

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

GEOTECHNICAL DESIGN REPORT

For the Replacement of:

**MCLEAN BROOK BRIDGE
ROUTE 162 OVER MCLEAN BROOK
TWP 17 R 04 WELS, MAINE**

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Soils Report No. 2013-17
Bridge No. 3960

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Table of Contents

GEOTECHNICAL DESIGN SUMMARY	1
1.0 INTRODUCTION.....	3
2.0 GEOLOGIC SETTING.....	3
3.0 SUBSURFACE INVESTIGATION	4
4.0 LABORATORY TESTING	4
5.0 SUBSURFACE CONDITIONS	5
5.1 FILL SOILS	5
5.2 PEAT AND WOOD	5
5.3 GLACIAL TILL	5
5.4 GROUNDWATER	6
6.0 FOUNDATION ALTERNATIVES.....	6
7.0 GEOTECHNICAL DESIGN RECOMMENDATIONS	6
7.1 PRECAST CONCRETE BOX CULVERT DESIGN AND CONSTRUCTION.....	7
7.2 PRECAST CONCRETE BOX CULVERT HEADWALLS	7
7.3 BEARING RESISTANCE	8
7.4 SETTLEMENT.....	8
7.5 FROST PROTECTION	8
7.6 SCOUR AND RIPRAP	9
7.7 SEISMIC DESIGN CONSIDERATIONS.....	9
7.8 CONSTRUCTION CONSIDERATIONS.....	9
8.0 CLOSURE	10

Sheets

Sheet 1 - Location Map

Sheet 2 - Boring Location Plan and Interpretive Subsurface Profile

Sheet 3 - Boring Logs

Appendices

Appendix A - Boring Log

Appendix B - Laboratory Test Results

Appendix C - Calculations

Appendix D - Special Provisions

GEOTECHNICAL DESIGN SUMMARY

The purpose of this Geotechnical Design Report is to present subsurface information and make geotechnical recommendations for the replacement of McLean Brook Bridge which carries Route 162 over McLean Brook in TWP 17 R 04 WELS, Maine. McLean Brook Bridge was constructed in 1966 and consists of twin steel pipe arches. The proposed replacement structure will be a precast concrete box culvert with a 20-foot wide by 8-foot high hydraulic opening. The following design recommendations are discussed in detail in Section 7.0 of this report.

Precast Concrete Box Culvert, Headwall and Toe Wall Design and Construction - The precast concrete box culvert will be supplier-designed in accordance with Special Provision 534 - Precast Structural Concrete Arches, Box Culverts, Frames and AASHTO LRFD Bridge Design Specifications, 6th Edition, 2012. The loading specified for the structure should be Modified HL-93 Strength I in which the HS-20 design truck wheel loads are increased by a factor of 1.25. The precast concrete box culvert shall be designed for all relevant strength and service limit states and load combinations. The precast concrete box culvert shall be constructed in conformance with the MaineDOT Bridge Design Guide Section 8 and Special Provision 534.

The proposed box culvert will have 1-foot tall, integral precast headwalls. The box will be embedded approximately 2 feet into the streambed and 1 foot of dredged, native material will be placed inside the bottom of the box to create a natural streambed crossing. The precast concrete box shall include accommodations for toe walls at both the inlet and outlet ends to prevent undermining. The cutoff walls should extend below the maximum depth of scour. The box culvert will be constructed on a 2-foot thick layer of $\frac{3}{4}$ -inch crushed stone reinforced with geogrid and encapsulated in reinforcement geotextile.

Bearing Resistance - The calculated factored bearing resistance at the strength limit state for a box culvert with a base width of 22 feet is 7.5 kips per square foot (ksf). The maximum factored bearing pressure for the strength limit state determined by the precast box culvert designer-manufacturer shall not exceed this factored bearing resistance. The bearing resistance of the box culvert shall be investigated by the designer-manufacturer at the service limit state using a factored bearing resistance of 5.0 ksf to control settlement. The service limit state bearing resistance may govern the design. In no instance shall the bearing stress exceed the nominal structural resistance of the structural concrete which may be taken as $0.3f'_c$.

Settlement – We anticipate that soft peat deposits and wood will be encountered at the elevation of the box culvert bottom slab and the 2-foot thick crushed stone mat. All peat, organics and wood in the box culvert and backfill envelope footprint shall be removed and replaced with compacted granular borrow or $\frac{3}{4}$ -inch stone to the bearing elevation. The underlying foundation soils are medium dense, glacial till soils. These soils are not expected to consolidate. There is no plan to change in the horizontal alignment or vertical profile from

the existing. Therefore, we anticipate there will be minimal settlement of the foundation soils.

Frost Protection – Foundations placed on soil should be founded a minimum of 8.2 feet below finished exterior grade for frost protection.

Scour and Riprap – The box culvert shall be constructed with integral concrete headwalls to retain riprap slopes and prevent riprap from dropping or eroding into the waterway. Inlet and outlet cutoff walls will be provided that extend below the maximum depth of scour. The slopes shall be armored with a 3-foot thick layer of riprap. The riprap shall be underlain by a Class 1 erosion control geotextile and a 1-foot layer of bedding material. The toe of the riprap sections shall be constructed 1 foot below the streambed elevation. The riprap slopes shall be constructed no steeper than a maximum 1.75H:1V extending from the edge of the roadway down to the existing ground surface. Riprap aprons should be installed at both ends of the culvert and extended 10-feet in front of the inlet and outlet cutoff walls.

Seismic Design Considerations – 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.

Construction Considerations – The proposed box culvert will be bedded on mat consisting of a 2-foot thick layer of $\frac{3}{4}$ -inch crushed stone reinforced with and encapsulated with geosynthetic reinforcement. Based on the soils encountered in the boring is likely that peat and wood will be encountered at this elevation. All peat and wood in the footprint of the bottom slab of the precast box and underlying crushed stone mat shall be removed and replaced with compacted gravel borrow or $\frac{3}{4}$ -inch stone to the bearing elevation. Any silt or clay soils, if encountered, shall be excavated using a smooth edged backhoe bucket to minimize disturbance to the layer. The use of heavy equipment on the soft, fine grained soils, if encountered, should be prohibited.

Construction may require temporary earth support systems and/or cofferdams. A wood layer was encountered in the boring and wood may impede driving sheet piles that may be required for cofferdams.

The removal of fill soils may potentially result, if encountered, in the exposure of natural deposits of potentially sensitive silt and clay. These soils, if encountered, will be susceptible to disturbance and rutting as a result of exposure to water or construction traffic. If disturbance and rutting occur, we recommend that the contractor remove and replace the disturbed materials with $\frac{3}{4}$ -inch stone or compacted MaineDOT Standard Specification 703.20, Gravel Borrow. Any cobbles or boulders encountered in excess of 6 inches shall be removed and replaced with compacted gravel borrow or $\frac{3}{4}$ -inch stone.

Soils may become saturated and water seepage may be encountered during construction. There may be localized sloughing and instability in some excavations and cut slopes. The contractor should control groundwater, surface water infiltration and soil erosion.

1.0 INTRODUCTION

The purpose of this Geotechnical Design Report is to present subsurface information and make geotechnical recommendations for the replacement of McLean Brook Bridge which carries Route 162 over McLean Brook in TWP 17 R 04 WELS, Maine. A subsurface investigation has been completed. The purpose of the investigation was to explore subsurface conditions at the site in order to develop geotechnical recommendations for the bridge replacement. This report presents the subsurface information obtained at the site during the subsurface investigation, foundation design recommendations and geotechnical design parameters for the bridge replacement.

McLean Brook Bridge was constructed in 1966 and consists of twin 12-foot 6-inch steel pipe arches approximately 50 feet long. The steel pipes are heavily rusted and pitted throughout. The side of one pipe is unzipped for a 3-foot long section. There are large outlet end holes in both pipes. Approximately 2 feet of fill soil overlies the existing steel pipes.

The culvert is rated as “3” for “Excessive Damage” according to a 2012 Maine Department of Transportation (MaineDOT) Bridge Inspection Report. The bridge has a Sufficiency Rating of 52.3. The MaineDOT Bridge Program has determined that the advanced corrosion and section loss of the twin steel pipes warrants replacement of the buried structures.

The proposed replacement structure will be a single 20-foot span by 8-foot rise, approximately 62-foot long, precast concrete box culvert on a 0 degree skew. The box culvert will have 1-foot tall precast headwalls. The proposed box will have inlet and outlet toe walls, 1-foot thick and 2 feet tall. The invert of the box culvert will be embedded approximately 2 feet into the streambed and 1 foot of dredged, native material will be placed inside the bottom of the culvert to match the streambed. The box culvert will be constructed on a 2-foot thick layer of $\frac{3}{4}$ -inch crushed stone reinforced with geogrid and encapsulated in reinforcement geotextile. The new bridge will be located on the same horizontal alignment as the existing bridge. The finished grade on the bridge will match the existing. State Route 162 will be closed during the construction, which is expected to last approximately two weeks.

2.0 GEOLOGIC SETTING

McLean Brook Bridge is located on Route 162 in TWP 17 R 04 WELS and crosses McLean Brook approximately 3.6 miles southwest of the Saint Agatha town line, as shown on Sheet 1 – Location Map. McLean Brook empties into Long Lake approximately 200 feet downstream of the bridge.

The Maine Geologic Survey (MGS) Surficial Geology of the Square Lake Quadrangle (1978) indicates the surficial soils in the vicinity of the bridge project consist of swamp deposits comprised of peat, silt and clay, with nearby local contacts to glacial till. The predominant native soil units at the site based on our subsurface exploration are fill soils, swamp deposits and glacial till.

The Bedrock Geologic Map of Maine, MGS, (1985), cites the bedrock at the bridge site as unnamed, weakly metamorphosed sedimentary rocks consisting of interbedded pelite and sandstone.

3.0 SUBSURFACE INVESTIGATION

Subsurface conditions at the site were explored by drilling one (1) test boring. The boring was terminated at a depth of approximately 37 feet below the roadway surface without encountering bedrock. Test boring BB-MBB-101 was drilled in the southbound shoulder of Route 162, approximately 10 feet north of the existing twin steel pipe culverts. The boring location is shown on Sheet 2 - Boring Location Plan and Interpretive Subsurface Profile provided at the end of this report.

The boring was drilled on January 29, 2013 by the MaineDOT Drill Crew. Details and sampling methods used, field data obtained, and soil and groundwater conditions encountered are presented in the boring log provided in Appendix A – Boring Log and on Sheet 3 - Boring Logs found at the end of this report.

The boring was drilled using cased wash boring and solid stem auger techniques. Soil samples were typically obtained at 5-foot intervals using Standard Penetration Test (SPT) methods. During SPT sampling, the sampler is driven 24 inches and the hammer blows for each 6-inch interval of penetration are recorded. The sum of the blows for the second and third intervals is the N-value, or standard penetration resistance. The MaineDOT drill rig is equipped with an automatic hammer to drive the split spoon. The hammer was calibrated per ASTM D4633-05 “Standard Test Method for Energy Measurement for Dynamic Penetrometers” in August 2012 and was found to deliver approximately 26 percent more energy during driving than the standard rope and cathead system. All N-values discussed in this report are corrected values computed by applying an average energy transfer of 0.756 to the raw field N-values. This hammer efficiency factor (0.756) and both the raw field N-value and corrected N-value (N_{60}) are shown on the boring log.

