

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

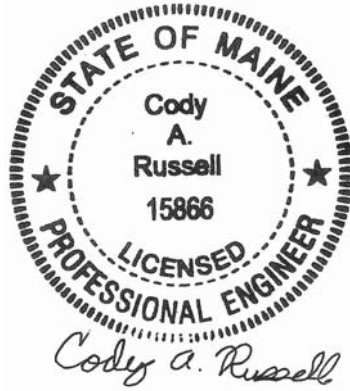
GEOTECHNICAL DESIGN REPORT

For the Construction of:

**SPECTACLE POND BRIDGE
ROUTE 6 \ 15
MONSON, MAINE**

Prepared by:

Cody Russell, P.E.
Assistant Geotechnical Engineer



Reviewed by:

Kathleen Maguire, P.E.
Senior Geotechnical Engineer

Piscataquis County
WIN 22930.00

Soils Report 2019-23
Bridge No. 6591

May 23, 2019
Federal Project No. 2293000

Table of Contents

1.0	INTRODUCTION	1
2.0	GEOLOGIC SETTING	1
3.0	SUBSURFACE INVESTIGATION.....	1
4.0	LABORATORY TESTING.....	2
5.0	SUBSURFACE CONDITIONS.....	2
6.0	GEOTECHNICAL DESIGN AND CONSTRUCTION RECOMMENDATIONS ...	3
6.1	PRECAST CONCRETE BOX CULVERT DESIGN AND CONSTRUCTION	4
6.2	SETTLEMENT	4
6.3	BEARING RESISTANCE	4
6.4	MODULUS OF SUBGRADE REACTION	5
6.5	SCOUR AND RIPRAP	5
6.6	SEISMIC DESIGN CONSIDERATIONS	5
6.7	CONSTRUCTION CONSIDERATIONS	5
7.0	CLOSURE.....	6

Sheets

Sheet 1 - Location Map

Sheet 2 - Boring Location Plan & Interpretive Subsurface Profile with Boring Logs

Appendices

Appendix A - Boring Logs

Appendix B - Laboratory Test Results

Appendix C - Calculations

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 (#267649) consisting of three corrugated metal pipes (CMPs) on Route 6 \ 15 in Monson, 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 approximately 76-foot long, 36-inch diameter, triplet, corrugated metal pipe (CMP) culverts. The CMPs are in critical condition and one inlet is buried. Route 6 / 15 is a Highway Corridor Priority 2 road.

The proposed replacement structure will be a 11-foot span by 5-foot rise by 78-foot long precast concrete box culvert on a skew of approximately 6 degrees to the roadway centerline. The invert of the proposed culvert is approximately 9 feet below the existing road grade at the roadway centerline. The roadway embankment slopes at the proposed culvert inlet and outlet shall be no steeper than 2H:1V to protect against erosion.

2.0 GEOLOGIC SETTING

The existing culverts act as an equalizer between Spectacle Pond West and Spectacle Pond East under Route 6 \ 15 in Monson and is located approximately 0.40 of a mile south of the Shirley town line as shown on Sheet 1 – Location Map.

According to the Maine Geological Survey (MGS) map titled Reconnaissance Surficial Geology of the Greenville Quadrangle, Maine, Open File 86-31 (1986) the surficial soils at the site consist of Till. These soils consist of a mixture of sand, silt, and stones and are generally underlain by bedrock.

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 Madrid Formation.

3.0 SUBSURFACE INVESTIGATION

One (1) boring (HB-MON-101) and one (1) probe (HB-MON-102) were drilled for this project on May 30, 2018 by the MaineDOT drill crew using a trailer mounted drill rig. Exploration locations are shown on Sheet 2 – Boring Location Plan & Interpretive Subsurface Profile with Boring Logs. Details and sampling methods used, field data obtained, and soil and groundwater conditions encountered are presented on the Boring Log in Appendix A.

Boring HB-MON-101 was drilled using solid stem auger, cased wash boring, open hole and rock core drilling techniques. Soil samples were obtained in boring HB-MON-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 55 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. The bedrock was cored in boring HB-MON-101 using an NQ 2-inch core barrel. The bedrock core was terminated after one foot of penetration due to a blockage in the core barrel. Probe HB-MON-102 was drilled using solid stem auger techniques. 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. An experienced Northeast Transportation Training and Certification Program (NETTCP) certified subsurface inspector logged the subsurface conditions encountered. The boring and probe were located in the field by taping to surveyed site features after completion of the drilling program.

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 four (4) standard grain size analyses with natural water content. The results of the laboratory testing program are discussed in the following section and are 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 boring and probe generally consisted fill sand overlying native glacial till. An interpretive subsurface profile depicting the generalized soil stratigraphy at the boring location is shown on Sheet 2 – Boring Location Plan & Interpretive Subsurface Profile with Boring Logs.

Boring HB-MON-101 was drilled to refusal at a depth of approximately 19.6 feet below ground surface (bgs). Bedrock was cored in the boring for a total depth of approximately 20.6 feet bgs. Probe HB-MON-102 was drilled to a depth of approximately 20.0 feet bgs and did not encounter a refusal surface.

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

Approx. Depth BGS ¹ (feet)	Soil Description	AASHTO ² Classification	USCS ³	WC% ⁴
0.0 – 9.0	Fill – Brown, damp, fine to coarse sand, some gravel, little silt. Grey, wet, fine to coarse sandy gravel, little silt.	A-1-b A-1-a	SM GM	3.6 6.0
9.0 – 21.0	Glacial Till – Grey, wet, gravel, some fine to coarse sand, some silt.	A-1-b	GM	7.7 to 20.9
21.0 – 26.0	Bedrock – Calcareous sandstone and interbedded sandstone and impure limestone.	--	--	--

¹BGS = below ground surface

²AASHTO = American Association of State Highway and Transportation Officials

³USCS = Unified Soil Classification System

⁴WC% = Water content in percent

Two corrected N-values obtained in the fill were 36 and 87 blows per foot (bpf), indicating that the fill is dense to very dense in consistency. No N-values were obtained in the glacial till due to the presence of cobbles and boulders. The till was too dense to drive the spoon the required depth in two samples. The Rock Quality Designation (RQD) of the bedrock was not calculated in boring HB-MON-101 due to the low penetration of the rock core.

Groundwater was observed in boring HB-MON-101 at a depth of approximately 5.0 feet bgs. Groundwater was not recorded in the probe. Groundwater levels can be expected to fluctuate subject to seasonal variations, local soil conditions, topography, precipitation, and construction activity.

6.0 GEOTECHNICAL DESIGN AND CONSTRUCTION RECOMMENDATIONS

The proposed replacement structure will consist of a 11-foot span by 5-foot rise by 78-foot long precast concrete box culvert on a skew of approximately 6 degrees to the roadway centerline. The proposed structure inlet and outlet slopes shall be riprapped with slopes no steeper than 2H:1V to protect against erosion. The following sections discuss geotechnical recommendations for the design and construction of the proposed culvert.

6.1 Precast Concrete Box Culvert Design and Construction

The proposed replacement structure will consist of a 11-foot span by 5-foot rise by 78-foot long precast concrete box culvert at a skew of approximately 6 degrees to the roadway centerline. The proposed box culvert shall be designed and constructed in accordance with MaineDOT Standard Specification 534.

The invert of the proposed box culvert will be set at approximate elevation 1160.5 feet with a 0.0 percent slope.

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 $\frac{3}{4}$ -Inch. The prepared subgrade shall be proof-rolled using a static roller to visually confirm the prepared subgrade is firm and stable. The exposed subgrade shall be free of ponded water so that bedding material placement and compaction can be completed in the dry.

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

6.2 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 precast concrete box 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 subgrade soils and bedding material will be immediate and negligible.

6.3 Bearing Resistance

The factored bearing resistances for the precast concrete box culvert bearing on compacted granular bedding material placed on native soils at the service and strength limit states are presented in the table below. Supporting calculations in accordance with AASHTO LRFD Bridge Design Specifications 8th Edition 2017 (LRFD) are provided in Appendix C – Calculations.

Limit State	Resistance Factor ϕ_b	AASHTO LRFD Reference	Factored Bearing Resistance (ksf)
Service	1.0	Article 10.5.5.1	12.0
Strength	0.45	Table 10.5.5.2.2-1	6.0

6.4 Modulus of Subgrade Reaction

A modulus of subgrade reaction (k_s) equal to 250 pounds per cubic inch shall be used for the structural design of the box culvert's base slab. Calculations are included in Appendix C – Calculations.

6.5 Scour and Riprap

Both the inlet and outlet of the precast concrete box 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 protective aggregate cushion consisting of Granular Borrow Material for Underwater Backfill (703.19). The toe of the riprap sections shall be keyed into the existing soils 1 foot below the streambed elevation.

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 the till or weathered 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 (#267649) consisting of three CMPs under Route 6 \ 15 in Monson, Maine in accordance with generally accepted geotechnical and foundation engineering practices. No other intended use or warranty is expressed or implied.

