

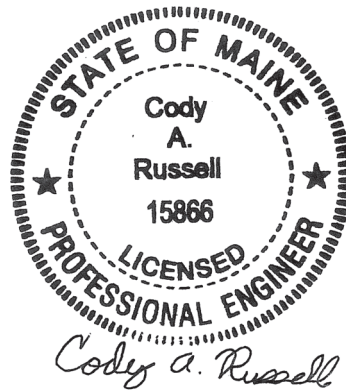
**MAINE DEPARTMENT OF TRANSPORTATION  
HIGHWAY PROGRAM  
GEOTECHNICAL SECTION  
AUGUSTA, MAINE**

**GEOTECHNICAL DESIGN REPORT**

*For the Construction of*

**CAMDEN ROAD BRIDGE  
ROUTE 90  
WARREN, MAINE**

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



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

Knox County  
WIN 26396.00

January 5, 2024

Soils Report 2024-03  
Bridge No. 6690

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## **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 large culvert (#46641) on Route 90 in Warren, 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 96-inch span by 72-inch rise by 185-foot-long multiplate pipe arch. The existing culvert is in poor condition. Route 90 is a Highway Corridor Priority 2 road.

The proposed replacement structure will be a 17-foot span by 200-foot-long open-bottom, detail-build structure founded on cast-in-place pedestal footings. To facilitate fish passage, Habitat Connectivity Design elements will be used inside the proposed structure as shown on the Special Details Sheet in the Plans. The invert of the proposed structure is approximately 19.8 feet below the existing road grade at the roadway centerline. The roadway embankment slopes at the proposed structure inlet and outlet shall be no steeper than 2H:1V to protect against erosion.

## **2.0 GEOLOGIC SETTING**

The existing culvert carries an unnamed stream under Route 90 in Warren and is located approximately 0.19 of a mile south of Packard Mill Road as shown on Sheet 1 – Location Map.

According to the Maine Geological Survey (MGS) map titled Surficial Geology West Rockport Quadrangle, Maine, Open File 10-12 (2010) the surficial soils at the site consist of Till. Till consists of a mixture of sand, silt, and gravel.

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 Pelite of the Megunticook Formation.

## **3.0 SUBSURFACE INVESTIGATION**

Three (3) borings (HB-WAR-101, HB-WAR-101A, and HB-WAR-103) and two (2) probes (HB-WAR-102 and HB-WAR-104) were drilled near the corners of the existing structure on September 19, 2022 and September 21, 2022 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.

Borings HB-WAR-101, HB-WAR-101A, and HB-WAR-103 were drilled using solid stem auger, cased wash boring, and, with the exception of HB-WAR-101, rock core drilling techniques. Soil samples were obtained in borings HB-WAR-101 and HB-WAR-103 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 62 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 0.974 to the raw field N-values. The bedrock was cored in borings HB-WAR-101 and HB-WAR-103 using an NQ 2-inch core barrel. Probes HB-WAR-102 and HB-WAR-104 were drilled using solid stem auger techniques. No soil samples were obtained in the probes.

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 borings and probes 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 six (6) standard grain size analysis with 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 at the test borings and probes generally consisted of fill sand underlain by native sand underlain by bedrock. A thin layer of peat was encountered in boring HB-WAR-101. An interpretive subsurface profile depicting the generalized soil stratigraphy at the boring location is shown on Sheet 2 – Boring Location Plan & Interpretive Subsurface Profile.

Boring HB-WAR-101 was drilled to a depth of approximately 16.5 feet below ground surface (bgs) where the casing broke, terminating the boring. Borings HB-WAR-101A and HB-WAR-103 were drilled to refusal at depths of 16.8 feet bgs and 19.8 feet bgs, respectively. Bedrock was cored in borings HB-WAR-101A and HB-WAR-103 for total boring depths of approximately 22.0 feet bgs and 24.8 feet bgs, respectively. Probes HB-WAR-102 and HB-WAR-104 were drilled to refusal at depths of approximately 14.1 feet bgs and 18.6 feet bgs, respectively. The exact nature of the refusal surface was not determined in the probes.

The sections below summarize the field and laboratory information obtained in borings HB-WAR-101, HB-WAR-101A, and HB-WAR-103.

## **5.1 Pavement and Fill Materials**

Boring HB-WAR-101 encountered approximately 3 inches of pavement at the ground surface underlain by fill soils. Boring HB-WAR-103 was drilled off pavement and the fill soils began at the ground surface. The fill soils consisted of brown, damp to moist, fine to coarse sand, trace to some gravel, little to some silt, occasional cobbles.

The thickness of the fill ranged from approximately 6.0 feet to 13.0 feet.  $N_{60}$ -values obtained in the fill ranged from 23 bpf to 39 bpf indicating that the fill is medium dense to dense in consistency.

Water contents from three (3) samples obtained within the fill ranged from approximately 8.1% to 9.7%. Grain size analyses conducted on three (3) samples of the fill resulted in the soil being classified as an A-1-b or A-2-4 under the AASHTO Soils Classification System and an SM under the Unified Soil Classification System.

## **5.2 Peat**

An approximately 0.5 foot thick layer of peat was encountered in boring HB-WAR-101 at a depth of approximately 6.0 feet bgs. The peat was interbedded within layers of fill sand. No laboratory testing was performed on peat samples.

## **5.3 Native Sand**

The fill soils and peat were underlain by native sand. The native sand consisted of brown, damp to wet, fine to coarse sand, little to some gravel, little silt, trace organics, and occasional cobbles.

