GEOTECHNICAL DESIGN REPORT
REPLACEMENT OF WEST MOUNT VERNON BRIDGE NO. 2390

ROUTE 41 OVER ECHO LAKE STREAM
MAINE DOT WIN 21698.00
MOUNT VERNON, MAINE

Proactive By Design.
Our Company Commitment

Prepared for:
Maine Department of Transportation
Augusta, Maine

October 2018
09.0025937.01

Prepared by:

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VIA EMAIL

October 9, 2018
File No. 09.0025937.01

Ms. Laura Krusinski
Maine Department of Transportation
16 State House Station
Augusta, Maine 04333

Re: Geotechnical Design Report
Replacement of West Mount Vernon Bridge No. 2930
Route 41 over Echo Lake Stream
MaineDOT WIN 21698.00
Mount Vernon, Maine

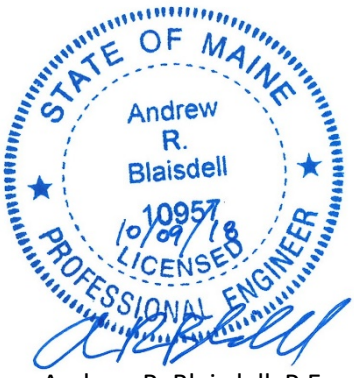
Dear Laura:

We are pleased to provide this Geotechnical Design Report, which includes design recommendations for the highway bridge foundations planned for the replacement of West Mount Vernon Bridge No. 2930, Route 41 over Echo Lake Stream in Mount Vernon, Maine. Our services were provided in accordance with Assignment Letter No. 11 (dated August 7, 2017) associated with the Bridge Program Multi-PIN Project Contract Number 20150608000000000793 between MaineDOT and GZA dated July 22, 2015, which incorporates GZA's Proposal No. 09.P000042.18, dated July 18, 2017. This report is subject to the *Limitations* included in **Appendix A**.

It has been a pleasure serving Maine Department of Transportation on this phase of the project, and we look forward to our continued work with you through project completion. If you have any questions regarding the report, or if we can provide further assistance, please do not hesitate to contact the undersigned.

Very truly yours,

GZA GEOENVIRONMENTAL, INC.



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1.0 INTRODUCTION

This report presents the results of GZA GeoEnvironmental, Inc.'s (GZA's) geotechnical evaluation for the replacement of West Mount Vernon Bridge No. 2930, Route 41 over Echo Lake Stream in Mount Vernon, Maine. Our services were provided in accordance with Assignment Letter No. 11 (dated August 7, 2017) associated with the Bridge Program Multi-PIN Project Contract Number 20150608000000000793 between Maine Department of Transportation (MaineDOT) and GZA dated July 22, 2015, which incorporates GZA's Proposal No. 09.P000042.18, dated July 18, 2017. This report is subject to the *Limitations* included in **Appendix A**.

1.1 BACKGROUND

MaineDOT plans to replace the West Mount Vernon Bridge carrying Route 41 over Echo Lake Stream. Our understanding of the existing bridge is based on drawings for the West Mount Vernon Bridge over Echo Lake Stream, dated March 1929. The West Mount Vernon Bridge was built in 1929 and is a scour critical, 46-foot-long, two-span, flat concrete slab bridge on mass concrete foundations supported by spread footings.

Based on our review of the 98 percent plan set prepared by HNTB, the bridge designer, and provided by MaineDOT, the replacement bridge is anticipated to be a 70-foot-long, single-span bridge consisting of precast concrete beams with integral abutment substructures, the location of which is shown on **Figure 2, Boring Location Plan**. The abutment height will be approximately 10 feet, with bottom-of-pile cap elevations of El. 314.8 and El. 315.9 at Abutment 1 and Abutment 2, respectively. Elevations in this report are in feet and reference the North American Vertical Datum of 1988 (NAVD 88).

Each abutment will be supported on four piles. Based on information provided by HNTB, we understand the maximum factored axial pile load is 365 kips for the strength loading condition and a four-pile configuration. HNTB estimated that the maximum thermal deformation of the bridge superstructure could result in 0.29 inches of lateral deflection at each abutment, including creep and shrinkage movement.

The horizontal alignment of the roadway and bridge in the project area will not be significantly modified as part of the project. The approach roadway will be filled to approximately 1 foot above existing grades, and the roadway will be super-elevated and widened by about 6 feet to match the increased bridge width of approximately 32 feet. Approach embankment modifications will include placing additional fill along the sides of the approach embankments to facilitate the widening and provide a slope inclination of 3 horizontal to 1 vertical (3H:1V) in the vicinity of the bridge, resulting in the new toe of the approach embankments up to about 10 feet outside of the current toe. The bridge opening at water level will be increased significantly, which will be achieved by removal of the existing pier and abutments down to El. 315 (approximately 1 foot below streambed level) and excavation of soil on the water side of the new abutments to proposed grades. Riprap will be placed in front of each abutment and along the lower portion of embankment slopes.

The project plans call for traffic to be maintained on Route 41 using a temporary bridge constructed south of the proposed bridge.

1.2 OBJECTIVES AND SCOPE OF SERVICES

The objectives of our work for the project are to evaluate subsurface conditions and provide geotechnical engineering recommendations and construction considerations for bridge construction. To meet these objectives, GZA completed the following Scope of Services:

- Reviewed subsurface information provided by MaineDOT;
- Logged three of the six borings completed for the project;
- Completed geotechnical evaluations for soil properties; frost susceptibility of approach embankments; AASHTO LRFD load and resistance factors associated with geotechnical design elements; nominal resistance of pile foundations; pile drivability; lateral pile evaluations; and seismic design considerations;
- Developed geotechnical engineering recommendations including foundation design recommendations for driven piles, lateral earth pressures and seismic design parameters; and
- Prepared this report summarizing our findings and design recommendations.

2.0 SUBSURFACE EXPLORATIONS

Six test borings were drilled in April and May 2017, including three behind each existing abutment. Borings BB-MLEV-101, -101A and -101B were drilled and logged by MaineDOT behind the existing west abutment. Borings BB-MLEV-102, -102A and -102B were drilled by Northern Test Boring, Inc. behind the existing east abutment and logged by GZA. Borings BB-MLEV-101, -101A, -102, and -102A either met refusal on cobbles/boulders in fill or were terminated due to broken casing in deeper natural materials, as noted on the boring logs in **Appendix B**.

The borings that were successfully drilled to the desired depth, BB-MVEL-101B and BB-MVEL-102B, were drilled to depths of 121 and 106 feet below existing ground surface, respectively. The other four borings met refusal or were terminated at depths between 7 and 47 feet. The borings were drilled using 3- and 4-inch casing and drive-and-wash drilling techniques, as noted on the boring logs. Standard penetration testing and split-spoon sampling were performed at 5-foot typical intervals, using a 24-inch-long, 1-3/8-inch inside-diameter sampler. The Standard Penetration Test (SPT) sampler was driven using an automatic hammer with a calibrated energy transfer rate of 0.854. 2-inch diameter bedrock cores were obtained from borings BB-MLEV-101B and -102B. Core lengths ranged from 5 to 12.3 feet in each boring.

Upon completion, the borings were backfilled with cuttings and asphalt cold patch and marked for MaineDOT Survey. The as-drilled locations and elevations were surveyed by MaineDOT surveyors and provided to GZA.

3.0 LABORATORY TESTING

Soil testing was performed by MaineDOT Testing Laboratories in Bangor, Maine. The testing program included:

- 14 gradation analysis / MaineDOT Frost Classification / Unified Soil Classification System (USCS) assessments; and
- 14 moisture content tests.

Results of the testing are included in **Appendix C**.

4.0 SUBSURFACE CONDITIONS

4.1 SURFICIAL AND BEDROCK GEOLOGY

Based on available literature[1], the surficial geologic unit mapped in the area is glacial till and is described as poorly sorted, massive to weakly stratified mixture of sand, silt, and gravel-sized rock debris deposited by glacial ice, with local lenses of water-laid sand and gravel (i.e., local alluvial deposits). An area of scattered boulders was mapped on the surface approximately 1,500 feet west of the site.

According to the available bedrock geology mapping [2,3], bedrock at the site is mapped as the Sangerville Formation, and is described as thickly bedded, fine- to coarse-grained, light gray, calcareous, graywacke metasandstone, with thinly interlaminated metasiltstone or metapelite.

4.2 SUBSURFACE PROFILE

Three soil units were encountered beneath asphalt pavement or topsoil and above bedrock at the site: Fill, Alluvium, and Glacial Till. The approximate thicknesses and generalized descriptions of the subsurface units are presented in the following table, in descending order from existing ground surface. Detailed descriptions of the materials encountered at specific locations are provided in the boring logs in **Appendix B**. The subsurface conditions are also shown in relation to the bridge alignment on the interpretive subsurface profile in **Figure 3**.

[1] Thompson, Woodrow B., and Smith, Geoffrey W., 2008, Surficial geology of the Fayette quadrangle, Maine: Maine Geological Survey, Open-File Map 08-44, map, scale 1:24,000.*Maine Geological Survey Maps*. 1804. http://digitalmaine.com/mgs_maps/1804

[2] Osberg, Philip H., Hussey II, Arthur M., Boone, Gary, M., 1985. Bedrock Geologic Map of Maine, Maine Geological Survey, Department of Conservation, map, scale 1:500,000.

[3] Pankiwskyj, Kost A., 1978. Bedrock Geology of the Livermore Quadrangle, Maine, Maine Geological Survey, Department of Conservation, map, Scale 1:62,500.

Soil Unit	Approximate Encountered Thickness (ft)	Generalized Description
Fill	8 to 23	Varying from brown to light brown, very loose to very dense, Gravelly fine to coarse SAND, trace Silt to Silty fine to coarse SAND, little to trace Gravel, probable cobbles and boulders throughout. (USCS: SM, SP). MaineDOT Frost Classification = II *Encountered in all borings.*
Alluvium	16 to 21	Varying from gray, medium dense to dense, Gravelly fine to coarse SAND, some Silt, to fine to coarse SAND, some Silt, some to trace Gravel, possible cobbles and boulders. (USCS: SM). MaineDOT Frost Classification = II *Encountered in boring BB-MVEL-101.*
Glacial Till	76 to 78	Varying from gray, very dense, fine to coarse SAND, some to little Silt, little to trace Gravel, possible cobbles and boulders (USCS: SM, SP), to Dark gray, hard, Sandy SILT, trace Gravel (USCS: ML). MaineDOT Frost Classification = II to IV *Encountered in all borings.*
Encountered Top of Bedrock Elevation	Abutment 1 (BB-MLEV-101B): Approx. El. 215 (109 feet bgs) Abutment 2 (BB-MLEV-102B): Approx. El. 223 (101 feet bgs)	

Note: "bgs" = below ground surface

4.2.1 Bedrock

Bedrock was cored in two test borings and was identified as Metasandstone and Schist. The bedrock was generally described as soft to hard, fresh to highly weathered, medium grained, and white to gray. The joints were very close to close, low angle to vertical, fresh to discolored, rough, planar to undulating, partially open to open, with sand infilling. The Rock Quality Designation (RQD) ranged from 0 to 40 percent corresponding to a Rock Mass Quality of Very Poor to Poor.

4.2.2 Groundwater

Groundwater depths measured in the borings ranged from approximately 4.6 to 7.8 feet bgs, corresponding to El. 317 to El. 319.4. Groundwater levels in the borings were measured during or immediately after drilling and may have been affected by drilling procedures, which included introduction of water for drilling purposes.

The groundwater observations were made at the times and under the conditions stated in the borings logs. Fluctuations in groundwater level occur due to variations in season, precipitation, and construction activities in the area. Consequently, water levels during construction are likely to vary from those encountered at the time the observations were made.

5.0 GEOTECHNICAL DESIGN CONSIDERATIONS

5.1 GENERAL

GZA has conducted geotechnical engineering evaluations in accordance with *2017 AASHTO LRFD Bridge Design Specifications, 8th Edition, with Interims* (AASHTO) and the *MaineDOT Bridge Design Guide, 2014 Edition* (MaineDOT BDG). Supporting calculations developed by GZA for the project are attached in **Appendix D** of this report.

5.2 APPROACH EMBANKMENTS

The approach embankments will be raised less than approximately 2 feet above existing grades, with minor widening of the side slopes. Soils beneath the embankment consist primarily of medium dense to very dense sand. As a result, negligible settlement is anticipated at the approaches, and it is our opinion that the potential for global instability of the approach embankments is low.

5.3 SEISMIC DESIGN CONSIDERATIONS

Seismic site class was evaluated in accordance with the 2017 AASHTO LRFD, along with consideration of the *2011 AASHTO Guide Specifications for LRFD Bridge Design* (Seismic Guide Specification).

The subsurface profile for seismic design includes the proposed approach fills and soil strata described above. Seismic site class was determined in general accordance with LRFD Table C3.10.3.1 using the average SPT N-value from the soil materials encountered in the borings. The average SPT N-value for the upper 100 feet is greater than 50 blows per foot. Therefore, we recommend that the site be assigned to Site Class C.

The available subsurface data indicates that the natural materials encountered at the site are sufficiently dense that the potential for liquefaction is very low.

5.4 EVALUATION OF FOUNDATIONS

5.4.1 Foundation Type Assessment

Based on constructability, cost considerations and scour concerns, we conclude that driven HP 14x89 steel piles are an appropriate foundation type for the bridge. Design considerations are presented below.

5.4.2 Pile Design Considerations

The axial geotechnical resistance of piles was calculated using the digital analytical software *APile* by Ensoft. Analytical methods employed in APile included the FHWA (Nordlund), USACE (Nordlund with effective stress cut-off at a critical depth [10B]), API and Meyerhof methods. Based on comparison of the results of each method, we conclude that the piles will achieve the required nominal resistance between 85 feet and the top of rock.

For H-piles, the potential for the tip to become partially- or fully-plugged, which would likely result in shorter pile lengths, depends on the presence of very dense soil and gravel, cobbles or boulders, which is difficult to predict. The resistance on our analyses is based on uniform granular soil properties in the Alluvium and Glacial Till strata and an unplugged pile tip (steel end area only) and does not consider the potential for discrete layers of dense gravel, cobbles, and boulders to cause a pile to refuse at shallower depth.

The results predict a pile length of 87 feet, and top-of-rock was encountered between 92 and 100 feet below the top-of-pile. Therefore, it is feasible that the piles will achieve the required pile resistance in glacial till above bedrock, especially if a partial plug is developed. Because geotechnical resistance is predicted to be achieved within 5 to 13 feet above the top-of-rock, we recommend assuming that the piles will be driven to bedrock to estimate pile quantities. The geotechnical side resistance was used as an input in wave equation analyses conducted to assess the pile drivability. Axial tensile geotechnical (uplift) resistance was not evaluated because the structural loads provided by HNTB do not include uplift loading on the piles.

By utilizing steel H-piles for support of the abutments driven to or near bedrock, total and differential settlement will be limited to elastic compression of the piles and should be less than ½ inch.

Boulders, cobbles, and debris were encountered within the top 30 feet of the borings. Difficult driving conditions are possible within this depth range. Therefore, GZA recommends predrilling to a depth of 30 feet below existing grade (approximately El. 294, 21 to 22 feet below the bottom of abutment), to limit potential for obstructions during pile driving. Predrilling will also ensure that the piles achieve sufficient penetration to achieve fixity for lateral load resistance. Additional construction considerations for predrilling are presented in **Section 7.2**.

The piles will be installed on land through the approach embankments. Therefore, corrosion was not considered in the design.

5.4.3 Load and Resistance Factors

Piles should be designed for the geotechnical resistance of the piles. In GZA's experience for piles gaining a significant portion of their geotechnical resistance in very dense soil or bedrock, the drivability resistance will control the geotechnical static resistance of the pile. The piles will be driven to a nominal resistance calculated by dividing the maximum factored pile load (Strength I load case) by a resistance factor of 0.65, per AASHTO Table 10.5.5.2.3-1. Resistance factors for service and extreme limit state design should be taken as 1.0.

Structural resistance of the piles should be checked at the strength limit state considering a resistance factor ϕ_c=0.50, per AASHTO LRFD Article 10.7.3.2.3 for hard driving condition. Since the piles will be subject to lateral loading, the piles should also be checked for resistance to combined axial compression and flexure per AASHTO LRFD Articles 6.9.2.2 and 6.15.2. Per LRFD Article 6.5.4.2, the axial resistance factor ϕ_{cc}=0.75 and the flexural resistance factor ϕ_f=1.0 should be applied to the combined axial and flexural resistance of the pile in the interaction equation (AASHTO LRFD Eq. 6.9.2.2-1).

AASHTO LRFD load factors should be applied to horizontal earth pressure (EH), vertical earth pressure (EV), earth surcharge (ES), live load surcharge (LS) loads, and components and attachments (DC) loads

using the load factors for permanent loads (γ_p) provided in LRFD Table 3.4.1-2 for strength limit state foundation design.

5.4.4 Pile Type and Loading

A single row of four steel HP14x89 H-section piles are planned to support each abutment. HNTB provided a maximum factored axial load of 365 kips per pile for the strength condition; therefore, piles should be installed to a nominal axial resistance of at least 562 kips, calculated by dividing the maximum factored axial load by a geotechnical resistance factor of 0.65 for piles installed under hard driving conditions. The resistance factor assumes dynamic pile testing with signal matching analysis will be conducted during construction in accordance with AASHTO requirements to assess nominal geotechnical pile resistance.

5.4.5 Preliminary Pile Drivability Analysis

The pile-driving criteria are expected to be established based on dynamic pile testing with signal matching analysis. The piles should be driven to a nominal capacity calculated by dividing the maximum factored pile load by a resistance factor of 0.65, per LRFD Table 10.5.5.2.3-1.

A 98-foot-long pile, driven to bedrock, was used as the basis to conduct wave equation analyses to assess pile drivability using GRLWEAP. The allowable driving stress is equal to 90 percent of the pile yield stress, 45 ksi for Grade 50 steel.

The analyses set out to evaluate a pile-driving system that could achieve the required nominal pile resistance with the selected soil model, and without exceeding allowable driving stresses in the pile. A PILECO D19-42 open-end diesel hammer, operated at 100 percent fuel pressure, was used for the evaluation. The rated energy of the selected hammer is 42,506 foot-pounds. The nominal resistance was assumed to include 85 percent side friction. The results are summarized below.

PRELIMINARY WAVE EQUATION ANALYSIS RESULTS						
Pile Type	**Embedded Pile Length**	**Driving System**	**Nominal Geotechnical Resistance (kips)**	**Factored Geotechnical Resistance (kips)**	**Max Driving Stress (ksi)**	**Final Penetration Resistance (blows per inch)**
HP 14x89	98 feet	Pileco D19-42	562	365	28.3	8

Since the driving stresses do not exceed the limiting driving stress of 45 ksi for ASTM A572 steel (50 ksi yield stress), and the calculated penetration resistance is within the MaineDOT preferred range of 6 to 15 blows per inch, the analyzed hammer system is judged acceptable to install the piles to the required nominal resistance noted.

5.4.6 Lateral Pile Evaluations

GZA developed two soil profiles for the top 20 feet, predrilled and in-situ. For the predrilled profile, the upper 20 feet is modeled as loose sand, and for the in-situ profile, the upper 20 feet is modeled as dense to very dense sand, consistent with the soil encountered in the borings. These two conditions are considered to bracket the anticipated performance, where the depth to fixity is greatest for the loose

predrilled condition and the total pile stress is greatest for the in-situ condition. The in-situ case also accounts for potential densification of predrilled soil caused by cyclic deflection of the piles. Our recommended L-Pile input parameters are summarized in the table below.

Predrilled Profile, Pile Length = 98 feet						
Stratum	**Soil Model**	**Top of Layer Elevation (ft-NAVD88)**	**Layer Thickness (ft)**	**k (pci)**	**ϕ' (deg)**	**γ_e (pcf)**
Predrill Backill	Reese Sand	314	20	20	30 deg	58
Glacial Till	Reese Sand	294	78	160	41 deg	68

In-situ Profile, Pile Length = 98 feet						
Stratum	**Soil Model**	**Top of Layer Elevation (ft-NAVD88)**	**Layer Thickness (ft)**	**k (pci)**	**ϕ' (deg)**	**γ_e (pcf)**
Alluvium	Reese Sand	314	20	160	39 deg	63
Glacial Till	Reese Sand	294	78	160	41 deg	68

Notes:
1. Predrill backfill assumes the predrilled hole is filled with sand or a uniform pea stone.
2. Soil strata were modelled after BB-MVEL-101.
3. Lateral pile evaluations should include both profiles to assess impacts on pile deflections/fixity and stress.
4. Recommended modulus and unit weight values assume groundwater level at El. 317.
5. pci = pounds per cubic inch, deg = degrees, psf = pounds per square foot,
   a. γ_T = total unit weight (used above anticipated groundwater level),
   b. γ_e = effective unit weight (used below anticipated groundwater), pcf = pounds per square foot.

We understand that HNTB is completing lateral pile analyses to evaluate pile fixity and combined stresses in conjunction with the structural design.

5.4.7 Lateral Earth Pressure

Thermal expansion of the bridge will cause the backwalls and wingwalls of the integral abutment to move toward the backfill, which will result in earth pressures ranging from at-rest to passive earth pressure. The material properties will be controlled by the backfill material, which is proposed to consist of BDG Type 4 soil.

Based on the estimated thermal bridge expansion of 0.29 inches and the abutment height of 10 feet, the calculated abutment rotation is 0.0024 feet/foot. In accordance with the requirements of the BDG Section 5.4.2.11, integral abutment reinforcement is to be designed for full Coloumb passive pressure if the wall rotation is greater than 0.005 feet/foot. Therefore, we conclude that a lateral earth pressure less than full Coloumb passive can be used for design. The *Massachusetts Department of Transportation LRFD Bridge Design Manual* provides the empirical equation below to calculate lateral earth pressure coefficient (K) based on the ratio of deflection (δ_t) and wall height (H).

$$K = 0.43 + 5.7[1 - e^{-190(\delta_T/H)}]$$

Design lateral earth pressure recommendations were developed based on this equation and are provided in **Section 6.3** of this report. AASHTO Commentary C3.10.9.1 specifies that single-span bridges are not required to include acceleration-augmented (earthquake-induced) soil pressures for design.

6.0 RECOMMENDATIONS

6.1 EMBANKMENT DESIGN CONSIDERATIONS

Embankment side slopes should be designed with MaineDOT-typical slope angles of 2H:1V or flatter, except in front of integral abutments where the typical 1.75H:1V slope angle will be used. Slopes should be provided with loam and seed for permanent erosion protection. If steeper slopes are required, additional means should be employed to limit surface erosion, such as fiber erosion control matting or riprap.

6.2 SEISMIC DESIGN

The United States Geological Survey Online Design Maps Tool was used to develop parameters for bridge design. Based on the site coordinates, the software provided the recommended AASHTO seismic design coefficients (Site Class C) for a 7 percent probability of exceedance in 75 years as follows:

SITE CLASS C SEISMIC DESIGN PARAMETERS	
Parameter	**Design Value**
Fpga	1.2
Fa	1.2
Fv	1.7
As (Period = 0.0 sec)	0.100 g
SDs (Period = 0.2 sec)	0.204 g
SD1 (Period = 1.0 sec)	0.080 g

Per AASHTO Article 4.7.4.2, single span bridges need not be analyzed for seismic loads, but the minimum requirements for superstructure connections and support lengths as specified in AASHTO Articles 4.7.4.4 and 3.10.9 apply.

