MAINE DEPARTMENT OF TRANSPORTATION
BRIDGE PROGRAM
GEOTECHNICAL SECTION
AUGUSTA, MAINE

GEOTECHNICAL DESIGN REPORT

For the Widening of:

MIDDLE RANGE BRIDGE
OVER POND OUTLET
POLAND, MAINE

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Soils Report No. 2003-14

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GEOTECHNICAL DESIGN SUMMARY

The purpose of this design report is to make geotechnical recommendations for the widening of Middle Range Bridge over the pond outlet between Middle Range Pond and Lower Range Pond on US Route 26 in Poland, Maine. The proposed bridge project will consist of a superstructure replacement and widening of the bridge and abutments. The abutment widening will consist of cast-in-place concrete abutments founded on spread footings placed on the native soils.

The following design recommendations are discussed in detail in the attached report:

Abutment Reuse and Rehabilitation - The make-up of the existing abutments can be investigated using geophysical methods including Impulse Response (Sonic Mobility) Testing and/or a Ground Penetrating Radar (GPR) survey. If no investigation of the existing abutments is made then the Designer should take care not to increase the Live Load or Dead Load currently handled by the existing structure.

Due to the age of the block abutments, the mortar holding the blocks in place has deteriorated. Additionally, a few of the granite blocks have cracks and show signs of movement. Any block showing signs of movement should be reset. Grout should be injected between the blocks and into cracks to increase the surficial contact between the blocks. The grout should be injected in a two-phase process. The first phase should be conducted to repoint the face of the abutment structure and the second phase to grout the materials behind the abutment face. Weep holes shall be cleaned or drilled and sleeved with 100 mm diameter PVC Pipe.

Bearing Elevation - The 1931 plans indicate that the existing bearing elevation is approximately 90.0 m (295.27 ft). This elevation should be used for the proposed abutment extensions and will place the bottom of the footing appropriately within the native sand soils.

Bearing Capacity - An allowable bearing capacity of 191 kPa (4.0 ksf) shall not be exceeded.

Frost Protection - All foundations placed on native subgrade soils should be founded a minimum of 1.3 m (4.3 ft) below finished exterior grade for frost protection.

Settlement - Settlement at the site is anticipated to be less than 12.5 mm (½ in). Settlement is anticipated to occur during construction having no effect on the finished structure.

Scour - The following riverbed parameters are to be used in scour analysis: AASHTO Soil Type A-3, D_{50} = 0.28 mm. The bottom of footing should be placed below the total scour line. AASHTO specification requires footings for stream abutments to be founded at least 1.8 m (6 ft) below the streambed. A monolithic cap/seat designed as a simply supported beam can be utilized to distribute superstructure live load and dead load to the adjacent abutment sections in the event that loss of bearing contact has occurred or does occur.

1.0 INTRODUCTION

A subsurface investigation and geotechnical design for the widening of the Middle Range Bridge on US Route 26, in Poland, Androscoggin County, Maine 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 widening. This report presents the soils information obtained at the site, geotechnical design recommendations, and foundation recommendations.

The original bridge was constructed in 1921 using spilt granite block abutments that are still in place. The bridge was widened in 1931 with cast-in-place concrete abutment extensions on the downstream side of the bridge (toward Lower Range Pond). A historic weir is located on the upstream side of the roadway in Upper Range Pond.

The proposed widening of Middle Range Bridge will consist of reuse of the existing granite block and concrete abutments, which will be widened with cast-in-place concrete abutment extensions. It is understood that the vertical alignment of the existing bridge will be raised slightly in the replacement of the bridge. The horizontal alignment of the bridge will be shifted to the downstream side in order to avoid impact to the upstream historic weir structure.

2.0 GEOLOGIC SETTING

The Middle Range Bridge on US Route 26 in Poland, Maine spans the outlet of Middle Range Pond into Lower Range Pond. The bridge is located 2.6 kilometers (1.6 miles) north of the junction of US Routes 26 and 122 as shown on Sheet 1 - Location Map presented at the end of this Report.

According to the Surficial Geologic Map of Maine published by the Maine Geological Survey (1985) the surficial soils in the vicinity of the site consist of till soils to the south and ice-contact glaciofluvial deposits to the north. The till soils consist of a heterogeneous mixture of sand, silt, clay, and stones. These soils are generally deposited by glacial ice in a blanket deposit that conforms to the underlying bedrock topography. The ice-contact glaciofluvial deposits consist of sand, gravel and silt deposited by meltwater streams adjacent to stagnant glacial ice. The site is located in the vicinity of the inland marine limit of the late-glacial marine submergence as mapped by Thompson (1983).

According to the Bedrock Geologic Map of Maine (1985) the bedrock at the site is identified as carboniferous muscovite granite. This bedrock is commonly known as the Sebago Pluton.

3.0 SUBSURFACE INVESTIGATION

Subsurface conditions were explored by drilling five (5) test borings (BB-PMR-101 and BB-PMR-102A, B, C, and D) in the vicinity of the existing abutments on the downstream side of the existing bridge as show in Sheet 2 - Foundation Survey found at the end of this Report. The borings were drilled between October 21 and 22, 2002 using Northeast Diamond Drilling, Inc of Brunswick, Maine to drill boring BB-PMR-101 and the Maine Department of Transportation (MDOT) drill rig to drill boring BB-PMR-102A, B, C, and D. Details and sampling methods used, field data obtained, and soil and groundwater conditions encountered are presented in the boring logs provided in Appendix A - Boring Logs and graphically on Sheet 3 - Boring Details found end of this Report.

The borings were drilled using spun casing wash boring techniques. Soil samples were obtained at 1.5-meter (5-foot) intervals using Standard Penetration Test (STP) methods. The MDOT Geotechnical Team member selected the boring locations and drilling methods, designated type and depth of sampling techniques, identified field and laboratory testing requirements and logged the subsurface conditions encountered. The borings were located in the field by use of a tape after completion if the drilling program.

4.0 LABORATORY TESTING

Laboratory testing for samples obtained in the borings consisted of four (4) standard grain size analyses. The results of these laboratory tests are provided in Appendix B - Laboratory Data at the end of this Report. Moisture content information and other soil test results are included on the Boring Logs in Appendix A and on Sheet 3 - Boring Details found at the end of this Report.

5.0 SUBSURFACE CONDITIONS

The general soil stratigraphy encountered at the site is as follows:

- **fill** underlain by
- **native sand** underlain by
- **layered silt and sand** underlain by
- **grey sand** underlain by
- **brown sand**

The soil stratum was not fully penetrated in the borings due to hard drilling conditions. An interpretive subsurface profile depicting the site stratigraphy is show on Sheet 2 - Foundation Survey found at the end of this Report. The following paragraphs discuss the soils encountered in detail:

Fill. A layer of sand fill soils was encountered under the pavement. This layer was found to be dry to wet, brown, fine to coarse sand with trace to little gravel and silt with broken rock fragments. SPT N-values in the fill layer were all recorded at greater than 50 blows per foot (bpf). It is believed that the presence of the broken rock fragments within the layer influenced the N-values making them artificially higher and that the layer has a medium dense consistency. The series of borings drilled behind the south abutment (BB-PMR-102A, B, and C) encountered obstructions within the fill layer causing the borings to be terminated within the fill. Boring BB-PMR-102D was drilled through the bridge deck in order to bypass the fill obstructions and continue the boring. The thickness of the fill layer ranged from approximately 3.47 m (11.4 ft) in boring BB-PMR-101 to approximately 3.02 m (9.9 ft) in boring BB-PMR-102D. A layer of wood was encountered at the bottom of the fill in boring BB-PMR-102D.

Native sand. Underlying the fill sands, a layer of native sand was encountered. This layer was found to be wet, brown to grey, fine to coarse sand with trace fine gravel, silt and organics. SPT N-values in the native sand layer ranged from 16 to 40 bpf indicating that the soil is medium dense to dense in consistency. The thickness of the layer was approximately 2.13 m (7.0 ft) in borings BB-PMR-101 and BB-PMR-102D. One water content determination of a sample from this layer indicated that the soil has a water content of approximately 21%. A grain size analysis of a sample from this layer indicates that the soil is classified as an A-3 by the AASHTO Classification System and a SP-SM by the Unified Soil Classification System.

Layered Silt and Sand. Underlying the native sand, layers of interbedded silt and sand were encountered. The silt layers were grey, soft to stiff, and slightly plastic and the sand layers were comprised of fine sand, which was dilatant. SPT N-values in this layer ranged from 7 to 26 bpf indicating that the soil is loose to medium dense in consistency. The thickness of the layer ranged from 4.36 m (14.3 ft) in boring BB-PMR-101 to 3.81 m (12.5 ft) in boring BB-PMR-102D. Water content determinations of samples from this layer indicate that the soil has a water content ranging from approximately 10% to 29%. Grain size analyses of samples from this layer indicate that the soil is classified as an A-4 by the AASHTO Classification System and a CL-ML or SM by the Unified Soil Classification System.

Grey Sand. A layer of grey sand was encountered beneath the layered silt and sand. This layer was found to be wet, fine to coarse silty sand with frequent cobbles and boulders. SPT N-values in the layer ranged from 4 to greater than 50 bpf indicating that the soil is of loose to very dense consistency. The thickness of the layer ranged from 4.79 m (15.7 ft) in BB-PMR-101 to 5.36 m (17.6 ft) in boring BB-PMR-102D. A granite boulder was cored at a depth of 12.2 m (40 ft) in boring BB-PMR-101. One water content determination of a sample from this layer indicated that the soil has a water content of approximately 14%. A grain size analysis of a sample of this layer indicates that the soil is classified as an A-4 by the AASHTO Classification System and a ML by the Unified Soil Classification System.

Brown Sand. A layer of brown sand was encountered beneath the grey sand. This layer was found to be wet, fine to coarse sand, little silt, with frequent cobbles and boulders. SPT N-values in the layer ranged from 33 to greater than 50 bpf indicating that the soil is of dense to very dense consistency. This stratum was not fully penetrated due to hard drilling conditions. A layer of cobbles and boulders was cored at a depth of 18.35 m (60.2 ft) in boring BB-PMR-102D. Rock samples retrieved in the core were granite of the Sebago Pluton.

Groundwater. Groundwater was observed at a depth of 2.44 m (8.0 ft) bgs in boring BB-PMR-101. The water level reading was taken during drilling with the casing in the ground. Groundwater levels are expected to fluctuate seasonally depending upon the local precipitation magnitudes.

6.0 Foundation Alternatives

Three project foundation alternatives were considered at this site:

- **Bridge Rehabilitation and Widening** - With this alternative the existing bridge structure would be rehabilitated and no additional work would be conducted with regard to the existing abutments prior to the widening of the structure and substructure. Due to the condition of the existing granite block abutments, rehabilitation work is recommended. Therefore, this alternative is not recommended.