The thickness of the native sand ranged from approximately 6.8 feet to 10.0 feet, but was not fully penetrated in boring HB-WAR-101.  $N_{60}$ -values obtained in the native sand ranged from 26 bpf to 156 bpf indicating that the native sand is medium dense to very dense in consistency.

Water contents from three (3) samples obtained within the native sand ranged from approximately 9.6% to 22.9%. Grain size analyses conducted on three (3) samples of the native sand resulted in the soil being classified as an A-1-b or A-2-4 under the AASHTO Soils Classification System and an SM under the Unified Soil Classification System.

## **5.4 Bedrock**

Refusal surfaces were encountered in borings HB-WAR-101A and HB-WAR-103 and probes HB-WAR-102 and HB-WAR-104. Refusal of the drilling tools varied from a depth of approximately 14.1 feet to 19.8 feet bgs. Bedrock was cored in borings HB-WAR-101A and HB-WAR-103. The exact nature of the refusal surface was not determined in the probes. No refusal surface was reached in boring HB-WAR-101 due to broken casing. Refusal depths and elevations are shown on the Boring Logs in Appendix A.

The bedrock consisted of Pelite of the Megunticook Formation. The Rock Quality Designation (RQD) of the bedrock was determined to range between 70% and 87% correlating to Rock Quality ranging from fair to good.

#### **5.4 Groundwater**

Groundwater level was not recorded in the borings or probes. 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 structure.

#### **6.1 Open-Bottom Detail Build Structure Design and Construction**

The proposed replacement structure will consist of a 17-foot span by 200-foot-long open-bottom detail-build structure founded on cast-in-place pedestal footings bearing on bedrock. The top-of-footing elevations of the proposed open-bottom structure range from approximately 194.42 feet at the inlet to approximately 192.22 feet at the outlet with a 1.10 percent slope. The 17-foot span by 200-foot-long open-bottom, detail-build structure shall be designed and constructed in accordance with Special Provision 531 and the applicable MaineDOT Standard Specifications.

The full nature of the bearing surface will not become evident until the culvert excavation is made. Prior to placement of the footings, the bedrock surface will be cleaned of all weathered bedrock, fractured material, loose soil, and/or ponded water. Smooth bedrock should be roughened or serrated prior to placing concrete to enhance sliding stability. The foundation bearing area should be sloped less than 6H:1V or benched in level steps.

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 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 Bedrock Removal and Subgrade Preparation**

The pedestal footings shall bear on and be keyed into and/or pinned into the prepared bedrock surface; a mixed subgrade surface consisting of bedrock and soil/aggregate fill shall not be accepted. The bedrock shall be prepared in accordance with MaineDOT standard practices. The footing bearing area shall be sloped less than 6H:1V or it shall be benched in level steps. The

nature, slope, and degree of fracturing in the bedrock bearing surfaces will not be evident until the excavation for the pedestal footings for the proposed open-bottom structure is made.

Construction activities should not be permitted to create any open fissures. Any irregularities in the existing bedrock surface or irregularities created during the excavation process shall be addressed using Concrete Fill (Pay Item 502.565) prior to footing construction.

The Contractor shall remove any overburden soil and weathered bedrock that can be removed using ordinary excavation equipment to expose competent bedrock at the required elevation. In accordance with MaineDOT standard practices, the bedrock shall be clean and free of debris, soil, and loose rock. The cleanliness and condition of the bedrock surface should be confirmed and accepted by the Resident prior to placing the cast-in-place concrete pedestal footings. If soil is encountered at bedding material subgrade it shall be overexcavated to expose the underlying bedrock surface.

Blasting, if necessary, shall be conducted in accordance with Section 105.2.7 and Section 203.042 of the MaineDOT Standard Specifications. It is also recommended that the Contractor conduct pre- and post-blast surveys, as well as blast vibration monitoring at nearby structures in accordance with the MaineDOT Standard Specifications and industry standards at the time of the blast. The Contractor’s blasting submittals shall address blasting procedures adjacent to an active roadway, including flyrock controls.

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.

### 6.3 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 structure will be constructed on bedrock. Any settlement due to elastic compression of the bedrock will be immediate and negligible.

### 6.4 Bearing Resistance

The factored bearing resistances for the cast-in-place pedestal footings bearing on bedrock at the service and strength limit states are presented in the table below. Supporting calculations in accordance with AASHTO LRFD Bridge Design Specifications 9<sup>th</sup> Edition 2020 (LRFD) are provided in Appendix C – Calculations.

| Limit State | Resistance Factor<br>$\phi_b$ | AASHTO LRFD<br>Reference | Factored Bearing<br>Resistance (ksf) |
|-------------|-------------------------------|--------------------------|--------------------------------------|
| Service     | 1.0                           | Article 10.5.5.1         | 40.0                                 |
| Strength    | 0.45                          | Table 10.5.5.2.2-1       | 30.0                                 |

## **6.5 Scour and Riprap**

Both the inlet and outlet of the open-bottom, detail-build structure 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 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 precast concrete box 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 native subsurface materials 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 open-bottom, detail-build structure 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 (#46641) under Route 90 in Warren, Maine in accordance with generally accepted geotechnical and foundation engineering practices. No other intended use or warranty is expressed or implied.

