MAINE DEPARTMENT OF TRANSPORTATION
BRIDGE PROGRAM
GEOTECHNICAL SECTION
AUGUSTA, MAINE

GEOTECHNICAL DESIGN REPORT

For the Replacement of:

SOUTHERN INLET BRIDGE
ROUTE 191 OVER SOUTHERN INLET
BERRY TWP, MAINE
(FORMERLY KNOWN AS TWP 18 ED, MAINE)

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Soils Report No. 2010-14
Bridge No. 5375

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GEOTECHNICAL DESIGN SUMMARY

This report provides geotechnical recommendations for the replacement of Southern Inlet Bridge over Southern Inlet in Berry TWP, Maine. The proposed replacement bridge will be a 6-foot high by 14-foot wide concrete box culvert. The road will be closed during construction. The bridge will be widened to 32 feet rail to rail width with 11-foot travel lanes and 5-foot shoulders, as well as accommodation for guardrail. No significant horizontal or vertical alignment changes are planned. The design and construction recommendations below are discussed in greater detail in Section 7.0 Foundation Considerations and Recommendations.

Box Culvert Design and Construction – The concrete box culvert will be supplier-designed and the design shall consider all relevant strength, service and extreme limit states and load combinations in accordance with the AASHTO LRFD Bridge Design Specifications, 4th Edition, 2007, with Interims through 2009 (herein referred to as LRFD). The culvert will be constructed in general conformance with the MaineDOT Bridge Design Guide (BDG) Section 8, Buried Structures, and Special Provision 534, Precast Structural Concrete Arches, Box Culverts. A copy of the special provision is presented in Appendix D, Special Provision. The box culvert designer may assume Soil Type 4 (BDG Section 3.6.1) for backfill soil properties. The backfill properties are as follows: ϕ = 32 degrees, γ = 125 pcf.

The box culvert will be bedded on a two foot thick layer of ¾-inch crushed stone reinforced with geogrid and wrapped in geotextile fabric. See Appendix D for the crushed stone and geogrid special provisions. The soil envelope and backfill shall consist of Standard Specification 703.19, Granular Borrow, Material for Underwater Backfill with a maximum particle size of 4.0 inches. The crushed stone bedding should be placed in 12-inch thick maximum lifts and compacted with a minimum of four passes of a large walk-behind compactor. The granular borrow backfill should be placed in lifts 6 to 8 inches thick loose measure and compacted to manufacturer's specifications, but in no case shall the backfill soil be compacted less than 92 percent of the AASHTO T-180 maximum dry density.

Culvert Headwall Design - Culvert headwalls should consider all relevant LRFD strength and service limit states and load combinations and be designed to resist and/or absorb lateral earth loads, vehicular loads, creep, and temperature and shrinkage deformations of the concrete box culverts. For the Berry TWP culvert replacement, the live load surcharge is 250 psf which is equivalent to two feet of soil.

Culvert headwall sections that are fixed to the box culverts to resist movement should be designed for earth pressure using an at-rest earth pressure coefficient, K_o, of 0.5. Headwall sections that are independent of the box culvert should be designed using the Rankine active earth pressure coefficient, K_a, equal to 0.31. This assumes level backslope. The earth pressure coefficient may change if backslope conditions are different.

Box Culvert Bearing Resistance – The factored bearing resistance at the strength limit state for a box culvert on compacted fill should not exceed 6.0 ksf. Based on presumptive bearing resistance values, a factored bearing resistance of 6.0 ksf may be used when analyzing box bottom slabs for the service limit state. In no instance shall the bearing stress exceed the nominal resistance of concrete, which may be taken as $0.3f'c$.

Settlement – Settlement as a result of fill replacement for minor embankment fill extensions over natural soils will be negligible. Total and post-construction settlements over the prepared subgrade consisting of compacted fill or native soils will also be negligible since no significant grade changes are proposed.

Scour Protection – The box culverts will be fitted with concrete headwalls and inlet and outlet seepage cutoff walls below the culvert, all to provide scour protection. We recommend that the bridge approach slopes be armored with a 3-foot thick layer of riprap up and down the alignment beyond the headwall. The riprap shall be underlain by a Class 1 erosion control geotextile and a 1-foot thick layer of bedding material conforming to Standard Specification 703.19, Granular Borrow for Underwater Backfill. Riprap shall meet the requirements of 703.26, Plain and Hand Laid Riprap, of Special Provision 703, Aggregates. The riprap slope protection should be constructed no steeper than a maximum 1.75:1 (H:V) extending from the bottom edge of the stone ditch protection down to the existing ground surface. The toe of riprap sections shall be constructed 1 foot below the streambed elevation.

Frost Protection – If used, foundations placed on granular soils shall be founded a minimum of 5.0 feet below finish exterior grade for frost protection.

Seismic Design Considerations – Since the buried structure does not cross active faults, no seismic analysis is required.

Construction Considerations –

<u>Excavation</u>

- Construction of the new concrete box culvert will require staged construction and soil excavation. Earth support systems may be required.
- Protect the excavated subgrade from exposure to water and unnecessary construction traffic. Remove and replace water-softened, disturbed, or rutted subgrade soil with compacted granular borrow.

<u>Dewatering</u>

- Control groundwater and surface water infiltration to permit construction in-the-dry.
- Temporary ditches, French drains, pumping from sumps, granular drainage blankets, stone ditch protection, or hand-laid riprap with geotextile underlayment may be needed to divert groundwater if significant seepage is encountered during excavation.

<u>Reuse of Excavated Soil and Bedrock</u>

- <u>Do not</u> use excavated existing subbase aggregate or approach fill soil for pavement structure construction or to re-base shoulders. Excavated subbase sand and gravel or granular fill may be used as fill below subgrade elevation in fill embankment areas provided all other requirements of MaineDOT Standard Specification Sections 203 and 703 are met.

<u>Embankment Fill Areas</u>

- Bench existing fill slope soils in accordance with MaineDOT Standard Specification 203.09, Preparation of Embankment Area, where new fill slope extensions are constructed over existing slopes.

1.0 INTRODUCTION

The Maine Department of Transportation (MaineDOT) plans to replace Southern Inlet Bridge carrying Route 191 over Southern Inlet in the Town of Berry TWP (formerly known as TWP 18 ED), Washigton County, Maine. We show the project location on Sheet 1, Site Location Map, appended to this report. We conducted subsurface investigations at the culvert site to develop geotechnical recommendations for the structure replacement. This report summarizes our findings, discusses our evaluation of the subsurface conditions and presents our geotechnical recommendations for design and construction of the bridge foundations.

The original 18-foot wide by 6.25-foot rise steel structural plate arch on concrete footings was built in 1951. The steel plate arch is heavily rusted and is rated in critical condition. The structure had a sufficiency of 35.6 in 2008.

MaineDOT is proposing a 6-foot high by 14-foot wide, concrete box culvert to replace the existing bridge. The new box culvert will be on the same horizontal alignment with a minor (approximately 0.75 feet) vertical grade rise and will have a rail-to-rail width of approximately 32 feet. Current plans include 11-foot travel lanes and 5-foot shoulders, as well as accommodation for guardrail and construction of concrete culvert headwalls and toe walls. The approach fill embankment slopes will be extended to 2:1 (H:V) and armored riprap embankment slopes will be constructed no steeper than 1.75:1 (H:V). MaineDOT plans to close the road for box culvert construction.

2.0 GEOLOGIC SETTING

The Maine Geologic Survey (MGS) “Surficial Geology of Gardiner Lake Quadrangle, Maine, Open-file No. 82-4” (1982) indicates that surficial soils in the vicinity of Southern Inlet Bridge consist of eskers, glacial stream sediments, glaciomarine sediments which often include silt, clay and sand, and glacial till soil unit contacts. The predominant native soil unit at the site based on our subsurface explorations is glaciomarine sand.

According to the “Bedrock Geologic Map of Maine” MGS (1985), the bedrock at the Southern Inlet Bridge site consists of Devonian gabbro to diorite plutonic rock.

3.0 SUBSURFACE INVESTIGATION

We investigated subsurface conditions at the site by drilling two test borings, BB-T18-101 and BB-T18-102, conducted by the MaineDOT drill crew on November 18 and 19, 2009. The borings were terminated at a depth of approximately 24 and 29 feet below ground surface (bgs), respectively. The boring locations and soil profile are shown on Sheet 2, Boring Location and Interpretive Subsurface Profile. Details and sampling methods used, field data obtained, and soil and groundwater conditions encountered are presented on Sheet 3, Boring Logs, and in Appendix A, Boring Logs, provided at the end of this report.

The MaineDOT geotechnical team member selected the boring locations and drilling methods, designated type and depth of sampling techniques, and identified field and laboratory testing requirements. A MaineDOT Certified Subsurface Inspector logged the subsurface conditions encountered on the field logs. The field crew tied down the boring locations by taping distances to adjacent site features.

We used solid stem auger and cased wash boring techniques to conduct the borings. Soil samples were obtained, where possible, at 5-foot intervals using Standard Penetration Test (SPT) methods. The standard penetration resistances, or N-values, discussed in this report are corrected for average hammer energy transfer. We compute the corrected or, N_{60}-values, by applying an average hammer energy transfer factor of 0.84 to the raw field N-values obtained with the MaineDOT drill rig. Boulders were cored using an NQ-2 core barrel producing a 2.0-inch diameter rock core.

4.0 LABORATORY TESTING

We conducted a laboratory soil testing program on selected samples recovered from the test borings to evaluate soil classification, material reuse, and subgrade soil properties. Laboratory testing consisted of ten (10) standard grain size analyses with natural water contents tests and three (3) loss on ignition tests. We present results of laboratory testing in Appendix B, Laboratory Test Data. The AASHTO and Unified Soil Classification System (USCS) soil classifications and water content data are also presented on the boring logs in Appendix A.

5.0 SUBSURFACE CONDITIONS

Regional surficial geology maps show that the bridge site is situated in an area of numerous widely variable glaciated soil units. The bridge itself is situated in a gap between portions of an esker. The approach embankment soil up and down station from the existing culvert is predominantly granular fill overlying variable and inter-fingered sequences of sand, peat, stratified marine sand and clay-silt and boulders. We present a profile depicting the generalized soil stratigraphy at the bridge site on Sheet 2, Boring Location Plan and Interpretive Subsurface Profile, provided at the end of this report. A summary description of the subsurface conditions follows.

5.1 Granular Fill

We encountered granular fill to a depth ranging between approximately 4.7 and 7.0 feet bgs. The granular fill consists of fine to coarse sand, with some gravel to gravelly and trace to little silt. The SPT N_{60}-values in the granular fill ranged from 10 to 34 blows per foot (bpf) indicating that the unit is loose to dense in consistency.

The granular fill samples had water contents ranging between approximately 5 and 7 percent. Grain size analyses conducted on selected samples of the fill soils indicate that the soils are classified as A-1-a and A-1-b by the AASHTO Classification System and SM and SW-SM under the Unified Soil Classification System.

5.2 Marine Sediments

The marine sediment soil units found in the borings generally comprised of glaciomarine clay-silt, fine to medium or fine to coarse sand with trace gravel and silt, some cases with organics and wood, or stratified clay-silt and fine to medium sand with little silt or silty fine sand. The thickness of individual soil units ranged between approximately 2 to 3 feet with combined total thickness on the order of 6 to 12 feet. SPT N_{60}-values ranged between 14 to 49 bpf, indicating the granular marine sediment deposits were medium dense to dense in consistency and the fine-grained units were very stiff in consistency.