- **Abutment Rehabilitation, Widening and Deck Replacement** - With this alternative the existing granite block and concrete abutments would be rehabilitated as a part of the widening. Both the bridge superstructure and substructure would be widened. This alternative is recommended.

- **Full Bridge Replacement** - With this alternative the entire bridge structure and substructure would be replaced. A historical weir is located adjacent to the bridge structure and ties into the existing bridge abutments. Any impact to this structure should be avoided. The existing bridge abutments are in good condition and can be reused provided they see some rehabilitation work. Due to the presence of the historic weir and the potential reuse of the existing abutments, this alternative is not recommended.

7.0 Foundation Considerations and Recommendations

7.1 Existing Abutment Reuse and Rehabilitation

The limited knowledge regarding the configuration of the existing granite block abutments creates a need for conservatism. The make-up of the abutments can be investigated using geophysical methods including Impulse Response (Sonic Mobility) Testing and/or a Ground Penetrating Radar (GPR) survey. If no investigation of the existing abutments is made then the Designer should take care not to increase the live load or dead load currently handled by the substructure.

It is anticipated that with proper rehabilitation the reuse of the existing granite block abutments supporting the bridge will be acceptable. Due to the age of the block abutments, the mortar holding the blocks in place has deteriorated. Additionally, a few of the granite blocks have cracks and show signs of movement. Any block showing signs of movement should be reset. Grout should be injected between the blocks and in any cracks to increase the surficial contact between the blocks. The grout should be injected in a two-phase process. The first phase should be conducted to repoint the face of the abutment structure and the second phase to grout the materials behind the abutment face. This two-phase process will prevent the loss of grout through any voids in the face of the abutment. After grouting, weep holes should be re-drilled and sleeved with 100 mm diameter PVC pipe.

During construction the condition of the existing footings should be evaluated to assess the bearing area. If it is determined that any of the existing footing area has experienced scour or undermining and that loss of contact with the bearing materials has occurred, the area shall be repaired using grout bags or other appropriate method to restore the bearing area as determined by the Designer.

7.2 Bearing Elevation

It is anticipated that the proposed abutment extensions will be founded at an elevation similar to that of the existing abutment extensions. The 1931 plans indicate that the bearing elevation should be approximately 89.96 m (295.16 ft). This elevation will place the bottom of the footing appropriately within the native sand soils. The final depth of footing embedment may be controlled by the scour susceptibility of the bearing soils and may, in fact, be deeper than this elevation.

7.3 Bearing Capacity

It is anticipated that the widened spread footings will be founded on the native granular soils. The allowable bearing capacity of the native sand layer at the estimated footing elevation of 90.0 m (295.27 ft) should not exceed 191 kPa (4.0 ksf). No footing shall be less than 0.6 m (2 ft) wide regardless of the applied bearing pressure. Any organic matter or fill materials encountered in the excavation for the spread footings shall be removed to the full depth and replaced with compacted granular fill.

7.4 Frost Protection

According to the MDOT design freezing index maps for the State of Maine, the site has a design-freezing index of approximately 1360 F-degree days. The value correlates to a frost depth of 1.3 m (4.3 ft). Therefore, any foundations placed on native subgrade soil should be founded a minimum of 1.3 m (4.3 ft) below finished exterior grade for frost protection. See Appendix C - Calculations for supporting documentation. The final depth of footing embedment may be controlled by the scour susceptibility of the bearing soils and may, in fact, be deeper than the depth required for frost protection.

7.5 Scour

A Grain Size Analysis was performed on a sample taken from boring BB-PMR-101 (Sample 3D, Reference No. 97875) in order to generate a grain size curve for determining parameters to be used in a scour analysis. This sample was assumed to be similar in nature to the soils at the bearing elevation. The gradation curve is included in Appendix B - Laboratory Testing. The following riverbed parameters are to be used in scour analysis: AASHTO Soil Type A-3, $D_{50} = 0.28$ mm.

The bottom of footing should be placed below the total scour line as calculated by the Designer. AASHTO specification requires footings for stream abutments to be founded at least 1.8 m (6 ft) below the streambed (FHWA - GEC # 6 September 2002). If scour is determined to be an issue at the site, an acceptable alternative method for prevention of scour effects is to leave the cofferdam sheet piling in place after construction providing protection for the foundation soils.

A monolithic cap/seat designed as a simply supported beam can be utilized to distribute superstructure live load and dead load to the adjacent abutment sections in the event that loss of bearing contact has occurred or does occur.

7.6 Settlement

It is understood that the vertical alignment of the existing bridge will be raised approximately 250 mm (10 in) in the widening of the Middle Range Bridge. Settlement at the site is anticipated to be less than 12.5 mm (½ in). Any settlement occurring due to the widening of the bridge should be immediate and will occur during construction having negligible impact of the final structure.

7.7 Drainage

The abutment extensions shall include a drainage system to intercept any groundwater. Drainage shall be in accordance with Section 700.B page 700(2) of the MDOT Bridge Design Manual.

7.8 Abutment Considerations

The bridge abutments shall be designed as unrestrained meaning that they are free to rotate at the top in an active state of earth pressure. Abutments and wingwalls should be designed to achieve a factor of safety of 2.0 against overturning and a factor of safety of 1.5 against sliding. The Designer may assume Soil Type 4 (BDM Section 700) for retaining wall back fill material soil properties. The backfill properties are as follows: ϕ = 32 degrees, γ = 19.6 kN/m^3 (125 pcf), and a soil-concrete friction coefficient of 0.45.

The wingwalls shall be designed as unrestrained retaining walls meaning that they are free to rotate at the top in an active state of earth pressure. An active earth pressure coefficient, K_a, shall be calculated using Rankine Theory for cantilever wingwalls and abutments and Coulomb Theory for gravity shaped structures. See Sheet 4 at the end of this Report for guidance in calculating these values. The backfill properties provided above apply to this method of analysis. Additional lateral earth pressure due to construction surcharge or traffic surcharge is required per the BDM for the wingwalls and abutments if an approach slab is not specified.

7.9 Backfill Material

Structure and head wall backfill within 3 m (10 ft) of the structure and side-slope fill materials shall conform to MDOT Specification 703.19 - Granular Borrow for Underwater Backfill. This gradation specifies that 10 percent or less of the material may pass the No. 200 sieve. This material is also specified in order to reduce the amount of fines and to minimize frost action behind the structure. The structure design shall include a drainage system to intercept any groundwater. Drainage behind structure shall be in accordance with Section 700.B of the MDOT Bridge Design Manual.

8.0 CLOSURE

This report has been prepared for the use of the CLD Consulting Engineers, Inc. and MDOT for specific application to the proposed widening of Middle Range Bridge in Poland, Maine in accordance with generally accepted soil and foundation engineering practices. No other intended use 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 the geotechnical team member 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.

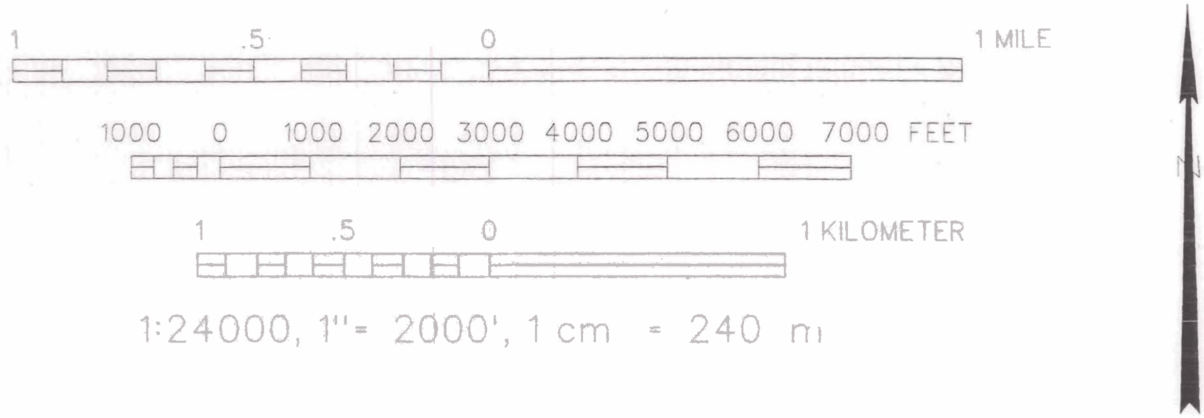
We also recommend that the geotechnical team member be provided the opportunity for a general review of the final design and specifications in order that the earthwork and foundation recommendations may be properly interpreted and implemented in the design.

Sheets

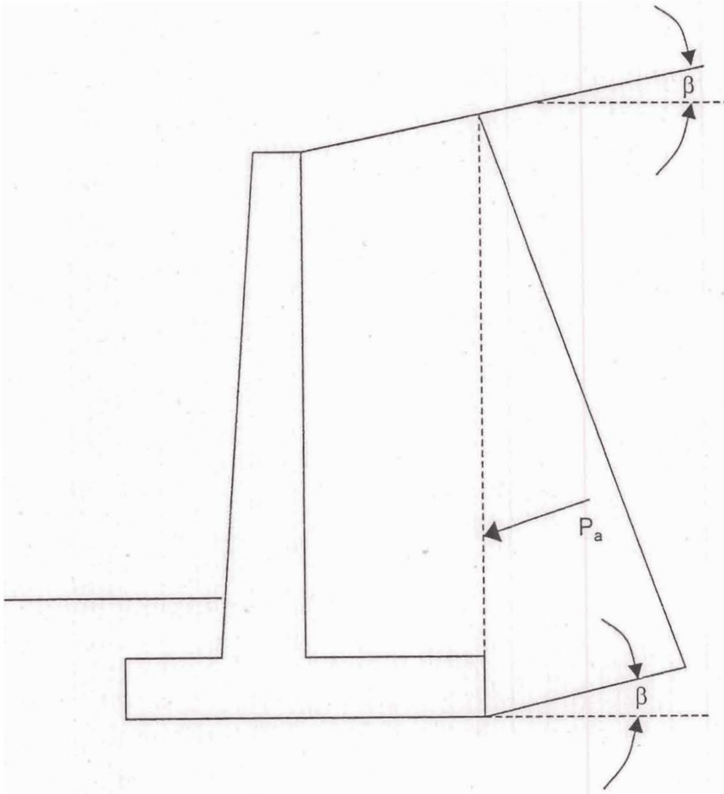
Location Map

Sheet No. 1

Poland, Maine, Middle Range Pond Bridge, PIN. 10014.00



1:24000, 1"= 2000', 1 cm = 240 m



For cases where interface friction between the backfill and wall are 0 or not considered, use Rankine.