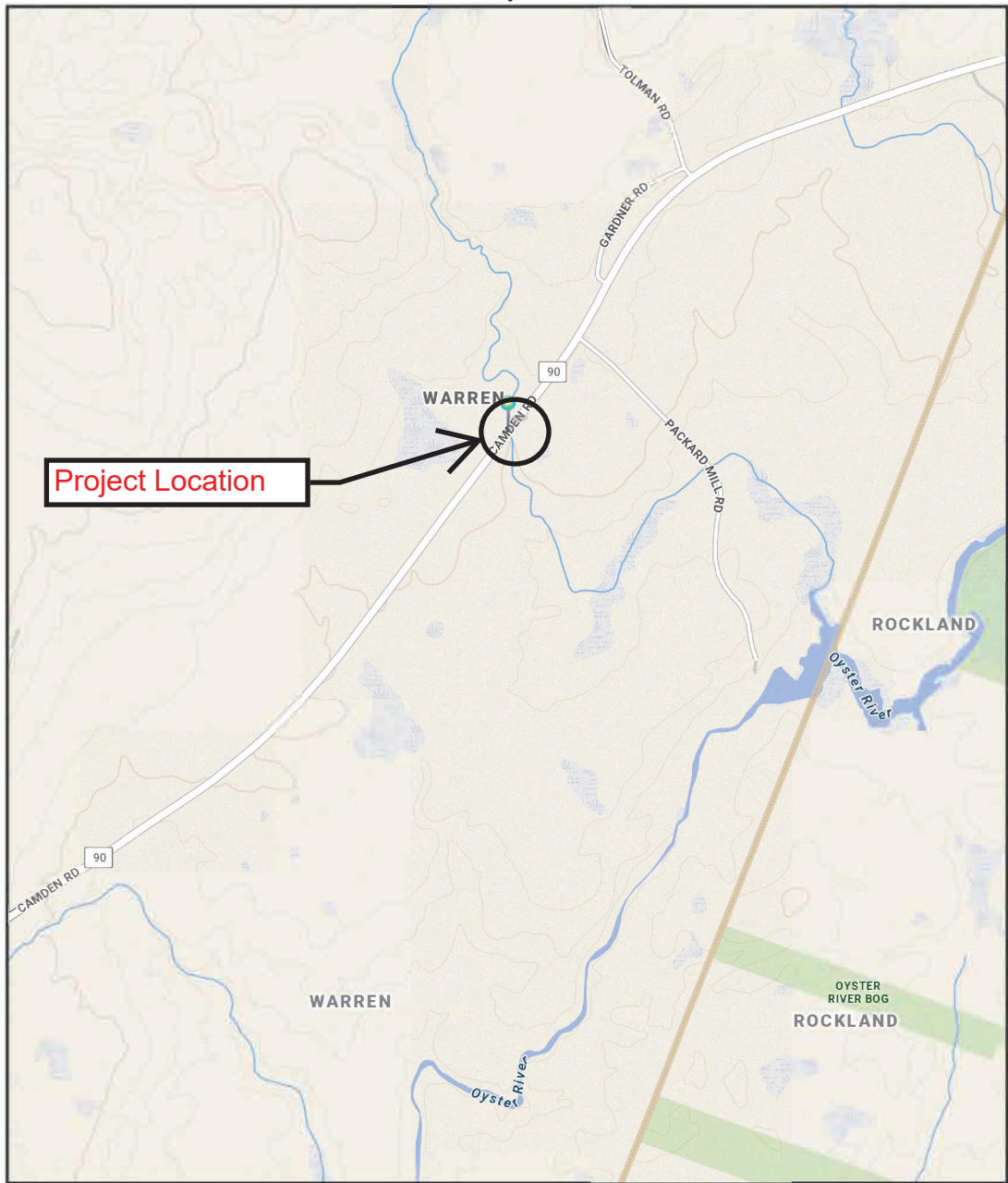
In the event that any changes in the nature, design, or location of the proposed project are planned, this report should be reviewed by a geotechnical engineer to assess the appropriateness of the conclusions and recommendations and to modify the recommendations as appropriate to reflect the changes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