The bedrock was not encountered in the boring. A Northeast Transportation Technician Certification Program (NETTCP) Certified Subsurface Inspector logged the subsurface conditions encountered. The MaineDOT geotechnical engineer selected the boring location and drilling methods, designated type and depth of sampling techniques, reviewed the draft boring log and identified field and laboratory testing requirements. The boring was located in the field using taped measurements at the completion of the drilling program.

4.0 LABORATORY TESTING

A laboratory testing program was conducted on selected soil recovered from test borings to assist in soil classification, evaluation of engineering properties of the soils, and geologic assessment of the project site.

Laboratory testing consisted of three (3) standard grain size analyses with water content, and one (1) ignition loss test with water content. The results of soil laboratory tests are included as Appendix B – Laboratory Test Results. Laboratory test information is also shown on the boring log provided in Appendix A – Boring Log and on Sheet 3 - Boring Logs.

5.0 SUBSURFACE CONDITIONS

Subsurface conditions encountered in the test boring generally consisted of fill soils, peat, and glacial till. The boring log is provided in Appendix A – Boring Log and on Sheet 3 – Boring Logs. A generalized subsurface profile is shown on Sheet 2 – Boring Location Plan and Interpretive Subsurface Profile. A summary description of the strata encountered follows:

5.1 Fill Soils

A layer of granular fill was encountered in the boring. The encountered thickness was approximately 10.5 feet. The fill is comprised of brown, dry to moist, gravelly, fine to coarse sand, little silt and grey, wet, silty, fine to coarse sand, some gravel.

SPT N-values in the fill soils ranged from 15 to greater than 50 blows per foot (bpf), indicating a soil that is medium dense in consistency. Frozen soils were encountered to a depth of approximately 3.5 feet.

One grain size analysis conducted resulted in the fill being classified as an A-1-b under the AASHTO Classification System and an SM under the Unified Soil Classification System. The measured natural water content of the fill soil sample tested was approximately 9 percent.

5.2 Peat and Wood

A layer of peat and wood was encountered below the fill. The encountered thickness was approximately 2.7 feet. The peat is described as dark brown to black, moist, organic silt with wood fragments.

One organic content analysis of the peat indicated that the peat has an organic content of approximately 43 percent. The natural water content of the sample tested was approximately 199 percent.

5.3 Glacial Till

Glacial till was encountered below the peat and wood layer in the boring. The thickness of the glacial till investigated was approximately 23.8 feet. The full thickness of the glacial till layer was not investigated due to the chosen replacement structure type.

The encountered thickness of the upper, cohesionless glacial till deposit was approximately 13.8 feet. The cohesionless glacial till consisted of grey, wet, gravelly, fine to coarse sand, little silt. Fragments of wood were encountered in the upper approximately 2 feet indicating the upper 2 feet of the glacial has been reworked.

SPT N-values in the upper glacial till ranged from 13 to 25 bpf indicating the soil is medium dense in consistency. One grain size analysis conducted on the sample resulted in the soil being classified as an A-1-b under the AASHTO Classification System and an SM under the Unified Soil Classification System. The measured natural water content of the sample tested was approximately 9 percent.

Below the cohesionless glacial till deposits we encountered a fine grained glacial till for a depth of approximately 10 feet. The till consisted of grey, silt, some fine to coarse sand, some gravel. SPT N-values obtained in the silty glacial till deposit were greater than 50 bpf indicating the deposit is hard in consistency. One grain size analysis conducted resulted in the soil being classified as an A-4 under the AASHTO Classification System and SM under the Unified Soil Classification System. The measured natural water content of the sample tested was approximately 9 percent.

The boring was terminated in the glacial till without encountering bedrock.

5.4 Groundwater

Groundwater was not observed in the boring. Groundwater levels will fluctuate with seasonal changes, precipitation, runoff, and construction activities.

6.0 FOUNDATION ALTERNATIVES

Due to the extensive corrosion and section loss of the existing steel pipes the Preliminary Design Report (PDR) prepared by MaineDOT Bridge Program recommends replacement of the existing twin steel pipes. The only replacement alternative considered that would provide adequate hydraulic performance is a precast concrete box with a 20-foot span and 8-foot rise. A 26 mile detour will be used to maintain traffic while the bridge is closed for approximately two weeks for removal and replacement.

7.0 GEOTECHNICAL DESIGN RECOMMENDATIONS

The proposed replacement structure will consist of a precast concrete box culvert with a 20-foot wide by 8-foot high hydraulic opening. The length of the box culvert will be approximately 62 feet on a 0 degree skew. The proposed box culvert will have integral 1-foot high precast headwalls. Both ends of the culvert will be slope tapered to match 1.75H:1V riprapped side slopes. The box will be embedded approximately 2 feet into the streambed and a 1-foot layer of native soils will be placed inside the bottom of the culvert to create a

natural stream crossing. The following sections will discuss geotechnical design recommendations for design of a precast concrete box culvert.

7.1 Precast Concrete Box Culvert Design and Construction

Precast concrete box culverts are typically detailed on the contract plans with only basic layout and required hydraulic opening. The manufacturer selected by the Contractor is responsible for the design of the structure including determination of wall thickness, haunch thickness and reinforcement in accordance with Special Provision 534 - Precast Structural Concrete Arches, Box Culverts, Frames which is included in Appendix D of this report. The loading specified for the structure should be Modified HL-93 Strength I in which the HS-20 design truck wheel loads are increased by a factor of 1.25. The design should use Soil Type 4 as presented in the MaineDOT Bridge Design Guide (BDG) Section 3.6 to design earth loads from the soil envelope. The backfill properties are as follows: $\phi = 32^\circ$, $\gamma = 125$ pcf.

The precast concrete box culvert will be supplier-designed in accordance with AASHTO LRFD Bridge Design Specifications 6th Edition 2012 (LRFD). The precast concrete box culvert shall be designed for all relevant strength and service limit states and load combinations specified in LRFD Article 3.4.1 and LRFD Section 12. The precast concrete box culvert shall be constructed in conformance with MaineDOT BDG Section 8 and Special Provision 534.

The box culvert will be constructed on a 2-foot thick layer of $\frac{3}{4}$ -inch crushed stone (see Special Provision 203 in Appendix D) reinforced with geogrid and encapsulated in reinforcement geotextile.

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 inches. The granular borrow backfill should be placed in lifts of 6 to 8 inches thick loose measure and compacted to the manufacturer's specifications. In no case shall the backfill soil be compacted less than 92 percent of the AASHTO T-180 maximum dry density. The crushed stone bedding should be placed in 12 inch maximum lifts and compacted with a minimum of four passes of a large walk-behind compactor.

The precast concrete box shall include 1-foot thick by minimum 2-foot deep toe walls at the inlet and outlet ends to prevent undermining per MaineDOT BDG Section 8.3.1. The cutoff walls should extend below the maximum depth of scour. The invert of the box culvert will be embedded approximately 2-feet into the streambed and 1 foot of dredged, native material will be placed inside the bottom of the culvert to match the streambed.

7.2 Precast Concrete Box Culvert Headwalls

Concrete headwalls will be included in the culvert design to retain riprap slopes and prevent riprap from dropping or eroding into the waterway. Nominal 1-foot by 1-foot concrete headwalls are recommended.

7.3 Bearing Resistance

The glacial till deposits at the anticipated foundation elevation for a precast box are medium dense in consistency. These soils are characterized as having adequate bearing resistance.

The calculated factored bearing resistance at the strength limit state for a box culvert with a base width of 22 feet is 7.5 kips per square foot (ksf). The maximum factored bearing pressure for the strength limit state determined by the precast box culvert designer-manufacturer shall not exceed this factored bearing resistance. The bearing resistance of the box culvert shall be investigated by the designer-manufacturer at the service limit state using a factored bearing resistance of 5.0 ksf. A factored bearing resistance of 5 ksf shall be used to control settlement when analyzing the culvert for the service limit state. The service limit state bearing resistance may govern the design. In no instance shall the bearing stress exceed the nominal structural resistance of the structural concrete which may be taken as $0.3f'_c$. See Appendix C – Calculations for supporting calculations.

7.4 Settlement

Based on the soils encountered in the boring, soft peat deposits and wood will be encountered at the elevation of the box culvert bottom slab and the 2-foot thick encapsulated crushed stone mat. All peat, organics and wood in the box culvert and backfill envelope footprint shall be removed and replaced with compacted granular borrow or $\frac{3}{4}$ -inch stone to the bearing elevation. The underlying glacial till deposits at foundation elevation are medium dense. These glacial till soils are not expected to consolidate, even if a load greater than the existing overburden pressure is applied. There is no plan to change the horizontal alignment or vertical profile from the existing. Therefore, we anticipate there will be minimal settlement of the foundation soils at the location of the replacement culvert.

To control future settlement, the envelope and backfill soil shall be compacted to no less than 92 percent of the AASHTO T-180 maximum dry density. Remove any wood or cribbing at the bearing elevation and replace with compacted granular borrow or $\frac{3}{4}$ inch stone to the bearing elevation.

7.5 Frost Protection

Foundations placed on the native soils should be designed with an appropriate embedment for frost protection. According to BDG Figure 5-1, Maine Design Freezing Index Map, TWP 17 R04 WELS has a design freezing index greater than 2600 F-degree days. Based on soil laboratory test results, a water content of 10% was used for coarse grained soils. These components correlate to a frost depth of approximately 9.1 feet. A similar analysis was performed using Modberg software by the US Army Cold Regions Research and Engineering Laboratory (CRREL). For the Modberg analysis, TWP17 R04 WELS was assigned a design freezing index of approximately 2462 F-degree days based on CRREL weather database information for Caribou, Maine. A water content of 10% was used for coarse grained soils. These components correlate to a frost depth of approximately 8.2 feet.

We recommend that foundations be designed with an embedment of 8.2 feet for frost protection. See Appendix C – Calculations for supporting calculations.

Riprap is not to be considered as contributing to the overall thickness of soils required for frost protection.

7.6 Scour and Riprap

The box culvert shall be constructed with integral concrete headwalls to retain riprap slopes and prevent riprap from dropping or eroding into the waterway. Inlet and outlet cutoff walls shall be provided that extend below the maximum depth of scour. Riprap aprons should be installed at both ends of the culvert and extended 10-feet outside of the inlet and outlet cutoff walls.

To protect the portion of the soil envelope surrounding the box culvert, the side slopes shall be armored with a 3-foot thick layer of riprap conforming to MaineDOT Supplemental Specification Section 703.26 Plain and Hand Laid Riprap. The riprap shall be underlain by a Class 1 erosion control geotextile and a 1-foot layer of bedding material conforming to MaineDOT Standard Specification 703.19 Granular Borrow Material for Underwater Backfill. The toe of the riprap sections shall be constructed 1-foot below the streambed elevation. The riprap slopes shall be constructed no steeper than a maximum 1.75H:1V extending from the edge of the roadway down to the existing ground surface.

7.7 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.

7.8 Construction Considerations

The proposed box culvert will be constructed on a 2-foot thick bed of ¾-inch crushed stone wrapped with reinforcement geotextile. Based on the soils encountered in the boring is likely that peat and wood will be encountered at this elevation. All wood and peat in the box culvert footprint shall be removed and replaced with compacted gravel borrow or ¾-inch crushed stone to the bearing elevation. Any fine grained soils, if encountered, should be excavated for the bedding material using a smooth edged backhoe bucket to minimize disturbance to the layer. If a smooth edged bucket is not used, all disturbed soils caused by the bucket teeth should be removed by hand prior to placement of the bedding materials. The use of heavy equipment on the soft fine grained soils, if encountered, should be prohibited.