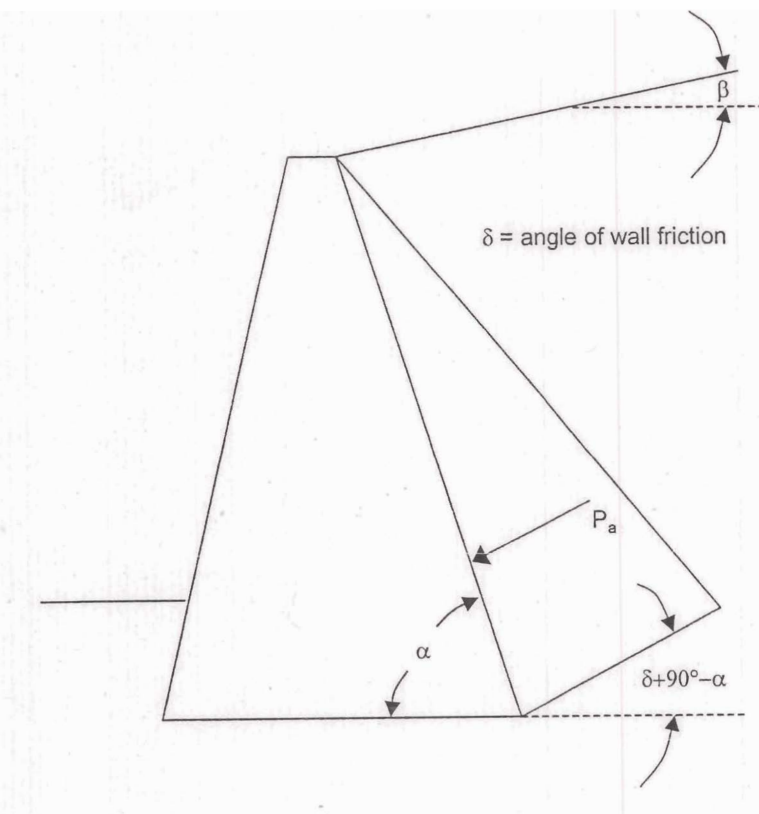
For a horizontal backfill surface, $\beta = 0°$:

$$K_a = \tan^2\left(45° - \frac{\phi}{2}\right)$$

For a sloped backfill surface, $\beta > 0°$:

$$K_a = \cos\beta * \frac{\cos\beta - \sqrt{\cos^2\beta - \cos^2\phi}}{\cos\beta + \sqrt{\cos^2\beta - \cos^2\phi}}$$

P_a is oriented at β



For cases where interface friction is considered, use Coulomb.

For horizontal or sloped backfill surfaces

$$K_a = \frac{\sin^2(\alpha + \phi)}{\sin^2\alpha * \sin(\alpha - \delta) * \left(1 + \sqrt{\frac{\sin(\phi + \delta) * \sin(\phi - \beta)}{\sin(\alpha - \delta) * \sin(\beta + \alpha)}}\right)^2}$$

P_a is oriented at $\delta + 90° - \alpha$

Rankine and Coulomb Active Earth Pressure Coefficients

Maine Department of Transportation — Soil/Rock Exploration Log — METRIC UNITS

Project: Middle Range Pond Bridge Over Pond Outlet
Location: US Route 26, Poland, Maine

Boring No.: BB-PMR-102C PIN: 10014.00

Driller:	MDOT	Elevation (m):	94.40	Auger ID/OD:	100 mm
Operator:	C.Mann/G.Lidstone/B.Hyland	Datum:	NGVD	Sampler:	N/A
Logged By:	K.Maguire	Rig Type:	CME 45C	Hammer Wt./Fall:	N/A
Date Start/Finish:	10/21/02-10/21/02	Drilling Method:	Solid Stem Auger	Core Barrel:	N/A
Boring Location:	23+021.7, 0.11 RT.	Casing ID/OD:	N/A	Water Level*:	None Observed

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample attempt
U = Thin Wall Tube Sample
R = Rock Core Sample
V = Insitu Vane Shear Test
SSA = Solid Stem Auger

Definitions:
S_u = Insitu Field Vane Shear Strength (kPa)
T_v = Pocket Torvane Shear Strength (kPa)
q_p = Unconfined Compressive Strength (Pa)
$S_{u(lab)}$ = Lab Vane Shear Strength (kPa)
WOH = weight of 64 kg hammer
WOR = weight of rods

Definitions:
WC = water content, percent
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index
G = Grain Size Analysis
C = Consolidation Test

Depth (m)	Sample No.	Pen/Rec (cm)	Sample Depth (m)	Blows (150 mm) Shear Strength (kPa) or RQD (%)	N-value	Casing Blows	Elevation (m)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
0						SSA	94.22		178 mm Pavement — 0.18	
							93.76		Auger refusal on obstruction. — 0.64	
									Bottom of Exploration at 0.64 m below ground surface.	

Remarks:
Soil description from auger cuttings. No soil samples were taken from this boring.

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.

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Boring No.: BB-PMR-102C

Maine Department of Transportation — Soil/Rock Exploration Log — METRIC UNITS

Project: Middle Range Pond Bridge Over Pond Outlet
Location: US Route 26, Poland, Maine

Boring No.: BB-PMR-102A PIN: 10014.00

Driller:	MDOT	Elevation (m):	94.40	Auger ID/OD:	100 mm
Operator:	C.Mann/G.Lidstone/B.Hyland	Datum:	NGVD	Sampler:	Standard Split Spoon
Logged By:	K.Maguire	Rig Type:	CME 45C	Hammer Wt./Fall:	63.5 kg/760 mm
Date Start/Finish:	10/21/02-10/21/02	Drilling Method:	Solid Stem Auger	Core Barrel:	N/A
Boring Location:	23+023.1, 0.2 LT.	Casing ID/OD:	N/A	Water Level*:	None Observed

Definitions: D = Split Spoon Sample; MD = Unsuccessful Split Spoon Sample attempt; U = Thin Wall Tube Sample; R = Rock Core Sample; V = Insitu Vane Shear Test; SSA = Solid Stem Auger
Definitions: S_u = Insitu Field Vane Shear Strength (kPa); T_v = Pocket Torvane Shear Strength (kPa); q_p = Unconfined Compressive Strength (Pa); $S_{u(lab)}$ = Lab Vane Shear Strength (kPa); WOH = weight of 64 kg hammer; WOR = weight of rods
Definitions: WC = water content, percent; LL = Liquid Limit; PL = Plastic Limit; PI = Plasticity Index; G = Grain Size Analysis; C = Consolidation Test

Depth (m)	Sample No.	Pen/Rec (cm)	Sample Depth (m)	Blows (150 mm) Shear Strength (kPa) or RQD (%)	N-value	Casing Blows	Elevation (m)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
0						SSA	94.22		178 mm Pavement — 0.18	
	1D	38.1/30.5	0.30 - 0.69	32/28/50(75)					Brown, dry, medium dense, fine to coarse SAND, little silt and gravel, with broken rock fragments. (Fill).	
	2D	2.5/2.5	1.52 - 1.55	50(25)			92.85		Brown, dry, fine to coarse SAND, little silt with broken rock fragments. (Fill). Spoon refusal, spoon bouncing on hard obstruction. — 1.55	
									Bottom of Exploration at 1.55 m below ground surface.	

Remarks:
Spoon driven with safety hammer

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.

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Boring No.: BB-PMR-102A

Maine Department of Transportation — Soil/Rock Exploration Log — METRIC UNITS

Project: Middle Range Pond Bridge Over Pond Outlet
Location: US Route 26, Poland, Maine

Boring No.: BB-PMR-102B PIN: 10014.00

Driller:	MDOT	Elevation (m):	94.40	Auger ID/OD:	100 mm
Operator:	C.Mann/G.Lidstone/B.Hyland	Datum:	NGVD	Sampler:	N/A
Logged By:	K.Maguire	Rig Type:	CME 45C	Hammer Wt./Fall:	N/A
Date Start/Finish:	10/21/02-10/21/02	Drilling Method:	Solid Stem Auger	Core Barrel:	N/A
Boring Location:	23+022.4, 0.43 LT.	Casing ID/OD:	N/A	Water Level*:	None Observed

Definitions: D = Split Spoon Sample; MD = Unsuccessful Split Spoon Sample attempt; U = Thin Wall Tube Sample; R = Rock Core Sample; V = Insitu Vane Shear Test; SSA = Solid Stem Auger
Definitions: S_u = Insitu Field Vane Shear Strength (kPa); T_v = Pocket Torvane Shear Strength (kPa); q_p = Unconfined Compressive Strength (Pa); $S_{u(lab)}$ = Lab Vane Shear Strength (kPa); WOH = weight of 64 kg hammer; WOR = weight of rods
Definitions: WC = water content, percent; LL = Liquid Limit; PL = Plastic Limit; PI = Plasticity Index; G = Grain Size Analysis; C = Consolidation Test

Depth (m)	Sample No.	Pen/Rec (cm)	Sample Depth (m)	Blows (150 mm) Shear Strength (kPa) or RQD (%)	N-value	Casing Blows	Elevation (m)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
0						SSA	94.22		178 mm Pavement — 0.18	
									Brown, dry, fine to coarse SAND, little silt with broken rock fragments. (Fill).	
							92.27		Auger refusal on obstruction. — 2.13	
									Bottom of Exploration at 2.13 m below ground surface.	

Remarks:
Soil description from auger cuttings. No soil samples were taken from this boring.

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-PMR-102B

Maine Department of Transportation — Soil/Rock Exploration Log — METRIC UNITS

Project: Middle Range Pond Bridge Over Pond Outlet
Location: US Route 26, Poland, Maine

Boring No.: BB-PMR-102D PIN: 10014.00

Driller:	MDOT	Elevation (m):	94.40	Auger ID/OD:	N/A
Operator:	C.Mann/G.Lidstone/B.Hyland	Datum:	NGVD	Sampler:	Standard Split Spoon
Logged By:	K.Maguire	Rig Type:	CME 45C	Hammer Wt./Fall:	63.5 kg/760 mm
Date Start/Finish:	10/21/02-10/22/02	Drilling Method:	Spun Cased Wash Boring	Core Barrel:	N/A
Boring Location:	23+025.5, CL	Casing ID/OD:	HW-100/113 mm	Water Level*:	

Definitions: D = Split Spoon Sample; MD = Unsuccessful Split Spoon Sample attempt; U = Thin Wall Tube Sample; R = Rock Core Sample; V = Insitu Vane Shear Test; SSA = Solid Stem Auger
Definitions: S_u = Insitu Field Vane Shear Strength (kPa); T_v = Pocket Torvane Shear Strength (kPa); q_p = Unconfined Compressive Strength (Pa); $S_{u(lab)}$ = Lab Vane Shear Strength (kPa); WOH = weight of 64 kg hammer; WOR = weight of rods
Definitions: WC = water content, percent; LL = Liquid Limit; PL = Plastic Limit; PI = Plasticity Index; G = Grain Size Analysis; C = Consolidation Test