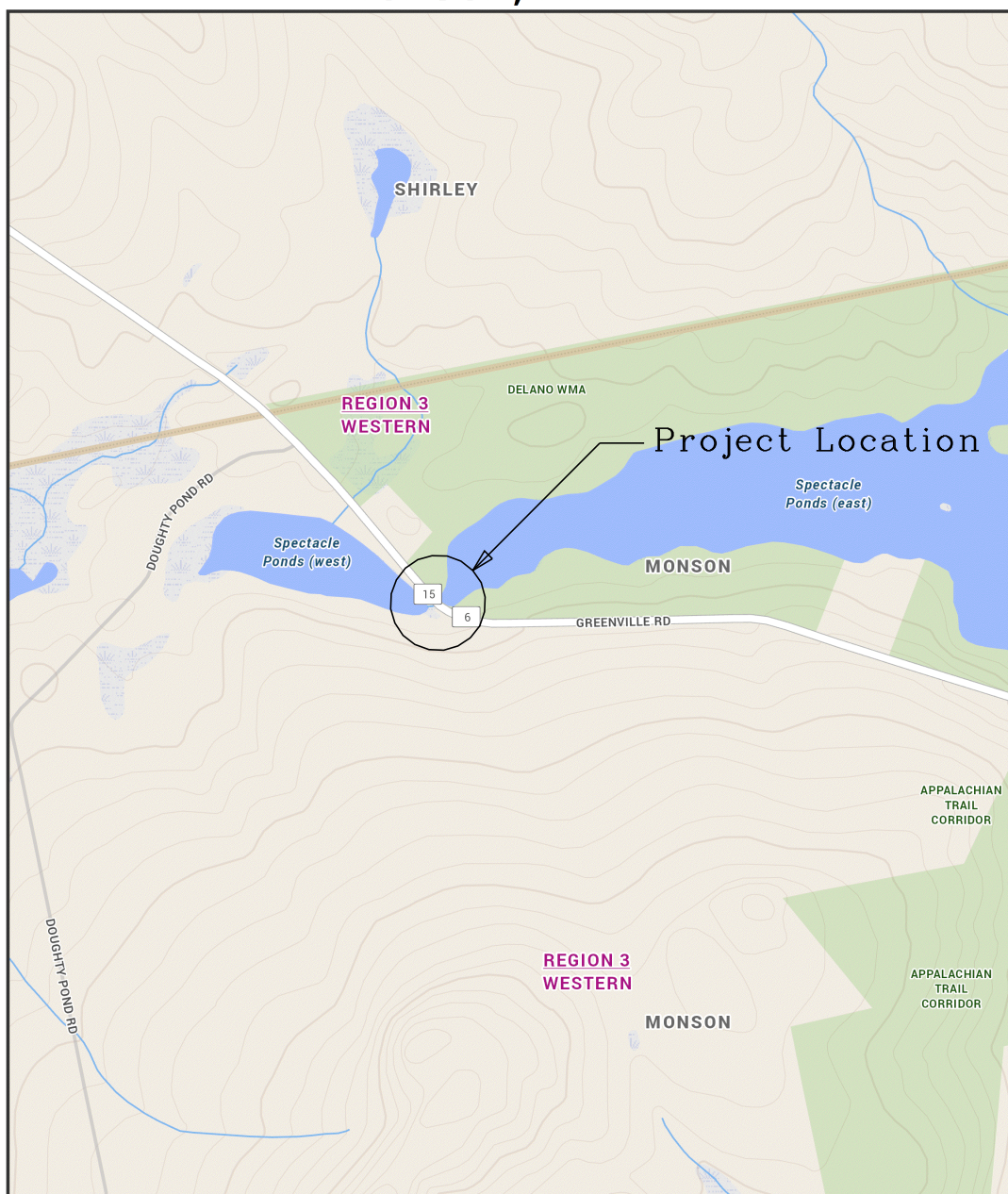
In the event that any changes in the nature, design, or location of the proposed project are planned, this report should be reviewed by a geotechnical engineer to assess the appropriateness of the conclusions and recommendations and to modify the recommendations as appropriate to reflect the changes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



MONSON, MAINE

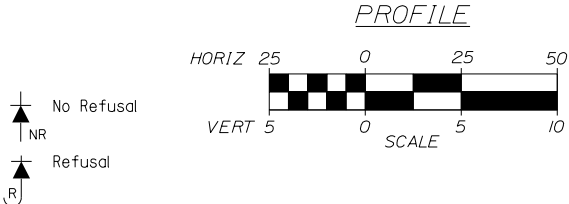
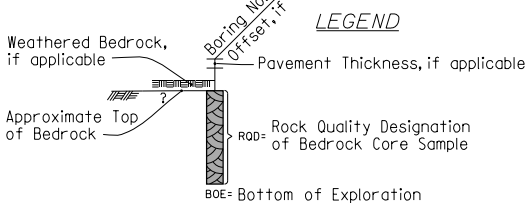
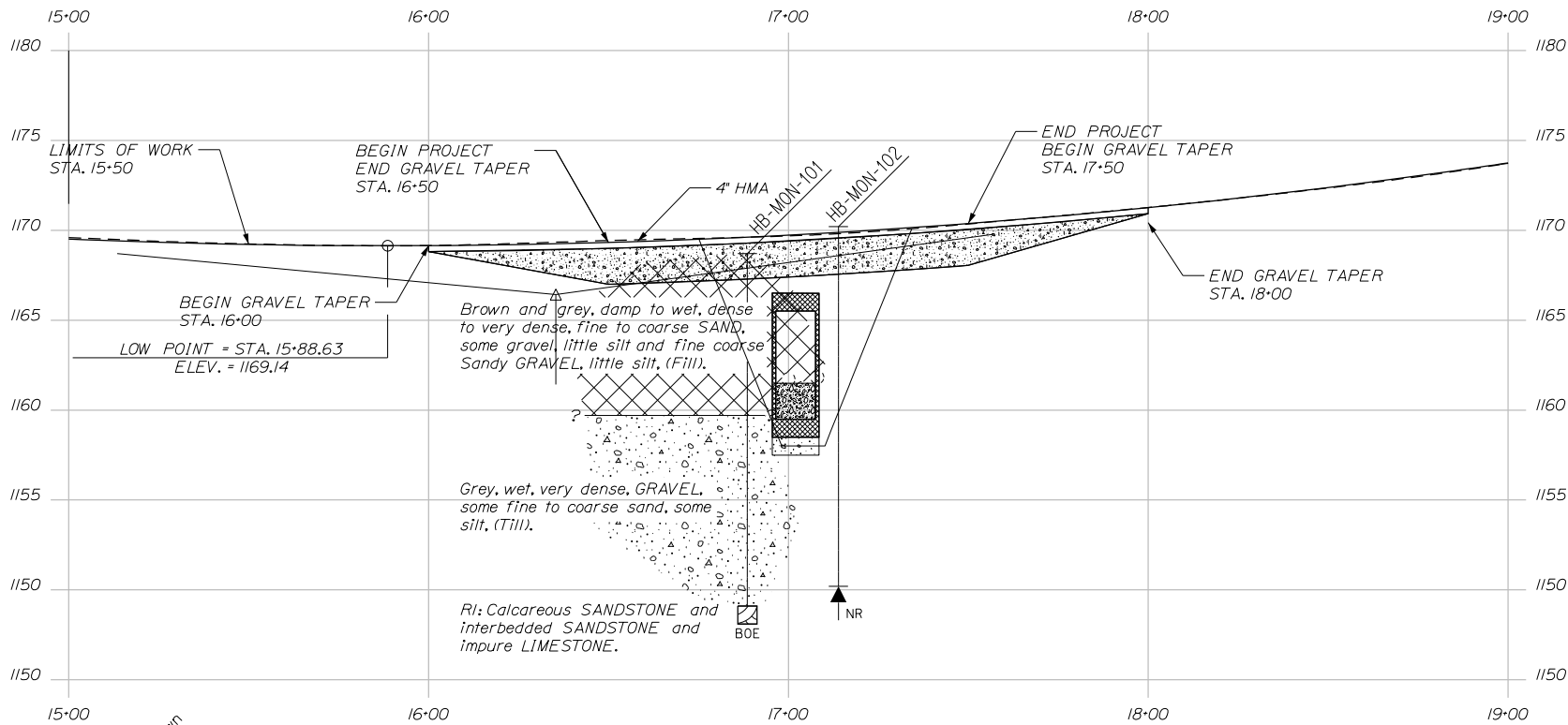
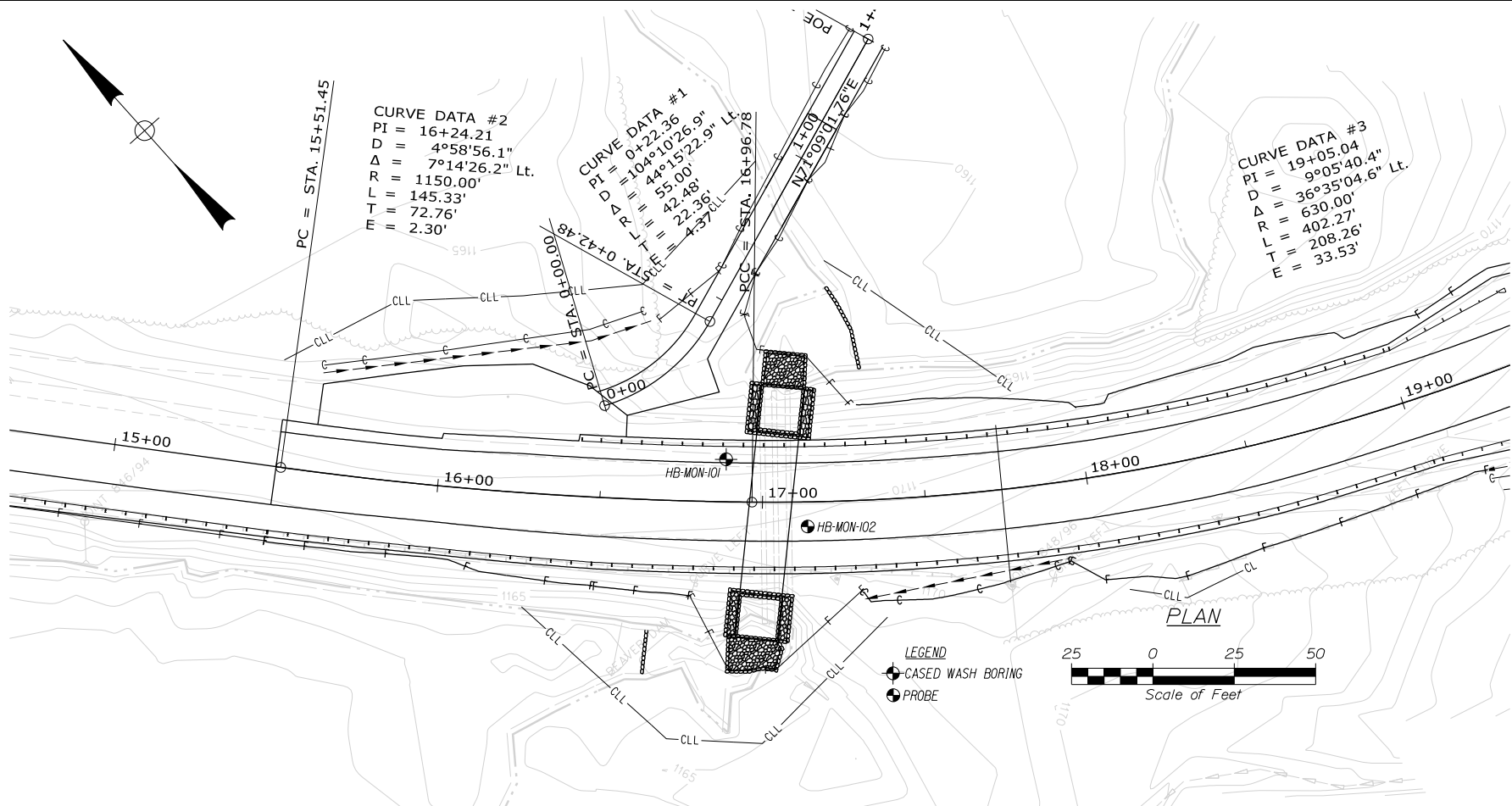


The Maine Department of Transportation provides this publication for information only. Reliance upon this information is at user risk. It is subject to revision and may be incomplete depending upon changing conditions. The Department assumes no liability if injuries or damages result from this information. This map is not intended to support emergency dispatch.