# WARREN, MAINE

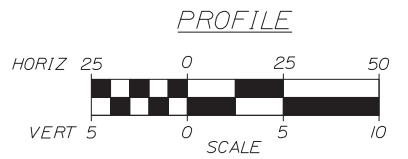
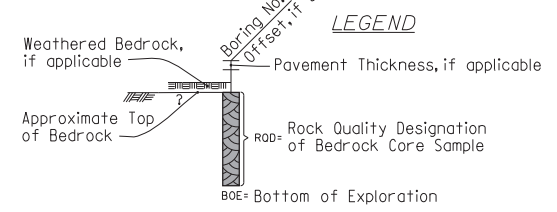
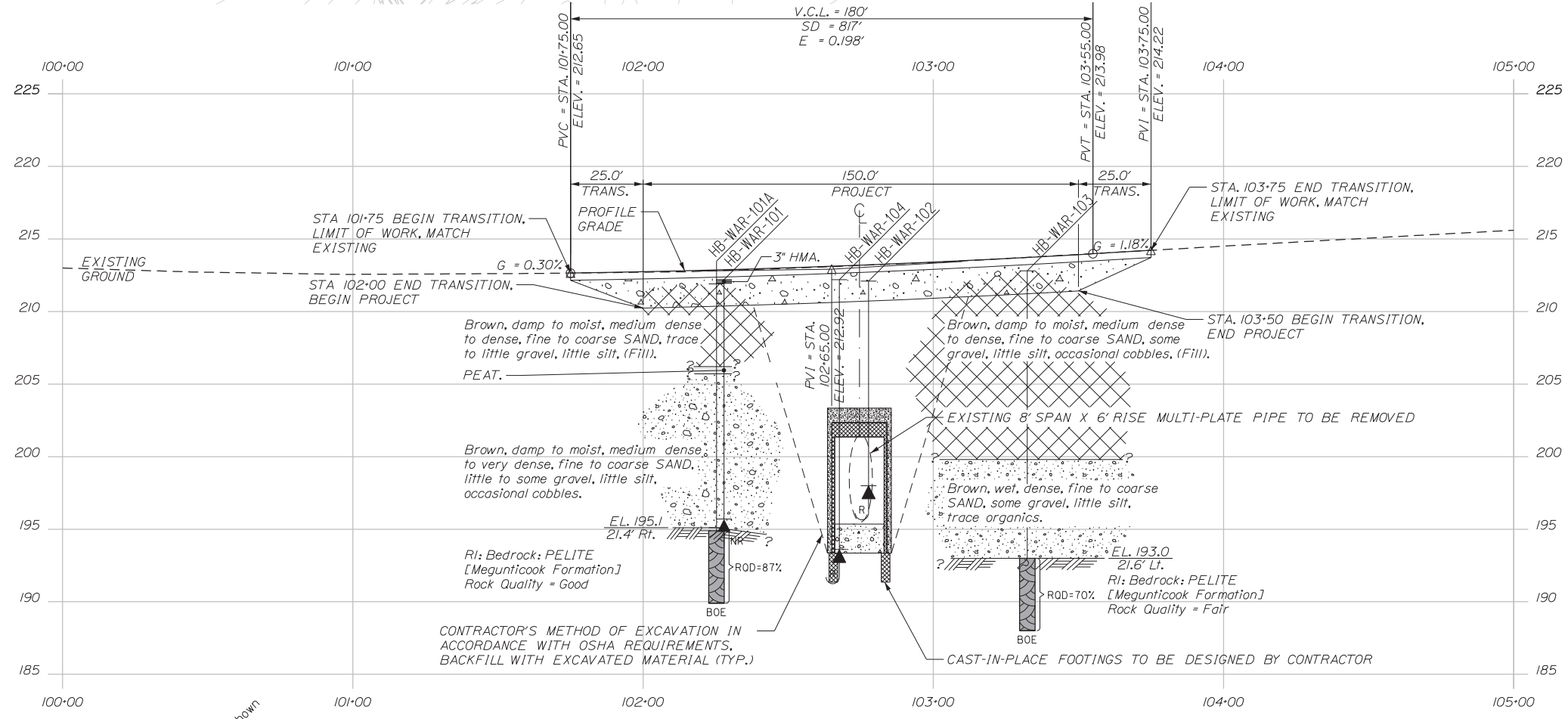
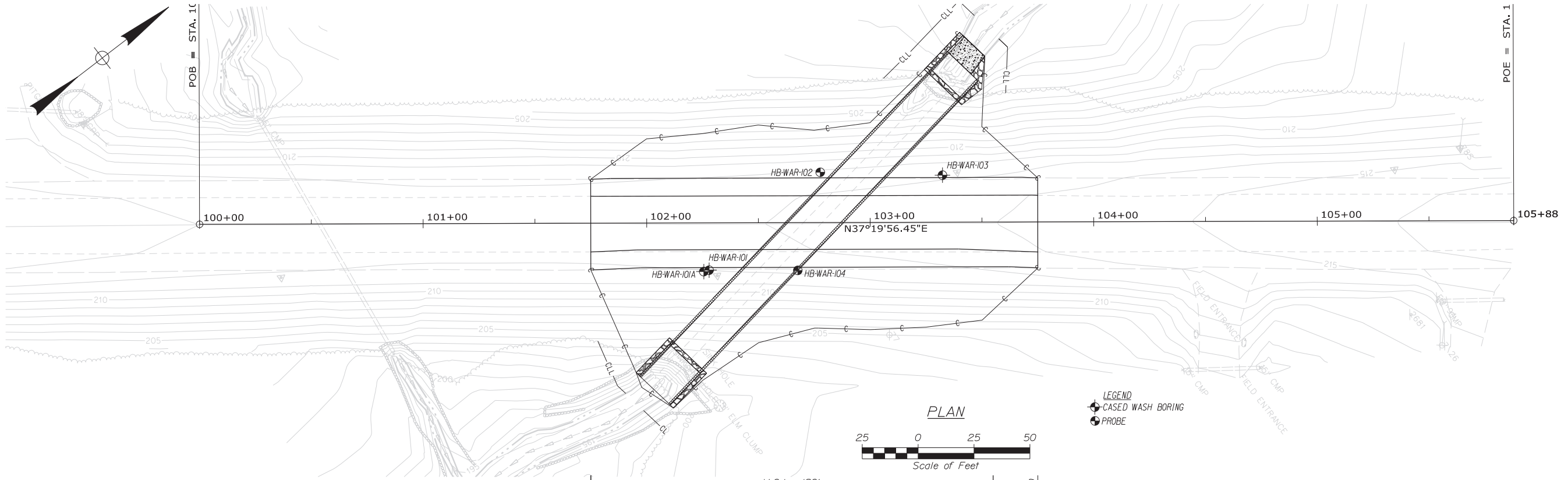


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0.25 Miles  
1 inch = 0.28 miles

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|  |                     |  |  |
|--|---------------------|--|--|
| SHEET NUMBER<br><br><b>1</b><br><br>OF 2 | WARREN<br>ROUTE 90  | STATE OF MAINE<br>DEPARTMENT OF TRANSPORTATION |  |
|  |                     | <b>2639600</b>                                 |  |
|  | <b>LOCATION MAP</b> | <b>WIN</b><br><b>26396.00</b> 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.