Depth (m)	Sample No.	Pen/Rec (cm)	Sample Depth (m)	Blows (150 mm) Shear Strength (kPa) or RQD (%)	N-value	Casing Blows	Elevation (m)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
0						Core	94.31		90 mm Pavement — 0.09	
									0.76 m Bridge Deck	
							93.64		2.8 m from Bridge Deck to Lake Bottom — 0.76	
	1D	2.5/2.5	2.80 - 2.83	50(25)		Spun H Casing	91.47		Broken concrete in nose of spoon, roller cone through. No soil recovered. — 2.93	
							91.20		Wood layer from 2.93-3.2 m bgs. — 3.20	
	2D	61.0/2.5	4.57 - 5.18	15/11/5/9	16				Brown, wet, medium dense, fine to coarse SAND, trace silt and organics.	
							89.07		— 5.33	
	3D	61.0/40.6	6.10 - 6.71	9/5/3/3	8				Grey, wet, layered, stiff, SILT, trace sand, and loose, silty fine SAND, slightly plastic.	G #97377 A-4, CL-ML wc=28.8%
	4D	61.0/38.1	7.62 - 8.23	4/5/2/2	7				Grey, wet, soft, SILT, little sand, with fine to medium sand layers, slightly plastic.	
							85.26		— 9.14	G #97378 A-4, ML wc=14.3%
	5D	61.0/35.6	9.14 - 9.75	3/5/5/1	10				Grey, wet, loose, fine SAND, some silt, dilatant.	
						Spun H Casing				
	6D	61.0/30.5	10.67 - 11.28	2/2/2/3	4				Grey, wet, loose, fine silty SAND, uniform, dilatant.	
	7D	61.0/20.3	12.19 - 12.80	2/6/4/11	10				Grey, wet, loose, fine to coarse, silty SAND with wood chips, rock in nose of spoon.	
							81.60		— 12.80	
	8D	61.0/35.6	13.72 - 14.33	21/21/27/28	48				Grey-brown, wet, very dense, fine to coarse silty SAND.	
							79.92		— 14.48	
	MD	61.0/0.0	15.24 - 15.85	3/12/21/33	33				Empty spoon, brown sand in wash.	
	9D	61.0/15.2	16.76 - 17.37	18/27/25/31	+50				Brown, wet, very dense, fine to coarse SAND, little silt, with broken rock.	
						Roller Cone			Roller cone in boulder from 17.98-18.35 m bgs.	
							76.05		— 18.35	
	R1	152.4/25.4	18.35 - 19.87	RQD = N/A%		NQ Rock Core			Cored through boulders to 19.87 m bgs. R1: Core Times (min:sec) 18.35-18.65 (10:11) 18.65-18.96 (2:50) 18.96-19.26 (1:44) 19.26-19.57 (3:12) 19.57-19.87 (4:05) When casing was pulled, spinning shoe was entirely worn away. No refusal encountered.	
							74.53		— 19.87	
									Bottom of Exploration at 19.87 m below ground surface.	

Remarks:
1. Spoon driven with safety hammer.
2. Elevation is from Bridge Deck, not from Lake Bottom.

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-PMR-102D

Maine Department of Transportation — Soil/Rock Exploration Log — METRIC UNITS

Project: Middle Range Pond Bridge Over Pond Outlet
Location: US Route 26, Poland, Maine

Boring No.: BB-PMR-101 PIN: 10014.00

Driller:	Northeast Diamond Drilling, Inc.	Elevation (m):	94.40	Auger ID/OD:	N/A
Operator:	Rich/Brian	Datum:	NGVD	Sampler:	Standard Split Spoon
Logged By:	K.Maguire	Rig Type:	Mobil B50	Hammer Wt./Fall:	63.5 kg/760 mm
Date Start/Finish:	10/21/02-10/22/02	Drilling Method:	Spun Cased Wash Boring	Core Barrel:	N/A
Boring Location:	23+030.2, 0.27 RT.	Casing ID/OD:	HW-100/113 mm	Water Level*:	~2.44 m bgs

Definitions: D = Split Spoon Sample; MD = Unsuccessful Split Spoon Sample attempt; U = Thin Wall Tube Sample; R = Rock Core Sample; V = Insitu Vane Shear Test; SSA = Solid Stem Auger
Definitions: S_u = Insitu Field Vane Shear Strength (kPa); T_v = Pocket Torvane Shear Strength (kPa); q_p = Unconfined Compressive Strength (Pa); $S_{u(lab)}$ = Lab Vane Shear Strength (kPa); WOH = weight of 64 kg hammer; WOR = weight of rods
Definitions: WC = water content, percent; LL = Liquid Limit; PL = Plastic Limit; PI = Plasticity Index; G = Grain Size Analysis; C = Consolidation Test

Depth (m)	Sample No.	Pen/Rec (cm)	Sample Depth (m)	Blows (150 mm) Shear Strength (kPa) or RQD (%)	N-value	Casing Blows	Elevation (m)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
0						Roller Cone	94.21		190 mm Pavement — 0.19	
	1D	33.0/30.5	0.30 - 0.64	70/21/50(25)	—				Brown, damp, medium dense, fine to coarse SAND, trace silt with broken rock fragments. (Fill). Obstruction at 0.64 m bgs - cobble, roller cone through.	
	2D	61.0/30.5	1.22 - 1.83	35/70/77/54	+50	Spun H Casing			Brown, wet, dense, fine to coarse SAND, little silt with angular rock fragments. (Fill).	
	MD	0.0/0.0	3.05 - 3.05	50(0)	—				Obstruction from 2.59-3.05 m bgs, spun casing through.	
							90.74		— 3.66	
	3D	61.0/35.6	4.27 - 4.88	7/21/19/19	40				Grey, wet, dense, fine to coarse SAND, trace fine gravel and silt, dilatant.	G #97875 A-3, SP-SM wc=20.6%
							88.61		— 5.79	
	4D	61.0/45.7	5.79 - 6.40	7/12/14/12	26				Grey, wet, medium dense, layered, fine sandy SILT, and fine SAND, slightly plastic.	
	5D	61.0/61.0	7.32 - 7.92	7/7/7/10	14				Grey, wet, medium dense, fine silty SAND, trace gravel and clay, slightly plastic.	G #97376 A-4, SM wc=10.0%
	6D	61.0/45.7	8.84 - 9.45	8/7/18/14	25				Grey, wet, medium dense, layers of fine silty SAND and sandy SILT, slightly plastic.	
						Spun H Casing	84.25		— 10.15	
	7D	61.0/38.1	10.36 - 10.97	4/3/4/6	7				Grey, wet, loose, fine SAND, trace silt, dilatant.	
							82.82		— 11.58	
									Boulder from 11.58-12.28 m bgs.	
	MD	0.0/0.0	11.89 - 11.89	50(0)	—				Spoon refusal, roller coned ahead to 12.19 m bgs.	
	R1	10.2/10.2	12.19 - 12.29						Cored through boulder, GRANITE.	
	8D	15.2/5.1	13.41 - 13.56	100(150)	—				Grey, wet, fine to coarse SAND, rock in end of spoon.	
							79.46		— 14.94	
	9D	61.0/38.1	14.94 - 15.54	16/40/62/51	+50				Brown, wet, fine to medium SAND with 25 mm stones.	
	10D	61.0/25.4	16.46 - 17.07	54/30/28/35	+50				Brown, wet, dense, fine to coarse SAND, trace silt, broken rock in nose of spoon. Cannot spin casing further. When casing was pulled, spinning shoe was entirely worn away. No refusal Encountered.	
							77.33		— 17.07	
									Bottom of Exploration at 17.07 m below ground surface.	