Construction of the proposed precast concrete box culvert will require soil excavation. The removal of fill soils may potentially result in the exposure of natural deposits of silt and clay. These soils, if encountered, may be susceptible to disturbance and rutting as a result of exposure to water and construction traffic. If disturbance and rutting occur, the Contract shall remove and replace disturbed areas with compacted gravel borrow or ¾-inch stone to

the bearing elevation. Any cobbles or boulders encountered in excess of 6 inches shall be removed and replaced with compacted gravel borrow or $\frac{3}{4}$ -inch crushed stone.

Construction may require earth support systems or cofferdams. A wood layer was encountered in the boring at the anticipated elevation of the bottom of the precast box. The wood may impede driving sheet pile that may be required for earth support systems or cofferdams.

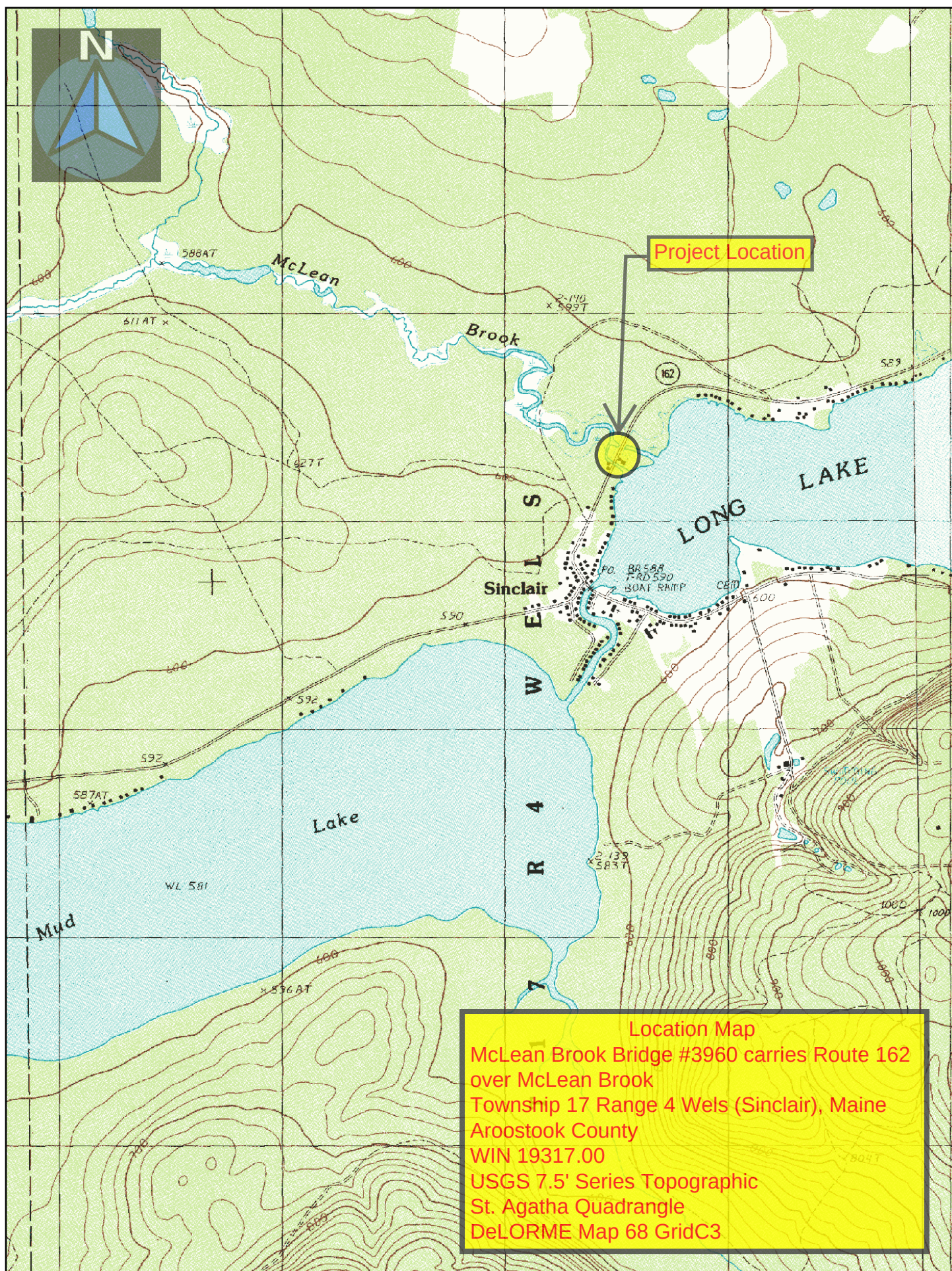
Any silt or clay soils encountered may become saturated and water seepage may be encountered during construction. There may be localized sloughing and instability in some excavations and cut slopes. The contractor should control groundwater, surface water infiltration and soil erosion. Water should be controlled by pumping from sumps.

8.0 CLOSURE

This report has been prepared for the use of the MaineDOT Bridge Program for specific application to the proposed replacement of McLean Brook Bridge on Route 162 in TWP 17 R 04 WELS, Maine in accordance with generally accepted geotechnical and foundation engineering practices. No other intended use or warranty is 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 at discrete locations 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.

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

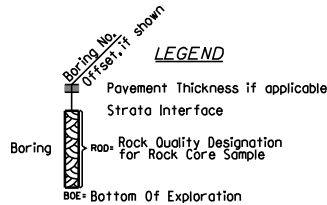
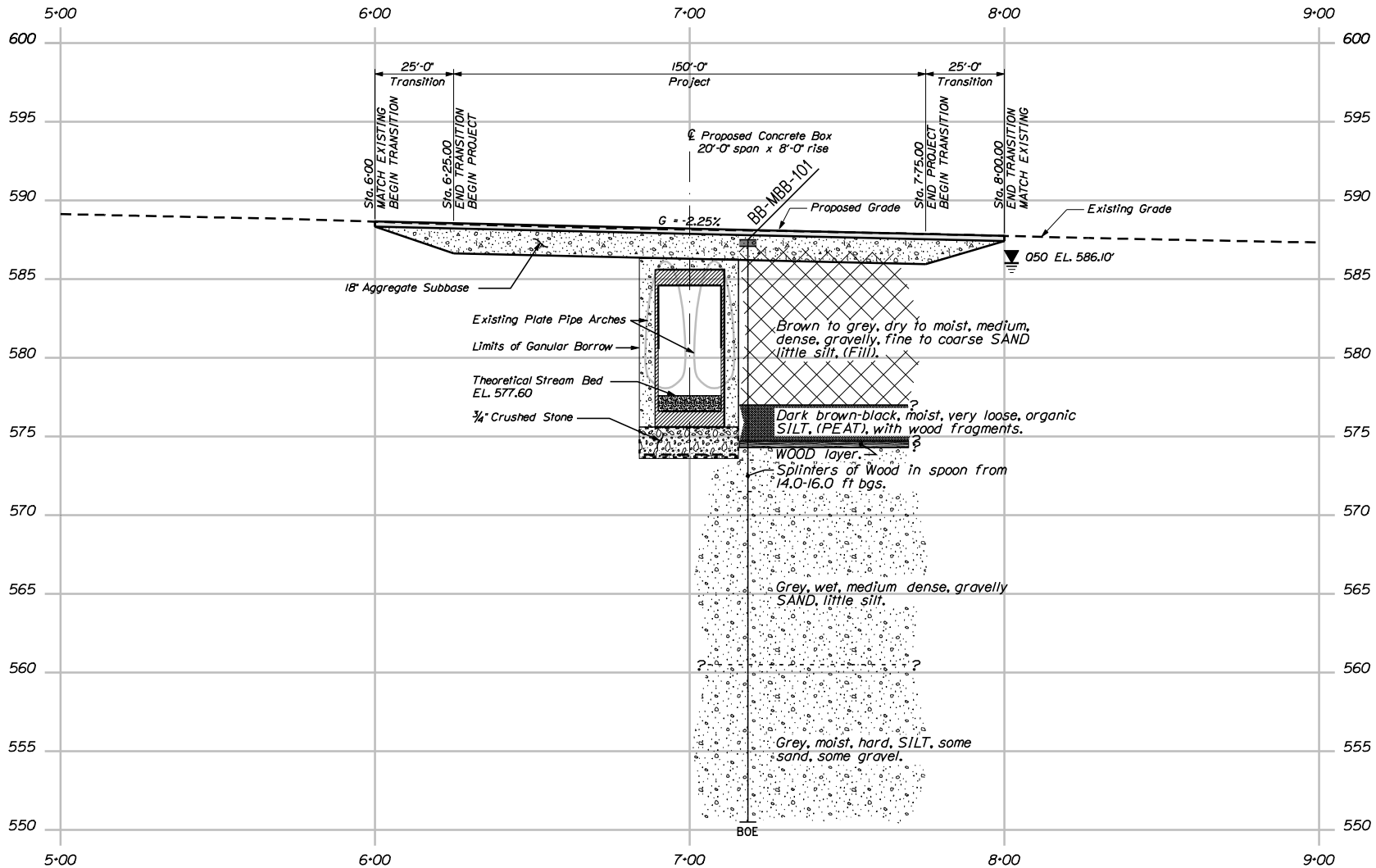
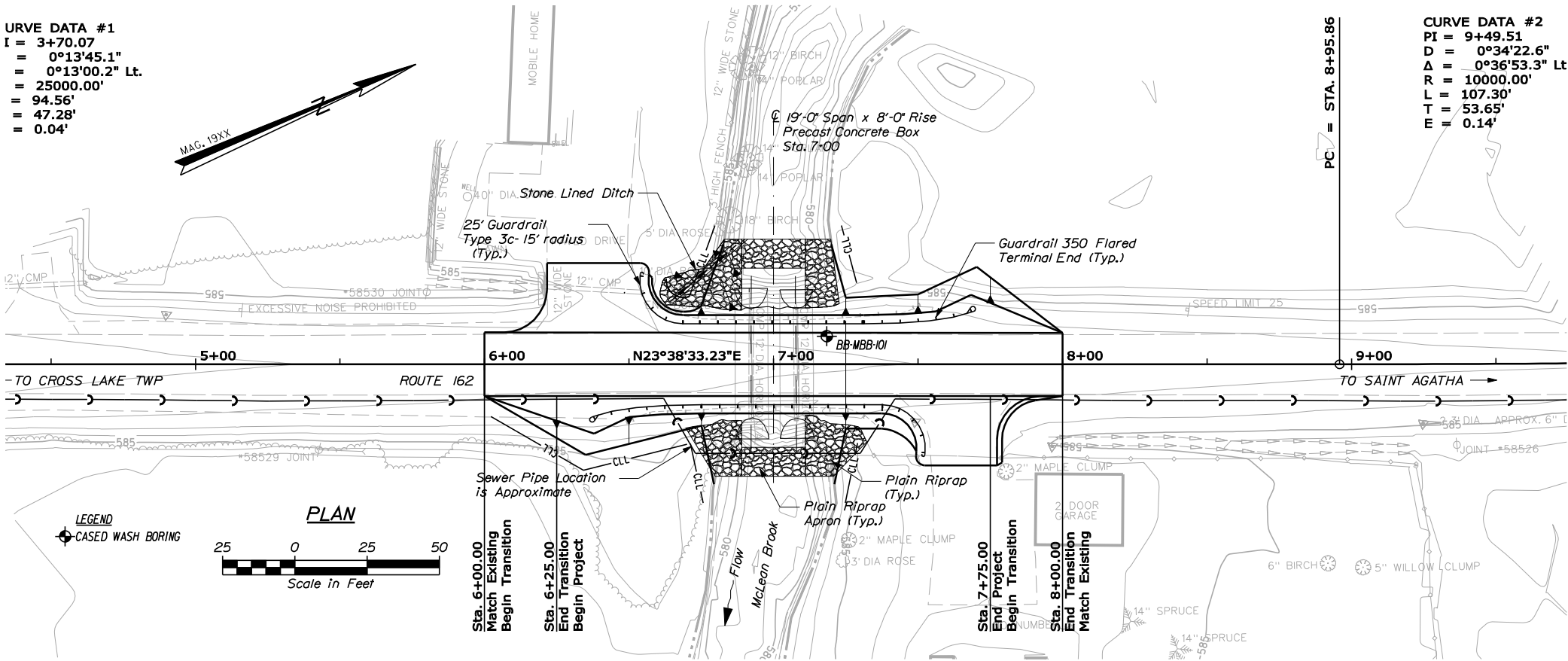
Sheets



Map Scale 1:24000

URVE DATA #1
 I = 3+70.07
 = 0°13'45.1"
 = 0°13'00.2" Lt.
 = 25000.00'
 = 94.56'
 = 47.28'
 = 0.04'

CURVE DATA #2
 PI = 9+49.51
 D = 0°34'22.6"
 Δ = 0°36'53.3" Lt
 R = 10000.00'
 L = 107.30'
 T = 53.65'
 E = 0.14'



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.