| PROJ. MANAGER       | BY       | DATE     | SIGNATURE | P.E. NUMBER | DATE |
|---------------------|----------|----------|-----------|-------------|------|
| C. RUSSELL          | T. WHITE | JAN 2024 |           |             |      |
| DESIGN-DETAILED     |          |          |           |             |      |
| CHECKED-REVIEWED    |          |          |           |             |      |
| DESIGNS-DETAILED 01 |          |          |           |             |      |
| DESIGNS-DETAILED 03 |          |          |           |             |      |
| REVISIONS 1         |          |          |           |             |      |
| REVISIONS 2         |          |          |           |             |      |
| REVISIONS 3         |          |          |           |             |      |
| REVISIONS 4         |          |          |           |             |      |
| FIELD CHANGES       |          |          |           |             |      |

WARREN  
ROUTE 90  
BORING LOCATION PLAN &  
INTERPRETIVE SUBSURFACE PROFILE

SHEET NUMBER

2

OF 2

## **Appendix A**

Boring Logs



|  |  |   |
|--|--|---|
| <b>Maine Department of Transportation</b><br>Soil/Rock Exploration Log<br>US CUSTOMARY UNITS | <b>Project:</b> Large Culvert #46641 Replacement on Route 90<br><b>Location:</b> Warren, Maine | <b>Boring No.:</b> HB-WAR-101<br><br><b>WIN:</b> 26396.00 |
|--|--|---|

|  |   |                                      |
|--|---|--------------------------------------|
| <b>Driller:</b> MaineDOT                         | <b>Elevation (ft.):</b> 212.2             | <b>Auger ID/OD:</b> 5" Solid Stem    |
| <b>Operator:</b> Daggett/Brooks                  | <b>Datum:</b> NAVD88                      | <b>Sampler:</b> Standard Split Spoon |
| <b>Logged By:</b> B. Wilder                      | <b>Rig Type:</b> CME 45C                  | <b>Hammer Wt./Fall:</b> 140#/30"     |
| <b>Date Start/Finish:</b> 9/21/2022; 07:30-10:00 | <b>Drilling Method:</b> Cased Wash Boring | <b>Core Barrel:</b> N/A              |
| <b>Boring Location:</b> 102+27.9, 20.7 ft Rt.    | <b>Casing ID/OD:</b> NW-3"                | <b>Water Level*:</b> None Observed   |

|  |   |   |
|--|---|---|
| <b>Hammer Efficiency Factor:</b> 0.974   | <b>Hammer Type:</b> Automatic <input checked="" type="checkbox"/> Hydraulic <input type="checkbox"/> Rope & Cathead <input type="checkbox"/>  |   |
| Definitions:<br>D = Split Spoon Sample<br>MD = Unsuccessful Split Spoon Sample Attempt<br>U = Thin Wall Tube Sample<br>MU = Unsuccessful Thin Wall Tube Sample Attempt<br>V = Field Vane Shear Test, PP = Pocket Penetrometer<br>MV = Unsuccessful Field Vane Shear Test Attempt | R = Rock Core Sample<br>SSA = Solid Stem Auger<br>HSA = Hollow Stem Auger<br>RC = Roller Cone<br>WOH = Weight of 140lb. Hammer<br>WOR/C = Weight of Rods or Casing<br>WO1P = Weight of One Person | S <sub>u</sub> = Peak/Remolded Field Vane Undrained Shear Strength (psf)<br>S <sub>u(lab)</sub> = Lab Vane Undrained Shear Strength (psf)<br>q <sub>p</sub> = Unconfined Compressive Strength (ksf)<br>N-uncorrected = Raw Field SPT N-value<br>Hammer Efficiency Factor = Rig Specific Annual Calibration Value<br>N <sub>60</sub> = SPT N-uncorrected Corrected for Hammer Efficiency<br>N <sub>60</sub> = (Hammer Efficiency Factor/60%)*N-uncorrected |
| T <sub>v</sub> = Pocket Torvane Shear Strength (psf)<br>WC = Water Content, percent<br>LL = Liquid Limit<br>PL = Plastic Limit<br>PI = Plasticity Index<br>G = Grain Size Analysis<br>C = Consolidation Test   |   |   |