Remarks:
Spoon driven with donut hammer

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-PMR-101

BRIDGE NO. 2550

STATE OF MAINE
DEPARTMENT OF TRANSPORTATION

MIDDLE RANGE POND BRIDGE
OVER
POND OUTLET
IN THE TOWN OF
POLAND
ANDROSCOGGIN COUNTY

BORING DETAILS

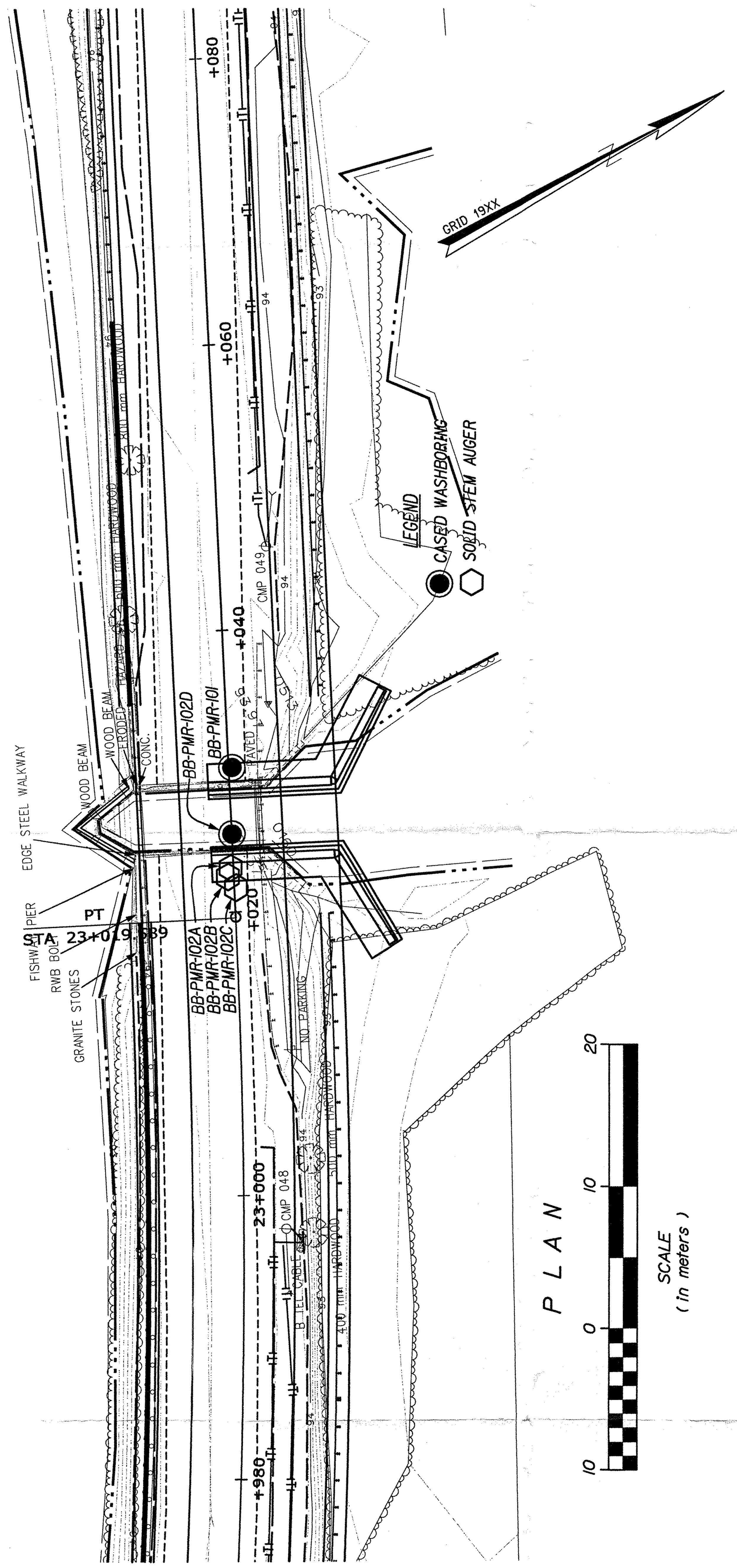
SHEET OF
AUGUSTA, MAINE

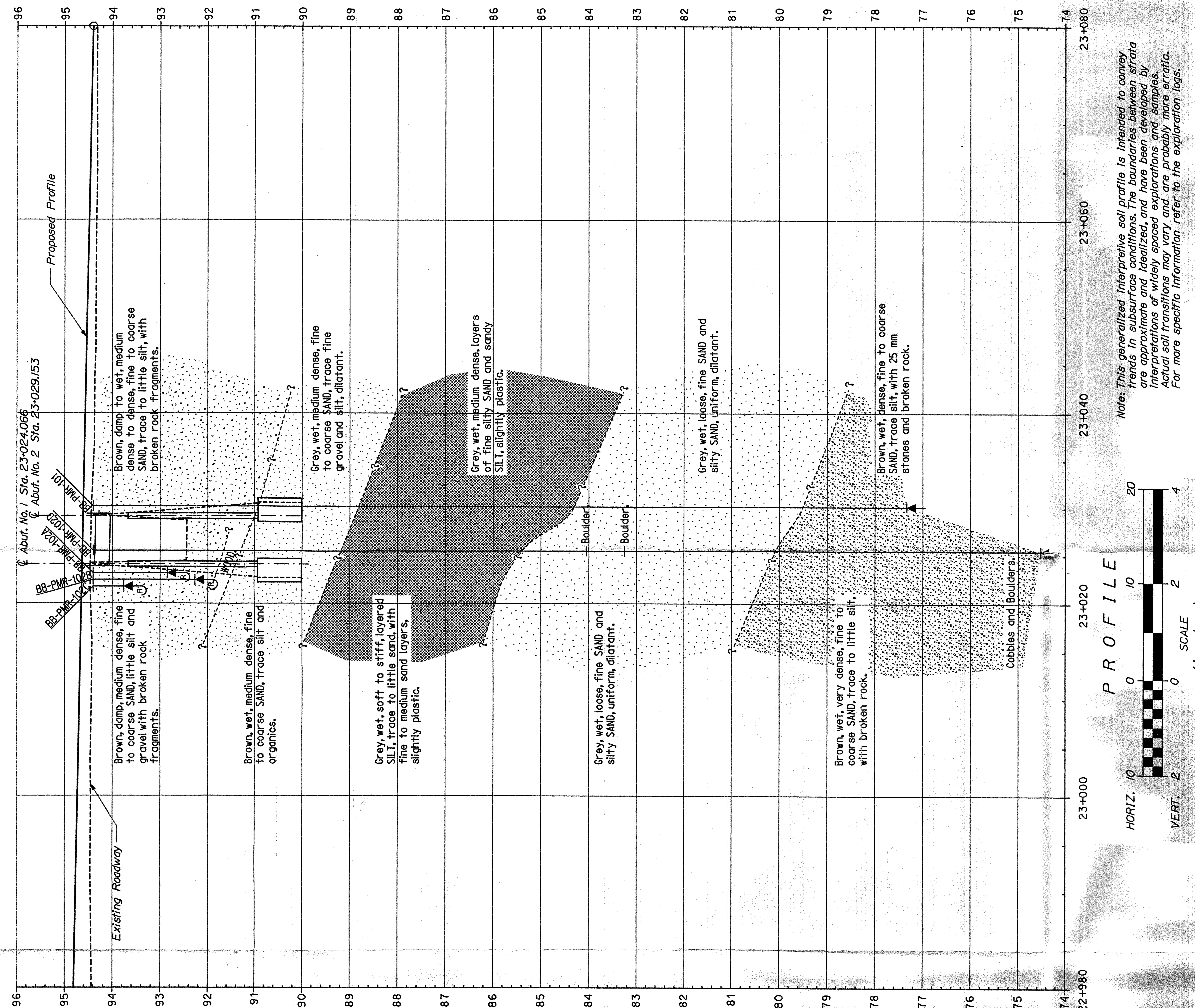
Date:$date$
$

METRIC 1. All dimensions are in millimeters unless otherwise noted.
2. All elevations and stations are in meters.

F.H.W.A. REG. NO.	STATE	PROJECT NUMBER	SHEET NO.	TOTAL SHEETS
1	MAINE	NH-1001(400)E	2	4

PIN. 10014.00





BRIDGE NO. 2550

STATE OF MAINE
DEPARTMENT OF TRANSPORTATION

MIDDLE RANGE POND BRIDGE
OVER
POND OUTLET
IN THE TOWN OF
POLAND
ANDROSCOGGIN COUNTY

FOUNDATION SURVEY

SHEET OF AUGUSTA, MAINE

Appendix A

Boring Logs

Maine Department of Transportation

Soil/Rock Exploration Log

METRIC UNITS

Project:	Middle Range Pond Bridge Over Pond Outlet	Boring No.:	BB-PMR-101		
Location:	US Route 26 Poland, Maine	PIN:	10014.00		
Driller:	Northeast Diamond Drilling, Inc.	Elevation (m):	94.40	Auger ID/OD:	N/A
Operator:	Rich/Brian	Datum:	NGVD	Sampler:	Standard Split Spoon
Logged By:	K.Maguire	Rig Type:	Mobil B50	Hammer Wt./Fall:	63.5 kg/760 mm
Date Start/Finish:	10/21/02-10/22/02	Drilling Method:	Spun Cased Wash Boring	Core Barrel:	N/A
Boring Location:	23+030.2, 0.27 RT.	Casing ID/OD:	HW-100/113 mm	Water Level*:	~2.44 m bgs

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample attempt
U = Thin Wall Tube Sample
R = Rock Core Sample
V = Insitu Vane Shear Test
SSA = Solid Stem Auger

Definitions:
S_u = Insitu Field Vane Shear Strength (kPa)
T_v = Pocket Torvane Shear Strength (kPa)
q_p = Unconfined Compressive Strength (Pa)
$S_{u(lab)}$ = Lab Vane Shear Strength (kPa)
WOH = weight of 64 kg hammer
WOR = weight of rods

Definitions:
WC = water content, percent
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index
G = Grain Size Analysis
C = Consolidation Test

Depth (m)	Sample No.	Pen/Rec (cm)	Sample Depth (m)	Blows (150 mm) Shear Strength (kPa) or RQD (%)	N-value	Casing Blows	Elevation (m)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
0						Roller Cone	94.21		190 mm Pavement 0.19	
	1D	33.0/30.5	0.30 - 0.64	70/21/50(25)	---				Brown, damp, medium dense, fine to coarse SAND, trace silt with broken rock fragments, (Fill). Obstruction at 0.64 m bgs - cobble, roller cone through.	
1.2	2D	61.0/30.5	1.22 - 1.83	35/70/77/54	+50	Spun H Casing			Brown, wet, dense, fine to coarse SAND, little silt with angular rock fragments, (Fill).	
2.4										
	MD	0.0/0.0	3.05 - 3.05	50(0)	---				Obstruction from 2.59-3.05 m bgs, spun casing through.	
3.6							90.74		3.66	
	3D	61.0/35.6	4.27 - 4.88	7/21/19/19	40				Grey, wet, dense, fine to coarse SAND, trace fine gravel and silt, dilatant.	G #97875 A-3, SP-SM wc=20.6%
4.8										
							88.61		5.79	
6	4D	61.0/45.7	5.79 - 6.40	7/12/14/12	26				Grey, wet, medium dense, layered, fine sandy SILT, and fine SAND, slightly plastic.	
7.2	5D	61.0/61.0	7.32 - 7.92	7/7/7/10	14				Grey, wet, medium dense, fine silty SAND, trace gravel and clay, slightly plastic.	G #97376 A-4, SM wc=10.0%
8.4										
	6D	61.0/45.7	8.84 - 9.45	8/7/18/14	25				Grey, wet, medium dense, layers of fine silty SAND and sandy SILT, slightly plastic.	

Remarks:

Spoon driven with donut hammer

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

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

Maine Department of Transportation

Soil/Rock Exploration Log
METRIC UNITS

Project:	Middle Range Pond Bridge Over Pond Outlet			Boring No.:	BB-PMR-101
Location:	US Route 26 Poland, Maine			PIN:	10014.00
Driller:	Northeast Diamond Drilling, Inc.	Elevation (m):	94.40	Auger ID/OD:	N/A
Operator:	Rich/Brian	Datum:	NGVD	Sampler:	Standard Split Spoon
Logged By:	K.Maguire	Rig Type:	Mobil B50	Hammer Wt./Fall:	63.5 kg/760 mm
Date Start/Finish:	10/21/02-10/22/02	Drilling Method:	Spun Cased Wash Boring	Core Barrel:	N/A
Boring Location:	23+030.2, 0.27 RT.	Casing ID/OD:	HW-100/113 mm	Water Level*:	~2.44 m bgs

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample attempt
U = Thin Wall Tube Sample
R = Rock Core Sample
V = Insitu Vane Shear Test
SSA = Solid Stem Auger

Definitions:
S_u = Insitu Field Vane Shear Strength (kPa)
T_v = Pocket Torvane Shear Strength (kPa)
q_p = Unconfined Compressive Strength (Pa)
$S_{u(lab)}$ = Lab Vane Shear Strength (kPa)
WOH = weight of 64 kg hammer
WOR = weight of rods

Definitions:
WC = water content, percent
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index
G = Grain Size Analysis
C = Consolidation Test

Depth (m)	Sample No.	Pen/Rec (cm)	Sample Depth (m)	Blows (150 mm) Shear Strength (kPa) or RQD (%)	N-value	Casing Blows	Elevation (m)	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
9.6						Spun H Casing			
							84.25	10.15	
	7D	61.0/38.1	10.36 - 10.97	4/3/4/6	7			Grey, wet, loose, fine SAND, trace silt, dilatant.	
10.8									
							82.82	11.58	
								Boulder from 11.58-12.28 m bgs. Spoon refusal, roller coned ahead to 12.19 m bgs.	
12	MD	0.0/0.0	11.89 - 11.89	50(0)	---				
	R1	10.2/10.2	12.19 - 12.29					Cored through boulder, GRANITE.	
13.2									
	8D	15.2/5.1	13.41 - 13.56	100(150)	---			Grey, wet, fine to coarse SAND, rock in end of spoon.	
14.4									
							79.46	14.94	
	9D	61.0/38.1	14.94 - 15.54	16/40/62/51	+50			Brown, wet, fine to medium SAND with 25 mm stones.	
15.6									
	10D	61.0/25.4	16.46 - 17.07	54/30/28/35	+50			Brown, wet, dense, fine to coarse SAND, trace silt, broken rock in nose of spoon. Cannot spin casing further. When casing was pulled, spinning shoe was entirely worn away. No refusal Encountered.	
16.8							77.33	17.07	
								Bottom of Exploration at 17.07 m below ground surface.	
18									