6.3 ABUTMENT AND WINGWALL DESIGN

- Backfill between new abutments and a 1.5H:1V plane extending up from the bottom of the abutment to the pavement subgrade should consist of MaineDOT 703.19 Granular Borrow for Underwater Backfill, BDG Type 4 soil. Recommended soil properties for Type 4 soils to be used as backfill are as follows:
  - Internal Friction Angle of Soil = 32°
  - Soil Total Unit Weight = 125 pcf
  - Coefficient of Earth Pressure, K= 2.52 (use for design of backwalls and wingwalls)
- Live load surcharge should be applied as a uniform lateral surcharge pressure using the equivalent fill height (H_{eq}) values developed in accordance with LRFD Section 3.11.6.4, based on the

abutment/wingwall height and distance from the wall backface to the edge of traffic. A minimum H_{eq} of 2 feet is recommended.

- Foundation drainage should be provided in accordance with Section 5.4.1.9 of the MaineDOT BDG. We recommend the use of French drains on the uphill side of abutments and wing walls to prevent buildup of differential hydrostatic pressure. The drains should be sloped to drain by gravity and should outlet through a series of 4-inch-diameter weep holes, spaced approximately 10 feet center-to-center.

6.4 PILE DESIGN

- The proposed abutments may be supported on HP14x89 ASTM A572, Grade 50 steel (50 ksi yield stress) H-piles driven to the required nominal resistance, anticipated to be developed through a combination of side friction and end-bearing on or near the bedrock surface.
- As a precaution against encountering refusal in a boulder in the overburden, cast steel pile points should be provided to limit pile damage during driving.
- Pile installation should be controlled using wave equation analysis and field logging of the pile installation with final penetration resistance based on dynamic pile testing with signal-matching analysis.
- The piles should be driven to a nominal resistance of 562 kips, calculated by dividing the maximum factored pile load of 365 kips by a resistance factor of 0.65.
- Preliminary wave equation analyses indicate that the piles can be driven to a nominal resistance of 562 kips using a diesel hammer with a rated energy of about 42.5 foot-kips for the anticipated 98-foot-long, ASTM A572 Grade 50 HP14x89 piles without exceeding the allowable driving stress of 45 ksi (0.9Fy for 50 ksi steel). The final penetration resistance was approximately 8 blows per inch, which is within the MaineDOT range of 6 to 15 blows per inch.
- The pile tip elevations used in the drawings should correspond to the bedrock elevations encountered in the borings and shown on the interpretive subsurface profile (approximately El. 215 at Abutment 1, and approximately El. 224 at Abutment 2). A provision is recommended in the drawings for extra pile length to account for variability in the top-of-rock surface and the potential for piles to penetrate a short distance into the bedrock.
- We recommend that one pile at each abutment be dynamically tested at the end of initial drive to assess driving stress and establish the penetration resistance criteria to achieve the required nominal resistance for the production piles. The plans should also require a restrike test on each test pile. In the event that the initial driving results are favorable and show sufficient excess resistance to allow for some relaxation, the restrike tests may be waived.
- Piles shall be spliced in accordance with MaineDOT Section 501.047.
- The structural engineer should complete structural evaluation of the piles, checking for combined stresses by incorporating the Lateral Input Parameters summarized in **Section 5.4.3** in accordance with the design steps listed in BDG Section 5.4.2.4.C.

6.5 GRADATION DATA FOR SCOUR ANALYSIS

Available laboratory data for the soil within the upper 30 feet below ground surface was evaluated to estimate D50 values, as summarized in the table below.

Boring & Sample ID Number	Depth (feet)	Water Content (%)	D_{50} (mm)	Classification	
				USCS	AASHTO
BB-MVEL-101, 4D	15.0-17.0	10.5	0.14	SM	A-2-4
BB-MVEL-101B, 1D	30.0-31.0	8.7	0.2	SM	A-2-4
BB-MVEL-102, 4D	14.0-16.0	13.4	0.15	SM	A-2-4
BB-MVEL-102, 6D	25.0-27.0	10.9	0.17	SM	A-2-4
BB-MVEL-102, 7D	30.0-32.0	9.6	0.11	SM	A-4

7.0 CONSTRUCTION CONSIDERATIONS

This section provides guidance regarding quality control during pile installation, excavation, dewatering, and foundation subgrade preparation and protection. These items are discussed in the paragraphs that follow.

7.1 PILE INSTALLATION CONTROL

We recommend that the pile installation be controlled using wave equation analysis and field logging of the pile installation and that final penetration resistance be based on dynamic pile testing with signal matching analysis. As previously noted, the piles should be driven to a nominal capacity calculated by dividing the maximum factored pile load by a resistance factor of 0.65, per AASHTO Table 10.5.5.2.3-1.

AASHTO Table 10.5.5.2.3-1 requires that at least one load test with signal-matching be performed per substructure to use a resistance factor of 0.65. Considering the uncertainty in pile length and geotechnical resistance for this project, it is recommended that a total of two Pile Driving Analyzer (PDA) tests with signal-matching be completed, one at each abutment, including at least one pile restrike. Pile restrikes with PDA testing may be warranted at both piles if significant variation is found between end of drive and beginning of restrike resistance.

Additional PDA testing may be recommended if unanticipated conditions are encountered during installation, including early pile take-up, pile driving out-of-plumb, or otherwise unexplained variations in hammer performance. Restrike tests should not be waived for this project.

7.2 PREDRILLING

As noted previously, we conclude there is potential for difficult driving conditions in the upper 20 feet of the piles associated with cobbles, boulders and/or debris in the fill. Therefore, GZA recommends predrilling at each pile location to a depth of 30 feet below existing grade, consistent with the top of the glacial till stratum.

The minimum recommended predrill hole diameter to promote removal or displacement of potential obstructions within the pile area would be 2 feet. If a continuous-flight auger was used, the auger could be spun in the opposite direction as it is withdrawn from the hole, leaving the existing material in a loose condition. However, continuous-flight augers of this size are not readily available. If drilling equipment operated by a Kelly bar attachment is used, a variety of auger sizes are available, but it is not feasible to drill to the recommended predrill depth while depositing material back in the holes.

For planning purposes, we preliminarily recommend the following procedure:

- Excavate to approximately bottom of integral backwall elevation (or deeper if preferred by the contractor);
- Drill a minimum 24-inch-diameter hole to a depth of 20 feet (approximately El. 294) at each pile location using a continuous flight auger that is withdrawn while being spun in the opposite direction (having the effect of loosening the material) or using a drilling auger operated by a Kelly bar attachment;
- Place temporary casing as needed to prevent hole cave-in;
- Place sand or pea stone in the excavation; and
- Drive the piles.

If the predrill holes do not stay open for the majority of the 20-foot predrill depth, it may be necessary to either drill with temporary casing, or place a 30-inch-diameter corrugated polyethylene or metal pipe, and backfill around the pipe with flow fill or pea stone.

Although this procedure will add time to the schedule, it limits the potential for unexpected delays due to pile refusals. Based on our discussions with contractors experienced in this type of work, we anticipate that the predrilling would add two to four days to the duration of foundation installation.

7.3 EXCAVATION, TEMPORARY LATERAL SUPPORT AND DEWATERING

Excavations for abutment foundations are anticipated to range from 9 to 12 feet below existing pavement grades. It is our understanding that a temporary detour will be constructed south of the existing bridge, and the existing abutments may still be in place between the stream and excavation. Therefore, we anticipate sufficient space may be available and water conditions may permit the excavation slopes to consist of sloped, open cuts. In all cases, temporary excavations should comply with OSHA excavation safety requirements.

Considering the proximity of the required abutment excavations to the river water level, management of water will be related to river water levels at the time of construction. Considering bottom of backwall elevations at approximately El. 314.8 to El. 315.9 and Q1.1 at El. 317.97 for the stream, water levels may be at or above the bottom of excavation level during construction. It may be desirable to over-excavate and place an 8- to 12-inch-thick crushed-stone working mat to improve accessibility and allow dewatering.

We anticipate that the inflow of groundwater or surface water to excavations could be handled by open pumping from sumps installed at the bottom of excavations if cofferdams are installed or if the existing

abutment is left in place during excavation. Stacked sand bags or a porta-dam-type system may be sufficient to limit inflow of surface water in lieu of a sheet pile cofferdam or the existing abutment, given the relatively small anticipated head. The contractor should be responsible for controlling groundwater, surface runoff, infiltration and water from all other sources by methods which preserve the subgrade and permit concrete placement in-the-dry. Discharge of pumped groundwater and river water should comply with all local, State, and federal regulations.

7.4 REUSE OF ON-SITE MATERIALS

Based on the test boring results, the two fill samples tested had greater than 20 percent passing the No. 200 sieve, indicating the fill may not meet MaineDOT specifications for Granular Borrow and/or Granular Borrow for Underwater Backfill. The material is not considered suitable for use as Common Borrow.

If the contractor wishes to reuse excavated material as embankment fill or in other areas, we recommend that the proposed material be stockpiled and tested for grain size distribution. Stockpiled materials meeting the appropriate MaineDOT specifications may be reused on the project.

FIGURES

USGS QUADRANGLE LOCATION

N
W E
S

SOURCE : THIS MAP CONTAINS THE ESRI ARCGIS ONLINE USA TOPOGRAPHIC MAP SERVICE, PUBLISHED DECEMBER 12, 2009 BY ESRI ARCIMS SERVICES AND UPDATED AS NEEDED. THIS SERVICE USES UNIFORM NATIONALLY RECOGNIZED DATUM AND CARTOGRAPHY STANDARDS AND A VARIETY OF AVAILABLE SOURCES FROM SEVERAL DATA PROVIDERS. THIS MAP ALSO CONTAINS THE ESRI ARCGIS ONLINE USA COUNTIES WHICH PROVIDES DETAILED BOUNDARIES THAT ARE CONSISTENT WITH THE TRACT, BLOCK GROUP, AND STATE DATA SETS AND ARE EFFECTIVE AT REGIONAL AND STATE LEVELS.

0 1,000 2,000 4,000 6,000

SCALE IN FEET

Data Supplied by :

esri

USGS science for a changing world

GZA

PROJ. MGR.: BMC
DESIGNED BY: NVW
REVIEWED BY: TRB
OPERATOR: NVW

DATE: 09-20-2017

LOCUS PLAN
WEST MOUNT VERNON BRIDGE #2390

MOUNT VERNON, MAINE
MAINEDOT WIN 21698.00

JOB NO.
09.0025937.01

FIGURE NO.
1

© 2017 - GZA GeoEnvironmental, Inc. P:\09 Jobs\00259\00s\09.0025937.00 - MEDOT Mt. Vernon\09.0025937.01 - MDOT W. Mt. Vernon Bridge\Figures-CAD\Figure1-LocusPlanTemplate.mxd, 9/20/2017, 2:00:20 PM, Nicholas.williams

Filename: ...\00\GEOTECH\MSTA\006_BLP1.dgn Username: Terry.White Date:8/28/2018 Division: GEOTECH

CURVE DATA #1
PI = 11+28.01
D = 16°51'06.1"
Δ = 41°15'47.8" Lt.
R = 340.00'
L = 244.86'
T = 128.01'
E = 23.30'

MAG. 19½°

To Mount Vernon

PC = STA. 10+00.00

10+00

Pavement Sawcut

Variable Depth Mill and 4" HMA

CLL

CLI

11+00

PT = STA. 12+44.86

Taylor Pond Dam

Brick Chimney

Anticipated Proposed Pole Location Sta. 12+30.00, 26' Lt.

Existing Utility Pole (Relocated By Others)

℄ Brg. Abut No. 1 Sta. 12+75.08

℄ Brg. Abut No. 2 Sta. 13+45.08

70'-0" Span

Install Sediment Trap

Install 18" - 72" CMP Option III

Remove Culvert

Anticipated Proposed Pole Location Sta. 13+93.00, 21' Lt.

Existing Utility Pole (Relocated By Others)

Remove and Reset Boulders (Typ.)

R=10'

Remove Culvert

Variable Depth Mill and 4" HMA

32+87

32+00

31+00

30+00

12+00

13+00

14+00

15+00

16+

Sandy River Road

S 70°13'14.05" E

Route 41 (Pond Road)

To Readfield

BB-WEL-101

BB-WEL-101B

BB-WEL-101A

BB-WEL-102

BB-WEL-102B

BB-WEL-102A

R=15'

2" Mill, Variable Depth Shim, and 1½" Surface

LEGEND
CASED WASH BORING
PROBE

PLAN

25 0 25 50
Scale in Feet

Flow

Echo Lake Stream

Remove and Reset Signs

PC = STA. 14+82.37

PT = STA. 16+11.44

W-Beam Guardrail Mid-way Splice, Flared Terminal (Typ.)

Remove Existing Guardrail (Typ.)

W-Beam Guardrail Mid-way Splice (Typ.)

Sta. 11+57.77 Route 41 (Pond Road) ℄ = Sta. 30+00.00 Sandy River Road ℄

Remove and Reset Sign

Bridge Transition Type "1A" (Typ.)

Plain Riprap (Typ.)

POE = STA. 32+86.61

ECHO LAKE

CURVE DATA #2
PI = 15+47.04
D = 7°09'43.1"
Δ = 9°14'36.6" Rt.
R = 800.00'
L = 129.06'
T = 64.67'
E = 2.61'

WEST MOUNT VERNON BRIDGE NO. 2390
MAINEDOT WIN 021698.00
MOUNT VERNON, ME

BORING LOCATION PLAN

PREPARED BY:		PREPARED FOR:	
GZA GeoEnvironmental, Inc. Engineers and Scientists www.gza.com		MAINE DEPARTMENT OF TRANSPORTATION	
PROJ MGR: ARB	REVIEWED BY: ARB	CHECKED BY: CLS	FIG 2
DESIGNED BY: TB	DRAWN BY: TW	SCALE:	
DATE: 10/9/18	PROJECT NO. 09.0025937.01	REVISION NO. 0	SHEET NO. 1 OF 1

STATE OF MAINE
DEPARTMENT OF TRANSPORTATION

STP-21169(800)

WIN 21698.00

BRIDGE NO. 2930

BRIDGE PLANS

	D.E.&TON	BY	DATE
PROJ. MANAGER			
DESIGN-DETAILED	A.SWEET	A.SWEET	JUN 2018
CHECKED-REVIEWED	L.KRUSINSKI	-----	-----
DESIGN2-DETAILED2	A.BLASDELL	T.WHITE	JUN 2018
DESIGN3-DETAILED3	-----	-----	-----
REVISIONS 1	-----	-----	-----
REVISIONS 2	-----	-----	-----
REVISIONS 3	-----	-----	-----
REVISIONS 4	-----	-----	-----
FIELD CHANGES	-----	-----	-----

SIGNATURE

P.E. NUMBER

DATE

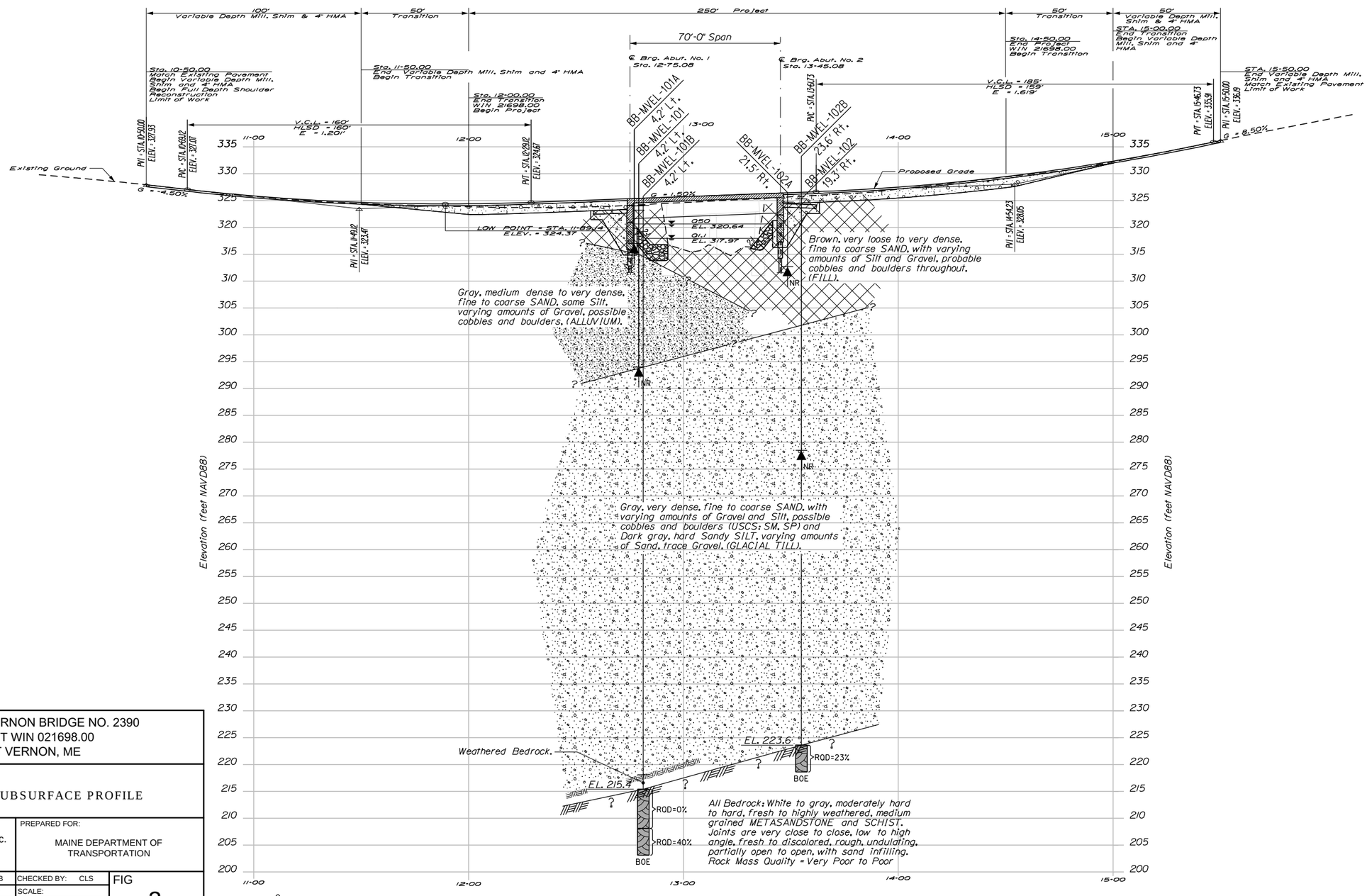
W. MT. VERNON BRIDGE
ECHO LAKE STREAM
MOUNT VERNON KENNEBEC COUNTY

BORING LOCATION PLAN

SHEET NUMBER

6

OF 28

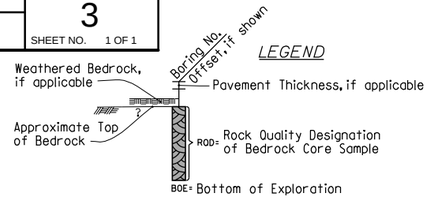


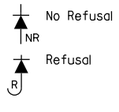
WEST MOUNT VERNON BRIDGE NO. 2390
MAINEDOT WIN 021698.00
MOUNT VERNON, ME

INTERPRETIVE SUBSURFACE PROFILE

PREPARED BY:		PREPARED FOR:	
GZA GeoEnvironmental, Inc. Engineers and Scientists www.gza.com		MAINE DEPARTMENT OF TRANSPORTATION	
PROJ MGR: ARB	REVIEWED BY: ARB	CHECKED BY: CLS	FIG 3
DESIGNED BY: TB	DRAWN BY: TW	SCALE:	SHEET NO. 1 OF 1
DATE: 10/9/18	PROJECT NO. 09.0025937.01	REVISION NO. 0	

LEGEND





PROFILE

Vertical Scale has been reduced by ½ its original.

Note: This generalized interpretive soil profile is intended to convey trends in subsurface conditions. The boundaries between strata are approximate and idealized, and have been developed by interpretations of widely spaced explorations and samples. Actual soil and bedrock transitions may vary and are probably more erratic. For more specific information refer to the exploration logs.

STATE OF MAINE
DEPARTMENT OF TRANSPORTATION

STP-2169(800)

WIN 21698.00

BRIDGE NO. 2930

BRIDGE PLANS

PROJ. MANAGER	D.EATON				
DESIGN-DETAILED	A.SWEET	A.SWEET	JUN 2018		
CHECKED-REVIEWED	L.KRUSINSKI	-----	-----	SIGNATURE	
DESIGN2-DETAILED2	A.BLASDELL	T.WHITE	JUN 2018		
DESIGN3-DETAILED3	-------	-------	-------	P.E. NUMBER	
REVISIONS 1	------	------	------		
REVISIONS 2	------	------	------		
REVISIONS 3	------	------	------	DATE	
REVISIONS 4	------	------	------		
FIELD CHANGES	------	------	------		

W. MT. VERNON BRIDGE
ECHO LAKE STREAM
MOUNT VERNON KENNEBEC COUNTY

INTERPRETIVE SUBSURFACE PROFILE

SHEET NUMBER
7
OF 28

Filename: ...\00\GEOTECH\MSTA\007_ISP1.dgn Username: Terry.White Division: GEOTECH Date:8/28/2018

APPENDIX A – LIMITATIONS

GEOTECHNICAL LIMITATIONS

Use of Report

1. GZA GeoEnvironmental, Inc. (GZA) prepared this report on behalf of, and for the exclusive use of our Client for the stated purpose(s) and location(s) identified in the Proposal for Services and/or Report. Use of this report, in whole or in part, at other locations, or for other purposes, may lead to inappropriate conclusions; and we do not accept any responsibility for the consequences of such use(s). Further, reliance by any party not expressly identified in the contract documents, for any use, without our prior written permission, shall be at that party's sole risk, and without any liability to GZA.

Standard of Care

2. GZA's findings and conclusions are based on the work conducted as part of the Scope of Services set forth in Proposal for Services and/or Report, and reflect our professional judgment. These findings and conclusions must be considered not as scientific or engineering certainties, but rather as our professional opinions concerning the limited data gathered during the course of our work. If conditions other than those described in this report are found at the subject location(s), or the design has been altered in any way, GZA shall be so notified and afforded the opportunity to revise the report, as appropriate, to reflect the unanticipated changed conditions .

3. GZA's services were performed using the degree of skill and care ordinarily exercised by qualified professionals performing the same type of services, at the same time, under similar conditions, at the same or a similar property. No warranty, expressed or implied, is made.

4. In conducting our work, GZA relied upon certain information made available by public agencies, Client and/or others. GZA did not attempt to independently verify the accuracy or completeness of that information. Inconsistencies in this information which we have noted, if any, are discussed in the Report.

Subsurface Conditions

5. The generalized soil profile(s) provided in our Report are based on widely-spaced subsurface explorations and are intended only to convey trends in subsurface conditions. The boundaries between strata are approximate and idealized, and were based on our assessment of subsurface conditions. The composition of strata, and the transitions between strata, may be more variable and more complex than indicated. For more specific information on soil conditions at a specific location refer to the exploration logs. The nature and extent of variations between these explorations may not become evident until further exploration or construction. If variations or other latent conditions then become evident, it will be necessary to reevaluate the conclusions and recommendations of this report.