5.3 Peat

Fibrous peat layers were encountered at each boring location ranging in thickness from approximately 1.5 to 3.0 feet thick. The peat contained a granular fraction that consisted of fine sand with little gravel and trace silt, or fine to coarse sand with some gravel and trace silt.

The peat samples had water contents ranging between approximately 57 and 244 percent. The loss on ignition values ranged between approximately 12 and 42 percent. Grain size analyses conducted on the granular fraction of the peat samples indicate that the granular fraction of the peat soils are classified as A-1-b and A-3 by the AASHTO Classification System and SW and SP under the Unified Soil Classification System.

5.4 Glacial Till

We observed a glacial till soil unit only in boring BB-T18-102. This till unit is generally comprised of fine to coarse sand with some gravel and little silt. We noted boulders associated with the till in this boring. We observed 15 feet of this soil unit but the boring was terminated before the bottom elevation of the till layer was encountered. SPT N_{60}-values ranged between 18 and 34 bpf, indicating the till deposit is medium dense to dense in consistency.

The glacial till sample we tested had a water content of approximately 9 percent. Grain size analyses conducted on the till sample indicated that the soil is classified as A-1-b by the AASHTO Classification System and SM under the Unified Soil Classification System.

5.4 Groundwater

We observed the groundwater level at approximate depths ranging between 4.8 and 5.0 feet bgs in the borings. However, the groundwater level will fluctuate with seasonal changes, runoff, and adjacent construction activities.

For a more detailed description of the subsurface conditions, please refer to Appendix A, Boring Logs attached to this report.

6.0 FOUNDATION ALTERNATIVES

The project team considered three alternate replacement designs: 1) twin 6-foot high by 9-foot wide structural plate pipe arches; 2) Three 7.5-foot diameter corrugated steel pipes; and 3) a 6-foot high by 14-foot wide concrete box culvert. The project team selected alternate No. 3, concrete box culvert, for the replacement structure. The following section presents geotechnical design recommendations for the concrete box culvert alternate.

7.0 FOUNDATION CONSIDERATIONS AND RECOMMENDATIONS

The design team has selected a concrete box culvert to replace the structure at the Berry TWP site. The proposed replacement structure will consist of a 6-foot high by 14-foot wide concrete box culvert. The new culvert will be on the same horizontal alignment with a minor 0.75 foot grade rise in final configuration. The new structure will have a rail-to-rail width of approximately 32 feet. The design methodology used in the following evaluation is referenced from the AASHTO LRFD Bridge Design Specifications, 4th Edition, 2007, with Interims through 2009. See Appendix C, Calculations, for supporting documentation for the design parameters discussed below.

7.1 Box Culvert Design and Construction

Precast concrete boxes are typically detailed on the contract plans with only the basic layout and required hydraulic opening so that the contractor may choose among available proprietary products. The manufacturer is responsible for the design of the structure in accordance with Special Provision 534, Precast Structural Concrete Arches, Box Culverts, in Appendix D which includes determination of the wall thickness, haunch thickness and reinforcement. The loading specified for the structure should be Modified HL-93 Strength 1, in which the HL-93 wheel loads are increased by a factor of 1.25. The designer should use Soil Type 4 as presented in Section 3.6, Earth Loads, of the BDG to design earth loads from the soil envelope. The Soil Type properties are as follows: ϕ = 32 degrees, γ = 125 pcf.

The concrete box culverts will be supplier-designed in accordance with LRFD specifications. The culverts should be designed for all relevant strength, service and extreme limit states and load combinations specified in LRFD Article 3.4.1, and LRFD Section 12. The culverts will be constructed in general conformance with BDG Section 8, Buried Structures, and Special Provision 534, Precast Structural Concrete Arches, Box Culverts.

The box culvert will be bedded on a two foot thick layer of ¾-inch crushed stone reinforced with geogrid and wrapped in geotextile fabric. The soil envelope and backfill shall consist of Standard Specification 703.19, Granular Borrow, Material for Underwater Backfill with a maximum particle size of 4.0 inches. The crushed stone bedding should be placed in 12-inch thick maximum lifts and compacted with a minimum of four passes of a large walk-behind compactor. The granular borrow backfill should be placed in lifts 6 to 8 inches thick loose measure and compacted to manufacturer's specifications, but in no case shall the backfill soil be compacted less than 92 percent of the AASHTO T-180 maximum dry density.

7.2 Culvert Headwall Design

Culvert headwalls are essentially retaining walls and should be designed for all relevant strength, service and extreme limit states and load combinations specified in LRFD Articles 3.4.1, and 11.5.5 and 11.6. The headwalls shall be designed to resist and/or absorb lateral earth loads, vehicular loads, creep, and temperature and shrinkage deformations of the concrete box culvert. The wall shall also be designed considering a live load surcharge equal to a uniform horizontal earth pressure due to an equivalent height of soil (h_{eq}) taken from the table below. For the Berry TWP culvert replacement, the live load surcharge is 250 psf which is equivalent to two feet of soil.

Retaining Wall Height (feet)	h_{eq} (feet)	
	Distance from wall pressure surface to edge of traffic: 0 feet	Distance from wall pressure surface to edge of traffic: $\geq$ 1 feet
5	5.0	2.0
10	3.5	2.0
$\geq$ 20	2.0	2.0

Culvert headwall sections that are fixed to the box culverts to resist movement should be designed using an at-rest earth pressure coefficient, K_o, of 0.5. Headwall sections that are independent of the box culvert should be designed using the Rankine active earth pressure coefficient, K_a, equal to 0.31. This assumes level backslope. The earth pressure coefficient may change if backslope conditions are different.

7.3 Box Culvert Bearing Resistance

The factored bearing resistance at the strength limit state for the box culvert on compacted fill should not exceed 6.0 ksf. Based on presumptive bearing resistance values, a factored bearing resistance of 6 ksf may be used when analyzing box bottom slabs for the service limit state as allowed in LRFD C10.6.2.6.1. In no instance shall the bearing stress exceed the nominal resistance of the structure concrete, which may be taken as 0.3 $f'c$.

7.4 Settlement

We have evaluated the potential settlement at the Berry TWP site. MaineDOT currently does not plan horizontal or significant vertical alignment changes. Consequently, settlement as a result of fill replacement for minor embankment fill extensions over natural soils will be negligible. Total and post-construction settlements over the prepared subgrade consisting of compacted fill or native soils will also be negligible since no significant grade changes are proposed.

7.5 Scour Protection

The box culvert will be fitted with concrete headwalls and inlet and outlet section seepage cutoff walls below the culvert, all to provide scour protection per BDG 8.3.1. We recommend that the bridge approach slopes be armored with a 3-foot thick layer of riprap up and down the alignment beyond the headwall. The riprap shall be underlain by a Class 1 erosion control geotextile and a 1-foot thick layer of bedding material conforming to Standard Specification 703.19, Granular Borrow for Underwater Backfill and as shown in Standard Detail 610(02). Riprap shall meet the requirements of 703.26, Plain and Hand Laid Riprap, of Special Provision 703, Aggregates. We recommend that the riprap slope protection be constructed no steeper than a maximum 1.75:1 (H:V) extending from the bottom edge of the stone ditch protection down to the existing ground surface. The toe of riprap sections shall be constructed 1 foot below the streambed elevation.

7.6 Frost Protection

We have evaluated the potential frost depth at the Berry TWP site. Based on State of Maine frost depth maps, MaineDOT Bridge Design Guide (BDG) Figure 5-1, the site has a design-freezing index of approximately 1230 F-degree days. This correlates to a frost depth of 6.2 feet. We also considered Modberg frost depth projections. The results of the Modberg frost depth model indicate a potential frost depth of 4.0 feet. Consequently, if spread footings are used, we recommend that any spread footing or leveling pads constructed at the site be founded a minimum of 5.0 feet below finished exterior grade for frost protection.

7.7 Seismic Design Considerations

In accordance with LRFD Article 12.6.1, Loading, earthquake loading should only be considered where buried structures cross active faults. Since there are no known active faults in Maine, no seismic analysis is required.

7.8 Construction Considerations

7.8.1 Excavation

Construction of the new concrete box culvert will require soil excavation. Earth support systems may be required. The fill and native glaciomarine, organic, and glacial till soils at the site will be susceptible to disturbance and rutting as a result of exposure to water or construction traffic. We recommend that the contractor protect any subgrade from exposure to water and any unnecessary construction traffic. If disturbance and rutting occur, we recommend that the contractor remove and replace the disturbed materials with compacted gravel borrow. If the subgrade soil contains cobbles or boulders, we recommend that the contractor remove any cobbles and boulders larger than 6 inches in diameter. After excavating to the subgrade level, the contractor should proof-roll the surface to identify weak soil areas.

If encountered, unsuitable soils should also be excavated from the subgrade to a depth of one foot and replaced with compacted granular borrow. Granular borrow should conform to MaineDOT Standard Specification 703.19, Granular Borrow. The granular borrow should be compacted to 92 percent of the Modified Proctor maximum dry density (AASHTO T-180).

7.8.2 Dewatering

The existing fill, peat and native glaciomarine soils within the project area are both poorly drained and moderately to highly frost susceptible. In some locations, these soil units may be saturated and significant water seepage may be encountered during excavation. The groundwater may be trapped in layers and lenses of coarse-grained soil overlying fine-grained or glacial till sediments. We anticipate that this seepage will be temporary but there may be localized sloughing and near-surface instability of some soil slopes.

The contractor should control groundwater and surface water infiltration to permit construction in-the-dry. We recommend that the contractor use temporary ditches, sumps, granular drainage blankets, stone ditch protection, or hand-laid riprap with geotextile underlayment to divert groundwater if significant seepage is encountered during construction. We also recommend using French drains daylighted to nearby ditches if significant seepage is encountered in the subgrade along the construction areas. If the amount of seepage is significant, we anticipate that pumping from sumps will likely be needed to control the water.

7.8.3 Reuse of Excavated Soil and Bedrock

The project plans call for excavation of the existing approach areas to achieve planned grades. In the process, the contractor will excavate both the existing subbase gravel, and subgrade fill soils. We do not recommend using the excavated subbase aggregate to re-base the bridge approaches. Excavated subbase and subgrade sand and gravel may be used as fill below subgrade elevation in fill embankment areas provided all other requirements of MaineDOT Standard Specification Sections 203 and 703 are met.

We do not recommend using any silty marine sediments or glacial till soil excavation as fill beneath the pavement structure. This soil may be used as common borrow in accordance with MaineDOT Standard Specification Sections 203 and 703. Contractors should expect that, prior to placement and compaction, it may be necessary to spread out and dry portions of the these soils that are excessively moist. This soil may also be used for dressing slopes, but only below the bottom elevation of the shoulder subbase gravel.

7.8.4 Embankment Fill Areas

The current project plans require construction of minor fill extensions along the bridge approaches. The plans indicate that the side slopes will be constructed to 1.75:1 (H:V) grades or flatter and will be armored with riprap. We recommend benching the existing fill slope soils in accordance with MaineDOT Standard Specification 203.09, Preparation of Embankment Area, where new fill slope extensions are constructed over existing slopes in preparation for construction of the riprap layer.