0.25 Miles
1 inch = 0.28 miles

Date: 3/26/2019
Time: 7:04:31 AM

SHEET NUMBER	MONSON ROUTE 6/15	STATE OF MAINE DEPARTMENT OF TRANSPORTATION	
1		02293000	
OF 2	LOCATION MAP	WIN BRIDGE NO. 6591 022930.00 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			Project: Large Culvert Replacement		Boring No.: HB-MON-101	
Soil/Book Exploration Log			Routes 6/15		WIN: 22930.00	
US CUSTOMARY UNITS			Location: Monson, Maine			
Driller:	Mofmoot	Elevation (ft.):	1168.7	Auger 10/00:	5" Solid Stem	
Operator:	Doggett/NTies	Station:	NAV088	Sampler:	Standard Split Spoon	
Logged By:	B. W. Tider	Rig Type:	CME 45C	Hammer Wt./Fall:	140lb/30"	
Date Start/Finish:	5/30/2018 08:30-13:00	Drilling Method:	Cased Hole Boring	Core Barrel:	NO-2	
Boring Location:	16+88.6, 13.0 ft. L.T. Shoulder	Coring 10/00:	NA-7	Water Level:	5.0 ft bgs.	
Notes:	Efficiency Factor: 0.928	Hammer Type:	Automatic BB	Hydraulic Oil:	Rock & Cathead Oil	
Description: 1. 0-2.00 ft. - Brown, damp, dense, fine to coarse SAND, some gravel, little silt, (FTIII). 2. 2.00-4.50 ft. - Grey, wet, very dense, fine to coarse SANDY GRAVEL, little silt, (FTIII). 3. 4.50-6.00 ft. - Boulder cone through Cobble from 6.0-6.8 ft bgs. 4. 6.00-7.26 ft. - Cobble from 7.5-8.0 ft bgs. 5. 7.26-10.00 ft. - Grey, wet, very dense, GRAVEL, some fine to coarse sand, some silt, (FTIII). 6. 10.00-11.00 ft. - Boulder from 11.0-12.0 ft bgs. 7. 11.00-12.00 ft. - Very dense from 12.0-15.6 ft bgs. 8. 12.00-15.60 ft. - Grey, wet, very dense, GRAVEL, some fine to coarse sand, some silt, (FTIII). 9. 15.60-20.60 ft. - Boulder from 15.6-19.6 ft bgs. 10. 20.60-20.60 ft. - R1: Calcareous SANDSTONE and interbedded SANDSTONE and impure LIMESTONE. Core Times (minutes): 15.0-20.6 (16:00) Core Blocked TSS Recovery Bottom of Exploration at 20.6 feet below ground surface.						
Laboratory Testing Results: ASHTO and Unified Class						
Stratification lines represent approximate boundaries between soil types; transitions may be gradual.						
* Water level readings have been made at 15min and under conditions shown. Groundwater fluctuations may occur due to conditions other than those present at the time measurements were made.						
Page 1 of 1 Boring No.: HB-MON-101						