6. In preparing this report, GZA relied on certain information provided by the Client, state and local officials, and other parties referenced therein which were made available to GZA at the time of our evaluation. GZA did not attempt to independently verify the accuracy or completeness of all information reviewed or received during the course of this evaluation.

7. Water level readings have been made in test holes (as described in this Report) and monitoring wells at the specified times and under the stated conditions. These data have been reviewed and interpretations have been made in this Report. Fluctuations in the level of the groundwater however occur due to temporal or spatial variations in areal recharge rates, soil heterogeneities, the presence of subsurface utilities, and/or natural or artificially induced perturbations. The water table encountered in the course of the work may differ from that indicated in the Report.

8. GZA's services did not include an assessment of the presence of oil or hazardous materials at the property. Consequently, we did not consider the potential impacts (if any) that contaminants in soil or groundwater may have on construction activities, or the use of structures on the property.

9. Recommendations for foundation drainage, waterproofing, and moisture control address the conventional geotechnical engineering aspects of seepage control. These recommendations may not preclude an environment that allows the infestation of mold or other biological pollutants.

Compliance with Codes and Regulations

10. We used reasonable care in identifying and interpreting applicable codes and regulations. These codes and regulations are subject to various, and possibly contradictory, interpretations. Compliance with codes and regulations by other parties is beyond our control.

Cost Estimates

11. Unless otherwise stated, our cost estimates are only for comparative and general planning purposes. These estimates may involve approximate quantity evaluations. Note that these quantity estimates are not intended to be sufficiently accurate to develop construction bids, or to predict the actual cost of work addressed in this Report. Further, since we have no control over either when the work will take place or the labor and material costs required to plan and execute the anticipated work, our cost estimates were made by relying on our experience, the experience of others, and other sources of readily available information. Actual costs may vary over time and could be significantly more, or less, than stated in the Report.

Additional Services

12. GZA recommends that we be retained to provide services during any future: site observations, design, implementation activities, construction and/or property development/redevelopment. This will allow us the opportunity to: i) observe conditions and compliance with our design concepts and opinions; ii) allow for changes in the event that conditions are other than anticipated; iii) provide modifications to our design; and iv) assess the consequences of changes in technologies and/or regulations.

APPENDIX B – TEST BORING LOGS

UNIFIED SOIL CLASSIFICATION SYSTEM

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

Desired Soil Observations (in this order, if applicable):

Color (Munsell color chart)
Moisture (dry, damp, moist, wet)
Density/Consistency (from above right hand side)
Texture (fine, medium, coarse, etc.)
Name (sand, silty sand, clay, etc., including portions - trace, little, etc.)
Gradation (well-graded, poorly-graded, uniform, etc.)
Plasticity (non-plastic, slightly plastic, moderately plastic, highly plastic)
Structure (layering, fractures, cracks, etc.)
Bonding (well, moderately, loosely, etc.,)
Cementation (weak, moderate, or strong)
Geologic Origin (till, marine clay, alluvium, etc.)
Groundwater level

MODIFIED BURMISTER SYSTEM

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

TERMS DESCRIBING DENSITY/CONSISTENCY

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

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

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

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

Rock Quality Designation (RQD):

RQD (%) = sum of the lengths of intact pieces of core* > 4 inches / length of core advance

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

Correlation of RQD to Rock Mass Quality

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

Desired Rock Observations (in this order, if applicable):

Color (Munsell color chart)
Texture (aphanitic, fine-grained, etc.)
Rock Type (granite, schist, sandstone, etc.)
Hardness (very hard, hard, mod. hard, etc.)
Weathering (fresh, very slight, slight, moderate, mod. severe, severe, etc.)
Geologic discontinuities/jointing:
- -dip (horiz - 0-5 deg., low angle - 5-35 deg., mod. dipping - 35-55 deg., steep - 55-85 deg., vertical - 85-90 deg.)
- -spacing (very close - <2 inch, close - 2-12 inch, mod. close - 1-3 feet, wide - 3-10 feet, very wide >10 feet)
- -tightness (tight, open, or healed)
- -infilling (grain size, color, etc.)

Formation (Waterville, Ellsworth, Cape Elizabeth, etc.)
RQD and correlation to rock mass quality (very poor, poor, etc.)
ref: ASTM D6032 and AASHTO Standard Specification for Highway Bridges, 17th Ed. Table 4.4.8.1.2A
Recovery (inch/inch and percentage)
Rock Core Rate (X.X ft - Y.Y ft (min:sec))

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

Sample Container Labeling Requirements:

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

May 2016

Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project: W. Mt. Vernon Bridge #2930 carries Route 41 over Echo Lake Stream
Location: Mt. Vernon, Maine

Boring No.: BB-MVEL-101
WIN: 21698.00

Driller:	MaineDOT	**Elevation (ft.)**	324.0	**Auger ID/OD:**	5" Solid Stem
Operator:	Daggett/James	**Datum:**	NAVD88	**Sampler:**	Standard Split Spoon
Logged By:	B. Wilder	**Rig Type:**	CME 45C	**Hammer Wt./Fall:**	140-lbs/30-inches
Date Start/Finish:	4/5/2017; 08:00-14:00	**Drilling Method:**	Cased Wash Boring	**Core Barrel:**	N/A
Boring Location:	146+15.4, 6.4 feet Lt.	**Casing ID/OD:**	NW-3"	**Water Level*:**	4.6 feet bgs.
Hammer Efficiency Factor: 0.854		**Hammer Type:**	Automatic ☒ Hydraulic ☐ Rope & Cathead ☐		

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample Attempt
U = Thin Wall Tube Sample
MU = Unsuccessful Thin Wall Tube Sample Attempt
V = Field Vane Shear Test, PP = Pocket Penetrometer
MV = Unsuccessful Field Vane Shear Test Attempt
R = Rock Core Sample
SSA = Solid Stem Auger
HSA = Hollow Stem Auger
RC = Roller Cone
WOH = Weight of 140lb. Hammer
WOR/C = Weight of Rods or Casing
WO1P = Weight of One Person
S_u = Peak/Remolded Field Vane Undrained Shear Strength (psf)
$S_{u(lab)}$ = Lab Vane Undrained Shear Strength (psf)
q_p = Unconfined Compressive Strength (ksf)
N-uncorrected = Raw Field SPT N-value
Hammer Efficiency Factor = Rig Specific Annual Calibration Value
N_{60} = SPT N-uncorrected Corrected for Hammer Efficiency
N_{60} = (Hammer Efficiency Factor/60%)*N-uncorrected
T_V = Pocket Torvane Shear Strength (psf)
WC = Water Content, percent
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index
G = Grain Size Analysis
C = Consolidation Test

Depth (ft.)	Sample Information: Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N_{60}	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
0							SSA	323.21		9.5-inches HMA.	
										0.79	
	1D	24/14	1.00 - 3.00	6/9/5/6	14	20				Brown, damp, medium dense, fine to coarse SAND, little gravel, trace silt, (Fill).	
5	2D	24/9	5.00 - 7.00	18/19/12/9	31	44	34			Brown, moist, dense, Gravelly fine to coarse SAND, trace silt, (Fill).	
							73				
							169				
							70				
							74	315.00		9.00	
10	3D	24/10	10.00 - 12.00	18/19/18/17	37	53	22			Grey, wet, dense, Gravelly fine to coarse SAND, some silt.	
							34				
							30				
							26				
							36	310.00		14.00	
15	4D	24/14	15.00 - 17.00	9/10/9/11	19	27	3			Grey, wet, medium dense, fine to coarse SAND, some silt, trace gravel.	G#271162 A-2-4, SM WC=10.5%
							18				
							23				
							60				
							45				
20	5D	24/10	20.00 - 22.00	10/12/16/17	28	40	13			Grey, wet, dense, fine to coarse SAND, some silt, some gravel.	
							33				
							139				
							310				
25							199				

Remarks:

-Left 20.0 feet of NW Casing in bore hole.

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

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Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project: W. Mt. Vernon Bridge #2930 carries Route 41 over Echo Lake Stream
Location: Mt. Vernon, Maine

Boring No.: BB-MVEL-101
WIN: 21698.00

Driller:	MaineDOT	**Elevation (ft.)**	324.0	**Auger ID/OD:**	5" Solid Stem
Operator:	Daggett/James	**Datum:**	NAVD88	**Sampler:**	Standard Split Spoon
Logged By:	B. Wilder	**Rig Type:**	CME 45C	**Hammer Wt./Fall:**	140-lbs/30-inches
Date Start/Finish:	4/5/2017; 08:00-14:00	**Drilling Method:**	Cased Wash Boring	**Core Barrel:**	N/A
Boring Location:	146+15.4, 6.4 feet Lt.	**Casing ID/OD:**	NW-3"	**Water Level*:**	4.6 feet bgs.
Hammer Efficiency Factor: 0.854		**Hammer Type:**	Automatic ☒ Hydraulic ☐ Rope & Cathead ☐		

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample Attempt
U = Thin Wall Tube Sample
MU = Unsuccessful Thin Wall Tube Sample Attempt
V = Field Vane Shear Test, PP = Pocket Penetrometer
MV = Unsuccessful Field Vane Shear Test Attempt
R = Rock Core Sample
SSA = Solid Stem Auger
HSA = Hollow Stem Auger
RC = Roller Cone
WOH = Weight of 140lb. Hammer
WOR/C = Weight of Rods or Casing
WO1P = Weight of One Person
S_u = Peak/Remolded Field Vane Undrained Shear Strength (psf)
$S_{u(lab)}$ = Lab Vane Undrained Shear Strength (psf)
q_p = Unconfined Compressive Strength (ksf)
N-uncorrected = Raw Field SPT N-value
Hammer Efficiency Factor = Rig Specific Annual Calibration Value
N_{60} = SPT N-uncorrected Corrected for Hammer Efficiency
N_{60} = (Hammer Efficiency Factor/60%)*N-uncorrected
T_v = Pocket Torvane Shear Strength (psf)
WC = Water Content, percent
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index
G = Grain Size Analysis
C = Consolidation Test

Depth (ft.)	Sample Information: Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N_{60}	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
25	6D	24/10	25.00 - 27.00	17/21/24/22	45	64	30			Grey, wet, dense, fine to coarse SAND, some silt, some gravel.	
							54				
							31				
							46				
							105				
30								294.00		30.00	
										Bottom of Exploration at 30.00 feet below ground surface. Broke NW Casing at 30.0 feet bgs., moved to BB-MVEL-101A.	
35											
40											
45											
50											

Remarks:

-Left 20.0 feet of NW Casing in bore hole.

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Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project: W. Mt. Vernon Bridge #2930 carries Route 41 over Echo Lake Stream
Location: Mt. Vernon, Maine

Boring No.: BB-MVEL-101A
WIN: 21698.00

Drilling Contractor:	MaineDOT	**Elevation (ft.)**	324.0	**Auger ID/OD:**	5" Dia.
Operator:	Daggett/James	**Datum:**	NAVD88	**Sampler:**	N/A
Logged By:	B. Wilder	**Rig Type:**	CME 45C	**Hammer Wt./Fall:**	N/A
Date Start/Finish:	4/5/2017; 14:00-14:30	**Drilling Method:**	Solid Stem Auger	**Core Barrel:**	N/A
Boring Location:	146+13.3, 6.4 feet Lt.	**Casing ID/OD:**	N/A	**Water Level*:**	4.8 feet bgs.

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

Depth (ft.)	Sample Information: Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-value	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
0						SSA			No material description given.	
5										
							317.00		7.00	
									Bottom of Exploration at 7.00 feet below ground surface. Large Cobble REFUSAL, moved to BB-MVEL-101B.	
10										
15										
20										
25										

Remarks:

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Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project: W. Mt. Vernon Bridge #2930 carries Route 41 over Echo Lake Stream
Location: Mt. Vernon, Maine

Boring No.: BB-MVEL-101B
WIN: 21698.00

Driller:	MaineDOT	**Elevation (ft.)**	324.1	**Auger ID/OD:**	5" Solid Stem
Operator:	Daggett/James	**Datum:**	NAVD88	**Sampler:**	Standard Split Spoon
Logged By:	B. Wilder	**Rig Type:**	CME 45C	**Hammer Wt./Fall:**	140-lbs/30-inches
Date Start/Finish:	4/5,7,10,12/2017	**Drilling Method:**	Cased Wash Boring	**Core Barrel:**	N/A
Boring Location:	146+17.5, 6.3 feet Lt.	**Casing ID/OD:**	NW-3"	**Water Level*:**	6.8 feet bgs.
Hammer Efficiency Factor:	0.854	**Hammer Type:**	Automatic ☒ Hydraulic ☐ Rope & Cathead ☐		

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SSA = Solid Stem Auger
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WOH = Weight of 140lb. Hammer
WOR/C = Weight of Rods or Casing
WO1P = Weight of One Person
S_u = Peak/Remolded Field Vane Undrained Shear Strength (psf)
$S_{u(lab)}$ = Lab Vane Undrained Shear Strength (psf)
q_p = Unconfined Compressive Strength (ksf)
N-uncorrected = Raw Field SPT N-value
Hammer Efficiency Factor = Rig Specific Annual Calibration Value
N_{60} = SPT N-uncorrected Corrected for Hammer Efficiency
N_{60} = (Hammer Efficiency Factor/60%)*N-uncorrected
T_V = Pocket Torvane Shear Strength (psf)
WC = Water Content, percent
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index
G = Grain Size Analysis
C = Consolidation Test

Depth (ft.)	Sample Information: Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N_{60}	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
0							SSA			Augered to 30.0 feet bgs. No material description given.	
5											
10											
15											
20											
25											

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Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project: W. Mt. Vernon Bridge #2930 carries Route 41 over Echo Lake Stream
Location: Mt. Vernon, Maine

Boring No.: BB-MVEL-101B
WIN: 21698.00

Driller:	MaineDOT	**Elevation (ft.)**	324.1	**Auger ID/OD:**	5" Solid Stem
Operator:	Daggett/James	**Datum:**	NAVD88	**Sampler:**	Standard Split Spoon
Logged By:	B. Wilder	**Rig Type:**	CME 45C	**Hammer Wt./Fall:**	140-lbs/30-inches
Date Start/Finish:	4/5,7,10,12/2017	**Drilling Method:**	Cased Wash Boring	**Core Barrel:**	N/A
Boring Location:	146+17.5, 6.3 feet Lt.	**Casing ID/OD:**	NW-3"	**Water Level*:**	6.8 feet bgs.
Hammer Efficiency Factor: 0.854		**Hammer Type:**	Automatic ☒ Hydraulic ☐ Rope & Cathead ☐		

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Depth (ft.)	Sample Information: Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N_{60}	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
25							10			Set in NW Casing at 25.0 feet bgs.	
							43				
							48				
							45				
							52				
30	1D	12/10	30.00 - 31.00	35/55	---		OPEN HOLE	294.10		30.00 Grey, wet, very dense, fine to coarse SAND, some silt, little gravel, (Glacial Till). Roller Coned ahead to 35.0 feet bgs.	G#271163 A-2-4, SM WC=8.7%
35	2D	3.6/3.6	35.00 - 35.30	40(3.6")	---					Roller Coned ahead to 36.0 feet bgs.	
	R1	60/8	36.00 - 41.00							R1: Cobbles. Roller coned ahead to 41.0 feet bgs.	
40											
	3D	9.6/9.6	41.00 - 41.80	46/60(3.6")	---					Similar to above. Roller Coned ahead to 45.0 feet bgs, drove casing back down to 45.0 feet bgs.	
45	4D	18/18	45.00 - 46.50	34/59/55	114	162				Grey, wet, very dense, Silty SAND, little gravel. Roller Coned ahead to 50.0 feet bgs.	G#271164 A-4, SM WC=10.3%
50											

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Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project: W. Mt. Vernon Bridge #2930 carries Route 41 over Echo Lake Stream
Location: Mt. Vernon, Maine

Boring No.: BB-MVEL-101B
WIN: 21698.00

Driller:	MaineDOT	**Elevation (ft.)**	324.1	**Auger ID/OD:**	5" Solid Stem
Operator:	Daggett/James	**Datum:**	NAVD88	**Sampler:**	Standard Split Spoon
Logged By:	B. Wilder	**Rig Type:**	CME 45C	**Hammer Wt./Fall:**	140-lbs/30-inches
Date Start/Finish:	4/5,7,10,12/2017	**Drilling Method:**	Cased Wash Boring	**Core Barrel:**	N/A
Boring Location:	146+17.5, 6.3 feet Lt.	**Casing ID/OD:**	NW-3"	**Water Level*:**	6.8 feet bgs.
Hammer Efficiency Factor: 0.854		**Hammer Type:**	Automatic ☒ Hydraulic ☐ Rope & Cathead ☐		

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WC = Water Content, percent
LL = Liquid Limit
PL = Plastic Limit
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C = Consolidation Test

Depth (ft.)	Sample Information: Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N_{60}	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
50	5D	10.8/10	50.00 - 50.90	26/55(4.8")	---					Similar to above. Roller Coned ahead to 60.0 feet bgs.	G#271165 A-4, SM WC=9.5%
55	6D	8.4/8.4	55.00 - 55.70	60/50(2.4")	---					Similar to above. Drove casing to 55.0 feet bgs.	
60	7D	6/6	60.00 - 60.50	60	---					Similar to above. Roller Coned ahead to 70.0 feet bgs. Drove casing to 65.0 feet bgs for the weekend.	
65											
70	MD	2.4/2.4	70.00 - 70.20	40(2.4")	---					Similar to above in wash water. Roller Coned ahead to 73.0 feet bgs.	
75											

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Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project: W. Mt. Vernon Bridge #2930 carries Route 41 over Echo Lake Stream
Location: Mt. Vernon, Maine

Boring No.: BB-MVEL-101B
WIN: 21698.00

Driller:	MaineDOT	**Elevation (ft.)**	324.1	**Auger ID/OD:**	5" Solid Stem
Operator:	Daggett/James	**Datum:**	NAVD88	**Sampler:**	Standard Split Spoon
Logged By:	B. Wilder	**Rig Type:**	CME 45C	**Hammer Wt./Fall:**	140-lbs/30-inches
Date Start/Finish:	4/5,7,10,12/2017	**Drilling Method:**	Cased Wash Boring	**Core Barrel:**	N/A
Boring Location:	146+17.5, 6.3 feet Lt.	**Casing ID/OD:**	NW-3"	**Water Level*:**	6.8 feet bgs.
Hammer Efficiency Factor: 0.854		**Hammer Type:**	Automatic ☒ Hydraulic ☐ Rope & Cathead ☐		

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SSA = Solid Stem Auger
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WOH = Weight of 140lb. Hammer
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N-uncorrected = Raw Field SPT N-value
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N_{60} = (Hammer Efficiency Factor/60%)*N-uncorrected
T_v = Pocket Torvane Shear Strength (psf)
WC = Water Content, percent
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index
G = Grain Size Analysis
C = Consolidation Test

Depth (ft.)	Sample Information: Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N_{60}	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
75											
								247.10		77.00	
										Casing installed in Open Hole to 80.0 ft. Then continued Open Hole below.	
80	8D	24/24	80.00 - 82.00	13/17/23/31	40	57	NW			Dark grey, wet, hard, fine to medium Sandy SILT, little clay, trace gravel, (Glacial Till).	G#271168 A-4, ML WC=9.7%
85											
90	9D	24/20	90.00 - 92.00	12/15/22/30	37	53				Dark grey, wet, hard, Sandy SILT, trace gravel, (Glacial Till).	G#271166 A-4, ML WC=11.1%
95										Casing driven 80 to 95 ft. Then continued with Open Hole.	
								228.10		96.00	
100											

Remarks:

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Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project: W. Mt. Vernon Bridge #2930 carries Route 41 over Echo Lake Stream
Location: Mt. Vernon, Maine

Boring No.: BB-MVEL-101B
WIN: 21698.00

Driller:	MaineDOT	**Elevation (ft.)**	324.1	**Auger ID/OD:**	5" Solid Stem
Operator:	Daggett/James	**Datum:**	NAVD88	**Sampler:**	Standard Split Spoon
Logged By:	B. Wilder	**Rig Type:**	CME 45C	**Hammer Wt./Fall:**	140-lbs/30-inches
Date Start/Finish:	4/5,7,10,12/2017	**Drilling Method:**	Cased Wash Boring	**Core Barrel:**	N/A
Boring Location:	146+17.5, 6.3 feet Lt.	**Casing ID/OD:**	NW-3"	**Water Level*:**	6.8 feet bgs.
Hammer Efficiency Factor: 0.854		**Hammer Type:**	Automatic ☒ Hydraulic ☐ Rope & Cathead ☐		

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MV = Unsuccessful Field Vane Shear Test Attempt
R = Rock Core Sample
SSA = Solid Stem Auger
HSA = Hollow Stem Auger
RC = Roller Cone
WOH = Weight of 140lb. Hammer
WOR/C = Weight of Rods or Casing
WO1P = Weight of One Person
S_u = Peak/Remolded Field Vane Undrained Shear Strength (psf)
$S_{u(lab)}$ = Lab Vane Undrained Shear Strength (psf)
q_p = Unconfined Compressive Strength (ksf)
N-uncorrected = Raw Field SPT N-value
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N_{60} = (Hammer Efficiency Factor/60%)*N-uncorrected
T_v = Pocket Torvane Shear Strength (psf)
WC = Water Content, percent
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index
G = Grain Size Analysis
C = Consolidation Test

Depth (ft.)	Sample Information: Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N_{60}	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
100	10D	12/10	100.00 - 101.00	30/66	---					Grey, wet, very dense, Silty fine to coarse SAND, with seams of white, weathered bedrock, (Glacial Till),	
105										Drove casing through open hole to 105.5	
							RC	218.10		106.00 Weathered Bedrock. Roller Coned ahead 108.7 feet bgs.	
	R2	87.6/32	108.70 - 116.00	RQD = 0%			NQ-2	215.40		108.70 R2: Bedrock: White, medium grained, METASANDSTONE, moderately hard to soft, very weathered, joints at low angle, open with sand infilling. Parkman Hill Formation. Rock Mass Quality = Very Poor. R2: Core Times (min:sec) 108.7-109.7 feet (0:22) 109.7-110.7 feet (0:30) 110.7-111.7 feet (0:51) 111.7-112.7 feet (0:53) 112.7-113.7 feet (0:42) 113.7-114.7 feet (1:42) 114.7-115.7 feet (1:51) 115.7-116.0 feet (2:00) 36% Recovery	
115	R3	60/47	116.00 - 121.00	RQD = 40%				208.10		116.00 R3: Bedrock: White, medium grained, METASANDSTONE/ SCHIST, moderately hard, fresh to slightly weathered, joint sets at low angles and vertical, open, sand infilling. Parkman Hill Formation. Rock Mass Quality = Poor R3: Core Times (min:sec) 116.0-117.0 feet (1:21) 117.0-118.0 feet (1:17) 118.0-119.0 feet (1:15) 119.0-120.0 feet (1:28) 120.0-121.0 feet (1:39) 78% Recovery Possible 12-inch core in bottom of bore hole.	
120								203.10		121.00 **Bottom of Exploration at 121.00 feet below ground surface.**	
125											

