENT OF TRANSPORTATION

26799.00

WIN
26799.00

HIGHWAY PLANS

PROJ. MANAGER	BY	DATE
DESIGN-DETAILED	T. WHITE	OCT 2024
CHECKED-REVIEWED	-----	-----
DESIGN2-DETAILED2	-----	SIGNATURE
DESIGN3-DETAILED3	-----	-----
REVISIONS 1	-----	P.E. NUMBER
REVISIONS 2	-----	-----
REVISIONS 3	-----	DATE
REVISIONS 4	-----	-----
FIELD CHANGES	-----	-----

EDGECOMB
RIVER ROAD

BORING LOCATION PLAN & INTERPRETIVE SUBSURFACE PROFILE

SHEET NUMBER
2
OF 2

Appendix A

Boring Logs

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

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))

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

Sample Container Labeling Requirements:

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

Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project: River Road Large Culvert Replacement

Location: Edgecomb, Maine

Boring No.: HB-EDG-101

WIN: 26799.00

Driller:	MaineDOT	**Elevation (ft.)**	53.0	**Auger ID/OD:**	5" Dia.
Operator:	Daggett/Brooks	**Datum:**	NAVD88	**Sampler:**	N/A
Logged By:	B. Wilder	**Rig Type:**	CME 45C	**Hammer Wt./Fall:**	N/A
Date Start/Finish:	1/12/2021	**Drilling Method:**	Solid Stem Auger	**Core Barrel:**	N/A
Boring Location:	102+03.5, 11.5 ft Lt.	**Casing ID/OD:**	N/A	**Water Level*:**	None Observed
Hammer Efficiency Factor:		**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 Information: 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			Probe, no material samples taken.	
5											
10											
15								38.5		14.5 **Bottom of Exploration at 14.5 feet below ground surface.** REFUSAL	
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: River Road Large Culvert Replacement

Location: Edgecomb, Maine

Boring No.: HB-EDG-102

WIN: 26799.00

Driller:	MaineDOT	**Elevation (ft.)**	53.3	**Auger ID/OD:**	5" Solid Stem
Operator:	Daggett/Brooks	**Datum:**	NAVD88	**Sampler:**	Standard Split Spoon
Logged By:	B. Wilder	**Rig Type:**	CME 45C	**Hammer Wt./Fall:**	140#/30"
Date Start/Finish:	1/12/2021; 08:30-11:00	**Drilling Method:**	Cased Wash Boring	**Core Barrel:**	NQ-2"
Boring Location:	102+17.5, 7.6 ft Rt.	**Casing ID/OD:**	NW-3"	**Water Level*:**	9.0 ft bgs.
Hammer Efficiency Factor: 0.89		**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	52.9		5" HMA. 0.4	
	1D	24/8	1.00 - 3.00	23/28/26/20	54	80				Brown, damp, very dense, Gravelly fine to coarse SAND, little silt, (Fill).	G#340933 A-1-a, SM WC=2.6%
5	2D	24/16	5.00 - 7.00	4/23/12/23	35	52				Brown, moist, very dense, Gravelly fine to coarse SAND, trace silt, occasional small cobbles, (Fill).	G#340934 A-1-a, SW-SM WC=4.1%
								44.8		8.5	
10	3D	24/18	10.00 - 12.00	4/5/6/6	11	16				Olive, wet, very stiff, SILT, some fine to coarse sand, some gravel, little clay, wood.	G#340935 A-4, SC-SM WC=25.0%
								40.3		13.0	
15	4D	21.6/15	15.00 - 16.80	5/32/58/70(3.6")	90	134	35			Grey, wet, very dense, fine to coarse SAND, some gravel, little silt, weathered rock.	G#340936 A-1-b, SM WC=8.2%
							[a]100	37.3		16.0	
	R1	60/56	17.00 - 22.00	RQD = 0%			NQ-2	36.3		[a]100 blows for 0.8 ft. Weathered ROCK at 16.0 ft bgs. Roller Coned ahead to 17.0 ft bgs. 17.0	
20										Top of Bedrock at Elev. 36.3 ft. R1: Bedrock: Calcareous SANDSTONE and interbedded SANDSTONE and impure LIMESTONE, [Bucksport Formation]. Rock Quality = Very Poor R1: Core Times (min:sec) 17.0-18.0 ft (1:25) 18.0-19.0 ft (1:35) 19.0-20.0 ft (1:00) 20.0-21.0 ft (0:40) 21.0-22.0 ft (1:01) 93% Recovery	
								31.3		22.0	
25										**Bottom of Exploration at 22.0 feet below ground surface.**	