7.8.5 Erosion Control Recommendations

The fine-grained soils along the project are susceptible to erosion. We recommend using appropriate erosion control measures during construction as described in the MaineDOT Best Management Practices February 2008 guidelines to minimize erosion of the fine-grained soils at the site.

8.0 CLOSURE

This report has been prepared for use by the MaineDOT Bridge Program for specific application to the replacement of the Southern Inlet Bridge over Southern Inlet in Berry TWP, Maine. We have prepared the report in accordance with generally accepted soil 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. Further, the analyses and recommendations are based in part upon limited soil explorations completed at discrete locations on the project 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.

We recommend that we be provided the opportunity for a general review of the final design drawings and specifications in order that we may verify that the earthwork and foundation recommendations have been properly interpreted and implemented in the design.

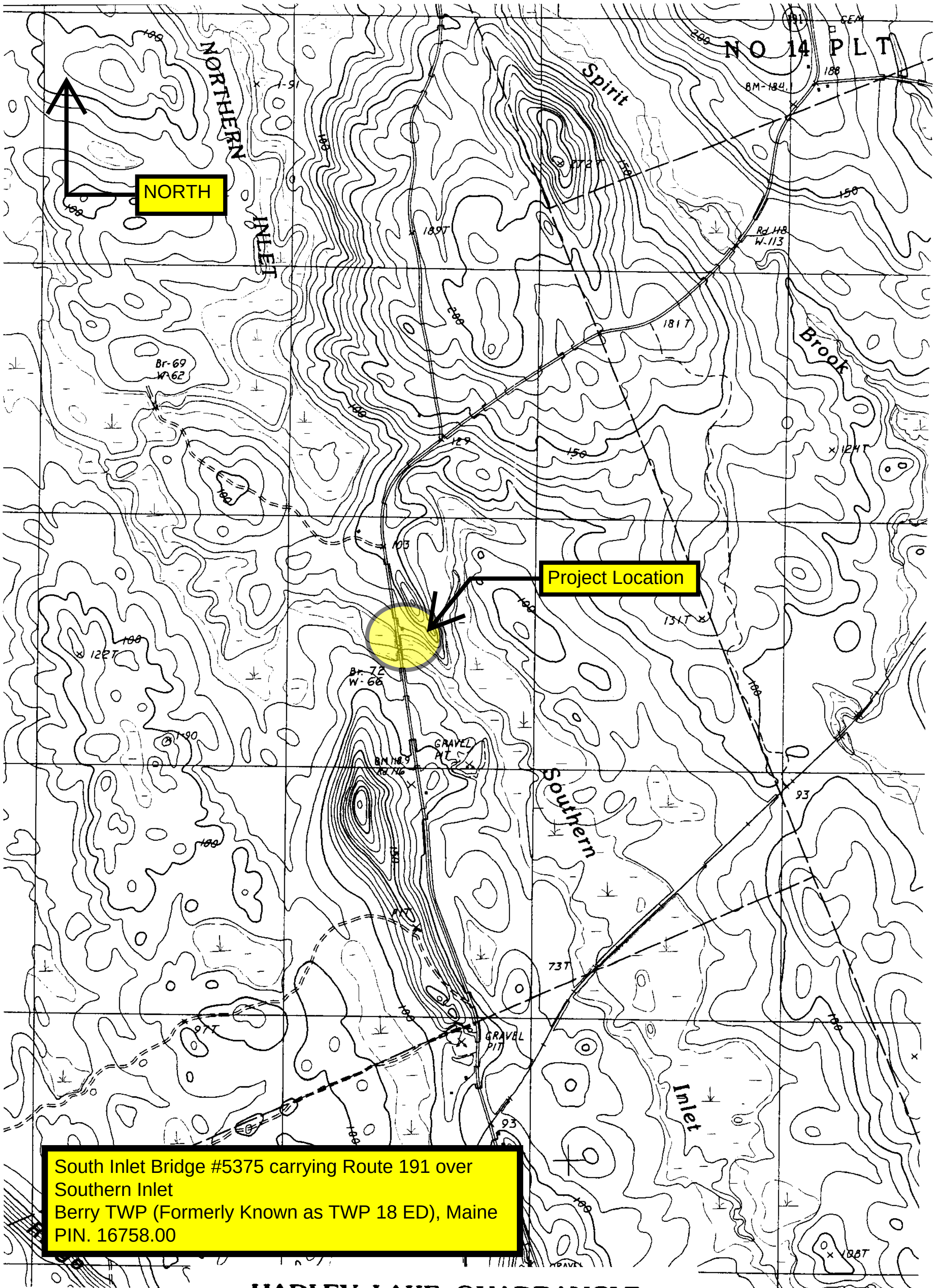
REFERENCES

AASHTO, (2007), LRFD Bridge Design Specifications, Fourth Edition, with Interims through 2009, AASHTO, Washington, D.C.

Bowles, Joseph E. (1996), Foundation Analysis and Design, Fifth Edition, McGraw-Hill, New York, NY.

MaineDOT, (2003), Bridge Design Guide, MaineDOT Bridge Program, Augusta, ME with various Interims.

Sheets



HADLEY LAKE QUADRANGLE
MAINE–WASHINGTON CO.
7.5 MINUTE SERIES (TOPOGRAPHIC)

SCALE 1:24 000

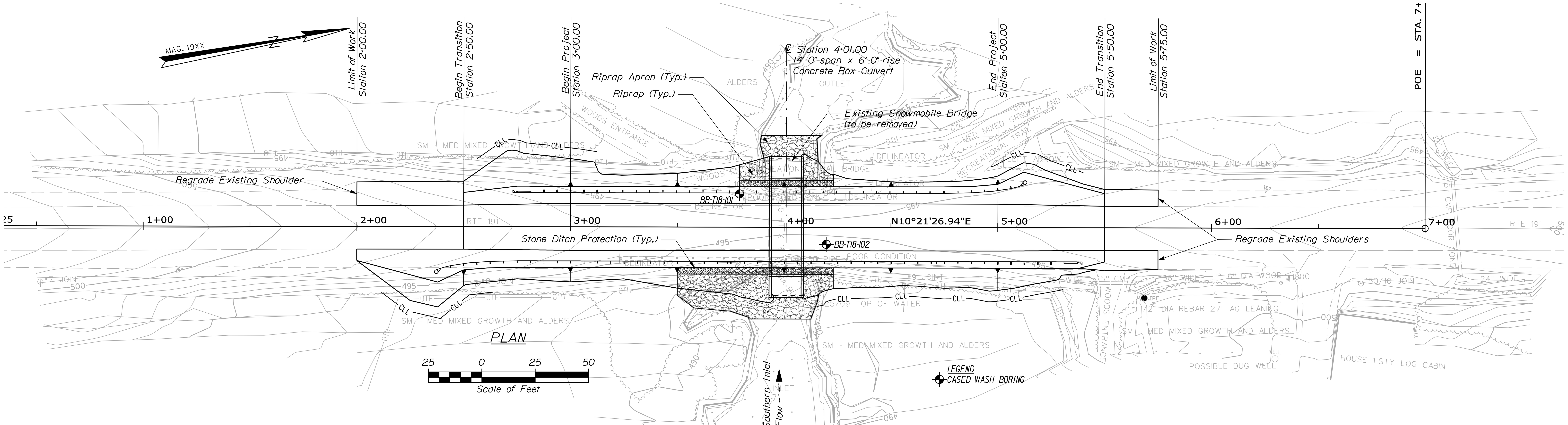
1 .5 0 1
MILES

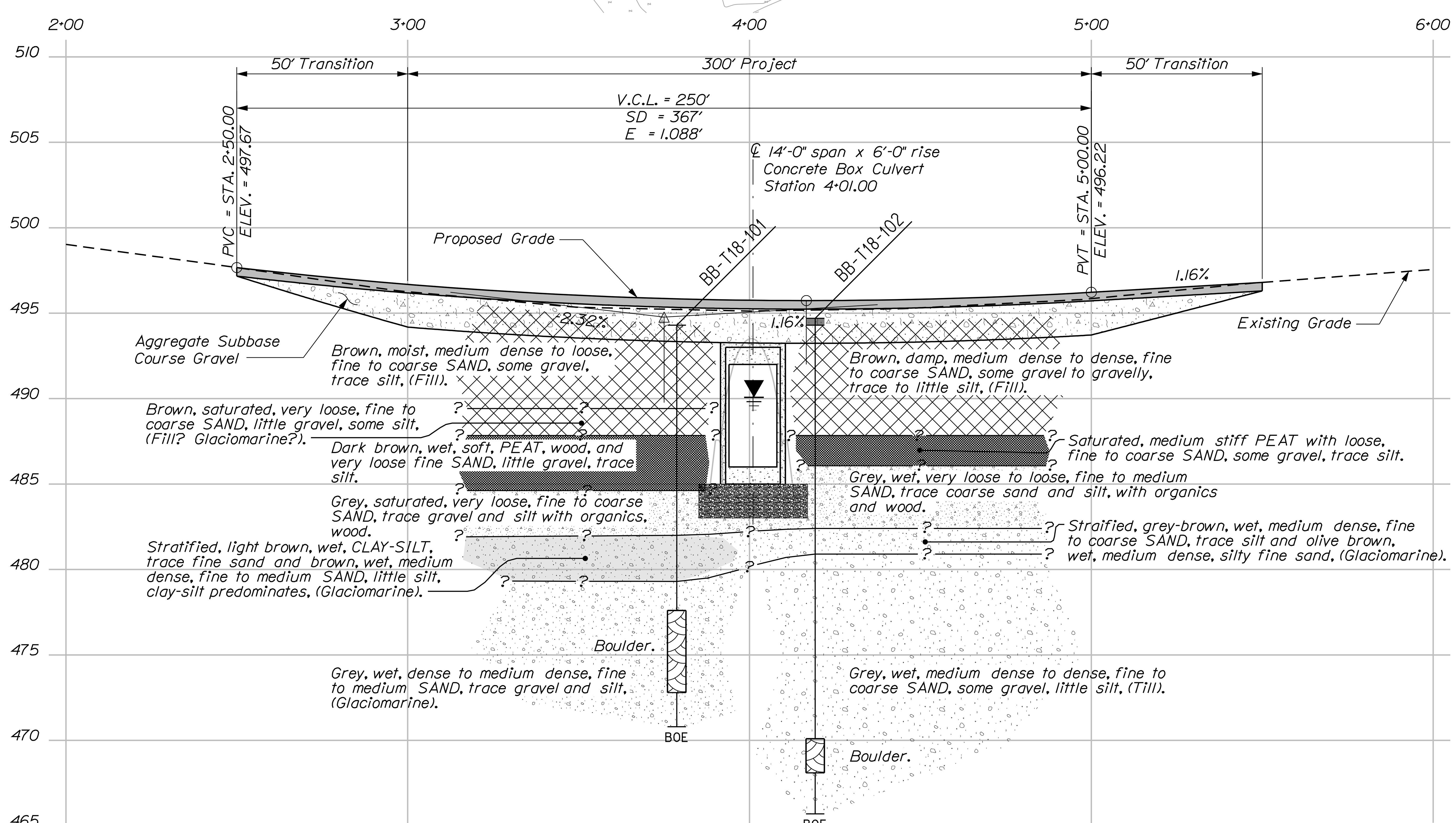
1000 0 1000 2000 3000 4000 5000 6000 7000 8000 9000 10 000
FEET

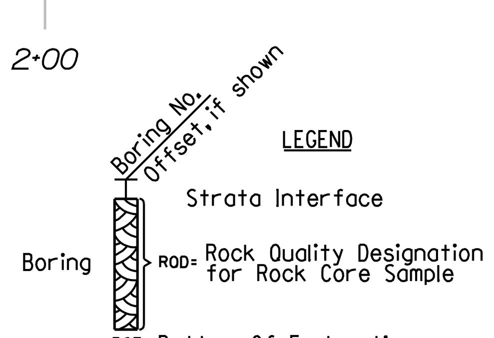
1 .5 0 1 2
KILOMETERS

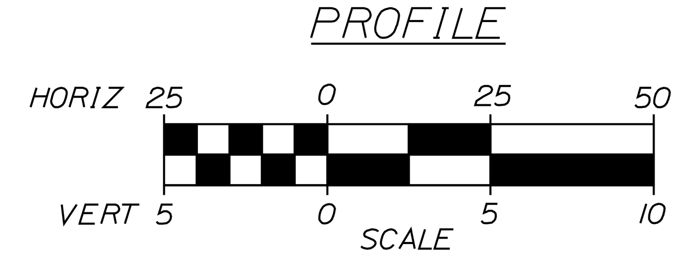
1000 0 1000 2000
METERS

CONTOUR INTERVAL 10 FEET









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 transitions may vary and are probably more erratic. For more specific information refer to the exploration logs.