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Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project: W. Mt. Vernon Bridge #2930 carries Route 41 over Echo Lake Stream
Location: Mt. Vernon, Maine

Boring No.: BB-MVEL-102
WIN: 21698.00

Driller:	Maine Test Boring	**Elevation (ft.)**	325.3	**Auger ID/OD:**	5" Hollow Stem
Operator:	Nadeau	**Datum:**	NAVD88	**Sampler:**	Standard Split Spoon
Logged By:	B. Cardali	**Rig Type:**	Diedrich D50 Turbo	**Hammer Wt./Fall:**	140-lbs/30-inches
Date Start/Finish:	5/2/2017-5/3/2017	**Drilling Method:**	Cased Wash Boring	**Core Barrel:**	N/A
Boring Location:	146+91.3, 16.4 feet Rt.	**Casing ID/OD:**	HW-4"	**Water Level*:**	7.9 feet bgs.
Hammer Efficiency Factor: .979		**Hammer Type:**	Automatic ☒ Hydraulic ☐ Rope & Cathead ☐		

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MV = Unsuccessful Field Vane Shear Test Attempt
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SSA = Solid Stem Auger
HSA = Hollow Stem Auger
RC = Roller Cone
WOH = Weight of 140lb. Hammer
WOR/C = Weight of Rods or Casing
WO1P = Weight of One Person
S_u = Peak/Remolded Field Vane Undrained Shear Strength (psf)
$S_{u(lab)}$ = Lab Vane Undrained Shear Strength (psf)
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N-uncorrected = Raw Field SPT N-value
Hammer Efficiency Factor = Rig Specific Annual Calibration Value
N_{60} = SPT N-uncorrected Corrected for Hammer Efficiency
N_{60} = (Hammer Efficiency Factor/60%)*N-uncorrected
T_V = Pocket Torvane Shear Strength (psf)
WC = Water Content, percent
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PL = Plastic Limit
PI = Plasticity Index
G = Grain Size Analysis
C = Consolidation Test

Depth (ft.)	Sample Information: Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N_{60}	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
0	1D	24/7	0.00 - 2.00	1/2/4/5	6	10	HSA	324.80		Brown, moist, loose, fine to coarse SAND, little silt with organics, (Topsoil).	
										0.50	
	2D	24/3	4.50 - 6.50	11/27/9/9	36	59				Brown, moist, dense, Silty fine to coarse SAND, little gravel, with probable cobbles and boulders, (Fill).	
5											
	3D	24/13	9.00 - 11.00	1/1/1/2	2	3				(3D) Top 3-inches: Light brown, wet, very loose, fine to medium SAND, some silt, trace gravel, (Fill). Bottom 10-inches, Apparent horizontal grained wood.	
10											
	4D	24/10	14.00 - 16.00	2/4/5/8	9	15				Light brown, wet, medium dense, fine to medium SAND, some silt, trace gravel, with probable cobbles and boulders, (Fill).	G#271155 A-2-4, SM WC=13.4%
15							26				
							73				
							88				
							57				
20	5D	24/12	20.00 - 22.00	17/21/19/15	40	65	61			Light brown, wet, very dense, fine to medium SAND, some silt, little gravel, with probable cobbles and boulders, (Fill).	SM
							71				
							144				
							236	301.80		23.50	
							RC			Roller Coned ahead to 47.0 feet bgs.	
25											

Remarks:

- Auto Hammer #377.
- During advancement of 4-inch casing from 45.0-50.0 ft bgs, the casing broke. Twenty feet of casing left in hole. Moved to BB-MVEL-102A.
- Water level was taken approximately 15 minutes after casing was removed.

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

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

Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project: W. Mt. Vernon Bridge #2930 carries Route 41 over Echo Lake Stream
Location: Mt. Vernon, Maine

Boring No.: BB-MVEL-102
WIN: 21698.00

Driller:	Maine Test Boring	**Elevation (ft.)**	325.3	**Auger ID/OD:**	5" Hollow Stem
Operator:	Nadeau	**Datum:**	NAVD88	**Sampler:**	Standard Split Spoon
Logged By:	B. Cardali	**Rig Type:**	Diedrich D50 Turbo	**Hammer Wt./Fall:**	140-lbs/30-inches
Date Start/Finish:	5/2/2017-5/3/2017	**Drilling Method:**	Cased Wash Boring	**Core Barrel:**	N/A
Boring Location:	146+91.3, 16.4 feet Rt.	**Casing ID/OD:**	HW-4"	**Water Level*:**	7.9 feet bgs.
Hammer Efficiency Factor:	.979	**Hammer Type:**	Automatic ☒ Hydraulic ☐ Rope & Cathead ☐		

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample Attempt
U = Thin Wall Tube Sample
MU = Unsuccessful Thin Wall Tube Sample Attempt
V = Field Vane Shear Test, PP = Pocket Penetrometer
MV = Unsuccessful Field Vane Shear Test Attempt
R = Rock Core Sample
SSA = Solid Stem Auger
HSA = Hollow Stem Auger
RC = Roller Cone
WOH = Weight of 140lb. Hammer
WOR/C = Weight of Rods or Casing
WO1P = Weight of One Person
S_u = Peak/Remolded Field Vane Undrained Shear Strength (psf)
$S_{u(lab)}$ = Lab Vane Undrained Shear Strength (psf)
q_p = Unconfined Compressive Strength (ksf)
N-uncorrected = Raw Field SPT N-value
Hammer Efficiency Factor = Rig Specific Annual Calibration Value
N_{60} = SPT N-uncorrected Corrected for Hammer Efficiency
N_{60} = (Hammer Efficiency Factor/60%)*N-uncorrected
T_v = Pocket Torvane Shear Strength (psf)
WC = Water Content, percent
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index
G = Grain Size Analysis
C = Consolidation Test

Depth (ft.)	Sample Information: Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N_{60}	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
25	6D	24/19	25.00 - 27.00	32/35/41/46	76	124				Light brown, wet, very dense, fine to coarse SAND, some silt, trace gravel, (Glacial Till).	G#271156 A-2-4, SM WC=10.9%
30	7D	24/18	30.00 - 32.00	20/44/49/43	93	152				Grey, wet, very dense, Silty fine to coarse SAND, little gravel, (Glacial Till).	G#271157 A-4, SM WC=9.6%
35	8D	19.2/19.2	35.00 - 36.60	47/78/196/50(1")	274	447				Grey, wet, very dense, fine to medium SAND, some silt, little gravel, (Glacial Till).	
40	9D	9.6/9.6	40.00 - 40.80	61/209(3.6")	---					Grey, wet, very dense, fine to coarse SAND, little silt, little gravel, (Glacial till).	
45	10D	24/24	45.00 - 47.00	19/68/88/106	156	255				Grey, wet, very dense, fine to coarse SAND, some silt, little gravel, (Glacial Till).	
								278.30		47.00 **Bottom of Exploration at 47.00 feet below ground surface.** Broke Casing, moved to BB-MVEL-102A.	
50											

Remarks:

- Auto Hammer #377.
- During advancement of 4-inch casing from 45.0-50.0 ft bgs, the casing broke. Twenty feet of casing left in hole. Moved to BB-MVEL-102A.
- Water level was taken approximately 15 minutes after casing was removed.

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

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

Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project: W. Mt. Vernon Bridge #2930 carries Route 41 over Echo Lake Stream
Location: Mt. Vernon, Maine

Boring No.: BB-MVEL-102A

WIN: 21698.00

Drilling Contractor:	Maine Test Boring	**Elevation (ft.)**	324.7	**Auger ID/OD:**	5" Dia.
Operator:	Nadeau	**Datum:**	NAVD88	**Sampler:**	N/A
Logged By:	B. Cardali	**Rig Type:**	Diedrich D50 Turbo	**Hammer Wt./Fall:**	N/A
Date Start/Finish:	5/3/2017-5/5/2017	**Drilling Method:**	Solid Stem Auger	**Core Barrel:**	N/A
Boring Location:	146+84.8, 18.8 feet Rt.	**Casing ID/OD:**	N/A	**Water Level*:**	7.9 feet bgs.

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

Depth (ft.)	Sample Information: Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-value	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
0						SSA			No material description given, see BB-MVEL-102.	
5										
10										
							312.70		12.00	
									Bottom of Exploration at 12.00 feet below ground surface. Large cobble kicked auger, moved to BB MVEL-102B.	
15										
20										
25										

Remarks:

- Multiple attempts were made between BB-MVEL-102A and BB-MVEL-102B; Casing broke during attempts ranging from 23.0 to 35.0 feet bgs. A 10.0 foot rod with roller cone and an auger head were left in attempts at approximately 30.0 feet and 20.0 feet respectively.

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Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project: W. Mt. Vernon Bridge #2930 carries Route 41 over Echo Lake Stream
Location: Mt. Vernon, Maine

Boring No.: BB-MVEL-102B
WIN: 21698.00

Driller:	Maine Test Boring	**Elevation (ft.)**	324.8	**Auger ID/OD:**	5" Solid Stem
Operator:	Nadeau	**Datum:**	NAVD88	**Sampler:**	Standard Split Spoon
Logged By:	B. Cardali	**Rig Type:**	Diedrich D50 Turbo	**Hammer Wt./Fall:**	140-lbs/30-inches
Date Start/Finish:	5/5/2017-5/8/2017	**Drilling Method:**	Cased Wash Boring	**Core Barrel:**	NX-2"
Boring Location:	146+91.2, 20.9 feet, Rt.	**Casing ID/OD:**	HW-4" & NW-3"	**Water Level*:**	7.8 feet bgs.
Hammer Efficiency Factor: 0.979		**Hammer Type:**	Automatic ☒ Hydraulic ☐ Rope & Cathead ☐		

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample Attempt
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MU = Unsuccessful Thin Wall Tube Sample Attempt
V = Field Vane Shear Test, PP = Pocket Penetrometer
MV = Unsuccessful Field Vane Shear Test Attempt
R = Rock Core Sample
SSA = Solid Stem Auger
HSA = Hollow Stem Auger
RC = Roller Cone
WOH = Weight of 140lb. Hammer
WOR/C = Weight of Rods or Casing
WO1P = Weight of One Person
S_u = Peak/Remolded Field Vane Undrained Shear Strength (psf)
$S_{u(lab)}$ = Lab Vane Undrained Shear Strength (psf)
q_p = Unconfined Compressive Strength (ksf)
N-uncorrected = Raw Field SPT N-value
Hammer Efficiency Factor = Rig Specific Annual Calibration Value
N_{60} = SPT N-uncorrected Corrected for Hammer Efficiency
N_{60} = (Hammer Efficiency Factor/60%)*N-uncorrected
T_V = Pocket Torvane Shear Strength (psf)
WC = Water Content, percent
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index
G = Grain Size Analysis
C = Consolidation Test

Depth (ft.)	Sample Information: Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N_{60}	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
0							SSA			No samples taken from 0.0-50.0 feet bgs, refer to BB-MVEL-102 for material descriptions.	
15							RC			Roller Coned ahead to 101.2 feet bgs.	

Remarks:

- Auto Hammer #377.
- Second 5.0 foot core run could not be taken due to broken casing and running sands within 3-inch casing.
- 4-inch casing to 32.0 feet bgs, then 3-ich casing to 101.2 feet bgs.

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

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

Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project: W. Mt. Vernon Bridge #2930 carries Route 41 over Echo Lake Stream
Location: Mt. Vernon, Maine

Boring No.: BB-MVEL-102B
WIN: 21698.00

Driller:	Maine Test Boring	**Elevation (ft.)**	324.8	**Auger ID/OD:**	5" Solid Stem
Operator:	Nadeau	**Datum:**	NAVD88	**Sampler:**	Standard Split Spoon
Logged By:	B. Cardali	**Rig Type:**	Diedrich D50 Turbo	**Hammer Wt./Fall:**	140-lbs/30-inches
Date Start/Finish:	5/5/2017-5/8/2017	**Drilling Method:**	Cased Wash Boring	**Core Barrel:**	NX-2"
Boring Location:	146+91.2, 20.9 feet, Rt.	**Casing ID/OD:**	HW-4" & NW-3"	**Water Level*:**	7.8 feet bgs.
Hammer Efficiency Factor: 0.979		**Hammer Type:**	Automatic ☒ Hydraulic ☐ Rope & Cathead ☐		

Definitions:
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SSA = Solid Stem Auger
HSA = Hollow Stem Auger
RC = Roller Cone
WOH = Weight of 140lb. Hammer
WOR/C = Weight of Rods or Casing
WO1P = Weight of One Person
S_u = Peak/Remolded Field Vane Undrained Shear Strength (psf)
$S_{u(lab)}$ = Lab Vane Undrained Shear Strength (psf)
q_p = Unconfined Compressive Strength (ksf)
N-uncorrected = Raw Field SPT N-value
Hammer Efficiency Factor = Rig Specific Annual Calibration Value
N_{60} = SPT N-uncorrected Corrected for Hammer Efficiency
N_{60} = (Hammer Efficiency Factor/60%)*N-uncorrected
T_v = Pocket Torvane Shear Strength (psf)
WC = Water Content, percent
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index
G = Grain Size Analysis
C = Consolidation Test

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

Remarks:

- Auto Hammer #377.
- Second 5.0 foot core run could not be taken due to broken casing and running sands within 3-inch casing.
- 4-inch casing to 32.0 feet bgs, then 3-ich casing to 101.2 feet bgs.

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Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project: W. Mt. Vernon Bridge #2930 carries Route 41 over Echo Lake Stream
Location: Mt. Vernon, Maine

Boring No.: BB-MVEL-102B
WIN: 21698.00

Driller:	Maine Test Boring	**Elevation (ft.)**	324.8	**Auger ID/OD:**	5" Solid Stem
Operator:	Nadeau	**Datum:**	NAVD88	**Sampler:**	Standard Split Spoon
Logged By:	B. Cardali	**Rig Type:**	Diedrich D50 Turbo	**Hammer Wt./Fall:**	140-lbs/30-inches
Date Start/Finish:	5/5/2017-5/8/2017	**Drilling Method:**	Cased Wash Boring	**Core Barrel:**	NX-2"
Boring Location:	146+91.2, 20.9 feet, Rt.	**Casing ID/OD:**	HW-4" & NW-3"	**Water Level*:**	7.8 feet bgs.
Hammer Efficiency Factor: 0.979		**Hammer Type:**	Automatic ☒ Hydraulic ☐ Rope & Cathead ☐		

Definitions:
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SSA = Solid Stem Auger
HSA = Hollow Stem Auger
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WOH = Weight of 140lb. Hammer
WOR/C = Weight of Rods or Casing
WO1P = Weight of One Person
S_u = Peak/Remolded Field Vane Undrained Shear Strength (psf)
$S_{u(lab)}$ = Lab Vane Undrained Shear Strength (psf)
q_p = Unconfined Compressive Strength (ksf)
N-uncorrected = Raw Field SPT N-value
Hammer Efficiency Factor = Rig Specific Annual Calibration Value
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N_{60} = (Hammer Efficiency Factor/60%)*N-uncorrected
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G = Grain Size Analysis
C = Consolidation Test

Depth (ft.)	Sample Information: Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N_{60}	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
50	1D	24/16	50.00 - 52.00	41/52/71/72	123	201		274.80		50.00 Grey, wet, very dense, fine to medium SAND, some silt, little gravel, (Glacial Till).	
	2D	24/22	54.00 - 56.00	29/39/58/36	97	158				Grey, wet, very dense, Silty fine to coarse SAND, little gravel, (Glacial Till).	G#271158 A-4, SM WC=8.8%
55											
	3D	24/24	59.00 - 61.00	25/35/44/53	79	129				Grey, wet, very dense, Silty fine SAND, little gravel, (Glacial Till).	
60											
	4D	24/24	64.00 - 66.00	21/32/52/54	84	137				Grey, wet, very dense, Sandy SILT, trace gravel , (Glacial Till).	G#271160 A-4, ML WC=10.0%
65											
	5D	9.6/8	69.00 - 69.80	25/62(3.6")	---					Grey, wet, very dense, fine to medium SAND, some silt, little gravel, (Glacial Till).	
70								252.80		72.00	
	6D	15.6/15.6	74.00 - 75.30	25/44/50(3.6")	---					Light brown, wet, very dense, Silty SAND, (Glacial Till).	G#271159 A-4, SM
75											

Remarks:

- Auto Hammer #377.
- Second 5.0 foot core run could not be taken due to broken casing and running sands within 3-inch casing.
- 4-inch casing to 32.0 feet bgs, then 3-ich casing to 101.2 feet bgs.

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Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project: W. Mt. Vernon Bridge #2930 carries Route 41 over Echo Lake Stream
Location: Mt. Vernon, Maine

Boring No.: BB-MVEL-102B
WIN: 21698.00

Driller:	Maine Test Boring	**Elevation (ft.)**	324.8	**Auger ID/OD:**	5" Solid Stem
Operator:	Nadeau	**Datum:**	NAVD88	**Sampler:**	Standard Split Spoon
Logged By:	B. Cardali	**Rig Type:**	Diedrich D50 Turbo	**Hammer Wt./Fall:**	140-lbs/30-inches
Date Start/Finish:	5/5/2017-5/8/2017	**Drilling Method:**	Cased Wash Boring	**Core Barrel:**	NX-2"
Boring Location:	146+91.2, 20.9 feet, Rt.	**Casing ID/OD:**	HW-4" & NW-3"	**Water Level*:**	7.8 feet bgs.
Hammer Efficiency Factor: 0.979		**Hammer Type:**	Automatic ☒ Hydraulic ☐ Rope & Cathead ☐		

Definitions:
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SSA = Solid Stem Auger
HSA = Hollow Stem Auger
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WOH = Weight of 140lb. Hammer
WOR/C = Weight of Rods or Casing
WO1P = Weight of One Person
S_u = Peak/Remolded Field Vane Undrained Shear Strength (psf)
$S_{u(lab)}$ = Lab Vane Undrained Shear Strength (psf)
q_p = Unconfined Compressive Strength (ksf)
N-uncorrected = Raw Field SPT N-value
Hammer Efficiency Factor = Rig Specific Annual Calibration Value
N_{60} = SPT N-uncorrected Corrected for Hammer Efficiency
N_{60} = (Hammer Efficiency Factor/60%)*N-uncorrected
T_v = Pocket Torvane Shear Strength (psf)
WC = Water Content, percent
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index
G = Grain Size Analysis
C = Consolidation Test

Depth (ft.)	Sample Information: Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N_{60}	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
75											WC=21.5%
	7D	13.2/13.2	79.00 - 80.10	28/68/50(1.2")	---					Light brown, wet, very dense, fine to medium SAND, little silt, trace gravel, (Glacial Till).	
80											
	8D	10.8/10.8	84.00 - 84.90	25/50(4.8")	---					Light brown, wet, very dense, fine to medium SAND, little silt, (Glacial Till).	
85											
	9D	14.4/14.4	89.00 - 90.20	28/51//50(2.4")	---					Light brown, wet, very dense, fine to coarse SAND, little silt, (Glacial Till).	G#271161 A-2-4, SM WC=15.0%
90											
	10D	14.4/14.4	94.00 - 95.20	25/51/50(2.4")	---					Light brown, wet, very dense, fine to coarse SAND, some silt, trace gravel, (Glacial Till).	G#271167 A-2-4, SM WC=16.2%
95											
	11D	14.4/10	99.00 - 100.20	40/54/50(2.4")	---					Light brown, wet, very dense, fine to coarse SAND, some gravel, trace silt, (Glacial Till).	
100											

Remarks:

- Auto Hammer #377.
- Second 5.0 foot core run could not be taken due to broken casing and running sands within 3-inch casing.
- 4-inch casing to 32.0 feet bgs, then 3-ich casing to 101.2 feet bgs.

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Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project: W. Mt. Vernon Bridge #2930 carries Route 41 over Echo Lake Stream
Location: Mt. Vernon, Maine

Boring No.: BB-MVEL-102B
WIN: 21698.00

Driller:	Maine Test Boring	**Elevation (ft.)**	324.8	**Auger ID/OD:**	5" Solid Stem
Operator:	Nadeau	**Datum:**	NAVD88	**Sampler:**	Standard Split Spoon
Logged By:	B. Cardali	**Rig Type:**	Diedrich D50 Turbo	**Hammer Wt./Fall:**	140-lbs/30-inches
Date Start/Finish:	5/5/2017-5/8/2017	**Drilling Method:**	Cased Wash Boring	**Core Barrel:**	NX-2"
Boring Location:	146+91.2, 20.9 feet, Rt.	**Casing ID/OD:**	HW-4" & NW-3"	**Water Level*:**	7.8 feet bgs.
Hammer Efficiency Factor: 0.979		**Hammer Type:**	Automatic ☒ Hydraulic ☐ Rope & Cathead ☐		

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample Attempt
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MV = Unsuccessful Field Vane Shear Test Attempt
R = Rock Core Sample
SSA = Solid Stem Auger
HSA = Hollow Stem Auger
RC = Roller Cone
WOH = Weight of 140lb. Hammer
WOR/C = Weight of Rods or Casing
WO1P = Weight of One Person
S_u = Peak/Remolded Field Vane Undrained Shear Strength (psf)
$S_{u(lab)}$ = Lab Vane Undrained Shear Strength (psf)
q_p = Unconfined Compressive Strength (ksf)
N-uncorrected = Raw Field SPT N-value
Hammer Efficiency Factor = Rig Specific Annual Calibration Value
N_{60} = SPT N-uncorrected Corrected for Hammer Efficiency
N_{60} = (Hammer Efficiency Factor/60%)*N-uncorrected
T_v = Pocket Torvane Shear Strength (psf)
WC = Water Content, percent
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index
G = Grain Size Analysis
C = Consolidation Test

Depth (ft.)	Sample Information: Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N_{60}	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
100											
	R1	60/60	101.20 - 106.20	RQD = 23%			NX-2	223.60		101.20 Top of Bedrock at Elev. 223.6 feet. R1: Bedrock: Grey, medium-grained, SCHIST, hard, fresh to slightly weathered. Primary joints are very close to close, low angle, fresh to discolored, rough, undulating, partally open to open. Secondary joints are very close to close, high angle, rough, planar, discolored with sand infilling. One per vertical joint. Rock Mass Quality = Very Poor R1: Core Times (min/sec) 101.2-102.2 feet (2:01) 102.2-103.2 feet (1:57) 130.2-104.2 feet (2:52) 104.2-105.2 feet (2:12) 105.2-106.2 feet (1:30) 100% Recovery 106.20 **Bottom of Exploration at 106.20 feet below ground surface.**	
105								218.60			
110											
115											
120											
125											

Remarks:

- Auto Hammer #377.
- Second 5.0 foot core run could not be taken due to broken casing and running sands within 3-inch casing.
- 4-inch casing to 32.0 feet bgs, then 3-ich casing to 101.2 feet bgs.