| Depth (ft.) | Sample Information |                 |                    |   |               |                 |              |  | Elevation (ft.) | Graphic Log | Visual Description and Remarks  | Laboratory Testing Results/ AASHTO and Unified Class.                              |
|-------------|--------------------|-----------------|--------------------|---|---------------|-----------------|--------------|--|-----------------|-------------|---|--|
|             | Sample No.         | Pen./Rec. (in.) | Sample Depth (ft.) | Blows (6 in.) Shear Strength (psf) or RQD (%) | N-uncorrected | N <sub>60</sub> | Casing Blows |  |                 |             |   |  |
| 0           |                    |                 |                    |   |               |                 |              |  | 212.0           |             | 3" HMA in Shoulder.   |  |
|             | 1D                 | 24/20           | 1.00 - 3.00        | 6/7/8/19                                      | 15            | 24              |              |  |                 |             |   | Brown, moist, medium dense, fine to coarse SAND, little silt, trace gravel (Fill). |
| 5           |                    |                 |                    |   |               |                 |              |  | 206.2           |             | Cobble from 4.2-4.8 ft bgs.   |  |
|             | 2D                 | 24/11           | 5.00 - 7.00        | 13/11/9/8                                     | 20            | 32              |              |  | 205.7           |             |   | Brown, damp, dense, fine to coarse SAND, little gravel, little silt, (Fill).       |
|             |                    |                 |                    |   |               |                 |              |  |                 |             | PEAT  |  |
| 10          |                    |                 |                    |   |               |                 |              |  |                 |             | Very dense cobbles from 8.0-14.5 ft bgs.  |  |
|             | 3D                 | 24/14           | 10.00 - 12.00      | 3/5/11/5                                      | 16            | 26              |              |  |                 |             |   | Brown, damp, medium dense, fine to coarse SAND, little gravel, little silt.        |
|             |                    |                 |                    |   |               |                 |              |  |                 |             | Cobble from 13.0-13.5 ft bgs.   |  |
| 15          |                    |                 |                    |   |               |                 |              |  |                 |             | Brown, moist, very dense, fine to coarse SAND, some gravel, little silt.                                  |  |
|             | 4D                 | 18/12           | 15.00 - 16.50      | 13/41/55                                      | 96            | 156             |              |  | 195.7           |             |   |  |
|             |                    |                 |                    |   |               |                 |              |  |                 |             | <b>Bottom of Exploration at 16.5 feet below ground surface.</b><br>Broke NW Casing, moved to HB-WAR-101A. |  |

**Remarks:**



|  |  |   |
|--|--|---|
| <b>Maine Department of Transportation</b><br>Soil/Rock Exploration Log<br>US CUSTOMARY UNITS | <b>Project:</b> Large Culvert #46641 Replacement on Route 90<br><b>Location:</b> Warren, Maine | <b>Boring No.:</b> HB-WAR-102<br><b>WIN:</b> 26396.00 |
|--|--|---|

|   |  |                                    |
|---|--|------------------------------------|
| <b>Drilling Contractor:</b> MaineDOT          | <b>Elevation (ft.):</b> 212.1            | <b>Auger ID/OD:</b> 5" Dia.        |
| <b>Operator:</b> Daggett/Brooks               | <b>Datum:</b> NAVD88                     | <b>Sampler:</b> N/A                |
| <b>Logged By:</b> B. Wilder                   | <b>Rig Type:</b> CME 45C                 | <b>Hammer Wt./Fall:</b> N/A        |
| <b>Date Start/Finish:</b> 9/19/2022-9/19/2022 | <b>Drilling Method:</b> Solid Stem Auger | <b>Core Barrel:</b> N/A            |
| <b>Boring Location:</b> 102+77.7, 23.1 ft Lt. | <b>Casing ID/OD:</b> N/A                 | <b>Water Level*:</b> None Observed |

Definitions: D = Spilt Spoon Sample      MU = Unsuccessful Thin Wall Tube Sample Attempt      WO1P = Weight of 1 Person  
 S = Sample off Auger Flights              R = Rock Core Sample                              S<sub>u</sub> = Peak/Remolded Field Vane Undrained Shear Strength (psf)  
 B = Bucket Sample off Auger Flights      HSA = Solid Stem Auger                            S<sub>u(lab)</sub> = Lab Vane Undrained Shear Strength (psf)      LL = Liquid Limit  
 MD = Unsuccessful Split Spoon Sample Attempt      HSA = Hollow Stem Auger                        q<sub>p</sub> = Unconfined Compressive Strength (ksf)              PL = Plastic Limit  
 U = Thin Wall Tube Sample                      RC = Roller Cone                                    N-value = Raw Field SPT N-value                              PI = Plasticity Index  
 MV = Unsuccessful Field Vane Shear Test Attempt      WOH = Weight of 140lb. Hammer              T<sub>v</sub> = Pocket Torvane Shear Strength (psf)                    G = Grain Size Analysis  
 V = Field Vane Shear Test      PP= Pocket Penetrometer      WOR/C = Weight of Rods or Casing              WC = Water Content, percent      ≐ = Similar or Equal too                              C = Consolidation Test

| Depth (ft.) | Sample Information |                 |                    |  |         |              |                 |             |  | Visual Description and Remarks                                   | Laboratory Testing Results/ AASHTO and Unified Class. |
|-------------|--------------------|-----------------|--------------------|--|---------|--------------|-----------------|-------------|--|--|---|
|             | Sample No.         | Pen./Rec. (in.) | Sample Depth (ft.) | Blows (/6 in.) Shear Strength (psf) or RQD (%) | N-value | Casing Blows | Elevation (ft.) | Graphic Log |  |  |   |
| 0           |                    |                 |                    |  |         |              | SSA             |             |  | Probe, no materials samples taken.                               |   |
| 5           |                    |                 |                    |  |         |              |                 |             |  | Very dense, from 8.0-14.0 ft bgs.                                |   |
| 10          |                    |                 |                    |  |         |              |                 |             |  |  |   |
| 15          |                    |                 |                    |  |         |              |                 | 198.0       |  | Bottom of Exploration at 14.1 feet below ground surface. REFUSAL | 14.1  |
| 20          |                    |                 |                    |  |         |              |                 |             |  |  |   |
| 25          |                    |                 |                    |  |         |              |                 |             |  |  |   |