STATE OF MAINE
DEPARTMENT OF TRANSPORTATION

16758.00

PIN 16758.00

BRIDGE PLANS

BRIDGE NO. 5375

PROJ. MANAGER	S. BODGE	
DESIGN-DETAILED	M.MOREAU	
CHECKED-REVIEWED	T.WHITE	11/2009
DESIGN2-DETAILED2		
DESIGN3-DETAILED3		
REVISIONS 1		
REVISIONS 2		
REVISIONS 3		
REVISIONS 4		
FIELD CHANGES		

BY / DATE

SIGNATURE

P.E. NUMBER

DATE

SOUTHERN INLET BRIDGE
SOUTHERN INLET
TWP18 ED BPP WASHINGTON COUNTY

BORING LOCATION PLAN & INTERPRETIVE SUBSURFACE PROFILE

SHEET NUMBER
2
OF 3

Filename: ...\GEOTECH\MSTA\004_BLP&SP1.dgn Division: GEOTECH Username: Terry.White Date:5/13/2010

Filename: ...\MSTA\005_BORING LOGS1.dgn   Division: GEOTECH   Username: Terry.White   Date:5/13/2010

Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project: South Inlet Bridge #5375 carrying Route 191 over Southern Inlet
Location: Berry TWP., Maine

Boring No.: BB-T18-101
PIN: 16758.00

Driller:	MaineDOT	Elevation (ft.)	494.3	Auger ID/OD:	5" Solid Stem
Operator:	Giguere/Giles/Wright	Datum:	Assumed	Sampler:	Standard Split Spoon
Logged By:	B. Wilder	Rig Type:	CME 45C	Hammer Wt./Fall:	140#/30"
Date Start/Finish:	11/18/09; 10:00-14:30	Drilling Method:	Cased Wash Boring	Core Barrel:	NQ-2"
Boring Location:	3+79.1, 15.6 Lt.	Casing ID/OD:	NW	Water Level*:	5.0' bgs.
Hammer Efficiency Factor: 0.84		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 = Insitu Vane Shear Test, PP = Pocket Penetrometer
MV = Unsuccessful Insitu 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 = Insitu Field Vane Shear Strength (psf)
T_v = Pocket Torvane Shear Strength (psf)
q_p = Unconfined Compressive Strength (ksf)
N-uncorrected = Raw field SPT N-value
Hammer Efficiency Factor = Annual Calibration Value
N_{60} = SPT N-uncorrected corrected for hammer efficiency
N_{60} = (Hammer Efficiency Factor/60%)*N-uncorrected
$S_{u(lab)}$ = Lab Vane Shear Strength (psf)
WC = water content, percent
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index
G = Grain Size Analysis
C = Consolidation Test

Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N_{60}	Casing Blows	Elevation (ft.)	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class
0	1D	24/10	0.00 - 2.00	6/6/5/5	11	15	SSA		Brown, moist, medium dense to loose, fine to coarse SAND, some gravel, trace silt, (Fill).	
	2D	24/15	2.50 - 4.50	4/4/3/2	7	10			Similar to above, except loose.	G#236862 A-1-a, SW-SM WC=4.9%
5	3D	24/3	5.00 - 7.00	WOH/WOH/WOH/WOH	---			489.60	4.70 Brown, saturated, very loose, fine to coarse SAND, little gravel, some silt, (Fill? Glaciomarine?).	G#236863 A-2-4, SM WC=24.1%
	MV 4D	24/8	7.00 - 7.10 7.50 - 9.50	Could not Push 1/2/1/3	3	4	a3	487.80	6.50 Failed 55x110 mm vane attempt. a3 blows from 7.5-8.0' bgs. Dark brown, wet, soft, PEAT, wood, and very loose fine SAND, little gravel, trace silt.	G#236864 A-1-b, SW WC=56.8% Loss=14.8% H2O=57.1%
							5			
							9	484.80	9.50	
10	5D MV	24/10	10.00 - 12.00 10.00 - 10.20	2/1/2/2 Could not Push	3	4	6		Grey, saturated, very loose, fine to coarse SAND, trace gravel and silt with organics, wood. Failed 55x110 mm vane attempt.	G#236865 A-3, SP WC=69.6% Loss=11.5% H2O=66.0%
							6	482.30	12.00	
	6D	24/18	12.00 - 14.00	2/18/3/8	21	29	10		Stratified, light brown, wet, CLAY-SILT, trace fine sand and brown, wet, medium dense, fine to medium SAND, little silt, clay-silt predominates, (Glaciomarine)	
							15			
							29		Failed 55x110 mm vane attempt at 15'.	
15	MV 7D	20.4/17	15.00 - 15.10 15.00 - 16.70	Could not Push 4/4/6/25	10	14	10	479.30	15.00 Grey, wet, medium dense, fine to medium SAND, trace gravel and silt, (Glaciomarine). b40 blows for 0.7'.	G#236866 A-3, SP WC=21.0%
	R1	57.6/55	16.70 - 21.50				b40 NQ-2	477.60	16.70 R1: Large Diorite BOULDER. R1:Core Times (min:sec) 16.7-17.7' (2:38) 17.7-18.7' (2:13) 18.7-19.7' (2:43) 19.7-20.7' (2:41) 20.7-21.5' (1:15)	
20										
	8D	24/24	21.50 - 23.50	17/17/18/24	35	49		472.80	21.50 Grey, wet, dense, fine to medium SAND, trace silt, (Glaciomarine).	
								470.80	23.50 Bottom of Exploration at 23.50 feet below ground surface. Boring terminated per Geotechnical Engineer.	
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.: BB-T18-101

Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project: South Inlet Bridge #5375 carrying Route 191 over Southern Inlet
Location: Berry TWP., Maine

Boring No.: BB-T18-102
PIN: 16758.00

Driller:	MaineDOT	Elevation (ft.)	494.7	Auger ID/OD:	5" Solid Stem
Operator:	Giguere/Giles/Wright	Datum:	Assumed	Sampler:	Standard Split Spoon
Logged By:	B. Wilder	Rig Type:	CME 45C	Hammer Wt./Fall:	140#/30"
Date Start/Finish:	11/19/09; 08:00-?	Drilling Method:	Cased Wash Boring	Core Barrel:	NQ-2"
Boring Location:	4+19.7, 8.0 Rt.	Casing ID/OD:	NW	Water Level*:	4.8' bgs.
Hammer Efficiency Factor: 0.84		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 = Insitu Vane Shear Test, PP = Pocket Penetrometer
MV = Unsuccessful Insitu 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 = Insitu Field Vane Shear Strength (psf)
T_v = Pocket Torvane Shear Strength (psf)
q_p = Unconfined Compressive Strength (ksf)
N-uncorrected = Raw field SPT N-value
Hammer Efficiency Factor = Annual Calibration Value
N_{60} = SPT N-uncorrected corrected for hammer efficiency
N_{60} = (Hammer Efficiency Factor/60%)*N-uncorrected
$S_{u(lab)}$ = Lab Vane Shear Strength (psf)
WC = water content, percent
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index
G = Grain Size Analysis
C = Consolidation Test

Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N_{60}	Casing Blows	Elevation (ft.)	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class
0							SSA	494.30	PAVEMENT. 0.40	
	1D	24/18	1.00 - 3.00	9/12/8/8	20	28			Brown, damp, medium dense to dense, fine to coarse SAND, some gravel, trace silt, (Fill).	G#236867 A-1-b, SW-SM WC=4.8%
	2D	24/9	3.00 - 5.00	7/7/7/6	14	20		491.70	3.00 Similar to above but little silt.	G#236868 A-1-a, SW WC=7.2%
5	3D	24/10	5.00 - 7.00	9/10/14/8	24	34		489.70	5.00 Similar to above, except wet and gravelly.	
	4D/A	24/18	7.50 - 9.50	WOR/WOH/4/3	4	6		487.70	7.00 (4D/A) 7.5-8.5' bgs. Saturated, medium stiff PEAT with loose, fine to coarse SAND, some gravel, trace silt.	G#236869 A-1-b, SW WC=238.9% Loss=41.5% H2O=243.7%
								486.20	8.50 (4D) 8.5-9.5' bgs. Grey, wet, loose, fine to medium SAND, trace coarse sand, trace silt, (Glaciomarine)	G#236870 A-3, SP-SM WC=25.0%
10	5D	24/19	10.00 - 12.00	1/2/1/2	3	4		484.70	10.00 Same but with layer of organics and wood and very loose.	
	6D	24/14	12.00 - 14.00	3/4/17/15	21	29		482.70	12.00 Stratified, grey-brown, wet, medium dense, fine to coarse SAND, trace silt and olive brown, wet, medium dense, silty fine sand, (Glaciomarine).	
15	7D	24/16	15.00 - 17.00	29/11/13/14	24	34		480.70	14.00 Grey, wet, medium dense, fine to coarse SAND, some gravel, little silt, (Till).	G#236871 A-1-b, SM WC=8.5%
20	8D	24/4	20.00 - 22.00	5/7/7/8	14	20			Similar to above.	
25	R1	24/22	24.60 - 26.60				NQ-2	470.10	24.60 R1: Diorite BOULDER. R1:Core Times (min:sec) 24.6-25.6' (3:48) 25.6-26.6' (2:10)	
	9D	24/4	27.00 - 29.00	4/6/7/9	13	18		468.10	26.60 Gravel wash in Spoon.	
								465.70	29.00 Bottom of Exploration at 29.00 feet below ground surface.	
30										
35										
40										
45										
50										

Remarks:

Stratification lines represent approximate boundaries between soil types; transitions may be gradual.