PROJ. MANAGER	BY	DATE	SIGNATURE
S. BOODE	D. SHAW		
CHECKED-REVIEWED			
DESIGN DETAILING	D. BOSSON	FEB 2013	
REVISIONS 1			
REVISIONS 2			
REVISIONS 3			
REVISIONS 4			
FIELD CHANGES			

Maine Department of Transportation

Soil/Rock Exploration Log

US CUSTOMARY UNITS

Project: McLean Brook Bridge #3960 carries Route 162 over McLean Brook

Location: T17 R4 Wels, Sinclair, Maine

Boring No. : BB-MBB-101

WIN: 19317.00

Driller: MaineDOT

Elevation (ft.): 587.5

Auger ID/DD: 5" Solid Stem

Operator: Enos/Giles

Datum: NAVD88

Sampler: Standard Split Spoon

Logged By: B. Wilder

Rig Type: CME 45C

Hammer Wt./Fall: 140#/30"

Date Start/Finish: 1/29/2013: 08:30-13:00

Drilling Method: Cased Wash Boring

Core Barrel: N/A

Boring Location: T+18.5, 10.1 ft Lt.

Casing ID/DD: NW

Water Level*: None Observed

Hammer Efficiency Factor: 0.756

Hammer Type: Automatic Hydraulic Rope & Cathead

Definitions:
B = Rock Core Sample
D = Split Spoon Sample
MS = Unsuccessful Split Spoon Sample attempt
U = Thin Wall Tube Sample
MU = Unsuccessful Thin Wall Tube Sample attempt
V = Intitu Vane Shear Test
WP = Pocket Penetrometer
WC = Unsuccessful Intitu Vane Shear Test attempt
WSP = Weight of one person

S_u = Intitu Field Vane Shear Strength (psf)
T_v = Pocket Torvane Shear Strength (psf)
C_u = Unconfined Compressive Strength (psf)
N-uncorrected = Raw field SPT N-value
Hammer Efficiency Factor = Annual Calibration Value
N₆₀ = SPT N-uncorrected corrected for hammer efficiency
N₆₀ = 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
C = Consolidation Test

Depth (ft.)	Sample Information										Graphic Log	Visual Description and Remarks	Laboratory Testing Results/AASHTO and Unified Class
	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (1/6 in. Sample Length) (pcf) or ROD (%)	N-uncorrected	N ₆₀	Casing Strokes	Elevation (ft.)					
5								587.08			5" PAVEMENT. Brown, dry, gravelly, fine to coarse SAND, little silt. (Ffill). Frost to a depth of 3.5 ft bgs. Similar to above, except moist, medium dense, (Ffill). 30 (10.0-10.5 ft bgs) Grey, wet, very loose, silty, fine to coarse SAND, some gravel, (Ffill). 30/A (10.5-12.0 ft bgs) Dark brown to black, moist, very loose, organic SILT, with wood fragments, (PEAT). WOOD layer from 12.8-13.2 ft bgs. 40 (14.0-16.0 ft bgs) Splinters of wood in spoon.	G#261924 A-1-b, SM WC=8.7%	
	10	24/20	2.00 - 4.00	51/57/31/25	88	111							
	20	24/19	5.00 - 7.00	8/6/6/6	12	15							
10								578.50			#261925 Ignition Loss Loss=42.6% H2O=199.4%		
	30/A	24/16	10.00 - 12.00	3/1/1/2	2	3	13	577.00					
15								574.70			G#266755 A-1-b, SM WC=8.9%		
								574.30					
20											G#266756 A-4, SM WC=8.7%		
	40	24/2	14.00 - 16.00	6/5/5/5	10	13	17						
25											G#266756 A-4, SM WC=8.7%		
	50	24/15	19.00 - 21.00	8/9/11/11	20	25	6						
30											G#266756 A-4, SM WC=8.7%		
	60	24/13	24.00 - 26.00	11/8/7/8	15	19	47						
35											G#266756 A-4, SM WC=8.7%		
	70	24/17	30.00 - 32.00	30/34/50/48	84	106							
40											G#266756 A-4, SM WC=8.7%		
	80	24/16	35.00 - 37.00	10/27/38/37	65	82							
45											G#266756 A-4, SM WC=8.7%		
50											G#266756 A-4, SM WC=8.7%		

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-MBB-101

Appendix A

Boring Log

UNIFIED SOIL CLASSIFICATION SYSTEM					TERMS DESCRIBING DENSITY/CONSISTENCY																														
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	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 <table><tr><th>Descriptive Term</th><th>Portion of Total</th></tr><tr><td>trace</td><td>0% - 10%</td></tr><tr><td>little</td><td>11% - 20%</td></tr><tr><td>some</td><td>21% - 35%</td></tr><tr><td>adjective (e.g. sandy, clayey)</td><td>36% - 50%</td></tr></table> <table><tr><th>Density of Cohesionless Soils</th><th>Standard Penetration Resistance N-Value (blows per foot)</th></tr><tr><td>Very loose</td><td>0 - 4</td></tr><tr><td>Loose</td><td>5 - 10</td></tr><tr><td>Medium Dense</td><td>11 - 30</td></tr><tr><td>Dense</td><td>31 - 50</td></tr><tr><td>Very Dense</td><td>> 50</td></tr></table>				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					
		Descriptive Term	Portion of Total																																
		trace	0% - 10%																																
	little	11% - 20%																																	
	some	21% - 35%																																	
	adjective (e.g. sandy, clayey)	36% - 50%																																	
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Very loose	0 - 4																																		
Loose	5 - 10																																		
Medium Dense	11 - 30																																		
Dense	31 - 50																																		
Very Dense	> 50																																		
(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	SW	Well-graded sands, gravelly sands, little or no fines																																
	(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.	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. <table><tr><th>Consistency of Cohesive soils</th><th>SPT N-Value blows per foot</th><th>Approximate Undrained Shear Strength (psf)</th><th>Field Guidelines</th></tr><tr><td>Very Soft</td><td>WOH, WOR, WOP, <2</td><td>0 - 250</td><td>Fist easily Penetrates</td></tr><tr><td>Soft</td><td>2 - 4</td><td>250 - 500</td><td>Thumb easily penetrates</td></tr><tr><td>Medium Stiff</td><td>5 - 8</td><td>500 - 1000</td><td>Thumb penetrates with moderate effort</td></tr><tr><td>Stiff</td><td>9 - 15</td><td>1000 - 2000</td><td>Indented by thumb with great effort</td></tr><tr><td>Very Stiff</td><td>16 - 30</td><td>2000 - 4000</td><td>Indented by thumbnail</td></tr><tr><td>Hard</td><td>>30</td><td>over 4000</td><td>Indented by thumbnail with difficulty</td></tr></table>				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
		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																																
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					Rock Quality Designation (RQD): RQD = $\frac{\text{sum of the lengths of intact pieces of core}^* > 100 \text{ mm}}{\text{length of core advance}}$ *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) 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				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: <table><tr><td>PIN</td><td>Blow Counts</td></tr><tr><td>Bridge Name / Town</td><td>Sample Recovery</td></tr><tr><td>Boring Number</td><td>Date</td></tr><tr><td>Sample Number</td><td>Personnel Initials</td></tr><tr><td>Sample Depth</td><td></td></tr></table>				PIN	Blow Counts	Bridge Name / Town	Sample Recovery	Boring Number	Date	Sample Number	Personnel Initials	Sample Depth																		
PIN	Blow Counts																																		
Bridge Name / Town	Sample Recovery																																		
Boring Number	Date																																		
Sample Number	Personnel Initials																																		
Sample Depth																																			