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-EDG-102

Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project: River Road Large Culvert Replacement
Location: Edgecomb, Maine

Boring No.: HB-EDG-103
WIN: 26799.00

Driller:	MaineDOT	**Elevation (ft.)**	53.7	**Auger ID/OD:**	5" Solid Stem
Operator:	Daggett/Brooks	**Datum:**	NAVD88	**Sampler:**	Standard Split Spoon
Logged By:	B. Wilder	**Rig Type:**	CME 45C	**Hammer Wt./Fall:**	140#/30"
Date Start/Finish:	1/12/2021; 13:00-14:00	**Drilling Method:**	Cased Wash Boring	**Core Barrel:**	N/A
Boring Location:	102+31.1, 7.0 ft Lt.102+321	**Casing ID/OD:**	NW-3"	**Water Level*:**	None Observed
Hammer Efficiency Factor: 0.89		**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 Information: 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	53.3		5" HMA. 0.4	
	1D	24/15	1.00 - 3.00	7/6/8/11	14	21				Brown, moist, medium dense, fine to coarse SAND, some gravel, trace silt, (Fill).	G#340937 A-1-b, SW-SM WC=4.8%
										Cobble from 4.5-5.0 ft bgs.	
5	2D	24/14	5.00 - 7.00	8/9/9/6	18	27		48.7		5.0 Brown, wet, very stiff, SILT, some fine to coarse sand, little gravel.	G#340938 A-4, CL WC=18.4%
10	3D	24/16	10.00 - 12.00	2/2/5/7	7	10	6			Grey, wet, stiff, SILT, some fine to coarse sand, little clay, trace gravel.	G#340940 A-4, CL WC=39.7%
							17				
							30				
							57	40.2		13.5	
							55				
15	4D	24/15	15.00 - 17.00	12/16/18/33	34	50				Brown, wet, dense, fine to coarse SAND, some gravel, little silt.	G#340939 A-1-b, SM WC=10.5%
								36.7		17.0	
20										**Bottom of Exploration at 17.0 feet below ground surface.** NO REFUSAL	
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.

Boring No.: HB-EDG-103

Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project: River Road Large Culvert Replacement

Location: Edgecomb, Maine

Boring No.: HB-EDG-104

WIN: 26799.00

Driller:	MaineDOT	**Elevation (ft.)**	53.8	**Auger ID/OD:**	5" Solid Stem
Operator:	Daggett/Brooks	**Datum:**	NAVD88	**Sampler:**	Standard Split Spoon
Logged By:	B. Wilder	**Rig Type:**	CME 45C	**Hammer Wt./Fall:**	140#/30"
Date Start/Finish:	1/12/2021; 11:00-12:30	**Drilling Method:**	Cased Wash Boring	**Core Barrel:**	NQ-2"
Boring Location:	102+33.6, 7.0 ft Rt.	**Casing ID/OD:**	NW-3"	**Water Level*:**	None Observed
Hammer Efficiency Factor:	0.89	**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	53.3		5½" HMA. 0.5	
	1D	24/16	1.00 - 3.00	6/8/6/4	14	21				Light brown, moist, medium dense, fine to coarse SAND, some gravel, trace silt, (Fill).	G#340941 A-1-b, SP-SM WC=6.2%
								49.8		4.0	
5	2D	24/14	5.00 - 7.00	3/7/5/5	12	18				Olive, wet, very stiff, SILT, some fine to coarse sand, trace gravel.	G#340942 A-4, CL WC=20.5%
								45.8		8.0	
10	3D	24/15	10.00 - 12.00	2/5/7/10	12	18	5			Grey, wet, medium dense, Silty fine to coarse SAND, trace gravel.	G#340943 A-4, SM WC=27.7%
							24				
							25				
							28				
	R1	60/57	14.20 - 19.20	RQD = 80%			a70 NQ-2	39.6		[a]70 blows for 0.2 ft. 14.2	
15										Top of Bedrock at Elev. 39.6 ft. R1: Bedrock: Calcareous SANDSTONE and interbedded SANDSTONE and impure LIMESTONE, [Bucksport Formation]. Rock Quality = Good R1: Core Times (min:sec) 14.2-15.2 ft (1:43) 15.2-16.2 ft (1:45) 16.2-17.2 ft (1:54) 17.2-18.2 ft (2:02) 18.2-19.2 ft (1:58) 95% Recovery	
								34.6		19.2	
20										**Bottom of Exploration at 19.2 feet below ground surface.**	
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.