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Page 1 of 1

Boring No.: BB-T18-102

STATE OF MAINE
DEPARTMENT OF TRANSPORTATION

16758.00

PIN 16758.00

BRIDGE PLANS

BRIDGE NO. 5375

PROJ. MANAGER	S. BODGE	BY	DATE
DESIGN-DETAILED	M.MOREAU	T.WHITE	11\2009
CHECKED-REVIEWED			
DESIGN2-DETAILED2			
DESIGN3-DETAILED3			
REVISIONS 1			
REVISIONS 2			
REVISIONS 3			
REVISIONS 4			
FIELD CHANGES			

SIGNATURE

P.E. NUMBER

DATE

SOUTHERN INLET BRIDGE
SOUTHERN INLET
TWP18 ED BPP   WASHINGTON COUNTY

BORING LOGS

SHEET NUMBER 3 OF 3

Appendix A

Boring Logs

Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project:	South Inlet Bridge #5375 carrying Route 191 over Southern Inlet	**Boring No.:**	BB-T18-101
Location:	Berry TWP., Maine	**PIN:**	16758.00

Driller:	MaineDOT	**Elevation (ft.)**	494.3	**Auger ID/OD:**	5" Solid Stem
Operator:	Giguere/Giles/Wright	**Datum:**	Assumed	**Sampler:**	Standard Split Spoon
Logged By:	B. Wilder	**Rig Type:**	CME 45C	**Hammer Wt./Fall:**	140#/30"
Date Start/Finish:	11/18/09; 10:00-14:30	**Drilling Method:**	Cased Wash Boring	**Core Barrel:**	NQ-2"
Boring Location:	3+79.1, 15.6 Lt.	**Casing ID/OD:**	NW	**Water Level*:**	5.0' bgs.
Hammer Efficiency Factor:	0.84	**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 = Insitu Vane Shear Test, PP = Pocket Penetrometer
MV = Unsuccessful Insitu 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 = Insitu Field Vane Shear Strength (psf)
T_v = Pocket Torvane Shear Strength (psf)
q_p = Unconfined Compressive Strength (ksf)
N-uncorrected = Raw field SPT N-value
Hammer Efficiency Factor = Annual Calibration Value
N_{60} = SPT N-uncorrected corrected for hammer efficiency
N_{60} = (Hammer Efficiency Factor/60%)*N-uncorrected
$S_{u(lab)}$ = Lab Vane Shear Strength (psf)
WC = water content, percent
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index
G = Grain Size Analysis
C = Consolidation Test

Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N_{60}	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
0	1D	24/10	0.00 - 2.00	6/6/5/5	11	15	SSA			Brown, moist, medium dense to loose, fine to coarse SAND, some gravel, trace silt, (Fill).	
	2D	24/15	2.50 - 4.50	4/4/3/2	7	10				Similar to above, except loose.	G#236862 A-1-a, SW-SM WC=4.9%
5	3D	24/3	5.00 - 7.00	WOH/WOH/WOH/WOH	---			489.60		4.70 Brown, saturated, very loose, fine to coarse SAND, little gravel, some silt, (Fill? Glaciomarine?).	G#236863 A-2-4, SM WC=24.1%
	MV 4D	24/8	7.00 - 7.10 7.50 - 9.50	Could not Push 1/2/1/3	3	4	a3 5 9	487.80		6.50 Failed 55x110 mm vane attempt. a3 blows from 7.5-8.0' bgs. Dark brown, wet, soft, PEAT, wood, and very loose fine SAND, little gravel, trace silt.	G#236864 A-1-b, SW WC=56.8% Loss=14.8% H2O=57.1%
10	5D MV	24/10	10.00 - 12.00 10.00 - 10.20	2/1/2/2 Could not Push	3	4	6 6	484.80		9.50 Grey, saturated, very loose, fine to coarse SAND, trace gravel and silt with organics, wood. Failed 55x110 mm vane attempt.	G#236865 A-3, SP WC=69.6% Loss=11.5% H2O=66.0%
	6D	24/18	12.00 - 14.00	2/18/3/8	21	29	10 15 29	482.30		12.00 Stratified, light brown, wet, CLAY-SILT, trace fine sand and brown, wet, medium dense, fine to medium SAND, little silt, clay-silt predominates, (Glaciomarine) Failed 55x110 mm vane attempt at 15'.	
15	MV 7D	20.4/17	15.00 - 15.10 15.00 - 16.70	Could not Push 4/4/6/25	10	14	10	479.30		15.00 Grey, wet, medium dense, fine to medium SAND, trace gravel and silt, (Glaciomarine). b40 blows for 0.7'.	G#236866 A-3, SP WC=21.0%
	R1	57.6/55	16.70 - 21.50				b40 NQ-2	477.60		16.70 R1: Large Diorite BOULDER. R1:Core Times (min:sec) 16.7-17.7' (2:38) 17.7-18.7' (2:13) 18.7-19.7' (2:43) 19.7-20.7' (2:41) 20.7-21.5' (1:15)	
20											
	8D	24/24	21.50 - 23.50	17/17/18/24	35	49		472.80		21.50 Grey, wet, dense, fine to medium SAND, trace silt, (Glaciomarine).	
								470.80		23.50 **Bottom of Exploration at 23.50 feet below ground surface.** Boring terminated per Geotechnical Engineer.	
25											

Remarks:

Stratification lines represent approximate boundaries between soil types; transitions may be gradual.

* Water level readings have been made at times and under conditions stated. Groundwater fluctuations may occur due to conditions other than those present at the time measurements were made.

Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project: South Inlet Bridge #5375 carrying Route 191 over Southern Inlet
Location: Berry TWP., Maine

Boring No.: BB-T18-102
PIN: 16758.00

Driller:	MaineDOT	**Elevation (ft.)**	494.7	**Auger ID/OD:**	5" Solid Stem
Operator:	Giguere/Giles/Wright	**Datum:**	Assumed	**Sampler:**	Standard Split Spoon
Logged By:	B. Wilder	**Rig Type:**	CME 45C	**Hammer Wt./Fall:**	140#/30"
Date Start/Finish:	11/19/09; 08:00-?	**Drilling Method:**	Cased Wash Boring	**Core Barrel:**	NQ-2"
Boring Location:	4+19.7, 8.0 Rt.	**Casing ID/OD:**	NW	**Water Level*:**	4.8' bgs.
Hammer Efficiency Factor:	0.84	**Hammer Type:**	Automatic ☒ Hydraulic ☐ Rope & Cathead ☐		

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample attempt
U = Thin Wall Tube Sample
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V = Insitu Vane Shear Test, PP = Pocket Penetrometer
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SSA = Solid Stem Auger
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WOH = weight of 140lb. hammer
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T_v = Pocket Torvane Shear Strength (psf)
q_p = Unconfined Compressive Strength (ksf)
N-uncorrected = Raw field SPT N-value
Hammer Efficiency Factor = Annual Calibration Value
N_{60} = SPT N-uncorrected corrected for hammer efficiency
N_{60} = (Hammer Efficiency Factor/60%)*N-uncorrected
$S_{u(lab)}$ = Lab Vane Shear Strength (psf)
WC = water content, percent
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index
G = Grain Size Analysis
C = Consolidation Test

Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N_{60}	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
0							SSA	494.30		PAVEMENT. 0.40	
	1D	24/18	1.00 - 3.00	9/12/8/8	20	28				Brown, damp, medium dense to dense, fine to coarse SAND, some gravel, trace silt, (Fill).	G#236867 A-1-b, SW-SM WC=4.8%
	2D	24/9	3.00 - 5.00	7/7/7/6	14	20		491.70		3.00 Similar to above but little silt.	G#236868 A-1-b, SM WC=7.2%
5	3D	24/10	5.00 - 7.00	9/10/14/8	24	34		489.70		5.00 Similar to above, except wet and gravelly.	
	4D/A	24/18	7.50 - 9.50	WOR/WOH/4/3	4	6		487.70		7.00 (4D/A) 7.5-8.5' bgs. Saturated, medium stiff PEAT with loose, fine to coarse SAND, some gravel, trace silt.	G#236869 A-1-b, SW WC=238.9% Loss=41.5% H2O=243.7%
								486.20		8.50 (4D) 8.5-9.5' bgs. Grey, wet, loose, fine to medium SAND, trace coarse sand, trace silt, (Glaciomarine)	G#236870 A-3, SP-SM WC=25.0%
10	5D	24/19	10.00 - 12.00	1/2/1/2	3	4		484.70		10.00 Same but with layer of organics and wood and very loose.	
	6D	24/14	12.00 - 14.00	3/4/17/15	21	29		482.70		12.00 Statified, grey-brown, wet, medium dense, fine to coarse SAND, trace silt and olive brown, wet, medium dense, silty fine sand, (Glaciomarine).	
15	7D	24/16	15.00 - 17.00	29/11/13/14	24	34		480.70		14.00 Grey, wet, medium dense to dense, fine to coarse SAND, some gravel, little silt, (Till).	G#236871 A-1-b, SM WC=8.5%
20	8D	24/4	20.00 - 22.00	5/7/7/8	14	20				Similar to above.	
25	R1	24/22	24.60 - 26.60				NQ-2	470.10		24.60	

Remarks:

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Maine Department of Transportation Soil/Rock Exploration Log US CUSTOMARY UNITS	Project: South Inlet Bridge #5375 carrying Route 191 over Southern Inlet Location: Berry TWP., Maine	Boring No.: BB-T18-102 PIN: 16758.00

Driller:	MaineDOT	**Elevation (ft.)**	494.7	**Auger ID/OD:**	5" Solid Stem
Operator:	Giguere/Giles/Wright	**Datum:**	Assumed	**Sampler:**	Standard Split Spoon
Logged By:	B. Wilder	**Rig Type:**	CME 45C	**Hammer Wt./Fall:**	140#/30"
Date Start/Finish:	11/19/09; 08:00-?	**Drilling Method:**	Cased Wash Boring	**Core Barrel:**	NQ-2"
Boring Location:	4+19.7, 8.0 Rt.	**Casing ID/OD:**	NW	**Water Level*:**	4.8' bgs.
Hammer Efficiency Factor:	0.84	**Hammer Type:**	Automatic ☒ Hydraulic ☐ Rope & Cathead ☐		

Definitions:
D = Split Spoon Sample
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SSA = Solid Stem Auger
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N-uncorrected = Raw field SPT N-value
Hammer Efficiency Factor = Annual Calibration Value
N_{60} = SPT N-uncorrected corrected for hammer efficiency
N_{60} = (Hammer Efficiency Factor/60%)*N-uncorrected
$S_{u(lab)}$ = Lab Vane Shear Strength (psf)
WC = water content, percent
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index
G = Grain Size Analysis
C = Consolidation Test

Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N_{60}	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
25										R1: Diorite BOULDER. R1:Core Times (min:sec) 24.6-25.6' (3:48) 25.6-26.6' (2:10)	
								468.10		26.60	
	9D	24/4	27.00 - 29.00	4/6/7/9	13	18				Gravel wash in Spoon.	
								465.70		29.00	
										Bottom of Exploration at 29.00 feet below ground surface.	
30											
35											
40											
45											
50											

Remarks:

Stratification lines represent approximate boundaries between soil types; transitions may be gradual.