Maine Department of Transportation			Project: Large Culvert Replacement		Boring No.: HB-MON-102	
Soil/Book Exploration Log			Routes 6/15		WIN: 22930.00	
US CUSTOMARY UNITS			Location: Monson, Maine			
Drilling Contractor: Mofmoot		Elevation (ft.):	1170.2	Auger 10/00:	5" Dia.	
Operator: Doggett/NTies		Station:	NAV088	Sampler:	N/A	
Logged By: B. W. Tider		Rig Type:	CME 45C	Hammer Wt./Fall:	N/A	
Date Start/Finish: 5/30/2018 08:30-13:00		Drilling Method:	Solid Stem Auger	Core Barrel:	N/A	
Boring Location: 17+13.9, 7.6 ft R1		Coring 10/00:	N/A	Water Level:	None Observed	
Soil/Terms: Soil: Open Sample S = Sample off Auger / Fall B = Bucket Sample off Auger / Fall U = Undisturbed Soil / Open Sample Attempt I = Thin Wall Tube Sample T = Field Vane Shear Test SP = Pocket Penetrometer WSP = Weight of 1 Person L = Push/Pull/Retract Load from Undrained Shear Strength Test T _u = 1.5 x Undrained Shear Strength Test q _u = Undrained Compressive Strength Test N = Standard Penetration Test N ₆₀ = Standard Penetration Test N ₁₀₀ = Standard Penetration Test N ₁₅₀ = Standard Penetration Test N ₂₀₀ = Standard Penetration Test N ₂₅₀ = Standard Penetration Test N ₃₀₀ = Standard Penetration Test N ₃₅₀ = Standard Penetration Test N ₄₀₀ = Standard Penetration Test N ₄₅₀ = Standard Penetration Test N ₅₀₀ = Standard Penetration Test N ₅₅₀ = Standard Penetration Test N ₆₀₀ = Standard Penetration Test N ₆₅₀ = Standard Penetration Test N ₇₀₀ = Standard Penetration Test N ₇₅₀ = Standard Penetration Test N ₈₀₀ = Standard Penetration Test N ₈₅₀ = Standard Penetration Test N ₉₀₀ = Standard Penetration Test N ₉₅₀ = Standard Penetration Test N ₁₀₀₀ = Standard Penetration Test N ₁₀₅₀ = Standard Penetration Test N ₁₁₀₀ = Standard Penetration Test N ₁₁₅₀ = Standard Penetration Test N ₁₂₀₀ = Standard Penetration Test N ₁₂₅₀ = Standard Penetration Test N ₁₃₀₀ = Standard Penetration Test N ₁₃₅₀ = Standard Penetration Test N ₁₄₀₀ = Standard Penetration Test N ₁₄₅₀ = Standard Penetration Test N ₁₅₀₀ = Standard Penetration Test N ₁₅₅₀ = Standard Penetration Test N ₁₆₀₀ = Standard Penetration Test N ₁₆₅₀ = Standard Penetration Test N ₁₇₀₀ = Standard Penetration Test N ₁₇₅₀ = Standard Penetration Test N ₁₈₀₀ = Standard Penetration Test N ₁₈₅₀ = Standard Penetration Test N ₁₉₀₀ = Standard Penetration Test N ₁₉₅₀ = Standard Penetration Test N ₂₀₀₀ = Standard Penetration Test N ₂₀₅₀ = Standard Penetration Test N ₂₁₀₀ = Standard Penetration Test N ₂₁₅₀ = Standard Penetration Test N ₂₂₀₀ = Standard Penetration Test N ₂₂₅₀ = Standard Penetration Test N ₂₃₀₀ = Standard Penetration Test N ₂₃₅₀ = Standard Penetration Test N ₂₄₀₀ = Standard Penetration Test N ₂₄₅₀ = Standard Penetration Test N ₂₅₀₀ = Standard Penetration Test N ₂₅₅₀ = Standard Penetration Test N ₂₆₀₀ = Standard Penetration Test N ₂₆₅₀ = Standard Penetration Test N ₂₇₀₀ = Standard Penetration Test N ₂₇₅₀ = Standard Penetration Test N ₂₈₀₀ = Standard Penetration Test N ₂₈₅₀ = Standard Penetration Test N ₂₉₀₀ = Standard Penetration Test N ₂₉₅₀ = Standard Penetration Test N ₃₀₀₀ = Standard Penetration Test N ₃₀₅₀ = Standard Penetration Test N ₃₁₀₀ = Standard Penetration Test N ₃₁₅₀ = Standard Penetration Test N ₃₂₀₀ = Standard Penetration Test N ₃₂₅₀ = Standard Penetration Test N ₃₃₀₀ = Standard Penetration Test N ₃₃₅₀ = Standard Penetration Test N ₃₄₀₀ = Standard Penetration Test N ₃₄₅₀ = Standard Penetration Test N ₃₅₀₀ = Standard Penetration Test N ₃₅₅₀ = Standard Penetration Test N ₃₆₀₀ = Standard Penetration Test N ₃₆₅₀ = Standard Penetration Test N ₃₇₀₀ = Standard Penetration Test N ₃₇₅₀ = Standard Penetration Test N ₃₈₀₀ = Standard Penetration Test N ₃₈₅₀ = Standard Penetration Test N ₃₉₀₀ = Standard Penetration Test N ₃₉₅₀ = Standard Penetration Test N ₄₀₀₀ = Standard Penetration Test N ₄₀₅₀ = Standard Penetration Test N ₄₁₀₀ = Standard Penetration Test N ₄₁₅₀ = Standard Penetration Test N ₄₂₀₀ = Standard Penetration Test N ₄₂₅₀ = Standard Penetration Test N ₄₃₀₀ = Standard Penetration Test N ₄₃₅₀ = Standard Penetration Test N ₄₄₀₀ = Standard Penetration Test N ₄₄₅₀ = Standard Penetration Test N ₄₅₀₀ = Standard Penetration Test N ₄₅₅₀ = Standard Penetration Test N ₄₆₀₀ = Standard Penetration Test N ₄₆₅₀ = Standard Penetration Test N ₄₇₀₀ = Standard Penetration Test N ₄₇₅₀ = Standard Penetration Test N ₄₈₀₀ = Standard Penetration Test N ₄₈₅₀ = Standard Penetration Test N ₄₉₀₀ = Standard Penetration Test N ₄₉₅₀ = Standard Penetration Test N ₅₀₀₀ = Standard Penetration Test N ₅₀₅₀ = Standard Penetration Test N ₅₁₀₀ = Standard Penetration Test N ₅₁₅₀ = Standard Penetration Test N ₅₂₀₀ = Standard Penetration Test N ₅₂₅₀ = Standard Penetration Test N ₅₃₀₀ = Standard Penetration Test N ₅₃₅₀ = Standard Penetration Test N ₅₄₀₀ = Standard Penetration Test N ₅₄₅₀ = Standard Penetration Test N ₅₅₀₀ = Standard Penetration Test N ₅₅₅₀ = Standard Penetration Test N ₅₆₀₀ = Standard Penetration Test N ₅₆₅₀ = Standard Penetration Test N ₅₇₀₀ = Standard Penetration Test N ₅₇₅₀ = Standard Penetration Test N ₅₈₀₀ = Standard Penetration Test N ₅₈₅₀ = Standard Penetration Test N ₅₉₀₀ = Standard Penetration Test N ₅₉₅₀ = Standard Penetration Test N ₆₀₀₀ = Standard Penetration Test N ₆₀₅₀ = Standard Penetration Test N ₆₁₀₀ = Standard Penetration Test N ₆₁₅₀ = Standard Penetration Test N ₆₂₀₀ = Standard Penetration Test N ₆₂₅₀ = Standard Penetration Test N ₆₃₀₀ = Standard Penetration Test N ₆₃₅₀ = Standard Penetration Test N ₆₄₀₀ = Standard Penetration Test N ₆₄₅₀ = Standard Penetration Test N ₆₅₀₀ = Standard Penetration Test N ₆₅₅₀ = Standard Penetration Test N ₆₆₀₀ = Standard Penetration Test N ₆₆₅₀ = Standard Penetration Test N ₆₇₀₀ = Standard Penetration Test N ₆₇₅₀ = Standard Penetration Test N ₆₈₀₀ = Standard Penetration Test N ₆₈₅₀ = Standard Penetration Test N ₆₉₀₀ = Standard Penetration Test N ₆₉₅₀ = Standard Penetration Test N ₇₀₀₀ = Standard Penetration Test N ₇₀₅₀ = Standard Penetration Test N ₇₁₀₀ = Standard Penetration Test N ₇₁₅₀ = Standard Penetration Test N ₇₂₀₀ = Standard Penetration Test N ₇₂₅₀ = Standard Penetration Test N ₇₃₀₀ = Standard Penetration Test N ₇₃₅₀ = Standard Penetration Test N ₇₄₀₀ = Standard Penetration Test N ₇₄₅₀ = Standard Penetration Test N ₇₅₀₀ = Standard Penetration Test N ₇₅₅₀ = Standard Penetration Test N ₇₆₀₀ = Standard Penetration Test N ₇₆₅₀ = Standard Penetration Test N ₇₇₀₀ = Standard Penetration Test N ₇₇₅₀ = Standard Penetration Test N ₇₈₀₀ = Standard Penetration Test N ₇₈₅₀ = Standard Penetration Test N ₇₉₀₀ = Standard Penetration Test N ₇₉₅₀ = Standard Penetration Test N ₈₀₀₀ = Standard Penetration Test N ₈₀₅₀ = Standard Penetration Test N ₈₁₀₀ = Standard Penetration Test N ₈₁₅₀ = Standard Penetration Test N ₈₂₀₀ = Standard Penetration Test N ₈₂₅₀ = Standard Penetration Test N ₈₃₀₀ = Standard Penetration Test N ₈₃₅₀ = Standard Penetration Test N ₈₄₀₀ = Standard Penetration Test N ₈₄₅₀ = Standard Penetration Test N ₈₅₀₀ = Standard Penetration Test N ₈₅₅₀ = Standard Penetration Test N ₈₆₀₀ = Standard Penetration Test N ₈₆₅₀ = Standard Penetration Test N ₈₇₀₀ = Standard Penetration Test N ₈₇₅₀ = Standard Penetration Test N ₈₈₀₀ = Standard Penetration Test N ₈₈₅₀ = Standard Penetration Test N ₈₉₀₀ = Standard Penetration Test N ₈₉₅₀ = Standard Penetration Test N ₉₀₀₀ = Standard Penetration Test N ₉₀₅₀ = Standard Penetration Test N ₉₁₀₀ = Standard Penetration Test N ₉₁₅₀ = Standard Penetration Test N ₉₂₀₀ = Standard Penetration Test N ₉₂₅₀ = Standard Penetration Test N ₉₃₀₀ = Standard Penetration Test N ₉₃₅₀ = Standard Penetration Test N ₉₄₀₀ = Standard Penetration Test N ₉₄₅₀ = Standard Penetration Test N ₉₅₀₀ = Standard Penetration Test N ₉₅₅₀ = Standard Penetration Test N ₉₆₀₀ = Standard Penetration Test N ₉₆₅₀ = Standard Penetration Test N ₉₇₀₀ = Standard Penetration Test N ₉₇₅₀ = Standard Penetration Test N ₉₈₀₀ = Standard Penetration Test N ₉₈₅₀ = Standard Penetration Test N ₉₉₀₀ = Standard Penetration Test N ₉₉₅₀ = Standard Penetration Test N ₁₀₀₀₀ = Standard Penetration Test N ₁₀₀₅₀ = Standard Penetration Test N ₁₀₁₀₀ = Standard Penetration Test N ₁₀₁₅₀ = Standard Penetration Test N ₁₀₂₀₀ = Standard Penetration Test N ₁₀₂₅₀ = Standard Penetration Test N ₁₀₃₀₀ = Standard Penetration Test N ₁₀₃₅₀ = Standard Penetration Test N ₁₀₄₀₀ = Standard Penetration Test N ₁₀₄₅₀ = Standard Penetration Test N ₁₀₅₀₀ = Standard Penetration Test N ₁₀₅₅₀ = Standard Penetration Test N ₁₀₆₀₀ = Standard Penetration Test N ₁₀₆₅₀ = Standard Penetration Test N ₁₀₇₀₀ = Standard Penetration Test N ₁₀₇₅₀ = Standard Penetration Test N ₁₀₈₀₀ = Standard Penetration Test N ₁₀₈₅₀ = Standard Penetration Test N ₁₀₉₀₀ = Standard Penetration Test N ₁₀₉₅₀ = Standard Penetration Test N ₁₁₀₀₀ = Standard Penetration Test N ₁₁₀₅₀ = Standard Penetration Test N ₁₁₁₀₀ = Standard Penetration Test N ₁₁₁₅₀ = Standard Penetration Test N ₁₁₂₀₀ = Standard Penetration Test N ₁₁₂₅₀ = Standard Penetration Test N ₁₁₃₀₀ = Standard Penetration Test N ₁₁₃₅₀ = Standard Penetration Test N ₁₁₄₀₀ = Standard Penetration Test N ₁₁₄₅₀ = Standard Penetration Test N ₁₁₅₀₀ = Standard Penetration Test N ₁₁₅₅₀ = Standard Penetration Test N ₁₁₆₀₀ = Standard Penetration Test N ₁₁₆₅₀ = Standard Penetration Test N ₁₁₇₀₀ = Standard Penetration Test N ₁₁₇₅₀ = Standard Penetration Test N ₁₁₈₀₀ = Standard Penetration Test N ₁₁₈₅₀ = Standard Penetration Test N ₁₁₉₀₀ = Standard Penetration Test N ₁₁₉₅₀ = Standard Penetration Test N ₁₂₀₀₀ = Standard Penetration Test N ₁₂₀₅₀ = Standard Penetration Test N ₁₂₁₀₀ = Standard Penetration Test N ₁₂₁₅₀ = Standard Penetration Test N ₁₂₂₀₀ = Standard Penetration Test N ₁₂₂₅₀ = Standard Penetration Test N ₁₂₃₀₀ = Standard Penetration Test N ₁₂₃₅₀ = Standard Penetration Test N ₁₂₄₀₀ = Standard Penetration Test N ₁₂₄₅₀ = Standard Penetration Test N ₁₂₅₀₀ = Standard Penetration Test N ₁₂₅₅₀ = Standard Penetration Test N ₁₂₆₀₀ = Standard Penetration Test N ₁₂₆₅₀ = Standard Penetration Test N ₁₂₇₀₀ = Standard Penetration Test N ₁₂₇₅₀ = Standard Penetration Test N ₁₂₈₀₀ = Standard Penetration Test N ₁₂₈₅₀ = Standard Penetration Test N ₁₂₉₀₀ = Standard Penetration Test N ₁₂₉₅₀ = Standard Penetration Test N ₁₃₀₀₀ = Standard Penetration Test N ₁₃₀₅₀ = Standard Penetration Test N ₁₃₁₀₀ = Standard Penetration Test N ₁₃₁₅₀ = Standard Penetration Test N ₁₃₂₀₀ = Standard Penetration Test N ₁₃₂₅₀ = Standard Penetration Test N ₁₃₃₀₀ = Standard Penetration Test N ₁₃₃₅₀ = Standard Penetration Test N ₁₃₄₀₀ = Standard Penetration Test N ₁₃₄₅₀ = Standard Penetration Test N ₁₃₅₀₀ = Standard Penetration Test N ₁₃₅₅₀ = Standard Penetration Test N ₁₃₆₀₀ = Standard Penetration Test N ₁₃₆₅₀ = Standard Penetration Test N ₁₃₇₀₀ = Standard Penetration Test N ₁₃₇₅₀ = Standard Penetration Test N ₁₃₈₀₀ = Standard Penetration Test N ₁₃₈₅₀ = Standard Penetration Test N ₁₃₉₀₀ = Standard Penetration Test N ₁₃₉₅₀ = Standard Penetration Test N ₁₄₀₀₀ = Standard Penetration Test N ₁₄₀₅₀ = Standard Penetration Test N ₁₄₁₀₀ = Standard Penetration Test N ₁₄₁₅₀ = Standard Penetration Test N ₁₄₂₀₀ = Standard Penetration Test N ₁₄₂₅₀ = Standard Penetration Test N ₁₄₃₀₀ = Standard Penetration Test N ₁₄₃₅₀ = Standard Penetration Test N ₁₄₄₀₀ = Standard Penetration Test N ₁₄₄₅₀ = Standard Penetration Test N ₁₄₅₀₀ = Standard Penetration Test N ₁₄₅₅₀ = Standard Penetration Test N ₁₄₆₀₀ = Standard Penetration Test N ₁₄₆₅₀ = Standard Penetration Test N ₁₄₇₀₀ = Standard Penetration Test N ₁₄₇₅₀ = Standard Penetration Test N ₁₄₈₀₀ = Standard Penetration Test N ₁₄₈₅₀ = Standard Penetration Test N ₁₄₉₀₀ = Standard Penetration Test N ₁₄₉₅₀ = Standard Penetration Test N ₁₅₀₀₀ = Standard Penetration Test N ₁₅₀₅₀ = Standard Penetration Test N ₁₅₁₀₀ = Standard Penetration Test N ₁₅₁₅₀ = Standard Penetration Test N ₁₅₂₀₀ = Standard Penetration Test N ₁₅₂₅₀ = Standard Penetration Test N ₁₅₃₀₀ = Standard Penetration Test N ₁₅₃₅₀ = Standard Penetration Test N ₁₅₄₀₀ = Standard Penetration Test N ₁₅₄₅₀ = Standard Penetration Test N ₁₅₅₀₀ = Standard Penetration Test N ₁₅₅₅₀ = Standard Penetration Test N ₁₅₆₀₀ = Standard Penetration Test N ₁₅₆₅₀ = Standard Penetration Test N ₁₅₇₀₀ = Standard Penetration Test N ₁₅₇₅₀ = Standard Penetration Test N ₁₅₈₀₀ = Standard Penetration Test N ₁₅₈₅₀ = Standard Penetration Test N ₁₅₉₀₀ = Standard Penetration Test N ₁₅₉₅₀ = Standard Penetration Test N ₁₆₀₀₀ = Standard Penetration Test N ₁₆₀₅₀ = Standard Penetration Test N ₁₆₁₀₀ = Standard Penetration Test N ₁₆₁₅₀ = Standard Penetration Test N ₁₆₂₀₀ = Standard Penetration Test N ₁₆₂₅₀ = Standard Penetration Test N ₁₆₃₀₀ = Standard Penetration Test N ₁₆₃₅₀ = Standard Penetration Test N ₁₆₄₀₀ = Standard Penetration Test N ₁₆₄₅₀ = Standard Penetration Test N ₁₆₅₀₀ = Standard Penetration Test N ₁₆₅₅₀ = Standard Penetration Test N ₁₆₆₀₀ = Standard Penetration Test N ₁₆₆₅₀ = Standard Penetration Test N ₁₆₇₀₀ = Standard Penetration Test N ₁₆₇₅₀ = Standard Penetration Test N ₁₆₈₀₀ = Standard Penetration Test N ₁₆₈₅₀ = Standard Penetration Test N ₁₆₉₀₀ = Standard Penetration Test N ₁₆₉₅₀ = Standard Penetration Test N ₁₇₀₀₀ = Standard Penetration Test N ₁₇₀₅₀ = Standard Penetration Test N ₁₇₁₀₀ = Standard Penetration Test N ₁₇₁₅₀ = Standard Penetration Test N ₁₇₂₀₀ = Standard Penetration Test N ₁₇₂₅₀ = Standard Penetration Test N ₁₇₃₀₀ = Standard Penetration Test N ₁₇₃₅₀ = Standard Penetration Test N ₁₇₄₀₀ = Standard Penetration Test N ₁₇₄₅₀ = Standard Penetration Test N ₁₇₅₀₀ = Standard Penetration Test N ₁₇₅₅₀ = Standard Penetration Test N ₁₇₆₀₀ = Standard Penetration Test N ₁₇₆₅₀ = Standard Penetration Test N ₁₇₇₀₀ = Standard Penetration Test N ₁₇₇₅₀ = Standard Penetration Test N ₁₇₈₀₀ = Standard Penetration Test N ₁₇₈₅₀ = Standard Penetration Test N ₁₇₉₀₀ = Standard Penetration Test N ₁₇₉₅₀ = Standard Penetration Test N ₁₈₀₀₀ = Standard Penetration Test N ₁₈₀₅₀ = Standard Penetration Test N ₁₈₁₀₀ = Standard Penetration Test N ₁₈₁₅₀ = Standard Penetration Test N ₁₈₂₀₀ = Standard Penetration Test N ₁₈₂₅₀ = Standard Penetration Test N ₁₈₃₀₀ = Standard Penetration Test N ₁₈₃₅₀ = Standard Penetration Test N ₁₈₄₀₀ = Standard Penetration Test N ₁₈₄₅₀ = Standard Penetration Test N ₁₈₅₀₀ = Standard Penetration Test N ₁₈₅₅₀ = Standard Penetration Test N ₁₈₆₀₀ = Standard Penetration Test N ₁₈₆₅₀ = Standard Penetration Test N ₁₈₇₀₀ = Standard Penetration Test N ₁₈₇₅₀ = Standard Penetration Test N ₁₈₈₀₀ = Standard Penetration Test N ₁₈₈₅₀ = Standard Penetration Test N ₁₈₉₀₀ = Standard Penetration Test N ₁₈₉₅₀ = Standard Penetration Test N ₁₉₀₀₀ = Standard Penetration Test N ₁₉₀₅₀ = Standard Penetration Test N ₁₉₁₀₀ = Standard Penetration Test N ₁₉₁₅₀ = Standard Penetration Test N ₁₉₂₀₀ = Standard Penetration Test N ₁₉₂₅₀ = Standard Penetration Test N ₁₉₃₀₀ = Standard Penetration Test N ₁₉₃₅₀ = Standard Penetration Test N ₁₉₄₀₀ = Standard Penetration Test N ₁₉₄₅₀ = Standard Penetration Test N ₁₉₅₀₀ = Standard Penetration Test N ₁₉₅₅₀ = Standard Penetration Test N ₁₉₆₀₀ = Standard Penetration Test N ₁₉₆₅₀ = Standard Penetration Test N ₁₉₇₀₀ = Standard Penetration Test N ₁₉₇₅₀ = Standard Penetration Test N ₁₉₈₀₀ = Standard Penetration Test N ₁₉₈₅₀ = Standard Penetration Test N ₁₉₉₀₀ = Standard Penetration Test N ₁₉₉₅₀ = Standard Penetration Test N ₂₀₀₀₀ = Standard Penetration Test N ₂₀₀₅₀ = Standard Penetration Test N ₂₀₁₀₀ = Standard Penetration Test N ₂₀₁₅₀ = Standard Penetration Test N ₂₀₂₀₀ = Standard Penetration Test N ₂₀₂₅₀ = Standard Penetration Test N ₂₀₃₀₀ = Standard Penetration Test N ₂₀₃₅₀ = Standard Penetration Test N ₂₀₄₀₀ = Standard Penetration Test N ₂₀₄₅₀ = Standard Penetration Test N ₂₀₅₀₀ = Standard Penetration Test N ₂₀₅₅₀ = Standard Penetration Test N ₂₀₆₀₀ = Standard Penetration Test N ₂₀₆₅₀ = Standard Penetration Test N ₂₀₇₀₀ = Standard Penetration