Boring No.: HB-EDG-104

Appendix B

Laboratory Test Results

State of Maine - Department of Transportation

Laboratory Testing Summary Sheet

Town(s): Edgecomb Work Number: 26799.00

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-EDG-102, 1D	102+17.5	7.6 Rt.	1.0-3.0	340933	1	2.6			SM	A-1-a	II
HB-EDG-102, 2D	102+17.5	7.6 Rt.	5.0-7.0	340934	1	4.1			SW-SM	A-1-a	0
HB-EDG-102, 3D	102+17.5	7.6 Rt.	10.0-12.0	340935	1	25.0			SC-SM	A-4	III
HB-EDG-102, 4D	102+17.5	7.6 Rt.	15.0-16.8	340936	1	8.2			SM	A-1-b	II
HB-EDG-103, 1D	102+31.1,	7.0 Lt.	1.0-3.0	340937	2	4.8			SW-SM	A-1-b	0
HB-EDG-103, 2D	102+31.1,	7.0 Lt.	5.0-7.0	340938	2	18.4			CL	A-4	IV
HB-EDG-103, 3D	102+31.1,	7.0 Lt.	10.0-12.0	340940	2	39.7			CL	A-4	IV
HB-EDG-103, 4D	102+31.1,	7.0 Lt.	15.0-17.0	340939	2	10.5			SM	A-1-b	II
HB-EDG-104, 1D	102+33.6	7.0 Rt.	1.0-3.0	340941	3	6.2			SP-SM	A-1-b	0
HB-EDG-104, 2D	102+33.6	7.0 Rt.	5.0-7.0	340942	3	20.5			CL	A-4	IV
HB-EDG-104, 3D	102+33.6	7.0 Rt.	10.0-12.0	340943	3	27.7			SM	A-4	III

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.