Maine Department of Transportation Soil/Rock Exploration Log US CUSTOMARY UNITS				Project: McLean Brook Bridge #3960 carries Route 162 over McLean Brook Location: T17 R4 Wels, Sinclair, Maine				Boring No.: BB-MBB-101 WIN: 19317.00																																																																																																																																																																																																																																																																																																																																																																															
Driller: MaineDOT				Elevation (ft.) 587.5				Auger ID/OD: 5" Solis Stem																																																																																																																																																																																																																																																																																																																																																																															
Operator: Enos/Giles				Datum: NAVD88				Sampler: Standard Split Spoon																																																																																																																																																																																																																																																																																																																																																																															
Logged By: B. Wilder				Rig Type: CME 45C				Hammer Wt./Fall: 140#/30"																																																																																																																																																																																																																																																																																																																																																																															
Date Start/Finish: 1/29/2013; 08:30-13:00				Drilling Method: Cased Wash Boring				Core Barrel: N/A																																																																																																																																																																																																																																																																																																																																																																															
Boring Location: 7+18.5, 10.1 ft Lt.				Casing ID/OD: NW				Water Level*: None Observed																																																																																																																																																																																																																																																																																																																																																																															
Hammer Efficiency Factor: 0.756				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 N₆₀ = SPT N-uncorrected corrected for hammer efficiency N₆₀ = (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																																																																																																																																																																																																																																																																																																																																																																																							
<table><tr><th rowspan="2">Depth (ft.)</th><th colspan="8">Sample Information</th><th rowspan="2">Graphic Log</th><th rowspan="2">Visual Description and Remarks</th><th rowspan="2">Laboratory Testing Results/ AASHTO and Unified Class.</th></tr><tr><th>Sample No.</th><th>Pen./Rec. (in.)</th><th>Sample Depth (ft.)</th><th>Blows (6 in.) Shear Strength (psf) or RQD (%)</th><th>N-uncorrected</th><th>N₆₀</th><th>Casing Blows</th><th>Elevation (ft.)</th></tr><tr><td>0</td><td></td><td></td><td></td><td></td><td></td><td></td><td>SSA</td><td>587.08</td><td rowspan="10"></td><td>5" PAVEMENT.</td><td rowspan="10">G#261924 A-1-b, SM WC=8.7%</td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>0.42</td></tr><tr><td></td><td>1D</td><td>24/20</td><td>2.00 - 4.00</td><td>51/57/31/25</td><td>88</td><td>111</td><td></td><td></td><td></td><td>Brown, dry, gravelly, fine to coarse SAND, little silt, (Fill).</td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>Frost to a depth of 3.5 ft bgs.</td></tr><tr><td>5</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>Similar to above, except moist, medium dense, (Fill).</td></tr><tr><td></td><td>2D</td><td>24/19</td><td>5.00 - 7.00</td><td>8/6/6/6</td><td>12</td><td>15</td><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>10</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td rowspan="10">#261925 Ignition Loss Loss=42.6% H2O=199.4%</td></tr><tr><td></td><td>3D/A</td><td>24/16</td><td>10.00 - 12.00</td><td>3/1/1/2</td><td>2</td><td>3</td><td>13</td><td>577.00</td><td></td><td>3D (10.0-10.5 ft bgs) Grey, wet, very loose, silty, fine to coarse SAND, some gravel, (Fill).</td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>6</td><td></td><td></td><td>10.50</td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>31</td><td></td><td></td><td>3D/A (10.5-12.0 ft bgs) Dark brown to black , moist, very loose, organic SILT, with wood fragments, (PEAT).</td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>80</td><td></td><td></td><td>12.80</td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>574.70</td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>574.30</td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>WOOD layer from 12.8-13.2 ft bgs.</td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>13.20</td></tr><tr><td></td><td>4D</td><td>24/2</td><td>14.00 - 16.00</td><td>6/5/5/5</td><td>10</td><td>13</td><td>17</td><td></td><td></td><td>4D (14.0-16.0 ft bgs) Splinters of wood in spoon.</td></tr><tr><td>15</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td rowspan="10">G#266755 A-1-b, SM WC=8.9%</td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>31</td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>35</td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>45</td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>56</td><td></td><td></td><td></td></tr><tr><td></td><td>5D</td><td>24/15</td><td>19.00 - 21.00</td><td>8/9/11/11</td><td>20</td><td>25</td><td>6</td><td></td><td></td><td>Grey, wet, medium dense, gravelly, fine to coarse SAND, little silt.</td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>33</td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>57</td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>56</td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>27</td><td></td><td></td><td></td></tr><tr><td>25</td><td>6D</td><td>24/13</td><td>24.00 - 26.00</td><td>11/8/7/8</td><td>15</td><td>19</td><td>47</td><td></td><td></td><td>Similar to above.</td></tr></table>												Depth (ft.)	Sample Information								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	Elevation (ft.)	0							SSA	587.08		5" PAVEMENT.	G#261924 A-1-b, SM WC=8.7%											0.42		1D	24/20	2.00 - 4.00	51/57/31/25	88	111				Brown, dry, gravelly, fine to coarse SAND, little silt, (Fill).											Frost to a depth of 3.5 ft bgs.	5										Similar to above, except moist, medium dense, (Fill).		2D	24/19	5.00 - 7.00	8/6/6/6	12	15																																																	10											#261925 Ignition Loss Loss=42.6% H2O=199.4%		3D/A	24/16	10.00 - 12.00	3/1/1/2	2	3	13	577.00		3D (10.0-10.5 ft bgs) Grey, wet, very loose, silty, fine to coarse SAND, some gravel, (Fill).								6			10.50								31			3D/A (10.5-12.0 ft bgs) Dark brown to black , moist, very loose, organic SILT, with wood fragments, (PEAT).								80			12.80											574.70											574.30											WOOD layer from 12.8-13.2 ft bgs.											13.20		4D	24/2	14.00 - 16.00	6/5/5/5	10	13	17			4D (14.0-16.0 ft bgs) Splinters of wood in spoon.	15											G#266755 A-1-b, SM WC=8.9%								31											35											45											56					5D	24/15	19.00 - 21.00	8/9/11/11	20	25	6			Grey, wet, medium dense, gravelly, fine to coarse SAND, little silt.								33											57											56											27				25	6D	24/13	24.00 - 26.00	11/8/7/8	15	19	47			Similar to above.
Depth (ft.)	Sample Information								Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.																																																																																																																																																																																																																																																																																																																																																																												
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	3D/A	24/16	10.00 - 12.00	3/1/1/2	2	3	13	577.00		3D (10.0-10.5 ft bgs) Grey, wet, very loose, silty, fine to coarse SAND, some gravel, (Fill).																																																																																																																																																																																																																																																																																																																																																																													
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							31			3D/A (10.5-12.0 ft bgs) Dark brown to black , moist, very loose, organic SILT, with wood fragments, (PEAT).																																																																																																																																																																																																																																																																																																																																																																													
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	4D	24/2	14.00 - 16.00	6/5/5/5	10	13	17			4D (14.0-16.0 ft bgs) Splinters of wood in spoon.																																																																																																																																																																																																																																																																																																																																																																													
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	5D	24/15	19.00 - 21.00	8/9/11/11	20	25	6			Grey, wet, medium dense, gravelly, fine to coarse SAND, little silt.																																																																																																																																																																																																																																																																																																																																																																													
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Maine Department of Transportation <u>Soil/Rock Exploration Log</u> US CUSTOMARY UNITS				Project: McLean Brook Bridge #3960 carries Route 162 over McLean Brook Location: T17 R4 Wels, Sinclair, Maine				Boring No.: BB-MBB-101 WIN: 19317.00																																																																																																																																																																																																																																																																								
Driller: MaineDOT				Elevation (ft.): 587.5				Auger ID/OD: 5" Solis Stem																																																																																																																																																																																																																																																																								
Operator: Enos/Giles				Datum: NAVD88				Sampler: Standard Split Spoon																																																																																																																																																																																																																																																																								
Logged By: B. Wilder				Rig Type: CME 45C				Hammer Wt./Fall: 140#/30"																																																																																																																																																																																																																																																																								
Date Start/Finish: 1/29/2013; 08:30-13:00				Drilling Method: Cased Wash Boring				Core Barrel: N/A																																																																																																																																																																																																																																																																								
Boring Location: 7+18.5, 10.1 ft Lt.				Casing ID/OD: NW				Water Level*: None Observed																																																																																																																																																																																																																																																																								
Hammer Efficiency Factor: 0.756				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 N₆₀ = SPT N-uncorrected corrected for hammer efficiency N₆₀ = (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																																																																																																																																																																																																																																																																																
<table><thead><tr><th rowspan="2">Depth (ft.)</th><th colspan="8">Sample Information</th><th rowspan="2">Elevation (ft.)</th><th rowspan="2">Graphic Log</th><th rowspan="2">Visual Description and Remarks</th><th rowspan="2">Laboratory Testing Results/ AASHTO and Unified Class</th></tr><tr><th>Sample No.</th><th>Pen./Rec. (in.)</th><th>Sample Depth (ft.)</th><th>Blows (6 in.) Shear Strength (psf) or RQD (%)</th><th>N-uncorrected</th><th>N₆₀</th><th>Casing</th><th>Blows</th></tr></thead><tbody><tr><td>25</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>34</td><td rowspan="4">560.50</td><td rowspan="4"></td><td rowspan="4">Grey, moist, hard, SILT, some fine to coarse SAND, some gravel, blocky.</td><td rowspan="4">G#266756 A-4, SM WC=8.7%</td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>58</td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>74</td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>OPEN HOLE</td></tr><tr><td>30</td><td>7D</td><td>24/17</td><td>30.00 - 32.00</td><td>30/34/50/48</td><td>84</td><td>106</td><td></td><td></td><td rowspan="4">550.50</td><td rowspan="4"></td><td rowspan="4">Similar to above.</td><td rowspan="4">Bottom of Exploration at 37.00 feet below ground surface. NO REFUSAL</td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>35</td><td>8D</td><td>24/16</td><td>35.00 - 37.00</td><td>10/27/38/37</td><td>65</td><td>82</td><td></td><td></td><td rowspan="4">550.50</td><td rowspan="4"></td><td rowspan="4"></td><td rowspan="4"></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>40</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td rowspan="4">550.50</td><td rowspan="4"></td><td rowspan="4"></td><td rowspan="4"></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>45</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td rowspan="4">550.50</td><td rowspan="4"></td><td rowspan="4"></td><td rowspan="4"></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>50</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td rowspan="4">550.50</td><td rowspan="4"></td><td rowspan="4"></td><td rowspan="4"></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr></tbody></table>												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	25								34	560.50		Grey, moist, hard, SILT, some fine to coarse SAND, some gravel, blocky.	G#266756 A-4, SM WC=8.7%									58									74									OPEN HOLE	30	7D	24/17	30.00 - 32.00	30/34/50/48	84	106			550.50		Similar to above.	Bottom of Exploration at 37.00 feet below ground surface. NO REFUSAL																												35	8D	24/16	35.00 - 37.00	10/27/38/37	65	82			550.50																															40									550.50																															45									550.50																															50									550.50																														
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Appendix B

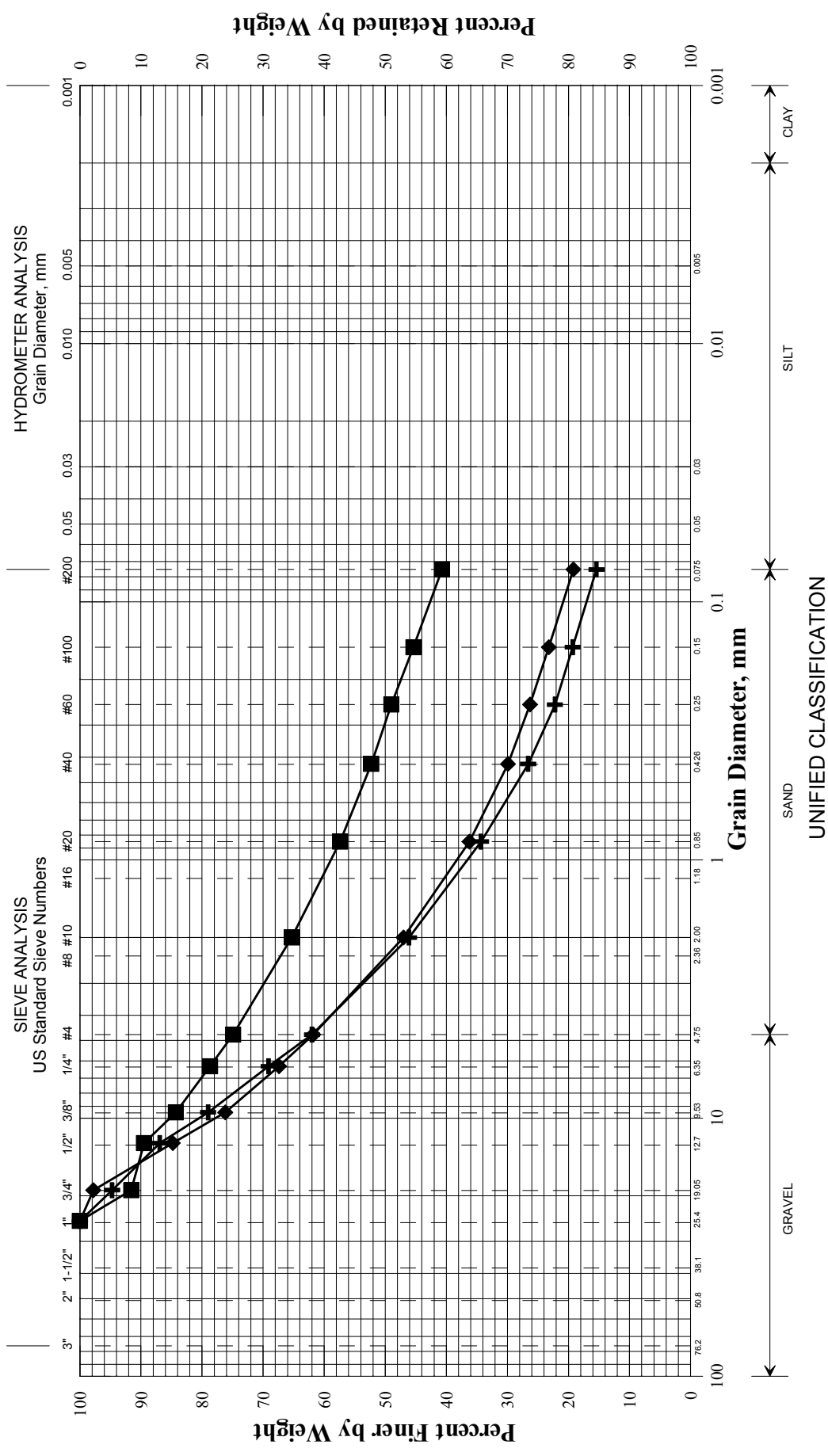
Laboratory Test Results

Town(s): T17 R4 (Sinclair) Work Number: 19317.00

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.