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 C – LABORATORY TESTING RESULTS

State of Maine - Department of Transportation

Laboratory Testing Summary Sheet

Town(s): Mt. Vernon Work Number: 21698.00

Boring & Sample Identification Number	Station (Feet)	Offset (Feet)	Depth (Feet)	Reference Number	G.S.D.C. Sheet	W.C. %	L.L.	P.I.	Classification		
									Unified	AASHTO	Frost
BB-MVEL-101, 4D	146+15.4	6.4 Lt.	15.0-17.0	271162	1	10.5			SM	A-2-4	II
BB-MVEL-101B, 1D	146+17.5	6.3 Lt.	30.0-31.0	271163	1	8.7			SM	A-2-4	II
BB-MVEL-101B/4D	146+17.5	6.3 Lt.	45.0-46.5	271164	1	10.3			SM	A-4	III
BB-MVEL-101B/5D	146+17.5	6.3 Lt.	50.0-50.9	271165	1	9.5			SM	A-4	III
BB-MVEL-101B/8D	146+17.5	6.3 Lt.	80.0-82.0	271168	1	9.7			CL	A-4	IV
BB-MVEL-101B/9D	146+17.5	6.3 Lt.	90.0-92.0	271166	1	11.1			CL	A-4	IV
BB-MVEL-102/4D	146+91.3	16.4 Rt.	14.0-16.0	271155	2	13.4			SM	A-2-4	II
BB-MVEL-102/6D	146+91.3	16.4 Rt.	25.0-27.0	271156	2	10.9			SM	A-2-4	II
BB-MVEL-102/7D	146+91.3	16.4 Rt.	30.0-32.0	271157	2	9.6			SM	A-4	III
BB-MVEL-102B/2D	146+91.2	20.9 Rt.	54.0-56.0	271158	3	8.8			SC-SM	A-4	III
BB-MVEL-102B/4D	146+91.2	20.9 Rt.	64.0-66.0	271160	3	10.0			CL	A-4	IV
BB-MVEL-102B/6D	146+91.2	20.9 Rt.	74.0-75.3	271159	3	21.5			SM	A-4	III
BB-MVEL-102B/9D	146+91.2	20.9 Rt.	89.0-90.2	271161	3	15.0			SM	A-2-4	II
BB-MVEL-102B/10D	146+91.2	20.9 Rt.	94.0-95.2	271167	3	16.2			SM	A-2-4	II

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

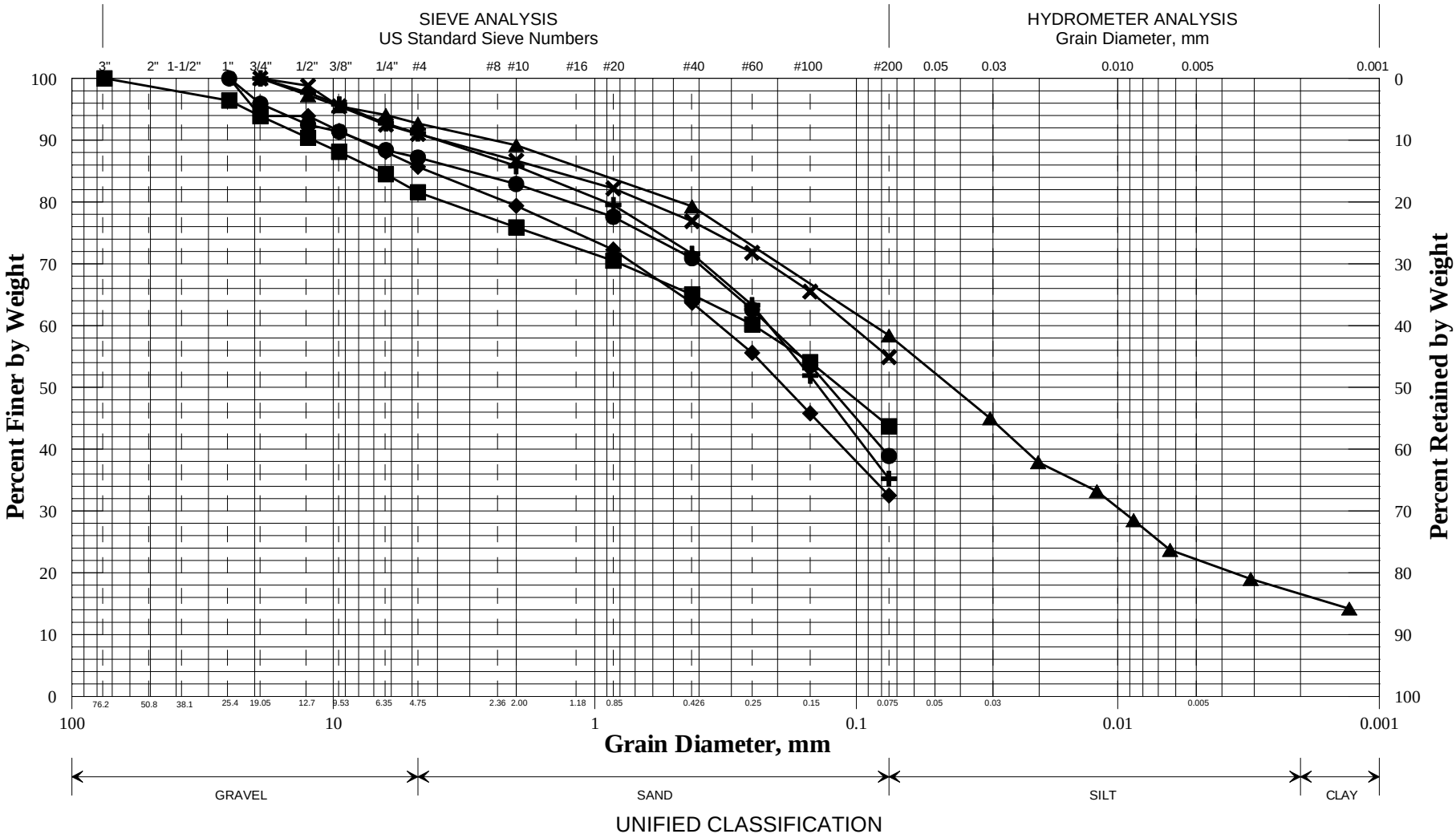
GSDC = Grain Size Distribution Curve as determined by AASHTO T 88-93 (1996) and/or ASTM D 422-63 (Reapproved 1998)

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

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

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-MVEL-101/4D	146+15.4	6.4 LT	15.0-17.0	SAND, some silt, trace gravel.	10.5			
◆	BB-MVEL-101B/1D	146+17.5	6.3 LT	30.0-31.0	SAND, some silt, little gravel.	8.7			
■	BB-MVEL-101B/4D	146+17.5	6.3 LT	45.0-46.5	Sandy SILT, little gravel.	10.3			
●	BB-MVEL-101B/5D	146+17.5	6.3 LT	50.0-50.9	Silty SAND, little gravel.	9.5			
▲	BB-MVEL-101B/8D	146+17.5	6.3 LT	80.0-82.0	SILT, some sand, little clay, trace gravel.	9.7			
✖	BB-MVEL-101B/9D	146+17.5	6.3 LT	90.0-92.0	Sandy SILT, trace gravel.	11.1			

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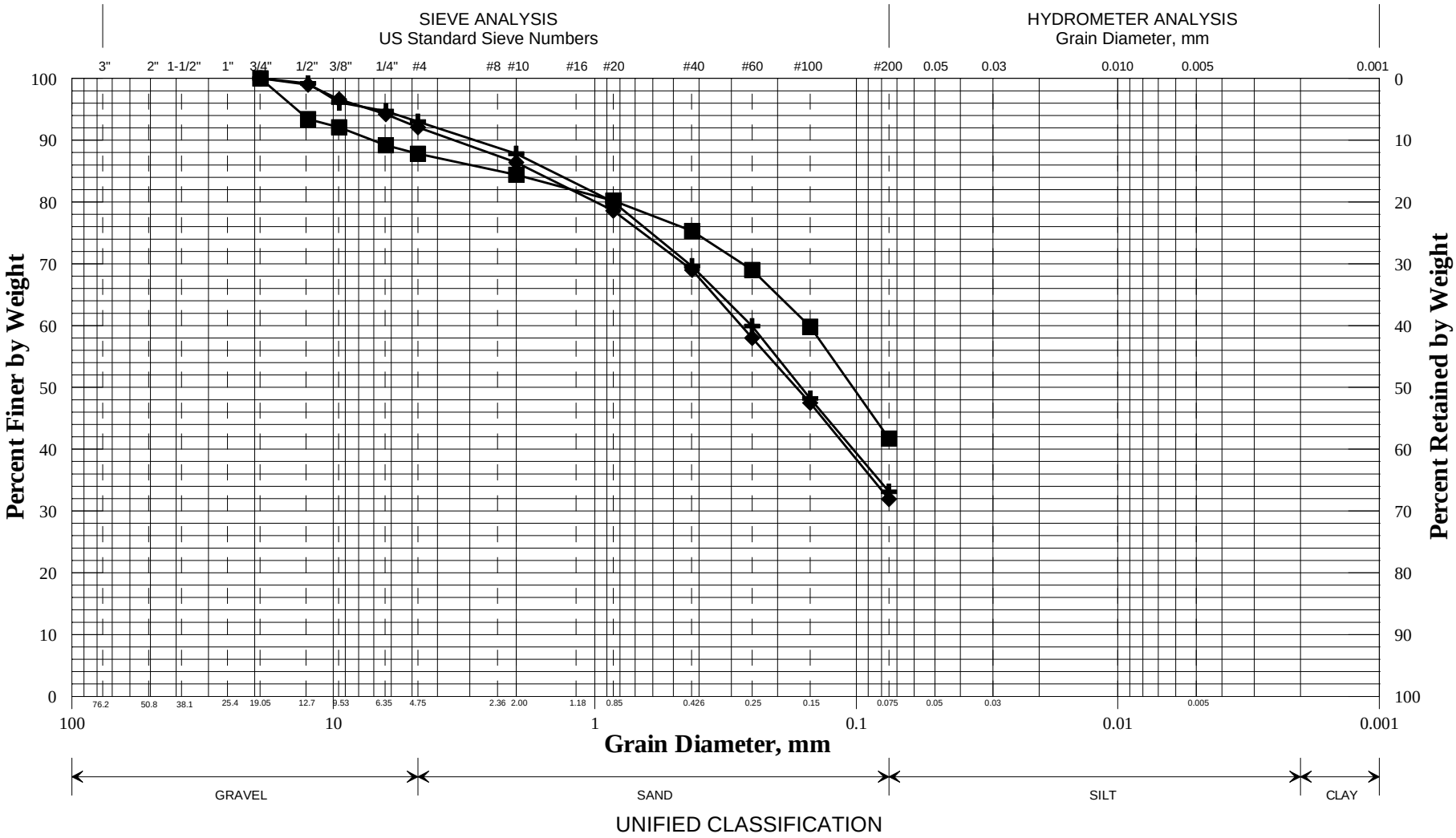
GRAIN SIZE DISTRIBUTION CURVE



	Boring/Sample No.	Station	Offset, ft	Depth, ft	Description	W, %	LL	PL	PI
✚	BB-MVEL-102/4D	146+91.3	16.4 RT	14.0-16.0	SAND, some silt, trace gravel.	13.4			
◆	BB-MVEL-102/6D	146+91.3	16.4 RT	25.0-27.0	SAND, some silt, trace gravel.	10.9			
■	BB-MVEL-102/7D	146+91.3	16.4 RT	30.0-32.0	Silty SAND, little gravel.	9.6			
●									
▲									
✖									

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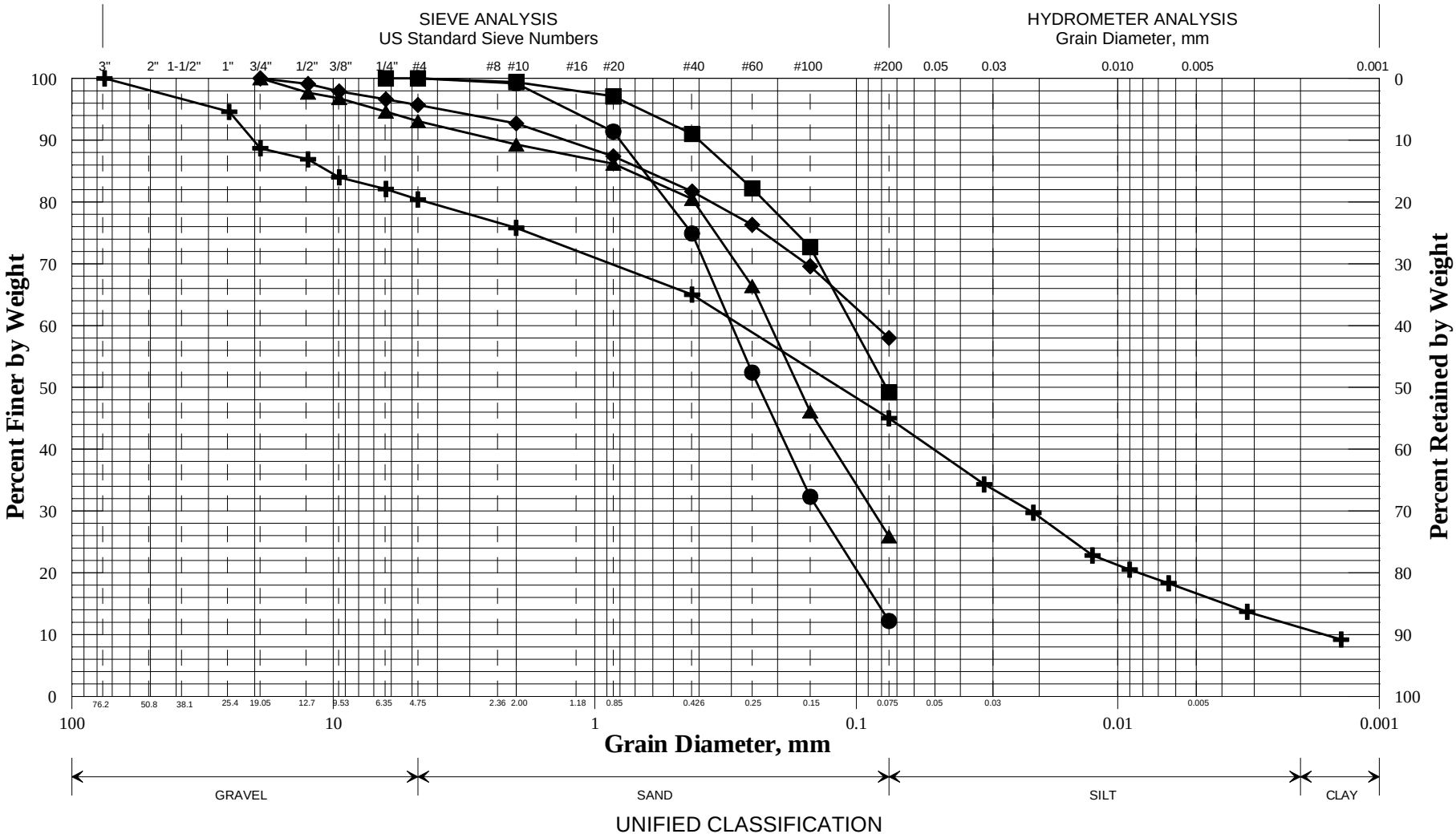
WHITE, TERRY A 6/8/2017

State of Maine Department of Transportation
GRAIN SIZE DISTRIBUTION CURVE



	Boring/Sample No.	Station	Offset, ft	Depth, ft	Description	W, %	LL	PL	PI
✚	BB-MVEL-102B/2D	146+91.2	20.9 RT	54.0-56.0	SAND, some silt, little gravel, little clay.	8.8			
◆	BB-MVEL-102B/4D	146+91.2	20.9 RT	64.0-66.0	SILT, some sand, trace gravel.	10.0			
■	BB-MVEL-102B/6D	146+91.2	20.9 RT	74.0-75.3	Silty SAND.	21.5			
●	BB-MVEL-102B/9D	146+91.2	20.9 RT	89.0-90.2	SAND, little silt.	15.0			
▲	BB-MVEL-102B/10D	146+91.2	20.9 RT	94.0-95.2	SAND, some silt, trace gravel.	16.2			
✖									

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Town
Mount Vernon
Reported by/Date
WHITE, TERRY A 6/8/2017

MaineDOT

GEOTECHNICAL TEST REPORT
Central Laboratory

SAMPLE INFORMATION

Reference No.	Boring No./Sample No.	Sample Description	Sampled	Received
271162	**BB-MVEL-101/4D**	**GEOTECHNICAL (DISTURBED)**	**4/5/2017**	**5/22/2017**

Sample Type: **GEOTECHNICAL** Location: Station: **146+15.4** Offset, ft: **6.4** **LT** Dbfg, ft: **15.0-17.0**

WIN/Town **021698.00 - MOUNT VERNON** Sampler: **BRUCE WILDER**

TEST RESULTS

Sieve Analysis (T 27, T 11)

Wash Method: Procedure A

SIEVE SIZE U.S. [SI]	% Passing
3 in. [75.0 mm]	
1 in. [25.0 mm]	
¾ in. [19.0 mm]	**100.0**
½ in. [12.5 mm]	**97.7**
⅜ in. [9.5 mm]	**95.8**
¼ in. [6.3 mm]	**92.7**
No. 4 [4.75 mm]	**91.1**
No. 10 [2.00 mm]	**85.8**
No. 20 [0.850 mm]	**79.5**
No. 40 [0.425 mm]	**71.6**
No. 60 [0.250 mm]	**63.3**
No. 100 [0.150 mm]	**51.9**
No. 200 [0.075 mm]	**35.2**

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)	
Water Content (T 265), %	**10.5**

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		

Vane Shear Test on Shelby Tubes (Maine DOT)

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

Comments:

AUTHORIZATION AND DISTRIBUTION

Reported by: **GREGORY LIDSTONE** Date Reported: **5/26/2017**

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GEOTECHNICAL TEST REPORT
Central Laboratory

SAMPLE INFORMATION

Reference No.	Boring No./Sample No.	Sample Description	Sampled	Received
271163	**BB-MVEL-101B/1D**	**GEOTECHNICAL (DISTURBED)**	**4/6/2017**	**5/22/2017**

Sample Type: **GEOTECHNICAL** Location: Station: **146+17.5** Offset, ft: **6.3** **LT** Dbfg, ft: **30.0-31.0**

WIN/Town **021698.00 - MOUNT VERNON** Sampler: **BRUCE WILDER**

TEST RESULTS

Sieve Analysis (T 27, T 11)	
Wash Method	
Procedure A	
SIEVE SIZE U.S. [SI]	% Passing
3 in. [75.0 mm]	
1 in. [25.0 mm]	**100.0**
¾ in. [19.0 mm]	**93.9**
½ in. [12.5 mm]	**93.9**
⅜ in. [9.5 mm]	**91.5**
¼ in. [6.3 mm]	**88.1**
No. 4 [4.75 mm]	**85.7**
No. 10 [2.00 mm]	**79.4**
No. 20 [0.850 mm]	**72.3**
No. 40 [0.425 mm]	**63.7**
No. 60 [0.250 mm]	**55.6**
No. 100 [0.150 mm]	**45.8**
No. 200 [0.075 mm]	**32.5**

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)	
Water Content (T 265), %	**8.7**

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		

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 tons/ft²	Remold tons/ft²	U. Shear tons/ft²	Remold tons/ft²		

Comments:

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GEOTECHNICAL TEST REPORT
Central Laboratory

SAMPLE INFORMATION

Reference No.	Boring No./Sample No.	Sample Description	Sampled	Received
271164	**BB-MVEL-101B/4D**	**GEOTECHNICAL (DISTURBED)**	**4/10/2017**	**5/22/2017**

Sample Type: **GEOTECHNICAL** Location: Station: **146+17.5** Offset, ft: **6.3** **LT** Dbfg, ft: **45.0-46.5**

WIN/Town **021698.00 - MOUNT VERNON** Sampler: **BRUCE WILDER**

TEST RESULTS

Sieve Analysis (T 27, T 11)	
Wash Method	
Procedure A	
SIEVE SIZE U.S. [SI]	% Passing
3 in. [75.0 mm]	**100.0**
1 in. [25.0 mm]	**96.4**
¾ in. [19.0 mm]	**93.9**
½ in. [12.5 mm]	**90.4**
⅜ in. [9.5 mm]	**88.1**
¼ in. [6.3 mm]	**84.5**
No. 4 [4.75 mm]	**81.6**
No. 10 [2.00 mm]	**75.9**
No. 20 [0.850 mm]	**70.5**
No. 40 [0.425 mm]	**65.0**
No. 60 [0.250 mm]	**60.2**
No. 100 [0.150 mm]	**54.1**
No. 200 [0.075 mm]	**43.7**

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)	
Water Content (T 265), %	**10.3**

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		

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 tons/ft²	Remold tons/ft²	U. Shear tons/ft²	Remold tons/ft²		

Comments:

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GEOTECHNICAL TEST REPORT
Central Laboratory

SAMPLE INFORMATION

Reference No.	Boring No./Sample No.	Sample Description	Sampled	Received
271165	**BB-MVEL-101B/5D**	**GEOTECHNICAL (DISTURBED)**	**4/7/2017**	**5/22/2017**

Sample Type: **GEOTECHNICAL** Location: Station: **146+17.5** Offset, ft: **6.3** **LT** Dbfg, ft: **50.0-50.9**

WIN/Town **021698.00 - MOUNT VERNON** Sampler: **BRUCE WILDER**

TEST RESULTS

Sieve Analysis (T 27, T 11)	
Wash Method	
Procedure A	
SIEVE SIZE U.S. [SI]	% Passing
3 in. [75.0 mm]	
1 in. [25.0 mm]	**100.0**
¾ in. [19.0 mm]	**95.9**
½ in. [12.5 mm]	**92.5**
⅜ in. [9.5 mm]	**91.4**
¼ in. [6.3 mm]	**88.4**
No. 4 [4.75 mm]	**87.2**
No. 10 [2.00 mm]	**82.9**
No. 20 [0.850 mm]	**77.6**
No. 40 [0.425 mm]	**70.9**
No. 60 [0.250 mm]	**62.6**
No. 100 [0.150 mm]	**53.6**
No. 200 [0.075 mm]	**38.9**

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)	
Water Content (T 265), %	**9.5**

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		

Vane Shear Test on Shelby Tubes (Maine DOT)

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

Comments:

AUTHORIZATION AND DISTRIBUTION

Reported by: **GREGORY LIDSTONE** Date Reported: **5/26/2017**

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GEOTECHNICAL TEST REPORT
Central Laboratory

SAMPLE INFORMATION

Reference No.	Boring No./Sample No.	Sample Description	Sampled	Received
271168	**BB-MVEL-101B/8D**	**GEOTECHNICAL (DISTURBED)**	**4/10/2017**	**5/22/2017**

Sample Type: **GEOTECHNICAL** Location: Station: **146+17.5** Offset, ft: **6.3** **LT** Dbfg, ft: **80.0-82.0**

WIN/Town **021698.00 - MOUNT VERNON** Sampler: **BRUCE WILDER**

TEST RESULTS

Sieve Analysis (T 88)

Wash Method

SIEVE SIZE U.S. [SI]	% Passing
3 in. [75.0 mm]	
1 in. [25.0 mm]	
¾ in. [19.0 mm]	**100.0**
½ in. [12.5 mm]	**97.3**
⅜ in. [9.5 mm]	**95.5**
¼ in. [6.3 mm]	**94.1**
No. 4 [4.75 mm]	**92.7**
No. 10 [2.00 mm]	**89.2**
No. 20 [0.850 mm]	
No. 40 [0.425 mm]	**79.3**
No. 60 [0.250 mm]	
No. 100 [0.150 mm]	
No. 200 [0.075 mm]	**58.4**
[0.0308 mm]	**45.0**
[0.0202 mm]	**37.9**
[0.0120 mm]	**33.2**
[0.0087 mm]	**28.5**
[0.0063 mm]	**23.7**
[0.0031 mm]	**19.0**
[0.0013 mm]	**14.2**