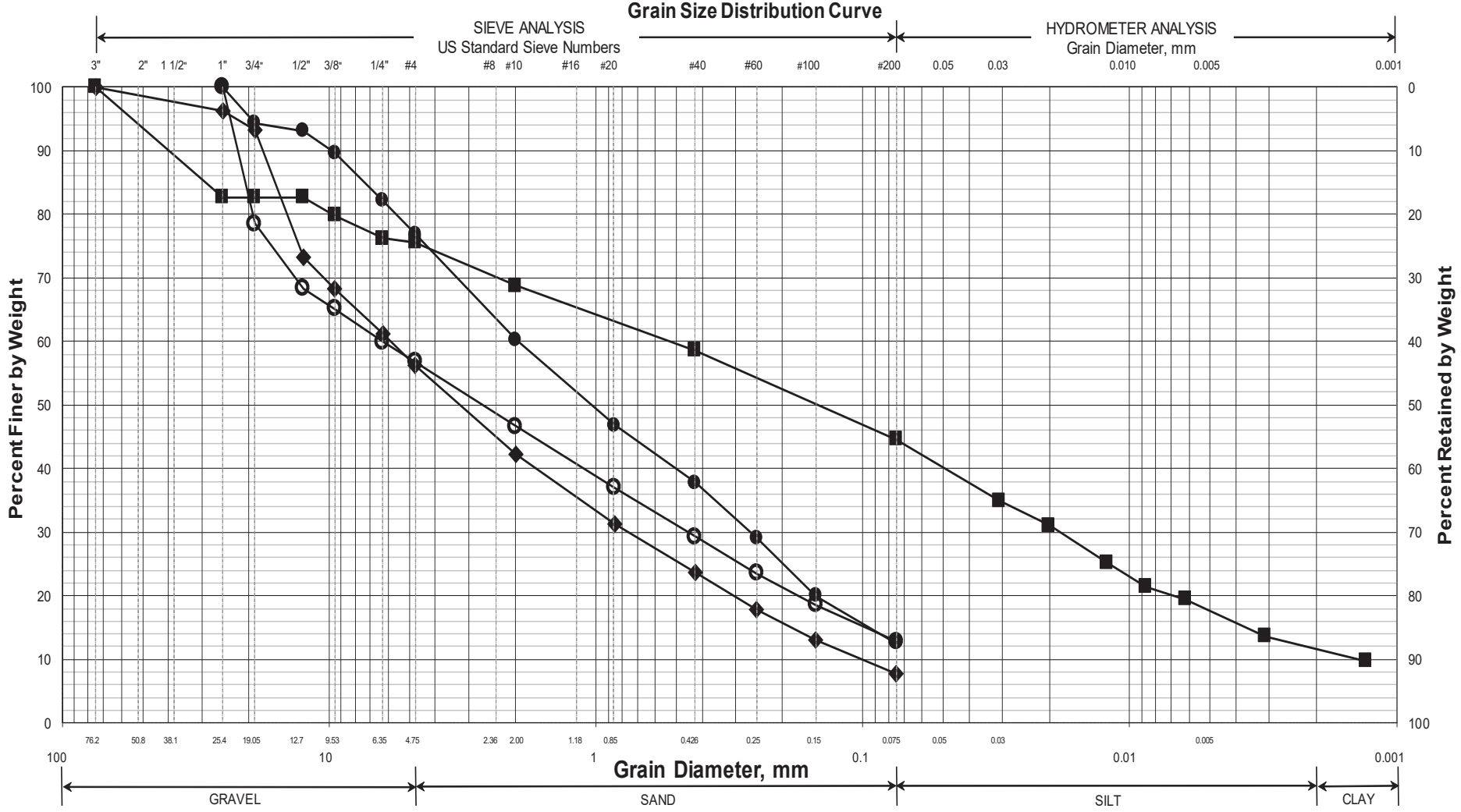
GSDC = Grain Size Distribution Curve as determined by AASHTO T 88-93 (1996) and/or ASTM D 422-63 (Reapproved 1998)

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-EDG-102/1D	102+17.5	7.6 RT	1.0-3.0	Gravelly SAND, little silt.	2.6			
◆	HB-EDG-102/2D	102+17.5	7.6 RT	5.0-7.0	Gravelly SAND, trace slt.	4.1			