Remarks:

Spoon driven with donut hammer

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

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

Maine Department of Transportation Soil/Rock Exploration Log METRIC UNITS	Project: Middle Range Pond Bridge Over Pond Outlet Location: US Route 26 Poland, Maine	Boring No.: BB-PMR-102A PIN: 10014.00

Driller:	MDOT	Elevation (m):	94.40	Auger ID/OD:	100 mm
Operator:	C.Mann/G.Lidstone/B.Hyland	Datum:	NGVD	Sampler:	Standard Split Spoon
Logged By:	K.Maguire	Rig Type:	CME 45C	Hammer Wt./Fall:	63.5 kg/760 mm
Date Start/Finish:	10/21/02-10/21/02	Drilling Method:	Solid Stem Auger	Core Barrel:	N/A
Boring Location:	23+023.1, 0.2 LT.	Casing ID/OD:	N/A	Water Level*:	None Observed

Definitions:	Definitions:	Definitions:
D = Split Spoon Sample MD = Unsuccessful Split Spoon Sample attempt U = Thin Wall Tube Sample R = Rock Core Sample V = Insitu Vane Shear Test SSA = Solid Stem Auger	S_u = Insitu Field Vane Shear Strength (kPa) T_v = Pocket Torvane Shear Strength (kPa) q_p = Unconfined Compressive Strength (Pa) $S_{u(lab)}$ = Lab Vane Shear Strength (kPa) WOH = weight of 64 kg hammer WOR = weight of rods	WC = water content, percent LL = Liquid Limit PL = Plastic Limit PI = Plasticity Index G = Grain Size Analysis C = Consolidation Test

Depth (m)	Sample No.	Pen/Rec (cm)	Sample Depth (m)	Blows (150 mm) Shear Strength (kPa) or RQD (%)	N-value	Casing Blows	Elevation (m)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
0						SSA	94.22		178 mm Pavement 0.18	
	1D	38.1/30.5	0.30 - 0.69	32/28/50(75)					Brown, dry, medium dense, fine to coarse SAND, little silt and gravel, with broken rock fragments, (Fill).	
1.2										
	2D	2.5/2.5	1.52 - 1.55	50(25)			92.85		Brown, dry, fine to coarse SAND, little silt with broken rock fragments, (Fill). Spoon refusal, spoon bouncing on hard obstruction. 1.55	
									Bottom of Exploration at 1.55 m below ground surface.	
2.4										
3.6										
4.8										
6										
7.2										
8.4										

Remarks:

Spoon driven with safety hammer

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

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

Maine Department of Transportation

Soil/Rock Exploration Log
METRIC UNITS

Project: Middle Range Pond Bridge Over Pond Outlet
Location: US Route 26 Poland, Maine

Boring No.: BB-PMR-102B
PIN: 10014.00

Driller:	MDOT	Elevation (m):	94.40	Auger ID/OD:	100 mm
Operator:	C.Mann/G.Lidstone/B.Hyland	Datum:	NGVD	Sampler:	N/A
Logged By:	K.Maguire	Rig Type:	CME 45C	Hammer Wt./Fall:	N/A
Date Start/Finish:	10/21/02-10/21/02	Drilling Method:	Solid Stem Auger	Core Barrel:	N/A
Boring Location:	23+022.4, 0.43 LT.	Casing ID/OD:	N/A	Water Level*:	None Observed

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample attempt
U = Thin Wall Tube Sample
R = Rock Core Sample
V = Insitu Vane Shear Test
SSA = Solid Stem Auger

Definitions:
S_u = Insitu Field Vane Shear Strength (kPa)
T_v = Pocket Torvane Shear Strength (kPa)
q_p = Unconfined Compressive Strength (Pa)
$S_{u(lab)}$ = Lab Vane Shear Strength (kPa)
WOH = weight of 64 kg hammer
WOR = weight of rods

Definitions:
WC = water content, percent
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index
G = Grain Size Analysis
C = Consolidation Test

Depth (m)	Sample No.	Pen/Rec (cm)	Sample Depth (m)	Blows (150 mm) Shear Strength (kPa) or RQD (%)	N-value	Casing Blows	Elevation (m)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
0						SSA	94.22		178 mm Pavement 0.18	
									Brown, dry, fine to coarse SAND, little silt with broken rock fragments, (Fill).	
1.2										
							92.27		Auger refusal on obstruction. 2.13	
									Bottom of Exploration at 2.13 m below ground surface.	
2.4										
3.6										
4.8										
6										
7.2										
8.4										

Remarks:

Soil description from auger cuttings. No soil samples were taken from this boring.

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

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

Boring No.: BB-PMR-102B

Maine Department of Transportation

Soil/Rock Exploration Log
METRIC UNITS

Project: Middle Range Pond Bridge Over Pond Outlet
Location: US Route 26 Poland, Maine

Boring No.: BB-PMR-102C
PIN: 10014.00

Driller:	MDOT	Elevation (m):	94.40	Auger ID/OD:	100 mm
Operator:	C.Mann/G.Lidstone/B.Hyland	Datum:	NGVD	Sampler:	N/A
Logged By:	K.Maguire	Rig Type:	CME 45C	Hammer Wt./Fall:	N/A
Date Start/Finish:	10/21/02-10/21/02	Drilling Method:	Solid Stem Auger	Core Barrel:	N/A
Boring Location:	23+021.7, 0.11 RT.	Casing ID/OD:	N/A	Water Level*:	None Observed

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample attempt
U = Thin Wall Tube Sample
R = Rock Core Sample
V = Insitu Vane Shear Test
SSA = Solid Stem Auger

Definitions:
S_u = Insitu Field Vane Shear Strength (kPa)
T_v = Pocket Torvane Shear Strength (kPa)
q_p = Unconfined Compressive Strength (Pa)
$S_{u(lab)}$ = Lab Vane Shear Strength (kPa)
WOH = weight of 64 kg hammer
WOR = weight of rods

Definitions
WC = water content, percent
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index
G = Grain Size Analysis
C = Consolidation Test

Depth (m)	Sample No.	Pen/Rec (cm)	Sample Depth (m)	Blows (150 mm) Shear Strength (kPa) or RQD (%)	N-value	Casing Blows	Elevation (m)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
0						SSA	94.22		178 mm Pavement 0.18	
							93.76		Auger refusal on obstruction. 0.64	
									Bottom of Exploration at 0.64 m below ground surface.	
1.2										
2.4										
3.6										
4.8										
6										
7.2										
8.4										

Remarks:

Soil description from auger cuttings. No soil samples were taken from this boring.

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

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

Boring No.: BB-PMR-102C

Maine Department of Transportation Soil/Rock Exploration Log METRIC UNITS	Project: Middle Range Pond Bridge Over Pond Outlet Location: US Route 26 Poland, Maine	Boring No.: BB-PMR-102D PIN: 10014.00

Driller:	MDOT	Elevation (m):	94.40	Auger ID/OD:	N/A
Operator:	C.Mann/G.Lidstone/B.Hyland	Datum:	NGVD	Sampler:	Standard Split Spoon
Logged By:	K.Maguire	Rig Type:	CME 45C	Hammer Wt./Fall:	63.5 kg/760 mm
Date Start/Finish:	10/21/02-10/22/02	Drilling Method:	Spun Cased Wash Boring	Core Barrel:	N/A
Boring Location:	23+025.5, CL	Casing ID/OD:	HW-100/113 mm	Water Level*:	

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample attempt
U = Thin Wall Tube Sample
R = Rock Core Sample
V = Insitu Vane Shear Test
SSA = Solid Stem Auger

Definitions:
S_u = Insitu Field Vane Shear Strength (kPa)
T_v = Pocket Torvane Shear Strength (kPa)
q_p = Unconfined Compressive Strength (kPa)
$S_{u(lab)}$ = Lab Vane Shear Strength (kPa)
WOH = weight of 64 kg hammer
WOR = weight of rods

Definitions:
WC = water content, percent
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index
G = Grain Size Analysis
C = Consolidation Test

Depth (m)	Sample No.	Pen/Rec (cm)	Sample Depth (m)	Blows (150 mm) Shear Strength (kPa) or RQD (%)	N-value	Casing Blows	Elevation (m)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
0						Core	94.31		90 mm Pavement ——0.09	
									0.76 m Bridge Deck	
							93.64		——0.76	
									2.8 m from Bridge Deck to Lake Bottom	
1.2										
2.4										
	1D	2.5/2.5	2.80 - 2.83	50(25)		Spun HW Casing	91.47		Broken concrete in nose of spoon, roller cone through. No soil recovered. ——2.93	
							91.20		Wood layer from 2.93-3.2 m bgs. ——3.20	
3.6										
4.8	2D	61.0/2.5	4.57 - 5.18	15/11/5/9	16				Brown, wet, medium dense, fine to coarse SAND, trace silt and organics.	
							89.07		——5.33	
6	3D	61.0/40.6	6.10 - 6.71	9/5/3/3	8				Grey, wet, layered, stiff, SILT, trace sand, and loose, silty fine SAND, slightly plastic.	G #97377 A-4, CL-ML wc=28.8%
7.2	4D	61.0/38.1	7.62 - 8.23	4/5/2/2	7				Grey, wet, soft, SILT, little sand, with fine to medium sand layers, slightly plastic.	
8.4										G #97378 A-4,ML wc=14.3%
	5D	61.0/35.6	9.14 - 9.75	3/5/5/1	10		85.26		- - - - 9.14 Grey, wet, loose, fine SAND, some silt, dilatant.	