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UNIFIED SOIL CLASSIFICATION SYSTEM

MAJOR DIVISIONS			GROUP SYMBOLS	TYPICAL NAMES
COARSE-GRAINED SOILS (more than half of material is larger than No. 200 sieve size)	GRAVELS (more than half of coarse fraction is larger than No. 4 sieve size)	CLEAN GRAVELS (little or no fines)	GW	Well-graded gravels, gravel-sand mixtures, little or no fines
			GP	Poorly-graded gravels, gravel sand mixtures, little or no fines
		GRAVEL WITH FINES (Appreciable amount of fines)	GM	Silty gravels, gravel-sand-silt mixtures.
			GC	Clayey gravels, gravel-sand-clay mixtures.
	SANDS (more than half of coarse fraction is smaller than No. 4 sieve size)	CLEAN SANDS (little or no fines)	SW	Well-graded sands, gravelly sands, little or no fines
			SP	Poorly-graded sands, gravelly sand, little or no fines.
		SANDS WITH FINES (Appreciable amount of fines)	SM	Silty sands, sand-silt mixtures
			SC	Clayey sands, sand-clay mixtures.
FINE-GRAINED SOILS (more than half of material is smaller than No. 200 sieve size)	SILTS AND CLAYS (liquid limit less than 50)		ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands, or clayey silts with slight plasticity.
			CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.
			OL	Organic silts and organic silty clays of low plasticity.
	SILTS AND CLAYS (liquid limit greater than 50)		MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.
			CH	Inorganic clays of high plasticity, fat clays.
			OH	Organic clays of medium to high plasticity, organic silts
	HIGHLY ORGANIC SOILS		Pt	Peat and other highly organic soils.

Desired Soil Observations: (in this order)

Color (Munsell color chart)
Moisture (dry, damp, moist, wet, saturated)
Density/Consistency (from above right hand side)
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., if applicable)
Cementation (weak, moderate, or strong, if applicable, ASTM D 2488)
Geologic Origin (till, marine clay, alluvium, etc.)
Unified Soil Classification Designation
Groundwater level

TERMS DESCRIBING DENSITY/CONSISTENCY

Coarse-grained soils (more than half of material is larger than No. 200 sieve): Includes (1) clean gravels; (2) silty or clayey gravels; and (3) silty, clayey or gravelly sands. Consistency is rated according to standard penetration resistance.

Modified Burmister System

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

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

Fine-grained soils (more than half of material is smaller than No. 200 sieve): Includes (1) inorganic and organic silts and clays; (2) gravelly, sandy or silty clays; and (3) clayey silts. Consistency is rated according to shear strength as indicated.

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

Rock Quality Designation (RQD):

$$RQD = \frac{\text{sum of the lengths of intact pieces of core* > 100 mm}}{\text{length of core advance}}$$

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

Correlation of RQD to Rock Mass Quality

Rock Mass Quality	RQD
Very Poor	<25%
Poor	26% - 50%
Fair	51% - 75%
Good	76% - 90%
Excellent	91% - 100%

Desired Rock Observations: (in this order)

Color (Munsell color chart)
Texture (aphanitic, fine-grained, etc.)
Lithology (igneous, sedimentary, metamorphic, 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, low angle - 5-35, mod. dipping - 35-55, steep - 55-85, vertical - 85-90)
- -spacing (very close - <5 cm, close - 5-30 cm, mod. close 30-100 cm, wide - 1-3 m, very wide >3 m)
- -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: AASHTO Standard Specification for Highway Bridges 17th Ed. Table 4.4.8.1.2A
Recovery

Sample Container Labeling Requirements:

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

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

Appendix B

Laboratory Test Data

State of Maine - Department of Transportation

Laboratory Testing Summary Sheet

Town(s): Berry TWP. Project Number: 16758.00

Boring & Sample Identification Number	Station (Feet)	Offset (Feet)	Depth (Feet)	Reference Number	G.S.D.C. Sheet	W.C. %	L.L.	P.I.	Classification		
									Unified	AASHTO	Frost
BB-T18-101, 2D	3+79.1	15.6 Lt.	2.5-4.5	236862	1	4.9			SW-SM	A-1-a	0
BB-T18-101, 3D	3+79.1	15.6 Lt.	5.0-7.0	236863	1	24.1			SM	A-2-4	II
BB-T18-101, 4D	3+79.1	15.6 Lt.	7.5-9.5	236864	1	56.8			SW	A-1-b	0
BB-T18-101, 5D	3+79.1	15.6 Lt.	10.0-12.0	236865	1	69.6			SP	A-3	0
BB-T18-101, 7D	3+79.1	15.6 Lt.	15.0-16.7	236866	1	21.0			SP	A-3	0
BB-T18-102, 1D	4+19.7	8.0 Rt.	1.0-3.0	236867	2	4.8			SW-SM	A-1-b	0
BB-T18-102, 2D	4+19.7	8.0 Rt.	3.0-5.0	236868	2	7.2			SM	A-1-b	II
BB-T18-102, 4D/A	4+19.7	8.0 Rt.	7.5-8.5	236869	2	239			SW	A-1-b	0
BB-T18-102, 4D	4+19.7	8.0 Rt.	8.5-9.5	236870	2	25.0			SP-SM	A-3	0
BB-T18-102, 7D	4+19.7	8.0 Rt.	15.0-17.0	236871	2	8.5			SM	A-1-b	II
							Loss on Ignition (T 267)				
							Loss, %			H2O, %	
BB-T18-101, 4D	3+79.1	15.6 Lt.	7.5-9.5	236864	1	56.8	14.8			57.1	
BB-T18-101, 5D	3+79.1	15.6 Lt.	10.0-12.0	236865	1	69.6	11.5			66.0	
BB-T18-102, 4D/A	4+19.7	8.0 Rt.	7.5-8.5	236869	2	239	41.5			243.7	

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

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

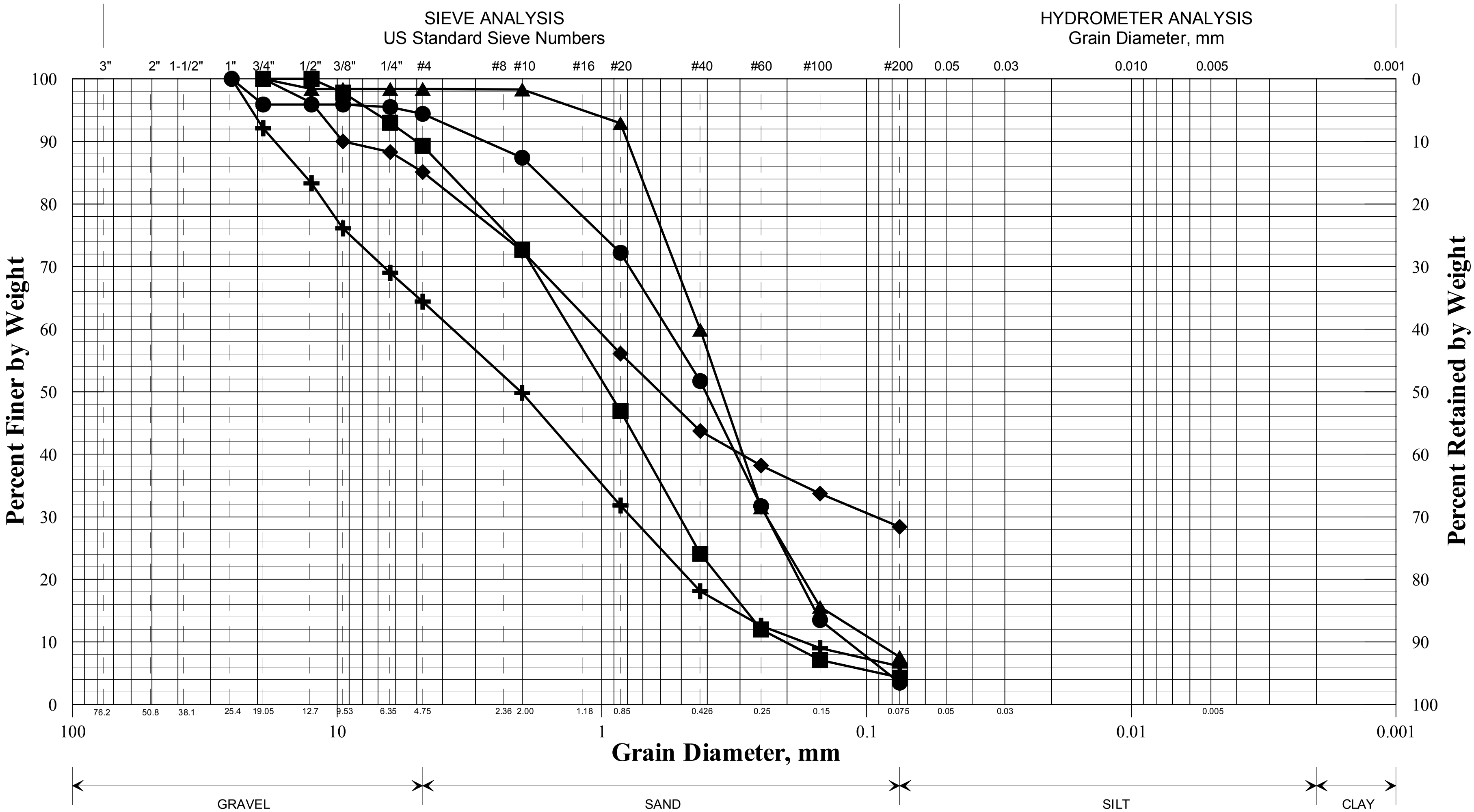
WC = water content as determined by AASHTO T 265-93 and/or ASTM D 2216-98