Test N ₂₀₇₅₀ = Standard Penetration Test N ₂₀₈₀₀ = Standard Penetration Test N ₂₀₈₅₀ = Standard Penetration Test N ₂₀₉₀₀ = Standard Penetration Test N ₂₀₉₅₀ = Standard Penetration Test N ₂₁₀₀₀ = Standard Penetration Test N ₂₁₀₅₀ = Standard Penetration Test N ₂₁₁₀₀ = Standard Penetration Test N ₂₁₁₅₀ = Standard Penetration Test N ₂₁₂₀₀ = Standard Penetration Test N ₂₁₂₅₀ = Standard Penetration Test N ₂₁₃₀₀ = Standard Penetration Test N ₂₁₃₅₀ = Standard Penetration Test N ₂₁₄₀₀ = Standard Penetration Test N ₂₁₄₅₀ = Standard Penetration Test N ₂₁₅₀₀ = Standard Penetration Test N ₂₁₅₅₀ = Standard Penetration Test N ₂₁₆₀₀ = Standard Penetration Test N ₂₁₆₅₀ = Standard Penetration Test N ₂₁₇₀₀ = Standard Penetration Test N ₂₁₇₅₀ = Standard Penetration Test N ₂₁₈₀₀ = Standard Penetration Test N ₂₁₈₅₀ = Standard Penetration Test N ₂₁₉₀₀ = Standard Penetration Test N ₂₁₉₅₀ = Standard Penetration Test N ₂₂₀₀₀ = Standard Penetration Test N ₂₂₀₅₀ = Standard Penetration Test N ₂₂₁₀₀ = Standard Penetration Test N ₂₂₁₅₀ = Standard Penetration Test N ₂₂₂₀₀ = Standard Penetration Test N ₂₂₂₅₀ = Standard Penetration Test N ₂₂₃₀₀ = Standard Penetration Test N ₂₂₃₅₀ = Standard Penetration Test N ₂₂₄₀₀ = Standard Penetration Test N ₂₂₄₅₀ = Standard Penetration Test N ₂₂₅₀₀ = Standard Penetration Test N ₂₂₅₅₀ = Standard Penetration Test N ₂₂₆₀₀ = Standard Penetration Test N ₂₂₆₅₀ = Standard Penetration Test N ₂₂₇₀₀ = Standard Penetration Test N ₂₂₇₅₀ = Standard Penetration Test N ₂₂₈₀₀ = Standard Penetration Test N ₂₂₈₅₀ = Standard Penetration Test N ₂₂₉₀₀ = Standard Penetration Test N ₂₂₉₅₀ = Standard Penetration Test N ₂₃₀₀₀ = Standard Penetration Test N ₂₃₀₅₀ = Standard Penetration Test N ₂₃₁₀₀ = Standard Penetration Test N ₂₃₁₅₀ = Standard Penetration Test N ₂₃₂₀₀ = Standard Penetration Test N ₂₃₂₅₀ = Standard Penetration Test N ₂₃₃₀₀ = Standard Penetration Test N ₂₃₃₅₀ = Standard Penetration Test N ₂₃₄₀₀ = Standard Penetration Test N ₂₃₄₅₀ = Standard Penetration Test N ₂₃₅₀₀ = Standard Penetration Test N ₂₃₅₅₀ = Standard Penetration Test N ₂₃₆₀₀ = Standard Penetration Test N ₂₃₆₅₀ = Standard Penetration Test N ₂₃₇₀₀ = Standard Penetration Test N ₂₃₇₅₀ = Standard Penetration Test N ₂₃₈₀₀ = Standard Penetration Test N ₂₃₈₅₀ = Standard Penetration Test N ₂₃₉₀₀ = Standard Penetration Test N ₂₃₉₅₀ = Standard Penetration Test N ₂₄₀₀₀ = Standard Penetration Test N ₂₄₀₅₀ = Standard Penetration Test N ₂₄₁₀₀ = Standard Penetration Test N ₂₄₁₅₀ = Standard Penetration Test N ₂₄₂₀₀ = Standard Penetration Test N ₂₄₂₅₀ = Standard Penetration Test N ₂₄₃₀₀ = Standard Penetration Test N ₂₄₃₅₀ = Standard Penetration Test N ₂₄₄₀₀ = Standard Penetration Test N ₂₄₄₅₀ = Standard Penetration Test N ₂₄₅₀₀ = Standard Penetration Test N ₂₄₅₅₀ = Standard Penetration Test N ₂₄₆₀₀ = Standard Penetration Test N ₂₄₆₅₀ = Standard Penetration Test N ₂₄₇₀₀ = Standard Penetration Test N ₂₄₇₅₀ = Standard Penetration Test N ₂₄₈₀₀ = Standard Penetration Test N ₂₄₈₅₀ = Standard Penetration Test N ₂₄₉₀₀ = Standard Penetration Test N ₂₄₉₅₀ = Standard Penetration Test N ₂₅₀₀₀ = Standard Penetration Test N ₂₅₀₅₀ = Standard Penetration Test N ₂₅₁₀₀ = Standard Penetration Test N ₂₅₁₅₀ = Standard Penetration Test N ₂₅₂₀₀ = Standard Penetration Test N ₂₅₂₅₀ = Standard Penetration Test N ₂₅₃₀₀ = Standard Penetration Test N ₂₅₃₅₀ = Standard Penetration Test N ₂₅₄₀₀ = Standard Penetration Test N ₂₅₄₅₀ = Standard Penetration Test N ₂₅₅₀₀ = Standard Penetration Test N ₂₅₅₅₀ = Standard Penetration Test N ₂₅₆₀₀ = Standard Penetration Test N ₂₅₆₅₀ = Standard Penetration Test N ₂₅₇₀₀ = Standard Penetration Test N ₂₅₇₅₀ = Standard Penetration Test N ₂₅₈₀₀ = Standard Penetration Test N ₂₅₈₅₀ = Standard Penetration Test N ₂₅₉₀₀ = Standard Penetration Test N ₂₅₉₅₀ = Standard Penetration Test N ₂₆₀₀₀ = Standard Penetration Test N ₂₆₀₅₀ = Standard Penetration Test N ₂₆₁₀₀ = Standard Penetration Test N ₂₆₁₅₀ = Standard Penetration Test N ₂₆₂₀₀ = Standard Penetration Test N ₂₆₂₅₀ = Standard Penetration Test N ₂₆₃₀₀ = Standard Penetration Test N ₂₆₃₅₀ = Standard Penetration Test N ₂₆₄₀₀ = Standard Penetration Test N ₂₆₄₅₀ = Standard Penetration Test N ₂₆₅₀₀ = Standard Penetration Test N ₂₆₅₅₀ = Standard Penetration Test N ₂₆₆₀₀ = Standard Penetration Test N ₂₆₆₅₀ = Standard Penetration Test N ₂₆₇₀₀ = Standard Penetration Test N ₂₆₇₅₀ = Standard Penetration Test N ₂₆₈₀₀ = Standard Penetration Test N ₂₆₈₅₀ = Standard Penetration Test N ₂₆₉₀₀ = Standard Penetration Test N ₂₆₉₅₀ = Standard Penetration Test N ₂₇₀₀₀ = Standard Penetration Test N ₂₇₀₅₀ = Standard Penetration Test N ₂₇₁₀₀ = Standard Penetration Test N ₂₇₁₅₀ = Standard Penetration Test N ₂₇₂₀₀ = Standard Penetration Test N ₂₇₂₅₀ = Standard Penetration Test N ₂₇₃₀₀ = Standard Penetration Test N ₂₇₃₅₀ = Standard Penetration Test N ₂₇₄₀₀ = Standard Penetration Test N ₂₇₄₅₀ = Standard Penetration Test N ₂₇₅₀₀ = Standard Penetration Test N ₂₇₅₅₀ = Standard Penetration Test N ₂₇₆₀₀ = Standard Penetration Test N ₂₇₆₅₀ = Standard Penetration Test N ₂₇₇₀₀ = Standard Penetration Test N ₂₇₇₅₀ = Standard Penetration Test N ₂₇₈₀₀ = Standard Penetration Test N ₂₇₈₅₀ = Standard Penetration Test N ₂₇₉₀₀ = Standard Penetration Test N ₂₇₉₅₀ = Standard Penetration Test N ₂₈₀₀₀ = Standard Penetration Test N ₂₈₀₅₀ = Standard Penetration Test N ₂₈₁₀₀ = Standard Penetration Test N ₂₈₁₅₀ = Standard Penetration Test N ₂₈₂₀₀ = Standard Penetration Test N ₂₈₂₅₀ = Standard Penetration Test N ₂₈₃₀₀ = Standard Penetration Test N ₂₈₃₅₀ = Standard Penetration Test N ₂₈₄₀₀ = Standard Penetration Test N ₂₈₄₅₀ = Standard Penetration Test N ₂₈₅₀₀ = Standard Penetration Test N ₂₈₅₅₀ = Standard Penetration Test N ₂₈₆₀₀ = Standard Penetration Test N ₂₈₆₅₀ = Standard Penetration Test N ₂₈₇₀₀ = Standard Penetration Test N ₂₈₇₅₀ = Standard Penetration Test N ₂₈₈₀₀ = Standard Penetration Test N ₂₈₈₅₀ = Standard Penetration Test N ₂₈₉₀₀ = Standard Penetration Test N ₂₈₉₅₀ = Standard Penetration Test N ₂₉₀₀₀ = Standard Penetration Test N ₂₉₀₅₀ = Standard Penetration Test N ₂₉₁₀₀ = Standard Penetration Test N ₂₉₁₅₀ = Standard Penetration Test N ₂₉₂₀₀ = Standard Penetration Test N ₂₉₂₅₀ = Standard Penetration Test N ₂₉₃₀₀ = Standard Penetration Test N ₂₉₃₅₀ = Standard Penetration Test N ₂₉₄₀₀ = Standard Penetration Test N ₂₉₄₅₀ = Standard Penetration Test N ₂₉₅₀₀ = Standard Penetration Test N ₂₉₅₅₀ = Standard Penetration Test N ₂₉₆₀₀ = Standard Penetration Test N ₂₉₆₅₀ = Standard Penetration Test N ₂₉₇₀₀ = Standard Penetration Test N ₂₉₇₅₀ = Standard Penetration Test N ₂₉₈₀₀ = Standard Penetration Test N ₂₉₈₅₀ = Standard Penetration Test N ₂₉₉₀₀ = Standard Penetration Test N ₂₉₉₅₀ = Standard Penetration Test N ₃₀₀₀₀ = Standard Penetration Test N ₃₀₀₅₀ = Standard Penetration Test N ₃₀₁₀₀ = Standard Penetration Test N ₃₀₁₅₀ = Standard Penetration Test N ₃₀₂₀₀ = Standard Penetration Test N ₃₀₂₅₀ = Standard Penetration Test N ₃₀₃₀₀ = Standard Penetration Test N ₃₀₃₅₀ = Standard Penetration Test N ₃₀₄₀₀ = Standard Penetration Test N ₃₀₄₅₀ = Standard Penetration Test N ₃₀₅₀₀ = Standard Penetration Test N ₃₀₅₅₀ = Standard Penetration Test N ₃₀₆₀₀ = Standard Penetration Test N ₃₀₆₅₀ = Standard Penetration Test N ₃₀₇₀₀ = Standard Penetration Test N ₃₀₇₅₀ = Standard Penetration Test N ₃₀₈₀₀ = Standard Penetration Test N ₃₀₈₅₀ = Standard Penetration Test N ₃₀₉₀₀ = Standard Penetration Test N ₃₀₉₅₀ = Standard Penetration Test N ₃₁₀₀₀ = Standard Penetration Test N ₃₁₀₅₀ = Standard Penetration Test N ₃₁₁₀₀ = Standard Penetration Test N ₃₁₁₅₀ = Standard Penetration Test N ₃₁₂₀₀ = Standard Penetration Test N ₃₁₂₅₀ = Standard Penetration Test N ₃₁₃₀₀ = Standard Penetration Test N ₃₁₃₅₀ = Standard Penetration Test N ₃₁₄₀₀ = Standard Penetration Test N ₃₁₄₅₀ = Standard Penetration Test N ₃₁₅₀₀ = Standard Penetration Test N ₃₁₅₅₀ = Standard Penetration Test N						