**Remarks:**

|  |  |   |
|--|--|---|
| <b>Maine Department of Transportation</b><br>Soil/Rock Exploration Log<br>US CUSTOMARY UNITS | <b>Project:</b> Large Culvert #46641 Replacement on Route 90<br><b>Location:</b> Warren, Maine | <b>Boring No.:</b> HB-WAR-103<br><br><b>WIN:</b> 26396.00 |
|--|--|---|

|  |   |                                      |
|--|---|--------------------------------------|
| <b>Driller:</b> MaineDOT                         | <b>Elevation (ft.):</b> 212.8             | <b>Auger ID/OD:</b> 5" Solid Stem    |
| <b>Operator:</b> Daggett/Brooks                  | <b>Datum:</b> NAVD88                      | <b>Sampler:</b> Standard Split Spoon |
| <b>Logged By:</b> B. Wilder                      | <b>Rig Type:</b> CME 45C                  | <b>Hammer Wt./Fall:</b> 140#/30"     |
| <b>Date Start/Finish:</b> 9/21/2022; 12:30-14:30 | <b>Drilling Method:</b> Cased Wash Boring | <b>Core Barrel:</b> NQ-2"            |
| <b>Boring Location:</b> 103+32.4, 21.6 ft Lt.    | <b>Casing ID/OD:</b> NW-3"                | <b>Water Level*:</b> None Observed   |

|   |  |  |
|---|--|--|
| <b>Hammer Efficiency Factor:</b> 0.974  | <b>Hammer Type:</b> Automatic <input checked="" type="checkbox"/> Hydraulic <input type="checkbox"/> Rope & Cathead <input type="checkbox"/> |  |
| <small>           Definitions:<br/>           D = Split Spoon Sample<br/>           MD = Unsuccessful Split Spoon Sample Attempt<br/>           U = Thin Wall Tube Sample<br/>           MU = Unsuccessful Thin Wall Tube Sample Attempt<br/>           V = Field Vane Shear Test, PP = Pocket Penetrometer<br/>           MV = Unsuccessful Field Vane Shear Test Attempt<br/>           R = Rock Core Sample<br/>           SSA = Solid Stem Auger<br/>           HSA = Hollow Stem Auger<br/>           RC = Roller Cone<br/>           WOH = Weight of 140lb. Hammer<br/>           WOR/C = Weight of Rods or Casing<br/>           WO1P = Weight of One Person<br/>           S<sub>u</sub> = Peak/Remolded Field Vane Undrained Shear Strength (psf)<br/>           S<sub>u(lab)</sub> = Lab Vane Undrained Shear Strength (psf)<br/>           q<sub>p</sub> = Unconfined Compressive Strength (ksf)<br/>           N-uncorrected = Raw Field SPT N-value<br/>           Hammer Efficiency Factor = Rig Specific Annual Calibration Value<br/>           N<sub>60</sub> = SPT N-uncorrected Corrected for Hammer Efficiency<br/>           N<sub>60</sub> = (Hammer Efficiency Factor/60%)*N-uncorrected<br/>           T<sub>v</sub> = Pocket Torvane Shear Strength (psf)<br/>           WC = Water Content, percent<br/>           LL = Liquid Limit<br/>           PL = Plastic Limit<br/>           PI = Plasticity Index<br/>           G = Grain Size Analysis<br/>           C = Consolidation Test         </small> |  |  |

| Depth (ft.) | Sample Information |                 |                    |   |               |                 |              |  | Elevation (ft.) | Graphic Log  | Visual Description and Remarks    | Laboratory Testing Results/ AASHTO and Unified Class. |
|-------------|--------------------|-----------------|--------------------|---|---------------|-----------------|--------------|--|-----------------|--|-----------------------------------|---|
|             | Sample No.         | Pen./Rec. (in.) | Sample Depth (ft.) | Blows (6 in.) Shear Strength (psf) or RQD (%) | N-uncorrected | N <sub>60</sub> | Casing Blows |  |                 |  |                                   |   |
| 0           | 1D                 | 24/16           | 0.00 - 2.00        | 5/7/7/8                                       | 14            | 23              | SSA          |  |                 | Brown, damp, medium dense, fine to coarse SAND, some gravel, little silt, (Fill).  | G#380752<br>A-2-4, SM<br>WC=9.3%  |   |
| 5           | 2D                 | 21.6/14         | 5.00 - 6.80        | 5/7/13/50                                     | 20            | 32              |              |  |                 | Brown, moist, dense, fine to coarse SAND, some gravel, little silt, occasional cobble, (Fill).<br><br>Cobble from 6.8-7.3 ft bgs.<br><br>Very dense cobbles from 8.0-14.5 ft bgs.  |                                   |   |
| 10          | 3D                 | 24/19           | 10.00 - 12.00      | 10/16/8/16                                    | 24            | 39              | 296          |  | 199.8           | Brown, moist, dense, fine to coarse SAND, some gravel, little silt, occasional cobble, (Fill).   | G#380753<br>A-1-b, SM<br>WC=8.1%  |   |
| 15          | 4D                 | 24/17           | 14.00 - 16.00      | 34/14/11/7                                    | 25            | 41              | 26           |  | 199.8           | Brown, wet, dense, fine to coarse SAND, some gravel, little silt, trace organics (roots).  | G#380754<br>A-1-b, SM<br>WC=14.5% |   |
| 20          | R1                 | 60/60           | 19.80 - 24.80      | RQD = 70%                                     |               |                 | a80 NQ-2     |  | 193.0           | a80 blows for 0.8 ft.  |                                   |   |
| 25          |                    |                 |                    |   |               |                 |              |  | 188.0           | Top of Bedrock at Elev. 193.0 ft.<br>R1: Bedrock: PELITE [Megunticook Formation].<br>R1: Core times (min:sec)<br>19.8-20.8 ft (2:32)<br>20.8-21.8 ft (2:44)<br>21.8-22.8 ft (2:47)<br>22.8-23.8 ft (3:03)<br>23.8-24.8 ft (3:06)<br>Rock Quality = Fair<br>100% Recovery |                                   |   |