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

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

State of Maine Department of Transportation

GRAIN SIZE DISTRIBUTION CURVE

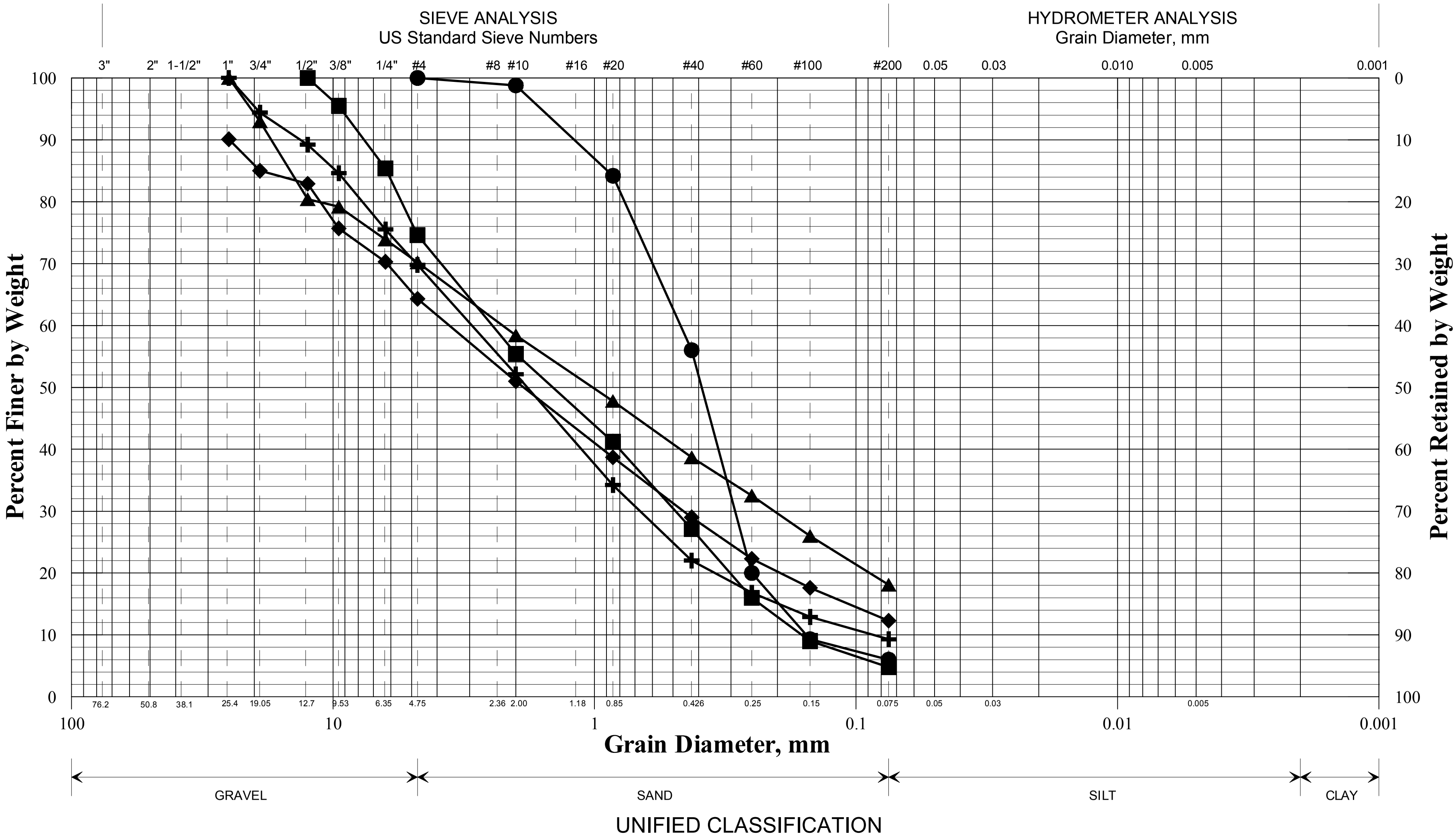


	Boring/Sample No.	Station	Offset, ft	Depth, ft	Description	W, %	LL	PL	PI
✚	BB-T18-101/2D	3+79.1	15.6 LT	2.5-4.5	SAND, some gravel, trace silt.	4.9			
◆	BB-T18-101/3D	3+79.1	15.6 LT	5.0-7.0	SAND, some silt, little gravel.	24.1			
■	BB-T18-101/4D	3+79.1	15.6 LT	7.5-9.5	SAND, little gravel, trace silt.	56.8			
●	BB-T18-101/5D	3+79.1	15.6 LT	10.0-12.0	SAND, trace gravel, trace silt.	69.6			
▲	BB-T18-101/7D	3+79.1	15.6 LT	15.0-16.7	SAND, trace silt, trace gravel.	21.0			
✖									

PIN	
016758.00	
Town	
Berry Twp	
Reported by/Date	
WHITE, TERRY A	1/26/2010

SHEET 1

State of Maine Department of Transportation
GRAIN SIZE DISTRIBUTION CURVE



	Boring/Sample No.	Station	Offset, ft	Depth, ft	Description	W, %	LL	PL	PI
✚	BB-T18-102/1D	4+19.7	8.0 RT	1.0-3.0	SAND, some gravel, trace silt.	4.8			
◆	BB-T18-102/2D	4+19.7	8.0 RT	3.0-5.0	SAND, some gravel, little silt.	7.2			
■	BB-T18-102/4DA	4+19.7	8.0 RT	7.5-8.5	SAND, some gravel, trace silt.	238.9			
●	BB-T18-102/4D	4+19.7	8.0 RT	8.5-9.5	SAND, trace silt.	25.0			
▲	BB-T18-102/7D	4+19.7	8.0 RT	15.0-17.0	SAND, some gravel, little silt.	8.5			
✖									

PIN
016758.00
Town
Berry Twp
Reported by/Date
WHITE, TERRY A 1/26/2010

SHEET 2

Appendix C

Calculations

HEADWALL ACTIVE EARTH PRESSURE:

Rankine Theory - Active Earth Pressure from MaineDOT Bridge Design Guide Section 3.6.5.2, pg. 3-7

Either Rankine or Coulomb may be used for long-heeled cantilever walls where the failure surface is uninterrupted by the top of the wall stem. In general, use Rankine though.

Soil angle of internal friction: $\phi := 32deg$

Slope angle of backfill soil from horizontal: $\beta := 0deg$

$$K_a := \tan\left[45deg - \left(\frac{\phi}{2}\right)\right]^2$$

$K_a = 0.31$

FROST PROTECTION
Method 1:

From the Maine Design Freezing Index Map:
DFI = 1230 degree-days
Site has Coarse Grained Soils (Assume Peat Removed) With Wn ≤ 10%

From the 2003 Bridge Design Guide Table 5-1:

$Frost\_depth := [0.3 \cdot (76.3in - 73.1in) + 73.1in]$

$Frost\_depth = 74.06 \cdot in$

$Frost\_depth = 6.17 \cdot ft$

Method 2:

```
                        ------------------------
                        --- ModBerg Results ---
                        -----------------------

Project Location: Eastport, Maine

Air Design Freezing Index          =  1102 F-days
N-Factor                           =  0.70
Surface Design Freezing Index      =   771 F-days
Mean Annual Temperature            =  43.5 deg F
Design Length of Freezing Season  =  122 days

---------------------------------------------------------
Layer
#:Type            t     w%     d     Cf   Cu    Kf    Ku      L
---------------------------------------------------------
1-Asphalt        7.0    .1  140.0   28   28    .9    .9       0
2-Coarse        40.5  10.0  120.0   26   32   1.7   1.5   1,728
---------------------------------------------------------

t  = Layer thickness, in inches.
w% = Moisture content, in percentage of dry density.
d  = Dry density, in lbs/cubic ft.
Cf = Heat Capacity of frozen phase, in BTU/(cubic ft degree F).
Cu = Heat Capacity of thawed phase, in BTU/(cubic ft degree F).
Kf = Thermal conductivity in frozen phase, in BTU/(ft hr degree).
Ku = Thermal conductivity in thawed phase, in BTU/(ft hr degree).
L  = Latent heat of fusion, in BTU / cubic ft.

*********************************************************
  Total Depth of Frost Penetration = 3.96 ft = 47.5 in.
*********************************************************
```

Use 5.0 feet

BEARING RESISTANCE ON COMPACTED FILL SOILS:

Consider this for use with Box Culverts and Headwalls.

SERVICE LIMIT STATE:

LRFD Table C10.6.2.6.1-1, (Based on NAVFAC DM 7.2) - "Presumptive Bearing Resistances for Spread Footing Foundations at the Service Limit State"

Bearing Material	Consistency in Place	Bearing Resistance (kips per sq. foot)	Recommend Value
Coarse to Medium sand, little gravel	Very dense	8 to 12	8 ksf
	Medium dense to dense	4 to 8	6 ksf
	Loose	2 to 4	3 ksf

Recommend **6.0 ksf** to control settlements for **Service Limit State** analyses and for preliminary footing sizing.

STRENGTH LIMIT STATE:

Nominal and Factored Bearing Resistance for box culvert on fill soils at the Strength Limit State:

Assumptions:

1. Box Culvert will be embedded 2.0 feet for frost protection.

   $D_f := 2.0ft$

2. Assumed parameters for soils:
   Assume granular fill

   Moist unit weight: $\gamma_m := 125pcf$

   Saturated unit weight: $\gamma_{sat} := 130pcf$

   Soil angle of internal friction: $\phi_{ns} := 32$

   Undrained shear strength (cohesion): $c_{ns} := 0psf$

3. Use Terzaghi strip equations as L > B

Depth to Groundwater table based on boring data: $D_w := 0 \cdot ft$

Unit weight of water: $\gamma_w := 62.4pcf$

Effective Stress at the footing bearing level: $q_{eff\_str} := D_w \cdot \gamma_m + (D_f - D_w) \cdot (\gamma_{sat} - \gamma_w)$

$q_{eff\_str} = 0.14 \cdot ksf$

Box Culvert Width: $B := 14ft$

Terzaghi Shape Factors from Table 4-1, p. 220
For strip footing:

$s_c := 1.0$

$s_\gamma := 1.0$

Meyerhof Bearing Capacity Factors For ϕ = 32 deg Bowles 5th Ed. Table 4-4 pg. 223

$N_c := 35.47$ $N_q := 23.2$ $N_\gamma := 22.0$

Nominal Bearing Resistance per Terzaghi equation Bowles 5th Ed. Table 4-1 pg. 220

$q_{nom} := c_{ns} \cdot N_c \cdot s_c + q_{eff\_str} \cdot N_q + 0.5(\gamma_{sat} - \gamma_w) \cdot B \cdot N_\gamma \cdot s_\gamma$

$q_{nom} = 13.5 \cdot ksf$

Resistance Factor from LRFD Table 10.5.5.2.2-1 pg. 10-32: $\phi_b := 0.45$

$q_{fac} := q_{nom} \cdot \phi_b$

$q_{fac} = 6.1 \cdot ksf$

Recommend **Strength Limit State** Factored Bearing Resistance of **6.0 ksf** for the box culvert.

Appendix D

Special Provisions

SPECIAL PROVISION
SECTION 203
CRUSHED STONE

Description This work shall consist of constructing a leveling pad of crushed stone in accordance with these specifications and in reasonably close conformity with the width, grade and thickness shown on the plans or established by the Resident.

MATERIALS

Aggregate Crushed stone material shall meet the requirements of ASTM Standard Specification C33, Standard Specification for Concrete Aggregates.

The aggregate shall meet the following gradation requirements:

Particle size	Percent by Weight Passing
1 inch	100
¾ inch	90 – 100
½ inch	20 – 55
⅜ inch	0 – 15
No. 4	0 - 5

Construction Requirements The crushed stone shall be placed and graded as shown on the plans or as directed by the Resident. The crushed stone shall be compacted as required to ensure that all voids in the stone are filled, as approved by the Resident.

Method of Measurement Aggregate for crushed stone will be measured by the cubic yard complete in place.

Basis of Payment The accepted quantity of crushed stone will be paid for at the contract unit price per cubic yard of aggregate complete in place.

Payment will be under

Pay Item	Unit
203.35 Crushed Stone	Cubic Yard

SPECIAL PROVISION
SECTION 620
REINFORCEMENT GEOGRID

Description

This work shall consist of furnishing and installing reinforcement geogrid in accordance with these specifications and in reasonably close conformity with the lines, grades, and dimensions shown on the plans or as directed by the Resident.

Material

Geogrids shall consist of a regular network of integrally connected polymeric tensile elements with aperture geometry sufficient to permit significant mechanical interlock with the surrounding soil, aggregate or other material. The geogrid structure shall be dimensionally stable to retain its geometry under construction stresses and shall have high resistance to damage during construction, ultraviolet degradation, and all forms of chemical and biological degradation encountered in the soil being reinforced. Woven geogrids are not acceptable for this application.

The reinforcement geogrid shall meet or exceed the Minimum Average Roll Values (MARV) of the properties in Table 1.