Appendix A

Boring Logs

UNIFIED SOIL CLASSIFICATION SYSTEM					MODIFIED BURMISTER SYSTEM															
MAJOR DIVISIONS			GROUP SYMBOLS	TYPICAL NAMES																
COARSE-GRAINED SOILS (more than half of material is larger than No. 200 sieve size)	GRAVELS (more than half of coarse fraction is larger than No. 4 sieve size)	CLEAN GRAVELS	GW	Well-graded gravels, gravel-sand mixtures, little or no fines.	<u>Descriptive Term</u>		<u>Portion of Total (%)</u>													
		(little or no fines)	GP	Poorly-graded gravels, gravel sand mixtures, little or no fines.	trace	0 - 10														
					little	11 - 20														
					some	21 - 35														
					adjective (e.g. sandy, clayey)	36 - 50														
	SANDS (more than half of coarse fraction is smaller than No. 4 sieve size)	CLEAN SANDS	SW	Well-graded sands, gravelly sands, little or no fines	TERMS DESCRIBING DENSITY/CONSISTENCY															
		(little or no fines)	SP	Poorly-graded sands, gravelly sand, little or no fines.																
		SANDS WITH FINES (Appreciable amount of fines)	GM	Silty gravels, gravel-sand-silt mixtures.	<u>Coarse-grained soils</u> (more than half of material is larger than No. 200 sieve); Includes (1) clean gravels; (2) silty or clayey gravels; and (3) silty, clayey or gravelly sands. Density is rated according to standard penetration resistance (N-value).															
			GC	Clayey gravels, gravel-sand-clay mixtures.																
			SM	Silty sands, sand-silt mixtures	<u>Density of Cohesionless Soils</u> Very loose Loose Medium Dense Dense Very Dense															
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.	<u>Standard Penetration Resistance</u> <u>N-Value (blows per foot)</u>																
		CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.	Very loose	0 - 4															
		OL	Organic silts and organic silty clays of low plasticity.	Loose	5 - 10															
				Medium Dense	11 - 30															
				Dense	31 - 50															
	SILTS AND CLAYS (liquid limit greater than 50)	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.	Very Dense	> 50															
		CH	Inorganic clays of high plasticity, fat clays.	<u>Fine-grained soils</u> (more than half of material is smaller than No. 200 sieve); Includes (1) inorganic and organic silts and clays; (2) gravelly, sandy or silty clays; and (3) clayey silts. Consistency is rated according to undrained shear strength as indicated.																
		OH	Organic clays of medium to high plasticity, organic silts.																	
		HIGHLY ORGANIC SOILS	Pt	Peat and other highly organic soils.	<u>Approximate Undrained Shear Strength (psf)</u>		<u>Field Guidelines</u>													
						Very Soft	Fist easily penetrates													
					Soft	Thumb easily penetrates														
					Medium Stiff	Thumb penetrates with moderate effort														
					Stiff	Indented by thumb with great effort														
					Very Stiff	Indented by thumbnail														
					Hard	Indented by thumbnail with difficulty														
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					Rock Quality Designation (RQD): RQD (%) = <u>sum of the lengths of intact pieces of core* > 4 inches</u> length of core advance *Minimum NQ rock core (1.88 in. OD of core) Correlation of RQD to Rock Mass Quality <table><tr><th>Rock Mass Quality</th><th>RQD (%)</th></tr><tr><td>Very Poor</td><td>≤25</td></tr><tr><td>Poor</td><td>26 - 50</td></tr><tr><td>Fair</td><td>51 - 75</td></tr><tr><td>Good</td><td>76 - 90</td></tr><tr><td>Excellent</td><td>91 - 100</td></tr></table> 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 mass quality (very poor, poor, etc.) ref: ASTM D6032 and AASHTO Standard Specification for Highway Bridges, 17th Ed. Table 4.4.8.1.2A Recovery (inch/inch and percentage) Rock Core Rate (X.X ft - Y.Y ft (min:sec))				Rock Mass Quality	RQD (%)	Very Poor	≤25	Poor	26 - 50	Fair	51 - 75	Good	76 - 90	Excellent	91 - 100
Rock Mass Quality	RQD (%)																			
Very Poor	≤25																			
Poor	26 - 50																			
Fair	51 - 75																			
Good	76 - 90																			
Excellent	91 - 100																			
Maine Department of Transportation Geotechnical Section Key to Soil and Rock Descriptions and Terms Field Identification Information					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: Large Culvert Replacement Routes 6/15 Location: Monson, Maine				Boring No.: HB-MON-101 WIN: 22930.00				
Driller: MaineDOT				Elevation (ft.): 1168.7				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: 5/30/2018; 08:30-13:00				Drilling Method: Cased Wash Boring				Core Barrel: NQ-2"				
Boring Location: 16+88.6, 13.0 ft Lt. Shoulder				Casing ID/OD: NW-3"				Water Level*: 5.0 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 Information								Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N ₆₀	Casing Blows					
0	1D	24/19	0.00 - 2.00	7/12/11/18	23	36	SSA				Brown, damp, dense, fine to coarse SAND, some gravel, little silt, (Fill).	G#296338 A-1-b, SM WC=3.6%
5	2D	18/13	4.50 - 6.00	3/6/50	56	87					Grey, wet, very dense, fine to coarse Sandy GRAVEL, little silt, (Fill).	G#296339 A-1-a, GM WC=6.0%
											Roller Cone through Cobble from 6.0-6.8 ft bgs.	
											Cobble from 7.5-8.0 ft bgs.	
10	3D	7.2/6	10.00 - 10.60	7/25(1.2")	---		50		1159.7		Grey, wet, very dense, GRAVEL, some fine to coarse sand, some silt, (Till).	G#296340 A-1-b, GM WC=20.9%
							85				Boulder from 11.0-12.0 ft bgs.	
								OPEN HOLE			Very dense from 12.0-19.6 ft bgs.	
15	4D	9.6/6	15.00 - 15.80	11/50(3.6")	---						Grey, wet, very dense, GRAVEL, some fine to coarse sand, some silt, (Till).	G#296341 A-1-b, GM WC=7.7%
								RC			Roller Coned ahead to 19.6 ft bgs.	
20	R1	12/9	19.60 - 20.60					NQ-2	1149.1		R1: Calcareous SANDSTONE and interbedded SANDSTONE and impure LIMESTONE.	
									1148.1		Core Times (min:sec) 19.6-20.6 ft (6:00) Core Blocked 75% Recovery	
											Bottom of Exploration at 20.6 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.										Page 1 of 1 Boring No.: HB-MON-101		

Maine Department of Transportation Soil/Rock Exploration Log US CUSTOMARY UNITS				Project: Large Culvert Replacement Routes 6/15 Location: Monson, Maine				Boring No.: HB-MON-102 WIN: 22930.00			
Drilling Contractor: MaineDOT				Elevation (ft.) 1170.2				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: 5/30/2018; 08:30-13:00				Drilling Method: Solid Stem Auger				Core Barrel: N/A			
Boring Location: 17+13.9, 7.6 ft Rt.				Casing ID/OD: N/A				Water Level*: None Observed			
Definitions: D = Spilt Spoon Sample S = Sample off Auger Flights B = Bucket Sample off Auger Flights MD = Unsuccessful Split Spoon Sample Attempt U = Thin Wall Tube Sample MV = Unsuccessful Field Vane Shear Test Attempt V = Field Vane Shear Test, PP= Pocket Penetrometer MU = Unsuccessful Thin Wall Tube Sample Attempt R = Rock Core Sample SSA = Solid Stem Auger HSA = Hollow Stem Auger RC = Roller Cone WOH = Weight of 140lb. Hammer WOR/C = Weight of Rods or Casing WO1P = Weight of 1 Person S_u = Peak/Remolded Field Vane Undrained Shear Strength (psf) S_u(lab) = Lab Vane Undrained Shear Strength (psf) q_p = Unconfined Compressive Strength (ksf) N-value = Raw Field SPT N-value T_v = Pocket Torvane Shear Strength (psf) WC = Water Content, percent ≈ = Similar or Equal too LL = Liquid Limit PL = Plastic Limit PI = Plasticity Index G = Grain Size Analysis C = Consolidation Test											
Depth (ft.)	Sample Information								Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.	
	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (6 in.) Shear Strength (psf) or RQD (%)	N-value	Casing Blows	Elevation (ft.)	Graphic Log			
0						SSA			Probe, no soil samples taken.		
5											
10									Cobble from 8.4-9.0 ft bgs.		
15											
20							1150.2		Bottom of Exploration at 20.0 feet below ground surface. NO REFUSAL		
25											
Remarks:											
Stratification lines represent approximate boundaries between soil types; transitions may be gradual.									Page 1 of 1		
* Water level readings have been made at times and under conditions stated. Groundwater fluctuations may occur due to conditions other than those present at the time measurements were made.									Boring No.: HB-MON-102		