■	HB-EDG-102/3D	102+17.5	7.6 RT	10.0-12.0	SILT, some sand, some gravel, little clay.	25.0			
●	HB-EDG-102/4D	102+17.5	7.6 RT	15.0-16.8	SAND, some gravel, little silt.	8.2			
▲									
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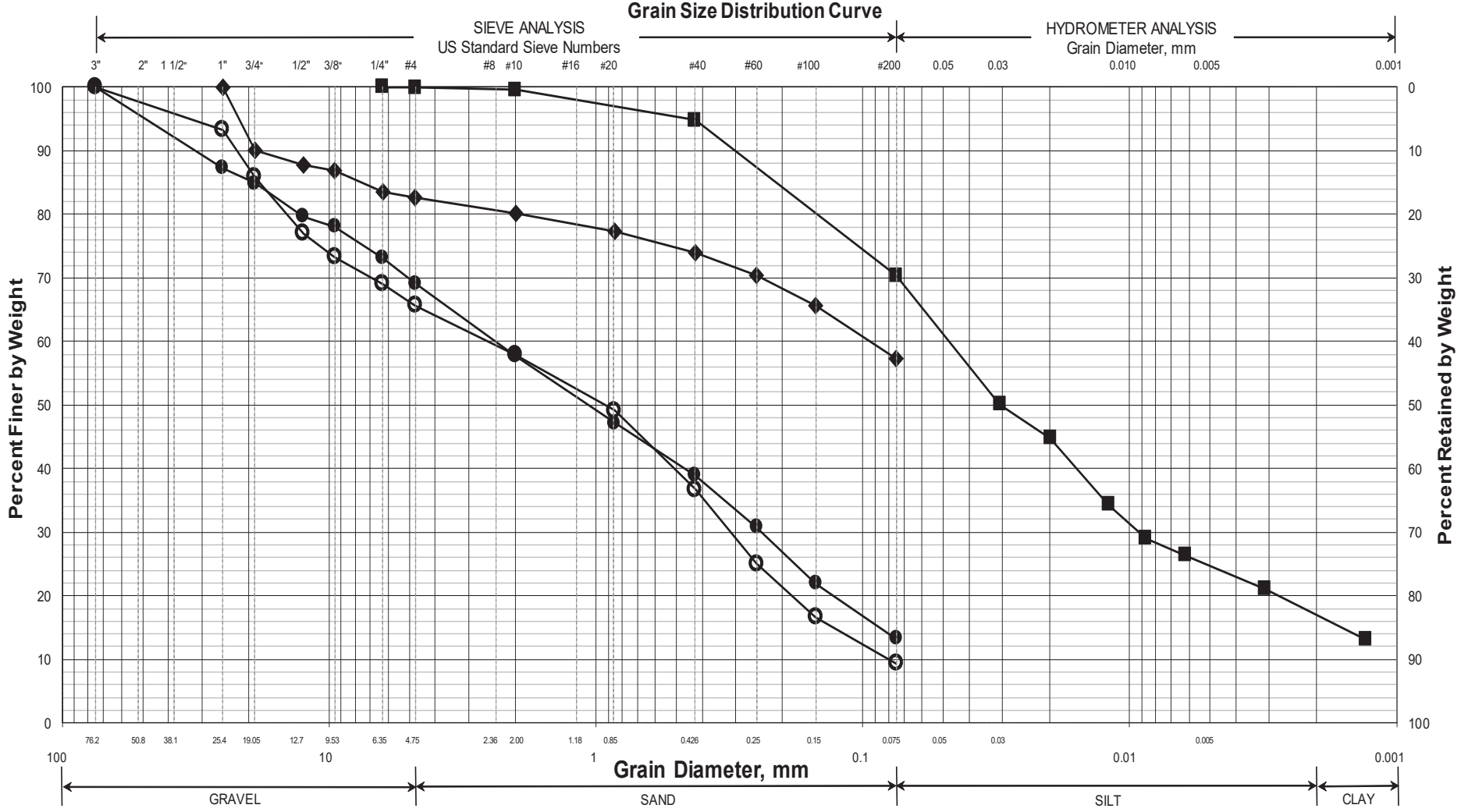
Town
Edgecomb
Reported by/Date
WHITE, TERRY A 8/30/2024