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-MBB-10/1/2D	7+18.5	10.1 LT	5.0-7.0	Gravelly SAND, little silt.	8.7			
◆	BB-MBB-10/1/5D	7+18.5	10.1 LT	19.0-21.0	Gravelly SAND, little silt.	8.9			
■	BB-MBB-10/1/7D	7+18.5	10.1 LT	30.0-32.0	SILT, some sand, some gravel.	8.7			
●									
▲									
×									

WIN	
019317.00	
Town	
T-17 R4 WELS	
Reported by/Date	
WHITE, TERRY A	2/13/2013



GEOTECHNICAL TEST REPORT

Central Laboratory

SAMPLE INFORMATION

Reference No. **261925** Boring No./Sample No. **BB-MBB-101/3DA** Sample Description **GEOTECHNICAL (DISTURBED)** Sampled **1/29/2013** Received **2/5/2013**

Sample Type: **GEOTECHNICAL** Location: **ROADWAY** Station: **7+13.5** Offset, ft: **10.1** LT Dbfg, ft: **10.0-12.0**

WIN/Town **019317.00 - T17 R4 WELS** Sampler: **WILDER, BRUCE H**

TEST RESULTS

Sieve Analysis (T 27)

Wash Method

SIEVE SIZE U.S. [SI]	% Passing
3 in. [75.0 mm]	
1 in. [25.0 mm]	
¾ in. [19.0 mm]	
½ in. [12.5 mm]	
⅜ in. [9.5 mm]	
¼ in. [6.3 mm]	
No. 4 [4.75 mm]	
No. 10 [2.00 mm]	
No. 20 [0.850 mm]	
No. 40 [0.425 mm]	
No. 60 [0.250 mm]	
No. 100 [0.150 mm]	
No. 200 [0.075 mm]	

Direct Shear (T 236)

Shear Angle, °			
Initial Water Content, %			
Normal Stress, psi			
Wet Density, lbs/ft³			
Dry Density, lbs/ft³			
Specimen Thickness, in			

Consolidation (T 216)

Trimmings, Water Content, %

	Initial	Final		Void Ratio	% Strain
Water Content, %			Pmin		
Dry Density, lbs/ft³			Pp		
Void Ratio			Pmax		
Saturation, %			Cc/C'c		

Miscellaneous Tests

Liquid Limit @ 25 blows
(T 89), %

Plastic Limit (T 90), %

Plasticity Index (T 90), %

Specific Gravity, Corrected to
20°C (T 100)

Loss on Ignition (T 267)

Loss, % H₂O, %**42.6** **199.4**

Water Content (T 265), %

Vane Shear Test on Shelby Tubes (Maine DOT)

Depth taken in tube, ft	3 In.		6 In.		Water Content, %	Description of Material Sampled at the Various Tube Depths
	U. Shear	Remold	U. Shear	Remold		
	tons/ft²	tons/ft²	tons/ft²	tons/ft²		

Comments:

AUTHORIZATION AND DISTRIBUTION

Reported by: **FOGG, BRIAN**Date Reported: **2/7/2013**

Paper Copy: Lab File; Project File; Geotech File

Appendix C

Calculations

Analysis : Bearing Resistance of Box Culvert on medium dense, glacial till soils**Assumptions**

- Box bottom is embedded 2 feet below the streambed
- Assumed parameters for undrained medium dense, medium sand (glacial till)
 Tested soil samples are SM, A-1-b
 Saturated unit weight = 120 pcf (Bowles Table 3-4; for medium dense, medium sand. Holtz, Kovacs, Table 2-1 1981)
 Dry unit weight = 117 pcf
 $\phi = 33 - 44$ degrees, dense saturated sand, undrained (ref: Bowles, 5th Edition, Table 2-6).
 $= 43 - 50$ degrees, dense sand consolidated & drained (ref: Bowles, 5th Edition, Table 2-6).
 $= 31$ degrees, for $N=13$ bpf, based on SPT N_{60} values = 13, 25 and 19 (ref: Peck, Hanson Thornburn, 1983).
Use $\phi = 32$ degrees for this Design
 S_u = undrained shear strength, $c = 0$ psf
- Method used: Terzaghi, use strip equations since $L > B$

Foundation Widths and Depth

$$B := \begin{pmatrix} 19 \\ 20 \\ 21 \\ 22 \end{pmatrix} \cdot \text{ft}$$

$$D_f := 2.0 \cdot \text{ft}$$

$$D_w := 0 \cdot \text{ft}$$

$$\gamma_w := 62.4 \cdot \text{pcf}$$

Foundation soils:

Samples of the upper glacial till deposits are SM

$$\gamma_{1\text{sat}} := 120 \cdot \text{pcf}$$

$$\gamma_{1d} := 117 \cdot \text{pcf}$$

$$\phi := 32 \cdot \text{deg}$$

$$c := 0 \cdot \text{psf}$$

Nominal Bearing Resistance - For Service Limit State

Method: LRFD Table C10.6.2.6.1-1, Presumptive Bearing Resistance for Spread Footings at the Service Limit State, based on *NavFac DM 7.2, May 1983, Foundations and Earth Structures*, Table 1, 7.2-142, "Presumptive Values of Allowable Bearing Pressures for Spread Foundations".

Samples of the medium dense, glacial till are SM

<u>Bearing Material:</u>	<u>Consistency in Place:</u>	<u>Bearing Pressure Resistance Range (ksf)</u>	<u>Recommended Value (ksf)</u>
Fine to medium sand, silty or clayey med. to coarse sand (SW, SM, SC)	medium dense to dense	4-8 ksf	5 ksf

Recommend 5 ksf to limit settlement to 1.0 inch for Bearing Resistance for the Service Limit State. Applied pressures from the service limit state shall not exceed this value.

Nominal Bearing Resistance for Strength Limit States: Terzaghi Method - ϕ and c soil.

Shape Factors for strip footing (Bowles 5th Ed., pg 220)

$$s_{\gamma} := 1.0$$

$$s_c := 1.0$$

Meyerhof Bearing Capacity Factors - (Ref: Bowles Table 4-4, 5th Ed. pg 223) for $\phi = 32$ degrees

$$N_c := 35.47$$

$$N_q := 23.2$$

$$N_{\gamma} := 22$$

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

$$q := D_f \cdot (\gamma_{1\text{sat}} - \gamma_w) \quad q = 0.115 \cdot \text{ksf}$$

$$q_n := c \cdot N_c \cdot s_c + q \cdot N_q + 0.5 \cdot (\gamma_{1\text{sat}} - \gamma_w) \cdot B \cdot N_{\gamma} \cdot s_{\gamma}$$

$$q_n = \begin{pmatrix} 14.7 \\ 15.3 \\ 16 \\ 16.6 \end{pmatrix} \cdot \text{ksf}$$

Factored Bearing Resistance for strength limit state

Use a resistance factor per AASHTO LRFD Table 10.5.5.2.2-1

$$\varphi_b := 0.45$$

$$Q_r := Q_n \cdot \varphi_b$$

$$Q_r = \begin{pmatrix} 6.6 \\ 6.9 \\ 7.2 \\ 7.5 \end{pmatrix} \cdot \text{ksf}$$

for

$$B = \begin{pmatrix} 19 \\ 20 \\ 21 \\ 22 \end{pmatrix} \cdot \text{ft}$$

Recommendation: Use a factored bearing resistance of 7.5 ksf for strength limit state design for a 22-foot wide precast box culvert with a 20-foot hydraulic opening. The applied, factored bearing pressures determined by the designer-supplier for the strength limit state shall not exceed this value.

Factored Bearing Resistance for extreme limit state

Use a resistance factor per AASHTO LRFD Table 10.5.5.2.2-1

$$\varphi_b := 1.0$$

$$Q_r := Q_n \cdot \varphi_b$$

$$Q_r = \begin{pmatrix} 14.7 \\ 15.3 \\ 16 \\ 16.6 \end{pmatrix} \cdot \text{ksf}$$

for

$$B = \begin{pmatrix} 19 \\ 20 \\ 21 \\ 22 \end{pmatrix} \cdot \text{ft}$$

Recommendation: Use a factored bearing resistance of 16 ksf for extreme limit state design for a 22-foot wide precast box culvert with a 20-foot hydraulic opening, if EE analysis is required. The applied, factored bearing pressures determined by the designer-supplier for the EE limit state shall not exceed this value.

Method 1 - MaineDOT Design Freezing Index (DFI) Map and Depth of Frost Penetration Table, BDG Section 5.2.1.

From Design Freezing Index Map: **TWP17 R04, Maine**

DFI >2600 degree-days. Use DFI=2600 degree-days (maximum in BDG Table 5-1)

Case 1 - coarse grained soils W=10%

Depth of Frost Penetration = 109 inch

$$d := 109 \cdot \text{in} \quad d = 109 \cdot \text{in} \quad d = 9.083 \cdot \text{ft}$$

Method 2 - ModBerg Software

Examine potential precast box slab foundation placed on coarse-grained glacial till deposit at Caribou (CRREL weather database station closest to TWP17 R4) with a DFI per the CRREL weather database of 2462 F-days

--- ModBerg Results ---

Project Location: Caribou WSO Airport, Maine

Air Design Freezing Index = 2462 F-days
N-Factor = 0.80
Surface Design Freezing Index = 1970 F-days
Mean Annual Temperature = 39.2 deg F
Design Length of Freezing Season = 156 days

Layer #	Type	t	w%	d	Cf	Cu	Kf	Ku	L
1	Coarse	98.3	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 = 8.19 ft = 98.3 in.

Recommendation: 8.2 feet for design of foundations constructed on coarse grained w=10% soil deposits

Appendix D

Special Provisions

SPECIAL PROVISION
SECTION 203
Crushed Stone

Amend Section 203.01 Description to include:

This work shall consist of constructing a reinforced soil foundation of crushed stone in accordance with these specifications, Special Provision Section 620 Geosynthetic Reinforcement and in reasonably close conformity with the width, grade and thickness shown on the plans or established by the Resident.

Amend Section 203.02 Materials to include:

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:

<u>Particle size</u>	<u>Percent by Weight Passing</u>
1 inch	100
¾ inch	90 - 100
½ inch	20 - 55
3/8 inch	0 - 15
No. 4	0 - 5

The following Subsection is added:

203.13 Construction Requirements. The crushed stone shall be placed and graded as shown on the plans and in accordance with Special Provision 620 – Geosynthetic Reinforcement, or directed by the Resident. The crushed stone shall be compacted as required to ensure all voids in the stone are filled, as approved by the Resident.