Miscellaneous Tests

Liquid Limit @ 25 blows (T 89), %	
Plastic Limit (T 90), %	
Plasticity Index (T 90), %	
Specific Gravity, Corrected to 20°C (T 100)	**2.66**
Loss on Ignition, % (T 267)	
Water Content (T 265), %	**9.7**

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		

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 tons/ft²	Remold tons/ft²	U. Shear tons/ft²	Remold tons/ft²		

Comments:

AUTHORIZATION AND DISTRIBUTION

Reported by: **GREGORY LIDSTONE** Date Reported: **6/5/2017**

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MaineDOT

GEOTECHNICAL TEST REPORT
Central Laboratory

SAMPLE INFORMATION

Reference No.	Boring No./Sample No.	Sample Description	Sampled	Received
271166	**BB-MVEL-101B/9D**	**GEOTECHNICAL (DISTURBED)**	**4/10/2017**	**5/22/2017**

Sample Type: **GEOTECHNICAL** Location: Station: **146+17.5** Offset, ft: **6.3** **LT** Dbfg, ft: **90.0-92.0**

WIN/Town **021698.00 - MOUNT VERNON** Sampler: **BRUCE WILDER**

TEST RESULTS

Sieve Analysis (T 27, T 11)	
Wash Method	
Procedure A	
SIEVE SIZE U.S. [SI]	% Passing
3 in. [75.0 mm]	
1 in. [25.0 mm]	
¾ in. [19.0 mm]	**100.0**
½ in. [12.5 mm]	**98.8**
⅜ in. [9.5 mm]	**95.5**
¼ in. [6.3 mm]	**92.5**
No. 4 [4.75 mm]	**91.0**
No. 10 [2.00 mm]	**86.7**
No. 20 [0.850 mm]	**82.2**
No. 40 [0.425 mm]	**76.9**
No. 60 [0.250 mm]	**71.8**
No. 100 [0.150 mm]	**65.5**
No. 200 [0.075 mm]	**54.9**

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)	
Water Content (T 265), %	**11.1**

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		

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 tons/ft²	Remold tons/ft²	U. Shear tons/ft²	Remold tons/ft²		

Comments:

AUTHORIZATION AND DISTRIBUTION

Reported by: **GREGORY LIDSTONE** Date Reported: **5/26/2017**

Paper Copy: Lab File; Project File; Geotech File

MaineDOT

GEOTECHNICAL TEST REPORT
Central Laboratory

SAMPLE INFORMATION

Reference No.	Boring No./Sample No.	Sample Description	Sampled	Received
271155	**BB-MVEL-102/4D**	**GEOTECHNICAL (DISTURBED)**	**5/2/2017**	**5/22/2017**

Sample Type: **GEOTECHNICAL** Location: Station: **146+91.3** Offset, ft: **16.4** **RT** Dbfg, ft: **14.0-16.0**

WIN/Town **021698.00 - MOUNT VERNON** Sampler: **CONSULTANT PERSONNEL**

TEST RESULTS

Sieve Analysis (T 27, T 11)

Wash Method: Procedure A

SIEVE SIZE U.S. [SI]	% Passing
3 in. [75.0 mm]	
1 in. [25.0 mm]	
¾ in. [19.0 mm]	**100.0**
½ in. [12.5 mm]	**99.2**
⅜ in. [9.5 mm]	**96.1**
¼ in. [6.3 mm]	**94.7**
No. 4 [4.75 mm]	**93.0**
No. 10 [2.00 mm]	**87.8**
No. 20 [0.850 mm]	**80.0**
No. 40 [0.425 mm]	**69.6**
No. 60 [0.250 mm]	**59.9**
No. 100 [0.150 mm]	**48.2**
No. 200 [0.075 mm]	**33.1**

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)	
Water Content (T 265), %	**13.4**

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		

Vane Shear Test on Shelby Tubes (Maine DOT)

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

Comments:

AUTHORIZATION AND DISTRIBUTION

Reported by: **GREGORY LIDSTONE** Date Reported: **5/26/2017**

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MaineDOT

GEOTECHNICAL TEST REPORT
Central Laboratory

SAMPLE INFORMATION

Reference No.	Boring No./Sample No.	Sample Description	Sampled	Received
271156	**BB-MVEL-102/6D**	**GEOTECHNICAL (DISTURBED)**	**5/2/2017**	**5/22/2017**

Sample Type: **GEOTECHNICAL** Location:

Station: **146+91.3** Offset, ft: **16.4** **RT** Dbfg, ft: **25.0-27.0**

WIN/Town **021698.00 - MOUNT VERNON**

Sampler: **CONSULTANT PERSONNEL**

TEST RESULTS

Sieve Analysis (T 27, T 11)

Wash Method

Procedure A

SIEVE SIZE U.S. [SI]	% Passing
3 in. [75.0 mm]	
1 in. [25.0 mm]	
¾ in. [19.0 mm]	**100.0**
½ in. [12.5 mm]	**99.0**
⅜ in. [9.5 mm]	**96.6**
¼ in. [6.3 mm]	**94.2**
No. 4 [4.75 mm]	**92.1**
No. 10 [2.00 mm]	**86.4**
No. 20 [0.850 mm]	**78.6**
No. 40 [0.425 mm]	**69.0**
No. 60 [0.250 mm]	**58.0**
No. 100 [0.150 mm]	**47.5**
No. 200 [0.075 mm]	**31.9**

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)	
Water Content (T 265), %	**10.9**

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		

Vane Shear Test on Shelby Tubes (Maine DOT)

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

Comments:

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GEOTECHNICAL TEST REPORT
Central Laboratory

SAMPLE INFORMATION

Reference No.	Boring No./Sample No.	Sample Description	Sampled	Received
271157	**BB-MVEL-102/7D**	**GEOTECHNICAL (DISTURBED)**	**5/2/2017**	**5/22/2017**

Sample Type: **GEOTECHNICAL** Location:

Station: **146+91.3** Offset, ft: **16.4** **RT** Dbfg, ft: **30.0-32.0**

WIN/Town **021698.00 - MOUNT VERNON**

Sampler: **CONSULTANT PERSONNEL**

TEST RESULTS

Sieve Analysis (T 27, T 11)

Wash Method

Procedure A

SIEVE SIZE U.S. [SI]	% Passing
3 in. [75.0 mm]	
1 in. [25.0 mm]	
¾ in. [19.0 mm]	**100.0**
½ in. [12.5 mm]	**93.4**
⅜ in. [9.5 mm]	**92.1**
¼ in. [6.3 mm]	**89.2**
No. 4 [4.75 mm]	**87.8**
No. 10 [2.00 mm]	**84.4**
No. 20 [0.850 mm]	**80.2**
No. 40 [0.425 mm]	**75.3**
No. 60 [0.250 mm]	**69.0**
No. 100 [0.150 mm]	**59.8**
No. 200 [0.075 mm]	**41.7**

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)	
Water Content (T 265), %	**9.6**

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		

Vane Shear Test on Shelby Tubes (Maine DOT)

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

Comments:

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Reported by: **GREGORY LIDSTONE** Date Reported: **5/26/2017**

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GEOTECHNICAL TEST REPORT
Central Laboratory

SAMPLE INFORMATION

Reference No.	Boring No./Sample No.	Sample Description	Sampled	Received
271158	**BB-MVEL-102B/2D**	**GEOTECHNICAL (DISTURBED)**	**5/3/2017**	**5/22/2017**

Sample Type: **GEOTECHNICAL** Location: Station: **146+91.2** Offset, ft: **20.9** **RT** Dbfg, ft: **54.0-56.0**

WIN/Town **021698.00 - MOUNT VERNON** Sampler: **CONSULTANT PERSONNEL**

TEST RESULTS

Sieve Analysis (T 88)

Wash Method

SIEVE SIZE U.S. [SI]	% Passing
3 in. [75.0 mm]	**100.0**
1 in. [25.0 mm]	**94.6**
¾ in. [19.0 mm]	**88.7**
½ in. [12.5 mm]	**86.9**
⅜ in. [9.5 mm]	**84.0**
¼ in. [6.3 mm]	**82.1**
No. 4 [4.75 mm]	**80.4**
No. 10 [2.00 mm]	**75.8**
No. 20 [0.850 mm]	
No. 40 [0.425 mm]	**65.0**
No. 60 [0.250 mm]	
No. 100 [0.150 mm]	
No. 200 [0.075 mm]	**45.0**
[0.0324 mm]	**34.3**
[0.0210 mm]	**29.7**
[0.0125 mm]	**22.8**
[0.0090 mm]	**20.5**
[0.0064 mm]	**18.3**
[0.0032 mm]	**13.7**
[0.0014 mm]	**9.2**

Miscellaneous Tests

Liquid Limit @ 25 blows (T 89), %	
Plastic Limit (T 90), %	
Plasticity Index (T 90), %	
Specific Gravity, Corrected to 20°C (T 100)	**2.65**
Loss on Ignition, % (T 267)	
Water Content (T 265), %	**8.8**

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		

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 tons/ft²	Remold tons/ft²	U. Shear tons/ft²	Remold tons/ft²		

Comments:

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Reported by: **GREGORY LIDSTONE** Date Reported: **6/7/2017**

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GEOTECHNICAL TEST REPORT
Central Laboratory

SAMPLE INFORMATION

Reference No.	Boring No./Sample No.	Sample Description	Sampled	Received
271160	**BB-MVEL-102B/4D**	**GEOTECHNICAL (DISTURBED)**	**5/5/2017**	**5/22/2017**

Sample Type: **GEOTECHNICAL** Location: Station: **146+91.2** Offset, ft: **20.9** **RT** Dbfg, ft: **64.0-66.0**

WIN/Town **021698.00 - MOUNT VERNON** Sampler: **BRUCE WILDER**

TEST RESULTS

Sieve Analysis (T 27, T 11)	
Wash Method	
Procedure A	
SIEVE SIZE U.S. [SI]	% Passing
3 in. [75.0 mm]	
1 in. [25.0 mm]	
¾ in. [19.0 mm]	**100.0**
½ in. [12.5 mm]	**99.1**
⅜ in. [9.5 mm]	**97.9**
¼ in. [6.3 mm]	**96.6**
No. 4 [4.75 mm]	**95.7**
No. 10 [2.00 mm]	**92.7**
No. 20 [0.850 mm]	**87.4**
No. 40 [0.425 mm]	**81.7**
No. 60 [0.250 mm]	**76.3**
No. 100 [0.150 mm]	**69.6**
No. 200 [0.075 mm]	**58.0**

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)	
Water Content (T 265), %	**10.0**

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		

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 tons/ft²	Remold tons/ft²	U. Shear tons/ft²	Remold tons/ft²		

Comments:

AUTHORIZATION AND DISTRIBUTION

Reported by: **GREGORY LIDSTONE** Date Reported: **5/26/2017**

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GEOTECHNICAL TEST REPORT
Central Laboratory

SAMPLE INFORMATION

Reference No.	Boring No./Sample No.	Sample Description	Sampled	Received
271159	**BB-MVEL-102B/6D**	**GEOTECHNICAL (DISTURBED)**	**5/8/2017**	**5/22/2017**

Sample Type: **GEOTECHNICAL** Location: Station: **146+91.2** Offset, ft: **20.9** **RT** Dbfg, ft: **74.0-75.3**

WIN/Town **021698.00 - MOUNT VERNON** Sampler: **BRUCE WILDER**

TEST RESULTS

Sieve Analysis (T 27, T 11)	
Wash Method	
Procedure A	
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]	**100.0**
No. 4 [4.75 mm]	**100.0**
No. 10 [2.00 mm]	**99.4**
No. 20 [0.850 mm]	**97.1**
No. 40 [0.425 mm]	**91.0**
No. 60 [0.250 mm]	**82.2**
No. 100 [0.150 mm]	**72.7**
No. 200 [0.075 mm]	**49.2**

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)	
Water Content (T 265), %	**21.5**

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		

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 tons/ft²	Remold tons/ft²	U. Shear tons/ft²	Remold tons/ft²		

Comments:

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Reported by: **GREGORY LIDSTONE** Date Reported: **5/26/2017**

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GEOTECHNICAL TEST REPORT
Central Laboratory

SAMPLE INFORMATION

Reference No.	Boring No./Sample No.	Sample Description	Sampled	Received
271161	**BB-MVEL-102B/9D**	**GEOTECHNICAL (DISTURBED)**	**5/8/2017**	**5/22/2017**

Sample Type: **GEOTECHNICAL** Location: Station: **146+91.2** Offset, ft: **20.9** **RT** Dbfg, ft: **89.0-90.2**

WIN/Town **021698.00 - MOUNT VERNON** Sampler: **BRUCE WILDER**

TEST RESULTS

Sieve Analysis (T 27, T 11)	
Wash Method	
Procedure A	
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]	**100.0**
No. 10 [2.00 mm]	**99.2**
No. 20 [0.850 mm]	**91.4**
No. 40 [0.425 mm]	**74.9**
No. 60 [0.250 mm]	**52.4**
No. 100 [0.150 mm]	**32.3**
No. 200 [0.075 mm]	**12.2**

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)	
Water Content (T 265), %	**15.0**

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		

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 tons/ft²	Remold tons/ft²	U. Shear tons/ft²	Remold tons/ft²		

Comments:

AUTHORIZATION AND DISTRIBUTION

Reported by: **GREGORY LIDSTONE** Date Reported: **5/26/2017**

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GEOTECHNICAL TEST REPORT
Central Laboratory

SAMPLE INFORMATION

Reference No.	Boring No./Sample No.	Sample Description	Sampled	Received
271167	**BB-MVEL-102B/10D**	**GEOTECHNICAL (DISTURBED)**	**5/8/2017**	**5/22/2017**

Sample Type: **GEOTECHNICAL** Location: Station: **146+91.2** Offset, ft: **20.9** **RT** Dbfg, ft: **94.0-95.2**

WIN/Town **021698.00 - MOUNT VERNON** Sampler: **BRUCE WILDER**

TEST RESULTS

Sieve Analysis (T 27, T 11)	
Wash Method	
Procedure A	
SIEVE SIZE U.S. [SI]	% Passing
3 in. [75.0 mm]	
1 in. [25.0 mm]	
¾ in. [19.0 mm]	**100.0**
½ in. [12.5 mm]	**97.7**
⅜ in. [9.5 mm]	**96.8**
¼ in. [6.3 mm]	**94.6**
No. 4 [4.75 mm]	**93.1**
No. 10 [2.00 mm]	**89.3**
No. 20 [0.850 mm]	**86.2**
No. 40 [0.425 mm]	**80.5**
No. 60 [0.250 mm]	**66.4**
No. 100 [0.150 mm]	**46.1**
No. 200 [0.075 mm]	**25.9**

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)	
Water Content (T 265), %	**16.2**

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		

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 tons/ft²	Remold tons/ft²	U. Shear tons/ft²	Remold tons/ft²		

Comments:

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APPENDIX D – CALCULATIONS

USGS Design Maps Detailed Report

2009 AASHTO Guide Specifications for LRFD Seismic Bridge Design (44.45273°N, 70.0144°W)

Site Class C – "Very Dense Soil and Soft Rock"

Article 3.4.1 — Design Spectra Based on General Procedure

Note: Maps in the 2009 AASHTO Specifications are provided by AASHTO for Site Class B. Adjustments for other Site Classes are made, as needed, in Article 3.4.2.3.

From Figure 3.4.1-2 [1]	PGA = 0.083 g
From Figure 3.4.1-3 [2]	S_S = 0.170 g
From Figure 3.4.1-4 [3]	S_1 = 0.047 g

Article 3.4.2.1 — Site Class Definitions

The authority having jurisdiction (not the USGS), site-specific geotechnical data, and/or the default has classified the site as Site Class C, based on the site soil properties in accordance with Article 3.4.2.

Table 3.4.2.1–1 Site Class Definitions

SITE CLASS	SOIL PROFILE NAME	Soil shear wave velocity, $\overline{v}_s$, (ft/s)	Standard penetration resistance, $\overline{N}$	Soil undrained shear strength, $\overline{s}_u$, (psf)
A	Hard rock	$\overline{v}_s > 5{,}000$	N/A	N/A
B	Rock	$2{,}500 < \overline{v}_s \leq 5{,}000$	N/A	N/A
C	Very dense soil and soft rock	$1{,}200 < \overline{v}_s \leq 2{,}500$	$\overline{N} > 50$	>2,000 psf
D	Stiff soil profile	$600 \leq \overline{v}_s < 1{,}200$	$15 \leq \overline{N} \leq 50$	1,000 to 2,000 psf
E	Stiff soil profile	$\overline{v}_s < 600$	$\overline{N} < 15$	<1,000 psf
E	—	Any profile with more than 10 ft of soil having the characteristics: 1. Plasticity index $PI > 20$, 2. Moisture content $w \geq 40\%$, and 3. Undrained shear strength $\overline{s}_u < 500$ psf		
F	—	Any profile containing soils having one or more of the following characteristics: 1. Soils vulnerable to potential failure or collapse under seismic loading such as liquefiable soils, quick and highly sensitive clays, collapsible weakly cemented soils. 2. Peats and/or highly organic clays ($H > 10$ feet of peat and/or highly organic clay where H = thickness of soil) 3. Very high plasticity clays ($H > 25$ feet with plasticity index $PI > 75$) 4. Very thick soft/medium stiff clays ($H > 120$ feet)		

For SI: 1ft/s = 0.3048 m/s 1lb/ft² = 0.0479 kN/m²

Article 3.4.2.3 — Site Coefficients

Table 3.4.2.3-1 (for F_{pga})—Values of F_{pga} as a Function of Site Class and Mapped Peak Ground Acceleration Coefficient

Site Class	Mapped Peak Ground Acceleration				
	PGA ≤ 0.10	PGA = 0.20	PGA = 0.30	PGA = 0.40	PGA ≥ 0.50
A	0.8	0.8	0.8	0.8	0.8
B	1.0	1.0	1.0	1.0	1.0
C	1.2	1.2	1.1	1.0	1.0
D	1.6	1.4	1.2	1.1	1.0
E	2.5	1.7	1.2	0.9	0.9
F	See AASHTO Article 3.4.3				

Note: Use straight–line interpolation for intermediate values of PGA

For Site Class = C and PGA = 0.083 g, F_{PGA} = 1.200

Table 3.4.2.3-1 (for F_a)—Values of F_a as a Function of Site Class and Mapped Short-Period Spectral Acceleration Coefficient

Site Class	Spectral Response Acceleration Parameter at Short Periods				
	$S_S \leq 0.25$	$S_S = 0.50$	$S_S = 0.75$	$S_S = 1.00$	$S_S \geq 1.25$
A	0.8	0.8	0.8	0.8	0.8
B	1.0	1.0	1.0	1.0	1.0
C	1.2	1.2	1.1	1.0	1.0
D	1.6	1.4	1.2	1.1	1.0
E	2.5	1.7	1.2	0.9	0.9
F	See AASHTO Article 3.4.3				

Note: Use straight–line interpolation for intermediate values of S_S

For Site Class = C and S_S = 0.170 g, F_a = 1.200

Table 3.4.2.3-2—Values of F_v as a Function of Site Class and Mapped 1-sec Period Spectral Acceleration Coefficient

Site Class	Mapped Spectral Response Acceleration Coefficient at 1-sec Periods				
	$S_1 \leq 0.10$	$S_1 = 0.20$	$S_1 = 0.30$	$S_1 = 0.40$	$S_1 \geq 0.50$
A	0.8	0.8	0.8	0.8	0.8
B	1.0	1.0	1.0	1.0	1.0
C	1.7	1.6	1.5	1.4	1.3
D	2.4	2.0	1.8	1.6	1.5
E	3.5	3.2	2.8	2.4	2.4
F	See AASHTO Article 3.4.3				

Note: Use straight–line interpolation for intermediate values of S_1

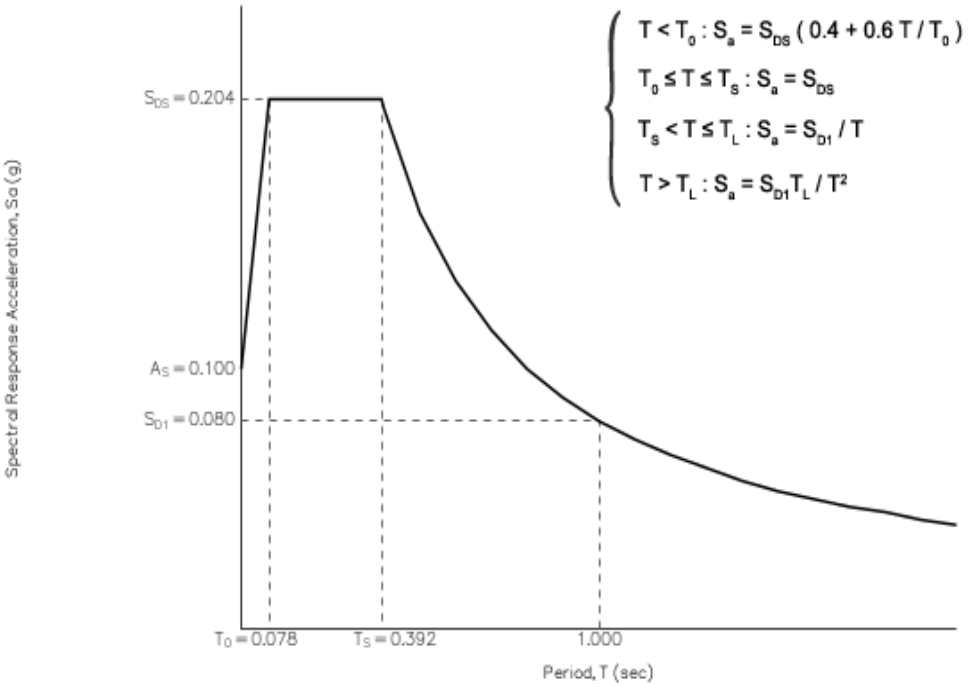
For Site Class = C and S_1 = 0.047 g, F_v = 1.700

Equation (3.4.1-1): $A_S = F_{PGA}\ PGA = 1.200 \times 0.083 = 0.100$ g

Equation (3.4.1-2): $S_{DS} = F_a\ S_S = 1.200 \times 0.170 = 0.204$ g

Equation (3.4.1-3): $S_{D1} = F_v\ S_1 = 1.700 \times 0.047 = 0.080$ g

Figure 3.4.1-1: Design Response Spectrum



Article 3.5 - Selection of Seismic Design Category (SDC)

Table 3.5-1—Partitions for Seismic Design Categories A, B, C, and D

VALUE OF S_{D1}	SDC
$S_{D1} < 0.15g$	A
$0.15g \le S_{D1} < 0.30g$	B
$0.30g \le S_{D1} < 0.50g$	C
$0.50g \le S_{D1}$	D

For S_{D1} = 0.080 g, Seismic Design Category = A

Seismic Design Category ≡ "the design category in accordance with Table 3.5-1" = A

References

1. *Figure 3.4.1-2*: https://earthquake.usgs.gov/hazards/designmaps/downloads/pdfs/AASHTO-2009-Figure-3.4.1-2.pdf
2. *Figure 3.4.1-3*: https://earthquake.usgs.gov/hazards/designmaps/downloads/pdfs/AASHTO-2009-Figure-3.4.1-3.pdf
3. *Figure 3.4.1-4*: https://earthquake.usgs.gov/hazards/designmaps/downloads/pdfs/AASHTO-2009-Figure-3.4.1-4.pdf

SPT Blow Count Conversions and Design Parameter Development
Maine DOT - West Mount Vernon Bridge No. 2930 over Echo Lake - Mount Vernon, ME
GZA GeoEnvironmental, Inc.