Remarks:

1. Spoon driven with safety hammer.
2. Elevation is from Bridge Deck, not from Lake Bottom.

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

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

Boring No.: BB-PMR-102D

Maine Department of Transportation

Soil/Rock Exploration Log
METRIC UNITS

Project:	Middle Range Pond Bridge Over Pond Outlet	Boring No.:	BB-PMR-102D		
Location:	US Route 26 Poland, Maine	PIN:	10014.00		
Driller:	MDOT	Elevation (m):	94.40	Auger ID/OD:	N/A
Operator:	C.Mann/G.Lidstone/B.Hyland	Datum:	NGVD	Sampler:	Standard Split Spoon
Logged By:	K.Maguire	Rig Type:	CME 45C	Hammer Wt./Fall:	63.5 kg/760 mm
Date Start/Finish:	10/21/02-10/22/02	Drilling Method:	Spun Cased Wash Boring	Core Barrel:	N/A
Boring Location:	23+025.5, CL	Casing ID/OD:	HW-100/113 mm	Water Level*:	

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample attempt
U = Thin Wall Tube Sample
R = Rock Core Sample
V = Insitu Vane Shear Test
SSA = Solid Stem Auger

Definitions:
S_u = Insitu Field Vane Shear Strength (kPa)
T_v = Pocket Torvane Shear Strength (kPa)
q_p = Unconfined Compressive Strength (Pa)
$S_{u(lab)}$ = Lab Vane Shear Strength (kPa)
WOH = weight of 64 kg hammer
WOR = weight of rods

Definitions:
WC = water content, percent
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index
G = Grain Size Analysis
C = Consolidation Test

Depth (m)	Sample No.	Pen/Rec (cm)	Sample Depth (m)	Blows (150 mm) Shear Strength (kPa) or RQD (%)	N-value	Casing Blows	Elevation (m)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
9.6						Spun H Casing				
10.8	6D	61.0/30.5	10.67 - 11.28	2/2/2/3	4				Grey, wet, loose, fine silty SAND, uniform, dilatant.	
12	7D	61.0/20.3	12.19 - 12.80	2/6/4/11	10				Grey, wet, loose, fine to coarse, silty SAND with mica chips, rock in nose of spoon.	
							81.60		12.80	
13.2	8D	61.0/35.6	13.72 - 14.33	21/21/27/28	48				Grey-brown, wet, very dense, fine to coarse silty SAND.	
14.4							79.92		14.48	
	MD	61.0/0.0	15.24 - 15.85	3/12/21/33	33				Empty spoon, brown sand in wash.	
15.6										
16.8	9D	61.0/15.2	16.76 - 17.37	18/27/25/31	+50				Brown, wet, very dense, fine to coarse SAND, little silt, with broken rock.	
18						Roller Cone			Roller cone in boulder from 17.98-18.35 m bgs.	
							76.05		18.35	
	R1	152.4/25.4	18.35 - 19.87	RQD = N/A%		NQ Rock Core			Cored through boulders to 19.87 m bgs. R1: Core Times (min:sec) 18.35-18.65 (10:11) 18.65-18.96 (2:50)	

Remarks:

1. Spoon driven with safety hammer.
2. Elevation is from Bridge Deck, not from Lake Bottom.

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

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

Maine Department of Transportation Soil/Rock Exploration Log METRIC UNITS	Project: Middle Range Pond Bridge Over Pond Outlet Location: US Route 26 Poland, Maine	Boring No.: BB-PMR-102D PIN: 10014.00

Driller:	MDOT	Elevation (m):	94.40	Auger ID/OD:	N/A
Operator:	C.Mann/G.Lidstone/B.Hyland	Datum:	NGVD	Sampler:	Standard Split Spoon
Logged By:	K.Maguire	Rig Type:	CME 45C	Hammer Wt./Fall:	63.5 kg/760 mm
Date Start/Finish:	10/21/02-10/22/02	Drilling Method:	Spun Cased Wash Boring	Core Barrel:	N/A
Boring Location:	23+025.5, CL	Casing ID/OD:	HW-100/113 mm	Water Level*:	

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample attempt
U = Thin Wall Tube Sample
R = Rock Core Sample
V = Insitu Vane Shear Test
SSA = Solid Stem Auger

Definitions:
S_u = Insitu Field Vane Shear Strength (kPa)
T_v = Pocket Torvane Shear Strength (kPa)
q_p = Unconfined Compressive Strength (Pa)
$S_{u(lab)}$ = Lab Vane Shear Strength (kPa)
WOH = weight of 64 kg hammer
WOR = weight of rods

Definitions:
WC = water content, percent
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index
G = Grain Size Analysis
C = Consolidation Test

Depth (m)	Sample No.	Pen/Rec (cm)	Sample Depth (m)	Blows (150 mm) Shear Strength (kPa) or RQD (%)	N-value	Casing Blows	Elevation (m)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
19.2									18.96-19.26 (1:44) 19.26-19.57 (3:12) 19.57-19.87 (4:05) When casing was pulled, spinning shoe was entirely worn away. No refusal encountered.	
							74.53		19.87	
									Bottom of Exploration at 19.87 m below ground surface.	
20.4										
21.6										
22.8										
24										
25.2										
26.4										
27.6										

Remarks:

1. Spoon driven with safety hammer.
2. Elevation is from Bridge Deck, not from Lake Bottom.

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.

Appendix B

Laboratory Data

State of Maine - Department of Transportation

Laboratory Testing Summary Sheet

Town(s): Poland   Project Number: 10014.00

Boring & Sample Identification Number	Station (Meter)	Offset (Meter)	Depth (Meter)	Reference Number	G.S.D.C. Sheet	W.C.	L.L.	P.I.	Classification		
									Unified	AASHTO	Frost
BB-PMR-101, 3D	23+030.2	0.27 RT.	4.27-4.88	97875	1	20.6			SP-SM	A-3	0
BB-PMR-101, 5D	23+030.2	0.27 RT.	7.32-7.92	97376	1	10.0			SM	A-4	IV
BB-PMR-102D, 3D	23+025.5	CL	6.10-6.71	97377	2	28.8			CL-ML	A-4	IV
BB-PMR-102D, 5D	23+025.5	CL	9.14-9.75	97378	2	14.3			ML	A-4	IV

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 MDOT and Corps of Engineers Classification Systems.

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

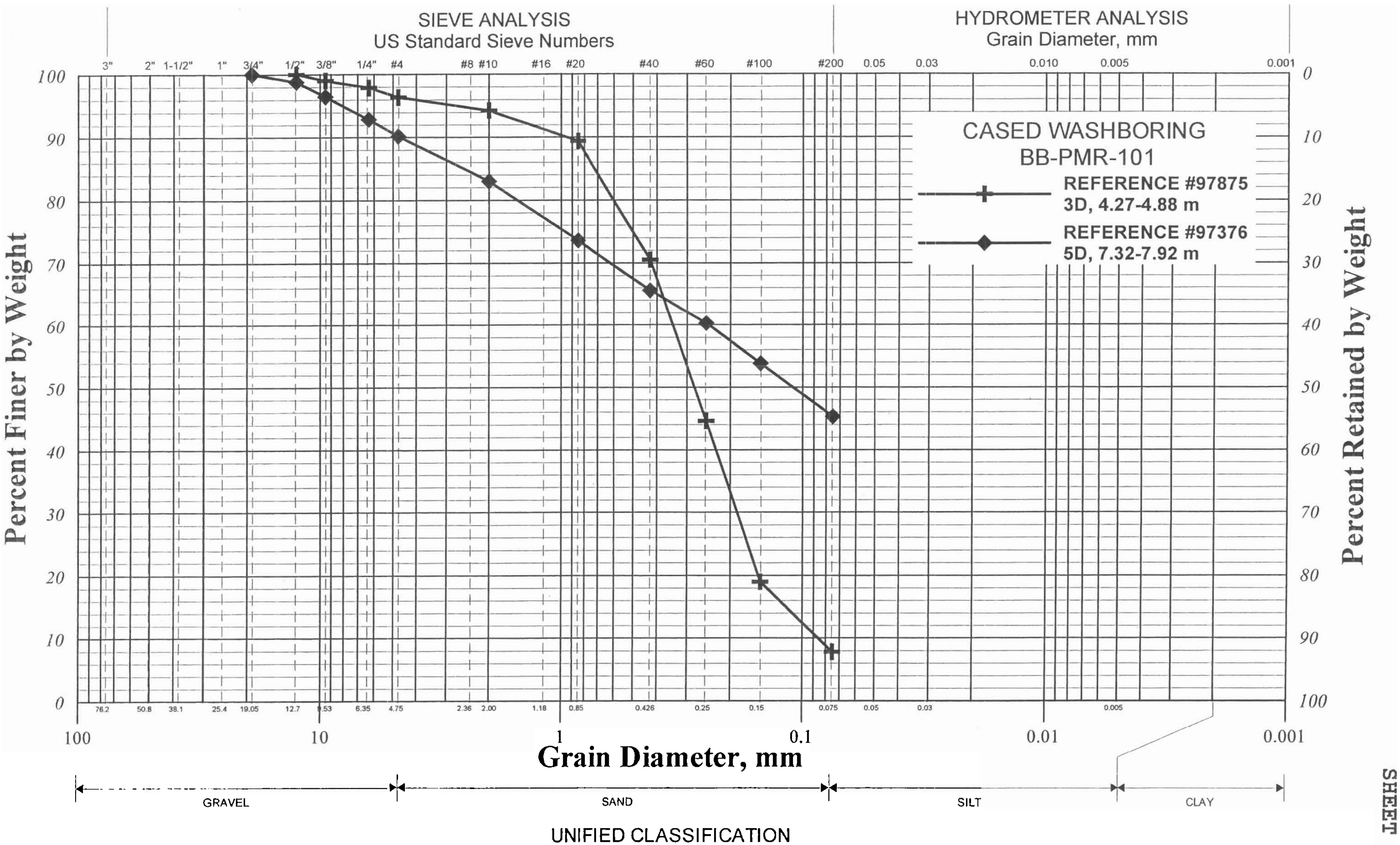
WC = water content as determined by AASHTO T 265-93 and/or ASTM D 2216-98