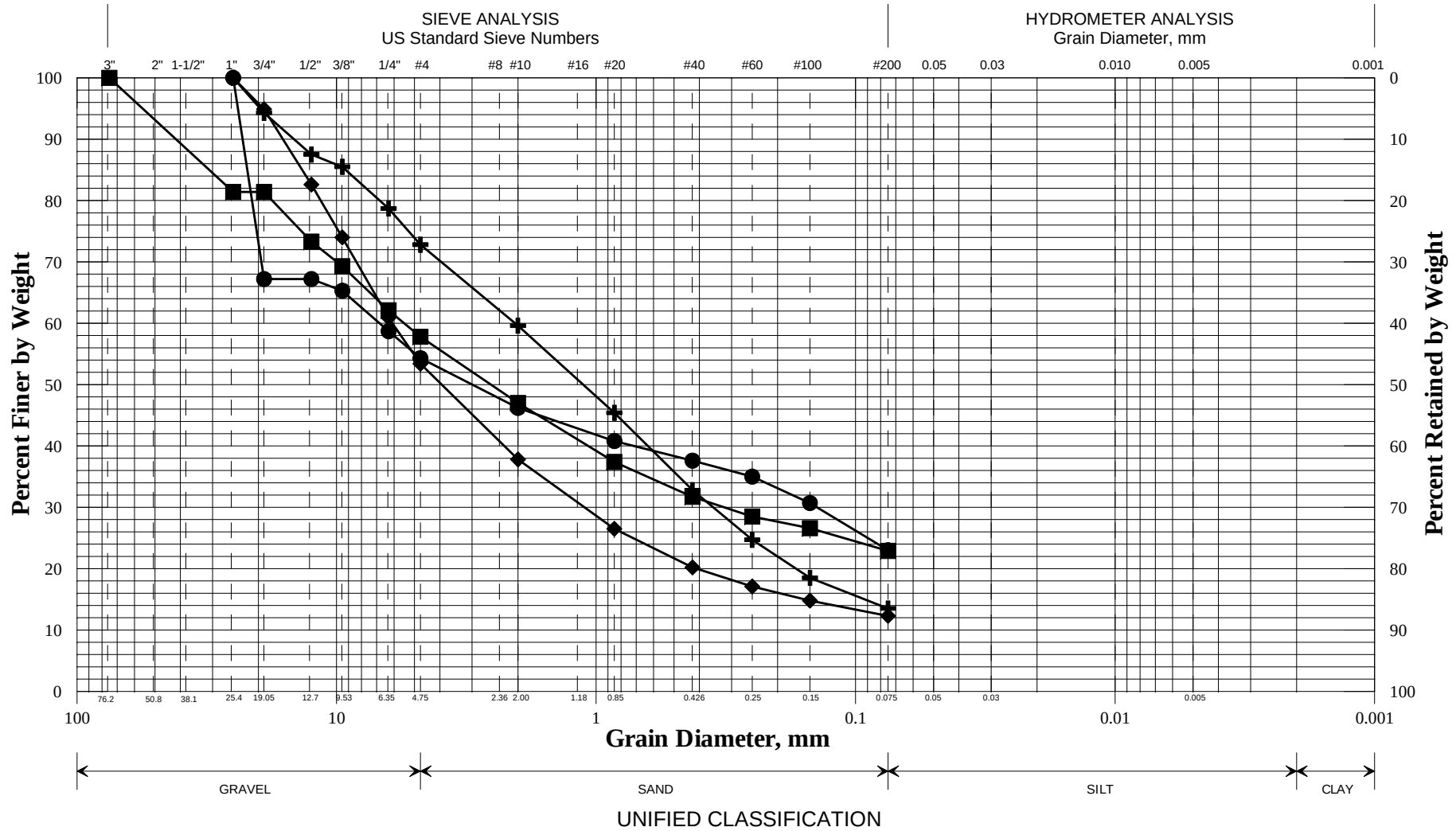
Appendix B

Laboratory Test Results

Work Number: 22930.00

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

State of Maine Department of Transportation
GRAIN SIZE DISTRIBUTION CURVE



	Boring/Sample No.	Station	Offset, ft	Depth, ft	Description	W, %	LL	PL	PI
+	HB-MON-101/1D	16+88.6	13.0 LT	0.0-2.0	SAND, some gravel, little silt.	3.6			
◆	HB-MON-101/2D	16+88.6	13.0 LT	4.5-6.0	Sandy GRAVEL, little silt.	6.0			
■	HB-MON-101/3D	16+88.6	13.0 LT	10.0-10.6	GRAVEL, some sand, some silt.	20.9			
●	HB-MON-101/4D	16+88.6	13.0 LT	15.0-15.8	GRAVEL, some sand, some silt.	7.7			
▲									
×									

WIN	
022930.00	
Town	
Monson	
Reported by/Date	
WHITE, TERRY A	6/19/2018

Appendix C

Calculations

Bearing Resistance - Existing Soils:

Part 1 - Service Limit State

Nominal and factored Bearing Resistance - Box Culvert on Till

Presumptive Bearing Resistance for Service Limit State ONLY

Reference: AASHTO LRFD Bridge Design Specifications 8th Edition 2017
Table C10.6.2.6.1-1 Presumptive Bearing Resistances for Spread Footings at the
Service Limit State Modified after US Department of Navy (1982)

Type of Bearing Material: gravel (GM)

Based on N-values, soils are very dense at the bearing elevation

Density In Place: very dense

Bearing Resistance: Ordinary Range (ksf) 12 to 20

Recommended Value of Use:

$$q_{nom} := 12 \cdot \text{ksf}$$

Resistance factor at the **service limit state** = 1.0 (LRFD Article 10.5.5.1)

$$\phi_{service_bc} := 1.0$$

$$q_{factored_service_bc} := q_{nom} \cdot \phi_{service_bc}$$

$$q_{factored_service_bc} = 12 \cdot \text{ksf}$$

Note: This bearing resistance is settlement limited (1 inch) and applies only at the service limit state.

Part 2 - Strength Limit State

Nominal and factored Bearing Resistance - Box Culvert on Till

Reference: AASHTO LRFD Bridge Design Specifications 8th Edition 2017 - Article 10.6.3.1

Assumptions:

1. The box will be founded at ~ Elev 1160.5 feet

Bottom of Construction will be 2 feet below box invert

$$D_{footing} := 2.0 \cdot \text{ft}$$

2. Assumed parameters for fill soils:

Saturated unit weight: $\gamma_s := 125 \cdot \text{pcf}$

Internal friction angle: $\phi_{ns} := 32 \cdot \text{deg}$

Undrained shear strength: $c_{ns} := 0 \cdot \text{psf}$

3. Box Culvert parameters

Width of box culvert, B $B_{box} := 11 \cdot \text{ft}$

Length of box culvert, L $L_{box} := 78 \cdot \text{ft}$

Nominal Bearing Resistance per LRFD Equation 10.6.3.1.2a-1

$$q_n = cN_{cm} + \gamma D_f N_{qm} C_{wq} + 0.5\gamma B N_{\gamma m} C_{w\gamma}$$

Bearing Capacity Factors - LRFD Table 10.6.3.1.2a-1

For $\phi=32$ deg $N_c := 35.5$ $N_q := 23.2$ $N_\gamma := 30.2$

Shape Correction Factors LRFD Table 10.6.3.1.2a-3

for $\phi=32$ degrees

$$s_c := 1 + \left(\frac{B_{box}}{L_{box}} \right) \left(\frac{N_q}{N_c} \right) \quad s_c = 1.09$$

$$s_\gamma := 1 - 0.4 \left(\frac{B_{box}}{L_{box}} \right) \quad s_\gamma = 0.9436$$

$$s_q := 1 + \left(\frac{B_{box}}{L_{box}} \cdot \tan(\phi_{ns}) \right) \quad s_q = 1.09$$

Load Inclination Factors:

Assume all are 1.0 (LRFD Article C10.6.3.1.2a)

$i_c := 1.0$ $i_q := 1.0$ $i_\gamma := 1.0$

Depth Correction Factor LRFD Table 10.6.3.1.2a-4

$$\frac{D_{footing}}{B_{box}} = 0.1818 \quad \text{for } \phi=32 \text{ degrees} \quad d_q := 1.2$$

$$N_{cm} := N_c \cdot s_c \cdot i_c \quad N_{cm} = 38.7718 \quad \text{LRFD Eq. 10.6.3.1.2a-2}$$

$$N_{qm} := N_q \cdot s_q \cdot d_q \cdot i_q \quad N_{qm} = 30.29 \quad \text{LRFD Eq. 10.6.3.1.2a-3}$$

$$N_{\gamma m} := N_\gamma \cdot s_\gamma \cdot i_\gamma \quad N_{\gamma m} = 28.5 \quad \text{LRFD Eq. 10.6.3.1.2a-4}$$

Coefficients for Groundwater Depths LRFD Table 10.6.3.1.2a-2

Depth the water table: $D_w := 0 \cdot \text{ft}$ $C_{wq} := 0.5$ $C_{w\gamma} := 0.5$

$$q_{nominal} := c_{ns} \cdot N_{cm} + \gamma_s \cdot D_{footing} \cdot N_{qm} \cdot C_{wq} + 0.5(\gamma_s) B_{box} \cdot N_{\gamma m} \cdot C_{w\gamma}$$

$$q_{nominal} = 13.6 \cdot \text{ksf}$$

Factored Bearing Resistance for Strength Limit State

Resistance Factor: $\phi_b := 0.45$ LRFD Table 10.5.5.2.2-1

$$q_{factored} := q_{nominal} \cdot \phi_b$$

$$q_{factored} = 6.1 \cdot \text{ksf}$$

Recommend a limiting factored bearing resistance of 6.0 ksf for the Strength Limit State.

Modulus of Subgrade Reaction:

Reference: Foundation Analysis and Design 5th Edition JE Bowles Section 9-6

Width of box culvert, B $B_{box} := 11 \cdot \text{ft}$

Length of box culvert, L $L_{box} := 78 \cdot \text{ft}$

Thickness of box culvert, t $t_{box} := 12 \cdot \text{in}$ assumed

Depth of box, D $D_{box} := 10 \cdot \text{ft}$

Bearing Resistance: $q_{factored_service_bc} = 12 \cdot \text{ksf}$ Calculated above

Modulus of Site soils at bearing elevation are Gravel (very dense)

Elasticity: From Bowles Table 2-8 Modulus E_s for sand and gravel, dense ranges from 2100 - 4200 ksf

Use Modulus of Elasticity, E_s $E_s := 2100 \cdot \text{ksf}$

Poisson's Ratio: Site soils are Gravel (very dense)

From Bowles Table 2-7 Poisson's Ratio μ for Sand/Gravelly Sand ranges from 0.3 - 0.4

Use Poisson's Ratio, μ $\mu := 0.35$

$$E_{prime_s} := \frac{1 - \mu^2}{E_s} \quad E_{prime_s} = 0.000418 \cdot \frac{\text{ft}^2}{\text{kip}}$$

Analyze corner:

Take H as 5*B as recommended in Bowles Chapter 5

$$H_{inf} := \frac{5 \cdot B_{box}}{B_{box}} \quad H_{inf} = 5 \quad N \text{ in Table 5-2}$$

From Table 5-2 for N=5 and M=7.1

$$\frac{L_{box}}{B_{box}} = 7.0909 \quad M \text{ in Table 5-2}$$

$$I_1 := 0.543$$

$$I_2 := 0.128$$

by interpolation

Determine Steinbrenner influence factor - Bowles Section 5-6:

$$I_s := I_1 + \left[\frac{1 - (2 \cdot \mu)}{1 - \mu} \right] \cdot I_2 \quad I_s = 0.6021$$

Determine Influence factor for footing depth - Bowles Figure 5-7

$$\text{Depth ratio: } \frac{D_{box}}{B_{box}} = 0.9091 \quad \frac{L_{box}}{B_{box}} = 7.0909 \quad \mu = 0.35 \quad I_F := 0.85$$

Calculate modulus of subgrade reaction - Bowles Eq. 9-7

$$k_s := \frac{1}{B_{box} \cdot E_{prime_s} \cdot I_s \cdot I_F} \quad \text{Bowles Eq. 9-7}$$

$$k_s = 246 \cdot \text{pci}$$

Recommend Modulus of Subgrade Reaction of 250 pci