GZA FILE NO. 09.0025937.01
CALCULATED BY T.Bair 8/29/17
CHECKED BY A. Blaisdell, 9/11/17

Test Boring Elevations:

Boring Designation	Approx. Ground Surface
BB-MVEL-101	324.0
BB-MLEV-101B	324.1
BB-MLEV-102	325.3
BB-MVEL-102B	324.8

Stratum	γt (pcf)	Description For Table 3-4 Bowles
Fill	120	Dense, f-c SAND
Alluvial Deposit	125	Dense, Silty f-c SAND
Glacial Till	130	Very Dense, f-c SAND

Conversion of Blow Counts:

Boring (BB-WMR-XXX)	Depth to center (ft)	Sample ID	Elev.	Blows	Field N (bpf)	Total Unit Wt (pcf)	Effective overburden pressure (psf)	Cn	CE	CR	CB	Cs	Corrected N60	Corrected N160	Dr	Stratum	Groundwater Depth (ft)
101	2	1D	322.0	6-9-5-6	14	120	240	1.70	1.42	0.75	1	1	15	25	72%	Fill	4.6
101	6	2D	318.0	18-19-12-9	31	120	633	1.70	1.42	0.75	1	1	33	56	97%	Fill	
101	11	3D	313.0	18-19-18-17	37	125	946	1.45	1.42	0.75	1	1	39	57	100%	Alluvial Deposit	
101	16	4D	308.0	9-10-9-11	19	125	1259	1.26	1.42	0.85	1	1	23	29	85%	Alluvial Deposit	
101	21	5D	303.0	10-12-16-17	28	125	1572	1.13	1.42	0.95	1	1	38	43	100%	Alluvial Deposit	
101	26	6D	298.0	17-21-24-22	45	125	1885	1.03	1.42	1.00	1	1	64	66	100%	Alluvial Deposit	
101B	30.5	1D	293.6	35-55	--	130	2189	0.96	1.42	1.00	1	1	>100	--	--	Glacial Till	6.8
101B	35.15	2D	289.0	40(3.6")	--	130	2503	0.89	1.42	1.00	1	1	>100	--	--	Glacial Till	
101B	41.4	3D	282.7	46-60(3.6")	--	130	2926	0.83	1.42	1.00	1	1	>100	--	--	Glacial Till	
101B	45.75	4D	278.4	34-59-55	100	130	3220	0.79	1.42	1.00	1	1	142	112	100%	Glacial Till	
101B	50.45	5D	273.7	26-55(4.8")	--	130	3537	0.75	1.42	1.00	1	1	>100	--		Glacial Till	
101B	55.35	6D	268.8	60-50(2.4")	--	130	3869	0.72	1.42	1.00	1	1	>100	--		Glacial Till	
101B	60.25	7D	263.9	60.0	--	130	4200	0.69	1.42	1.00	1	1	>100	--		Glacial Till	
101B	70.1	MD	254.0	40(2.4")	--	130	4866	0.64	1.42	1.00	1	1	>100	--		Glacial Till	
101B	81	8D	243.1	13-17-23-31	40	130	5603	0.60	1.42	1.00	1	1	57	34	81%	Glacial Till	
101B	91	9D	233.1	12-15-22-30	37	130	6279	0.56	1.42	1.00	1	1	53	30	78%	Glacial Till	
101B	100.5	10D	223.6	30-66	--	130	6921	0.54	1.42	1.00	1	1	>100	--		Glacial Till	
102	1	1D	324.3	1-2-4-5	6	120	120	1.70	1.42	0.75	1	1	6	11	48%	Fill	7.9
102	5.5	2D	319.8	11-27-9-9	36	120	660	1.70	1.42	0.75	1	1	38	65	100%	Fill	
102	10	3D	315.3	1-1-1-2	2	120	1069	1.37	1.42	0.75	1	1	2	3	32%	Fill	
102	15	4D	310.3	2-4-5-8	9	120	1357	1.21	1.42	0.85	1	1	11	13	62%	Fill	
102	21	5D	304.3	17-21-19-15	40	120	1703	1.08	1.42	0.95	1	1	54	59	100%	Fill	
102	26	6D	299.3	32-35-41-46	76	130	2041	0.99	1.42	0.95	1	1	103	102	100%	Glacial Till	
102	31	7D	294.3	20-44-49-43	93	130	2379	0.92	1.42	0.95	1	1	126	115	100%	Glacial Till	
102	35.8	8D	289.5	47-78-196-50(1")	100	130	2703	0.86	1.42	1.00	1	1	142	122	100%	Glacial Till	
102	40.4	9D	284.9	61-209(3.6")	--	130	3014	0.81	1.42	1.00	1	1	>100	--		Glacial Till	
102	46	10D	279.3	19-68-88-106	100	130	3393	0.77	1.42	1.00	1	1	142	109	100%	Glacial Till	
102B	51	1D	273.8	41-52-71-72	100	130	3731	0.73	1.42	1.00	1	1	142	104	100%	Glacial Till	7.8
102B	55	2D	269.8	29-39-58-36	97	130	4001	0.71	1.42	1.00	1	1	138	98	100%	Glacial Till	
102B	60	3D	264.8	25-35-44-53	79	130	4339	0.68	1.42	1.00	1	1	112	76	100%	Glacial Till	
102B	65	4D	259.8	21-32-52-54	84	130	4677	0.65	1.42	1.00	1	1	120	78	100%	Glacial Till	
102B	69.4	5D	255.4	25-62(3.6")	--	130	4974	0.63	1.42	1.00	1	1	>100	--		Glacial Till	
102B	74.65	6D	250.2	25-44-50(3.6")	--	130	5329	0.61	1.42	1.00	1	1	>100	--		Glacial Till	
102B	79.55	7D	245.3	28-68-50(1.2")	--	130	5661	0.59	1.42	1.00	1	1	>100	--		Glacial Till	
102B	84.45	8D	240.4	25-50(4.8")	--	130	5992	0.58	1.42	1.00	1	1	>100	--		Glacial Till	
102B	89.6	9D	235.2	28-51-50(2.4")	--	130	6340	0.56	1.42	1.00	1	1	>100	--		Glacial Till	
102B	94.6	10D	230.2	25-51-50(2.4")	--	130	6678	0.55	1.42	1.00	1	1	>100	--		Glacial Till	
102B	99.6	11D	225.2	40-54-50(2.4")	--	130	7016	0.53	1.42	1.00	1	1	>100	--		Glacial Till	

SPT Blow Count Conversions and Design Parameter Development
Maine DOT - West Mount Vernon Bridge No. 2930 over Echo Lake - Mount Vernon, ME
GZA GeoEnvironmental, Inc.

GZA FILE NO. 09.0025937.01
CALCULATED BY T.Bair 8/29/17
CHECKED BY A. Blaisdell, 9/11/17

Estimate N60 for Dr and k Analysis:

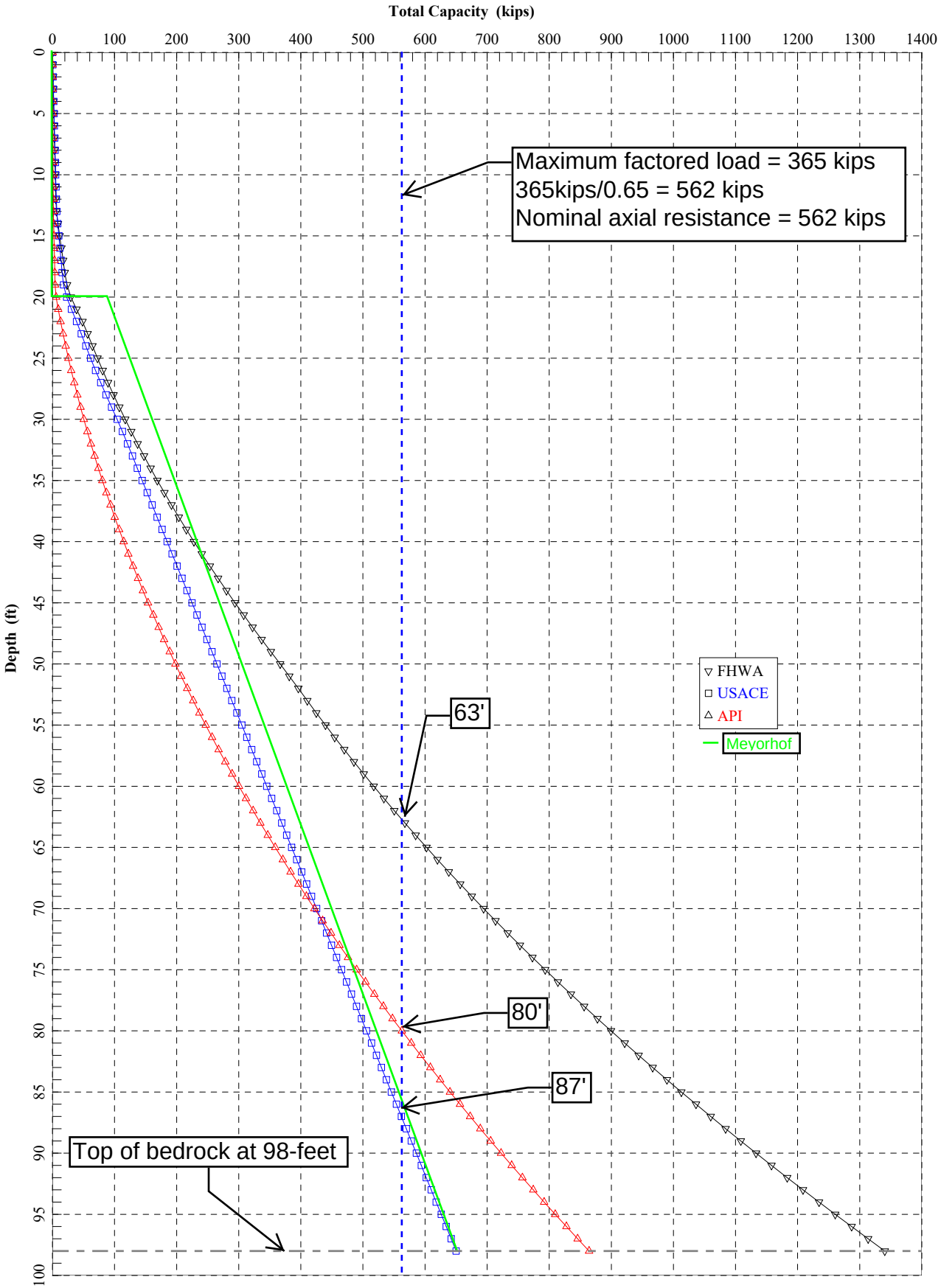
	Avg N60	N60 St. Dev	Design Basis N60 (Avg-0.5 St. Dev)	Avg σv'	Dr	Dr St. Dev	Design Basis Dr (Avg-1 St. Dev)	Design k above GWT (pci)	Design k below GWT (pci)
Fill	23	18	14	826	73%	25%	48%	80	50
Alluvial Deposit	41	15	34	1415	96%	6%	90%	280	160
Glacial Till	116	32	100	4384	96%	8%	88%	280	160

Notes:
1) N60 used to correlate properties per FB-Multipier Manual correlations due to overburden effect built into relative density (Dr) correlation Figure 12.3.b.
2) Dr was calculated using N60 Avg-0.5*Standard Deviation.
3) N60 values for samples that met refusal at less than 18" recovery not calculated or used.
4) Average effective stress for layer calculated for all SPT samples taken in stratum.
5) Dr interpolated from FBPier Manual Fig. 12.3.b using Dr and N60 (selected by hand from Engineering Properties sheets).
6) Subgrade modulus (k) values calculated as a function of Design Basis Dr using correlation in Figure 12.3.c from FB-Multipier manual.

Estimate Friction Angles:

	Avg N160	N160 St. Dev	Design Basis N160 (Avg-0.5 St. Dev)	Friction Angle (Deg)
Fill	33	24	21	35
Alluvial Deposit	49	14	42	39
Glacial Till	89	30	74	41

Notes:
1) Phi estimated based on the correlation of N160 and friction angle presented in AASHTO LRFD Table 10.4.6.2.4-1.
2) Friction angle was calculated using N160 Avg-0.5*Standard Deviation.
3) Strikethrough of corrected N160 value indicates cobble/boulder fragments in recovery, result not used.


Total Capacity (kips)
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
Depth (ft)
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100
Maximum factored load = 365 kips
365kips/0.65 = 562 kips
Nominal axial resistance = 562 kips
FHWA
USACE
API
Meyorhof
63'
80'
87'
Top of bedrock at 98-feet

APILE for Windows, Version 2015.7.8

Serial Number : 653550831

A Program for Analyzing the Axial Capacity
and Short-term Settlement of Driven Piles
under Axial Loading.

(c) Copyright ENSOFT, Inc., 1987-2015
All Rights Reserved

This program is licensed to :

GZA GeoEnvironmental, Inc.
Portland, OR

Path to file locations : P:\09 Jobs\0025900s\09.0025937.00 - MEDOT Mt. Vernon\09.0025937.01 - MDOT W. Mt. Vernon Bridge\Work\APile\
Name of input data file : 14x89.ap7d
Name of output file : 14x89.ap7o
Name of plot output file : 14x89.ap7p

Time and Date of Analysis

Date: August 14, 2018 Time: 14:45:23

1

****
* INPUT INFORMATION *

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Check Side resistance of a HP14x89

DESIGNER : B. Cardali

JOB NUMBER : 09.0025937.01

METHOD FOR UNIT LOAD TRANSFERS :

- API RP 2A (American Petroleum Institute)
  Unfactored Unit Side Friction and Unit Side Resistance are used.

COMPUTATION METHOD(S) FOR PILE CAPACITY :

- FHWA (Federal Highway Administration)
- USACE (U.S. Army Corps of Engineers)
  # Critical Depth Method for Sand:
  10 to 20 Pile Diameter based on the Density
- API RP 2A (American Petroleum Institute)

TYPE OF LOADING :
- COMPRESSION

PILE TYPE :

H-Pile/Steel Pile

DATA FOR AXIAL STIFFNESS :

- MODULUS OF ELASTICITY = 0.290E+08 PSI
- CROSS SECTION AREA = 26.10 IN2

NONCIRCULAR PILE PROPERTIES :

- TOTAL PILE LENGTH, TL = 100.00 FT.
- PILE STICKUP LENGTH, PSL = 2.00 FT.
- ZERO FRICTION LENGTH, ZFL = 20.00 FT.
- PERIMETER OF PILE = 57.00 IN.
- TIP AREA OF PILE = 26.10 IN2
- INCREMENT OF PILE LENGTH USED IN COMPUTATION = 1.00 FT.

SOIL INFORMATIONS :

DEPTH FT.	SOIL TYPE	LATERAL EARTH PRESSURE	EFFECTIVE UNIT WEIGHT LB/CF	FRICTION ANGLE DEGREES	BEARING CAPACITY FACTOR
0.00	SAND	0.80	57.60	35.00	10.00
15.00	SAND	0.80	57.60	35.00	10.00
15.00	SAND	0.80	62.60	39.00	20.00
20.00	SAND	0.80	62.60	39.00	20.00
20.00	SAND	0.80	67.60	41.00	20.00
120.00	SAND	0.80	67.60	41.00	40.00

MAXIMUM UNIT FRICTION	MAXIMUM UNIT BEARING	UNDISTURB SHEAR STRENGTH	REMOLDED SHEAR STRENGTH	BLOW COUNT	UNIT SKIN FRICTION	UNIT END BEARING
KSF	KSF	KSF	KSF		KSF	KSF
0.10E+08*	0.10E+08*	0.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.00	0.00	0.00	0.00	0.00

* MAXIMUM UNIT FRICTION AND/OR MAXIMUM UNIT BEARING WERE SET TO BE 0.10E+08 BECAUSE THE USER DOES NOT PLAN TO LIMIT THE COMPUTED DATA.

DEPTH FT.	LRFD FACTOR ON UNIT FRICTION	LRFD FACTOR ON UNIT BEARING
0.00	1.000	1.000
15.00	1.000	1.000
15.00	1.000	1.000
20.00	1.000	1.000
20.00	1.000	1.000
120.00	1.000	1.000

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* COMPUTATION RESULT *
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* FED. HWY. METHOD *
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PILE PENETRATION FT.	TOTAL SKIN FRICTION KIP	END BEARING KIP	ULTIMATE CAPACITY KIP
0.00	0.0	0.3	0.3
1.00	0.0	0.5	0.5
2.00	0.0	0.9	0.9
3.00	0.0	1.4	1.4
4.00	0.0	1.8	1.8
5.00	0.0	2.3	2.3
6.00	0.0	2.7	2.7
7.00	0.0	3.2	3.2
8.00	0.0	3.6	3.6
9.00	0.0	4.1	4.1
10.00	0.0	4.5	4.5
11.00	0.0	5.0	5.0
12.00	0.0	5.5	5.5
13.00	0.0	6.4	6.4
14.00	0.0	8.9	8.9
15.00	0.0	11.6	11.6
16.00	0.0	14.4	14.4
17.00	0.0	17.3	17.3
18.00	0.0	19.7	19.7
19.00	0.0	23.5	23.5
20.00	2.2	27.5	29.7
21.00	7.1	31.6	38.7
22.00	12.4	35.9	48.4
23.00	18.1	38.5	56.6
24.00	24.0	40.4	64.4
25.00	30.2	42.3	72.5
26.00	36.7	44.2	80.9
27.00	43.5	46.0	89.5
28.00	50.6	47.9	98.5
29.00	57.9	49.8	107.7
30.00	65.5	51.7	117.2
31.00	73.4	53.6	127.0
32.00	81.6	55.5	137.1

33.00	90.1	57.4	147.5
34.00	98.9	59.2	158.1
35.00	107.9	61.1	169.0
36.00	117.2	63.0	180.3
37.00	126.9	64.9	191.8
38.00	136.7	66.8	203.5
39.00	146.9	68.7	215.6
40.00	157.4	70.6	227.9
41.00	168.1	72.4	240.6
42.00	179.2	74.3	253.5
43.00	190.5	76.2	266.7
44.00	202.1	78.1	280.2
45.00	213.9	80.0	293.9
46.00	226.1	81.9	308.0
47.00	238.6	83.8	322.3
48.00	251.3	85.6	336.9
49.00	264.3	87.5	351.8
50.00	277.6	89.1	366.7
51.00	291.2	90.2	381.4
52.00	305.0	90.9	396.0
53.00	319.2	91.2	410.4
54.00	333.6	91.3	424.9
55.00	348.3	91.3	439.6
56.00	363.3	91.3	454.6
57.00	378.6	91.3	469.9
58.00	394.2	91.3	485.4
59.00	410.0	91.3	501.3
60.00	426.1	91.3	517.4
61.00	442.6	91.3	533.8
62.00	459.3	91.3	550.5
63.00	476.2	91.3	567.5
64.00	493.5	91.3	584.8
65.00	511.0	91.3	602.3
66.00	528.9	91.3	620.1
67.00	547.0	91.3	638.3
68.00	565.4	91.3	656.7
69.00	584.1	91.3	675.3

70.00	603.0	91.3	694.3
71.00	622.3	91.3	713.5
72.00	641.8	91.3	733.1
73.00	661.6	91.3	752.9
74.00	681.7	91.3	773.0
75.00	702.1	91.3	793.4
76.00	722.8	91.3	814.0
77.00	743.7	91.3	835.0
78.00	765.0	91.3	856.2
79.00	786.5	91.3	877.7
80.00	808.3	91.3	899.5
81.00	830.4	91.3	921.6
82.00	852.7	91.3	944.0
83.00	875.4	91.3	966.6
84.00	898.3	91.3	989.6
85.00	921.5	91.3	1012.8
86.00	945.0	91.3	1036.3
87.00	968.8	91.3	1060.1
88.00	992.9	91.3	1084.1
89.00	1017.2	91.3	1108.5
90.00	1041.9	91.3	1133.1
91.00	1066.8	91.3	1158.0
92.00	1092.0	91.3	1183.2
93.00	1117.5	91.3	1208.7
94.00	1143.2	91.3	1234.5
95.00	1169.3	91.3	1260.5
96.00	1195.6	91.3	1286.9
97.00	1222.2	91.3	1313.5
98.00	1249.1	91.3	1340.4

****
* ARMY CORPS METHOD *
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PILE	TOTAL SKIN	END	ULTIMATE

PENETRATION FT.	FRICTION KIP	BEARING KIP	CAPACITY KIP
0.00	0.0	0.3	0.3
1.00	0.0	0.6	0.6
2.00	0.0	1.0	1.0
3.00	0.0	1.6	1.6
4.00	0.0	2.1	2.1
5.00	0.0	2.6	2.6
6.00	0.0	3.1	3.1
7.00	0.0	3.6	3.6
8.00	0.0	4.1	4.1
9.00	0.0	4.7	4.7
10.00	0.0	5.2	5.2
11.00	0.0	5.7	5.7
12.00	0.0	6.2	6.2
13.00	0.0	7.0	7.0
14.00	0.0	8.6	8.6
15.00	0.0	10.3	10.3
16.00	0.0	12.0	12.0
17.00	0.0	13.9	13.9
18.00	0.0	15.5	15.5
19.00	0.0	17.9	17.9
20.00	2.4	20.5	22.8
21.00	7.4	23.1	30.5
22.00	12.9	25.9	38.8
23.00	18.7	27.6	46.3
24.00	24.7	29.0	53.7
25.00	31.1	30.3	61.4
26.00	37.8	31.7	69.4
27.00	44.7	33.0	77.7
28.00	51.9	34.4	86.3
29.00	59.5	35.7	95.2
30.00	67.3	36.9	104.2
31.00	75.3	37.4	112.7
32.00	83.3	37.7	120.9
33.00	91.3	37.6	128.9
34.00	99.3	37.2	136.6

35.00	107.4	37.1	144.4
36.00	115.4	37.1	152.5
37.00	123.4	37.1	160.5
38.00	131.4	37.1	168.5
39.00	139.5	37.1	176.5
40.00	147.5	37.1	184.6
41.00	155.5	37.1	192.6
42.00	163.5	37.1	200.6
43.00	171.6	37.1	208.7
44.00	179.6	37.1	216.7
45.00	187.6	37.1	224.7
46.00	195.7	37.1	232.7
47.00	203.7	37.1	240.8
48.00	211.7	37.1	248.8
49.00	219.7	37.1	256.8
50.00	227.8	37.1	264.8
51.00	235.8	37.1	272.9
52.00	243.8	37.1	280.9
53.00	251.8	37.1	288.9
54.00	259.9	37.1	296.9
55.00	267.9	37.1	305.0
56.00	275.9	37.1	313.0
57.00	283.9	37.1	321.0
58.00	292.0	37.1	329.0
59.00	300.0	37.1	337.1
60.00	308.0	37.1	345.1
61.00	316.0	37.1	353.1
62.00	324.1	37.1	361.2
63.00	332.1	37.1	369.2
64.00	340.1	37.1	377.2
65.00	348.2	37.1	385.2
66.00	356.2	37.1	393.3
67.00	364.2	37.1	401.3
68.00	372.2	37.1	409.3
69.00	380.3	37.1	417.3
70.00	388.3	37.1	425.4
71.00	396.3	37.1	433.4