Amend 203.18 Method of Measurement to include:

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

Amend 203.19 Basis of Payment to include:

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:

<u>Item No.</u>	<u>Pay Item</u>	<u>Pay Unit</u>
203.35	Crushed Stone	Cubic Yard

SPECIAL PROVISION 534
PRECAST STRUCTURAL CONCRETE
(Precast Structural Concrete Arches, Box Culverts, Frames)

The following replaces Section 534 in the Standard Specifications in its entirety:

534.01 Description The Contractor shall design, manufacture, furnish, and install elements, precast structural concrete structures, arches, box culverts or three sided frames and associated wingwalls, headwalls, toe walls/cut off walls and appurtenances, in accordance with the Contract Documents.

534.02 Materials Structural precast elements for the arch, box culvert, or frame and associated precast elements shall meet the requirements of the following Subsection except as noted otherwise in this specification:

Structural Precast Concrete Units

712.061

New concrete mix designs and mix designs not previously approved by the Fabrication Engineer, including Self-Consolidating Concrete (SCC) mixes, shall be qualified by trial batches prepared in accordance with AASHTO T 126 (ASTM C 192). The test results shall demonstrate that the concrete meets the requirements of the Plans and this Specification. If accelerated curing is to be used in production, the test specimens shall be similarly cured.

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

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, or as shown on the Plans.

534.03 Drawings Prepare shop detail, erection and other necessary Working Drawings in accordance with Section 100 of the Standard Specifications. The Department will review and approve the drawings in accordance with the applicable requirements of Section 100 of the Standard Specifications. Changes and revisions to the approved Working Drawings shall require further approval by the Fabrication Engineer.

Concrete mix designs shall be part of the Working Drawing submittal. Include aggregate specific gravity, absorption, percent fracture, fineness modulus and gradation as part of the mix design. Provide the mix design calculations demonstrating how the batch weights, water-cement ratio and admixture dosage rate were determined.

534.04 Design Requirements The Contractor shall design the precast structural concrete structure in accordance with the AASHTO LRFD Bridge Design Specifications, latest edition. The HL-93 live load specified in the AASHTO LRFD Bridge Design Specifications shall be used for all limit states except for Strength I. The live load used for the Strength I

limit state shall be the Maine Modified live load which consists of the standard HL-93 Live Load with a 25% increase in the Design Truck. (Wheel loads based on the Design Truck shall be increased 25%). In addition, if the governing load rating factor based on the HL-93 live load is equal to or less than 1.10 a load rating based on the Maine legal truck (Configuration #6) shall also be checked to insure the rating factor is equal to or greater than 1.0.

The live load deflection check per AASHTO LRFD Bridge Design Specifications Section 2.5.2.6.2 for the top slab of box culverts and frames with clear spans 15 feet or greater and cover depths of 4 feet or less is mandatory. The live load deflection check shall be documented in the design computations submittal.

Design calculations that consist of computer program generated output shall be supplemented with at least one hand calculation and graphic demonstrating the design methodology used. The hand calculation shall document at a minimum the Strength I load case flexural design check of the top slab positive moment reinforcing steel. Design calculations shall provide thorough documentation of the sources of equations used and material properties.

The design shall be load rated in accordance with the AASHTO Manual for Bridge Evaluation, latest edition by the LRFR method and in accordance with the MaineDOT Load Rating Guide.

The Contractor shall submit design calculations, load rating if applicable and working/shop drawings for the precast structure to the Department for approval. A Licensed Professional Engineer, licensed in accordance with State of Maine laws, shall sign and seal all design calculations and drawings. Drawings shall conform with Section 105.7 - Working Drawings.

The Contractor shall submit the following items for review by the Resident at least forty five (45) working days prior to production:

- A) The name and location of the manufacturer.
- B) Method of manufacture and material certificates.
- C) Description of method of handling, storing, transporting, and erecting the members.
- D) Design computations (bound and indexed)
- E) Load rating computations and completed load rating form (bound and indexed)
- F) Shop Drawings with the following minimum details:
 - 1) Fully dimensioned views showing the geometry of the members, including all projections, recesses, notches, openings, block outs, and keyways.
 - 2) Details and bending schedules of reinforcing steel including the size, spacing, and location. Reinforcing provided under lifting devices shall be shown in detail.
 - 3) Details and locations of all items to be embedded.
 - 4) Total weight of each member.

534.05 Facilities for Inspection Provide a private office at the fabrication plant for the Department's inspection personnel, or Quality Assurance Inspectors (QAI's). The office shall be in close proximity to the Work. The office shall be climate controlled to maintain the temperature between 68° F and 75° F and have the exit(s) closed by a door(s) equipped with a lock and 2 keys which shall be furnished to the QAI's.

The QAI's office shall meet the following minimum requirements:

<u>Description</u>	<u>Quantity</u>
QAI's office (minimum ft ²)	100
Drafting Table Surface (ft ²)	35
Drafting stools-each	1
Office Desk	1
Ergonomic Swivel Chairs	1
Folding Chairs	2
Cordless telephone	1
Answering machine	1
High-speed internet connection (ports)	1
Fluorescent Lighting of 100 ft-candles minimum for all work areas	2
110 Volt 60 Cycle Electric Wall Outlets	3
Wall Closet	1
Plan Rack	1
Waste Basket with trash bags	1
Two-drawer file cabinet (locking)	1
Broom	1
Dustpan	1
Cleaning Materials	1
Water Cooler	1

The Contractor will be responsible for disposing of trash and supplying commercially bottled water for the water cooler.

The QAI will have the option to reject any furniture or supplies provided to the QAI's office, based on general poor condition.

Provide parking space for the QAI(s) in close proximity to the entrance to the QAI's office. Maintain the pathway between the parking area and the QAI's office so that it is free of obstacles, debris, snow and ice.

The facilities and all furnishings shall remain the property of the Contractor upon completion of the Work. Payment for the facilities, heating, lighting, telephone installation, internet connection, basic monthly telephone and internet charges and all furnishings shall be incidental to the Contract.

Failure to comply with the above requirements will be considered denial of access to the Work for the purpose of inspection. The Department will reject all Work done when access for inspection is denied.

534.06 Notice of Beginning Work Give the Department a minimum of two weeks notice for in-state work and three weeks notice for out-of-state work prior to beginning production. If the production schedule changes, notify the Fabrication Engineer no less than three (3) working days prior to the initial start-up date. Any Work done without the QAI present will be rejected. Advise the Fabrication Engineer of the production schedule and any changes to it. If Work is suspended on a project, the Fabrication Engineer will require 72 hours notice prior to the resumption of Work.

534.07 Quality Control Quality Control (QC) is the responsibility of the Contractor.

Provide a copy of the Quality System Manual (QSM) to the Fabrication Engineer if requested.

Inspect all aspects of the Work in accordance with the Contractor's QSM. Reject materials and workmanship that do not meet Contract requirements.

Record measurements and test results on the appropriate forms from APPENDIX E of Precast/Prestressed Concrete Institute Manual for Quality Control for Plants and Production of Structural Precast Concrete Products MNL 116 or an equivalent form prepared by the user. Provide copies of measurements and test results to the QAI as follows:

Type of Report	When Provided to QAI*
Aggregate gradations-fine aggregate and coarse aggregate	Prior to beginning work and at least once a week thereafter
Material certifications / stressing calculations / calibration certifications	Prior to beginning work (anticipate adequate time for review by QAI)
Pre-pour inspection report	Prior to the concrete placement
Concrete Batch Slips	The morning of the next work day
Results of concrete testing	The morning of the next work day
Concrete temperature records	Provide with compressive testing (for release)
Non-conformance reports/repair procedures	Within 24 hours of discovery
Results of compressive testing (for design strength)	Prior to stopping curing / Prior to final acceptance
Post-pour inspection report	Prior to final acceptance

* The Contractor and QAI may, by mutual agreement, modify any part of the schedule; however, failure to provide the documentation when required by the Fabrication Engineer will result in the product being deemed unacceptable. The Contractor may perform testing in addition to the minimum required. The results of all testing shall be made available to the Department.

534.08 Quality Assurance Quality Assurance (QA) is the prerogative of the Department.

The QAI will witness or review documentation, workmanship, testing and assure the Work is being performed in accordance with the QSM.

The QAI has the authority to reject materials and products that do not meet the Contract requirements including Work rejected due to denial of access or the lack of adequate notice of the beginning of production. The acceptance of material or workmanship by the QAI will not prevent subsequent rejection, if the Work is unacceptable.

534.09 Rejections Correct or replace rejected material and/or workmanship. Generate a non-conformance report (NCR); provide a copy to the QAI and forward a copy to the Fabrication Engineer for determination of corrective action.

In the event that an item fabricated under this Specification does not meet the Contract requirements but is deemed suitable for use by the Department, said item may be accepted in accordance with Section 100 of the Standard Specifications (see 106.8).

534.10 Forms and Casting Beds Construct forms to conform to the Working Drawings. The forms shall be well constructed, carefully aligned and sufficiently tight to prevent leakage of mortar. Reject forms that do not maintain the Plan dimensions. Inspect the bulkheads after each cast and repair or replace worn or damaged pieces.

Seal wooden forms to prevent absorption of water. Apply and cure the sealer in accordance with the manufacturer's product data sheet.

Remove all paint, adherent material, foreign matter and debris prior to placing concrete.

Apply a non-staining bond-breaking compound to the forms in accordance with the manufacturer's product data sheet. Solvent clean reinforcing steel and welded steel wire fabric contaminated with the bond-breaking compound.

534.11 Reinforcing Steel Fabricate, package, handle, store, place, splice and repair reinforcing steel in accordance with Section 503 of the Standard Specifications.

Accurately locate and securely anchor the reinforcing steel to prevent displacement during concrete placement. Install and secure all reinforcing steel prior to beginning the concrete placement.

The concrete cover shown on the approved Working Drawings shall be the minimum allowable cover. Use sufficient bar supports and spacers to maintain the minimum concrete cover. The bar supports and spacers shall be made of a dielectric material or other material approved by the Fabrication Engineer.

If reinforcing steel is not noted on the plans or drawings, the minimum amount of steel required shall be the area of steel equal to a grid of No. 4 bars at 18 inches in both directions, horizontally and vertically. Only one mat of steel is required for concrete thickness of 7 inches or less; two mats, one each face is required for thickness greater than 7 inches.

534.12 Voids and Inserts Voids shall be non-absorbent. The out-to-out dimensions of the voids shall be within 2% of Plan dimensions. Repair damaged voids in a manner acceptable to the Fabrication Engineer. Store, handle and place voids in a manner that prevents damage.

Accurately locate and securely anchor, securely cap and vent the voids in the form. Any portion of a void that is displaced beyond the allowable dimensional tolerances shall be cause for rejection of the slab or beam.

Open the void drains immediately upon removing the product from the form.

Recess inserts, ties or other steel items a minimum of 1 inch from the surface unless noted otherwise on the Plans. Any recess shall be filled with a product from the Department's Qualified Products List. The QAI is not responsible for verifying the location of inserts or other hardware installed for the convenience of the Contractor.

534.13 Concrete Placement Do not batch or place concrete until all the form(s) for any continuous placement have been inspected and accepted by the QCI and the QAI concurs.