Maine Department of Transportation
Grain Size Distribution Curve



UNIFIED CLASSIFICATION

	Boring/Sample No.	Station	Offset, ft	Depth, ft	Description	WC, %	LL	PL	PI
○	HB-EDG-103/1D	102+31.1	7.0 LT	1.0-3.0	SAND, some gravel, trace silt.	4.8			
◆	HB-EDG-103/2D	102+31.1	7.0 LT	5.0-7.0	SILT, some sand, little gravel.	18.4			
■	HB-EDG-103/3D	102+31.1	7.0 LT	10.0-12.0	SILT, some sand, little clay, trace gravel.	39.7			
●	HB-EDG-103/4D	102+31.1	7.0 LT	15.0-17.0	SAND, some gravel, little silt.	10.5			
▲									
×									

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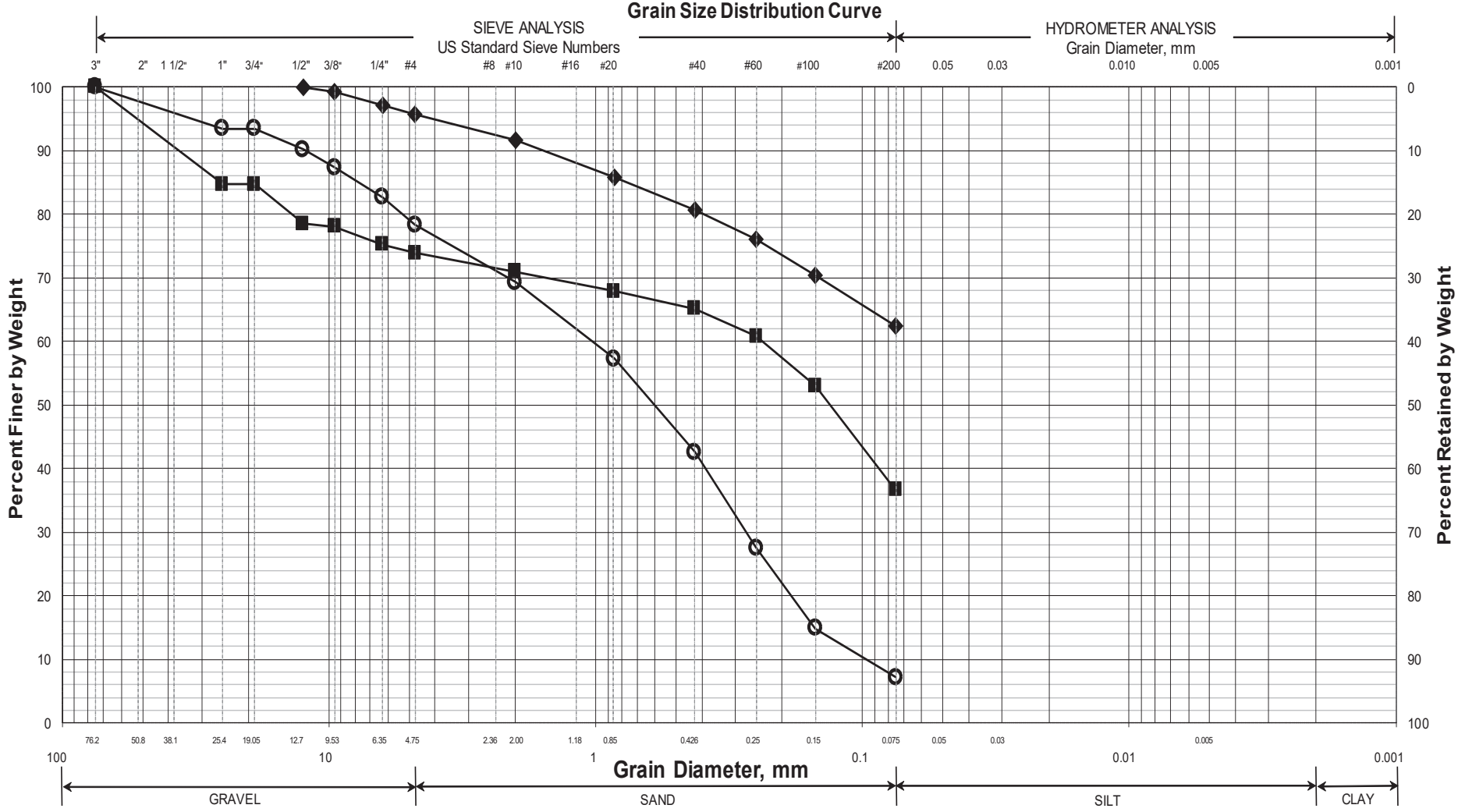
Town
Edgecomb
Reported by/Date
WHITE, TERRY A 8/30/2024

Maine Department of Transportation
Grain Size Distribution Curve



UNIFIED CLASSIFICATION

	Boring/Sample No.	Station	Offset, ft	Depth, ft	Description	WC, %	LL	PL	PI
○	HB-EDG-104/1D	102+33.6	7.0 RT	1.0-3.0	SAND, some gravel, trace silt.	6.2			
◆	HB-EDG-104/2D	102+33.6	7.0 RT	5.0-7.0	SILT, some sand, trace gravel.	20.5			
■	HB-EDG-104/3D	102+33.6	7.0 RT	10.0-12.0	Silty SAND, some gravel.	27.7			
●									
▲									
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WIN
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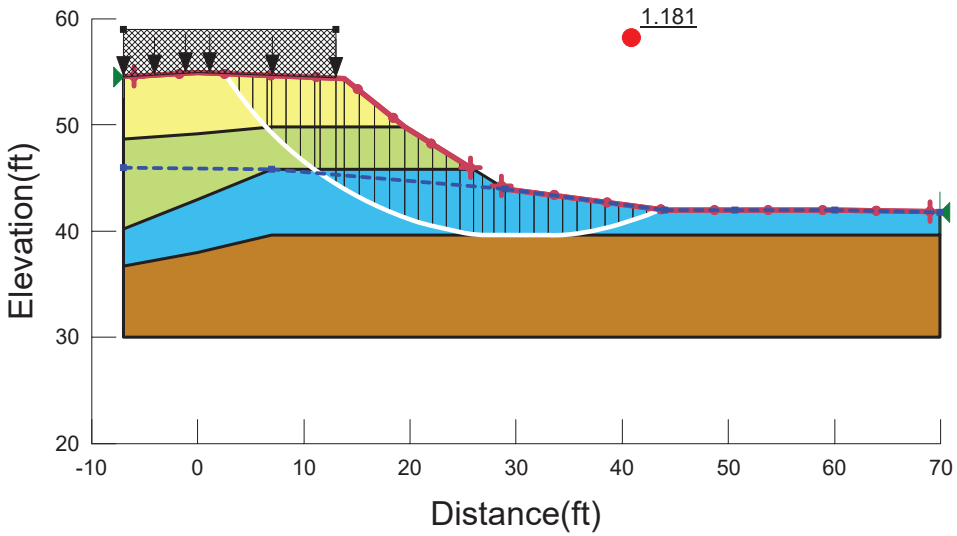
Town
Edgecomb
Reported by/Date
WHITE, TERRY A 8/30/2024