Acceptable manufacturers for reinforcement geogrids must be approved by the Resident.

Table 1. - Physical Property Requirements
(Non-Woven Biaxial Reinforcement Geogrid)

Reinforcement Geogrid Mechanical Property	Test Method	Minimum Average Roll Value (MARV)[1]
Tensile Strength at 5% Strain MD	ASTM D-6637	600 lb/ft
Tensile Strength at 5% Strain XD	ASTM D-6637	1,200 lb/ft
Rib Junction Strength	GRI-GG2	1,000 lb/ft in both directions
Aperture Openings		Between 0.75 and 3 inches
Percent Open Area		50 to 80%

Certification

Prior to construction the Contractor shall submit to the Resident the Manufacturer's certification that the geogrid supplied has been evaluated in full compliance with this Specification and is fit for long-term, critical soil reinforcement applications. The Contractor's submittal package shall include, but not be limited to, actual tests for tension/creep, durability/aging, construction damage, and quality control tensile testing.

Delivery, Storage and Handling

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

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

Construction Requirements

Reinforcement geogrid shall be installed, in accordance with the manufacturer's recommendations, to the proper elevation and alignment, as shown on the plans or as directed by the Resident.

1. The geogrid shall be laid at the proper elevation and alignment as shown on the plans. The Contractor shall verify correct orientation of the geogrid. Geogrid may be temporarily secured in-place with staples, pins, sand bags or backfill as required by fill properties, fill placement procedures, or weather conditions, or as directed by the Resident.

2. Reinforcement geogrid shall be oriented such that the roll length runs parallel to the construction centerline.

3. Adjacent rolls of reinforcement geogrid shall be overlapped a minimum of 1 foot.

4. Lengths of reinforcement geogrid shall be continuous, splicing along the length will not be allowed.

5. Seams along adjacent lengths of reinforcement geogrid shall be tied together with hog rings or cable ties every 3 to 6 feet.

6. The reinforcement geogrid shall be anchored at each end, and pulled taut, to reduce any considerable slack, as directed by the Resident.

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

8. The geogrid shall be covered with fill materials within 14 days of placement to protect against unnecessary exposure.

9. Fill may then be pushed onto the reinforcement geogrid using a track mounted bulldozer. At no time shall construction equipment be allowed directly onto the reinforcement geogrid. Track mounted equipment shall be allowed on previous courses of fill with a minimum compacted depth of 8 inches. Smooth drum roller compaction equipment shall be allowed on previous

courses of fill with a minimum compacted depth of 8 inches and spread fill with a minimum depth of 12 inches, loose measure. At no time shall rubber tired or sheeps-foot rollers be allowed onto the reinforced fill. Turning of vehicles should be kept to a minimum to prevent tracks from displacing the fill and damaging the geogrid. Sudden breaking and sharp turning shall be avoided. Equipment speeds over 15 MPH shall not be allowed.

10. Placement, spreading, and compaction of soil on top of the reinforcement geogrid shall advance from one end of the reinforcement geogrid and move towards the other. Care shall be taken to minimize the development of wrinkles and to ensure that the reinforcement geogrid doesn't move from its position during fill placement. Limited stacking may the permitted, as directed by the Resident.

11. Fill shall be compacted as specified in (1) the Standard Specifications or (2) to at least 90 percent of the maximum dry density determined in accordance with AASHTO T-180, whichever is greater. Density testing shall be made at a minimum frequency of one (1) test per lift or as otherwise specified in the Standard Specifications.

12. During construction the surface of the fill shall be kept approximately horizontal. Fill shall be graded away from the slope crest and rolled at the end of each work day to prevent ponding of water on the surface of the reinforced soil mass.

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

14. Rutting may develop within the initial granular lift but rut depths should not exceed 3 inches. It may be necessary to decrease the size and/or weight of the construction equipment or increase the thickness of the granular lift if rut depths of 3 inches or less cannot be maintained.

15. All rutting formed during construction shall be filled with new base material. In no case shall rutting be filled by blading down

<u>Method of Measurement</u>
Reinforcement Geogrid measurement will be by the square yard of material installed. Incidental overlaps for connections, splices, etc. are not included in the pay item.

<u>Basis of Payment</u>
Reinforcement geogrid placement will be paid for at the Contract unit price per square yard which shall be full compensation for all off-loading, inspection, storage, labor, materials, equipment, tools and any incidentals to complete the installation.

Pay Item	Description	Pay Unit
620.65	Reinforcement Geogrid	Square Yard

SPECIAL PROVISION
SECTION 534
PRECAST STRUCTURAL CONCRETE
(Precast Structural Concrete Arches, Box Culverts)
(Precast Concrete Box Culvert Installation)

534.10 Description The Contractor shall unload, store and install precast structural concrete box culvert(s) and associated wings, headwalls, toewalls and appurtenances, in accordance with the contract documents. The precast concrete box culverts shall be supplied by the Department. The culvert sections are equipped with joint closure mechanisms to draw section together and close joints to the required opening.

534.20 Materials Structural precast elements for the arch or box culvert and associated precast elements shall meet the requirements of the following Subsection:

Structural Precast Concrete Units	712.061

Grout, concrete patching material, cementitious anchoring material and geotextile shall be one of the products listed on the Department's list of prequalified materials, unless otherwise approved by the Department.

Box culvert joints shall be sealed with an approved flexible joint sealant in accordance with AASHTO M 198 (ASTM C990).

Box culvert bedding and backfill material shall consist of Standard Specification 703.19, Granular Borrow, Material for Underwater Backfill, with the additional requirement that the maximum particle size be limited to 4 inches.

534.40 Construction Requirements The Contractor shall store and transport members in a manner to prevent cracking or damage. The Contractor shall not place precast members in an upright position until a compressive strength of at least 4350 psi is attained.

Installation of Precast Units The Contractor shall not ship precast members until sufficient strength has been attained to withstand shipping, handling and erection stresses without cracking, deformation, or spalling (but in no case less than 4350 psi).

The Contractor shall set precast arch members on ½ inch neoprene pads during shipment to prevent damage to the section legs. When approved by the Resident, the Contractor shall repair any damage to precast members resulting from shipping or handling by saw cutting a minimum of ½ inch deep around the perimeter of the damaged area and placing a polymer-modified cementitious patching material.

When footings are required, the Contractor shall install the precast arch members on concrete footings that have reached a compressive strength of at least 3000 psi. The Contractor shall construct the completed footing surface to the lines and grades shown on the plans. When checked with a 10 ft straightedge, the surface shall not vary more than ¼ inch in 10 ft. The footing keyway shall be filled with a non-shrink flowable cementitious grout with a design compressive strength of at least 5000 psi.

Box culvert joints shall be sealed with an approved flexible joint sealant in accordance AASHTO M 198 (ASTM C 990). Joints shall be closed tight to within 0.625 inches ±0.125 inch. Culvert sections shall be equipped with joint closure mechanisms to draw sections together and close joints to the required opening.

The Contractor shall fill holes in arches or box culverts that were cast in the units for handling, with either Portland cement mortar, or with precast plugs secured with Portland cement mortar or other approved adhesive. The Contractor shall completely fill the exterior face of joints between precast members with an approved material and cover with a minimum 12 inches wide joint wrap. The surface shall be free of dirt and deleterious materials before applying the filler material and joint wrap. The Contractor shall install the external wrap in one continuous piece over each member joint, taking care to keep the joint wrap in place during backfilling. The Contractor shall seal the joints between the end arch or box units and attached associated retaining wall elements with a non-woven geotextile. The Contractor shall install and tighten the bolts fastening the connection plate(s) between the retaining wall elements that are designed to be fastened together by the manufacturer.

Final assembly shall be approved by the manufacturer's representative prior to backfilling. The Contractor shall place and compact the bedding material as shown on the plans prior to setting the box culvert sections. The Contractor shall backfill the structure in accordance with the manufacturer's instructions and the Contract Documents. The Contractor shall uniformly distribute backfill material in layers of not more than 8 inches depth, loose measure, and thoroughly compact each layer using approved compactors before successive layers are placed. The Contractor shall compact the granular borrow bedding and backfill in accordance with Section 203.12 - Construction of Earth Embankment with Moisture and Density Control, except that the minimum required compaction shall be 92 percent of maximum density as determined by AASHTO T180, Method C or D. The Contractor shall place and compact backfill without disturbance or displacement of the wall units, keeping the fill at approximately the same elevation on both sides of the structure. Whenever a compaction test fails, the Contractor shall not place additional backfill over the area until the lift is re-compacted and a passing test achieved.

The Contractor shall use hand-operated compactors within 5 ft of the precast structure as well as over the top until it is covered with at least 12 inches of backfill. Equipment in excess of 12 tons shall not use the structure until a minimum of 24 inches of backfill cover is in place and compacted.

Delivery of Precast Units

The manufacturer and/or Contractor shall set precast members on 1/2 inch neoprene pads during shipment to prevent damage to the section legs. The Contractor shall repair any damage to precast members resulting from shipping or handling by saw cutting a minimum of 1/2 inch deep around the perimeter of the damaged area and placing a polymer-modified cementitious patching material.

The manufacturer shall delivery the precast units to the project site on a weekday (Monday to Friday) in coordination with the Contractor that is installing the precast units. The precast units shall be delivered to the project site by the manufacturer by the following dates:

Embden, Maine - Moore Bridge #2579, PIN 016699.10
(Route 8/16/201A over Jackin Brook)
GPS coordinates: -69.86513333 44.89024698
Delivery date -July 9, 2010

Newport, Maine - Mulligan Stream Bridge #6103, PIN 016722.10
(Route 7 over Mulligan Stream)
GPS coordinates: -69.27547051 -44.88801
Delivery date -July 9, 2010

Prentiss TWP, Maine - Little Mud Brook Bridge # 5707, PIN 016742.10
(Route 170 over Little Mud Brook)
Approximately 4.5 miles north of Springfield, Maine
GPS coordinates: -68.0860914 45.51794
Delivery date - July 9, 2010

Twp #18 ED BPP, Maine -Southern Inlet Bridge #5375, PIN 016758.10
(Route 191 over Southern Inlet)
Approximately 6 miles North of East Machias, Maine
GPS coordinates: -67.42469593 44.85189
Delivery date – July 23, 2010

The Contractor, who is installing the precast units, shall be responsible for unloading the precast units at or near the project site. Any incidental materials needed to temporarily store the precast units at the project site shall be provided by the Contractor.

534.50 Method of Measurement The Department will measure Precast Structural Concrete Arch or Box Culvert for payment per Lump Sum each, complete in place and accepted.

534.60 Basis of Payment The Department will pay for the accepted quantity of Precast Structural Concrete Arch or Box Culvert at the Contract Lump Sum price, such payment being full compensation for all labor, equipment, materials, professional services, and incidentals for installing the precast concrete elements and accessories. Falsework, reinforcing steel, jointing tape, geotextile, flexible joint sealant, cementitious patching material, grout, cast-in-place concrete fill or grout fill for anchorage of precast wings and/or other appurtenances is incidental to the Lump Sum pay item. Excavation, backfill material, and membrane waterproofing will be measured and paid for separately under the provided Contract pay items

Payment will be made under:

Pay Item		Pay Unit
534.7101	Precast Concrete Box Culvert- State Supplied	Lump Sum