Test concrete in accordance with the following Standards:

- AASHTO T23 (ASTM C 31) Practice for Making and Curing Concrete Test Specimens in Field
- AASHTO T 22 (ASTM C 39) Test Method for Compressive Strength of Cylindrical Concrete Specimens
- AASHTO T119 (ASTM C 143) Test Method for Slump of Hydraulic Cement Concrete
- AASHTO T141 (ASTM C 172) Practice for Sampling Freshly Mixed Concrete
- AASHTO T152 (ASTM C 231) Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
- ASTM C 1064-Test Method for Temperature of Freshly mixed Portland Cement Concrete
- ASTM C 1611/C 1611M-05-Standard Test Method for Slump Flow of Self-Consolidating Concrete

Test the first two loads of concrete for temperature, air entrainment and slump, or spread for SCC. If the first load is unacceptable, test the second load as the first. Continue this process until two consecutive loads are acceptable. After two consecutive cylinders are acceptable, the frequency of testing shall be at the discretion of the QAI.

Test the concrete for temperature, air entrainment and slump, or spread for SCC, if there is a change in the dosage rate of any admixture, a change of three inches or more in slump or a change of more than 5° F in mix temperature.

Test every load of 1 cubic yard, or less, from a stationary mixer or 2 cubic yards, or less, from a transit mixer for temperature, air entrainment and slump, or spread for SCC, prior to placing the concrete in the forms.

Perform all testing in the presence of the QAI. The QAI will designate the loads to be tested. Make cylinders used to determine stripping strength during the last 1/3 of the placement.

Place the concrete as nearly as possible to its final location. Control the depth of each lift in order to minimize entrapped air voids. The maximum depth of an unconsolidated lift shall be 18 inches. Vibrate the concrete with internal or internal and external vibrators. Do not use external vibrators alone. Insert internal vibrators vertically and penetrate the lower layer of concrete by at least 4 inches. Insert the vibrators in the concrete to assure that the radii of action of the vibrators overlap. Hold the vibrators in position from 5 to 15 seconds. Do not use vibrators to move concrete horizontally. Each lift of concrete shall have sufficient plasticity to be consolidated with subsequent lifts.

Do not re-temper the concrete with water after discharging has begun. The Contractor may add HRWR to the concrete after batching if that practice conforms to the manufacturer's product data sheet. Discard concrete that becomes unworkable.

Do not use water or water-based products to aid in finishing fresh concrete.

After the concrete has been placed and finished and before the forms are covered, remove all concrete from projecting reinforcing steel

534.14 Process Control Test Cylinders Make concrete test cylinders for each day's casting. Cylinders tested to determine stripping strength and early design strength shall be field cured in accordance with AASHTO T23 (ASTM C 31). 28 day cylinders shall be standard cured. Record unit identification, entrained air content, water-cement ratio, slump and temperature of the sampled concrete at the time of cylinder casting. Once a week, make four cylinders for use by the Department. They shall be standard cured in accordance with AASHTO T23 (ASTM C 31).

If the Contractor fails to make enough cylinders to demonstrate that the product meets the Contract requirements, the product will be considered unacceptable.

The compressive strength of the concrete will be determined by averaging the compressive strength of two test cylinders made from the same sample. For the purpose of determining design strength, the average of two cylinders shall meet or exceed the design strength, and, neither cylinder shall have a compressive strength less than 90% of design strength.

Perform compressive testing to determine transfer and design strength in the presence of the QAI. Cylinder tests not witnessed by the QAI will not be acceptable.

534.15 Manufacture of Precast Units The cover of concrete over the outside circumferential reinforcement shall be 2 inches minimum. The concrete cover over the inside reinforcement shall be 1 ½ inches minimum. The clear distance of the end of circumferential wires shall not be less than 1 inch or more than 2 inches from the end of the sections. Reinforcement shall be single or multiple layers of welded wire fabric or a single layer of deformed billet steel bars.

Welded steel wire fabric shall meet the space requirements and contain sufficient longitudinal wires extending through the section to maintain the shape and position of the reinforcement. Longitudinal distribution reinforcement may be welded steel wire fabric or deformed steel bars which meet the spacing requirements. The ends of the longitudinal distribution reinforcement shall be not more than 3 inches from the ends of the sections.

Do not use more than three layers of reinforcing to form a single mat. If reinforcing steel is cut to install lifting devices install additional reinforcing adjacent to the cut steel.

Tension splices in the reinforcement will not be permitted. For splices other than tension splices, the overlap shall be a minimum of 12 inches for welded steel wire fabric or deformed steel bars. The spacing center to center of the circumferential wires in a wire fabric sheet shall be not less than 2 inches or more than 4 inches. For the wire fabric, the spacing center to center of the longitudinal wires shall not be more than 8 inches. The spacing center to center of the longitudinal distribution steel for either line of reinforcing in the top slab shall not be more than 15 inches.

The members shall be free of fractures. The ends of the members shall be normal to the walls and centerline of the section, within the limits of variation provided, except where beveled ends are specified. The surfaces of the members shall be a smooth steel form or troweled surface finish, unless a form liner is specified. The ends and interior of the assembled structure shall make a continuous line of members with a smooth interior surface.

Defects which may cause rejection of precast units include the following:

- 1) Any discontinuity (crack or rock pocket etc.) of the concrete which could allow moisture to reach the reinforcing steel.
- 2) Rock pockets or honeycomb over 6 square inches in area or over 1 inch deep.
- 3) Edge or corner breakage exceeding 12 inches in length or 1 inch in depth.
- 4) Extensive fine hair cracks or checks.
- 5) Any other defect that clearly and substantially impacts the quality, durability, or maintainability of the structure as measured by accepted industry standards.

The manufacturer of the members shall sequentially number and shop fit each adjacent member to ensure that they fit together in the field. This fit up shall be witnessed by the QA

inspector. Any non-fitting members shall be corrected or replaced at no cost to the Department.

Documentation The producer of the structural precast units shall keep accurate records of aggregate gradations, concrete batching, testing, curing, and inspection activities to verify that forms, reinforcing and unit dimensions conform to these requirements. Copies of reports shall be furnished to the Resident when requested.

534.16 Tolerances Dimensional tolerances shall be in conformance with the applicable reference specification or the established industry standards for the product being produced. The internal dimensions shall not vary by more than 1 percent from the design dimensions or 1 ½ inches, whichever is less with the exception of the cross diagonal dimension which shall not vary by more than ½ inch from the design dimension. The haunch dimensions shall not vary by more than ¾ inch from the design dimension. The dimension of the legs shall not vary by more than ¼ inch from the dimension shown on the approved shop drawings.

The slab and wall thickness shall not be less than the design thickness by more than ¼ inch. A thickness greater than the design thickness shall not be cause for rejection.

Variations in laying lengths of two opposite surfaces shall not be more than ⅝ inch in any section, except where beveled ends for laying of curves are specified.

The under-run in length of any section shall not be more than ½ in.

534.17 Finishing Concrete Products shall meet ordinary finish requirements per subsection 502.14. Fascia members shall receive a rubbed finish per subsection 502.14. The Contractor may use alternative methods of achieving an acceptable finish on fascia members if approved by the Fabrication Engineer.

Marking The date of manufacture, the production lot number, and the type of unit shall be clearly and indelibly scribed on a rear, unexposed portion of each unit.

543.18 Repairing Defects Exposed surfaces shall be of uniform appearance; only minor repairs to remove and blend fins, patch minor spalls and to repair small, entrapped air pockets shall be permitted. Units that are cracked or require surface repairs larger than 2 in² or an accumulated repair area greater than 10% of the surface being repaired may be rejected.

Repair honeycombing, ragged or irregular edges and other cosmetic defects using a patching material from the MaineDOT Qualified Products List. The repair, including preparation of the repair area, mixing and application and curing of the patching material, shall be in accordance with the manufacturer's product data sheet. Corners not exposed in the final product may be ground smooth with no further repair necessary if the depth of the defect does not exceed ½ inch. Remove form ties and other hardware to a depth of not less than 1 inch from the face of the concrete and patch the holes using a patching material from the MaineDOT Qualified Products List.

Repair structural defects only with the approval of the Fabrication Engineer. Submit a non-conformance report (NCR) to the Fabrication Engineer with a proposed repair procedure. Do not perform structural repairs without an approved NCR. Structural defects include, but are not be limited to, exposed reinforcing steel or strand, cracks in bearing areas, through cracks and cracks 0.013 inch in width that extend more than 12 inches in length in any direction. Give the QAI adequate notice prior to beginning structural repairs.

534.19 Handling, Storage and Transportation Handle store and transport members in a manner as to eliminate the danger of chipping, cracks, fracture, and excessive bending stresses. Any units found damaged upon delivery, or damaged after delivery, shall be subject to rejection.

Do not place precast members in an upright position until a compressive strength of at least 4350 psi is attained. Precast products a may be handled and moved, but do not transport products until the 28 day design strength has been attained.

Support stored precast/prestressed products above the ground on dunnage in a manner to prevent twisting or distortion. Protect the products from discoloration and damage.

534.20 Installation of Precast Units Do not ship precast members until sufficient strength has been attained to withstand shipping, handling and erection stresses without cracking, deformation, or spalling. A minimum strength of 4350 psi shall be attained prior to shipping in all cases.

Set precast members on ½ 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 ½ inch deep around the perimeter of the damaged area and placing a polymer-modified cementitious patching material.

When footings are required, install the precast members on concrete footings that have reached a compressive strength of at least 2900 psi. Construct the completed footing surface to the lines and grades shown on the Plans. When checked with a 10 foot straightedge, the surface shall not vary more than ¼ inch in 10 feet. 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.

Fill holes 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. Completely fill the exterior face of joints between precast members with an approved material and cover with a minimum 12 inch wide joint wrap. The surface shall be free of dirt and deleterious

materials before applying the filler material and joint wrap. Install the external wrap in one continuous piece over each member joint, taking care to keep the joint wrap in place during backfilling. Seal the joints between the end unit and attached elements with a non-woven geotextile. Install and tighten the bolts fastening the connection plate(s) between the elements that are designed to be fastened together as designated by the manufacturer.

Place and compact the bedding material as shown on the plans prior to lifting and setting the culvert sections. Backfill the structure in accordance with the manufacturer's instructions and the Contract Documents. Uniformly distribute backfill material in layers of not more than 8 inches in depth, loose measure, and thoroughly compact each layer using approved compactors before successive layers are placed. 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 T-180, Method C or D. Place and compact the backfill without disturbance or displacement of the structure, 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.

Use hand-operated compactors within 5 feet of the precast structure as well as over the top until it is covered with at least 12 inches of backfill. The Contractor shall take adequate precautions to protect the top of the culvert from damage during backfilling and/or paving operations. Any damage to the top of the culvert shall be repaired or members replaced at no cost to the Department.

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

534.22 Basis of Payment The Department will pay for the accepted quantity of Precast Structural Concrete Arch (Including Frames) or Precast Concrete Box Culvert at the Contract Lump Sum price, such payment being full compensation for all labor, equipment, materials, professional services, and incidentals for furnishing and installing the precast concrete elements and accessories. Falsework, reinforcing steel, welded steel wire fabric, jointing tape, geotextile, 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. Cast-in-place concrete, reinforcing steel in cast-in-place elements, and membrane waterproofing will be measured and paid for separately under the provided Contract pay items. Pay adjustments for quality level will not be made for precast concrete.

Payment will be made under:

<u>Pay Item</u>		<u>Pay Unit</u>
534.70	Precast Structural Concrete Arch	Lump Sum
534.71	Precast Concrete Box Culvert	Lump Sum