Appendix C

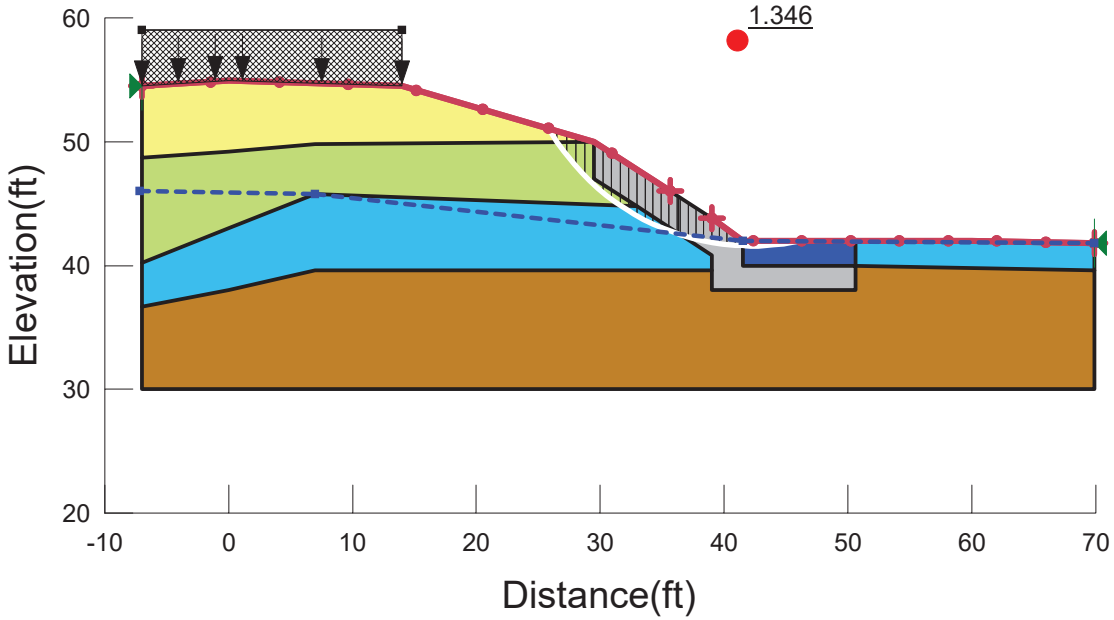
Laboratory Test Results Slope Stability Analyses

102+49.95 Existing Slope



Color	Name	Slope Stability Material Model	Unit Weight (pcf)	Effective Cohesion (psf)	Effective Friction Angle (°)
	Bedrock	Bedrock (Impenetrable)			
	Sand	Mohr-Coulomb	125	0	30
	Sand Fill	Mohr-Coulomb	125	0	34
	Silt	Mohr-Coulomb	115	1,000	0

102+49.95 Proposed Slope



Color	Name	Slope Stability Material Model	Unit Weight (pcf)	Effective Cohesion (psf)	Effective Friction Angle (°)
	Bedrock	Bedrock (Impenetrable)			
	Riprap	Mohr-Coulomb	145	0	42
	Sand	Mohr-Coulomb	125	0	30
	Sand Fill	Mohr-Coulomb	125	0	34
	Silt	Mohr-Coulomb	115	0	30
	Special Fill Apron	Mohr-Coulomb	125	0	34