**Remarks:**

|  |  |   |
|--|--|---|
| <b>Maine Department of Transportation</b><br>Soil/Rock Exploration Log<br>US CUSTOMARY UNITS | <b>Project:</b> Large Culvert #46641 Replacement on Route 90<br><b>Location:</b> Warren, Maine | <b>Boring No.:</b> HB-WAR-103<br><br><b>WIN:</b> 26396.00 |
|--|--|---|

|   |  |  |
|---|--|--|
| <b>Driller:</b> MaineDOT<br><b>Operator:</b> Daggett/Brooks<br><b>Logged By:</b> B. Wilder<br><b>Date Start/Finish:</b> 9/21/2022; 12:30-14:30<br><b>Boring Location:</b> 103+32.4, 21.6 ft Lt. | <b>Elevation (ft.):</b> 212.8<br><b>Datum:</b> NAVD88<br><b>Rig Type:</b> CME 45C<br><b>Drilling Method:</b> Cased Wash Boring<br><b>Casing ID/OD:</b> NW-3" | <b>Auger ID/OD:</b> 5" Solid Stem<br><b>Sampler:</b> Standard Split Spoon<br><b>Hammer Wt./Fall:</b> 140#/30"<br><b>Core Barrel:</b> NQ-2"<br><b>Water Level*:</b> None Observed |
|---|--|--|

|  |  |   |
|--|--|---|
| <b>Hammer Efficiency Factor:</b> 0.974   | <b>Hammer Type:</b> Automatic <input checked="" type="checkbox"/> Hydraulic <input type="checkbox"/> Rope & Cathead <input type="checkbox"/>   |   |
| Definitions:<br>D = Split Spoon Sample<br>MD = Unsuccessful Split Spoon Sample Attempt<br>U = Thin Wall Tube Sample<br>MU = Unsuccessful Thin Wall Tube Sample Attempt<br>V = Field Vane Shear Test, PP = Pocket Penetrometer<br>MV = Unsuccessful Field Vane Shear Test Attempt | R = Rock Core Sample<br>SSA = Solid Stem Auger<br>HSA = Hollow Stem Auger<br>RC = Roller Cone<br>WOH = Weight of 140 lb. Hammer<br>WOR/C = Weight of Rods or Casing<br>WO1P = Weight of One Person | S <sub>u</sub> = Peak/Remolded Field Vane Undrained Shear Strength (psf)<br>S <sub>u(lab)</sub> = Lab Vane Undrained Shear Strength (psf)<br>q <sub>p</sub> = Unconfined Compressive Strength (ksf)<br>N-uncorrected = Raw Field SPT N-value<br>Hammer Efficiency Factor = Rig Specific Annual Calibration Value<br>N <sub>60</sub> = SPT N-uncorrected Corrected for Hammer Efficiency<br>N <sub>60</sub> = (Hammer Efficiency Factor/60%)*N-uncorrected |

| Depth (ft.) | Sample Information |                 |                    |  |               |                 |              |                 | Elevation (ft.) | Graphic Log | Visual Description and Remarks | Laboratory Testing Results/ AASHTO and Unified Class. |
|-------------|--------------------|-----------------|--------------------|--|---------------|-----------------|--------------|-----------------|-----------------|-------------|--------------------------------|---|
|             | Sample No.         | Pen./Rec. (in.) | Sample Depth (ft.) | Blows (/6 in.) Shear Strength (psf) or RQD (%) | N-uncorrected | N <sub>60</sub> | Casing Blows | Elevation (ft.) |                 |             |                                |   |
| 25          |                    |                 |                    |  |               |                 |              |                 |                 |             | 24.8                           |   |
|             |                    |                 |                    |  |               |                 |              |                 |                 |             |                                |   |
|             |                    |                 |                    |  |               |                 |              |                 |                 |             |                                |   |
| 30          |                    |                 |                    |  |               |                 |              |                 |                 |             |                                |   |
|             |                    |                 |                    |  |               |                 |              |                 |                 |             |                                |   |
|             |                    |                 |                    |  |               |                 |              |                 |                 |             |                                |   |
|             |                    |                 |                    |  |               |                 |              |                 |                 |             |                                |   |
| 35          |                    |                 |                    |  |               |                 |              |                 |                 |             |                                |   |
|             |                    |                 |                    |  |               |                 |              |                 |                 |             |                                |   |
|             |                    |                 |                    |  |               |                 |              |                 |                 |             |                                |   |
|             |                    |                 |                    |  |               |                 |              |                 |                 |             |                                |   |
| 40          |                    |                 |                    |  |               |                 |              |                 |                 |             |                                |   |
|             |                    |                 |                    |  |               |                 |              |                 |                 |             |                                |   |
|             |                    |                 |                    |  |               |                 |              |                 |                 |             |                                |   |
|             |                    |                 |                    |  |               |                 |              |                 |                 |             |                                |   |
| 45          |                    |                 |                    |  |               |                 |              |                 |                 |             |                                |   |
|             |                    |                 |                    |  |               |                 |              |                 |                 |             |                                |   |
|             |                    |                 |                    |  |               |                 |              |                 |                 |             |                                |   |
|             |                    |                 |                    |  |               |                 |              |                 |                 |             |                                |   |
| 50          |                    |                 |                    |  |               |                 |              |                 |                 |             |                                |   |

**Remarks:**



## **Appendix B**

Laboratory Test Results