72.00	404.3	37.1	441.4
73.00	412.4	37.1	449.4
74.00	420.4	37.1	457.5
75.00	428.4	37.1	465.5
76.00	436.4	37.1	473.5
77.00	444.5	37.1	481.5
78.00	452.5	37.1	489.6
79.00	460.5	37.1	497.6
80.00	468.5	37.1	505.6
81.00	476.6	37.1	513.7
82.00	484.6	37.1	521.7
83.00	492.6	37.1	529.7
84.00	500.7	37.1	537.7
85.00	508.7	37.1	545.8
86.00	516.7	37.1	553.8
87.00	524.7	37.1	561.8
88.00	532.8	37.1	569.8
89.00	540.8	37.1	577.9
90.00	548.8	37.1	585.9
91.00	556.8	37.1	593.9
92.00	564.9	37.1	601.9
93.00	572.9	37.1	610.0
94.00	580.9	37.1	618.0
95.00	588.9	37.1	626.0
96.00	597.0	37.1	634.1
97.00	605.0	37.1	642.1
98.00	613.0	37.1	650.1

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* API RP-2A (1994) *
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PILE PENETRATION FT.	TOTAL SKIN FRICTION KIP	END BEARING KIP	ULTIMATE CAPACITY KIP

0.00	0.0	0.1	0.1
1.00	0.0	0.1	0.1
2.00	0.0	0.2	0.2
3.00	0.0	0.3	0.3
4.00	0.0	0.4	0.4
5.00	0.0	0.5	0.5
6.00	0.0	0.6	0.6
7.00	0.0	0.7	0.7
8.00	0.0	0.8	0.8
9.00	0.0	0.9	0.9
10.00	0.0	1.0	1.0
11.00	0.0	1.1	1.1
12.00	0.0	1.3	1.3
13.00	0.0	1.5	1.5
14.00	0.0	1.9	1.9
15.00	0.0	2.4	2.4
16.00	0.0	2.9	2.9
17.00	0.0	3.5	3.5
18.00	0.0	3.8	3.8
19.00	0.0	4.1	4.1
20.00	1.5	4.3	5.8
21.00	4.7	4.6	9.3
22.00	8.3	4.9	13.1
23.00	12.0	5.2	17.1
24.00	15.9	5.5	21.3
25.00	20.0	5.8	25.7
26.00	24.2	6.1	30.3
27.00	28.7	6.4	35.1
28.00	33.4	6.7	40.1
29.00	38.2	7.1	45.3
30.00	43.2	7.4	50.6
31.00	48.4	7.7	56.2
32.00	53.8	8.1	61.9
33.00	59.4	8.4	67.8
34.00	65.2	8.8	74.0
35.00	71.1	9.1	80.3
36.00	77.3	9.5	86.8

37.00	83.6	9.9	93.5
38.00	90.1	10.2	100.4
39.00	96.8	10.6	107.4
40.00	103.7	11.0	114.7
41.00	110.8	11.4	122.2
42.00	118.0	11.8	129.8
43.00	125.5	12.2	137.7
44.00	133.1	12.6	145.7
45.00	141.0	13.0	153.9
46.00	149.0	13.4	162.4
47.00	157.2	13.8	171.0
48.00	165.5	14.2	179.8
49.00	174.1	14.7	188.8
50.00	182.9	15.1	198.0
51.00	191.8	15.5	207.3
52.00	200.9	16.0	216.9
53.00	210.2	16.4	226.7
54.00	219.8	16.9	236.6
55.00	229.4	17.3	246.8
56.00	239.3	17.8	257.1
57.00	249.4	18.3	267.6
58.00	259.6	18.7	278.4
59.00	270.1	19.2	289.3
60.00	280.7	19.7	300.4
61.00	291.5	20.2	311.7
62.00	302.5	20.7	323.2
63.00	313.7	21.2	334.8
64.00	325.0	21.7	346.7
65.00	336.6	22.2	358.8
66.00	348.3	22.7	371.0
67.00	360.3	23.2	383.5
68.00	372.4	23.7	396.1
69.00	384.7	24.3	408.9
70.00	397.2	24.8	421.9
71.00	409.8	25.3	435.2
72.00	422.7	25.9	448.6
73.00	435.7	26.4	462.1

74.00	449.0	27.0	475.9
75.00	462.4	27.5	489.9
76.00	476.0	28.1	504.1
77.00	489.8	28.6	518.4
78.00	503.8	29.2	533.0
79.00	517.9	29.8	547.7
80.00	532.3	30.4	562.7
81.00	546.8	30.9	577.8
82.00	561.6	31.5	593.1
83.00	576.5	32.1	608.6
84.00	591.6	32.7	624.3
85.00	606.9	33.3	640.2
86.00	622.3	33.9	656.3
87.00	638.0	34.5	672.6
88.00	653.9	35.2	689.0
89.00	669.9	35.8	705.7
90.00	686.1	36.4	722.5
91.00	702.5	37.1	739.6
92.00	719.1	37.7	756.8
93.00	735.9	38.3	774.2
94.00	752.9	39.0	791.8
95.00	770.0	39.6	809.6
96.00	787.4	40.3	827.6
97.00	804.9	41.0	845.8
98.00	822.6	41.6	864.2

NOTES:
- AN ASTERISK IS PLACED IN THE END-BEARING COLUMN
  IF THE TIP RESISTANCE IS CONTROLLED BY THE FRICTION
  OF SOIL PLUG INSIDE AN OPEN-ENDED PIPE PILE.

****
* COMPUTE LOAD-DISTRIBUTION AND LOAD-SETTLEMENT *
* CURVES FOR AXIAL LOADING *

****

T-Z CURVE NO.	NO. OF POINTS	DEPTH TO CURVE FT.	LOAD TRANSFER PSI	PILE MOVEMENT IN.
1	10	-0.2000E+01		
			0.0000E+00	0.0000E+00
			0.0000E+00	0.2903E-01
			0.0000E+00	0.5625E-01
			0.0000E+00	0.1034E+00
			0.0000E+00	0.1451E+00
			0.0000E+00	0.1814E+00
			0.0000E+00	0.3629E+00
			0.0000E+00	0.5443E+00
			0.0000E+00	0.9072E+00
			0.0000E+00	0.3629E+01
2	10	-0.1000E+01		
			0.0000E+00	0.0000E+00
			0.0000E+00	0.2903E-01
			0.0000E+00	0.5625E-01
			0.0000E+00	0.1034E+00
			0.0000E+00	0.1451E+00
			0.0000E+00	0.1814E+00
			0.0000E+00	0.3629E+00
			0.0000E+00	0.5443E+00
			0.0000E+00	0.9072E+00
			0.0000E+00	0.3629E+01
3	10	-0.8333E-02		
			0.0000E+00	0.0000E+00
			0.0000E+00	0.2903E-01
			0.0000E+00	0.5625E-01
			0.0000E+00	0.1034E+00
			0.0000E+00	0.1451E+00
			0.0000E+00	0.1814E+00
			0.0000E+00	0.3629E+00
			0.0000E+00	0.5443E+00

```
0.0000E+00      0.9072E+00
0.0000E+00      0.3629E+01
 4         10      0.0000E+00
0.0000E+00      0.0000E+00
0.0000E+00      0.1000E-01
0.0000E+00      0.2000E-01
0.0000E+00      0.4000E-01
0.0000E+00      0.6000E-01
0.0000E+00      0.8000E-01
0.0000E+00      0.9000E-01
0.0000E+00      0.1000E+00
0.0000E+00      0.5000E+00
0.0000E+00      0.2000E+01
 5         10      0.7525E+01
0.0000E+00      0.0000E+00
0.0000E+00      0.1000E-01
0.0000E+00      0.2000E-01
0.0000E+00      0.4000E-01
0.0000E+00      0.6000E-01
0.0000E+00      0.8000E-01
0.0000E+00      0.9000E-01
0.0000E+00      0.1000E+00
0.0000E+00      0.5000E+00
0.0000E+00      0.2000E+01
 6         10      0.1496E+02
0.0000E+00      0.0000E+00
0.0000E+00      0.1000E-01
0.0000E+00      0.2000E-01
0.0000E+00      0.4000E-01
0.0000E+00      0.6000E-01
0.0000E+00      0.8000E-01
0.0000E+00      0.9000E-01
0.0000E+00      0.1000E+00
0.0000E+00      0.5000E+00
0.0000E+00      0.2000E+01
 7         10      0.1500E+02
0.0000E+00      0.0000E+00
```



```
0.0000E+00      0.1000E-01
0.0000E+00      0.2000E-01
0.0000E+00      0.4000E-01
0.0000E+00      0.6000E-01
0.0000E+00      0.8000E-01
0.0000E+00      0.9000E-01
0.0000E+00      0.1000E+00
0.0000E+00      0.5000E+00
0.0000E+00      0.2000E+01
 8         10      0.1753E+02
0.0000E+00      0.0000E+00
0.0000E+00      0.1000E-01
0.0000E+00      0.2000E-01
0.0000E+00      0.4000E-01
0.0000E+00      0.6000E-01
0.0000E+00      0.8000E-01
0.0000E+00      0.9000E-01
0.0000E+00      0.1000E+00
0.0000E+00      0.5000E+00
0.0000E+00      0.2000E+01
 9         10      0.1996E+02
0.0000E+00      0.0000E+00
0.4717E+00      0.1000E-01
0.9434E+00      0.2000E-01
0.1887E+01      0.4000E-01
0.2830E+01      0.6000E-01
0.3774E+01      0.8000E-01
0.4245E+01      0.9000E-01
0.4717E+01      0.1000E+00
0.4717E+01      0.5000E+00
0.4717E+01      0.2000E+01
10         10      0.2000E+02
0.0000E+00      0.0000E+00
0.4939E+00      0.1000E-01
0.9877E+00      0.2000E-01
0.1975E+01      0.4000E-01
0.2963E+01      0.6000E-01
```

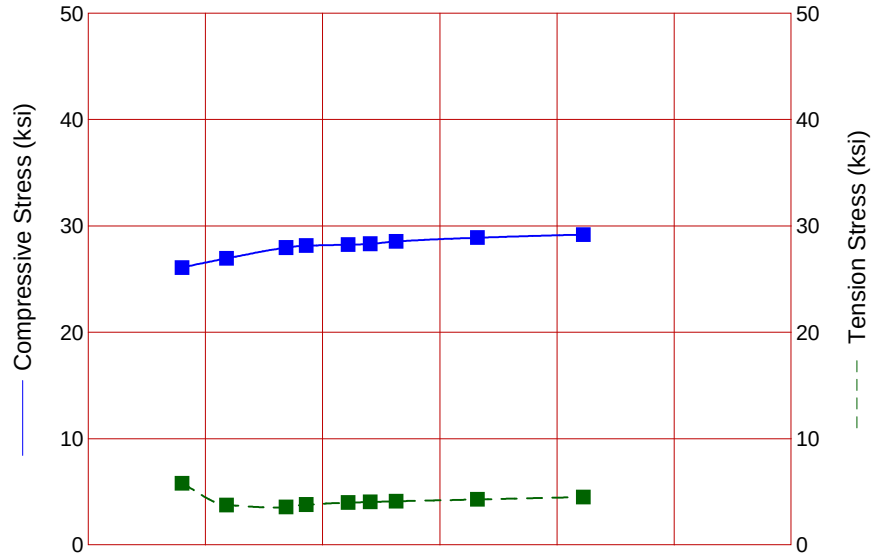
			0.3951E+01	0.8000E-01
			0.4445E+01	0.9000E-01
			0.4939E+01	0.1000E+00
			0.4939E+01	0.5000E+00
			0.4939E+01	0.2000E+01
11	10	0.7003E+02		
			0.0000E+00	0.0000E+00
			0.1867E+01	0.1000E-01
			0.3733E+01	0.2000E-01
			0.7467E+01	0.4000E-01
			0.1120E+02	0.6000E-01
			0.1493E+02	0.8000E-01
			0.1680E+02	0.9000E-01
			0.1867E+02	0.1000E+00
			0.1867E+02	0.5000E+00
			0.1867E+02	0.2000E+01
12	10	0.1200E+03		
			0.0000E+00	0.0000E+00
			0.2590E+01	0.1000E-01
			0.5179E+01	0.2000E-01
			0.1036E+02	0.4000E-01
			0.1554E+02	0.6000E-01
			0.2072E+02	0.8000E-01
			0.2331E+02	0.9000E-01
			0.2590E+02	0.1000E+00
			0.2590E+02	0.5000E+00
			0.2590E+02	0.2000E+01

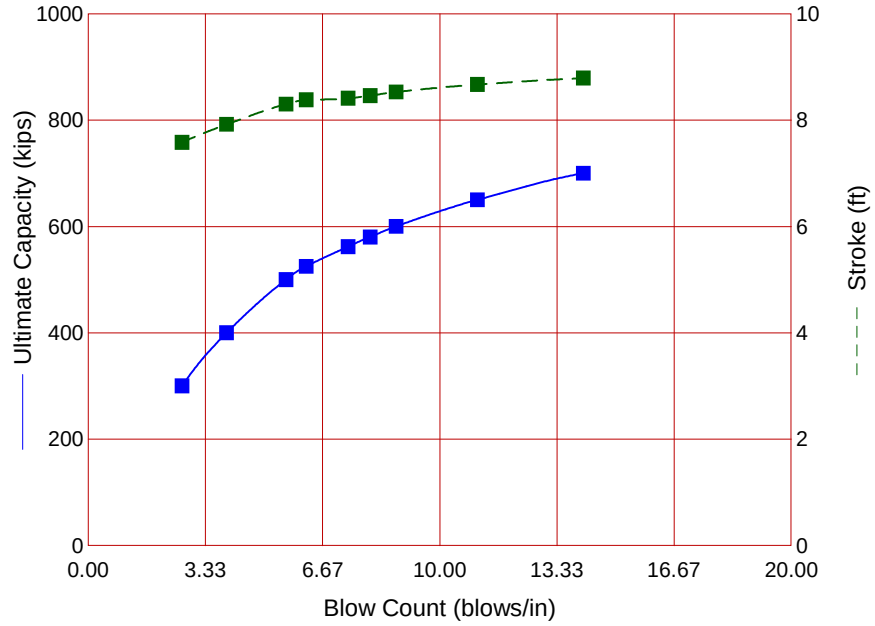
TIP LOAD KIP	TIP MOVEMENT IN.
0.0000E+00	0.0000E+00
0.2601E+01	0.9072E-02
0.5203E+01	0.1814E-01
0.1041E+02	0.3629E-01

0.2081E+02	0.2359E+00
0.3122E+02	0.7620E+00
0.3746E+02	0.1324E+01
0.4162E+02	0.1814E+01
0.4162E+02	0.2722E+01
0.4162E+02	0.3629E+01

LOAD VERSUS SETTLEMENT CURVE
****

TOP LOAD KIP	TOP MOVEMENT IN.	TIP LOAD KIP	TIP MOVEMENT IN.
0.2906E+01	0.2494E-02	0.2868E-01	0.1000E-03
0.2940E+02	0.2514E-01	0.2868E+00	0.1000E-02
0.1494E+03	0.1277E+00	0.1434E+01	0.5000E-02
0.2849E+03	0.2501E+00	0.2868E+01	0.1000E-01
0.6896E+03	0.7642E+00	0.1112E+02	0.5000E-01
0.8173E+03	0.9979E+00	0.1373E+02	0.1000E+00
0.8296E+03	0.1417E+01	0.2603E+02	0.5000E+00
0.8374E+03	0.1930E+01	0.3386E+02	0.1000E+01
0.8452E+03	0.2942E+01	0.4162E+02	0.2000E+01

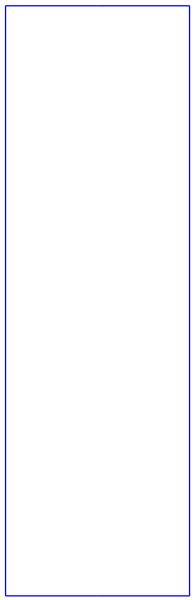




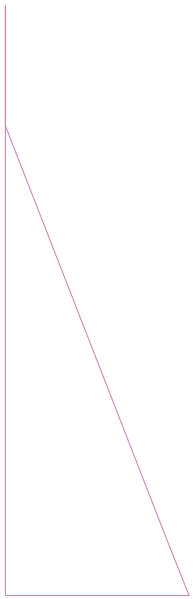
PILECO D19-42

Ram Weight	4.01	kips
Efficiency	0.800	
Pressure	1575 (100%)	psi
Helmet Weight	1.90	kips
Hammer Cushion	60155	kips/in
COR of H.C.	0.800	
Skin Quake	0.100	in
Toe Quake	0.040	in
Skin Damping	0.050	sec/ft
Toe Damping	0.150	sec/ft
Pile Length	98.00	ft
Pile Penetration	78.00	ft
Pile Top Area	26.10	in2

Pile Model



Skin Friction Distribution



Res. Shaft = 85 %
(Proportional)

Ultimate Capacity kips	Maximum Compression Stress ksi	Maximum Tension Stress ksi	Blow Count blows/in	Stroke ft	Energy kips-ft
300.0	26.08	5.79	2.7	7.58	18.46
400.0	26.94	3.75	3.9	7.92	19.13
500.0	27.95	3.56	5.6	8.30	20.01
525.0	28.14	3.79	6.2	8.38	20.20
562.0	28.23	3.98	7.4	8.41	20.21
580.0	28.30	4.04	8.0	8.46	20.33
600.0	28.54	4.11	8.8	8.53	20.50
650.0	28.89	4.28	11.1	8.67	20.82
700.0	29.17	4.50	14.1	8.79	21.09

allowed on the bridge before pouring the abutment diaphragm. In such cases, the Load Factors for Construction Loads shall be taken as per Article 3.4.2 of the *AASHTO LRFD Bridge Design Specifications*.

3.10.7 Superstructure Design Methodology

The connection between the beams and the abutment shall be assumed to be simply supported for superstructure design and analysis. It is recognized that, in some cases, it may be desirable to take advantage of the frame action in the superstructure design by assuming some degree of fixity. This, however, requires careful engineering judgment. Due to the uncertainty in the degree of fixity, frame action shall not be used to reduce design moments in the beams.

3.10.8 Pile Cap and Abutment Diaphragm Design

The superstructure is assumed to transfer moment, and vertical and horizontal forces due to all applicable loads, at the time when the rigid connection with the abutment is achieved. The effects of skew, curvature, thermal expansion of the superstructure, reveal, and grade are considered.

The design provisions below are conservative because the pile cap and the abutment diaphragm are very rigid members, therefore all loads shall be uniformly distributed across the abutment.

For the integral abutments constructed in two stages as specified above, the abutment shall be designed for the following two cases:

1. The pile cap is designed to resist all vertical loads including live load. It is assumed to act as a continuous beam supported by piles. The analysis can be simplified by assuming the pile cap acting as a simple span between piles and then taking 80% of simple span moments to account for continuity. Shears may be taken equal to simple span shears.

2. The entire abutment wall (the combined height of the pile cap and the abutment diaphragm) is designed to resist the earth pressure due to the backfill material, assuming the wall to act as a horizontal continuous beam supported on the girders, i.e., with spans equal to the girder spacing along the skew (if any).

The abutments should be kept as short as possible to reduce the magnitude of soil pressure developed. A minimum of 3'-0" for inspection access shall be provided. A minimum fill cover over the bottom of the abutment of 3'-0" is desirable. It is recommended to have abutments of equal height due to the fact that a difference in abutment heights causes more movements to take place at the shorter abutment. Abutments of unequal height shall be designed by balancing the earth pressure consistent with the magnitude of the displacement at each abutment.

The magnitude of lateral earth pressure developed by the backfill is dependent on the relative wall displacement, δ_T/H, and may be considered to develop between full passive and at-rest earth pressure. The backfill force shall be determined based on the movement-dependent coefficient of earth pressure (K). Results from full scale wall tests performed by UMASS[1] show reasonable agreement between the predicted average passive earth pressure response of MassDOT's standard compacted gravel borrow and the curves of K versus δ_T/H for dense sand found in design manuals DM-7[2] and NCHRP[3]. For the design of integral abutments, the coefficient of horizontal earth pressure when

using compacted gravel borrow backfill shall be estimated using the equation:

$$K = 0.43 + 5.7[1 - e^{-190(\delta_T/H)}]$$

K=0.43+5.7*(1-e^(-190*(0.29"/120")
K=2.52

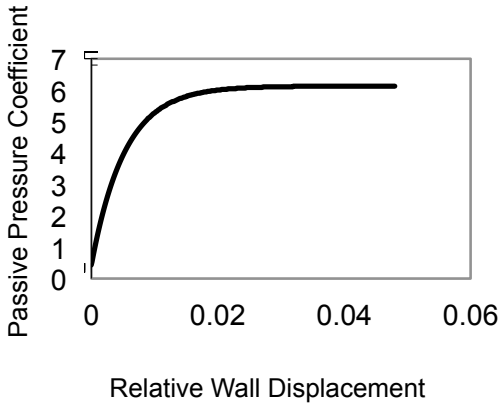


Figure 3.10.8-1: Plot of Passive Pressure Coefficient, K, vs. Relative Wall Displacement, δ_T/H.

The simplified approach may be used to calculate moments and shears in the abutment walls, assuming the abutment wall acting as a simple span between piles and then taking 80% of simple span moments to account for continuity. Shears may be taken equal to simple span shears. Due to the relatively large dimensions of the abutment walls, minimum reinforcement is usually sufficient to satisfy the strength requirements.

The longitudinal reinforcement of the pile cap shown in Chapter 12 of Part II of this Bridge Manual represents an upper–bound for the required reinforcement assuming the girders are located at the positions that produce maximum effects on the pile cap and assuming a conservative value of other dead loads on the abutment wall.

Stirrups intended to resist horizontal shear forces acting on the pile cap due to soil passive pressure shall be provided as shown in Part II of this Bridge Manual.

L-shaped connection reinforcing bars indicated in the standard drawings of Chapter 12 of Part II and Chapter 2 of Part III of this Bridge Manual shall be provided to transfer the maximum expected connection moment between the abutment and the superstructure. These bars shall be #6 @ 9" for girders up to 8 feet deep. For deeper girders they shall be designed. The vertical leg of the connection bars shall be placed as close as practical to the back face of the abutment. The horizontal leg shall be extended into the deck beyond the inside face of the abutment diaphragm at the elevation of the deck top longitudinal reinforcement for a length equal to 10% of the span plus the development length, for simple span bridges. For continuous span bridges the bars shall be extended to 10% of the end span plus the development length.

Refer to Chapter 12 of Part II and Chapter 2 of Part III of this Manual for more information on the integral abutment reinforcement.