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

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

State of Maine Department of Transportation

GRAIN SIZE DISTRIBUTION CURVE



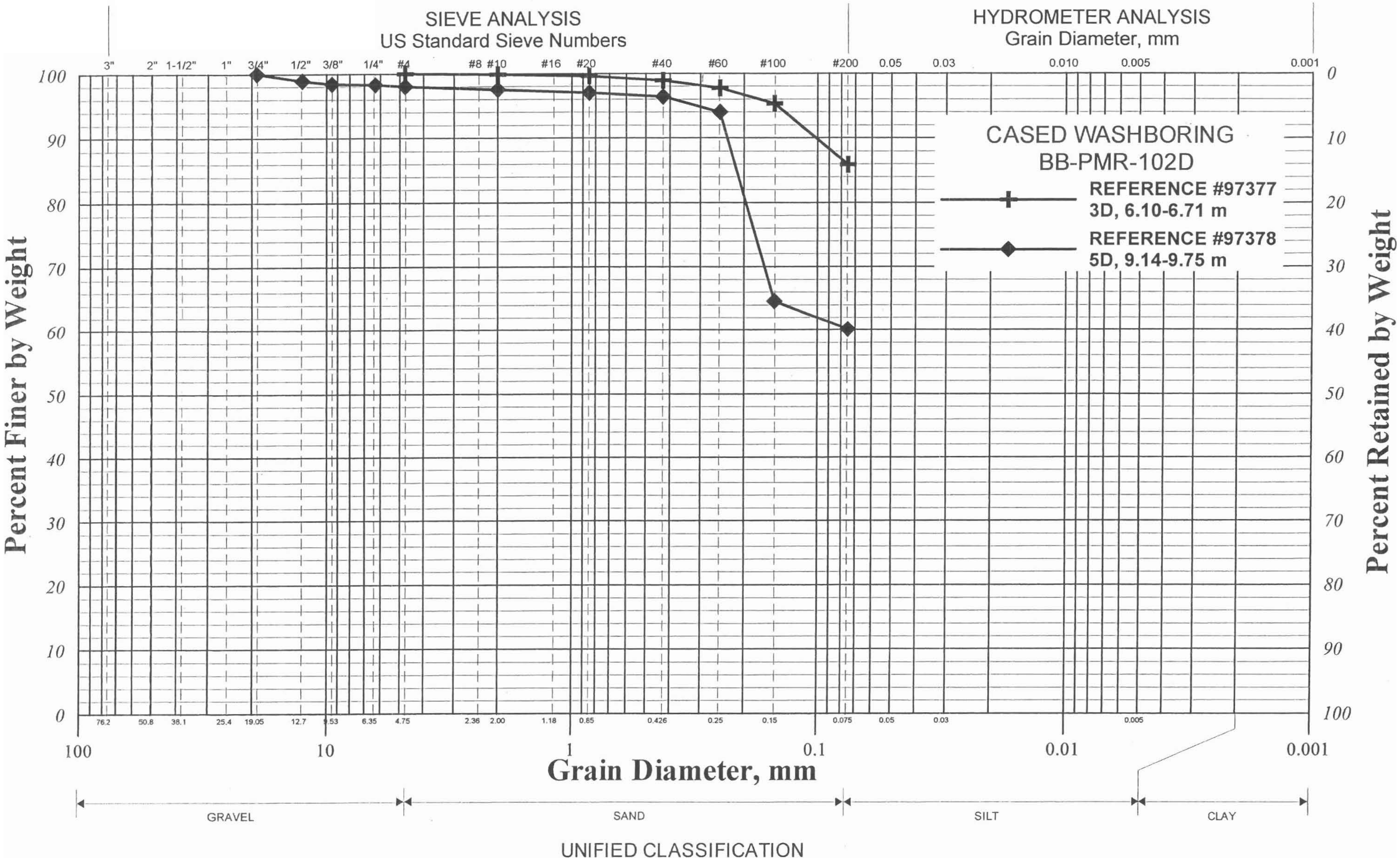
SHEET NO

PIN: 10014.00
Town: Poland

Reported by: T.White
Date: 11/13/02

State of Maine Department of Transportation

GRAIN SIZE DISTRIBUTION CURVE



PIN: 10014.00
Town: Poland

Reported by: T.White
Date: 11/13/02

Appendix C

Calculations

Definition of Units:

$psf := \frac{lbf}{ft^2}$ $pcf := \frac{lbf}{ft^3}$ $Mg := 1000 \cdot kg$ $kN := 1000 \cdot newton$ $kPa := \frac{kN}{m^2}$ $tsf := g \cdot \left(\frac{ton}{ft^2}\right)$ $kip := 1000 \cdot lbf$

$ksf := \frac{kip}{ft^2}$ $ft = 0.305\ m$ $in = 0.025\ m$ $MPa := 1000 \cdot kPa$ $ksi := \frac{kip}{in^2}$

Frost Protection:

From the Design Freezing Index Map:

DFI = 1360 degree-days

From the nomograph:

$Frost\_depth := 50\ in$

$Frost\_depth = 4.167\ ft$

$Frost\_depth = 1.27\ m$

Use 1.3 meters

Note: The final depth of footing embedment may be controlled by the scour susceptibility of the foundation material and may, in fact, be deeper than the depth required for frost protection.

Bearing Capacity: Native Soils

The spread footing for the widened abutments will be founded on native sands at an approximate Elevation of 90.0 meters (295.27 ft).

Part I.

Assumed parameters for the native sands:

$\gamma := 125 \cdot pcf$ $\phi := 34 \cdot deg$ $c := 0\ psf$ from Foundation Analysis and Design, Bowles 4th Edition Table 3-4 pg 141

$\gamma_1 := 125 \cdot pcf - 62.4 \cdot pcf$

$\gamma_1 = 62.6 \cdot pcf$ unit weight of native granular soils = 125 pcf less 62.4 pcf unit weight of water for effective unit weight

Assume a footing width of 0.6 m (2 ft) - for wingwall

$B := 2 \cdot ft$

From Bowles 4th Edition Table 4-2 pg 189 for ϕ = 34

$N_c := 52.6$ $N_q := 36.5$ $N_\gamma := 36.0$

From Bowles 4th Edition Table 4-1 pg 188
Assume strip footing:

$s_c := 1.0$ $s_\gamma := 1.0$

Assume footing embedment, D_f of 1.3 m (4.3 feet) based on frost protection

$D_f := 4.3 \cdot ft$ $q_{bar} := \gamma_1 \cdot D_f$ $q_{bar} = 269.18 \cdot psf$

$q_{ult} := c \cdot N_c \cdot s_c + q_{bar} \cdot N_q + 0.5 \cdot \gamma_1 \cdot B \cdot N_\gamma \cdot s_\gamma$

$q_{ult} = 5.783 \cdot 10^5\ Pa$ $q_{ult} = 1.208 \cdot 10^4 \cdot psf$

$q_{all} := \frac{q_{ult}}{3}$ $q_{all} = 1.928 \cdot 10^5\ Pa$ $q_{all} = 192.777 \cdot kPa$

$q_{all} = 4.026 \cdot 10^3 \cdot psf$ $q_{all} = 4.026 \cdot ksf$ $q_{all} = 2.013 \cdot tsf$

$Q_{all} := 2.0 \cdot tsf$ $Q_{all} = 191.521 \cdot kPa$ $Q_{all} = 4 \cdot 10^3 \cdot psf$ $Q_{all} = 4 \cdot ksf$

Part II.

Based on NavFac DM 7.2 pg 142-143 Table 1 - "Presumptive Values of Allowable Bearing Pressures for Spread Foundations"

Type of Bearing Material:	Consistency In Place:	Allowable Bearing Pressure tons per square foot:	Recommended value:
Fine to medium sand, silty or clayey medium to coarse sand	Very compact	3 to 5	3 tsf
	Medium to compact	2 to 4	2.5 tsf
	Loose	1 to 2	1.5 tsf

Assume medium to compact conditions Say 2.0 tsf

$bearing\_capacity := 2.0 \cdot tsf$ $\quad bearing\_capacity = 1.915 \cdot 10^{5}\ Pa$

$bearing\_capacity = 4 \circ ksf$ $\quad bearing\_capacity = 191.521 \circ kPa$

Settlement Analysis:

Schmertmann 1970/1978 Procedure
Reference: Fang - Foundation Engineering Handbook 1991
Section 5.5.3 pg 179

Spread footings for the widened abutmentswill be founded at approximately elevation 90.0 m (295.27 ft) on meduim dense, fine to coarse sand overlying a layered sand and silt.

Simplified soil profile:

Ground
Elevation 94.4 m (309.71 ft)

Fill Sand
Assume: N=12 bpf (medium dense)
γ = 125 pcf

Groundwater
Elevation 91.96 m (301.71 ft)

Footing
Elevation 90.0 m (295.27 ft)

fine to coarse Sand
Assume: N=16 bpf (medium dense)
γ = 125 pcf

Layered Sand and Silt
Elevation 88.5 m (290.35 ft)

Sand and Silty
Assume: N=25 bpf (medium dense)
γ=120 pcf

Silty Sand with cobbles and boulders
Elevation 82.0 m (269.03 ft)

Silty Sand with cobbles and boulders
Assume: N=50 bpf (dense)
γ=130 pcf

No refusal surface encountered

Schmertmann's 1978 procedure for strip footing:

Assume B = 2 ft (0.61 m) - minimum allowable footing width

$B = 0.61\ m$ $\qquad$ L / B = $\dfrac{3 \cdot m}{0.61 \cdot m} = 4.918$ $\qquad$ Look at plane-strain conditions L/B > 10

$L_{abt} := 3 \cdot m$

L is roadway width

$q_{allw} := 4000 \cdot psf$ $\qquad$ Based on bearing capacity calcs above

Δq is the change in vertical stress at the footing elevation

The thickness of the fill sand above is 11.4 ft (3.5 m)
Assume γ = 125 pcf for the fill sands
Water table is at elevation 301.71 ft

$$\Delta q := q_{allw} - (8.0 \cdot ft \cdot 125 \cdot pcf + 3.15 \cdot ft \cdot (125 \cdot pcf - 62.4 \cdot pcf))$$

$\Delta q = 134.199 \cdot kPa$ $\qquad$ $\Delta q = 2.803 \cdot 10^3 \cdot psf$ $\qquad$ net load intensity at foundation depth

$$q_{vo} := (8.0 \cdot ft \cdot 125 \cdot pcf + 3.15 \cdot ft \cdot (125 \cdot pcf - 62.4 \cdot pcf))$$

$$q_{vo} = 1.197 \cdot 10^3 \cdot psf$$

$$\sigma_{vp} := (8.0 \cdot ft \cdot 125 \cdot pcf) + 3.15 \cdot ft \cdot (125 \cdot pcf - 62.4 \cdot pcf) + (120 - 62.4) \cdot pcf \cdot 2 \cdot ft$$

$$\sigma_{vp} = 1.312 \cdot 10^3 \cdot psf$$

$I_{zp} := 0.5 + 0.1 \left(\sqrt{\dfrac{\Delta q}{\sigma_{vp}}} \right)$ $\qquad$ $I_{zp} = 0.646$

Determination of Es:

For medium dense silty sand N-value (Nv): $\qquad N_v := 16$ $\qquad$ From Boring data

$q_c := N_v \cdot 3.5$ $\qquad$ From table 5.6

$q_c = 56$

From Equation 5.11

$E_s := q_c \cdot 3.5$ $\qquad$ $E_s = 196$

For plane strain conditions

Layer	z	Δz	I_z	q_c	E_s	$I_z \cdot \frac{\Delta z}{E_s}$
1	2 ft	1 ft	0.42	56	196.0	0.00214
	6 ft	5 ft	0.32	56	196.0	0.00816
					Σ	0.01030

$\sigma_{vo} := q_{vo}$ $\qquad \sigma_{vo} = 1.197 \cdot 10^3 \cdot \mathrm{psf}$

$C_1 := 1 - 0.5 \cdot \left(\frac{\sigma_{vo}}{\Delta q}\right)$ $\qquad C_1 = 0.786$

$C_2 := 1.0$

Se = C1 x C2 x Δq x (Σ (Iz/Es) x Δz)

$Se := 0.786 \cdot 1.0 \cdot \frac{1197}{2000} \cdot 0.01030$

$Se = 0.00485$ Feet of settlement

$Se \cdot 12 = 0.058$ Inches of settlement